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MINNESOTA

May 26, 2017

Dear Librarian,
Enclosed please find a paper copy and electronic copy of the draft environmental impact statement (DEIS) for the Line 3 Pipeline Project and a notice listing the locations of DEIS public meetings in your county.

You are receiving this material because the proposed project traverses this county. Minnesota Rules 4410. 2600 subp. 3 requires the DEIS be available for review in a public library in each county where the proposed project will take place.

Please place this copy in a reference section or provide it upon request for citizens interested in the project. If you have any questions, please contact me.

We appreciate your assistance in assuring the public has the ability to review the document and provide their feedback regarding the adequacy of the document in advance of public meetings.

Sincerely,

Jamie MacAlister, Environmental Review Manager
Minnesota Department of Commerce
Jamie.macalister@state.mn.us
651-539-1775

REVISED

MINNESOTA

REVISED NOTICE OF AVAILABILITY OF DRAFT ENVIRONMENTAL IMPACT STATEMENT AND PUBLIC INFORMATION MEETINGS FOR THE PROPOSED LINE 3 PIPELINE PROJECT

Issued: May 15, 2017

Under the authority of the Minnesota Public Utilities Commission (MPUC), the Draft Environmental Impact Statement (DEIS) for Enbridge Energy's proposed Line 3 Pipeline Project has been made available for public review and comment. At the direction of the MPUC, this DEIS has been prepared by the Minnesota Department of Commerce (Department) in cooperation with the Minnesota Department of Natural Resources (DNR) and the Minnesota Pollution Control Agency (MPCA) to evaluate the potential human and environmental impacts of the proposed Line 3 Project.

The Department is accepting comments on the DEIS through July 10, 2017. Comments may be submitted orally during public meetings scheduled for June 6-22 (see schedule below) or in writing. Substantive comments will be addressed in a Final Environmental Impact Statement (FEIS).

Public Comment Period

Comment Period: Written comments will be accepted through **Monday, July 10, 2017**. Comments may be emailed, mailed, or faxed.

Email address: Pipeline.Comments@state.mn.us

U.S. Mail: Jamie MacAlister, Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 280
St. Paul, MN 55101-2198

Fax: 651-539-0109

Important: Please include the docket numbers CN-14-916 and PPL-15-137 on all comments. Comments will be made available to the public via the MPUC's electronic docketing system (eDockets) and the Department of Commerce's website, except in limited circumstances consistent with the Minnesota Government Data Practices Act. Personally identifying information is not edited or deleted from submissions.

Public Information Meetings

Each public information meeting will provide an opportunity to learn about the information contained in the EIS and provide oral or written comments into record. A court reporter will record all oral comments; comment forms will be available for persons who wish to provide written comments. Each meeting will provide the same opportunity to obtain information and the opportunity to comment.

Public information meetings will be held at the following times and locations:

DATE	TIME	LOCATION
Tuesday June 6, 2017	10:00 AM – 1:00 PM	Rice Lake Community Center 13830 Community Loop Bagley, MN 56621
Tuesday June 6, 2017	6:00 PM – 9:00 PM	IRA Civic Center 1401 NW 3rd Ave Grand Rapids, MN 55744
Wednesday June 7, 2017	10:00 AM – 1:00 PM	Park Rapids High School Cafetorium 401 Huntsinger Ave Park Rapids, MN 56470
Wednesday June 7, 2017	6:00 PM – 9:00 PM	Palace Casino Hotel 16599 69th Ave NW Cass Lake, MN 56633
Thursday June 8, 2017	10:00 AM – 1:00 PM	Downtown Fair Center 107 W 7th Ave Floodwood, MN 55736
Thursday June 8, 2017	6:00 PM – 9:00 PM	Central Lakes College Classroom E54, 501 West College Drive Brainerd, MN 56401
Friday June 9, 2017	11:00 AM – 2:00 PM	Maslowski Wellness & Research Center 17 5th Street Southwest Wadena, MN 56482
Monday June 12, 2017	10:00 AM – 1:00 PM	Grand Casino Hinckley 777 Lady Luck Drive Hinckley, MN 55037

DATE	TIME	LOCATION
Monday June 12, 2017	6:00 PM – 9:00 PM	East Lake Community Center 36666 State Hwy 65 McGregor, MN 56718
Tuesday June 13, 2017	10:00 AM – 1:00 PM	Fond du Lac Tribal and Community College 2101 14th Street Cloquet, MN 55720
Tuesday June 13, 2017	6:00 PM – 9:00 PM	Intercontinental Hotel Saint Paul 11 E. Kellogg Boulevard St. Paul, MN 55101
Wednesday June 14, 2017	11:00 AM – 2:00 PM	Staples Community Center 425 4th Street NE Staples, MN 56479
Wednesday June 14, 2017	6:00 PM – 9:00 PM	Initiative Foundation 405 1st Street Southeast Little Falls, MN 56345
Thursday June 15, 2017	10:00 AM – 1:00 PM	Henry's Catering and Banquet Hall 6774 MN-25 Foley, MN 56329
Thursday June 15, 2017	6:00 PM – 9:00 PM	Phoenix Hotel & Banquet Center 210 MN-23 Milaca, MN 56353
Friday June 16, 2017	10:00 AM – 1:00 PM	The Grand Event Center 2025 Rowland Rd Mora, MN 55051
Tuesday June 20, 2017	10:00 AM – 1:00 PM	Marshall County Central Schools 310 West Minnesota Avenue Newfolden, MN 56738
Tuesday June 20, 2017	6:00 PM – 9:00 PM	Hallock City Hall 163 3rd Street SE Hallock, MN 56728
Wednesday June 21, 2017	10:00 AM – 1:00 PM	Ralph Engelstad Arena Imperial Room 525 Brooks Avenue North Thief River Falls, MN 56701

DATE	TIME	LOCATION
Wednesday June 21, 2017	6:00 PM – 9:00 PM	Plummer Senior Citizen Center 185 Minnesota Street Plummer, MN 56748
Thursday June 22, 2017	10:00 AM – 1:00 PM	Gully Community Center 120 Main Street Gully, MN 56646
Thursday June 22, 2017	6:00 PM – 9:00 PM	Sanford Center and George W. Nielson Convention Center 1111 Event Center Drive NE Bemidji, MN 56601

DEIS Availability

The DEIS can be viewed on the Department's Line 3 website: mn.gov/commerce/energyfacilities/line3.

The DEIS can also be viewed through the MPUC's website: mn.gov/puc. Under the heading *Search Documents or File Here*, select *eDockets* and enter the year and the docket number ("14" and "916" or "15" and "137").

Electronic copies of the DEIS will be available at the public information meetings listed above. Copies on CD can also be requested from Department staff (see contact information below).

Electronic copies of the DEIS will be available for viewing at the following public libraries:

- Hennepin County Library - Minneapolis Central Library, 300 Nicollet Mall, Minneapolis, MN 55401
- Crookston Public Library, 110 N Ash St, Crookston, MN 56716
- Bemidji Public Library, 509 America Ave NW, Bemidji, MN 56601
- Duluth Public Library, 520 W Superior St, Duluth, MN 55802
- Kitchigami Regional Library, 212 Park Ave, Pine River, MN 56474
- Great River Regional Library, 1300 W St. Germain St, St. Cloud, MN 56301
- East Central Regional - Cambridge Public Library, 244 Birch St S, Cambridge, MN 55008
- Fergus Falls Public Library, 205 East Hampden Ave, Fergus Falls, MN 56537
- Montevideo Public Library, 224 S 1st St, Montevideo, MN 56265
- Willmar Public Library, 410 5th St SW, Wilmar, MN 56201

- Blue Earth County Library, 100 E Main St, Mankato, MN 56001
- Rochester Public Library, 101 2nd St SE, Rochester, MN 55904
- Hallock Public Library, 101 1st St E, Hallock, MN 56728
- Godel Memorial Library, 314 E Johnson Ave, Warren, MN 56762
- Thief River Falls Public Library, 102 1st St E, Thief River Falls, MN 56701
- Red Lake Falls Public Library, 105 Champagne Ave SW, Red Lake Falls, MN 56750
- McIntosh Public Library, 115 NW Broadway, McIntosh, MN 56556
- Bagley Public Library, 79 Spencer Ave SW, Bagley, MN 56621
- Park Rapids Area Library, 210 1st St W, Park Rapids, MN 56470
- Wadena City Library, 304 1st St SW, Wadena, MN 56482
- Crosslake Area Library, 14126 Daggett Pine Rd, Crosslake, MN 56442
- McGregor Public Library, 111 E Center Ave, McGregor, MN 55760
- Carlton Public Library, 213 Chestnut Ave, Carlton, MN 55718
- Cass Lake Community Library, 223 Cedar Ave, Cass Lake, MN 56633
- Grand Rapids Public Library, 140 NE 2nd St, Grand Rapids, MN 55744
- Great River Regional Library – Staples Public Library, 122 6th St NE, Staples, MN 56479
- Great River Regional Library – Little Falls Public Library, 108 NE 3rd St, Little Falls, MN 56345
- Foley Public Library, 251 4th Ave N, Foley, MN 56329
- Milaca Community Library, 235 1st St E, Milaca, MN 56353
- Mora Public Library, 200 W Maple Ave, Mora, MN 55051
- Hinckley Public Library, 106 1st St SE, Hinckley, MN 55037
- Wheaton Public Library, 901 1st Ave N, Wheaton, MN 56296
- Morris Public Library, 102 E 6th St, Morris, MN 56267
- Benson Public Library, 200 13th St N, Benson, MN 56215
- Olivia Public Library, 405 S 10th St, Olivia, MN 56277
- Sibley County - Gaylord Public Library, 428 Main Ave, Gaylord, MN 55334
- St. Peter Public Library - Central Library, 601 S Washington Ave, St. Peter, MN 56082
- Le Sueur Public Library, 118 Ferry St, Le Sueur, MN 56058
- Waseca-Le Sueur Library, 408 N State St, Waseca, MN 56093
- Albert Lea Public Library, 211 E Clark St, Albert Lea, MN 56007
- Austin Public Library, 323 4th Ave NE, Austin, MN 55912

Project Description and State of Minnesota Review Process

Enbridge Energy (Enbridge) is proposing to construct a new oil pipeline in Minnesota to replace its existing Line 3 pipeline. Enbridge proposes that the new pipeline follow the existing Line 3 pipeline from North Dakota to the Clearbrook Terminal in Clearwater County, Minnesota. From the Clearbrook Terminal eastward, Enbridge proposes that the pipeline be constructed in a new right-of-way, south of the existing Line 3, ending at an existing terminal in Superior, Wisconsin. Enbridge is proposing that the existing Line 3 pipeline be permanently deactivated and remain in place.

Enbridge's proposed Line 3 project requires two approvals from the MPUC – a certificate of need (CN) and a route permit. Enbridge applied to the Commission for these approvals in April 2015.

The Minnesota Environmental Policy Act (MEPA) requires that an EIS be prepared for major governmental actions that have the potential for creating significant environmental impacts. To fulfill its MEPA responsibilities, the Commission authorized the preparation of a joint EIS that addresses Enbridge's CN and route permit applications. By order of the Commission, the Department is preparing the EIS in cooperation with the DNR and MPCA.

The EIS has been issued in draft form so that it can be improved through public comment. A final EIS will be developed based on comments received on the DEIS.

Upon completion of the final EIS, public hearings will be held in the project area by an administrative law judge (ALJ) from the Office of Administrative Hearings. The hearings will address Enbridge's CN and route permit applications. At the public hearings, citizens will have an opportunity to submit comments, present evidence, and ask questions. After completion of the hearings, the ALJ will submit a report to the Commission with findings of facts, conclusions of law, and recommendations regarding a CN and route permit for the project. Decisions by the Commission on Enbridge's CN and route permit applications are anticipated in the spring of 2018.

How to Learn More

Department of Commerce Line 3 Website: mn.gov/commerce/energyfacilities/line3.

Project Mailing List: Sign up to receive notices about project milestones and opportunities to participate (meetings, comment periods, etc.). Contact docketing.puc@state.mn.us, 651-201-2204, or 800-657-3782 with the docket numbers (14-916 or 15-137), your name, mailing address, and email address.

Subscribe to the Docket: In addition to the project mailing list, interested persons can receive email notification every time new documents are filed in the CN and route permit dockets for this project by signing up at: mn.gov/puc. Under the heading *Email Alerts for New Documents Filed*, select *Subscribe* and follow the prompts.

Full Case Record: See all documents in the record for this project via the Commission's website: mn.gov/puc. Under the heading *Search Documents or File Here* select *eDockets* and enter the year and the docket number ("14" and "916" or "15" and "137").

Project Contacts

Department of Commerce
Jamie MacAlister: Pipeline.Comments@state.mn.us, 651-539-1775 or 800-657-3794
Ray Kirsch: 651-539-1841 or 800-657-3794

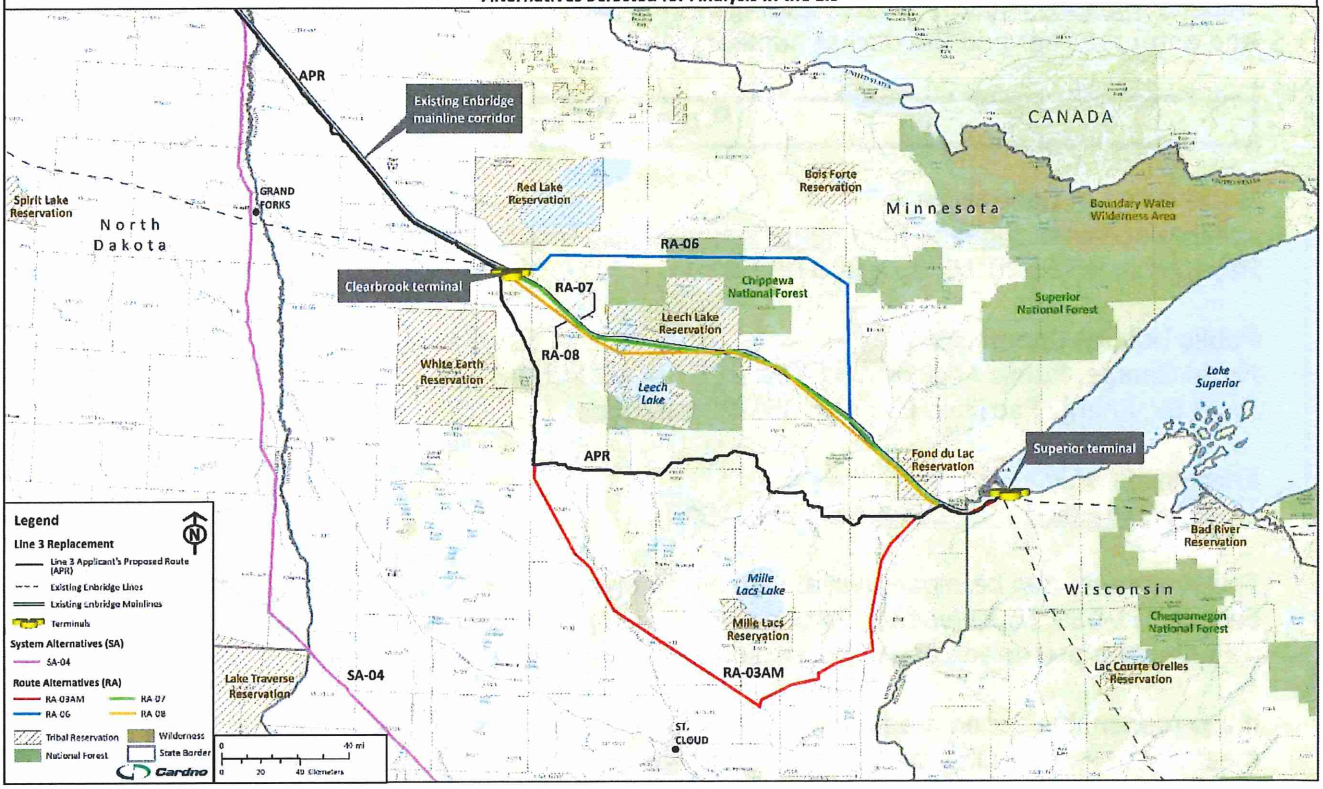
Public Utilities Commission
Kevin George, Public Advisor: 651-201-2251 or 800-657-3782
Scott Ek, Energy Facilities Planner: 651-201-2255

Enbridge Energy
enbridgeinmn@enbridge.com, 855-788-7805

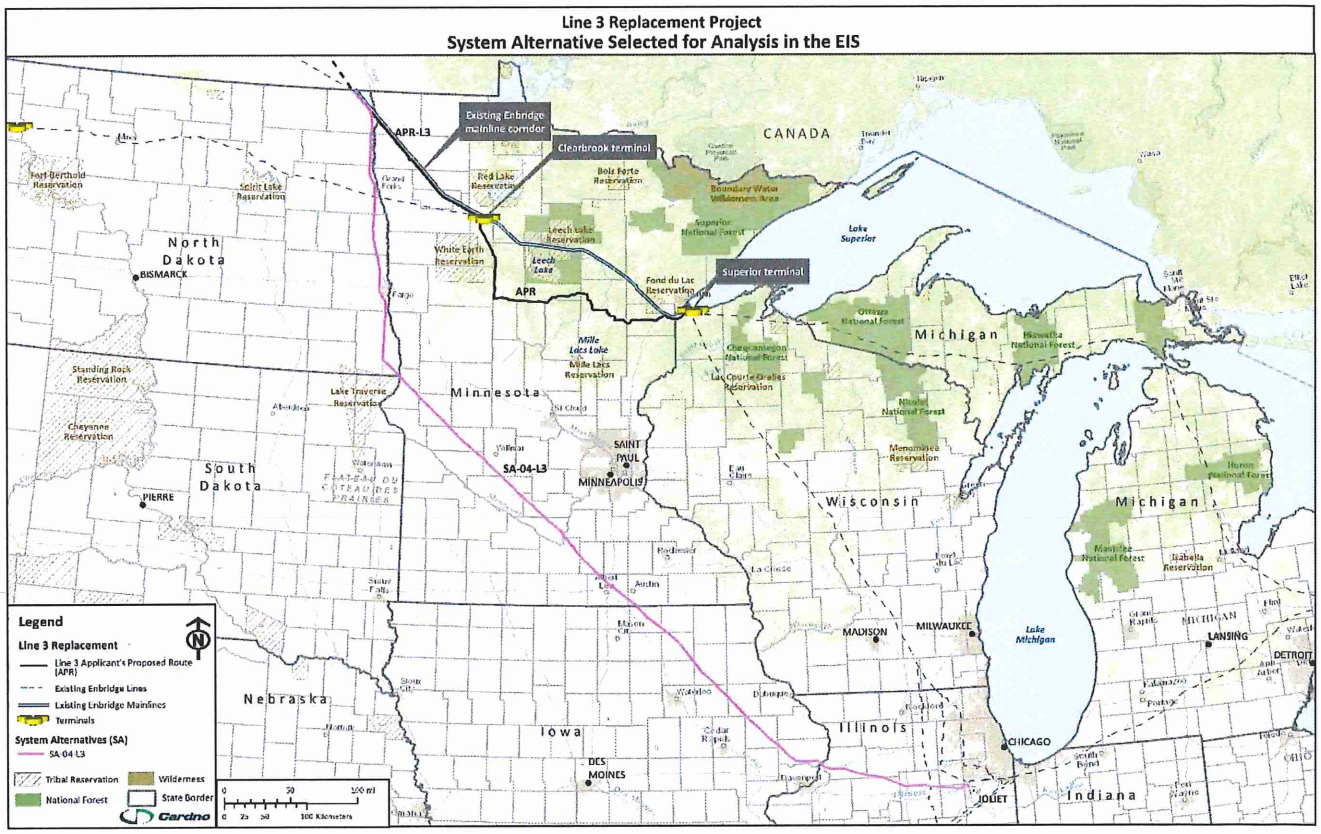
This document can be made available in alternative formats (e.g., large print or audio) by calling 651-539-1530 (voice). Persons with hearing or speech disabilities may call us through their preferred Telecommunications Relay Service.

If any reasonable accommodation is needed to enable you to fully participate in these meetings (e.g., sign language, foreign language interpreter, large print materials), please contact Commerce at 651-539-1530 or 800-657-3794 at least one week in advance of the meeting.

Line 3 Replacement Project
Alternatives Selected for Analysis in the EIS



Line 3 Replacement Project
System Alternative Selected for Analysis in the EIS



This amended page replaces the listing of public information meetings in the print DEIS and the CD version.

Public Information Meetings and Comment Period

This Draft EIS was issued on May 15, 2017. Comments on the Draft EIS will be accepted through July 10, 2017. Public information meetings on the Draft EIS will be held at the following locations and times:

Week of June 5th – June 9th	Week of June 12th – June 16th	Week of June 19th – June 23rd
Tuesday, June 6 10:00 AM – 1:00 PM Rice Lake Community Center 13830 Community Loop Bagley, MN 56621	Monday, June 12 10:00 AM – 1:00 PM Grand Casino Hinckley 777 Lady Luck Drive Hinckley, MN 55037	Tuesday, June 20 10:00 AM – 1:00 PM Marshall County Central Schools 310 West Minnesota Avenue Newfolden, MN 56738
Tuesday, June 6 6:00 PM – 9:00 PM IRA Civic Center 1401 NW 3rd Ave Grand Rapids, MN 55744	Monday, June 12 6:00 PM – 9:00 PM East Lake Community Center 36666 State Hwy 65 McGregor, MN 56718	Tuesday, June 20 6:00 PM – 9:00 PM Hallock City Hall 163 3rd Street SE Hallock, MN 56728
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Minnesota Department of Commerce
Energy Environmental Review and Analysis

Draft Environmental Impact Statement
Line 3 Project

Docket Nos. PPL-15-137/CN-14-916

May 15, 2017

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Line 3 Project Draft EIS Cover Sheet

Responsible Governmental Unit

Minnesota Public Utilities Commission
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Project Applicant

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Houston, Texas 77002
713-821-2000

Enbridge Energy Project Contact
Bobby Hahn
26 East Superior Street, Suite 313
Duluth, MN 55802
218-522-4751

Abstract

Enbridge Energy, Ltd. (Enbridge or Applicant) has proposed to construct and operate 340 miles of new 36-inch-diameter pipeline in Minnesota with an annual average capacity of 760,000 barrels per day (bpd) and to abandon in place 282 miles of the existing 34-inch-diameter, 390,000-bpd operating capacity, Line 3 pipeline (Line 3 Replacement Project or Project). The existing Line 3 pipeline originates in Canada and crosses the U.S.-Canada border near Neche, North Dakota. It continues through North Dakota and Minnesota and terminates at the Enbridge Superior Station and Terminal Facility (Superior terminal) near Superior, Wisconsin. As proposed by Enbridge, the new pipeline would generally parallel the existing Line 3 pipeline along the Enbridge Mainline system right-of-way from the North Dakota-Minnesota border in Kittson County to the Clearbrook terminal in Clearwater County. From Clearbrook to the terminal in Superior, Wisconsin, the proposed pipeline would diverge from the existing Line 3 corridor.

Enbridge's proposed project requires two separate approvals from the Minnesota Public Utilities Commission (Commission) – a certificate of need (CN) and a route permit. The Commission's docket numbers for these approvals are PL9/CN-14-916 and PL9/PPL-15-137.

Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) staff is responsible for conducting environmental review for CN and route permit applications submitted to the Commission. This environmental impact statement (EIS) has been prepared to meet the requirements of both review processes.

This Draft EIS addresses the issues identified in the Department's scoping decision of September 21, 2016. It evaluates the potential impacts of Enbridge's proposed Project and alternatives to the proposed Project, as well as possible mitigation measures for these impacts. The proposed Project route and alternatives to the proposed Project route pass through the following counties in Minnesota: Aitkin, Beltrami, Benton, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Kanabec, Kittson, Marshall, Mille Lacs, Morrison, Pennington, Pine, Polk, Red Lake, St Louis, Todd, and Wadena.

Public Information Meetings and Comment Period

This Draft EIS was issued on May 15, 2017. Comments on the Draft EIS will be accepted through July 10, 2017. Public information meetings on the Draft EIS will be held at the following locations and times:

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	Friday, June 16 10:00 AM – 1:00 PM The Grand Event Center 2025 Rowland Rd Mora, MN 55051	

Additional Information

Following the comment period, the Draft EIS will be revised to incorporate comments, and a Final EIS will be issued. Additional information on the Project is available in the Project application listed in the References chapter of this Draft EIS.

Other material related to this docket is available online at: https://mn.gov//commerce/energyfacilities/line3/ or on the eDockets website at https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showeDocketsSearch&showEdocket=true&userType=public (enter the docket year "14" and number "916" for CN and docket year "15" and number "137" for routing).

This document can be made available in alternative formats (i.e., large print or audio) by calling (651) 539-1530 (voice).

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
°F	Degrees Fahrenheit
AADT	annual average daily traffic
ACS	American Community Survey
ADW	Animal Diversity Web
AEO	Annual Energy Outlook
AMA	Aquatic Management Area
AER	Alberta Energy Regulator
AFF	annual failure frequency
ALJ	administrative law judge
AMA	Aquatic Management Area
ANSI	American National Standards Institute
AOI	area of interest
API	American Petroleum Institute
APP	Agricultural Protection Plan
Applicant	Enbridge Energy
AQI	Air Quality Index
ASME	American Society of Mechanical Engineers
ATWS	additional temporary workspace(s)
bbl	barrel(s)
BCC	birds of conservation concern
BGEPA	Bald and Golden Eagles Protection Act
BIA	Bureau of Indian Affairs

Acronym	Definition
BLM	Bureau of Land Management
BMP	best management practice
BNSF	Burlington Northern Santa Fe
BO	Biological Opinion
bpd	barrels per day
BTEX	benzene, toluene, ethylbenzene, and xylenes
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CN	Certificate of Need
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon-dioxide equivalent
Commission	Minnesota Public Utilities Commission
Control Center	Enbridge Control Center
CSW	construction stormwater
CWA	Clean Water Act
dB	decibel(s)
dBA	A-weighted decibel(s)
dilbit	diluted bitumen
DNR	Department of Natural Resources
DOC-EERA	Department of Commerce, Energy Environmental Review and Analysis
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior

Acronym	Definition
DOS	U.S. Department of State
DPS	distinct population segment
DSDD	Draft Scoping Decision Document
DWSMA	drinking water supply management area
EA	Environmental Assessment
EAW	Environmental Assessment Worksheet
ECD	erosion and sediment control device
ECS	Ecological Classification System
EI	Environmental Inspector
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	Environmental justice
Enbridge	Enbridge Energy (the Applicant)
EPA	U.S. Environmental Protection Agency
EQB	Environmental Quality Board
ERAP	Emergency Response Action Plan
ESA	federal Endangered Species Act
ESRI	Environmental Systems Research Institute
Exponent	Exponent, Inc.
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration

Acronym	Definition
FIRM	Flood Insurance Rate Map
FMA	Fisheries Management Area
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GAP	Gap Analysis Program
GHG	greenhouse gas
GIS	geographic information system
GLIFWC	Great Lakes Indian Fish and Wildlife Commission
GNTL	Great Northern Transmission Line Project
gpd	gallons per day
gpm	gallons per minute
GSOC	Gopher State One-Call
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
HARGIS	Historic Architectural/Archaeological Geographic Information System
HCA	high consequence area
HCAADT	heavy commercial vehicle portion of annual average daily traffic
HCVF	high conservation value forest
HDD	horizontal directional drilling
HHFT	high-hazard flammable train
hp	horsepower
HVTL	high-voltage transmission line
I&M	Illinois and Michigan

Acronym	Definition
IAC	Indian Affairs Commission
IAS	Inventory of Archaeological Sites
IBA	Important Bird Area
IBI	Index of Biotic Integrity
ICP	Integrated Contingency Plan
IHPA	Illinois Historic Preservation Agency
ILCS	Illinois Compiled Statutes
Ill. AC	Illinois Administrative Code
IMP	Integrity Management Plan
IMPLAN	Impact Model for Planning
Iowa AC	Iowa Administrative Code
Iowa DNR	Iowa Department of Natural Resources
IPaC	Information for Planning and Conservation
kg/m^3	kilogram per cubic meter
kV	kilovolt
L_{10}	the dBA that may be exceeded 10 percent of the time within 1 hour
L_{50}	the dBA that may be exceeded 50 percent of the time within 1 hour
LBS	Lakes of Biological Significance
LCM	lost circulation material
L_{dn}	day-night sound level
$L_{eq(24)}$	24-hour equivalent sound level
LGUs	local units of government
MBS	Minnesota Biological Survey
MBS Site	Minnesota Biological Survey Site of Biodiversity Significance

Acronym	Definition
MBTA	Migratory Bird Treaty Act
MEPA	Minnesota Environmental Policy Act
MERLA	Minnesota Environmental Response and Liability Act
mg/L	milligrams per liter
mgd	million gallons per day
MGS	Minnesota Geological Survey
MHS	Minnesota Historical Society
MIAC	Minnesota Indian Affairs Council
Minn. R.	Minnesota Administrative Rules
Minnesota BWSR	Minnesota Board of Water and Soil Resources
Minnesota DA	Minnesota Department of Agriculture
Minnesota DH	Minnesota Department of Health
Minnesota DNR	Minnesota Department of Natural Resources
Minnesota DPS	Minnesota Department of Public Safety
Minnesota PCA	Minnesota Pollution Control Agency
MLRA	major land resource area
MLV	mainline valve
mm	millimeter
MMcf/d	million cubic feet per day
mm^2/s	square millimeters per second
MNDOT	Minnesota Department of Transportation
MnOPS	Minnesota Office of Pipeline Safety
MP	milepost
MPL	Minnesota Pipe Line Company

Acronym	Definition
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NATHPO	National Association of Tribal Historic Preservation Officers
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDAC	North Dakota Administrative Code
NDCC	North Dakota Century Code
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NETL	National Energy Technology Laboratory
NFIP	National Flood Insurance Program
NHIS	Natural Heritage Information System
NHPA	National Historic Preservation Act
NLCD	National Land Cover Database
NLF	Northern Lakes and Forests
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
North Dakota DH	North Dakota Department of Health
North Dakota PR	North Dakota Parks and Recreation Department
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRDA	Natural Resource Damage Assessment
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory

Acronym	Definition
NRS	National Response System
NSPS	New Source Performance Standards
NTSB	National Transportation Safety Board
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
OAH	Office of Administrative Hearings
OFCVO	Office of Freight and Commercial Vehicle Operations
OPA 90	Oil Pollution Act of 1990
ORV	Outstanding Resource Value
ORVW	Outstanding Resource Value Waters
OSA	Office of the State Archaeologist
OSLTF	Oil Spill Liability Trust Fund
PAD-US	Protected Areas Database of the United States
PAH	polyaromatic hydrocarbons
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIG	pipeline inspection gauge
PM	particulate matter
PM-10	suspended particulate matter less than or equal to 10 microns in diameter
PM-2.5	suspended particulate matter less than or equal to 2.5 microns in diameter
PPE	personal protective equipment
PPV	peak particle velocity
PREP	National Preparedness for Response Exercise Program
PSD	Prevention of Significant Deterioration
psig	pounds per square inch gauge

Acronym	Definition
PW	Public Waters
PWS	Public Water Supply
RA-03AM	Route Alternative RA-03AM
RA-06	Route Alternative RA-06
RA-07	Route Alternative RA-07
RA-08	Route Alternative RA-08
RFAs	reasonably foreseeable actions
ROI	region of interest
RRT	Regional Response Team
RSA	route segment alternative
SA-04	System Alternative SA-04
SCADA	Supervisory Control and Data Acquisition
SCC	social cost of carbon
SDS	State Disposal System
SFHA	special flood hazard area
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Officer
SHSND	State Historical Society of North Dakota
SMPE	South Mist Pipeline Extension
SMS	Scenic Management System
SNA	Scientific and Natural Area
SO_2	sulfur dioxide
SPCC	Spill Prevention, Containment, and Control
SSURGO	Soil Survey Geographic Database

Acronym	Definition
STB	Surface Transportation Board
SWPPP	Stormwater Pollution Prevention Plan
TASC	Technical Assistance Services for Communities
TCP	Traditional Cultural Property
THPO	Tribal Historic Preservation Officer
TMDL	total maximum daily load
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VdB	vibration velocity decibels
VOC	volatile organic compound
WAN	Wildlife Action Network
WCA	Wetland Conservation Act
WCSB	Western Canadian Sedimentary Basin
WHAF	Watershed Health Assessment Framework
WHS	Wisconsin Historical Society
WIMN	What's in My Neighborhood
WMA	Wildlife Management Area
WPA	Wellhead Protection Area

Acronym	Definition
WRAPS	Watershed Restoration and Protection Strategy
yard	material/pipe storage yard

Executive Summary

THE PROJECT

What is the Line 3 Project?

Enbridge Energy, Limited Partnership (Enbridge) has submitted applications to the Minnesota Public Utilities Commission (Commission) to construct a new 340-mile, 36-inch-diameter pipeline in northern Minnesota to replace the aging 282-mile, 34-inch Line 3 oil pipeline. Line 3 is part of Enbridge's extensive Mainline system. Enbridge is proposing to abandon the existing Line 3 pipeline in place. (Figure ES-1 shows the existing Mainline system and Enbridge's proposed route for the new Line 3.)

Enbridge's Mainline system currently ships an estimated 2.9 million barrels of crude oil across northern Minnesota each day. The Minnesota portion runs from the Canadian border to a terminal in Clearbrook, Minnesota, and then on to Superior, Wisconsin. At the Clearbrook terminal, Enbridge transfers approximately 400,000 barrels per day to the Minnesota Pipe Line Company, which supplies the oil to the two petroleum refineries in the Twin Cities. Nearly all the heavy crude oil refineries in the Upper Midwest receive a portion of their oil, either directly or indirectly, from the Enbridge Mainline system.

The existing Line 3 pipeline has operated for approximately 50 years. It requires extensive maintenance and is currently restricted to a capacity of 390,000 barrels of crude oil per day. Enbridge's proposed new 36-inch-diameter pipeline would be capable of carrying up to 760,000 barrels of Canadian heavy crude oil per day, which was the original design capacity of the existing Line 3.

As proposed by Enbridge, the new Line 3 pipeline would generally parallel the existing Line 3 from the North Dakota-Minnesota border (in Kittson County) to the Clearbrook terminal in Clearwater County.

Between Clearbrook and Superior, Wisconsin, however, the proposed route moves outside the existing Mainline corridor. From Clearbrook, the proposed route first runs parallel to the Minnesota Pipe Line Company pipeline system to approximately Park Rapids, where it turns east and runs parallel to an existing high-voltage transmission line for 92 miles. Then it follows new right-of-way into Superior, Wisconsin. As shown in Figure ES-1, the existing six-pipeline Mainline crosses the Leech Lake Indian Reservation and the Fond du Lac Indian Reservation. Enbridge's proposed route for the new Line 3 avoids crossing the Leech Lake and Fond du Lac reservations but does cross a disputed section of the White Earth Indian Reservation, as well as ceded territory that tribal members value for wild rice, hunting, and fishing.

Chapter 2 provides a detailed description of the proposed Line 3 Replacement Project (Project), construction methods, and the measures Enbridge proposes to avoid or reduce potential environmental effects.

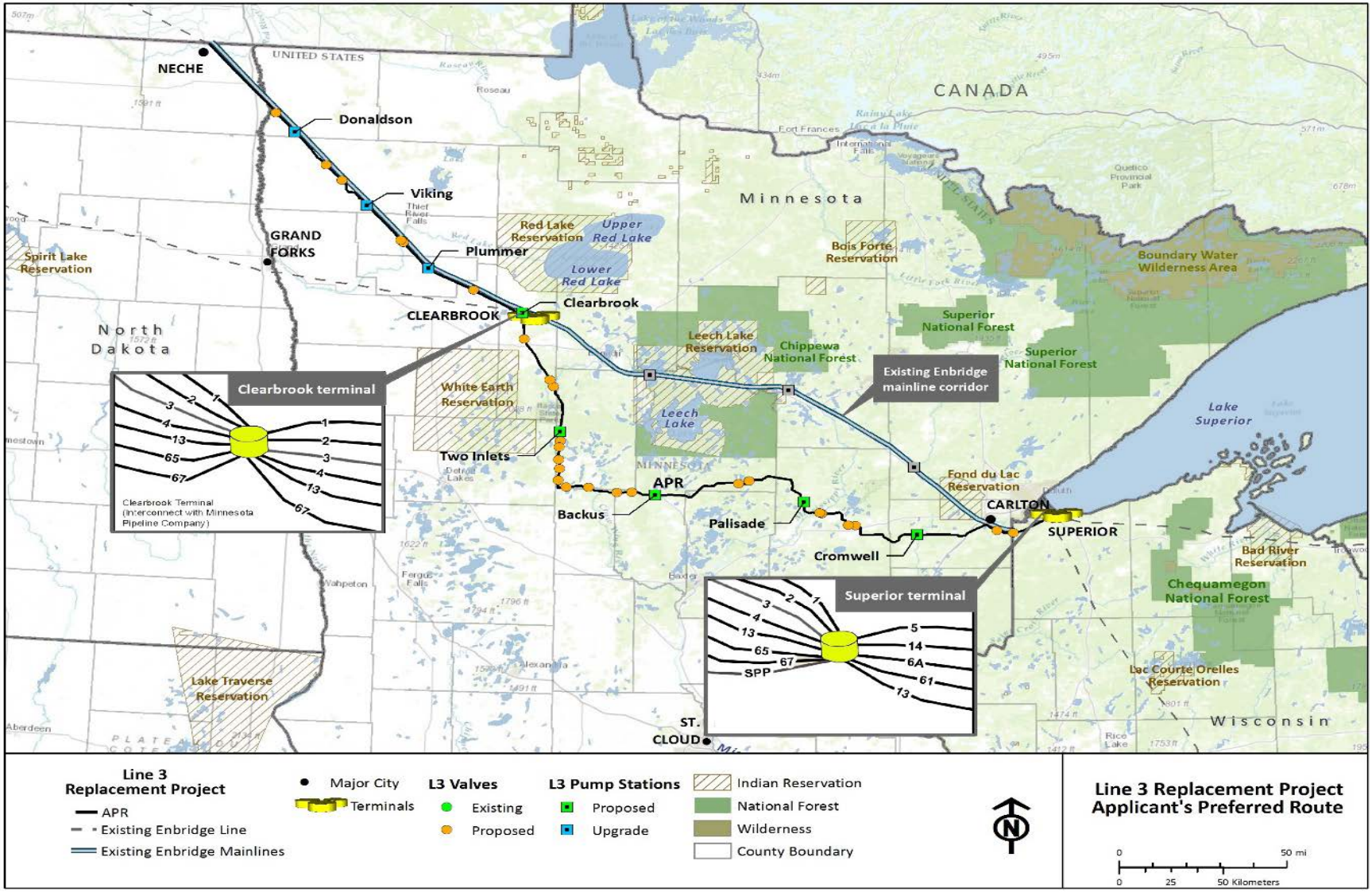

Figure ES-1. Overview of the Applicant's Preferred Route for the Line 3 Replacement Project

THE ENVIRONMENTAL IMPACT STATEMENT

What is the purpose of this Environmental Impact Statement?

The Minnesota Environmental Policy Act requires that "Where there is potential for significant environmental effects resulting from a major governmental action, the action shall be preceded by a detailed environmental impact statement." In this case, the "governmental action" includes two separate but related decisions by the Commission:

1. Whether to issue a Certificate of Need (CN).

2. Whether to issue a route permit for the Project, and if so, with what conditions.

In addition, Enbridge needs numerous other state and federal approvals before it can build the Project.

Therefore, the purpose of and need for this Environmental Impact Statement (EIS) is to help inform the Commission's decisions by evaluating the potential human and environmental effects of permitting the proposed Project, considering reasonable alternatives, and exploring methods for reducing adverse effects. In addition to the Commission, other permitting agencies, the public, and Enbridge can use the information in the EIS.

What decision-makers will use this EIS?

The Commission will use the EIS to help it decide whether to issue a CN and route permit. Other state and local agencies with permitting authority over the project will also use the EIS. Chapter 3 describes the Commission's process and summarizes the other federal, tribal, state, and local permits and approvals.

The Line 3 Project will also require permits from federal agencies, most notably the U.S. Army Corps of Engineers. Federal agencies must consider potential environmental impacts under the National Environmental Policy Act (NEPA). The federal agencies required to make decisions about the proposed Project may also use this EIS to inform their decisions or may prepare their own environmental review documents.

Who prepared the EIS?

The Commission must complete environmental review of the project before deciding whether to issue the CN or the route permit. The Commission has ordered an EIS for the CN and route permit applications, to be prepared by the Minnesota Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) in consultation with the Commission's Executive Secretary, and with assistance from the Minnesota Department of Natural Resources (Minnesota DNR) and Minnesota Pollution Control Agency (Minnesota PCA).

What is a Certificate of Need, and how will "need" be determined?

The first approval Enbridge must obtain is a CN. As its name indicates, the CN is a decision by the Commission about whether a proposed project is in the State's interest.

The Commission must consider each of the criteria in Minnesota Statutes § 216B.243 and Minnesota Administrative Rules Part 7853.0130 in determining need. Under the regulatory criteria, the Commission

first considers the underlying economic need for the proposed pipeline. This analysis, conducted by parties in a contested case hearing, will aid the Commission in making this evaluation. Then, if the Applicant establishes the underlying need, the environmental and socioeconomic analysis in the EIS will help the Commission weigh the advantages and disadvantages of alternative ways of meeting the need and decide whether to issue a CN for the proposed Project.

For the CN decision, the Commission has three options: (1) issue the CN for the Project as proposed; (2) deny the CN; or (3) issue a CN contingent on modifications.[1]

What alternatives were considered in the EIS for the Certificate of Need decision?

Minnesota's regulations require that the EIS evaluate the environmental consequences of the "No Action" Alternative. In this case, a Commission decision to deny the CN is the "No Action" Alternative.

If the Commission denies the requested CN, the Applicant (or entities other than the Applicant) could reasonably be expected to meet shipper demand for the oil through other means, such as a different pipeline system, or by train or truck.

Therefore, in analyzing the No Action Alternative, this EIS must consider the human and environmental impacts associated with denying the CN, including a variety of CN Alternatives that correspond to each of the decision criteria. Table ES-1 provides an overview of the alternatives evaluated in the EIS for the CN decision and illustrates how the alternatives evaluated in the EIS align with the four major need-related criteria in the regulations.

As indicated in Table ES-1, the No Action Alternative could not only lead to continuing operation of the existing Line 3 but also to other outcomes. The CN section of the EIS therefore evaluates the impact of approving the CN and the following potential outcomes of denying the CN:

1. Continued use of existing Line 3.
2. Use of other pipelines.
3. System alternative SA-04 (a conceptual new pipeline that would deliver oil directly to Joliet, Illinois, bypassing Clearbrook and Superior).
4. Use of rail as an alternative mode of transport.
5. Use of trucks as an alternative mode of transport.
6. Continued use of existing Line 3 supplemented by rail.
7. Continued use of existing Line 3 supplemented by truck.

Figure ES-2 shows the location of the existing Line 3, likely routes for the rail and truck alternatives, and an alternative pipeline system (system alternative SA-04).

[1] Minn. R. 7853.0800.

Table ES-1. Certificate of Need Alternatives and Criteria

Commission's Decision	Would denial adversely affect future adequacy, reliability, or efficiency of energy supply?	If yes, is there a more reasonable and prudent alternative, such as different endpoints or a different transport method?	If yes, are the consequences to society of granting the CN more favorable than denial? Does the project comply with other laws?	Certificate of Need Alternatives Evaluated for Environmental Impacts	
	Minnesota Administrative Rules Part 7853.0130 A	**Minnesota Administrative Rules Part 7853.0130 B**	**Minnesota Administrative Rules Part 7853.0130 C, D**		
Certificate of Need not granted (CN Alternatives)	No Keep using existing Line 3	--	--	**CN Alternative 1** Continued use of existing Line 3	Line 3 operates at existing capacity, no supplemental oil transportation.
	Yes	Yes Use a different pipeline system	--	**CN Alternative 2** Other pipelines	Other pipelines transport up to 760,000 barrels per day (bpd)
				CN Alternative 3 System alternative SA-04	SA-04 transports up to 760,000 bpd
		Yes Use a different oil transportation mode		**CN Alternative 4** Transportation by rail	Trains transport up to 760,000 bpd
				CN Alternative 5 Transportation by truck	Trucks transport up to 760,000 bpd
	Yes	Yes	No. The consequences to society of granting the CN are not more favorable than denying it	**CN Alternative 6** Existing Line 3 supplemented by rail	Line 3 operates at existing capacity; trains used to transport up to 370,000 additional bpd to market
				CN Alternative 7 Existing Line 3 supplemented by truck	Line 3 operates at existing capacity; trucks used to transport up to 370,000 additional bpd to market
Certificate of Need granted	Yes	Yes	Yes	Applicant's proposed Project	CN granted for the proposed Project or for a modified project (e.g., a new lower-capacity pipeline)

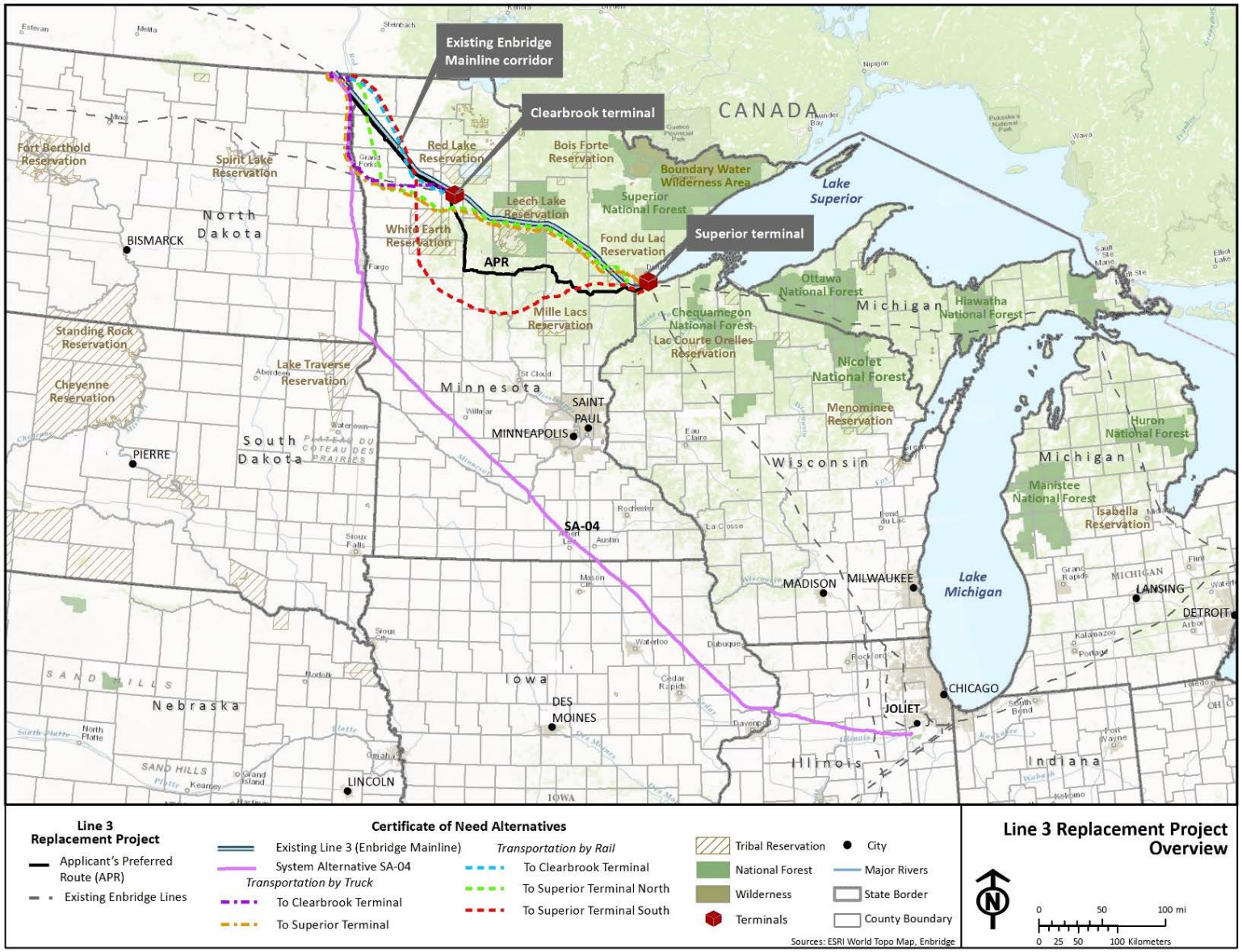

Figure ES-2. Certificate of Need Alternatives

What is a route permit and how will the route be determined?

In addition to deciding whether to issue a CN, the Commission then must decide whether to issue a pipeline route permit. The route permit is the Commission's approval to build the pipeline within a specific alignment and route width between two end points. Enbridge has identified its preferred 750-foot-wide route width and has identified a preferred alignment within this area (the Applicant's preferred route) (see the Applicant's preferred route in Figure ES-1).

The Commission cannot issue a route permit unless it first issues a CN. Enbridge has asked for approval to use a 120-foot-wide area to support construction activities and a 50-foot-wide permanent right-of-way once construction is complete. The permanent right-of-way allows Enbridge to monitor the pipeline and to conduct maintenance activities as required.

During the EIS scoping process, state agencies and citizens proposed alternative routes for the pipeline between Clearbrook and Carlton. The Commission approved four alternative routes to evaluate in this EIS. Chapter 4 describes these route alternatives. If the Commission issues a CN, it will compare the routes and determine which route to approve based on regulatory routing criteria. These criteria include the effects on human settlements, environmental resources, cultural resources, economics and cost, the amount of co-location with other infrastructure, and compliance with permitting requirements (Minn. R. 7853.1900, Subp. 3.)

Following a formal administrative contested case hearing on both the CN and route permit decisions, the Commission can approve Enbridge's proposed route or one of the alternatives if the Commission determines that an alternative route is in the best interest of the State. The Commission's route permit would confer the right of eminent domain on Enbridge should Enbridge need it to acquire the easements to build the Project. Chapter 3 describes the regulatory process. Chapter 4 describes the alternatives evaluated for the CN decision and the route permit decision.

How do the tribal and federal approvals affect the route decision?

Any routing option within the existing Mainline corridor (and some other routes) would require Enbridge to obtain permanent right-of-way across a large area of federal and state public lands and two American Indian reservations. Enbridge would need to acquire its permanent right-of-way in these locations through amicable agreements with tribal or federal landowners because it cannot use eminent domain to acquire a pipeline right-of-way across these lands.

Enbridge has constructed pipelines through these areas in the past, going back to 1949 when it installed the first line from Canada to Superior, Wisconsin. Since then, Enbridge has completed several projects within the Enbridge Mainline right-of-way in Minnesota, which crosses the Chippewa National Forest, state public lands, and the Leech Lake and Fond du Lac Reservations. In its permit applications for Line 3, however, Enbridge maintains that the ability to obtain limited-term permits and easements is too uncertain.

During the EIS scoping process, however, some commenters requested that the option of installing the new pipeline within the existing Mainline corridor be evaluated in the EIS. These commenters seek to avoid opening a new oil pipeline corridor across northern Minnesota, which would be required for part of Enbridge's proposed route.

What route alternatives are the Commission considering?

The Commission approved the route alternatives (RAs) included for evaluation in the EIS for the route permit. They include RA-03AM, the most southerly route; RA-06, the most northerly route; and RA-07 and RA-08, which generally follow the existing Enbridge pipeline corridor from Clearbrook to Carlton. RA-07 represents the option of installing the new Line 3 in the same trench as the existing Line 3. Figure ES-3 shows the route alternatives.

Are there other shorter route variations under consideration?

Yes. State agencies and the public proposed changes to Enbridge's proposed route during the EIS scoping process in order to avoid impacts or the threat of impacts on specific resources or other conflicts. Figure ES-3 shows the general locations of the route segment alternatives (RSAs). Most are relatively short; two, however, are more than 50 miles long.

Chapter 7 compares 24 individual RSAs to the segments of the Applicant's preferred route they would replace. Chapter 7 also analyzes a stand-alone segment: RSA-53. RSA-53 connects to RSA-21, making it possible for RA-06, RA-07, and RA-08 to avoid the Fond du Lac Reservation. Chapter 7 highlights the important variations between RSA-53 and the segment of the Applicant's preferred route it would replace.

CONSULTATIONS AND PUBLIC INVOLVEMENT

What was the role of federal agencies, tribal governments, and state and local governments in preparing the EIS; and how will they be involved in the final decision?

In addition to the Commission's CN and route permit, a number of other permits and approvals from different federal, state, and tribal jurisdictions will be required for the Project. A list of the possible "downstream" permits and approvals that might be required, depending on the specific route approved, is included in Chapter 3. At the federal level, for example, a U.S. Army Corps of Engineers permit must be obtained for construction across wetlands and at stream and river crossings. A special-use permit must be obtained from the U.S. Forest Service if the approved route crosses U.S. Forest Service land. State and federal agencies have participated in monthly conference calls for over a year, but these agencies have not been directly involved in preparing the EIS.

Enbridge would need tribal approval for the route to cross reservations. And if the approved route were to cross tribal trust lands or lands under the jurisdiction of the Bureau of Indian Affairs, right-of-way easements would be required from these entities.

Department of Commerce staff and management have met with northern Minnesota tribal staff and completed formal government-to-government tribal consultations. Chapter 9 summarizes these efforts. Several tribes provided input on Chapter 9 (Tribal Resources) and on Chapter 11 (Environmental Justice).

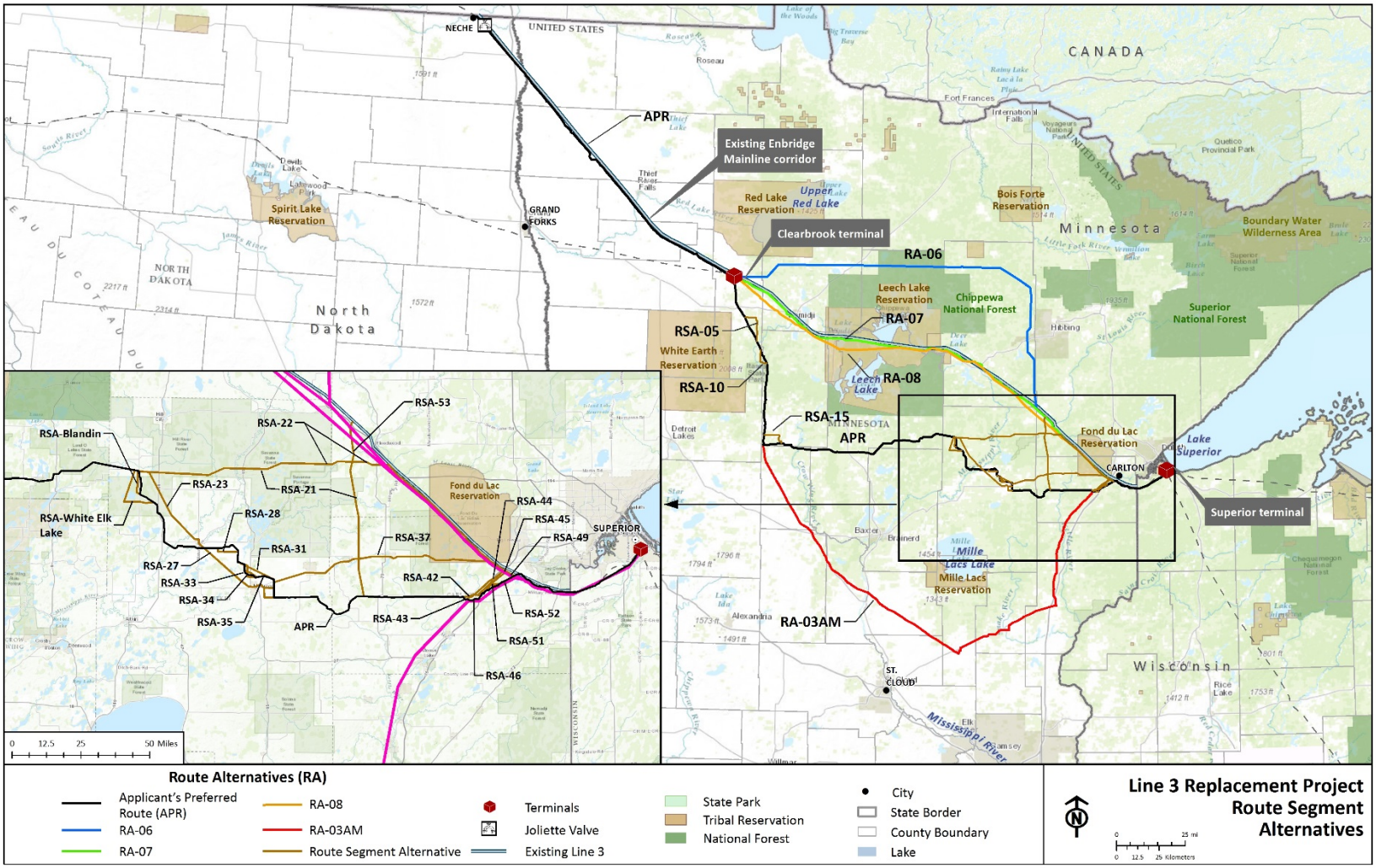

Figure ES-3. General Location of Route Alternatives and Route Segment Alternatives

How is the public involved in preparing the EIS, and how will they be involved in the final decision?

The EIS process and the Commission's decision-making process for the CN and route permit include four separate opportunities for public input and review. Chapter 3 includes a summary of the EIS scoping process. Other opportunities for public participation include:

- **Public Review and Comments on Draft EIS** – Release of the Draft EIS for public review and comment will start an 8-week period during which the public, agencies, and tribes will have an opportunity to comment on the Draft EIS. This period will include 3 weeks of public information meetings. Based on the comments, appropriate changes or additions to the Draft EIS will be made as part of the process of preparing a Final EIS. A response to each comment received will also be prepared.
- **Public Review and Comments on Final EIS –** Upon release of the Final EIS, the public, agencies, and tribes will have another opportunity to comment on whether the Final EIS has adequately complied with the requirements of the Minnesota Environmental Policy Act.
- **Public Comments at Commission Public Hearing** – As part of its deliberation on the CN and route permit applications, the Commission will have a contested case hearing to receive input from the public.

MAJOR ISSUES FOR THE CERTIFICATE OF NEED DECISION

The CN section of the EIS compares the environmental impacts of the Applicant's proposed Project to those of other alternatives, including:

- The Applicant's proposed pipeline to Superior, Wisconsin.
- Continued use of existing Line 3;
- Transport by train;
- Transport by truck; and
- System alternative SA-04, a conceptual pipeline to Illinois that bypasses Clearbrook and Superior.

The CN analysis in the EIS provides environmental information to aid the Commission in evaluating alternatives to the Applicant's proposed Project. Several key issues emerged:

- What are the advantages and disadvantages of continuing to use existing Line 3?
- How are the risks of accidental oil release different for pipelines, trains, and rail?
- What are the impacts of the CN Alternatives on high-quality water resources?
- Will the proposed Project damage forests and wildlife habitat in northern Minnesota more than other alternatives?
- Will shipping the oil by rail or truck affect movement of other commodities?
- What are the greenhouse gas (GHG) and climate change implications?

What are the advantages and disadvantages of continuing to use existing Line 3?

The January 2017 revised Consent Decree entered between Enbridge and the U.S. Department of Justice on behalf of the U.S. Environmental Protection Agency and the U.S. Coast Guard (81 Federal Register 62536) provides a framework to allow ongoing operation of the existing Line 3.[2] While this framework would require heightened integrity work and progressive decreases in operating pressure, continued operation of existing Line 3 is not impossible. The advantages and disadvantages of continuing to use existing Line 3 are evaluated in Chapter 5 of the EIS.

The primary benefits of continuing to use existing Line 3 instead of constructing the Applicant's proposed Project are that continuing to use existing Line 3 avoids:

- Impacts and risks of opening up a new oil pipeline corridor, and
- Impacts associated with construction of a new pipeline.

A significant portion of the Applicant's proposed Project would be located outside the existing Mainline corridor, causing habitat fragmentation and expanding the total acreage of land and resources exposed to the risk of a potential accidental release from a pipeline. Continued use of existing Line 3 avoids these impacts. Continued use of existing Line 3 also avoids the construction impacts associated with clearing a 120-foot-wide right-of-way and trenching hundreds of miles across Minnesota.

Continuing to use the existing Line 3 has drawbacks, however, including:

- Ongoing direct impacts on tribal communities as it passes through both the Leech Lake and Fond du Lac reservations, and
- Integrity issues that have arisen as the pipeline has aged and its coating has deteriorated.

Existing Line 3 goes through both the Leech Lake and Fond du Lac reservations. The existing Mainline was constructed decades ago. As a result, it was not subject to state or federal environmental review or state procedures for CN and route permitting, and did not consider environmental justice issues. Tribal members who submitted comments during this EIS process and provided input for this Draft EIS reported that all of the proposed routes, including either keeping the current Line 3 in place or abandoning it, would add to the negative mental, spiritual, and physical health impacts already disproportionately suffered by American Indian populations.[3]

In addition, Line 3 is old and has integrity problems. Built in 1962 and 1963, Line 3 has corroded and cracked, necessitating more than 950 excavations in the last 16 years. Line 3 uses a coating, popular at the time, which tends to dis-bond from the pipe. Line 3 has had 10 times as many anomalies per mile as any other pipeline in the Mainline corridor. The pipe was also flash welded, which makes it more susceptible to defects. Line 3 thus requires an extensive amount of extra maintenance, and the intensity of the maintenance program to maintain pipeline safety would continue to increase. Since 1990, Line 3 has experienced 15 failures that released more than 50 barrels of oil during each incident, with seven of

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2 United States of America v. Enbridge Energy, Limited Partnership, Draft Revised Following Public Comment available at: https://www.epa.gov/enbridge-spill-michigan/revised-enbridge-consent-decree.

3 See Brave Heart, M.Y.H. (2011). Welcome to Takini's historical trauma. Historical Trauma. Retrieved from http://historicaltrauma.com/" Historical trauma describes multigenerational trauma experienced by American Indians because of continuous subjection to trauma, poverty, dislocation, war, as cumulative and collective.

these failures occurring in Minnesota. Enbridge's use of pressure restrictions, intensive monitoring, and an extensive dig and repair program are so far preventing further releases. The program has required substantial investment, with no feasible technology or operational changes that can arrest or reverse the external corrosion on Line 3 or remove the defects that were inherent in the way the pipe was manufactured. Maintenance and repair activities and disturbance from successive integrity digs would continue to increase over time.

How are the risks of accidental oil release different for pipelines, trains, and rail?

The risks posed by an accidental release are a function of a number of factors, including:

- The likelihood of an accidental release incident;
- The size and trajectory of the accidental release incident if one occurs; and
- The types and distribution of resources exposed along a pipeline, rail, or truck route.

Trucks and trains are more likely than pipelines to have small to medium accidents and spills. This is because the number of transits required to transport crude oil is large, which increases the risk of human error. Tanker trucks also use major roadways and therefore present a greater risk of injuring or killing personnel or members of the public. Pipelines are less likely to have spills, but the amount of a pipeline spill is likely to be greater. Figure ES-4 shows the average annual incident rate for different transportation modes.[4]

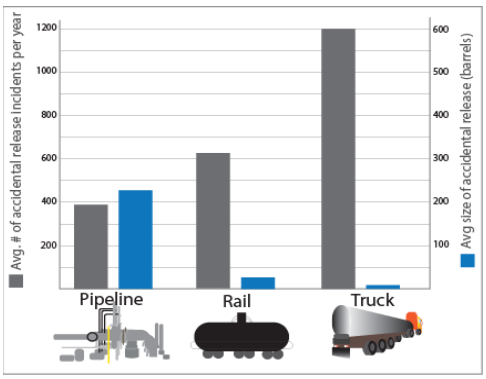


Figure ES-4. Annual Average Number of Incidents for Hazardous Materials Transport and Average Incident Size

Length is a key component in calculating the probability of pipeline failure because a longer pipeline has a greater area that could be exposed to the primary pipeline threats, such as third-party damages, construction defects, manufacturing defects, corrosion, and equipment (e.g., valve) failure. In general, longer pipelines pose a greater total risk of incident.

Even though the risk of an event occurring is higher for trains and trucks, the size of the release, if an incident occurs, is typically much smaller because the volume of a tanker truck or train car is smaller. The average release of crude oil from a truck incident is 16 barrels (687 gallons); from a train incident, 40 barrels (1,688 gallons); and from a pipeline incident, 462 barrels (19,412) gallons.

The CN Alternatives cross a wide range of habitats and conditions, including a variety of land uses, human uses, and ecosystems. Each alternative therefore differs in terms of the types and distribution of resources exposed. Table ES-2 illustrates the resources within specific distances of each CN Alternative.

[4] Average number of hazardous material (49 CFR 171.15, 171.16 [Form F 5800.1]) transport incidents based on Pipeline and Hazardous Materials Safety Administration data. Average number of rail incidents per year based on data spanning the period 2007–2017. Average number of truck incidents per year based on data spanning the period 2007–2017. Average number of pipeline incidents per year based on data spanning the period 2010–2017

Table ES-2. Summary of Potentially Exposed Resources of Concern from an Unanticipated Release of Crude Oil along the Applicant's Proposal and Certificate of Need Alternatives (acres)

Resources of Concern	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
HCA populated areas	10,959.8	25,697.9	25,128.7	41,579.2	44,431.8	67,277.1	70,129.6
HCA unusually sensitive ecological areas	12,318.0	27,527.8	20,378.4	27,578.6	37,272.0	55,106.4	64,799.8
HCA drinking water sources	2,443.9	4,521.9	24,468.7	14,787.2	27,941.9	19,309.1	32,463.8
Drinking water areas of interest	1,103.7	2,328.9	16,660.1	4,853.0	10,548.9	7,172.9	12,877.8
Cultural resources areas of interest	48.0	44,137.6	11,606.4	55,356.8	40,236.6	99,493.9	84,374.0
Biological areas of interest	102,365.7	99,943.8	369.3	94,763.6	87,200.5	194,894.1	186,640.8
Commodity production areas of interest	37,084.5	62,419.1	191.6	46,205.9	67,846.1	108,627.0	136,178.2
Recreation/tourism areas of interest	3,704.1	1,872.3	1,791.9	11,325.5	2,394.5	13,197.9	4,266.8
TOTAL	**170,027.6**	**268,449.3**	**100,595.1**	**296,449.9**	**317,872.2**	**565,078.4**	**591,730.8**



Notes: Acreages are the sum of acres within the 2,500-foot-wide and 10-mile-long downstream region of interest for each metric, with the exception of Drinking Water Areas of Interest, which reflects Wellhead Protection Areas within a 1-mile region of interest. See Section 10.4.1 for descriptions of areas of interest.

HCA = high consequence area (see Section 10.4.1 for descriptions of HCAs)

Drinking Water Areas of Interest include only Wellhead Protection Areas, as other resources were specific to Minnesota.

Alternatives with a higher number of resources within the areas identified in Table ES-2 have a greater level of exposure and potential adverse effects following a release. This comparison of resources at risk assesses acres of sensitive resources within a 5,000-foot-wide (2,500 feet on each side of the centerline of the pipeline or train or truck route) corridor for releases on land. For waterbody exposure, acres of sensitive resources were calculated along a 10-mile-long, 1,000-foot-wide (500 feet on each side of the centerline of the waterbody crossed) corridor downstream of a release. Table ES-2 shows the magnitude of exposure to resources of concern along a color gradient (green to red), with red indicating the most exposure and green representing the least.

The risk of accidental release for the CN Alternatives is addressed in Chapter 10 of the EIS.

What are the impacts of the CN Alternatives on high-quality water resources?

Surface Water

The Applicant's proposed Project (and to some extent transport by trucks and rail) would have construction impacts and introduce new risk of spills in northern Minnesota where the watersheds are in general very healthy and water quality is very good. System alternative SA-04 avoids northern Minnesota, instead routing through North Dakota and southern Minnesota. Impacts of the CN Alternatives on water resources are evaluated in Section 5.2.1 of the EIS.

There is no one way to measure the general region-wide or state-wide differences in surface water resource quality across Minnesota. The northcentral and northeastern portions of Minnesota, however, contain many water resources that are generally the highest quality water resources in the state. Figure ES-5 provides a comparison of the high-quality water resources at risk for each alternative, including:

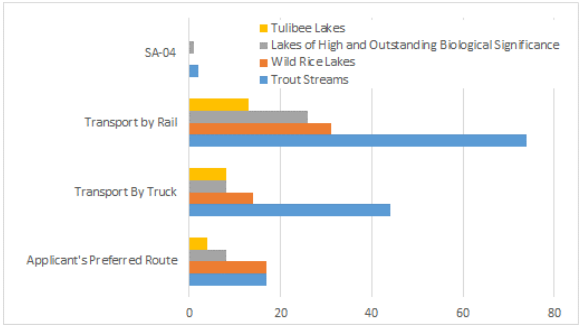


Figure ES-5. High-Quality Surface Waters Crossed by Certificate of Need Alternatives

- **Trout streams:** Because their watersheds are generally unpolluted, and because of their location, soils, and geologic setting within the state, these streams often represent high-quality cold, oxygenated water necessary for trout survival.
- **Wild rice:** Minnesota has more acres of natural wild rice (*Zizania palustris*) than any other state in the country. Wild rice has been historically documented in 45 of Minnesota's 87 counties and in all corners of the state. Anecdotal information suggests an even broader distribution prior to European settlement. Wild rice is a sacred plant for American Indian tribes and is an important social and cultural component for rural Minnesota communities.
- **Lakes of Biological Significance:** Lakes of Biological Significance are identified and classified by Minnesota DNR subject matter experts on objective criteria for four community types (aquatic plants, fish, amphibians, and birds). Unique plant or animal presence is the primary measure of a lake's biological significance.
- **Tullibee (cisco) lakes:** Minnesota has about 650 tullibee lakes, more than any other state in the lower 48. Many of these waters are prized by anglers because tullibee provide a high-

energy feast for walleye, northern pike, muskellunge, and lake trout. Changes in land use and climate are causing many lakes to lose tullibee. Keeping forested land intact can help maintain water quality in lakes with tullibee and other cold-water species.

Ground Water

Rail and truck alternatives pose the highest total potential impact on groundwater resources because they cross the largest acreage of:

- **High water table vulnerability areas:** These are areas where groundwater is especially susceptible to contamination because the physical and biochemical characteristics of the geology tend to allow the transport of pollutants into the groundwater more easily.
- **Wellhead protection areas:** These are areas surrounding public water supplies through which contaminants are likely to move, both toward and into the well or well field.

SA-04 is the only CN Alternative that crosses vulnerable karst topography. A karst aquifer is a type of bedrock aquifer that usually consists of basic rock types that are prone to chemical weathering and dissolution from the slight acidity of precipitation and groundwater. This can result in the formation of fractures, joints, sinkholes, cavities, caves, and void spaces that allow the movement of large volumes of surface water into and through the aquifer. These characteristics also allow contamination to spread rapidly within the aquifer. Karst aquifers are susceptible to collapse of the aquifer matrix, which can be triggered by construction activities on the land surface. This can lead to the formation of sinkholes in unconsolidated sediments that overlie the bedrock.

Will the proposed Project damage forests and wildlife habitat in northern Minnesota far more than other alternatives?

The Applicant's proposed project would require that an approximately 120-foot-wide construction area be cleared and that forested uplands and woody wetlands within the permanent right-of-way through northern Minnesota be permanently converted, thereby permanently affecting more land cover and habitat than any other CN Alternative. A total of 38 miles of the Applicant's preferred route, for example, would permanently fragment 21 large-block habitats. System alternative SA-04 avoids habitat fragmentation and permanent forest conversion in wooded northern Minnesota.

SA-04 passes instead through North Dakota and western and southern Minnesota where primary impacts would be on agricultural land, which can be restored to agricultural use after construction is complete. In addition, because SA-04 would be co-located with existing pipelines for much of its length, construction of the route would fragment less habitat than the Applicant's preferred route. The effects of CN Alternatives on vegetation are evaluated in Section 5.2.3 of the EIS, and effects on habitat and fish and wildlife are addressed in Section 5.2.4.

SA-04, however, would affect the most acres because it travels the greatest distance. It would mostly affect croplands, with 100 percent of the route adjacent to existing corridors. The Applicant's preferred route would affect about half as much land as SA-04 but would primarily run through both forest and croplands. Rail and truck alternatives would affect less land than either SA-04 or the Applicant's preferred route, because those alternatives would require only limited new infrastructure in Gretna, Clearbrook, and Superior. Continuing to use the existing Line 3 would not result in any construction effects on vegetation, but it would have ongoing effects because continuing to operate it would require hundreds of integrity digs each year to keep it safe.

Constructing and operating the Applicant's preferred route would have the greatest long-term major effects and would primarily affect forests. SA-04 would have the greatest short-term and minor impacts and would primarily affect croplands (Figure ES-6). The Applicant's preferred route and the rail alternative would affect the most sensitive vegetation categories—the rail alternative because it runs through 59 miles of railroad prairies and just over a mile through rare plant communities.

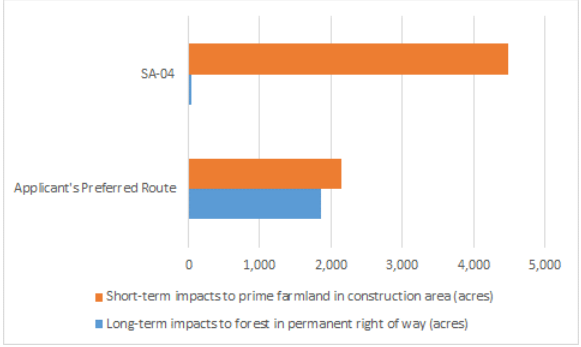


Figure ES-6. Impacts on Prime Farmland and Forest

SA-04 would pose an ongoing risk of accidental release in areas with high-quality agricultural soils, while the Applicant's proposed Project would place more high-quality forested and aquatic habitats at risk.

Potential impacts on individual threatened or endangered species or other unique natural resources varies widely across all CN Alternatives. The truck and rail alternatives would potentially affect the fewest individual species, while the Applicant's preferred route could potentially affect the most Minnesota Biological Survey Sites of Biodiversity Significance and Minnesota Wildlife Action Network Species in Greatest Conservation Need. The effects of CN Alternatives on these unique resources are addressed in Section 5.2.5.

Will shipping the oil by rail or truck affect the movement of other commodities and pose safety risks?

Train and truck alternatives could cause congestion that would affect the transport of other commodities. Transporting crude oil from near Gretna to Clearbrook and Superior would involve loading and dispatching 10 unit trains (each train consisting of 110 rail cars) per day onto the rail network in Minnesota. These unit trains would be dedicated to a single service and would return empty from Clearbrook and Superior. Since the overall round trip to Clearbrook or Superior would take more than a single day, some multiple of the 10 trains per day loaded and dispatched would be required to provide the required service.

It is likely that the increase in traffic on the rail system would cause congestion that would affect commodity producers during certain periods. For example, the record 2008/2009 grain harvest in western Canada caused increased demand for rail cars, and shippers experienced delays in their cargos being delivered to ports. The U.S. Surface Transportation Board has also indicated a concern about rail congestion and its potential to affect agricultural production, and it has initiated an oversight proceeding.

Rail and truck alternatives also pose safety risks, including increased risk of incidents involving fatalities. Compared to pipelines, both truck and rail transportation alternatives have a higher likelihood of accidents and spills due to the number of transits required to transport the crude oil and the associated increase in risk due to human error. Tanker trucks use major roadways and present a greater risk of injury and fatalities to personnel and members of the public. Trains can interfere with emergency vehicles and personnel where at-grade crossings bisect small towns along the route. The impact of alternative transport modes on commodity production and population centers are addressed in Section 5.3.

What are the implications of greenhouse gases and climate change?

All GHG emissions contribute to cumulative climate change, so all of the alternatives would play a role in global climate change. Recognizing this fact but acknowledging that current limitations in the science and earth systems modeling make it impossible to directly link the emissions from a single action to an incremental change in climate, the evaluation in the EIS focuses on three specific issues:

- Direct, indirect, and lifecycle GHG emissions from the proposed project and alternatives;
- The impacts of climate change on the Project; and
- The cumulative impacts on resources as a result of both the Project and climate change.

GHG emissions of the CN Alternatives are addressed in Section 5.2.7, and climate change impacts are addressed in the cumulative effects discussion in Section 12.5.

Direct and Indirect Emissions

GHG emissions from the CN Alternatives differ, with pipelines causing the fewest direct GHG emissions because the pump stations are powered by electricity, which results instead in indirect GHG emissions from power generation (Figure ES-7). Pipeline operations result in small amounts of direct fugitive emissions of GHGs from storage tanks, pumps, piping components, and the like. In addition, pipeline construction requires vegetation clearing, which would result in the release of stored carbon from trees and other vegetation. Maintaining the pipeline right-of-way would prevent woody vegetation from re-growing, and the conversion of forested land to a non-forested land use would result in a permanent loss of carbon sequestration.

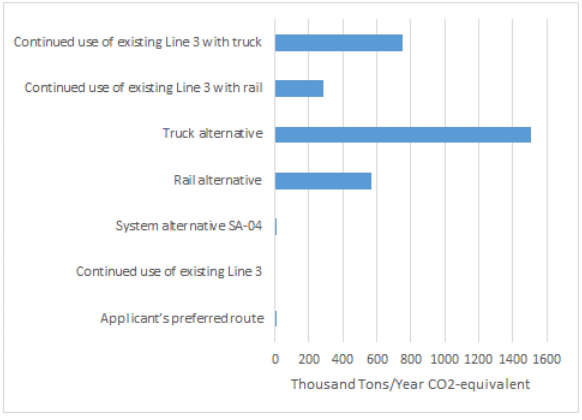


Figure ES-7. Direct GHG Emissions from Certificate of Need Alternatives

Other transport modes result in direct emissions of GHGs as trains and trucks combust fossil fuels. Table ES-3 compares estimated direct and indirect GHG emissions and loss of carbon sequestration for the Applicant's proposed Project and all of the CN Alternatives. The table also presents the estimated cost to society arising from man-made emissions of CO_2 and other GHGs using the federal social cost of carbon to monetize impacts.

Table ES-3. Summary of Greenhouse Gas Emissions and Costs for Certificate of Need Alternatives

Route/Certificate of Need Alternative	Direct GHG Emissions (tons per year)	Indirect GHG Emissions (tons per year)	30-Year SCC for Direct and Indirect GHG Emissions[a]	Loss of Carbon Sequestration (tons per year)
Applicant's preferred route	375.9	452,496.6	$673,365,150	1,262.3
Continued use of existing Line 3	--	--	--	--
System alternative SA-04[c]	850.3	946,670.5	$1,408,845,737	74.3
Rail alternative	568,472.8	--	$845,248,443	--
Truck alternative	1,506,291.3	--	$2,239,688,011	--
Continued use of existing Line 3 with rail	284,236.4	--	$422,624,221	--
Continued use of existing Line 3 with truck	753,145.6	--	$1,119,833,958	--

GHG = greenhouse gas, SCC = social cost of carbon

Lifecycle Greenhouse Gas Emissions

The proposed pipeline is part of a larger crude oil extraction, production, refining, and consumption system that is affected by changes in the availability and price of transportation to get crude oil from the point of extraction to the refineries that process the oil. An increase in the availability of options for transport via pipeline, for example, could lower the overall cost of transporting crude oil to market, thereby improving its market prospects. Similarly, increased upstream activity induced by the Project could ultimately result in increased end-use of refined products—gasoline, for example, becomes more abundant and cheaper as additional oil is extracted and pipeline transport becomes cheaper.

Changes in these upstream and downstream activities are accounted for by evaluating lifecycle GHG emissions—emissions of GHGs associated with all the steps in the extraction, upgrading, transport, refining, and end use of the oil. The lifecycle GHG emission estimates presented in Figure ES-8 bookend the range of possible impacts of the Project on upstream and downstream activity and associated GHG emissions, including:

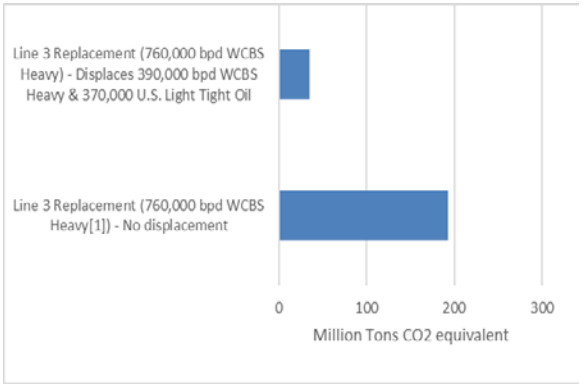


Figure ES-8. Direct Greenhouse Gas Emissions from Certificate of Need Alternatives

- **Zero displacement:** The Project creates 760,000 barrels per day of new production and consumption of Western Canadian Sedimentary Basin (WCSB) heavy crude, causing GHG emissions from extraction, upgrading, transporting, refining, and consuming 760,000 barrels of WCSB crude oil each day

- **Full displacement:** The Project does not create any new production or consumption of oil. However, a change in the emissions on the oil-production end could still occur if the heavy crude that the proposed Project would be capable of transporting replaces lighter crudes on the market. The process of extracting and upgrading heavy crudes requires much greater energy input (and GHG emissions) than extracting and upgrading light crudes, so the Project causes an incremental increase in extraction, upgrading, transport, and refining emissions over what would have occurred if demand was met instead with light crude oils.

The Effects of Climate Change on the Project

The primary impacts of climate change on the Project include severe weather, freeze-thaw cycles, and flooding, all of which could damage project facilities. Climate change could also intensify the effects of a spill. It could affect how spilled oil might move once there is a spill and could also affect how spilled oil might interact with the environment. Higher ambient temperatures, for example, could increase the volatilization of air contaminants from an accidental release, or flooding could cause spilled oil to be transported further downstream. In addition, heavy rain events have the potential to adversely affect spill response, including containment and clean-up actions.

Cumulative Impacts of the Project and Climate Change

Impacts of the Project and climate change could overlap for a number of resources, including aquatic species and other wildlife, threatened and endangered species, and tribal resources. For example:

- Increased water temperatures due to climate change could adversely affect aquatic species, and those effects could be exacerbated by the permanent loss of shading, nutrients, and habitat features for fish at some waterbody crossings, caused by removing vegetation along the permanent right-of-way. The use of pesticides and herbicides for maintenance during pipeline operation could also stress aquatic species.
- The changing composition of vegetation could affect resident wildlife unable to adapt to changing conditions. This could be worsened by the permanent loss of trees and shrubs, habitat fragmentation, and changes in vegetation cover in large blocks of forest habitats within the pipeline right-of-way.
- The lands and resources affected by the Project are important to preserving the traditional ways of life, including fishing, hunting, wild rice farming, maple sugar gathering, and the collection of plants for medicines, spiritual and ceremonial purposes, shelter, and other needs. Project impacts on tribal resources would be further exacerbated by climate changes that affect native communities—decreases, for example, in water quality and quantity in the Great Lakes region, threats to human health and safety, economic losses, loss of culturally important species, medicinal plants, cultural sites, and traditional foods, such as wild rice.

MAJOR ENVIRONMENTAL ISSUES FOR THE ROUTE PERMIT DECISION

The route permit section of the EIS compares the environmental impacts of different routing options, including:

- The Applicant's preferred route
- RA-03AM
- RA-06
- RA-07
- RA-08

If the Commission issues a CN for the Project, it must determine the best route. Therefore, the routing analysis in the EIS provides environmental information to aid the Commission in making that decision. In addition, the routing analysis in the EIS addresses the environmental impacts of abandonment versus removal of the existing Line 3, so that the Commission can make an informed decision about the fate of the existing Line 3 if it determines that a new pipeline is needed.

The following key issues emerged in the routing analysis:

- What are the advantages and disadvantages of removing the old pipeline from the corridor, abandoning it in place, or removing the old pipeline and installing a new one in the same trench?
- How do the risks of an accidental release differ among the route options?
- Does the risk of damage to high-quality water resources vary between routes?
- Are there differences between the level of information available for the Applicant's preferred route and other alternatives?
- Which alternative would result in the least habitat loss, habitat fragmentation, and loss of timber resources?
- How were environmental justice and tribal considerations evaluated?

What are the benefits or drawbacks of corridor sharing versus opening a new corridor?

Using existing pipeline corridors, or even transmission corridors or roadways can avoid new impacts and new risk exposures. Along existing corridors, resources have already been affected. New impacts occur at the margin of these previously disturbed and permanently altered areas, thereby minimizing further habitat fragmentation or degradation of aesthetics. Also, where pipeline corridors are shared, spill risk is incrementally increased as the addition of a new pipeline in an existing corridor adds to the overall probability of an incident but does not change the type or distribution of resources exposed if an accidental release does occur.

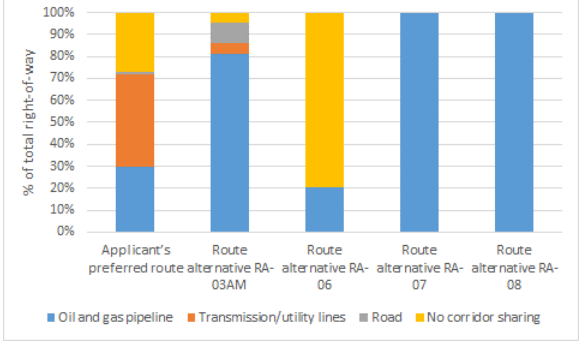


Figure ES-9. Route Alternatives Corridor Sharing

Between Clearbrook and Carlton, the Applicant's preferred route and most of the route alternatives would share or parallel existing rights-of-way for the majority of their lengths (Figure ES-9). RA-07 would parallel the Enbridge Mainline system right-of-way from the North Dakota border to the Wisconsin border and share the right-of way from Clearbrook to Carlton. RA-08 would share or parallel rights-of-way with existing pipelines for its entire length. The Applicant's preferred route would share or parallel existing rights-of-way along 73 percent of its length between Clearbrook and Carlton. RA-06 has the lowest proportion of its route co-located with existing rights-of-way between Clearbrook and Carlton (20 percent).

The Commission is required to consider corridor sharing in determining which route to select and permit (Minn. R. 7852.1900, Subp. 2 F). If a new pipeline corridor is permitted for this Project outside of the existing Enbridge Mainline, the new corridor creates an opportunity for future corridor sharing that could ultimately result in an accumulation of multiple pipelines within the corridor chosen for the Line 3 Replacement Project. This would be particularly the case with the Applicant's preferred route, RA03-AM, and RA-06.

The eventual addition of another pipeline within a new pipeline corridor like the existing Mainline would require widening of the right-of-way and would introduce additional spill risk in an already at-risk area. In general, the widening of the corridor would incrementally increase the effects on the resources described for each of the routes in Chapter 6 of this EIS. In the case of RA-06, for example, adding another pipeline in the corridor would result in additional clearing of forest in what is otherwise a densely forested, relatively undisturbed area with high-quality habitat and relatively pristine watersheds, but in relatively few populated areas.

In the case of RA-03AM or the Applicant's preferred route, adding another pipeline in the corridor would result in additional clearing in forested areas with slightly more disturbed habitat and affected watersheds, but in relatively more populated areas.

What are the advantages and disadvantages of removing the old pipeline from the corridor, abandoning it in place, or removing the old pipeline and installing a new one in the same trench?

As part of the Project, Enbridge proposes to abandon the existing Line 3, permanently removing it from service. Federal safety regulations outline the process and requirements for abandoning oil pipelines. As an alternative to abandonment, Chapter 8 of the EIS considers the possibility of excavating and removing the existing Line 3. Some potentially significant effects are associated with abandoning the existing Line 3. These longer-term impacts would be caused by the continued presence of undiscovered legacy contamination that could exist around the existing pipeline, as well as the potential hazards associated with the aging of the abandoned pipe. These impacts include soil and water contamination, the ability of the pipeline to serve as a water conduit, subsidence due to the failure over time of the pipeline, and loss of buoyancy control for the pipeline.

Although removing the pipeline is potentially desirable, abandonment is easier and far less risky.

Four of the five routes considered in this EIS (the Applicant's preferred route, RA-03AM, RA-06, and RA-08) could be coupled with abandonment or removal of the existing Line 3. As discussed in Chapter 4, RA-07 specifically contemplates removal of the existing Line 3 with the new pipeline placed in the existing trench.

Major issues considered in the assessment of abandoning the existing Line 3 include:

- Potential environmental benefits of not disturbing the active pipelines located on either side of existing Line 3,
- Potential environmental risks and impacts of any existing contamination surrounding the pipe that would never be discovered and remediated if the line were abandoned, and
- Potential environmental risks and impacts associated with ongoing deterioration of abandoned pipeline.

Major issues considered in the assessment of removing the existing Line 3 include:

- Potential risk that pipeline removal activities could damage an active pipeline located on either side of existing Line 3, causing an oil leak;
- Potential impacts associated with disturbances at waterbody and roadway crossings;
- Potential environmental benefits associated with discovering and remediating existing contamination surrounding the pipe, as it is being removed; and
- Avoidance of potential environmental risks and impacts associated with the ongoing deterioration of an abandoned pipeline.

Enbridge's assessment of the risks and benefits of removal contemplated the use of timber mats over operating pipelines to create a work and travel surface for equipment. These mats would help disperse the weight of the equipment and minimize potential impacts on these pipelines. Enbridge also indicates that sheet piling would likely be required to isolate specific segments of the existing Line 3, particularly in wet soils and wetlands. They further note that it might not be possible to use typical excavation equipment to excavate Line 3, due to the weight of the equipment and the proximity to operating pipelines. Enbridge notes that it would likely use a hydraulic vacuum or hand dig to minimize potential impacts on existing pipelines.

Certain segments of the existing Line 3 could not be removed using existing technology like timber mats or sheet piling without significant risk of damaging operating pipelines. If the existing Line 3 were removed in these areas and operating pipelines were damaged, the damaged pipelines would need to be excavated and repaired, with considerable risk of further damage and leakage.

Perhaps the primary challenge in removing Line 3 is that it is located in the middle of the Mainline system, between other active oil pipelines. The distance between pipelines within this corridor varies, but they are generally from 10 to 15 feet apart. Enbridge has indicated that there is a significant risk that pipeline removal activities could damage an active pipeline and cause an accidental release. Damage could be caused by striking a pipeline with equipment or by the weight of the equipment as it works

above operating pipelines. This damage would be immediately apparent if equipment struck a pipeline, or observable later if the pipeline was damaged and eventually leaked in the future.

As noted above, in addition to the question of abandonment versus removal, the EIS evaluates the alternative of removing the existing Line 3 and placing the new Line 3 pipeline in the same trench. This alternative, RA-07, is evaluated in Chapter 6. It would require a larger construction area than the Applicant's preferred route and the other route alternatives (approximately 205 feet wide instead of 120 feet wide). With most of the construction occurring within the existing Mainline corridor or immediately adjacent to it, however, new impacts associated with clearing woody vegetation and wooded habitat would be minimal. RA-07 is compatible with existing land use in the area and avoids new long-term exposures to spill risk, noise, aesthetic disturbance, and maintenance-related disruption.

Despite these benefits, Enbridge has identified a number of challenges presented by RA-07, including (1) the difficulties of securing long-term land use approvals from the Leech Lake and Fond du Lac Tribal Nations; and (2) difficulties of construction.

With the existing Line 3 located in the middle of the Mainline corridor with pipelines on either side of it, removal and replacement raises safety risks and construction challenges such as those from cave-ins and adjacent pipe movement due to the varying depths of cover, among other risks. Replacing Line 3 in the same trench would also affect wetlands and waterbodies where accessing the old pipeline would require trenching and excavation and would affect water quality where trenches would have to be left open for an extended period to allow time for both removal and replacement.

How do the risks of an accidental release differ among the route options?

Modeling, statistics, and resource mapping can help predict the probability of an accidental oil release, how crude oil would behave in the environment, and what resources could be at risk should there be an oil spill. It is impossible, however, to predict the location or magnitude of the spill, how far the impacts would extend, or what resources would be affected because there are so many incident-specific factors involved. The weather, time of year, water levels, human error, and even what type of wildlife is present at the time a spill occurs all affect its probability and outcome. While the EIS does not predict specific spill outcomes, it highlights:

- The general likelihood of a spill occurring, and
- The resources exposed.

Length is a key component in calculating the probability of pipeline failure because a longer pipeline has a greater area that could be exposed to the primary pipeline threats (third-party damages, construction defects, manufacturing defects, corrosion, and equipment [e.g., valve]) failure. In general, longer routes have a higher probability of an incident occurring than shorter routes.

Sensitive resources at risk were compared among the Applicant's preferred route and the route alternatives from Clearbrook to Carlton. As described in detail in Chapter 10, the federally defined high-consequence areas (HCAs) and state-specific areas of interest (AOIs) were used to quantify potential resources of concern.

Acres of sensitive resources were calculated within a 5,000-foot-wide (2,500 feet on each side of the centerline of the pipeline or train or truck route) corridor for releases on land. In addition, a 10-mile-long, 1,000-foot-wide (500 feet on each side of the centerline of the waterbody crossed) downstream corridor for releases to water were established as areas within which oil could be present after a release. Table ES-4 summarizes the potentially exposed resources of concern in the regions of interest (ROIs). A more detailed listing of each HCA and AOI category is provided in Table 10.7-11.

Overall, the potential acreage and number of HCA and AOI resources that could be exposed as a result of a crude oil release is greatest for RA-08 due to the combined acreages (for the 2,500-foot-wide and 10-mile-long ROIs) of resources within the ROIs. A spill in the ROIs of RA-07 would expose a slightly smaller number and acreage of HCAs and AOIs than for RA-08. The differences among the Applicant's preferred route, RA-03AM, and RA-06 are relatively small; but the total acreage and numbers of HCAs and AOIs potentially exposed is smaller than for RA-07 and RA-08.

Based on the results of these comparisons, RA-06 would have the least effect on resources of concern if a spill occurs; that is followed by RA-03AM, with the Applicant's preferred route third. It appears that RA-07 and RA-08 may be the least favorable routes in terms of potentially affected resources if a spill were to occur; and the Applicant's preferred route, RA-03AM, and RA-06 may represent more favorable route options.

The risk of an accidental release of crude oil for the route alternatives is addressed in Chapter 10.

How were environmental justice and tribal considerations evaluated?

Environmental justice refers to the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income. In general, environmental justice is intended to ensure that all people have the same opportunities to participate in decisions that may affect their environment or health.

Minority or low-income communities are often concentrated in small geographical areas within the larger geographically defined population. Minority communities and low-income communities may represent a very small percentage of the total population but may be concentrated in specific census tracts within a county.

Chapter 9 summarizes American Indian community values, uses, and attitudes toward their natural and cultural resources. It also briefly summarizes the challenges faced by tribal communities in general. American Indian communities and individuals have unique health issues associated with historical trauma and structural racism. Data from the Minnesota Department of Health indicates that American Indians in Minnesota have greater health disparities and poorer health outcomes compared to other racial or ethnic groups in Minnesota. Tribal impacts are magnified because (1) impacts would be associated with abandonment or removal of the existing Line 3; and (2) additional impacts would be associated with replacement of Line 3 in a new location.

Table ES-4. Summary of Potentially Exposed Resources of Concern from an Unanticipated Release of Crude Oil for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton (acres)

Resources of Concern	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
HCA populated area	4,814.1	12,829.2	3,230.0	20,806.6	17,363.7
HCA unusually sensitive ecological area	10,978.1	7,752.3	12,674.4	26,854.4	27,566.9
HCA drinking water source	501.1	2,399.1	718.0	2,942.0	2,998.3
Drinking water areas of interest	83,833.7	153,971.9	16,196.0	64,785.5	63,726.0
Cultural resources areas of interest	0.0	13.5	11,425.6	44,046.8	45,766.0
Biological areas of interest	94,028.5	46,575.5	58,815.6	88,739.9	96,480.2
Commodity production areas of interest	45,748.3	5,625.1	87,973.6	71,016.7	78,142.0
Recreation/tourism areas of interest	3,704.1	4,100.9	1,838.6	1,443.0	1,924.3
TOTAL	243,607.9	233,267.5	192,871.8	320,634.9	333,967.4



Notes: Acreages are the sum of acres within the 2,500-foot-wide and 10-mile-long downstream region of interest (ROI) for each metric, with the exception of Drinking water areas of interest, which reflects Wellhead Protection Areas within a 1-mile ROI. See Section 10.4.1 for descriptions of areas of interest.

HCA = high consequence area (see Section 10.4.1 for descriptions of HCAs)

Drinking water areas of interest include only Wellhead Protection Areas, as other resources were specific to Minnesota.

Chapter 11 contains an analysis of the potential for disproportionate and adverse impacts to American-Indian and low-income populations in the project area. Each of the five route options would cross one or more census tracts with a meaningfully higher minority population than that of the surrounding county. The Applicant's preferred route bisects, and RA-03AM crosses, the edge of such a census tract in Clearwater County, where the minority population of 25.3 percent exceeds the county level by more than 10 percentage points. This census tract includes a portion of the White Earth Reservation, and the minority population in the tract is overwhelmingly Native American (23.2 percent).

It is not possible, however, to determine which route option is better from an environmental justice perspective when each option affects tribal resources, tribal identity, and tribal health. Based on the information on tribal resources and uses given in Chapter 9, any of the routes selected between North Dakota and Superior, Wisconsin, would therefore have a disproportionate and adverse effect on tribal resources and tribal members, even if the route itself does not cross near residences.

Chapter 11 includes a preliminary list of potential mitigation measures for addressing any disproportionate adverse impacts on environmental justice communities.

Does the risk of damage to high-quality water resources vary between routes?

Surface Water

While the CN Alternatives differ significantly in their potential effects on water quality, the differences among the route alternatives are not as pronounced, because all of the route options pass through the northcentral and northeastern portions of Minnesota, which contain many of the highest quality water resources in the state. Effects of the route options on water resources are evaluated in Section 6.3.1 of the EIS. Figure ES-10 provides a comparison of the high-quality water resources at risk for each route option, including:

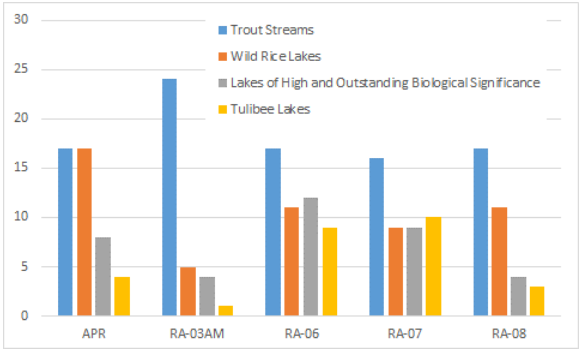


Figure ES-10. High-Quality Surface Waters Crossed by Route Options

- Trout streams
- Wild rice lakes
- Lakes of Biological Significance
- Tullibee (cisco) lakes

Ground Water

In general, RA-06 would least affect groundwater resources, including highly vulnerable aquifers and groundwater resources with high contamination sensitivity, high pollution sensitivity, and high to very high bedrock sensitivity. RA-03AM is the only route alternative that crosses vulnerable karst topography.

Are there differences between the level of information for the Applicant's preferred route and the route alternatives?

Yes. Enbridge has already optimized the Applicant's preferred route and completed preliminary engineering, as well as cultural and biological surveys. If the Commission issues a route permit for one of

the route alternatives, a similar level of survey and design work would be required prior to downstream permitting.

On the one hand, more detailed information was available for the EIS on some impacts (such as the extent of threatened or endangered species) for the Applicant's preferred route. This additional information can sometimes make the magnitude of the impacts from the Applicant's preferred route appear greater, simply because detailed information is not available for the other routes.

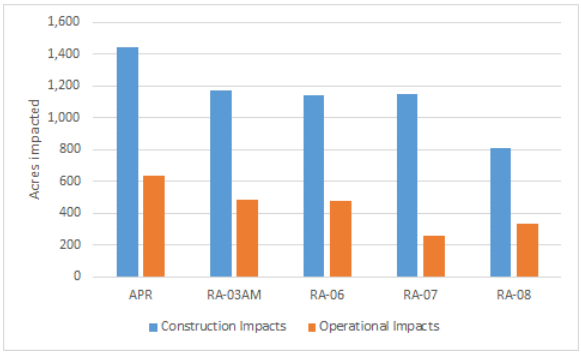
On the other hand, the predicted impacts of the route alternatives on some resources (e.g., displacement of homes or tree clearing) can appear to be greater than the impacts from the more optimized Applicant's preferred route, but these impacts could be reduced during optimization of the route if an alternative is chosen.

Which route option would result in the least habitat loss, habitat fragmentation, and loss of timber resources?

Habitat Loss

Vegetation management activities during pipeline operation would prevent trees and large shrubs from reestablishing within the permanent right-of-way. The greatest effect would be on 631 acres of previously forested areas within the permanent right-of-way for the Applicant's preferred route, and the least effect would be for RA-07, where forest clearing would be minimal because the route uses the existing Mainline corridor which is already clear of trees (Figure ES-11).

The forested and scrub/shrub areas cleared from the construction work area and outside of the permanent right-of-way would be allowed to regenerate, but the process could take decades to reach full recovery. The impacts on vegetation from each route option are addressed in Section 6.3.3.



**The resolution of the GIS landcover data does not provide accurate representation of land-cover/land use the scale of the Mainline corridor right-of-way. This limitation in the data creates some uncertainty about accuracy of the landcover within the anticipated construction work zone and permanent right-of way for RA-07. The numbers shown should be considered a very conservative estimate of forest impacts; the actual numbers are likely to be much lower.*

Figure ES-11. Disturbance and Loss of Forested Habitat from Construction and Operation of Route Options (Clearbrook to Carlton)

Habitat Fragmentation

Habitat fragmentation is caused when contiguous habitats are divided into separate fragments. Large-block habitats (habitats larger than 100 acres) are susceptible to fragmentation—particularly large, mature-core or interior forested areas that serve as habitat for migratory birds and other wildlife. Construction of linear projects such as pipelines can cause habitat fragmentation as well as changes in vegetation cover. Potential effects of fragmentation on wildlife habitat include a decrease in total habitat area and the amount of interior habitat, biodiversity (richness), and connectivity. Fragmentation could also increase the amount of edge habitat, increase the risk of the spread of invasive species, and isolate some habitat types.

The reduction in habitat connectivity can disrupt the behavior and movement of species, alter population dynamics, reduce the chance of recolonization in extirpated island habitats, and decrease genetic diversity. Forest-nesting birds are particularly vulnerable to the habitat fragmentation effects of linear construction projects. Habitat fragmentation can lead to increased predation, increased competition by generalist species, and changes in microclimate and vegetation that could result in extirpation and reduced reproductive success for area-sensitive species.

The Applicant's preferred route is co-located with other pipelines, utilities, or roads along most of its length. Between Clearbrook and Carlton, however, nine segments are not co-located with other infrastructure. Within this span, 21 large-block forested and wetland habitats would be crossed and fragmented by construction of the Applicant's preferred route. This would occur along approximately 38 miles of the Applicant's preferred route, or approximately 11 percent of the route in Minnesota and 17 percent of the route between Clearbrook and Carlton. These habitat "patches" that would be crossed include primarily forested and woody wetland habitats. The largest patch crossed is approximately 4,500 acres over approximately 7 miles, and the smallest patch crossed is about 130 acres over less than 1 mile.

Impacts on Fish and Wildlife Habitats

Impacts on fish and wildlife habitats would vary only slightly among the Applicant's preferred route and route alternatives. Fish and wildlife impacts of the route options are addressed in Section 6.2.4. The acreage of wildlife habitat affected by construction of the route options ranges from 2,286 acres (RA-08) to 3,578 acres (RA-03AM). All of the routes would cross wildlife management areas. The Applicant's preferred route, RA-06, and RA-07 would permanently convert the greatest number of acres to maintained pipeline right-of-way. Route alternatives RA-06, RA-07, and RA-08 would result in greater permanent habitat removal than RA-03AM or the Applicant's preferred route. RA-03AM and RA-06 would have the greatest number of surface water crossings.

Potential impacts on individual species and other unique natural resources are highly variable across all route options. RA-03AM has substantially less potential than the other route options to affect Sites of Biodiversity Significance and Minnesota Wildlife Action Network Species in Greatest Conservation Need. Using the effects on these sites as proxies for impacts on rare species would also indicate a smaller potential impact from RA-03AM.

NEXT STEPS

What happens next?

A number of future steps must be taken before the EIS can be completed or the Commission can reach a final decision on Enbridge's CN and route permit applications. Table ES-5 identifies the milestones and dates for achieving the Line 3 next steps.

Table ES-5. Key Milestones and Dates for the Line 3 Replacement Project

Milestone	Dates
Draft EIS public notice	May 15, 2017
Draft EIS information meetings	June 6, 2017 – June 22, 2017
End of Draft EIS 60-day comment period	July 10, 2017
DOC-EERA releases the Final EIS to the public, tribes, and agencies	August 2017
Joint public contested case hearings on Certificate of Need and route permit applications	September – November 2017
Law Judge report	February 2018
Minnesota Public Utilities Commission Decision on Certificate of Need and route permit applications	April 2018

How can I stay up to date as the process continues?

Interested parties can obtain information and follow the progress of the Project in four ways:

- Website – DOC-EERA maintains an internet website accessible by the public at:

  http://mn.gov/commerce/energyfacilities/Docket.html?Id=34079

- Commission Docket – Persons interested in documents and information submitted to the Commission, including Enbridge's applications and related filings, can obtain them from the Commission's electronic docket library (eDockets) at:

  https://www.edockets.state.mn.us/EFiling/search.jsp.

  After connecting to eDockets, search the Line 3 Replacement Project Need docket number 14(year) -916(number).

  After connecting to eDockets, search the Line 3 Replacement Project Routing docket number 15(year) -137(number).

- Public Advisor – DOC-EERA has a public advisor that can help interested persons understand the process and advise them on how to effectively participate in the process. The Public Advisor's contact information is:

  Ray Kirsch, Public Advisor
  Department of Commerce, Energy Environmental Review and Analysis
  85 7th Place East
  St. Paul, Minnesota 55101-2198
  651-539-1841 or raymond.kirsch@state.mn.us

- Mailing List – DOC-EERA maintains a mailing list of all interested parties for the Line 3 Replacement Project. Notices of key steps in the process are sent to all parties on the mailing list. Contact the Public Advisor to have your name and email address added to the list.

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Chapter 1
Introduction

Enbridge Energy, Limited Partnership (Enbridge) has applied for a certificate of need and a route permit from the Minnesota Public Utilities Commission to construct a new 340-mile, 36-inch-diameter pipeline in northern Minnesota to replace an aging 282-mile, 34-inch oil pipeline. The existing pipeline, called Line 3, is part of Enbridge's Mainline System. The existing Line 3 pipeline requires extensive maintenance and is currently restricted to a capacity of 390,000 barrels of crude oil per day. Enbridge's proposed new 36-inch-diameter pipeline would be capable of carrying up to 760,000 barrels of Canadian heavy crude oil per day, which was the original design capacity of the existing Line 3.

This EIS generally refers to the Enbridge proposal as the "Line 3 Project." Enbridge refers to their proposal as the "Line 3 Replacement Project," a term that is also used periodically in the EIS.

Purpose Of and Need for This EIS Is To Inform both Regulators and Citizens

Minnesota's declared environmental policy is "to create and maintain conditions under which human beings and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of the state's people."[1]

The Minnesota Environmental Policy Act also requires that "Where there is potential for significant environmental effects resulting from a major governmental action, the action shall be preceded by a detailed environmental impact statement." In this case, the "governmental action" are two separate but related decisions by the Minnesota Public Utilities Commission (Commission):

1. Whether to issue a certificate of need.
2. Whether to issue a route permit for the project, and if so, with what conditions.

Enbridge needs numerous other state and federal approvals before they can build the project. (See Chapter 4.)

Therefore, the purpose of and need for this Environmental Impact Statement (EIS) is primarily to help inform the Commission's decisions by evaluating the potential human and environmental effects of permitting the proposed Line 3 pipeline project, considering reasonable alternatives, and exploring methods for reducing adverse effects. Enbridge's proposed need for the Project is contained in their Certificate of Need application, and is summarized in Section 2.2 of the EIS.

The EIS is a factual document that is designed to inform public deliberations and government decision-making, but it does not make specific recommendations regarding either the CN or the route permit for the Project.

The Minnesota Public Utilities Commission asked the Minnesota Department of Commerce Energy Environmental Review and Analysis (DOC-EERA) staff to prepare this EIS in cooperation with the

[1] Minnesota Statutes § 116D.02.

Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency.to facilitate the review of Enbridge's Certificate of Need (CN) and route permit applications for the Project. Other agencies with permitting authority will also use information in this EIS.

EIS Focuses On Information That Is Directly Relevant To the CN and Route Decisions

Since the purpose of the EIS is to inform decision-making on Enbridge's CN and route permit applications for the Project, it focuses on providing information that is directly relevant to the two decisions in front of the Commission:

1. Whether the Commission should issue or deny the CN for Enbridge's Line 3 Replacement Project; and

2. If the Commission Issues a CN, what route should be approved, and with what conditions?

During the scoping process for this EIS, commenters raised a number of critical long-term energy-policy and tribal rights issues that do not easily fit within the framework of a project-specific EIS. Some of these issues are too broad to be resolved in this EIS, which is intended to facilitate decision-making on a single, specific pipeline proposal.

1.1 APPLICANT'S PROPOSAL AND REQUIRED APPROVALS

The Commission ordered this EIS to review Enbridge's April 24, 2015 applications for a CN and route permit for the Line 3 Replacement Project. As mentioned previously, in its CN application, Enbridge indicated that it proposes to replace the existing Line 3 pipeline for three main reasons. First, according to Enbridge, the Project would avoid the integrity risks associated with the existing Line 3 by replacing it with a new pipeline that uses new technology and materials (instead of continuing their ongoing dig and repair program). Second, Enbridge indicated that the new pipeline would improve their ability to fill all of the requests to ship Western Canadian crude oil on their system by allowing throughput of 760,000 barrels per day and improving the line's capacity to carry heavy crude oils. Third, Enbridge indicated that the new pipeline would reduce the amount of power used per barrel for Line 3 and on the Enbridge Mainline system (Enbridge 2014).

A New 340-Mile Route Would Create a New Corridor Southeast of Clearbrook, Minnesota

Enbridge's preferred route for the Project involves constructing approximately 340 miles of a new 36-inch-diameter pipeline in Minnesota to replace the 282-mile existing 34-inch-diameter Line 3 pipeline. While most of the proposed route would be co-located along existing infrastructure, it would create a new Enbridge corridor southeast from Clearbrook to Carlton, Minnesota. Enbridge proposes to abandon the current Line 3 in-place. The existing Line 3 pipeline originates in Canada and crosses the U.S.-Canada border near Neche, North Dakota. The line continues through North Dakota and Minnesota, terminating at the Enbridge Superior Station and Terminal Facility (Superior terminal) near Superior, Wisconsin. As proposed by Enbridge, the new pipeline would generally parallel the existing Line 3 pipeline along the Enbridge Mainline system right-of-way from the North Dakota-Minnesota border in Kittson County to the Clearbrook terminal in Clearwater County. However, from Clearbrook to the terminal in Superior, Wisconsin, the proposed pipeline would diverge from the existing Line 3 corridor. Enbridge proposes to abandon (permanently deactivate) the existing Line 3 pipeline in-place.

1.2 CONTEXT AND HISTORY

The Existing Pipeline Network in Minnesota Transports over 3 Million Barrels of Oil per Day

Enbridge's existing Line 3 is part of an extensive network of 4,100 miles of pipeline that currently transports an estimated 2.9 million barrels of crude oil across northern Minnesota each day. Line 3 is one of six crude oil pipelines that form Enbridge's Mainline system through Minnesota, carrying crude oil from western Canada through a corridor across northwestern Minnesota, through Clearbrook, and east to Superior.

The Enbridge Mainline system, together with four Minnesota Pipe Line Company pipelines that carry crude oil south in a corridor from Clearbrook to the Twin Cities area, supplies approximately 400,000 barrels of oil per day to Minnesota's two petroleum refineries. These refineries use about 15 percent of the crude oil crossing into the state, with the bulk of the products refined from Canadian crude oil. Nearly all the heavy crude oil refineries in the Upper Midwest receive a portion of their crude oil, either directly or indirectly, from the Enbridge pipeline system that crosses Minnesota.

The Enbridge Mainline System Was Constructed between 1950 and 1969

The first component of the Enbridge Mainline system was established when the Interprovincial Pipe Line, Inc. (now Enbridge Pipelines, Inc.) crude oil pipeline was laid in 1950 from Edmonton, Canada, to Superior, Wisconsin. The Mainline continued to expand over the following decades, by adding pumping or compression capacity, laying additional pipe, or both (Bott 2004). Construction of Line 3 in this Mainline corridor began in 1962 as 34-inch parallel loops to Enbridge's Line 2 pipeline, to create additional Enbridge Mainline system capacity. Additional loops were constructed annually until a continuous 34-inch line, referred to as "Line 3," was completed and separated from Line 2 in 1969.

This EIS and the Commission's Permit Processes Represent an Opportunity to Consider Current Environmental and Socioeconomic Issues

The Interprovincial Pipe Line and various expansions and additions that established the Mainline corridor were authorized prior to the passage of the National Environmental Policy Act, the Minnesota Environmental Policy Act (MEPA), and Minnesota's CN and Pipeline Routing statutes. [2]

As a result, the Mainline corridor was not subject to state or federal environmental review, or the Commission's procedures for CN and route permitting. Certain permits and authorizations were required prior to the construction of these early pipelines. However, some environmental review considerations that today are understood to be essential to informed decision-making (e.g., environmental justice issues, threats to rare resources, and climate change impacts) were not factored into the original establishment of the Mainline.

[2] Minnesota Statutes § 116D.

Unlike the original construction of the existing Line 3, the Line 3 Replacement Project is subject to the Commission's CN and route permitting process and is subject to formal state environmental review processes. While efficiencies associated with following existing infrastructure rights-of-way tend to encourage continued use of an established corridor like the Mainline, the environmental review and permitting procedure for the Project presents an opportunity for a full evaluation of environmental and socioeconomic factors that did not necessarily enter into the original routing decisions for Enbridge's Mainline system.

1.3 ENVIRONMENTAL REVIEW

The Commission Must Understand and Consider Impacts of Their CN and Routing Decisions

MEPA requires decision-makers like the Commission to be informed about the potentially significant human and environmental consequences of an action and alternatives to that action before they make the relevant permitting decisions.[3] In this case, the Commission needs to understand and consider the impacts associated with both the CN decision and the routing decision.

The Commission has ordered DOC-EERA to prepare an EIS in accordance with Minnesota Administrative Rules Chapter 4410 to provide this information.[4] The EIS content and procedures therefore are being completed under Minnesota Administrative Rules Chapter 4410.

The Commission's two decisions, however, are based on the criteria and parameters in Minnesota Administrative Rules Chapters 7853 and 7852 regarding need and routing determinations, respectively. Therefore, the EIS specifically considers impacts of the proposed action and alternatives that correspond with each decision point specified in these rules.

This EIS Evaluates Impacts and Alternatives for the CN Decision Using Applicable Criteria

The EIS evaluates impacts and alternatives for the CN determination, under Minnesota Administrative Rules Chapter 7853, which instructs the Commission to assess need via a multi-part decision.

A. The probable result of denial would adversely affect the future adequacy, reliability, or efficiency of energy supply to the Applicant, to the Applicant's customers, or to the people of Minnesota and neighboring states.[5]

B. A more reasonable and prudent alternative to the proposed facility has not been demonstrated by parties or persons other than the Applicant.[6]

3 Minnesota Statutes § 116D.04, Subpart 2.

4 Commission Order Joining Need and Routing Dockets, February 1, 2016, eDockets Number 20162-117877-01.

5 Minnesota Administrative Rules Part 7853.0130 (A).

6 Minnesota Administrative Rules Part 7853.0130 (B).

C. The consequences to society of granting the CN are more favorable than the consequences of denying the certificate.[7]

D. It has not been demonstrated that the design, construction, or operation of the proposed facility would fail to comply with the relevant policies, rules, or regulations of other federal, state, or local agencies.[8]

The EIS evaluates the impacts of granting a CN for the proposed action against denial of the CN by considering alternatives, including:

1. Continued use of the existing Line 3;
2. Use of alternative pipeline systems or modes of transport such as trucks and trains to support adequate, reliable, and efficient supply; and
3. Alternative methods of supplementing the existing Line 3 to support adequate, reliable, and efficient supply.

The EIS Also Evaluates Proposed and Alternative Routes, Contingent on CN Approval

A route permit for the Project cannot be approved without a CN. Even though the route decision is secondary, the Commission ordered this EIS is to address both the CN and route permit decisions so that, if the CN is granted, the information needed to understand the impacts of the route decision is already developed and available in this EIS. For the routing decision, Minnesota Administrative Rules Chapter 7852 instructs the Commission to consider the characteristics, potential impacts, and methods to minimize or mitigate the potential impacts of all proposed routes to select a route that minimizes human and environmental impact. For the Commission to be fully informed about the human and environmental impacts of this decision, the EIS evaluates the impacts of the proposed action against alternative routes.

Through these analyses, the EIS compares alternatives to allow the Commission and citizens, other agencies, and governments to work from a common set of facts. The EIS does not advocate or state a preference for a specific outcome or alternative route.

1.4 OVERARCHING POLICY ISSUES

Larger Energy Policy Issues Are Beyond the Scope of This EIS

As noted above, DOC-EERA staff, with the support of Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency, has prepared this EIS for the Commission, which has before it Enbridge's CN and route permit applications for the Line 3 Replacement Project, and for other agencies and entities with permitting authority related to the Project. The Commission has ordered this EIS so they can make an informed response to applications before them for the Project.

While pipeline projects are increasingly contributing to public debate over important broader energy policy issues, many of these overarching policy issues are beyond the scope of this EIS because they

7 Minnesota Administrative Rules Part 7853.0130 (C).

8 Minnesota Administrative Rules Part 7853.0130 (D).

stretch well beyond the specific decision before the Commission. However, where the policy issues specifically relate to the CN or routes, the EIS provides a project-level assessment.

1.4.1 Long-Term Reliance on Oil

1.4.1.1 Need for This Project

The EIS Does Not Determine Need for This Project

While the need for the proposed pipeline with the proposed throughput capacity is an issue for the Commission, this EIS will not assess the Project need. Instead, the environmental impacts of reasonable alternatives for the need decision are evaluated in this EIS to aid the Commission's evaluation of the criteria set forth in Minnesota Administrative Rules Chapter 7853. Based on the criteria and the information about environmental impacts in the EIS, the Commission ultimately will determine in its CN decision whether there is a need for the proposed Project. If the Applicant is granted a CN for the proposed Project, the Applicant's proposed start and endpoints will be used in the route permit decision. If the Commission determines that alternate start and endpoints would be more reasonable and prudent, a route with these start and endpoints could be applied for.

1.4.1.2 Need for Fossil Fuels

Comprehensive Policy-Level Assessment of Fossil Fuels in Our Society and Associated Tribal Rights Issues Is Beyond the Scope of an EIS for a Single Pipeline

Beyond market demand for the oil supplied by a single pipeline, or the practicality of replacing a pipeline versus repairing aging infrastructure, much of the debate surrounding recent oil pipeline projects has focused on the environmental and social cost of continuing to use fossil fuels. These issues include the human and environmental implications of climate change, and the risks associated with extracting and transporting fossil fuels, including potential threats to human rights. Human rights include:

- The right to water;
- The right to health;
- The right to information about the potential effects of these industries;
- The right to protest; and
- Indigenous rights to free, prior, and informed consent (Barlow 2014).

In the context of the Commission's CN process, which proceeds on a project-by-project basis the EIS addresses these issues as they relate to the proposal before the Commission but does not provide a policy-level assessment of the societal implications of continued reliance on fossil fuel. For example, the EIS addresses greenhouse gas and climate change implications of the Project, but does not address the long-term climate consequences of state or federal energy policy. Similarly, the EIS addresses the impact of the Project on tribal rights and ways of life but does not address the bigger-picture consequences of state or federal energy policy for tribal communities.

1.4.2 Routing Issues

1.4.2.1 Establishing a New Mainline Corridor

The Public Is Concerned About a New Pipeline Corridor Potentially Being Established

During the scoping of this EIS, many public comments raised concerns about the establishment of a new pipeline corridor—in the Mississippi River Headwaters area specifically, and in the "Lake District" generally. This concern stems from the fact that, as the pipelines in the existing Mainline corridor age and need to be replaced, a new corridor for the Line 3 Replacement Project may become a de facto new Mainline corridor. The need for a more deliberate energy infrastructure planning process, potentially through a "generic EIS," is at the core of the public's concern. An overwhelming amount of public comment and testimony in the Sandpiper docket[9] reflects this large and complicated question.

1.4.2.2 Resource Prioritization

The EIS Establishes Facts and Does Not Prioritize Some Resources over Others

The EIS assesses potential impacts on a wide range of resources and provides quantitative and qualitative descriptions of the nature, magnitude, and duration of these impacts. In addition, the EIS compares the nature, magnitude, and duration of impacts on a given resource across various alternatives. While the presentation of impact data in the EIS highlights tradeoffs across the different alternatives so that decision-makers and other stakeholders can work from a common set of facts, the EIS does not prioritize one resource over another, nor does it prescribe how impacts on different types of resources should be weighted. The analysis in the EIS may show, for example, that some alternatives would result in greater impacts on human settlement and fewer impacts on natural resources, or more impacts on pristine waters and fewer impacts on waters that already are stressed by pollution. Decisions about whether and how to prioritize avoiding populated areas over undisturbed natural areas, and whether to concentrate infrastructure in already disturbed watersheds or spread the burden to other areas are part of the Commission's charge and are not prescribed by the EIS.

1.5 ORGANIZATION OF THE EIS

The remainder of this EIS is organized into the following 12 chapters, followed by appendices.

Chapter 2 Project Description – Describes the Project as proposed by the Applicant, including the proposed route, objectives, and estimated costs. Chapter 2 also describes the Applicant's engineering, design, construction plans, land acquisition processes, and Applicant-proposed measures to avoid and minimize environmental impacts.

Chapter 3 Regulatory Framework – Describes the regulatory framework associated with the proposed Project, including the CN and route permit processes, the EIS process, major federal and tribal permits and consultation requirements, and other state and local permits.

[9] Enbridge and North Dakota Pipeline Company LLC. 2014. Docket No. PL-6668/CN13-473. Before the Minnesota Public Utilities Commission. Revised January 31.

Chapter 4 Alternatives – Describes alternatives to the proposed Project, including the No Action Alternatives (outcomes associated with denial of the CN), and alternative routes for the route permitting decision.

Chapter 5 Existing Conditions, Impacts, and Mitigation – Certificate of Need – Describes the existing conditions of resources with the potential to be affected by the proposed Project or CN Alternatives; describes the nature, magnitude, and duration of impacts associated with the proposed Project and each CN Alternative; and recommends mitigation measures that could reduce impacts.

Chapter 6 Existing Conditions, Impacts, and Mitigation – Routing Permit – Describes the existing conditions of resources with the potential to be affected by the proposed Project or route alternatives; describes the nature, magnitude, and duration of impacts associated with each routing option; compares route alternatives from Clearbrook, Minnesota to Carlton, Minnesota; and recommends mitigation measures that could reduce impacts.

Chapter 7 Existing Conditions, Impacts, and Mitigation – Route Segment Alternatives – Describes the route segment alternatives representing minor deviations along the Applicant's preferred route and compares the nature, magnitude, and duration of impacts associated with the route segment alternatives to those associated with the corresponding portion of the Applicant's preferred route.

Chapter 8 Line 3 Abandonment and Removal – Describes the process that would be followed for abandonment or for abandonment and removal of the existing Line 3.

Chapter 9 Tribal Resources – Describes the tribal resources that could be affected by the Applicant's preferred route and the route alternatives. These resources, which tend to be interconnected natural and cultural resources, provide the means for subsistence and economic viability to many tribal members. Tribal resources also reinforce traditional practices, beliefs, and tribal values, which closely tie into the health and well-being of the tribal community.

Chapter 10 Accidental Crude Oil Releases – Describes the potential for an unanticipated crude oil release during operation of the proposed Line 3 Replacement pipeline that could adversely affect environmental and human resources. The chapter discusses the potential for failures and subsequent releases, crude oil behavior in the environment, and the types of sensitive resources that could be affected should a release occur. This chapter provides context regarding observations from historical incidents and relevant studies while focusing on the proposed Project and alternatives. Comparisons of alternatives based on the probability of a release and the potential for exposures and impacts on sensitive resources are provided. Also described are spill prevention, preparedness, and response measures that could influence the extent and duration of a release, and the potential impacts on resources that might be particularly vulnerable to crude oil exposures.

Chapter 11 Environmental Justice – Assesses the potential for the proposed Project and route alternatives to disproportionately affect low-income and minority populations; and describes the nature, magnitude, and duration of any disproportionate impacts.

Chapter 12 Cumulative Potential Effects – Describes reasonably foreseeable projects in the proposed Project area and assesses the cumulative impacts of the proposed Project in the context of these reasonably foreseeable projects, along with other past and present projects in the same area.

Chapter 13 List of Preparers – Identifies the individuals and agencies involved in preparing the EIS.

1.6 REFERENCES

Barlow. 2014. Liquid Pipeline: Extreme energy's threat to the Great Lakes and the St. Lawrence River. https://canadians.org/sites/default/files/publications/GL-Pipelines-Final-web.pdf. Accessed on April 1, 2017.

Bott, Robert. 2004. Evolution of Canada's Oil and Gas industry. Canadian Centre for Energy Information, Calgary, Alberta, Canada. (ISBN 1-894348-16-8.)

Enbridge and North Dakota Pipeline Company, LLC. 2014. Certificate of Need Application, Section 1.0. (Docket No. PL-6668/CN13-473.)

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Chapter 2
Project Description

Enbridge (the Applicant) proposes to construct, operate, and maintain a pipeline and related facilities to transport crude oil from its existing facilities in Edmonton, Alberta, Canada, to its existing terminals in Clearbrook, Minnesota, and Superior, Wisconsin. Enbridge has termed this proposed Project the "Line 3 Replacement Project." This chapter describes Enbridge's proposed Project, including Enbridge's proposed action within Minnesota and those portions of the Project that lie within North Dakota and Wisconsin. Detailed maps along the Applicant's preferred route are provided in Appendix A.

The Project information in this chapter is primarily based on public filings by the Applicant.

2.1 PROJECT SUMMARY

The Project Would Replace an Aging Pipeline and Increase Throughput

Enbridge's proposed Project would be constructed with a 36-inch-diameter pipeline and associated facilities to replace the existing 34-inch-diameter Line 3 pipeline, which currently crosses Minnesota as part of the Enbridge Mainline system corridor. Enbridge has indicated that the new pipeline would address safety and reliability, restore the line's capacity to carry heavy crude oils, and allow transport of 760,000 barrels per day (bpd), an increase over the current Line 3 operating level of 390,000 bpd.

The Project Would Primarily, but Not Always, Follow Existing Rights-of-Way

Enbridge's proposed Line 3 Replacement pipeline route would begin at the Joliette Valve near Neche, North Dakota, and extend 365 miles across Minnesota to the Superior terminal at Superior, Wisconsin (Figure 2.1-1). Approximately 340 miles of the route would be located in Minnesota. The Line 3 Replacement pipeline permanent right-of-way would follow the existing Enbridge Line 67 pipeline in the Enbridge Mainline corridor for approximately 110 miles from North Dakota to the existing Clearbrook terminal in Clearwater County. The right-of-way would diverge from the Mainline corridor at the Clearbrook terminal, routing south and then east for approximately 220 miles, where it would then rejoin the Mainline corridor near Carlton, Minnesota, and extend for approximately 10 miles to the Minnesota-Wisconsin border.

From the Clearbrook terminal to Carlton, the right-of-way would primarily follow third-party pipeline, utility, and transportation corridors, although some construction would occur through areas where no third-party utilities are present.

Enbridge Has Requested a 750-Foot Route Width for the Construction Phase

Enbridge has requested that the Commission permit a 750-foot route width (375 feet on each side of the Line 3 Replacement pipeline centerline). The 50-foot permanent right-of-way would be located within this 750-foot corridor. The 750-foot route width would encompass construction workspace for the pipeline and associated facilities, and would allow Enbridge to make small-scale refinements of the pipeline centerline within the corridor, as needed, prior to and during construction.

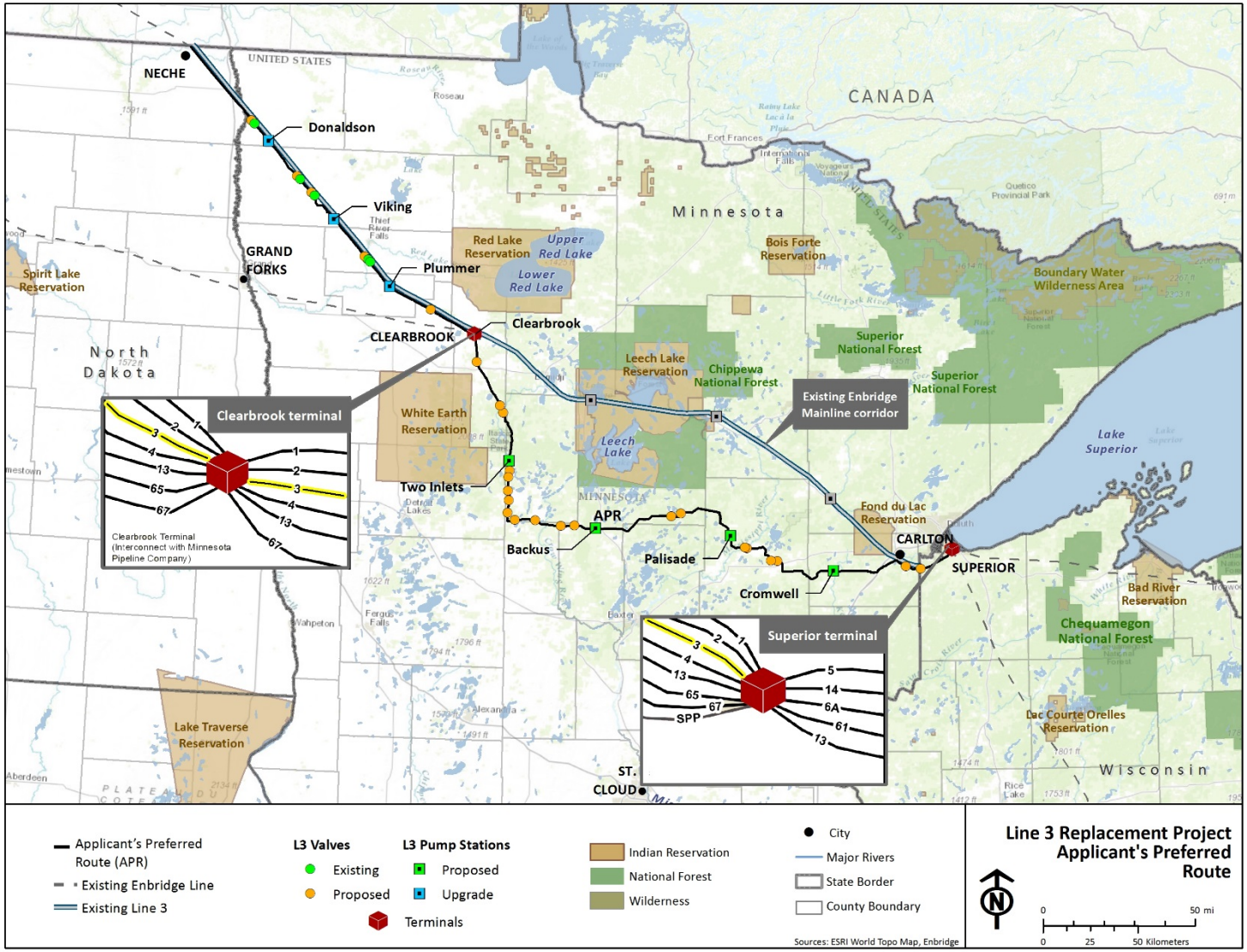

Figure 2.1-1. Overview of the Applicant's Preferred Route for the Line 3 Replacement Project

Enbridge's Application materials use the term "construction right-of-way" when referring to the temporary construction areas located alongside the permanent right-of-way that would be used temporarily for construction of the pipeline (see Section 2.7.1.2 for further information). The Applicant uses the term "construction workspace" to encompass additional temporary workspaces, or ATWS (see Section 2.3.5). This Environmental Impacts Statement (EIS) uses the term "construction work area" when referring to the temporary construction areas located alongside the permanent right-of-way, and uses the term "ATWS" when referring to the ATWS required for staging equipment, storing some excavation spoil materials, and providing additional workspace where required for special construction methods.

Pump Stations, Valves, Roads, and Cathodic Protection Systems Also Would Be Constructed

The proposed Project includes constructing and operating (new or modified) pump stations, Mainline valves (MLVs), block valves, cathodic protection systems, pipe yards, and permanent access roads. During construction, additional temporary material storage yards, contractor yards, and access roads would be required.

Pump stations include expansion of three existing pump stations in Kittson, Marshall, and Red Lake counties; expansion of one pump station and existing equipment at the Clearbrook terminal in Clearwater County; and construction of four new pump stations in Hubbard, Cass, Aitkin, and Carlton counties. Remotely controlled MLVs would be installed along the new pipeline to control and stop the flow of oil and to isolate segments of the pipeline should a pipeline leak or to perform pipeline repairs. These valves generally would be installed near populated areas, major waterbody crossings, drinking water resources, and environmentally sensitive areas. Cathodic protection systems would be installed with the buried pipelines to reduce external corrosion on the pipeline.

During Construction, the Project Would Require Additional Staging and Material Storage Areas

During construction, Enbridge would temporarily use off-pipeline-route areas (yards) for pipe and material storage, to receive deliveries of materials by rail (at rail sidings), and to park equipment and stage construction activities. Pipe yards and rail sidings would be located in Polk, Hubbard, Cass, Carlton, Red Lake, Kittson, and Beltrami counties. Contractor yard locations would be identified as planning and engineering for the Project progresses. Enbridge would attempt to use existing public or privately owned roads to gain access to construction work areas along the right-of-way. Where public or privately owned roads are not available, Enbridge would construct new access roads. Enbridge would also construct permanent access roads to each MLV.

The installed pipeline and other permanent facilities would require 2,134 acres of land; 3,309 additional acres would be required for construction.

The Existing Pipeline Would Be Removed in Accord with Existing Regulations

Enbridge proposes to permanently remove the existing Line 3 pipeline from service (i.e., abandon the pipeline) once the Line 3 Replacement pipeline is placed into service (for more details on abandonment see Section 2.9, Chapter 8, and Appendix B). Following 49 Code of Federal Regulations (CFR) 195.402 (c)(10), which details the process and requirements for pipeline abandonment, Enbridge would disconnect the existing Line 3 pipeline at each of the pump stations, purge the pipeline of all combustible materials, and permanently seal the ends of the pipeline. Enbridge would file a report with the Pipeline and Hazardous Materials Safety Administration (PHMSA) to identify where the pipeline is abandoned wherever it crosses over, under, or through a commercially navigable waterway.

2.2 PROJECT PURPOSE

Corrosion and Cracking of the Existing Pipeline Have Reduced Performance

The Line 3 Replacement pipeline would replace the existing Line 3 pipeline within the Enbridge Mainline pipeline system. The Enbridge Integrity Management Program, comprising inspections, repair, and maintenance, has detected a high amount of corrosion and long-seam cracking along the existing Line 3 pipeline.

A consent decree between Enbridge and the U.S. Department of Justice entered by the Justice Department in September 2016 on behalf of the U.S. Environmental Protection Agency and the U.S. Coast Guard (81 Federal Register 62536) requires replacement or heightened integrity work on the Existing Line 3. The consent decree has not been finalized at this time, but the draft consent decree is incorporated here by reference.[1]

Enbridge reduced discharge pressures of the Line 3 pump stations in 2008, extended the pressure reduction to the entirety of the Line 3 pipeline in 2010, and proportionately reduced the maximum allowable operating pressure of the Line 3 pipeline in 2012.

Enbridge Believes Replacing the Existing Pipeline Is Less Expensive and Avoids Extensive Inspections

Despite reducing pressure at the pump stations, along the entire line, and reducing the maximum allowable pressure, 4,000 integrity digs over the next 15 years along the U.S. portion of the line would be necessary if the Line 3 pipeline remained in service. According to Enbridge, constructing their proposed Project would be less expensive for the company than conducting the integrity dig program. Enbridge believes that the Line 3 Replacement pipeline would be less invasive than continuously conducting digs along the existing right-of-way to maintain and repair the existing Line 3 pipeline. Enbridge has estimated that it would cost $30 to $40 million per year to maintain the U.S. portion of the existing Line 3 pipeline. For comparison, Enbridge estimates maintaining the new Line 3 would cost approximately $2 million (Enbridge 2014).

Enbridge States that Demand for Canadian Crude Oil Exceeds Current Capacity

The Line 3 Replacement pipeline would be designed to transport light and heavy crude oil. The crude oil refineries of Minnesota and the other states in the northern portion of the Petroleum Administrative Defense District II, which includes Minnesota and the surrounding states of the Midwest, rely solely on crude oil transported from western Canada and the United States. The Enbridge Mainline system transported upward of 74 percent of Canadian crude oil consumed in Petroleum Administrative Defense District II in 2014. Nonetheless, Enbridge maintains the demand for crude oil feedstock from western Canada is currently greater than the capacity of the Enbridge pipeline system.

Enbridge has Indicated that Expanded Capacity Would Reduce Curtailment and Improve Operational Flexibility

As a common carrier, Enbridge is required to treat all similarly situated crude oil customers on the Enbridge Mainline system without discrimination. Thus, when demand from refineries is greater than the capacity of the pipeline system, Enbridge must apportion the pipeline capacity as regulated by the

[1] United States of America v. Enbridge Energy, Limited Partnership, Draft Revised Following Public Comment available at: https://www.epa.gov/enbridge-spill-michigan/revised-enbridge-consent-decree.

Federal Energy Regulatory Commission, typically resulting in all refineries receiving less capacity to transport crude oil nominations than requested.

Enbridge's objective for the proposed Line 3 Replacement project would be to restore the capability of this line to carry heavy crude and increase capacity, which would allow operational flexibility to the Enbridge system. This would reduce ongoing and forecasted apportionment to the refining industry in eastern Canada, the Gulf Coast, and the Midwest, including the Flint Hills and Northern Tier Energy refineries in Minnesota. Although the increased capacity of the Line 3 Replacement pipeline would not be sufficient to meet all of the demand noted, Enbridge's goal would be to increase its ability to respond to fluctuating demand of different refineries in the United States in general and in Minnesota in particular.

Expanded Capacity Would Improve Energy Efficiency on Enbridge's System

According to Enbridge, the increased capacity of the Line 3 Replacement pipeline also would increase the energy efficiency of transporting crude oil. The gain in energy efficiency would result from the principle that pumping the same volume of crude oil through a 36-inch-diameter pipeline as through a 34-inch-diameter pipeline requires lower pressure due to decreased friction in the larger pipeline. The lower pressure required translates to less horsepower, and consequently less energy, needed to operate the pumps. Increased operational flexibility resulting from increased capacity would allow Enbridge to operate its pipeline system as efficiently as possible.

2.3 PROPOSED FACILITIES

The permanent and temporary facilities proposed to be constructed or used as part of the proposed Line 3 Replacement Project are (as discussed below) the pipeline, associated facilities, permanent access roads, temporary contractor and material/pipe storage yards, additional temporary workspaces, and temporary access roads.

An overview of the Applicant's preferred route and proposed facilities is shown in Figure 2.1-1. Land requirements for the installed pipeline and other permanent facilities would be 2,134 acres; 3,309 additional acres would be required for construction. Detailed route maps are provided in Appendix A.

2.3.1 Pipeline

Proposed Pipeline Would Primarily Follow Existing Rights-of-Way

In Minnesota, Enbridge's proposed Line 3 Replacement pipeline would consist of approximately 340 miles of new 36-inch-diameter underground pipeline that would enter Minnesota approximately 10 miles southwest of the city of Hallock in Kittson County and traverse southeast through Marshall, Pennington, Red Lake, and Polk counties to the existing Enbridge Clearbrook terminal in Clearwater County. The proposed Line 3 Replacement pipeline right-of-way would be primarily co-located with the Enbridge Line 67 pipeline for 110 miles from where the right-of-way would enter Minnesota to the Clearbrook terminal.

From the Clearbrook terminal, the route would continue south through Clearwater and Hubbard counties and then turn east through Wadena, Cass, Crow Wing, Aitkin, and Carlton counties (Table 2.3-1). Throughout this area, the Line 3 Replacement pipeline right-of-way would be primarily co-located with the Minnesota Pipe Line Company pipeline right-of-way until it reached the southern

extent of Hubbard County. At the southern end of Hubbard County, the right-of-way would turn and be routed eastward, where it would then be generally co-located with third-party electric transmission, pipeline, and transportation corridors, although some portions would not be co-located with existing utility corridors.

Table 2.3-1. Pipeline Length by County for the Line 3 Replacement Project

County	Milepost Range[a]	Approximate Pipeline Length	
		Miles	Percent
Kittson	801.8 – 816.9	15.4	4.5
Marshall	816.9 – 851.7	36.3	10.7
Pennington	851.7 – 871.3	19.7	5.8
Red Lake	871.3 – 886.9	15.7	4.6
Polk	886.9 – 900.5	14.0	4.1
Clearwater	900.5 – 942.8	42.2	12.4
Hubbard	942.8 – 987.4	44.6	13.1
Wadena	987.4 – 994.4	7.1	2.1
Cass[b]	994.4 – 1015.8	21.4	6.3
	1020.6 – 1046.7	26.1	7.7
Crow Wing	1015.8 – 1020.6	4.8	1.4
Aitkin	1046.7 – 1098.3	51.6	15.2
Carlton	1098.3 – 1139.3	41.0	12.1
TOTAL		**339.7**	**100**

[a] Milepost numbering begins at the Hardisty terminal in Alberta, Canada. Mileposts are used as reference markers only; they are not accurate indicators of pipeline lengths.

[b] Two milepost ranges are presented for Cass County because the route would exit Cass County into Crow Wing County and then re-enter Cass County.

The Line 3 Replacement pipeline would cross the Minnesota-Wisconsin border in Carlton County approximately 12 miles southeast of the city of Cloquet, Minnesota (Figure 2.1-1). Approximately 3 miles southwest of the city of Carlton, the right-of-way would rejoin and be co-located with the Enbridge Mainline system for approximately 10 miles until it crossed the Minnesota-Wisconsin border in eastern Carlton County.

The Life of the Proposed Pipeline Could Be Indefinite, with an Economic Life of More Than 30 Years

The Applicant anticipates that the physical life of the Line 3 Replacement pipeline (i.e., the number of years that the pipeline would be capable of transporting crude oil) would be indefinite given appropriate construction, maintenance, and integrity systems. The economic life of the Project (i.e., the number of years that continued operation of the Project would be feasible) is anticipated to be no less than 30 years.

Design Capacity Would Be 844,000 bpd, with Annual Capacity of 760,000 bpd, with Annual Capacity of 760,000 bpd

The capacity of a liquids pipeline is expressed as design capacity or annual capacity. "Design capacity" is the theoretical flow rate of a pipeline for a specific type of liquid and is calculated assuming theoretically ideal operating conditions. In liquid petroleum pipelines, the design capacity is the maximum instantaneous throughput that a pipeline is capable of achieving under design conditions for a specific liquid. The design capacity of the Line 3 Replacement pipeline would be 844,000 bpd, assuming that the total volume of crude oil transported by the pipeline would consist of 65 percent heavy crude oil and 35 percent light crude oil. This flow rate is also based on the number, spacing, and horsepower of the pump stations that are proposed.

"Annual capacity" is the average sustainable throughput over a year and is calculated assuming average annual historical operating conditions, including scheduled and unscheduled maintenance and the availability of crude oil. The annual capacity of a pipeline is typically 90 percent of its design capacity. Based on the proposed pipeline design and pumping capacity, the annual capacity of the Line 3 Replacement pipeline would be approximately 760,000 bpd.

The maximum allowable operating pressure would be 1,440 pounds per square inch gauge (psig). The pipeline would be designed to withstand pressures over and above normal operating pressures, and would operate according to applicable codes and regulations.[2]

2.3.2 Associated Facilities

Associated Facilities Were Located after Hydraulic Studies and in Accord with Federal Regulations

Additional facilities associated with the Line 3 Replacement pipeline include modified and new pump stations, MLVs, and cathodic protection systems.

Appropriate locations for pump stations along the pipeline route were determined by hydraulic studies of the pipeline operations that optimized pumping requirements at the design capacity. Optimizing the pumping requirements in turn minimizes the amount of energy needed for pumping.

MLVs were located based on federal regulations[3] for protection of human and natural resources during hydraulic operation of the pipeline.

Cathodic protection sites were located adjacent to the permanent pipeline right-of-way as required to meet the operational requirements of the cathodic protection system.

The location of pump stations and currently planned MLVs are shown in Figure 2.1-1.

[2] 49 CFR 195 Subpart F.

[3] 49 CFR 195.260. (See details in Section 2.3.2.2.).

2.3.2.1 Pump Stations

2.3.2.1.1 Modification of the Clearbrook Terminal

Area of Clearbrook Terminal Would Permanently Expand by About 13 Acres

As part of the proposed Project, Enbridge would modify and expand the existing Clearbrook terminal at milepost (MP) 909.4 in Clearwater County, Minnesota. The expansion would include installation of four additional pumps and associated equipment, including:

- Four 7,000-horsepower (hp) electric motor and pump units;
- Two 7,000-hp variable frequency drives;
- A crude oil reinjection pump and sump tank;
- A 36-inch pipeline inspection gauge (PIG) launcher;
- Valves, metering equipment, pump station-to-terminal interconnections, and associated terminal piping;
- Instrumentation and monitoring equipment; and
- Associated electrical facilities, including a substation with redundant utility transformers and breakers.

Additional modification of the Clearbrook terminal would include:

- An additional 36-inch PIG receiver;
- A pressure relief system;
- Additional valves, metering equipment, terminal piping, and manifold interconnections;
- Instrumentation and monitoring equipment and associated electrical facilities; and
- A 16-inch meter manifold run with associated valves, interconnections, piping, instrumentation, electrical facilities, and sample system, which would be added to the existing meter manifold 152.

The existing Clearbrook terminal would be permanently expanded by approximately 13 acres. An additional approximately 2 acres would be temporarily disturbed during construction of the Clearbrook terminal expansion (Table 2.3-2). This acreage would be restored to preconstruction conditions once construction is complete. Plot plans showing the boundary of the Project area for expansion of the Clearbrook terminal, including electrical and spill containment facilities associated with the existing Clearbrook terminal and details of pipeline routes in the vicinity of the expanded terminal, are provided in Appendix C.

Table 2.3-2. Locations and Land Requirements for the Clearbrook Terminal Expansion and Pump Stations for the Line 3 Replacement Project

Facility	County	Milepost	Construction Area (acres)	Permanent Area (acres)
Terminal Expansion				
Clearbrook terminal	Clearwater	909.4	15.3	13.3
Modification of Existing Pump Stations				
Donaldson pump station	Kittson	814.5	8.0	7.1
Viking pump station	Marshall	848.2	10.1	7.7
Plummer pump station	Red Lake	877.0	8.2	8.2
Subtotal			***26.3***	***23.0***
New Pump Stations				
Two Inlets pump station	Hubbard	956.1	10.1	8.1
Backus pump station	Cass	1006.7	9.4	7.4
Palisade pump station	Aitkin	1061.2	9.3	7.3
Cromwell pump station	Carlton	1108.1	7.3	5.7
Subtotal			***36.1***	***28.5***
TOTAL			**77.7**	**64.8**

2.3.2.1.2 Modification of Existing Pump Stations

23 Acres Would Be Permanently Disturbed by Pump Station Modifications

Enbridge would modify three existing pump stations located along the Enbridge Mainline system corridor right-of-way west of the Clearbrook terminal. At each facility, Enbridge would install additional pumps, MLVs, metering and monitoring equipment, and associated electrical facilities.

Each pump station, including the Clearbrook terminal, would have a maximum allowable operating pressure of 1,440 pounds per square inch gauge (psig) and an average annual capacity of 760,000 barrels per day (bpd). The maximum power capacity of the motors at each of the facilities would be 7,000 hp.

Approximately 26 acres would be temporarily disturbed during construction of the modified pump stations, and 23 acres would be permanently converted as a result of the modifications. Plot plans showing the boundary of the Project area for expansion of the existing pump stations, including the electrical and spill containment facilities associated with the existing pump stations and details of pipeline routes through the pump stations, are provided in Appendix C.

2.3.2.1.3 New Pump Stations

29 Acres Would Be Permanently Disturbed by Construction of New Pump Stations

Enbridge would construct new pump stations at four locations along the right-of-way east of the Clearbrook terminal. Each facility would contain three 7,000-hp motor and pump units with a maximum operating pressure of 1,440 psig and an average annual capacity of 760,000 bpd. The stations would also include MLVs, metering, monitoring equipment, and associated electrical facilities. In addition, the Backus pump station would contain a PIG receiver and launcher traps (see Section 2.8.2.1 for additional information on PIGs).

A total of 36 acres would be temporarily disturbed during construction of the new pump stations, and 29 acres would be permanently converted (Table 2.3-2).

2.3.2.2 Mainline Valves and Pressure Transmitters

MLVs and Pressure Transmitters Would Be Placed to Best Protect the Environment

MLVs are remotely controlled valves that are operated to shut down movement of oil in the pipeline and to isolate segments of the pipeline in the event of a leak or to perform pipeline repairs. MLVs are used as safeguards near populated areas, major waterbody crossings, drinking water sources, and environmentally sensitive areas identified during environmental review and permitting.

Each MLV location would contain a slide gate valve that could be remotely controlled from the Enbridge Control Center or manually operated; digital pressure and temperature monitoring equipment; and associated electrical and communications equipment necessary to control the MLVs and transmit pressure and temperature information to the Control Center.

Enbridge conducted an analysis to determine the most appropriate locations for MLVs in compliance with the requirements of 49 CFR Part 195.260. Once the optimal locations for MLVs are chosen, Enbridge must then conduct field surveys to confirm that there are no constraints to locate the MLVs at the given sites, obtain landowner agreement to locate the MLVs at the given sites, and submit the final locations listing to PHMSA for review to confirm compliance with 49 CFR Part 195.260. Based on these criteria, Enbridge is proposing to install 27 MLVs. As a result of the action of permitting agencies with jurisdiction, including PHMSA, however, the final number and location of MLVs may be modified.

MLVs and Pressure Transmitters Would Require Negligible Space

Enbridge also would install two pressure transmitters in conjunction with the MLVs. Pressure transmitters monitor pipeline pressure at specific points and transmit the values electronically to a control system. Pressure transmitters and MLVs are located within the permanent right-of-way; therefore, their number and location do not affect the total land area required for construction and operation of the proposed Project. A typical valve installation in the permanent pipeline right-of-way is shown in Figure 2.3-1. Each valve would be enclosed within a security fence and encompass an area of approximately 0.1 acre.

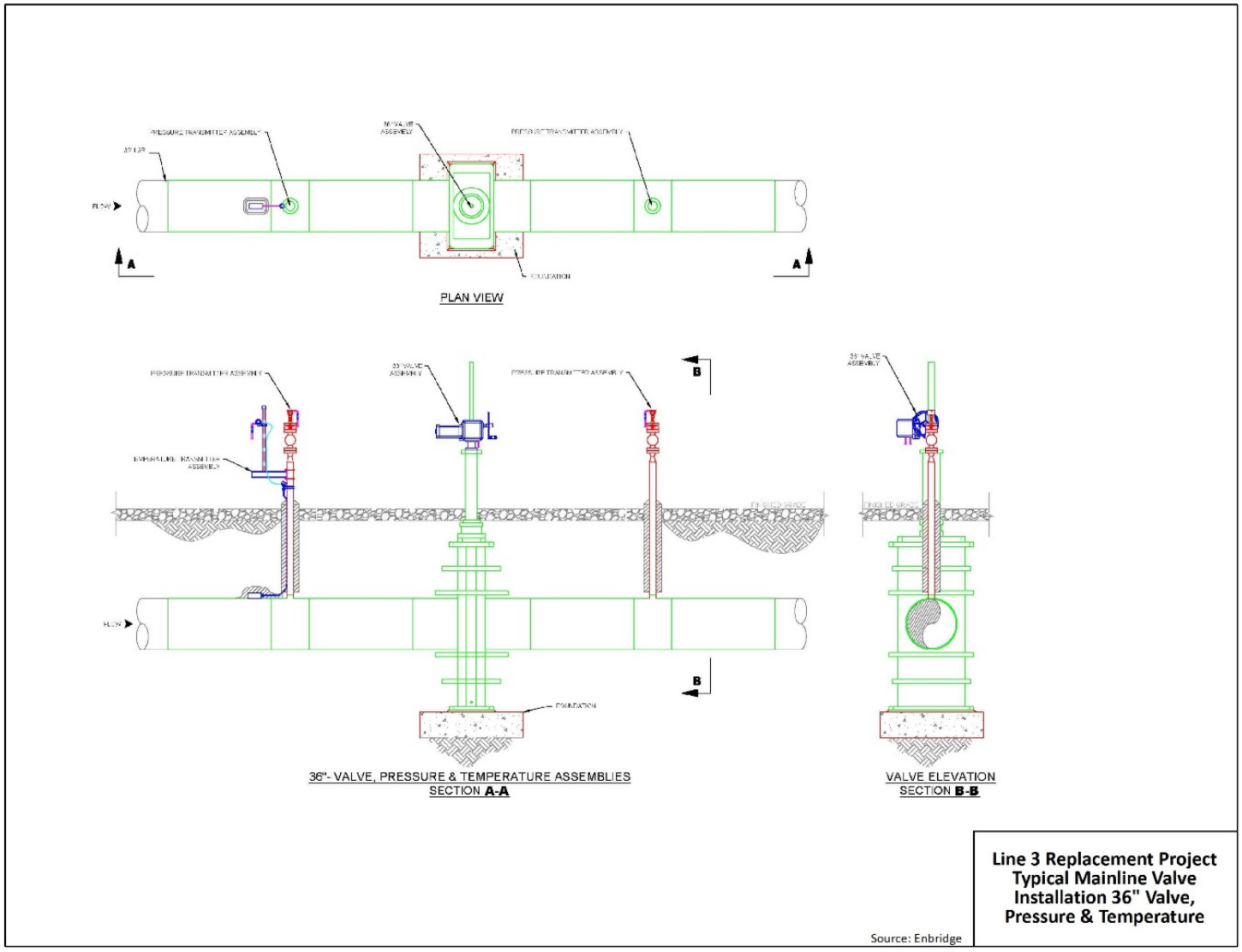

Figure 2.3-1. Typical Mainline Valve Installation

2.3.2.3 Cathodic Protection Systems

Cathodic Protection Would Be Installed Within a Year After Construction

The buried pipeline would be protected from external corrosion by application of a coating to the pipeline and by installation and operation of a cathodic protection system. A cathodic protection system must be constructed and operated in accordance with the requirements of 49 CFR Subpart H – Corrosion Control (Section 195.563 and Sections 195.567 through 195.577). The cathodic protection system electrically connects the pipeline to anodes buried in ground beds adjacent to the pipeline and located along the pipeline route. The cathodic protection system would be located within the right-of-way disturbed for construction.

The area necessary for the cathodic protection system anode beds would range between 0.2 and 0.6 acre per system, and the only aboveground features at each site would be a junction box and small-diameter vent pipe installed above the deep well beds.

Enbridge also would install alternating current/direct current mitigation to protect the pipeline and cathodic protection system from electromagnetic-induced voltage and stray current from co-located electric transmission lines. Enbridge would assess the electric transmission lines (that the Line 3 Replacement pipeline would be co-located with) to determine the extent of cathodic protection necessary for the Project. Section 195.563 of 49 CFR Subpart H – Corrosion Control states that cathodic protection must be in operation no later than 1 year after the pipeline is constructed.

2.3.3 Permanent Access Roads

Permanent Roads Would Provide Access to Pump Stations and MLVs

Enbridge proposes to construct or improve permanent roads along the permanent right-of-way to access the pump stations. Enbridge also proposes to construct permanent roads along the permanent right-of-way to access the MLVs in accordance with the request of the Minnesota Public Utilities Commission. The amount of land required would range from 0.1 to 0.5 acre, with the average being closer to 0.1.

2.3.4 Temporary Contractor and Material/Pipe Storage Yards

Temporary Construction Sites Would Be Restored After Use

Construction of the Line 3 Replacement pipeline would require that land be temporarily used for pipe and materials storage, construction staging, and offloading rail deliveries of construction materials. These pipe and material storage yards, contractor yards, and rail sidings would be located apart from the pipeline right-of-way.

Enbridge proposes to lease the sites on which the yards would be located and restore the land to its general condition prior to use once it is no longer required for construction. Several locations for pipe yards have received National Pollution Discharge Elimination System (NPDES) Construction Stormwater (CSW) permits through the Minnesota Pollution Control Agency (Minnesota PCA). These NPDES permits authorize ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on the construction sites.

Temporary Sites Chosen by Proximity, Accessibility, Ability to Be Restored, and Landowner Approvals

These NPDES permits authorize ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on the construction sites. Rail sidings would be placed on land currently used for railroads, and pipe yards would be located on cultivated or uncultivated agricultural land. The locations of contractor yards would be determined as Project planning progresses. Locations for contractor yards would be chosen based on their proximity to the construction work area, access by sufficient load-rated haul roads, water drainage capabilities from soil and topography at the sites, ability for restoration of the sites to preconstruction conditions, and landowner approvals.

2.3.5 Additional Temporary Workspaces

Each ATWS Would Require Less Than Half an Acre

Outside of the construction work area along the pipeline alignment, ATWS would be required for staging equipment, storing some excavation spoil materials, and providing additional workspace where required for special construction methods. ATWS might, for example, be needed where the pipeline crosses waterbodies, wetlands, steep slopes, roads, railroads, and other pipelines or utilities. ATWS will also use appropriate stormwater erosion prevention and sediment control best management practices (BMPs) per Minnesota PCA's NPDES CSW Permit.

Additionally, ATWS would be required for accommodating equipment and resources necessary at horizontal directional drilling (HDD) sites and for withdrawing and discharging water during cleaning and hydrostatic testing of the pipeline. Generally, ATWS would be located adjacent to the construction work area and measure half an acre or less. Dimensions of ATWS would vary according to site-specific conditions.

2.3.6 Temporary Access Roads

288 Proposed Access Roads Would Disturb Approximately 271 Acres

During construction, Enbridge proposes to use public roads wherever possible. Where public roads do not cross the right-of-way, Enbridge would request the use of privately owned roads. If neither public nor private roads are available, Enbridge would construct new access roads. Enbridge would need to obtain environmental permits and landowner permission for use or modification of existing public and private roads and construction of new access roads.

Enbridge has proposed a preliminary list of 288 access roads distributed throughout the counties in the Project (Appendix D). At some points along the pipeline route, final construction planning and Project permitting could require additional or different access roads. Enbridge estimates that roads used to access the construction work area along the pipeline route would temporarily disturb approximately 271 acres, based on a standard 30-foot-wide road. Of the proposed 288 access roads, 75 would be existing roads, 172 would be new roads, and 41 would be a combination of new and existing roads.

A final list of roads proposed to access the construction work area and the degree to which the roads would need improvement will not be available until the final planning and engineering phase of the Project.

Temporary access roads will also use appropriate stormwater erosion prevention and sediment control BMPs per Minnesota PCA's NPDES General CSW permit.

2.4 RIGHT-OF-WAY REQUIREMENTS

Rights-of-Way Would Differ for Different Segments of the Proposed Pipeline

Construction of the Line 3 Replacement pipeline would generally require a 50-foot-wide permanent right-of-way in uplands and an additional 70-foot-wide construction work area (Table 2.4-1). The combined 120-foot-wide construction work area would be required to accommodate construction vehicles, string and install the pipeline, and temporarily store topsoil and trench spoil. In wetlands, the width of the construction work area would be reduced to 95 feet.

From the North Dakota-Minnesota border to the Clearbrook terminal and from Carlton to the Minnesota-Wisconsin border, approximately 40 feet of the Line 67 pipeline permanent right-of-way would be included as part of the construction work area for the Line 3 Replacement pipeline. After construction, 25 of the 40 feet of the Line 67 pipeline permanent right-of-way would serve as shared permanent right-of-way for the Line 3 Replacement and Line 67 pipelines, resulting in 25 feet of new permanent right-of-way attributable to the Line 3 Replacement pipeline in both uplands and wetlands.

Between the Clearbrook terminal and Carlton, the permanent right-of-way for the pipeline would be 50 feet wide in both uplands and wetlands. Plan views of the permanent right-of-way and the construction work area with respect to the pipeline alignment are shown in Figures 2.4-1 through 2.4-6.

Table 2.4-1. Temporary Construction Work Area, Permanent Right-of-Way, and Total Land Requirements for the Line 3 Replacement Project

Route Segment	Temporary Construction Work Area (feet)[a]	Permanent Right-of-Way (feet)	Total Land Requirements (feet)	Corresponding Plan View Figure for Reference
North Dakota-Minnesota border to Clearbrook terminal – co-located with existing Enbridge pipeline (Line 67)	70 (upland)	50 (~25 new)	120 (upland)	2.4-1
	45 (wetland)		95 (wetland)	2.4-2
Clearbrook terminal to Minnesota-Wisconsin border – co-located with existing third-party utilities or greenfield construction	70 (upland)	50	120 (upland)	2.4-3, 2.4-5
	45 (wetland/ saturated wetland)		95 (wetland/ saturated wetland)	2.4-4, 2.4-6

[a] Construction work area includes the temporary construction work area plus the permanent right-of-way.

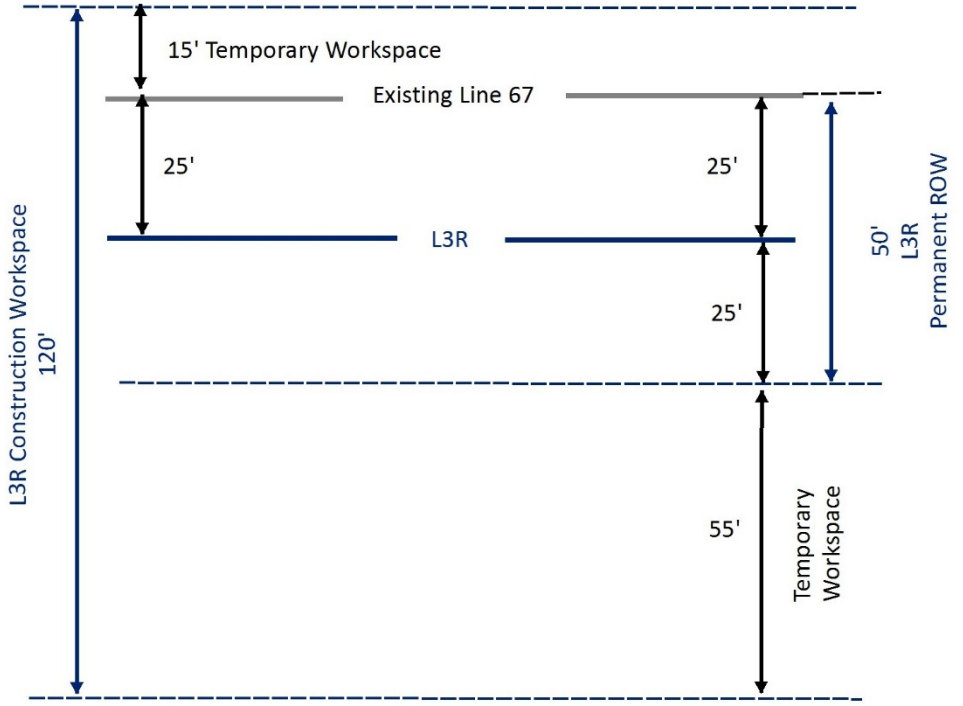

Figure 2.4-1. Plan View – Proposed Co-Location of the Line 3 Replacement Pipeline Right-of-Way with the Existing Line 67 Pipeline Right-of-Way in Uplands

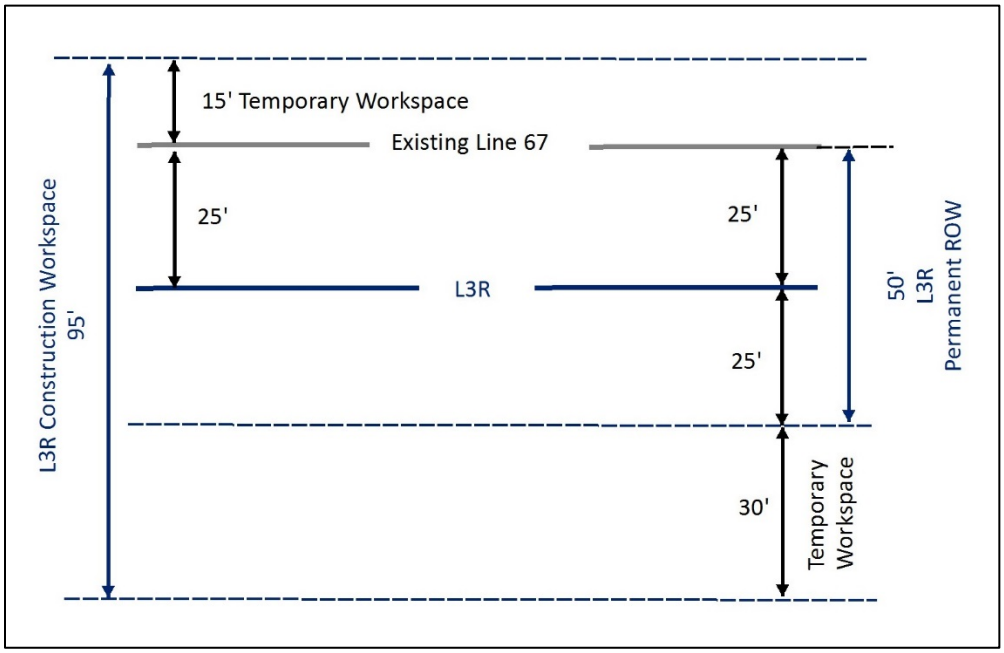

Figure 2.4-2. Plan View – Proposed Co-Location of the Line 3 Replacement Pipeline Right-of-Way with the Existing Line 67 Pipeline Right-of-Way in Wetlands

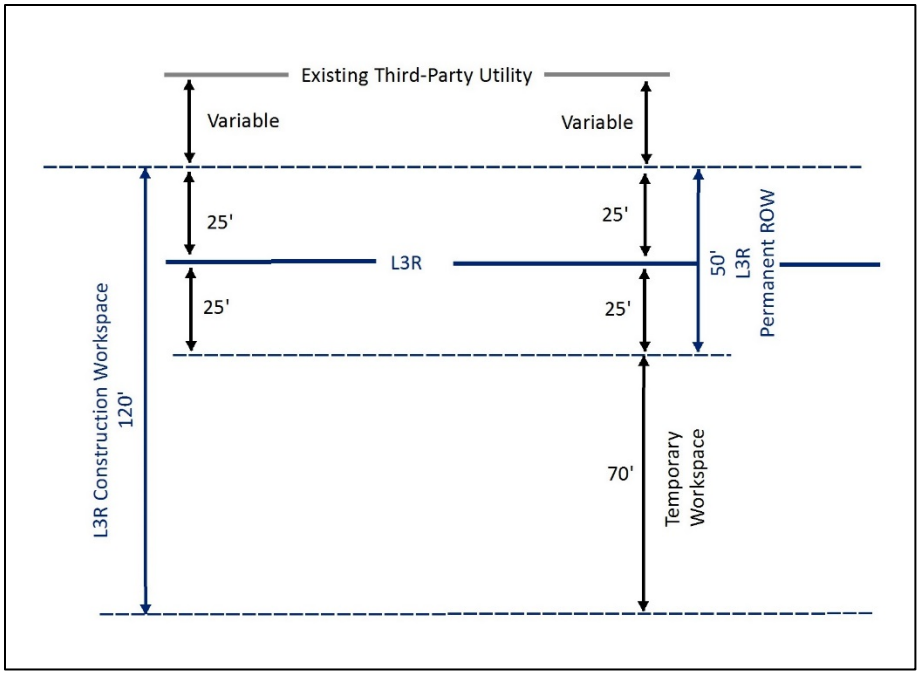

Figure 2.4-3. Plan View – Proposed Co-Location of the Line 3 Replacement Pipeline Right-of-Way with Existing Pipelines, Transmission Lines, and Highways in Uplands

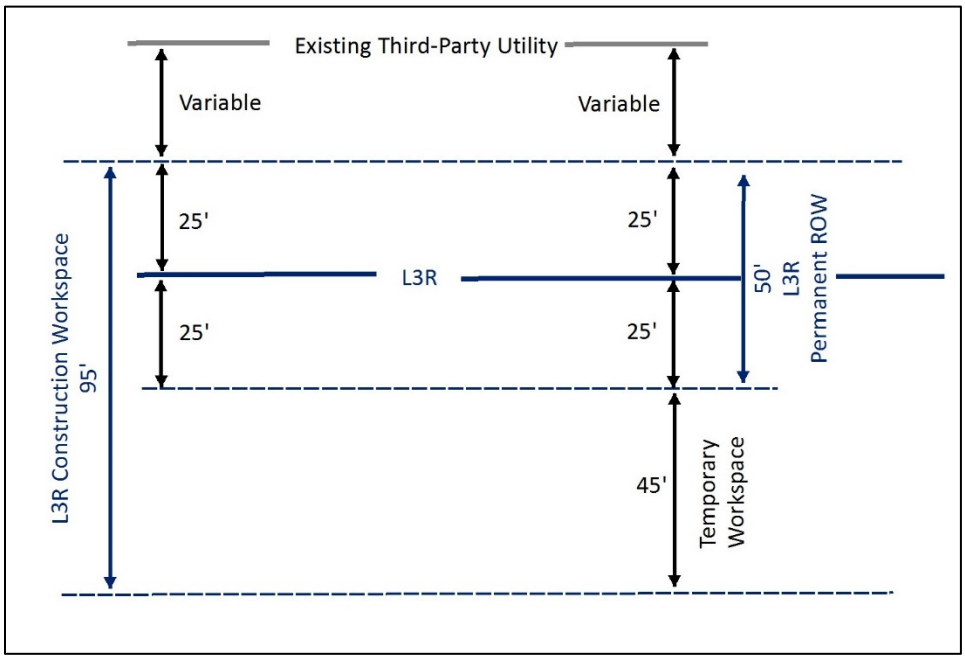

Figure 2.4-4. Plan View – Proposed Co-Location of the Line 3 Replacement Pipeline Right-of-Way with Existing Pipelines, Transmission Lines, and Highways in Wetlands

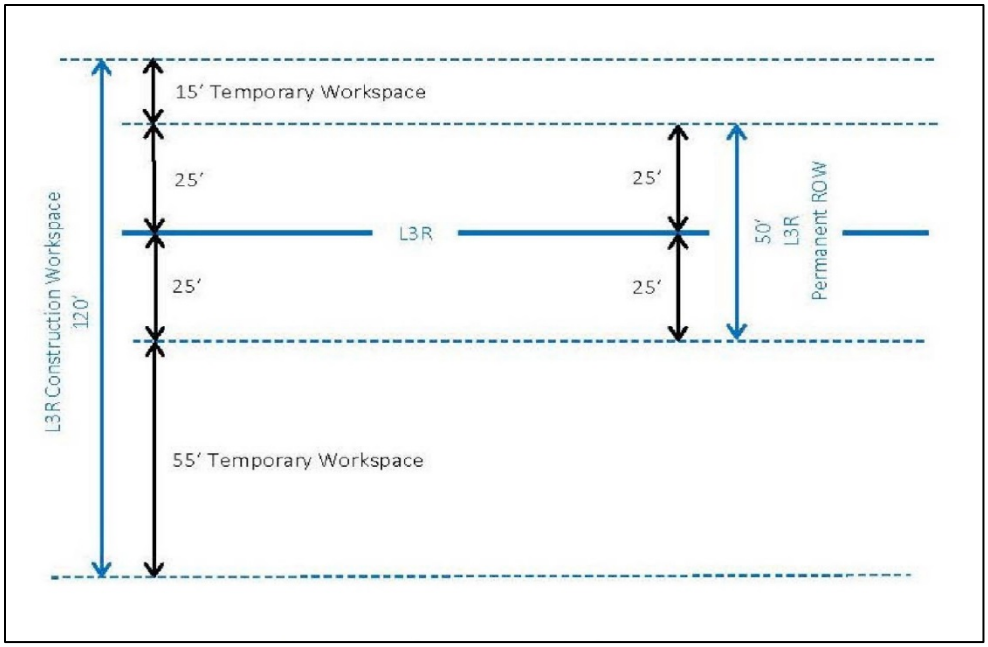

Figure 2.4-5. Plan View – Permanent Right-of-Way and Construction Work Area for Line 3 Replacement Pipeline Route not Co-Located with Other Facilities in Uplands

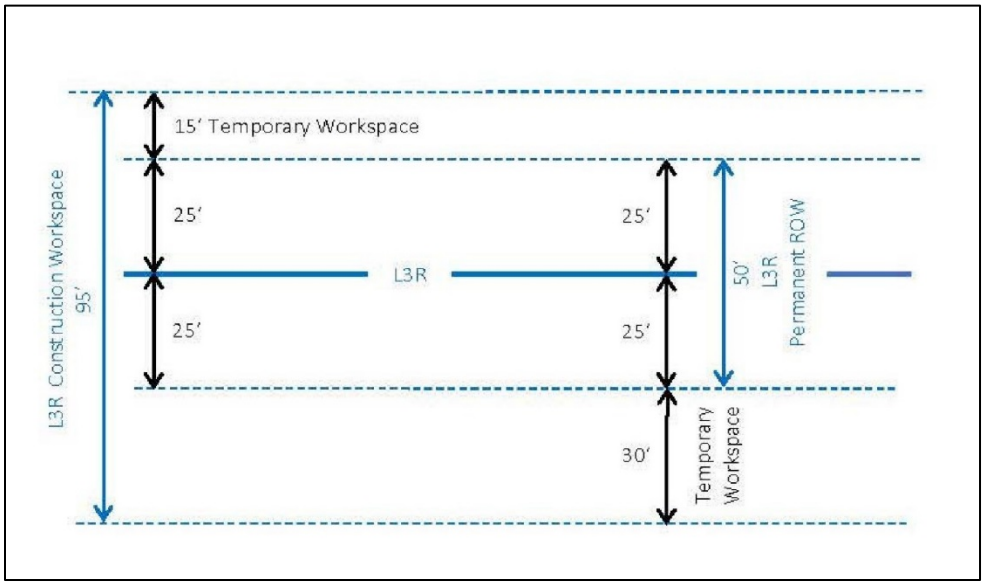

Figure 2.4-6. Plan View – Permanent Right-of-Way and Construction Work Area for Line 3 Replacement Pipeline Route not Co-Located with Other Facilities in Wetlands

2.5 PROJECT COSTS

Total Costs in Minnesota Would Be $2.1 Billion, Excluding Land Purchases and Some Other Items

Enbridge expects the total costs of designing, permitting, and constructing the Line 3 Replacement Project from Hardisty, Alberta, Canada, to Superior, Wisconsin, to be $7.5 billion. Enbridge expects the U.S. portion of the Project to total approximately $2.6 billion and the Minnesota portion of the Project to account for approximately 80 percent, or $2.1 billion, of the U.S. total.

2.6 PROJECT SCHEDULE

Once Approved, Construction Would Start, with Commissioning Expected within 12 Months

Enbridge proposes to begin building the Line 3 Replacement pipeline and associated facilities as soon as all construction-related regulatory approvals have been obtained. Enbridge plans to complete construction, testing, and commissioning of the new pipeline and associated facilities within approximately 12 months of initiating construction. Final restoration activities would likely extend beyond 12 months.

Prepositioning of pipe, construction materials, and construction equipment would begin approximately 60 days before the commencement of construction and would be expected to be completed within 45 days. Construction activities would be conducted simultaneously across seven construction segments. The planned construction spreads would be delineated as follows:

- Spread 1: MP 789.4 – MP 848.2
- Spread 2: MP 848.2 – MP 909.4
- Spread 3: MP 909.4 – MP D962.6
- Spread 4: MP D962.6 – MP D1014.4
- Spread 5: MP D1014.4 – MP D1066.6
- Spread 6: MP D1066.6 – MP D1118.3
- Spread 7: MP D1118.3 – MP 1097.8

Construction spreads 1 and 2 and portions of spreads 3 and 7 would be along Enbridge's Mainline corridor. The remaining construction would be conducted along other rights-of-way or a new corridor (mileposts identified with a "D").

Enbridge proposes to begin building pump stations as soon as they are permitted and expects that pump stations would be completed within approximately 10 months, depending on contractor availability, final design, and weather-induced delays. The order of events for typical construction efforts is described in Section 2.7.

Testing and certification would include hydrostatic testing and caliper tool runs. Testing and certification would be completed before line fill begins.

Commissioning would take place once all hydrostatic testing, caliper tool runs, and pump station construction is completed and would likely take about 45 days per pump station, with overlapping schedules across 3 months.

2.7 CONSTRUCTION METHODS

Measures are Proposed to Minimize Construction Impacts

This section describes the procedures that Enbridge would follow while constructing the Line 3 Replacement pipeline and associated facilities, yards, and roads. It also summarizes the measures Enbridge would be required and/or has proposed to take to avoid or minimize potential impacts from the Project.

Based on regulatory requirements and industry BMPs, Enbridge has developed and proposed various measures for minimizing the potential impacts of construction and operation. Enbridge has committed to implementing and adhering to these Applicant-proposed measures, and they are considered are part of the proposed Project. Additional details about some of these measures are contained in Appendices E, F, and G. Specific regulatory requirements that will govern construction are addressed in Chapters 5 and 6 as well as additional mitigation measures to further minimize construction impacts.

2.7.1 Conventional Pipeline Construction Procedures

2.7.1.1 Construction Monitoring and Inspection

Construction Would Be Monitored and Inspected by Both Enbridge and State Agencies

Construction of the proposed Project would be subject to the requirements of a number of permit programs that are in place to manage impacts to the environment. Monitoring and inspection are requirements under the relevant permit programs for this Project. For example, under Minnesota PCA's NPDES CSW Permit, Enbridge will be required to conduct monitoring and inspections related to stormwater.

Consistent with the relevant permit programs, which are discussed in greater detail in Chapters 5 and 6, Enbridge proposes a two-tiered program for monitoring and inspecting construction: (1) a direct program of Environmental Inspectors (EIs); and (2) an independent third-party system of monitors to be implemented by state agencies.

EIs supplied by Enbridge would monitor and document compliance with company requirements, and the requirements of permit conditions,[4] the environmental protection measures contained in the Environmental Protection Plan included as Appendix E, and contract specifications. The specific concerns of landowners along the pipeline route would also be monitored during construction.

EIs Would Identify Environmental Issues and Train Project Personnel

EIs would serve as liaisons between Enbridge's Project management personnel, construction contractors, and federal and state agency officials. Their designated responsibilities would include identifying and marking environmentally sensitive areas to avoid during construction, clarifying environmental requirements within permit conditions, identifying potential environmental issues or challenges that might arise on a construction spread, and providing day-to-day oversight to ensure that construction practices abide by Enbridge's Environmental Protection Plan.

[4] Minnesota PCA's NPDES CSW Permit would require stormwater-specific inspections of all active construction areas and areas of exposed soils every 7 days and after every rainfall event of 0.5 inch or greater.

The EIs also would conduct appropriate environmental training for Project construction personnel, including how to identify and provide notification of the presence of sensitive environmental resources (such as cultural and archaeological resources and threatened or endangered species). EIs would have the authority to stop construction activities and order corrective mitigation for actions that fail to comply with the environmental requirements imposed on the Project, including permit conditions and landowner agreements. Information on compliance provided by the EIs would be entered into an Enbridge database of Project commitments, permit conditions, and regulatory requirements.

State Agencies Would Independently Monitor Construction

Enbridge has committed to participating with state agencies with jurisdiction to establish a third-party monitoring program. Third-party monitors are independent monitors who document compliance with the environmental requirements of permits and Enbridge's construction plans. They do not have stop-work authority but do submit daily reports about construction activities to Enbridge and the agencies. Enbridge would coordinate with the participating agencies to identify the appropriate qualifications of the third-party monitors and determine their specific role during construction.

2.7.1.2 Construction Work Area

In the Construction Area, Storage and Work Areas Would Be Separated

The full width or limits of the pipeline construction work area would be 120 feet in uplands and 95 feet in wetlands. Within the construction limits would be two areas: one area for temporary storage of topsoil and trench excavation spoil (the non-working area), and a second area for active construction (i.e., the actual working area and travel lane for construction equipment) (Figure 2.7-1). The construction limits would include both the permanent right-of-way and the temporary construction work area.

Width of Temporary Work Area Would Be Determined by Co-Location Opportunities and Terrain

Three different conditions exist along the pipeline route that determine the width of the temporary construction work area within the overall 120-foot-wide construction limits: the pipeline would be located (1) near an existing Enbridge easement; (2) near utilities owned by others; and (3) not near any existing Enbridge easements or other utilities.

From the Minnesota border to the Clearbrook terminal and from the Carlton Junction to the Wisconsin border, the pipeline would be installed adjacent to Enbridge's Line 67 where the company maintains an existing easement. In these segments of the route, a portion of the Line 67 easement would be used for the non-working area, as shown in Figures 2.4-1 and 2.4-2.

The portion of the route east of the Clearbrook terminal generally runs adjacent to pipelines, transmission lines, or roads owned by others where Enbridge does not have access to the adjacent easement. In these segments of the route, space is not available to extend the construction limit beyond the limit of permanent easement; therefore, the entire work area would be on one side of the pipeline alignment, as shown in Figures 2.4-3 and 2.4-4.

In some portions of the route between the Clearbrook terminal and the Carlton Junction, the route is not co-located with other facilities, and temporary construction work area can be used on both sides of the pipeline alignment, as shown in Figures 2.4-5 and 2.4-6.

In wetland areas, the overall width of the construction limits would be reduced to 95 feet. This would reduce the active working area from 80 feet to 55 feet in wetland areas.

During construction, the topsoil and trench spoil would be segregated where required by permit conditions.[5] Trench spoil would be stored on the opposite side of the pipe trench from the construction work area, within the non-working portion of the construction work area. Segregated topsoil typically would be stored along the outer edge of the construction work area opposite of the pipe trench or within an ATWS. In some instances, topsoil may be stored on the trench spoil side of the construction works area (Figure 2.7-1). The sections below discuss clearing and grading of the construction work area and associated erosion control measures that would be implemented during this process.

2.7.1.3 Typical Pipeline Construction Procedures

Before Excavating, Work Area Would Be Surveyed and Safety Precautions Would Be Taken

First, the construction work area and ATWS would be surveyed and staked. The construction work area would then be cleared and graded as necessary. Silt fencing or other erosion and sediment control devices (ECDs) would be installed, and environmentally or culturally sensitive areas would be flagged by the EI as places construction personnel should avoid.

Second, before excavating, appropriate safety precautions would be taken, such as notifying the One-Call system to ensure that third-party utilities and pipelines are appropriately marked. Pipes, valves, and fittings would be placed along the construction work area in preparation for pipe stringing, bending, and welding and subsequent trenching, lowering of the pipeline, and backfilling of the trench. The pipeline then would be hydrostatically tested, and the right-of-way restoration process would begin. The following sections provide more detail for each of step of the typical construction process. The general construction sequence for the pipeline is depicted in Figure 2.7-2.

2.7.1.4 Surveying and Staking

2.7.1.4.1 Construction Survey

Before construction begins, Enbridge crews would survey and stake the centerline and construction limits and the exterior boundaries of the ATWS (Figure 2.7-2, panel 1). The exterior boundary stakes would mark the limit of approved disturbance areas that would be maintained throughout the construction period. Prior to any construction activity, Enbridge would contact the Minnesota Gopher State One-Call system to identify and mark the locations of underground utilities.

[5] Topsoil is segregated from trench spoil to maintain the integrity of the existing seed bed and facilitate natural restoration.

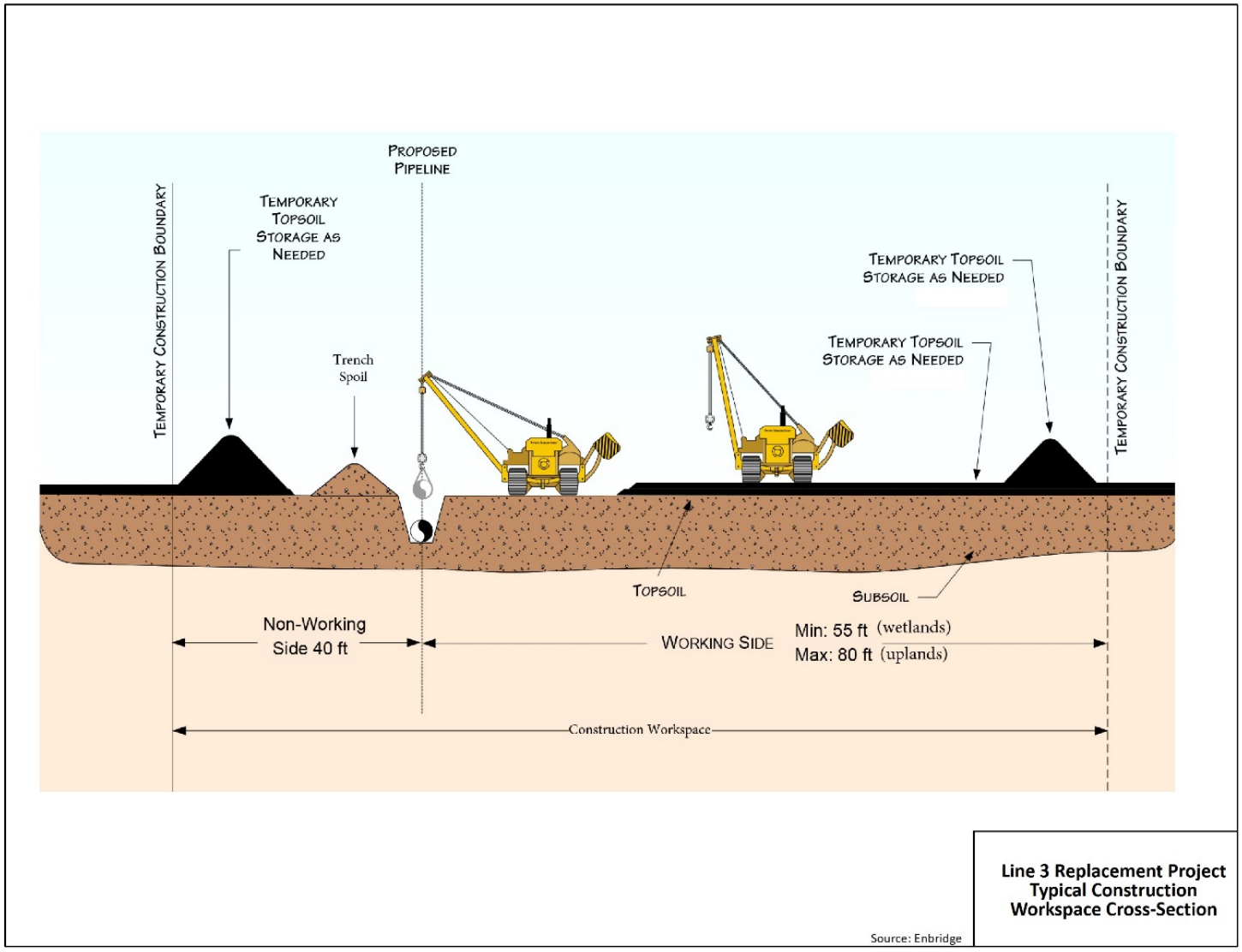

Figure 2.7-1. Typical Construction Cross-Section Adjacent to Line 67 or Where No Adjacent Facilities Occur

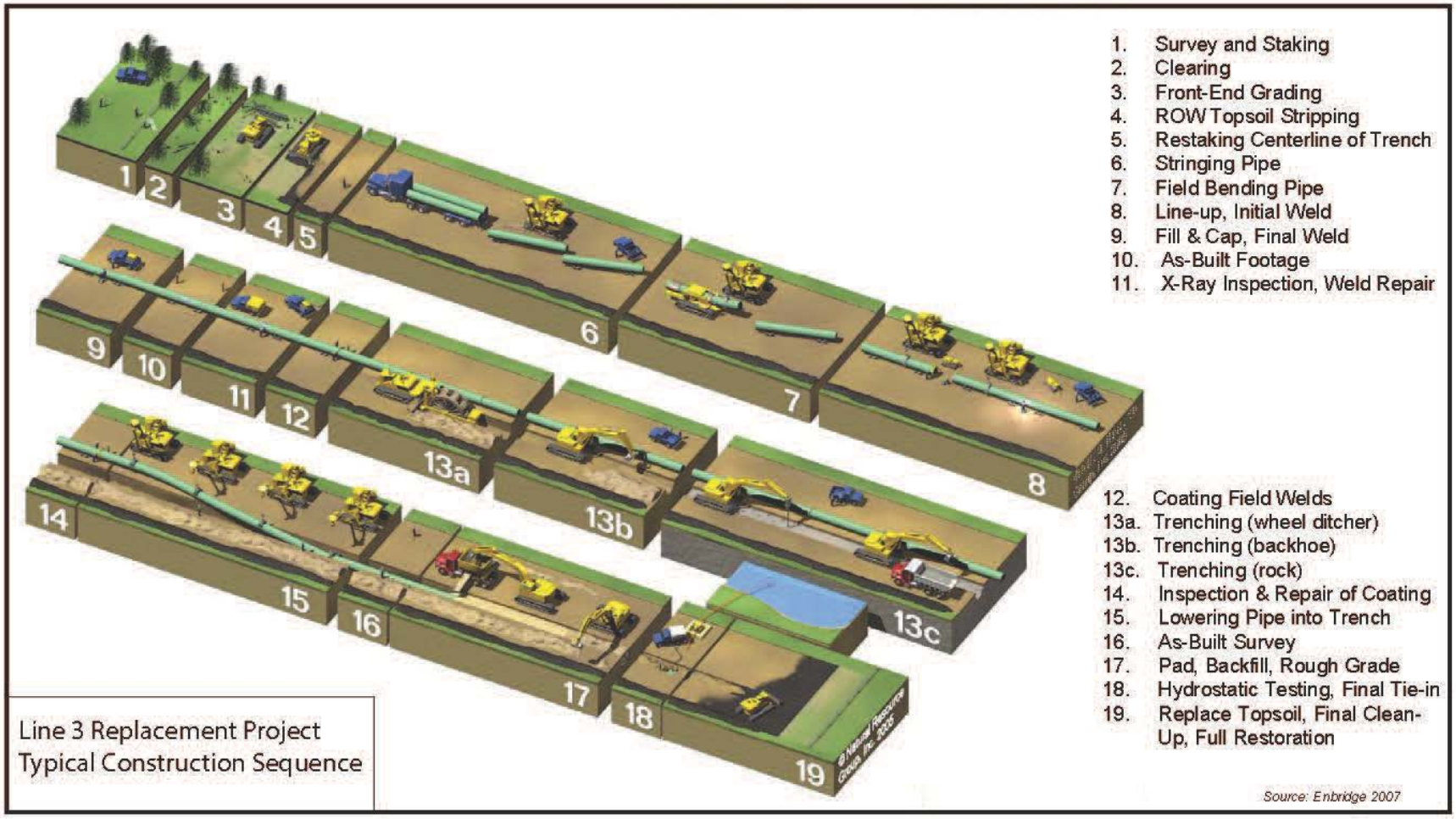

Figure 2.7-2. Planned Construction Sequence for the Line 3 Replacement Pipeline

2.7.1.4.2 Noxious Plant Survey and Treatment

Enbridge Would Take Measures to Prevent the Spread of Noxious Weeds or Invasive Species

During preconstruction surveys, Enbridge would also identify and mark the locations of noxious and invasive species as a part of its program to minimize or prevent the introduction and spread of those species along the right-of-way. Major infestation areas would be identified and treated with the recommended herbicides or their equivalents as agreed to by local agencies and landowners.

Construction equipment would be cleaned prior to arriving at the right-of-way. Equipment designated for construction within waterbodies would be washed and dried before use. In addition, construction equipment used in infested areas would be cleaned before departing from the infested areas. Methods could include mechanical means (scrape down; blow down) or washing with high-pressure water if mechanical means are not sufficient. Construction contractors would be required to document the cleaning history of all equipment planned for use. Equipment deemed not to be sufficiently cleaned would be denied access to the construction spreads until it could be cleaned in accordance with the measures identified in the Environmental Protection Plan to prevent the spread of noxious weeds and invasive species.

Methods for preventing and controlling noxious weeds and invasive species are detailed further in the Environmental Protection Plan (Appendix E).

2.7.1.5 Clearing and Grading

Shrubs, Trees, and Rocks Would Be Removed and Disposed of in Accordance with the Environmental Protection Plan

Enbridge proposes to clear the construction work area and ATWS of shrubs and trees (Figure 2.7-2, panels 2 and 3). The clearing crew would typically mow, chip, or mulch shrubs and ground cover vegetation. All non-merchantable timber would be chipped onsite or removed from the construction work area. To facilitate cleanup and restoration in upland areas, tree stumps outside the trench line would be ground to below the normal ground surface or removed and hauled to an approved disposal facility. Stumps along the trench line would be completely removed and ground or hauled to an approved disposal facility.[6]

With landowner approval in non-agricultural upland areas, chipped or mulched woody debris may be uniformly broadcast across the construction work area or incorporated into the topsoil. Non-merchantable wood could be burned if Enbridge obtains the appropriate permits and approvals from the Minnesota Department of Natural Resources (Minnesota DNR). Enbridge would address handling of merchantable timber on private lands based on negotiations with the respective landowners. Enbridge would follow Minnesota DNR guidelines to address merchantable timber removed on State-managed forest lands.

Excess stones and rocks larger than 4 inches in diameter generally would be removed from the upper 8 inches of soil, or managed as otherwise specified in permit conditions or landowner agreements.

[6] "Approved disposal facilities" are locations licensed or permitted to receive waste materials. These include municipal or construction debris landfills or other upland locations with documented landowner approval that are in compliance with federal, state, and county laws and local ordinances for such use.

Excess rock would be piled in upland areas where landowner permission has been obtained or would be hauled offsite to an approved disposal site.

Erosion and Sediment Control Devices Would Be Installed after Clearing but Before Grading

Temporary ECDs are proposed to be installed in accordance with the procedures given in the Environmental Protection Plan (Appendix E) and Minnesota PCA's NPDES CSW Permit. This would include but not be limited to installing devices that would slow surface runoff flows (such as slope breakers, trench breakers, and stormwater diversions) and sediment barriers to prevent sediment from leaving the construction area (such as silt fencing and straw bales).

Enbridge proposes that temporary ECDs would be installed after clearing but prior to grading activities. Damaged or non-functioning ECDs would be repaired, replaced, or supplemented with functional devices within 24 hours of discovery, or as specified in applicable permits. Temporary ECDs present within the travel lane of the construction work area could be removed during active construction periods but would be replaced upon passage of the construction equipment or once construction activities have concluded for the day. Erosion control mats, mulch, or temporary seeding also may be installed in the right-of-way, depending on site conditions or if delays at a construction spread last more than 14 days.

2.7.1.6 Topsoil Stripping

Topsoil Typically Would Be Stripped to a Depth of 12 Inches and Would Be Segregated According to the Environmental Protection Plan

Enbridge proposes that topsoil would be stripped and segregated to maintain the integrity of the existing seed bed in cropland, hayfields, pastures, government set-aside program areas, and other areas as requested by landowners along the construction work area and in accordance with the Environmental Protection Plan (Appendix E) and the Agricultural Protection Plan (Appendix F) (Figure 2.7-2, panel 4).

On active agricultural lands, Enbridge proposes use one of three topsoil segregation methods: the full right-of-way method, the modified ditch-plus-spoil side method, or the trench-line-only method. A full description of these methods is included in the Agricultural Protection Plan. The type of topsoil segregation method used would depend on specific landowner agreements, site conditions, applicable permit requirements, and other factors.

Topsoil would be stripped to a maximum depth of 12 inches, except in the Red River Valley region, where up to 18 inches of topsoil would be stripped. Topsoil would be replaced within 14 days of backfilling the pipeline trench. If seasonal or other conditions prevent replacement within 14 days, temporary ECDs would be installed and maintained until conditions allow the replacement.

2.7.1.7 Delivery of Pipe Sections to Construction Spreads

Pipe and Construction Materials and Equipment Would Be Positioned before the Start of Construction

As noted in Section 2.6, prepositioning of pipe, construction materials, and construction equipment would begin approximately 60 days before the commencement of construction and would be expected to be completed within 45 days. Construction activities would be conducted simultaneously across seven construction spreads.

2.7.1.8 Pipe Stringing and Bending

Pipe Would Be Placed and Bent in the Construction Work Area

Prior to trench excavation, pipe would be placed (strung) along the construction work area and arranged to be accessible to construction personnel (Figure 2.7-2, panels 6 and 7). Specially designed stringing trucks would be used to deliver pipe from the pipe yards to the construction work area. Small portable cranes or side-boom tractors would be used to offload pipe from the stringing trucks and place it along the right-of-way. A mechanical pipe bending machine would bend individual joints of pipe to the angle required to traverse natural ground contours or to follow the pipeline alignment. In some areas, prefabricated fittings would be used where field bending is not practical.

2.7.1.9 Welding, Inspection, and Coating

Pipe Would Be Pre-Coated with Anti-Corrosives and Would Be Welded and Inspected

After stringing and bending are completed, pipe sections would be aligned, welded together, and placed on temporary supports along the edge of the area to be trenched (Figure 2.7-2, panels 8–12). All welds joining pipe segments or pipe fittings would be inspected visually and X-rayed by Enbridge personnel to ensure the integrity of all weld joints. The pipe would be coated at the factory with bonded epoxy or a similar material to prevent corrosion. Enbridge would apply a similar coating to welded joints and electronically inspect the pipeline coating before the pipe is lowered into the trench.

2.7.1.10 Trenching

Trench Typically Would Be 7 Feet Deep, 5 Feet Wide at the Bottom and 7 Feet Wide at the Top

Trenching typically would begin after the pipe has been welded and placed near the trench line. Backhoes or ditching machines would be used to excavate the trenches and place the excavated materials in stockpiles adjacent to the trench (Figure 2.7-2, panels 13a–13c). Areas where agricultural drain tiles[7] would be cut during trenching would be flagged. If drain tiles are damaged during construction, they would be repaired to restore operating condition in compliance with the Agricultural Protection Plan (Appendix F). Enbridge is developing a Contaminated Sites Management Plan in consultation with Minnesota PCA. This plan will be completed prior to construction to be implemented in the event that potentially contaminated properties are discovered within the construction work area.

Trenching would be conducted to a depth of approximately 48 inches burial depth plus the 36-inch pipeline diameter, or approximately 7 feet, except where described below. Table 2.7-1 lists the current U.S. Department of Transportation (USDOT) regulations (49 CFR 195.248, July 1998)[8] for the required minimum burial depth (depth from soil surface to the top of the pipe) for the pipeline. Although Enbridge would be required to bury the pipeline to at least these depths, the pipeline would be buried to a depth of 48 inches where possible, except as described below.

[7] Drain tiles are subsurface drainage systems—typically consisting of networks of pipes that can be an assortment of diameters, depending on the drainage capacity required and made from an assortment of materials (e.g., concrete, clay, polyethylene)—that facilitate removal of excess water from agricultural lands.

[8] The USDOT PHMSA has established regulations governing the safety of hazardous liquid pipeline facilities and the transportation of hazardous liquids associated with those facilities in or affecting interstate commerce.

Table 2.7-1. U.S. Department of Transportation Required Minimum Burial Depths (Cover) of Crude Oil Pipelines

Location Type	Cover (inches)	
	Normal Excavation	Rock Excavation[a]
Industrial, commercial, and residential areas	36	30
Crossing of inland waterbodies ≥ 100 feet wide	48	18
Drainage ditches at public roads and railroads	36	36
Any other area	30	18

[a] "Rock excavation" is defined by the U.S. Department of Transportation as any excavation that requires blasting or removal by equivalent (49 CFR 195.248, July 1998).

In agricultural areas, State law (Minn. Stat. 2014, 216G.07, Subd. 1) requires 54 inches of cover over the installed pipeline, unless the landowner waives the minimum depth requirement. Enbridge would request landowners to waive this requirement so that Enbridge could maintain the target depth of 48 inches. If landowners do not waive this requirement, Enbridge would abide by the 54-inch requirement.

Trench at Any Given Location Would Be Left Open for a Maximum of 3 Days

To achieve the desired burial cover for the pipe, the trench would typically be about 5 feet wide at the base and up to about 7 feet wide at the top, with walls sloped to maintain stability according to soil types and other site-specific conditions. In unstable and saturated soils, the trench might be wider.

Enbridge plans to minimize the amount of time that a trench is left open to 3 days at any given construction spread. This duration could be shortened based on site conditions or as specified by site-specific permits.

If trench dewatering is necessary, the onsite EI would review and approve in advance the water discharge plan to ensure that BMPs are being used, including the use of a dewatering filter device to minimize scour and the potential for sediment-laden water from reaching nearby wetlands or waterbodies. BMPs that would be used are described in the Environmental Protection Plan (Appendix E).

2.7.1.11 Lowering-In and Backfilling

After welding, inspection, coating, and trench excavation have been completed, the pipe would be lowered into the trench by side-boom tractors (Figure 2.7-2, panels 15–17). In sloped areas, trench breakers would be installed to avoid subsurface water flow and erosion along the trench line.

Lowering-In and Backfilling Would Be Conducted so as to Minimize Effects on Sensitive Resources

To best protect sensitive resource areas such as wetlands or waterbodies, trench breakers would be installed based on site-specific conditions, including the degree and length of the slope; the presence of sensitive resource areas downslope, such as wetlands or waterbodies; and proximity to other features, such as roads or railroads.

The trench would be backfilled with the material previously excavated. In areas where the topsoil is segregated, the subsoil would be replaced first and the topsoil spread uniformly on top. The trench would be backfilled to the approximate ground surface elevation no more than 6 inches above the level of the surrounding ground.

The backfilled trench would be compacted to minimize settlement. A greater level of compaction would be required when backfilling trenches at railroad crossings, pipeline crossings, and stream and river crossings; in irrigated lands; and at valve sites. Trench compaction would not be required in rocky or swampy areas. Excess trench spoil would be feathered to the existing grade within the existing stripped area in a manner that does not impede drainage patterns or agricultural operations.

Spoil that could not be distributed in this way would be disposed of in accordance with the Environmental Protection Plan.

For more detailed information on lowering-in and backfilling, see Applicant's Environmental Protection Plan (Appendix E).

2.7.1.12 Mainline Valve Installation

Installing MLVs Would Follow a Process Similar to That Used for Construction Generally

Installation of MLVs would require similar steps to the overall construction of the pipeline. The land on which the MLV would be located would be surveyed, staked, cleared, graded, and excavated following the same procedures as for the pipeline. Next, the Mainline pipe, MLV foundation, and valve would be installed (Figure 2.3-1) and the site would be backfilled. After backfilling, the MLV would undergo testing as described in Section 2.7.1.13, and electrical and controls equipment would be installed and tested. Once the tests are complete, the MLV would be operational. Cleanup, restoration, and revegetation of the site would occur as described in Section 2.7.1.14.

2.7.1.13 Pipeline Testing

Pipeline Would Be Cleaned and Tested to Ensure It Could Be Operated at Design Pressure

After backfilling, Enbridge would hydrostatically test the pipeline in accordance with PHMSA regulations to ensure that the system would be capable of operating at the design pressure (Figure 2.7-2, panel 18). Hydrostatic testing involves filling a segment of the pipeline with water, hydraulically pressurizing it to a prescribed pressure, and maintaining that pressure for a given amount of time. The pressure and testing duration are specified by federal (USDOT) testing specifications.

Prior to conducting hydrostatic tests, Enbridge would run a cleaning PIG through the pipe to remove any construction debris, mill scale, dirt, and dust. Rinse (or wash) water would be used in conjunction with the cleaning PIG. The pipe debris and rinse water would be disposed of offsite at an appropriate waste facility.

Generally, the hydrostatic test water volumes required for each construction spread would range from approximately 11 million gallons to 17 million gallons. These volumes do not account for transferring water between testing segments. Transferring or recycling test water between pipeline segments would reduce the total volume needed for hydrostatic testing.

2.7.1.14 Cleanup, Restoration, and Revegetation

Enbridge Would Restore the Site as Much as Possible to Its Original Condition

Following backfilling of the pipeline trench, the construction work area would be cleaned and re-graded. Temporary erosion control devices would be installed according to timelines specified by applicable permits (Figure 2.7-2, panel 19). The trench and construction work area would be re-graded and restored as nearly as practicable to the original contour of the land. Topsoil would be redistributed over areas from which it was originally removed. Fences that had been removed to install the pipeline would be reconstructed across the right-of-way.

During final grading, slopes in areas other than active agricultural lands would be stabilized using permanent erosion control devices, including permanent berms.

Prior to replacing topsoil, compacted or rutted soils in cultivated fields would be loosened with a deep-tillage device or a chisel plow. If subsequent cleanup and restoration activities result in further compaction, additional measures would be undertaken to alleviate the condition.

Disturbed areas would be revegetated in accordance with the Environmental Protection Plan, permit requirements, and site-specific easement agreements with landowners. Enbridge would coordinate with landowners on any perceived restoration problems.

2.7.2 Special Pipeline Construction Procedures

Where the pipeline route crosses wetlands, waterbodies, steep terrain, and other infrastructure, or is near residences, construction techniques other than those previously described would be used.

2.7.2.1 Conventional Construction in Wetlands

Wetland Construction Would Require Special Methods and Close Monitoring

All wetland construction would be in accordance with Clean Water Act (CWA) permits issued by the U.S. Army Corps of Engineers (USACE) and Minnesota PCA's NPDES CSW. Wetland construction would require monitoring to ensure compliance during construction (see Section 2.7.1.1). Along most of the pipeline route, construction in wetlands would consist of the same sequence as construction in uplands, albeit within narrower construction limits (see Figures 2.4-2, 2.4-4, and 2.4-6).

Wetland construction would consist of clearing, grading, trenching, installation, backfilling, cleanup, and revegetation, as described below. Access to wetlands would be limited to the construction work area or by approved access roads. Construction equipment would be limited to low-ground-pressure equipment or conventional equipment working from timber construction mats. Final wetland crossing methods for each wetland would be determined in coordination with USACE and local government units.

2.7.2.2 Clearing and Grading

ATWS Typically Would Be Located 50 Feet from Wetlands, and Grading Would Be Minimized

Vegetation within wetlands would be cut at ground level, leaving root systems intact. Trees and shrubs would be removed, and stumps that are cleared from wetlands would be removed to proper disposal locations. Hydro-axe debris could be left in the cleared area but would be evenly spread throughout.

Enbridge would locate ATWS in upland areas at least 50 feet from wetlands, to the extent possible, and would limit the size of the ATWS to the minimum needed to conduct the wetland crossing. Where site conditions do not enable a 50-foot buffer, the ATWS would be located as far as practicable from the wetland. Vegetation would not be cleared nor construction activities undertaken between the ATWS and wetlands. In some cases, Enbridge might seek regulatory agency approval to locate ATWS in select wetlands. These instances would include when wetlands are adjacent to waterbodies, roads, railroads, non-Enbridge utility crossings, and pipeline crossovers.

At and adjacent to wetland crossings, grading would be minimized to the extent practicable. Enbridge would typically confine grading activities to the area of the trench, with grading allowed elsewhere only where required for safety reasons or to restore the construction work area after backfilling the trench.

Enbridge would install and maintain erosion control devices in construction work areas upslope from wetland boundaries to prevent sediment from entering wetlands from along the work area, and along the edge of the construction work area to contain spoil and sediment within the construction work area as it passes through or upslope of wetlands.

2.7.2.3 Trenching and Installation

Large Wetlands Require Different Modes of Trenching and Installation Than Small Wetlands

While trenching in unsaturated wetlands, up to 1 foot of the topsoil (i.e., the organic layer) would be segregated from the remaining trench spoil. If the soils in the wetland area are stable and capable of supporting equipment, Enbridge would string, weld, and lower the pipe into the trench as described for upland areas.

The construction methods described above apply to smaller wetlands that provide some bearing capacity for the moving of equipment and materials. When crossing large wetlands with standing water and saturated soils that are incapable of supporting large equipment, the trench would be excavated using a backhoe supported on timber mats. With this method, it is often not feasible to separate topsoil from the underlying soil. However, as much of the organic layer as possible would be segregated, based on the level of saturation or site conditions.

For crossing large wetlands with standing water and saturated soils, the pipe string would be assembled in an ATWS and floated across the wetland into the excavated trench. Once the pipeline is in position, it would be sunk into position and welded to the adjacent, upland segments of the pipeline. After the pipe is installed, the trench would be backfilled and restored.

2.7.2.4 Cleanup and Revegetation

Enbridge Would Remove Debris, Seed Disturbed Wetlands and Enable Natural Regeneration

Enbridge proposes to begin rough grading and cleanup as soon as practical after the trench is backfilled. Rough grading includes restoring the construction work area and ATWS to their original conditions, installing or repairing temporary erosion control devices, and installing temporary slope breakers on sloped uplands adjacent to the wetlands.

Construction debris and timber mats would be removed, and any fences removed during construction would be replaced. Disturbed wetlands would be seeded with oats or a temporary seed mix (unless standing water is prevalent), or as otherwise directed by landowners or regulatory agencies. Enbridge

would otherwise allow the wetlands to revegetate naturally from the seeds and rhizomes present in the topsoil and natural recruitment.

Fertilizer, lime, or mulch would not be used to restore wetlands. Enbridge would also implement any further restoration and long-term monitoring guidance required by USACE in the required CWA Section 404 permit or by the local government unit in relation to the Wetland Conservation Act permit.

2.7.2.5 Horizontal Directional Drilling or Guided Bore in Wetlands

HDD Would Be Used to Cross Especially Sensitive Areas and Would Be Closely Monitored

At certain locations along the pipeline route where trenching methods are not feasible, HDD or guided bore methods would be used to install the pipeline. HDD involves drilling under a wetland or waterbody and installing the pipeline without physical disturbance of the wetland or waterbody feature. These methods would be used to cross environmentally sensitive areas such as riparian forested wetlands, sensitive fishery resources, and impaired waters. The method is described in detail in Appendix G.

The Guided Bore Method Would Be Used for Waterbody Crossings near Roads or Railroads

The guided bore method would be used at crossings of narrow wetlands and ditches adjacent to roads or railroads. It is not suitable adjacent to steep slopes, where water tables are near the surface, or where substrates consist of loose sand and gravel. The guided bore method consists of boring an auger from an entrance hole on one side of the wetland to a corresponding hole on the other side of the wetland. The bore may or may not include a casing. An advantage of the guided bore is that there is no concern for a sediment release. The method is described in detail in Appendix G.

2.7.2.6 Winter Construction of Wetland Crossings

Winter Construction Can Be Useful in Large Saturated Wetlands, but Weather Is a Constraint

In large saturated wetlands with unconsolidated soils, construction of large-diameter pipelines is often difficult and has the potential for greater impacts than in other wetland areas because of the wider trench widths required and the greater amount of surface disturbances.

Overall, winter construction disturbs soil and vegetation less than does summer construction—when unstable soils would result in increased sloughing of trench walls and wider trenches, and would cause significantly more soil disturbance than excavation under frozen conditions. In addition, frost or ice roads during winter construction could allow heavy construction equipment to access the construction work area without damaging the underlying wetland vegetation and upper layers of the wetland surfaces.

Enbridge would attempt to construct the entire pipeline without using winter construction methods, which require long stretches of sustained cold weather, for instance, to construct and use ice roads to access the construction area. However, Enbridge could be required to use winter construction procedures at locations where the approach to saturated areas is lengthy or the length of the saturated areas themselves is long.

2.7.2.6.1 Clearing and Grading

After Construction of Ice Roads, Winter Construction Methods Are the Same as Regular Construction

At winter construction locations, construction vehicles compress frost within the ground until it reaches a depth that would safely support heavy construction equipment and ice roads can be built. At that point, the sequence for winter construction mostly includes the same components and methods as conventional, non-winter construction, including clearing and grading.

2.7.2.6.2 Trenching and Installation

After Segregating Topsoil, Installing the Pipe Follows the Conventional Pattern

Trenching during winter construction is conducted using a saw or ripper to cut the frost along the trench line to allow excavation of the trench spoil. If the soil is frozen to a depth that extends deeper than the depth of the topsoil, topsoil segregation might not be effective because the frozen soil could come out of the trench in chunks that contain both subsoil and topsoil. In such cases, the saw or ripper would cut just to the depth of the topsoil to remove and segregate the topsoil prior to resuming the trenching process.

Once the sawing or ripping is complete and the trench is excavated, installation of the pipe follows conventional, non-winter lowering-in and backfilling methods.

2.7.2.6.3 Cleanup and Revegetation

If Winter Weather Impedes Cleanup, Enbridge Could Install Erosion Control Devices

The size of the excavated trench would be reduced during winter construction to minimize the amount of frozen backfill removed from the trench and to facilitate restoration of the trench to its preconstruction contours. If winter conditions impede or prevent final grading and cleanup of the construction area, Enbridge would stabilize the area and maintain temporary ECDs in place until permanent ECDs could be installed. Based on the construction location and weather conditions, Enbridge could install dormant seeding and mulch to allow revegetation to occur once spring arrives.

2.7.2.7 Waterbody Crossings

Proposed Crossing of 242 Waterbodies Would Require Regulatory Approvals

All waterbody construction would require a Minnesota DNR License to Cross Public Waters and would be subject to CWA permits issued by USACE. After consulting with appropriate regulatory agencies and doing an engineering review, Enbridge would cross waterbodies using the most environmentally appropriate and constructible method. The types of methods that could be used include wet trench, dam and pump, flume, and HDD or guided bore. The locations and initial method proposed for undertaking each crossing are shown in Appendix G.

Waterbodies Would Be Crossed Perpendicularly and in Short Timeframes

To minimize the length of the crossing, waterbody crossings would be designed to align as close to perpendicular to the axis of the waterbody as engineering and routing constraints allow. Unless specified otherwise in applicable permits or through consultation with regulatory agencies, Enbridge plans to cross minor waterbodies (less than 10 feet wide) within 24 hours, intermediate waterbodies (10 to 100 feet) within 48 hours, and large waterbodies as specified in applicable permits.

The construction techniques used would include appropriate clearing and grading; installing erosion control measures; possibly removing beavers and removing or altering beaver dams; constructing temporary equipment bridges; and installing the pipeline by either the wet trench, dam and pump, flume, HDD, or guided bore methods. Trenching and Installation methods are summarized below and detailed in Appendix G. All construction techniques would need to comply with regulations and the terms of various permits, which are discussed further in Sections 5.2.1 and 6.3.1.

2.7.2.7.1 Clearing and Grading

Enbridge would clear existing vegetation from the construction work area on the banks of the waterbodies as necessary to prepare for grading operations. A 20-foot-wide buffer of non-woody vegetation would be maintained on the banks of waterbodies until beginning trenching at the crossing. Woody vegetation (trees and shrubs) may be cut and removed within this buffer during initial clearing of the right-of-way and construction work area. The stumps of woody vegetation outside the trench line would be ground to below the normal ground surface or removed and hauled to an approved disposal facility. Stumps along the trench line would be completely removed and ground or hauled to an approved disposal facility. In addition, grading could be necessary on the banks of some waterbodies to install temporary bridges across the waterbodies. Grading also could be necessary for approaches to waterbodies in order to create safe working surfaces and allow for limitations on pipe bending.

Grading would be directed away from the waterbody to reduce the potential for material to enter the waterbody. Temporary erosion control measures and spoil containment devices (such as silt fences and straw bales) would be installed as necessary to minimize the potential for disturbed soils or trench spoil to enter the waterbody from the permanent right-of-way and construction work area. ATWS at waterbody crossings typically would be set back 50 feet from the water's edge where topographic and other site conditions allow.

Enbridge may be required to trap beavers or alter or remove beaver dams to lower water elevations within the Project corridor prior to construction. To alter a beaver dam, a perforated steel culvert, or equivalent device, would be inserted through the dam to facilitate water drainage. The culvert would be a minimum of 12 inches in diameter and 20 feet in length. The perforations would be a minimum of 1.5 inches in diameter and would encompass the entire circumference of the culvert and extend along its entire length. Enbridge would obtain landowner approval and all necessary environmental permits for all trapping of beavers and alteration or removal of beaver dams.

2.7.2.7.2 Temporary Equipment Bridges

Enbridge would install temporary equipment bridges across most waterbodies, including agricultural and intermittent drainage ditches that may connect to sensitive habitats downstream. The equipment bridges would allow vehicles and equipment to travel along the construction work area without transporting sediment or hazardous fluids into the waterbodies. Equipment required to install the equipment bridges would be permitted to ford a waterbody a single time prior to installing the bridge; otherwise, construction equipment would not be permitted to ford waterbodies (except for trench excavators, which may be required to enter a waterbody during excavation; in such cases, the excavator would enter the waterbody on clean construction mats).

Typically, Enbridge would not install equipment bridges across waterbodies that would be directionally drilled unless an efficient and economical method to transport construction equipment beyond the waterbody (i.e., a nearby road or bridge) is not available.

Equipment bridges would include (1) prefabricated timber mats that span the waterbody, with or without an instream support culvert; (2) clean rock placed over flume pipes; (3) railroad flat cars; (4) flexi-float or other temporary bridging; or (5) other methods as approved by appropriate regulatory agencies. Enbridge would design the equipment bridges to accommodate the maximum foreseeable stream flow and prevent flow restrictions while in place. Support structures would be placed above the ordinary high water mark of the waterbody. The bridges would be constructed with clean materials and would be maintained to prevent soil accumulation on the bridge from entering the waterbody. Enbridge would remove the temporary equipment bridges as soon as possible during final restoration.

2.7.2.7.3 Trenching and Installation

After initial clearing and grading is completed, Enbridge would install the pipeline across the waterbody using one of the four crossing methods: wet trench, dam and pump, flume, or HDD or guided bore. These methods are summarized below and are further described in the Environmental Protection Plan (Appendix E) and in Appendix G. Enbridge currently does not anticipate the need to conduct blasting activities to excavate trenches through any of the waterbodies. As such, Enbridge does not anticipate any complications with reaching the proper depth for installing the pipeline across the waterbodies.

- Wet trench method – The open-cut method (also known as the "wet open-cut" method) is typically used to cross waterbodies for which dam and pump, flume, and HDD are not permitted. This method involves digging an open trench across the waterbody, installing pipe, and backfilling the trench.
- Dam-and-pump method – The dam-and-pump method is a dry crossing method that is typically used for waterbodies with low gradients and flow or waterbodies with meandering channels. This method involves constructing temporary dams across the waterbody, both upstream and downstream of the crossing, prior to excavation. Dams generally would be installed using sandbags, plastic sheeting, sheet piling, or steel plates. Pumps and piping would be used to transport the stream flow around the construction area for the duration of the process.
- Wet flume method – The flume method is a dry crossing method used for relatively narrow waterbodies free of large rocks and bedrock at the trench line and with a relatively straight channel across the construction work area. The flume method generally is not appropriate for wide, deep, or heavily flowing waterbodies. Use of this method involves installing dams upstream and downstream of the construction area and installing one or more pipes (flumes) that would extend along the course of the waterbody and through both dams. Streamflow would be carried through the construction area by the flume pipe(s).
- HDD – HDD involves drilling under a waterbody and installing the pipeline without physical disturbance of the wetland or waterbody feature. This method could be used to cross environmentally sensitive areas identified by permitting agencies, including Minnesota DNR and USACE, such as riparian forested wetlands, sensitive fishery resources, and impaired waters.
- Guided bore – The guided bore method typically is used for crossings of narrow wetlands and ditches adjacent to roads or railroads. It is not suitable adjacent to steep slopes, where water tables are near the surface, or where substrates consist of loose sand and gravel. The guided bore method consists of boring an auger from an entrance hole on one side of the wetland to

a corresponding hole on the other side of the wetland. The bore may or may not include a casing. An advantage of the guided bore is that there is no concern for a sediment release.

2.7.2.7.4 Restoration and Revegetation

Enbridge Would Restore and Revegetate Water Crossings and Would Stabilize Streambanks

Once a waterbody has been crossed using the wet trench, dam-and-pump, or flume method, the crossing site would be revegetated and restored. Such restoration and revegetation are generally not necessary when using the HDD method, which does not generally disturb surface features.

Enbridge would stabilize streambanks and install temporary ECDs within 24 hours of completing the crossing (weather and soil conditions permitting) to minimize the potential for sedimentation. On unstable slopes, Enbridge would install temporary slope breakers on all sloped approaches to waterbodies. The greater the slope, the closer together the slope breakers would be placed.

Other stabilization methods Enbridge might use are berms, creating 50-foot buffers, seeding, mulch, or erosion control blankets. For banks potentially subject to significant erosion, Enbridge could also install riprap after getting the necessary permits. Enbridge would stabilize a 50-foot buffer on either side of the waterbody crossings using a temporary seed mix (consisting of vegetation such as annual rye or annual oats; see the Environmental Protection Plan [Appendix E]), mulch, and/or erosion control blankets. Silt fences or a functional equivalent would be installed upslope of the temporarily seeded buffer area. Enbridge would not plant seed in cultivated land, standing water wetland, or other standing water areas.

If the soils of the streambank are considered unstable or there is a potential for significant bank erosion, Enbridge would use supplemental bank stabilization methods such as rock riprap. However, rock riprap would be used only where site-specific conditions require such use and after applicable agency permits or approvals have been acquired.

During final cleanup, Enbridge would install permanent slope breakers across the full width of the permanent right-of-way and construction work area to slow surface runoff flows that could cause erosion and carry sediments into the waterbodies. Once the streambanks have been reestablished, Enbridge would conduct final seeding of the streambanks using native seed varieties intended to supplement revegetation through recruitment from the existing seed stock within the replaced topsoil.

Where necessary for access, the travel lane portion of the construction work area and temporary bridges at water crossings would remain in place until Enbridge completes final cleanup activities. Temporary equipment bridges would be removed after final cleanup, seeding, mulching, and other right-of-way restoration activities have been completed. The temporary ECDs would be removed after vegetation is reestablished. Additional detail on restoration and revegetation methods is provided in the Environmental Protection Plan.

2.7.2.8 Infrastructure Crossings

Enbridge Would Cross Railroads, Roads, and Other Pipelines

To cross existing infrastructure, Enbridge proposes to bore under railroads and bore under or use an open-cut trench method at road crossings. At these locations, an ATWS might be required and would be determined on a site-specific basis. The ATWS would be adjacent to the crossings and would be limited to the size necessary to contain spoil from the crossing. Roadway crossings would be maintained to

prevent tracking mud onto the roadways. A listing of railroad and road crossings and Enbridge's proposed crossing method for each is provided in Appendix H.

The Line 3 Replacement Project would cross existing Enbridge pipelines at two locations immediately west of the Clearbrook terminal. The Line 3 Replacement pipeline would run below the existing Enbridge lines at a general separation distance of 2 feet.

2.7.2.9 Construction in Urban Areas

In Urban Areas, Enbridge Would Control Noise and Dust Emissions

Enbridge's proposed Line 3 Replacement Project is routed through predominately rural areas. Approximately 8 acres of the total area of the proposed Line 3 Replacement Project construction work area would include "developed land," defined as land consisting of more than 30 percent asphalt, concrete, and buildings. Approximately 124 residences would be within 300 feet of the Project's construction work area, and 19 residences would be within 50 feet, including seven within the construction workspace and one within the permanent right-of-way. Enbridge would conduct most construction activities during daylight hours, in part to reduce the duration of increased noise emissions associated with construction. Enbridge would also spray water on the construction work area and access roads near residences to reduce dust emissions during construction. Enbridge would obtain permits and approval from Minnesota DNR, as needed, for water appropriations used for dust suppression.

2.7.2.10 Blasting

To date, Enbridge has identified only one location where blasting would be necessary for installing the pipeline. The location is at MP D1128.4 within Carlton County. The area contains rock outcroppings near the ground surface that extend for an estimated 0.25 mile. Enbridge would develop a Blasting Plan prior to commencement of construction.

2.7.3 Construction of New and Modified Pump Stations and Terminal Modifications

Constructing aboveground facilities (MLVs and pump stations) would involve clearing and grading, as necessary, including some cut-and-fill activities, construction of foundations, and installation of equipment such as new pumps and pipe reconfigurations. Small amounts of fill that may be needed for the foundations would be obtained from existing commercial pits. Switchgear buildings and buildings used to house the variable frequency drive equipment would be prefabricated and installed onsite. Pumps would be installed on foundations and would not be housed in buildings.

2.7.4 Preparation of Contractor/Materials and Pipe Storage Areas

In Building Storage Yards, Enbridge Would Avoid Environmentally Sensitive Areas

Enbridge proposes to select contractor/materials and pipe storage yards based on their proximity to the construction work area. Additionally, sites would be selected based on whether they can be accessed by sufficient load-rated haul roads, whether the soil and topography promote water drainage from the sites, whether Enbridge would be able to restore the sites to preconstruction conditions, and whether Enbridge could obtain landowner approval to use the sites.

If a site meets the above parameters, Enbridge would conduct environmental surveys to identify environmentally sensitive areas and other potential environmental impacts of the proposed yard.

Enbridge would then design the layout of the contractor/material or pipe storage yard to minimize environmental impacts during use of the site.

The current pipe and rail yards permitted for use by Enbridge do not affect any identified sensitive environmental features. The yards are leased or fee-owned sites that would be restored upon completion of the Project.

2.7.5 Constructing New or Upgrading Existing Access Roads

Enbridge Would Use Existing Roads and Would Upgrade or Build New Roads as Needed

Enbridge would attempt to use existing roads to access the construction work area as much as possible. Roads that can currently accommodate construction vehicles and traffic would not require improvement or modification. However, roads that could not accommodate construction vehicles, such as certain dirt and gravel roads, would require widening or grading. Enbridge would widen roads by increasing the width of the road bed. Enbridge would grade only the existing road beds or newly widened road beds and would leave the land adjacent to the road beds in its existing state.

Enbridge would restore widened and graded roads to preconstruction conditions upon completion of construction. Enbridge would re-contour graded roads and areas beyond the original road bed of widened roads. Enbridge would also seed disturbed areas with a suitable seed mix for the area. Enbridge would leave any improved roads intact if requested by the respective landowner.

2.7.6 Environmental Compliance and Inspection

EIs would monitor compliance with the environmental restoration and mitigation measures included as permit conditions and in contract specifications with landowners along the construction work area.

2.8 OPERATION AND MAINTENANCE METHODS

The Enbridge operations and maintenance program complies with USDOT regulations included in 49 CFR Parts 194 and 195 and in other applicable federal and state regulations. The program is summarized in the sections that follow.

2.8.1 Project Operations

Enbridge Is Proposing to Transport Light and Heavy Crude Oils

The design, construction, maintenance, and operation of the Line 3 Replacement pipeline are regulated by PHMSA under 49 CFR Part 195, which governs transportation of hazardous liquids by pipeline. Enbridge abides by all PHMSA regulations and works directly with regional, state, and local agencies, landowners, and other stakeholders to ensure that its programs meet the needs of the community in which it operates.

Crude oil from the Hardisty terminal in Alberta, Canada, would be transported in the Line 3 Replacement pipeline to the Clearbrook and Superior terminals. From these locations, oil would be distributed into existing pipelines, for delivery from the Clearbrook terminal to Minnesota refineries and from the Superior terminal to refineries in the Midwest, on the Gulf of Mexico, and in eastern Canada.

The composition of the crude oil to be transported is set forth in Enbridge's tariff that is filed with the Federal Energy Regulatory Commission. Under this tariff, the proposed pipeline would be authorized to transport both light and heavy crude oils.

Information on Project operations is provided in the sections that follow.

2.8.1.1 Enbridge Control Center

Enbridge has an existing Control Center and a fully operational back-up Control Center that would monitor operation, maintenance, monitoring, and emergency response for the Line 3 Replacement pipeline. The Control Center, which is staffed by pipeline operators 24 hours a day, includes computerized pipeline control and computational monitoring systems that allow operators to monitor and remotely control the pipelines and related facilities.

2.8.1.1.1 Pipeline Control System

Enbridge's Supervisory Control and Data Acquisition (SCADA) system is the central component of its existing pipeline control system. The Line 3 Replacement pipeline would be incorporated into the existing SCADA system.

SCADA System Detects Anomalies and Allows Corrective Action

The Enbridge SCADA system, which is staffed by pipeline operators 24 hours a day, consists of pipeline sensing devices (including pressure, temperature, density, and flow sensors), a remote computer at each Enbridge pump station, a real-time communications network, a centralized data processing system, and a complete data display that is available to the pipeline control operator. The system includes automated alarms to warn operators when measurements depart from predetermined maximum and minimum limits.

The SCADA system reduces control errors and can automatically initiate pump station shut downs to maintain safe operating pressures. Pipeline control operators can also manually shut down the pipeline when they observe or suspect abnormal conditions. Enbridge enforces a "10-minute rule" that requires operators to shut down a pipeline within 10 minutes of observation of an abnormal condition that cannot be attributed to normal fluctuations in pressures and operating conditions.

2.8.1.1.2 Small Release Detection System

Small Release Detection System Compares Actual Behavior with Expected Behavior

To detect small releases, Enbridge operates a computational pipeline monitoring system and line balance calculations. The computational pipeline monitoring system uses computer models to determine oil flow rate and pressure values that would be expected under normal circumstances, and compares them to actual oil flow rate and pressure values recorded at the inlets and outlets of the pipeline.

Line balance calculations similarly compare the volume of oil injected into the pipeline at an inlet with the volume that is delivered at an outlet to confirm that the values match. Differences in the actual values compared to the expected values, or imbalances in the line calculations beyond a certain threshold, could indicate a release. In these circumstances, a leak alarm would be triggered, which could lead to shut down of the pipeline (see Chapter 10).

2.8.1.2 Unauthorized Use of the Right-of-Way

Enbridge Would Take Measures to Prevent Unauthorized Use of Rights-of-Way

Unauthorized use of the Line 3 Replacement Project right-of-way is considered trespassing and is not allowed by law. Although it is not feasible for Enbridge to patrol its entire right-of-way at all times to prevent unauthorized use, Enbridge has previously stated that it would consider site-specific measures, in cooperation with Minnesota DNR and landowners, to curtail unauthorized activities near sensitive resources on Enbridge's pipeline rights-of-way. Enbridge would also install access control measures at points of entry to the right-of-way as requested by landowners. Control measures could include fences and gates, or placement of other barriers such as boulders or timber barriers.

2.8.1.3 Training

Enbridge Provides Classroom and On-the-Job Training in Pipeline Operations and Maintenance

Enbridge has a comprehensive orientation, technical, safety, emergency, and on-the-job training program that complies with the Operator Qualification rules issued by PHMSA under 49 CFR Part 195. Enbridge personnel receive both formal and on-the-job training on pipeline operation and maintenance. Competence is demonstrated through job performance, periodic pipeline control system simulations, emergency exercises, welding certification tests, and other functions required to safely operate and maintain the pipeline.

Enbridge conducts semi-annual sessions for control operations staff that focus on lessons learned and communicate the importance of adhering to specific rules for control operations. Mandatory simulator sessions are included as part of training programs to provide operations staff with the opportunity to practice procedures while responding to abnormal and emergency operating conditions.

2.8.1.4 Public Awareness Program

Enbridge's existing public awareness program would be expanded to include the Line 3 Replacement pipeline corridor where it deviates from the existing Mainline corridor east of the Clearbrook terminal (see Figure 2.1-1).

Public Awareness Program Educates the Public, Local Government Officials, and First Responders

The public awareness program includes a comprehensive public education program for the affected public (those who work and live along the pipeline corridor), excavators, local public officials, and emergency response units of government. The program also entails providing emergency response personnel with information in key areas, such as pipeline operation and pipeline safety, how to recognize and respond to pipeline releases, and the locations of pipelines as a way to prevent damage from excavating equipment.

As part of keeping the public informed, all Enbridge lines are marked with signage and warnings, in accordance with federal regulations, at road and highway crossings, railroad crossings, navigable rivers, and other locations. This alerts the public to the presence of the pipelines and provides information, contact numbers, and emergency data. Further, Enbridge participates in the One-Call systems in the states along its pipeline alignments.

2.8.2 Maintenance

Enbridge would control vegetation along the pipeline rights-of-way to maintain the integrity of the pipeline and provide access for pipeline integrity surveys. The permanent right-of-way of the Line 3 Replacement Project would be added to the existing Enbridge right-of-way maintenance program. Enbridge would maintain vegetation along the permanent right-of-way by regularly removing trees and shrubs to inhibit woody vegetation growth over the pipelines, which can create safety and pipeline integrity issues.

2.8.2.1 Pipeline and Right-of-Way Inspections and Monitoring

Various routine operational and maintenance activities are required to maintain pipeline integrity, along with safe and reliable operations. In accordance with PHMSA requirements,[9] Enbridge maintains an Environmental Mitigation Plan (Pipeline Maintenance Projects) that outlines maintenance-related environmental policies, procedures, and mitigations for their pipeline maintenance projects (Enbridge 2013). The maintenance activities addressed in the plan are described further below.

Enbridge Regularly Inspects and Monitors Pipelines by Computer, in Person, and from the Air

Enbridge would integrate the Line 3 Replacement Project into the existing Enbridge pipeline inspection program, which would include regularly deploying computerized inspection tools that travel through the inside of the pipeline to test its integrity, inspecting the pump stations and terminals, testing the MLVs and pressure transmitters, inspecting the cathodic protection system, and conducting regular visual surveys of the pipeline right-of-way.

In accordance with USDOT requirements, Enbridge would periodically inspect the pipeline internally with electronic in-line inspection instruments or PIGs. As the PIG travels through the inside of the pipeline, its onboard computers mechanically, ultrasonically, or magnetically examine the condition of the pipe.

This technique identifies potential problems such as dents, gouges, corrosion, or cracks. If potential problems are identified, the pipe would be inspected to verify preliminary findings and repaired as needed. USDOT requires the inspections to occur at 5-year (and no more than 68-month) intervals. Since Enbridge, however, uses multiple types of in-line inspection technologies to detect various types of possible pipeline features, inspections are typically carried out more frequently than every 5 years.

Enbridge would physically inspect tanks, equipment, and piping at all pump stations and terminals, as well as Mainline valves, safety devices, cathodic protection systems and other components at regular intervals.

[9] 49 CFR Part 195 (Transportation of Hazardous Liquids by Pipeline) prescribes the design, construction, operational and maintenance safety standards, and reporting requirements for hazardous liquid pipelines and facilities—including requirements related to safety, integrity management, public awareness programs and environmental protection. Subpart F describes the operation and maintenance of steel pipeline systems. It also requires development and implementation of an integrity management program specifying supplemental integrity management requirements for pipelines that could affect high consequence areas, including populated areas, drinking water resources, and unusually sensitive ecological resources.

Enbridge also patrols the entire Mainline system by air every two weeks to observe the condition of the right-of-way, nearby construction, erosion and other circumstances that could affect the safety and operation of the pipelines or could indicate a potential crude oil release.

If irregular conditions are observed during the air surveys, Enbridge personnel would be deployed to investigate the irregularity on the ground. If a release is suspected, the survey pilot/ground personnel would immediately notify the Enbridge Control Center by radio so the affected pipeline could be shut down pending an onsite investigation.

For more detailed information on monitoring and inspection measures, see Applicant's Certificate of Need Application.

Maintenance of the Right-of-Way Includes Routine Mowing and Brush Removal

Maintenance of the right-of-way requires periodic clearing of vegetation to improve conditions for visual and aerial right-of-way inspection, maintain a safe and apparent corridor, and allow maintenance access. Clearing typically includes brushing equipment travelling down the right-of-way, which may consist of tracked or rubber-tired equipment and hand-held saws or other manual methods. Vegetation management may include application of herbicides.

Subsurface Investigations, Integrity Digs, and Inspection and Repair Require Ground Disturbance

Subsurface investigations occur on rare occasions and involve conducting soil borings on or near the right-of-way to investigate subsurface geotechnical and/or environmental conditions. The activity uses standard drilling rigs where access and soil conditions are adequate, and uses low-ground-pressure, ATV-type rigs in or near a wetland area, soft soils, or other sensitive locations.

When integrity digs or visual inspection and repair are needed, ground clearing and excavation around the pipe is necessary. The typical workspace at a dig site is 80 by 250 feet, equating to a total disturbance area of approximately 20,000 square feet, and includes:

- 40- by 80-foot area for excavation,
- 50- by 50-foot workspace for dewatering, and
- 100- by 100-foot workspace for staging and vehicle parking.

The typical access area for a dig site may be smaller or larger, depending on site-specific factors and the nature of the dig.

If Enbridge identifies coating problems, maintenance crews remove the old coating via scraping and sandblasting and apply a new coating; if the pipe itself needs repair, sleeves may be welded onto the pipeline or defective sections removed and replaced. Coating consists of non-hazardous fusion-bonded epoxy. During removal, crews place a barrier (e.g., tarp) beneath the removal area and then collect the material for proper disposal at a licensed landfill. Enbridge's Environmental Protection Plan (Appendix E) describes waste and hazardous material handling and disposal.

2.8.3 Emergency Response

2.8.3.1 Emergency Response Plan

Enbridge's Emergency Response Plan Has Specific Details for Specific Regions

Enbridge's emergency response plan is referred to as its Integrated Contingency Plan (ICP). The ICP, which was formally implemented in 2013, would be updated to include the Line 3 Replacement pipeline.

The ICP consists of two parts: the Core Plan, which is the overall response tool, and a series of zone-specific annexes based on geographic regions (North Dakota, Superior, Chicago, and Cushing). The Line 3 Replacement pipeline would fall within the Superior Response Zone.

The ICP is structured in accord with the Incident Command System, which public and private sector emergency teams use to allow responders to work together without being hindered by jurisdictional boundaries. The ICP provides the following:

- Guidelines for responding to an emergency, including alert, notification, and response procedures and techniques to follow in response to and during an incident;
- Documentation of available equipment, personnel, and resources for responding to an incident; and
- Descriptions of the response teams and the roles and responsibilities of the team members within the structure of the Incident Command System.

Enbridge has also developed Emergency Response Action Plans (ERAPs) for the four response zones noted above. The ERAPs are condensed versions of the ICP specifically tailored for each response zone. The ERAPs include maps, line information, and equipment lists. Information specific to the Line 3 Replacement pipeline would be included in the Superior Response Zone ERAP, once Enbridge finalizes the Project route and construction design.

The ERAP is publically available (www.emergencyresponderinfo.com) and is distributed to emergency response agencies in addition to Enbridge personnel. For further information about Enbridge's emergency response plan, see Applicant's Certificate of Need Application and Chapter 10 in this EIS.

2.8.3.2 Pre-Positioned Response Equipment and Staff

Enbridge Pre-Positions Emergency Equipment and Staff for Most Effective Response

The Enbridge facilities in Thief River Falls and Bemidji, Minnesota, and in Superior, Wisconsin, house emergency response equipment to respond to pipeline spill incidents. The fourth maintenance facility to be located east of the Clearbrook terminal would maintain similar emergency response equipment. Equipment housed at these facilities includes vacuum trucks, boats, containment booms, skimmers, pumps, and other related equipment and vehicles.

Pre-positioned containment and recovery equipment would also be maintained and available at each of the pipeline pump stations and at district Enbridge offices along the rights-of-way of the Line 3 Replacement pipeline. Enbridge also maintains an Enterprise Emergency Response Team, which responds to large-scale incidents throughout the United States that require more resources than are available within a single response zone.

2.8.3.3 Spill Response Training

Enbridge's Spill Response Training Exceeds National Standards

Enbridge's ongoing spill response training programs meet the requirements of the National Preparedness for Response Exercise Program (PREP) standards. The PREP standards were developed by PHMSA, the U.S. Coast Guard, the U.S. Environmental Protection Agency, and the U.S. Department of Interior's Bureau of Safety and Environmental Enforcement to establish a training program that meets the intent of Section 4202(a) of the Oil Pollution Act of 1990. Completion of the PREP training allows federally regulated companies to maintain compliance with federal oil pollution response exercise requirements mandated by the Oil Pollution Act of 1990.

Enbridge personnel participate in both classroom and practical training in safety and emergency response procedures, including Incident Command System training, and are required to demonstrate knowledge and proficiency in these areas as appropriate to their responsibilities in accordance with the approved ERAP. PREP standards require at least one written/classroom spill response exercise and one equipment deployment exercise annually. Enbridge has indicated that their training programs exceed this standard.

2.9 ABANDONMENT OF THE LINE 3 PIPELINE

In Abandoning the Existing Pipeline, Enbridge Would Comply with All Regulations

Once the Line 3 Replacement pipeline is placed in service, Enbridge would abandon the existing Line 3 pipeline in accordance with federal, state, and tribal statutes, rules, and regulations. Abandoning the existing Line 3 pipeline would consist of disconnecting the pipeline from pump stations, terminals, and other operating facilities; purging all crude oil or other combustibles from the line;[10] charging the pipeline with an inert gas; and sealing the pipes and facilities left in place. Enbridge would subsequently file a report with PHMSA, documenting where the line crosses over, under, or through a commercially navigable waterway and would maintain permanent records so that the pipeline could be accurately located in the field according to Minnesota Department of Transportation regulations.

Enbridge would continue to maintain and monitor the Line 3 pipeline right-of-way after the pipeline is removed from service. Enbridge would maintain signage and continue to include the pipeline in the Minnesota Gopher State One-Call system. Enbridge would continue to regularly patrol the right-of-way to monitor surface conditions, mow brush within the right-of-way, and inspect and maintain the cathodic protection system. Finally, Enbridge would retain the abandoned Line 3 pipeline within the Enbridge emergency response protocols.

For further information on abandonment, see Appendix B and Chapter 8.

2.10 POTENTIAL CONNECTED ACTION – TRANSMISSION LINES

Connected actions to the proposed Project include transmission lines and associated infrastructure as described below. These actions are undergoing separate environmental reviews and permitting, and

[10] Waste produced during purging is collected for proper disposal at a licensed landfill. Enbridge's Environmental Protection Plan describes waste and hazardous material handling and disposal.

would be constructed by entities other than the Applicant.[11] The environmental review documents that have already been prepared for these proposed connected actions are incorporated by reference into this EIS. Chapter 12 includes additional information on these connected activities and their impacts, including a map of their locations.

Any future actions associated with additional increases in throughput on the proposed Line 3 Replacement would require a new application for a Certificate of Need from the Commission and a review of the need for the requested increase. Enbridge has not indicated any plans for future increases in throughput at this time and hypothetical future increases in throughput have not been evaluated as part of this EIS.

Transmission Lines, for Which Enbridge Is Not Responsible, Also Must Be Considered

Electrical power to the new pump stations would be supplied by electrical transmission lines constructed by third-party utilities for the Line 3 Replacement Project. Each line would terminate at the electrical switching equipment within the pump station. Construction and operation of the transmission line and associated facilities would be the responsibility of the electrical utility.

2.10.1 Two Inlets Pump Station – Clover-Potato Lake Transmission Line

The Clover-Potato Lake transmission line would be a 7-mile-long, 115-kilovolt (kV) line connecting the Two Inlets pump station to the existing Great River IM-MPT Line within Arago and Clover townships in Hubbard County. The transmission line would be supported by 70- to 80-foot-tall single-pole structures with horizontal post insulators and 350- to 400-foot spans between them. It would follow the Line 3 Replacement pipeline route for approximately 5 miles but would not be co-located with any other pipeline or utility corridor for the remaining 2 miles. The transmission line would be constructed within a 100-foot-wide right-of-way. This Project would be subject to environmental review under Minnesota Administrative Rules Chapter 7850 to address environmental impacts ranging from construction-related ground disturbance, stormwater, noise, and air emissions, to maintenance of a cleared right-of-way throughout the operational life of the transmission line.

2.10.2 Backus Pump Station – Bull Moose Transmission Line

The Bull Moose transmission line would be a 2.5-mile-long, 115 kV line connecting the Backus pump station to the existing Minnesota Power Badoura-to-Pine River 115 kV transmission line in Cass County. The transmission line would primarily be supported by 70- to 80-foot-tall single-pole structures with horizontal post insulators. In certain locations, H-frame, three-pole structures might be used in place of the single-pole structures. The spans between the structures would measure 350 to 400 feet. The transmission line would run parallel to Minnesota Power's DC line for about 2 miles before crossing about 0.3 mile of rural land to meet the Minnesota Power Badoura-to-Pine River line. It would be constructed within a 100-foot-wide right-of-way. Department of Commerce, Energy Environmental Review and Analysis prepared an environmental assessment for this Project in 2016.[12]

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[11] Connected actions are defined in Minnesota Rules 4410.4300 Subpart 9. Two projects are "connected actions" if a responsible governmental unit determines they are related in any of the following ways: (A) one project would directly induce the other; (B) one project is a prerequisite for the other and the prerequisite project is not justified by itself; or (C) neither project is justified by itself.

[12] Department of Commerce, Energy Environmental Review and Analysis, March 2016. Environmental Assessment for the Bull Moose Transmission Line Project. http://mn.gov/commerce/energyfacilities//resource.html?Id=34428.

2.10.3 Palisade Pump Station – Palisade Transmission Line

The Palisade transmission line would be a 13-mile-long, 115 kV line connecting the Palisade pump station to a new Rice River breaker station constructed for the Project in Aitkin County. The transmission line would be supported by 70- to 80-foot-tall single-pole structures with horizontal post insulators. In certain locations, H-frame, three-pole structures might be used in place of the single-pole structures. The spans between the structures would measure 275 to 450 feet. The transmission line would parallel Highway 169 across primarily agricultural lands for the 13 miles between the Palisade pump station and the Rice River breaker station, and would be constructed within a 100-foot-wide right-of-way. Department of Commerce, Energy Environmental Review and Analysis prepared an environmental assessment for this Project in 2016.[13]

2.10.4 Cromwell Pump Station – Cromwell Transmission Line

The Cromwell transmission line would be a 115 kV line spanning the less-than-1,500 feet between the Cromwell pump station and Great River Energy's 115 kV LC-CSX transmission line near the Great River Energy Cromwell substation in Carlton County. The line would be supported by 70- to 80-foot-tall single-pole structures with horizontal post insulators. The transmission line would cross rural land between the Cromwell pump station and Great River Energy's transmission line, and would likely be constructed within a 100-foot-wide right-of-way. The transmission line, however, is currently subject to final design. This Project would be subject to environmental review under Minnesota Administrative Rules Chapter 7850 to address environmental impacts ranging from construction-related ground disturbance, stormwater, noise, and air emissions, to maintenance of a cleared right-of-way throughout the operational life of the transmission line.

2.11 REFERENCES

Enbridge Energy, Limited Partnership (Enbridge). 2013. Environmental Mitigation Plan: Pipeline Maintenance Projects.

Enbridge and North Dakota Pipeline Company, LLC. 2014. Certificate of Need Application, Section 1.0. (Docket No. PL-6668/CN13-473.)

[13] Department of Commerce, Energy Environmental Review and Analysis, March 2016. Environmental Assessment for Palisade 115 kV Transmission Project http://mn.gov/commerce/energyfacilities//resource.html?Id=34467.

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Chapter 3
Regulatory Framework

Aside from Federal Regulations, States Regulate the Routing and Construction of Pipelines

This chapter addresses the regulations for constructing and operating oil pipelines in Minnesota. Pipelines in the United States are regulated by a variety of state and federal agencies. The Federal Energy Regulatory Commission, for example, regulates interstate oil pipeline rates and terms of service; and the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) regulates pipeline safety.

The federal government, however, does not determine whether an oil pipeline is needed or where it should be located. Those determinations are generally left to the states.[1] As a result, states regulate the routing and construction of oil pipelines through a variety of approvals, permits, and licenses.

The First Two Required State Approvals Are for Certificate of Need and Route Permit

Enbridge's (the Applicant's) proposed Line 3 Replacement Project (Project) requires two initial approvals from the Minnesota Public Utilities Commission (Commission): a Certificate of Need (CN) and a route permit. The CN determines whether a project is needed and, if it is determined to be needed, the route permit determines where it should be located. Figure 3-1 provides an overview of the CN and route permit process.

Subsequent Approvals Are Needed from Federal, State, Local, and Tribal Agencies

If the CN and route permit are granted, additional approvals and consultations with other federal, state, and local agencies would be required before the pipeline could be constructed and operated along the permitted route. A license to cross public waters from the Minnesota Department of Natural Resources (Minnesota DNR), for example, would be required for each public water crossing along the permitted route; and potential wetland impacts would require a Section 404 wetland permit from the U.S. Army Corps of Engineers (USACE). This wetland permit would require federal environmental review under the National Environmental Policy Act (NEPA) as well as consultation with other federal, tribal, and state agencies that are responsible for resources such as threatened or endangered species and cultural resources.

Depending on the route approved by the Commission, a project also could require approvals from tribal nations, and associated approvals from and consultations with federal agencies. Any routes that pass through reservations and tribal trust lands, for example, would require review under NEPA as well as consultations and approvals from USACE, the Bureau of Indian Affairs (BIA), and possibly the U.S. Environmental Protection Agency.

[1] The U.S. Department of State is responsible for determining whether issuing a Presidential Permit for a proposed new oil pipeline crossing the Canadian or Mexican border would "serve the national interest." See Executive Order 11423 on pipelines: http://www.state.gov/e/eb/rls/othr/exec/114274.htm. No Presidential Permit amendment is required for the Line 3 Replacement Project.

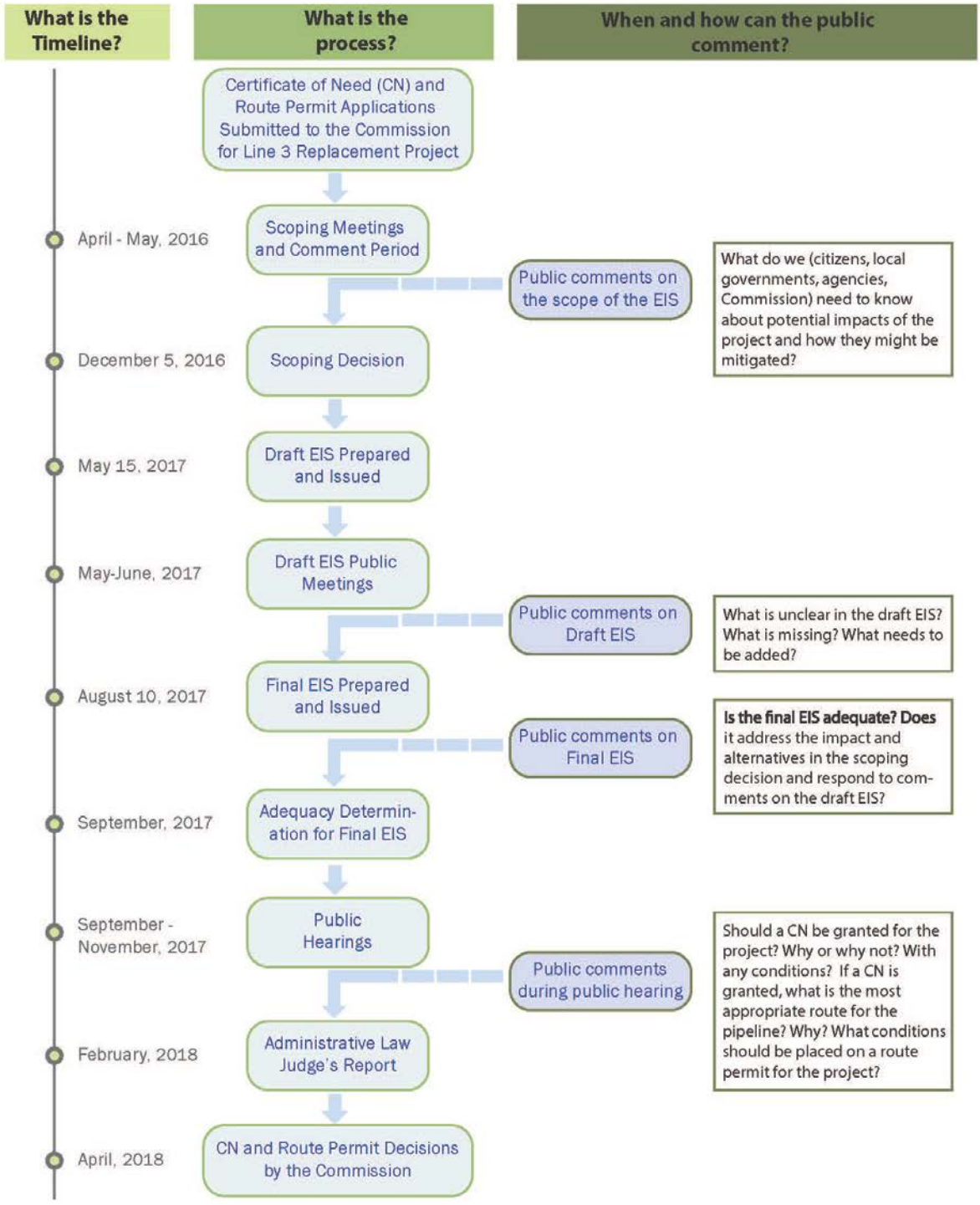

Figure 3-1. Environmental Review and Commission Permitting Process for Line 3 Replacement Project

A preliminary list of these required permits is provided in Table 3.6-1. Each of these permits and approvals is addressed in greater detail as part of the regulatory context for each resource impact evaluation in Chapters 5 and 6 of this Environmental Impact Statement (EIS).

3.1 CERTIFICATE OF NEED

A CN Is Required for the Proposed Project, and This EIS Addresses Both CN and Routing Permit Issues

In Minnesota, no person may construct a large energy facility without a CN from the Commission.[2] The definition of "large energy facility" includes an oil pipeline with a diameter greater than 6 inches and more than 50 miles of its length in Minnesota.[3] Enbridge's proposed Project therefore requires a CN because it is an oil pipeline with a 36-inch diameter and is approximately 340 miles long.

Enbridge submitted a CN application to the Commission on April 24, 2015. After accepting the application as complete, the Commission ordered the Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) to prepare a combined EIS that addressed both the CN and routing permit dockets in accordance with Minnesota Administrative Rule Chapter 4410. The Commission also referred the application to the Office of Administrative Hearings (OAH) for a contested case hearing for the CN decision, to be conducted jointly with the hearing for Enbridge's route permit application (discussed below).[4]

3.1.1 Certificate of Need Criteria

CN Criteria Address Energy Efficiency and Reliability, and Potential Social and Environmental Effects

In deciding on Enbridge's CN application, the Commission must determine whether the Project is needed, or whether some other project would be more appropriate for the State of Minnesota. Minnesota Administrative Rules Part 7853.0130 provides four criteria that the Commission must use in determining whether to approve Enbridge's CN application. The Commission must grant a CN if it determines that:

A. The probable result of denial would adversely affect the future adequacy, reliability, or efficiency of energy supply to the Applicant, to the Applicant's customers, or to the people of Minnesota and neighboring states.[5]

B. A more reasonable and prudent alternative to the proposed facility has not been demonstrated by parties or persons other than the Applicant.[6]

C. The consequences to society of granting the CN are more favorable than the consequences of denying the certificate.[7]

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2 Minnesota Statutes § 216B.243.

3 Minnesota Statutes § 216B.2421.

4 Commission Order Joining Need and Routing Dockets, February 1, 2016, PL-9/CN-14-916 and PL-9/PPL-15-137, eDockets Number 20162-117877-01 [hereinafter Commission Order Joining Need and Routing Dockets].

5 Minnesota Administrative Rules Part 7853.0130 (A).

6 Minnesota Rules Administrative Rules Part 7853.0130 (B).

7 Minnesota Administrative Rules Part 7853.0130 (C).

D. It has not been demonstrated that the design, construction, or operation of the proposed facility would fail to comply with the relevant policies, rules, or regulations of other federal, state, or local agencies.[8]

Under these criteria, the Commission would first consider the underlying economic drivers for the proposed pipeline. If denying the CN would adversely affect the future adequacy, reliability, or efficiency of energy supply, the Commission would consider the EIS's analysis of the advantages and disadvantages of alternative ways of addressing these issues.

If the Commission denies a CN for the Project, it is adopting a no build or No Action Alternative (see Chapter 4). If the Commission issues a CN for the Project, it could approve the Project as proposed by Enbridge or it could issue a CN contingent upon modifications to the Project.[9]

The Commission's CN decision would determine the pipeline's characteristics, including its diameter, throughput, and endpoints in Minnesota. The Commission could grant a CN with pipeline characteristics as proposed by Enbridge or could modify them. It also could place conditions on a CN by requiring Enbridge to take certain actions related to the receipt of a CN for the Project. These conditions, if any, would flow from the record developed during the environmental review and hearing process.

The Commission's CN decision does not determine the route that the pipeline would take between its endpoints in Minnesota. The route is determined by the Commission's route permit process (as discussed below and in Table 3.1-1 (further discussion is provided in Chapter 4).

8 Minnesota Administrative Rules Part 7853.0130 (D).

9 Minnesota Administrative Rules Part 7853.0800.

Table 3.1-1. Commission Decisions and Decision Criteria

Commission Decision	Certificate of Need				Route Permit
	Would denial adversely affect future adequacy, reliability, or efficiency of energy supply?	If yes, is there a more reasonable and prudent alternative, such as different endpoints or transport method?	If yes, are the consequences to society of granting the CN more favorable than denial?	Does the Project comply with other laws?	If yes, what is the most appropriate route for the pipeline?
Commission Decision Criteria	Minnesota Administrative Rules Part 7853.0130 (A)	Minnesota Administrative Rules Part 7853.0130 (B)	Minnesota Administrative Rules Part 7853.0130 (C)	Minnesota Administrative Rules Part 7853.0130 (D)	Minnesota Administrative Rules Part 7852.1900
Analysis in EIS	Economic analysis conducted by Minnesota Department, Energy Environmental Review and Analysis and other parties to the contested case hearing	EIS Chapter 5: Existing Conditions, Impacts, and Mitigation – CN			EIS Chapter 6: Existing Conditions, Impacts, and Mitigation – Route Permit

CN = Certificate of Need; EIS = Environmental Impact Statement

3.2 ROUTE PERMIT

A Route Permit Is Required for the Proposed Project, and This EIS Addresses Both CN and Routing Permit Issues

In Minnesota, no person may construct a pipeline with a diameter of 6 inches or more that is designed to carry a hazardous liquid without a route permit from the Commission.[10] Accordingly, Enbridge's proposed Project, an oil pipeline with a diameter of 36 inches, requires a route permit. The Commission may not grant a route permit for the Project until a CN has been issued (although these approvals could occur consecutively at the same Commission meeting).

Enbridge submitted a route permit application to the Commission on April 24, 2015. After accepting the application as complete, the Commission ordered DOC-EERA to prepare an EIS for the Project and referred the application to OAH for a contested case hearing to be conducted jointly with the hearing for Enbridge's CN application.

[10] Minnesota Statute § 216G.02.

3.2.1 Route Permit Criteria

Route Permit Criteria Address Human and Environmental Effects, Including Cumulative Effects

The Commission is charged with routing pipelines in an orderly manner that minimizes or mitigates human and environmental impacts.[11] Minnesota Administrative Rules Part 7852.1900 provides the criteria that the Commission must consider in evaluating Enbridge's route permit application:

A. Human settlement, existence and density of populated areas, existing and planned future land use, and management plans;

B. The natural environment, public and designated lands, including but not limited to natural areas, wildlife habitat, water, and recreational lands;

C. Land of historical, archaeological, and cultural significance;

D. Economies within the route, including agricultural, commercial or industrial, forestry, recreational, and mining operations;

E. Pipeline cost and accessibility;

F. Use of existing rights-of-way and right-of-way sharing or paralleling;

G. Natural resources and features;

H. The extent to which human or environmental effects can be mitigated by regulatory control and by applying the permit conditions contained in Minnesota Administrative Rule 7852.3400 for preparing the right-of-way, constructing the pipeline and associated facilities, and cleaning up, and restoring the right-of-way.

I. Cumulative potential effects of related or anticipated future pipeline construction; and

J. The relevant applicable policies, rules, and regulations of other state and federal agencies, and local government land use laws, including ordinances adopted under Minnesota Statutes Section 299J.05, on the design, construction, or operation of the proposed pipeline and associated facilities.

A pipeline route permit must designate a route for the pipeline and the conditions for preparing the right-of-way, constructing the pipeline and associated facilities, and cleaning up and restoring the right-of-way—in addition to any other appropriate conditions relevant to minimizing human and environmental impacts.[12] If issued a CN and route permit by the Commission, Enbridge could exercise the power of eminent domain to acquire land for the Project.[13] EERA has provided a sample Route Permit in Appendix I.

11 Minnesota Administrative Rules Part 7852.0200.

12 Minnesota Administrative Rules Part 7852.3200.

13 Ibid.

3.3 ENVIRONMENTAL REVIEW

This EIS Addresses CN and Routing Permit Issues to Facilitate Informed Decision-Making

The Minnesota Environmental Policy Act (MEPA) requires that an EIS be prepared for major governmental actions with the potential to create significant environmental impacts.[14]

An EIS is intended to facilitate informed decision-making by entities with regulatory authority over a project. It also assists citizens in providing guidance to decision-makers regarding the project. An EIS describes and analyzes the potential environmental and socioeconomic impacts of a project and possible mitigation measures, including alternatives to the project.[15] It does not advocate or state a preference for a specific alternative. Instead, it analyzes and compares alternatives so that citizens, agencies, and governments can work from a common set of facts.

3.3.1 Scoping

After Obtaining Agency and Public Input, the Commission Determined the Scope of the EIS

The first step in preparing an EIS is scoping. The purpose of scoping is "to reduce the scope and bulk of the EIS, identify only those potentially significant issues relevant to the proposed project, define the form, level of detail, content, alternatives, time table for preparation, and preparers of the EIS, and to determine the permits for which information will be developed concurrently with the EIS."[16]

A scoping Environmental Assessment Worksheet and a Draft Scoping Decision Document were issued for Enbridge's Project on April 11, 2016. DOC-EERA staff provided notice of the scoping Environmental Assessment Worksheet and the Draft Scoping Decision Document as well as the schedule for EIS scoping meetings. The scoping notice initiated a 45-day comment period, and comments on the scope of the EIS were accepted through May 26, 2016.

Between April 25, 2016, and May 11, 2016, DOC-EERA, Minnesota DNR, and Minnesota Pollution Control Agency (Minnesota PCA) staff conducted 12 scoping meetings throughout the Project area. In addition to making oral comments at these meetings, citizens and agencies submitted 322 scoping comment letters and 1,118 form letters.[17]

For the CN decision, based on the scoping comments, DOC-EERA suggested to the Commission several Project alternatives for inclusion in the scope of the EIS, including alternative technologies and a system alternative.[18] The Commission therefore included these in the scope of the EIS.[19] These alternatives are

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14 Minnesota Statutes § 116D.04.

15 Minnesota Administrative Rules Part 4410.2300.

16 Minnesota Administrative Rules Part 4410.2100.

17 DOC-EERA Comments and Recommendations to the Commission, September 21, 2016, PL-9/CN-14-916 and PL-9/PPL-15-137, eDockets Numbers 20169-125060-02, 20169-125058-02, 20169-125058-04, 20169-125058-06, 20169-125058-08, 20169-125058-10, 20169-125058-12, 20169-125058-14, 20169-125058-16, 20169-125058-18, 20169-125058-20, 20169-125064-01, 20169-125064-03, 20169-125064-05, 20169-125064-07, 20169-125064-09, 20169-125064-11, 20169-125064-13, 20169-125064-15, 20169-125064-17, 20169-125064-19 [hereinafter DOC-EERA Scoping Comments].

18 Id.

19 Order Denying Motion, Approving Scoping Decision as Modified, and Requiring Expanded Notice, November 30, 2016, eDockets Number 201611-126917-01 [hereinafter Order Approving Scoping Decision].

described in detail in Chapter 4 and are analyzed and compared in Chapters 5 and 10 through 12 of this EIS.

DOC-EERA also recommended four route alternatives and 23 route segment alternatives for inclusion in the scope of the EIS,[20] which the Commission included in the scope of the EIS.[21] The Commission also included an additional route segment alternative (RSA-53).[22] These alternatives are described in detail in Chapter 4 and are analyzed and compared in Chapters 6 and 10 through 12 of this EIS.

3.3.2 Environmental Impact Statement

A Key Purpose of This EIS Is to Help the Commission Decide on CN and Route Permit Applications

This combined CN and route permit EIS has been prepared by DOC-EERA staff in cooperation with the Minnesota DNR and Minnesota PCA. It is issued as a draft EIS so that it can be improved through public comment[23] and a Final EIS can be developed based on those comments.[24] Once a Final EIS is issued, the public may comment on the adequacy of the Final EIS.[25] The Commission must then determine whether the Final EIS is adequate for decision-making purposes or whether it needs to be revised.[26]

On the issue of need, this EIS for the combined CN and route permit proceedings will aid the Commission's consideration under Minnesota Administrative Rules Part 7853.0130 (B) about whether a more reasonable and prudent alternative to the proposed facility exists as well as the Commission's consideration of societal consequences under Minnesota Administrative Rules Part 7853.0130 (C). Specifically, the EIS will help to inform the Commission regarding reasonable and prudent alternatives as the Commission considers "the effect of the proposed facility on the natural and socioeconomic environments compared to the effects of reasonable alternatives"[27] and as it considers "the effect of the proposed facility, or a suitable modification of it, upon the natural and socioeconomic environments compared to the effect of not building the facility."[28]

On the issue of routing, this EIS for the combined CN and route permit proceedings will aid the Commission's consideration of each of the Commission's decision criteria in Minnesota Administrative Rules Part 7852.1900, Subpart 3.

20 DOC-EERA Scoping Comments.

21 Order Approving Scoping Decision.

22 Ibid.

23 Minnesota Administrative Rules Part 4410.2600.

24 Minnesota Administrative Rules Part 4410.2700.

25 Minnesota Administrative Rules Part 4410.2800.

26 Ibid.

27 Minnesota Administrative Rules Part 7853.0130 (B)(2).

28 Minnesota Administrative Rules Part 7853.0130 (C)(3).

3.4 PUBLIC HEARINGS

Public Hearings Will Determine Whether CN and Route Permit Criteria Have Been Met

After the Final EIS has been completed, public hearings, presided over by an administrative law judge (ALJ) from OAH, will be held in the Project area. The hearings on the CN will be held jointly with those for the route permit.[29] At those hearings, citizens, agencies, and governmental bodies will have an opportunity to submit comments, present evidence, and ask questions. Commenters specifically will be able to address whether CN and route permit criteria have been met. After the public hearings, an evidentiary hearing will be held, and the ALJ will submit a report to the Commission with findings of facts, conclusions of law, and recommendations about issuing a CN and a route permit for the Project.

3.5 COMMISSION DECISION

The Commission Will Use All Information to Decide on the CN and Route Permit

After considering the entire record, including the Final EIS, input received during the public hearings, and the ALJ's findings and recommendations, the Commission will determine whether to deny the CN, grant a CN for the Project as proposed, or grant a CN contingent upon modifications to the Project.[30] As noted previously, the Commission may place conditions on a CN, requiring Enbridge to take certain actions before it can receive a CN for the Project.

The Commission will similarly determine what route should be permitted. Route permits include a permitted route and an anticipated alignment, as well as conditions specifying construction and operating standards. Route permits also typically include mitigation plans and project-specific mitigation measures (Interagency Pipeline Coordination Team 2015).

Decisions by the Commission on Enbridge's CN and route permit applications are anticipated in spring 2018.

3.6 ADDITIONAL PERMITS AND APPROVALS

Additional Federal, Tribal, State, and Local Approvals Also Could Be Required

A route permit from the Commission is the only state permit required for the routing of Enbridge's Project—that is, the Commission's route permit determines where the pipeline would be located. The Commission's route permit supersedes and preempts all local zoning, building, and land use regulations.[31]

Various federal, tribal, state, and local approvals could be required, however, for activities related to constructing and operating the Project. Once the route permit has been issued, Enbridge must obtain all other required permits (commonly referred to as "downstream permits"). The information in this EIS may be used by downstream permitting agencies in their evaluation of effects on resources. Table 3.6-1 lists the downstream permits and additional approvals required for Enbridge's Project.

29 Commission Order Joining Need and Routing Dockets.

30 Minnesota Administrative Rules Part 7853.0800.

31 Minnesota Statutes § 216G.02; Minnesota Administrative Rules Part 7852.0200.

Table 3.6-1. Additional Permits and Approvals Required for the Line 3 Replacement Project

Unit of Government	Type of Application	Reason Required
U.S. Army Corps of Engineers – St. Paul District and Minnesota Pollution Control Agency	Section 10/404 Individual Permit and associated state 401 Individual Water Quality Certification	Authorizes discharge of dredged and fill material into waters of the United States, including wetlands, and crossing of navigable waters of the United States
U.S. Fish and Wildlife Service	Section 7 Environmental Species Act consultation (federal endangered species)	Establishes conservation measures and authorizes, as needed, take of federally protected species
	Bald Eagle Removal Permit	Allows known bald eagle nests near construction activities to be removed
U.S. Forest Service	Special Use Permit	Authorizes crossing of U.S. Forest Service land
Bureau of Indian Affairs	Right-of-Way Grant	Authorizes crossing of tribal trust land
Minnesota Department of Natural Resources	License to Cross Public Waters	50-year license that allows a proposed utility to cross public waters
	License to Cross Public Lands[a]	50-year license that allows a proposed utility to cross public lands
	Water Appropriation Permit – Pipeline and Facilities	Authorizes withdrawal and use of water from surface water or groundwater sources
	State Endangered Species Permit and Avoidance Plan	Outlines plans for avoidance, minimization, and mitigation for take of state-listed species
	Fen Management Plan	Outlines plans for avoidance, minimization, and mitigation of fens within Project corridor
	Infested Waters Transport permit	Permits transport of waters with identified invasive species infestation
	Federal Consistency Review	Ensures that activities requiring a federal license or permit are consistent with the state's coastal management program

Table 3.6-1. Additional Permits and Approvals Required for the Line 3 Replacement Project

Unit of Government	Type of Application	Reason Required
Minnesota Pollution Control Agency	Clearbrook Terminal Air Quality Permit – Synthetic-Minor Individual State Operating Permit	Authorizes construction and operation at the modified Clearbrook terminal
	National Pollutant Discharge Elimination System (NPDES) Individual Construction Stormwater, Hydrostatic Test, and Trench Dewatering Permit – Pipeline Construction	Authorizes ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on construction site; discharge of water from hydrotesting activities; and removal of water that may accumulate in pipeline trench
	NPDES General Construction Stormwater Coverage – Facilities	Authorizes ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on construction site
	NPDES General Construction Stormwater Coverage – Pipeyards and Contractor Yards	Authorizes ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on construction site
Minnesota Department of Health	Drinking Water Supply Management Area/Wellhead Protection Area Consultation	Ensures that pipeline construction and operation are compatible with goals of relevant plans
Minnesota State Historic Preservation Office	Cultural resources consultation, National Historic Preservation Act Section 106 clearance	Ensures adequate consideration of impacts on significant cultural resources
Minnesota Department of Agriculture	Agricultural Protection Plan	Establishes measures for agricultural protection
Minnesota Department of Transportation	Road crossing permits	Authorizes crossings of state-jurisdictional roadways
Minnesota Board of Water and Soil Resources/Wetland Conservation Act Local Governmental Units	Notice of Intent to Utilize Federal Approvals for Utilities Project Exemption	Notice of use of exemption required
Mississippi Headwaters Board	Local Land Use Review	Ensures compatibility with land use plan
Red Lake, Wild Rice, Two Rivers, and Middle-Snake Watershed Districts	Watershed District Permit	Authorizes crossing of legal drains and ditches within watershed
Local/County	Permits pertaining to off-right-of-way yard use	Ensures compatibility with relevant land use plans

Source: Scoping Environmental Assessment Worksheet, Section 8.0, April 11, 2016, eDockets Numbers 20164-119956-01 and 20164-119956-03.

Note:

[a] Minnesota Department of Natural Resources has indicated that the agency would not grant license for line RA-03AM to cross Alexander Woods Scientific and Natural Area.

3.6.1 Federal Approvals

The proposed Project requires a number of federal permits, approvals, and decisions before construction and operation can begin. Before federal permits can be issued, the relevant agency must complete environmental review in accordance with NEPA and conduct consultations, such as with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA) and with the State Historic Preservation Office and tribal authorities under Section 106 of the National Historic Preservation Act. The permits and approvals required for the proposed Project are listed in Table 3.6-1 and discussed further below.

3.6.1.1 U.S. Army Corps of Engineers

USACE regulates impacts on navigable waters of the United States pursuant to Section 10 of the Rivers and Harbors Act of 1899 and potential impacts on waters of the United States, including wetlands, under Section 404 of the Clean Water Act. Dredged or fill material, including material that moves from construction sites into these waters, could affect the quality of the waters, and USACE requires permits for projects that could have such effects.

3.6.1.2 U.S. Fish and Wildlife Service

USFWS oversees compliance with the Bald and Golden Eagle Protection Act, which prohibits anyone from "taking" (which includes disturbing) birds, nests, or eggs without a permit from the Secretary of the Interior.

USFWS also oversees compliance with the federal ESA, which requires that federal agencies "insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat of such species." USFWS therefore requires permits for taking of threatened or endangered species (USFWS 2016). USFWS encourages project applicants to consult with the agency to ascertain a project's potential to affect these species, and to identify general mitigation measures for the project.

Prior to issuing permits for a project, federal agencies (e.g., USACE) are required to consult with USFWS under Section 7 of the ESA. The permitting agency must prepare a Biological Assessment in accordance with the ESA to analyze potential project-related effects on federally listed threatened or endangered species, candidate species, species proposed for listing, and their designated critical habitats. After consulting with the permitting agency, USFWS issues a Biological Opinion and Incidental Take Permit statement, if necessary.

3.6.1.3 U.S. Forest Service

The U.S. Forest Service (USFS) is charged with the protection of the nation's national forests (USFS 2016). Three route alternatives analyzed in this EIS (RA-06, RA-07, and RA-08) cross the Chippewa National Forest. USFS requires a Special Use Permit or a Right-of-Way Permit/Easement if a proposed project crosses land under its jurisdiction. The U.S. Department of Agriculture oversees special use permits for USFS under 36 Code of Federal Regulations 214 Subpart B.

As part of the proposed Project, Enbridge proposes to abandon the existing Line 3. This line currently proceeds through the Chippewa National Forest. Abandonment of the pipeline could affect forest resources and could require consultation with USFS.

3.6.1.4 U.S. Department of Transportation

The U.S. Department of Transportation PHMSA administers a national regulatory program to ensure the safe and reliable transportation of hazardous materials by pipeline, including oil, and is charged with preventing and minimizing associated human and environmental impacts. Through federal regulations at 49 CFR Part 195, PHMSA develops minimum standards to ensure the safe design, construction, testing, operation, and maintenance of pipeline facilities, as well as emergency response. Many of these regulations are written as performance standards allowing for pipeline companies to use different technologies to achieve the standard. New pipelines must meet all current standards. The general requirements, reporting requirements, operation, and maintenance and corrosion control requirements are all considered retroactive and apply to all pipelines regardless of age.

Although there is no specific permit or approval needed from PHMSA for the Project, it must be constructed and operated in accordance with PHMSA regulations. Additionally, the agency reviews oil spill response plans provided by pipeline operations and coordinates federal, state, and local planning and prevention activities.

3.6.2 Tribal Approvals

There are seven Anishinaabe (Ojibwe) and four Dakota (Sioux) reservations in Minnesota. Each reservation and community is an American Indian tribal nation and is a distinct, sovereign government.

The Applicant's preferred route and route alternatives evaluated in this EIS run near several tribal reservations. In addition, as part of the Project, Enbridge proposes to abandon the existing Line 3, which currently traverses the Leech Lake and Fond du Lac Indian reservations. Abandonment of the line could affect tribal resources within these reservations.

Two route alternatives analyzed in this EIS (RA-07 and RA-08) cross the Leech Lake Indian Reservation and three route alternatives (RA-06, RA-07, and RA-08) cross the Fond du Lac Indian Reservation. If the Commission were to select one of these alternatives as the route for the Project, Enbridge would be required to obtain authorizations from the Leech Lake and Fond du Lac Bands of Ojibwe and BIA. These routes also would require BIA to conduct an environmental review under NEPA, as well as associated consultations under Section 7 of the ESA and Section 106 of the National Historic Preservation Act.

DOC has consulted with or requested consultation with the Red Lake, White Earth, Leech Lake, Fond du Lac, and Mille Lacs Bands of Ojibwe regarding the Project. Tribal consultations are discussed further in Chapter 9.

3.6.3 State Approvals

3.6.3.1 Minnesota Department of Natural Resources

Minnesota DNR regulates potential effects on Minnesota's public lands and waters; crossing these areas requires a license, which could in turn require mitigation measures. Minnesota DNR has jurisdiction over wildlife in Minnesota and administers the Minnesota outdoor recreation system, including Wildlife Management Areas, Scientific and Natural Areas, state parks, and state forests. As with USFWS, Minnesota DNR encourages project applicants to consult with them to ascertain a project's potential to affect state-listed threatened and endangered species and to identify possible mitigation measures. Minnesota DNR also regulates water withdrawals from both groundwater and surface water sources, and requires a permit for withdrawals in excess of 10,000 gallons per day or 1 million gallons per year.

Minnesota's Lake Superior Coastal Program, within the Minnesota DNR, coordinates the review of federal actions to determine whether they will be consistent with the state's coastal management program. Minnesota DNR's federal consistency review includes activities requiring certain federal licenses or permits.

3.6.3.2 Minnesota Pollution Control Agency

Minnesota PCA monitors air and water quality in Minnesota and uses technical and financial assistance as well as a variety of regulations to protect and enhance environmental quality in Minnesota. A National Pollutant Discharge Elimination System/State Disposal System construction stormwater permit from Minnesota PCA is required for stormwater discharges from construction projects. The general NPDES/State Disposal System permit requires (1) use of best management practices; (2) a Stormwater Pollution Prevention Plan; and (3) adequate stormwater treatment capacity once the project is constructed.

Minnesota PCA must certify that proposed activities will not violate water quality standards.

3.6.3.3 Minnesota Department of Health

The Minnesota Department of Health assists local water suppliers in preparing wellhead protection plans for their drinking water supply management areas. The Department of Health and local water suppliers encourage project applicants to consult with them to evaluate and mitigate potential effects on drinking water supplies.

3.6.3.4 Minnesota State Historic Preservation Office

The Minnesota State Historic Preservation Office oversees the protection of cultural resources in Minnesota by identifying, evaluating, and protecting historic and archaeological resources. The Office encourages project applicants to consult with them, and they can guide applicants on appropriate measures for mitigating effects on cultural resources.

3.6.3.5 Minnesota Department of Agriculture

The Minnesota Department of Agriculture (Minnesota DA) requires an agricultural impact mitigation plan that identifies measures that could be taken to avoid, mitigate, repair, or provide compensation for the adverse effects of constructing a pipeline on agricultural lands (Minn. Stat. § 216B.243, Subd. 7).

Minnesota DA is responsible for eradicating, controlling, and abating nuisance plant species (Minn. Stat. § 18G.04); and local county agricultural inspectors administer the program. The Applicant would be required to develop a vegetation maintenance and management plan for the proposed Project.

Pipeline project applicants must consult with Minnesota DA on the potential effects of issuing a pipeline route permit on agricultural lands.[32] This consultation could require development of an agricultural mitigation plan.[33]

[32] Minnesota Statutes § 216E.10, Subd. 3.

[33] Ibid.

3.6.3.6 Minnesota Department of Transportation

A permit from the Minnesota Department of Transportation (MNDOT) is required for pipelines that are adjacent to or cross under Minnesota trunk highway rights-of-way. MNDOT's utility accommodation policy generally allows utilities to occupy portions of highway rights-of-way where such occupation does not put the safety of the traveling public or highway workers at risk or unduly impair the public's investment in the transportation system (MNDOT 2017).

3.6.3.7 Minnesota Board of Water and Soil Resources

The Minnesota Board of Water and Soil Resources oversees local governmental units (LGUs) implementation of Minnesota's Wetland Conservation Act. For linear projects that cross multiple LGUs, Minnesota Board of Water and Soil Resources typically coordinates the review of potential wetland impacts among the affected LGUs. The Wetland Conservation Act requires anyone proposing to go through a wetland to (1) try to avoid the impact; (2) try to minimize any unavoidable impacts; and (3) replace any lost wetland functions. Utilities, including pipelines, however, can request exemption from wetland replacement requirements, and Enbridge has indicated that they will seek this exemption.

3.6.3.8 Minnesota Office of Pipeline Safety

Under an agreement with the federal Office of Pipeline Safety, within PHMSA, the Minnesota Office of Pipeline Safety (MnOPS) inspects liquid and natural gas pipelines and investigates pipeline accidents and spills as an authorized agent of the federal government. PHMSA officials decide the appropriate course of action with regard to non-compliance on interstate pipelines. MnOPS is responsible for reviewing pipeline spill prevention and response plans.[34] Although MnOPS would not issue a permit or approval for the proposed Project, if the Project is approved, they would conduct inspections and review prevention and response plans.

3.6.4 Local Approvals

The Mississippi Headwaters Board has adopted a comprehensive management plan to protect the natural, cultural, historic, and recreational values of the Mississippi Headwaters region, and the board encourages project applicants to consult with them to help protect these values.

Watershed districts in Minnesota monitor water quality and coordinate water management decisions in their particular watersheds. Project applicants are encouraged to consult with districts to evaluate and mitigate potential impacts on watersheds. Districts require permits for work within their watersheds.

Counties, townships, and cities in Minnesota regulate land use within their jurisdictions by requiring a variety of approvals. Although the Commission's route permit supersedes all local land use regulations, permittees are not excused from local approvals required for proper local government functioning, such as the safe use of local roads, or for temporary land uses associated with a project.

[34] Minnesota Statutes §115E; see also Interagency Report on Oil Pipelines (Interagency Pipeline Coordination Team 2015).

3.7 REFERENCES

Interagency Pipeline Coordination Team. 2015. Interagency Report on Oil Pipelines. Prepared for the Environmental Quality Board. December. https://www.eqb.state.mn.us/sites/default/files/documents/Interagency%20Report%20on%20Oil%20Pipelines4_0.pdf. Accessed January 24, 2017.

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Chapter 4
Alternatives to the Proposed Project

4.1 INTRODUCTION

Environmental Impact Statement Must Compare Proposed Project with Reasonable Alternatives

As outlined in Chapter 3, the Minnesota Environmental Policy Act requires that an Environmental Impact Statement (EIS) compare the potentially significant impacts of a proposed project to those of other reasonable alternatives.[1] In addition, both the Certificate of Need (CN)[2] and route permit[3] regulations require an evaluation of reasonable alternatives to a proposed project. More specifically, Minnesota environmental review regulations require that:

> *The EIS must address one or more alternatives of each of the following types of alternatives or provide a concise explanation of why no alternative of a particular type is included in the EIS: alternative sites, alternative technologies, modified designs or layouts, modified scale or magnitude, and alternatives incorporating reasonable mitigation measures identified through comments received during the comment periods for EIS scoping or for the draft EIS.*[4]

In Scoping the EIS, Commission Included Recommended Alternatives, Plus One Route Segment

During the scoping process, Minnesota Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) staff collected input from the public, agencies, tribes, and nongovernmental organizations—including suggestions for alternatives for the EIS. After reviewing the proposed alternatives, DOC-EERA prepared a proposed *Final Scoping Decision Document* and recommended the CN and route permit alternatives to be included in the scope of the EIS. The *Alternatives Screening Report*[5] and the *Final Scoping Decision Document*[6] describe the process used to solicit, evaluate, and select the alternatives included in this EIS.

On November 30, 2016, the Minnesota Public Utilities Commission (Commission) issued its EIS scoping order that included these alternatives as well as one additional route segment.[7]

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1 Minnesota Statutes § 216D.04, Subp. 2a.

2 Minnesota Administrative Rules Part 7853.0120.

3 Minnesota Administrative Rules Part 7852.1400.

4 Minnesota Administrative Rules Part 4410.2300(G).

5 *Alternatives Screening Report for Line 3 Replacement Project,* dated September 21, 2016, available at eDockets Number 20169-125058-08.

6 *Final Scoping Decisions Document for Line 3 Replacement Project*, dated September 21, 2016, available at eDockets Number 201612-127062-03.

7 Order Denying Motions, Approving Scoping Decision as Modified, and Requiring Expanded Notice, November 30, 2016, eDockets Numbers 201611-126917-02 and 201611-126917-02.

CN and Route Permit Alternatives Are Addressed Separately

The Commission will use the EIS to help inform its CN decision and the route permit decision. Therefore, the alternatives analysis is divided into two sections to match the alternatives under consideration in each of these two separate, sequential decisions. This chapter describes each of the CN, route, and route segment alternatives to the proposed Project. Chapter 5 evaluates the potential environmental impacts of CN Alternatives, and Chapter 6 evaluates the potential environmental impacts of route alternatives.

This EIS focuses on providing the applicable environmental information for the CN, the route permit, and other agency decisions. The next section, Section 4.2, describes the alternatives evaluated in the EIS for the CN decision. The majority of the economic analysis and other technical information for the CN decision will be provided by the Applicant, other parties, and the public that are participating in the contested case hearing.

4.2 DESCRIPTION OF ALTERNATIVES – CERTIFICATE OF NEED

CN Criteria Address Energy Efficiency and Reliability, and Potential Social and Environmental Effects

In analyzing the need for the proposed Project and alternatives, the Commission must consider whether:

A. The probable result of denial would adversely affect the future adequacy, reliability, or efficiency of energy supply to the Applicant, to the Applicant's customers, or to the people of Minnesota and neighboring states.[8]

B. A more reasonable and prudent alternative to the proposed facility has not been demonstrated by parties or persons other than the Applicant.[9]

C. The consequences to society of granting the CN are more favorable than the consequences of denying the certificate.[10]

D. It has not been demonstrated that the design, construction, or operation of the proposed facility would fail to comply with the relevant policies, rules, or regulations of other federal, state, or local agencies.[11]

For a more detailed discussion of CN criteria, see Chapter 3 in this EIS.

Commission Could Issue a CN for the Project as Proposed or Modified, or They Could Deny It

The Commission could issue a CN for the Project as proposed, modify it, or deny it. As discussed in Chapter 3, the Commission must consider each of the criteria in Minnesota Administrative Rules Part 7853.0130 in determining need. Under these criteria, the Commission first considers the underlying economic need for the proposed pipeline. This economic analysis, conducted by Minnesota Department

8 Minnesota Administrative Rules Part 7853.0130 (A).

9 Minnesota Administrative Rules Part 7853.0130 (B).

10 Minnesota Administrative Rules Part 7853.0130 (C).

11 Minnesota Administrative Rules Part 7853.0130 (D).

of Commerce Division of Energy Resources Energy Planning and Advocacy and other parties to the contested case hearing, will aid the Commission in making this evaluation. Then, if the Applicant establishes the underlying need, the environmental and socioeconomic analyses in the EIS will help the Commission weigh the advantages and disadvantages of alternative ways to meet the need and whether to issue a CN for the proposed Project. Therefore, for the CN decision, the Commission has three options: (1) issue the certificate for the Project as proposed; (2) deny the certificate; or (3) issue a certificate contingent on modifications.[12]

Table 4.2-1 provides an overview of the alternatives included in this section and illustrates how the range of alternatives evaluated in the EIS aligns with each of the four major need-related criteria in Minnesota Administrative Rules Part 7853.0130, A through D. The rows in Table 4.2-1 represent the CN Alternatives evaluated in the EIS, and the columns are the applicable CN criteria.

The sections that follow provide a detailed description of each of the CN Alternatives. In addition to the CN Alternatives included in Table 4.2-1 and discussed in Sections 4.2.1 through 4.2.6. Section 4.2.10 discusses the alternative of using a smaller diameter pipeline.

4.2.1 Action Alternative – Certificate of Need Approved

Chapter 2 describes the Applicant's proposed Project in detail.

4.2.2 No Action Alternative – Certificate of Need Denied

No Action Alternative is The Denial of Certificate of Need, and Potential Consequences

The EIS must evaluate the environmental consequences of the No Action Alternative. In this case, a Commission decision to deny the certificate of need is the "No Action" Alternative. If the Commission determines that the demand for increased shipping capacity exists but denies the CN, the Applicant (or entities other than the Applicant) could reasonably be expected to meet shipper demand through other means, such as a different pipeline system, or by train or truck.

In analyzing the No Action Alternative, this EIS must therefore consider the human and environmental impacts associated with a variety of CN Alternatives that corresponds to potential other reasonable alternatives and the applicable CN decision criteria. As indicated in Table 4.2-1, the No Action Alternative, denying the CN, could lead to any of the following:

1. Continued use of existing Line 3
2. Use of other pipelines
3. System Alternative SA-04
4. Use of Rail as an alternate mode of transport
5. Use of Trucks as an alternate mode of transport
6. Continued use of existing Line 3 supplemented by rail
7. Continued use of existing Line 3 supplemented by truck

The sections that follow provide a detailed description of each of the CN Alternatives. In addition, Section 4.2.10 discusses the alternative of a smaller diameter pipeline.

[12] Minnesota Administrative Rules Part 7853.0800.

Table 4.2-1. Certificate of Need Alternatives and Criteria

Commission's Decision	Would denial adversely affect future adequacy, reliability, or efficiency of energy supply? Minnesota Administrative Rules Part 7853.0130 A	If yes, is there a more reasonable and prudent alternative, such as different endpoints or a different transport method? Minnesota Administrative Rules Part 7853.0130 B	If yes, are the consequences to society of granting the CN more favorable than denial? Does the Project comply with other laws? Minnesota Administrative Rules Part 7853.0130 C, D	Certificate of Need Alternatives Evaluated for Environmental Impacts	
Certificate of Need Not Granted (CN Alternatives)	Keep using existing Line 3	—	—	**CN Alternative 1** Continued use of existing Line 3	Line 3 operates at existing capacity, no supplemental oil transportation
	Yes	Use a different pipeline system	—	**CN Alternative 2** Other pipelines	Other pipelines transport up to 760,000 bpd
				CN Alternative 3 System alternative SA-04	SA-04 transports up to 760,000 bpd
		Use a different oil transportation mode		**CN Alternative 4** Transportation by rail	Trains transport up to 760,000 bpd
				CN Alternative 5 Transportation by truck	Trucks transport up to 760,000 bpd
	Yes	Yes	The consequences to society of granting the CN are not more favorable than denying it	**CN Alternative 6** Existing Line 3 supplemented by rail	Line 3 operates at existing capacity; trains used to transport up to 370,000 additional bpd to market
				CN Alternative 7 Existing Line 3 supplemented by truck	Line 3 operates at existing capacity; trucks used to transport up to 370,000 additional bpd to market

Table 4.2-1. Certificate of Need Alternatives and Criteria

Commission's Decision	Would denial adversely affect future adequacy, reliability, or efficiency of energy supply?	If yes, is there a more reasonable and prudent alternative, such as different endpoints or a different transport method?	If yes, are the consequences to society of granting the CN more favorable than denial? Does the Project comply with other laws?	Certificate of Need Alternatives Evaluated for Environmental Impacts	
	Minnesota Administrative Rules Part 7853.0130 A	Minnesota Administrative Rules Part 7853.0130 B	Minnesota Administrative Rules Part 7853.0130 C, D		
Certificate of Need Granted	Yes	Yes	Yes	Applicant's proposed Project	CN granted for the proposed Project or for a modified Project (e.g., a new lower capacity pipeline)

To provide a basis for evaluating the No Action Alternative, the following throughput volumes by destination were assumed for each of the CN Alternatives (Table 4.2-2).

Table 4.2-2. Annual Delivery Volume by Destination for Existing Line 3 and Certificate of Need Alternatives (barrels per day)

Alternative	Destination			Total Deliveries
	Clearbrook	Superior[a]	Other	
Continued use of existing Line 3	360,000	30,000	0	390,000
Use of other pipelines	0	0	760,000/various	760,000
System alternative SA-04	0	0	760,000 – Joliet, Illinois	760,000
Transportation by rail	360,000	400,000	0	760,000
Transportation by truck	360,000	400,000	0	760,000
Existing Line 3 supplemented by rail	360,000	400,000	0	760,000
Existing Line 3 supplemented by truck	360,000	400,000	0	760,000

[a] Deliveries by rail or truck would range from 154,000 barrels per day (bpd) (supplement to continued use of existing Line 3 at 390,000 bpd) to up to 494,000 bpd (exclusive use of rail or truck) to achieve a total volume of 760,000 bpd.

4.2.3 Certificate of Need Alternative 1 – Continued Use of Existing Line 3

As Table 4.2-2 shows, if the existing Line 3 continued to operate under the No Action Alternative, only 390,000 barrels per day (bpd) of transfer capacity would be available, considerably less than the 760,000 bpd planned capacity of the Line 3 Replacement Project.

Line 3 has operated at the current lower capacity for integrity reasons. Under the current version of the proposed consent decree (see Section 2.2), increasing the capacity of the existing Line 3 to a higher operating capacity would require significant investment by Enbridge to repair and maintain the existing facilities. Enbridge previously determined that such an investment in new facilities is cost prohibitive and not feasible. Because Enbridge has already determined that upgrading the existing line is not feasible, upgrading the existing line to a higher capacity was not considered in the CN evaluation and, as noted in Table 4.2-2, the analysis of this CN Alternative assumes 390,000 bpd throughput.

Maintaining the Existing Line 3 Would Require 4,000 Excavations over the Next 15 Years

Continued operation of Line 3 at its present capacity would require that Enbridge continue the high level of maintenance that the pipeline currently requires. Enbridge has estimated that up to 4,000 integrity digs (excavating and exposing the pipeline for maintenance and correction of anomalies) would be required over the next 15 years of operation (approximately 267 procedures per year) (Enbridge 2015). The effects of this high level of maintenance activity would continue under the No Action Alterative.

Integrity digs occur when a potential anomaly in the pipeline structure is detected and must be investigated and repaired. The potential repair site is identified and, if required for protecting adjacent operating pipelines, protective matting, or an additional soil layer is temporarily installed around the site. Topsoil at the repair site may be removed and stockpiled.

The pipeline trench is opened using excavating equipment, and the exposed pipeline is inspected and repaired, as warranted. In some cases, a portion of the pipe is removed and a replacement section welded into place, inspected, and tested. When the repair is completed and protective external coating is reapplied, the trench is backfilled, topsoil is replaced, and if appropriate, vegetation is restored. The disturbed area within the pipeline right-of-way may be a small area for repair of the pipeline at a specific point or a larger area if a section of the pipe is replaced.

Under the consent decree, increasing the capacity of the existing Line 3 to a higher operating capacity would require significant investment by Enbridge in repair and maintenance of the existing facilities.

Annual Cost for Continued Maintenance of Existing Line 3 Is Estimated at $30 to $40 Million

Enbridge estimates that it would cost $30 to $40 million per year to maintain the U.S. portion of the existing Line 3. For comparison, Enbridge estimates that maintaining the new Line 3 would cost approximately $2 million (Enbridge 2014).

4.2.4 Certificate of Need Alternative 2 – Use of Other Pipelines

Other existing and potential future pipelines with available capacity were considered as alternatives to the Project if they (1) interconnected in the crude oil supply region near Edmonton, Alberta; and (2) served the same Clearbrook and Superior destinations.

Environmental Impacts of Alternative Pipeline Capacity Owned by Enbridge or Others Are Not Evaluated

Existing regional pipelines that originate in the Edmonton area include TransCanada's Keystone pipeline system and the Enbridge Mainline system, which consists of Line 3 and other pipelines, including Line 1 (237,000 bpd), Line 2A (442,000 bpd), Line 2B (442,000 bpd), Line 4 (796,000 bpd), and Line 67 (570,000 bpd). Other pipelines that have recently been constructed, are planned for construction, or are in the planning and permitting stage were also considered. Each potential alternative pipeline is listed and described in Table 4.2-3.

Table 4.2-3. Certificate of Need Alternative Pipelines

Pipeline	Route	Status
Keystone XL pipeline	Canada, North Dakota, South Dakota, Nebraska	Presidential Permit granted. Does not enter Minnesota and does not interconnect with Clearbrook or Superior.
TransCanada Energy East pipeline	From Hardisty, Alberta, to Montreal parallel to the U.S.-Canada border	Not currently approved for construction. Does not enter Minnesota and does not interconnect with Clearbrook or Superior.
Woodriver pipeline	Woodriver, Illinois, to Cushing, Oklahoma	Existing pipeline (inactive)
Minnesota pipeline	Clearbrook to Twin Cities	Existing pipeline
Enbridge Mainline system	Edmonton to Superior via Clearbrook	Existing pipelines

Source: Information Technology Associates 2008.

The EIS is not evaluating these alternatives based on whether they meet the need for this proposed Project. Their environmental impacts have been (or would be) evaluated in other jurisdictions. Therefore, the "other pipeline" CN Alternatives are not evaluated in the EIS.

4.2.5 Certificate of Need Alternative 3 – System Alternative SA-04

System Alternative SA-04 Would Mostly Run Through North Dakota, Iowa, and Illinois

SA-04 was proposed by commenters during the scoping process as an alternative that would completely avoid northern and central Minnesota, and would interconnect with the regional pipeline system closer to the major refineries in central Illinois. In the *Final Scoping Decision Document*, SA-04 was shown to terminate near Joliet, Illinois. Approximately 68 percent of SA-04 is located outside Minnesota in North Dakota, Iowa, and Illinois.

4.2.5.1 Route Location

The SA-04 route follows the Applicant's preferred route from Neche, North Dakota, to the vicinity of U.S. Highway 29 in the northeast corner of North Dakota, where it intersects with the Alliance pipeline corridor. It follows the pipeline corridor until it crosses into Minnesota near Wheaton, in Traverse County. In Minnesota, SA-04 parallels the Alliance pipeline right-of-way and the Minnesota River through Big Stone, Swift, Chippewa, Renville, and Nicolet counties to near Mankato, in Blue Earth County.

The route continues southeast, diagonally across Faribault and Freeborn counties to the vicinity of Albert Lea. South of Albert Lea, the route crosses the Minnesota-Iowa border and continues southeast to the vicinity of Clinton, in Clinton County, Iowa, generally following the Cedar River. The route crosses the Iowa-Illinois border southeast of Clinton, Iowa, and continues along existing pipelines (Alliance Pipeline, LP; Enterprise Products Operations, LLC; NGL Pipeline, LP) to Joliet, Illinois.

Figure 4.2-1 illustrates the route of SA-04. Figures showing the route at a larger scale are included in Appendix A. Distances for the SA-04 route are summarized in Table 4.2-4.

4.2.5.2 Pump Stations and Mainline Valves

System Alternative SA-04 Length Would Require 16 New Pump Stations

Enbridge indicated that 16 pump stations would be required along SA-04, or one every 50 miles on average, which is comparable to Enbridge's proposed Project. It was assumed that each pump station would require approximately 8 acres of land and would be located adjacent to the system alternative alignment. Similar to the proposed Project, mainline valves (MLVs) would be required near water crossings, significant environmental resources, and populated areas in order to shut off oil in case of a leak. Hydraulic analysis of operating the pipeline on the SA-04 route is not available, so the specific locations of pump stations and MLVs cannot presently be determined.



Figure 4.2-1. System Alternative SA-04 Route

Table 4.2-4. Measurements for System Alternative SA-04

Feature	Measurement
Total length (origin to destination)	795.4 miles
Length in Minnesota	251.0 miles
Length outside Minnesota	544.4 miles
States crossed (distance)	North Dakota – 233.5 miles Iowa – 187.9 miles Illinois – 123.0 miles
Counties crossed	North Dakota: Pembina, Walsh, Grand Forks, Trail, Cass, Richland Minnesota: Traverse, Stevens, Swift, Chippewa, Kandiyohi, Renville, Sibley, Nicollet, Le Sueur, Blue Earth, Waseca, Freeborn, Mower Iowa: Mitchell, Howard, Chickasaw, Bremer, Fayette, Buchanan, Delaware, Jones, Clinton Illinois: Rock Island, Whiteside, Lee, Bureau, LaSalle, Grundy, Will

4.2.5.3 Construction and Operation of System Alternative SA-04

Constructing and Operating System Alternative SA-04 Could Require Additional State and Local Permits

The analysis of impacts associated with SA-04 in the EIS assumes that it would be constructed and operated in the same manner as the Applicant's preferred route. SA-04 is located within other local and state jurisdictions (approximately 544 miles, or 68 percent of the total route), so other state and local regulations would apply.

4.2.6 Certificate of Need Alternative 4 – Transportation by Rail

This alternative considers rail as an alternative mode of transport to transfer 760,000 bpd to Enbridge's terminals in Clearbrook, Minnesota and Superior, Wisconsin. The analysis assumes that 48 percent of the 760,000 bpd total (360,000 bpd) would be delivered to Clearbrook, Minnesota, based on the approximate capacity of the Twin Cities refineries that the Clearbrook terminal serves via the Minnesota Pipe Line Company (MPL) pipeline system. The analysis assumes that the remaining 52 percent (400,000 bpd) would be delivered to Superior, Wisconsin. It also assumes that existing rail lines would primarily be used. These destinations and existing routes are shown in Figure 4.2-2.

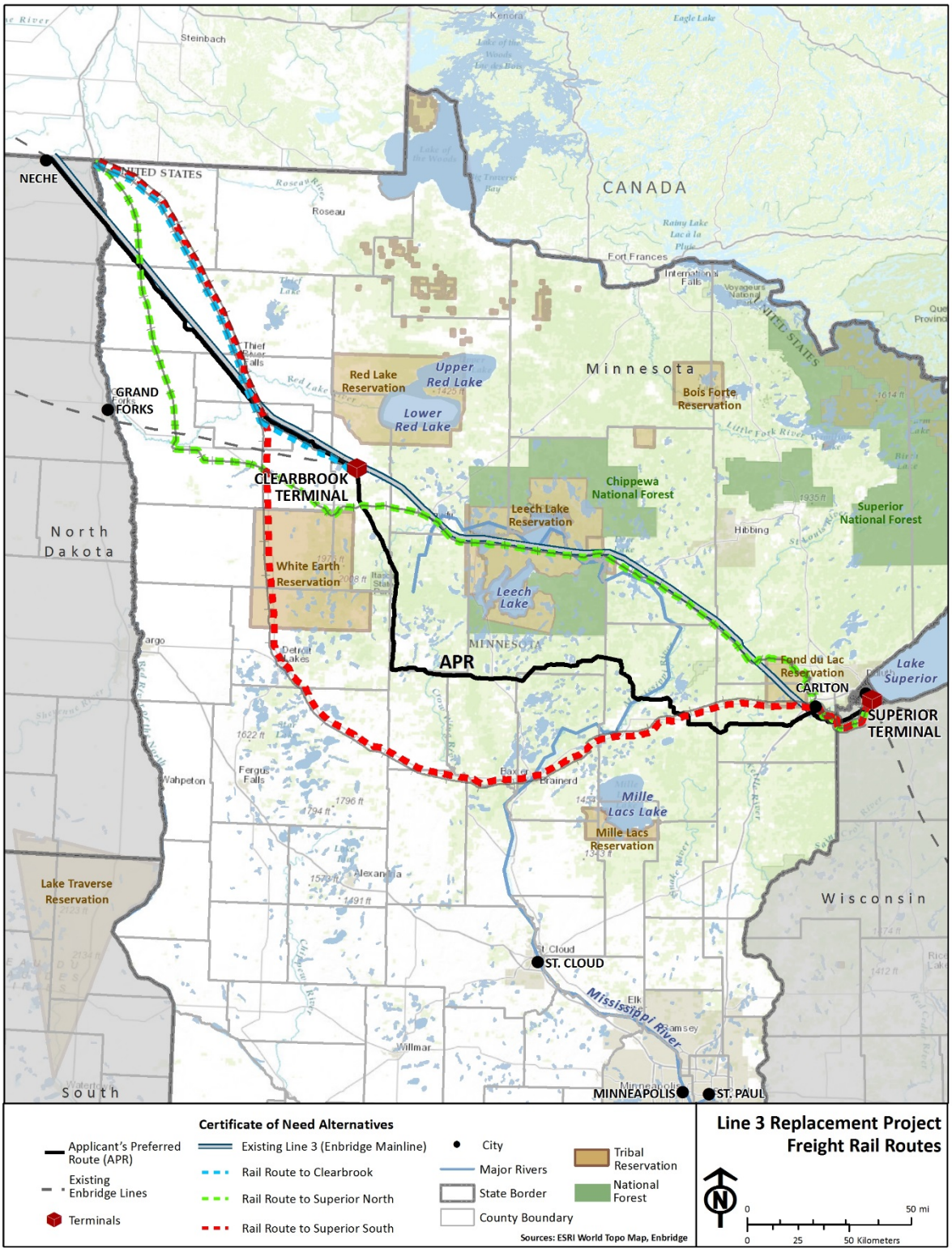

Figure 4.2-2. Potential Railway Routes from Gretna to the Clearbrook and Superior Terminals

Rail Transport Would Require New Oil Storage and Loading Facilities and Upgraded Rail Access

Transporting oil by rail would require an oil storage and rail loading facility near Neche, North Dakota, and could be transported by either the Burlington Northern Santa Fe (BNSF) or the Canadian Pacific rail lines to the Clearbrook and Superior terminals, respectively. There are currently no oil storage facilities, rail loading facilities, or rail access immediately adjacent to the Mainline near the international border. In addition, no rail offloading facilities or rail access are adjacent to the Clearbrook terminal. Some rail access and existing rail offloading capacity is currently available at Superior. Transporting crude oil by rail would require that loading/offloading facilities and new rail access be developed and that existing rail access be upgraded. To implement the rail alternative, the following facilities would be required.

- Gretna (near Neche) – The Mainline pump station and storage facilities closest to Neche are located at Enbridge's pump station in Gretna, Canada, approximately 2 miles north of Neche, North Dakota. Both BNSF and Canadian Pacific rail lines have mainline rail facilities at West Lynn/Emerson, Canada; a distance of approximately 14 miles. The Gretna pump station is in a rural location surrounded primarily by disturbed agricultural land. A 14-mile-long rail line across agricultural land, including some wetlands, would require disturbance of approximately 84 acres in addition to an area of 100 to 200 acres for the rail loading facility.

  The loading facility, which would be constructed in Canada, would include approach tracks, storage tracks, and active loading facilities, which would need to be enclosed to allow operations during winter and would need to accommodate railroad siding, metering equipment, underground piping, secondary containment and vapor control systems, catch basins, retention ponds, electric power, sewer and water systems, and other associated facility requirements. There are existing storage facilities at the Gretna pump station. Rail access would be directly east and could require an estimated six new rural road crossings. Any loading facility at Gretna would require permitting by provincial and national entities in Canada.

- Clearbrook – The existing Enbridge terminal and pump station at Clearbrook is surrounded by semi-disturbed agricultural lands and wetlands. An abandoned rail right-of way is directly adjacent to the existing pump station site. The line is abandoned, and the track from Clearbrook approximately 10 miles northwest to Gully, Minnesota, has been removed. At Gully, rail facilities are still present but would likely need to be upgraded or replaced along the Canadian Pacific route from Gully to Thief River Falls.

  The offloading facility would require converting 100 to 200 acres of agricultural lands and wetlands to accommodate arrival and departure tracks, enclosed transfer structures, concrete containment areas, repair facilities, support buildings, pumps, above- and below-ground pipelines providing connections to the Clearbrook terminal, electric power, stormwater infrastructure, sewer and water systems, and an oil-water separation area. Recommissioning the abandoned rail facilities could require re-converting approximately 60 acres of partially reclaimed right-of-way. Because an existing rail line would be used, no new road crossings would be created, but existing road crossings would be reactivated.

- Superior – An existing rail logistics facility is located adjacent to the Enbridge terminal at Superior. This facility could have limited capacity and would require expansion to accommodate crude oil transfers of 760,000 bpd. The land adjacent to the existing rail logistics facility consists primarily of wetlands that would need to be converted if used for

expansion. Rail access to the BNSF and Canadian Pacific systems appears to be available subject to appropriate tariffs. No new road crossings are likely to be required.

Transporting 760,000 bpd of Oil by Rail Would Require Ten 110-Car Trainloads a Day

Oil is typically transported on unit trains, which consist of approximately 110 specialized tank cars designed to haul liquid freight, and specifically crude. Each of these specialized tank cars, which are regulated by the U.S. Department of Transportation (USDOT), could hold up to 800 barrels (33,600 gallons) of oil. Therefore, a full unit train of 110 tank cars could transport 88,000 barrels (3.7 million gallons) of oil.

Transporting 760,000 bpd of oil by rail would require 10 loaded unit trains per day to travel from Gretna to the Clearbrook and Superior terminals. Assuming that the volume of oil transported to the Clearbrook terminal and subsequently pumped to Minnesota refineries would equal 48 percent of this total and the remaining 52 percent of the total would be transported to Superior, five loaded unit trains would be required to travel from Gretna to the Clearbrook terminal per day, and five loaded unit trains would be required to travel from Gretna to the Superior terminal per day (Table 4.2-5).

Table 4.2-5. Summary of Transportation Requirements for the Rail Alternative

Unit Trains		
Volume	**Number Required[a]**	**Departures per Day**
760,000 barrels per day	66 trains/7,244 cars	10
Facilities		
Facility	**Facility Requirements**	**Land Requirements**
Rail loading and offloading facilities	Gretna – New 100- to 200-acre[b] facility with Class 1 rail connection adjacent to the existing Mainline right-of-way	Gretna – Adjacent agricultural land
	Clearbrook – New 100-to 200-acre[b] facility with Class 1 rail connection adjacent to the existing Clearbrook terminal	Clearbrook – Adjacent semi-disturbed land, agricultural land and wetlands
	Superior – Approximately 100-acre[b] expansion of existing rail logistics facility adjacent to existing Enbridge terminal	Superior – Adjacent wetlands and recreation land (golf course)
Rail upgrades	Gretna – New approximately 14-mile-long spur line connection from Gretna pump station to BNSF or Canadian Pacific rail line at West Lynn/ Emerson in Canada	Gretna – Approximately 84 acres[c] of permanent agricultural land converted to rail use; additional road crossings
	Clearbrook – Reestablish approximately 10 miles of track from Gully to Clearbrook and upgrade portions of the existing Canadian Pacific rail line from Thief River Falls to Gully, Minnesota	Clearbrook – Approximately 60 acres[c] of existing abandon right-of-way converted back to rail use
	Superior – Direct interconnection with existing BNSF and Canadian Pacific Class 1 rail line. Less than 0.5 mile of new spur may be required.	Superior – Less than 3 acres[c] of semi-disturbed land converted to rail use

[a] Number of unit trains does not include requirements for locomotives.

[b] Area required for loop track, storage tracks, and transfer facilities for loading or offloading operations are exclusive of rail spur to interconnect with Class 1 rail line.

[c] Assumes a 50-foot-wide permanent right-of-way. An additional right-of-way of up to 50 feet could be disturbed during construction.

Cost of the Required Number of New Tank Cars Estimated at $1 Billion

Based on the calculations for the number of tank cars needed to deliver the specified volumes per day, the estimated transit times of the unit trains, and the time necessary for loading and offloading the tank cars and for empty trains to make return trips to Gretna, approximately 7,200 new tank cars would be required.[13] Assuming a cost of $140,000 per car, the capitalization to amass the needed number of unit trains would be approximately $1 billion.

Availability of Existing and New Tank Cars is Assumed in the Analysis

This estimate assumes that the proposed stock of tank cars would be available. While tank car manufacturers were said to have over 50,000 tank cars back ordered in 2013, more recent analysis indicates that this backlog has cleared (Kloster 2015) This estimate also does not include the cost of constructing the new rail spurs or any associated rail infrastructure needed, railway maintenance, labor costs, fuel, or other associated expenses. Nor does it include the cost of constructing unit train terminal facilities for loading and offloading, which have been estimated to range from approximately $85 to $125 million.

This scenario also assumes that the BNSF and Canadian Pacific rail carriers have availability for this increase in rail traffic and would provide joint rail tariffs for the service proposed. It would require one available route on Canadian Pacific to the Clearbrook terminal and two available routes to the Superior terminal through various combinations and routings of the BNSF and Canadian Pacific rail lines. See Figure 4.2-2.

4.2.7 Certificate of Need Alternative 5 – Transportation by Truck

This alternative considers truck as an alternative mode of transport to transfer 760,000 bpd to Enbridge's terminals in Clearbrook, Minnesota, and Superior, Wisconsin. As with the rail alternative, transporting crude oil by truck as an alternative to replacing Line 3 would require that oil be pumped through the existing Mainline from the Applicant's facilities in Edmonton, Alberta, to an oil storage and truck loading facility at Gretna, adjacent to the existing Mainline. Oil would subsequently be loaded into tanker trucks and transported by highway to the Clearbrook and Superior terminals. The analysis assumes that 48 percent of the 760,000 bpd total (360,000 bpd) would be delivered to Clearbrook, Minnesota, based on the approximate capacity of the Twin Cities refineries that the Clearbrook terminal serves via the MPL system. The analysis assumes that the remaining 52 percent (400,000 bpd) would be delivered to Superior, Wisconsin. It also assumes that existing highways would primarily be used. These destinations and existing routes are shown in Figure 4.2-3.

[13] Calculations are based on figures provided in the MPL, LLC Certificate of Need Application for the Minnesota Pipe Line Reliability Project. MPUC Docket No. PL-5/CN-14-320.

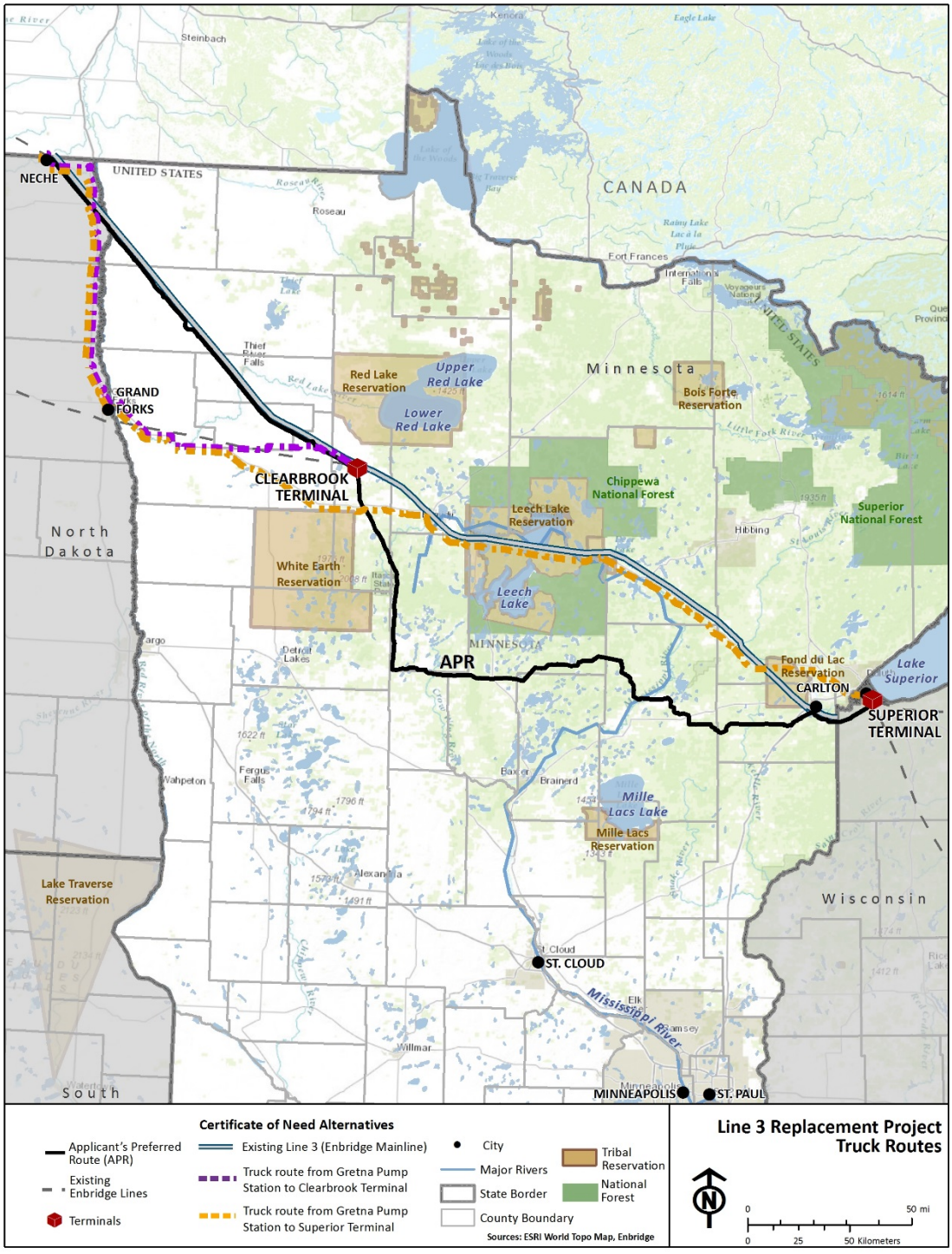

Figure 4.2-3. Potential Truck Routes from Gretna to the Clearbrook and Superior Terminals

Truck Transport Would Require New Loading Facilities and New or Upgraded Access to Highways

This alternative would require development of truck loading and offloading facilities and new or upgraded road access to the interstate highway system. Assuming that the Applicant could maximize use of that portion of Line 3 approved for upgrade in Canada, a truck loading facility would likely be located at the Gretna pump station near the U.S. border. From this point, trucks could be routed to Enbridge's Clearbrook and Superior terminals. To implement the truck alternative, the following facilities would be required.

- Gretna – A truck loading facility would most likely be located at the Gretna pump station. Manitoba Provincial Highway 30, North Dakota State Highway 18, and North Dakota County Road 55 would link the facility to Interstate 29 at Pembina, North Dakota. These roads, spanning 18 miles, may require the addition of passing lanes and other configuration changes to support the increased truck traffic. Due to the uncertainty of what upgrades would be required, amounts for permanently disturbed areas were not estimated, but road upgrades likely would involve only minimal acreage. The facility would require that rural agricultural land and some wetlands be permanently converted to industrial use—approximately 50 acres for the loading facility and 102 acres for road access.

  The loading facility would consist of covered loading bays, piping to connect to existing storage tanks, primary and secondary spill and runoff containment facilities, wastewater systems, and other associated components, including contained overnight parking facilities for the trucks. The location of facilities in Canada could be influenced by permitting and international border crossing requirements.

- Clearbrook – Tanker trucks using the interstate highway system would arrive at the Applicant's Clearbrook terminal and offload crude oil to be delivered to those customers taking deliveries at Clearbrook. It was assumed that existing storage tanks would be sufficient to support the truck delivery operation, but truck offloading facilities would need to be constructed with the same components as the loading facilities described above.

  The existing Enbridge terminal and pump station at Clearbrook are surrounded by semi-disturbed agricultural lands and wetlands that would need to be converted to industrial use to accommodate an approximately 50-acre truck offloading facility. A new 0.6-mile-long access road from the terminal to State Highway 92 would need to be constructed. In addition, State Highway 92 from Clearbrook to its intersection with County Highway 7 south of Oklee, County Highway 7 south of Oklee to its intersection with U.S. Highway 59 south of Brooks, a 1-mile expanse of U.S. Highway 59 connecting State Highway 92 and County Highway 49, and County Highway 49 south of Brooks to its intersection with U.S. Highway 2 15 miles east of Crookston could require upgrades.

  The existing 42-mile-long route consists of two-lane highways that could require adding passing lanes and other configuration changes to support the increased truck traffic. Because of the uncertainty of what upgrades would be required, amounts for permanently disturbed areas were not estimated, but road upgrades would likely involve only minimal acreage. U.S. Highway 2 runs west to Grand Forks, where it intersects Interstate 29 and the route to Gretna.

- Superior – The route from Gretna to Enbridge's existing terminal at Superior would be on U.S. Highway 2 from the west. This highway crosses into Superior on the Richard I. Bong Bridge and is then routed to the Superior Bay waterfront and on to Enbridge's Superior terminal.

Significant additional tanker truck traffic on this route could, however, create unacceptable congestion.

A new, approximately 5-mile-long more direct truck route could be developed by using an existing rail corridor and airport property. This new access would permanently disturb approximately 34 acres of semi-disturbed and industrial land. Installing a truck offloading facility would permanently disturb an additional approximately 50 acres of wetlands and possibly recreation land (golf course) directly adjacent to the Superior terminal.

Transporting 760,000 bpd by Truck Would Require 4,000 Truck Trips a Day

Tanker trucks can carry approximately 190 barrels and are often used to move oil from wellhead locations not served by pipeline gathering systems to aggregation points and storage facilities. They are not typically used to transport the volumes proposed by the Project. Transporting 760,000 bpd of oil by tanker truck would require 4,000 tanker trucks per day to travel from Gretna to the Clearbrook and Superior terminals.

As noted above, the analysis assumes that the volume of oil transported to the Clearbrook terminal and subsequently pumped to Minnesota refineries would equal approximately 48 percent of this total and that the remaining 52 percent of the total would be transported to Superior. To travel from Gretna to the Clearbrook terminal, 1,920 loaded trucks per day would be required; and 2,080 loaded trucks per day would be required to travel from Gretna to the Superior terminal (Table 4.2-6).

The Cost of the New Trucks for Transportation by Truck Is Estimated at $2.4 Billion per 5 Years

Although the amount of oil transported per day could vary by demand, the Applicant would need to operate a fleet of trucks capable of transporting the full estimated volumes per day. The shortest distances by highway from Gretna to the Clearbrook and Superior terminals are approximately 193 miles and 360 miles, respectively (Figure 4.2-3). Based on the estimated number of tanker trucks needed to deliver the specified volumes per day, a conservative estimate of the time necessary for loading and offloading the tanker trucks, and the time necessary for empty trucks to return to Gretna, 12,000 new tanker trucks would be required.

Assuming an estimated cost of $200,000 per truck, an initial capital investment of $2.4 billion would be required. With the mileage the trucks would cover in steady service, the economic life of a truck would be approximately 5 years, so that cost would be repeated every 5 years throughout the lifespan of the Project.

Table 4.2-6. Summary of Transportation Requirements for the Truck Alternative

Truck Units		
Volume	**Number Required**	**Departures per Day**
760,000 barrels per day	12,200 trucks	4,000 trucks
Facilities		
Facility	**Facility Requirements**	**Land Requirements**
Loading and offloading facilities	Gretna – New approximately 50-acre[a] site with access to freeway	Gretna – Adjacent to agricultural land
	Clearbrook – New approximately 50-acre[a] site with access to freeway	Clearbrook – Adjacent to semi-disturbed land, agricultural land, and wetlands
	Superior – New approximately 50-acre[a] site with access to freeway	Superior – Adjacent to wetlands and recreation land (golf course)
Road access requirements	Gretna – Improvement of approximately 18-miles of Provincial and State Highway and County Road from Gretna pump station to U.S. Interstate 29 at Pembina, North Dakota	Gretna – Upgrades to existing roads.
	Clearbrook – Approximately 0.6-mile-long truck access to State Highway 92 at Clearbrook; potential improvement of approximately 42 miles of State Highway and County Highways from Clearbrook to U.S. Highway 2 near Crookston, North Dakota	Clearbrook – Approximately 4.4 acres[b] of semi-disturbed agricultural land and wetlands converted to road use
	Superior – Could require new, approximately 4.7-mile-long truck route from U.S. Highway 2 entrance to Superior to the vicinity of the terminal	Superior – Less than 34 acres[b] of semi-disturbed land converted to road use

[a] Area required for loading and unloading bays, storage tanks, piping, containment facilities, catch basins, roads, water, wastewater systems and other associated components.

[b] Assumes 60-foot-wide permanent right-of-way. An additional right-of-way of up to 60 feet may be disturbed during construction.

4.2.8 Certificate of Need Alternative 6 – Existing Line 3 Supplemented by Rail

This alternative considers continued operation of existing Line 3 with trains transporting additional oil to achieve a total transfer capacity of 760,000 bpd. This alternative assumes existing Line 3 would supply 390,000 barrels per day to Superior. Assuming that Line 3 would transport the full amount of its daily operating volume (390,000 bpd) to the Superior terminal, the assumed 48 percent/52 percent division of total oil volume transported to the Clearbrook and Superior terminals, respectively, would result in 360,000 bpd of oil transported by rail to the Clearbrook terminal and 10,000 bpd of oil transported by rail to the Superior terminal.

This alternative would require the ongoing maintenance and repair activities associated with continued use of existing Line 3 (Section 4.2.3) as well as development of the infrastructure for rail transport described in 4.2.6.

Existing Line 3 Supplemented by Rail Would Require Six 110-Car Trainloads a Day

Transporting 370,000 bpd of oil by rail would require six loaded unit trains to travel from Gretna to the Clearbrook and Superior terminals per day. Five loaded unit trains would travel from Gretna to the Clearbrook terminal per day, and one unit train would travel from Gretna to the Superior terminal per day.

Existing Line 3 Supplemented by Rail Would Require $500 Million Investment in New Tank Cars and $30 to $40 Million per Year Continued Maintenance of Existing Line 3

Based on the calculations for the number of tank cars needed to deliver the specified volumes per day, the estimated transit times of the unit trains, and the time necessary for loading and offloading the tank cars and for empty trains to make return trips to Gretna, approximately 3,500 new tank cars would be required.[14] Assuming a cost of $140,000 per car, the capitalization to amass the needed number of unit trains would be approximately $495 million.

As noted above, Enbridge estimates that it would cost $30 to $40 million per year to maintain the U.S. portion of the existing Line 3.

4.2.9 Certificate of Need Alternative 7 – Existing Line 3 Supplemented by Truck

This alternative considers continued operation of existing Line 3 with trucks transporting additional oil to achieve a total transfer capacity of 760,000 bpd. This alternative assumes that existing Line 3 would supply 390,000 barrels per day to Superior. Assuming that Line 3 would transport the full amount of its daily operating volume (390,000 bpd) to the Superior terminal, the assumed 48 percent/52 percent division of total oil volume transported to the Clearbrook and Superior terminals, respectively, would result in 360,000 bpd of oil transported by truck to the Clearbrook terminal and 10,000 bpd of oil transported by truck to the Superior terminal.

This alternative would require the ongoing maintenance and repair activities associated with continued use of existing Line 3 (Section 4.2.3) as well as development of the infrastructure for truck transport described in 4.2.7.

Existing Line 3 Supplemented by Trucks Would Require 1,947 Truck Trips per Day

Transporting 360,000 bpd of oil by truck to the Clearbrook terminal and 10,000 bpd to the Superior terminal would require 1,889 trucks per day to travel from Gretna to the Clearbrook terminal and 58 trucks per day to travel from Gretna to the Superior terminal.

The Cost of the New Trucks for Transportation by Truck Is Estimated at $1.2 Billion per 5 Years and $30 to 40 Million per Year Continued Maintenance of Existing Line 3

As noted in Section 4.2.7, although the amount of oil transported per day could vary by demand, the Applicant would need to operate a fleet of trucks capable of transporting the full estimated volumes per day. The shortest distances by highway from Gretna to the Clearbrook and Superior terminals are approximately 193 miles and 360 miles, respectively (Figure 4.2-3). Based on the estimated number of

[14] Calculations are based on figures provided in the MPL, LLC Certificate of Need Application for the Minnesota Pipe Line Reliability Project. MPUC Docket No. PL-5/CN-14-320.

tanker trucks needed to deliver the specified volumes per day, a conservative estimate of the time necessary for loading and offloading the tanker trucks, and the time necessary for empty trucks to return to Gretna, 6,000 new tanker trucks would be required.

As noted above, Enbridge estimates that it would cost $30 to $40 million per year to maintain the U.S. portion of the existing Line 3.

4.2.10 Alternative Pipeline Configuration – Smaller Diameter Pipeline

Smaller Diameter Pipeline Would Have Smaller Throughput but Many of the Same Adverse Effects

The suggestion that a smaller diameter pipeline be used was reviewed. The Applicant's proposed Project includes a pipeline 36 inches in diameter. A smaller diameter pipeline (24 to 34 inches in diameter) operating in the same pressure range as the proposed Project would provide less annual throughput capacity and would likely reduce pumping energy requirements and associated indirect air emissions from electrical energy generation.

It would not, however, change any construction or operating impacts. Installing a smaller diameter pipeline would likely require the same construction work area, materials marshaling areas, earth-moving and pipe-laying equipment, access roads, and permanent right-of-way. The actual construction trench would be narrower and would result in a smaller volume of excavation spoils to be managed, but stripping, storing, and replacing topsoils would be the same.

After the pipeline was installed, restoring the construction work area and monitoring and maintaining the permanent right-of-way long-term would be the same.

A smaller diameter pipeline with lower throughput capacity could possibly be operated with one less pumping station. Determining pumping requirements and optimum pump station locations would, however, depend on pipeline design and operational simulations that are not available. The disturbed area for pump stations is a small area when compared to the disturbed area for the Project overall, so having one fewer pump station would not materially affect overall land disturbance.

MLVs and cathodic protection facilities are located within the permanent right-of-way, so they would not affect the overall area of land disturbance or permanent right-of-way.

The probability of an incident leading to a crude oil release would also be similar for a smaller diameter pipeline. Because the impacts are generally the same, a smaller diameter pipeline configuration was not evaluated in detail as a Project configuration alternative.

4.3 DESCRIPTION OF ALTERNATIVES – ROUTE PERMIT

If the Commission grants a CN for replacement of Line 3 at the Applicant's proposed start and endpoints (North Dakota border to Superior, Wisconsin), the Commission must then determine the best route for the pipeline between those two points. The route permit decision requires a more detailed review of specific routing alternatives between the origin and destination points as approved in the CN process. Since this joint EIS covers both the CN and route permit decisions, the EIS also includes an evaluation of selected routes within Minnesota between the North Dakota and Wisconsin borders.

This section describes the reviewed route alternatives and route segment alternatives that will inform the Commission's decision.

4.3.1 Overview – Route Alternatives

4.3.1.1 Route Locations

The locations of route alternatives RA-03AM, RA-06, RA-07, and RA-08 are shown in Figure 4.3-1. Figures showing the location of each route at a larger scale are included in Appendix A. Detailed descriptions of each route follow. Technically, each of the route alternatives extends from Neche, North Dakota, to Superior, Wisconsin. However, the alignment of all route alternatives is identical to the Applicant's preferred route from Neche to approximately the Clearbrook terminal and from Carlton, Minnesota, to Superior (see description in Section 2.3). As the alignments for all route alternatives only diverge from the alignment for the Applicant's preferred route between approximately Clearbrook and Carlton, the description of each route alternative below, and the environmental impact assessment of the route alternatives in Chapter 6 is limited to the segment between Clearbrook and Carlton.

4.3.1.2 Construction and Operation – Route Alternatives

All route alternatives except RA-07 would be constructed and operated in the same manner as the Applicant's preferred route (see Section 2.7). RA-07 would call for removing the old pipeline and placing the new pipeline in the same location. The construction methods for this alternative are described below and are illustrated in Figure 4.3-2.

4.3.2 Route Alternative RA-03AM

Route Alternative RA-03AM Would Avoid Lakes, Fens, Fish Hatcheries, and Wildlife Management Areas

Route alternative RA-03AM is an alternative between Clearbrook and Carlton. The Minnesota Pollution Control Agency (Minnesota PCA) originally proposed this as a CN "system alternative" that included a new terminal in Crookston, Minnesota, in part to avoid the Mississippi River Headwaters area as well as the Minnesota's Lakes region. During scoping for the Sandpiper Project, this route option was added as a modified version of the original proposal that would provide access to the Clearbrook terminal, allowing deliveries to the Northern Tier Energy and Flint Hills Resources refineries through MPL's pipeline. (Thus, it is called RA-03AM, or "as modified.") Minnesota Department of Natural Resources (Minnesota DNR) subsequently proposed additional modifications during the 2015 Line 3 process. This route alternative parallels an existing pipeline right-of-way from Clearbrook to Park Rapids, thereby focusing pipeline construction and operations impacts in an area already affected by a crude oil pipeline. Compared to other alternatives, this option reroutes around fens, fish hatcheries, and communities, and avoids specific Wildlife Management Areas (WMAs).

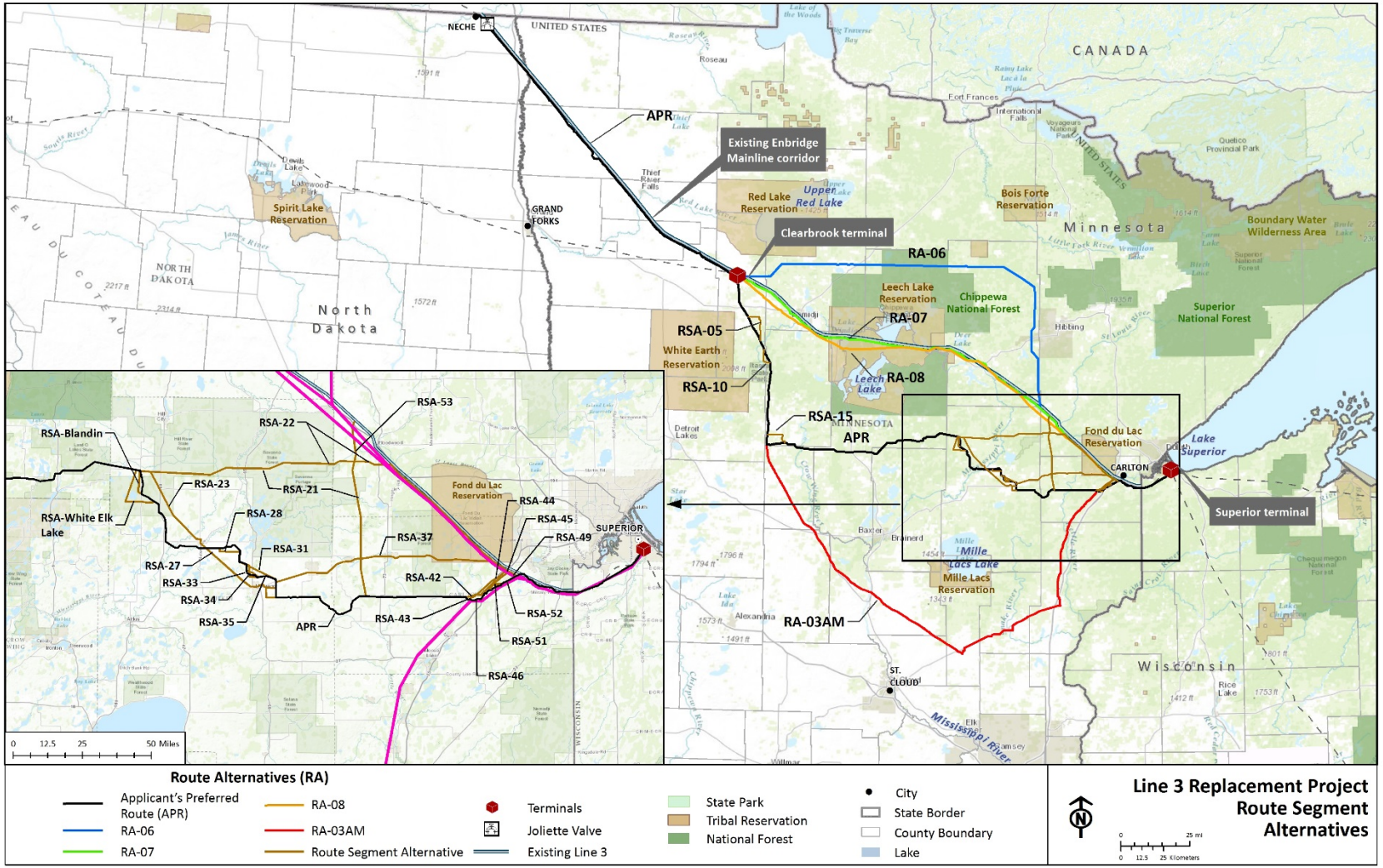

Figure 4.3-1. General Locations of Route Alternatives

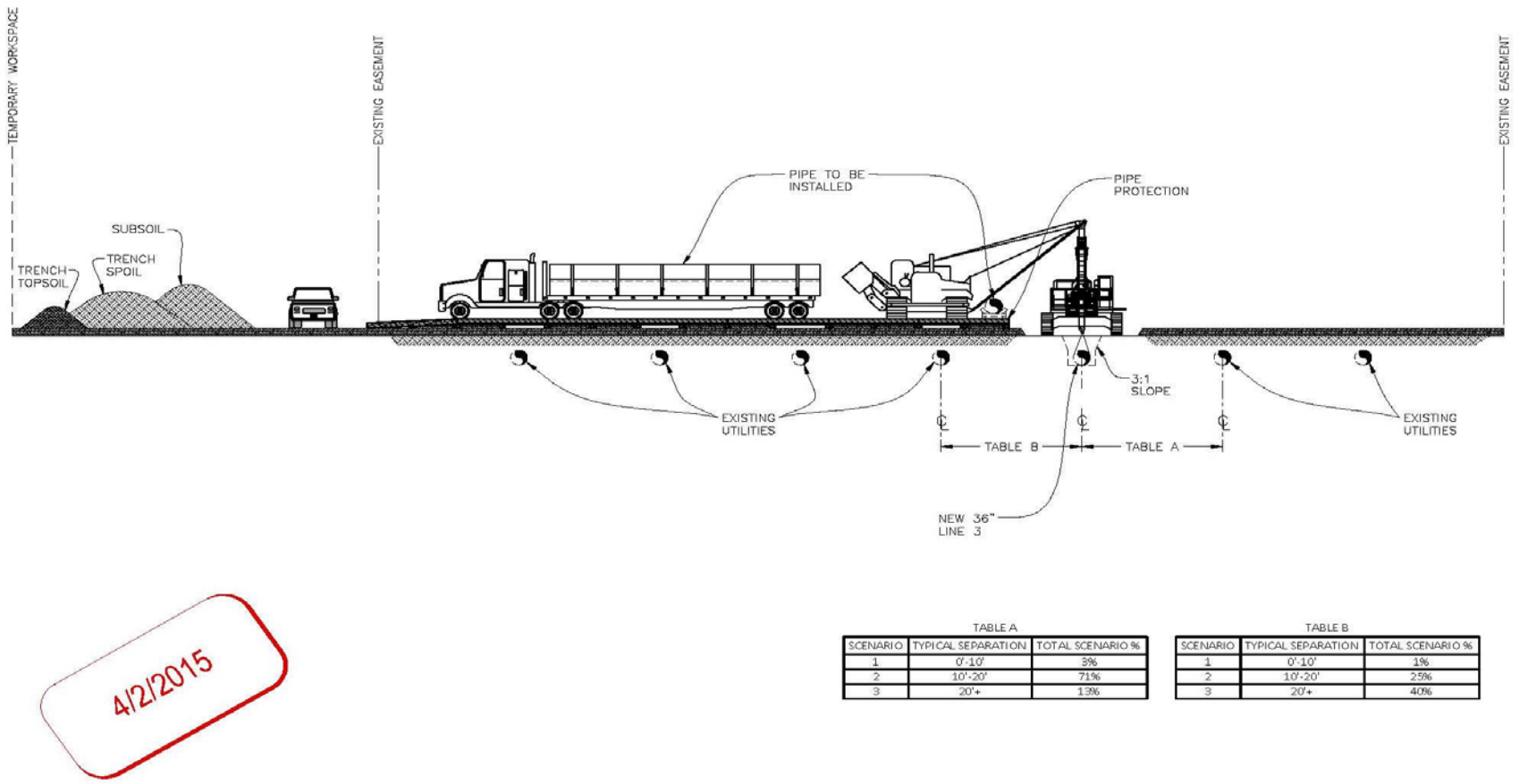

TABLE A

SCENARIO	TYPICAL SEPARATION	TOTAL SCENARIO %
1	0'-10'	3%
2	10'-20'	71%
3	20'+	13%

TABLE B

SCENARIO	TYPICAL SEPARATION	TOTAL SCENARIO %
1	0'-10'	1%
2	10'-20'	25%
3	20'+	40%

Figure 4.3-2. Typical Construction Profile – Same Trench Replacement

4.3.2.1 Route Location

From Clearbrook, the route generally follows the existing MPL right-of-way south into Hubbard County. The route runs along the western border of Hubbard County to the vicinity of Park Rapids. The route then turns southeasterly, following the Minnkota Power Cooperative transmission line across Wadena County, the northeast corner of Todd County, and diagonally across Morrison County.

It continues across the northeast corner of Benton County and the southern portion of Mille Lacs County to the vicinity of Milaca. The route then turns northeasterly, generally following State Route 23 to the vicinity of Hinckley in Pine County. It then turns northeasterly, paralleling the existing 8-inch Magellan Refined Products pipeline or a Northern Natural Gas pipeline to a point where it meets the Applicant's preferred route near Carlton in Carlton County and then continues to Superior, Wisconsin. Measurements for RA-03AM are summarized in Table 4.3-1.

Table 4.3-1. Measurements for Route Alternative RA-03AM

Feature	Measurement
Total length (origin to destination)	435.6 miles
Length in Minnesota	394.9 miles
Length outside Minnesota	40.8 miles
States crossed – distance	North Dakota – 27.6 miles Minnesota – 394.9 miles Wisconsin – 13.1 miles
Counties crossed in Minnesota	Benton, Carlton, Clearwater, Hubbard, Kanabec, Kittson, Marshall, Mille Lacs, Morrison, Pennington, Pine, Polk, Red Lake, Todd, and Wadena

4.3.2.2 Pump Stations and Mainline Valves

Route Alternative RA-03AM Would Require 9 Pump Stations and Approximately 29 MLVs

Enbridge has indicated that nine pump stations would be required along the route of RA-03AM in Minnesota, with six of them between Clearbrook and Carlton. It was assumed that each pump station would require approximately 8 acres of land. The specific location of each pump station would be determined based on pipeline operation hydraulic studies.

As with the proposed Project, MLVs would be placed near water crossings, significant environmental resources, and populated areas. Enbridge has stated that at least 29 MLVs would be located along RA-03AM in Minnesota, including 23 MLVs between Clearbrook and Carlton. Each valve would occupy approximately 0.1 acre and would be located within the permanent pipeline right-of-way. Final valve spacing and location would be determined during final Project permitting.

4.3.3 Route Alternative RA-06

Route Alternative RA-06 Would Avoid Minnesota's Main Lakes Region

Route alternative RA-06 is another alternative to the Applicant's preferred route between Clearbrook and Carlton. RA-06 was proposed by scoping commenters to develop a route north of the Enbridge Mainline corridor to avoid the Mississippi Headwaters and crossing Minnesota's Lakes region.

4.3.3.1 Route Location

At Clearbrook, the route alternative runs easterly across Beltrami County to the south of Lower Red Lake and enters the northwest corner of Itasca County. The route intersects the Fond du Lac Reservation and the Chippewa National Forest and continues eastward to the eastern border of Itasca County, primarily across state and national forest lands.

Within George Washington State Forest, the route turns south, adjacent to the eastern border of Itasca County. In the southeast corner of Itasca County, the route rejoins the major pipeline corridor traversing Minnesota from the Canadian border to Superior, which includes the existing Line 3 pipeline. The route then trends southeast across the southwest corner of St. Louis County and the northeast portion of Carlton County, crossing the Fond du Lac Indian Reservation. It crosses the Minnesota-Wisconsin border and terminates in Superior, Wisconsin. Measurements for RA-06 are summarized in Table 4.3-2.

Table 4.3-2. Measurements for Route Alternative RA-06

Feature	Measurement
Total length (origin to destination)	357.3 miles
Length in Minnesota	316. 6 miles
Length outside Minnesota	40.7 miles
States crossed – distance	North Dakota – 27.6 miles Minnesota – 316.6 miles Wisconsin – 13.1 miles
Counties crossed in Minnesota	Aitkin, Beltrami, Carlton, Clearwater, Itasca, Kittson, Marshall, Pennington, Polk, Red Lake, and St. Louis

4.3.3.2 Pump Stations and Mainline Valves

Route Alternative RA-06 Would Require 7 Pump Stations and Approximately 24 MLVs

Enbridge has indicated that seven pump stations would be needed along RA-06 in Minnesota, including four pump stations between Clearbrook and Carlton. It was assumed that each pump station would require approximately 8 acres of land. The specific location of each pump station would be determined based on pipeline operation hydraulic studies.

As with the proposed Project, MLVs would be placed near water crossings, significant environmental resources, and populated areas. Enbridge has indicated that at least 24 MLVs would be required along the route of RA-06, including 16 MLVs between Clearbrook and Carlton. Each valve would occupy

approximately 0.1 acre and would be located within the permanent pipeline right-of-way. Final valve spacing and location would be determined during final Project permitting.

4.3.4 Route Alternative RA-07

Route Alternative RA-07 Would Remove the Old Pipeline and Place the New Pipeline Mostly in the Same Trench

Similar to the previous routes, RA-07 is an alternative to the Applicant's preferred route between Clearbrook and Carlton. It was proposed by scoping commenters that the existing Line 3 pipeline be removed and that a new pipeline be installed in the same trench, allowing the use of the existing pipeline corridor without further expansion. This alternative would minimize the exposure of new areas of the state to pipeline construction and operations, while increasing overall pipeline capacity for deliveries to Superior. This alternative addressed concerns of Minnesota DNR, Minnesota PCA, and others about further development of a new corridor for other new or replaced oil pipelines and other infrastructure that could also use the Applicant's preferred route in the future.

RA-07 assumes removing and replacing the existing Line 3 in the same trench from Clearbrook to Carlton. However, the analysis assumed, for the purpose of directly comparing RA-07 to the other route alternatives, that RA-07 would follow the Applicant's preferred route from Neche to Clearbrook, with the existing Line 3 abandoned along this stretch and the RA-07 pipeline placed within a new (25-foot) right-of-way parallel to Enbridge's existing Mainline corridor. Similarly, east of Carlton, the analysis assumed that the RA-07 route would follow the Applicant's preferred route, with the existing Line 3 pipeline abandoned and the RA-07 pipeline placed within a new (25-foot) right-of-way parallel to Enbridge's existing Mainline corridor.

4.3.4.1 Route Location

At Clearbrook, the route continues on the Enbridge Mainline system corridor, where it would be located adjacent to existing pipelines. From Clearbrook, this route trends southeastward across the southern part of Beltrami County, the Lakes region, the northern part of Cass County, and the southern portion of Itasca County, intersecting the Leech Lake Band of Ojibwe and Fond du Lac reservations and the Chippewa National Forest. It continues across the southwest corner of Itasca County into Carlton County and then eastward to Superior. Measurements for RA-07 are summarized in Table 4.3-3.

Table 4.3-3. Measurements for Route Alternative RA-07

Feature	Measurement
Total length (origin to destination)	328.3 miles
Length in Minnesota	287.5 miles
Length outside Minnesota	40.7 miles
States crossed – distance	North Dakota – 27.6 miles Minnesota – 287.5 miles Wisconsin – 13.1 miles
Counties crossed in Minnesota	Aitkin, Beltrami, Carlton, Cass, Clearwater, Hubbard, Itasca, Kittson, Marshall, Pennington, Polk, Red Lake, and St. Louis

4.3.4.2 Pump Stations and Mainline Valves

Route Alternative RA-07 Would Require 7 New or Upgraded Pump Stations and Approximately 22 MLVs

Enbridge has indicated that RA-07 would require three new pump stations west of Clearbrook and upgrades to four pump stations between Clearbrook and Carlton. It was assumed that upgrades to the existing pump stations along the Enbridge Mainline corridor would consist of adding new pumps and would require minimal additional land disturbance.

As with the proposed Project, MLVs would be placed near water crossings, significant environmental resources, and populated areas. Enbridge has indicated that at least 22 MLVs would be located along RA-07 in Minnesota, including 14 MLVs between Clearbrook and Carlton. Each valve would occupy approximately 0.1 acre and would be located within the permanent pipeline right-of-way. Final valve spacing and location would be determined during final Project permitting.

4.3.4.3 Construction – Pipeline Removal and Replacement

From Neche to Clearbrook, Line 3 is one of six pipelines co-located in a single corridor. Line 3 is in the interior of the multi-pipeline configuration (see Figure 4.3-3), where the pipelines are spaced from 10 to 15 feet apart. From Clearbrook to Superior, the corridor includes seven pipelines. Unlike constructing a new pipeline along the edge of an existing pipeline corridor, removing and replacing the pipeline in the existing trench would require working over the top of existing operating high-pressure pipelines (see Figure 4.3-2). In addition to the construction procedures described in Section 2.7 for normal pipeline construction, removing and replacing the pipeline would require the following:

- Protection for existing buried pipes – A layer of protective soil, mats, or bridging would be placed over the existing pipelines to protect them during the movement of heavy equipment and materials to the work area along the existing pipeline alignment. This protective layer would be continuously moved with the construction activity as pipe removal and replacement progressed.
- Additional work space required – During normal pipeline construction, the additional work space required for operating equipment, storing topsoil and trenching spoils, staging of pipe, and lowering in and backfilling operations would be available directly adjacent to the Mainline corridor permanent right-of-way.

  The presence of the existing pipelines precludes these activities occurring adjacent to the Line 3 trench. They would need to be located adjacent to the outermost buried pipeline. This would increase the construction work area from a width of approximately 120 feet for normal construction to approximately 205 feet for removal and replacement.
- Increased time of open trench – The addition of pipeline removal activity would lengthen the time required for maintaining an open trench. Normal construction would include maintaining an open trench for approximately 3 days. Time for pipeline removal would require extending this time.
- Removal and disposal of existing Line 3 pipe – Following removal and stoppage of topsoil, the existing Line 3 pipeline trench would be open, and the existing pipe would be freed from its bed. The pipe would then be cut into lengths suitable for transport by truck. Removal of the

pipe lengths from the work area would require additional truck movements, although trucks staging new pipe to the work area could be used to haul existing pipe from the work area.

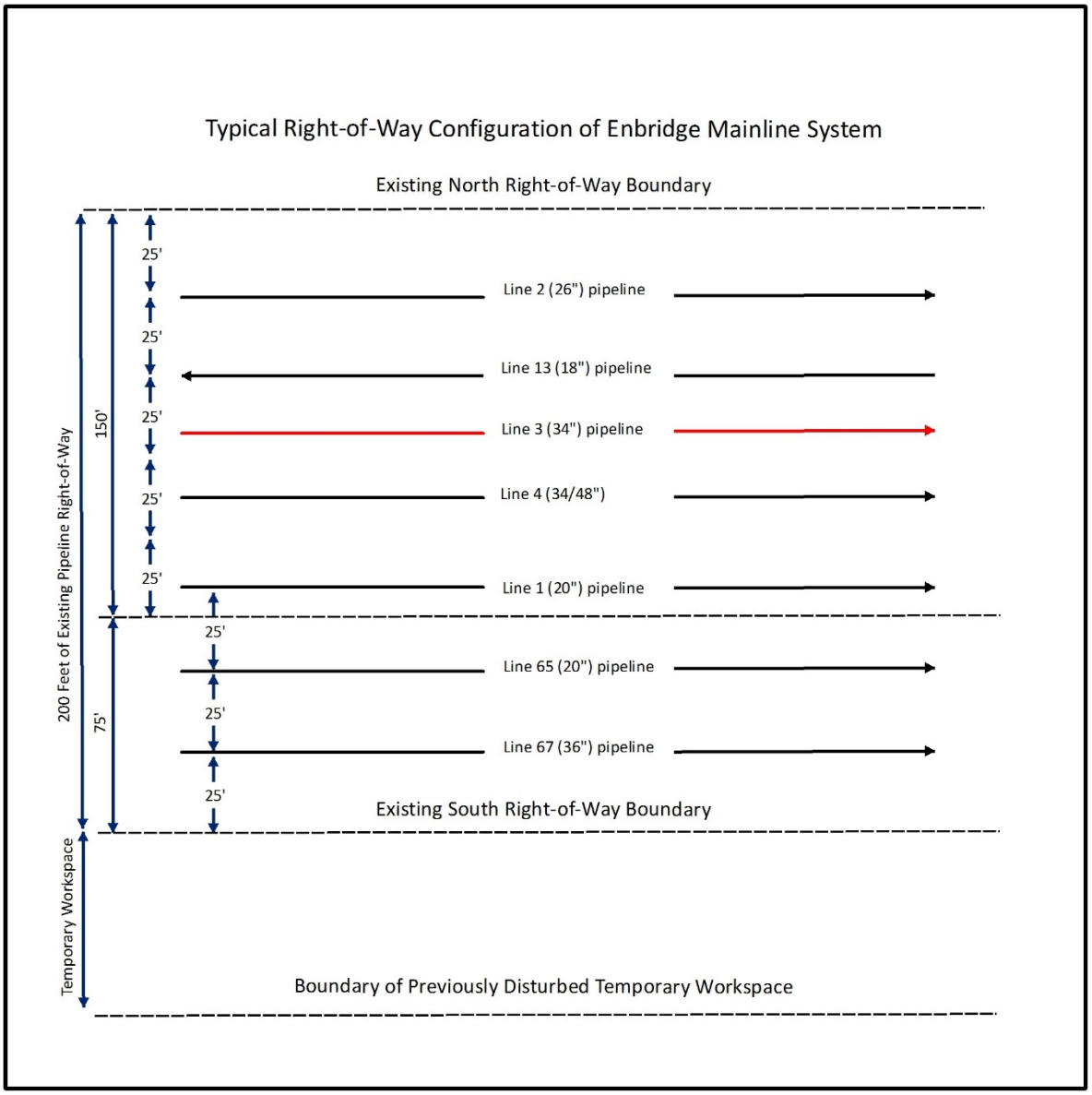

Figure 4.3-3. Enbridge Mainline System Right-of-Way Configuration

4.3.5 Route Alternative RA-08

Route Alternative RA-08 Is in Enbridge Mainline Corridor near RA-07, but along a New Route

Route alternative RA-08 is also an alternative to the Applicant's preferred route between Clearbrook and Carlton. Similar to RA-07, RA-08 was proposed to reduce development in the Lakes region in that it does not require an entirely new oil pipeline corridor between Clearbrook and Superior. The route alignment

is generally located south of U.S. Highway 2 along an existing natural gas pipeline and reduces the length of the crossings of the Chippewa National Forest and the Leech Lake Band of Ojibwe Reservation.

4.3.5.1 Route Location

From Clearbrook, the route follows the same general configuration as RA-07 to Superior, except that in the portion of the route located in Beltrami, Cass, Itasca, and St Louis counties, the route has been repositioned south of and parallel to U.S. Highway 2. The route intersects the Leech Lake Band of Ojibwe and Fond du Lac reservations and the Chippewa National Forest. Measurements for RA-08 are summarized in Table 4.3-4.

Table 4.3-4. Measurements for Route Alternative RA-08

Feature	Measurement
Total length (origin to destination)	325.4 miles
Length in Minnesota	284.6 miles
Length outside Minnesota	40.7 miles
States crossed – distance	North Dakota – 27.6 miles Minnesota – 284.6 miles Wisconsin – 13.1 miles
Counties crossed in Minnesota	Aitkin, Beltrami, Carlton, Cass, Clearwater, Hubbard, Itasca, Kittson, Marshall, Pennington, Polk, Red Lake and St. Louis

4.3.5.2 Pump Stations and Mainline Valves

Route Alternative RA-08 Would Require 6 New or Upgraded Pump Stations and Approximately 22 MLVs

Enbridge has indicated that RA-08 could require two new pump stations west of Clearbrook and upgrades to four existing pump stations between Clearbrook and Carlton. It was assumed that the existing pump stations along the Enbridge Mainline corridor would be upgraded to accommodate new pumps for the Project, requiring minimal additional land disturbance.

As with the proposed Project, MLVs would be placed near water crossings, significant environmental resources, and populated areas. Enbridge indicated that at least 22 MLVs would be located along RA-08, including 14 MLVs between Clearbrook and Carlton. Each valve would occupy approximately 0.1 acre and would be located within the permanent pipeline right-of-way. Final valve spacing and location would be determined during final Project permitting.

4.3.6 Overview – Route Segment Alternatives

Enbridge Adopted Some Suggested Route Segment Alternatives, and Others are Discussed Below

During the scoping process, a number of route segment alternatives (RSAs) were recommended for consideration. DOC-EERA and the Applicant reviewed these alternatives, and a number of the shorter RSAs were adopted by Enbridge and integrated into the proposed alignment of the Applicant's preferred route. The adopted modifications are included in the proposed Project evaluated in the EIS. The

remaining RSAs, which range in length from 1 mile or 2 to more than 60 miles, are evaluated in this EIS (Table 4.3-5). The general location of the RSAs and their relationship to the Applicant's preferred route are shown in Figure 4.3-4.

Table 4.3-5 describes the purpose of each RSA, the route of the RSA, the length compared to the substituted length of the Applicant's preferred route, and a brief summary of the general features of the area surrounding the RSA.

The milepost designations in Table 4.3-5 and in Figure 4.3-4 are based on mile zero at Neche, North Dakota. Milepost designations given by Enbridge in some Project documentation are based on mile zero at Edmonton, Alberta where Line 3 originates.

4.3.6.1 Pump Stations and Mainline Valves

Need for and Location of Pump Stations and Distance between MLVs Cannot Currently Be Determined

Based on the spacing of pump stations along the Applicant's preferred route, new pump stations would likely be required along the route for RSA-21, RSA-22, RSA-23, or RSA-37. Deciding, however, on whether a pump station might be needed and where specifically it should be placed can only be done based on hydraulic studies of pipeline operations, which are not available. It was assumed that approximately 8 acres of land would be required for a pump station on the RSAs.

Similar to the proposed Project, MLVs would be placed near water crossings, significant environmental resources, and populated areas. Average spacing of MLVs along the Applicant's preferred route is approximately 12 miles between valves. It was assumed that similar spacing would occur along the RSA. The specific spacing of valves would be determined during final permitting. It was further assumed that RSAs shorter than approximately 12 miles likely would not include any additional valves. RSAs that would require MLVs (and the number of valves required) include RSA-05 (one), RSA-21 (five), RSA-22 (five), RSA-23 (three), RSA-27 (one), and RSA-37 (three). The average area required for each valve would be 0.1 acre, and each valve would be located within the permanent pipeline right-of-way.

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
Clearbrook to Aitkin County								
RSA-05	Clearwater	Minnesota PCA requested a route alternative to avoid the Eastern Wild Rice Watershed, and a possible hydrological connection to Lower Rice Lake.	RSA-05 starts at MP 154.1 on the Applicant's preferred route and runs east for approximately 4.0 miles adjacent to the Otter Tail Power Company Minnkota-Winger 230 kV transmission line right-of-way. It then turns south for approximately 9.0 miles, rejoining the Applicant's preferred route at MP 164.0. The route traverses an area of mixed active farm and forested land.	154.1	164.0	13.0	9.8	3.2
RSA-10	Clearwater, Hubbard	Minnesota PCA requested a route alternative that would move the route to a crossing at LaSalle Creek that is more accessible for emergency response in case of a spill.	RSA-10 starts at MP 167.4 and runs south 4.2 miles adjacent to State Highway 108 where it intersects State Highway 200. It then turns east and runs parallel to State Highway 200 for approximately 1.3 miles where it intersects Itasca Township Road 4. RSA-10 then enters Hubbard County where Itasca Township Road 4 becomes 400th Street. The route continues eastward parallel to 400th Street for approximately 1.4 miles, where it rejoins the Applicant's preferred route at MP 173.2. RSA-10 would increase the separation between the Applicant's preferred route and Big LaSalle Lake from 0.1 to approximately 0.7 mile. While it would mainly be located adjacent to highway rights-of-way, the area surrounding the RSA is forested or heavily vegetated areas with some mixed farmland.	167.4	173.1	6.8	5.6	1.2

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-15	Hubbard	Minnesota PCA requested a route alternative that would provide better pipeline access near Twin Lakes (wild rice lakes) and Shell River for emergency response in case of a spill.	RSA-15 starts at approximately MP 199.7 on the Applicant's preferred route and runs eastward 5.5 miles adjacent to County Road 14 and the Great River Energy 34.5 kV electric distribution line right-of-way. It then turns south and then east, paralleling Minnesota Power's 34.5 kV distribution line and access road for 3.2 miles to the intersection of County Road 6. At County Road 6, it again turns south and runs adjacent to another Minnesota Power 34.5 distribution line and Road 6 for 0.8 mile, where it rejoins the Applicant's preferred route at MP 210.1.	199.7	210.1	9.5	10.4	-0.9
RSA-Blandin	Aitkin	Minnesota DNR requested a route alternative to avoid a conservation easement held by Minnesota DNR on lands owned by Blandin Paper Company.	RSA-Blandin starts at MP 278.3 on the Applicant's preferred route and runs south approximately 3.2 miles through forested/scrub and wetlands. It turns southeast for another 0.6 mile and rejoins the Applicant's preferred route at MP 282.2. For most of its length, RSA-Blandin runs parallel and approximately 0.3 mile west of County Road 29 – Osprey Avenue.	278.3	282.2	3.9	3.9	0.0
RSA-White Elk Lake	Aitkin	Minnesota DNR requested a route alternative to avoid a Forest Legacy Program easement and fragmenting a Minnesota Biological Survey Site of Biodiversity Significance.	RSA-White Elk Lake departs from the Applicant's preferred route at MP 277.9 and runs south-southwest approximately 5.2 miles parallel to Minnesota Power's Blackberry to Riverton 230 kV transmission line. It then turns east for 4.5 miles along County Road 68 – 540th Lane and rejoins the Applicant's preferred route at approximately MP 284.7. The proposed route for RSA-White Elk Lake runs between Mud Lake and White Elk Lake with a separation of 0.3 mile from either lake. The separation between White Elk Lake and the Applicant's preferred route is 0.7 mile. The RSA runs adjacent to existing infrastructure through forested and wetland areas.	277.9	284.7	9.7	6.8	2.9

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-21	Aitkin, St. Louis, Carlton	Minnesota DNR recommended the Aitkin County power line as a route alternative to eliminate concerns regarding Sandy River fisheries, wild rice habitat, and trout stream habitat.	RSA-21 starts at MP 278.5 on the Applicant's preferred route and runs east approximately 33.2 miles adjacent to the right-of-way for the Minnkota Power Cooperative's Arrowhead-Center-1 1,000 kV high voltage DC transmission line. It intersects Northern States Power Company's Forbes-Chisago 500 kV high voltage transmission line and then turns south to run adjacent to the Forbes-Chisago transmission line right-of-way for 20.7 miles, where it rejoins the Applicant's preferred route at MP 331.9. A large portion of the route for RSA-21 is located in wetlands and forested areas.	278.5	331.9	53.9	53.5	0.4
RSA-22	Aitkin, St. Louis, Carlton	Minnesota DNR recommended a route alternative that would avoid important habitat in the Big Sandy Lake watershed as well as Grayling Marsh WMA, McGregor WMA, Lawler WMA, and Salo Marsh WMA.	RSA-22 begins at the same point on the Applicant's preferred route as RSA-21 (MP 278.5). RSA-22 uses the same route as RSA-21 to the point where RSA-21 intersects the Northern States Power Company's Forbes-Chisago 500 kV high voltage transmission line right-of-way (approximately 33.2 miles). Instead of turning south along the Forbes-Chisago transmission line right-of-way, RSA-22 continues east adjacent to the Detroit Edison Forbes to Center-1 transmission line right-of-way for an additional approximately 5.7 miles, where it intersects the Enbridge Mainline corridor. It then runs approximately 25.8 miles southeast adjacent or parallel to the existing Enbridge Mainline corridor fir 26 miles and rejoins the Applicant's preferred route at MP 356.8. Similar to RSA-21, most of the route is located in forested and wetland areas until it joins the Enbridge Mainline corridor, which is located in areas that include some farming in addition to forest/wetlands land cover types.	278.5	356.8	64.7	73.8	-9.1

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-23	Aitkin	The Applicant removed this route segment alternative from further analysis; however, it is being carried forward into the route alternatives analysis because it was recommended by several landowners throughout the comment period.	Similar to RSA-21 and RSA-22, RSA 23 starts at MP 278.5 on the Applicant's preferred route but runs generally southeast instead of directly eastward. It is located adjacent to Minnkota Power Cooperative's Arrowhead-Center-1 1000 kV high voltage DC transmission line right-of-way eastward for 1.6 miles where it intersects the Soo Line North ATV Trail. RSA-21 turns and runs south-southeast approximately 12.9 miles adjacent to the trail, approximately to the town of Palisade. The route jogs 1.2 miles to the east around Palisade and rejoins the Soo Line North ATV Trail as it continues southeast. On the south side of Palisade, the route is located adjacent to the Great Power Energy Round Lake to Palisade 69 kV distribution line right-of-way for a short distance. From Palisade, the route then continues southeast for 9.7 miles to the vicinity of the town of McGregor. At McGregor, SA-23 turns east and crosses north of the town for 1.0 mile, where it intersects the BNSF railroad right-of-way. It runs northeast adjacent to the railroad right-of way for 1.0 mile, turns southeast, crosses under the rail line, and then continues south approximately 2.2 miles, were it intersects Minnesota Power's McGregor to Cromwell 115 kV transmission line. RSA-23 then turns east and runs adjacent to the transmission line right-of-way for approximately 1.5 miles, where it rejoins the Applicant's preferred route at MP 315.5. RSA-23 is primarily dominated by wetlands, with some forested areas.	278.5	315.5	31.2	37.0	-5.8

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-27	Aitkin	Minnesota DNR recommended that the analysis include the Soo Line to avoid the McGregor Scientific and Natural Area and the Sandy River watershed.	RSA-27 starts at MP 298.1 on the Applicant's preferred route just south of the town of Palisade. It follows the same route as RSA-23 along the Soo Line Trail (an abandoned railroad right-of-way designated as a recreation trail) southeast for approximately 9.0 miles to the vicinity of the town of McGregor. It continues to follow the same route as RSA-23 around the northern side of McGregor adjacent to a railroad right-of-way for approximately 2.0 miles. It then turns southeast, crosses under the rail line, and runs south approximately 0.8 mile, where it turns east for 1.5 miles and rejoins the Applicant's preferred route at approximately MP 314.0. A major portion of the route for RSA-27 occurs in an area of agricultural use with some forest/wetlands. A portion of the route is also located near McGregor.	298.1	314.0	13.2	16.0	-2.8
RSA-28	Aitkin	There was a map submitted without a written comment. It appears the segment was suggested to avoid gravel pits. It also avoids diagonal crossings of rural land.	RSA-28 starts at MP 300.2 on the Applicant's preferred route and runs south for approximately 0.5 mile adjacent to an existing road. It then turns east for 3.1 miles, also adjacent to an existing road, and intersects the Applicant's preferred route at approximately MP 303.9. This RSA generally shifts the pipeline route approximately 0.8 mile to the south and runs adjacent to existing roads. It is located in an area of agricultural use and wetlands.	300.2	303.9	3.6	3.8	-0.2
RSA-31	Aitkin	Commenter requested a route alternative to cut straight and diagonally across several miles in Aitkin County.	RSA-31 starts at MP 305.5 on the Applicant's preferred route and runs southeast for approximately 6.1 miles to rejoin the Applicant's preferred route at MP 312.7. The route cuts diagonally across developed farmland and undeveloped forest/wetland areas. It does not follow any existing linear infrastructure.	305.5	312.7	6.1	7.2	-1.1

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-33	Aitkin	This RSA would move the route to a different portion of the commenter's property, where it is adjacent to a peat plant.	RSA-33 starts at MP 306.7 on the Applicant's preferred route and runs southeast for 0.5 mile. It then turns south for 1.4 miles and rejoins the Applicant's preferred route at MP 308.4. RSA-33 is located approximately 0.4 mile east of the Applicant's preferred route and is not located adjacent to any existing infrastructure rights-of-way. It is located in undeveloped forested land and farmlands.	306.7	308.4	1.8	1.7	0.1
RSA-34	Aitkin	A commenter suggested shifting the pipeline north into the tree line to increase the distance from a residence.	RSA-34 starts at MP 307.6 on the Applicant's referred route and runs southeast for approximately 2.2 miles, where it rejoins the Applicant's preferred route at MP 310.1. The proposed RSA route runs diagonally, primarily across undeveloped land but intersects some developed farmland.	307.6	310.1	2.2	2.5	-0.3
RSA-35	Aitkin	A commenter suggested a route alternative that would cut south on Township Road 270 and travel east until it rejoins the Applicant's preferred route to increase the distance from a residence.	RSA-35 starts at MP 308.4 on the Applicant's preferred route and runs south adjacent to an unnamed road approximately 0.4 mile. It then turns eastward and runs 1.3 miles, where it rejoins the Applicant's preferred route at MP 309.8. The portion of the route adjacent to the road is generally forested. The remaining portion of the route is primarily developed farmland.	308.4	309.8	1.6	1.4	0.2

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-37	Aitkin, Carlton	A commenter suggested a route alternative that would parallel State Highway 210 after mile marker 550 and then turn south to reconnect with the Applicant's preferred route south of Cloquet avoiding Salo Marsh and Lawler WMAs.	RSA-37 starts at MP 313.1 on the Applicant's preferred route and runs generally eastward parallel to State Highway 210, on the south side of the highway right-of-way. It runs 34.4 miles to the Enbridge Mainline corridor between Clearbrook and Superior. Along this portion of the route, the RSA passes near the communities of Tamarack, Wright, Cromwell, and Sawyer. At its intersection with the Mainline corridor, RSA-37 turns southeast for 4.3 miles, where it rejoins the Applicant's preferred route. Along the last section of the route, RSA-37 is located adjacent to the Mainline corridor. A major portion of the area adjacent to RSA-37 is forested/ scrub and wetlands. The remaining portion of the route is generally located in areas of active agriculture. The route also is located adjacent to four communities.	313.1	356.8	38.7	43.7	-5.0
Carlton County								
RSA-42	Carlton	A commenter requested co-location of the pipeline with an existing transmission line corridor.	RSA-42 starts at MP 347.1 on the Applicant's preferred route and runs east-northeast approximately 1.8 miles adjacent to Minnesota Power's Wrenshall to Mahtowa 115 kV transmission line right-of-way. It turns east-southeast and continues to parallel the right-of-way of the Wrenshall to Mahtowa transmission line for approximately 0.6 mile, crossing under State Highway 61. It then turns northeast continuing to parallel the transmission line for approximately 1.1 miles, where it crosses under Interstate Highway 35 and rejoins the Applicant's preferred route at MP 351.4. Most of the area adjacent to RSA-42 is forested land and wetlands.	347.1	351.4	3.5	4.3	-0.8

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-43	Carlton	A commenter suggested moving the pipeline to the north side of U.S. Highway 61 and co-locating it with a utility corridor.	RSA-43 starts at MP 347.9 on the Applicant's preferred route and runs northeast 1.4 miles parallel to State Highway 61 and the Willard Munger State Trail on the highway's north side. The route then intersects Minnesota Power's Wrenshall to Mahtowa 115 kV transmission line right-of-way, where it turns eastward for 0.6 mile running adjacent to the transmission line right-of-way and crosses under State Highway 61. It then turns northeast, continuing to parallel the transmission line for approximately 1.3 miles, where it crosses under Interstate Highway 35 and rejoins the Applicant's preferred route at MP 351.4. Most of the area adjacent to RSA-42 is forest/wetlands.	347.9	351.4	3.1	3.5	-0.4
RSA-44	Carlton	A commenter suggested following an existing utility corridor on the north side of U.S. Highway 61 to avoid the Blackhoof River watershed and potential impacts from groundwater flow around the watershed.	RSA-44 starts at MP 347.9 and runs northeast 7.2 miles parallel to State Highway 61 and the Willard Munger State Trail. The pipeline is offset from the highway right-of-way approximately 0.1 mile. RSA-45 intersects the Enbridge Mainline corridor, where it turns southeast and runs approximately 1.8 miles and rejoins the Applicant's preferred route at MP 356.8. Approximately half of the area adjacent to the proposed route is forest/wetland. The remaining area is active agriculture and includes residential uses and gravel mining activity.	347.9	356.8	9.1	8.9	0.2

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-45	Carlton	A commenter suggested following an existing utility corridor on the north side of U.S. Highway 61 to avoid the Blackhoof River watershed and potential impacts from groundwater flow around the watershed.	RSA-45 also starts at MP 347.9 on the Applicant's preferred route and runs 1.4 miles northeast, parallel to the State Highway 61 and the Willard Munger State Trail. It then turns eastward and crosses under State Highway 61, following the same alignment as RSA-44 for approximately 0.6 mile. It then turns northeast and runs for approximately 3.3 miles generally parallel to Interstate Highway 35 to the vicinity of the community of Otter Creek, where it intersects the Interstate Highway 35 right-of-way. The route crosses under Interstate Highway 35 and runs 2.3 miles generally parallel to the highway to intersect the Enbridge Mainline corridor. It then turns southeast and continues for 1.5 miles, where it rejoins the Applicant's preferred route at MP 356.8. Approximately one-third of the area adjacent to the proposed route is forest/wetland. The remainder is active agriculture, open undeveloped land, and limited agriculture.	347.9	356.8	9.0	8.8	0.2
RSA-46	Carlton	RSA-46 shifts the pipeline to the south to avoid active farmland.	RSA-45 starts at MP 348.9 on the Applicant's preferred route and runs east for approximately 0.8 mile, where it turns north for 0.2 mile and rejoins the Applicant's preferred route and RA-03AM at MP 349.8. RSA-45 re-locates a short portion of the Applicant's preferred route approximately 0.2 mile to the south; the RSA is located in a forested area adjacent to active agriculture.	348.9	349.8	1.0	0.9	0.1
RSA-49	Carlton	A commenter requested following the south sides of Interstate 35 and State Highway 61 to distance the pipeline from multiple properties.	RSA-49 starts at MP 351.4 on the Applicant's preferred route and runs parallel, on the south side of the right-of-way of Interstate Highway 35 and State Highway 61 for approximately 4.5 miles, where it intersects the existing Enbridge Mainline corridor. It then turns southeast for 1.5 miles and rejoin the Applicant's preferred route at MP 356.8. The area adjacent to the RSA is primarily forest and wetland.	351.4	356.8	6.0	5.3	0.7

Table 4.3-5. Purpose and Location of Route Segment Alternatives

Route Segment Alternative	County	Purpose of Route Segment Alternative	Location[a]	Mileposts		Route Segment Alternative Length (miles)	Applicant's Preferred Route Length (miles)	Route Segment Alternative Change (miles)
				From	To			
RSA-51	Carlton	A commenter proposed shifting the pipeline north to follow the tree line and distance it from homesteads.	RSA-51 starts at MP 352.8 on the Applicant's preferred route and runs north and then northeast for approximately 0.6 mile, where it turns eastward. It then runs 0.8 mile and rejoins the Applicant's preferred route at MP 354.1. The route does not parallel any existing infrastructure right-of-way. It is located in an area of undeveloped forest and agricultural land.	352.8	354.1	1.4	1.3	0.1
RSA-52	Carlton	A commenter proposed shifting the pipeline north to follow the tree line and distance it from homesteads.	RSA-52 starts at approximately MP 353.2 on the Applicant's preferred route and runs north along the west side of State Highway 5 for approximately 0.3 mile. It then turns east and runs 0.7 mile, where it rejoins the Applicant preferred route at MP 3.54.1. The route parallels an existing road and traverses agricultural land.	353.2	354.1	1.0	0.9	0.1
RSA-53 (RA-07)	St. Louis	The alternative route was proposed to connect RA-07 with RSA-22, allowing a connection between the northern routes (RA-06, RA-07, and RA-08) and the Applicant's preferred route to avoid crossing the Fond du Lac Reservation.	RSA-53 starts at the point where RA-07, which parallels the Enbridge Mainline corridor, intersects the Northern States Power Company's Forbes – Chisago 500 kV high voltage transmission line, approximately 4.8 miles northwest of the town of Fleetwood. RSA-53 runs south adjacent to the transmission line for approximately 6.2 miles in an area of primarily undeveloped and forested land and active farmland, where it intersects the Minnkota Power Cooperative's Arrowhead-Center-1 high voltage 1,000 kV DC transmission line.	270.4	279.4	11.9	9.0	2.9

Notes:

[a] See Figure 4.3-2 for locations of RSAs.

ATV = all-terrain vehicle, kV = kilovolt, MP = milepost, Minnesota DNR = Minnesota Department of Natural Resources, Minnesota PCA = Minnesota Pollution Control Agency, RSA = route segment alternative, WMA = Wildlife Management Area

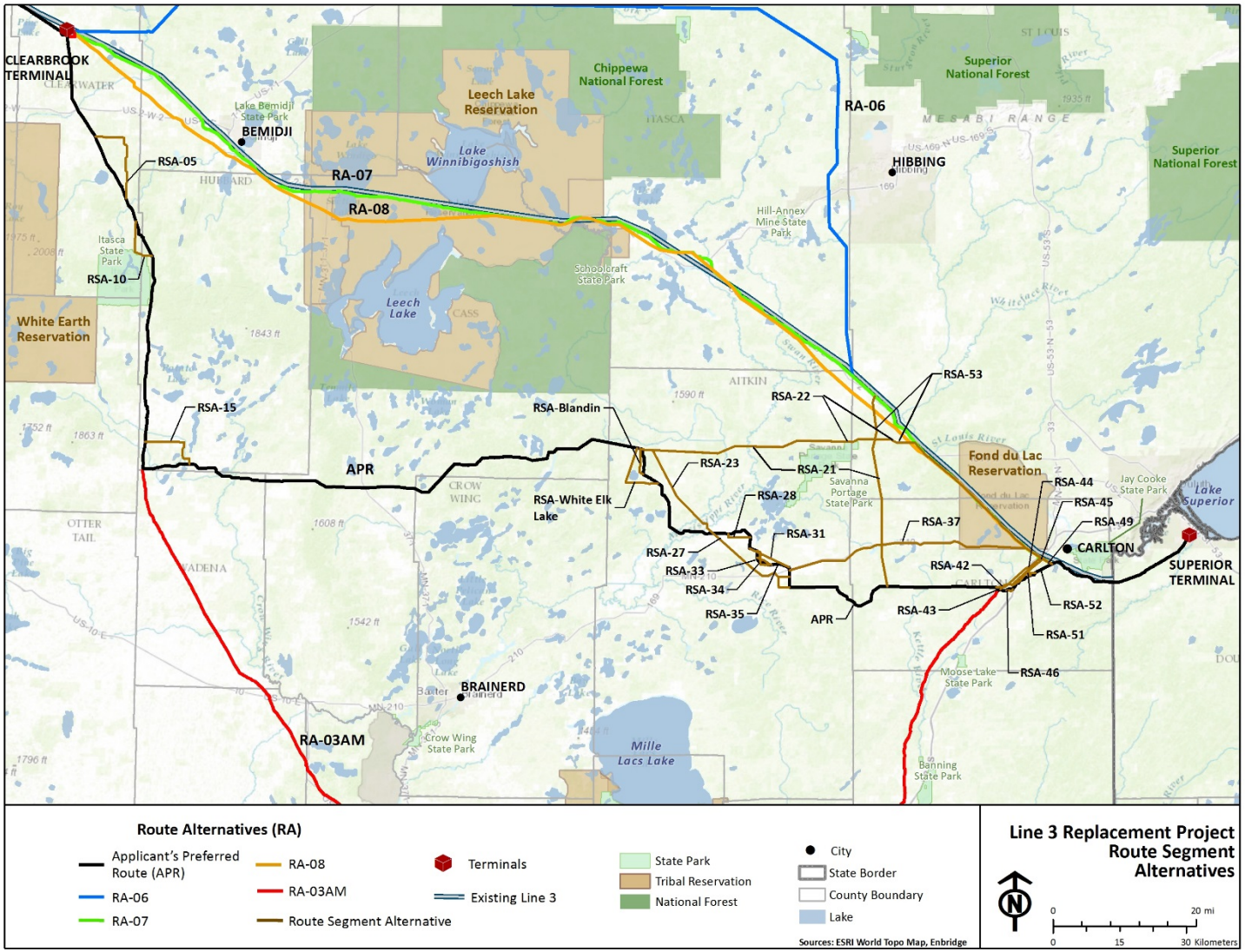

Figure 4.3-4. Locations of Route Segment Alternatives

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Chapter 5
Existing Conditions, Impacts, and Mitigation – Certificate of Need

5.1 INTRODUCTION

This chapter assesses potential construction and operations impacts of the Applicant's preferred route and each of the Certificate of Need (CN) Alternatives discussed in Chapter 4. As discussed in Section 4.2, the Minnesota Public Utilities Commission (Commission) must determine whether the benefits to society of granting a CN for Enbridge's proposed Project outweigh the consequences, or whether a more reasonable and prudent alternative is available. This review of Enbridge's proposed Project and the range of CN Alternatives identified in Chapter 4 will help to inform the Commission's decision on need.

The impact assessment in this chapter is split into three sub-sections (natural environment, socioeconomic environment, and cultural resources) that correspond to the environmental and socioeconomic components of the criteria the Commission is required to consider in determining whether to issue a CN.[1] While impact assessment of cultural resources is not required for a CN determination, the evaluation of historical and archaeological resources provides context relevant to the socioeconomic and natural environments. The chapter evaluates potential impacts on various resources associated with the natural environment, socioeconomic environment, and cultural resources. The impact assessment focuses on issues of concern for each resource that were identified based on:

- relevant regulatory requirements;
- input during scoping from the public, agencies, non-governmental organizations, and tribal representatives;
- consultation with knowledgeable resource management agencies and tribal resource representatives; and
- professional judgment, in part based on other impact assessments in recent energy infrastructure environmental impact statements (EISs) and agency guidance (U.S. Department of State [DOS] 2009; Federal Energy Regulatory Commission [FERC] 2013a, 2013b; U.S. Department of Energy [DOE] 2015; Wisconsin Department of Natural Resources 2016).

The following sub-sections are presented in this chapter for each resource:

- Regulatory Context and Methodology
- Existing Conditions

[1] According to Minnesota Administrative Rules § 7853.0130 B(3), the Commission must consider "the effect of the proposed facility upon the natural and socioeconomic environments compared to the effects of reasonable alternatives." According to Minnesota Administrative Rules § 7853.0130 C(2), the Commission must consider the effect of the proposed facility, or a suitable modification of it, upon the natural and socioeconomic environments compared to the effect of not building the facility.

- Impact Assessment
- Summary and Mitigation

The general contents of each of the sub-sections in this chapter are described below, and a summary of the CN analysis in this chapter is provided in Section 5.5. The route permit analysis of route alternatives is described in Chapter 6, and the analysis of route segment alternatives is described in Chapter 7. The analysis of potential impacts associated with crude oil releases is presented in Chapter 10. Cumulative potential effects are discussed in Chapter 12.

5.1.1 Regulatory Context and Methodology

The regulatory context describes the framework of laws, regulations, ordinances, and policies intended to protect and manage an affected resource with regard to impacts associated with the proposed Project and CN Alternatives. As described in Chapter 3, these regulations are implemented under a variety of federal, state, and local jurisdictions.

For each affected resource, the impact assessment methodology is described. This includes identifying the region of interest (ROI) for the resource (the geographic scope), the specific data sets acquired and analyzed, the analytical methods and assumptions used, and the quantitative or qualitative metrics for assessing impacts relative to each issue of concern. The ROI incorporates the geographic extent of each CN Alternative, as described in Chapter 4. The extent of the ROI beyond the physical footprint of each CN Alternative varies among resources according to the characteristics of the resource and the Project-related effects that could occur (e.g., potential effects on vegetation would be localized while effects on air quality may be localized and regional).

5.1.2 Existing Conditions

The existing conditions within the ROI for each affected resource are described for the Applicant's preferred route and each CN Alternative. Sources of data used to characterize existing conditions were identified based on a review of publically available geospatial datasets; federal, state, and local government reports, assessments, and planning documents; and input during the scoping process, including input from the public, tribes, agencies, and non-governmental organizations. In addition, data available as part of Enbridge's application, Enbridge's April 2016 Environmental Assessment Worksheet (EAW), and responses to data requests from the Minnesota Department of Commerce Energy, Environmental Review and Analysis (DOC-EERA) were considered. Literature addressing the potential impacts of Project construction and operations was reviewed. Information was evaluated for its relevancy in assessing Project-related impacts based on the data collection methods used and the geographic extent, study duration and age, detail, and usefulness of the data in characterizing existing conditions. Project-specific mileposts included in Chapter 5 resource sections and figures are based on the Applicant's preferred route and system alternative SA-04 starting at milepost (MP) 0.0 from Neche, North Dakota, and extending to Superior, Wisconsin, or Joliet, Illinois, respectively. Maps depicting a range of existing resource conditions and data associated with land ownership and physical features are provided in Appendix A.

5.1.3 Impact Assessment

Resource-specific impact assessment methods are described in each resource section of this chapter. The impact assessments focus on direct impacts from construction and operation of the Project, describe the nature of the impacts, and provide quantifiable estimates of those direct impacts where

feasible and meaningful. Examples of direct impacts include habitat fragmentation due to permanent loss of woody vegetation within the permanent right-of-way and contributions to climate change from greenhouse gas (GHG) emitted as a result of fossil fuel combustion in construction equipment. Indirect impacts, which may result from or be influenced by the Project later in time or further removed from direct Project activities, are described where appropriate. Examples of indirect impacts include economic growth, reduced productivity in wildlife due to stress, and direct impacts on aesthetics from vegetation removal indirectly affecting recreational use.

Within each resource section, the nature of impacts are discussed and the impacts are characterized in terms of their geographic extent, duration, and magnitude or severity. Impact duration was characterized as *temporary, short term, long term,* or *permanent*. Impact duration was considered temporary if the impact would occur only during and immediately following construction activity (e.g., turbidity due to instream construction). Impacts were considered short term if the resource recovery would last up to 3 years following construction (e.g., vegetation clearing in pastures). Impacts were considered long term if resource recovery would require more than 3 years but would occur during the life of the Project (e.g., clearing of trees in temporary construction work areas). Impacts were considered permanent if they would last for the life of the Project (e.g., clearing of trees within the permanent right-of-way). See Table 5.1-1.

Table 5.1-1. Definitions of Impact Duration

Term	Definition
Temporary	Impacts that would occur during and immediately following construction
Short term	Impacts that would continue for up to 3 years after construction
Long term	Impacts that would last more than 3 years but would recover during the life of the proposed Project or alternative
Permanent	Impacts that would last for at least the duration of the proposed Project or alternative

Categories of impact magnitude or severity for the purposes of this EIS include *negligible*, *minor*, and *major*. Impacts were considered negligible if they have the potential to occur but generally would not be measurable or noticeable. Impacts were considered minor if they were expected to be evident but below resource-specific standards or metrics, such as those used in other recent linear infrastructure EISs in the region (e.g., Great Northern Transmission Line, Alberta Clipper, Wisconsin Sandpiper/Line 3 Replacement) and requirements by the Federal Energy Regulatory Commission for interstate natural gas pipelines crossing wetlands, waterbodies, or uplands (DOS 2009; FERC 2013a, 2013b; DOE 2015; Wisconsin Department of Natural Resources 2016). Impacts were considered major if they were expected to potentially exceed the resource-specific standards or metrics. See Table 5.1-2.

Table 5-1-2. Definition of Impact Magnitude

Term	Definition
Negligible	Impacts could potentially occur, but not expected to be measureable or noticeable
Minor	Impacts are evident, but expected to be below resource-specific standards or metrics
Major	Impacts are evident and expected to exceed resource-specific standards or metrics

In each resource area, available datasets and metrics were reviewed to identify "factors" that provide an indication of how a given resource could be affected. For example, the presence of different vegetation types, noxious weeds, native plants, and old-growth forest were identified as factors that could be examined to understand how vegetation resources as a whole could be affected. In most cased, impacts were assessed by mapping available data for each of the relevant factors and overlaying information on the construction and operations footprint for the Applicant's preferred route and CN Alternative. These overlays were reviewed in order to identify the location, type, and condition of resources within and adjacent to the construction and operations features. In addition, methods of construction and operations, including Applicant-proposed measures to minimize impacts, were reviewed. Together, the spatial analysis and review of construction and operation methods were used to determine the nature, duration, and magnitude of impacts on a given resource. In addition to the impact assessment for the Applicant's preferred route, the CN Alternatives analyzed in this chapter include:

- Continued use of existing Line 3
- System alternative SA-04
- Transportation by rail
- Transportation by truck
- Existing Line 3 supplemented by rail
- Existing Line 3 supplemented by truck

The footprint of the Applicant's preferred route was defined based on the Project applications and additional information provided by Enbridge. This information is summarized in Chapter 2, which includes the Applicant-proposed measures to limit or avoid impacts during construction and operations. It was assumed that the Applicant-proposed measures would be applied to other pipeline alternatives, as appropriate. In addition, it was assumed that the rail and truck alternatives would be constructed and operated in accordance with standard best management practices (BMPs), and that all alternatives would incorporate regulatory and permit requirements.

As described in Chapter 2, Enbridge provided the location and land requirements of the proposed Project during construction and operation, including the construction work area along the pipeline route, additional temporary workspaces (ATWS), temporary and permanent access roads, temporary contractor and material/pipe storage yards (yards), and aboveground facilities. Enbridge provided DOC-EERA with geo-referenced geographic information system (GIS) shapefiles of these features. Over 80 percent of the 5,604 acres that would be disturbed during construction of the Project would be associated with the construction work area along the pipeline (typically 120 feet wide). The remaining land disturbance primarily would be associated with temporary construction, including ATWS (9 percent), access roads (5 percent), and yards (4 percent). During operation62 percent (3,480 acres) of the land disturbed during construction would return to preconstruction uses (, and the majority of the permanent operations-related land disturbance would be associated with maintenance of the permanent right-of-way (97 percent, or 2,057 acres). The remaining 3 percent of permanently disturbed land would be associated with aboveground facilities, including access roads (67 acres). Each resource section in this chapter discusses the impacts of construction and operations for the Applicant's preferred route based on this detailed geo-referenced information.

In contrast, the available data for the CN Alternatives are not as extensive or complete as those for the Applicant's preferred route—in part, because no one has designed or engineered those alternatives as

stand-alone projects. For continued use of the existing Line 3, data are available on pipeline location, some existing resources along the Enbridge Mainline system corridor, and Enbridge's ongoing integrity digs (as discussed in Section 4.2.3). In addition, approximately 42 percent of the Applicant's preferred route would be located in the same Enbridge corridor as the existing Line 3; consequently, much of the data for the Applicant's preferred route can be used to describe existing conditions for Line 3. However, no information is available on the precise location of future integrity digs if existing Line 3 operations continued, and the extent of disturbance at a dig site would be based in part on initial findings in the field. As a result, the environmental analysis for continued use of the existing Line 3 identifies the types of resources that may be affected and qualitatively assesses the nature, magnitude, and duration of those impacts.

For system alternative SA-04, quantitative analysis was conducted using the digital centerline identified during scoping; no corresponding geo-referenced information is available on aboveground facilities, ATWS, access roads, or yards. Along the SA-04 route, a standard 120-foot-wide construction work area, 60 feet either side of the centerline, was applied to assess the impacts associated with pipeline construction. This allowed quantification of construction and operations impacts on land cover, habitat, and resources along the SA-04 route based on publically available information on existing conditions. Applying the relative proportion of land requirements for the Applicant's preferred route to the AS-04 alternative, the 120-foot-wide construction footprint equates to approximately 80 percent of the overall construction acreage that would be required to construct the system alternative (the other 20 percent being associated with unidentified ATWS, access roads, yards, and aboveground facilities). The 50-foot-wide permanent right-of-way along the SA-04 centerline would account for 97 percent of the operations footprint of the system alternative (based on the relative proportion of the land requirements for the Applicant's preferred route). Without knowing precise locations of aboveground facilities and secondary construction features (e.g., ATWS, yards, and temporary access roads), potential impacts were qualitatively assessed by applying assumptions used in the evaluation of the Applicant's preferred route. For example, although the exact locations for pump stations are not known, they average about 8 acres each for the proposed Project and would be expected to be located in open upland areas—especially with all the available agricultural land along the SA-04 route. If the proposed Project is not constructed, field surveys, landowner and agency coordination, and site-specific engineering would be conducted to develop routing; develop specialized construction methods; and locate aboveground facilities, access roads, and yards along any other pipeline route.

It was assumed that transportation by rail and transportation by truck would require a new oil loading facility at the closest Enbridge pump station to Neche, North Dakota (Gretna, Canada); a new offloading facility at Clearbrook, Minnesota; an expansion of the offloading facility in Superior, Wisconsin; and associated upgrades to access those facilities. In addition, the rail and truck alternatives would entail rail/truck traffic to deliver oil from Gretna to Clearbrook and Superior. Although the exact facility locations and designs and the transit routes are not known, the environmental analysis was predicated on the general size of the facilities; an assumption that the facilities would be located within 1 mile of the Gretna pump station, Clearbrook terminal, and Superior terminal; and the likely train and truck transit routes described in Sections 4.2.6 and 4.2.7.

The environmental analysis of supplementing existing Line 3 with rail or truck transport assumed that (1) operation and maintenance of the existing Line 3 would continue as described for the existing Line 3; and (2) the same rail and truck facilities and access upgrades would be needed as described for transportation by rail and transportation by truck. Thus, the only difference in combining the impacts for the continued use of existing Line 3 with those for the rail or truck alternative would be associated with

a decrease in the number of required train and truck transits during operations because of the reduced volume of oil that would be transported via train or truck with continued use of existing Line 3 (see Section 4.2.6-4.2.7).

5.1.4 Summary and Mitigation

Each resource discussion in this chapter concludes with a general summary of the anticipated impacts on the resource for the Applicant's preferred route and each CN Alternative based on the nature, extent, duration, and magnitude of potential impacts.

As discussed in Section 5.1.3, because of the lack of locational data for secondary facilities (aboveground facilities, access roads, ATWS, and yards) for the CN Alternatives, the impacts are more quantifiable for the Applicant's preferred route than for the CN Alternatives.

To allow for a more direct comparison between the Applicant's preferred route and the CN Alternatives, the impacts for both the Applicant's preferred route and SA-04 in the summary sub-section are calculated based on Enbridge's refined construction work area (typically 120 feet wide) and 50-foot-wide permanent right-of way. This approach results in underestimating impacts for both alternatives by approximately 3 percent (operations) to 20 percent (construction). As discussed in Section 5.1.3, it is expected that the majority of the acreage of aboveground facilities, access roads, ATWS, and yards for the SA-04 alternative would be located in upland open lands. From an overall acreage perspective, the 3- to 20-percent underestimate does not substantially alter the general relationship between the Applicant's preferred route and CN Alternatives, as the land requirements for construction and operation along the SA-04 alternative are over twice the amount for the Applicant's preferred route; both the Applicant's preferred route and SA-04 would require acreage for construction an order of magnitude greater than for construction of the rail or truck facilities (see Sections 2.4 and 4.2).

In addition to incomplete information on the extent of upland impacts for SA-04, the primary shortcoming of the above approach for the environmental analysis is associated with Enbridge's proposal to reduce the width of the construction work area for the Applicant's preferred route in some wetlands and waterbodies (from 120 feet to 95 feet) based on site-specific field investigations and engineering. These refinements have not been incorporated into the general approach for the SA-04 footprint. For wetlands, this discrepancy is addressed in the wetlands resource section. For the analysis of surface water, the issue is recognized but is less integral, as the impact assessment for surface waters is not driven by the acreage of waterbody crossings as much as the resulting impact on water quality, aquatic habitat, and fisheries, and the measures to minimize those impacts. As noted above, if SA-04 is approved, it is expected that field surveys and engineering would result in refinements to the route, the width of the construction footprint, and construction methods to further avoid and minimize impacts on wetlands and waterbodies.

Comprehensive quantitative data were not available for all resource-specific factors associated with existing Line 3 operations, or with construction and operation of the rail or truck alternative. As a result, some of the summary sub-sections present quantitative information for these factors where available and qualitative results for those alternatives where quantitative information is not available.

The summary sub-section for each resource includes a summary table to highlight impacts on the resources among need alternatives. The summary sub-section also identifies mitigation, as appropriate, to further avoid and minimize impacts. Mitigation may include expanding BMPs, initiating

agency/landowner coordination, and identifying potential permit conditions (Section 3.6 summarizes the permits and approval processes for the Project).

5.1.5 References

Federal Energy Regulatory Commission (FERC). 2013a. Upland erosion control, revegetation, and maintenance plan. May. Washington, DC.

_____. 2013b. Wetland and Waterbody Construction and Mitigation Procedures. May. Washington, DC.

U.S. Department of Energy (DOE). 2015. Great Northern Transmission Line Final Environmental Impact Statement. (DOE/EIS0499.) Prepared by the U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability and the Minnesota Department of Commerce, Energy Environmental Review and Analysis. October. Washington, DC.

U.S. Department of State (DOS). 2009. Final Environmental Impact Statement for the Alberta Clipper Pipeline Project. U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs. June. Washington, DC.

Wisconsin Department of Natural Resources. 2016. Final Environmental Impact Statement Enbridge Sandpiper and Line 3 Replacement Projects. August.

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5.2 NATURAL ENVIRONMENT

Project actions have the potential to affect the natural environment. This section describes the existing conditions and assesses potential impacts on water resources, geology and soils, flora and fauna, and air quality associated with the Applicant's preferred route and CN Alternatives.

5.2.1 Water Resources

This section describes water resources, including groundwater, surface water, wetlands, and floodplains, located along the Applicant's preferred route and the existing Line 3 pipeline in North Dakota, Minnesota, and Wisconsin and along system alternative system alternative SA-04 in North Dakota, Minnesota, Iowa, and Illinois. The analysis focuses on major groundwater aquifers and wells; surface waterbodies, including streams, rivers, and lakes, and their designations; Public Waters Wetlands, calcareous fens, and wetland reserve programs; and floodplains designated by the Federal Emergency Management Agency (FEMA). The potential impacts of pipeline construction and operation on water resources are described for and compared between the Applicant's preferred route and the CN Alternatives (continued use of the existing Line 3, system alternative SA-04, transportation by rail or truck, and supplementing continued use of the existing Line 3 with rail or truck transportation).

5.2.1.1 Groundwater

Groundwater is water that collects or flows beneath the Earth's surface, filling the porous spaces in soil, sediment, and rocks. Groundwater originates from rain and from melting snow and ice that infiltrate into the ground; it is the source of water for springs and wells. Groundwater is relied on as a source for drinking water, irrigation, and industrial use (USGS 1992). Groundwater can be sourced from shallow surficial aquifers or from deeper confined aquifers. Activities that reduce the quantity of available water or introduce contaminants into these aquifers can affect groundwater resources and the people and industries that rely on them.

This section assesses the potential for construction and operation of the Project to affect the quantity of available water or to introduce pollutants that would degrade the quality of groundwater resources. Groundwater impacts that could occur during construction and operation are evaluated and compared for the Applicant's preferred route and the CN Alternatives.

The potential construction-related groundwater impacts to be addressed include the following:

- Changes in groundwater availability (from withdrawals for hydrostatic testing and other construction activities including the "French drain" effects of a pipeline);
- Increases in total suspended solid (TSS) concentrations during trenching/excavation activities in shallow aquifers;
- Degradation of shallow groundwater quality from blasting, spills, or existing contamination;
- Degradation of groundwater quality in potable supply wells, sole source aquifers,[2] or other designated groundwater protection areas; and

[2] EPA defines a "sole source aquifer" as one that supplies at least 50 percent of the drinking water for its service area and there are no reasonably available alternative drinking water sources should the aquifer become contaminated.

- Degradation of water quality from drilling mud releases during horizontal directional drilling (HDD) crossings.

Potential operations-related groundwater issues addressed in this section include:

- The potential for ongoing groundwater availability changes due to repair and maintenance activities and the risk of French drain effects, and
- Contamination resulting from small fuel and lubricant leaks and spills from maintenance and inspection vehicles.

This section first describes the existing groundwater resource conditions within an area along the Applicant's preferred route and each of the CN Alternatives where groundwater could be affected by construction or operation activities. The potential impacts on groundwater resources from construction and operation of the Applicant's preferred route and CN Alternatives are considered next. A summary and comparison of the impacts of the Applicant's preferred route and CN Alternatives are included at the end of the section. Potential impacts on groundwater resources due to a release of crude oil from the pipeline are discussed in Chapter 10.

5.2.1.1.1 Regulatory Context and Methodology

Regulatory Context

A number of water management and groundwater regulations control activities have the potential to affect the quantity or quality of groundwater resources. These programs and their relevance to construction and operation of pipelines are summarized by state in Table 5.2.1.1-1.

Continued use of existing Line 3 and transport by rail or truck require no, or minimal, construction of above ground facilities; they do not require appropriation of large quantities of water that would trigger regulatory approval. The minimal construction activities related to these alternatives (see Chapter 4) would be subject to general stormwater management practices and associated BMPs.

Methodology

The ROI for the analysis of potential impacts on groundwater during construction generally consists of the pipeline, rail, or truck corridor and a 1,000-foot buffer on either side of the centerline of the Applicant's preferred route and the CN Alternatives. Although the precise location of rail and truck offloading facilities are not known, they would be located in proximity to the Clearbrook and Superior terminals, where existing conditions would be the same as those described for the Applicant's preferred route. Routes for rail and truck transportation have been assumed for this impact analysis but could vary in actual operation.

Table 5.2.1.1-1. Regulatory Requirements for Protection of Groundwater during Pipeline Construction

Unit of Government	Type of Application	Reason Required
North Dakota		
North Dakota State Water Commission[a]	Water Appropriation Permit	Authorizes withdrawal and use of groundwater for hydrostatic testing, dust control, HDD installation, and trench dewatering.
North Dakota Department of Health[b]	North Dakota Source Water Protection Program – Wellhead Protection Area consultation	Determines whether pipeline construction would affect existing wellhead protection areas.
Minnesota		
Minnesota Department of Natural Resources[c]	Water Appropriation Permit for withdrawals exceeding 10,000 gallons per day or 1 million gallons per year	Authorizes withdrawal and use of water from groundwater from private or municipal wells for hydrostatic testing, dust control, HDD installation, and trench dewatering.
	Calcareous Fen Management Plans	Impacts on calcareous fens are managed by Minnesota Department of Natural Resources under approved calcareous fen management plans.[d]
Minnesota Department of Health[e]	Drinking Water Supply Management Area – Wellhead Protection Area consultation	Ensures that pipeline construction and operation are compatible with goals of relevant Drinking Water Supply Management Area and Wellhead Protection Area plans.
Minnesota Pollution Control Agency[f]	Permitting of actions that may result in discharges to surface water or groundwater	Requires certification by Minnesota Pollution Control Agency that the Project would not result in violation of state water quality standards.
		Prevention/remediation of groundwater contamination.
Iowa		
Iowa State Department of Natural Resources[h]	Water Use Permit	Registration of a minor, non-recurring use of water is required for a project where at least 25,000 gallons of water would be used in a 24-hour period and the project does not exceed a 1-year duration (e.g., well drilling and highway construction activities).
Illinois		
Illinois Environmental Protection Agency[i]	Illinois Groundwater Protection Act – Wellhead Protection Area consultation	Ensures that pipeline construction and operation are compatible with goals of relevant plans.
Wisconsin		
Wisconsin Department of Natural Resources[g]	Water Use Permit	Users in Great Lakes Basin withdrawing quantities averaging 100,000 gallons per day or more in a 30-day period must secure a Water Use Permit to ensure that withdrawals do not harm rivers, streams, lakes, wetlands, springs, groundwater, or plants and animals that depend on them.

[a] Source: North Dakota State Water Commission 2015.

[b] Source: North Dakota DH 2016.

[c] Source: *Minnesota DNR 2017a.*

[d] Calcareous fens are discussed in Wetlands, Section 5.2.1.3.

[e] Source: *Minnesota DH 2014.*

[f] Source: *Minnesota PCA* n.d.[a].

[g] Source: Wisconsin DNR n.d.

[h] Source: *Iowa State DNR n.d.*

[i] Source: Illinois EPA 2015.

HDD = horizontal directional drilling

The ROI for assessment of operations impacts varied according to the configuration of the alternative. Operations impacts for the Applicant's preferred route were estimated based on the footprints for the permanent right-of-way provided by the Applicant. Operations impacts for the existing Line 3 were evaluated based on the existing permanent right-of-way for that pipeline. Operations impacts for system alternative SA-04 were estimated by overlaying a standardized 50-foot-wide permanent right-of-way centered on the route. As noted above, specific routes for rail and truck transportation were assumed for the impact analysis, although other routes also may be used. Potential impacts on groundwater associated with transportation by rail and truck operations were assessed qualitatively.

Impacts on groundwater resources were identified based on common construction methods; peer-reviewed literature; agency documents, including permit requirements and guidance manuals; Applicant-submitted documents, including the November 2016 EAW and associated construction BMP plans (Enbridge 2016a); and the experience and professional judgment of the hydrogeologists involved in developing this analysis.

Identification of groundwater resources potentially affected by the Project was completed by reviewing reports and data from the U.S. Geological Survey (USGS); the State Geological Surveys of Minnesota, Iowa, and Illinois; the North Dakota State Water Commission and North Dakota Source Water Protection Program; the Minnesota Department of Natural Resources (Minnesota DNR), Minnesota Pollution Control Agency (Minnesota PCA), Minnesota Department of Agriculture (Minnesota DA), and Minnesota Department of Health (Minnesota DH); Iowa Department of Natural Resources (Iowa DNR); and the U.S. Environmental Protection Agency (EPA).

Impacts related to groundwater resources were evaluated by overlaying the Applicant's preferred route and CN Alternative footprints with the following data sources:

- Aquifer locations and type, including EPA-designated sole source aquifers;
- Wellhead protection areas[3] in North Dakota; Minnesota, Iowa, and Illinois;
- Domestic and public water supply wells in North Dakota, Minnesota, Iowa, and Illinois. A Public Water Supply (PWS) in Minnesota by definition must serve 25 or more people for at least 60 days of the year as defined by the Federal Safe Drinking Water Act. PWSs are broken down into community and non-community:
  - Community PWS (Municipal and Non-municipal) – provides water to the public in their primary living space—where people live and sleep—(i.e., homes, apartments, nursing homes, prisons, mobile home parks, etc.)
  - Non-community PWS – provides water to the public in places other than their homes—where people work, gather and play. Two types are:
    - Transient Noncomm PWS – facilities that serve at least 25 people at least 60 days of the year, but do not serve the same 25 people over 6 months of the year (i.e., restaurants, campgrounds, hotels, churches)

[3] A wellhead protection area is the surface and subsurface area surrounding a public water supply well or well-field that is regulated to prevent contamination; any potential contaminants would be likely to move toward this area and reach the well or well-field capture zone.

    - Nontransient Noncomm PWS – facilities that serve at least 25 of the same people over 6 months of the year (i.e., schools, offices, factories, daycare centers);
- Minnesota water table aquifer vulnerability; Iowa groundwater vulnerability; and Illinois aquifer sensitivity maps;
- Minnesota DNR's Watershed Health Assessment Framework groundwater contamination susceptibility index;
- Minnesota PCA's "What's in My Neighborhood?" (WIMN) database and EPA's Facility Registry Service (EPA-listed contaminated sites);
- Minnesota drinking water supply management areas (DWSMAs);[4] and
- Minnesota pollution sensitivity of near-surface materials.

The impact analysis for the Applicant's preferred route and CN Alternatives was made using available comparable data. Individual states monitor and categorize groundwater quantity and quality in different manners; thus, the same or even similar data are not available across all states. Minnesota DH, Minnesota DNR, and Minnesota PCA provided data and guidance for these analyses.

5.2.1.1.2 Existing Conditions

Groundwater can accumulate in underground layers of permeable rock, sediment, or soil and when these layers yield usable amounts of water, they are known as "aquifers." Aquifers can be classified as unconfined or confined. When the top of the aquifer is not overlain by impermeable layers that restrict the vertical movement of water, the aquifer is unconfined. The upper surface of groundwater in this type of aquifer is referred to as the "water table." When there is a layer of low-permeability material between the top of the aquifer and overlying sediments that restricts the vertical movement of water, the aquifer is confined. The low-permeability layers are called "confining units," or aquitards, which are mainly composed of silt and clay. Both of these aquifer types occur beneath the Applicant's preferred route and the CN Alternatives.

Confined and unconfined aquifers occur in both glacial and bedrock materials. Glacial aquifers consist of unconsolidated sediments deposited and reworked by glaciers that range in depth from just below to several hundred feet below the land surface. Bedrock aquifers underlie the glacial materials and consist of deeper consolidated bedrock layers, such as limestone or sandstone.

The following discussion details the existing groundwater conditions in the vicinity of the Applicant's preferred route and CN Alternatives, including aquifer types, characteristics of the materials that make up the aquifers, water yield, and water quality.

[4] A drinking water supply management area is the surface and subsurface area surrounding a public water supply well that is approved by Minnesota DH and completely contains the scientifically calculated wellhead protection area; these are managed by the entity identified in a Wellhead Protection Plan.

Applicant's Preferred Route

Glacial Aquifers

Groundwater in permeable glacial sediments and recent stream-derived (alluvial) sediments is an important source of water in the vicinity of the Applicant's preferred route in North Dakota and Minnesota. These sediments comprise glacial till, outwash, glacial lake sediments, or sand and gravel that have been deposited along streams.

The thickness of glacial aquifers is highly variable, ranging from a few feet to greater than 150 feet. The highly variable composition of these aquifers, both vertically and horizontally, results in widely varying yields at different depths and locations. Well yields in glacial aquifers range from approximately 10 to 1,000 gallons per minute (gpm) (Adolphson et al. 1981), which makes them important sources of drinking water for domestic and municipal use (Minnesota PCA 1999).

The quality of water in glacial aquifers is generally good, but minerals such as iron and manganese may be present in a dissolved state in concentrations that exceed secondary drinking water standards (levels at which human health is not affected, but at which the taste, odor, and color of water may be negatively affected).

Water Table Glacial Aquifers

Most glacial aquifers that contain sands and gravels near the land surface contain surficial or water table aquifers because they receive direct recharge from infiltrating precipitation, melting snow, and overlying wetlands. Groundwater in surficial aquifers generally moves downhill or down-gradient from upland areas, recharges deeper aquifers, and discharges at lakes and streams. Water table aquifers are inherently more vulnerable to construction and spill impacts because they are in direct contact with the land surface. The depth to the water table along with the soil types indicates the degree of vulnerability to impacts.

Confined Glacial Aquifers

Glacial aquifers also exist as confined aquifers near the Applicant's preferred route. Confined glacial aquifers consist of permeable sand and gravel sediments at variable depths from the land surface, overlain by confining units. The confining units restrict the movement of water between the aquifers and the land surface; therefore, these aquifers are generally better protected from human activity on the land surface and thus not generally affected by pipeline activities. Confined glacial aquifers are recharged primarily by downward leakage from overlying surficial aquifers or upward leakage from deeper confined aquifers. No available datasets show the exact location of confined glacial aquifers in the ROI, but their locations can be inferred from nearby well and boring records.

Bedrock Aquifers

In areas with greater thicknesses of glacial material overlying bedrock aquifers, there is a higher likelihood that low-permeability confining layers are present in the overlying glacial sediments, and the potential for groundwater within the aquifers to be affected by construction or operation of a pipeline is low. Where the depth to bedrock is shallow, there is a lower likelihood that low-permeability confining layers are present in the overlying glacial sediments, and there is a higher potential for groundwater within these bedrock aquifers to be affected by construction or operation of the pipeline.

Generally, two types of bedrock aquifers occur beneath the glacial aquifers along the Applicant's preferred route. The first type consists of hard and very old igneous and metamorphic rocks where

groundwater occurs mostly in fractures. In most instances, this type of material does not yield usable quantities of water. The exception is where this bedrock is shallow and more highly fractured.

The second type of bedrock aquifer consists of thick, laterally extensive sequences of sandstone, limestone, and dolostone of sedimentary origin. This type of bedrock aquifer tends to be more productive than the first type. Similar to confined glacial aquifers discussed above, the majority of this type of bedrock aquifer often is isolated from overlying surficial aquifers by confining units, which decreases their vulnerability to contamination from land surface activities. The exception to this is karst aquifers, which are vulnerable to contamination.

A karst aquifer is a type of bedrock aquifer that usually consists of limestone but also can consist of dolostone or sandstone. Aquifers composed of these pH basic rock types are prone to chemical weathering and dissolution from the slight acidity of precipitation and groundwater, which can result in the formation of fractures, joints, sinkholes, cavities, caves, and void spaces that allow the movement of large volumes of surface water into and through the aquifer. These aquifers are often the source of abundant springs and seeps. These characteristics also allow contamination to spread rapidly within the aquifer. Karst aquifers are susceptible to collapse of the aquifer matrix, which can be triggered by construction activities on the land surface. This can lead to the formation of sinkholes in unconsolidated sediments that overlie the bedrock. Paleozoic limestones and some Precambrian sandstones found in southeastern and eastern Minnesota and in northeast Iowa are susceptible to dissolution and result in karst topography. Bedrock in these areas often is less than 50 feet below land surface and is considered vulnerable to contamination (Minnesota DNR 2016; Iowa DNR 2010). Karst conditions are not believed to be present along the Applicant's preferred route.

With the exception of shallow bedrock (either igneous/metamorphic or sedimentary, which is not common along the Applicant's preferred route) and karst bedrock, bedrock aquifers are not expected to be affected by pipeline construction and operation because they exist at depths averaging from 300 to 400 feet, which is well below pipeline construction depths. These deeper bedrock aquifers often are overlain by thick confining layers, which protect them from disturbance by human activities on the land surface. These aquifers are listed below in Table 5.2.1.1-2 but generally are not discussed further.

Beneath the Applicant's preferred route in Minnesota, bedrock aquifers consist of hard and very old igneous and metamorphic rocks. Groundwater in these rocks occurs mostly in fractures that may not yield usable quantities of water.

Table 5.2.1.1-2. Bedrock Aquifers Crossed by the Applicant's Preferred Route

State	Bedrock Aquifer	Description
North Dakota	Unit D	• Primarily consists of limestone. • Includes some sandstone and shale. • The top of this unit is a few hundred feet below land surface in the area. • Very little is known about the water-bearing properties of the rocks in this unit.
North Dakota and Minnesota	Red River-Winnipeg	• Occupies a depression in the crystalline bedrock of northwestern Minnesota and is overlain by several hundred feet of glacial till and lake sediments. • A porous zone at the top of the upper limestone yields most of the water to wells in the aquifer. Groundwater generally flows eastward through the aquifer from North Dakota and discharges upward to wells and to overlying deposits. • Yields of wells open to the full thickness of the aquifer range from 100 to 250 gpm. • Water is unsuitable for most uses because of the high mineral content; concentrations of dissolved solids range from about 3,000 mg/L in the eastern part of the aquifer to about 60,000 mg/L in the northwestern corner of Minnesota.
Minnesota	Proterozoic	• Underlies glacial drift and rocks in much of the north-central part of Minnesota. • Yields to wells are generally less than 20 gpm, but yields of 30 gpm can be obtained locally from wells completed in the fractured zone near the upper surface of the aquifer. • Water is used for numerous domestic and some municipal supplies, and is of the calcium-magnesium-bicarbonate type. It contains much less iron, manganese, dissolved solids, and hardness than most water from glacial drift aquifers in the area.
Minnesota	Cretaceous	• Present in Kittson and Itasca counties in the Applicant's preferred route. • Aquifer is not widely used except where glacial drift aquifers are absent or where well yields are poor. • Most water is used to supply farms, and wells typically yield from 10 to 25 gpm. • Major source of water locally, southwest of the Minnesota River. • Water quality is typically poor compared to glacial aquifers, and it has naturally elevated levels of arsenic in many parts of the state.
Minnesota and Wisconsin	Precambrian Undifferentiated	• Underlies the entire state. • Source of minor water supplies in the central portion of the region of interest and along the Applicant's preferred route in Carlton County. • Yields generally range from 1 to 25 gpm. • Quality of water often is similar to that contained in overlying glacial drift aquifers. Concentrations of dissolved solids are generally less than 300 mg/l. Calcium-magnesium-bicarbonate type water is the most common water type, and concentrations of total dissolved solids are typically less than 300 mg/l.

Sources: Paulsen 1983; Adolphson et al. 1981; Wisconsin GNHS 2013.

gpm = gallons per minute, mg/L = milligrams per liter

Sole Source Aquifers

The Applicant's preferred route would not cross any aquifers designated by EPA as sole source aquifers.

Domestic Wells, Public Wells, and Wellhead Protection Areas

There are 304 domestic wells within the ROI for the Applicant's preferred route (98 unverified and 205 verified location domestic wells in Minnesota and 1 in North Dakota). Well data were requested for the Wisconsin portions of the Applicant's preferred routes and alternatives but were not made available. There are two unverified and four verified location public wells within Minnesota in the ROI.

The Applicant's preferred route would not cross any wellhead protection areas in North Dakota, and it would cross 87 acres in Minnesota. Wellhead protection area data were requested for the Wisconsin portions of the Applicant's preferred routes and CN Alternatives but were not made available.

Aquifer Vulnerability Areas

Minnesota provides rankings of water table aquifer vulnerability based on the water time of travel to the aquifer. The vulnerability ranking is inversely proportional to the time of travel: in areas of higher sensitivity, contaminants may reach the groundwater within hours to months; and in areas of lower sensitivity, surface contamination may take months to years to travel into groundwater. The Applicant's preferred route would cross 25,765 acres of high vulnerability water table aquifers in Minnesota. Comparable data are not available for North Dakota or Wisconsin.

Contaminated Sites

There are 19 EPA-designated contaminated sites within the ROI for the Applicant's preferred route (13 in Minnesota and 6 in Wisconsin). There are 104 WIMN sites (three Minnesota DA and 101 Minnesota PCA) within the ROI for the Applicant's preferred route in Minnesota (these data are not available in other states).

Minnesota Groundwater Contamination Susceptibility and Pollution Sensitivity of Near-Surface Materials

Minnesota also evaluates the vulnerability of groundwater to contamination based on the shape, type, and relative position of surface and subsurface geology (e.g., the geomorphic setting), which controls the flow paths of water and dissolved elements above and below the surface. Sandiness, permeability, depth to rock outcrops, fracturing and permeability of bedrock, flow-restricting layers, and surface and subsurface connections all affect how vulnerable groundwater is to contamination. Areas of highest groundwater contamination susceptibility are in central, north-central, and east-central Minnesota and in the southeastern corner of the state in areas dominated by sand and gravel aquifers or in areas with karst bedrock. The Applicant's preferred route would cross 26,382 acres of high groundwater contamination susceptibility in Minnesota. Comparable data are not available for North Dakota or Wisconsin.

Additionally, Minnesota DNR classifies the sensitivity to pollution of near-surface materials, which is an estimate of the time it takes for water to travel through the unsaturated zone to reach the water table, which is assumed to be 10 feet below land surface. Generally, areas of coarse-grained material are modeled as higher sensitivity to pollution compared to areas of fine-grained material. Based on these data, the Applicant's preferred route would cross 16,299 acres of high pollution sensitivity in Minnesota. The DNR also classifies bedrock (aquifer) surface sensitivity to pollution and there are 1700 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers within the Applicant's preferred route ROI. There is no karst at or near the land surface within the ROI.

DWSMAs

The Applicant's preferred route ROI would cross 538 acres of DWSMAs in Minnesota. DWSMA data do not exist for other states.

Continued Use of Existing Line 3

Glacial Aquifers

The confined and unconfined glacial aquifers below the existing Line 3 pipeline are similar to those described above for the Applicant's preferred route.

Bedrock Aquifers

The existing Line 3 crosses the same bedrock aquifers as those crossed by the Applicant's preferred route (see Table 5.2.1.1-2). In addition, the primary fractured bedrock aquifer beneath existing Line 3 is the Biwabik Iron-formation aquifer. This Precambrian age aquifer is composed of chert and iron materials. It generally underlies glacial materials; however, it outcrops[5] above the land surface in north-central Minnesota. The yields of this aquifer range from 250 to 1,000 gpm. It is one of the most productive aquifers for the Mesabi Iron Range and is a primary source of drinking water for many municipalities. Dissolved solids range from 100 to 300 milligrams per liter (mg/L); and the water can contain high concentrations of iron, manganese and silica. This aquifer is susceptible to contamination where surficial materials are thin, at outcrops, and in mine pits. Groundwater flow in this aquifer occurs as regional flow along bedding planes and large fracture networks, as localized flow in discrete fractures near wells, or as a combination of both.

Sole Source Aquifers

The existing Line 3 route does not cross any aquifers designated by EPA as sole source aquifers.

Domestic Wells, Public Wells, and Wellhead Protection Areas

There are 589 domestic wells within the ROI for the existing Line 3 (366 unverified location and 222 verified location domestic wells in Minnesota and 1 in North Dakota). There are four unverified and 44 verified location public wells within the ROI for the existing Line 3, and all are located in Minnesota. The existing Line 3 crosses 624 wellhead protection area acres in Minnesota. It does not cross any wellhead protection areas in North Dakota. Well and wellhead protection data were requested for the Wisconsin portions of the route but were not made available.

Aquifer Vulnerability Areas

The existing Line 3 crosses 69,614 acres of high vulnerability water table aquifers in Minnesota. Comparable data are not available for North Dakota and Wisconsin.

Contaminated Sites

There are 107 EPA-designated contaminated sites within the ROI for the existing Line 3 (101 in Minnesota and 6 in Wisconsin). There are 159 WIMN sites (one Minnesota DA and 158 Minnesota PCA) within the ROI for the existing Line 3 in Minnesota (these data are not available in other states).

[5] An outcrop is a visible exposure of bedrock on the land surface.

Minnesota Groundwater Contamination Susceptibility and Pollution Sensitivity of Near-Surface Materials

The existing Line 3 would cross 19,833 acres of high groundwater contamination susceptibility, 16,179 acres of high pollution sensitivity of near-surface materials, and 1700 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers in Minnesota. Comparable data are not available for North Dakota or Wisconsin. No other karst aquifers or bedrock at or near the land surface are within the ROI.

DWSMAs

The ROI for the existing Line 3 crosses 1,120 acres of DWSMAs in Minnesota. DWSMA data do not exist for the other states.

System Alternative SA-04

Glacial Aquifers

Groundwater in permeable glacial sediments and recent stream-derived (alluvial) sediments is an important source of water in the vicinity of system alternative SA-04 in North Dakota, Minnesota, Iowa, and Illinois (Kay and Bailey 2016; Prior et al. 2003; Sadorf and Linhart 2000; Visocky et al. 1985; Voelker 1986).

Bedrock Aquifers

North Dakota

System alternative SA-04 also would cross the Unit D bedrock aquifer described for the Applicant's preferred route (see Table 5.2.1.1-2).

Minnesota

Beneath system alternative SA-04 in southwest Minnesota and above the hard, fractured bedrock, bedrock aquifers consist of Cretaceous sandstones that are interbedded with thick shale. These sandstone aquifers are relatively thin and only locally useful. Cretaceous bedrock aquifers are present in Traverse, Stevens, Swift, Chippewa, Renville, Sibley, Nicollet counties although not everywhere that SA-04 crosses in these counties. Similar to the Applicant's preferred route, shallow bedrock is not common along system alternative SA-04, with depths to bedrock along both alignments averaging from 300 to 400 feet. System alternative SA-04 in Minnesota crosses the same bedrock aquifers as the Applicant's preferred route listed above, with the exception of the Proterozoic Aquifer.

In the southeastern third of Minnesota, beneath system alternative SA-04, the bedrock aquifers consist of thick, laterally extensive sequences of sandstone, limestone, and dolostone of sedimentary origin. In these bedrock aquifers, groundwater occurs in granular pore spaces, partings, joints, fractures, and dissolution features. Karst features are common in bedrock in the extreme southeast of Minnesota. Conditions vary locally, but generally these aquifers are capable of yielding quantities of groundwater that are sufficient for most purposes. However, these aquifers are highly vulnerable to contamination and structural changes with ground disturbance; including induced sinkhole formation and alteration of groundwater flow.

Karst topography is found in southeastern and eastern Minnesota, where Paleozoic limestones and some Precambrian sandstones are susceptible to dissolution. Along system alternative SA-04, relatively shallow carbonate bedrock with potential for karst intersects the route across Minnesota, Iowa, and Illinois (none is present in North Dakota). Karst features are present in Minnesota along 8 miles of

system alternative SA-04 in Mower County and 3 miles in Le Seur and Blue Earth counties (Minnesota DNR 2016; USGS 2016). Known and potential karst conditions also are present along approximately 63 miles of the route in Iowa and 5 miles in Illinois.

Iowa

The Silurian-Devonian and Upper Carbonate aquifers are present near the land surface and supply approximately 37 percent of groundwater used in northeastern and southeastern Iowa. The Silurian-Devonian aquifer would be crossed by the central and southern portion of system alternative SA-04 in Iowa, and the Upper Carbonate aquifer would be crossed in the north (Savoca et al. 1998).

The Silurian-Devonian aquifer consists of shallow marine limestones, shales, evaporites, dolostone, and sandstone. Shale underlies quaternary alluvial deposits and acts as a confining unit to the dolomite, limestone, gypsum, and sandstone units below (Savoca et al. 1998). The Silurian-Devonian aquifer only reaches the surface in outcrops along the major river valleys (Prior et al. 2003).

The Upper Carbonate aquifer underlies unconsolidated Quaternary and Cretaceous sand, gravel, and clay deposits. The aquifer consists of shallow marine limestone, dolostone, and shale from the Ordovician and Devonian. The Upper Carbonate aquifer is unconfined in the ROI and is underlain by confining units of shale (Savoca et al. 1998).

Illinois

Below the surficial aquifer, Pennsylvanian and Devonian limestones, shales, and some sandstones act as confining/semi-confining layers to the bedrock aquifers. Water supply wells typically are cased through these confining units, but no water supplies are obtained from bedrock aquifers that outcrop at the land surface (Kay and Bailey 2016).

Sole Source Aquifers

System alternative SA-04 would not cross any aquifers designated by EPA as sole source aquifers (EPA 2016).

Domestic Wells, Public Wells, and Wellhead Protection Areas

The ROI for system alternative SA-04 would encompass domestic and public wells in the states through which it would be built. Data provided by the states differ in terms of clarity and classification of wells; therefore, direct comparison between states is difficult. The SA-04 ROI would encompass 17 domestic wells in North Dakota, 36 unverified location and 134 verified location domestic wells in Minnesota, 46 permitted private wells and 190 wells included in the private well tracking system in Iowa, and 205 domestic wells in Illinois. Public wells encompassed by the SA-04 ROI are as follows: one in North Dakota; nine verified location public wells in Minnesota; four in Iowa; and one in Illinois.

System alternative SA-04 would cross 1,203 acres of wellhead protection areas: 538 acres in North Dakota, 138 acres in Minnesota, 36 acres in Iowa, and 491 acres in Illinois.

Aquifer Vulnerability Areas

Minnesota, Iowa, and Illinois rank groundwater and aquifer vulnerability in different ways (Table 5.2.1.1-3). Iowa data represent areas with similar hydrogeologic characteristics thought to represent similar potentials for contamination of groundwater and/or water wells. Illinois data presented below are based on the vulnerability of aquifers to pesticide leaching. No aquifer or groundwater vulnerability data exist for North Dakota. In total, SA-04 would cross 30,201 acres of high vulnerability aquifers (5,687 acres in Minnesota; 12,280 acres of sinkholes and alluvial aquifers in Iowa; and 12,233 acres of high or excessive risk aquifers in Illinois).

Table 5.2.1.1-3. Acres of Aquifer or Groundwater Vulnerability Crossed by System Alternative SA-04

State Vulnerability Ranking	Acres Crossed
Minnesota Total	**60,781.7**
Low	3,821.7
Medium	50,225.2
High	5,686.8
Unrated	1,047.9
Iowa Total	**45,493.7**
Good bedrock aquifers; thin drift confinement	16,994.0
Sinkholes (400-meter radius around each is shown)	1,475.5
Good bedrock aquifers; moderate drift confinement	16,219.3
Alluvial aquifers (southeast Iowa)	2,984.2
Alluvial aquifers (northeast Iowa)	7,820.7
Illinois Total	**29,456.4**
Very limited	15,629.3
Somewhat limited	804.3
Limited	255.0
Moderate	569.6
High	11,705.1
Excessive	528.3

Sources: Illinois State Geological Survey 1995; Iowa DNR 2013; Minnesota DA 2015.

Contaminated Sites

There are 212 EPA-listed contaminated sites within the ROI for system alternative SA-04 (44 in North Dakota, 34 in Minnesota, 55 in Iowa, and 79 in Illinois). There are 80 Minnesota PCA and 3 Minnesota DA WIMN sites within the ROI for system alternative SA-04 in Minnesota (these data are not available in other states).

Minnesota Groundwater Contamination Susceptibility and Pollution Sensitivity of Near-Surface materials

Within the ROI in Minnesota, system alternative SA-04 would cross 4,674 acres of high groundwater contamination susceptibility, 1,493 acres of high pollution sensitivity, 2,053 acres of karst topography and very limited amounts of bedrock at or near the land surface.

Minnesota DWSMAs

System alternative SA-04 would cross 224 acres of DWSMAs within the ROI in Minnesota. DWSMA data do not exist for the other states crossed by system alternative SA-04.

Transportation by Rail

Glacial Aquifers

The glacial aquifers below the assumed rail routes are similar to those described above for the Applicant's preferred route.

Bedrock Aquifers

Beneath the assumed rail routes in Minnesota, bedrock aquifers consist of hard and very old igneous and metamorphic rocks. Groundwater in these rocks occurs mostly in fractures that may not yield usable quantities of water. The rail routes would cross the same general bedrock aquifers as those described for the Applicant's preferred route.

Sole Source Aquifers

The assumed rail routes do not cross any aquifers designated by EPA as sole source aquifers.

Domestic Wells, Public Wells, and Wellhead Protection Areas

The ROI for the assumed rail routes would encompass 584 domestic wells and no public wells in Minnesota. The assumed rail routes would cross 3,059 acres of wellhead protection areas in Minnesota. The ROI for the rail routes does not encompass any public or private wells or wellhead protection areas in North Dakota. Well and wellhead protection area data were requested for the Wisconsin portions of the route but were not made available.

Aquifer Sensitivity Areas

The assumed rail routes would cross 78,190 acres of high vulnerability aquifers in Minnesota. Comparable data are not available for North Dakota and Wisconsin.

Contaminated Sites

Within the ROI for the assumed rail routes, there are 2,251 EPA-listed contaminated sites (2,215 in Minnesota, 36 in Wisconsin, and none in North Dakota) and 2,108 Minnesota PCA WIMN sites.

Minnesota Groundwater Contamination Susceptibility and Pollution Sensitivity of Near-Surface Materials

Within the ROI in Minnesota, the assumed rail routes also would cross 41,707 acres of high groundwater contamination susceptibility, 43,189 acres of high pollution sensitivity of near-surface materials, no areas of karst topography, and very limited bedrock at or near the land surface.

Minnesota DWSMAs

The assumed rail routes would cross 3,678 acres of DWSMAs in Minnesota.

Transportation by Truck

Glacial Aquifers

The glacial aquifers below the assumed truck routes are similar to those described for the Applicant's preferred route.

Bedrock Aquifers

Beneath the assumed truck routes in Minnesota, bedrock aquifers consist of hard and very old igneous and metamorphic rocks. Groundwater in these rocks occurs mostly in fractures that may not yield usable quantities of water. The assumed truck routes would cross the same general bedrock aquifers as those described for the Applicant's preferred route.

Sole Source Aquifers

The assumed truck routes would not cross any aquifers designated by EPA as sole source aquifers.

Domestic Wells, Public Wells, and Wellhead Protection Areas

The ROI for the assumed truck routes would encompass 301 domestic wells in Minnesota and none in North Dakota. No Minnesota or North Dakota public wells are located within the ROI for the assumed truck routes. The potential truck routes would cross 2,197 acres of wellhead protection area acres (1,303 acres in Minnesota and 894 in North Dakota). Well and wellhead protection area data were requested for the Wisconsin portions of the route but were not made available.

Aquifer Sensitivity Areas

The assumed truck routes would cross 40,573 acres of high vulnerability aquifers in Minnesota. Comparable data are not available for North Dakota and Wisconsin.

Contaminated Sites

A total of 1,318 EPA-listed contaminated sites (1,023 in Minnesota, 270 in North Dakota, and 25 in Wisconsin) and 2,108 Minnesota PCA WIMN sites are within the ROI for the assumed truck routes.

Minnesota Groundwater Contamination Susceptibility and Pollution Sensitivity of Near-Surface Materials

The assumed truck routes also would cross 21,412 acres of high groundwater contamination susceptibility, 16,699 acres of high pollution sensitivity of near-surface materials, and no karst topography within the ROI in Minnesota.

Minnesota DWSMAs

The assumed truck routes would cross 1,567 acres of DWSMAs in Minnesota.

Existing Line 3 Supplemented by Rail

Existing conditions for the existing Line 3 supplemented by rail transport are similar to those described above for continued use of the existing Line 3 pipeline and the assumed rail routes.

Existing Line 3 Supplemented by Truck

Existing conditions for the existing Line 3 supplemented by truck transport are similar to those described above for continued use of the existing Line 3 pipeline and the assumed truck routes.

5.2.1.1.3 Impact Assessment

The Applicant's preferred route and each of the CN Alternatives were assessed separately for the construction and operations phases.

For construction, the following potential impacts were assessed:

- Changes in groundwater availability from withdrawals;
- Increases in TSS concentrations during excavation, trenching, and backfilling;
- Degradation of shallow groundwater quality from blasting, spills, or contamination;
- Degradation of groundwater quality in potable supply wells, sole source aquifers, or designated protection areas; and
- Degradation of water quality from drilling mud releases during HDD crossings.

Continuing potential impacts that could occur during operation include:

- Changes in groundwater availability; and
- Changes in groundwater quality.

Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Construction activities that could affect groundwater include groundwater withdrawals and discharges, dewatering and trenching, blasting, access road construction, waterbody crossings, and fueling and use of hazardous materials. These activities may affect groundwater quantity and quality; the extent and magnitude of the impacts would be influenced by the proximity and sensitivity of groundwater resources to construction work areas.

Changes in Groundwater Availability from Withdrawals

Impacts on groundwater availability could occur in two ways: (1) water withdrawals for hydrostatic testing; and (2) groundwater inflows to the pipe trench during construction and subsequent drawdown of the aquifer, if dewatering is required. The Applicant would withdraw water for construction activities such as dust control, HDD installation, and hydrostatic testing of the pipeline. Approximately 120 million gallons of water would be requested through water appropriation permits for hydrostatic testing for the 340 miles of the Applicant's preferred route in Minnesota. The total amounts of water needed for these activities for the Applicant's preferred route have not been determined for North Dakota and Wisconsin. The Applicant would source water from surface water and private and public wells; the proportion of water that would be obtained from groundwater versus surface water has not been determined. Prior to construction, the Applicant would obtain water appropriation permits from the appropriate state agencies (listed in Table 5.2.1.1-1). The rate and total volumes of water withdrawn would be measured with a flow meter and would not exceed the rate and amount specified in the permits (Appendix E).

Dewatering of the pipeline trench may be required before the pipe is lowered into it. It also may be necessary at road boring sites adjacent to wetlands, areas where excessive volumes of groundwater flow into the trench either as a result of seepage or artesian flow, or locations where increased visibility or physical access is necessary. Depending on the state, trench dewatering is considered a water

appropriation or water use permit activity that is regulated based on withdrawal volumes. In areas where an aquifer that is under artesian conditions is exposed by the trench, the volume of inflowing water could cause rapid flooding of the trench and the bottom or sides to become unstable. In these areas, the pipeline trench may have a French drain effect, allowing water to migrate down the trench. Soil borings would be advanced to the design depth of the pipeline in areas where artesian conditions are possible to determine whether a confining layer may be breached (Enbridge 2016a). To protect against subsurface water flow along the pipe after the trench is backfilled, the Applicant would install trench breakers from the bottom of the trench to near the top of the trench, completely surrounding the pipe. The trench breakers would be constructed of bags filled with rock-free subsoil or sand, and their locations would be based on field conditions—including the degree and length of slope, presence of down-slope sensitive resource areas such as wetland and waterbodies, and proximity to other features such as roads and railroads (Appendix E). Once construction in the area is completed and the trench was backfilled, groundwater levels likely would return to preconstruction levels because shallow aquifers readily recharge due to precipitation and surface water inflow.

With adherence to Water Appropriation Permit conditions and implementation of Applicant-proposed measures, impacts on groundwater availability from water withdrawals would be temporary and minor.

Increases in Total Suspended Solid Concentrations in Groundwater

During trenching, excavation, and backfilling, the water table in surficial aquifers could be exposed, which could increase TSS concentrations in water in the trench or excavated area. The Applicant would use temporary erosion and sediment controls, including slope breakers, sediment barriers, stormwater diversions, trench breakers, and mulch, to minimize sedimentation in water resources during construction. The Applicant also would limit the amount of excavated open trench to a maximum of 3 days of anticipated welding production per spread, per pipe to minimize the potential for erosion and sedimentation (Appendix E). In addition, the relatively slow groundwater flow rate and fine-grained nature of the glacial sediments likely would filter out TSS from infiltrating groundwater. Thus, increases in TSS concentrations in groundwater, in aquifers near trenched and excavated areas would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination

The quality of shallow groundwater may be degraded from blasting; small spills and leaks of lubricants, oil, or other hazardous chemicals used during construction; or disturbance of existing contamination. Blasting is likely to be necessary only in Carlton County, Minnesota, near the Wisconsin border where surface bedrock composed of slate and graywacke material of the Thomson Formation is present. The Applicant has identified one location at MP 354.6 where bedrock outcrops at the surface for approximately 0.3 mile, and four blasting events would be required to install the pipeline (Enbridge 2016b). Blasting has been carried out in this segment previously for installation of existing pipelines in the Enbridge Mainline system corridor.

Where blasting would occur, rock would be removed to a depth of 7 feet, which could be above the elevation of the water table in the area. If the water table is exposed by blasting, the turbidity, sedimentation, or chemical contamination that could result would be localized. Prior to construction, the Applicant would develop a site-specific Blasting Plan, which would include measures for transporting, storing, handling, detonating, and disposing of blasting materials to protect groundwater resources.

Groundwater may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel

storage, equipment refueling, and equipment maintenance. Water table aquifers are most vulnerable to contamination because they lack confining layers and directly interact with the land surface (certain states identify areas of high aquifer and groundwater vulnerability or susceptibility to contamination; see Section 5.2.1.1.2 above). The Applicant would follow Spill Prevention, Containment, and Control (SPCC) measures outlined in Appendix E to minimize the likelihood of spills and of contamination entering groundwater. The Applicant would store petroleum products, hazardous chemicals, and lubricating oils; conduct refueling, maintenance, and lubricating operations; and perform concrete coating activities in upland areas at least 100 feet away from wells and use secondary containment (Appendix E). Concrete wash water, grindings, and slurry disposal would be limited to a designated area, away from wetlands and other sensitive areas. Rinse water, used in conjunction with a cleaning pig to remove any accumulated construction debris, dirt, and dust prior to hydrostatic testing, would be treated and disposed of or discharged in accordance with applicable National Pollutant Discharge Elimination System (NPDES) permit conditions. Excess HDD drilling mud would be disposed of offsite at an approved disposal facility. In addition to these prevention measures, the Applicant would be responsible for cleaning up small spills through procedures outlined in the Environmental Protection Plan (Appendix E), including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities. Prevention and response procedures for an unanticipated release of crude oil are discussed in Chapter 10.

If contaminated soils or groundwater are encountered during construction, they would be handled and disposed of in accordance with applicable regulations; the Environmental Protection Plan; and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction. The plan would describe site assessment and response actions that would be implemented to manage contaminated soils and groundwater (Enbridge 2016a). With implementation of Applicant-proposed measures and adherence to the Blasting and Contaminated Soils Management plans, impacts on groundwater quality from blasting, small leaks and spills, and existing contamination would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Designated Protection Areas

Potable water supply wells and wellhead protection areas could be affected by construction activities that include groundwater withdrawals, minor spills of industrial chemicals and hazardous materials, and drilling mud releases during HDD installation, depending on how close the wells are to construction areas. The Applicant's preferred route crosses the City of Plummer City of Oklee, Sundruds Court, and the City of Wrenshall's Wellhead Protection areas. With adherence to the Applicant-proposed measures discussed above and below (e.g., water appropriation BMPs, erosion/sedimentation controls, SPCC measures, and HDD monitoring and clean-up procedures) construction impacts on groundwater in these sensitive areas and wells would be temporary and minor.

The Applicant's preferred route would not cross any aquifers designated by EPA as sole source aquifers. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings

HDD installation involves drilling under a waterbody and installing the pipeline without physical disturbance of the waterbody feature. This method would be used to cross environmentally sensitive areas such as certain wetlands, sensitive fishery resources, and impaired waters (Appendix G). Geotechnical surveys are conducted to determine which waterbodies exist in areas that are geologically suitable for HDD based on properties such as depth to aquifer, aquifer flow properties, aquifer material

type, strength, and deformational properties. Areas not conducive to HDD include soils containing cobbles, boulders, layers of gravel, or non-cohesive sands. During drilling, fluid (water, bentonite clay, and possible Minnesota PCA-approved additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole.

The potential exists for an inadvertent rupture of the bore hole or "frac-out" and release of the drilling fluid. Such events can occur when pressurization of the drill hole increases beyond the containment capability of the overburden soil material, which allows the drilling fluid to flow to the ground surface. The general risks to groundwater associated with HDD construction methods include loss of drilling mud into surficial aquifers, which could lead to turbidity in nearby aquifers and wells. Partial or full loss of drilling mud may occur as a result of encountering loose, unstable zones of soil, particularly in areas of karst. A large subsurface drilling fluid escape that does not reach the surface may fill subsurface voids and potentially cause the upward displacement of water and materials, creating a "doming" effect until the water in the dome reaches equilibrium with the surrounding hydrology. No known areas of karst topography occur along the Applicant's preferred route.

Additives may be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only non-hazardous additives approved under permit conditions would be used, and a Material Safety Data Sheet for the drilling fluid would be maintained onsite. Construction personnel would monitor the crossing to detect releases of drilling mud and would implement containment, response, and clean-up procedures outlined in the Applicant's Environmental Protection Plan (Appendix E) to minimize the potential for drilling mud to reach groundwater resources. If a frac-out occurred and went undetected or was not quickly contained, impacts on groundwater quality could be long term and major. With implementation of the Applicant-proposed measures for drilling mud releases during HDD construction, impacts on groundwater quality would be temporary and minor.

Operations Impacts

Changes in Groundwater Availability

Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. With proper installation of trench breakers and soil compaction during backfilling during construction as described above, impacts on groundwater availability during pipeline operations would be temporary and negligible.

Normal operation of the Applicant's preferred route would not require withdrawal or discharge of water. During maintenance and repair of the pipe, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. As described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures as described above for construction, impacts on groundwater from withdrawals would be temporary and negligible.

Degradation of Groundwater Quality

Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small and would largely remain on the land surface, and only very low concentrations likely would infiltrate into groundwater supplies. Therefore, impacts related to groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. Potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Continued Use of Existing Line 3

Construction Impacts

There would be no construction impacts on groundwater from continued use of the existing Line 3 pipeline because it is already built.

Operations Impacts

Operations impacts for continued use of the existing Line 3 pipeline would be similar to those discussed above for the Applicant's preferred route. In addition, continued use of Line 3 at its present capacity would require high levels of maintenance, with an estimated 267 repair procedures per year in the form of integrity digs (see Section 4.2.3 for more detail). Integrity digs require opening the pipeline trench with excavation equipment and making any necessary repairs. The impacts associated with integrity digs and subsequent pipeline repairs would be comparable to those associated with construction of new pipeline as described above, but on a much smaller scale. It was assumed that the Applicant would adhere to the same measures as proposed for new pipeline construction to protect groundwater resources during repair and maintenance procedures. As such, impacts associated with potential French drain effects, increased TSS concentrations, and degradation of water quality resulting from integrity digs would be expected to be temporary and negligible to minor when they occur; but they would occur as long as Line 3 was operational. Impacts on public or private wells from integrity digs are not anticipated.

Changes in Groundwater Availability

Continued use of the existing Line 3 also may require withdrawal and discharge of hydrostatic testing water. The frequency with which hydrostatic testing would occur, locations of testing, and amounts of water needed for testing are not defined. As described for new pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures. With adherence to permit conditions and implementation of Applicant-proposed measures, impacts on groundwater from water appropriation would be temporary and negligible.

Degradation of Groundwater Quality

Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Refueling, fuel storage, and vehicle maintenance were assumed to follow measures similar to the Applicant-proposed measures described above for maintenance activities and therefore would be minor. Further, the volume of such spills and leaks would be small and would largely remain on the land surface, and only very low concentrations likely would infiltrate into groundwater supplies. Therefore, impacts associated with groundwater contamination from small leaks and spills during operation likely would be temporary and negligible to minor. The potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

System Alternative SA-04

Construction Impacts

Construction for system alternative SA-04 would result in impacts of the same type, magnitude, and duration as discussed above for the Applicant's preferred route. If SA-04 is constructed, it was assumed that the Applicant would implement the same Applicant-proposed measures identified for the Applicant's preferred route (Appendix E) and would implement all necessary requirements mandated by North Dakota, Minnesota, Iowa, and Illinois permits to reduce impacts on groundwater resources for the route.

Changes in Groundwater Availability from Withdrawals

With adherence to Water Appropriation Permit conditions and implementation of Applicant-proposed BMPs (Appendix E), temporary and minor alterations in groundwater quantity would occur from water withdrawn from groundwater wells during construction. The correct use of trench breakers during construction would result in temporary and minor impacts on groundwater migration (i.e., the French drain effect).

Increases in Total Suspended Solid Concentrations in Groundwater

Increases in TSS concentrations and sedimentation could occur in areas of construction with shallow aquifers. However, the relatively slow groundwater flow rate and fine-grained nature of glacial sediments likely would filter out TSS from infiltrating groundwater. With implementation of the Applicant-proposed measures discussed above for the Applicant's preferred route, increases in TSS concentrations during construction of system alternative SA-04 would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination

The quality of shallow groundwater may be degraded from blasting; small spills and leaks of lubricants, oil, or other hazardous chemicals used during construction; or disturbance of existing contamination. The need for blasting along system alternative SA-04 is not known but may be required in areas where bedrock is at or near the land surface. If the water table is exposed by blasting, the turbidity, sedimentation, or chemical contamination that could result would be localized and likely would be diluted or attenuated before it could travel very far into the aquifer. For all blasting, the Applicant would develop a site-specific Blasting Plan, which would include measures to protect groundwater resources.

Temporary and minor impacts on groundwater quality could occur from small leaks and spills, as discussed above for the Applicant's preferred route. If any contaminated soils or groundwater are encountered during construction they would be handled and disposed of in accordance with applicable regulations; the Environmental Protection Plan; and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction. The plan would describe site assessment and response actions that would be implemented to manage contaminated soils and groundwater (Enbridge 2016a).

With implementation of the Applicant-proposed measures and adherence to the Contaminated Soils Management Plan discussed for the Applicant's preferred route, impacts on groundwater quality from small leaks and spills, blasting activities, and existing contamination would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Other Designated Groundwater Protection Areas

Construction activities, including groundwater withdrawals, minor spills of industrial chemicals and hazardous materials, and drilling mud releases during HDD installation, could affect domestic and PWS wells and wellhead protection area groundwater quality. With implementation of the Applicant-

proposed measures described for the Applicant's preferred route, construction impacts on groundwater in these sensitive areas would be temporary and minor.

System alternative SA-04 would not cross any aquifers designated by EPA as sole source aquifers. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings

The number of HDDs to be constructed along system alternative SA-04 is not known at this time. Loss of drilling fluid into loose unstable zones of soil could temporarily restrict water movement in shallow aquifers. A loss of drilling fluid in areas prone to karst formation, of which system alternative SA-04 crosses over 2,000 acres in Minnesota, could affect local karst aquifers. Construction through karst areas would require a site-specific plan which would include preconstruction assessment and surveys, construction monitoring, and karst mitigation and conservation procedures. A large subsurface drilling fluid escape that does not reach the surface may fill subsurface voids and potentially cause the upward displacement of water and materials, creating a doming effect until the water in the dome reaches equilibrium with the surrounding hydrology. Long-term major impacts on surface water quality could result if a frac-out occurred and went undetected or was not quickly contained. These impacts would be temporary and minor with implementation of Applicant-proposed measures for drilling mud releases during HDD construction (Appendix E).

Operations Impacts

Changes in Groundwater Availability

Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. With proper installation of trench breakers and soil compaction during backfilling during construction, as described for the Applicant's preferred route, impacts on groundwater availability during pipeline operations would be temporary and negligible.

Normal operation of system alternative SA-04 would not require withdrawal or discharge of water. During maintenance and repair activities over the duration of the pipeline's operation, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. As described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures, impacts on groundwater from withdrawals would be temporary and negligible.

Degradation of Groundwater Quality

Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small and would largely remain on the land surface, and only very low concentrations likely would infiltrate into groundwater supplies. Therefore, any groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. Potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Transportation by Rail

Construction Impacts

Transportation of crude oil by rail would require construction of temporary storage and offloading facilities, and upgrade or replacement of existing rail lines. The exact locations and footprints for these facilities have not been identified. In general, clearing and grading would be required for these activities, which would not affect groundwater.

Changes in Groundwater Availability from Withdrawals

Water likely would be used for common construction purposes, such as dust control, but it would not be needed for hydrostatic testing. Therefore, impacts on groundwater availability from well withdrawals likely would not occur.

Increases in Total Suspended Solid Concentrations in Groundwater

The rail alternative does not appear to require trenching and excavation activities; therefore, no impacts on TSS concentrations in groundwater are expected to occur.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination

Degradation of groundwater quality could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals that could infiltrate into surficial aquifers during construction activities. These spills would be managed according to SPCC plans that would be developed for each facility.

Because potential rail lines already exist, construction would occur only at localized facility sites, not along the entire rail routes. With implementation of measures similar to those described above for the Applicant's preferred route and adherence to SPCC and Contaminated Soils Management plans, impacts on groundwater quality from small leaks and spills, blasting activities, and existing contamination likely would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Other Designated Groundwater Protection Areas

Minor spills of industrial chemicals and hazardous materials during construction could affect groundwater quality in domestic and PWS wells and wellhead protection areas. Because potential rail lines already exist, construction would occur only at localized facility sites, not along the entire rail routes. Small spills would be managed according to SPCC plans that would be developed for each facility. Therefore, construction impacts on groundwater quality in wells and wellhead protection areas would be temporary and negligible.

The rail alternative would not cross any aquifers designated by EPA as sole source aquifers. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings

The rail alternative does not appear to require construction through waterbodies; therefore, no impacts on water quality from HDD crossings are expected to occur.

Operations Impacts

Changes in Groundwater Availability

Transportation by rail operations would not require groundwater appropriation: therefore, no impacts on groundwater availability are expected to occur.

Degradation of Groundwater Quality

Impacts of rail transportation on groundwater quality could result from brakepad consumption, locomotive lubrication, and small cargo (i.e., crude oil) and fuel (i.e., diesel) drips and leaks that could infiltrate into surficial aquifers. The volume of such drips and leaks would be small and would largely remain on the rail bed, and only very low concentrations likely would infiltrate into groundwater supplies. These are existing impacts from trains currently transporting crude oil along existing rail lines. Impacts on groundwater quality would be temporary and negligible. Potential impacts of a crude oil release on groundwater resources are discussed in Chapter 10.

Transportation by Truck

Construction Impacts

Transportation of crude oil by truck would require construction of offloading facilities and new road access. The exact locations and footprints for storage and offloading facilities and new roads have not been identified. In general, clearing and grading would be required for these activities, which would not affect groundwater.

Changes in Groundwater Availability from Withdrawals

Water likely would be used for common construction purposes, such as dust control, but would not be needed for hydrostatic testing. Therefore, no impacts on groundwater availability from well withdrawals are expected to occur.

Increases in Total Suspended Solid Concentrations in Groundwater

The truck alternative does not appear to require trenching and excavation activities; therefore, no impacts on TSS concentrations in groundwater are expected to occur.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination

Degradation of groundwater quality could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals that could infiltrate into surficial aquifers during construction activities. These spills would be managed according to SPCC plans that would be developed for each facility.

Because potential roadways already exist, construction would occur only at localized facility sites, not along the entire truck routes. With implementation of Applicant-proposed measures and adherence to the SPCC and Contaminated Soils Management plans described for the Applicant's preferred route, impacts on groundwater quality from small leaks and spills, blasting activities, and existing contamination would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Other Designated Groundwater Protection Areas

Minor spills of industrial chemicals and hazardous materials during construction activities could affect groundwater quality in domestic and PWS wells and wellhead protection areas. Because potential

roadways already exist, construction would occur only at localized facility sites, not along the entire truck routes. Small spills would be managed according to SPCC plans that would be developed for each facility. Therefore, construction impacts on groundwater quality would be temporary and negligible.

The truck alternative would not cross any aquifers designated by EPA as sole source aquifers. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings

The truck alternative does not appear to require construction through waterbodies; therefore, no impacts on water quality from HDD crossings are expected to occur.

Operations Impacts

Changes in Groundwater Availability

The truck alternative would not require groundwater appropriation: therefore, no impacts on groundwater availability are expected to occur.

Changes in Groundwater Quality

Impacts of additional truck traffic on groundwater quality could result from small cargo (i.e., crude oil) and fuel (i.e., diesel) drips and leaks that could infiltrate into surficial aquifers. These are existing impacts from trucks currently transporting crude oil along highways. The volume of such drips and leaks would be small and would largely remain on the road surface, and only very low concentrations likely would infiltrate into groundwater supplies. Impacts on groundwater quality would be temporary and negligible. Potential impacts of a crude oil release on groundwater resources are discussed in Chapter 10.

Existing Line 3 Supplemented By Rail

Construction Impacts

There would be no construction impacts from the continued use of the existing Line 3 because it is already built.

Impacts on groundwater during construction of the temporary storage and offloading facilities and upgrade or replacement of rail lines would be the same as those described above for the rail alternative, including potential degradation of groundwater quality from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals that could infiltrate into surficial aquifers during construction activities. Impacts on groundwater during construction would be temporary and negligible to minor with implementation of appropriate BMPs and adherence to permit requirements.

Operations Impacts

Operations impacts on groundwater during integrity digs and subsequent excavation and repair work for continued use of the existing Line 3 would be the same as those described above for the existing Line 3 alternative, including temporary and negligible impacts from hydrostatic test water withdrawal and discharge, and temporary and negligible or minor impacts on groundwater contamination from minor leaks and spills during operation. Impacts of excavation activities from integrity digs associated with continued use of the existing Line 3 would be comparable to impacts described for construction of new pipeline. These impacts are expected to be temporary and minor.

Impacts of rail transportation on groundwater resources could result from brakepad consumption, locomotive lubrication, and small cargo (i.e., crude oil) and fuel (i.e., diesel) drips and leaks, although these are existing conditions for crude oil trains traveling on existing rail lines. The associated impacts on groundwater quality likely would be temporary and negligible to minor. Groundwater impacts for the existing Line 3 supplemented by train alternative would be less than for the rail alternative as fewer trains would be used to transport crude oil under this alternative.

Existing Line 3 Supplemented By Truck

Construction Impacts

There would be no construction impacts from continued use of the existing Line 3 because it is already built.

Impacts on groundwater during construction of the truck storage and offloading facilities and new road access would be the same as those described above for the truck alternative, including degradation of groundwater quality from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals that could infiltrate into surficial aquifers during construction activities. The impacts on groundwater during construction would be temporary and negligible to minor with implementation of appropriate BMPs and adherence to permit requirements.

Operations Impacts

Operations impacts on groundwater during integrity digs and subsequent excavation and repair work for continued use of the existing Line 3 would be the same as those described above for the existing Line 3 alternative, including temporary and negligible impacts from hydrostatic test water withdrawal and discharge, and temporary and negligible or minor impacts on groundwater contamination from minor leaks and spills during operation. Impacts of excavation activities for integrity digs associated with continued use of the existing Line 3 would be comparable to the impacts of new pipeline construction. These impacts are expected to be temporary and negligible to minor.

Impacts of truck transportation on groundwater resources could result from small cargo (i.e., crude oil) and fuel (i.e., diesel) drips and leaks, although these are existing conditions for trucks traveling on existing roads, and associated impacts on groundwater quality likely would be temporary and negligible to minor. Impacts on groundwater from trucks for the existing Line 3 supplemented by truck alternative would be less than under the truck alternative as fewer trucks would be used to transport crude oil.

5.2.1.1.4 Summary and Mitigation

Summary

Overall, impacts on groundwater for the Applicant's preferred route and the CN Alternatives would be temporary and negligible to minor, or no impact would occur. Potential construction impacts due to karst sensitivity would be the highest for SA-04. Potential construction and operation impacts due to vulnerable groundwater would be the highest for the Applicant's preferred route. Table 5.2.1.1-4 provides a summary and comparison of potential construction and operations impacts for the Applicant's preferred route and CN Alternatives. These impacts are listed below.

Construction Impacts

- Potential impacts on groundwater availability from groundwater withdrawals, hydrostatic testing, trench dewatering, and other construction activities, as a result of the Applicant's preferred route and the SA-04, would be temporary and minor.
- Impacts on groundwater quality from construction-related increases in TSS for the Applicant's preferred route and SA-04 would be temporary and minor, wherever trenching, excavation, and backfilling occurred.
- The potential for degradation of water quality in shallow groundwater aquifers from blasting is known for only one location along the Applicant's preferred route, and impacts are expected to minor and temporary. It is not known whether blasting would be necessary for system alternative SA-04; and it is unlikely that it would be necessary for the rail, truck, and combination alternatives.
- Impacts from small spills of chemicals and fuels and lubricants are expected to be temporary and negligible to minor for the Applicant's preferred route and all of the CN Alternatives.
- Degradation of groundwater quality from drilling mud releases during HDD crossings for the Applicant's preferred route and system alternative SA-04 is expected to be temporary and minor with adherence to Applicant-proposed detection, response, and clean-up measures. Impacts could be long term and major if an inadvertent release of drilling mud went undetected.

Operations Impacts

- Operational impacts of the Applicant's preferred route and CN Alternatives on groundwater quality from small fuel, lubricant, and hazardous material leaks and drips would be temporary and negligible to minor because the volume of such drips and leaks would be relatively small, likely would remain on the land surface, and only very low concentrations would likely infiltrate into groundwater supplies.
- Operational impacts on groundwater from continued use of the existing Line 3 would primarily be associated with ongoing integrity digs. As no specific locations for integrity digs have been identified, there is no specific information on the exact extent to which the integrity digs may occur proximal to sensitive groundwater resources. However, it is expected that continued use would entail the same types of activities and impacts associated with new pipeline construction (e.g., trenching, hydrostatic testing, and potential for minor leaks). As a result, impacts on groundwater would be expected to be temporary and minor when they would occur at an integrity dig, but would occur over the life of the pipeline.
- The potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Table 5.2.1.1-4. Summary of Potential Impacts on Groundwater for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Changes in groundwater availability from withdrawals	Temporary/minor impacts	No impact	Temporary/minor impacts	No impact	No impact	No impact	No impact
Increases in TSS concentrations	Temporary/minor impacts	No impact	Temporary/minor impacts	No impact	No impact	No impact	No impact
Degradation of shallow groundwater quality from blasting, spills, or contamination	Temporary/minor impacts • 25,765 acres of high vulnerability water table aquifers (in MN) • 26,382 acres of high groundwater contamination susceptibility (in MN) • 16,299 acres of high pollution sensitivity (in MN) • 19 EPA-listed contaminated sites (13 in MN; 6 in WI) • 101 WIMN sites (in MN)	No impact • 28,691 acres of high vulnerability water table aquifers (in MN) • 19,833 acres of high groundwater contamination susceptibility (in MN) • 16,179 acres of high pollution sensitivity (in MN) • 107 EPA-listed contaminated sites (101 in MN; 6 in WI) • 159 WIMN sites (in MN) • No karst topography	Temporary/minor impacts • 30,170 acres of high water table vulnerability aquifers (5,687 in MN; 12,280 in IA; 12,233 in IL) • 4,674 acres of high groundwater contamination susceptibility (in MN) • 1,493 acres of high pollution sensitivity (in MN) • 212 EPA-listed contaminated sites (55 in IA; 79 in IL; 34 in MN; 44 in ND)	Temporary/minor impacts • 78,190 acres of high water table vulnerability aquifers (in MN) • 41,707 acres of high groundwater contamination susceptibility (in MN) • 43,189 acres of high pollution sensitivity (in MN) • 2,251 EPA-listed contaminated sites (2,215 in MN; 36 in WI; 0 in ND)	Temporary/minor impacts • 40,573 acres of high water table vulnerability aquifers (in MN) • 21,412 acres of high groundwater contamination susceptibility (in MN) • 16,699 acres of high pollution sensitivity (in MN) • 1,318 EPA-listed contaminated sites (1,023 in MN; 270 in ND; 25 in WI)	Temporary/minor impacts	Temporary/ minor impacts

Table 5.2.1.1-4. Summary of Potential Impacts on Groundwater for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
	• No karst topography • 1700 acres of high and very high bedrock sensitivity	• 1700 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers	• 80 WIMN sites (in MN) • 2,053 acres of karst topography in MN • Known or potential karst topography along 11 miles in MN; 63 miles in IA; 5 miles in IL	• 2,108 WIMN site (in MN) • No karst topography	• 2,108 WIMN sites (in MN) • No karst topography		
Degradation of groundwater quality in potable supply wells, sole source aquifers, or other designated groundwater protection areas	Temporary/minor impacts • 87 acres of wellhead protection areas (all in MN, 0 in ND) • 304 domestic wells (303 in MN; 1 in ND) • 6 public wells (in MN) • 0 sole source aquifers • 538 acres of DWSMAs (in MN)	No impact • 624 acres of wellhead protection areas (all in MN; 0 in ND) • 589 domestic wells (588 in MN; 1 in ND) • 48 public wells (all in MN) • 0 sole source aquifers • 1,120 acres of DWSMAs (in MN)	Temporary/minor impacts • 1,203 acres of wellhead protection areas (538 in ND; 138 in MN; 36 in IA; 491 in IL) • 628 domestic wells (17 in ND; 170 in MN; 46 permitted and 190 private in IA; and 205 in IL) • 15 public wells (1 in ND; 9 in MN; 4 in IA; and 1 in IL)	Temporary/ negligible impacts • 3,059 acres of wellhead protection areas (all in MN; 0 in ND) • 584 domestic wells (all in MN; 0 in ND) • 0 public wells • 0 sole source aquifers • 3,678 acres of DWSMAs (in MN)	Temporary/ negligible impacts • 2,197 acres of wellhead protection areas (1,303 in MN; 894 in ND) • 301 domestic wells (all in MN; 0 in ND) • 0 public wells • 0 sole source aquifers • 1,567 acres of DWSMAs (in MN)	Temporary/ negligible impacts	Temporary/ negligible impacts

Table 5.2.1.1-4. Summary of Potential Impacts on Groundwater for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
			• 0 sole source aquifers • 224 acres of DWSMAs (in MN)				
Degradation of water quality from release of drilling mud during HDD crossings	Temporary/minor impacts (*if quickly contained*) to long-term/major impacts (*if undetected or uncontained*)	No impact	Temporary/minor impacts (*if quickly contained*) to long-term/major impacts (*if undetected or uncontained*)	No impact	No impact	No impact	No impact
Operations Impacts							
Changes in groundwater availability	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	No impact	No impact	Temporary/ negligible impacts	Temporary/ negligible impacts
Changes in groundwater quality	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts

WIMN = "What's in My Neighborhood?" [database]

Mitigation

Beyond the Applicant-proposed measures described for the Applicant's preferred route listed in Chapter 2, potential mitigation measures to minimize impacts on groundwater could include:

- If the owner of a potable supply well believed that the quality or yield of their water was negatively affected as a result of a pipeline construction-related activity, the Applicant could engage a third party to determine the nature and severity of the impact. If it was determined that impacts were related to construction, the Applicant could provide an alternate source of water to the well owner until the well water returned to preconstruction conditions. If the well water did not return to preconstruction conditions within a reasonable time period, the Applicant could compensate the landowner for the installation of a new well or otherwise arrange for provision of a suitable water supply.
- To prevent the loss of drilling fluid from the borehole during HDD installation, the properties of drilling fluid may be augmented to aid in stabilizing the soils and in maintaining drilling fluid returns to the entry and exit pits. If circulation is lost, lost circulation materials can be used to seal around the borehole and prevent drilling fluid from escaping into the formation, and allow for reestablishment of drilling fluid returns to the entry and exit pits. Many types of lost circulation materials that are inert and environmentally benign are available for use during HDD installation. These can include wood fibers, cotton seed husks, ground walnut shells, and other natural materials. Special polymers that swell to several times their original size when introduced to water also can be used. These polymers are industrial-grade equivalents of food-grade polymers that are used to swell and absorb fluids in the food industry.

The potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

5.2.1.1.5 References

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5.2.1.2 Surface Water

Surface water in the vicinity of the Applicant's preferred route and CN Alternatives consists of streams, rivers, lakes, wild rice waterbodies, and wetlands. Streams, rivers, lakes, and wild rice waterbodies are discussed in this section; wetlands are discussed in Section 5.2.1.3. This section assesses the potential for construction and operation of the proposed Project to affect surface water resources. Surface water impacts that could occur during construction and operation are evaluated and compared for the Applicant's preferred route and the CN Alternatives. The impact analysis focuses on potential impacts on surface waters associated with the following concerns:

- Runoff and flows – increases in stormwater runoff and erosion, increases in TSS concentrations and increased sedimentation, changes in stream flows from water withdrawals and discharges, and disruption of flow paths or local hydrologic connectivity;
- Surface water and aquatic habitat quality – degradation of surface water quality, degradation of aquatic habitat from instream and other construction activities, degradation of water quality and habitat from releases of drilling mud during HDD crossings;
- Channel morphology and stability – changes in channel morphology and stability caused by channel and streambank modifications; and
- Disturbance of wild rice waterbodies.

This section first describes the regulations relevant to assessing surface water impacts, the methods used to conduct the impact assessment, and the existing surface water conditions within the defined ROIs for the Applicant's preferred route and CN Alternatives. The potential impacts of construction and operation of the Applicant's preferred route and CN Alternatives on surface waters are considered next. A summary and comparison of the impacts for the Applicant's preferred route and CN Alternatives are presented at the end of the section along with potential mitigation measures that could be used to minimize impacts.

Surface water quality impacts that affect fish and wildlife and their habitats, including fisheries, Aquatic Management Areas, waterbodies assigned an Index of Biotic Integrity, Lakes of Biological Significance, designated wildlife lakes, trout streams, and invasive species, are discussed in Section 5.2.4. This section and Section 5.2.4 should be considered together to provide an overall picture of the potential impacts of the Project on surface water.

Potential impacts on surface water due to unanticipated crude oil releases are discussed in Chapter 10.

5.2.1.2.1 Regulatory Context and Methodology

Regulatory Context

Federal, state, and local agencies have oversight and permitting authority for activities that may affect surface water use, flow, current, or quality. These permits include required actions and BMPs that would reduce potential impacts on surface water resources. EPA delegates authority to the states to regulate water quality and implement permitting (including the NPDES program) required by the Clean Water Act (CWA). The Applicant would be required to obtain NPDES permits from the North Dakota Department of Health's (North Dakota DH's) Division of Water Quality, Minnesota PCA, Iowa DNR, Wisconsin DNR, and Illinois EPA prior to construction in each respective state. Permits for withdrawal and use of water from surface water or groundwater sources also would be required from the North Dakota State Water

Commission, Minnesota DNR, Iowa DNR, Wisconsin DNR, and Illinois DNR. Any pipeline crossings of public water within Minnesota would require a license to cross from the Minnesota DNR.

State and federal rules as they pertain to surface water resources that could be affected by the Project are described below.

State-Designated/Sensitive Surface Waters

Each state designates certain surface waters as sensitive based on the beneficial use and water quality of the waterbody in order to maintain and protect the present and future beneficial uses of the designated waters. Each state designates the beneficial uses of its waters independently and with slight variations, including state-specific criteria such as whether the waterbody supports warmwater or coldwater aquatic life; is suitable for human contact and recreation; is suitable for drinking or for agricultural or industrial purposes; and is a lake, reservoir, or wetland. Each state also sets water quality standards (allowable concentrations of nutrients and pollutants) for each waterbody to protect the beneficial use(s). In Minnesota, stringent water quality standards and fishing restrictions are implemented in streams and lakes designated as trout streams to maintain and propagate healthy communities of trout.[6]

Nationwide Rivers Inventory

Rivers or segments of rivers listed on the National Park Service's (NPS's) Nationwide Rivers Inventory (NRI) are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance (NPS 2011). All federal agencies must seek to avoid or mitigate actions that would adversely affect (e.g., decrease water quality or alter the free-flowing nature of the river) any NRI-listed river segments. Some NRI-listed rivers also are designated as Wild and Scenic Rivers, which are rivers or river segments with outstanding natural, cultural, and recreational values that are to be voluntarily protected in a free-flowing condition for the characteristics for which they were first designated.

Impaired Surface Waters

Section 303(d) of the CWA requires that states review, establish, and revise water quality standards for all surface waters within the state. Every 2 years, each state, territory, and authorized tribe must submit to the EPA a list of surface waters that do not meet EPA-approved water quality standards. These waters are considered impaired and do not meet their designated beneficial use from such causes as elevated contaminant levels, low dissolved oxygen, turbidity, high temperature, or bacterial contamination. The law also requires that the states establish priority rankings for waters on the Section 303(d) lists and develop total maximum daily loads (TMDLs) for these waters. North Dakota DH, Minnesota PCA, Iowa DNR, and Illinois EPA implement federal water quality regulations and identify and manage the list of impaired surface waters in their respective states. These agencies seek to avoid further impairment to these waterbodies by setting water quality standards and TMDLs (which are included in permit conditions and not to be exceeded by construction and operations activities), conducting water quality assessments, and developing plans to restore waterbodies to meet their designated use(s).

Navigable Waterways

USACE has jurisdiction over navigable waterways in accordance with Section 10 of the Rivers and Harbors Act of 1899. Navigable waters of the United States include those that are subject to the ebb and

[6] Minn. R. 7050.0222 and 6264.0050

flow of the tide or are presently used, have been used in the past, may be susceptible for use to transport interstate or foreign commerce, or have a defined streambed and streambanks and an ordinary high water mark. Surface water crossings of navigable waters would require authorization from USACE under the CWA Section 404 and Rivers and Harbors Act Section 10. CWA Section 401 Individual Water Quality Certification for the Project in Minnesota is under the jurisdiction of USACE – St. Paul District and Minnesota PCA. For CWA Section 401 certification, Minnesota PCA is responsible in Minnesota, Wisconsin DNR is responsible for wetlands in Wisconsin, and North Dakota DH's Division of Water Quality is responsible for wetlands in North Dakota. Permitting for system alternative SA-04 would require obtaining a CWA Section 401 certification from Iowa DNR and Illinois DNR.

Wild Rice Waterbodies

Wild rice waterbodies are shallow bodies of water where rice, a persistent annual grass, reproduces each year from seed stock deposited in previous fall seasons. Wild rice beds are very attractive to migrating waterfowl, and many rice areas are traditional waterfowl staging and hunting areas. Because they are an important component of Minnesota's agricultural economy, wild rice waterbodies are specifically protected from destruction and disturbance. Wild rice is grown in Minnesota and Wisconsin but does not occur in North Dakota, Iowa, or Illinois. Various tribal, federal, state, and local laws and regulations are designed to manage and protect wild rice. These are associated with formal recognition of the significance of natural wild rice and its protection, management, and harvest. The Wisconsin DNR and Chippewa Tribes work together to determine the season, number of permits, and prescribed method in which Wisconsin residents are allowed to harvest wild rice. No other formal wild rice protection regulations, beyond federal and state wetland and waterbody permitting, exist in Wisconsin.

In Minnesota, wild rice and other aquatic vegetation growing in public waters is owned by the state, and a person may not acquire a property interest in or destroy wild rice except as allowed by law. Outside of tribal jurisdictions, Minnesota statutes and agency rules regulate the harvest of natural wild rice, including methods and timing of harvest. The Minnesota DNR Aquatic Plant Management Program prohibits removal of wild rice without an approved permit. Wild rice also is protected through shoreland protection laws and regulations, which are based on a system of classification for lakes and rivers that applies different zoning regulations depending on their classification. Minnesota PCA is proposing amendments to Minnesota Administrative Rules, Chapters 7001, 7050, 7052, and 7053. These amendments would refine how a wild rice waterbody is defined as well as acceptable sulfate levels for wild rice waterbodies (Minnesota PCA 2016a).

Tribal regulations related to the harvest and protection of wild rice within reservation boundaries vary from tribe to tribe and are managed by tribe-specific wild rice committees. In addition to tribal regulations, treaties (e.g., 1854 Treaty Authority) and other agreements with the U.S. government have reserved off-reservation harvesting rights for some tribes.

Methodology

Potential impacts on surface water were assessed from construction and operation of the Applicant's preferred route and CN Alternatives. Impacts on surface waters from pipeline construction would be largely due to waterbody crossing procedures and ground disturbing activities near waterbodies. Potential impacts from normal pipeline operation typically are localized and would likely be associated with maintenance activities. Therefore, the ROI for the assessment of construction impacts on surface waters includes the construction work area for each surface water crossed by the Applicant's preferred route in Minnesota (typically 120 feet wide) as well as the area immediately downstream from the

crossing for flowing surface waters, and in the immediate vicinity for crossings of non-flowing surface waters such as lakes and wild rice waterbodies. Similarly, the ROI for construction impacts for SA-04 is based on a 120-foot-wide construction work area and the areas immediately downstream of flowing surface waters and in the immediate vicinity of non-flowing surface waters. The assessment of operations impacts is based on the location of the 50-foot-wide permanent pipeline right-of-way centered on the pipeline for the Applicant's preferred route and SA-04, as well as areas immediately downstream of flowing surface waters and in the immediate vicinity of non-flowing surface waters. Operations impacts for continued use of the existing Line 3 were evaluated based on the location of the existing permanent right-of-way for that pipeline and assuming that the integrity digs typically would be limited to the permanent right-of-way. The integrity repairs would consist of pipe repair or replacement, and the impacts address the potential for these actions to occur in or near-surface waters.

Potential impacts on surface waters from construction and operation of the rail and truck alternatives were evaluated based on the locations of surface waters at or near the routes described in Chapter 4 and on general information provided by the Applicant about the potential locations of offloading facilities. The waterbodies crossed by the potential rail and truck routes already exist and would only require construction for those crossings that need repair or upgrades to accommodate additional truck or rail traffic. Therefore, a more qualitative assessment of existing conditions and impacts was performed for these routes than for the Applicant's preferred route and system alternative SA-04.

Watersheds and surface waters within the ROIs for the Applicant's preferred route and CN Alternatives were identified using GIS datasets and layers in the following data sources:

- USGS National Hydrography Dataset,
- USACE Section 10 navigable waterways,
- NPS's NRI national datasets,
- Minnesota DNR's Public Waters Inventory,
- Minnesota-designated trout streams,
- Minnesota DNR-identified wild rice waterbodies, and
- Section 303(d)-listed impaired surface waters in each state.

Acreages of wild rice waterbodies that could be affected were estimated using maps of the Minnesota DNR-identified wild rice waterbodies and rivers database (Minnesota DNR 2009), classified according to U.S. Fish and Wildlife Service (USFWS) Circular No. 39 (EPA 2002). These maps were overlaid with the construction work area and permanent right-of-way for the Applicant's preferred route, and the 120-foot-wide construction work area for SA-04.

Potential impacts on surface waters were evaluated by:

- Identifying the existing conditions of surface waters that would be crossed, such as water quality and impairment, fishery resources (i.e., trout streams), beneficial use designations, state and federal classifications, and watershed water quality.
- Comparing the Applicant's proposed construction methods described in Chapter 2 and the special wetland construction methods described in the Applicant's November 2016 EAW and associated construction BMP plans (Enbridge 2016a) to peer-reviewed literature and agency

documents, including permit requirements and guidance manuals, related to the proposed pipeline construction methods.

- Considering the potential for construction and operation of the Applicant's preferred route and CN Alternatives to affect the identified surface waters. The specific environmental concerns addressed in the impact analysis are listed in the introduction to Section 5.2.1.2.4.
- A separate analysis was prepared to evaluate potential impacts on high-quality surface waters. This was also a GIS analysis, but it was conducted using datasets that can help distinguish between the quality of surface waters that may be affected by the proposed Project and CN Alternatives.

Broader regional indicators of surface water quality were also reviewed to identify regional differences in existing conditions and extent of impacts. Due to unavailability of data from other states, this analysis was limited to Minnesota. These broad regional issues in Minnesota were evaluated by buffering GIS shapefiles the Applicant's preferred route and CN Alternatives by one-half mile and identifying intersections of features indicative of surface water quality, including trout streams, wild rice lakes, Lakes of Biological Significance (high and outstanding) and Tullibee (cisco) Lakes. Intersections of same stream over 1 mile apart were counted as separate intersections.

5.2.1.2.2 Existing Conditions

This section identifies surface waters that could be affected by construction and operation of the Applicant's preferred route and CN Alternatives. These include surface waters with beneficial use designations, state-designated/sensitive surface waters, NRI-listed rivers, impaired surface waters, wild rice waterbodies, and public waters in Minnesota. Information is presented on water quality, designated uses, and state and federal classifications.

Public waters have been defined in Minnesota Law since 1897. The waters included in the definition have evolved and been refined over the years. Significant clarification was given to which waters were included as public waters in the Public Waters Inventory process conducted in the late 1970s through the early 1980s. Public waters are protected from destruction and degradation because of their value to the people of Minnesota for water supplies; groundwater recharge potential; retention of water to prevent and minimize downstream flooding and property damage; entrapment of nutrients and sediment; recreational activities such as boating, swimming, fishing and hunting, and navigation; and wildlife habitat areas for spawning, rearing, feeding, and nesting of wildlife.

Applicant's Preferred Route

Drainage Basins and Watersheds

A "drainage basin" is an area of land where all surface water from rain and snowmelt converges to a single point at a lower elevation, such as a river, lake, reservoir, or wetland. Drainage basins are made up of smaller watershed units. Table 5.2.1.2-1 provides the number of acres of each watershed that would be crossed by the construction work area and permanent right-of-way for the Applicant's preferred route.

The Red River of the North Basin encompasses a 39,270-square-mile surface drainage area to the mainstem of the Red River of the North within the United States. The basin stretches from northeastern South Dakota and west-central Minnesota northward through eastern North Dakota and northwestern Minnesota into southern Manitoba. It ends where the Red River empties into the southern end of Lake

Winnipeg. The Minnesota portion of the Red River Basin covers approximately 37,100 square miles in northwestern Minnesota in all or part of 21 counties. It contains approximately 17,840 miles of streams and 668,100 acres of lakes. Land use in the Red River Basin consists of 74 percent agricultural land, 12 percent forest, 4 percent water/wetlands, 3 percent urban, and 7 percent other (Minnesota PCA and Red River Watershed Management Board 2006).

Table 5.2.1.2-1. Major Drainage Basins and Watersheds Crossed by the Applicant's Preferred Route

Drainage Basin	State(s)	Watershed	HUC-8	Watershed Water Quality Score[a]	Applicant's Preferred Route	
					Construction[b] (acres)	Operation[c] (acres)
Red River of the North	ND, MN	Tamarac River	09020311	63	463.9	198.0
	ND, MN	Grand Marais Creek	09020306	58	39.0	17.1
	MN	Red Lake River	09020303	63	301.2	132.8
	MN	Clearwater River	09020305	70	719.4	323.9
	MN, ND	Wild Rice River	09020108	77	72.0	33.4
	MN	Snake River	09020309	66	242.2	105.7
Lake Superior	MN, WI	Nemadji River	04010301	80	161.3	72.0
	MN	St. Louis River	04010201	56	64.8	28.0
St. Croix River	MN	Kettle River	07030003	76	317.9	149.8
Upper Mississippi River (Mississippi Headwaters)	MN	Mississippi River – Headwaters	07010101	89	251.2	112.7
	MN	Crow Wing River	07010106	79	664.1	299.8
	MN	Pine River	07010105	95	551.9	244.2
	MN	Leech Lake River	07010102	89	7.6	3.2
	MN	Mississippi River – Grand Rapids	07010103	83	621.0	298.5
	MN	Mississippi River – Brainerd	07010104	76	77.9	38.1

Source: USGS 2016, Minnesota DNR 2015.

Notes:

[a] Minnesota Department of Natural Resources implements the Watershed Health Assessment Framework to calculate a watershed health index score that represents the overall health of the watershed based on parameters that are grouped into five main components: biology, connectivity, geomorphology, hydrology, and water quality. Water quality scores, shown in this table, are based on various indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values).

[b] Watershed acres that would be crossed by the construction work area.

[c] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016)

The Lake Superior Basin encompasses 9,126 square miles in Minnesota and Wisconsin. The Minnesota part of the basin encompasses portions of Aitkin, Carlton, Cook, Itasca, Lake, Pine, and St. Louis counties, covering approximately 6,200 square miles. Streams within the basin flow to Lake Superior, which discharges into Lake Huron, and ultimately flows into the St. Lawrence Seaway via Lakes Erie and Ontario. Nearly one-fifth of the state's 15,000 lakes and over 150 trout streams are located in four of the seven counties that make up the basin in Minnesota. Forests cover approximately 84 percent of the basin (Minnesota PCA 2004).

The St. Croix River Basin covers approximately 7,760 square miles and extends from near Mille Lacs Lake in Minnesota on the west to near Cable, Wisconsin, on the east. Approximately 46 percent of the basin is located in Minnesota. The St. Croix River's headwaters are at St. Croix Lake near Solon Springs, Wisconsin, from where it flows west and south over 160 miles until it joins the Mississippi River at Prescott, Wisconsin. The upper 20 percent of the St. Croix River is entirely within Wisconsin, and the lower 80 percent (129 miles) of the river forms part of the boundary between Wisconsin and Minnesota.

The Upper Mississippi River Basin covers approximately 20,100 square miles in Minnesota. It stretches from the headwaters of the Mississippi River at Lake Itasca to Lock and Dam Number 2 near Hastings. From its start at Itasca State Park, the Mississippi River flows south 2,350 miles, to the Gulf of Mexico. The basin drains 15 of the 80 major watersheds in Minnesota and all or parts of 21 counties. It is the only basin in the State of Minnesota with its watersheds wholly in the state (Minnesota PCA 2000).

Surface Waters Crossed

Various surface waters would be crossed by the Applicant's preferred route, as shown in Table 5.2.1.2-2. The Applicant's preferred route also would cross numerous non-jurisdictional ditches/drains, for which flows are unknown and crossing permits are not required. Appendix G contains a complete list of surface waters that would be crossed by the Applicant's preferred route.

The Applicant's preferred route crosses a total of 56 public waters in Minnesota. These include 4 public water ditches, 14 artificial paths, 25 perennial streams/rivers and 13 intermittent streams/rivers.

Sensitive/Specially Designated Surface Waters

As described in Section 5.2.1.2.1, states designate certain surface waters based on beneficial uses and water quality. The Applicant's preferred route would require 46 crossings of designated surface waters (5 in North Dakota, 39 in Minnesota, and 2 in Wisconsin). It also would cross six trout streams, all of which are located in Minnesota. Appendix G provides the designated uses of the surface waters crossed by the Applicant's preferred route in each state.

Nationwide Rivers Inventory

The Applicant's preferred route would cross seven NRI-listed rivers in Minnesota, with two crossings of two rivers, for a total of nine NRI-listed river crossings (Table 5.2.1.2-3). These waterbody crossings also are shown in Appendix A.

Table 5.2.1.2-2. Surface Waters Crossed by the Applicant's Preferred Route

Waterbody Type/Flow	North Dakota	Minnesota (PWI)	Wisconsin	Total
Artificial path	2	15 (14)	0	17
Canal/ditch	4	49 (4)	0	53
Connector	0	4 (0)	0	4
Lake/pond – perennial	3	18 (0)	0	21
Stream/river – intermittent	9	72 (13)	5	86
Stream/river – perennial	6	34 (25)	5	45
Swamp/marsh	1	0 (0)	0	1
TOTAL	**25**	**192 (56)**	**10**	**227**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

PWI = Public Waters Inventory

Table 5.2.1.2-3. Rivers Listed in the Nationwide Rivers Inventory Crossed by the Applicant's Preferred Route

Waterbody	Outstanding Resource Value	Crossing Milepost
Pembina River	Scenery; Geology; Wildlife	ND 1.4 and 1.7
Middle River	Scenery	MN 62.3
Red Lake River	Scenery; Recreation	MN 91.9
Clearwater River	Scenery	MN 149.5
Shell River	Scenery	MN 209.5 and 215.3
Crow Wing River	Scenery; Recreation	MN 217.4
Willow River	Scenery	MN 292.8

Source: NPS 2011.

Notes:

Geology: The river or the area within the river corridor contains one or more examples of a geologic feature, process, or phenomenon that is unique or rare within the region of comparison.

Recreation: Recreational opportunities are, or have the potential to be, popular enough to attract visitors or are unique or rare within the region. Visitors are willing to travel long distances to use the river resources for recreational purposes.

Scenery: The landscape elements of landform, vegetation, water, color, and related factors result in notable or exemplary visual features and/or attractions.

Wildlife: The river or area within the river corridor contains nationally or regionally important populations of indigenous wildlife species, and/or provides exceptionally high-quality habitat for wildlife of national or regional significance, and/or may provide unique habitat or a critical link in habitat conditions for federal or state-listed (or candidate) threatened, endangered, or sensitive species.

Also see maps in Appendix A.

Impaired Surface Waters

Impaired surface waters have been identified by states as not meeting certain water quality criteria. Table 5.2.1.2-4 lists the impaired surface waters that would be crossed by the Applicant's preferred route, their impairment, and the milepost in each state where the crossing would occur. No impaired surface waters would be crossed in Wisconsin. The Applicant's preferred route would require 16 crossings of impaired surface waters. These impaired waterbody crossings are shown in Appendix A.

Table 5.2.1.2-4. Impaired Surface Waters Crossed by the Applicant's Preferred Route

State	Waterbody Name	Impaired Beneficial Use	Impairment	Crossing by Milepost
North Dakota	Tongue River Cutoff	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments	ND 9.2
North Dakota	Pembina River	Fish and other aquatic biota	Metals (Se, Cd, Cu, Pb); sedimentation/siltation	ND 1.4 / 1.7
		Municipal/ domestic	Metals (Pb, As)	
		Recreation	*E. coli*	
Minnesota	Mississippi River	Aquatic consumption	Mercury in fish tissue	MN 296.7
Minnesota	Kettle River	Aquatic consumption	Mercury in fish tissue	MN 338.2
Minnesota	Walker Brook	Aquatic life	Dissolved oxygen	MN 151.4
Minnesota	Clearwater River	Aquatic consumption; aquatic life	Mercury in fish tissue; dissolved oxygen	MN 149.5
Minnesota	Mississippi River	Aquatic life	Dissolved oxygen	MN 165.1
Minnesota	Silver Creek	Aquatic recreation	Fecal coliform	MN 135.9
Minnesota	Tamarac River	Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments	MN 54.4
Minnesota	Middle River	Aquatic life	Dissolved oxygen; turbidity; aquatic macroinvertebrate bioassessments	MN 62.3
Minnesota	Clearwater River	Aquatic consumption; aquatic life	Mercury in fish tissue; dissolved oxygen; turbidity	MN 103.0
Minnesota	Black River	Aquatic life	Dissolved oxygen	MN 82.6
Minnesota	Red River of the North	Aquatic consumption	Mercury in fish tissue	MN 27.6
Minnesota	Silver Creek	Aquatic recreation	Fecal coliform	MN 135.3 / 135.6

Sources: Iowa DNR 2017; North Dakota DH 2012; Minnesota PCA 2014, 2016b; Illinois EPA 2016.

Al = aluminum, As = arsenic, Cd = cadmium, Cu = copper, Pb = lead, PCBs = polychlorinated biphenyls, Se = selenium

Navigable Waterways

The Applicant's preferred route would require the following seven crossings of navigable waterways (five in Minnesota), as shown in Appendix A:

- Mississippi River – MN MP 296.7,
- Kettle River – MN MP 338.2,
- Sandy River – MN MP 305.9,
- Red Lake River – MN MP 91.9,
- Red River of the North – MN MP 27.6, and
- Pembina River – ND MPs 1.4 and 1.7.

Wild Rice Waterbodies

All wild rice waterbodies that would be crossed by the Applicant's preferred route occur between Clearbrook and Carlton. Fifteen wild rice waterbodies occur within 0.5 mile of the Applicant's preferred route. Five wild rice waterbodies could be affected by construction and operation of the Applicant's preferred route: Mud Lake, Hay Creek (HDD crossing), Portage Lake, Peterson Lake, and Shell River (HDD crossing). The areas of wild rice waterbodies that would be affected by construction and operation of the Applicant's preferred route are listed in Table 5.2.1.2-5.

Table 5.2.1.2-5. Wild Rice Waterbodies Crossed by the Applicant's Preferred Route in Minnesota (acres)

Wild Rice Waterbody Type	Construction[a]	Operations[b]	Within 0.5 Mile of Centerline
Type 3 – Inland shallow fresh marshes	0.4	0.8	83.1
Type 4 – Inland deep fresh marshes	1.4	0.8	182.5
Type 5 – Inland open fresh water	3.1	1.7	475.0
Type 9 – Inland saline flats	0.0	0.0	2.6
TOTAL	**4.9**	**3.2**	**743.3**

Source: Minnesota DNR 2009.

[a] Acres of wild rice waterbodies that would be crossed by the construction work area.

[b] Acres of wild rice waterbodies that would be crossed by the permanent right-of-way during operations.

Continued Use of Existing Line 3

The existing Line 3 pipeline crosses the same drainage basins as the Applicant's preferred route. Various surface waters are crossed by existing Line 3, as shown in Table 5.2.1.2-6.

The existing Line 3 pipeline crosses a total of 53 public waters in Minnesota. These include 4 public water ditches, 1 connector, 9 artificial paths, 24 perennial streams/rivers, 13 intermittent streams/rivers, 1 perennial lake/pond, and 1 intermittent swamp/marsh.

Eleven wild rice waterbodies occur within 0.5 mile of the existing Line 3. One wild rice waterbody (White Oak Lake) is crossed by the existing Line 3 corridor at the stream inlet to the lake basin portion of the wild rice lake boundary.

Table 5.2.1.2-6. Surface Waters Crossed by Existing Line 3

Waterbody Type/Flow	Number of Crossings (PWI)
Artificial path	11 (9)
Canal/ditch	57 (4)
Connector	3 (1)
Lake/pond – perennial	12 (1)
Stream/river – intermittent	66 (13)
Stream/river – perennial	48 (24)
Swamp/marsh	1
Swamp/marsh – intermittent	1 (1)
TOTAL	**199 (53)**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

Also see maps in Appendix A.

PWI = Public Waters Inventory

System Alternative SA-04

Drainage Basins and Watersheds

Table 5.2.1.2-7 provides the number of acres of each watershed that would be crossed by the construction work area and permanent right-of-way for system alternative SA-04.

System alternative SA-04 follows the Applicant's preferred route in the Red River of the North Basin, as described above, before diverging from the Applicant's preferred route and entering the Minnesota River Basin. The Minnesota River Basin covers approximately 16,770 square miles. The Minnesota River flows southeast from its source at Big Stone Lake on the South Dakota border to Mankato, Minnesota, then northeast to join the Mississippi River at Fort Snelling (about 335 total miles). Thirteen major watersheds in Minnesota drain into the basin, which touches 37 counties.

Table 5.2.1.2-7. Major Drainage Basins and Watersheds Crossed by System Alternative SA-04

Drainage Basin (area)	State(s)	Watershed	HUC-8	Watershed Water Quality[a]	Construction[b] (acres)	Operation[c] (acres)
Red River of the North	ND	Goose	09020109	10.6%/37%	122.5	51.0
	ND	Park	09020310	9.6%/60.4%	75.7	31.6
	ND	Forest	09020308	NA	81.7	34.0
	ND	Lower Sheyenne	09020204	16.3%/25.2%	259.4	109.1
	ND	Turtle	09020307	NA	339.1	141.3
	ND	Maple	09020205	2.3%/0%	47.9	18.9
	ND	Western Wild Rice	09020105	52%/8%	776.0	323.3
	ND	Lower Pembina River	09020316	NA	240.8	100.3
	ND, MN	Bois De Sioux	09020101	53	209.3	87.2
	ND, MN	Upper Red	09020104	46	45.4	18.9
	ND, MN	Sandhill-Wilson	09020301	66	482.7	201.1
	ND, MN	Tamarac River	09020311	63	347.2	22.6
	ND, MN	Elm-Marsh	09020107	27.5%/0%	362.1	150.9
	ND, MN	Grand Marais Creek	09020306	58	88.1	36.7
	MN	Mustinka	09020102	47	372.6	155.2
Minnesota River	MN	Hawk-Yellow Medicine	07020004	52	278.4	116.0
	MN	Le Sueur	07020011	52	555.3	231.4
	MN	Chippewa	07020005	64	572.7	238.6
	MN	Lower Minnesota	07020012	51	496.7	207.0
	MN	Middle Minnesota	07020007	47	298.6	124.4
	MN	Pomme de Terre	07020002	56	238.1	99.2
	MN	South Fork Crow	07010205	49	297.7	124.0
Upper Mississippi-Skunk-Wapsipinicon	MN, IA	Shell Rock	07080202	39	178.9	74.5
	MN, IA	Upper Wapsipinicon	07080102	39	994.6	414.4
	MN, IA	Upper Cedar	07080201	39	613.9	255.8
	IA, IL	Copperas-Duck	07080101	NA	185.7	77.4
	IA	Lower Wapsipinicon	07080103	NA	563.4	234.7
Upper Mississippi-Maquoketa-Plum	IA	Maquoketa	07060006	NA	752.1	313.4

Table 5.2.1.2-7. Major Drainage Basins and Watersheds Crossed by System Alternative SA-04

Drainage Basin (area)	State(s)	Watershed	HUC-8	Watershed Water Quality[a]	Construction[b] (acres)	Operation[c] (acres)
Rock	IL	Green	07090007	NA	216.7	90.3
	IL	Lower Rock	07090005	NA	416.3	173.5
Upper Illinois	IL	Lower Fox	07120007	NA	261.2	108.86
	IL	Upper Illinois	07120005	NA	317.9	132.46
	IL	Des Plaines	07120004	NA	78.8	32.82
Lower Illinois	IL	Lower Illinois-Senachwine Lake	07130001	NA	400.6	166.92

Sources: USGS 2017; Minnesota DNR 2015; NRCS n.d.

Notes:

[a]. Watershed water quality values for North Dakota are presented as two numbers: the percentage of total miles of rivers/streams in the watershed that are impaired and the percentage of total acres of lakes/reservoirs in the watershed that are impaired. Watershed health values for MN watersheds represent water quality scores, which are based on various indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values). Iowa and Illinois do not categorize watershed health.

[b] Watershed acres that would be crossed by the construction work area.

[c] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit Hydrologic Unit Code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016); NA = not available

The Rock River Basin occupies the northwest portion of Illinois. It includes watersheds of the Rock, Green, Kishwaukee, and Pecatonica rivers, in addition to areas drained by the Galena, Apple, and Plum rivers and other small tributaries entering directly into the Mississippi River. The Rock River originates in the Horicon Marsh in Dodge County, Wisconsin, and flows in a generally southerly direction until it enters Illinois just south of Beloit. There, it flows in a southwesterly direction until it joins the Mississippi River at Rock Island. The river is about 163 miles long in Illinois, and its total length is about 318 miles. The basin covers 6,481 square miles (Sinclair 1996).

The Upper Illinois River Basin encompasses 10,949 square miles upstream from Ottawa, Illinois, on the Illinois River. It includes parts of 16 counties in northeastern Illinois (62 percent of the basin), 13 counties in northwestern Indiana (28 percent of the basin), 7 counties in southeastern Wisconsin (10 percent of the basin), and 1 county in southwestern Michigan (< 0.1 percent of the basin) (USGS 2004).

The Lower Illinois River Basin covers 18,000 square miles of central and west-central Illinois between the upper end at Ottawa and the confluence of the Illinois River with the Mississippi River near Grafton. The basin includes all of 22 and parts of 19 counties in Illinois. Agriculture accounts for 88 percent of the overall land area, whereas forests account for 7 percent and urban areas account for about 2 percent (USGS 2000).

Surface Waters Crossed

The types of surface waters crossed by system alternative SA-04 are listed in Table 5.2.1.2-8. System alternative SA-04 also would cross many non-jurisdictional ditches/drains, for which flows are unknown and crossing permits are not required. Appendix G contains a complete list of surface waters that would be crossed by system alternative SA-04.

SA-04 would cross a total of 49 public waters in Minnesota. These include 11 public water ditches, 6 artificial paths, 8 perennial streams/rivers and 24 intermittent streams/rivers.

Table 5.2.1.2-8. Surface Waters Crossed by System Alternative SA-04

Waterbody Type/Flow	North Dakota	Minnesota (PWI)	Iowa	Illinois	Total
Artificial path	10	6 (6)	5	16	37
Canal/ditch	17	71 (11)	0	3	91
Connector	0	1 (0)	0	0	1
Lake/pond – intermittent	0	0 (0)	4	0	4
Lake/pond – perennial	5	3 (0)	4	1	13
Stream/river – intermittent	74	81 (24)	152	77	384
Stream/river – perennial	13	10 (8)	54	19	96
Swamp/marsh	2	0 (0)	4	4	10
TOTAL	**121**	**172 (49)**	**223**	**120**	**636**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

Also see maps in Appendix A.

PWI = Public Waters Inventory

Sensitive/Specially Designated Surface Waters

System alternative SA-04 would require 56 crossings of designated surface waters, of which 18 are in North Dakota, 18 are in Minnesota, and 20 are in Iowa. Illinois designates only a small number of its surface waters, principally in the Chicago area, and none of these waterways would be crossed by system alternative SA-04. System alternative SA-04 would not cross any trout streams. Of the 636 (172 in Minnesota) surface waters crossed by system alternative SA-04, a total of 526 are unnamed and do not have designations. Appendix G provides the designated uses of the surface waters crossed by system alternative SA-04 in each state.

Nationwide Rivers Inventory

System alternative SA-04 would cross five NRI-listed rivers (one in Minnesota), with two crossings of one river, for a total of six crossings of NRI-listed rivers (Table 5.2.1.2-9). These waterbody crossings also are shown in Appendix A.

Table 5.2.1.2-9. Rivers Listed in the Nationwide Rivers Inventory Crossed by System Alternative SA-04

Waterbody	Outstanding Resource Value	Crossing by Milepost
Pembina River	Scenery; Geology; Wildlife	ND 1.4 and 1.7
Minnesota River	Scenery; Recreation; Wildlife; History	MN 406.6
Rock River	Recreation	IL 694.5
Indian Creek	Scenery	IL 759.9
Fox River	Scenery, Recreation; Geology	IL 762.9

Source: NPS 2011.

Notes:

Geology: The river or the area within the river corridor contains one or more examples of a geologic feature, process, or phenomenon that is unique or rare within the region of comparison.

History: The river or area within the river corridor contains a site(s) or feature(s) associated with a significant event, an important person, or a cultural activity of the past that was rare or one-of-a-kind in the region.

Recreation: Recreational opportunities are, or have the potential to be, popular enough to attract visitors or are unique or rare within the region. Visitors are willing to travel long distances to use the river resources for recreational purposes.

Scenery: The landscape elements of landform, vegetation, water, color, and related factors result in notable or exemplary visual features and/or attractions.

Wildlife: The river or area within the river corridor contains nationally or regionally important populations of indigenous wildlife species, and/or provides exceptionally high-quality habitat for wildlife of national or regional significance, and/or may provide unique habitat or a critical link in habitat conditions for federal or state-listed (or candidate) threatened, endangered, or sensitive species.

Also see maps in Appendix A.

Impaired Surface Waters

Table 5.2.1.2-10 lists the impaired surface waters that would be crossed by system alternative SA-04, their impairment, and the milepost in each state where the crossing would occur. System alternative SA-04 would require 32 crossings of impaired waterways. These impaired waterbody crossings are shown in Appendix A.

Table 5.2.1.2-10. Impaired Surface Waters Crossed by System Alternative SA-04

State	Waterbody Name	Impaired Beneficial Use	Impairment	Crossing by Milepost
North Dakota	Wild Rice River	Fish and other aquatic biota	Sedimentation/siltation; dissolved oxygen	ND 213.0
North Dakota	Antelope Creek	Fish and other aquatic biota	Sedimentation/siltation; benthic-macroinvertebrate bioassessments; temperature	ND 203.9
North Dakota	Wild Rice River	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments; dissolved oxygen	ND 185.6/173.3
North Dakota	Sheyenne River	Recreation	Fecal coliform	ND 167.5

Table 5.2.1.2-10. Impaired Surface Waters Crossed by System Alternative SA-04

State	Waterbody Name	Impaired Beneficial Use	Impairment	Crossing by Milepost
North Dakota	Maple River	Fish and other aquatic biota	Sedimentation/siltation	ND 154.7
		Recreation	*E. coli*	
North Dakota	Rush River	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments	ND 149.8
North Dakota	North Branch Elm River	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments	ND 126.2
North Dakota	Goose River	Fish and other aquatic biota	Fishes bioassessments	ND 120.0
North Dakota	Cole Creek	Fish and other aquatic biota	Combination benthic/fishes bioassessments	ND 96.9
North Dakota	Turtle River	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments; metals (Cd, Se)	ND 69.1
		Municipal/ domestic	Chloride and metals (As, Se, Cd)	
North Dakota	Park River	Fish and other aquatic biota	Metals (Cd, Se, Pb, Cu)	ND 43.3
North Dakota	Forest River	Fish and other aquatic biota	Sedimentation/siltation; benthic-macroinvertebrate bioassessments	ND 53.9
North Dakota	Tongue River Cutoff	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments	ND 9.2
North Dakota	Pembina River	Fish and other aquatic biota	Metals (Se, Cd, Cu, Pb); sedimentation/siltation	ND 1.4 / 1.7
		Municipal/ domestic	Metals (Pb, As)	
		Recreation	*E. coli*	
Minnesota	Minnesota River	Aquatic consumption	Mercury and PCBs in fish tissue	MN 406.6
		Aquatic life	Turbidity	
Minnesota	Cedar River	Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments; turbidity	MN 478.6
		Recreation	Fecal coliform	

Table 5.2.1.2-10. Impaired Surface Waters Crossed by System Alternative SA-04

State	Waterbody Name	Impaired Beneficial Use	Impairment	Crossing by Milepost
Minnesota	Pomme de Terre River	Aquatic consumption	Mercury in fish tissue	MN 277.5
		Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments; turbidity	
		Aquatic recreation	Fecal coliform	
Minnesota	South Branch Rush River	Aquatic recreation	Fecal coliform	MN 383.4
Minnesota	Woodbury Creek	Aquatic recreation	Fecal coliform	MN 472.7
Minnesota	Otter Creek	Aquatic recreation	Fecal coliform	MN 484.2
Minnesota	Twelvemile Creek	Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments; turbidity	MN 247.5
		Aquatic recreation	*E. coli*	
Minnesota	Bois de Sioux River	Fish and other aquatic biota	Sedimentation/siltation; combination benthic/fishes bioassessments	MN 233.6
Iowa	Brophy Creek	Aquatic life	Biological – low biotic index	IA 664.1
Iowa	East Branch Buffalo Creek[a]	Aquatic life	Dissolved oxygen	IA 571.1
Iowa	Mississippi River	Aquatic life	Metals (Al)	IA 672.3
Illinois	Rock River	Fish consumption	Mercury and PCBs	IL 694.5
Illinois	Illinois River	Fish consumption	Mercury	IL 772.5
Illinois	Fox River	Fish consumption	PCBs	IL 762.9
Illinois	Aux Sable Creek	Aquatic recreation	Fecal coliform	IL 784.7
Illinois	Des Plaines River	Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments; turbidity; metals (Cu),	IL 792.2
		Fish consumption	Mercury	

Sources: Iowa DNR 2017; North Dakota DH 2012; Minnesota PCA 2014, 2016b; Illinois EPA 2016.

Notes:

[a] East Branch Buffalo Creek has been a pending listing since 2012.

Al = aluminum, As = arsenic, Cd = cadmium, Cu = copper, Pb = lead, PCBs = polychlorinated biphenyls, Se = selenium

Navigable Waterways

System alternative SA-04 would require the following nine crossings of navigable waterways (two in Minnesota), as shown in Appendix A:

- Minnesota River – MN MP 406.6,
- Bois de Sioux River – MN MP 233.6,
- Rock River – IL MP 694.5,
- Mississippi River – IA MP 672.3,
- Illinois River – IL MP 772.5,
- Fox River – IL MP 763.3,
- Des Plaines River – IL 792.2, and
- Pembina River – ND MPs 1.4 and 1.7.

Wild Rice Waterbodies

No wild rice waterbodies would be crossed by system alternative SA-04 (Great Lakes Indian Fish and Wildlife Commission 2017; Wisconsin DNR 2017).

Transportation by Rail

The potential rail routes cross the same drainage basins as does the Applicant's preferred route. Various surface waters are crossed by the rail beds that would be used by the rail alternative, as shown in Table 5.2.1.2-11. The potential rail routes also cross numerous non-jurisdictional ditches/drains, for which flows are unknown.

Table 5.2.1.2-11. Surface Waters Crossed by the Rail Alternative

Waterbody Type/Flow	Rail Route to Clearbrook	Rail Route to Superior North	Rail Route to Superior South	Total
Artificial path	6	9	15	30
Canal/ditch	30	50	62	142
Connector	1	4	4	9
Stream/river – intermittent	26	65	68	159
Stream/river – perennial	6	50	52	108
TOTAL	**69**	**178**	**201**	**448**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

Also see maps in Appendix A.

No wild rice waterbodies are crossed by rail lines that could be used to transport crude oil (Great Lakes Indian Fish and Wildlife Commission 2017; Wisconsin DNR 2017).

Transportation by Truck

The potential truck routes cross the same drainage basins as the Applicant's preferred route, except for the St. Croix River Basin. Various surface waters are crossed by the routes that could be used for the truck transport alternative, as shown in Table 5.2.1.2-12. The potential truck routes also cross numerous non-jurisdictional ditches/drains, for which flows are unknown.

No wild rice waterbodies are crossed by existing road networks that could be used to transport crude oil (Great Lakes Indian Fish and Wildlife Commission 2017; Wisconsin DNR 2017).

Table 5.2.1.2-12. Surface Waters Crossed by the Truck Alternative

Waterbody Type/Flow	Truck Route Gretna to Clearbrook Terminal	Truck Route Gretna to Superior Terminal	Total
Artificial path	7	15	22
Canal/ditch	28	48	76
Connector	0	5	5
Stream/river – intermittent	23	50	73
Stream/river – perennial	9	40	49
TOTAL	**67**	**158**	**225**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

Also see maps in Appendix A.

Existing Line 3 Supplemented by Rail

Existing conditions for the existing Line 3 supplemented by rail alternative are similar to those described above for continued use of the existing Line 3 pipeline and the rail alternative.

Existing Line 3 Supplemented by Truck

Existing conditions for the existing Line 3 supplemented by truck alternative are similar to those described above for continued use of the existing Line 3 pipeline and the truck alternatives.

5.2.1.2.3 Regional Analysis of the Quality of Existing Surface Water Conditions

This analysis provides a summary of general quality comparisons of surface water conditions across Minnesota as well as more detailed potential effects on specific surface water resources along the Applicant's preferred route and the CN Alternatives.

The north-central and northeast portion of Minnesota consist of water resources that are generally the highest quality recreational water resources in the state. To describe the general region wide or state wide difference in surface water resource quality across Minnesota, different general methods can be used including the Minnesota PCA ecoregion concept to guide typical water quality conditions and Minnesota DNR Watershed Health Assessment Framework. Quality of existing surface water conditions are discussed using each of these frameworks below.

- **Minnesota PCA Ecoregion Concept to Guide Typical Water Quality Conditions**: The State is divided into seven different ecoregions based on soils. Ecoregions have similar soil, geomorphology, land use and natural vegetation. The Northern Lakes and Forests (NLF) Ecoregion typically has the highest water quality as compared to other ecoregions, especially those that are representative with areas more dominated by altered landscapes. The Minnesota PCA offers a guide to typical water quality conditions in these seven "ecoregions," large expanses of land containing a geographically distinct collection of plants, animals, natural communities and environmental conditions."[7]
- **Minnesota DNR Watershed Health Assessment Framework:** Another approach used to describe surface water quality conditions across landscapes in Minnesota is the Watershed Health Assessment Framework (WHAF) Tool, developed by the Minnesota DNR which uses the science of watershed health. The science of watershed health is based on a whole-system approach. Ecological processes interact to provide services such as clean air and water, available groundwater, and diverse plant and animal communities. The science of health explores how all the parts system work together to provide a "healthy watershed". In order to explore the watershed system in a consistent, systematic way, the ecological processes have been divided into five different components: Biology, Connectivity, Geomorphology, Hydrology and Water Quality. A suite of **watershed health index scores** have been calculated that represent many of the important ecological relationships within and between the components. These scores are built on statewide GIS data that is compared consistently across Minnesota to provide a baseline health condition report for each of the 81 major watersheds in the state. The Watershed Health Assessments consist of health scores that rank the condition of Minnesota's watersheds from 0 (poor health condition, red) to 100 (good health condition, green). Watershed report cards indicate poorer water quality related to altered land use indicators as depicted in this analysis[8] (Appendix J-1).

The ecoregion approach used to assess water quality by the Minnesota PCA and the WHAF Tool developed by the Minnesota DNR are useful in describing existing surface water conditions across Minnesota. In general, the north-central and northeast forested portions of Minnesota are the least affected and have the highest quality surface water resources, and areas in the west and south agricultural portions of the state have the most affected surface water resources and are of poorer quality.

Specifically, the data indicate that there are higher quality resources in the NLF Ecoregion of the State. Lower nutrients (mainly phosphorus) and chlorophyll-a (algae) and greater transparency are indicative of lakes in this ecoregion. Streams in this ecoregion exhibit lower nutrients, turbidity, and fecal coliform, as well as lower temperature and biological oxygen demand conditions. A spatial distribution of lakes and streams depicted in Appendix J-2 and J-3, which show lakes and streams relative to pipeline routes

[7] https://www.pca.state.mn.us/quick-links/eda-guide-typical-minnesota-water-quality-conditions

[8] http://www.dnr.state.mn.us/whaf/index.html

across the state. There are a large number of lakes and streams in north-central and northeast Minnesota and they are of the highest quality when comparing Ecoregion data.

In reviewing three selected watersheds throughout the state, that each represent potential pipeline routing areas, the Pine River watershed (north-central), Chippewa River (west) and Le Sueur River (south). The Watershed health index scores indicate the best health scores are represented in the Pine River and the worst scores in the Chippewa and Le Sueur River watersheds accordingly. Further, in general, statewide maps indicate better health scores across the north and east and poorer scores across the south and west as depicted by analysis of the five different components: Biology, Connectivity, Geomorphology, Hydrology and Water Quality (Appendix J-1). Water quality scores for the Applicant's preferred route and SA-04 are provided in Tables 5.2.1.2-1 and 5.2.1.2-8.

Trout Streams

Several trout streams are intersected by the Applicant's preferred route. Often because of their non- or minimally-affected watersheds and their location, soils and geologic setting within the state, these streams represent high-quality cold oxygenated water necessary for trout survival.

The Applicant's preferred route passes within ½ mile of 17 designated trout streams or protected tributaries to designated trout streams. Truck and rail routes pass within ½ mile of 35 to 44 of these streams. In contrast, Route SA-04 crosses within two designated trout streams or protected tributaries to designated trout streams (Table 5.2.1.2-13)**.** Though more streams/ditches are crossed in southern areas, the analysis indicates the quality of the streams crossed in northern routes is greater since many are trout waters.

Table 5.2.1.2-13. High-Quality Surface Water Resources within ½ Mile of Route Centerline

High-Quality Resources	Applicant's Preferred Route	System Alternative SA-04	Transport by Truck	Transport by Rail (North)	Transport by Rail (South)
Trout Streams	17	2	44	35	39
Wild Rice Lakes	17	0	14	13	18
Lakes of High and Outstanding Biological Significance	8	1	8	10	16
Tulibee Lakes	4	0	8	9	4

Wild Rice Lakes

Minnesota has more acres of natural wild rice (*Zizania palustris*) than any other state in the country. Wild rice has been historically documented in 45 of Minnesota's 87 counties and in all corners of the state. Anecdotal information suggests an even broader distribution prior to European settlement. Wild rice is an important social and cultural component for Native American tribes and rural Minnesota communities.

A DNR assessment found over 1,200 lakes and rivers in 54 counties that currently contain or historically had wild rice. Over 64,000 acres of wild rice (out of roughly 2 million basin acres) were found on these waters. More than half of the acreage was found in Aitkin, Cass, Crow Wing, Itasca, and St. Louis counties.

Lakes of Biological Significance (high and outstanding)

Lakes of Biological Significance (LBS) were identified and classified by DNR subject matter experts on objective criteria for four community types (aquatic plants, fish, amphibians, and birds). Unique plant or animal presence was the primary measure of a lake's biological significance. Lakes were rated and grouped for each of the following communities: aquatic plants, fish, birds, and amphibians. Lakes were assigned one of three biological significance classes (outstanding, high, or moderate). This assessment viewed outstanding and high sites as they are representative of the highest quality conditions. Many Minnesota lakes have not been sampled for plants and/or animals, so this list of lakes would be periodically revised as additional biological data become available.

There are a large number of lakes with high and outstanding biological significance in the NLF. The Applicant's preferred route crosses some of these lakes in this ecoregion (see Table 5.2.1.2-13).

Tullibee Lakes

Minnesota has about 650 tullibee lakes, more than any other state in the lower 48. Many of these waters are prized by anglers because tullibee (also known as cisco, or lake herring in Lake Superior) provide a high-energy feast for walleye, northern pike, muskellunge, and lake trout. Changes in land use and climate are causing many lakes to lose tullibee. Keeping forested land intact can help maintain water quality in lakes with tullibee and other coldwater species. The Tullibee Lake Watershed Forest Stewardship Project[9] is engaging owners of private woodlands and other conservation partners to protect vulnerable waters in north-central Minnesota (see Table 5.2.1.2-13).

Other Spatial Indicators of the Quality of Surface Water

Ditches

An evaluation was also done on the number of public water ditches crossed by the routes. High numbers of ditches is an indication of landscape alteration that adversely affects water resources, thus diminishing the quality of water resources in the area. An image of the total number of ditches, including private, in the vicinity Applicant's preferred route and alternatives is depicted on a statewide map in Appendix J-4.

Perennial Cover

Areas that tend to rate low in perennial cover, terrestrial habitat quality and connectivity have poorer overall health index scores as depicted in Watershed Health Scores for the Pine, Chippewa and Le Sueur River Watersheds (Appendix J-5).

Wetlands

Minnesota's six million acres of peatlands represent a major component of the state's natural heritage. In a world-wide context, the patterned peatlands in Minnesota are extremely valuable for the study of ecological and developmental processes in peatlands as noted in "Recommendations for the Protection of Ecologically Significant Peatlands in Minnesota" (Minnesota DNR 1984). The number of wetlands statewide is also depicted in viewing Watershed Health Scores under Loss of Hydrologic Storage, Wetland Loss in (Appendix J-6 though J-7).

[9] http://www.dnr.state.mn.us/tullibeelake.html

Walleye Lakes

Walleye Lakes are spatially represented to indicate the location of these waters relative to the pipeline routes. Walleyes and walleye fishing is an important heritage to all Minnesotans, and can be an indicator of ecological condition of lakes. Walleye lakes are fairly dispersed across the state, however habitat suitable for reproduction and self-sustaining populations has a much higher presence in the high-quality waters representative of the NLF Ecoregion.

Existing Surface Water Conditions in the Region of Interest

Applicant's Preferred Route

The Applicant's preferred route follows a route south of Clearbrook following an existing pipeline right-of-way, and then follows an existing transmission line corridor easterly toward Carlton. The Applicant's preferred route, along with northern pipeline route alternatives discussed in Section 6.3.1.2 (RA-06, RA-07, and RA-08), all pass through a large number of streams, lakes, wetlands, and accompanying resources, all of which are generally of high quality. The Applicant's preferred route intersects the highest number of wild rice lakes (17) compared to the CN Alternatives. For other notable resources, this route passes 17 trout streams and 8 lakes of high and outstanding biodiversity significance as well as 4 tullibee lakes. See Table 5.2.1.2-13 for comparison of resources intersected.

System Alternative SA-04

System alternative SA-04 lies in an agriculture dominated area and has surface water resources of poorer quality. This is especially shown in Minnesota PCA's Ecoregion Concept for assessing surface waters, in the Minnesota DNR WHAF Tool, in evaluating specific high-quality surface water indicators (see Table 5.2.1.2-13), as well as altered landscape indicators such as ditching as an indicator of poorer water quality or altered landscape. These indicators are seen in areas to the south and west that tend to rate low in perennial cover, terrestrial habitat quality and connectivity that reduce overall health index scores.

Truck Route Gretna to Clearbrook Terminal

This route follows U.S. Highway 2 from Clearbrook to Duluth then crosses the St. Louis River Estuary over the Richard I. Bong Bridge to Superior Wisconsin. There are numerous waters intersected by this route including 44 trout stream and designated trout stream tributaries and 14 wild rice lakes as well as the St. Louis River Estuary. There are 8 tullibee lakes and 8 lakes of high and outstanding biodiversity significance. Like all northern pipeline routes (RA-06, RA-07, RA-08, and the Applicant's preferred route) and the Superior North Rail Route, the Truck Route passes through a large number of streams, lakes, wetlands and accompanying resources, all of which are generally of high quality.

Alternative Rail Route to Superior North

The Superior North Rail Route like the northern pipeline routes (RA-06, RA-07, RA-08, and the Applicant's preferred route) and the Truck Route passes through a large number of streams, lakes, wetlands, and accompanying resources, all of which are generally of high quality. This route passes 35 trout streams, 13 wild rice lakes, 10 lakes of high and outstanding biodiversity significance, and 9 tullibee lakes. The truck and rail routes pass more sensitive resources overall than all other routes except for SA-04. See Table 5.2.1.2-13 for comparison of resources intersected.

Alternative Rail Route to Superior South

The Superior South Rail Route like the northern pipeline routes (RA-06, RA-07, RA-08, and the Applicant's preferred route), Truck Route, and Superior North Rail Route passes through a large number of streams, lakes, wetlands and accompanying resources, all of which are generally of high quality. This route passes 39 trout streams, 18 wild rice lakes, 16 lakes of high and outstanding biodiversity significance and 4 tullibee lakes. The truck and rail routes pass more sensitive resources overall than all other routes except for SA-04. See Table 5.2.1.2-13 for comparison of resources intersected.

5.2.1.2.4 Impact Assessment

This section addresses the impact analysis conducted for the Applicant's preferred route and the CN Alternatives. The analysis assessed potential impacts on surface waters in the ROIs, as described in Section 5.2.1.2.1, related to the following concerns:

- Runoff and flows – increases in stormwater runoff and erosion, increases in TSS concentrations and increased sedimentation, changes in stream flows from water withdrawals and discharges, and disruption of flow paths or local hydrologic connectivity;
- Surface water and aquatic habitat quality – degradation of surface water quality, degradation of aquatic habitat from instream and other construction activities including vegetation removal near waterbodies, degradation of water quality and habitat from releases of drilling mud during HDD crossings;
- Channel morphology and stability – changes in channel morphology and stability caused by channel and streambank modifications; and
- Disturbance of wild rice waterbodies.

Many pipeline construction activities have the potential to affect surface water flow and quality. These activities include clearing and grading, dewatering and trenching, blasting, access road construction, waterbody crossings, surface water withdrawals and discharges (e.g., for hydrostatic test water), fueling and use of hazardous materials, and restoration or reclamation of construction areas. Construction of the offloading facilities for the rail and truck alternatives also would include many of the activities listed above, including clearing and grading, dewatering, access road construction, surface water withdrawals (e.g., for dust control), fueling and use of hazardous materials, and restoration or reclamation of some of the areas affected by construction. The potential impacts on surface water from these activities are addressed below for the Applicant's preferred route and CN Alternatives. After the discussion of construction impacts, the potential impacts of operations on surface waters are addressed for the Applicant's preferred route and each CN Alternative.

Applicant's Preferred Route (from Neche to Superior)

The Applicant's preferred route would require 227 surface water crossings (192 in Minnesota) (listed in Table 5.2.1.2-2), including 46 state-designated use/sensitive surface waters, 9 (7 in Minnesota) NRI-listed rivers (listed in Table 5.2.1.2-3), 16 (12 in Minnesota) impaired surface waters (listed in Table 5.2.1.2-4), 6 trout streams, and 7 (6 in Minnesota) navigable river crossings. The potential impacts of construction on these surface waterbodies are addressed below.

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required within the construction work area for the pipeline, mainline valves (MLVs), new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including pipe yards. Newly cleared areas and new impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters. Consequently, this increased runoff and erosion would increase TSS concentrations and sedimentation. The Applicant would obtain construction stormwater NPDES permits in each state for the pipeline, MLVs, pump stations, cathodic protection sites, access roads and ATWS, and pipe yards prior to construction. NPDES permits require outline BMPs for erosion and sediment control and pollution prevention, regulate, discharges into surface waters impaired waters, pollution prevention, and require inspection of these items at construction sites. As part of the construction stormwater NPDES permits, the Applicant would be required to develop a Stormwater Pollution Prevention Plan (SWPPP) that would include a site description identifying construction activities and the locations of stormwater discharges and receiving waters. The SWPPP would describe erosion and sediment controls to be implemented during construction, stormwater pollution management, waste disposal, maintenance and inspection practices, and any additional requirements to prevent stormwater pollution.

The Applicant's Environmental Protection Plan (Appendix E) describes the Applicant-proposed measures to be used during construction that likely would be stipulated in the SWPPP and NPDES permits, including temporary sediment and erosion control such as slope breakers, sediment barriers (e.g., silt fence, straw bales, and bio-logs), stormwater diversions, trench breakers, mulch, and erosion control blankets. These temporary controls would be placed across the entire construction work area at the base of slopes greater than 5 percent where the base is less than 50 feet from surface waters, until the area is revegetated and there is no potential for scouring or sediment transport to surface waters. Trench breakers would be used at all waterbody crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep accumulated trench water out of the waterbody. Permanent berms, as approved by permit conditions, would be installed on all slopes greater than 3 percent to prevent erosion and sedimentation into surface waters once construction is complete, unless otherwise specified by permit conditions.

To further reduce the potential for long-term erosion and sedimentation, disturbed areas at waterbody crossings would be restored and stabilized to the extent practicable after pipeline installation. The Applicant proposes to reestablish streambank vegetation in North Dakota using North Dakota Seed Mix 2, in Minnesota using Minnesota Seed Mix 2, and in Wisconsin using Wisconsin Seed Mix 1 (described in Appendix C of the Applicant's Environmental Protection Plan [Appendix E]) unless an alternate seed mix is requested by a landowner or agencies such as the Minnesota Board of Water and Soil Resources (Minnesota BWSR). These seed mixes have been developed by the Applicant to reestablish herbaceous vegetation quickly following pipeline construction.

By complying with these NPDES permit conditions and implementing the Applicant-proposed measures to minimize impacts, the impact of increases in stormwater runoff and erosion from clearing and grading due to construction would be short term to long term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, construction activities such as blasting, trenching, waterbody crossings, establishment of ATWS and access road construction, and water discharges may cause increased suspended solids and

sedimentation in surface waters crossed. The Applicant's proposed temporary erosion controls, SWPPP requirements, and NPDES permit requirements described above would be implemented during these activities to prevent sediment transport into surface waters during construction.

The Applicant anticipates the need for blasting from MP 354.6 to 356.6 in Carlton County, Minnesota, due to shallow bedrock. Blasting can increase TSS and sedimentation in surface waters near the blast site. Prior to construction, the Applicant would develop a Blasting Plan, which would adhere to all stipulations set forth by federal (Title 29 Code of Federal Regulations [CFR], Part 1926 Safety and Health Regulations for Construction/Subpart U – Blasting and the Use of Explosives) and state regulations and include measures to protect nearby surface waters from these impacts. Therefore, impacts on TSS from this localized blasting event likely would be temporary and negligible to minor.

During pipeline construction across a waterbody, the extent and duration of sedimentation and increased erosion potential depend on the soils and topography of the site and the proposed crossing method. The types of methods that may be used include the wet crossing method (wet trench), dry crossing methods (dam-and-pump and flume), and HDD or guided bore as described in Appendix E. Construction of the pipeline across the waterbody using dry open-cut methods would occur in a dry area created by temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate in the downstream vicinity of the crossing. As a result, impacts from increases in TSS concentrations and increased sedimentation in surface waters crossed using dry open-cut crossing methods would be temporary to short term and minor. However, some streams are not spring fed, instead they originate from surface water flow. Consequently they are more susceptible to erosion, low light conditions, and surface water temperature changes. Many of these may already be subjected to sediment influx from other sources and therefore are susceptible to moderate to major impacts from additional sediment. The sediment would impact the substrate, turbidity, flow, from the point of construction at the crossing include any area affected just upstream, and continue to impact the stream as the water flows downstream.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel, and excavated soils would be in direct contact with surface water. The Applicant would install sediment containment devices (e.g., in-water BMPs such as floating silt curtains) to contain the excavated material and minimize the potential for increased sedimentation (Appendix E). The in-water BMPs would remain in place until construction is completed. If the Applicant maintains compliance with NPDES permit conditions and implements Applicant-proposed measures, impacts on surface water quality due to increases in TSS concentrations and increased sedimentation in surface waters crossed using the wet open-cut crossing method would be temporary to short term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. The Applicant would withdraw water for hydrostatic testing, dust control, trench dewatering, and HDD installation. Hydrostatic testing would require approximately 120 million gallons of water (between 11 and 17 million gallons for each of seven construction spreads) (Enbridge 2016b), which the Applicant would obtain from lakes, streams, or groundwater wells. The proportion of water that would be obtained from groundwater versus surface water has not been determined. Water appropriation needs for dust control, trench dewatering, and HDD installation have not been determined. Prior to construction, the Applicant would obtain water appropriation permits from the state agencies with jurisdiction (listed in Section 5.2.1.2.1). These permits would require identification of and rationale for choosing specific surface water sources; requested maximum pumping rates and maximum annual volumes of water to be used; monitoring of

pumping rates during appropriation with an approved device or method; and reporting of daily, monthly, and/or yearly appropriation amounts.

In accordance with water use permit conditions, the Applicant has proposed the measures described below in the Environmental Protection Plan (Appendix E). If surface water is used, hose intakes would be equipped with a screen to prevent entrainment of aquatic species, and adequate waterbody flow rates and volumes would be maintained to protect aquatic life and allow for downstream uses. The Applicant is currently evaluating transferring water from one test section to another in order to minimize the total quantity of water needed to complete the hydrostatic test.

Hydrostatic test water would be discharged from a test section in accordance with the NPDES permit in one of two ways: (1) into well-vegetated upland areas using controlled-flow velocity with a dewatering structure such as a silt fence and straw bales or into geotextile filter bags that are used to avoid soil erosion, sediment transport, and bottom scouring; or (2) into the waterbody from which it was withdrawn to prevent the spread of invasive species or degradation in water quality; the discharge rate would not exceed the permitted applicable discharge rate (Appendix E). Water would be treated as specified in NPDES permits prior to discharge; and the Applicant would monitor pH, dissolved oxygen levels, and any other parameters required by the permit, as described in Appendix D of the Environmental Protection Plan (Appendix E). Hydrostatic test water withdrawal and discharges would avoid the use of surface waters with commercially or recreationally important species, including trout streams and Outstanding Resource Value Waters, as intake sources and discharge locations. Discharges would adhere to all conditions set forth in an NPDES permit. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, alterations in stream flows from water appropriation and discharge during construction would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. "Hydrologic connectivity" is the water-mediated transport of matter, energy, and organisms within or between elements of the hydrologic cycle (i.e., the continuous movement of water on, above, and below the Earth's surface) (Pringle 2003). Pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, and channel and streambank modifications caused by waterbody crossings. Hydrologic connectivity can be decreased if barriers are constructed to prevent the natural flow of water and can be increased if natural barriers are removed. Disruption of hydrologic connectivity and the natural interaction between groundwater and surface water can affect water quality by altering the acidity, dissolved oxygen levels, and nutrient and contaminant loads in surface waters, thereby affecting the aquatic environment. It also can allow the spread of invasive species and prevent migration and reproduction of species.

With implementation of the Applicant-proposed measures described above to prevent or minimize erosion and sedimentation, monitor stream flows during water appropriation and discharge, and restore streambanks to their original attributes after construction, impacts on flow and hydrologic connectivity during construction along the construction work area would be temporary to permanent and minor to major. Potential impacts that are permanent and major would be associated with specific site features that are sensitive to disruption of hydrologic connectivity. Springs and other surface water features that are dependent on shallow groundwater have the potential for permanent and major impacts.

Construction would create temporary and permanent access roads that also could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that were widened and graded, to preconstruction conditions upon completion of construction. The restoration would include

seeding disturbed areas with a suitable seed mix for the area. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads is expected to be short term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low. The impact of contaminants in stormwater runoff on surface water quality therefore would be short term and negligible to minor, continuing until vegetative cover is restored to approximate preconstruction conditions.

Trout rely on coldwater habitats for survival, and exposure to sunlight from vegetation removal can cause adverse warming of the water. Therefore, construction NPDES permits typically prohibit removal of woody vegetation and replacement with grassy vegetation near trout streams unless the reasons are absolutely necessary and completely documented in the SWPPP. Further, to minimize stormwater discharge into and temperature increases in trout streams, NPDES permits typically require that impervious surfaces be minimized; discharges be made into vegetated areas or grass swales, avoiding impervious surfaces when possible; and Infiltration or other volume reduction practices be used to reduce runoff in excess of pre-Project conditions. By complying with these NPDES permit conditions and implementing the Applicant-proposed measures to minimize impacts, it is not likely that construction would impact water temperature in surface waters crossed.

During construction, surface water may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals as a result of activities such as fuel storage, equipment refueling, and equipment maintenance. To protect surface water resources, the Applicant would store petroleum products, hazardous chemicals, and lubricating oils; conduct refueling, maintenance, and lubricating operations; and perform concrete coating activities in upland areas more than 100 feet from surface waters (Appendix E). Concrete wash water, grindings, and slurry disposal would be limited to a designated area and would not be discharged to surface waters. Rinse water, used in conjunction with a cleaning pig to remove any accumulated construction debris, dirt, and dust prior to hydrostatic testing, would be treated and disposed of or discharged in accordance with applicable NPDES permit conditions. During HDD installation, drilling mud and slurry would be stored away from the waterbody in an earthen berm sediment control structure, in tanks, or by other methods so that it does not flow into the waterbody. Excess drilling mud would be disposed of offsite at an approved disposal facility. In addition to these prevention measures, the Applicant would be responsible for cleaning up small spills through procedures described in the Environmental Protection Plan (Appendix E), including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities. With adherence to NPDES permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills during construction would be temporary and minor.

Potential impacts on surface water due to an unanticipated crude oil release are discussed in Chapter 10.

For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. Aquatic life, human health, and recreational activities are already at risk in these surface waters, and further degradation of water quality may exacerbate an existing impairment, Cause additional impairments, interfere with restoration activities, or delay attainment of water quality standards. NPDES permits would require identification of impaired waters. If the impaired waters have an approved TMDL implementation plan, the plan must be incorporated into the SWPPP, and discharges must comply with specified TMDLs. With adherence to the above NPDES permit conditions and implementation of Applicant-proposed measures, impacts of construction activities on Section 303(d)-listed surface waters would be temporary to short term and negligible to minor.

Degradation of Aquatic Habitat from Instream Construction Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. High mortality rate for freshwater mussels living in gravel-bedded or sand-bedded channels, negative and greatly reduced survival rates for fish eggs resulting from silt deposits have been documented.

Stream crossings would be designed as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow to create the shortest possible crossing length to minimize disturbance to the stream. The Applicant has proposed primary and alternative crossing methods for the Applicant's preferred route based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability installation, and anticipated season of installation (Appendix G). If a pipeline route is approved, the Applicant would be required to coordinate with the appropriate state agencies to determine waterbody crossing methods for each waterbody and to obtain crossing permits.

In general, surface waters with stable banks in mineral soil with noticeable flow at the time of construction would be crossed using dry crossing methods, HDD, or guided bore. Surface waters that are dry during construction and selected surface waters that consist of ditches in peatland with no banks or impoundments (e.g., beaver dams and plugged culverts), with stagnant or no noticeable flow conditions, and that would not support dams necessary to isolate and dry the construction area, likely would be crossed using the wet open-cut method.

One of two types of dry open-cut crossing methods would be used for certain sensitive surface waters. The dam-and-pump method would be used for surface waters of low flow, those with meandering channels, and those for which fish passage is not a concern; the flume method would be used in narrow surface waters with defined banks and a straight channel across the construction work area with a solid substrate. Appendix E provides additional details on water crossing methods. Dry crossing methods are advantageous because they limit sediment release and downstream transport, maintain stream flow, reduce the potential for trench sloughing, and provide a dry working environment for pipe installation. However, dry crossing methods are slower than wet trenching, may require fish salvage, and create a short-term barrier to fish passage.

Crossings constructed using either dry open-cut crossing method would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry crossing method is expected to be temporary to short term and minor for each crossing.

Wet open-cut crossings would be used to limit the duration of instream disturbance, as construction and pipeline installation via this method is rapid, and where dry crossing methods and HDD are not permitted. Instream construction activities for wet open-cut crossing methods would be completed within 24 hours for minor surface waters (i.e., those less than or equal to 10 feet wide at the water's edge at the time of crossing), within 48 hours for intermediate surface waters (i.e., those greater than 10 feet wide but less than 100 feet wide at the water's edge at the time of crossing), and as specified in applicable permits or by the Applicant for major surface waters (i.e., those greater than 100 feet wide at the time of crossing). The erosion and sedimentation control measures discussed above would be implemented during and after wet open-cut crossings, and disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation. As a result, instream construction activities for wet open-cut crossings would cause short-term and minor impacts on aquatic habitat.

Guided bore crossings would be used at narrow wetlands and at shallow ditches adjacent to roads or railroads. Disturbance to the water in the ditch is avoided because the guided bore method involves boring an auger from one side of the ditch to a hole on the other side. This method is not suitable in areas with a high water table, loose sand and gravel substrates, or steep slopes. It also requires excavations and ATWS on either side of the crossing and increases the potential for streambank subsidence; if dewatering is required, sediment release is possible. However, successful bore crossings would cause no impact on aquatic habitat.

HDD crossings would be used to avoid impacts on certain sensitive surface waters, such as impaired waters and coldwater fishery resources; particularly deep, wide, or high-flow surface waters; and where appropriate based on subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks and they maintain stream flow and fish passage. However, they require ATWS on both sides of the crossing, which involves vegetative clearing, soil disturbance, and subsequent restoration activities. Woody vegetation in riparian areas typically would not be cleared for the purpose of ATWS unless approved by appropriate regulatory agencies, as stipulated in permits issued for the Project (Appendix E). Installation of HDD crossings has the potential for inadvertent releases (discussed below). However, successful HDD crossings would cause no impact on aquatic habitat.

Degradation of Water Quality and Habitat from Releases of Drilling Mud during HDD Crossings. Geotechnical surveys would be conducted to determine which surface waters to be crossed are geologically suitable for HDD. During drilling, fluid (water, bentonite clay, and possible Minnesota PCA-approved additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or "frac-out" of this drilling fluid to occur when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Although bentonite clay is non-toxic, drilling mud can smother aquatic wildlife and increase turbidity in affected surface waters. Additives may be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only Minnesota PCA -approved non-hazardous additives approved under permit conditions would be used, and a Material Safety Data Sheet for the drilling fluid would be maintained onsite. If a frac-out occurred near the streambank, bank stability may be compromised. Construction personnel would monitor the crossing to detect releases of drilling mud.

When used in appropriate conditions and completed successfully, HDD Crossings have the potential to reduce the amount of sedimentation produced by conventional techniques (Golder, 1998). Consequently, HDD can provide a cost effective and environmentally viable solution to water crossings.

This appealing potential has encouraged its use in sensitive crossings such as wetlands and trout streams. Despite increased use over time a serious risk of inadvertent releases or 'frac-outs' exists (Golder 1998).

Multiple conditions can lead to frac-outs, such as circulation losses when drilling into highly permeable gravels and inaccurate drilling of pilot holes. The amount of fluid released is related to variables such as the pressure exerted on the fluid by the hydraulic system. Finally, "the subsequent dispersion from the release point will then be a function of the energy, or sediment transport characteristics of the receiving waterbody" (Golder 1998).

Negative impacts from frac-outs include: toxicity of drilling mud to aquatic organisms; the effects of spills or inadvertent releases of drilling fluid; and the disposal of drilling wastes. Slade (2000), reports "short-term effects of releasing drilling fluid into wetlands include temporary displacement of resident fauna, smothering of benthic organisms and plant root systems, increased turbidity of water quality, and effects on water chemistry and wetland hydrology." A release can reduce densities and emergence of adult benthic invertebrates, change hydrological and soil conditions, change fish physiology, behavior, and habitat suitability; and cause long-term impacts on the aquatic ecosystem (Golder 1998). Slade 2000, also identifies additional environmental considerations for the drill rig set-up with respect to water resources and sensitive areas: containment and storage placement of raw fluids, water appropriation and water storage areas, delineation of the "no fueling" areas, and disposal of drilling fluid and cuttings upon completion.

It can be difficult to predict the probability of an occurrence. Yet loss of circulation is common in HDD operations. Longer crossings and HDDs passing through glacial tills, boulders and gravels, have a higher risk of failure. Slade 2000, studied a pipeline construction project from Stockbridge to Freedom Junction Michigan (Enbridge). This was a 35-mile, 16-inch crude petroleum pipeline using 11 HDDs to cross through wetlands, streams and state recreational areas. Results determined multiple relatively minor releases requiring less clean up and two major frac-outs resulting in significant (volume, location, ecology) issues.

It is important to consider the implications (on organisms, sediment, physical disturbance) of potential frac-outs and clean-up operations, identify the pros and cons of each type of crossing method, then match the appropriate technique to each crossing based on the site characteristics and conditions. Therefore, this Project would take all of these into consideration for deciding what technique is applied to each site when using HDD[1] (see HDD contingency plan). This Project would follow best management practices to minimize potential impacts for all crossings during this Project.

The HDD operator would constantly monitor drilling fluid pressures during pilot hole operations and, if a loss in fluid pressure or circulation were identified, the operator would notify onsite construction observers who would visually monitor the portion of the drill path where the drill tool is located to determine whether a drilling mud release occurred. If a release occurred, the Applicant would implement containment, response, and clean-up procedures as outlined in the Applicant's Environmental Protection Plan (Appendix E) to limit the potential for drilling mud to reach surface water. These procedures include containment using straw bales, sandbags, pumps and hoses, vacuum trucks; response activities including adjusting drill rates and pump volumes or stopping drilling, removal of mud with pumps and appropriate storage away from the waterbody prior to disposal; and coordination with appropriate agencies to discuss additional containment or clean-up requirements. If the frac-out caused impacts on the streambank, the bank would be restored to the extent possible using

the channel and streambank modification BMPs described above. If a frac-out occurred and went undetected or was not quickly contained, impacts on surface water quality could be long-term and major. However, with implementation of the Applicant-proposed measures to respond to a drilling mud release during HDD construction, the impact of a release could be short term and minor to major.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. As described in the Environmental Protection Plan (Appendix E), temporary erosion control measures would be implemented as appropriate to minimize the impacts of surface water crossing activities; rock riprap, geotextile fabric, and other bioengineering techniques would be used to stabilize streambanks as needed. However, rock riprap can cause additional bank erosion.

After pipeline installation at river beds and streambeds crossed using dry crossing methods, the trench would be backfilled to restore the streambed or river bed to approximately preconstruction conditions. Although the pipeline trench created with the wet open-cut crossing technique also would be backfilled, it would be more difficult to restore the streambed or river bed to approximately preconstruction conditions. Sediments in those surface waters would continue to be deposited and it is likely that the streambed or river bed eventually would return to preconstruction conditions. For either type of crossing method, there would be little or no impediment to water flow. In addition to backfilling, streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation.

The use of open-cut crossing methods for pipeline construction, along with the measures described above, would result in short-term to long-term and minor impacts on channel morphology and streambank stability. Construction of crossings using the HDD method would result in no impact on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies

Wild rice waterbodies can be susceptible to disturbance in all habitats (lake or river) and are sensitive to temperature changes, contaminants, and hydrology changes—all of which on their own or in combination could affect germination and production. Five wild rice waterbodies would be crossed by the Applicant's preferred route, with about 5 acres of the delineated waterbody basins within the construction work area. Construction would occur across the edge of the basins within the existing pipeline corridor but not through the wild rice stands on Mud Lake, Peterson Lake, and Portage Lake (Appendix A). In addition, some or all of the wild rice areas occur along the margins of larger waterbodies where the Applicant would use site-specific waterbody crossing techniques, including HDD. HDD would be used to cross the unnamed wild rice waterbody at Hay Creek and the crossing of Shell River, a wild rice waterbody. At this location and at other sites where HDD is used as the crossing method, the wild rice waterbodies would not be affected unless a frac-out occurs (see above for information on frac-outs).

Where HDD is not used, the wild rice waterbodies would be crossed using applicable wetland crossing methods for the water saturation conditions at the crossing (see Appendix E for a description of the wet waterbody and wetland construction methods). Trenched crossing could remove the rice plants and disturb sediments and increase sedimentation within the remainder of the waterbody. Although the Applicant would restore the hydrology and soils of the affected wild rice waterbodies after construction,

rice yield would be reduced in the portion of the waterbody directly affected by the repair or replacement activities for the first growing season after construction. To minimize impacts of construction through wild rice waterbodies, the Applicant would implement applicable measures identified in the Environmental Protection Plan (Appendix E). This plan contains measures to reduce or avoid impacts on wild rice during construction. Avoidance measures include use of a narrower construction work area, reseeding, monitoring, and use of timber mats, and would incorporate any additional measures proposed by local and state agencies to reflect existing regional policies and procedures to protect wild rice. Wild rice stands also would be monitored for overall condition, function, and vegetative regrowth after construction until the permit conditions are met.

Although not anticipated, construction-related impacts on wild rice waterbodies could include longer than expected recovery time for native wild rice stands (i.e., could affect rice waterbodies beyond the first growing season after construction), introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions—all of which could be detrimental to wild rice germination and production. These potential impacts would be reduced through Project-specific SPCC plans, invasive species management plans, and post-construction monitoring of vegetation for a period of time until permit conditions are met, as described in the Applicant's Environmental Protection Plan (Appendix E). With implementation of these measures, impacts on wild rice waterbodies are expected to be short term and minor. However, if HDD frac-out, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions occur as a result of construction, impacts could be major.

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except for areas where new impervious surfaces are created, as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way therefore would be altered during the first few years of operation, resulting in impacts of increased runoff and erosion that would be short term and negligible to minor. After vegetation is reestablished along the permanent right-of-way, surface water runoff and erosion would return to approximately preconstruction conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements.

Within Minnesota, expansion of the Clearbrook terminal, modification of three pump stations, construction of four new pump stations, and installation of 27 MLVs would add approximately 67 acres of impervious surfaces, with approximately 30 acres of that area between Clearbrook and Carlton. Stormwater retention ponds would be located at each pump station, consisting of an additional approximately 10 acres. No new permanent facilities are proposed outside of Minnesota for the Applicant's preferred route. The new and expanded facilities would be required to manage stormwater runoff through NPDES permits and SWPPPs as described above and through installation of stormwater retention ponds. Impacts on surface water from increased stormwater runoff from these facilities would be permanent and negligible to minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. During the first few years of operation, there may be a small increase in surface water runoff and erosion as revegetation continues, potentially resulting in increases in TSS and sedimentation in nearby surface waters. The impact of this increase on surface waters would be short term and negligible to minor.

The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation within the permanent right-of-way in areas adjacent to waterbody crossings would result in localized alterations in habitat, streambank stability loss and erosion, and sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. With implementation of these measures, the impacts associated with the localized changes to topography or vegetation would result in short-term to permanent and minor impacts in the vicinity of the alteration.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities would be similar to those experienced during construction, but over a much smaller area. The impacts from increased TSS and sedimentation in nearby surface waters would be short term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the Applicant's preferred route would not require withdrawal or discharge of water. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. As described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of BMPs, impacts associated with alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity in the areas excavated for pipe repair or replacement would be temporary to short term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic

connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that the impact of their presence would be permanent but negligible to minor.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by the Applicant's preferred route would not result in degradation of the watershed water quality score. As a result, water quality would not change in the surface waters of the basins and watershed along the route, including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Minor accidental fuel and lubricant leaks and spills could be released from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Thus, minor leaks and spills during operations would result in temporary and negligible to minor impacts on surface water quality. The potential impacts of a crude oil release on surface water quality are addressed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact of using the dry open-cut method for instream integrity digs on aquatic habitat is expected to be temporary to short term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs, and if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities for using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method, or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river bed or streambed. This could result in a minor, temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short term and negligible to minor for each crossing.

The impacts associated with using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short term and minor for each crossing.

Disturbance of Wild Rice Waterbodies

The wild rice waterbodies crossed by HDD at Hay Creek and Shell River would not be affected during operations. Wild rice waterbodies would not be affected by normal pipeline operation unless it is necessary to repair or replace a section of pipe within the waterbody as a part of the Applicant's Integrity Management Program. In that event, the impacts would be similar to those of the original crossing construction. Although the Applicant would restore the hydrology and soils of the affected portion of the wild rice waterbody after construction, rice yield in the portion of the waterbody affected by the repair or replacement activities could be reduced for the first growing season after completion of the activity. It is likely that only a portion of the approximately 3 acres of wild rice waterbodies within the permanent right-of-way would require repair or replacement at any one time; these activities could result in short-term and negligible to minor impacts. However, if replacement of a section of pipe within the waterbody resulted in, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions impacts could be major.

Continued Use of Existing Line 3

Construction Impacts

Continued use of Line 3 would not require construction because the full length of the pipeline was previously installed. As a result, there would be no construction impacts on surface water from continued use of the existing Line 3 pipeline.

Operations Impacts

Operations impacts for continued use of the existing Line 3 would be similar to those discussed for the Applicant's preferred route. However, continued use of Line 3 at its present capacity would require more frequent activities associated with Applicant's Integrity Management Program than for the Applicant's preferred route or for SA-04. The Applicant estimated that an average of 267 integrity digs

(i.e., excavations to repair or replace sections of pipe) would be required per year (see Section 4.2.3 for more detail). These activities may result in extensive disturbance at surface water crossings and near-surface waters. The impacts of the integrity excavations, backfilling, and revegetation are described below; impacts would be comparable to new pipeline construction but on a smaller scale as they would be localized in the area of each integrity dig.

Runoff and Flows

Increases in Stormwater Runoff and Erosion. The existing Line 3 pipeline has been in place for decades, and the vegetative cover is well established. As a result, stormwater runoff and erosion would continue at the same level as in the past.

During operation, the Applicant would implement its Integrity Management Program, which can require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on stormwater runoff and erosion would be short term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project. As noted above, the number of integrity digs required for the decades-old existing pipeline would be substantially greater than for new pipe, and the impacts would occur more frequently than for a new pipeline.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. As noted above, the existing Line 3 pipeline has been in place for decades, and the vegetative cover is well established. Therefore, stormwater runoff and erosion would continue at the same level as in the past. No increase in eroded soils reaching surface waters with stormwater runoff would occur, and TSS and sedimentation in those waters would not change.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. In upland areas, this could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion and the potential for eroded soil to reach nearby surface waters. This could result in increases in TSS and sedimentation within the affected surface waters. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on TSS and sedimentation would be short term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Repair or replacement of sections of pipe buried under surface waters would be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods. Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns, which would increase both TSS and downstream sedimentation. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact of increased TSS and sedimentation from using either of the dry open-cut methods for instream integrity digs is expected to be short term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement comparable erosion and sediment control measures as discussed above for construction of surface water crossings. It was assumed that these measures would be implemented during and after wet open-cut integrity digs. If streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of pipe repair or replacement. As a result, instream integrity dig activities using the wet open-cut method would be expected to result in short-term and minor impacts on aquatic habitat.

For all integrity digs addressed above, the number of digs required for the decades-old existing pipeline would be substantially greater than for new pipe, and the impacts would occur more frequently than for a new pipeline.

Changes in Stream Flows from Water Withdrawals and Discharges. Continued normal operation of existing Line 3 would not require withdrawal or discharge of water beyond current requirements, if any. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. As described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of BMPs, minor alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity in the areas excavated for pipe repair or replacement would be temporary to short term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor to major.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. As noted above, the existing Line 3 pipeline has been in place for decades, and the vegetative cover is well established. During operation, there would be no potential for increased runoff to carry contaminants to nearby surface waters; and continued operation would not

influence temperature changes to the water beyond those currently occurring, if any. As a result, normal operations would not affect water quality, including temperature.

Similarly, maintenance of the permanent right-of-way during operation would be expected to continue at the current level of activity. Consequently, the current level of contamination of surface waters, if any, would not change because of minor leaks and spills of petrochemicals and other chemicals from maintenance vehicles using the permanent right-of-way and nearby areas. Because of the increased need for integrity digs for the decades-old pipeline, the number of vehicles transiting the permanent right-of-way and nearby areas would increase, with the potential for an increase in the number of small leaks from the vehicles. Although this would increase the potential for petrochemicals to reach surface waters, the Applicant would implement the BMPs described for construction of the Applicant's preferred route, which would minimize the impacts. The impact on surface water quality related to small leaks from vehicles used during integrity digs would be temporary to short term and negligible to minor.

During operation, the Applicant would implement its Integrity Management Program, which can require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion and the potential for contaminants to reach nearby surface waters. In addition, repair or replacement of sections of pipe buried under surface waters would result in changes to water quality in the area of and immediately downstream of the excavated pipe section. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on surface water quality would be short term and negligible to minor for each local occurrence, but they would occur periodically over the life of the Project. As noted above, the number of integrity digs required for the decades-old existing pipeline would be substantially greater than for new pipe, and the impacts would occur more frequently than for a new pipeline.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by the existing Line 3 would not result in degradation of the watershed water quality score. As a result, water quality would not change in the surface waters of the basins and watershed along the route, including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Potential impacts on surface water due to an unanticipated crude oil release are discussed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve using one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact of using the dry open-cut method for instream integrity digs on aquatic habitat is expected to be temporary to short term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs, and if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities for using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river bed or streambed. This could result in a minor, temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short term and negligible to minor for each crossing.

The impacts associated with using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short term and minor for each crossing.

Disturbance of Wild Rice Waterbodies

One wild rice waterbody is located within the permanent right-of-way for the existing Line 3 route. However, the pipeline is not installed within the waterbody but only crosses the dry basin portion of the wild rice lake boundary. If excavation and repair or replacement of a segment of pipeline in this area are required, no direct impacts on the wild rice waterbody would occur. This activity could result in topographical changes and loss of vegetation in the area near the wild rice waterbody for a relatively short period of time. Although there is a potential that these changes could alter runoff patterns and increase erosion, the Applicant would implement measures to minimize changes in stormwater runoff and erosion, as described above, during and after the integrity dig. Consequently, the impacts on a wild rice waterbody of an integrity dig near the waterbody would be short term and negligible. However, if introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions occur as a result of an integrity dig, impacts could be major.

System Alternative SA-04

System alternative SA-04 would require 636 waterbody crossings (172 in Minnesota) (see Table 5.2.1.2-8 for the types of surface waters crossed), including 56 state-designated use/sensitive surface waters, 6 (1 in Minnesota) NRI-listed river crossings (listed in Table 5.2.1.2-9), 32 (8 in Minnesota) impaired surface water crossings (listed in Table 5.2.1.2-10), and 9 (2 in Minnesota) navigable waterway crossings.

The types of activities that could result in impacts during construction and operation of SA-04 would be essentially the same as those described for the Applicant's preferred route. As a result, some of those activities are briefly mentioned below, with more details provided in the sections above for construction and operation of the Applicant's preferred route. Construction and operation of SA-04 would affect more surface waters because the route crosses substantially more surface waters than the Applicant's preferred route.

Construction Impacts

Construction impacts for system alternative SA-04 would include impacts of the same type, magnitude, and duration as discussed above for the Applicant's preferred route; specific crossing methods for each waterbody and the construction timeline for system alternative SA-04 have not been developed. If SA-04 is constructed, it was assumed that the Applicant would implement the same Applicant-proposed measures identified for the Applicant's preferred route (Appendix E) and would implement all necessary requirements mandated by North Dakota, Minnesota, Iowa, and Illinois permits to reduce impacts on surface water for the route.

Based on the spacing of pump stations along the Applicant's preferred route, and estimated 16 new pump stations would be required and located approximately every 50 miles along system alternative SA-04. Each pump station would require approximately 8 acres of land and would be within the construction work area. The assumption for facility location assumed that MLVs would be sited in a manner similar to that of the Applicant's preferred route: near water crossings, significant environmental resources, and populated areas. Hydraulic analysis of operation of the pipeline on system alternative SA-04 is not available; therefore, the specific locations of pump stations and MLVs were not available at the time of preparation of this EIS analysis.

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required for construction of the SA-04 pipeline, MLVs, new and expanded pump stations, cathodic protection sites, and for access roads and ATWS, including pipe yards. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, the Applicant would comply with the requirements of applicable permit programs that are in place to manage potential impacts. This would include NPDES permits that would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible. With adherence to NPDES permit stipulations and use of appropriate BMPs, similar to those described above for the Applicant's preferred route, impacts from increases in stormwater runoff and erosion from clearing and grading during construction would be short term to long term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, other construction activities such as blasting, trenching, waterbody crossings, ATWS and access road construction, and water discharges may cause increased suspended solids and sedimentation in the surface waters crossed by SA-04. The Applicant-proposed measures for temporary erosion controls, SWPPP requirements, and NPDES permit requirements described above for the Applicant's preferred route would be implemented during these activities to prevent sediment transport into surface waters during construction. During pipeline construction across a waterbody, the extent and duration of sedimentation and increased erosion potential depend on the soils, sediments, and topography of the crossing site and the proposed crossing method used.

The need for blasting along system alternative SA-04 is not known. If blasting was required, the Applicant would develop a Blasting Plan prior to construction that would include measures to protect nearby surface waters from impacts. Therefore, impacts on TSS from this localized blasting event likely would be temporary and negligible to minor.

Specific crossing methods for surface waters have not been determined for system alternative SA-04. When using the dry crossing method, increases in TSS and sedimentation would be localized and temporary in surface waters crossed because construction of the pipeline across the waterbody would occur in a dry area created by the temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate to negligible levels downstream in the vicinity of the crossing. As a result, impacts would be temporary to short term and minor.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel, and excavated soils would be in direct contact with surface water. With adherence to NPDES permit stipulations and use of appropriate BMPs, similar to those described above for the Applicant's preferred route, impacts from increases in TSS concentrations and increased sedimentation in surface waters from using open-cut wet crossings would be temporary to short term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of SA-04 would require water withdrawal for hydrostatic testing, dust control, trench dewatering, and HDD installation, which would be sourced from lakes, streams, or groundwater wells. Approximately 11 to 17 million gallons would be required for hydrostatic testing for each construction spread; the number of construction spreads for SA-04 has not been determined, but substantially more spreads would be required than for the Applicant's preferred route because of the greater length of the route (about 795 miles for SA-04 versus about 340 miles for the Applicant's preferred route). The volume of water appropriation needed for dust control, trench dewatering, and HDD installation for system alternative SA-04 has not been determined. If a route permit is issued for this route, the Applicant would need to obtain a Water Appropriation Permit from each state crossed by the route prior to construction.

Hydrostatic test water would be discharged from a test section in one of two ways, as described for the Applicant's preferred route. Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on stream flows from water appropriation and discharge during construction of SA-04 would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. As described above for the Applicant's preferred route, pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, construction of temporary and permanent access roads, and channel and streambank modifications caused by waterbody crossings. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation, to monitor stream flows during water appropriation and discharge, and to restore streambanks to their original attributes following construction, impacts on flow and hydrologic connectivity during construction of SA-04 would be temporary to permanent and minor to major.

Construction would involve creation of both temporary and permanent access roads that also could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that were widened and graded, to preconstruction conditions upon completion of construction. The restoration would include seeding disturbed areas with a suitable seed mix for the area. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads for SA-04 is expected to be short term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, as noted above, the potential for stormwater to carry contaminants into surface waters is low. The impact of contaminants in stormwater runoff on surface water quality therefore would be short term and negligible to minor, continuing until vegetative cover is restored to approximate preconstruction conditions.

Surface water along SA-04 could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. However, to protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles. Similar treatment/disposal or discharge measures to those described for the Applicant's preferred route would be necessary for handling concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing.

In addition, the Applicant would be responsible for cleaning up small spills during construction of the route through procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. NPDES permits for construction of SA-04 likely would require identification of Section 303(d) waters with phosphorus, turbidity, dissolved oxygen, or biotic impairment within 1 mile of construction. If the impaired waters have an approved TMDL implementation plan, the plan likely would be required to be incorporated into the SWPPP, and discharges must comply with specified TMDLs. With adherence to these permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills during construction would be temporary to short term and minor.

Degradation of Aquatic Habitat from Instream Construction Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. High mortality rate for freshwater mussels living in gravel-bedded or sand-bedded channels, negative and greatly reduced survival rates for fish eggs resulting from silt deposits have been well documented. The specific crossing method for each crossing has not been determined for construction of SA-04 but would be selected

based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability, and anticipated season of installation. If a route permit is issued for this route, the Applicant would be required to obtain crossing permits for the surface waters crossed by the route.

Similar to construction of the Applicant's preferred route, dry and wet open-crossing crossing methods would be used. Each method has advantages and disadvantages for minimizing potential impacts on aquatic habitats. Assuming that erosion and sedimentation control measures would be the same as those discussed above for the Applicant's preferred route and that disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation, using the dry open-cut crossing method would result in temporary to short-term and minor impacts on aquatic habitat for each crossing; with use of the wet open-cut method, the impact on aquatic habitat would be short term and minor.

If selected for certain crossings along the route (e.g., roads and ditches), successful guided bore crossings would result in no impacts on aquatic habitat. In addition, HDD crossings likely would be used to avoid impacts on certain sensitive surface waters, such as impaired waters and coldwater fishery resources; and particularly deep, wide, or high-flow surface waters. The use of HDD crossings would be determined based on evaluations of subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks, and they maintain stream flow and fish passage. Construction of an HDD crossing is slower than a dry crossing, and there is the potential for inadvertent releases (discussed below). As described above for the Applicant's preferred route, successful HDD crossings would result in no impacts on aquatic habitat during construction of SA-04.

Degradation of Water Quality and Habitat from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for system alternative SA-04. Geotechnical surveys would need to be conducted along the route of SA-04 to determine which surface waters would benefit from use of the HDD method and which of those surface waters are in areas that are geologically suitable for HDD. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or frac-out of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Risk of HDD frac-out is discussed above in the assessment of impacts on surface water and aquatic habitat quality from the Applicant's preferred route. If a frac-out occurred during construction of the route and went undetected or was not quickly contained, impacts on surface water quality could be long term and major. However, with implementation of measures similar to those described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along SA-04, the impact of a release of drilling fluid on surface water quality and streambank structure would be short term and minor.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. To minimize impacts on surface waters, the Applicant would consider crossing surface waters at the narrowest section of a waterbody where feasible, avoiding crossing when possible, and avoiding crossing on or under the beds of trout streams unless there is no feasible alternative. The Applicant would adhere to these stipulations when feasible, and each waterbody crossing would be approved prior to construction. Similar to construction of the Applicant's preferred route, temporary erosion control measures during construction of SA-04 would be implemented as necessary during waterbody crossing activities; and rock riprap, geotextile fabric, and

other bioengineering techniques would be used to stabilize sites as needed. Following crossing construction, river beds and streambeds would be restored to approximately preconstruction conditions, with no impediments to water flow; and streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. Finally, streambanks would be restored with appropriate vegetation.

The use of dry or wet open-cut crossings for pipeline construction, along with the Applicant-proposed measures described above, would result in short-term to long-term minor impacts on channel morphology and streambank stability. Successful construction of HDD crossings, where implemented for construction of SA-04, would result in no impacts on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies

No wild rice waterbodies are within or adjacent to the construction work area of SA-04. Therefore, construction of this alternative would not affect those surface waters.

Operations Impacts

Operations impacts for system alternative SA-04 would include the same types, magnitudes, and durations of impacts discussed for the Applicant's preferred route, but impacts would occur in more surface waters because more surface waters would be crossed by system alternative SA-04 compared to the Applicant's preferred route. The locations, numbers, and types of permanent aboveground facilities that would be constructed for system alternative SA-04 have not been determined. The potential impacts on surface water resources from a crude oil release are discussed in Chapter 10.

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except for areas where new impervious surfaces are created, as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way would be altered during the first few years of operation, resulting in impacts on runoff and erosion that would be short term to long term and negligible to minor. After vegetation is reestablished along the permanent right-of-way, surface water runoff and erosion would return to approximately preconstruction conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements.

The number, types, and locations of associated facilities that would be required for pipeline operation along SA-04 have not been determined. However, the Applicant would be required to manage stormwater runoff at these new facilities as stipulated in NPDES permits and SWPPPs, which include the use of permanent stormwater control systems. As a result, the potential impacts on surface water due to increased stormwater runoff from impervious surfaces would be negligible to minor and permanent.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. During the first few years of operation, surface water runoff and erosion may slightly increase as revegetation continues, resulting in short-term and negligible to minor impacts related to increases in TSS and sedimentation. Similar to the Applicant's preferred route, the permanent right-of-way for SA-04 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access for inspection, monitoring, and maintenance. The permanent removal of large woody vegetation also would result in permanent but minor and localized alterations in habitat, streambank stability loss and erosion, and

sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. In other portions of the permanent right-of-way, there would be a permanent but negligible impact from increased TSS and sediments in surface water.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the route would not require withdrawal or discharge of water. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. However, as described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures and the volume of water would be substantially less than for construction. With adherence to permits and implementation of existing BMPs, minor alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity during in the areas excavated for pipe repair or replacement would be temporary to short term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The permanent right-of-way of SA-04 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by system alternative SA-04 would not result in degradation of the watershed water quality score. As a result, water quality would not change in the surface waters of the basins and watershed along the route,

including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Minor fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles operating along SA-04. However, any refueling, fuel storage, or vehicle maintenance would follow measures similar to those in the Applicant's proposed Environmental Protection Plan (Appendix E). Thus, minor leaks and spills would result in temporary and negligible to minor impacts on surface water quality. The potential impacts of an unanticipated crude oil release are discussed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry open-cut method for instream integrity digs is expected to be temporary to short term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs; if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Excavation and repair or replacement of pipe may be required within or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river bed or streambed. This could result in a minor, temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short term and negligible to minor for each crossing.

Using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology

and stability of using the wet open-cut method for instream integrity digs is expected to be short term and minor for each crossing.

Disturbance of Wild Rice Waterbodies

Impacts on wild rice waterbodies would not occur during operations, as no wild rice waterbodies occur within or near the permanent right-of-way for SA-04.

Transportation by Rail

Construction Impacts

Transportation of crude oil by rail would require development of rail loading and offloading facilities, and replacement and upgrade of existing rail access (described in Section 4.2.6). As currently envisioned, the rail loading facility would be constructed and operated in Gretna, Canada. Those facilities would require permitting by provincial and national entities in Canada, and therefore are not addressed in this EIS. The offloading facilities would be sited near the existing Enbridge terminal in Clearbrook, Minnesota, and near the existing Enbridge terminal in Superior, Wisconsin. The specific locations of the offloading facilities have not been identified. The existing rail line near Clearbrook would need to be upgraded to a Class 1 standard, and a portion of abandoned line near Clearbrook would need to be re-installed. New construction would be required in undeveloped areas at both offloading facility locations.

Runoff and Flows

Increases in Stormwater Runoff and Erosion*.* Clearing and grading would be required for construction of new facilities and access roads, resulting in changes to stormwater runoff and erosion and the potential for runoff to reach nearby surface waters. It is likely that stormwater NPDES permits would be required, along with measures to address erosion and sediment controls to be implemented during construction, stormwater pollution management, waste disposal, maintenance and inspection practices, and any additional requirements to prevent stormwater pollution. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, the requirements of applicable permit programs are in place to manage potential impacts. This includes NPDES permits that would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible. With adherence to stipulations in NPDES permits and use of appropriate BMPs, similar to those described above for the Applicant's preferred route, impacts on surface waters from increases in stormwater runoff and erosion from clearing and grading during construction of facilities would be short term and minor.

The improvements required for the rail lines would be accomplished on the existing rail embankments and would not be expected to alter stormwater runoff and erosion patterns; consequently, no impacts on surface waters would be associated with rail line improvements.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation*.* The temporary erosion controls, SWPPP requirements, and NPDES permit requirements described above would be implemented during construction of the offloading and related facilities to prevent sediment transport into nearby surface waters during construction. As a result, there would be no or small increases in TSS concentrations and sedimentation in nearby water crossings. Therefore, construction of these facilities likely would result in temporary negligible impacts related to increased TSS concentrations and sedimentation in surface waters.

The improvements required for the rail lines would be accomplished on the existing rail embankments and, as noted above, would not be expected to result in a substantial change in stormwater runoff or erosion patterns. Although construction activities could cause a small increase in erosion in some locations, the impact of increased TSS and sedimentation in nearby surface waters would be temporary and negligible.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of the offloading facilities would require water for dust control and other construction activities such as preparation of concrete. Water also may be required for hydrostatic testing of new storage tanks if they are included in the design. The source of the water, whether it would be withdrawn from surface waters or a PWS, is not known. If obtained from surface waters, it was assumed that appropriate BMPs would be implemented such as those described in the Environmental Protection Plan (Appendix E), and that all necessary permits (e.g., NPDES permits for discharges) would be obtained. Consequently, impacts on surface waters would be expected to be temporary and negligible to minor. If water is obtained from public water supplies provided by a local utility, there would be no withdrawals of surface water and therefore no impact.

Disruption of Flow Paths or Local Hydrologic Connectivity. Construction of the offloading facilities may disrupt flow paths and groundwater-surface water interaction due to clearing and grading and water appropriation (for dust control and other construction-related activities) and discharge. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation and, if applicable, to monitor stream flows during water appropriation and discharge, impacts on flow and hydrologic connectivity during construction of the offloading and related facilities would be temporary to short term and minor.

Construction of the offloading facilities also would involve creation of temporary and permanent access roads that could affect hydrologic connectivity. Applicable permits likely would stipulate that temporary access roads, including roads that were widened and graded, be restored to preconstruction conditions upon completion of construction. The restoration likely would include seeding disturbed areas with a suitable seed mix for the area. Impacts on hydrologic connectivity associated with temporary access roads likely would be short term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Because the improvements required for the rail lines would be accomplished on the existing rail embankments, they would not be expected to affect hydrologic connectivity.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction of offloading facilities, the potential for stormwater to carry contaminants into surface waters is low. Surface water near construction areas could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. However, to protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles. Similar treatment/disposal or discharge measures to those described above for the Applicant's preferred route would be necessary for handling concrete wash water and rinse water generated by construction and hydrostatic testing, if such testing is done.

In addition, permits would stipulate the Applicant's responsibility for cleaning up small spills during construction, using procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

With implementation of the above practices and adherence to the requirements of NPDES permits, impacts related to degradation of water quality on nearby surface waters from small spills and leaks during construction would be temporary and negligible to minor.

Disturbance of Wild Rice Waterbodies

No wild rice waterbodies are located within the general area for the new rail access route from Gully to Clearbrook, and the offloading facility near Clearbrook in Minnesota. Therefore, no impacts on wild rice waterbodies are expected from construction associated with the rail alternative. No wild rice waterbodies are located in the general area for the new rail offloading facility near Superior in Wisconsin.

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. The offloading facilities would be designed to comply with NPDES permits and other permitting requirements that control runoff from industrial sites. The increase in impermeable surfaces would alter runoff patterns; however, with adherence to permitting requirements, a substantial increase in stormwater runoff and erosion would not be anticipated. Consequently, potential impacts on surface waters from increases in stormwater runoff and erosion would be permanent and negligible to minor.

Rail transport would be conducted on existing embankments, with no changes to stormwater runoff or erosion patters and no impact on surface waters.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. Operation of the rail facilities and train transportation would not likely result in increased runoff or introduction of eroded materials into nearby surface waters, causing increases in TSS concentrations or sedimentation. Therefore, no impact would occur.

Disruption of Flow Paths or Local Hydrologic Connectivity. The presence of the permanent offloading facilities would affect hydrologic connectivity. The specific locations and acreages covered by permanent facilities were not known at the time this EIS was prepared. However, the footprints of these facilities would be relatively small in comparison to the hydrogeologic flows in the areas near the facilities. Consequently, it is anticipated that the impact of their presence would be permanent but negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area

and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Operation of unit trains would increase the amount of materials dropping from the trains to the railroad bed from the current level. Material reaching the railroad bed could include materials from brakepad consumption, lubrication, and fuel drips and leaks. The increase above current conditions is expected to be minor and typical of transport of cargo by rail. If petrochemicals reach areas of the railroad bed adjacent to surface waters, it is possible that the petrochemicals could migrate to the surface water and create a sheen. However, the quantity of materials leaking during normal operation would be small, and the associated impact on surface water quality likely would be temporary and minor. The potential impacts on surface water resources due to an unanticipated crude oil release are discussed in Chapter 10.

Disturbance of Wild Rice Waterbodies

Because no wild rice waterbodies are located within the general area for the offloading facility near the Clearbrook terminal in Minnesota or the offloading facility near the Superior terminal in Wisconsin, no impacts on wild rice waterbodies would occur from operation of these facilities. Rail transport routes through Minnesota and Wisconsin would cross near multiple wild rice waterbodies. Degradation of surface water quality from drips, leaks, and mechanical wear from train transportation could result in temporary and negligible to minor impacts on wild rice waterbodies.

Transportation by Truck

Transportation of crude oil by truck would require development of truck loading and offloading facilities, transport on existing roadways, construction of new roadways to access the offloading terminals, and also may require roadway improvements near the facilities (described in Section 4.2.7). As currently envisioned, the truck loading facility would be constructed and operated in Gretna, Canada. Those facilities would require permitting by provincial and national entities in Canada and therefore are not addressed in this EIS. The offloading facilities would be sited within and adjacent to the existing Enbridge terminals in Clearbrook, Minnesota, and in Superior, Wisconsin. The specific locations of the offloading facilities have not been identified. New construction would be required in undeveloped areas at both offloading facility locations.

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion*.* Clearing and grading would be required for construction of new facilities, new roadways, access roads, and roadway improvements, resulting in changes to stormwater runoff and erosion and the potential for runoff to reach nearby surface waters. It is likely that stormwater NPDES permits would be required, along with measures to address erosion and sediment controls to be implemented during construction, stormwater pollution management, waste disposal, maintenance and inspection practices, and any additional requirements to prevent stormwater pollution. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, requirements of applicable permit programs are in place to manage potential impacts. This includes NPDES permits that would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site

to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible. With adherence to NPDES permit stipulations and use of appropriate BMPs, similar to those described for the Applicant's preferred route, impacts on surface waters from increases in stormwater runoff and erosion from clearing and grading during construction would be short term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. The temporary erosion controls, SWPPP requirements, and NPDES permit requirements described above likely would be required during construction of the offloading and related facilities, including new roads, to prevent sediment transport into nearby surface waters during construction. As a result, no increases or small increases in TSS concentrations and sedimentation would occur in nearby water crossings. Therefore, construction of facilities for the truck alternative would result in temporary negligible impacts related to increased TSS concentrations and sedimentation in surface waters.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of offloading and related facilities would require water for dust control and other construction activities such as preparation of concrete. Water may also be required for hydrostatic testing of new storage tanks if they are included in the design. The source of the water, whether it would be withdrawn from surface waters or a PWS, is not known. If obtained from surface waters, it was assumed that appropriate BMPs would be implemented such as those described in the Environmental Protection Plan (Appendix E), and that all necessary permits (e.g., NPDES permits for discharges) would be obtained. Consequently, impacts on surface waters would be expected to be temporary and negligible to minor. If water is obtained from public water supplies provided by a local utility, there would be no withdrawals of surface water and therefore no impact.

Disruption of Flow Paths or Local Hydrologic Connectivity. Construction of the offloading facilities may disrupt flow paths and groundwater-surface water interaction due to clearing and grading and water appropriation (for dust control and other construction-related activities) and discharge. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation and, if applicable, to monitor stream flows during water appropriation and discharge, impacts on flow and hydrologic connectivity during construction of the offloading and related facilities would be temporary to short term and minor.

Construction would involve creation of both temporary and new permanent roadways roads that also could affect hydrologic connectivity. Applicable permits likely would stipulate that temporary access roads, including roads that were widened and graded, be restored to preconstruction conditions upon completion of construction. The restoration likely would include seeding disturbed areas with a suitable seed mix for the area. Impacts on hydrologic connectivity associated with temporary access roads likely would be short term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low. Surface water near construction areas could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. However, to protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites,

containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles. Similar treatment/disposal or discharge measures to those described for the Applicant's preferred route would be necessary for handling concrete wash water and rinse water generated by construction and hydrostatic testing, if such testing is done.

In addition, permits would stipulate responsibilities for cleaning up small spills during construction using procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

With implementation of the above practices and compliance with requirements of NPDES permits, the impact on nearby surface waters of small leaks and spills during construction would be temporary and negligible to minor.

Disturbance of Wild Rice Waterbodies

No wild rice waterbodies are located within the general area for the truck access and offloading facility near the Clearbrook terminal in Minnesota. Therefore, no impacts on wild rice waterbodies are expected from construction associated with the truck alternative.

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. The offloading facilities would be designed to comply with NPDES permits and other permitting requirements that control runoff from industrial sites. New roadways and improvements to existing roadways would be expected to comply with state and local permitting requirements, although there would be an increase in runoff, and the increase in impermeable surfaces would alter runoff patterns. With adherence to permitting requirements, there likely would not be a substantial increase in stormwater runoff or erosion. Therefore, the impact on surface waters due to changes in stormwater runoff and erosion would be permanent and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. As noted above, *o*peration of the truck offloading facilities would not likely result in substantial increased runoff or introduction of eroded materials into nearby surface waters. Therefore, TSS and sedimentation in the surface waters are not likely to increase, with no associated impact from operation of the facilities.

Construction of new roadways and improvement of new roadways would increase runoff and the potential for eroded materials and materials on the roadway to reach nearby surface waters. If surface waters are adjacent to or near the roadways, an increased amount of these materials could reach nearby surface waters. However, the quantity of materials reaching surface waters likely would be small, and the associated impact on surface water from increases in TSS and sedimentation would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. The presence of the permanent offloading facilities would affect hydrologic connectivity. The specific locations and acreages covered by permanent facilities are not known. However, the footprints of these facilities would be relatively small in comparison to the hydrogeologic flows in the areas near the facilities. Consequently, it is anticipated that their presence would result in permanent but negligible to minor impacts.

It is anticipated that permanent access roads constructed for the truck alternative would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Operation of trucks on the highways and other roadways would increase the amount of materials dropping from the trucks to the roadway. Material reaching the roadway primarily would consist of materials from brakepad consumption, lubrication, and petrochemical drips and leaks from engines. The increase above current conditions is expected to be minor and typical of transport of cargo by truck. If petrochemicals reach areas of the roadway adjacent to surface waters, it is possible that the petrochemicals could migrate to the surface water and create a sheen. However, the quantity of materials leaking during normal operation would be small, and the associated impact on surface water quality likely would be temporary and minor. The potential impacts on surface water resources due to an unanticipated crude oil release are discussed in Chapter 10.

Disturbance of Wild Rice Waterbodies

Because no wild rice waterbodies are located within the general area for the truck offloading facilities, no impacts on wild rice waterbodies would occur from operation of these facilities. Truck transport routes through Minnesota and Wisconsin would cross near multiple wild rice waterbodies. Degradation of surface water quality from drips, leaks, and mechanical wear from truck transportation could result in temporary and negligible to minor impacts on wild rice waterbodies

Existing Line 3 Supplemented by Rail

Surface water impacts associated with the combined use of the existing Line 3 pipeline and the rail alternative would be the same as those identified for the continued operation of the existing Line 3 pipeline in addition to those of the rail alternative identified above.

Existing Line 3 Supplemented by Truck

Surface water impacts associated with the combined use of the existing Line 3 pipeline and the truck alternative would be the same as those identified for the continued operation of the existing Line 3 pipeline in addition to those of the truck alternative identified above.

5.2.1.2.5 Regional Analysis of Impacts on Quality of Existing Surface Water Conditions

For northern Minnesota streams, the conversion of forested perennial cover to grassland dominated cover can have an overall effect on local hydrology by affecting the smaller peak flows. This is the yearly bankfull flow that shapes the channel and builds the floodplain (Verry 2001). Removing permanent perennial cover along streams also reduces instream quality and habitat by increasing water temperatures, negatively affecting trout. Nutrient export from converted landscapes can also increase to lakes or streams when changing from forested to open grassland cover. The amount may be

dependent on soil, slope and other factors (Radomski 2005). The overall effects of changes in forest cover on hydrology, nutrient export and temperature are dependent on the condition of the nearby watershed. The greater the landscape alteration the more potential for these changes. Quantifiable estimates of impacts from land use change activities is available and has been used to predict hydrology and water quality changes to surface waters with the use of computer modeling programs.

Northern forested wetlands that are converted to open linear landscapes can allow for invasive species or other aggressive plants to develop monocultures and displace native vegetation. Corridors are often prone to infestations of narrowleaf (*Typha angustifolia*) or hybrid cattail (*Typha X glauca*) which are not listed as an invasive plant but have been an aggressive nuisance with previous pipeline development.

5.2.1.2.6 Summary and Mitigation

Summary

At any specific surface water location along all the alternatives may be minor with appropriate use of construction and operation practices, however due to the great lengths of all alternatives the total impact would be additive and distributed along the routes. The importance of these impacts is determined by the distance of the alternative, number of surface water interactions, and the quality of surface water resources affected.

Potential impacts of the Applicant's preferred route and the CN Alternatives to surface waters from construction and normal operations range from no impact to permanent impacts (Table 5.2.1.2-14) and from negligible to major, with the exception of instances where a "frac-out" occurs while doing HDD boring. Temporary impacts are mostly related to construction and permanent impacts are identified for some operational practices. There are potential minor to major construction impacts on rice growing waterbodies for the Applicant's preferred route. SA-04, does not have wild rice waterbodies located within the ROI and thus would have no impacts on rice growing waterbodies.

Greater potential for construction-related impacts would likely occur for the Applicant's preferred route and SA-04, which would both require pipeline construction over long distances. Since rail and truck would rely mainly on existing infrastructure, construction-related impacts would be limited to new offloading facilities adjacent to the Clearbrook and Superior terminals and re-installation/upgrade of a limited length of track in the vicinity of Clearbrook. Continued use of existing Line 3 would not require any new construction and thus have no construction impacts.

During operations, continued use of existing Line 3, the Applicant's preferred route, and SA-04 could all require integrity digs that have the potential for localized limited impacts. The potential for integrity digs however, would likely be lower for the Applicant's preferred route or SA-04 as they would be for new pipelines, whereas the other alternatives would include continued use of existing Line 3, which is projected to require a number of integrity digs (see Chapter 4).

Table 5.2.1.2-14. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Increases in stormwater runoff and erosion from newly cleared areas and impervious surfaces	Short-term to long-term/minor impacts • 227 waterbody crossings (192 in MN) • 46 designated waterbody crossings • 6 trout stream crossings • 9 NRI-listed river crossings (7 in MN) • 16 impaired waterbody crossings (12 in MN) • 7 navigable waterway crossings (6 in MN)	No impact	Short-term to long-term /minor impacts • 636 waterbody crossings (172 in MN) • 56 designated waterbody crossings • 526 undesignated waterbody crossings • 6 NRI-listed river crossings (1 in MN) • 32 impaired waterbody crossings (8 in MN) • 9 navigable waterway crossings (2 in MN)	Short-term to long-term /minor impacts • 448 waterbody crossings	Short-term to long-term /minor impacts • 225 waterbody crossings	Short-term to long-term /minor impacts • 448 waterbody crossings	Short-term to long-term /minor impacts • 225 waterbody crossings
Increases in total suspended solids concentrations and increased sedimentation	Temporary to short-term/negligible to minor impacts	No impact	Temporary to short-term/negligible to minor impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts

Table 5.2.1.2-14. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Changes in stream flows from water withdrawals and discharges	Temporary/minor impacts	No impact	Temporary/minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts
Disruption of flow paths or local hydrologic connectivity	Temporary to permanent negligible to major impacts	No impact	Temporary to permanent negligible to major impacts	Temporary to permanent negligible to major impacts	Temporary to permanent negligible to major impacts	Temporary to permanent negligible to major impacts	Temporary to permanent negligible to major impacts
Degradation of surface water quality	Temporary to short-term/negligible to minor impacts	No impact	Temporary to short-term/negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts
Degradation of aquatic habitat from instream activities	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*)	No impact	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*)	No impact	No impact	No impact	No impact
Degradation of water quality and habitat from releases of drilling mud during HDD crossings	Short-term/minor impacts *(if quickly contained*) to long-term/major impacts (*if undetected or uncontained)*	No impact	Short-term/minor impacts *(if quickly contained*) to long-term/major impacts (*if undetected or uncontained)*	No impact	No impact	No impact	No impact
Changes in channel morphology and stability caused by channel and streambank modifications	Short-term to long-term/ minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*)	No impact	Short-term to long-term/ minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*)	No impact	No impact	No impact	No impact

Table 5.2.1.2-14. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Disturbance of wild rice waterbodies	Short-term/minor to major impacts • 5 acres • 5 waterbodies	No impact	No impact • No wild rice waterbodies along the route	No impact • No wild rice waterbodies in the general area of rail offloading facilities	No impact • No wild rice waterbodies within the general area of truck offloading facilities	No impact	No impact
Operations Impacts							
Increases in stormwater runoff and erosion	Short-term to permanent/ negligible to minor impacts	Short-term to permanent/ negligible to minor impacts	Short-term to permanent/ negligible to minor impacts	Permanent/ negligible to minor impacts	Permanent/ negligible to minor impacts	Short-term to permanent/ negligible to minor impacts	Short-term to permanent/ negligible to minor impacts
Increases in total suspended solids concentrations and increased sedimentation	Short-term to permanent/ negligible to minor impacts	Short-term to permanent/ negligible to minor impacts	Short-term to permanent/ negligible to minor impacts	No impact	Temporary/ minor impacts	Short-term to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts
Changes in stream flows from water withdrawals and discharges	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	No impact	No impact	Temporary/ negligible impacts	Temporary/ negligible impacts
Disruption of flow paths or local hydrologic connectivity	Temporary to permanent/ negligible to minor impacts from access roads	Temporary to permanent/ negligible to minor impacts from access roads	Temporary to permanent/ negligible to minor impacts from access roads	Permanent/ negligible to minor impacts	Permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts
Degradation of surface water quality	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts	Temporary/ minor impacts	Temporary/ minor impacts	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts

Table 5.2.1.2-14. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Degradation of aquatic habitat from instream activities	Temporary to short-term/minor impacts from integrity digs	Temporary to short-term/ minor impacts from integrity digs	Temporary to short-term/minor impacts from integrity digs	No impact	No impact	Temporary to short-term/minor impacts from integrity digs	Temporary to short-term/ minor impacts from integrity digs
Changes in channel morphology and stability caused by channel and streambank modifications	Temporary to short-term/negligible to minor impacts from integrity digs	Temporary to short-term/ negligible to minor impacts from integrity digs	Temporary to short-term/negligible to minor impacts from integrity digs	No impact	No impact	Temporary to short-term/ negligible to minor impacts from integrity digs	Temporary to short-term/ negligible to minor impacts from integrity digs
Disturbance of wild rice waterbodies	Short-term/ negligible to major impacts • 3 acres • 5 waterbodies	Short-term/ negligible to major impacts • 1 wild rice waterbody in proximity	No impact • No wild rice waterbodies occur along this route	Temporary/ negligible to minor impacts • Multiple wild rice water bodies along rail routes	Temporary/ negligible to minor impacts • Multiple wild rice water bodies along truck routes	Short-term/ negligible impacts • 1 wild rice waterbody in proximity	Short-term/ negligible impacts • 1 wild rice waterbody in proximity

HDD = horizontal directional drilling, NRI = Nationwide Rivers Inventory

Construction Impacts

Runoff and Flows

Construction of the Applicant's preferred route and the CN Alternatives, except for continued use of the existing Line 3, would cause changes to runoff and flows. The disruption of flow paths and local hydrologic connectivity for Applicant's preferred rout and SA-04 could result in permanent impacts. Permanent impacts would also result from construction of aboveground pipeline facilities and permanent access roads for pipeline alternatives and offloading facilities for the rail and truck transport alternatives. These impacts would occur along approximately 795 miles (250 in Minnesota) for SA-04 compared to approximately 340 miles in Minnesota for the Applicant's preferred route. For the rail and truck alternatives, construction impacts would occur over a smaller total area and would include areas near the offloading terminals and the new and improved roadways. Individual impacts on runoff and flows at any specific surface water location along all the alternatives is anticipated to be minor with appropriate use of construction and operation practices, however due to the great lengths of all alternatives the total impact would be additive and distributed along the routes. The importance of these impacts is determined by the distance of the alternative, number of surface water interactions, and the quality of surface water resources affected.

Surface Water and Aquatic Habitat Quality

Construction would mainly result in temporary impacts on surface water quality for the pipeline alternatives unless drilling fluids are released during HDD crossings and remain uncontained or undetected. In that event, the water quality impact would be long term and major. Construction of the pipeline alternatives would result in temporary impacts on aquatic habitat quality; construction of the rail and truck alternatives would only affect aquatic habitats for those areas where needed upgrades and surface waters coincide, such as improved river crossings. There would be a substantial difference in the number of surface waters affected by pipeline crossings: the Applicant's preferred route would cross 227 (192 in Minnesota) surface waters, and SA-04 would cross 636 (172 in Minnesota) surface waters. However, the existing condition of water resources as represented through comparisons of state geographic areas indicate the preferred alternative crosses higher quality surface water resources. The number of surface water ditches and the lack of perennial cover as well as ecoregion water quality are good indicators of the specific type of poorer surface water quality areas crossed by or near SA-04. High-quality surface water resources are managed most appropriately with long-term watershed "protection" strategies to maintain existing conditions.

SA-04 also would cross more NRI-listed river crossings (fewer in Minnesota—one vs. seven for the Applicant's preferred route) and impaired waterbody crossings (12 in Minnesota for the Applicant's preferred route and 8 in Minnesota for SA-04). If construction activities are not properly mitigated or managed, impacts on impaired or low-quality waterbodies may cause further degradation of the waterbody, exacerbate an existing impairment, cause additional impairments, interfere with restoration activities, and/or delay attainment of water quality standards. Impaired waters are more related to watershed-scale factors such as lack of perennial cover and ditching and/or more direct hydrology impacts of tiling related to agriculture as well as the lack of natural stream conditions. Restoration in some areas after construction could be managed through improved runoff and instream management with newly added perennial vegetation and properly sloped banks at crossings.

Impacts on high-quality waterbodies (i.e., trout streams, NRI-listed rivers, and wild rice waterbodies) may decrease the suitability of surface water as a habitat for sensitive species or degrade the existing beneficial use of the waterbody. There are a large number of lakes and streams in north-central and

northeast Minnesota and they are of the highest quality when comparing ecoregion data and Watershed Health Scores as well as other specific indicators such as tullibee lakes, wild rice lakes, LBS and trout streams. Further, in general, statewide maps indicate better health scores across the north and east and poorer scores across the south and west as depicted by analysis of the five different indicator components (Biology, Connectivity, Geomorphology, Hydrology and Water Quality). Keeping high-quality surface waters off impaired waters listings is highly important to current Clean Water activities however, keeping these resources in their current condition is just as important for maintaining surface water health components. Removing riparian zone vegetation such as trees and shrubs and herbaceous layers within the surface water areas of the NLF Ecoregion may be a permanent or take decades to recover whereas southern areas generally have fewer trees and other perennial cover and are often plowed to the stream edge. Recovery in southern Minnesota areas within SA-04 would generally happen more quickly, often within the first year. Effects of individual stream crossings on aquatic habitat and temperature of streams in the NLF would potentially be greater.

Channel Morphology and Stability

Pipeline construction impacts on channel morphology and stability would be short term to long term and minor, except where an HDD or guided bore crossing method is used; impacts on channel morphology and stability are not anticipated to occur at those locations. As noted above, SA-04 would cross a substantially greater number of surface waters (fewer in Minnesota) compared to the Applicant's preferred route. The rail and truck alternatives could affect channel morphology or stability in the areas where improved river crossings are needed.

Wild Rice Waterbodies

Construction of SA-04, the rail alternative, and the truck alternative would not affect any wild rice waterbodies. Construction of the Applicant's preferred route would result in impacts on approximately 5 acres of wild rice waterbodies.

Operations Impacts

Runoff and Flows

For all routes, the impacts of operation on runoff and flows range from temporary to permanent at each affected location. For the pipeline alternatives, short-term impacts would result from periodic integrity digs to repair or replace segments of pipe, including the need for hydrostatic test water for new pipe segments. The decades-old existing Line 3 would require substantially more digs than either of the two new pipeline alternatives.

Permanent impacts on stormwater runoff would result from the presence of new aboveground pipeline facilities and permanent access roads, and new offloading facilities and associated new and improved roads. The operator of the new and expanded facilities would be required to manage stormwater runoff through NPDES permits and SWPPPs and through installation of stormwater retention ponds. These impacts would occur along a greater distance for the SA-04 alternative compared to both pipeline alternatives. Impacts on runoff and flows from the rail and truck alternatives would be limited to the offloading facilities and new and improved roads/rails, and nearby areas.

Temporary to permanent disruption of flow paths and local hydrologic connectivity would result from construction of aboveground pipeline facilities and permanent access roads for pipeline alternatives and offloading facilities for the rail and truck transport alternatives. These impacts would occur along approximately 795 miles (250 miles in Minnesota) for SA-04 compared to approximately 340 miles for

the Applicant's preferred route. Removing riparian zone vegetation such as trees and shrubs and herbaceous layers within the surface water areas of the NLF Ecoregion may be permanent or take decades to recover whereas southern areas generally have fewer trees and other perennial cover and are often plowed to the stream edge. Recovery in southern Minnesota areas within SA-04 would generally happen more quickly, often within the first year. Final recovery during operation may not represent historic natural riparian zone quality in the NLF. Effects on runoff and quality during operation in the NLF would potentially be greater than historic natural conditions.

Surface Water and Aquatic Habitat Quality

Impacts on water quality during operation primarily would be temporary for all CN Alternatives but would occur periodically over the life of the Project. In areas where woody riparian vegetation would be permanently removed from the permanent rights-of-way for the Applicant's preferred route and SA-04, the effect on water temperature would be permanent. This impact would occur along a substantially longer (shorter in Minnesota) pipeline route for SA-04. Removing riparian zone vegetation such as trees and shrubs and herbaceous layers within the surface water areas of the NLF Ecoregion may be permanent or take decades to recover whereas southern areas generally have fewer trees and other perennial cover and are often plowed to the stream edge. Recovery in southern Minnesota areas within SA-04 would generally happen more quickly, often within the first year. Effects on habitat, temperature of streams and runoff rate and quality in the NLF would potentially be greater. Surface water temperature would not be affected by continued use of the existing Line 3.

The primary impact on water quality and habitat quality during operations likely would result from periodic integrity digs to repair or replace segments of pipe installed across surface waters. This would occur more often for continued use of the existing Line 3 because of its age compared to a new pipeline. The rail and truck alternatives would not affect instream habitats.

Channel Morphology and Stability

Operation of all pipeline alternative routes could result in impacts on channel morphology and stability, primarily from periodic integrity digs that are expected to be temporary. Integrity digs would occur substantially more often for the existing Line 3 because of its age compared to a new pipeline. The rail and truck alternatives would not affect channel morphology or stability.

Wild Rice Waterbodies

Integrity digs for the Applicant's preferred route during operation could affect as much as 3 acres of wild rice waterbodies, and integrity digs for continued use of the existing Line 3 could affect up to 1 acre of wild rice waterbodies. Operation of SA-04 would not affect wild rice waterbodies. Drips, leaks, and mechanical wear from normal train and truck transportation for the rail and truck alternatives could lead to impacts on nearby wild rice waterbodies. Large numbers of wild rice lakes exist in the NLF, and this is represented by several lakes within ½ mile of the alternatives in this ecoregion including train and truck routes.

Mitigation

In addition to the Applicant-proposed measures to avoid or minimize impacts that would be incorporated into the Project and the stipulations in permits required for the Project, Minnesota DNR identified the following mitigation measures for consideration by the Commission to further avoid and minimize impacts:

- Where riparian vegetation is removed at surface water crossings, revegetate the construction work area with a minimum 50-foot-wide buffer of woody vegetation to reduce runoff, erosion, bank stability, water quality degradation, sunlight penetration, and water temperature warming, and increase bank stability.
- Longer term impacts of clearing in temporary work areas could be offset by reestablishing or enhancing the existing cover type within up to 500 feet of waterbodies, depending on topography.
- After construction on state forest lands or state Wildlife Management Areas, tree planting on all temporary workspaces could be accomplished to reduce erosion and runoff, as well as to ensure that forested areas within the riparian zone are restored to forest cover.

Rock riprap should be considered or permitted only when infrastructure (public or private) is at risk. Natural channel design and bioengineering methods should be considered the primary means of streambed and streambank restoration and stabilization.

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5.2.1.3 Wetlands

A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. Wetlands are defined in a variety of ways for federal, state, and local regulatory protection; however, the common factors that distinguish wetlands from other landforms or waterbodies are the presence of a hydrophytic (waterlogged) vegetation community, hydric soils,[10] and hydrology. All wetlands provide a variety of functions of social significance, including: surface water storage (flood control), shoreline stabilization (wave damage protection/shoreline erosion control), stream flow maintenance (maintaining aquatic habitat and aesthetic appreciation opportunities), groundwater recharge (some types replenish water supplies), sediment removal and nutrient cycling (water quality protection), aquatic productivity (fishing, shellfishing, and waterfowl hunting), production of trees (timber harvest), production of herbaceous growth (livestock grazing and haying), production of peaty soils (peat harvest), and wildlife habitat (hunting, trapping, plant/wildlife/nature photography, nature observation, and aesthetics) (EPA 2002a, 2006).

The analysis of impacts on wetlands during construction of the Applicant's preferred route and CN Alternatives considered changes to wetland characteristics and functions by alteration or loss of the plant communities through removal or cover with fill, and by alteration or loss of the hydrologic

[10] A soil that forms under conditions of water saturation long enough during the growing season to develop anaerobic conditions in the upper part of the soil.

conditions that maintain wetland plant communities and wetland soils. Construction and operations impacts considered included:

- Changes to forested and scrub/shrub wetland characteristics and functions
- Changes to emergent wetland characteristics and functions
- Changes to Minnesota Public Waters Wetlands characteristics and functions
- Changes to Minnesota calcareous fen characteristics and functions
- Changes to Wetland Reserve Program wetland characteristics and functions
- Changes to wetland mitigation bank easements characteristics, functions and availability

This section first describes the existing wetlands, including Public Waters Wetlands, calcareous fen wetlands, and wetland conservation easements, within the area along the Applicant's preferred route and each of the CN Alternatives where wetlands could be affected by construction and operation of the Project. The potential Project-related impacts of the Applicant's preferred route on wetlands during construction and operation then are discussed, along with measures the Applicant would implement to minimize impacts. Next, the potential impacts on wetlands during construction and operation are addressed for each CN Alternative (continued use of existing Line 3, SA-04, transportation by rail, transportation by truck, and existing Line 3 supplemented by rail or truck). A summary and comparison of potential Project-related impacts are included at the end of the section, with potential mitigation measures to be considered.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

5.2.1.3.1 Regulatory Context and Methodology

Regulatory Context

General Wetlands

Federal and State Jurisdictional Wetlands

CWA Section 404 and Rivers and Harbors Act Section 10 Individual Permits and associated state CWA Section 401 Individual Water Quality Certification for the Project in Minnesota are under the jurisdiction of USACE – St. Paul District and Minnesota PCA. USACE requires that projects avoid impacts on wetlands to the extent practicable, potential impacts have been minimized, and may require compensation be provided for unavoidable impacts (addressed below).

For CWA Section 401 certification, Minnesota PCA is responsible for non-reservation wetlands in Minnesota, Wisconsin DNR is responsible for wetlands in Wisconsin, and North Dakota DH's Division of Water Quality is responsible for wetlands in North Dakota. Permitting for system alternative SA-04 would require obtaining a CWA Section 401 certification from Iowa DNR and Illinois DNR. Adherence to state-specific general construction and stormwater permit conditions, buffer laws, and other state and local resource protection measures also would be required, which would serve as a duplicative mechanism for oversight and protection of jurisdictional wetland resources.

In Minnesota, the Wetland Conservation Act (WCA) protects wetlands and applies to all wetlands except Public Waters Wetlands (described below). The WCA requires projects that affect wetlands to try to

avoid the impact, minimize any unavoidable impacts, and replace any lost wetland functions. Responsibility for administration of the WCA is shared by local government units and Minnesota Board of Water and Soil Resources (Minnesota BWSR) (Minn. R. Ch. 8420), and is enforced by Minnesota DNR.

In North Dakota, the Office of the State Engineer is responsible for first review of a project permit that affects a wetland. If the project does not have a large-scale impact on the state, it is directed to a jurisdictional Water Resource District Board for review and approval (North Dakota AC 89-02-01-09). In Illinois, the Interagency Wetland Act of 1989, administered by Illinois DNR, establishes a zero net loss for wetlands in the state, which would require mitigation by the Applicant for any wetlands affected (Illinois DNR 2000). Iowa relies solely on CWA Section 401 for wetland permitting and does not have supplemental required regulations (Illinois AC 567-61.2). In Wisconsin, Wisconsin DNR regulates wetlands in addition to USACE and reviews projects for water resources permits, including wetland crossings, and may require compensatory mitigation under Wisconsin Statute § 281.36 and Wisconsin Administrative Code NR 299 and NR 103.

Compensatory Mitigation

Compensatory wetland mitigation may be required in federal and state-specific permitting for permanent impacts on forested, scrub/shrub, and emergent wetlands. The overall objective of compensatory wetland mitigation would be to compensate for lost wetland aquatic resource functions, taking into consideration what is available and feasible. Compensatory wetland mitigation would be consistent with applicable policies, regulations, and rules governing compensatory wetland mitigation for the purposes of Section 404 CWA, including, but not limited to:

- USACE, St. Paul District Draft Compensatory Mitigation Policy for Minnesota, dated January 23, 2009;
- Joint guidance between St. Paul District and Minnesota BWSR for Developing Mitigation Plan Performance Standards and Credit Release Schedules in Minnesota, dated December 16, 2015;
- USACE and EPA Final Rule Regarding Compensatory Mitigation for Losses of Aquatic Resources, dated April 10, 2008; and
- Minnesota Office of the Revisor of Statutes 7050.0186 Wetlands Standards and Mitigation, dated April 1, 2008 and wetland replacement regulations as described under the WCA.

Specially Designated Wetlands

Minnesota Public Waters Wetlands

Public Waters Wetlands are a subset of the State's jurisdictional wetlands regulated under Minnesota Statutes § 103G. Public Waters Wetlands are regulated as public waters under Minnesota DNR's License to Cross Public Waters program. Where Public Waters Wetlands occur, or a License to Cross Public Waters would be required from Minnesota DNR.

Minnesota DNR is responsible for granting utility crossing licenses for any utility projects proposing to cross Public Waters Wetlands, if the crossing plans are reasonable, practical, and will adequately protect public safety and promote the public welfare (Minn. Stat. § 84.415, and §103G.315). The Applicant may request exemption from wetland replacement requirements under existing utility exemptions for those portions of the Project within Public Waters Wetlands that would be regulated under WCA standards.

Utility crossing licenses generally are required for installation of electrical, pipeline, and communication projects and are granted for a term of 25 or 50 years.

Calcareous Fen Wetlands

Calcareous fens are wetlands characterized by a substrate of non-acidic peat and dependent on a constant supply of cold, oxygen-poor groundwater rich in calcium and magnesium bicarbonates. They are rare and typically occur on slight slopes where upwelling water eventually drains away and where surface water inputs are minimal.

Impacts on calcareous fens are regulated by Minnesota DNR under the WCA. Under this act, a calcareous fen may not be filled, drained, or otherwise degraded, wholly or partially, by any activity. If impacts are identified and deemed necessary by the Minnesota Commissioner of Natural Resources, a Fen Management Plan must be provided by the applicant (Minn. Stat. § 103G.223). Eight state-listed, rare plant species are known to be commonly found within calcareous fens; these plant species would be additionally protected under Minnesota's Endangered Species Act (Minn. Stat. § 84.0895).

Calcareous fens in Iowa and Illinois, where local state rules and regulations apply, would need to be surveyed and protected, if present along system alternative SA-04. In Iowa, 20 threatened plant species were identified in the calcareous fen wetlands located in the northern portion of the state. They would require compliance with the Threatened and Endangered Species Program managed by Iowa DNR. Projects with potential impacts on calcareous fen wetlands in Illinois would need to follow the State's Interagency Wetland Act of 1989 (20 ILCS 830).

Wetland Reserve Program

The Wetland Reserve Program, a voluntary federal program managed by NRCS, supported wetland conservation, restoration, and enhancement projects on private agricultural and pastoral land through easements and restoration cost-share agreements. The Wetland Reserve Program ran from 2009 to 2014 and was replaced by the Agricultural Conservation Easement Program of the Agricultural Act of 2014, which has the same objectives and implementation tools.

Minnesota Wetland Mitigation Bank Easements

The Minnesota BWSR Mitigation Banking Program administered under the WCA (Minn. R. 8420.0700 to 8420.0820) facilitates applying for or purchasing wetland credits toward future wetland impacts. The Minnesota BWSR oversees the program with local government units involved in landowner application and monitoring. Minnesota created 10 wetland bank service areas. Bank credit ratio is reduced if the credit area used is in a different service area than the disturbance area (Minnesota BWSR 2016).

Methodology

As a part of the evaluation of potential impacts on wetlands and effects on specially designated wetland resources, the following information sources were used to identify wetlands potentially affected by construction and operation of the Project:

- USFWS National Wetlands Inventory (NWI) database (USFWS 2016), classified using the Cowardin classification system (Cowardin et al. 1979);
- Minnesota DNR Public Waters Wetlands database (Minnesota DNR 2014), classified based on USFWS Circular No. 39 (EPA 2002b);

- Minnesota DNR calcareous fens database (Minnesota DNR 2008), ranked based on the conservation status ranking (or "S-rank") methodology developed by NatureServe and its member natural heritage programs in North America (NatureServe 2016), and classified using Minnesota's native plant community classifications (Minnesota DNR 2005);
- USGS Protected Area Database – Wetland Reserve Programs (USGS 2016); and
- Minnesota wetland mitigation bank easements database (Minnesota BWSR 2015).

The ROI for the wetland evaluation encompasses areas that could be directly or indirectly affected by pipeline construction and areas within the footprints of new or expanded facilities required for the rail and truck alternatives.

Typical wetland disturbance effects for the Applicant's preferred route and system alternative SA-04 were based on the Applicant's proposed construction methods described in Chapter 2 and the special wetland construction methods described in the Applicant's November 2016 EAW (Enbridge 2016). Wetland disturbance effects for the rail and truck alternatives were based on implementing general construction practices and BMPs.

Potential wetland impacts for the Applicant's preferred route were evaluated by overlaying the footprints of the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, MLV pads and driveways, and pump stations on the identified wetland maps. Comparisons of construction impacts between the Applicant's preferred route and SA-04 were based on the evaluations of the Applicant's preferred route and a 120-foot-wide construction work area centered on system alternative SA-04. Comparisons of operations impacts were based on the Enbridge-provided footprint for the Applicant's preferred route permanent right-of-way and a 50-foot-wide permanent right-of-way for system alternative SA-04. It should be noted that the Applicant's preferred route incorporates measures to avoid or minimize wetland impacts and these types of measures are accounted for in the impacts estimates. These same types of wetland impact reductions are not incorporated into SA-04 for this evaluation.

The potential wetland impacts of continued use of the existing, transportation by rail, transportation by truck, existing Line 3 supplemented by rail, and existing Line 3 supplemented by truck were qualitatively assessed based on publically available wetland information, potential locations for new facilities, and potential transportation routes.

5.2.1.3.2 Existing Conditions

Wetland Types

Wetlands potentially affected by the CN Alternatives were grouped into three wetland categories: forested wetland, scrub/shrub wetland, and emergent wetland.

General Wetlands

Forested wetlands are dominated by woody vegetation 20 feet or taller, including evergreen forest, deciduous forest, and mixed forest wetlands. Scrub/shrub wetlands are dominated by woody vegetation less than 20 feet tall including tall and low-growing woody shrubs. Woody wetlands include both forested and scrub/shrub wetlands: the term "woody wetlands" is sometimes used in this EIS when discussing forested and scrub/shrub wetlands. Emergent wetlands that would be crossed by the Applicant's preferred route are dominated by erect, rooted, herbaceous wetland plants such as sedges,

rushes, and grasses. Most of the emergent prairie wetlands that were previously in the region have been converted to croplands. Federal and state jurisdictional wetlands occur along the routes for the CN Alternatives, including specially designated wetlands.

Detailed maps that show the locations of wetlands and calcareous fens are in Appendix A.

Specially Designated Wetlands

Specially designated wetlands are identified as high-value wetlands resources based on environmental and socioeconomic factors such as size, environmental function, presence of high-value resources, habitat qualities, species diversity, and participation in federally and state-funded conservation programs. Specially designated wetlands and their values are of specific concern to state and local agencies. The specially designated wetlands addressed in this analysis are:

- Minnesota DNR's Public Waters Inventory – Public Waters Wetlands,
- Minnesota calcareous fen wetlands,
- NRCS managed wetlands, and
- Minnesota BWSR Mitigation Banking Program wetlands.

Minnesota Public Waters Wetlands

Public Waters Wetlands include wetlands 10 acres or larger in unincorporated areas or 2.5 acres or larger in incorporated areas. Because of the size of these wetlands and their associated environmental and socioeconomic functions, they are afforded legal protection in Minnesota. Public Waters Wetlands are categorized by wetland type as defined in USFWS Circular No. 39 (EPA 2002). Public Waters Wetlands that potentially would be crossed include Type 3 wetlands (inland, shallow fresh marshes), Type 4 wetlands (inland, deep fresh marshes), and Type 5 wetlands (open fresh water).

Minnesota Calcareous Fen Wetlands

As noted above, calcareous fens are rare peat-accumulating wetlands formed as a result of groundwater upwelling through calcareous substrates; they are designated in Minnesota as Outstanding Resource Value Waters. Because of their regional rarity, biodiversity, and sensitivity to disturbance, calcareous fens are afforded legal protection in Minnesota.

Wetland Reserve Program and Minnesota Board of Water and Soil Resources Banking Program

Wetlands identified under the NRCS or state Wetland Reserve Programs and Minnesota BWSR Mitigation Banking Program include those wetlands that are a part of an existing federally funded or state-managed Wetland Reserve Program. These wetlands are of significance as they offer landowners the voluntary opportunity to protect, restore, enhance, and develop mitigation wetlands under a protective easement managed by NRCS or Minnesota BWSR. Pipeline construction through or placement of facilities on wetland reserves or mitigation banks may prevent these wetlands from being eligible for these programs. During pipeline operation, the permanent right-of-way and potentially some adjacent areas would be subject to disturbance (1) during activities associated with the Applicant's Integrity Management Program (e.g., excavation to repair or replace sections of pipe); and (2) during maintenance of the right-of-way (e.g., brush cutting, mowing).

Applicant's Preferred Route

General Wetlands

The estimated acreages of wetlands potentially affected by construction and operation of the Applicant's preferred route are presented in Table 5.2.1.3-1 (Appendix A). The Applicant's preferred route would potentially impact 618.2 acres of wetlands during construction and 313.3 acres of wetlands during operations. Construction-related wetland impacts would potentially affect 195.7 acres of forested wetlands that are difficult to restore and mitigate.

Table 5.2.1.3-1. Estimated Acreage of Wetlands Crossed by the Applicant's Preferred Route

Wetland Classification	Con	Op	ATWS	Access Roads	Pump Stations	MLVs	Total[c]	
							Con	Op
North Dakota[a]								
Forested wetland	0.6	0.2	NA	NA	NA	NA	0.6	0.2
Scrub/shrub wetland	0.0	0.0	NA	NA	NA	NA	0.0	0.0
Emergent wetland	12.0	5.0	NA	NA	NA	NA	12.0	5.0
Wetland subtotal	***12.6***	***5.2***	***NA***	***NA***	***NA***	***NA***	***12.6***	***5.2***
Minnesota[b]								
Forested wetland	141.1	66.3	6.3	3.5	0.8	0.1	147.5	70.6
Scrub/shrub wetland	214.5	115.7	7.5	8.3	0.2	0.3	224.6	122.0
Emergent wetland	143.8	79.2	5.5	4.8	0.8	0.0	151.6	82.5
Wetland subtotal	***499.3***	***261.2***	***19.4***	***16.7***	***1.8***	***0.4***	***523.7***	***275.1***
Wisconsin[a]								
Forested wetland	47.6	19.4	NA	NA	NA	NA	47.6	19.4
Scrub/shrub wetland	19.7	8.0	NA	NA	NA	NA	19.7	8.0
Emergent wetland	14.6	5.6	NA	NA	NA	NA	14.6	5.6
Wetland subtotal	***81.9***	***33.0***	***NA***	***NA***	***NA***	***NA***	***81.9***	***33.0***
All States								
Forested wetland	189.3	85.9	6.3	3.5	0.8	0.1	195.7	90.2
Scrub/shrub wetland	234.2	123.7	7.5	8.3	0.2	0.3	244.3	130.0
Emergent wetland	170.4	89.8	5.5	4.8	0.8	0.0	178.2	93.1
WETLAND TOTAL	***593.8***	***299.4***	***19.4***	***16.7***	***1.8***	***0.4***	***618.2***	***313.3***

Source: USFWS 2016.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the pipeline route

[b] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way; additional temporary workspaces (ATWS), including pipe yards; and mainline valves (MLVs), including valve pads and driveways

[c] Con = sum of pipeline construction work area, ATWS, and temporary access roads; Op = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs

NA = not applicable

Specially Designated Wetlands

Public Waters Wetlands crossed by the Applicant's preferred route include 2.8 acres of wetland Types 3 and 4 (Table 5.2.1.3-2) for construction and 1.9 acres for operation. Because of their overall size and associated environmental and socioeconomic functions, Public Waters Wetlands are afforded legal protection in Minnesota.

Table 5.2.1.3-2. Estimated Acreages of Public Waters Wetlands Crossed by the Applicant's Preferred Route in Minnesota

Wetland Type	Con[a]	Op[a]	ATWS	Access Roads	Pump Stations	MLVs	Total[b]	
							Con	Op
Type 3 – Inland shallow fresh marshes	2.1	1.7	0.0	0.0	0.0	0.0	2.1	1.7
Type 4 – Inland deep fresh marshes	0.6	0.2	0.1	0.0	0.0	0.0	0.7	0.2
TOTAL	**2.7**	**1.9**	**0.1**	**0.0**	**0.0**	**0.0**	**2.8**	**1.9**

Source: Minnesota DNR 2014.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), and temporary access roads; Op = sum of pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves.

One northwestern calcareous fen would be crossed by the Applicant's preferred route, and four others are near the route (Table 5.2.1.3-3). All northwestern calcareous fens near the Applicant's preferred route are located on the portion of the route between the North Dakota border and Clearbrook, Minnesota. The fen near MP 122 named Gully 30 is approximately 63 feet from the route centerline. Calcareous fen surveys completed in 2010 identified the presence of Gully 30 during development of the Alberta Clipper pipeline. As part of the environmental review for the Alberta Clipper pipeline, a Gully 30 Fen Management Plan was developed in coordination with Minnesota DNR (Natural Resource Group 2009). As proposed, portions of the Applicant's preferred route would be co-located with the Alberta Clipper pipeline where Gully 30 and other nearby fens occur (Table 5.2.1.3-3).

Table 5.2.1.3-3. Calcareous Fen Wetlands near the Applicant's Preferred Route in Minnesota

Approximate Milepost	Distance from Route	Name – Elemental Occurrence Identifier	MBS Native Plant Community Code	State Rank[a]	County
APR 72.0	796 feet	Viking 18 – 14377	OPp93a	S2	Marshall
APR 73.5	2,042 feet	Viking 20 – 15297	OPp93a	S2	Marshall
APR 81.0	525 feet	Norden 18 – 34586	OPp93a	S2	Pennington
APR 120.5	2,011 feet	Chester 24 – 35384	OPp93a	S2	Polk
APR 122.0	63 feet	Gully 30 – 35382	OPp93a	S2	Polk

Sources: Minnesota DNR 2008, 2016, Enbridge 2016.

Notes:

[a] State Rank: S1 = critically imperiled; S2 = imperiled; S3 = vulnerable to extirpation; S4 = apparently secure; S5 = secure, common, widespread, and abundant

APR = Applicant's preferred route, MBS = Minnesota Biological Survey

No wetlands enrolled in the NRCS Wetland Reserve Program or the Minnesota BWSR Mitigation Banking Program would be crossed by the Applicant's preferred route or facilities.

Continued Use of Existing Line 3

General Wetlands

Existing Line 3 crosses 86 miles of wetlands that originally were 60 percent forested wetlands, 25 percent scrub/shrub wetlands, and 15 percent emergent wetlands (DOS 2009). These wetland areas have been maintained primarily as emergent wetlands through removal of woody vegetation over the permanent pipeline right-of-way. Previous HDD crossings of forested and scrub/shrub wetlands would not have been altered.

Specially Designated Wetlands

The existing Line 3 pipeline corridor crosses through one Minnesota Public Waters Wetland. This Type 3 – inland shallow marsh is located between the North Dakota border and Clearbrook. Three Minnesota northwestern calcareous fens are crossed by the existing Line 3: Viking 18, Chester 24, and Gully 30. No wetlands enrolled in the NRCS Wetland Reserve Program are present near the existing Line 3 pipeline in Minnesota. No Minnesota BWSR Mitigation Banking Program wetlands are crossed by the existing Line 3 pipeline.

System Alternative SA-04

General Wetlands

The estimated acreages of wetlands potentially affected by construction and operation of SA-04 are presented in Table 5.2.1.3-4. SA-04 would potentially impact 286.5 acres of wetlands during construction and 113.1 acres of wetlands during operations. Construction-related wetland impacts would potentially affect 17.8 acres of forested wetlands that are difficult to restore and mitigate.

Table 5.2.1.3-4. Estimated Acreage of Wetlands Crossed by System Alternative SA-04

Wetland Classification	Construction[a]	Operations[b]
North Dakota		
Forested wetland	1.1	0.5
Scrub/shrub wetland	8.6	3.6
Emergent wetland	145.0	53.6
Wetland subtotal	***154.8***	***57.7***
Minnesota		
Forested wetland	10.3	4.2
Scrub/shrub wetland	7.5	3.4
Emergent wetland	77.9	32.7
Wetland subtotal	***95.7***	***40.3***
Iowa		
Forested wetland	3.7	1.5
Scrub/shrub wetland	0.3	0.2
Emergent wetland	22.7	9.7
Wetland subtotal	***26.8***	***11.3***
Illinois		
Forested wetland	2.6	0.9
Scrub/shrub wetland	0.0	0.0
Emergent wetland	6.7	2.9
Wetland subtotal	***9.3***	***3.8***
All States		
Forested wetland	17.8	7.1
Scrub/shrub wetland	16.4	7.2
Emergent wetland	252.4	98.8
WETLAND TOTAL	**286.5**	**113.1**

Source: USFWS 2016.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route

Specially Designated Wetlands

SA-04 would cross near one Public Waters Wetland. This Type 3 – inland shallow fresh marsh would be encroached on through an agricultural field that surrounds the marsh. One southwestern calcareous fen (Kasota 7) is located 2,359 feet from SA-04 in Le Sueur County, Minnesota. Four state-managed wetland reserves (wetlands under a Wetland Reserve Program) would be crossed by SA-04 (Table 5.2.1.3-5). No Minnesota BWSR Mitigation Banking Program wetlands are crossed by the existing Line 3 pipeline.

Table 5.2.1.3-5. Estimated Acreages and Number of Wetland Reserves Crossed by System Alternative SA-04

State Wetland Reserves	Construction[a]	Operations[b]
North Dakota		
Wetlands Reserve Program	5.8 acres (two reserves)	2.4 acres (two reserves)
Minnesota		
Wetlands Reserve Program	2.5 acres (two reserves)	1.0 acre (one reserve)
Iowa		
Wetlands Reserve Program	0.0	0.0
TOTAL	**8.3 acres (four reserves)**	**3.5 acres (three reserves)**

Source: USGS 2016.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route

Transportation by Rail

General Wetlands

The rail offloading facility near Clearbrook would require between 100 and 200 acres of land that is identified as agricultural lands and wetlands, including emergent, scrub/shrub, and forested wetlands. Redevelopment of 10 miles of rail access would require approximately 60 acres between Clearbrook and Gully, Minnesota that would cross through several small emergent wetlands. The undeveloped area required for the approximately 100-acre expansion for rail facilities near the Superior terminal is entirely wetlands, primarily forested and scrub/shrub wetlands.

Specially Designated Wetlands

Three Minnesota Public Waters Wetlands occur near the area identified for the Clearbrook offloading facility. No calcareous fens, federal or state wetland reserves, or BWSR mitigation bank easements occur near Clearbrook. No federal or state wetland reserves occur near the Superior terminal.

Transportation by Truck

General Wetlands

Truck facilities near Clearbrook would require approximately 50 acres to construct and operate offloading facilities, and approximately 5 acres for road access. Potential construction locations near the Clearbrook terminal include varying proportions of emergent, scrub/shrub, and forested wetlands. The undeveloped area near the Superior terminal required for development of truck facilities is entirely wetlands, primarily forested and scrub/shrub wetlands.

Specially Designated Wetlands

Three Minnesota Public Waters Wetlands occur near the area identified for the Clearbrook offloading facility. No calcareous fens, federal or state wetland reserves, or Minnesota BWSR mitigation bank easements occur near Clearbrook. No federal or state wetland reserves occur near the Superior terminal.

Existing Line 3 Supplemented by Rail

The existing wetland conditions for this combined alternative are similar to those described above for continued use of the existing Line 3 pipeline and rail alternatives.

Existing Line 3 Supplemented by Truck

The existing wetland conditions for this combined alternative are similar to those described above for continued use of the existing Line 3 pipeline and truck alternatives.

5.2.1.3.3 Impact Assessment

This section addresses the potential impacts on wetlands during construction and operation of the Applicant's preferred route and the CN Alternatives. Impacts from construction and operation of the Applicant's preferred route and SA-04 were evaluated quantitatively, using state and federal wetland maps. Wetland disturbance effects for existing Line 3 were estimated based on the existing conditions along Enbridge's Mainline corridor (e.g., the Alberta Clipper Final EIS [DOS 2009]). Wetland disturbance effects for the rail and truck alternatives were based on existing conditions in the potential locations for new infrastructure, general construction practices, and BMPs. Potential impacts on wetlands associated with continued use of the existing Line 3, transportation by rail, transportation by truck, existing Line 3 supplemented by rail, and existing Line 3 supplemented by truck were qualitatively assessed based on publically available wetland information, potential locations for new facilities, and potential transportation routes.

Generally, pipeline and facility construction through wetlands can result in changes to vegetation, soils, hydrology, and wildlife habitats, including:

- Changes in wetland vegetation community composition, structure, and productivity due to modification of surface and subsurface flow patterns as a result of ground clearing and pipeline construction;
- Loss of sensitive plant species as a result of construction clearing and grading;
- Wetland soil disturbance as a result of mixing of topsoil and subsoil during trenching and backfilling;
- Changes to water-retaining substrates, thereby causing permanent alterations to their water-holding capacity;
- Alteration of surface and subsurface hydrology that is important for maintaining wetland communities and microhabitats as a result of trenching and backfilling during pipeline construction;
- Sedimentation of wetlands and fluctuations in wetland hydrology as a result of trenching, dewatering, and stockpiling activities;
- Reduction in wildlife habitat and forage productivity, and increased risk of soil erosion and weed invasion due to removal of vegetation;
- Potential spread of invasive species and noxious weed populations along the pipeline construction impact area; and
- Contamination from equipment drips or spills during refueling operations.

Generally, pipeline and facility operations can affect wetlands by:

- Disturbance to reclaimed wetlands within the permanent right-of-way as a result of excavation to repair or replace sections of pipe as a part of the Applicant's Integrity Management Program, and as a result of right-of-way vegetation maintenance activities;
- Permanent modification of forested or scrub/shrub wetland plant community composition and structure in the permanent right-of-way as a result of vegetation management activities; and
- Establishment and spread of noxious weeds and invasive plants within the permanent right-of-way and at aboveground facilities due to ground disturbance as part of the Applicant's Integrity Management Program, and as a result of right-of-way vegetation maintenance activities.

All construction through wetlands would need to be approved by the authorizing agencies and identified by milepost. In areas where permanent aboveground facilities are not proposed, construction of a pipeline through emergent wetlands would result primarily in short-term and minor impacts if the wetland can be restored to preconstruction conditions. If wetland impacts result in changes in hydrology and vegetation including introduction of invasive plant species to emergent wetlands they would result in long-term impacts. Construction of a pipeline through forested wetlands would result primarily in long-term or permanent and major impacts. Post-construction wetland reclamation and monitoring would be required for a period of time until reclamation standards and permit conditions are met, or otherwise could be offset through compensatory mitigation in an onsite or offsite location.

The Applicant would use BMPs to avoid and minimize impacts on wetlands from pipeline and facility construction and operation. Many of these BMPs also may be applicable to construction and operation of rail and truck offloading facilities. Unavoidable impacts on wetlands may require compensatory mitigation.

The Applicant has committed to implementing the following BMPs during construction to minimize wetland impacts:

- Developing and adhering to the Project-specific Construction Methods and Procedures for Wetland and Waterbody Crossings and site-specific crossing plans (Enbridge 2016);
- Using wetland crossings designed and approved by engineers, reviewed onsite by the Project engineer, and approved by agencies for each crossing;
- Committing to consideration of a variety of wetland and waterbody crossing techniques to identify the most appropriate site-specific methods, including open-cut (wet trench, push-pull with excavator, push-pull with swamphoe); dry crossing methods (dry trench, dam-and-pump, or flume); trench breakers; trenchless (guided bore, HDD); and those described in the Enbridge November 2016 EAW (Enbridge 2016);
- Implementing mitigation measures that protect adjacent waterbodies during construction including, but not limited to, use of a vegetated buffer, slope breakers, sediment barriers (i.e., silt fencing and sediment curtains), filtration devices during dewatering, or trench breakers;
- Conducting wetland shoreline stabilization measures, including the erosion controls identified above and erosion control blankets, mulching, seeding (with Minnesota BWSR seed mixes or

other agency-approved seed mix), cat tracking, placing temporary slope breakers, and placing riprap where necessary;

- Developing and adhering to the wetland-specific avoidance measures in the Applicant's Environmental Protection Plan (Appendix E);
- Reducing temporary construction work area beyond the 50-foot-wide permanent right-of-way in wetlands areas from 70 feet to 45 feet, except in areas where trench wall failure or other construction constraints have been identified as a concern;
- Restoring wetland vegetation cover types following construction, as described in the Environmental Protection Plan;
- Co-locating the Project with existing rights-of-way unless co-location would result in a greater impact on wetlands or other sensitive resources;
- Minimizing impacts on sensitive wetland soils during wet conditions by use of timber mats, low-ground-weight equipment, and other methods identified in the Environmental Protection Plan;
- Designing and planning Project pipeline routes and infrastructure sites to reduce impacts on sensitive wetland resources;
- Adhering to the measures in the Environmental Protection Plan for monitoring for inadvertent release of drilling fluid during HDD construction and procedures for the containment, response, and cleanup to limit the potential for drilling mud to reach wetlands;
- Placing petroleum products storage, refueling, maintenance, and lubricating operations a minimum of 100 feet from wetlands;
- Placing concrete wash water, grindings, and slurry away from wetlands with no allowable discharge of these waste products into wetlands or waterbodies;
- During trench dewatering, pumping discharge water at controlled discharge rates into a filtration device located in a well-vegetated area and in a manner to prevent the migration of silt-laden water into wetlands;
- Posting signage during construction noting sensitive environmental features and wetlands;
- Cutting off wetland vegetation at ground level and removing it from wetland areas;
- Stripping the top 1 foot of topsoil or the amount of topsoil present, whichever is less, over the trench line, segregating it, and replacing it after pipe installation and backfilling in unsaturated wetlands;
- Avoiding the use of fertilizer, lime, and mulch in wetlands;
- Complying with USACE and state wetland permits, including compliance with permit conditions and long-term monitoring plans;
- Restoring wetlands to preconstruction contours;
- Maintaining wetland hydrology by using trench breakers in any area where the potential to drain, or partially drain, a wetland exists; sufficiently compacting the pipeline trench; and placing the pipeline on native material as opposed to gravel; and

- Using construction mats, as needed, to facilitate equipment access and pipeline installation and to minimize soil compaction and/or mixing.

Compensatory Mitigation

Compensatory wetland mitigation would be provided by the Applicant for permanent impacts on forested, scrub/shrub, and emergent wetlands as required in the federal and state-specific permits issued. The overall objective of compensatory wetland mitigation would be to compensate for aquatic resource functions lost due to construction of the Applicant's preferred route, taking into consideration what is available and feasible. Although site-specific compensatory wetland mitigation has yet to be identified, it would continue to be considered in consultation with the permitting agencies to minimize and offset wetland impacts. Compensatory wetland mitigation would be consistent with applicable policies, regulations, and rules governing compensatory wetland mitigation for purposes of Section 404 CWA (see Section 5.2.1.3.1).

The assessments for the Applicant's preferred route and CN Alternatives are discussed within the following categories:

- General wetland impacts,
- Impacts on Minnesota Public Waters Wetlands,
- Impacts on Minnesota calcareous fen wetlands, and
- Impacts on federal and state Wetland Reserves and Minnesota BWSR Mitigation Bank easements.

Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

General Wetlands

Construction through or on wetlands would result in impacts on wetland vegetation, soils, hydrology, and wildlife habitats. Construction activities may result in reduction of a wetland's ability to trap and slowly release surface water, rain, snowmelt, groundwater, and flood waters. Wetland soils would be disturbed by trenching and backfilling during pipeline construction. Impacts on wetlands outside the construction work area are not expected because sediment containment barriers would be used until construction is complete and vegetation cover has reestablished. Over time, provided that original contours are restored and hydrology is maintained, most affected wetland vegetation would regenerate and wetland function would return. In general, wetland construction impacts that do not result from placement of fill in wetlands would be returned to preconstruction contours and wetland conditions.

The majority of wetland impacts (85 percent) would occur within Minnesota. The Applicant's preferred route would affect up to 618 acres of wetlands during construction in North Dakota, Minnesota, and Wisconsin. Up to 440 acres of scrub/shrub and forested wetlands would be cleared during construction, after which woody vegetation would be allowed to reestablish within most construction work areas outside of the permanent right-of-way. Woody wetlands (scrub/shrub and forested) would be cleared within the entire construction work area during construction, after which woody wetlands would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Woody

vegetation and all other wetland vegetation would be permanently removed from the areas where aboveground facilities (pump stations and MLVs) and access roads would be constructed.

Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation, resulting in major changes both to vegetation structure and wetland functions. Wetland habitats containing large mature woody growth would reestablish in temporary construction work areas within 3 to 50 years, depending on the vegetation community and vegetation structure (Jacobson 2006, Wenzel et al. 2012). Forested wetlands may require from 35 to 50 years to achieve vegetation and wildlife habitat similar to mature forested wetlands (Wenzel et al. 2012). Clearing of forested wetlands in construction work areas may require compensatory mitigation, as these wetland types would be converted to other wetland types on a long-term or permanent basis. Compensatory wetland mitigation for impacts on forested wetlands could offset these changes.

Construction of the route would affect up to 178 acres of emergent wetlands (Table 5.2.1.3-1). Emergent wetland vegetation would reestablish within 3 years as a community functionally similar to that of the wetland prior to construction (Jacobson 2006, Wenzel et al. 2012), provided that disturbance to vegetation is minimized, root structures are retained to the extent practicable, and preconstruction wetland contours and wetland hydrology are maintained. In areas where the disturbance to vegetation is minimal and the root structures, preconstruction wetland contours, and wetland hydrology are maintained, the impacts would be short-term and minor. In areas where trenching occurs directly through a wetland, the impacts would be short- to long-term and minor to major. Where emergent wetlands are cleared for construction of aboveground facilities and access roads (about 19 acres), the impacts on these wetlands would be permanent and minor to major; however, the impacts could be offset by compensatory wetland mitigation.

Approximately 19 acres of wetlands could be affected by use as ATWS and pipe storage yards for pipeline construction, resulting in short-term to long-term minor impacts, as these areas would be restored to wetlands after construction.

Crossings by HDD for selected waterbodies and associated wetlands generally would avoid direct impacts on wetland resources. Each crossing selected for HDD would be identified, and permitting would be carried out (including identification of BMPs) at each location. Fluid (water, bentonite clay, and possible additives) is used during drilling to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or "frac-out" of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground. If a frac-out occurred within a wetland, the vegetation and soil would be compromised. During drilling, construction personnel would monitor the crossing to detect releases of drilling mud and would implement containment, response, and clean-up procedures as outlined in the Applicant's Environmental Protection Plan (Appendix E) to limit the potential for drilling mud to reach surface water. If a frac-out occurred and went undetected or was not quickly contained, impacts on wetlands could be long-term and major. However, with implementation of the Applicant-proposed measures to respond to a drilling mud release during HDD construction, the impact of a release could be short-term and minor. Successful construction of wetland crossings using HDD (i.e., the crossing is completed without a frac-out) would not affect wetlands.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. The Applicant's preferred route would affect 3 acres of Public Waters Wetlands during construction, primarily between the North Dakota border and Carlton in

Minnesota (Table 5.2.1.3-2). Impacts on Minnesota Public Waters Wetlands during construction would result from alteration of wetland vegetation, soils, and hydrology; however, these areas would be restored as wetlands after construction.

Minnesota DNR would be consulted regarding Public Waters Wetland crossings as part of the License to Cross Public Waters permitting process that would occur prior to construction. All impacts, BMPs, and proposed avoidance related to Public Waters Wetlands would be subject to conditions contained in a License to Cross Public Waters. Any dewatering of the trench that would be required for construction across Public Waters Wetlands would require a Water Appropriation Permit. Implementation of the measures identified in the license would limit potential impacts on Public Waters Wetlands.

As part of permit requirements, the Applicant would identify and prepare site-specific crossing plans, avoid and minimize impacts on Public Waters Wetlands to the extent possible, and restore affected Public Waters Wetlands onsite. Restoration to the existing level of wetland function would likely take several years. As a result, the impacts on Public Waters Wetlands from construction of the Applicant's preferred route would be short-term and minor.

Impacts on Minnesota Calcareous Fen Wetlands. Gully 30 could be affected by pipeline construction (Table 5.2.1.3-3) (Appendix A). Impacts on other nearby fens would be avoided. The Applicant's preferred route diverges from the Mainline corridor to avoid crossing Chester 24, Viking 18, and Norden 18 calcareous fens. Potential impacts on Gully 30 include alteration of hydrology, introduction of contaminants, loss of rare or unique plants, introduction of invasive species, and altered peat formation—all of which could be detrimental to calcareous fen wetland functions.

The results of calcareous fen surveys completed in 2010 during development of the Alberta Clipper pipeline identified the presence of a single calcareous fen (Gully 30), located 63 feet away from the centerline. As part of the environmental review for the Alberta Clipper project, a Gully 30 Fen Management Plan was developed in coordination with Minnesota DNR. As proposed, portions of the Applicant's preferred route are co-located with the Alberta Clipper pipeline, including the area where this fen occurs. If it is determined that impacts on this fen could not be practicably avoided by Project construction, construction would be subject to a Fen Management Plan approved by the Commissioner of Natural Resources of Minnesota DNR.

Prior to construction, the Minnesota DNR would be consulted to aid in the identification of potential impacts on and major mitigation measures for calcareous fens. Where calcareous fens are identified, the Minnesota DNR would request preparation of a Fen Management Plan, which would identify impacts and BMPs specific to the affected fen. These BMPs would include the general BMPs identified to avoid major impacts on wetlands discussed above. Overall, it is expected that the Applicant's preferred route would result in a short-term to long-term minor impact on one calcareous fen wetland.

Impacts on Wetland Reserves. No NRCS Wetland Reserves or state wetland reserves would be crossed by the Applicant's preferred route or associated facilities. A state wetland reserve is located between the North Dakota border and Clearbrook, Minnesota. Impacts on this reserve are not expected as the reserve is not near the pipeline route. No mitigation bank wetlands would be crossed by the Applicant's preferred route, and no impacts are expected to occur.

Operations Impacts

General Wetlands

Operation of the Project would potentially affect up to 313 acres of wetlands within the permanent right-of-way and associated facilities. About 19 acres of wetlands would be permanently converted to developed land for aboveground facilities (pump stations and MLVs) and access roads (Appendix A). The impacts on these wetlands would be permanent and minor to major; however, the impacts could be offset by compensatory wetland mitigation.

Impacts on wetlands could result from maintenance activities, including vegetation management and pipeline inspections that would occur for the life of the Project. Because trees and shrubs would not be allowed to reestablish within the permanent right-of-way, vegetation management would represent a permanent major impact through maintaining forested and scrub/shrub wetlands as emergent or early-stage scrub/shrub wetlands.

A total of 210 acres of previously forested and scrub/shrub wetlands converted during construction would be maintained as emergent wetlands within the pipeline permanent right-of-way for the life of the Project (Table 5.2.1.3-1). Woody vegetation within the permanent right-of-way would be managed (cut every 3 to 5 years) to prevent large shrubs and trees from reestablishing over the pipeline to allow for visual inspection of the right-of-way.

Emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise maintained and would not be affected by mowing or vegetation management activities. Routine vegetation management would use a rubber-tracked skid-steer vehicle, or similar, with specialized cutting equipment to minimize disturbance to low-growing herbaceous cover and compaction and rutting of wetland soils. However, this loss of woody vegetation communities would result in permanent and major impacts on wetland structure and functions that could require compensatory mitigation.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. If excavation is required within a wetland, impacts would likely be short-term and minor but could occur periodically over the life of the Project.

Operation of the Applicant's preferred route may increase the potential for the introduction and spread of noxious weeds and invasive plants for the life of the Project and beyond. The Environmental Protection Plan (Appendix E) and wetland permitting documents would describe measures to prevent the spread of noxious and invasive weeds in wetlands during wetland vegetation management and during pipeline maintenance activities. The presence of noxious weeds and potential for spread of infestations within the Project area are addressed in Section 5.2.3.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Short-term minor impacts could occur on up to 2 acres of Public Waters Wetlands within the permanent right-of-way for the Applicant's preferred route from maintenance activities. Impacts would result from vegetation management, however, it is unlikely that the shallow fresh marsh crossed would require vegetation management as shrubs are unlikely to grow as long as the marsh hydrology is maintained (Table 5.2.1.3-2). In addition, pipeline maintenance activities could spread noxious weeds and invasive plants. The potential impact is expected to be short-

to long-term and minor to major after each maintenance activity, but would occur periodically over the life of the Project.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on Public Wetland Waters would be limited to the pipeline segment through the 2 acres of these wetlands, and repeated repairs or replacement at those locations are unlikely. Impacts on the Public Waters Wetlands from integrity digs likely would be short-term and minor to major.

Impacts on Minnesota Calcareous Fen Wetlands. The Applicant's preferred route would cross the Gully 30 calcareous fen and has been routed to avoid the Chester 24 and Viking 18 calcareous fens that are crossed by the existing Line 3. All activities occurring near calcareous fens would be subject to BMPs identified in a Fen Management Plan, if one needed to be developed for the Project.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on calcareous fens would be limited to the pipeline segment through the Gully 30 fen, and repeated repairs or replacement at this location are unlikely. Impacts on calcareous fens as a result of pipeline maintenance activities during normal operation of the Project would be short- to long-term and minor but could occur periodically over the life of the Project.

Impacts on Wetland Reserves. Impacts on wetland reserves would not occur during operation of the pipeline because no wetland reserves or mitigation bank easements are located within the permanent right-of-way.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

Continued Use of Existing Line 3

Construction Impacts

No construction impacts on wetlands are associated with continued use of the existing Line 3 pipeline because it is already in place and operating.

Operations Impacts

General Wetlands

Operations activities for the existing Line 3 pipeline include continued vegetation management to remove trees and large shrubs from the permanent right-of-way, and continuing potential for the spread of noxious weeds and invasive plants along the right-of-way and at aboveground facilities. These activities would occur within the pipeline corridor whether or not Line 3 remains in use.

The Applicant's ongoing Integrity Management Program for Line 3 would require excavation and repair or replacement of sections of the pipeline that could occur within wetlands. Because of the age of the existing Line 3, excavation and repair or replacement of the pipeline would occur at a higher rate than for new pipelines, with an estimated 267 excavations per year over the next 15 years. Potential impacts on wetlands associated with these maintenance activities could be short- to long-term and minor to major, depending on the frequency of occurrence within wetlands and the lengths of the pipeline segments requiring replacement.

Specially Designated Wetlands

The Public Waters Wetland crossed by Line 3 could be affected by integrity management actions if excavation is required at this location. No vegetation maintenance would be required at this location because it is an emergent marsh. Line 3 crosses three calcareous fen wetlands (Chester 24, Viking 18, and Gully 30). Potential impacts on calcareous fens during operations could occur if excavation is required at these locations; however, repeated pipeline repairs or replacement are unlikely at these locations. The resultant impacts would be similar to those for initial construction of the pipeline through the fens (i.e., the impact is expected to be short- to long-term and minor).

Impacts on wetland reserves would not be associated with operation of the pipeline because no wetland reserves or mitigation bank easements occur within the permanent right-of-way for the existing Line 3.

System Alternative SA-04

Construction and operation activities that would result in potential wetlands impacts for SA-04 are the same as those described for the Applicant's preferred route. Most impacts would be similar and are summarized in this section, along with information on impacts that would be different.

Construction Impacts

General Wetlands

System alternative SA-04 would affect 287 acres of wetlands during construction in North Dakota, Minnesota, Iowa, and Illinois (Table 5.2.1.3-4). About 34 acres of forested and scrub/shrub wetlands would be cleared during construction along the entire route. After construction woody vegetation would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation resulting in long-term to permanent major impacts on both vegetation structure and wetland functions.

About 252 acres of emergent wetlands would be affected by construction. The wetlands along the route would be reclaimed after construction (Table 5.2.1.3-4), but would require several years for vegetation to become fully reestablished. As a result, the impact of construction on emergent wetlands within the construction impact area would be short-term and minor.

While footprints are not available for aboveground facilities for system alternative SA-04 at this time, impacts during construction would be permanent and major if placement of facilities within wetlands was unavoidable. However, the impact could be offset with compensatory mitigation.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Construction of system alternative SA-04 would result in short-term minor impacts on up to 0.1 acre of inland shallow fresh marsh Public Waters Wetlands during construction. Impacts on Public Waters Wetlands would be subject to state-specific permitting requirements, and implementation of BMPs would be required for Project approval.

Impacts on Minnesota Calcareous Fen Wetlands. Impacts would not occur on calcareous fens under this alternative because the nearest calcareous fen (Kasota 7) is located 2,359 feet from system alternative SA-04 in Le Sueur County, Minnesota, within the Kasota Prairie SNA (Minnesota DNR 2008).

Impacts on Wetland Reserves. Four NRCS Wetland Reserves are located within the construction work area; there would be short-term minor impacts on up to 8 acres of wetland reserves (Table 5.2.1.3-5) because all wetlands in the construction work area would be reclaimed.

Operations Impacts

General Wetlands

Operation of system alternative SA-04 pipeline would be as described for the Applicant's preferred route above. Operation of SA-04 could affect 113 acres of wetlands within the permanent right-of-way (Table 5.2.1.3-4). The impacts would result from maintenance activities, including vegetation management that would occur for the life of the Project. Of the initial 34 acres of forested and scrub/shrub wetlands about 14 acres would be managed to prevent trees and shrubs from reestablishing within the permanent right-of-way. Vegetation management would represent a permanent minor to major impact through conversion of forested and scrub/shrub wetlands to emergent or early-stage scrub/shrub wetlands. This loss of woody vegetation would result in permanent and major impacts on wetland structure and functions that could be offset with compensatory mitigation.

Emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise managed and would not be affected by vegetation management activities. If emergent vegetation is affected by vegetation management, the impact is expected to be short-term and minor.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on emergent wetlands as a result of these activities would likely be short-term and minor, but would occur periodically over the life of the Project.

While footprints are not available for aboveground facilities for system alternative SA-04 at this time, impacts during construction would be permanent and major if placement of facilities within wetlands was unavoidable. However, the impact could be offset with compensatory mitigation.

Operation of SA-04 may increase the potential for the introduction and spread of noxious weeds and invasive plants for the life of the Project. The Applicant would implement the procedures in the Environmental Protection Plan (Appendix E) prepared for the Project, and wetland permitting documents would describe measures to prevent the spread of noxious and invasive weeds in wetlands. With implementation of those procedures, the impact of the introduction and spread of noxious weeds and invasive plants would be short-term and minor.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. No Public Waters Wetlands would be affected during operation as they do not occur within the permanent right-of-way of SA-04.

Impacts on Minnesota Calcareous Fen Wetlands. No calcareous fens would be affected during operation as they do not occur within the permanent right-of-way of SA-04.

Impacts on Wetland Reserves. Three NRCS Wetland Reserves are located within the permanent right-of-way of SA-04, which would result in permanent minor impacts on up to 4 acres of wetland reserves

(Table 5.2.1.3-5). All wetlands within the permanent right-of-way would become ineligible as conservation easements, as the wetlands would no longer be protected from future disturbance due to routine maintenance, pipeline monitoring, and integrity management activities. However, in-kind compensatory mitigation could be used to offset wetland impacts.

Transportation by Rail

The rail alternative would require an area of approximately 100 to 200 acres for construction and operation of a rail loading facility, and an additional 84 acres to construct and operate a new 14-mile-long rail connection near Gretna, Canada. The rail access and loading facilities would be located in Canada and as such are not addressed as part of this MEPA EIS.

Construction Impacts

General Wetlands

The rail offloading facility near Clearbrook would require between 100 and 200 acres of land that is identified as agricultural lands and wetlands. Wetlands located in this area would likely be affected, since potential construction locations near the Clearbrook terminal include emergent, scrub/shrub, and forested wetlands. However, the acreage of wetlands that would be affected by construction of the facilities has not been determined since the facility footprint has not been identified. Construction of rail facilities near Superior, Wisconsin, would likely affect wetlands. Construction of the Superior offloading facility could affect up to 100 acres. The undeveloped area near the Superior terminal is entirely wetlands, primarily forested and scrub/shrub wetlands, which would be permanently converted to developed use. Compensatory mitigation could be used to offset these permanent impacts.

New facilities constructed under the rail alternative would undergo permitting, would be sited to avoid wetland resources to the extent practicable, and would require avoidance, minimization, and may require compensatory mitigation for unavoidable impacts on wetlands per state and federal regulations. During construction, direct impacts on wetlands would occur from clearing and grading for site preparation, and placement of fill for construction of offloading facilities and new rail connections for operation of the rail alternative. Some wetlands would likely be lost by construction of offloading facilities at Clearbrook and Superior, which would result in permanent major wetland impacts. Compensatory mitigation similar to that applied for the Applicant's preferred route could be used to offset wetland impacts.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Three Public Waters Wetlands occur near the Clearbrook terminal, although it is unlikely that these wetlands would be directly affected by construction of the facility, as it is likely that siting the new facility on these wetlands would be avoidable. Temporary to short-term minor impacts could occur as these wetlands may be indirectly affected through an increase in impervious surface and potential changes in runoff water quality within the watersheds that support these wetlands.

Impacts on Minnesota Calcareous Fen Wetlands. Calcareous fens would not be affected since these do not occur in the area.

Impacts on Wetland Reserves. Wetland Reserve Program wetlands would not be affected since these do not occur in the area.

Operations Impacts

General Wetlands

Up to about 100 acres of forested and scrub/shrub wetlands could be permanently converted to industrial/developed use for the rail facilities, which would result in permanent major wetland impacts. However, compensatory mitigation similar to that applied for the Applicant's preferred route could be used to offset impacts would reduce the impact.

During operation there may be small leaks of petrochemicals from rail cars; the materials leaked would reach the rail bed and be susceptible to movement with runoff. However, due to the small amounts anticipated and the area over which the leaks would occur, the impacts would likely be short-term and negligible to minor. Unanticipated releases of crude oil from rail transport are addressed in Chapter 10. The transfer facilities would be constructed to include primary and secondary containment structures in accordance with applicable regulatory requirements. Small spills and leaks at the transfer facilities would be retained within the facility and there would not be an impact outside of the facility.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Three Public Waters Wetlands occur near the Clearbrook terminal. These wetlands could be indirectly affected due to increased runoff resulting from the increase in impervious surfaces and the potential of the runoff containing contaminants. However, the changes in total runoff reaching the wetlands would likely be small, and the resultant impacts on the wetlands would be short-term and negligible to minor, but would occur for the life of the Project.

Impacts on Minnesota Calcareous Fen Wetlands. Calcareous fens would not be affected since these do not occur in the area.

Impacts on Wetland Reserves. Wetland Reserve Program wetlands would not be affected since these do not occur in the area.

Transportation by Truck

The truck alternative would require an area of approximately 140 acres for construction and operation of a truck loading facility, and an additional acreage to construct and operate a new access road connection near Gretna, Canada. The truck access road and loading facilities would be located in Canada and as such are not addressed as part of this MEPA EIS.

Construction Impacts

General Wetlands

Construction of a new truck offloading facility near Clearbrook would require approximately 50 acres; and an additional 5 acres for a new access road. Potential construction locations near the Clearbrook terminal include agricultural lands and emergent, scrub/shrub, and forested wetlands. Although the site for the facilities has not been selected, due to the number of wetlands in the general area, it is likely that some wetland impacts may be unavoidable. However, the acreage of wetlands that would be affected by construction of the facilities has not been determined since the facility footprint has not been identified. Construction of new truck offloading facilities near the terminal in Superior, Wisconsin would require approximately 50 acres and an additional 34 acres to establish a truck route to the facilities. The undeveloped area near the Superior terminal is entirely wetlands, primarily forested and scrub/shrub wetlands, which would be permanently converted to developed use. Up to 50 acres of

primarily scrub/shrub and forested wetlands could be permanently converted to industrial/developed use for the truck facilities, which would result in permanent major wetland impacts. Compensatory mitigation could be used to offset these permanent impacts.

New facilities would undergo permitting, would be sited to avoid wetland resources to the extent practicable, and where avoidance is not possible would likely require minimization and may require compensatory mitigation for unavoidable impacts on wetlands as required by per state and federal regulations. During construction, direct impacts on wetlands would occur from clearing and grading for site preparation, and placement of fill for construction of offloading facilities and new highway connections for operation of the truck alternative.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Three Public Waters Wetlands occur near the Clearbrook terminal, but are not likely to be directly affected by construction of an offloading facility, as direct clearing and fill impacts would likely be avoidable. These wetlands could be indirectly affected due to increased runoff resulting from the increase in impervious surfaces and the potential of the runoff containing contaminants. However, the changes in total runoff reaching the wetlands would likely be small, and the resultant impacts on the wetlands would be short-term and negligible to minor, but would occur for the life of the Project.

Impacts on Minnesota Calcareous Fen Wetlands. No calcareous fens would be affected by construction of these facilities and access roads since none are located in the vicinity.

Impacts on Wetland Reserves. No federal or state Wetland Reserve Program wetlands would be affected by construction of these facilities and access roads since none are located in the vicinity.

Operations Impacts

General Wetlands

Up to 50 acres of forested and scrub/shrub wetlands could be permanently converted to industrial/developed use for the truck facilities, which could result in permanent major wetland impacts (Appendix A). However, compensatory mitigation could be used to offset and reduce these impacts.

During truck transit, there may be minor leaks of petrochemicals from some vehicles. However, due to the small amounts anticipated and the area over which the leaks would occur, any impacts on wetlands would likely be short-term and negligible to minor. Unanticipated releases of crude oil from truck transport are addressed in Chapter 10.

The offloading facilities would be constructed to include primary and secondary containment structures in accordance with applicable regulatory requirements. Small spills and leaks at the transfer facilities would be retained within the facility and there would not be an impact outside of the facility.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Three Public Waters Wetlands occur near the Clearbrook terminal, but are not likely to be directly affected by construction or operation of an offloading facility.

Impacts on Minnesota Calcareous Fen Wetlands. Calcareous fens would not be affected since these do not occur in the area of the truck offloading facilities.

Impacts on Wetland Reserves. Wetland Reserve Program wetlands would not be affected since these do not occur in the area of the truck offloading facilities.

Existing Line 3 Supplemented by Rail

Wetland impacts associated with the combined use of the existing Line 3 pipeline and the rail alternative would be the same as those identified for the continued operation of the existing Line 3 pipeline in addition to those of the rail alternative identified above.

Existing Line 3 Supplemented by Truck

Wetland impacts associated with the combined use of the existing Line 3 pipeline and the truck alternative would be the same as those identified for the continued operation of the existing Line 3 pipeline in addition to those of the truck alternative identified above.

5.2.1.3.4 Summary and Mitigation

Summary

Construction and operation of the Applicant's preferred route or reliance on any of the CN Alternatives could result in impacts on wetlands, ranging from no impact to permanent major impacts (see Table 5.2.1.3-6). Measurable impacts would likely occur on forested, scrub/shrub, and emergent wetlands from the Applicant's preferred route and each of the CN Alternatives although to a different degree.

No impacts or negligible or minor impacts would likely occur on specially designated wetlands, including Minnesota Public Waters Wetlands, Minnesota calcareous fen wetlands, federal and state wetland reserves, and Minnesota BWSR wetland mitigation bank easements. This occurs because either the Applicant's proposed route or the CN Alternatives do not intersect any of the specially designated wetlands or the area affected would be very small.

Avoidance and minimization measures include Applicant-proposed measures and measures stipulated in pending state and federal permits. All wetland changes would be reviewed and approved by the appropriate authorizing agency prior to any construction being allowed. The Applicant has committed to provide compensatory wetland mitigation for permanent impacts on forested, scrub/shrub, and emergent wetlands as required in the federal and state-specific permits. Many of the avoidance and minimization measures and the standard BMPs described for the Applicant's preferred route also would be applicable to the CN Alternatives.

Beyond the general findings given above a more detailed comparison of the Applicant's preferred route and the CN Alternatives shows that the effects on wetlands would vary primarily between the Applicant's preferred route and SA-04.

Construction Impacts

General Wetlands

For the CN Alternatives, the largest area of potential permanent fill impacts on forested and scrub/shrub wetlands is associated with the rail alternative, followed by the truck alternative. The largest area of long-term to permanent changes to wetlands is associated with tree and shrub clearing of forested wetland and scrub/shrubs within the Applicant's preferred route (Table 5.2.1.3-6). The Applicant's preferred route has the largest total wetland impact from construction and operation of all CN Alternatives.

Table 5.2.1.3-6. Summary of Potential Impacts on Wetlands for the Applicant's Preferred Route and the Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Changes to forested and scrub/shrub wetland characteristics and functions	Long-term to permanent/major impacts • 440 acres	No impact	Long-term to permanent/major impacts • 34 acres	Permanent/ major impacts • ~260–360 acres total, with potential fill of up to ~100 acres of wetlands	Permanent/ major impacts • ~140 acres total, with potential fill of up to ~50 acres of wetlands	Permanent/ major impacts • ~260–360 acres total, with potential fill of up to 100 acres of wetlands	Permanent/major impacts • ~140 acres total, with potential fill of up to ~50 acres of wetlands
Changes to emergent wetland characteristics and functions	Short-term/minor impacts • 178 acres	No impact	Short-term/minor impacts • 252 acres	Permanent/ major impacts • ~260–360 acres total – with potential fill of some wetlands	Permanent/ major impacts • ~140 acres total – with potential fill of some wetlands	Permanent/ major impacts • ~260–360 acres total – with potential fill of some wetlands	Permanent/major impacts • ~140 acres total – with potential fill of some wetlands
Changes to Minnesota Public Waters Wetlands characteristics and functions	Short-term/minor impacts • 3 acres	No impact	Short-term/minor impacts • 0.1 acre	Short-term/ negligible to minor indirect impacts	Short-term/ negligible to minor indirect impacts	Short-term/ negligible to minor indirect impacts	Short-term/ negligible to minor indirect impacts
Changes to Minnesota calcareous fen characteristics and functions	Short-term to long-term/minor impacts • Gully 30	No impact	No impact	No impact	No impact	No impact	No impact

Table 5.2.1.3-6. Summary of Potential Impacts on Wetlands for the Applicant's Preferred Route and the Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Changes to Wetland Reserve Program wetland characteristics and functions	No impact	No impact	Short-term/minor impacts • 8 acres	No impact	No impact	No impact	No impact
Changes to wetland mitigation bank easements characteristics and functions	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Operations Impacts							
Forested and scrub/shrub wetlands permanently converted to emergent wetlands or filled	Permanent/major impacts • 210 acres	Short-term to long-term/minor to major impacts	Permanent/major impacts • 14 acres	Permanent/ major impacts • Potential fill of up to ~100 acres of wetlands	Permanent/ major impacts • Potential fill of up to ~50 acres of wetlands	Permanent/ major impacts • Potential fill of up to ~100 acres of wetlands	Permanent/major impacts • Potential fill of up to ~50 acres of wetlands
Potential changes to emergent wetland characteristics and functions	Short-term/minor impacts • 90 acres	Short-term to long-term/minor to major impacts	Short-term/minor impacts • 99 acres	Permanent/ major impacts • Potential fill of some acres of wetlands	Permanent/ major impacts • Potential fill of some acres of wetlands	Permanent/ major impacts Potential fill of some wetlands	Permanent/ major impacts Potential fill of some wetlands
Potential changes to Minnesota Public Waters Wetlands characteristics and functions	Short-term/minor impacts • 2 acres	Short-term/minor impacts	No impact	Short-term/ negligible to minor indirect impacts	Short-term/ negligible to minor indirect impacts	Short-term/ negligible to minor indirect impacts	Short-term/ negligible to minor indirect impacts

Table 5.2.1.3-6. Summary of Potential Impacts on Wetlands for the Applicant's Preferred Route and the Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Changes to Minnesota calcareous fen characteristics and functions	Short-term to long-term/minor impacts • Gully 30	Short-term to long-term/minor impacts • Chester 24 • Viking 18 • Gully 30	No impact	No impact	No impact	No impact	No impact
Changes to Wetland Reserve Program wetland characteristics and functions	No impact	No impact	Permanent/minor impacts • 4 acres	No impact	No impact	No impact	No impact
Wetland mitigation banks within the permanent right-of-way that would become ineligible as conservation easement	No impact	No impact	No impact	No impact	No impact	No impact	No impact

Emergent wetlands generally reestablish more quickly. While fill impacts would result in a permanent loss of emergent wetlands, vegetation cover and functions would be restored within several years after pipeline construction through emergent wetlands. For the CN Alternatives, the largest area of potential permanent fill impacts on emergent wetlands is associated with the rail and truck alternatives.

Specially Designated Wetlands

Construction of the Applicant's preferred route and SA-04 would directly affect Minnesota Public Waters Wetlands, while the rail and truck alternatives would result in indirect impacts (Table 5.2.1.3-6). Because few, if any, Minnesota Public Waters Wetlands would be affected by construction of the Applicant's preferred route or the CN Alternatives, impacts would be short-term and negligible to minor for all options.

Minnesota's calcareous fens represent a rare habitat that supports several plants protected as threatened or endangered. Only the Applicant's preferred route has the potential to affect a calcareous fen during construction. Wetland Reserve Program wetlands and mitigation bank easement wetlands represent conservation programs to protect and enhance wetlands. Only SA-04 has the potential to affect Wetland Reserve Program wetlands during construction. Neither the Applicant's preferred route nor the CN Alternatives have the potential to alter Minnesota BWSR wetland mitigation bank wetlands during construction (Table 5.2.1.3-6).

Operations Impacts

General Wetlands

Fill placed for aboveground facilities for pipelines and rail and truck infrastructure would result in permanent loss of wetlands. Pipeline operation would continue to disturb wetlands through vegetation maintenance that prevents trees and large shrubs from reestablishing within the pipeline permanent right-of-way. In addition, activities required by the Applicant's Integrity Management Program may require excavation to repair or replace sections of pipe that may be located within wetlands. Permanent fill impacts would be greatest for the rail alternative, followed by the truck alternative. The largest area of previously forested and scrub/shrub wetlands that would be permanently maintained as emergent wetland is associated with the Applicant's preferred route. The largest area of emergent vegetation potentially affected by excavation for pipeline maintenance is associated with SA-04.

Specially Designated Wetlands

Fill of Minnesota Public Waters Wetlands would not be required for the Applicant's preferred route or any of the CN Alternatives. Potential impacts associated with the rail and truck alternatives would be indirect through an increase in impermeable surface at offloading facilities and potential increased runoff from these facilities. Pipeline operation could continue to disturb specially designated wetlands because the Integrity Management Program may require excavation to repair or replace sections of pipe that may be located within wetlands. Both the Applicant's preferred route and continued use of the existing Line 3 could contribute to short-term minor impacts on Public Waters Wetlands from pipeline maintenance that could require excavation. The rail and truck alternatives could result in short-term and negligible to minor indirect effects on Public Waters Wetlands if these wetlands are near offloading facilities. Similarly, calcareous fens could be disturbed by pipeline maintenance that required excavation in the vicinity of the fen. Continued use of the existing Line 3 has the greatest potential to affect calcareous fens because the existing Line 3 crosses three fens, followed by the Applicant's preferred route which crosses one fen. For Wetland Reserve Program wetlands, only SA-04 has the potential to

result in operations impacts. Neither the Applicant's preferred route nor any of the CN Alternatives could affect wetland mitigation bank wetlands during operation.

Mitigation

All alternatives could result in permanent major impacts on wetlands associated with conversion of forested and scrub/shrub wetlands, with the potential exception of continued use of the existing Line 3. For the Applicant's preferred route and SA-04, this conversion primarily would consist of converting forested scrub/shrub wetlands to emergent wetlands (about 210 acres for the Applicant's preferred route and 14 acres for SA-04). New infrastructure for the rail alternative would require filling up to 100 acres, and new infrastructure for the truck alternative would require filling up to 50 acres of forested and scrub/shrub wetlands (Table 5.2.1.3-6). The Applicant has committed to provide compensatory wetland mitigation for permanent impacts on forested, scrub/shrub, and emergent wetlands associated with the Applicant's preferred route, as required in federal and state-specific permits. It is anticipated that any permanent wetland conversion for rail and truck alternatives also would require compensatory mitigation by the authorizing agencies. No additional mitigation measures have been identified.

5.2.1.3.5 References

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5.2.1.4 Floodplains

Periodically, rivers, streams, and lakes will overflow their banks and inundate adjacent low-lying floodplains. Functioning of a floodplain can affect stormwater runoff, water quality, vegetative diversity, wildlife habitat, and aesthetic qualities of waterbodies (Minnesota DNR 2017). Because of their proximity to waterbodies, intermittent flooding, rich soils, and wetland complexes, floodplains form diverse and high-quality habitats under natural conditions. In addition, their naturally flat topography has resulted in historical development within these areas. Construction of facilities such as a pipeline in a floodplain may affect the ability of the floodplain to store excess water or may raise flood elevations upstream. Flood damage can occur when natural flooding processes are disturbed by altering a watercourse or building inappropriately in the floodplain itself (FEMA 2009). The analysis of impacts on floodplains during construction and operation of the Applicant's preferred route and CN Alternatives considered the following:

- Altering floodplain topography;
- Changing flow patterns of flood waters, thereby increasing flooding;
- Blocking or restricting flows;
- Reducing the area within a floodplain that carries floodwaters; and
- Increasing flood elevations upstream.

The analysis of impacts on facilities located within a floodplain and subjected to flooding for the Applicant's preferred route and CN Alternatives considered:

- Disruption of construction activities and loss of materials;
- Damage to equipment and facilities from inundation by floodwaters or flood scour; and
- Interruption of operations.

This section describes the existing conditions for floodplains along the Applicant's preferred route and CN Alternatives that could be affected by construction and operation of the Project. The potential impacts on floodplains or on the pipeline and associated facilities from flood events are compared for the Applicant's preferred route and CN Alternatives. Flood-related spill hazards and potential impacts on floodplains from crude oil releases are discussed in Chapter 10.

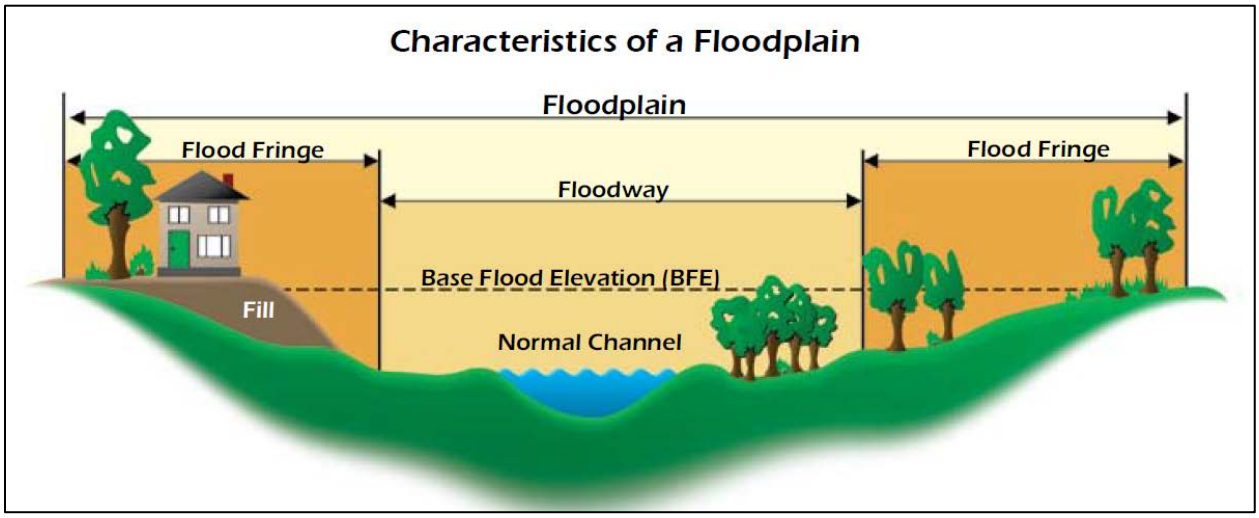
5.2.1.4.1 Regulatory Context and Methodology

Regulatory Context

Under Minnesota state law, a "floodplain" is the land adjoining lakes and rivers that would be inundated by a 100-year flood (flood event expected to occur only once every 100 years). Flood Insurance Rate Maps (FIRMs) produced by the FEMA define the boundaries of floodplains and floodways. These maps indicate areas of the floodplain that are critical for conveying floodwaters (the floodway), the extent of the 100-year flood or special flood hazard areas (SFHAs) (areas subject to a 1-percent annual chance of a flood event), and areas subject to the 500-year flood (areas subject to a 0.2-percent annual chance of a flood). FEMA has not developed flood maps for some counties. The cross-section diagram in Figure 5.2.1.4-1 depicts the general relationship of the normal waterway channel to flood elevations and the area that may be inundated in the flood fringe. Development in floodplains typically is regulated by

local building, floodplain development, and shoreline permit regulations and ordinances and FEMA's National Flood Insurance Program (NFIP).[11] In Minnesota, development within a floodplain can be permitted with implementation of proper floodplain management measures to minimize risk from potential flood hazards (Minn. R. Ch. 6120).

For the portion of the Applicant's preferred route or the CN Alternative constructed within a floodplain, a local building, floodplain development, or shoreline permit for construction or staging within a FEMA-designated SFHA or designated shoreline would be required from each local jurisdiction participating in the NFIP. Aboveground facilities located within the SFHA also would require a floodplain permit and may require an engineering certification demonstrating that the proposed facility complies with the local regulations. All required permits would need to be obtained through the North Dakota Floodplain Administrator, Minnesota DNR, Iowa DNR, Illinois DNR, or Wisconsin DNR prior to construction in the respective state.



Source: FEMA 2009.

Figure 5.2.1.4-1. Characteristics of a Floodplain

Methodology

Impacts on floodplains by were assessed by:

- Using GIS to overlay onto FEMA 100-year flood maps the construction and operations footprints for the Applicant's preferred route from Neche, North Dakota, to Superior, Wisconsin, and the footprints for each CN Alternative.
- Calculating the number of waterbody crossings where full coverage of FEMA flood maps are not available (i.e., not developed by FEMA) to approximate potential floodplains. Because not all waterbodies have designated floodplains (even where floodplains have been mapped), the

[11] The general purposes of the NFIP are to offer primary flood insurance to properties with significant flood risk and to reduce flood risk through adoption of floodplain management standards. Generally, communities volunteer to participate in the NFIP in order to have access to flood insurance; in return, they are required to adopt minimum standards for construction within floodplains. To participate in the NFIP, local jurisdictions (typically cities or counties) must develop local floodplain regulations that meet the NFIP standards.

number of waterbody crossings was considered only as an approximation of potential floodplain impacts for comparison purposes.

- Identifying any Project features that would be located within a FEMA-designated floodplain.

For the Applicant's preferred route and system alternative SA-04, the footprints included the right-of-way, construction work area, facilities, and access roads (where available) to determine whether any of the Project features would be located within a FEMA-designated floodplain. FEMA flood maps also were overlain in GIS with footprints for the assumed rail and truck routes. FEMA flood maps were available for portions of the Applicant's preferred route, existing Line 3, SA-04, and the general area for rail or truck offloading facilities. These mapped areas were designated as the ROI for the floodplains analysis.

5.2.1.4.2 Existing Conditions

Along large rivers, like the Mississippi River or Red River of the North, floodplains typically are flooded during spring after a heavy winter snow season. On these and other floodplains, flooding also can result from intense rains. In areas with small streams or ponds, flooding can occur within hours of intense rain. Floods of 100-year magnitude most recently occurred in 2001 (Minnesota DNR 2006, 2017).

Applicant's Preferred Route

Approximately 31 miles (432 acres) of the construction work area along the Applicant's preferred route would be located within FEMA-mapped 100-year floodplains in the counties for which FEMA mapping has been conducted (46 percent of the route has been mapped). The Applicant's preferred route would require 227 waterbody crossings. (See Section 5.2.1.2.2 and Appendix G for details on waterbody crossings.) Approximately 30 acres of ATWS also would be located within mapped SFHAs. One construction access road (totaling approximately 4 acres) would be located in the 100-year floodplain. No pump stations would be located in a 100-year floodplain, but portions of three MLVs, including an associated access road, would be located in a designated 100-year floodplain (Table 5.2.1.4-1).

Table 5.2.1.4-1. Permanent Aboveground Facilities and Access Roads within FEMA-Designated Special Flood Hazard Areas for the Applicant's Preferred Route in Minnesota

Feature	Acres[a]
Mainline valve access road	0.5
Mainline valve sites	0.5
TOTAL	**1.0**

Notes:

Special flood hazard areas represent the 100-year floodplain.

[a] Acreage reflects counties for which Federal Emergency Management Agency (FEMA) maps are published.

Continued Use of Existing Line 3

Approximately 30 miles of the existing Line 3 pipeline are located within SFHAs (57 percent of the route has been mapped). None of the existing pump stations that are part of existing Line 3 are located within designated floodplains.

System Alternative SA-04

For system alternative SA-04, 95 percent of the route has been mapped by FEMA to designate SFHAs. Approximately 2,187 acres of SA-04 construction work area within these counties would be located within SFHAs, and the route would require 636 waterbody crossings. Once constructed, approximately 151 miles of SA-04 would be located within mapped SFHAs.

Information regarding the location of permanent aboveground facilities and associated access roads has not been determined for SA-04, but some of these facilities may be sited in FEMA-designated floodplains.

Transportation by Rail

As described in Section 4.2, transportation of crude oil by rail would require development of rail loading and offloading facilities (two 100- to 200-acre facilities), upgrade of approximately 35 miles of existing rail line, and reestablishing approximately 10 miles of rail on an existing rail embankment (see Chapter 4 and Table 4.2-5). Construction of offloading facilities in Clearbrook, Minnesota and in Superior, Wisconsin would occur outside of FEMA-designated floodplains.

The assumed rail transportation routes occur within FEMA-designated floodplains. All rail line upgrades and replacement would occur on existing rail embankments that, if located in or near floodplains, are typically established above the flood elevation.

Transportation by Truck

The assumed truck transportation routes occur within FEMA-designated floodplains. As described in Section 4.2, transportation of crude oil by truck would require development of loading and offloading facilities (potentially three 50-acre facilities) and approximately 38 acres for new or reconfigured local road access to these facilities (see Chapter 4 and Table 4.2-6). The exact locations and configurations of the proposed facilities and local access are not known, but they may occur near flood channels and could be constructed within floodplain areas. No new highway construction would be required for truck transportation, although some highway upgrades may be necessary that likely would be constructed on existing highway embankments.

Existing Line 3 Supplemented by Rail

The existing conditions for the existing Line 3 supplemented by rail alternative are those described above for continued use of the existing Line 3 pipeline and the rail alternative. With the combined use of the existing Line 3 pipeline and rail transportation, some FEMA-mapped floodplains would be crossed during operations.

Existing Line 3 Supplemented by Truck

The existing conditions for the existing Line 3 supplemented by truck alternative are those described above for continued use of the existing Line 3 pipeline and the truck alternative. With the combined use of the existing Line 3 pipeline and truck transportation, some FEMA-mapped floodplains would be crossed during operations.

5.2.1.4.3 Impact Assessment

The floodplain analysis considers the potential impacts of the Applicant's preferred route and CN Alternatives on FEMA-mapped 100-year floodplains and the potential impacts of flooding on Project facilities located in the floodplain. Potential operations impacts on floodplains due to a crude oil release are discussed in Chapter 10.

Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Construction activities, including land clearing, grading, trenching, and excavating, within the 31 miles (432 acres) of the construction work area along the Applicant's preferred route, would occur within a FEMA-mapped 100-year floodplain. One construction access road (totaling approximately 4 acres) also would be located in the 100-year floodplain. These activities would temporarily alter floodplain topography, resulting in minor alterations to water flows in the event of a flood in the area. Construction activities are unlikely to block or restrict flows, reduce the area within a floodplain that carries floodwaters, or increase flood elevations upstream. The Applicant would restore temporary roadways built within the floodplain to original ground conditions to avoid permanent impacts on floodplain flow pathways, connectivity, and function. Construction impacts on floodplains generally would be temporary to short term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored. Construction and restoration would follow the plans contained in the Environmental Protection Plan (Appendix E), which would reduce potential impacts.

Impacts on Project elements from flooding could occur during pipeline construction in floodplains and at river crossings. Although the chance of a severe flood event occurring during the relatively short construction period would be low (because severe flood events occur infrequently), storm events could cause minor to major flooding and erosion at the construction site. Applicant-proposed measures to reduce flooding impacts include limiting the amount of time the trench is open at a location to 3 days, which would limit the amount of open trench and soil storage subject to flooding and storm events. Following construction through smaller waterbodies (less than 100 feet wide), the trench would be filled and recontoured within 24 to 48 hours of construction. Larger rivers would be crossed using site-specific methods, including HDD, which may involve placing more equipment in the floodplain (or immediately adjacent) during construction but would not result in temporary or permanent disturbance of the floodplain for the length of the drill. (See Appendix G for details on HDD crossings.) Impacts on construction activities and equipment in a flood event would generally be temporary and negligible to minor from disruption of construction activities and damage to equipment and structures from inundation by floodwaters.

Operations Impacts

Permanent facilities such as pump stations and MLVs would be constructed aboveground and operate for the duration of the Project. No pump stations would be located in a designated floodplain; where feasible, permanent facilities would be constructed outside of the 100-year floodplain. The siting of three MLVs within designated floodplains (1 acre total for the Applicant's preferred route) would not create a measurable impact because of their relatively small footprints. Aboveground facilities in floodplains would require floodplain development permitting, which likely would require measures to reduce impacts on floodwater conveyance (e.g., berm construction, raising the ground elevation above the floodplain) associated with permanent structures.

The pipeline would be constructed below the ground surface, typically with a minimum of 48 inches of ground cover. For waterbody crossings greater than 100 feet wide, the minimum burial depth is 48 inches below the channel bottom. Major river crossings (see Section 6.3.1.2 for details) would use HDD methods, generally resulting in pipeline placement 30 feet or more below the stream channel. The below-ground pipeline would not affect floodplain function once construction and restoration activities have been completed. Impacts on operations activities and equipment from inundation by floodwaters in a flood event generally would be temporary and negligible to minor.

Continued Use of Existing Line 3

Construction Impacts

No new construction would occur with continued use of the existing Line 3 pipeline. Periodic excavation of segments of the pipeline would occur as a maintenance activity (maintenance digs); these are addressed under operations impacts.

Operations Impacts

Continued use of Line 3 at its present capacity is expected to require high levels of maintenance, with an estimated 267 procedures per year in the form of integrity digs (Enbridge 2015). Some of these digs could occur within FEMA-designated floodplains; associated impacts would be temporary to short term and minor (similar to those discussed above for new pipeline construction). Continued use of existing Line 3 would not change the number of permanent aboveground facilities within designated floodplains, and maintenance digs are already occurring. Therefore, continued use of the existing Line 3 would result in no change in the degree of impacts on floodplains or the likelihood of flood-related damage to Line 3 facilities beyond those associated with existing conditions. Impacts on operations activities and equipment from inundation by floodwaters in a flood event generally would be temporary and negligible to minor.

Potential impacts on floodplains due to an unanticipated crude oil release are discussed in Chapter 10.

System Alternative SA-04

Construction Impacts

Approximately 2,187 acres of construction activities, including land clearing, grading, trenching, and excavating activities, would occur within designated SFHAs. Impacts from these activities would be similar to those described above for the Applicant's preferred route: they would be temporary to short-term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored. Construction of SA-04 would require 409 more water crossings than the Applicant's preferred route. Information regarding the specific crossing method for each waterbody has not been determined for SA-04; however, the design and construction methods for waterbody crossings are expected to be comparable to those for the Applicant's preferred route. Construction activities also could be affected by flood events, including disruption of construction activities and damage to equipment and structures from inundation by floodwaters. These impacts would be temporary and negligible to minor.

Operations Impacts

The types of impacts during operation of SA-04 would be the same as those discussed for the Applicant's preferred route. Impacts on floodplain function and impacts from flood events would be temporary and minor to negligible if they did occur during the life of the Project.

SA-04 would cross a significantly larger number of designated floodplains and rivers than the Applicant's preferred route. The greater length of this alternative increases the number of locations with the potential for impacts on floodplain function and impacts on facilities from flood events. SA-04 would require approximately twice as many pump stations, MLVs, and access roads as the Applicant's preferred route; and some of these facilities would be located in designated floodplains. Siting aboveground facilities in floodplain areas would require floodplain development permitting, which likely would require measures to reduce impacts on floodwater conveyance (e.g., berm construction, raising the ground elevation above the floodplain) associated with permanent structures. The impacts would be expected to be negligible to minor and last for the life of the Project.

The type of permanent aboveground facilities and associated access roads has not been determined for SA-04. As with the Applicant's preferred route, it is expected that these features would be located outside of FEMA-designated floodplains to the extent practicable, and the design and construction methods are expected to be comparable to those for the Applicant's preferred route. As a result, the overall impact of operation of SA-04 related to floodplains would be negligible to minor and permanent. Impacts on operations activities and equipment from inundation by floodwaters in a flood event generally would be temporary and negligible to minor.

Potential impacts on floodplains due to an unanticipated crude oil release are discussed in Chapter 10.

Transportation by Rail

Construction Impacts

Rail offloading facilities required at Clearbrook and Superior would not be located in FEMA-designated floodplains; therefore, no impact on floodplain function would occur. Rail line upgrades/replacement that would be required to provide rail service to Clearbrook and are located in or near floodplains would occur on existing rail embankments; therefore, they would not likely change flood flows or floodplain function.

Operations Impacts

Depending on the route to Superior, approximately 10 to 20 miles of the rail line would occurs within designated SFHAs. Operations impacts on floodplains from unit train transport of the oil would be negligible because the rail lines are located on existing embankments. Flood impacts on rail operations resulting from maintenance repairs and operational delays would be temporary and minor to negligible when they did occur, but they may occur over the life of the Project. To the extent that flood flows in flood-prone areas overtop rail lines used for transport of crude oil, rail operations may be temporarily suspended. The likelihood of such events is low because flood height and probability are considered when establishing rail line embankment height.

Transportation by Truck

Construction Impacts

Truck offloading facilities required at Clearbrook and Superior would not be located in FEMA-designated floodplains; therefore, no impacts on floodplain function would occur.

Because truck transport would occur over existing highways, no new road construction would occur except in the immediate vicinity of the Clearbrook and Superior terminals. Some portions of two-lane county roads may require upgrading near the Clearbrook and Superior terminals. The configuration of the offloading facilities and access is not known. Although impacts associated with these facilities cannot

be assessed, they were assumed to be minimal because any construction would be in compliance with floodplain permitting requirements.

Operations Impacts

Approximately 83 miles of the truck route from Gretna to the Superior Terminal occurs within designated SFHAs, and the majority of the route has been mapped by FEMA. Operations impacts on floodplains from truck transportation would be negligible. During operations, trucks transporting crude oil would operate over existing highways; therefore, no change to floodplain function would be expected to occur. Flood impacts on truck operations would be negligible to minor and temporary if they did occur, but could occur over the life of the Project. To the extent that flood flows in flood-prone areas overtop highways used for transport of crude oil, highway operations may be temporarily suspended. However, the likelihood of such events is low because flood height and probability are considered when establishing major state and interstate highway embankment height.

Existing Line 3 Supplemented by Rail

Construction Impacts

No new construction would occur with continued use of the existing Line 3 pipeline. Impacts on floodplains from construction of rail facilities would be the same as those described above for the rail alternative.

Operations Impacts

No change in the degree of impacts on floodplains or the likelihood of flood-related damage to existing Line 3 facilities would occur beyond those associated with existing conditions (including maintenance digs). The impacts associated with supplemental transport by rail would be similar to those described above for operation of the rail alternative, although fewer crude oil trains per day would be exposed to flood-related hazards.

Existing Line 3 Supplemented By Truck

Construction Impacts

No new construction would occur with continued use of the existing Line 3 pipeline. Impacts on floodplains from construction of truck facilities would be the same as those described above for the truck alternative.

Operations Impacts

No change in impacts on floodplains or the likelihood of flood-related damage to existing Line 3 facilities would occur beyond those associated with existing conditions (including maintenance digs). The impacts associated with supplemental transport by truck would be similar to those described above for operation of the truck alternative, although fewer crude oil trucks per day would be exposed to flood-related hazards.

5.2.1.4.4 Summary and Mitigation

Summary

Overall, potential impacts on FEMA-designated floodplains for the Applicant's preferred route and CN Alternatives range from no impact to minor and temporary to permanent impacts. Differences in effects

among alternatives were apparent, especially between the Applicant's preferred route and SA-04, which both require significant construction, and the existing Line 3, transportation by rail, and transportation by truck, which require no or very little construction. These impacts are summarized in Table 5.2.1.4-2.

Construction Impacts

Construction-related impacts on floodplains for the Applicant's preferred route and SA-04, including temporary alterations of topography that could change flow patterns of flood waters and increase flooding, would be temporary to short term and minor, lasting until the disturbed areas are recontoured and vegetation is reestablished. A greater amount of construction in designated SFHAs and more water crossings would be required for construction of SA-04 compared to construction of the Applicant's preferred route. However, the types of potential impacts on floodplains would be similar to those for the Applicant's preferred route: temporary to short term and minor. No impacts on floodplains from construction activities are expected to occur from continued use of existing Line 3, transportation by rail or truck, or continued use of existing Line 3 supplemented by rail or truck transport.

Operations Impacts

The Applicant's preferred route in Minnesota includes about 1 acre of permanent facilities that would be located within a FEMA-designated 100-year floodplain in areas for which FEMA mapping is available; these facilities would be allowed under state and local floodplain regulations if the appropriate permits are obtained. The location, number, and type of permanent aboveground facilities and the number and location of access roads have not been determined for SA-04; therefore, a comparison of specific impacts on floodplains from permanent facilities between these alternatives is not possible. With continued use of the existing Line 3, some ongoing maintenance digs could occur within FEMA-designated floodplains; associated impacts would be temporary to short term and minor. No impacts on floodplains from operations would be expected from transportation by rail or truck or continued use of existing Line 3 supplemented by rail or truck beyond the maintenance digging along existing Line 3 that already occurs.

Mitigation

Identified mitigation measures for the Applicant's preferred route and SA-04 include:

- In areas without available FEMA-designated floodplains, require Enbridge to site all pump stations and MLVs outside of potential floodplains.

Table 5.2.1.4-2. Summary of Potential Impacts on Floodplains for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Construction activities and equipment altering floodplain function and water flow patterns	Temporary to short-term/minor impacts • 432 acres within SFHAs • 30 acres of ATWS within SFHAs • 4 acres of access roads within SFHAs • 227 waterbody crossings	No impact	Temporary to short-term/minor impacts • 2,187 acres within SFHAs • 636 waterbody crossings	*Locations of facilities and access not known but could be constructed within floodplain areas*		No impact for existing Line 3 *Exact locations of facilities not known but would be expected to be constructed within floodplain areas*	
Disruption of construction activities and loss of materials during a flood event	Temporary/ negligible to minor impacts	No impact	Temporary/ negligible to minor impacts	No impact	No impact	No impact	No impact
Damage to construction equipment and facilities from inundation by floodwaters or flood scour	Temporary/ negligible to minor impacts	No impact	Temporary/ negligible to minor impacts	No impact	No impact	No impact	No impact

Table 5.2.1.4-2. Summary of Potential Impacts on Floodplains for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Operations Impacts							
Operation and permanent facilities altering floodplain function	No impact	Temporary to short-term/minor impacts over the life of the Project • 267 annual maintenance procedures	Permanent/ negligible to minor impacts	No impact	No impact	Temporary to short-term/minor impacts over the life of the Project • 267 annual maintenance procedures	Temporary to short-term/minor impacts over the life of the Project • 267 annual maintenance procedures
Interruption of operations caused by flooding	Temporary/ negligible to minor impacts • 31 miles within SFHAs	Temporary/minor impacts • 30 miles within SFHAs	Temporary/ negligible to minor impacts • 151 miles within SFHAs	Temporary/ negligible to minor impacts • 10 to 20 miles within SFHAs	Temporary/ negligible to minor impacts • 83 miles within SFHAs	Temporary/ negligible to minor impacts • 40 to 50 miles within SFHAs	Temporary/ negligible to minor impacts • 113 miles within SFHAs
Damage to operations equipment and facilities from inundation by floodwaters or flood scour	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	No impact	No impact	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts

ATWS = additional temporary workspaces, SFHA = special flood hazard area

5.2.1.4.5 References

Enbridge Energy, Limited Partnership (Enbridge). 2015. Certificate of Need Application to the Minnesota Public Utilities Commission for the Line 3 Replacement Project. April 24. (Docket No. PL 9/CN-14-916.)

Federal Emergency Management Agency (FEMA). 2009. NFIP Floodplain Management Guidebook. Region 10. 5th Edition. March. https://www.fema.gov/media-library-data/20130726-1647-20490-1041/nfipguidebook_5edition_web.pdf. Accessed on February 21, 2017.

Minnesota Department of Natural Resources (Minnesota DNR). 2006. Floodplains and Floodplain Management. http://files.dnr.state.mn.us/publications/waters/floodplain_basics.pdf. Accessed on February 21, 2017.

_____. 2017. Floodplain Regulations. http://www.dnr.state.mn.us/waters/watermgmt_section/floodplain/regulations.html. Accessed on February 21, 2017.

5.2.2 Geology and Soils

Activities that disturb sensitive soils, alter topography, or introduce geologic hazards can negatively affect geology and soil resources, and the people and industries that rely on them. In addition, geologic hazards such as landslides and subsidence and sinkholes can affect the integrity of infrastructure like pipelines, roads, and railways.

The construction-related geology and soils issues to be addressed include the following:

- Soil erosion;
- Soil compaction;
- Soil mixing;
- Soil contamination;
- Presence of shallow bedrock that may require blasting;
- Impacts on paleontological resources;
- Changes to topography; and
- Subsidence and sinkhole hazards.

The operations-related geology and soils impacts addressed in this section include:

- Permanent loss of soil cover;
- Soil erosion and compaction;
- Landslide hazards; and
- Subsidence and sinkhole hazards.

This section describes the existing conditions for the geology and soils within an area along the Applicant's preferred route and CN Alternatives where these resources could be affected by construction and operation of the Project. Potential impacts on geology and soils are discussed and compared for the Applicant's preferred route and the CN Alternatives (continued use of the existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, and continued use of the existing Line 3 supplemented by rail or truck). Potential impacts on geology and soils from an accidental release of crude oil are discussed in Chapter 10.

5.2.2.1 Regulatory Context and Methodology

5.2.2.1.1 Regulatory Context

The NPDES General Construction Stormwater Coverage Permit requires that permittees use approved protection measures to manage soil erosion and minimize soil compaction. The Applicant would be required to obtain NPDES permits from North Dakota DH's Division of Water Quality, Minnesota PCA, Iowa DNR, Wisconsin DNR, and Illinois EPA prior to construction in each respective state. In addition, Minnesota Statutes Chapter 103F Soil Erosion Law prohibits activities that allow for excessive soil loss, as defined by NRCS guidelines. 29 CFR Part 1926, Subpart U regulates the storage and use of explosives for blasting of bedrock. Minnesota Administrative Rules Chapter 7500 also regulates the storage and use of explosives,

and designates municipal supervision of compliance with federal blasting regulations. Other geologic resource guidance and regulations include design and engineering protocols for dealing with site-specific geologic hazards (such as burial or reinforcement of pipelines to protect from landslides). Federal design and engineering specifications in 49 CFR Parts 192 and 193 ensure that pipeline facilities are protected from potential landslides and unstable slopes. Because no significant seismic hazard is present in the Project area, pipeline engineering requirements to address the seismic stability of the pipeline are not applicable to the Project (USGS 2016).

5.2.2.1.2 Methodology

To assess potential construction and operations impacts on geology and soils, and to assess potential impacts of geologic hazards on Project elements, relevant geologic resources present along the Applicant's preferred route and the CN Alternatives were reviewed and inventoried. These resources included soils, shallow bedrock, paleontological resources, and topography. Soil characteristics that may be sensitive to disturbance, including prime farmland, soils highly erodible by water or wind, hydric soils, compaction-prone soils, stony/rocky soils and coarse-textured soils, were identified from NRCS soil data, including both SSURGO and STATSGO2 data (NRCS 2016). Other data sources included maps and publications from USGS, the Minnesota Geological Survey (MGS), and the Paleontology Portal. Potential geologic hazards, including landslide hazards and subsidence/sinkhole-prone areas, were also identified and inventoried using maps and publications from USGS and MGS.

Data for the relevant geologic resources and geologic hazards were overlain in GIS with maps of the estimated construction and operations footprints for the Applicant's preferred route and CN Alternatives to determine the locations and extent of potential impacts. Potential impacts on geologic resources for the Applicant's preferred route and the CN Alternatives were considered where construction or operation of the Applicant's preferred route or a CN Alternative could cause disturbance, loss, or modification of the resource—and where estimated footprints for these actions intersected potential geologic hazards that could cause damage or injury.

The ROI for the geology and soils impact analysis consists of areas where soils, topography, or potentially bedrock would be disturbed during construction or operation of the Applicant's preferred route or a CN Alternative. For the Applicant's preferred route, this includes temporary construction work areas; permanent rights-of-way; temporary and permanent access roads; and the locations of associated facilities outside the permanent rights-of-way, such as pump stations. For the existing Line 3, this was considered to be within the permanent right-of-way for the Mainline corridor. For SA-04, this includes a 120-foot-wide construction work area and a 50-foot-wide permanent right-of-way centered on the SA-04 alignment. For the rail and truck alternatives, the potential locations of offloading facilities and new or expanded rail lines or roads were included. No additional impacts on soils or geologic resources would be expected along existing rail lines or roads as no new footprint from construction or operation is anticipated along existing rail lines or roads for these alternatives.

5.2.2.2 Existing Conditions

The general geology and soil characteristics that may be affected by the various alternatives are described below, followed by additional detail on those resources associated with the Applicant's preferred route and specific CN Alternatives.

Soils

Soil types and characteristics are diverse, dependent on parent material, climate, topography, age of the soils, and potential modification by human activity. Throughout the ROI for the Applicant's preferred route and CN Alternatives, most soils tend to be deep, high-quality agricultural soils, with high organic matter content. Wetland (hydric) soils also are common throughout the ROI. Any soil type has the potential to be affected by pipeline development, but some soils found in the ROI are more susceptible than others to impacts such as erosion, compaction, and contamination. Soils that may be sensitive to disturbance include prime farmland, highly erodible soils (by water or wind), hydric soils, compaction-prone soils, stony/rocky soils, and coarse-textured soils. These sensitive soils are described as follows:

- Prime farmland soils – These include soils with the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if they are treated and managed according to acceptable farming methods—whether or not they are used for agriculture. "Prime farmlands" as defined herein include those soils that are prime farmlands with no limiting factor, as well as those soils that are considered prime farmlands when drained of excessive moisture. Such high-quality soils are critical to domestic crop production and the agricultural economy; and disturbance, contamination, or loss of these soils can reduce crop yields.
- Highly erodible soils – These soils are prone to high rates of erosion when exposed to wind or water after removal of vegetation. A soil's susceptibility to erosion is dependent on texture, moisture, slope, and soil management practices. Loss of soil from erosion, especially topsoil, can reduce the soil's ability to support plant growth. Highly erodible soils may require protective measures during soil disturbance to minimize soil loss.
- Hydric soils – These soils are sufficiently wet near the surface to develop anaerobic conditions during the growing season and are often found in association with wetlands. Hydric soils are particularly susceptible to compaction and rutting from operation of heavy equipment on the soil surface. Compaction of soils can create difficult conditions for plant growth, delaying or reducing plant reestablishment following disturbance. In agricultural areas, artificial drainage systems (i.e., drainage tiles) have been installed in many soils that are classified as hydric soils; these systems allow excess moisture to drain out of the soil. Where hydric soils are drained, they are less likely to be susceptible to compaction. (Drainage of otherwise water-logged agricultural land is common practice throughout the Upper Midwest; this is discussed further in Section 6.5.1.3.1.) Hydric soils may require modified construction methods to minimize potential compaction by heavy machinery.
- Compaction-prone soils – These include soils with clay loam or finer textures in somewhat poor, poor, and very poor drainage classes. When wet, these fine soils are susceptible to compaction and rutting from operation of heavy equipment on the soil surface. Compaction of soils can create difficult conditions for plant growth, delaying or reducing plant reestablishment following disturbance. Compaction-prone soils may require modified construction methods to minimize potential compaction by heavy machinery.
- Coarse-textured soils — Sandy loams and coarser soils, including gravels, allow for rapid infiltration of potential contaminants downward toward the water table. Additionally, HDD techniques may not be feasible through coarse-textured soils because of borehole instability during drilling. Coarse-textured soils are somewhat abundant in the Upper Midwest.

- Stony/rocky soils – These include soils with a cobbly, stony, bouldery, gravelly, or shaly modifier to the textural class. During soil disturbance activities, removal and replacement of stony/rocky soils may introduce more stones into the topsoil, which can reduce crop yields and lead to problems with operation of farm equipment. Rocks present in the soil also can damage a pipeline during backfilling, if the pipeline is not properly padded, and can prohibit the use of HDD water crossings. Stony/rocky soils occur only in minor, isolated areas throughout the region. Because of their very limited occurrence across the routes, stony/rocky soils are not anticipated to exacerbate the impact of soil disturbance, or impede pipeline installation or construction of other facilities, and therefore are not addressed further herein.

Subsurface Substrate

Subsurface substrate consists of the soils and sediments deeper than the surficial soils discussed above. The substrate may consist of soil, rock, glacial deposits, sand, and gravel. Some of these subsurface substrates outcrop at the surface, while others are present at shallow depths.

Shallow Bedrock

Shallow bedrock is considered bedrock within approximately 6 feet or less of the ground surface. Bedrock is the hard, solid rock beneath the soil or subsurface substrate.

Paleontology

Paleontological resources include the fossilized remains, traces, or imprints of organisms preserved in rock or sediments that are of scientific interest and that provide information about the history of life on earth. Young glacial sediments that make up most of the region's surficial geology rarely contain remains of Pleistocene megafauna, such as wooly mammoths or mastodon, but such remains are considered scientifically important when discovered (Paleontology Portal 2016). Sedimentary rock formations present at or near the surface in some areas throughout the ROI may contain common marine invertebrate fossils. These fossil remains are globally abundant and are not considered scientifically significant.

Topography

The distribution of abundant glacial sediments across the Upper Midwest has created relatively flat terrain.

Landslide Hazards

Landslide hazard potential is generally low across the ROI, including the Applicant's preferred route, SA-04, the existing Line 3, and potential locations for the rail and truck facilities. The rail and truck routes were not analyzed for landslide hazards.

Karst Conditions

Chemical weathering and dissolution of subsurface bedrock from the slight acidity of groundwater can result in the formation of caves, cavities, and void spaces in the rock, known as "karst topography." Overlying rock and sediment may sink downward into large void spaces, causing subsidence of the overlying land surface. In extreme cases, where large bedrock cavities are shallow, rocks and soils at the surface may collapse downward into a cavity, creating a sinkhole. Karst topography features are the source of abundant springs and seeps found throughout southeastern Minnesota and parts of northern Iowa. Rock types most susceptible to subsidence and sinkhole formation include limestone, dolostone, and some sandstones. Some limestones and sandstones found in southeastern Minnesota and northeast

Iowa are susceptible to subsidence and sinkhole formation. Because of the very permeable nature of karst topography, potential contaminants can travel rapidly downward through the formations to the water table. Karst regions therefore have increased susceptibility to potential groundwater pollution (addressed in Section 5.2.1.1).

5.2.2.2.1 Applicant's Preferred Route

Soils

Table 5.2.2-1 provides information on the sensitive soils along the Applicant's preferred route by miles and percentages of the total route.

Table 5.2.2-1. Sensitive Soils along the Applicant's Preferred Route

Soil Type	Miles	Percentage of Total Route
Length	380.4	
Prime farmland	158.7	42
Highly erodible soils (by water)	3.7	1
Highly erodible soils (by wind)	106.9	28
Hydric soils	154.2	41
Compaction-prone soils	38.4	10
Coarse-textured soils	42.5	11
Stony/rocky soils	1.5	<1

Sources: NRCS 2016; Minnesota DNR 2016a.

As indicated by Table 5.2.2-1, prime farmland, hydric soils, and highly erodible soils (by wind) are within the ROI for the Applicant's preferred route. Highly erodible soils (by water) and stony/rocky soils are rare. Sites with existing soil contamination are addressed in Section 5.2.1.1.

Subsurface Substrate

The characteristics of the subsurface substrate (soils and sediments deeper than the surficial soils discussed above) are important in determining the method of pipeline installation, particularly regarding the use of HDD methods for pipeline installation. Some subsurface sand and gravel layers are not conducive to HDD techniques, as the unconsolidated sediments are prone to collapse during drilling. Some of these deposits have been well mapped and serve as aquifers, as discussed in Section 5.2.1.1. Geotechnical drilling is required to determine the site-specific characteristics of these deposits in order to determine the feasibility of using HDD to install the pipeline.

Shallow Bedrock

The depth to bedrock along the Applicant's preferred route ranges from 0 to over 450 feet, with depths averaging approximately 200 feet (MGS 2016). Where bedrock is present at or near the surface within the pipeline corridor, blasting of the rock with explosives would be required for installation of buried pipeline. Surface bedrock that may require blasting is present in one segment of the Applicant's preferred route between mileposts 354.6 to 356.6 in Carlton County, Minnesota.

Paleontology

The ROI for the Applicant's preferred route has isolated sections of sedimentary rock formations that are likely to contain common marine invertebrate fossils. These layers generally are found at depths greater than 30 feet, with very few outcrops occurring at or near the surface (MGS 2016). Along the eastern end of the route in Carlton County, bedrock may be at the surface or near the surface, and common marine invertebrate fossils could be present in shallow bedrock. Rare Pleistocene megafauna remains may also be present in the sediments overlying the bedrock.

Topography

Topographical variation is modest across the ROI, punctuated in some areas by isolated ridges and hills, with some steep slopes occurring along streambanks (Appendix A). Elevations range from approximately 903 to 1,681 feet above sea level across the Applicant's preferred route (NED DEM 2016).

Landslide Hazards

Landslide hazard potential is generally low for the ROI. However, near the eastern end of the Applicant's preferred route between Carlton and the Wisconsin border, 8 miles of the route intersect areas with a high susceptibility to landslides, mostly in isolated sections at stream crossings. Between Clearbrook and Carlton is an additional 0.4 mile of high landslide hazard (NPMS LSHR 2016; Enbridge 2016a).

Karst Conditions

Karst conditions, which could lead to subsidence and sinkhole formation, are not believed to be present along the Applicant's preferred route (Minnesota DNR 2016b; USGS 2016).

5.2.2.2.2 Continued Use of Existing Line 3

Soils

Table 5.2.2-2 provides information on the sensitive soils along the existing Line 3 by miles and percentages of the total route.

Table 5.2.2-2. Sensitive Soils along Existing Line 3

Soil Type	Miles	Percentage of Total Route
Length	326.3	
Prime farmland	129.9	40%
Highly erodible soils (by water)	3.7	1%
Highly erodible soils (by wind)	105.2	32%
Hydric soils	147.9	45%
Compaction-prone soils	40.8	13%
Coarse-textured soils	40.3	12%
Stony/rocky soils	2.9	<1%

Sources: NRCS 2016; Minnesota DNR 2016a.

As indicated in Table 5.2.2-2, prime farmland and hydric soils are prevalent along the ROI for existing Line 3. Soils highly erodible by water are rare, while those highly erodible by wind are somewhat common. Compaction-prone and coarse-textured soils are not common, and stony/rocky soils are relatively rare along the existing Line 3.

Bedrock may be present at or near the surface in isolated segments along the eastern portion of Line 3, including isolated segments near Carlton. Some of the bedrock is likely to contain common marine invertebrate fossils. Rare Pleistocene megafauna remains also may be present in the glacial sediments overlying the bedrock.

The existing Line 3 passes through 8.4 miles of high landslide susceptibility, and does not intersect any known karst topography.

5.2.2.2.3 System Alternative SA-04

Soils

Soil characteristics along the SA-04 route were analyzed from NRCS soil data, including both SSURGO and STATSGO2 data (NRCS 2016). Table 5.2.2-3 provides the miles and percentages of the occurrence of sensitive soils across the SA-04 route.

Table 5.2.2-3. Sensitive Soils along System Alternative SA-04

Soil Type	Miles	Percentage of Total Route
Length	795.4	
Prime farmland	675.5	85
Highly erodible soils (by water)	0.9	<1
Highly erodible soils (by wind)	20.3	3
Hydric soils	361.8	45
Compaction-prone soils	216.0	27
Coarse-textured soils	12.3	2
Stony/rocky soils	0.1	<1

Sources: NRCS 2016; Minnesota DNR 2016a.

As indicated in Table 5.2.2-3, prime farmland and hydric soils are prevalent along the ROI for SA-04. Highly erodible soils, coarse-textured soils, and stony-rocky soils are relatively rare.

Subsurface Substrate

Similar to the Applicant's preferred route, SA-04 crosses a variety of shallow sand and gravel layers; some of these outcrop at the surface, while others are present at shallow depths. Geotechnical drilling would be required to determine the site-specific characteristics of these deposits in order to determine appropriate methods of pipeline installation.

Shallow Bedrock

Shallow bedrock also is not common along SA-04, with depths in North Dakota and Minnesota averaging approximately 300 to 400 feet (Bluemle 1986; MGS 2016). Where SA-04 crosses southernmost Minnesota and northeastern Iowa, the average depth to bedrock is approximately 100 feet, with shallow bedrock present in isolated sections. Shallow and exposed bedrock is present where SA-04 crosses the Minnesota River at MP 406.6, between Nicollet and Blue Earth Counties, Minnesota. Shallow bedrock also may be encountered within an 8-mile segment in Mower County, Minnesota, near the Iowa border (MGS 2016). Where SA-04 crosses northeastern Iowa, bedrock outcrops are at or near the surface in several isolated sections (Iowa DNR 2017). Within northern Illinois, bedrock depths are generally several hundred feet deep, but the SA-04 route likely crosses isolated sections of bedrock at or near the surface (Hansel and McKay 2010). Geotechnical field investigations would be necessary to determine locations of shallow bedrock and the specific requirements for any blasting along the SA-04 route.

Paleontology

Similar to the Applicant's preferred route, the SA-04 route would cross isolated sections of sedimentary rock formations that are known to contain common marine invertebrate fossils. These layers generally are found at depths greater than 30 feet, with very few outcrops occurring at or near the surface. Where rocks potentially containing fossils outcrop at or near the surface, the blasting necessary for buried pipeline installation likely would destroy or damage fossils. Rare Pleistocene megafauna remains also may be present in the glacial sediments overlying bedrock.

Topography

Topographical variation is modest across the ROI, punctuated in some areas by isolated ridges and hills, with some steep slopes occurring along streambanks (Appendix A). Elevations along the SA-04 route range from 493 to 1,367 feet above sea level (NED DEM 2016).

Landslide Hazards

SA-04 would pass through 3 miles of land considered at high risk for landslides (NPMS LSHR 2016).

Karst Conditions

Along the SA-04 route, relatively shallow carbonate bedrock with potential for subsidence and sinkholes would intersect approximately 76 miles of the route across Minnesota, Iowa, and Illinois (none is present in North Dakota). A total of 8 miles of the SA-04 route in Mower County, Minnesota, has known karst conditions and thus a higher potential for subsidence and sinkholes where shallow carbonate bedrock is present (Minnesota DNR 2016c). Known and potential karst conditions also are present along approximately 63 miles of the route in Iowa, and 5 miles in Illinois (Weary and Doctor 2014).

5.2.2.2.4 Transportation by Rail

Soil and geology conditions for the rail alternative are similar to those of the other alternatives. While specific locations for these facilities have not been identified, the general areas likely to be designated for temporary storage and rail offloading facilities in Clearbrook and Superior contain substantial soils designated as prime farmland, and substantial hydric (wetland) soils. No soils in these areas are designated as highly erodible by water, but some soils are highly erodible by wind. Coarse-textured soils and stony/rocky soils are not common in these areas.

The presence of shallow bedrock and paleontological resources are not relevant for development of these facilities and access as they would not involve construction at depths that would require blasting or significant excavation. The relief is low across the ROI for the rail offloading facilities and associated access.

Areas likely to be designated for temporary storage and rail offloading facilities in Clearbrook and Superior do not intersect areas of elevated landslide hazard or known karst conditions.

5.2.2.2.5 Transportation by Truck

Soil and geology conditions for the truck alternative would be similar to those of the other alternatives. Areas likely to be designated for temporary storage and truck offloading facilities in Clearbrook and Superior contain substantial soils designated as prime farmland and substantial hydric (wetland) soils. No soils in these areas are designated as highly erodible by water, but some soils are highly erodible by wind. Coarse-textured soils and stony/rocky soils are not common in these areas.

The presence of shallow bedrock and paleontological resources are not relevant because development of offloading facilities and associated access for this alternative would not involve construction at depths that would require blasting or significant excavation. The relief is low across the ROI for truck offloading facilities and access.

Areas likely to be designated for temporary storage and truck offloading facilities in Clearbrook and Superior do not intersect areas of elevated landslide hazard or known karst conditions.

5.2.2.2.6 Existing Line 3 Supplemented by Rail

The existing conditions presented for the existing Line 3 and the rail alternatives are representative of existing soil and geology conditions for this combined alternative.

5.2.2.2.7 Existing Line 3 Supplemented by Truck

The existing conditions presented for the existing Line 3 and the truck alternative are representative of existing soil and geology conditions for this combined alternative.

5.2.2.3 Impact Assessment

5.2.2.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

In general, construction activities that can affect geology and soils include trenching and backfilling, blasting, grading, installation of permanent roads and facilities, and the use of fuels and other hazardous materials. Construction would cause disturbance to soils and topography. Where present, shallow bedrock and potential fossil remains could be destroyed through excavation or blasting. Impacts from pipeline construction would mostly occur within the construction work areas along the length of the route and at aboveground facilities, staging areas, and access roads.

Soil disturbance along the Applicant's preferred route during construction would total approximately 5,147 acres. Of the amount disturbed during construction, 2,304 acres would be maintained as permanent right-of-way and dedicated to aboveground facilities during operations. Approximately 84 percent of the route would be co-located with existing infrastructure where prior disturbance to soils likely has occurred. Much of the remaining greenfield portion of the route has been disturbed by human

activities, especially activities related to agriculture and timber harvesting. Additional detail on potential construction-related impacts for the Applicant's preferred route is provided below.

Soil Erosion

Removal of crops, sod, and other vegetation during construction would leave soil exposed to erosion by wind and water. Heavy equipment operation on the exposed soil loosens soil and breaks up soil peds (i.e., aggregations of soil particles that make the soil surface more stable), making the soil more susceptible to erosion, especially during periods of heavy rainfall or windy conditions. Erosion could continue to be a minor impact for several years after construction is complete while plant communities stabilize in the disturbed ground. Any exposed soil would be subject to erosion by water or wind.

As discussed in Section 5.2.2.2, the potential for soil erosion from exposure to water would be highest in areas with water erosion-prone soils, which occur along only approximately 4 miles of the Applicant's preferred route. Soils prone to erosion from exposure to wind are more common along the Applicant's preferred route (approximately 107 miles). Applicant-proposed measures to reduce the potential for soil erosion include using slope breakers (e.g., earthen berms) and erosion control blankets (straw mats, jute mats, coconut or biodegradable synthetic blankets) on sloped terrain and at stream crossings during construction. Erosion control blankets would be placed across the entire construction work area where the base of slopes greater than 5 percent are less than 50 feet from wetlands, waterbodies, drainage tile inlets, or drainageways until the area is revegetated and there is no longer an increased potential for erosion. Trench breakers would reduce or control erosion within the trench during pipe installation.

Erosion control BMPs would be implemented to reduce the potential for long-term erosion effects, including the use of mulch and revegetation in disturbed areas, and permanent earthen berms or installation of biodegradable erosion control blankets on slopes during final grading. Other erosion control BMPs are outlined in Enbridge's Environmental Protection Plan (Appendix E). Potential sedimentation resulting from soil erosion also would be reduced or controlled through stormwater diversions and sediment barriers (sedimentation is addressed in Section 5.2.1.2). Erosion and sedimentation control measures would be inspected and maintained according to Enbridge's Environmental Protection Plan (Appendix E). These Applicant-proposed measures would minimize the potential for soil erosion of all soils, including erosion-prone soils, such that soil erosion due to construction likely would be a temporary to short term, localized, and minor impact.

Soil Compaction

Heavy equipment passage and transport of pipe sections may compact soils, particularly during grading of the right-of-way. Compacted soils impede penetration of plant roots, which affects reestablishment of plant communities after construction activities are completed. Soil compaction also reduces pore space and infiltration within the soil, leading to increased runoff that can further promote erosion. Hydric soils and compaction-prone soils, particularly when wet, would be most susceptible to these impacts.

As indicated in Section 5.2.2.2.1, hydric soils occur across 41 percent of the Applicant's preferred route, and compaction-prone soils occur along approximately 10 percent of the route. Applicant-proposed measures to alleviate soil compaction include deep tillage operations prior to topsoil replacement and during clean-up activities, as necessary. In wetland areas with hydric soils, timber mats and/or low-ground-pressure equipment (which distributes a machine's weight over a larger area) would be used to reduce compaction from heavy machinery (Appendix E). In addition, when soil conditions are wet, such as after periods of heavy rainfall, certain heavy equipment operation activities would be avoided until

soils dry out. If these measures are followed, soil compaction from proposed Project construction likely would be temporary, localized, and negligible to minor.

Soil Mixing

Topsoil and subsoil removal during excavation may cause some mixing of these soil layers. If soil is mixed during backfilling, some biological and chemical properties of the soil may be altered, which may affect reestablishment of plant communities in the short term (several years) after reclamation. In addition, rocks from the subsoil or from potential blasting operations may become mixed into the topsoil, further reducing its productivity.

The Applicant has proposed measures to reduce the potential for soil mixing (Appendix E). Soil mixing would be reduced by removal (stripping), segregation, stockpiling, and replacement of topsoil and subsoil—particularly in areas where soil productivity is an important consideration (e.g., in croplands, hay fields, pastures, residential areas, and other areas as requested by the landowner or as specified in Project plans and/or permits). In wetland environments where there is no standing water, up to 1 foot of topsoil may be stripped and stockpiled. If standing water is present, attempts would be made to segregate the topsoil/organic layer, but it may not be practical. An Environmental Inspector (EI) would perform audits of the topsoil and subsoil removal and segregation. Efforts would be made to remove excess rock (stone equal to or larger than 4 inches in diameter) from the upper 8 inches of subsoil or as specified by permits, contracts, or landowner agreements. If these measures are followed, soil mixing from Project construction likely would be short term and negligible to minor.

Soil Contamination

Soils may become contaminated from minor spills of industrial chemicals or hazardous materials (e.g., lubricants, gasoline, oil, other fuels, coolants, and transmission fluid) during construction activities such as fuel storage, equipment refueling, and equipment maintenance. This is a particular concern in areas of agricultural production, especially prime farmland soils, where contaminated soils can affect the quality and yield of crops. Contamination within soils also can migrate into surface waters or groundwater aquifers; therefore, soil contamination above or adjacent to sensitive water resources, and in areas where the water table is high, would be of particular concern.

Applicant-proposed measures to reduce the potential for minor spills include proper fuel storage practices, fuel dispensing operations, and other hazardous materials handling processes. In the event of a spill of hazardous material, clean-up measures would be in place to reduce the extent of soil contamination. Such measures include immediate assessment and notifications; mobilization of response personnel, equipment, and materials for containment and/or cleanup, such as spill kits with adsorbents; and proper storage and disposal of contaminated material. These spills would be managed according to SPCC Plans. All employees who handle fuels and other regulated substances would be trained by the contractor in these and other BMPs, as outlined in Enbridge's Environmental Protection Plan (Appendix E). The Applicant also would employ a Spill Coordinator, designated by the contractor, to report spills and mobilize spill response in the event of a spill. If Applicant-proposed measures are followed, potential impacts from minor spills likely would be localized, temporary, and negligible to minor.

Presence of Shallow Bedrock

The Applicant has identified one 0.3-mile segment of the Applicant's preferred route in Carlton County, Minnesota, where bedrock outcrops at the surface for approximately 1,500 feet. Blasting with explosives would be required to break up and remove the bedrock in order to install the pipeline in this

segment. The Applicant anticipates that four blasting events would be required, each event breaking up approximately 400 feet of the rock outcrop (Enbridge 2016b).

The Applicant would develop a Blasting Plan prior to construction, which would comply with all federal, state, and local regulations, including those related to the safety, use, storage, and transportation of explosives (Enbridge 2016a). After blasting and pipe installation, the pipe would be surrounded with padding material, such as sand, and the fragments of blasted rock would be used to infill the trench. Large fragments of rock (larger than those in surrounding undisturbed areas) would be removed from the construction work area. Removal of bedrock by blasting would be a permanent impact; however, unless the rock is a source of rare or unique fossils or mineral resources, the impact on geology and soils would be considered minor.

Impacts on Paleontological Resources

Potential impacts on paleontological resources during construction include damage to or destruction of fossils from excavation and blasting operations, if conducted; erosion of fossil beds from grading; and unauthorized collection of fossils by construction personnel or the public. Where blasting is required, it likely would disturb and fracture any fossils potentially found in shallow bedrock. Fossils most likely to be present in shallow bedrock are common marine invertebrate fossils that are globally abundant and not considered scientifically significant. Damage to or destruction of common marine invertebrate fossils from blasting or ripping of bedrock would be a permanent minor impact.

Pleistocene-age mammal fossils are rare but may be unearthed from glacial sediments overlying bedrock during excavation activities for the Project; these fossils are considered scientifically important. The Applicant has developed a state-specific Unanticipated Discovery Plan (Appendix O) that requires work to stop in the event that important paleontological resources are discovered during construction activities. With adherence to the Plan, impacts on rare or unique paleontological resources could be negligible to minor. However, if a rare or unique paleontological resource was damaged or destroyed prior to being discovered, the impact could be permanent and major to the individual resource. The likelihood of such an occurrence, however, is low.

Changes to Topography

Temporary, localized, and minor modifications to topography would take place during grading, trench excavation, and backfilling of the right-of-way. During construction in areas with slopes greater than 30 percent, slope stabilization blankets would be used (e.g., straw mats, jute mats, or coconut or biodegradable synthetic erosion blankets) (Appendix E). At the close of construction, the Applicant would restore the natural contour of any slopes and drainage patterns, which would stabilize the slopes. After pipe installation is complete, backfilling and regrading of the right-of-way would return the disturbed surface to pre-Project conditions.

Minor, localized, and temporary modifications to topography may take place during construction of temporary material storage yards, contractor yards, and temporary access roads. Disturbed areas would be re-graded at the close of construction, and surfaces would be returned to their pre-Project elevations, in accordance with BMPs. Differential settling of the land surface may occur in the months following regrading, but impacts would be negligible.

Minor permanent modifications to topography (e.g., excavations for foundations, permanent road grading) may be required for some new or expanded pipeline-associated facilities (e.g., pump stations, MLVs, cathodic protection systems, and permanent access roads).

Subsidence and Sinkhole Hazards

Subsidence or sinkhole formation is not anticipated within the Applicant's preferred route, as no known shallow carbonate rocks intersect the route.

Operations Impacts

During standard operations, impacts on soil and geologic resources would be limited to permanent loss of soil cover where soils/surface sediments would be converted to impervious surfaces on new roads and aboveground facilities; and potential erosion and compaction during permanent right-of-way maintenance and use of permanent unpaved access roads.

Permanent Loss of Soil Cover

Construction of permanent access roads and associated facilities would require permanent removal of soil, to be replaced with materials such as cement and gravel. Loss of soil cover would total 278 acres for access roads and 67 acres for other permanent facilities along the Applicant's preferred route in Minnesota. Additional acreage for permanent facilities in Wisconsin and North Dakota are unknown at this time. This loss of soil resources would be a permanent and minor impact. In addition, replacement of natural soil cover with less permeable cement and other materials could increase runoff and potential erosion and sedimentation. Runoff and sedimentation are addressed in Section 5.2.1.2.

Soil Erosion and Compaction

Approximately 2,304 acres that encompasses the permanent right-of-way would be subject to permanent, minor soil compaction from maintenance operations (i.e., vehicles traversing the area). New permanent access roads that are unpaved would be subject to minor, localized, and permanent erosion and sedimentation (sedimentation is addressed in Section 5.2.1.2). The locations of new permanent access roads that are unpaved also would experience negligible to minor, localized, permanent soil compaction.

Landslide Hazards

Landslide potential is low across most of the Applicant's preferred route. There is increased potential for landslide activity in isolated sections of the Applicant's preferred route, mostly at stream crossings between Carlton and the Minnesota-Wisconsin border. Areas along the Applicant's preferred route known to have high susceptibility to landslides are limited to 0.4 mile between Clearbrook and Carlton and 8 miles between Carlton and the Minnesota-Wisconsin border. The Project would follow existing design and engineering specifications (in accordance with 49 CFR Parts 192 and 193) to ensure that pipeline facilities are protected from potential landslides. Due to the low landslide potential across most of the route, the likelihood of a landslide affecting the pipeline or associated facilities would be low. The severity of impact on pipeline facilities for an individual landslide event would depend on the nature of the slope, the geologic materials present, and the design of the facilities; such a determination is beyond the scope of this analysis. It should be noted that, although the potential is low, a landslide could occur at any time throughout the life of the Project.

Subsidence and Sinkhole Hazards

Subsidence or sinkhole formation is not anticipated within the Applicant's preferred route because no known shallow carbonate rocks intersect the route.

5.2.2.3.2 Continued Use of Existing Line 3

Construction Impacts

There would be no construction impacts on geology and soils from continued use of the existing Line 3 pipeline because it is already built.

Operations Impacts

Operations impacts on geology and soils from continued use of the existing Line 3 would occur during maintenance, with an estimated 267 repair procedures per year in the form of integrity digs (see Section 4.2.1 for more detail). Soil disturbance from integrity digs and subsequent pipeline repairs (if required) could cause soil erosion. If BMPs to reduce soil erosion are implemented, this impact would be localized, temporary to short term, and negligible to minor. Other impacts from operation of the existing Line 3 would be part of the existing conditions and are not included in the analysis.

5.2.2.3.3 System Alternative SA-04

Construction Impacts

Impacts from pipeline construction for SA-04 primarily would occur within construction work areas along the length of the route, as well as at aboveground facilities, staging areas, and access roads. Soil disturbance along the route during construction would total approximately 11,568 acres. Of the amount disturbed during construction, 4,820 acres would be maintained as permanent right-of-way and dedicated to aboveground facilities during operations. Over 99 percent of the SA-04 route would be co-located with existing infrastructure, where prior disturbance to soils likely has occurred. Co-location of the route is discussed in Section 6.7.

Geologic resource impacts for SA-04 are expected to be similar to those described for the Applicant's preferred route, except for the greater extent of the impacts because the SA-04 route is significantly longer. Geology impacts that vary from the Applicant's preferred route include an increased occurrence of shallow bedrock and karst terrain on the SA-04 route. If constructed, it was assumed that measures similar to the Applicant-proposed measures would be implemented along the SA-04 route to reduce the impacts on geologic resources and soils that were identified for the Applicant's preferred route.

Soil Erosion

Highly erodible soils of concern are not common along the SA-04 route. As detailed in Table 5.2.2-2, the route intersects less than 1 mile of soils that are highly susceptible to water erosion, and approximately 20 miles of soils highly susceptible to wind erosion. It is assumed that measures similar to the Applicant-proposed measures described above would be implemented to minimize the potential for soil erosion. As a result, minor, localized, and temporary to short-term soil erosion would be likely due to construction and restoration activities.

Soil Compaction

Operation of heavy equipment during construction and restoration can compact soils, especially hydric soils and fine-grained soils prone to compaction. As detailed in Table 5.2.2-3, hydric soils are found along approximately 362 miles (45 percent) of the SA-04 route, and compaction-prone soils are encountered along 216 miles (27 percent) of the route. It was assumed that the Applicant-proposed measures described for the Applicant's preferred route would be implemented to minimize the potential impacts

of compaction. With implementation of these, or similar measures, impacts from soil compaction likely would be localized, temporary, and negligible to minor.

Soil Mixing

The potential for soil mixing along the SA-04 route would be the same as for the Applicant's preferred route. With adherence to measures similar to the Applicant-proposed measures for soil removal and segregation described above, impacts from soil mixing should be short term and negligible to minor.

Soil Contamination

The types of soil contamination that could occur along the SA-04 route from minor spills during construction are the same as discussed for the Applicant's preferred route, although the potential for a minor spill to occur is greater because the SA-04 route is over twice as long as the Applicant's preferred route. With implementation of measures similar to the Applicant-proposed measures described above, impacts from soil contamination likely would be localized, temporary, and negligible to minor.

Presence of Shallow Bedrock

Shallow bedrock is not common for most of the length of the SA-04 route; however, in a variety of isolated segments in southern Minnesota, Iowa, and Illinois, shallow bedrock is likely to be present. Blasting likely would be required at multiple locations along this route. Geotechnical field investigation ultimately would be required to determine the specific need for blasting of shallow bedrock since bedrock blasting sites have not yet been identified for the SA-04 route. Removal of bedrock by blasting would be a permanent impact; however, unless the rock is a source of rare or unique fossils or mineral resources, the impact on geology and soils would be considered minor.

Impacts on Paleontological Resources

Potential impacts on fossil resources for SA-04 would be essentially the same as those described above for the Applicant's preferred route, except for a greater potential because of the greater length of the SA-04 route. In addition, the SA-04 route is likely to have more outcrops of shallow bedrock that may contain common marine invertebrate fossils and thus more potential for construction to affect fossils. Damage to or destruction of common marine invertebrate fossils from blasting or ripping of bedrock would be a permanent minor impact.

The likelihood of impacts on rare or unique paleontological resources (such as Pleistocene mammals found in glacial sediments overlying bedrock) is low because of the rarity of these significant remains. With implementation of the Unanticipated Discovery Plan (Appendix O), work would stop if a discovery was made; and impacts on the fossil resource could be negligible to minor. If a rare or unique paleontological resource was damaged or destroyed prior to being discovered, the impact could be permanent and major for the individual resource.

Changes to Topography

Impacts on topography along the SA-04 route would be essentially the same as those described for the Applicant's preferred route—including both temporary, negligible to minor modifications to the ground surface elevation within the construction work area and permanent minor impacts from installation of some aboveground facilities. Applicant-proposed measures to minimize impacts on topography include backfilling and regrading surfaces at the close of construction to restore the natural contour of the land, when possible.

Subsidence and Sinkhole Hazards

Relatively shallow carbonate bedrock with potential for subsidence and sinkholes intersects approximately 76 miles of the SA-04 route across Minnesota, Iowa, and Illinois (none is present in North Dakota). Known karst conditions are present along approximately 8 miles of the SA-04 route in Mower County, Minnesota, with the possibility of cavities at depth. Known and potential karst conditions also are present along approximately 63 miles of the route in Iowa and 5 miles of the route in Illinois. Thus, the potential exists for subsidence and sinkhole formation across the SA-04 route (Minnesota DNR 2016c; Weary and Doctor 2014).

Karst topography can pose increased risks to the successful installation of pipelines by HDD, including difficulties arising from very loose unstable soils and open voids along the drill path. Potential impacts include loss of drilling fluid into open conduits and inadvertent drilling fluid returns, leading to potential contamination and turbidity in nearby wells, springs, and rivers (addressed in Section 5.2.1.1 and 5.2.1.2); and ground subsidence and possible sinkhole formation due to excavating zones of loose unstable soils. The probability and severity of subsidence or sinkhole formation impacts on pipeline installation or construction of associated facilities depend on the nature of the bedrock, the groundwater conditions, the timing of the occurrence, and the design of the facilities. Such a determination is beyond the scope of this analysis.

Operations Impacts

Permanent Loss of Soil Cover

The types of operations impacts along the SA-04 route would be similar to those described for the Applicant's preferred route, except for the extent of those impacts given that the SA-04 route would be significantly longer. Consequently, the permanent, minor loss of soil cover at aboveground facilities along the 795-mile SA-04 route would generally be more than twice that for the 380-mile Applicant's preferred route.

Soil Erosion and Compaction

The extent of soil erosion and compaction impacts associated with right-of-way maintenance along the 795-mile SA-04 route generally would be more than twice that for the 380-mile Applicant's preferred route. Soil erosion and compaction impacts from SA-04 operations would be permanent, localized, and negligible to minor.

Landslide Hazards

Landslide hazards are generally low for the SA-04 route. The SA-04 route passes through 2.8 miles of land considered to be at high risk for landslides (NPMS LSHR 2016). Due to the low landslide potential across most of the route, the likelihood of a landslide affecting the pipeline or associated facilities is low. The severity of the impact of a landslide on pipeline facilities depends on the nature of the slope, the geologic materials, and the design of the facilities; such a determination is beyond the scope of this analysis.

Subsidence and Sinkhole Hazards

The potential exists for subsidence and sinkhole formation due to karst conditions across the SA-04 route (Minnesota DNR 2016c; Weary and Doctor 2014). The probability and severity of an impact on the pipeline or associated facilities related to subsidence or sinkhole formation during Project operations depend on the nature of the bedrock, the groundwater conditions, the timing of the occurrence, and the design of the facilities. Such a determination is beyond the scope of this analysis.

5.2.2.3.4 Transportation by Rail

Construction Impacts

Transportation of crude oil by rail would require development of temporary storage and offloading facilities, new rail access, and upgrade of existing rail access. Development of new rail facilities, as well as installation of a new interconnection between existing rail lines, would require clearing and grading adjacent to the Clearbrook and Superior terminals. During construction, clearing and grading would include a temporary to short-term increase in soil erosion and compaction. With implementation of measures and BMPs similar to those described in the Environmental Protection Plan (Appendix E), these impacts on soils would be temporary to short term, localized, and negligible to minor. Modifications to topography from grading would be minor and permanent. It was assumed that all of the surface soils at the offloading facilities at the Clearbrook and Superior terminals would be permanently converted to impervious substrate (e.g., concrete, pavement) as discussed below.

Contamination of soil could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities. These spills would be managed according to SPCC Plans. With implementation of BMPs and measures similar to the Applicant-proposed measures described above, impacts on soil contamination likely would be temporary and negligible to minor.

Because no known karst conditions are present within the ROI for the rail alternative, no subsidence and sinkhole impacts are anticipated to occur.

Operations Impacts

Development and operation of temporary storage and offloading facilities in Clearbrook and Superior and new or expanded rail lines would permanently convert soil cover to impervious surfaces, resulting in a loss of up to about 360 acres of soil cover including 260 acres associated with the Clearbrook terminal and about 100 acres associated with the Superior terminal. This is considered a minor permanent impact on soils.

In addition, minor spills and leaks of crude oil, fuel, and lubricants from train transit could cause minor and localized soil contamination along the rail corridor and adjacent right-of-way. Regular inspection of rail cars for leaks would minimize the potential for such contamination; impacts likely would be minor and localized, and generally would remain on the rail line bed.

5.2.2.3.5 Transportation by Truck

Construction Impacts

Transportation of crude oil by truck would require development of temporary storage and offloading facilities at Clearbrook and Superior, and new or upgraded road access near Neche, Clearbrook, and Superior. During construction, clearing and grading for offloading facilities or rail access would cause a temporary to short-term increase in soil erosion and compaction. With implementation of measures and BMPs similar to those described in the Environmental Protection Plan (Appendix E), these impacts on soils would be temporary to short term, localized, and negligible to minor.

Construction of the offloading facilities would result in conversion of approximately 100 acres of soil cover to an impervious surface (up to 50 acres adjacent to both the Clearbrook and Superior terminals).

It was assumed that new and ungraded roads also would convert existing soil cover to impervious surfaces, including approximately 4 acres at Clearbrook and 34 acres at Superior (it is not expected that upgrades near Neche would increase the impervious surface of the existing roadway). Modifications to topography from grading would be minor and permanent.

Soil contamination could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities. These spills would be managed according to SPCC Plans that would be developed for each facility. With implementation of BMPs and measures similar to the Applicant-proposed measures described for the Applicant's preferred route, impacts on soil contamination would be temporary and negligible to minor.

Operations Impacts

Operation of temporary storage and offloading facilities in Clearbrook and Superior would permanently convert pervious soils to impervious surfaces, resulting in a loss of approximately 138 acres of soil cover. This is considered a permanent and minor impact on soils. Operations of the truck alternative would result in no other impacts on geology and soils.

5.2.2.3.6 Existing Line 3 Supplemented by Rail

Construction Impacts

Construction impacts would be the same as those described above for the transportation by rail alternative.

Operations Impacts

Operations impacts would be the same as those described above for continued use of the existing Line 3 and transportation by rail. The only anticipated difference would be a reduction in rail traffic for this alternative compared to the rail alternative, which could reduce the potential for localized soil contamination from minor leaks in the vicinity of the offloading facilities and along the existing rail routes.

5.2.2.3.7 Existing Line 3 Supplemented by Truck

Construction Impacts

Construction impacts would be the same as those described above for the transportation by truck alternative.

Operations Impacts

Operations impacts would be the same as those described for continued use of the existing Line 3 and transportation by truck. The only anticipated difference would be a reduction in truck traffic for this alternative compared to the truck alternative, which could reduce the potential for localized soil contamination from minor leaks in the vicinity of the offloading facilities and along the existing truck routes.

5.2.2.4 Summary and Mitigation

5.2.2.4.1 Summary

Construction and operation of the Applicant's preferred route and all CN Alternatives would affect geologic and soil resources. Table 5.2.2-4 provides a summary of the occurrence and extent of potential impacts on geology and soils associated with the Applicant's preferred route and CN Alternatives. If the protective measures outlined in the Applicant's Environmental Protection Plan (Appendix E) or similar measures are implemented, most construction impacts on geology and soils would be negligible to minor and temporary to short term.

During construction, soil erosion by wind and water likely would be a minor, temporary to short-term impact. Hydric and compaction-prone soils occur to some extent along the Applicant's preferred route and the CN Alternatives (except that continued use of the existing Line 3 does not involve construction). If Applicant-proposed measures or similar measures and BMPs to reduce compaction are followed, compaction of soils likely would be temporary and minor for the Applicant's preferred route and the CN Alternatives.

Shallow bedrock is not prevalent along the Applicant's preferred route or in affected areas for any of the CN Alternatives. One instance of shallow bedrock along the Applicant's preferred route would require blasting. Shallow bedrock is not common along the SA-04 route, but in limited sections within Minnesota, Iowa, and Illinois blasting could be required. Geotechnical field investigations would be necessary to determine the specific requirements for blasting along the SA-04 route. No blasting of bedrock would be expected for rail or truck transport, as construction of those alternatives would require no significant excavation. The potential for encountering fossil-bearing rock or sediments is similarly low for all potential routes, although the SA-04 route is likely to require more excavation and blasting, with the resulting higher potential for damage or destruction of fossils. As noted, continued use of the existing Line 3 does not involve construction. Except for integrity digs required for maintenance, other impacts from operation of the existing Line 3 would be part of the existing conditions and are not included in the analysis.

Impacts on Project elements from geologic hazards are not likely for the Applicant's preferred route or any CN Alternative because the overall landslide potential is low. The potential exists for subsidence or sinkhole formation on the SA-04 route but not for the Applicant's preferred route, existing Line 3, or the rail or truck facilities.

The greatest impact during operations would the loss of soil cover associated with aboveground facilities; these permanent losses would be minor for the Applicant's preferred route and all CN Alternatives. The extent of permanent soil conversion to an impervious surface would be up to 140 acres for the truck alternative, up to 360 acres for the rail alternative, about 345 acres for the Applicant's preferred route, and about 700 acres for SA-04.

5.2.2.4.2 Mitigation

Beyond the potential for an unanticipated discovery of and damage to a rare paleontological resource, no major impacts are expected on geologic or soil resources for the Applicant's preferred route or any CN Alternative. Beyond the Applicant-proposed measures described above, no mitigation measures have been identified to further avoid and minimize impacts on geology and soils.

Table 5.2.2-4. Summary of Potential Impacts on Geology and Soils for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	System Alternative SA-04	Continued Use of Existing Line 3	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Prone to soil erosion by water or wind (miles)	Temporary to short-term/minor localized impacts • 110.6 miles	Temporary to short-term/minor localized impacts • 21.2 miles	No impact	Temporary to short-term/minor impacts • *Sensitive soils are present but are not quantifiable because the specific locations of activities and facilities are not known.*			
Prone to soil compaction, hydric, or other sensitive soils (miles)	Temporary/ negligible to minor localized impacts • 192.6 miles	Temporary/ negligible to minor localized impacts • 578.6 miles	No impact	Temporary to short-term/negligible to minor impacts • *Sensitive soils are present but are not quantifiable because the specific locations of activities and facilities are not known.*			
Increase in soil mixing	Short-term/ negligible to minor impacts	Short-term/ negligible to minor impacts	No impact	No impact	No impact	No impact	No impact
Potential for soil contamination from minor spills	Temporary/ negligible to minor localized impacts	Temporary/ negligible to minor localized impacts	No impact	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts	Temporary/ negligible to minor impacts
Potential for shallow bedrock blasting (miles)	Permanent/minor impacts • 0.3 mile	Permanent/minor impacts[a]	No impact	No impact	No impact	No impact	No impact
Potential paleontological disturbance from excavation or blasting (miles)	Permanent/ negligible to major impacts • 0.3 mile	Permanent/ negligible to major impacts[a]	No impact	No impact	No impact	No impact	No impact

Table 5.2.2-4. Summary of Potential Impacts on Geology and Soils for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	System Alternative SA-04	Continued Use of Existing Line 3	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Potential for modifications to topography	Temporary/ negligible to minor impacts[b] Permanent/ minor impacts from installation of aboveground facilities[c]	Temporary/ negligible to minor impacts[b] Permanent/ minor impacts from installation of aboveground facilities[c]	No impact	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts
Subsidence or sinkhole hazard?	No	Yes	No	No	No	No	No
Operations Impacts							
Permanent loss of soil cover	Permanent/ minor impacts • 345 acres in MN • Additional acreage in ND and WI unknown	Permanent/ minor impacts • Acreage unknown, but likely twice that of the Applicant's preferred route	No impact	Permanent/minor impacts • Up to 360 acres	Permanent/minor impacts • Up to 140 acres	Permanent/minor impacts • Up to 360 acres	Permanent/minor impacts • Up to 140 acres
Potential for soil erosion and compaction	Permanent/ negligible to minor localized impacts	Permanent/ negligible to minor localized impacts	Temporary to short-term/ negligible to minor localized impacts from erosion No impact from compaction	No impact	No impact	Temporary to short-term/negligible to minor localized impacts from erosion No impact from compaction	Temporary to short-term/negligible to minor localized impacts from erosion No impact from compaction

Table 5.2.2-4. Summary of Potential Impacts on Geology and Soils for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	System Alternative SA-04	Continued Use of Existing Line 3	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Landslide hazard?	Yes	Yes	Yes	No impact for storage areas and facilities; entire route not analyzed	No impact for storage areas and facilities; entire route not analyzed	Yes	Yes
Subsidence or sinkhole hazard?	No	Yes	No	No	No	No	No

[a] Shallow bedrock is not common along the SA-04 route, but in sections within Minnesota, Iowa, and Illinois, blasting likely would be required. Geotechnical field investigations would be necessary to determine the specific requirements for blasting along the SA-04 route. Because the longer SA-04 route is likely to require more blasting, the potential for encountering fossil-bearing rock is higher, with the resulting higher potential for damage or destruction of fossils.

[b] Minor, localized, and temporary modifications to topography may take place during (1) grading, trench excavation, and backfilling of the right-of-way; and (2) construction of temporary material storage yards, contractor yards, and temporary access roads.

[c] Minor permanent modifications to topography (e.g., excavations for foundations, permanent road grading) may be required for some new or expanded pipeline-associated facilities (e.g., pump stations, mainline valves, cathodic protection systems, and permanent access roads).

5.2.2.5 References

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5.2.3 Vegetation

Vegetation is a critical component of ecosystem sustainability, as it regulates biological and biochemical cycles, influences water quality, replenishes and stabilizes soils, provides habitat for wildlife, and contributes directly and indirectly to socioeconomic benefits.

Vegetation is represented by land cover types (assemblages of plants that grow in similar habitat). The evaluation considered the existing land cover types and site-specific impacts to identify and quantify potential changes to vegetation cover, native plant communities, old-growth forests, high conservation value forests (HCVFs), and noxious weed and invasive plant distributions affected by the Applicant's preferred route and each of the CN Alternatives (continued use of the existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, and existing Line 3 supplemented by rail or truck). The analysis of impacts on vegetation during construction and operation of the Applicant's preferred route and CN Alternatives considered the following:

- Loss or alteration of existing vegetation cover;
- Loss or alteration of native plant communities, including Sites of Biodiversity Significance, old-growth forest complexes and HCVFs; and
- Spread of noxious weeds and invasive plants.

After providing information on applicable regulations and the methodology for review, this section describes the existing conditions within an area along the Applicant's preferred route and each of the CN Alternatives where vegetation could be affected by construction or operation of the Project. Next, the potential Project-related impacts of construction and operation on vegetation are discussed for the Applicant's preferred route and each of the CN Alternatives. A summary and comparison of the impacts are included at the end of the section.

Potential effects on animals and plants that are protected under federal and state regulations (termed "unique natural resources") are evaluated in Section 5.2.5.

Potential impacts on vegetation due to an unanticipated release of crude oil are addressed in Chapter 10.

5.2.3.1 Regulatory Context and Methodology

5.2.3.1.1 Regulatory Context

Regulations pertaining to the conservation, protection, and management of vegetation are established at various levels of federal, state, and local government. Conservation and protection activities regarding sensitive plant resources are managed by state agencies. Regulatory protection for calcareous fens and other wetlands are addressed in the Water Resources Section. Other regulatory measures protect federally and state-listed endangered or threatened plants, as discussed in the Unique Natural Resources Section.

Native plant communities (defined under methodology) are naturally-occurring vegetation with considerable resource value. These are identified by the North Dakota Parks and Recreation Department, Minnesota DNR, Iowa DNR, Illinois DNR, and Wisconsin DNR. Data collected by these departments typically are used to identify native plant community types, evaluate quality and quantity,

assign rarity, and provide recommendations for land management practices to avoid and minimize disturbance of rare resources. Few regulations provide protection for native plant communities, although resource agencies devote considerable expense to their conservation for ecological and public values. A "noxious weed" is "any plant or plant product that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture, irrigation, navigation, natural resources of the United States, public health, or the environment" as defined in the U.S. Plant Protection Act of 2000 (7 U.S. Code 7701–7772). Invasive plants are non-native plants also identified as a potential threat to the natural environment because of their tendency to dominate and exclude other vegetation. Weed and invasive plant classifications and rules vary between regulating agencies.

Each state is responsible for managing noxious weeds on its lands in accordance with the rules and regulations identified under the U.S. Plant Protection Act of 2000 (7 U.S. Code 7701–7772). Noxious weed management is regulated by the departments in each state listed in Table 5.2.3-1. In Minnesota, the Department of Natural Resources is responsible for state-prohibited and state-regulated invasive aquatic plants, and the Department of Agriculture is responsible for state-prohibited and state-regulated terrestrial plants classified as noxious weeds.

Table 5.2.3-1. State Regulations Concerning Noxious Weed Management

State	Administering Agency	Regulation
North Dakota	North Dakota Department of Agriculture	Noxious Weed Control (ND Law Ch. 4.1-47-02)
Minnesota	Minnesota Department of Agriculture	Minnesota Noxious Weed Law (Minn Stat. § 18.75 to 18.91;)
Iowa	Iowa Weed Commissioners' Association	Iowa Noxious Weeds and the Iowa Weed Law (IA Code Ch. 317)
Illinois	Illinois Department of Agriculture	Illinois Noxious Weed Law (Illinois Administrative Code, Title 8, Ch. I, Subchapter f, Part 220)
Wisconsin	Wisconsin Department of Natural Resources	Invasive Species Rule (WI Code Ch. NR 40)

5.2.3.1.2 Methodology

The ROI for this evaluation encompassed the area within 0.5 mile of the Applicant's preferred route and CN Alternatives in North Dakota, Minnesota, Iowa, Illinois, and Wisconsin. Vegetation cover, noxious weeds and invasive plant locations were identified within 0.5 mile from pipeline route centerlines or other facilities.

Existing vegetation resources were identified and analyzed using multiple information sources, starting at a broad scale and narrowing to a more localized scale. These data provided classification and nomenclature of vegetation that allowed comparison of the impacts of the Applicant's preferred route and CN Alternatives on specific vegetation resources at different levels.

The following data are used to describe existing conditions and perform analysis:

- EPA Ecoregions, Levels III and IV (existing conditions only)
- National Land Cover Database

- Minnesota Sites of Biodiversity Significance
- Minnesota Native Plant Community Hierarchy
- Minnesota DNR Old Growth and HCVFs
- Interstate noxious weeds

EPA ecoregions are areas where ecosystems are generally similar. They denote areas of similarity in the mosaic of biotic and abiotic components, including geology, landforms, soils, vegetation, climate, land use, wildlife, and hydrology (EPA 2016).The EPA Level III and IV Ecoregions data (EPA 2016) was used to identify broad-scale patterns of existing vegetation.

The National Land Cover Database (NLCD) (Homer et al. 2015) was used to analyze construction and operations impacts on 10 broad-scale land classes of vegetation cover. NLCD uses a combination of satellite imagery, national vegetation survey data, and local vegetation survey data to provide a spatial reference and descriptive data for characteristics of the land surface by grouping similar types of land cover into a variety of classifications (e.g., developed, forested, and cultivated).

Not all of the NLCD cover classifications are used in this analysis. For example, because the category of developed lands (residential, commercial, and industrial lands) primarily include artificially created landscapes with minimal naturally-occurring vegetation, these lands were not included in the vegetation impact summaries.

The NLCD vegetation cover classes that are within the ROI for the Applicant's preferred route and CN Alternatives are defined in Table 5.2.3-2 below and illustrated in Figure 5.2.3-1 under Existing Conditions.

Minnesota Sites of Biodiversity Significance (MBS Sites) are extensive landscape areas mapped by state DNR staff that communicate the native biological diversity significance of each site to natural resource professionals, state and local government officials, and the public. Mapping is still being conducted for portions of the northern-most counties crossed by all routes, except SA-04. MBS Sites are rated for a suite of biodiversity values and are assigned a rank from "outstanding" to "below." The biodiversity ranks help to guide conservation and management. (Refer to the ranking criteria in Unique Natural Resources: Minnesota Biological Survey Sites of Biodiversity Significance.) Outstanding and high-ranked sites are of most concern for conservation, as they contain rare species, native plant communities, and intact landscapes (Figure 5.2.3-2).

Minnesota native plant communities (NPCs) are groups of native plants that associate with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable plant communities that re-occur in similar ecological conditions. NPC mapping continues across the state; all completed MBS Sites have NPC mapping done within outstanding and high-ranked units only. NPCs are also mapped outside of MBS Sites. NPCs are ranked by state conservation status, which reflects the level of rarity across the state. The conservation status ranks range from S1 – critically imperiled to S5 – secure, common, widespread, and abundant; native plant communities ranked as S1 – critically imperiled, S2 – imperiled, and S3 – vulnerable to extirpation or extinction are considered to be "rare."

Table 5.2.3-2. Natural Land Cover Database Classifications

Classification	Definition
Barren Land (Rock/Sand/Clay)	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrub/Scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Grassland/Herbaceous	Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Cultivated Crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Woody Wetlands	Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Old-growth forests, identified in Minnesota DNR's Forest Stand Inventory, are designated forests in Minnesota that have not experienced severe, stand-replacing disturbance over the last 120 years. Old-growth forests are recognized as valuable resources in Minnesota and are protected from harvesting operations. They provide unique wildlife habitat, rare plant refugia, genetic reservoirs, and research opportunities.

Minnesota DNR requires designation of HCVFs as part of the Forest Stewardship Council's® forest certification (Minnesota DNR 2016f). HCVFs are forest areas that contain concentrations of rare, threatened, or endangered species; natural communities; and other biodiversity values that occur in numbers, frequency, quality, and/or density that are sufficiently outstanding to be considered unique or highly important in comparison with other forest areas within the ecoregion. HCVF lands are managed for a broad set of objectives and forest resources in a manner that will maintain or enhance these values across the landscape.

The site-specific impacts of the Applicant's preferred route and the CN Alternatives on existing native vegetation communities were analyzed by overlaying in GIS the footprints for the Applicant's preferred route and CN Alternatives on state agency resource data.

Potential impacts on old-growth forests and HCVFs in Minnesota were quantified by overlaying the footprints for the Applicant's preferred route and CN Alternatives on the Minnesota DNR Forest Stand Inventory (Minnesota DNR 2016c) and HCVF (Minnesota DNR 2016f) databases. Potential impacts on native plant communities in Minnesota associated with rail and truck transportation were evaluated by overlays of the rail and truck routes on remnant railroad right-of-way prairies (Minnesota DNR 2017) and native plant community maps (Minnesota DNR 2016a).

Noxious weed and invasive plant infestations (described under Regulatory Context) that could be spread by construction and operation activities were identified by overlaying the footprints for the Applicant's preferred route and CN Alternatives on state- and county-level data for noxious weeds and invasive plants (University of Georgia 2016; Minnesota DA 2016; Minnesota DNR 2016b).

Construction impacts for the Applicant's preferred route were estimated by overlaying refined footprints provided by Enbridge that identify the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations. Construction impacts for continued use of the existing Line 3 pipeline are qualitatively addressed for integrity digs and subsequent pipeline repair and address the potential for these actions to occur in various vegetation cover classes, rare plant communities and noxious weed infestations.

Construction impacts for system alternative SA-04 were estimated by overlaying a standardized 120-foot-wide construction work area centered on the SA-04 route. Although the precise routes and facility locations for the rail and truck alternatives are not known, potential construction-related impacts for these alternatives were qualitatively reviewed based on the descriptions of potential locations for new facilities, the descriptions of potential transportation routes, and available vegetation information for these areas.

Operations impacts for the Applicant's preferred route were estimated based on the permanent right-of-way footprints provided by the Applicant. Operations impacts for continued use of the existing Line 3 were evaluated based on the existing permanent right-of-way for that pipeline. Operations impacts for SA-04 were estimated by overlaying a standardized 50-foot-wide permanent right-of-way centered on the route. Although the precise routes and facility locations of the rail and truck alternatives are not known, operations impacts for these alternatives were qualitatively evaluated using broad-scale spatial analysis and assumptions about the potential routes for train and truck transport.

To assess and quantify the magnitude of impacts, this section draws on the land cover and vegetation datasets referenced above to identify the number of acres of each vegetation type or rare native plant community that may be affected.

5.2.3.2 Existing Conditions

The ecoregions that would be crossed by the Applicant's preferred route and CN Alternatives include Levels III and IV EPA ecoregions which are described through analysis of patterns and composition of geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The ecoregions are described and miles crossed are enumerated in tables under the Applicant's preferred route and each of the CN Alternatives.

NLCD vegetation cover classes that are within the ROI for the Applicant's preferred route and CN Alternatives are shown in Figure 5.2.3-1, and discussed under the Applicant's preferred route and each of the CN Alternatives.

MBS Sites of Biodiversity Significance are shown in Figure 5.2.3-2 and discussed under the Applicant's preferred route and each of the CN Alternatives.

Noxious weeds and invasive plants within 0.5 mile of the Applicant's preferred route and system alternative SA-04 are listed in Table 5.2.3-2.

All other existing vegetation conditions are addressed under their respective routes and detailed breakdown of vegetation types by alternative are provided in Appendix K.

Applicant's Preferred Route

Most of the Applicant's preferred route (53 percent) is within the EPA Northern Lakes and Forest Level III ecoregion, followed by the Lake Agassiz Plain ecoregion (35 percent) (Table 5.2.3-4). These ecoregions largely represent prairies, forests, wetlands, and agricultural vegetation communities. The Applicant's preferred route occurs within an area of the Midwest dominated by rolling hills, plains, and rich soils suitable for agricultural development. The route is located within ecoregions that support forested uplands, forested wetlands, and agricultural areas. The topography ranges from flat river terrace croplands to forested ridges and plains.

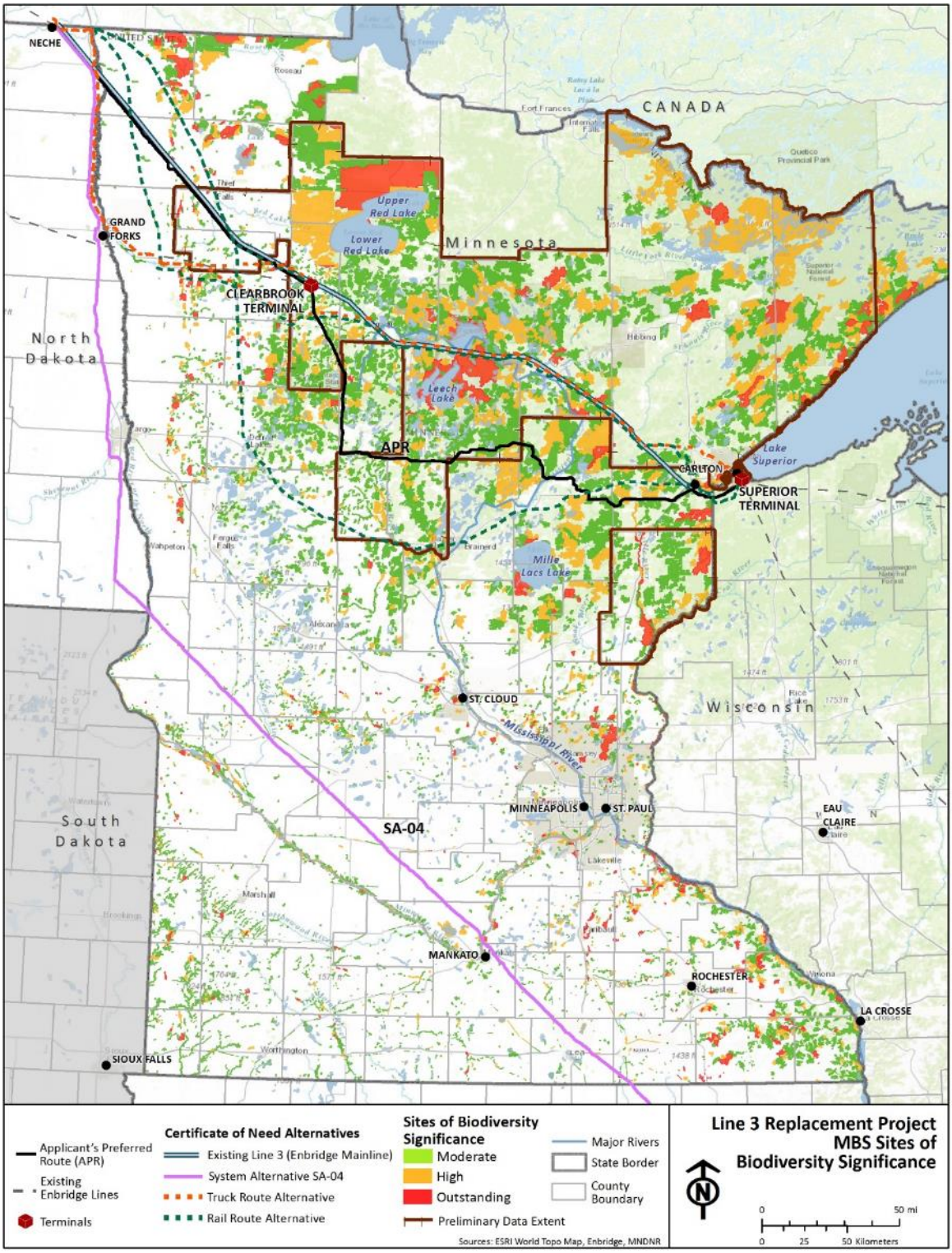
The NLCD includes detailed vegetation and land use patterns for the United States. The Applicant's preferred route crosses 10 broad-scale vegetation cover classes: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Figure 5.2.3-1). Developed lands (residential, commercial, and industrial lands) primarily include artificially created landscapes with minimal naturally-occurring vegetation and therefore were not included in the analysis. Broad-scale vegetation cover patterns demonstrate that the Applicant's preferred route occurs within areas dominated by the presence of forested vegetation cover classes (e.g., deciduous forest, woody wetland), followed by shorter-canopied vegetation communities such as cultivated crops and hay pasture cover classes.

Minnesota DNR native plant community systems that occur within 0.5 mile of the Applicant's preferred route include 11 sensitive prairie, wetland, and forest communities. These occur within Sites of Biodiversity Significance that are ranked as moderate to outstanding under the MBS Sites significance ranking (Figure 5.2.3-2). Specific locations for moderate to outstanding-ranked MBS Site and the imbedded native plant communities relative to the location of the Applicant's preferred route are shown in greater detail in Appendix A. Nineteen rare native plant communities (with S1, S2, or S3 conservation rank) were documented within 0.5 mile of the Applicant's preferred route.



Source: Homer et al. 2015.

Figure 5.2.3-1. NLCD Vegetation Cover in the Region of Interest for the Applicant's Preferred Route and Certificate of Need Alternatives



Source: Minnesota DNR 2016d, note that some data are preliminary.

Figure 5.2.3-2. Sites of Biodiversity Significance in the Region of Interest for the Applicant's Preferred Route and Certificate of Need Alternatives

Table 5.2.3-3. Noxious Weeds and Invasive Plants within 0.5 Mile of the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State Observed[a]	Status[b]
Alyssum, hoary	*Berteroa incana*	MN	INV
Buckthorn, common	*Rhamnus cathartica*	MN, WI	RNW, INV, R, I
Buckthorn, glossy	*Frangula alnus*	WI	R, I
Daisy, oxeye	*Leucanthemum vulgare*	MN	INV, I
Grass, reed canary	*Phalaris arundinacea*	MN	INV, N
Grass, smooth brome	*Bromus inermis*	MN	INV, I, N,
Hawkweed, orange	*Hieracium aurantiacum*	MN	INV I,
Honeysuckle, exotic	*Lonicera spp.*	MN	INV, I
Knapweed, spotted	*Centaurea stoebe*	MN	INV, I
Lilac	*Syringa spp.*	MN, WI	I
Loosestrife, purple	*Lythrum salicaria*	MN, WI	PNW, NUW, R, I,
Maple, amur	*Acer ginnala*	MN, WI	INV, R, I
Peashrub, Siberian	*Caragana arborescens*	MN, WI	INV, R, I
Queen of the prairie	*Filipendula rubra*	MN, WI	N
Spurge, leafy	*Euphorbia esula*	MN	PNW, I
Sweetclover, white	*Melilotus alba*	MN	INV, I
Sweetclover, yellow	*Melilotus officinalis*	MN	INV, I
Tansy	*Tanacetum vulgare*	MN	INV, I
Thistle spp.	*Cirsium spp.*	MN	PNW, I
Thistle, bull	*Cirsium vulgare*	MN, ND	PNW, I
Thistle, Canada	*Cirsium arvense*	MN, ND	PNW, NW, I
Thistle, plumeless	*Carduus acanthoides*	MN	PNW, I
Thistle, sow	*Sonchus arvensis*	MN	PNW, I
Trefoil, birdsfoot	*Lotus corniculatus*	MN	INV, I
Valerian, common	*Valeriana officinalis*	MN,WI	R, I
Number of taxa = 25			

Sources: Minnesota DNR 2016b; Minnesota DA 2016; University of Georgia 2016.

[a] State Observed = Occurrences of infestations within 0.5 mile from the Applicant's preferred route and SA-04.

[b] Status (MN): PNW – Prohibited Noxious Weed, RNW – Restricted Noxious Weed (NRCS 2016), INV - Invasive (Minnesota DNR 2016b)
Status (ND): NW – Noxious Weed (NRCS 2016)
Status (WI): NUW – Nuisance Weed; NW – Noxious Weed (NRCS 2016), R – Restricted Noxious Weed (Wisconsin DNR 2016b)
NRCS: I – Introduced in the lower 48 (states within the contiguous United States); N – Native to the lower 48

Table 5.2.3-4. EPA Ecoregions Crossed by the Applicant's Preferred Route

Level III[a]	Level IV[a]	Description[a]	Miles within Ecoregion
48. Lake Agassiz Plain	Beach Ridges and Sand Deltas	Low ridges of gravel and sand with mix of row crops, small grains, woodland, and wetlands	35.5
	Glacial Lake Agassiz Basin	Flat former lake bed dominated by row crops and grains	56.1
	Lake Agassiz Plains	Flat land higher than 48a with row crops, small grains, and pasture	42.7
50. Northern Lakes and Forests	Chippewa Plains	Mostly level landscape with forest, crops, and pasture and many lakes	30.1
	Glacial Lakes Upham and Aitken	Flat former lake beds with peat and sandy soils covered with wetlands, forest, and some pasture	31.4
	Itasca and St. Louis Moraines	Mostly forested rolling landscape with some lakes, crops, and pasture	74.7
	Lake Superior Clay Plain	Clay-covered former lake bed strongly dissected with mixed land use	19.1
	Minnesota/Wisconsin Upland Till Plain	Rolling landscape of woods, wetlands, pasture, and crops	45.6
51. North Central Hardwood Forests	Alexandria Moraines and Detroit Lakes Outwash Plain	Elevated knob and kettle landscape with many lakes and mix of forest, row crops, and pasture	11.1
	Wadena/Todd Drumlins and Osakis Till Plain	Drumlins and rolling plains with row crops, pasture, and woodland	34.3
TOTAL			**380.5**

Notes:

Values in table may not sum to total due to rounding.

[a] Source: EPA 2016.

Although the Applicant's preferred route does not cross any old-growth forest stands or HCVF, three old-growth forest stands were identified within 0.5 mile of the Applicant's preferred route; these include two ash and one Norway pine cover types and one HCVF was identified within 0.5 mile of the Applicant's preferred route (Kettle Lake Peatlands HCVF).

Continued Use of Existing Line 3

The existing Line 3 pipeline route extends through four EPA Level III ecoregions, initiating in the Lake Agassiz Plain and terminating in the Northern Lakes and Forests ecoregion.

NLCD vegetation cover classes that are crossed by the existing Line 3 pipeline include all 10 vegetation cover classes; however, vegetation within the existing Line 3 pipeline permanent right-of-way is managed to prevent the growth of trees and large shrubs to allow for visual inspection of the right-of-way. Trees and shrubs are cleared at regular intervals to promote shorter-growth vegetation cover classes, including emergent marsh, grassland/herbaceous, and hay/pasture as shown in Figure 5.2.3-1. Forest and shrub covers is retained above HDD crossings.

Nine Minnesota native plant communities within seven native plant community systems ranked from moderate to outstanding for MBS Site rank (Figure 5.2.3-2) and one rare native prairie plant community (S2) occur within the existing Line 3 pipeline permanent right-of-way. These rare and native plant community sites may have each been avoided or previously disturbed during the original Line 3 construction.

One old-growth forest stand is adjacent to the existing Line 3 pipeline permanent right-of-way; no HCVFs are within 0.5 mile of the existing Line 3 pipeline permanent right-of-way.

System Alternative SA-04

The SA-04 route would initiate within the Lake Agassiz Plain EPA ecoregion and terminate in the Central Corn Belt Plains of western Illinois. Table 5.2.3-5 describes the ecoregions crossed by SA-04. The route of SA-04 is within an area of the Midwest dominated by rolling hills, plains, and rich soils suitable for agricultural development. It is largely dominated (82 percent) by ecoregions that support croplands and other agricultural activities. The topography ranges from flat river terrace croplands to forested ridges and plains.

The SA-04 route crosses 10 broad-scale vegetation cover classes: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Figure 5.2.3-1). Broad-scale vegetation cover patterns demonstrate that the SA-04 route occurs within areas dominated by the presence of cultivated crop cover classes.

Minnesota native plant community systems that occur within 0.5 mile of the SA-04 route include seven prairie, wetland, and forest communities; ranked as moderate to outstanding under the MBS Sites significance ranking (Figure 5.2.3-2). Specific locations for moderate to outstanding-ranked MBS Sites native plant communities relative to the location of the SA-04 route are shown in greater detail in Appendix A. Thirteen rare native plant communities (S1, S2, or S3 conservation rank) were documented within 0.5 mile of the SA-04 route.

No old-growth forests and no HCVFs were identified within 0.5 mile of SA-04.

Table 5.2.3-5. EPA Ecoregions Crossed by System Alternative SA-04

Level III[a]	Level IV[a]	Description[a]	Miles within Ecoregion
46. Northern Glaciated Plains	Tewaukon/Big Stone Stagnation Moraine	Gently undulating moraine field with mix of row crops, many small lakes, marshes, and potholes	39.0
47. Western Corn Belt Plains	Des Moines Lobe	Vast, fertile plain of deep soils dominated by row crops	140.5
	Eastern Iowa and Minnesota Drift Plains	Older till plain with mostly row crops and some pasture	177.2
	Rolling Loess Prairies	Loess-covered undulating plain with dissecting rivers and predominantly row crops	54.3
48. Lake Agassiz Plain	Beach Ridges and Sand Deltas	Low ridges of gravel and sand with mix of row crops, small grains, woodland, and wetlands	15.2
	Glacial Lake Agassiz Basin	Flat former lake bed dominated by row crops and grains	223.3
	Saline Area	Salt-affected soils from artesian groundwater flows. Areas of reduced crop productivity are used for range or wildlife habitat.	18.7
51. North Central Hardwood Forests	Big Woods	Rolling plain with some lakes, mostly row crops with pasture and suburban development; formerly extensive hardwood forest	3.9
54. Central Corn Belt Plains	Illinois/Indiana Prairies	Vast flat to rolling plains with fertile soils that developed under tallgrass prairies. Marshes and wet prairies naturally occurred in poorly drained areas, and forests grew on concentric moraines and floodplains.	71.3
	Rock River Hills	Agriculturally dominated, rolling hills, and undulating plains. Rugged areas are partly forested. Physiography is strongly influenced by the underlying limestone, dolomite, and sandstone.	1.4
	Sand Area	Disjunct, sandy outwash plains, sand plains, relict dunes; mix of natural vegetation, natural soil drainage properties, irrigation needs, and stream characteristics	31.7
72. Interior River Valleys and Hills	Upper Mississippi Alluvial Plain	Broad floodplains and low river terraces of the Mississippi River and its major tributaries above the Mississippi's confluence with the Missouri River, including much of the Illinois River	18.8
TOTAL			**795.4**

Notes:

Values in table may not sum to total due to rounding.

[a] Source: EPA 2016.

Transportation by Rail

New transport and loading facilities for the rail alternative would be located near Gretna, Canada, within the Lake Agassiz Plain EPA ecoregion—in an area dominated by agricultural lands. Near Clearbrook, Minnesota, offloading facilities and a reactivated rail line would be located within the North Central Hardwoods ecoregion, in an area with a mix of developed land, forests, row crops, and pastures. Near Superior, Wisconsin, the offloading facilities would be located within the Northern Lakes and Forests ecoregion in an area with a mix of developed land, forests, and wetlands.

NLDC vegetation cover near the Clearbrook and Superior terminals where facilities likely would be developed includes a combination of primarily deciduous forest, evergreen forest, cultivated crops, and woody wetlands. Vegetation cover classes within the ROI for the rail alternative are as shown in Figure 5.2.3-1.

No Minnesota native plant communities occur near the potential locations for the offloading facility at the Clearbrook terminal. The new rail line between Clearbrook and Gully would cross just south of a forested area and a prairie ranked as moderate MBS Site native plant communities. No native plant communities were identified at the Superior terminal, although several Wisconsin threatened and endangered plants occur near this location (Wisconsin DNR 2016a) (see Section 5.2.5). No old-growth forest stands or HCVFs occur near the Clearbrook terminal or along the new rail line.

Railroad rights-of-way, established prior to the widespread conversion of native prairies to croplands in the Prairie Parkland and Eastern Broadleaf Forest provinces, contain some of the last native prairie remnants (Merchant and Biederman 1999). Of the approximately 332 miles of railroad rights-of-way that would most likely be used under this alternative that were evaluated in the Merchant and Biederman (1999) study, approximately 59 miles (18 percent) contain prairie remnants (Table 5.2.3-6). Mesic prairie was the most abundant type, and for all prairie remnants along the proposed routes, 14.5 miles (25 percent) were rated very good. Approximately 1.1 miles of native plant communities (S2 and S3) are crossed by the rail transportation route, most of which are prairies (Table 5.2.3-7). One aspen old-growth forest stand occurs along the southern rail route; one HCVF, Kertsonville Wildlife Management Area (WMA), is crossed by the northern rail route.

Table 5.2.3-6. Prairie Remnants along the Likely Rail Transportation Routes (miles)

Prairie Type	Quality Rating[a]			
	Fair	Good	Very Good	TOTAL
Wet prairie	2.6	4.9	1.0	8.6
Wet-brush prairie	--	--	2.5	2.5
Mesic prairie	13.1	23.5	10.8	47.4
Dry prairie	--	--	0.2	0.2
TOTAL	15.8	28.5	14.5	58.7

Sources: Minnesota DNR 2017; Merchant and Biederman 1999.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Fair: greater than 25% native grass cover, greater than 5% native forb cover, and less than 50% woody cover
Good: greater than 55% native grass cover, greater than 9% native forb cover, and less than 25% woody cover
Very Good: greater than 70% native grass cover, greater than 15% native forb cover, and less than 10% woody cover

"--" = no occurrence

Table 5.2.3-7. Native Plant Communities Crossed by the Likely Rail Transportation Routes (miles)

Native Plant Community	MBS Site Significance Rank[a]	Conservation Rank[b]	Total
Dry sand – gravel prairie (northern)	Moderate	S2	<0.1
Mesic prairie (northern)	Below	S2	0.1
	Moderate	S2	0.1
	High	S2	0.6
Rich black spruce swamp (basin)	High	S3	0.2
Wet prairie (northern)	Outstanding	S3	<0.1
White pine – white spruce – paper birch forest	High	S2	<0.1
TOTAL			**1.1**

Sources: Minnesota DNR 2016a, 2016d.

Notes:

Values in table may not sum to total due to rounding.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank;

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation

Transportation by Truck

Transport and loading facilities for the truck alternative would be located near Gretna, Canada, within the Lake Agassiz Plain ecoregion, in an area dominated by agricultural lands. Near Clearbrook, Minnesota, the offloading facilities would be located within the North Central Hardwoods ecoregion in an area with a mix of developed, forest, row crops, and pasture. Near Superior, Wisconsin, the offloading facilities would be located within the Northern Lakes and Forests ecoregion in an area with mixed developed land, forests, and wetlands.

Vegetation cover near the Clearbrook and Superior terminals where facilities likely would be developed includes a combination of primarily deciduous forest, evergreen forest, cultivated crops, and woody wetlands. Vegetation cover classes within the ROI for the rail alternative are shown in Figure 5.2.3-1.

No Minnesota native plant communities occur near the potential locations for the offloading facility at the Clearbrook terminal. No native plant communities were identified near the potential locations for the offloading facility at the Superior terminal, although several Wisconsin threatened and endangered plants occur near this location (Wisconsin DNR 2016a) (see Section 5.2.5). No old-growth forest stands or HCVFs occur near the Clearbrook terminal.

No native plant communities are crossed by the truck routes. Four rare native plant communities occur next to the routes, including Northern Dry Sand-Gravel Prairie (S2, Chester 25); seepage meadow/Carr

(S3, McIntosh Channel Delta); tamarack seepage swamp (S3, McIntosh Channel Delta); and northern wet prairie (S3, Marcoux Corners). No old-growth forest stands or HCVFs are crossed by the truck routes, although the route passes just north of the Floodwood Bog HCVF.

Existing Line 3 Supplemented by Rail

Existing conditions for the existing Line 3 supplemented by rail are similar to those described above for continued use of the existing Line 3 pipeline and the rail alternative.

Existing Line 3 Supplemented by Truck

Existing conditions for the existing Line 3 supplemented by truck are similar to those described above for continued use of the existing Line 3 pipeline and the truck alternative.

5.2.3.3 Impact Assessment

This section describes the potential Project-related general construction and operation impacts on existing vegetation cover, native plant communities, and spread of noxious and invasive plants. The potential effects on vegetation of the Applicant's preferred route and CN Alternatives are described below in the following three categories:

- Loss or alteration of vegetation cover,
- Loss or alteration of native plant communities, and
- Spread of noxious weeds and invasive plants.

5.2.3.3.1 Applicant's Preferred Route (Neche to Superior)

Vegetation cover would be temporarily or permanently altered by construction and operations within the affected ecoregions and rare plant communities, as discussed in the sections below.

Construction Impacts

Loss or Alteration of Vegetation Cover

Construction of the Applicant's preferred route would result in loss or alteration of up to 5,617 acres of existing vegetation during construction in North Dakota, Minnesota, and Wisconsin (Tables 5.2.3-8 and 5.2.3-9). The three most commonly occurring vegetation cover types occupy approximately 4,278 acres (76 percent) of the vegetation cover along the Applicant's preferred route and include cultivated crops (2,028 acres), deciduous forest (1,544 acres), and hay/pasture (706 acres). Thirty-nine percent, or 2,201 acres, of the vegetation cover within the Applicant's preferred route consists of forested vegetation cover types (evergreen forest, deciduous forest, mixed forest, and woody wetlands) (Table 5.2.3-8). Vegetation cover by state is presented in Table 5.2.3-9. Eleven Minnesota native plant community systems (Table 5.2.3-9) and 19 rare native plant communities (Table 5.2.3-10) were identified within 0.5 mile of the Applicant's preferred route. Twenty-five noxious weeds or invasive plants were documented to occur within and near the Applicant's preferred route (Table 5.2.3-2). Up to 3,415 acres of non-forested vegetation communities would be altered during construction; these areas would be reclaimed following construction and would return to a similar vegetation type over time.

Table 5.2.3-8. Estimated Impacts on NLCD Vegetation Cover for the Applicant's Preferred Route (acres)

Vegetation Cover Class	Con[a]	Op[b]	ATWS	Access Roads	Pump Stations	MLVs	Total Construction[c]		Total Operation[c]	
							Acres	%	Acres	%
Evergreen forest	177	71	18	19	1	1	199	4%	87	4%
Deciduous forest	1416	622	97	103	2	2	1,544	28%	698	29%
Mixed forest	20	8	1	2	<0.1	<0.1	21	04%	11	0%
Scrub/shrub	239	117	15	13	2	<0.1	256	5%	131	5%
Grassland/herbaceous	131	63	32	9	4	0	165	3%	73	3%
Hay/pasture	585	262	121	45	16	1	706	13%	323	13%
Cultivated crops	1699	726	327	22	20	2	2,028	36%	768	31%
Woody wetlands	419	204	18	13	3	1	438	8%	219	9%
Emergent herbaceous wetlands	229	122	19	7	3	0	249	4%	132	5%
Barren land	4	2	8	1	<0.1	<0.1	12	0%	2	0%
TOTAL	**4,917**	**2,197**	**656**	**234**	**50**	**6**	**5,617**	**100%**	**2,444**	**100%**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Minnesota: Con = Enbridge-provided construction work area, which includes 50-foot-wide permanent right-of-way; North Dakota and Wisconsin: Con = estimated construction impact area in acres based on 120-foot-wide construction footprint centered on route, which includes the 50-foot-wide permanent right-of-way

[b] Minnesota: Op = Enbridge-provided footprint of permanent right-of-way; North Dakota and Wisconsin: Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route

[c] Total Construction = sum of pipeline construction work area, ATWS (additional temporary workspaces), including pipe yards, and temporary access roads; Total Operations = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs (mainline valves), including valve pads and driveways

Table 5.2.3-9. Estimated Impacts on NLCD Vegetation Cover by State for the Applicant's Preferred Route (acres)

Vegetation Cover Class	Con[a]	Op[b]	ATWS	Access Roads	Pump Stations	MLVs	Total Construction[c]		Total Operation[c]	
							Acres	%	Acres	%
North Dakota[a]										
Evergreen forest	1	0	--	--	--	--	1	0%	0	0%
Deciduous forest	2	1	--	--	--	--	2	0%	1	0%
Mixed forest	<0.1	<0.1	--	--	--	--	<0.1	0%	<0.1	0%
Scrub/shrub	<0.1	<0.1	--	--	--	--	<0.1	0%	<0.1	0%
Grassland/herbaceous	0	0	--	--	--	--	0	0%	0	0%
Hay/pasture	5	2	--	--	--	--	5	1%	2	1%
Cultivated crops	363	151	--	--	--	--	363	97%	151	97%
Woody wetlands	3	1	--	--	--	--	3	1%	1	1%
Emergent herbaceous wetlands	<0.1	<0.1	--	--	--	--	<0.1	0%	<0.1	0%
Barren land	<0.1	<0.1	--	--	--	--	<0.1	0%	<0.1	0%
Subtotal	374	156	0	0	0	0	374	100%	156	100%
Minnesota[b]										
Evergreen forest	176	71	18	19	1	1	198	4%	86	4%
Deciduous forest	1,349	594	97	103	2	2	1,477	29%	670	30%
Mixed forest	18	8	1	2	<0.1	<0.1	20	0%	10	0%
Scrub/shrub	226	112	15	13	2	<0.1	243	5%	125	6%
Grassland/herbaceous	130	62	32	9	4	0	164	3%	73	3%
Hay/pasture	577	259	121	45	16	1	699	14%	320	14%
Cultivated crops	1,336	575	327	22	20	2	1,665	33%	617	28%
Woody wetlands	336	170	18	13	3	1	355	7%	185	8%

Table 5.2.3-9. Estimated Impacts on NLCD Vegetation Cover by State for the Applicant's Preferred Route (acres)

Vegetation Cover Class	Con[a]	Op[b]	ATWS	Access Roads	Pump Stations	MLVs	Total Construction[c]		Total Operation[c]	
							Acres	%	Acres	%
Emergent herbaceous wetlands	229	122	19	7	3	0	249	5%	132	6%
Barren land	4	2	8	1	<0.1	<0.1	12	0%	2	0%
Subtotal	***4,380***	***1,973***	***656***	***234***	***50***	***6***	***5,081***	***100%***	***2,220***	***100%***
Wisconsin[a]										
Evergreen forest	1	0	--	--	--	--	1	0%	0	1%
Deciduous forest	65	28	--	--	--	--	65	1%	28	40%
Mixed forest	1	1	--	--	--	--	1	0%	1	1%
Scrub/shrub	13	6	--	--	--	--	13	0%	6	8%
Grassland/herbaceous	1	0	--	--	--	--	1	0%	0	0%
Hay/pasture	3	1	--	--	--	--	3	0%	1	2%
Cultivated crops	0	0	--	--	--	--	0	0%	0	0%
Woody wetlands	79	33	--	--	--	--	79	1%	33	48%
Emergent herbaceous wetlands	<0.1	<0.1	--	--	--	--	<0.1	0%	<0.1	0%
Barren land	<0.1	<0.1	--	--	--	--	<0.1	0%	<0.1	0%
Subtotal	***163***	***69***	***--***	***--***	***--***	***--***	***163***	***3%***	***69***	***100%***
TOTAL	**4,917**	**2,197**	**656**	**234**	**50**	**7**	**5,617**	**100%**	**2,444**	**100%**

Source: Homer et al. 2015.

Notes:

[a, b, c] Refer to notes in Table 5.2.3-8

"--" = no occurrence

Table 5.2.3-10. Estimated Impacts on Minnesota Native Plant Community Systems and MBS Sites for the Applicant's Preferred Route

Native Plant Community System	MBS Site Significance Rank[a]	Construction[b]		Operations[c]		Facilities				Totals[d]				Within 0.5 Mile	
						Construction		Operations		Construction		Operations			
		Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	2.4	3	1.2	3	--	--	--	--	2.4	3	1.2	3	340	23
Complex community	High	--	--	--	--	--	--	--	--	--	--	--	--	135	7
	Moderate	5.8	2	3.1	2	--	--	--	--	5.8	2	3.1	2	288	5
Fire-dependent forest/woodland system	Outstanding	--	--	--	--	--	--	1.5	2	<0.1	<0.1	1.5	2	267	32
	High	--	--	--	--	0.3	1	--	--	0.3	1	--	--	277	24
	Moderate	28.7	9	13.7	9	3.5	19	3.5	6	32.2	28	17.2	15	1,817	59
Forested rich peatland system	Outstanding	3.5	2	1.8	2	--	--	--	--	3.5	2	1.8	2	27	1
	High	17.6	6	9	6	--	--	1	2	18	6	10	8	650	32
	Moderate	4.9	5	4.6	5	0.1	1	--	--	5.0	6	4.6	5	442	19
Marsh system	Outstanding	--	--	--	--	--	--	--	--	--	--	--	--	197	29
	Moderate	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	1
Mesic hardwood forest system	Outstanding	--	--	--	--	--	--	--	--	--	--	--	--	129	30
	High	9.0	7	4.0	7	0.2	2	--	--	9.2	9	4.0	7	566	30
	Moderate	42.7	7	19.0	7	12.0	37	2.1	5	54.7	44	21.1	12	1,394	28
Open rich peatland system	Outstanding	--	--	--	--	--	--	--	--	--	--	--	--	49.5	3
	High	--	--	--	--	--	--	--	--	--	--	--	--	7.1	1
	Moderate	5.5	7	4.3	7	<0.1	3	--	--	5.5	10	4.3	7	515	16
Upland prairie system	Outstanding	--	--	--	--	--	--	--	--	--	--	--	--	37	6
	High	--	--	--	--	--	--	--	--	--	--	--	--	93	3
	Moderate	1.7	1	0.7	1	0.3	1	--	--	2.0	2	0.7	1	44	1
Wet forest system	Outstanding	--	--	--	--	--	--	--	--	--	--	--	--	52	11
	High	6.2	4	2.8	4	0.6	3	--	--	6.8	7	2.8	4	206	18

Table 5.2.3-10. Estimated Impacts on Minnesota Native Plant Community Systems and MBS Sites for the Applicant's Preferred Route

Native Plant Community System	MBS Site Significance Rank[a]	Construction[b]		Operations[c]		Facilities				Totals[d]				Within 0.5 Mile	
						Construction		Operations		Construction		Operations			
		Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
	Moderate	2.8	3	1.9	3	0.1	1	--	--	2.9	4	1.9	3	207	8
Wet meadow/Carr system	Outstanding	--	--	--	--	--	--	0	1	--	--	0	1	35	35
	High	0.5	1	0.3	1	10.5	11	--	--	11.0	12	0.3	1	177	19
	Moderate	4.7	16	4.1	11	--	--	--	--	4.7	16	4.1	11	765	106
Wetland prairie system	High	--	--	--	--	--	--	--	--	--	--	--	--	164	8
Total		**135.9**	**73**	**70.5**	**68**	**27.7**	**79**	**7.9**	**16**	**163.6**	**152**	**78.4**	**84**	**8,881**	**555**

Sources: Minnesota DNR 2016a, 2016d.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Refer to Note [a] in Table 5.2.3-6

[b] Minnesota: Con = Enbridge-provided construction work area, which includes 50-foot-wide permanent right-of-way; North Dakota and Wisconsin: Con = estimated construction impact area in acres based on 120-foot-wide construction footprint centered on route, which includes the 50-foot-wide permanent right-of-way

[c] Minnesota: Op = Enbridge-provided footprint of permanent right-of-way; North Dakota and Wisconsin: Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route

[d] Total: Construction = sum of pipeline construction work area, ATWS (additional temporary workspaces), including pipe yards, and temporary access roads; Operations = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs (mainline valves), including valve pads and driveways)

"--" = no occurrence

Soils present in all vegetation classes would be disturbed by grading, trenching, and backfilling during pipeline construction, which could affect rates of regrowth, health, and productivity of vegetation. Over time, sterile subsoil would become more biologically active due to its exposure to air, water, wildlife, and the environment. Following construction, the entire pipeline right-of-way would be subject to vegetation replanting and reclamation commitments in the Applicant's Environmental Protection Plan (Appendix E). The plan includes compaction prevention measures, seeding (with Minnesota BWSR or other agency-approved seed mix), plantings, application of soil amendments, and monitoring to document vegetation restoration and site stability as a part of the post-construction monitoring. Further discussion regarding impacts on soils and measures to reduce the extent and duration of impacts on soils is found in Section 5.2.2.

Construction within existing vegetation communities also would result in a short-term reduction in wildlife habitat and forage productivity in and near the active construction areas, as discussed in Section 5.2.4.

Construction impacts on shrubs and grassland cover classes (scrub/shrub, grassland/herbaceous, and emergent herbaceous wetlands) would be short- to long-term and minor, as these vegetation cover types would regenerate over time. Herbaceous cover would be seeded on disturbed areas following completion of pipeline construction, and it is expected that preexisting herbaceous and shrub habitats would quickly become reestablished within several years following construction. Scrub/shrub cover, dominated by low woody cover and emergent wetlands, may require a longer time to establish cover similar to adjacent undisturbed lands when drought or the presence of livestock interfere with vegetation regrowth. Rapid colonization by annual and perennial herbaceous plants within the disturbed areas generally would restore most herbaceous groundcover within the first growing season; however, perennial herbaceous cover may require a longer time to establish cover similar to adjacent undisturbed lands when drought or the presence of livestock interfere with vegetation regrowth.

Pipeline construction impacts on cultivated croplands would be short-term and minor, with impacts typically limited to a single growing season. Impacts on hay pastures, rotated croplands, and open grassland range would be short- to long-term and minor, with vegetation reestablishing within several years following construction. Until reestablished, these vegetation cover classes would not be able to stabilize soils, provide mechanical filtration and energy dissipation during precipitation events, and provide wildlife habitat for cover and foraging. Short-term loss of these functions is of concern during the first one or two growing seasons, particularly along slopes where the potential for erosion from stormwater runoff and other areas prone to erosion exist.

Long-term or permanent major construction impacts would occur on approximately 2,202 acres of forested upland and wetland vegetation. Clearing trees within forested cover classes, including evergreen forest, deciduous forest, mixed forest, and woody wetland, would result in long-term and major impacts because these vegetation cover classes generally would require over a decade to regenerate outside the permanent right-of-way. After construction, all temporary construction work areas would be seeded with herbaceous species; previously forested areas would be allowed to revegetate naturally with trees and shrubs common to the area. Following construction, forested areas within the temporary construction work areas would return to forested vegetation type over time (up to 50 years for full recovery for some forest types).

Clearing trees within the construction work area would cause short-term and minor indirect impacts in adjacent forested areas by affecting interior forest vegetation along the edges of the construction work areas. By exposing adjacent trees to elevated levels of sunlight, wind, and evaporation rates, the

probability of tree knockdown could increase, resulting in potential alteration of adjacent forest stands. Because of increased light levels penetrating the previously shaded interior, shade-intolerant species would be able to grow, and the native plant community composition within these forest edge habitats likely would change. Clearing also could temporarily reduce local competition for available soil moisture and light, and may allow some early successional species to become established and persist on the edge of the undisturbed areas adjacent to the right-of-way.

Loss or Alteration of Native Plant Communities

Long-term to permanent major impacts on 164 acres (152 occurrences), representing the 9 plant community systems, would occur during construction due to a loss of native plant community habitat. This would include 4 acres within outstanding-ranked MBS Sites, 47 acres within high-ranked MBS Sites, and 113 acres within moderate-ranked MBS Sites that would be subject to direct disturbance during construction (Table 5.2.3-10). Some local native plant communities may reestablish over time; however, it is expected that the quality and diversity of these communities would be lowered. Specific locations for moderate to outstanding-ranked MBS Site native plant communities relative to the location of the Applicant's preferred route are shown in greater detail in Appendix A.

Nineteen rare native plant communities occur within 0.5 mile of the Applicant's preferred route, six of which occur within the construction footprint (Table 5.2.3-11). These six communities would be subject to direct disturbance, resulting in long-term to permanent major impacts, and are not expected to fully recover following restoration. In some circumstances, partial recovery may occur; however it is expected that the quality and diversity of these communities would be lowered over time. Construction also would decrease the habitat available to the rare plant species that depend on the native plant communities. Construction activities occurring in native plant communities would decrease the size of the communities and could fragment the communities where they are crossed.

Permanent major impacts on 46 acres (43 occurrences) of six rare plant communities would occur as a result of pipeline and facilities construction. This includes 45.5 acres of S1, S2, and S3 ranked rare native plant communities in 39 occurrences (Table 5.2.3-11). Permanent and major impacts on rare native wetland plant communities and complexes could include potential permanent loss of sensitive plant species, alteration of hydrology, introduction of contaminants, introduction of aquatic invasive plants, and altered peat formation. Impacts on forested rare native plant communities include loss of trees, potential loss of old-growth stands, and fragmentation of forest patches leading to invasion by grasses and non-native plants that may prevent succession to the original native forest community. Construction impacts would be considered long-term to permanent and major because mature forests would require decades to reestablish.

Long-term and major impacts on native prairie communities include the potential for alteration of prairie soils, loss of sensitive plant communities, and introduction of invasive plants. Direct impacts on untilled prairie soils and vegetation during construction are expected to be long-term and could require a significant amount of time to achieve full recovery.

Table 5.2.3-11. Estimated Impacts on Rare Native Plant Communities and MBS Sites for the Applicant's Preferred Route

Native Plant Community	MBS Site Significance Rank[a]	Conservation Rank[b]	Construction[c]		Operations[d]		Facilities				Total Impacts[e]				Within 0.5 mile of route	
							Construction		Operations		Construction		Operations			
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Minnesota																
Alder – (red currant – meadow-rue) swamp	Outstanding	S3	--	--	--	--	--	--	--	--	--	--	--	--	2	2
	Not Ranked	S3	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	1
Black ash – (red maple) seepage swamp	High	S1S2	5.1	2	2.4	2	0.6	3	--	--	5.7	5	2.4	2	66	5
Calcareous fen (northwestern)	High	S2	--	--	--	--	--	--	--	--	--	--	--	--	7	1
Graminoid poor fen (basin)	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	12	3
Jack pine – (bush honeysuckle) woodland	Moderate	S1 or S3	10.3	5	5.4	5	1.4	5	2.3	4	11.7	10	7.7	9	715	22
Jack pine – (bush honeysuckle) woodland, bracken subtype	High	S1	--	--	--	--	0.3	1	--	--	0.3	1	--	--	68	2
Jack pine – (yarrow) woodland	High	S1S2	--	--	--	--	--	--	--	--	--	--	--	--	30	1
Mesic brush-prairie (northern)	Outstanding	S2	--	--	--	--	--	--	--	--	--	--	--	--	33	4
	High	S2	--	--	--	--	--	--	--	--	--	--	--	--	93	3
Mesic prairie (northern)	Outstanding	S2	--	--	--	--	--	--	--	--	--	--	--	--	4	2
	Moderate	S2	1.7	1	0.7	1	0.3	1	--	--	2.0	2	0.7	1	44	1

Table 5.2.3-11. Estimated Impacts on Rare Native Plant Communities and MBS Sites for the Applicant's Preferred Route

Native Plant Community	MBS Site Significance Rank[a]	Conservation Rank[b]	Construction[c]		Operations[d]		Facilities				Total Impacts[e]				Within 0.5 mile of route	
							Construction		Operations		Construction		Operations			
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Oak – aspen forest	Outstanding	S3	--	--	--	--	--	--	0.8	1	--	--	0.8	1	128	15
	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	88	2
	Moderate	S3	16.4	3	7.2	3	1.6	9	1.2	2	18.0	12	8.4	5	1,024	34
	Below	S3	6.3	1	2.6	1	0.9	4	<0.1	1	7.2	5	2.6	2	60	1
	Not Ranked	S3	--	--	--	--	--	--	--	--	--	--	--	--	0	2
Red pine – white pine forest	Outstanding	S2	--	--	--	--	--	--	0.7	1	--	--	0.7	1	5	1
	High	S2	--	--	--	--	--	--	--	--	--	--	--	--	50	13
	Moderate	S2	--	--	--	--	--	--	--	--	--	--	--	--	44	1
Red pine – white pine woodland, balsam fir subtype	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	23	3
Red pine – white pine woodland, mountain maple subtype	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	10	2
Spikerush – bur reed marsh (northern)	Outstanding	S2	--	--	--	--	--	--	--	--	--	--	--	--	13	23
	Moderate	S2	--	--	--	--	--	--	--	--	--	--	--	--	0	1
	Not Ranked	S2	--	--	--	--	--	--	--	--	--	--	--	--	0	7
Sugar maple – basswood – (bluebead lily) forest	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	98	2
Tamarack seepage swamp (aspen parkland)	Outstanding	S3	--	--	--	--	--	--	--	--	--	--	--	--	27.0	1
	Moderate	S3	--	--	--	--	--	--	--	--	--	--	--	--	10.1	1

Table 5.2.3-11. Estimated Impacts on Rare Native Plant Communities and MBS Sites for the Applicant's Preferred Route

Native Plant Community	MBS Site Significance Rank[a]	Conservation Rank[b]	Construction[c]		Operations[d]		Facilities				Total Impacts[e]				Within 0.5 mile of route	
							Construction		Operations		Construction		Operations			
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Wet-brush prairie (northern)	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	65	5
Wet prairie (northern)	High	S3	--	--	--	--	--	--	--	--	--	--	--	--	100	3
White pine – white spruce – paper birch forest	High	S2	0.6	3	0.3	3	<0.1	1	--	--	0.6	4	0.3	3	60	9
Minnesota subtotal			***40***	***15***	***19***	***15***	***5***	***24***	***5***	***9***	***46***	***39***	***24***	***24***	***2,878***	***173***

Sources: Minnesota DNR 2016a, 2016d; North Dakota PR 2016; Wisconsin DNR 2016a.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

No occurrences of rare native plant communities are listed for North Dakota or Wisconsin.

[a] Refer to Note [a] in Table 5.2.3-6

[b] Conservation status rank denotes rarity of S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation; some ranks encompass ranges (ex: S1S2, S1 or S3), CMX = community complex

[c, d, e] Refer to Notes of Table 5.2.3-9

"--" = no occurrence

In addition to direct effects in the construction footprint, construction activities could result in negligible to short-term minor impacts on native plant communities adjacent to the construction work area. Potential impacts caused by surface runoff from the construction work area include increased sedimentation and the introduction or spread of invasive species. Sedimentation can affect surrounding uplands or wetlands, as well as waterways in the vicinity of the construction. While these impacts could occur, the Applicant would implement construction procedures to control runoff through use of a variety of sediment control barriers and procedures aimed at minimization or reduction of impacts on adjacent habitats. Noxious weed and invasive plant management and control would be implemented during construction and operations in an effort to minimize the effect of noxious weeds on adjacent habitats.

Although three old-growth forest stands and one HCVF, Kettle Lake Peatlands, were identified within 0.5 mile of the Applicant's preferred route, no construction would occur within these forests. All temporary construction areas (ATWS, access roads, and yards) avoid these forests, and no direct construction impacts would occur. Potential Indirect impacts include the spread of noxious weeds and invasive plants and potential removal of contiguous forest areas that serve as protective buffers.

Spread of Noxious Weeds and Invasive Plants

Barren soil in cleared work areas would be susceptible to invasion by noxious weeds and invasive plants, which may inhibit regeneration of native vegetation. Impacts associated with invasion of noxious weeds are difficult to quantify; however, impacts likely would be short-term and minor, as noxious weeds and invasive plant management measures would be in place during and after construction, as identified in the Applicant's Environmental Protection Plan (Appendix E). This plan details noxious weed and invasive plant control measures for construction, and management of noxious weeds and invasive species for the operational life of the pipeline. The Project would be required to manage all noxious weeds (including those not identified in Table 5.2.3-3) for which federal, state, or local (county or city) agency management policies or regulations exist. Measures to ensure that the spread of weeds is minimized include equipment cleaning, use of weed-free mulch, and use of weed-free seed mix.

Operations Impacts

Loss or Alteration of Vegetation Cover

Permanent major impacts would occur on 291 acres of existing vegetation that would be converted to aboveground facilities (pump stations and MLV sites) and access roads for the life of the Project.

The Applicant's preferred route would be subject to vegetation management, including periodic mowing, brush clearing, tree cutting and pipeline inspections that would occur for the life of the Project. Short-term and negligible to minor impacts would occur within the affected vegetation cover classes as a result of routine vegetation management. Maintenance requiring pipeline inspection would result in short-term minor impacts on existing vegetation because measures would be implemented to avoid impacts on vegetation and the disturbed areas would revegetated following construction.

Approximately 906 acres of forested vegetation communities within the operational footprint would be subject to routine vegetation management. This represents a permanent major impact as these forested communities would be effectively converted to other vegetation cover types for the life of the Project, as described above.

Loss or Alteration of Native Plant Communities

Up to 78 acres of previously disturbed native plant communities occurs within the operations right-of-way. These represent nine native plant community systems, including 3 acres of communities ranked as outstanding, 18 acres of communities ranked as high, and 57 acres of acres of communities ranked as moderate. Short-term minor impacts on previously disturbed rare native plant communities could occur during routine management and pipeline maintenance requiring visual inspections. These maintenance activities would be generally limited in duration, and the rare native plant communities affected by maintenance activity would have been previously disturbed during pipeline construction.

Six rare native plant communities occur within the permanent right-of-way. Short-term to minor impacts on 24 acres of previously disturbed rare plant communities would occur as a result of pipeline operation, as maintenance work may occur in previously disturbed rare native plant communities. This includes 10 acres of S1 rank and 2 acres of S2 rank rare native plant communities (Table 5.2.3-11).

Following operations maintenance activities that required ground disturbance, all disturbed areas would be recontoured and reclaimed, and then revegetated according to existing vegetation management plans and agency approvals (such as a fen management plan) for work in and near rare native plant communities.

Spread of Noxious Weeds and Invasive Plants

For the life of the Project, maintenance activities would provide an opportunity for noxious weeds and invasive species to spread. Permanent minor impacts are expected to occur as a result of noxious weed and invasive plant infestations in some areas during operation. The noxious weed and invasive plant occurrence information provided in this analysis did not identify all noxious weed or invasive species known or documented within the region; however, routine vegetation maintenance along the permanent right-of-way may include treatment/mitigation or similar measures of mechanical or chemical management of undesirable species once they are identified. The Environmental Protection Plan (Appendix E) details control measures for noxious weeds and invasive plants for the Project. The Project would be required to manage all noxious weeds for which federal, state, or local (county or city) agency management policies or regulations exist, including but not limited to, those identified in Table 5.2.3-3. Measures implemented to ensure that the spread of weeds is minimized may include equipment cleaning, use of weed-free mulch, use of weed-free seed mix during site restoration, and ensuring that noxious weed and invasive plant species management is a continued commitment during operations involving vegetation management activities.

5.2.3.3.2 Continued Use of Existing Line 3

Construction Impacts

No construction impacts would be associated with vegetation cover, rare native plant communities, or spread of noxious weeds and invasive plants from the continued use of the existing Line 3 pipeline because the pipeline is already constructed.

Operations Impacts

Estimated vegetation cover for the operations area for the existing Line 3 is listed in Table 5.2.3-12. Operations impacts associated with the continued use of existing Line 3 would be similar to those discussed for the Applicant's preferred route and are currently ongoing.

Table 5.2.3-12. Estimated Operations Impacts on Vegetation Cover for the Existing Line 3 Pipeline (acres)

Vegetation Cover Class	Operations[a]
Evergreen forest	39
Deciduous forest	245
Mixed forest	29
Scrub/shrub	96
Grassland/herbaceous	125
Hay/pasture	175
Cultivated crops	673
Woody wetlands	281
Emergent herbaceous wetlands	181
Barren land	3
TOTAL	**1,847**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] The estimate is based on total acres for the Applicant's preferred route and route alternative RA-07 along the Enbridge Mainline.

Loss or Alteration of Vegetation Cover

Vegetation management within the permanent right-of-way includes periodic mowing and brush clearing about every 3 to 5 years to ensure safe operation and allow for visual inspection of the permanent right-of-way. Current Line 3 operations include vegetation management; no new operations impacts from vegetation management would result from continued use of the existing Line 3. Continued use of Line 3 at its present capacity would require high levels of pipeline maintenance, with an estimated average of 267 repair or replacement procedures needed per year over the next 15 years (see Section 4.2.1 for more detail). Pipeline integrity digs require opening a trench over the pipeline with excavation equipment. Excavation and repair or replacement activities would remove vegetation cover and disturb soils similar to new pipeline construction, but excavations would be over a smaller area and would occur within the permanent right-of-way. The area of excavations are unknown, but likely would result in short- to long-term and minor to major impacts on the vegetation cover classes listed in Table 5.2.3-12.

Loss or Alteration of Native Plant Communities

Current Line 3 operations include vegetation management. No new operation impacts on Minnesota native plant communities from vegetation management would result from continued use of the existing Line 3. Long-term and major impacts on rare native plant communities that persist within the permanent right-of-way could occur during pipeline repair or replacement. Excavation and repair or replacement activities could affect nine native plant communities covering approximately 11 acres within the permanent right-of-way (Table 5.2.3-13). The areas of future excavations are unknown but could result in long-term and major impacts if excavation is required within the small area of native plant communities remaining in the permanent right-of-way.

Table 5.2.3-13. Estimated Operations Impacts on Minnesota Native Plant Community Systems for the Existing Line 3 Pipeline

Native Plant Community System	MBS Site Significance Rank	Acres[a]	No.[a]
Acid peatland system	High	3.4	1
Complex community	Moderate	3.1	2
Fire-dependent forest/woodland system	Moderate	1.1	1
Forested rich peatland system	High	0.3	1
Marsh system	Outstanding	1.8	2
Mesic hardwood forest system	High	<0.1	1
Upland prairie system	Moderate	0.7	1
TOTAL		**10.5**	**9**

Sources: Minnesota DNR 2016a, 2016d.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Estimate based on totals for the Applicant's preferred route for the segment from the North Dakota border to Clearbrook, plus RA-07 from Clearbrook to Carlton along the Enbridge Mainline. No native plant communities would be crossed within the segment from Carlton to the Wisconsin border.

According to the Minnesota native plant community database, no rare native plant communities persist along the existing Line 3 pipeline between Clearbrook and Carlton. Less than 1 acre of rare (S2 rank) northern mesic prairie occurs along the Line 3 route between the North Dakota border and Clearbrook, which could be affected by pipeline repair or replacement activities. The area of future excavations are unknown but could result in short-term and minor impacts if excavation is required within the one previously disturbed rare plant community remaining within the permanent right-of-way. One old-growth forest stand is located adjacent to the existing Line 3 right-of-way; no HCVFs are located within 0.5 mile of the existing Line 3 permanent right-of-way. These special-status forests would not be affected by continued use of Line 3.

Spread of Noxious Weeds and Invasive Plants

The opportunity for noxious weeds and invasive species to spread would be increased with continued use of the existing Line 3, facilitated by the frequent excavations for pipeline repair and replacement. Permanent minor impacts are expected to occur as a result of noxious weed and invasive plant infestations during operation.

5.2.3.3.3 System Alternative SA-04

Construction Impacts

The types of impacts associated with construction of the SA-04 route would be similar to impacts discussed above for the Applicant's preferred route.

Loss or Alteration of Vegetation Cover

Approximately 95 percent of the SA-04 route is located in ecoregions and supported by vegetation cover classes dominated by agricultural land (Table 5.2.3-5). The total acreages of vegetation cover types that would be affected by construction of the SA-04 route are summarized in Table 5.2.3-14 and presented by state in Table 5.2.3-15. The exact descriptions for and detailed layouts of permanent surface facilities have not been developed for this alternative; however, it is expected that a small percentage of vegetation cover classes (largely cropland due to its dominance within this route) would be permanently converted to surface facilities to support pipeline operations.

Table 5.2.3-14. Estimated Impacts on Vegetation Cover for System Alternative SA-04

Vegetation Cover Class	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
	Acres	%	Acres	%	Acres	%
Evergreen forest	1	0%	0	0%	150	0%
Deciduous forest	98	1%	41	1%	7,207	2%
Mixed forest	<0.1	0%	<0.1	0%	29	0%
Scrub/shrub	<0.1	0%	<0.1	0%	33	0%
Grassland/herbaceous	181	2%	76	2%	8,010	2%
Hay/pasture	100	1%	41	1%	6,642	1%
Cultivated crops	10,217	95%	4,266	95%	429,450	93%
Woody wetlands	54	0%	23	1%	4,431	1%
Emergent herbaceous wetlands	85	1%	35	1%	5,735	1%
Barren land	20	0%	9	0%	672	0%
TOTAL	**10,756**	**100%**	**4,490**	**100%**	**462,357**	**100%**

Source: Homer et al. 2015.

[a] Based on 120-foot-wide construction work area centered on the pipeline route

[b] Based on a 50-foot-wide operations right-of-way centered on the pipeline alignment

[c] Within 0.5 mile of the pipeline route

Table 5.2.3-15. Estimated Impacts on Vegetation Cover by State for System Alternative SA-04

Vegetation Cover Class	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
	Acres	%	Acres	%	Acres	%
North Dakota						
Evergreen forest	1	0%	0	0%	52	0%
Deciduous forest	23	1%	10	1%	995	1%
Mixed forest	<0.1	0%	<0.1	0%	<0.1	0%
Scrub/shrub	<0.1	0%	<0.1	0%	<0.1	0%
Grassland/herbaceous	5	0%	2	0%	144	0%
Hay/pasture	10	0%	4	0%	624	0%
Cultivated crops	2,957	98%	1,239	98%	125,930	98%
Woody wetlands	17	1%	8	1%	1,056	1%
Emergent herbaceous wetlands	9	0%	4	0%	339	0%
Barren land	<0.1	0%	<0.1	0%	18	0%
North Dakota subtotal	***3,022***	***100%***	***1,267***	***100%***	***129,158***	***100%***
Minnesota						
Evergreen forest	<0.1	0%	<0.1	0%	0	0%
Deciduous forest	8	0%	3	0%	1,974	1%
Mixed forest	<0.1	0%	<0.1	0%	<0.1	0%
Scrub/shrub	<0.1	0%	<0.1	0%	5	0%
Grassland/herbaceous	36	1%	15	1%	2,442	2%
Hay/pasture	19	1%	8	1%	1,466	1%
Cultivated crops	3,328	96%	1,388	96%	138,013	92%
Woody wetlands	10	0%	4	0%	972	1%
Emergent herbaceous wetlands	64	2%	26	2%	4,875	3%
Barren land	17	0%	7	0%	558	0%
Minnesota subtotal	***3,482***	***100%***	***1,451***	***100%***	***150,306***	***100%***
Iowa						
Evergreen forest	8	0%	3	0%	44	0%
Deciduous forest	10	0%	4	0%	1,253	1%
Mixed forest	<0.1	0%	<0.1	0%	<0.1	0%
Scrub/shrub	<0.1	0%	<0.1	0%	<0.1	0%
Grassland/herbaceous	103	4%	43	4%	4,570	4%
Hay/pasture	39	1%	16	1%	2,879	3%
Cultivated crops	2,429	93%	1,012	93%	101,765	91%

Table 5.2.3-15. Estimated Impacts on Vegetation Cover by State for System Alternative SA-04

Vegetation Cover Class	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
	Acres	%	Acres	%	Acres	%
Woody wetlands	14	1%	6	1%	1,284	1%
Emergent herbaceous wetlands	11	0%	5	0%	468	0%
Barren land	3	0%	1	0%	64	0%
Iowa subtotal	***2,616***	***100%***	***1,090***	***100%***	***112,326***	***100%***
Illinois						
Evergreen forest	<0.1	0%	<0.1	0%	54	0%
Deciduous forest	60	4%	25	4%	2,985	4%
Mixed forest	<0.1	0%	<0.1	0%	29	0%
Scrub/shrub	<0.1	0%	<0.1	0%	27	0%
Grassland/herbaceous	37	2%	16	2%	855	1%
Hay/pasture	33	2%	13	2%	1,664	2%
Cultivated crops	1,503	91%	626	91%	63,528	90%
Woody wetlands	13	1%	5	1%	1,119	2%
Emergent herbaceous wetlands	<0.1	0%	<0.1	0%	54	0%
Barren land	<0.1	0%	<0.1	0%	32	0%
Illinois subtotal	***1,645***	***100%***	***686***	***100%***	***70,345***	***100%***
TOTAL	**10,766**	**100%**	**4,494**	**100%**	**462,136**	**100%**

Source: Homer et al. 2015.

[a] Based on 120-foot-wide construction work area centered on the pipeline route

[b] Based on a 50-foot-wide operations right-of-way centered on the pipeline alignment

[c] Within 0.5 mile of the pipeline route

Agricultural lands, including cultivated crops and hay/pasture vegetation cover types, occupy 10,318 acres of the vegetation cover within the construction footprint for the SA-04 route. Pipeline construction impacts on cultivated croplands would be short-term and minor, with impacts typically limited to a single growing season. Impacts on hay pastures, rotated croplands, and open grassland range would be short- to long-term and minor, with vegetation reestablishing within several years following construction.

Approximately 265 acres (2 percent) of the construction footprint for the SA-04 route consists of grassland/herbaceous and emergent herbaceous wetlands vegetation cover. Construction impacts on shrub and grassland cover classes (scrub/shrub, grassland/herbaceous, and emergent herbaceous wetlands) would be short- to long-term and minor, as these vegetation cover types would regenerate over time. Herbaceous cover would be seeded on disturbed areas following completion of pipeline construction, and it is expected that preexisting herbaceous and shrub habitats would quickly become reestablished within several years following construction. Scrub/shrub, dominated by low woody cover

and emergent wetlands, may require a longer time to establish cover similar to adjacent undisturbed lands when drought or the presence of livestock interfere with vegetation regrowth.

Approximately 152 acres (1 percent) of the construction footprint for the SA-04 route consists of forested vegetation cover. Clearing trees within forested cover classes, including evergreen forest, deciduous forest, mixed forest, and woody wetland, would result in long-term and major impacts because these vegetation cover classes generally require over a decade to regenerate outside the permanent right-of-way and may take up to 50 years for full recovery following construction. Clearing trees within the construction work area would cause short-term, minor indirect impacts in adjacent forested areas from effects on interior forest vegetation along the edges of the construction areas (see Section 5.2.3.3.1).

Loss or Alteration of Native Plant Communities

Seven Minnesota native plant community systems occur within 0.5 mile of the SA-04 route. Construction would result in long-term to permanent major impacts on approximately 4 acres, representing three Minnesota native plant community systems, resulting in a loss of native plant community habitat in these locations. All native plant community systems identified within the SA-04 construction footprint fall within MBS Sites with a moderate rank (Table 5.2.3-16).

Table 5.2.3-16. Estimated Impacts on Minnesota Native Plant Community Systems for System Alternative SA-04

Native Plant Community System	MBS Site Biodiversity Significance Rank	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
		Acres	No.	Acres	No.	Acres	No.
Complex community	Outstanding	--	--	--	--	109	1
Floodplain Forest System	Outstanding	--	--	--	--	16	2
	Moderate	1.0	2	0.4	2	260	5
Mesic Hardwood Forest System	Outstanding	--	--	--	--	57	3
	High	--	--	--	--	102	4
	Moderate	1.1	3	0.4	3	211	6
Open Rich Peatland System	Outstanding	--	--	--	--	1	1
Upland Prairie System	Outstanding	--	--	--	--	3	4
	High	<0.1	1	--	--	173	22
	Moderate	1.5	2	0.6	2	64	11
Wet Meadow/Carr System	Outstanding	--	--	--	--	7	1
Wetland Prairie System	High	--	--	--	--	11	1
	Moderate	--	--	--	--	4	2
TOTAL		**3.6**	**8**	**1.4**	**7**	**1,019**	**63**

Sources: Minnesota DNR 2016a, 2016d.

Notes:

[a] Based on 120-foot-wide construction work area centered on the pipeline route

[b] Based on a 50-foot-wide operations right-of-way centered on the pipeline alignment

[c] Within 0.5 mile of the pipeline route

"—" = no occurrence

Thirteen different rare native plant communities occur within 0.5 mile of the SA-04 route, three of which occur within the construction work area and two within the permanent right-of-way. Pipeline construction would cause permanent major impacts on a total of 2 acres (five occurrences) of rare native plant communities, resulting in a loss of rare native plant community habitat in these locations. This includes approximately 2 acres of S2 rank and 0.3 acre of S3 rank rare native plant communities (Table 5.2.3-17).

Table 5.2.3-17. Estimated Impacts on Rare native plant communities for System Alternative SA-04

Native Plant Community	MBS Site Significance Rank	Conservation Rank	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
			Acres	No.	Acres	No.	Acres	No.
North Dakota								
Northern reedgrass wet meadow	NA[d]	S2S3	--	--	--	--	17	1
Wet prairie	NA[d]	S2S3	--	--	--	--	35	1
Wet-mesic tallgrass prairie	NA[d]	S1	--	--	--	--	NA	1
North Dakota subtotal							***52***	***3***
Minnesota								
Calcareous fen (southeastern)	Outstanding	S1	--	--	--	--	1	1
Dry hill prairie (southern)	Moderate	S2	--	--	--	--	15	1
Mesic prairie (southern)	Outstanding	S2	--	--	--	--	2	3
	High	S2	--	--	--	--	113	3
	Moderate	S2	1.5	2	0.6	2	48	8
	Below	S2	--	--	--	--	33	1
	Not Ranked	S2	--	--	--	--	0	1
Red oak – sugar maple – basswood – (bitternut hickory) forest	High	S3	--	--	--	--	34	3
	Moderate	S3	0.3	1	0.1	1	106	2
Seepage meadow/carr	Outstanding	S3	--	--	--	--	7	1
Silver maple – (virginia creeper) floodplain forest	Outstanding	S3	--	--	--	--	0	1
	Moderate	S3	<0.1	1	<0.1	1	154	3
Sugar maple – basswood – (bitternut hickory) forest	Outstanding	S2	--	--	--	--	35	1
	High	S2	--	--	--	--	68	1
	Moderate	S2	0.2	1	<0.1	1	43	2
Wet prairie (southern)	High	S2	--	--	--	--	11	1
	Moderate	S2	--	--	--	--	4	2
Minnesota subtotal			***2.0***	***5***	***0.7***	***5***	***672***	***35***

Table 5.2.3-17. Estimated Impacts on Rare native plant communities for System Alternative SA-04

Native Plant Community	MBS Site Significance Rank	Conservation Rank	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
			Acres	No.	Acres	No.	Acres	No.
Illinois								
Unusual concentration of vascular plants	NA[d]	NA[e]	--	--	--	--	15	1
Dry Sand Prairie, Midwest Type	NA[d]	NA[e]	--	--	--	--	13	1
Illinois subtotal							***18***	***2***
TOTAL Rare native plant communities			**2.0**	**5**	**0.8**	**5**	**851**	**41**

Sources: Minnesota DNR 2016a, 2016d; North Dakota PR 2016; Iowa DNR 2016; Illinois DNR 2016.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

No occurrences of rare native plant communities are listed for Iowa.

[a] Based on 120-foot-wide construction work area centered on the pipeline route

[b] Based on a 50-foot-wide operations right-of-way centered on the pipeline alignment

[c] Within 0.5 mile of the pipeline route

"—" = no occurrence

Spread of Noxious Weeds and Invasive Plants

Construction-related impacts include the potential introduction and spread of 25 or more noxious weed and invasive plant species. The types of impacts and the Applicant-proposed measures to address them would be identical to those described for the Applicant's preferred route in Section 5.2.3.3.1. Impacts associated with invasion of noxious weeds are difficult to quantify; however, impacts likely would be short-term and minor because management actions for noxious weeds and invasive plants would be in place during and after construction.

Operations Impacts

Loss or Alteration of Vegetation Cover

Operations impacts would occur within the permanent right-of-way, as periodic mowing and brush clearing would be required every 3 to 5 years following construction to ensure safe operation of the pipeline and allow for routine maintenance and inspections throughout the life of the Project.

Acreages of vegetation cover types that would be affected by operation of the SA-04 route are summarized in Table 5.2.3-14 and listed by state in Table 5.2.3-15. Impacts on large portions of the route would be short-term and minor because 95 percent of the SA-04 route is used for agriculture. These areas would be maintained as agricultural land, which would not require mowing but could be subject to vegetation removal, excavation, and reclamation for future pipeline inspection activities.

Mowing of the permanent right-of-way would result in short-term minor impacts on 99 acres of woody wetland, shrub, and grassland vegetation. These impacts would occur periodically for the life of the Project.

Approximately 64 acres (1 percent) of previously forested land would be maintained as herbaceous vegetation by removing trees and shrub to allow for visual inspection of the right-of-way (Table 5.2.3-14). Forested cover classes in the permanent right-of-way would be maintained as other vegetation cover classes (scrub/shrub, grassland, or emergent wetland) for the life of the Project, resulting in a permanent major impact on forested cover classes within the operational footprint of SA-04.

Loss or Alteration of Native Plant Communities

During operations-related vegetation maintenance activities and pipeline inspections within the permanent right-of-way, short-term minor impacts could occur on 1 acre (seven occurrences) of previously disturbed moderate-ranked Minnesota native plant communities and approximately 1 acre of previously disturbed S2 rank and S3 rank rare native plant communities (Table 5.2.3-17). Impacts specific to these activities on Minnesota native plant communities and rare native plant communities are addressed in Section 5.2.3.3.1.

Spread of Noxious Weeds

The opportunity for noxious weeds and invasive species to spread would continue for the life of the Project. The types of permanent impacts and the Applicant-proposed measures to address them would be identical to those described for the Applicant's preferred route in Section 5.2.3.3.1.

5.2.3.3.4 Transportation by Rail

Construction Impacts

Loss or Alteration of Vegetation Cover

The rail alternative would require as much as 200 acres to construct and operate an offloading facility and 60 acres to reactivate an abandoned rail line near Clearbrook, Minnesota. It would require as much as 100 acres to construct and operate offloading facilities and an additional 3 acres to establish a new rail spur near Superior, Wisconsin. Vegetation cover near the Clearbrook terminal includes deciduous forest, evergreen forest, cultivated crops, and woody wetlands in undeveloped areas. Vegetation cover near the Superior terminal includes deciduous forest, woody wetlands, and scrub/shrub cover in undeveloped areas. Because a specific site has not been identified or designed, impacts on habitat by acreage cannot be quantified, but it was assumed that any impacts would be permanent and major as vegetation would be cleared during construction and permanently converted to facilities. Clearing trees within the construction work area could result in short-term, minor indirect impacts in adjacent forested areas from affecting interior forest vegetation along the edges of the construction areas, as discussed in Section 5.2.3.3.1.

Loss or Alteration of Native Plant Communities

No rare native plant communities in the vicinity of the Clearbrook terminal would be affected by construction of the rail alternative. Native plant communities occur to the north along the potential rail access route between Clearbrook and Gully, near Gully. Two Minnesota native plant communities could be crossed, including northwest dry-mesic oak woodland and the imperiled northern dry sand – gravel prairie (S2). These native plant communities could be affected by construction of a new reactivated rail connection between Clearbrook and Gully. This would be a reactivation of an existing rail line, and the facilities are on the edge of the mapped communities; therefore, construction impacts likely would be permanent and minor.

No native plant communities were identified in the undeveloped area around the Superior terminal where the offloading facility could be located; however, multiple occurrences of protected plants are near the terminal (Wisconsin DNR 2016a). New facilities constructed for the rail alternative would undergo permitting, likely would be sited to avoid rare native plant communities or other sensitive resources to the extent practicable, and would require minimization measures to reduce potential impacts.

Spread of Noxious Weeds and Invasive Plants

Barren soil in cleared work areas would be susceptible to invasion by noxious weeds and invasive plants, which may inhibit regeneration of native vegetation. Most areas would be converted to impervious surfaces or permanent facilities; consequently, little barren soil would be subject to these impacts. Impacts associated with invasion of noxious weeds likely would be short-term and negligible to minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Once the facilities are constructed, no other direct impacts on vegetation would occur during operations of the Clearbrook or Superior terminals, as the areas would be permanently converted to rail lines and rail offloading facilities for the life of the Project. Small spills and leaks at transfer facilities would be controlled, and capture of spills is an enforced regulatory component of licensed facilities' operations, resulting in negligible to minor impacts on vegetation in these areas.

Loss or Alteration of native plant communities

Operation of the rail facilities and train transportation would not likely result in loss or alteration of native plant communities because the rail alternative does not involve vegetation management or other actions that could cause such impacts. However, the existing rail transportation corridors include remnant prairies and other sensitive plant communities that could be affected by small spills and leaks if they leach into the surrounding soils from the rail bed, resulting in long-term minor to major impacts in these areas.

Spread of Noxious Weeds and Invasive Plants

The risk of introduction and spread of noxious weeds and invasive plant species would be permanent and minor to major as the use of new and existing transportation corridors would provide avenues to transport noxious weeds and invasive plants into areas where they do not presently occur.

5.2.3.3.5 Transportation by Truck

Construction Impacts

Loss or Alteration of Vegetation Cover

The truck alternative also would require approximately 50 acres to construct and operate an offloading facility and approximately 5 acres for road access near Clearbrook, Minnesota, resulting in a permanent loss of vegetation cover from facilities construction. Vegetation cover near the Clearbrook terminal includes deciduous forest, evergreen forest, cultivated crops, and woody wetlands in undeveloped areas. In addition, the truck alternative would require approximately 50 acres to construct and operate an offloading facility and an additional 34 acres to establish a truck route near the terminal in Superior, Wisconsin. Vegetation cover near the Superior terminal includes deciduous forest, woody wetlands, and scrub/shrub cover in undeveloped areas. During construction, permanent major impacts on vegetation would occur from clearing and grading for site preparation and from placement of fill for construction of loading/offloading facilities and new roads for access. Clearing trees within the construction work area

would cause short-term, minor indirect impacts in adjacent forested areas from affecting interior forest vegetation along the edges of the construction areas, as discussed in Section 5.2.3.3.1.

Loss or Alteration of Native Plant Communities

No Minnesota native plant community sites in the vicinity of the Clearbrook terminal could be affected during construction. No native plant communities were identified near the potential locations for the offloading facility at the Superior terminal, although several Wisconsin threatened and endangered plants occur near this location (Wisconsin DNR 2016a) (see Section 5.2.5). Because no native plant communities were identified near the areas that likely would be used to construct the offloading facilities, none are likely to be affected by construction. New facilities constructed for the truck alternative would undergo permitting, likely would be sited to avoid any rare native plant communities or other sensitive resources that may subsequently be found, and would require minimization measures to reduce potential impacts.

Spread of Noxious Weeds and Invasive Plants

Barren soil in cleared work areas would be susceptible to invasion by noxious weeds and invasive plants, which may inhibit regeneration of native vegetation. Most areas would be converted to impervious surfaces or permanent facilities; therefore, little barren soil would be subject to these impacts. Impacts associated with invasion of noxious weeds likely would be short-term and negligible to minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Once the facilities are constructed, no other direct impacts on vegetation would occur during operations of the Clearbrook or Superior terminals, as the areas would be permanently converted to access roads and offloading facilities for the life of the Project. Small spills and leaks at transfer facilities would be controlled, and capture of spills is an enforced regulatory component of licensed facilities' operations, resulting in negligible to minor impacts on vegetation in these areas.

Loss or Alteration of Native Plant Communities

Once the facilities are constructed, no other direct impacts on native plant communities would occur. Four rare native plant communities and the Floodwood Bog HCVF border the truck transportation routes. Mechanical wear, equipment spills, and leaks could contribute to short-term and minor impacts on these rare native plant communities if contamination disperses from the roadways. Small spills and leaks from tanker trucks during transit likely would remain on the roadway; however, the existing transportation corridors are adjacent to several sensitive plant communities that could be affected by small spills, result in potential long-term minor to major impacts in affected areas.

Spread of Noxious Weeds and Invasive Plants

The risk of introduction and spread of noxious weeds and invasive plants would be permanent and minor to major, as the use of new and existing transportation corridors would provide avenues to transport noxious weeds and invasive plants into areas where they do not presently occur.

5.2.3.3.6 Existing Line 3 Supplemented By Rail

Impacts on vegetation associated with the combined use of the existing Line 3 pipeline and the rail alternative would be the same as the impacts identified for continued operation of the existing Line 3 pipeline in addition to the identified for the rail alternative.

5.2.3.3.7 Existing Line 3 Supplemented By Truck

Impacts on vegetation associated with the combined use of the existing Line 3 pipeline and the rail alternative would be the same as the impacts identified for continued operation of the existing Line 3 pipeline in addition to the identified for the truck alternative.

5.2.3.4 Summary and Mitigation

5.2.3.4.1 Summary

Potential impacts on all vegetation types for the Applicant's preferred route and CN Alternatives are summarized in Table 5.2.3-18. This includes a summary of construction- and operations-related impacts on existing land cover, MBS Sites and native plant communities, as well as potential impacts from the spread of noxious weeds and invasive plants. Avoidance and minimization measures considered in the assessment of pipeline alternatives include rerouting, use of HDD, and preparation and adherence to an agency-approved site- and resource-specific crossing plan. Many of these procedures would also be applicable to the rail and truck transport alternatives.

The impact assessment also considered the effects of implementation of BMPs during construction and operation and the Applicant's revegetation and reclamation commitments for the pipeline rights-of-way. Similar construction practices and revegetation and reclamation were assumed to be implemented for relevant construction areas of the other CN Alternatives.

Construction Impacts

Many impacts on vegetation would be short-term and minor, while other impacts would be permanent and major within the footprint of the aboveground facilities and the permanent right-of-way. Individual impacts at specific locations along all the alternatives where the existing vegetation can recover is anticipated to be minor, with appropriate use of BMP construction and operation practices. However, others would need to be maintained in a way that prohibits return to its existing state, and would be permanently altered or removed. Due to the great lengths of all alternatives, the total impact would be additive and distributed along the routes. The importance of these impacts is determined by the distance of the alternative, number of vegetation communities affected, and the quality of vegetation resources affected.

Loss or Alteration of Vegetation Cover

Clearing and grading the pipeline construction work area and other construction-related areas would result in a loss and alteration of vegetation. Forested and scrub/shrub vegetation communities within the construction work area would be cleared and would require many years to reestablish in areas outside of the permanent right-of-way, resulting in long-term to permanent major impacts. The Applicant's preferred route would have a substantially greater impact on forested and scrub/shrub vegetation communities than the other CN Alternatives, all of which would have a similar level of impact.

Areas cleared of other vegetation types during pipeline construction, including grassland/herbaceous, hay/pasture, cultivated crops, and emergent wetlands vegetation cover class types, would be reclaimed after construction to the specifications or conditions of the authorizing/permitting agency. The recovery period for these areas would range from a single growing season to several years. As a result, the impacts would be short-term and minor. SA-04 would affect a substantially greater area of these vegetation types than the other CN Alternatives, with the Applicant's preferred route affecting substantially more than the rail or truck alternatives. However, the impact from implementation of the

rail or truck alternatives would be permanent and major since construction of permanent aboveground facilities would not provide the opportunity for reclamation of vegetation.

Loss or Alteration of Rare Native Plant Communities

Clearing and grading would also result in the loss of rare native plant communities. The impacts typically would be permanent and major as these communities would be lost. The Applicant's preferred route would affect approximately 46 acres of rare native plant communities, whereas SA-04 would affect approximately 2 acres of the communities, the rail transport alternative would affect 1 rare plant community, and the truck transport alternative would not affect any rare native plant communities. For the pipeline alternatives, the impacts would be long-term to permanent and major.

Spread of Noxious Weeds and Invasive Plants

Noxious weed and invasive plant management and control would be implemented during construction to minimize the effect of noxious weeds. The potential for impacts due to the spread of noxious weeds and invasive plants during construction would be the same for all CN Alternatives, although the potentially affected area would be greatest for SA-04 followed by the area of the Applicant's preferred route. The impact due to construction for all alternatives would be short-term and negligible to minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Vegetation management activities during pipeline operation would prevent trees and large shrubs from reestablishing within the pipeline permanent right-of-way. This would affect approximately 1,105 acres of previously forested areas within the permanent right-of-way for the Applicant's preferred route and about 64 acres for SA-04. The impact for both pipelines would be permanent and major. The forested and scrub/shrub areas cleared from the construction work area and outside of the permanent right-of-way would be allowed to regenerate, but the process would take decades to reach full recovery. For the pipeline alternatives, the Applicant's Integrity Management Program would require periodic excavation to repair or replace sections of pipe segments, which would affect the vegetative cover of the permanent right-of-way. The existing Line 3 pipeline would require substantially more of these integrity digs than a newly installed pipeline and would therefore have a greater impact on vegetation.

Loss or Alteration of Rare Native Plant Communities

Potential impacts on rare native plant communities from pipeline operations would likely be minor because these communities are unlikely to persist within the permanent right-of-way after the construction disturbance. The Applicant's preferred route supports the largest area of rare native plant communities within the permanent right-of-way and represents the greatest potential impact on these communities. The rail and truck alternatives could affect rare native plant communities along the rail and truck routes if petrochemicals from engine leaks leach into the surrounding soils.

Spread of Noxious Weeds and Invasive Plants

As a result of implementation of a noxious weed and invasive plant management and control plan for the pipeline alternatives, the risk of spreading infestations of noxious weeds and invasive plants during operations would be similar for the pipeline routes. The impact would be long-term and minor, although SA-04 would have a greater area potentially affected than either of the other pipeline alternatives—the Applicant's preferred route or use of existing Line 3. The rail and truck alternatives may present a greater transmission risk because the large increase in traffic along new and existing transportation corridors would provide avenues to transport noxious weeds and invasive plants into areas where they

do not presently occur. For all CN Alternatives, the potential impact of the spread of noxious weeds and invasive species would be permanent and minor.

5.2.3.4.2 Mitigation

Best management practices for vegetation are presented in the revegetation and monitoring guidance in the Applicant's Environmental Protection Plan (Appendix E). Following construction, the entire pipeline right-of-way would be reclaimed following the detailed measures in this plan, including implementation of compaction prevention measures, seeding, plantings, application of soil amendments, and a period of monitoring to document stabilization of the right-of-way. In areas where soil quality is a concern for revegetation, applicable agencies would be consulted to develop seed mixes and seeding dates adapted to the immediate areas of concern.

The Applicant has committed to preparation and implementation of the following plans, procedures, and general vegetation protection measures during construction:

- Co-locate construction within and near existing utility corridors to minimize environmental impacts;
- Develop and adhere to Project-specific construction methods and procedures for vegetation clearing methods, including treatment of existing vegetation, topsoil segregation, storage, and reapplication;
- Restore preconstruction contours and use slope breakers, sediment barriers, mulch, geotextile fabric, and other erosion control devices to stabilize the disturbed areas during the vegetation regrowth phase and reduce runoff into the adjacent environment;
- Co-locate the Project with existing rights-of-way where feasible;
- Design and plan Project pipeline construction (including parking, access, and temporary work areas) to reduce environmental impacts on sensitive plant communities, such as rare native plant communities, calcareous fens, wetland vegetation, old-growth forests, and prairie vegetation;
- Inspect and clean all equipment prior to bringing it to the site to prevent the introduction and spread of invasive species; and
- Use certified weed-free mulch, topsoil, and seed mix.

Prior to construction, the lead and assisting agencies would be consulted on identification of avoidance and mitigation measures for rare plant communities, old-growth forests, and HCVFs that are located within the pipeline route and could be affected by construction or operation. Avoidance measures could include minor pipeline route adjustments, use of directional drilling, or preparation and adherence to an agency-approved, site-specific crossing plan. Impacts on rare plant communities that cannot be avoided would be addressed through implementation of the Project's approved revegetation and monitoring measures, and invasive and noxious weed control measures outlined in the Environmental Protection Plan (Appendix E).

Measures that would be implemented to prevent the spread of noxious and invasive weeds during construction and operations include minimizing the time between ground-disturbing work and site reclamation and reseeding, staking avoidance areas at known weed locations, and implementing other BMPs.

In addition to the avoidance and minimization measures and BMPs that the Applicant has identified, Minnesota DNR identified the following mitigation measures that could reduce impacts on vegetation:

- Defining equipment cleaning methods and inspection standards to ensure that equipment is free of invasive species. On Minnesota DNR lands, following Operational Order 113 would further reduce the spread of noxious weeds and invasive plants and animals.
- Replanting appropriate tree species for restoration within cleared forested areas to reduce the recovery time, prevent changes in watershed hydrology, and runoff impacts that could alter stream geomorphology.
- Woody vegetation typically would not be cleared at ATWS. If clearing of woody vegetation is necessary, potential mitigation to offset the clearing could include reestablishing or enhancing the existing cover type within up to 50 feet of surface waters, depending on topography. On state forest lands or WMAs, tree planting may be desired for all temporary workspaces within the property boundary to reduce erosion and runoff, and to reestablish trees for potential future large woody habitat recruitment to streams and rivers.
- In counties where oaks are affected by oak wilt disease caused by a non-native fungus, seasonal restrictions on tree clearing would reduce the chance of sap-sucking beetles transporting fungal spores through fresh wounds during the infection period that extends from April through July.
- Removal, debarking, or chipping of cut pines and pine slash larger than 3 inches in diameter within 3 weeks of cutting during May through mid-August would prevent pine bark beetle outbreaks in pine stands.

Table 5.2.3-18. Summary of Potential Impacts on Vegetation for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Loss or alteration of vegetation cover	Long-term to permanent/ major impacts • 2,202 acres of forests Short-term/minor impacts • 256 acres of scrub/shrub • 871 acres of grasslands • 2,028 acres of croplands • 5,617 acres total • 84% adjacent to existing corridors	No impact	Long-term to permanent/ major impacts • 152 acres of forests Short-term/minor impacts • <1 acre of scrub/shrub • 281 acres of grasslands • 10,217 acres of croplands • 10,756 acres total • 100% adjacent to existing corridors	Permanent/major impacts • 263 to 363 acres total	Permanent/major impacts • 139 acres total	Permanent/major impacts • 263 to 363 acres total	Permanent/major impacts • 139 acres total
Loss or alteration of rare native plant communities	Long-term to permanent/major impacts • 46 acres of rare native plant communities	No impact	Long-term to permanent/major impacts • 2 acres of rare native plant communities	Permanent/major impacts • 1 rare native plant community	No impact	Permanent/major impacts • 1 rare native plant community	No impact
Spread of noxious weeds and invasive plants	Short-term/minor impacts	No impact	Short-term/minor impacts	Short-term/ negligible to minor impacts	Short-term/ negligible to minor impacts	Short-term/ negligible to minor impacts	Short-term/ negligible to minor impacts

Table 5.2.3-18. Summary of Potential Impacts on Vegetation for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Operations Impacts							
Loss or alteration of vegetation cover (permanent right-of-way)	Permanent/major impacts • 1,105 acres of forests Short-term/minor impacts • 131 acres of scrub/shrub • 396 acres of grasslands • 768 acres of croplands • 2,444 acres total	Permanent/major impacts • 594 acres of forests Short-term/minor impacts • 96 acres of scrub/shrub • 300 acres of grasslands • 673 acres of croplands • 1,847 acres total	Permanent/major impacts • 64 acres of forests Short-term/minor impacts • <1 acre of scrub/shrub • 117 acres of grasslands • 4,266 acres of croplands • 4,490 acres total	Negligible to minor impacts	Negligible to minor impacts	Short-term to permanent/minor to major impacts	Short-term to long-term/minor to major impacts
Loss or alteration of rare native plant communities	Short-term/minor • 24 acres in 6 different rare native plant communities	Short-term/minor • <1 acre in 1 rare native plant community	Short-term/minor impacts • <1 acre in 4 rare native plant communities	Long-term/minor to major impacts • 1.1 miles in 5 rare native plant communities • 59 miles railroad prairies	Short-term to long-term/minor to major impacts • 4 rare native plant communities • Floodwood Bog HCVF	Short-term/minor impacts • See existing Line 3 and Rail	Short-term/minor impacts • See existing Line 3 and Truck
Spread of noxious weeds and invasive plants	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor to major impacts	Permanent/minor to major impacts	Permanent/minor to major impacts	Permanent/minor to major impacts

HCVF = high conservation value forest

5.2.3.5 References

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5.2.4 Fish and Wildlife

Fish and wildlife provide important social and cultural resources; they are managed by federal and state agencies for consumption and conservation. The general Project area supports a diversity of fish and wildlife, including coldwater, coolwater, and warmwater fisheries; reptiles, amphibians, and mammals; including big and small game mammals; fur-bearing mammals; and nongame mammal species; and various avian species; non-migratory game birds, migratory birds (waterfowl, raptors, shorebirds, and passerines) and non-migratory, nongame bird species. Lakes, rivers, streams, and wetlands provide habitat for fish as well as for aquatic and terrestrial wildlife. Wildlife habitats include a variety of vegetation communities that provide foraging opportunities shelter, overwintering, migration stopover, and breeding habitats for a wide variety of wildlife.

This section identifies the common and abundant fish and wildlife resources that may be affected by construction or operation of the Applicant's preferred route or the CN Alternatives (continued use of existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, or existing Line 3 supplemented by rail or truck). It also presents the assessment of the potential for construction and operation to affect those resources.

This section first describes the regulations relevant to assessing impacts on fish and wildlife resources, the methods used to conduct the impact assessment, and the existing conditions within the defined ROIs (identified below). The potential construction- and operations-related impacts on fish and wildlife for the Applicant's preferred route and the CN Alternatives are presented next. A summary and comparison of the impacts for the alternatives are included at the end of the section, along with potential mitigation measures that could minimize impacts.

Wildlife protected under state and federal endangered species regulations are addressed in Section 5.2.5. Outstanding resource value waters are addressed in Section 5.2.1.2. Potential impacts on fish and wildlife resources from an unanticipated crude oil release are addressed in Chapter 10.

5.2.4.1 Regulatory Context and Methodology

5.2.4.1.1 Regulatory Context

Regulations pertaining to fish and wildlife are managed by federal (e.g., USFWS) and state natural resources agencies The goal of these agencies is to conserve, protect, and enhance fish, wildlife, and other natural resources for the benefit of the public. Fish, wildlife, and their habitats that are protected under federal or state endangered species or other protective regulations for special or unique resources are discussed in Section 5.2.5. Other federally enacted regulations provide protection for fish and wildlife not otherwise protected under the Endangered Species Act of 1973 (ESA). These include the Migratory Bird Treaty Act of 1918 (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). USFWS has statutory authority and responsibility for enforcing the MBTA (16 U.S. 703–712; 40 Stat. 755 as amended), and the BGEPA (16 U.S. 66-8-668d).

The MBTA makes it illegal for anyone to capture, kill, or possess migratory birds, or any parts, nests, or eggs of any migratory bird except under terms of a valid permit issued pursuant to federal regulations. In addition to the MBTA, Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," further directs executive departments and agencies to promote migratory bird conservation conventions to protect migratory birds and their habitats, including migratory waterfowl and game birds. The MBTA prohibits the take of any migratory bird without authorization from USFWS.

"Migratory birds" are all species native to the United States or its territories. Nonnative birds are not protected under the MBTA (USFWS 2016a).

Bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are additionally protected under the BGEPA. This act prohibits anyone from taking (i.e., pursuing, shooting or shooting at, poisoning, wounding, killing, capturing, trapping, molesting, or disturbing) eagles, including their parts (e.g., feathers), nests, or eggs (USFWS 2016b). This definition also covers impacts from human-induced alterations at nest sites when eagles are not present; therefore, if removal of an eagle nest is necessary and unavoidable, a permit and consultation with USFWS would be required. Minnesota also issues permits for removal or disturbance of active and inactive bald eagle and osprey (*Pandion haliaetus*) nests per its statutory authority as provided by Chapter 97A (Game and Fish), Part 97A.045 (Commissioner, General Powers and Duties), Subdivision 2 (Power to Protect Wild Animals).

The National Invasive Species Act (16 U.S. Code 4701) is a federal law that requires state management plans along with regional panels to actively fight the spread of aquatic invasive species in U.S. waterways. Table 5.2.4-1 identifies the appropriate state agency and regulations pertaining to transport, introduction, or spread of invasive species that would apply to the Applicant's preferred route and CN Alternatives.

Table 5.2.4-1. State Regulations Concerning Invasive Species

State	Administering Agency	Regulation
North Dakota	North Dakota Game and Fish Department	Aquatic Nuisance Species (ND Century Code Ch. 30.03.06)
Minnesota	Minnesota Department of Natural Resources	Invasive species laws (Minn. Stat. Ch. 84D and Minn. R. Ch. 6216)
Iowa	Iowa Department of Natural Resources	Aquatic Invasive Species (Iowa AC 571.90)
Illinois	Illinois Department of Natural Resources	Injurious Species (Illinois AC 17 Ch. 1[b][805])
Wisconsin	Wisconsin Department of Natural Resources	Invasive Species Rule (WI Code Ch. NR 40)

States also have fisheries and wildlife protection and management laws in addition to endangered species laws. Individual states have developed a variety of management unit structures to address specific goals and agency strategies (e.g., state parks, wildlife refuges, and waterfowl protection areas).

5.2.4.1.2 Methodology

The methods used to assess potential impacts on fish and wildlife resources and their habitats from construction and operation of the Applicant's preferred route and CN Alternatives are described in this section. The ROIs for this evaluation encompassed the area that could be affected, including indirectly, by construction and operation within 0.5 mile from the centerlines of the alternative pipeline routes. As described below, the assessment of potential direct impacts focused on the areas directly affected by construction and operation activities. In addition, invasive species locations were identified within 1 mile of the pipeline route centerlines. For facilities required for the rail and truck transport alternatives, impacts were evaluated in the areas where the new structures and roadways likely would be constructed and in areas adjacent to those sites.

The impact analysis identified changes to fish and wildlife resources and their habitats, including consideration of the following:

- Fish and aquatic habitats
  - Fish distribution and habitat use, muskellunge (*Esox masquinongy)* waters, designated trout streams and lakes and mussel concentration areas; and
  - Lakes, rivers, and streams, Aquatic Management Areas (AMAs), Fish Index of Biotic Integrity (Fish IBI) Lakes, waters infested with aquatic invasive species, Lakes of Biological Significance, and Sentinel Lakes.
- Wildlife and wildlife habitats
  - Wildlife distribution and habitat use, raptor nests and colonial waterbird colonies; and
  - Vegetated land cover, designated wildlife conservation areas (e.g., WMAs, waterfowl production areas, wetland management districts, BLM land, federal and state forests, state parks, recreation areas, natural areas, nature preserves, scenic trails, and private conservation areas), and Audubon Important Bird Areas (IBAs).

The methods used to evaluate potential impacts on fisheries and aquatic habitats, and on wildlife and wildlife habitats are described below.

Fisheries and Aquatic Habitat

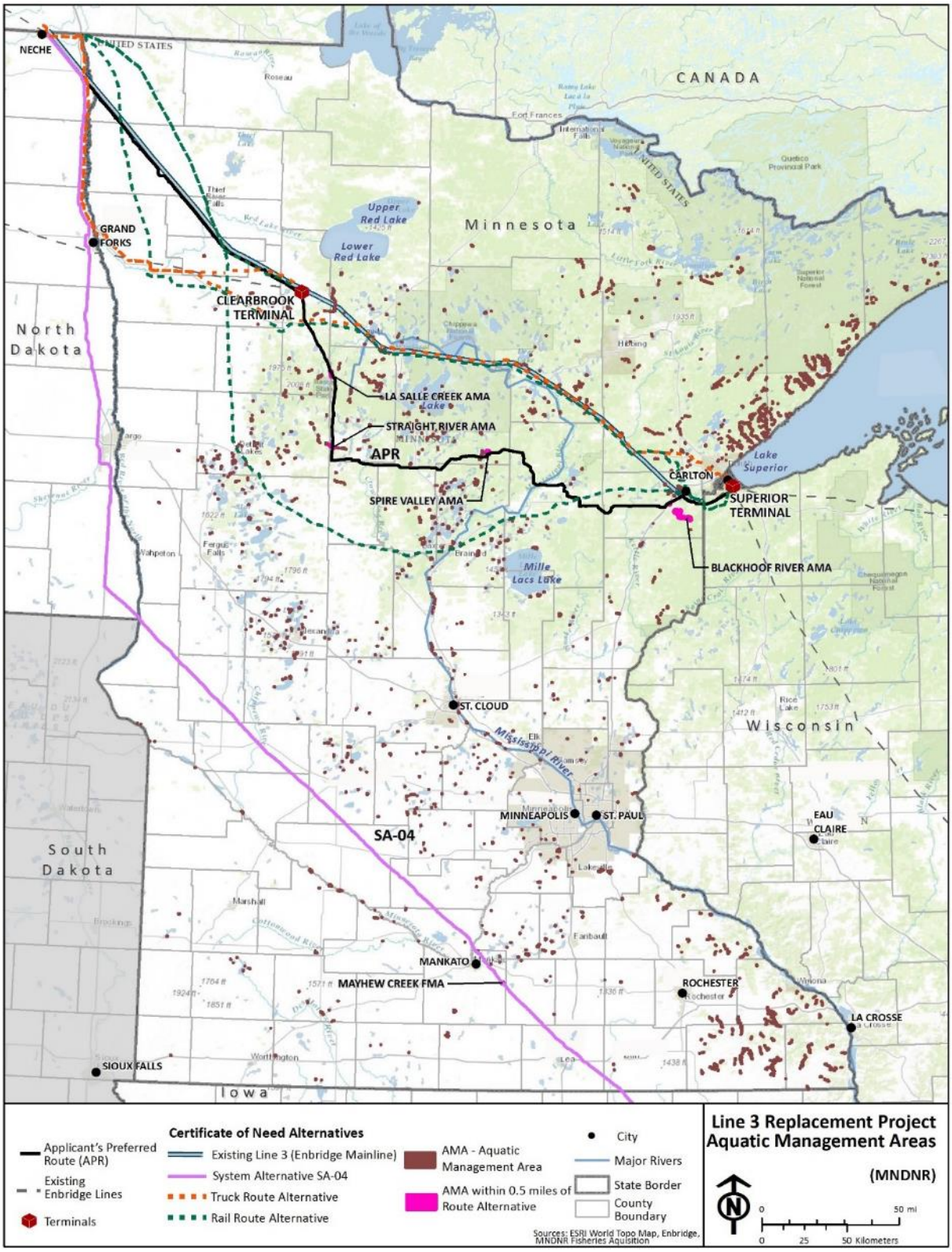
Descriptions of fish, fisheries, aquatic habitats, and aquatic invasive species were obtained from publicly available sources published by federal and state agencies, including data from USFWS, USGS, Minnesota DNR, Wisconsin DNR, North Dakota Game and Fish, Iowa DNR, and Illinois DNR.

The analysis of Project impacts considered the proximity of the Applicant's preferred route and CN Alternatives to classified waterbodies or areas, including AMAs, Sentinel Lakes, Lakes of Biological Significance, designated wildlife lakes, and waterbodies assigned an IBI. These management units are described below. Additional waterbody classifications specific to individual species (e.g., trout streams and muskellunge lakes) were also included in the analysis.

Management Units Considered

Aquatic Management Areas were established by the State of Minnesota to "protect, develop and manage lakes, rivers, streams, and adjacent wetlands and lands that are critical for fish and other aquatic life for water quality, and for their intrinsic biological value, public fishing, or other compatible outdoor recreational uses" (Minn. Stat. Ch. 86A, Subd. 14) (Figure 5.2.4-1). In Minnesota, the demand for shoreline property is high, and such areas are rapidly being developed. Minnesota DNR acquires riparian shoreline parcels to designate as AMAs in order to (1) establish protections for critical fish and wildlife habitat; (2) ensure that non-boat public access to water resources will always be available; and (3) ensure that habitat can be developed in previously disturbed areas (Minnesota DNR 2016a). North Dakota and Wisconsin do not specifically designate AMAs but manage more general wildlife areas for hunting, fishing, trapping, and other recreational activities (see Section 5.2.4.2.3).

Sentinel Lakes have been designated to model and monitor Minnesota ecosystems for detection and better understanding of environmental stressors in order to guide management that sustains fisheries and water resources for future generations (Minnesota DNR 2016b).



Source: Minnesota DNR 2016a

Figure 5.2.4-1. Aquatic Management Areas Crossed by the Applicant's Preferred Route and CN Alternatives

Lakes of Biological Significance have been identified and classified by Minnesota DNR subject matter experts based on objective criteria for four community types (aquatic plants, fish, amphibians, and birds). Unique plant or animal presence is the primary measure of a lake's biological significance. Lakes are assigned one of three biological significance classes:

- Outstanding – Plants: high aquatic plant richness, high floristic quality, and a population of an endangered or threatened plant; important wild rice lakes. Fish: exceptional fishery for selected game fish or an outstanding nongame fish community. Birds: endangered or threatened colonial waterbird nesting area; presence of several endangered, threatened, or special concern lake bird species; or six or more lake bird Species of Greatest Conservation Need.[12]
- High – Plants: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. Fish: populations of more than one fish of special concern or Species of Greatest Conservation Need. Birds: colonial waterbird nesting area; history of endangered or threatened colonial waterbird nesting; presence of endangered, threatened, or special concern lake bird species or five lake bird Species of Greatest Conservation Need. Amphibians – mudpuppy presence.
- Moderate – Plants: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. Fish: populations of one fish species of special concern or fish Species of Greatest Conservation Need. Birds: history of colonial waterbird nesting; presence of an endangered, threatened, or special concern lake bird species; or several lake bird Species of Greatest Conservation Need (Minnesota DNR 2015a).

Index of Biotic Integrity is a biologically-based method for measuring the integrity of aquatic systems that incorporates fish data on species richness, community assemblage, and trophic composition. Each metric represents an aspect of the biological assemblage structure, function, or other measurable characteristic that changes in some predictable way with increased human-induced stress. Fish IBI scores respond to differences in land use patterns, trophic state, and aquatic vegetation.

Other waterbodies evaluated include DNR fish hatcheries, muskellunge waters, and designated trout streams and lakes. In Minnesota, Iowa, and Wisconsin, trout streams and lakes are designated to protect and foster the propagation of trout and provide fishing opportunities and angler access. Further detail for these waterbody classification systems is included in the discussions of existing conditions below.

Data Sources and Potential Impact Areas

Specific geospatial data sources evaluated for impacts on fish and aquatic habitats included:

- USGS National Hydrography Dataset;
- Minnesota DNR and Minnesota PCA geospatial data for:
  - Aquatic Management Areas (Minnesota DNR 2016a),
  - Sentinel Lakes (Minnesota PCA 2016),
  - Lakes with Fish IBI scores (Minnesota DNR 2014a),

[12] Animals whose populations are rare, declining, or vulnerable to decline and are below levels desirable to ensure their long-term health and stability (Minnesota DNR 2006)

  - Lakes of Biological Significance (Minnesota DNR 2015b),
  - Trout lakes and streams (Minnesota DNR 2015c),
  - Muskie lakes (Minnesota DNR 2008),
  - Infested waters list (Minnesota DNR 2016d), and
  - Minnesota Natural Heritage Information System (NHIS) mussel concentration areas (Minnesota DNR 2016e); and
- USGS nonindigenous aquatic species (USGS NAS 2016).

Impacts on fish and aquatic habitats from construction of the Applicant's preferred route were evaluated within the footprints provided by the Applicant for the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations. Using GIS, these footprints were overlain on the resource maps to identify the potentially affected resources. The potentially affected areas during operation of the Applicant's preferred route were identified in a similar manner, using a 50-foot-wide permanent right-of-way.

Areas potentially affected during construction of SA-04 were estimated using the same method, except using a 120-foot-wide construction work area centered on the SA-04 route. Potential impact areas for operations were identified using a 50-foot-wide permanent right-of-way overlain on available resource maps.

For the Applicant's preferred route and System SA-04, the ROI for the fisheries and aquatic habitat evaluation encompasses the area that could be directly or indirectly affected by construction within 0.5 mile from the route centerlines because some construction activities and indirect effects may occur within areas beyond the construction work areas.

Other CN Alternatives evaluated consist of continued use of the existing Line 3 pipeline, rail transport, truck transport, and the combined use of the Line 3 pipeline supplemented by rail or truck transport. These alternatives were qualitatively reviewed for potential impacts based on available fish and aquatic habitat information, descriptions of potential locations for new facilities, and descriptions of potential transportation routes.

Wildlife and Wildlife Habitat

Descriptions of common wildlife (e.g., abundance, distribution, and seasonal sensitivity) and wildlife habitats were obtained from publicly available information published by state agencies, including Minnesota DNR, Wisconsin DNR, North Dakota Game and Fish, Iowa DNR, Illinois DNR, and the Audubon Society. Information on raptor nest locations was obtained from reports on raptor nest surveys completed for the Applicant's preferred route (Merjent 2015a, 2015b); data were not collected for the route alternatives. Colonial waterbird nesting locations were evaluated based on NHIS data (Minnesota DNR 2016e).

Designated Management Units

Wildlife conservation areas have been designated within each state that would be crossed by the Applicant's preferred route and CN Alternatives. The impacts analysis considered the proximity of the Applicant's preferred route and CN Alternatives to areas considered significant for conservation of wildlife or for preservation of wildlife habitat. The areas are presented under various naming

conventions, including but not limited to, WMAs, waterfowl production areas, wetland management districts, BLM land, federal and state forests, state parks, recreation areas, natural areas, nature preserves, scenic trails, and private conservation areas. USGS Gap Analysis Program (GAP) data provide a compilation of these conservation areas. Each area is assigned status codes (1, 2, and 3) to indicate the level of protection and management objectives. All three of these GAP Status Codes include permanent protection from conversion of natural land cover over all or most of their area (USGS GAP 2013). GAP Status 1 and 2 lands are managed for biodiversity, while GAP Status 3 lands include areas managed for multiple uses.

Each of the states crossed maintains designated WMAs. These areas generally are established to protect lands and waters with productive habitat for fish and wildlife, as well as fish- and wildlife-oriented recreation (e.g., hunting, fishing, and bird watching) (Minnesota DNR 2016f; Wisconsin DNR 2016a).

Audubon IBAs established by the National Audubon Society (rather than by state or federal agencies) are a useful management tool to identify areas that vital resources for birds and may concentrate birds. Audubon IBAs include both public and private lands and lack formal protections. IBAs are identified through a rigorous process by bird experts. Each IBA represents a place that supports: species of conservation concern (e.g., threatened and endangered species), range-restricted species (e.g., those species limited spatially), species in only one habitat type or biome, or species or groups of species (e.g., waterfowl or shorebirds) that are vulnerable because they congregate in large numbers.

In addition to these wildlife areas, general vegetation land cover including large blocks (greater than 100 acres) of forested and forested wetland habitats provides important information about available habitats and the wildlife that likely use them. Further details for each of these land classification systems are provided in the discussion of existing conditions below.

Data Sources and Potential Impact Areas

Specific geospatial data sources evaluated for impacts on wildlife and wildlife habitats included:

- U.S. NLCD (Homer et al. 2015) for land cover information including aquatic and terrestrial (vegetation) habitats;
- Federal, state, and local wildlife conservation areas and easements (USGS GAP 2016);
- Minnesota wildlife refuge inventory (Minnesota DNR 2016g);
- Audubon IBAs (Audubon 2016);
- Minnesota NHIS colonial waterbird nesting aggregations (Minnesota DNR 2016e); and
- Raptor nest surveys for the Applicant's preferred route (Merjent 2015a, 2015b).

Areas of potential impacts on wildlife and wildlife habitat from construction of the Applicant's preferred route were evaluated within the Project footprints provided by the Applicant for the construction work area, ATWS, access roads, pipe yards, permanent right-of-way, MLVs and driveways, and pump stations. Using GIS, these footprints were overlain on the resource maps to identify the resources potentially affected. The potentially affected areas during operation of the Applicant's preferred route were identified in a similar manner, using a 50-foot-wide permanent right-of-way.

Construction impacts for SA-04 were similarly evaluated using a 120-foot-wide construction work area centered on the SA-04 route, and operations impacts were estimated using a 50-foot-wide permanent right-of-way overlain on the wildlife distribution and wildlife habitat resource maps.

The ROI for the wildlife and wildlife habitat evaluation encompasses the area that could be directly or indirectly affected by pipeline construction within 0.5 mile from the route centerlines because some construction activities and indirect effects may occur in areas beyond the construction work areas.

Other CN Alternatives—including continued use of the existing Line 3 pipeline, rail transport, truck transport, and combined use of the Line 3 pipeline supplemented by rail or truck—were qualitatively reviewed for potential impacts based on available wildlife species distribution and wildlife habitat information, the descriptions of potential locations for new facilities, and the descriptions of potential transportation routes.

Typical impacts on terrestrial wildlife habitat from pipeline construction and operational maintenance were qualitatively evaluated, including the alteration of vegetation cover. Permanent loss of wildlife habitat was quantified as the area required for maintenance of permanent facilities. Temporary loss and permanent alteration of wildlife habitats were quantified as the size and quality of the area disturbed by the construction work areas and permanent right-of-way by providing the total acres disturbed within wildlife conservation areas and by vegetation cover class. Habitats susceptible to fragmentation were identified by locating large blocks (greater than 100 acres) (Homer et al. 2015) of continuous upland forest and woody wetland cover that would be crossed by the pipeline alternatives where the routes would not be co-located with other linear infrastructure. Particular attention was given to large, mature core or interior forested areas that serve as habitat for protected migratory birds and other wildlife.

The potential for wildlife mortality impacts was qualitatively evaluated based on occurrence, the animal's ability to move away from construction activities, and the animal's susceptibility to being run over or hit by equipment or crew vehicles. The potential for wildlife disturbance, displacement, or blockage of movements also was qualitatively evaluated based on occurrence, locations of migration corridors, locations of sensitive breeding or migration staging areas, and differential sensitivity to human activities.

5.2.4.2 Existing Conditions

5.2.4.2.1 Applicant's Preferred Route

Fisheries and Aquatic Habitat

The Applicant's preferred route would cross surface waters, including large rivers; perennial (permanent) streams, intermittent (wet part of the year) streams, and ephemeral (wet only after precipitation) streams; large lakes; shallow lakes; and wetlands. Potential impacts related to surface water crossings are addressed in Section 5.2.1.2.

Typically, large rivers are quite wide; flow more slowly than smaller rivers; and have numerous meanders and oxbows, islands, and backwaters. The backwater areas of these rivers are biologically productive and provide important spawning areas for several species of fish, as well as refuge habitat for many other animal species. Connectivity of these rivers is an important feature and influences the distribution of fish populations and other species. Smaller rivers, streams, and wetlands provide foraging areas, nesting areas, and refuge for a myriad of species of fish and wildlife, including Species of Greatest Conservation Need birds such as yellow rails (*Coturnicops noveboracensis*) and sedge wrens (*Cistothorus platensis*) (see Section 5.2.5 for more information about Species of Greatest Conservation Need). The

Mississippi River, also within the Clearbrook-to-Carlton segment of the Applicant's preferred route, has a naturally reproducing population of muskellunge that has been supplementally stocked with fingerlings or adults since 2006.

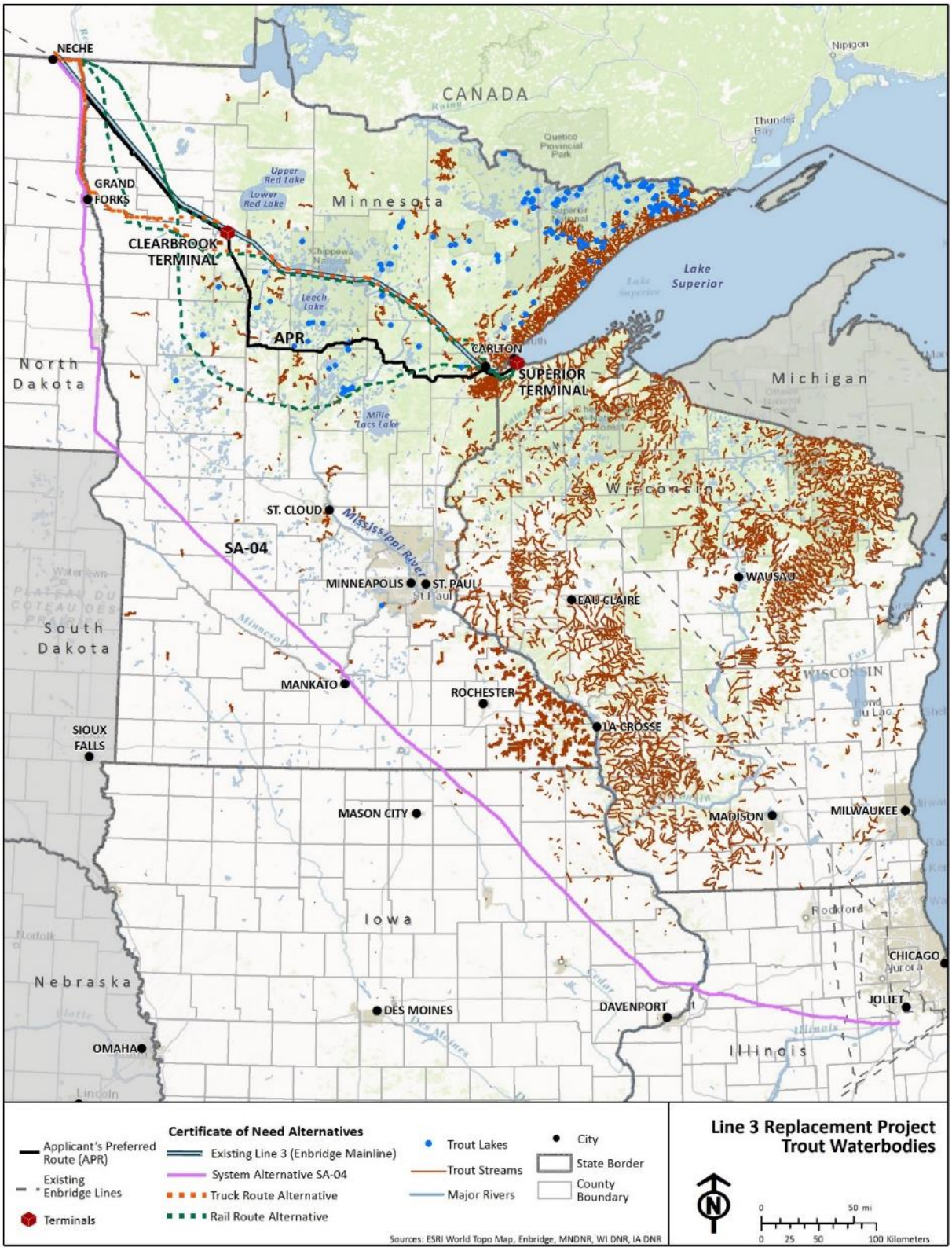
The Applicant's preferred route would traverse areas with abundant freshwater lakes. Lakes are important to Minnesota's environment and economy (e.g., hunting and fishing, many forms of lake recreation, and the tourism industry). Good-quality lake habitat is largely the result of healthy, intact watersheds and shorelines. Watersheds influence water quality, where more intact watersheds tend to result in lakes with better water quality. Shoreline habitat provides bottom substrates, structure, and vegetation that fish and other aquatic animals need for foraging, spawning substrate, and cover from predation.

Shallow lakes provide habitat for many species. They are permanent or semi-permanent waterbodies that are less than 15 feet deep and typified by abundant aquatic plant growth that results from generally high levels of nutrients (e.g., phosphorus, nitrogen, and minerals) and abundant sunlight availability in shallow water. Wetlands and vegetated fringes form along the edges of lakes and include stands of emergent and floating-leaved aquatic plants such as cattails (*Typha* spp.), bulrush (several genera), water lily (*Nymphaea* spp.) and reeds (several genera), as well as submerged plants (e.g., coontail [*Ceratophyllum demersum*]), creating an extended littoral zone. These plants provide excellent food and habitat for zooplankton, insects, fish, waterfowl, and other wildlife. Abundant aquatic vegetation also helps to maintain water clarity by anchoring sediments. Shallow lakes are important breeding, nesting, and foraging areas for waterfowl and waterbirds such as ducks, geese, herons, rails, and many more (Minnesota DNR 2016h).

Four AMAs occur within 0.5 mile of the Applicant's preferred route: Blackhoof River AMA, La Salle Creek AMA, Spire Valley AMA, and Straight River AMA (see Figure 5.2.4-1).The Applicant's preferred route runs directly adjacent to Portage Lake. Portage Lake meets the criteria for a Lake of Biological Significance and is also a Sentinel Lake.

The ROI includes Minnesota DNR-designated trout streams, which occur throughout the state (Figure 5.2.4-2). There are 22 trout streams (21 in Minnesota and one in Wisconsin) identified within 0.5 mile of the Applicant's preferred route, as described in more detail in Section 5.2.4.3.1. Five lakes rated for the Fish IBI are located in the ROI in the following watersheds: Roosevelt, Island, Waukenabo, Big LaSalle, and Portage. The Applicant's preferred route would cross or be located within 1 mile of waters containing invasive species in Minnesota and Wisconsin. Invasive species established in waters that would be crossed by the Applicant's preferred route include reed canary grass (*Phalaris arundinacea*), flowering rush (*Butomus umbellatus*), rusty crayfish (*Orconectes rusticus*), faucet snail (*Bithynia tentaculata*), zebra mussel (*Dreissena polymorpha),* curly leaf pondweed (*Potamogeton crispus*), common carp (*Cyprinus carpio*), ruffe (*Gymnocephalus cernua*), and Eurasian milfoil (*Myriophyllum spicatum*).

Federal, state, and tribal agencies have identified significant fisheries with recreational or commercial value that occur in waterbodies (e.g., streams, rivers, lakes, and ponds) at or immediately downstream of proposed crossings. Maintaining abundant populations of fish requires high-quality aquatic habitat and healthy ecosystems. Fisheries can be defined as coldwater, coolwater, or warmwater and are associated with particular fish assemblages. These fisheries can include both game and nongame species.



Source: Minnesota DNR 2015c

Figure 5.2.4-2. Trout Streams and Lakes in Relation to the Applicant's Preferred Route and Certificate of Need Alternatives

Coldwater fisheries support trout and salmon (Salmonidae); these are important commercial and sport fishes that require cold, clean water for survival and reproduction. Chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), and pink salmon (*Oncorhynchus gorbuscha*) have been introduced to Lake Superior and now spawn in its tributaries (Minnesota DNR 2016i). Lake trout (*Salvelinus namaycush*) are naturally reproducing in cold lakes throughout the region. The native brook trout (*Salvelinus fontinalis*) and the introduced brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) are also present in rivers and streams in the region.

Coolwater fisheries support gamefish such as northern pike (*Esox lucius*) and muskellunge or muskie, walleye (*Sander vitreus*), and yellow perch (*Perca flavescens*). Northern pike generally inhabit clear, shallow, warm waters near shore but move to deeper water midsummer to use coolwater areas (Michigan DNR 2016a). Muskellunge survive in a wide range of temperatures and prefer clear water (ADW 2016). They move from shallow, weedy water to deeper water as they grow larger (ADW 2016). Walleye occur in submerged bars and rocky areas of shallow bay lake waters in spring and fall but also move to cooler, deeper water (i.e., less than 50 feet) in summer (Michigan DNR 2016b). Yellow perch generally prefer relatively shallow water (i.e., less than 30 feet deep) near shore (Michigan DNR 2016c).

Warmwater fisheries support catfish and bullheads (Ictaluridae), sunfish and bass (Centrarchidae), carp and minnows (Cyprinidae), and temperate bass (Moronidae). Catfish and bullheads occur throughout the region, but are most common in warm, fertile rivers and lakes (Minnesota DNR 2016j). Sunfish, including the bluegill (*Lepomis macrochirus*), which is the most popular sunfish, prefer lakes and slow streams (Minnesota DNR 2016k). Bass, both largemouth (*Micropterus salmoides*) and smallmouth (*Micropterus dolomieu*), are becoming increasingly popular with anglers. Largemouth bass tend to favor clear lakes with abundant aquatic vegetation, and they can tolerate quite warm water temperatures. Smallmouth bass are often in rivers with suitable gravel or rubble for spawning that are warmer than those that support trout (Minnesota DNR 2016l). Carps and minnows occupy a variety of habitats, including coldwater and warmwater environments (Cornell 2016), and several are listed as Species of Greatest Conservation Need; however, the common carp, and a number of Asian carp species are invasive fish. The white bass (*Morone chrysops*), important for sport fishing due to its size and abundance, occurs in rivers, tributaries, and reservoirs, as well as in several lakes (Minnesota DNR 2016m). The yellow bass (*Morone mississippiensis*) is present in the Mississippi River backwaters below Lake Pepin (Minnesota DNR 2016m).

All three main types of fishery (coldwater, coolwater, and warmwater) are present in the region. Protected and rare species are discussed in Section 5.2.5, including species listed by state or federal endangered species regulations.

Wildlife and Wildlife Habitat

The Project region supports a diversity of wildlife, mammals, birds, amphibians, reptiles, and invertebrates. Mammals include both game (those species that are hunted or trapped such as big and small game animals, and fur-bearing animals) and nongame species (small mammals and non-hunted species). Birds can be resident or migratory and include game species (waterfowl and upland birds) and nongame species. Amphibians and reptiles include frogs, toads, salamanders, snakes, lizards, and turtles. Invertebrates include a wide variety of insects as well as mussels. This section describes the existing wildlife resources in the vicinity of the Applicant's preferred route.

Applicant's Preferred Route

Wildlife Habitats

Northern Minnesota is relatively undeveloped with large expanses of protected lands that are home to many species of wildlife. The Applicant's preferred route would cross 10 broad-scale vegetation cover classes: evergreen forest, deciduous forest, mixed forest, shrub/scrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Homer et al. 2015). Developed lands (residential, commercial, and industrial lands) primarily include artificially created landscapes with minimal naturally occurring vegetation. Broadly, the Applicant's preferred route occurs within ecoregions with forested uplands, forested wetlands, non-forested wetlands, prairie/grasslands, and agricultural areas. Table 5.2.4-2 lists the acreages of vegetation types crossed by the Applicant's preferred route.

Table 5.2.4-2. Vegetation Cover Potentially Affected by the Applicant's Preferred Route (acres)

Vegetation Cover Class	Con[a]	Op[b]	ATWS[c]	Access Roads	Pump Stations	MLVs	Total[d]	
							Con	Op
Evergreen forest	177.2	71.4	18.2	18.6	0.5	0.5	199.3	87.1
Deciduous forest	1,415.8	622.1	96.8	102.6	2.4	2.1	1,543.7	698.1
Mixed forest	19.6	8.4	1.4	2.3	0.0	0.0	21.1	10.6
Shrub/scrub	238.9	117.2	15.2	13.1	2.1	0.0	255.6	131.0
Grassland/herbaceous	130.7	62.5	32.4	8.7	3.5	0.2	165.0	72.9
Hay/pasture	584.6	261.8	120.7	45.4	15.7	1.2	706.1	323.3
Cultivated crops	1,698.9	726.1	326.9	22.3	20.1	1.8	2,027.9	768.3
Woody wetlands	418.5	203.8	17.7	13.0	3.0	0.5	437.8	218.8
Emergent herbaceous wetlands	229.2	122.4	18.9	7.1	3.0	0.1	249.2	131.5
Barren land	3.6	1.7	8.1	0.6	0.0	0.0	11.7	2.4
TOTAL	**4,916.9**	**2,197.4**	**656.2**	**233.8**	**50.2**	**6.6**	**5,617.4**	**2,443.7**

Source: Homer et al. 2015.

Note(s):

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area in Minnesota. In North Dakota and Wisconsin, estimated construction impact area in acres based on 120-foot-wide construction work area centered on route, including the 50-foot-wide permanent right-of-way.

[b] Op = Enbridge-provided footprint in Minnesota. Estimated permanent impact acres based on 50-foot-wide right-of-way centered on route in North Dakota and Wisconsin.

[c] ATWS = additional temporary workspaces (includes pipe yards)

[d] Total: Con = sum of pipeline construction work area, ATWS, and temporary access roads; Op = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs (mainline valves).

Forested uplands typically exhibit closed canopies, dense understories, large trees, and downed trees. These areas are important habitat components for a variety of birds, salamanders, white-tailed deer (*Odocoileus virginianus*), and even large carnivores such as gray wolves (*Canis lupus*) and black bears (*Ursus americanus*). Grasslands and prairies are typified by large open areas with grasses and flowering plants dominating, which provide habitat for many species of pollinators, songbirds, small mammals, snakes, deer, coyotes, and red fox.

Non-forested wetlands and wooded wetlands, such as marshes, are permanently or periodically inundated with water and provide habitat for amphibians and reptiles, aquatic insects, aquatic mammals such as muskrats (*Ondatra zibethicus*), and many species of birds. Calcareous fens are a type of wetland that support unique plant and animal species (see Sections 5.2.1.3 and 5.2.5). Lakes and rivers support wildlife, particularly waterfowl, shorebirds, bald eagles, muskrats, and beavers (*Castor canadensis*).

Agricultural lands attract white-tailed deer, sandhill cranes (*Grus canadensis*), trumpeter swans (*Cygnus buccinator*), and wild turkeys (*Meleagris gallopavo*) that come to feed on crops.

Management Units

Wildlife conservation lands that occur along or near the Applicant's preferred route are listed in Table 5.2.4-3. The Applicant's preferred route crosses a variety of Minnesota DNR wildlife management and conservation areas, including WMAs, wildlife refuges, state forests, and recreation areas. Minnesota's WMAs are established to protect lands and waters that have productive habitat for fish and wildlife, as well as fish- and wildlife-oriented recreation (e.g., hunting, fishing, and bird watching). WMA managers actively plant food plots, restore native plants and wetlands, conduct prescribed burns, and manipulate water levels.

The six WMAs (Grayling Marsh, Lawler, Lowe, McGregor, Mud Lake, and Salo Marsh) within the ROI for the Applicant's preferred route. Two are located within the construction and operation area Grayling Marsh WMA and Lawler WMA. Grayling Marsh WMA consists mostly of lowland habitats managed for sharp-tailed grouse (*Tympanuchus phasianellus*) and sandhill cranes. Other game species at this site include white-tailed deer, American black bear, small game, forest upland birds, and waterfowl. Lawler WMA consists mostly of marsh and low brush areas that are managed for deer and waterfowl (Minnesota DNR 2016l).

Figure 5.2.4-3 provides an overview of WMAs, wildlife refuges, and other conservation lands near the Applicant's preferred route and system alternative SA-04. The lands shown in Figure 5.2.4-3 include those assigned GAP Status Codes 1, 2, and 3 to indicate the level of protection and management objectives as well as wildlife refuges and state WMAs.

Table 5.2.4-3. Wildlife Conservation Lands within 0.5 Mile of the Applicant's Preferred Route and System Alternative SA-04

Location, Designation Type, and Name	Applicant's Preferred Route		System Alternative SA-04	
	Acres	Number	Acres	Number
North Dakota				
Habitat or Species Management Area				
Dakota Tallgrass Prairie Wildlife Management Area	--	--	34,806.8	1
Resource Management Area				
Pembina County Waterfowl Production Area (designated)	243.9	5	280.4	7
Pembina County Waterfowl Production Area (not designated)	--	--	36.5	2
North Dakota subtotal	***243.9***	***5***	***35,123.8***	***10***
Minnesota				
Protective Management Area				
Wetlands Reserve Program	--	--	11.4	2
Habitat or Species Management Area				
Clair Rollings Wildlife Management Area	--	--	29.7	1
Grayling Marsh Wildlife Management Area	820.1	1	--	--
Horning Pit Wildlife Management Area	--	--	34.2	2
Lawler Wildlife Management Area	197.8	2	--	--
Lowe Wildlife Management Area	57.9	1	--	--
Lyle-Austin Wildlife Management Area	--	--	12.4	1
McGregor Wildlife Management Area	152.1	1	--	--
Mud Lake Wildlife Management Area	3.6	1	--	--
Mueller Wildlife Management Area	--	--	38.4	1
Red Cedar River Wildlife Management Area	--	--	35.5	1
Salo Marsh Wildlife Management Area	201.6	1	--	--
Sena Wildlife Management Area	--	--	114.6	1
Swan Lake Wildlife Management Area	--	--	40.4	1
Windot Wildlife Management Area	--	--	5.7	2
Resource Management Area				
Bureau of Land Management land	60.8	1	--	--
Litchfield Wetland Management District	--	--	457.9	4
Morris Wetland Management District	--	--	319.4	6

Table 5.2.4-3. Wildlife Conservation Lands within 0.5 Mile of the Applicant's Preferred Route and System Alternative SA-04

Location, Designation Type, and Name	Applicant's Preferred Route		System Alternative SA-04	
	Acres	Number	Acres	Number
State Forest Lands				
Fond du Lac	987.8	2	--	--
Foothills	1,811.4	1	--	--
Hill River	5,056.0	1	--	--
Huntersville	4,504.0	2	--	--
Land O'Lakes	5,913.6	5	--	--
Mississippi Headwaters	1,335.2	2	--	--
Paul Bunyan	264.9	1	--	--
Savanna	579.6	6	--	--
Waukenabo	545.5	4	--	--
White Earth	207.6	1	--	--
Private Conservation Land				
Conservation Reserve Enhancement Program	--	--	751.0	32
Marginal cropland – limited	22.3	4	29.5	4
Marginal cropland – perpetual	--	--	33.2	5
Miller Prairie Fee	--	--	144.2	1
Reinvest in Minnesota Wetlands Reserve Program	--	--	431.1	10
Riparian buffer strip	--	--	5.3	2
Riparian lands	--	--	70.3	2
Minnesota subtotal	***22,721.8***	***37***	***2,564.0***	***78***
Iowa				
Habitat or Species Management Area				
Elma Wildlife Management Area	--	--	81.6	1
Recreation Management Area				
Pioneer State Recreation Area	--	--	8.3	2
Iowa subtotal	--	--	***89.9***	***3***
Illinois				
National Forest - National Grassland				
Midewin National Tallgrass Prairie	--	--	154.6	4
National Wildlife Refuge				
Upper Mississippi River Wildlife and Fish Refuge	--	--	0.9	1

Table 5.2.4-3. Wildlife Conservation Lands within 0.5 Mile of the Applicant's Preferred Route and System Alternative SA-04

Location, Designation Type, and Name	Applicant's Preferred Route		System Alternative SA-04	
	Acres	Number	Acres	Number
Protective Management Areas				
Coon Creek	--	--	10.7	1
East Grove	--	--	6.8	1
Lower Fox River-Blake's Landing Nature Preserve	--	--	0.0	4
Marsh Relicts	--	--	6.4	1
Mississippi River	--	--	213.4	1
Joliet Army Ammunition Plant	--	--	78.9	4
Des Plaines	--	--	10.2	1
State Park				
Hennepin Canal	--	--	44.1	1
Local Forest				
McKinley Woods Preserve 1	--	--	49.7	1
McKinley Woods Preserve 2	--	--	0.2	1
Illinois subtotal	--	--	***575.9***	***20***
Wisconsin				
Protective Management Area				
Statewide Natural Area	231.0	1	--	--
Recreation Management Area				
North Country National Scenic Trail	2.0	2	--	--
Wisconsin subtotal	***232.9***	***3***	--	--
TOTAL	**23,198.6**	**45**	**38,353.6**	**111**

Source: USGS GAP 2016.

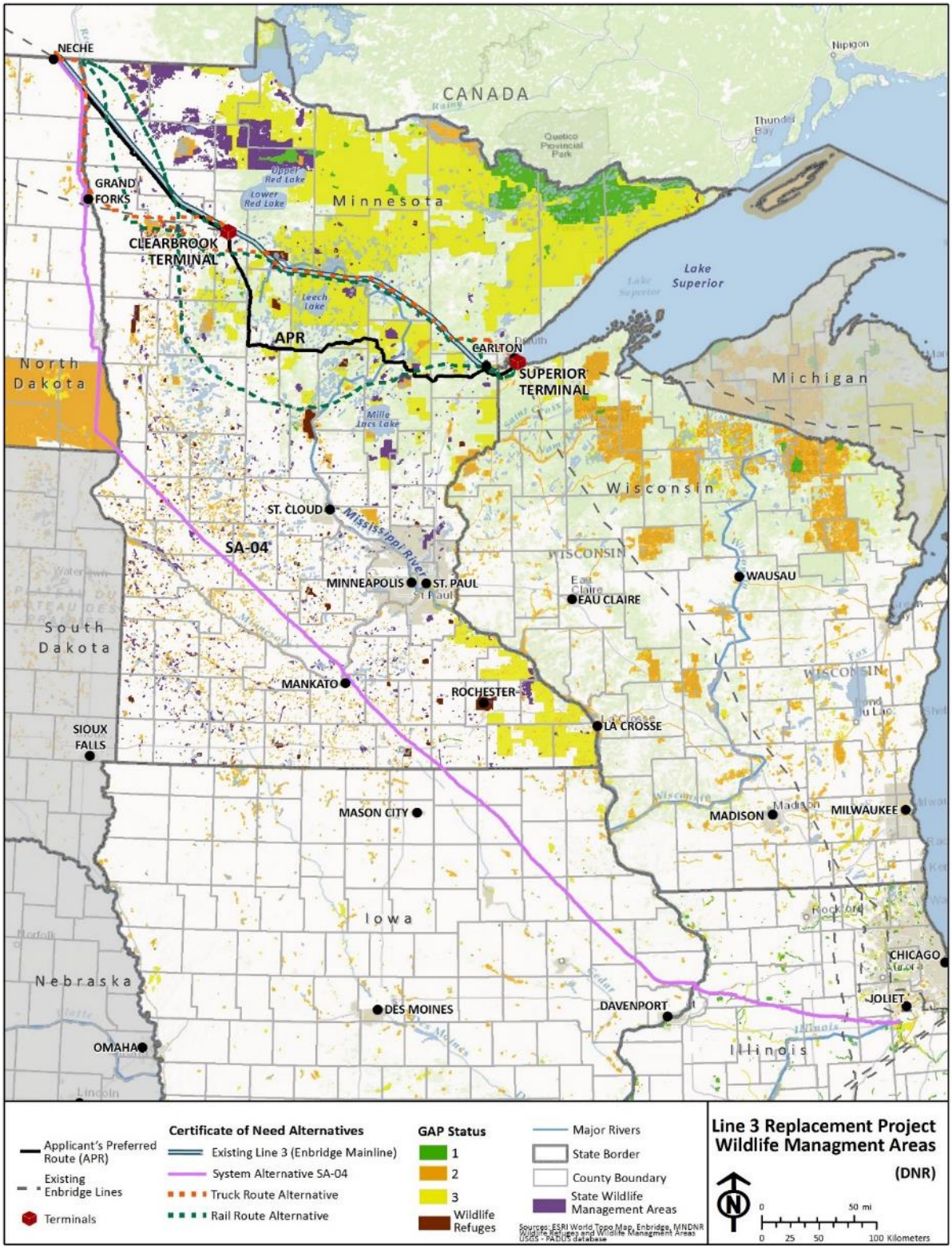
Note(s):

Values in table may not sum to subtotals and totals due to rounding.

Represents GAP Status 1, 2, and 3 areas only; these lands have permanent protection from conversion of natural land cover that provides wildlife habitat for all or most of the area.

Acreage of conservation lands and number of occurrences within 0.5 mile of the Applicant's preferred route and system alternative SA-04 route.

"--" = no occurrence



Source: USGS GAP 2016

Note: GAP Status 1 and 2 lands are managed for biodiversity, while GAP Status 3 lands include areas managed for multiple uses.

Figure 5.2.4-3. Wildlife Management Areas and Refuges near the Applicant's Preferred Route and Certificate of Need Alternatives

IBAs established by the National Audubon Society (rather than by state or federal agencies) are a useful management tool to identify areas with concentrations of habitat and other resources that birds depend on. Audubon IBAs include both public and private lands and lack formal protections. IBAs are identified through a rigorous process by bird experts. Each IBA represents a place that supports species of conservation concern (e.g., threatened and endangered species), range-restricted species (e.g., those species limited spatially), species that occur in only one habitat type or biome, or species or groups of species (e.g., waterfowl or shorebirds) that are vulnerable because they congregate in large numbers. IBAs in the vicinity of the Applicant's preferred route are as follows (Figure 5.2.4-4):

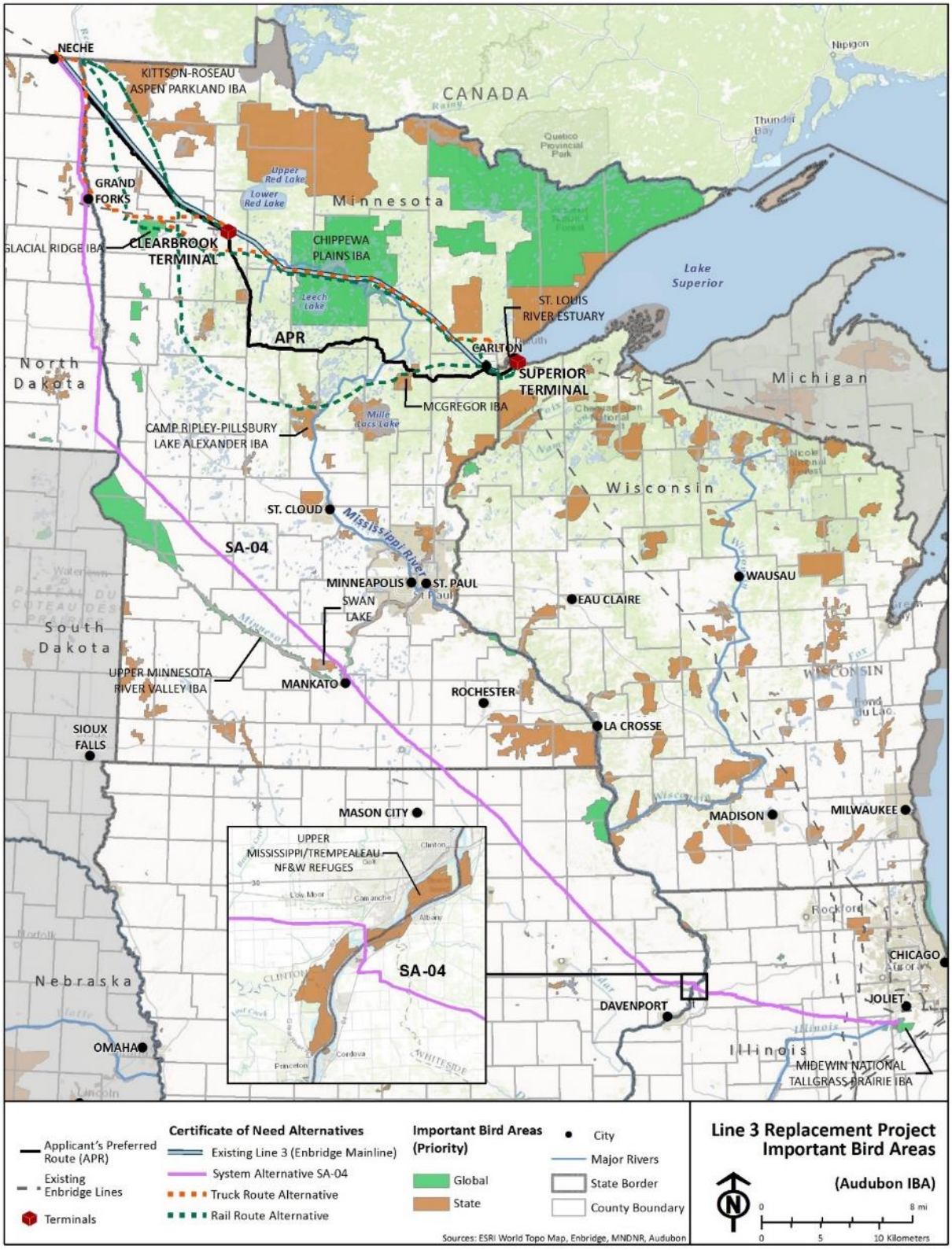
- Itasca State Park IBA – This state priority IBA supports 222 species of birds. Itasca's extensive stands of boreal forests with mixed hardwoods provide excellent habitat for many northern birds such as crossbills (*Loxia* spp.), gray jays (*Perisoreus canadensis)*, finches (Fringillidae), thrushes (Turdidae), black-backed woodpeckers (*Picoides arcticus*), and warblers (Parulidae). Over 20 species of warblers nest within the park.
- McGregor IBA – This state priority IBA has important habitat for many birds that includes wetlands, lowland forests, upland deciduous forests, open brushlands, and open grasslands. McGregor IBA is probably best known for the fall ring-necked duck (*Aythya collaris*) migration but also has a variety of nesting birds such as American bittern (*Botaurus lentiginosus*), yellow rail (*Coturnicops noveboracensis*), sora (*Porzana carolina*), black tern (*Chlidonias niger*), sandhill crane; 12 species of nesting warblers; trumpeter swan; bald eagle; American woodcock (*Scolopax minor*); wood thrush (*Hylocichla mustelina*); black-billed cuckoo (*Coccyzus erythropthalmus*); LeConte's sparrow (*Ammodramus leconteii*); and bobolink (*Dolichonyx oryzivorus*).

Wildlife in the Project Region

Mammals

Large Mammals and Big Game

White-tailed deer is the most common big game animal along the pipeline routes. Deer occur throughout the Project region and are an ecologically, socially, and economically important species. White-tailed deer inhabit a wide variety of habitats and are highly adaptable. Croplands, grasslands, shrublands, orchards, woodlands, and even residential areas provide foraging and resting areas for deer. White-tailed deer eat a varied diet that may include acorns, corn, soybeans, mushrooms, grasses, tree leaves, buds, twigs and bark, wild grapes, apples, and assorted shrubs. During winter, deer often aggregate or "yard" in forested stream bottoms and other areas protected from heavy snows. Wolves, coyotes (*Canis latrans*), bears, and bobcats (*Lynx rufus*) are natural predators of deer. White-tailed deer are hunted for sport and meat, and permits are available to hunt using regular firearms (e.g., shotgun, rifle), muzzleloaders, or archery (e.g., bow and arrow).



Source: Audubon 2016.

Figure 5.2.4-4. Audubon Important Bird Areas near the Applicant's Preferred Route and Certificate of Need Alternatives

Black bears are another big game mammal that occurs along the Project region. Black bears occur mainly in the northern third of Minnesota but range as far south as the interface between the forested and agricultural areas (Minnesota DNR 2016i). There are roughly 20,000 black bears in Minnesota (Minnesota DNR 2016n). Wisconsin is home to a robust black bear population estimated at more than 28,000 bears. The black bear's primary range in Wisconsin is located in the far northern third of the state (Wisconsin DNR 2016b). Black bears live in forests, swamps, and other areas with dense cover, but they also venture into clearings to feed. Black bears feed primarily on new plant growth in spring, switching to ants and ant pupae and a variety of berries in summer, and nuts (acorns and hazelnuts) in autumn. Black bears supplement their diets with corn and other crops, bird eggs, honey, and deer fawns opportunistically. Black bears are hunted for their meat and fur, and most bears are harvested in coniferous areas of northeast Minnesota. Sport hunting is their main source of mortality. Minnesota hunters harvest an average of about 3,000 black bears annually (Minnesota DNR 2016n).Wisconsin hunters harvested approximately 4,643 bears in 2016 (Wisconsin DNR 2016c).

While elk are managed as a game species in many states, only two small remnant populations are present in Minnesota and elk are listed as a Species of Concern in the state. Elk once were distributed throughout Minnesota, but the native woodland (*Cervus elaphus canadensis*) and prairie subspecies (*C. e. manitobensis*) were nearly extirpated from the state by the early 1900s because of excessive hunting during the 1800s. In the early 1930s, captive-bred elk were used to reestablish a population in northwest Beltrami County. Since that time, a second elk herd has become established in Kittson and Roseau counties near the Manitoba border. This northern herd is believed to include individuals that have naturally emigrated from Canada, North Dakota, or the original Beltrami County reintroduced herd (Minnesota DNR 2016o). Elk prefer a diet of grasses and forbs, but their diet varies by season. Elk will browse on willow (*Salix* spp.), aspen (*Populus* spp.), and other woody vegetation, and will consume many agricultural crops. Wolves, coyotes, black bears, and cougars (*Puma concolor*) are natural predators of elk. Elk hunting is conservatively managed in Minnesota. Each year, a limited number of licenses are offered to Minnesota residents to hunt elk. Hunters are selected using a lottery system. In 2014, 1,167 hunters applied for a license, but only nine permits were issued and six elk ultimately were harvested (Minnesota DNR 2014b).

Moose (*Alces alces*) occur in the Project region in the northeastern portion of North Dakota, and in the northwestern and northeastern portions of Minnesota. Moose hunting was allowed in Minnesota in both these regions until 1997 when it was prohibited in the northwest corner. Hunting continued in the northeast of the state until a 2013 aerial survey of moose revealed that the moose population had declined in this area by 52 percent since 2010, after which Minnesota DNR suspended moose hunting indefinitely (Minnesota DNR 2013, 2016p). Moose hunting is prohibited in Wisconsin, where a combination of parasites common to white-tailed deer and unregulated hunting caused their earlier disappearance by the early 1900s (Wisconsin DNR 2016d). Moose eat aspen, maple (*Acer* spp.), and cherry (*Prunus* spp.) trees and many kinds of water plants (Minnesota DNR 2016q). Wolves and bears are natural predators of moose.

Cougars, also known as mountain lions or pumas, are rare but could occur within the region. Cougars occurred throughout most of Minnesota prior to European settlement (Minnesota DNR 2016i). Today, they are occasionally observed in Minnesota. Because there is no evidence of a viable breeding population in Minnesota, cougars are not currently tracked in the Minnesota DNR's Rare Features Database. Cougars are hunted in southwestern North Dakota but not within the Project area. Cougars are not considered a game animal in Minnesota, Iowa, Illinois, or Wisconsin, and are considered rare migrant occurrences within these states.

Mid-Sized Mammals, Small Game, and Furbearers

The Project region is home to a number of mid-sized mammals, many of which are classified as "small game" in hunting regulations or as furbearers in trapping regulations. Common small game and furbearers that are hunted or trapped in the Project area include badger (*Taxidea taxus*), beaver (*Castor canadensis*), bobcat, coyote, fisher (*Martes pennant*), pine marten (*Martes martes*), red fox (*Vulpes vulpes),* and gray fox (*Urocyon cinereoargenteus*), mink (*Neovison vison*), muskrat, Virginia opossum (*Didelphis virginiana*), river otter (*Lontra canadensis*), rabbits and hares (*Leporidae*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), squirrels (*Sciuridae*), and weasels (*Mustelidae*). Many furbearers are associated with water and wetlands (e.g., muskrats, mink, otters, and beavers). Rabbits, raccoons, opossums, and coyotes are present in a wide variety of habitats, including croplands, residential areas, hedgerows, and forests. Squirrels require forested habitats with abundant mix of mast producing trees, elms, maples, oaks, walnut, and/or hickory. Mid-sized mammals not traditionally hunted or trapped include porcupine (*Erethizon dorsatum*) and groundhog (*Marmota monax*).

Small Mammals

Small mammals, including mice, moles, voles and shrews, are important members of ecosystems. Herbivorous small mammals shape vegetative communities by spreading seeds and grazing. Their burrowing activities and the addition of feces and urine to the soil influence soil chemistry through changes in nutrient and mineral cycling rates and pathways (Hull Sieg 1987). Small mammals such as shrews and bats also function as secondary consumers by preying on invertebrates and other mammals. Small mammals serve as food supply for a large number of predators and can influence predator population cycles. Predators such as foxes, various owl species, and various hawk species rely heavily on rodents and other small mammals for food.

Some representative species of small mammals that are likely to occur in the Project region include southern bog lemming (*Synaptomys cooperi*), meadow vole (*Microtus pennsylvanicus*), red-backed vole (*Myodes gapperi*), meadow jumping mouse (*Zapus hudsonius*), woodland jumping mouse (*Napaeozapus insignis*), western harvest mouse (*Reithrodontomys megalotis*), white-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus maniculatus*), house mouse (*Mus musculus*), star-nosed mole (*Condylura cristata*), and Norway rat (*Rattus norvegicus*) (Minnesota DNR 2016r). Shrews are the smallest mammals in the Project area. Shrews that could occur in the Project region include the pygmy shrew (*Sorex minutus*), short-tail shrew (*Blarina brevicauda*), and masked shrew (*Sorex cinereus*). Northern water shrews (*Sorex palustris*) and arctic shrews (*Sorex arcticus*) could also occur (Minnesota DNR 2016s).

Bats are important to ecosystems in part because they consume vast numbers of insects, including agricultural pests. The bats in the Project area are primarily forest dwelling and/or associated with riparian areas, and are insectivorous. In summer the bats roost in forests or in buildings, and in winter, most migrate to caves to hibernate. Little brown bats (*Myotis lucifugus*) and big brown bats (*Eptesicus fuscus*) are the most common species in Minnesota. Other species that in the Project region include northern myotis (*Myotis septentrionalis*), hoary bat (*Lasiurus cinereus*), eastern red bat (*Lasiurus borealis*), and silver-haired bat (*Lasionycteris noctivagans*). Northern myotis was recently listed as threatened by USFWS (see Section 5.2.5).

Birds

Waterfowl and Gamebirds

All waterfowl and some gamebirds occurring in the Project region are considered migratory birds and are protected under the MBTA (which prohibits the take of any migratory birds without authorization from USFWS). Hunting regulations are developed and authorized by USFWS and state game and fish departments. Waterfowl are harvested primarily in autumn, with some goose seasons occurring in spring. Many waterfowl species breed in or migrate through areas that would be crossed by the Applicant's preferred route, SA-04, or facilities developed for the CN Alternatives (Table 5.2.4-4). Important recreational waterfowl include Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), ring-necked duck, and blue-winged teal (*Anas discors*). Waterfowl habitats include wooded river bottoms, flooded forests, lakes (particularly those with wild rice), rivers, marshes, and flooded grain fields.

Other gamebird species include American woodcock, Wilson's snipe (*Gallinago delicate*), mourning dove (*Zenaida macroura*), wild turkey, sandhill crane, greater prairie chicken (*Tympanuchus cupido*), sharp-tailed grouse, and introduced gamebirds such as ring-necked pheasant (*Phasianus colchicus*) and gray partridge (*Perdix perdix*). These species occur in areas crossed by the Applicant's preferred route, SA-04, or facilities developed for the CN Alternatives (Table 5.2.4-4).

Nongame Birds

The upper Midwest is home to many nongame bird species. Birds are an important part of healthy functioning ecosystems, including forests and prairies, and also developed areas such as agricultural, urban, and suburban areas. While a number of bird species are resident or migrate only short distances, many species perform long annual migrations in spring and fall. Minnesota, Iowa, Illinois, and Wisconsin are located on the Mississippi Flyway, a key migration flyway for millions of birds and hundreds of species that roughly follows the Mississippi River for millions of birds and hundreds of species. North Dakota is part of the Central Flyway that encompasses the Great Plains area and links central Canada with the region surrounding the Gulf of Mexico. Nongame birds occur in all habitat types in the ROI, including coniferous, deciduous, and mixed forests; riparian areas and forested and non-forested wetlands; lakes, rivers, and streams; grasslands, prairies, and pastures; and shelterbelts and agricultural lands. Table 5.2.4-4 provides a list of some of the more common species expected to occur in the Project region.

Bald eagles once were protected by the ESA. Through the federal government's banning of DDT and various conservation actions taken across the United States, populations recovered sufficiently and bald eagles were removed from the endangered species list (delisted) in 2007. However, bald eagles are still protected under the MBTA and the BGEPA. This legislation also protects their nesting structures, which tend to be used for a number of years. Bald eagles prefer to nest near lakes and rivers in forested areas where tall, large-diameter trees are available for nesting. Due to a growing population, more eagles have been found nesting in non-typical locations, such as tree lines in agricultural landscapes.

Table 5.2.4-4. Game and Nongame Birds Typical of Habitats Crossed by the Certificate of Need Alternatives

Habitat	Game	Nongame
Evergreen and mixed forests	Sharp-tailed grouse (*Tympanuchus phasianellus*)	Broad-winged hawk (*Buteo platypterus*), northern goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), boreal owl (*Aegolius funereus*), eastern whip-poor-will (*Antrostomus vociferus*), black-backed woodpecker (*Picoides arcticus*), hairy woodpecker (*Picoides villosus*), northern flicker (*Colaptes auratus*), pileated woodpecker (*Dryocopus pileatus*), yellow-bellied sapsucker (*Sphyrapicus varius*), merlin (*Falco columbarius*), eastern wood-pewee (*Contopus virens*), least flycatcher (*Empidonax minimus*), blue-headed vireo (*Vireo solitarius*), red-eyed vireo (*Vireo olivaceus*), blue jay (*Cyanocitta cristata*), common raven (*Corvus corax*), gray jay (*Perisoreus canadensis*), brown creeper (*Certhia americana*), wood thrush (*Hylocichla mustelina*), veery (*Catharus fuscescens*), black-and-White Warbler (*Mniotilta varia*), black-throated green warbler (*Setophaga virens*), nashville warbler (*Oreothlypis ruficapilla*), yellow-rumped warbler (*Setophaga coronata*), chipping sparrow (*Spizella passerina*), dark-eyed junco (*Junco hyemalis*), white-throated sparrow (*Zonotrichia albicollis*), pine siskin (*Spinus pinus*)
Deciduous and mixed forests	Ruffed grouse (*Bonasa umbellus)*, wild turkey (*Meleagris gallopavo*)	Cooper's hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), barred owl (*Strix varia*), great horned owl (*Bubo virginianus*), ruby-throated hummingbird (*Archilochus colubris*), downy woodpecker (*Picoides pubescens*), red-bellied woodpecker (*melanerpes carolinus*), great crested flycatcher (*Myiarchus crinitus*), tufted titmouse (*Baeolophus bicolor*), white-breasted nuthatch (*Sitta carolinensis*), house wren (*troglodytes aedon*), hermit thrush (*Catharus guttatus*), veery, cedar waxwing (*Bombycilla cedrorum*), American redstart (*Setophaga ruticilla*), chestnut-sided warbler (*Setophaga pensylvanica*), ovenbird (*Seiurus aurocapilla*), indigo bunting (*Passerina cyanea*), rose-breasted grosbeak (*Pheucticus ludovicianus*), scarlet tanager (*Piranga olivacea*), Baltimore oriole (*Icterus galbula*)
Riparian areas, wetlands (forested or non-forested)	Canada goose (*Branta canadensis*), wood duck (*Aix sponsa*), gadwall (*anas strepera*), mallard (*Anas platyrhynchos*), blue-winged teal (*Anas discors*), northern shoveler (*Anas clypeata*), green-winged teal (*Anas crecca*), canvasback (*Aythya valisineria*), redhead (*Aythya americana*), ring-necked duck (*Aythya collaris*), lesser scaup (*Aythya affinis*), common goldeneye (*Bucephala clangula*), American coot (*Fulica americana*), sandhill crane (*Grus canadensis*), American woodcock (*Scolopax minor*), Wilson's snipe (*Gallinago delicate*)	Trumpeter swan (*Cygnus buccinator*), pied-billed grebe (*Podilymbus podiceps*), red-necked grebe (*Podiceps grisegena*), western grebe (*Aechmophorus occidentalis*), American bittern (*Botaurus lentiginosus*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), green heron (*Butorides virescens*), northern harrier (*Circus cyaneus*), sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), yellow rail (*Coturnicops noveboracensis*), black tern (*Chlidonias niger*), Forster's tern *(Sterna forsteri*), short-eared owl (*Asio flammeus*), belted kingfisher (*Megaceryle alcyon*), marsh wren (*Cistothorus palustris*), sedge wren (*Cistothorus platensis*), swamp sparrow (*Melospiza georgiana*), red-winged blackbird (*Agelaius phoeniceus*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*)

Table 5.2.4-4. Game and Nongame Birds Typical of Habitats Crossed by the Certificate of Need Alternatives

Habitat	Game	Nongame
Lakes, rivers, streams	Canada Goose, wood duck, canvasback, redhead, ring-necked duck, lesser scaup, common goldeneye	Common loon (*Gavia immer*), red-necked grebe, western grebe, double-crested cormorant (*Phalacrocorax auritus*), American white pelican (*Pelecanus erythrorhynchos*), osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), ring-billed gull (*Larus delawarensis*), belted kingfisher
Prairies, grasslands, pastures, open habitats	Greater prairie chicken (*Tympanuchus cupido*)	Turkey vulture (*Cathartes aura*), northern harrier, killdeer (*Charadrius vociferus*), upland sandpiper (*Bartramia longicauda*), American kestrel (*Falco sparverius*), eastern kingbird (*Tyrannus tyrannus*), loggerhead shrike (*Lanius ludovicianus*), horned lark (*Eremophila alpestris*), bank swallow (*Riparia riparia*), barn swallow (*Hirundo rustica*), eastern bluebird (*Sialia sialis*), clay-colored sparrow (*Spizella pallida*), field sparrow (*Spizella pusilla*), grasshopper sparrow (*Ammodramus savannarum*), Henslow's sparrow (*Ammodramus henslowii*), Savannah sparrow (*Passerculus sandwichensis*), vesper sparrow (*Pooecetes gramineus*), bobolink (*Dolichonyx oryzivorus*), eastern meadowlark (*Sturnella magna*), western meadowlark (*Sturnella neglecta*), dickcissel (*Spiza americana*)
Agricultural areas, shelterbelts	Canada goose, mallard, gray partridge (*Perdix perdix*), ring-necked pheasant (*Phasianus colchicus*), wild turkey, sandhill crane, mourning dove (*Zenaida macroura*)	Turkey vulture, northern harrier, red-tailed hawk (*Buteo jamaicensis*), killdeer, rock pigeon (*Columba livia*), great horned owl, common nighthawk (*Chordeiles minor*), American kestrel, American crow (*Corvus brachyrhynchos*), black-billed magpie (*Pica hudsonia*), black-capped chickadee (*Poecile atricapillus*), gray catbird (*Dumetella carolinensis*), northern mockingbird (*Mimus polyglottos*), American robin (*Turdus migratorius*), eastern bluebird, song sparrow (*Melospiza melodia*), brown-headed cowbird (*Molothrus ater*), common grackle (*Quiscalus quiscula*), red-winged blackbird, American goldfinch (*Spinus tristis*), house finch (*Haemorhous mexicanus*), house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*)

Sources: Minnesota DNR 2016t, 2016u.

Ospreys were also affected by DDT and suffered population declines in the 1960 and 1970s. Their populations have since recovered and they occur throughout much of the upper Midwest. While ospreys used to rely entirely on dead trees for nests, they now also use man-made structures such as powerlines and communication towers. Raptor stick nest surveys were conducted within 0.5 mile along the Applicant's preferred route to locate and identify bald eagle and osprey nests between 2014 and 2016. Six active bald eagle nests and one osprey nest were observed during the most recent survey in 2016 (Table 5.2.4-5).

Table 5.2.4-5. Raptor Stick Nests within the Construction Work Area for the Applicant's Preferred Route in North Dakota and Minnesota (2014, 2015, and 2016)

County, State	Distance from Workspace (miles)	Nest Status			Common Name
		2014	2015	2016	
Pembina, North Dakota	0.2	No data	Active	Active	Bald eagle
Clearwater, Minnesota	0.1	Not present	Not present	Active	Bald eagle
Clearwater, Minnesota	1.0	Not present	Inactive	Active	Bald eagle
Hubbard, Minnesota	0.0	Inactive	Active	Active	Osprey[a]
Carlton, Minnesota	0.2	Inactive	Inactive	No data	Unknown
Cass, Minnesota	0.1	Not present	Not present	Active	Bald eagle
Cass, Minnesota	0.5	Not present	Inactive	Active	Bald eagle
Aitkin, Minnesota	0.4	Not present	Active	Active	Bald eagle

Sources: Merjent 2015a, 2015b.

Note:

[a] Considered a bald eagle nest in 2014, but an osprey was observed in 2015 and 2016.

Reptiles and Amphibians

Amphibians are four-legged, cold-blooded (meaning they get their warmth from the environment) and typically start out as larvae living in water. The young generally undergo metamorphosis from larva with gills to an adult air-breathing form with lungs. Amphibians use their skin as a secondary respiratory surface; some small terrestrial salamanders and frogs lack lungs and rely entirely on their skin for respiration. Reptiles are cold-blooded and can be four-legged, like turtles and lizards, or may have descended from four-legged ancestors, like snakes. Unlike amphibians, reptiles do not have an aquatic larval stage. Many amphibians and reptiles move between aquatic and terrestrial habitats and as such are major links in the flow of energy between these habitats.

Amphibians and reptiles commonly occurring in and around wetlands, lakes, ponds, and rivers include: turtles such as the snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys picta*), map turtles (*Graptemys* spp.), and spiny softshell turtle (*Apalone spinifer*a); frogs that are highly aquatic as adults such as green frog (*Lithobates clamitans*) and mink frog (*Lithobates septentrionalis*); some aquatic salamander species such as eastern newt (*Notophthalmus viridescens*) and common mudpuppy (*Necturus maculosus*); and snakes, including the brown snake (*Storeria dekayi*) and northern watersnake (*Nerodia sipedon*). Amphibians and reptiles that are more likely to be associated with grasslands, prairies, and agricultural areas include hognose snakes (*Heterodon* spp.), garter snakes (*Thamnophis* spp.), and the smooth green snake (*Opheodrys vernalis*), prairie skink (Plestiodon septentrionalis), and Great Plains toad (*Anaxyrus cognatus*). Amphibians and reptiles associated with forested habitats include treefrogs (*Hyla* spp.), spring peeper (*Pseudacris crucifer*), American toad (*Anaxyrus americanus*), and salamanders (*Ambystoma* spp.). Many of these common species of reptiles and amphibians occur within the vicinity of the Applicant's preferred route and the CN Alternatives.

Invertebrates

Invertebrates are an essential component of the food chain in many ecosystems. Many hundreds of species of invertebrates occur within the aquatic, wetland, and upland areas that would be crossed by

the Applicant's preferred route and the CN Alternatives. Notable groups of aquatic insects include mayflies (Ephemeroptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata), and midges and mosquitoes (Diptera). Other aquatic invertebrates include mollusks such as native mussels (Palaeoheterodonta), snails (Gastropoda), and crayfish (Astacidea). Commonly seen upland invertebrates include bees, ants, and wasps (Hymenoptera); ladybugs and other beetles (Coleoptera); butterflies and moths (Lepidoptera); grasshoppers, katydids, and crickets (Orthoptera); cicadas, leafhoppers and other true bugs (Hemiptera); and ticks, spiders, and mites (Arachnida).

5.2.4.2.2 Continued Use of Existing Line 3 Pipeline

The existing Line 3 pipeline is co-located with existing pipelines, transmission lines, and roads along all of its length. The route, which extends through predominately forested and wetland areas, crosses 81 waterbodies, 6 trout streams, and 2 AMAs (Clearwater and Little Otter Creek), and is within 0.5 mile of 6 other AMAs. The route also crosses two Minnesota Lakes of Biological Significance with a rating of outstanding as well as passing within 0.5 mile of four lakes managed for muskellunge.

The route of the existing Line 3 pipeline crosses several wildlife conservation areas, including one wildlife refuge and three state forests; it also crosses the Chippewa Plains IBA.

The general types of aquatic resources, wildlife habitat, and species described for the Applicant's preferred route (see Section 5.2.4.2.1) also occur along the existing Line 3 pipeline right-of-way. The fish and wildlife species described above for the Applicant's preferred route are common to northern Minnesota and could be present in the areas crossed by existing Line 3.

5.2.4.2.3 System Alternative SA-04

Fisheries and Aquatic Habitat

System alternative SA-04 would cross over 600 waterbodies, including large rivers, perennial streams, intermittent streams, ephemeral streams, large lakes, shallow lakes, and wetlands. Water crossings are discussed in Section 5.2.1.2. Two trout streams occur within 0.5 mile of SA-04, although neither would be crossed.

SA-04 would pass through the Mayhew Creek Fisheries Management Area (FMA), as shown in Figure 5.2.4-1. North Dakota, Iowa, and Illinois do not specifically designate AMAs but manage more general wildlife areas for hunting, fishing, trapping, and other recreational activities.

No lakes rated for Fish IBI occur within 0.5 mile of SA-04 (Minnesota DNR 2014a), no Lakes of Biological Significance would be crossed by SA-04 (Minnesota DNR 2015b), and no Sentinel Lakes would be crossed by SA-04 (Minnesota DNR 2016b). The Minnesota River crossing for SA-04 contains a freshwater mussel site (Minnesota DNR 2016e).

SA-04 would cross infested waters in North Dakota, Minnesota, Iowa, Illinois, and Wisconsin. Invasive species established in these waters include common carp, zebra mussel, rusty crayfish, Eurasian milfoil, bighead carp, and silver carp.

All three types of fisheries (coldwater, coolwater, warmwater) are present in the regions crossed by SA-04. Protected and rare species are discussed in Section 5.2.5, including species listed by state or federal threatened and endangered species regulations.

Wildlife and Wildlife Habitat

The SA-04 would cross many different dominant vegetation classes, including evergreen forest, deciduous forest, mixed forest, shrub/scrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (see Section 5.2.3 for a general discussion of vegetation along SA-04). Broadly, SA-04 occurs within ecoregions that are dominated by agricultural activities but also include areas of prairie/grasslands and non-forested wetlands.

Each of the states crossed by SA-04 maintain designated WMAs. The SA-04 route would pass near 10 WMAs (1 in North Dakota, 8 in Minnesota, and 1 in Iowa). Figure 5.2.4-3 provides an overview of WMAs, wildlife refuges, and other conservation lands near SA-04. The lands shown in Figure 5.2.4-3 include those assigned GAP Status Codes 1, 2, and 3, which indicate the level of protection and management objectives as discussed previously.

Audubon IBAs are a conservation tool to identify priority habitats that birds depend on. IBAs in the vicinity of SA-04 include the following (Figure 5.2.4-4):

- Swan Lake IBA – This state priority IBA is a year-round birding spot. In summer, there is a large breeding colony of red-necked grebes, eared grebe (*Podiceps nigricollis*), and western grebes (*Aechmophorus occidentalis*). The lake also supports a large black-crowned night heron (*Nycticorax nycticorax*) rookery, a breeding population of least bitterns, Forster's terns (*Sterna forsteri*), and black terns (*Chlidonias niger*). Swamp sparrows (*Melospiza georgiana)* and marsh wrens (*Cistothorus palustris*) are common. In spring, nearly all the waterfowl usually present in southwestern Minnesota occur within this IBA.
- Upper Minnesota River Valley IBA – This global priority IBA contains significant bird habitat in an agricultural area. Well over 200 bird species occur during spring, summer, and fall throughout the valley. Surrounded by intensely farmed areas, the river valley corridor provides the prime bird habitat and is a natural migration corridor for waterfowl, shorebirds, raptors, warblers, vireos, thrushes, flycatchers, and sparrows.
- Upper Mississippi National Wildlife Refuge (NWR) IBA – This state priority IBA is an important site for migrating waterfowl, particularly canvasbacks and tundra swans, as well as nesting waterbirds and breeding and wintering bald eagles. The Mississippi River is a significant bird migration route, especially for seasonal flights of waterfowl. An estimated 40 percent of the nation's waterfowl and shorebirds use the Mississippi River valley during spring and fall migration.
- Upper Mississippi/Trempealeau National Forest and Wildlife Refuges IBA – This area encompasses the Trempealeau Refuge and the Upper Mississippi Refuge from the confluence of the Mississippi and Chippewa rivers south through eight counties in southwest Wisconsin. Habitats include large tracts of floodplain forest, forested wetlands, bluffs, braided river channels, open water, forested islands, riverine wetlands, and prairie. Hundreds of thousands of waterfowl and landbirds use this IBA as migratory corridors and stopover sites, including over half the eastern population of canvasbacks (*Aythya valisineria*) and 20 percent of tundra swans (*Cygnus columbianus*). The forests and wetlands also support significant breeding bird populations, including great blue heron, bald eagle, red-shouldered hawk (*Buteo lineatus*), yellow-billed cuckoo (*Coccyzus americanus*), cerulean warbler (*Setophaga cerulea*), and prothonotary warbler (*Protonotaria citrea*).

- Midewin National Tallgrass Prairie IBA – This global priority IBA is a 19,000-acre complex of 21 natural biological communities that provide habitat for 348 species of native plants, approximately 230 vertebrate species of animals, and numerous invertebrate species, including mussels. This IBA provide critical fall and spring migration habitat as well as breeding habitat for a large number of grassland birds, many of which are becoming rare (Audubon 2016).

The ROI for SA-04 supports a diversity of wildlife, mammals, birds, amphibians, reptiles, and invertebrates. Existing wildlife species in the vicinity of SA-04 are similar to those described above for the Applicant's preferred route; however, a few species, including elk, moose, and black bear are not found along this route.

5.2.4.2.4 Transportation by Rail

The rail alternative would require an area of between 100 and 200 acres for construction and operation of a rail loading facility and an additional 84 acres to construct and operate a new rail line connection near Gretna, Canada. These facilities would be located in Canada and as such are not addressed as part of this environmental review.

In the United States, the rail offloading facility would require between 100 and 200 acres of land that is identified as agricultural lands and wetlands near Clearbrook, Minnesota, along with reestablishment of 10 miles of existing track in Clearbrook.

The rail offloading facility near Superior, Wisconsin, would require approximately 100 acres adjacent to the existing Enbridge terminal and construction of a less than 1-mile interconnection between existing rail lines in Superior.

Fisheries and Aquatic Habitat

Small drainages occur in the area near Clearbrook, Minnesota. Several intermittent streams originate within the immediate area of the potential location for a new facility. No conservation lands or AMAs occur in the vicinity. Reestablishing rail line access would require several stream crossings.

The potential location for a new facility near the Superior terminal is entirely wetlands, primarily forested and scrub/shrub wetlands.

Wildlife and Wildlife Habitat

Along the rail route from northwest Minnesota to Clearbrook, the land cover is mostly cultivated farmland with remnant prairie patches. Reestablishing rail line access between Gully and Clearbrook would require passing through forested areas, including a patch of northwest dry-mesic oak woodland and northern dry prairie. A site of moderate biodiversity occurs near Gully, north of the rail line. The land cover around Clearbrook, Minnesota, includes deciduous and evergreen forests, woody and emergent wetlands, and hay/pasture and cultivated croplands, which provide habitat for white-tailed deer, small mammals, and birds. The rail line is surrounded by hay/pasture, cultivated croplands, and scattered forest and wetlands. The rail line east of Gully is bordered by dry sand-gravel prairie (northern) and northwestern dry-mesic oak woodland (Minnesota DNR 2016v).

From Clearbrook to Superior, land cover is dominated by woody and emergent wetlands along with some hay and cultivated croplands. The vegetation near Superior, Wisconsin, is deciduous forest with patches of woody wetlands and scrub/shrub wetlands that provide habitat and food for many breeding

birds as well as hunting areas for birds of prey, such as barn owls (*Tyto alba*) and kestrel (*Falco sparverius*). No conservation lands or wildlife refuges occur in the vicinity of the Superior terminal.

The rail route crosses several wildlife areas, with Chippewa National Forest being the largest, and also crosses several IBAs.

- Kittson-Roseau Aspen Parkland IBA – This IBA consists of almost 400,000 acres area of aspen parkland landscape in extreme northwestern Minnesota. This IBA lies within the Aspen Parkland Physiographic Area, which harbors the highest number of breeding birds of any physiographic area on the continent. Eleven sandhill crane roost sites with 12,000 birds and 262 species including significant numbers of horned grebes, Wilson's phalaropes, yellow rails, marbled godwits, short-eared owls, American bitterns, upland sandpipers, and Nelson's sharp-tailed sparrows are found here.
- Glacial Ridge IBA – This IBA includes a large complex of prairie grasslands and wetlands at the southern extent of Minnesota's Aspen Parkland region which is characterized by a mosaic of prairie, sedge wetlands, and aspen groves. Glacial Ridge is one of the top sites in Minnesota for prairie birds, particularly species dependent on wet prairie and sedge wetlands. Of the 164 species recorded here, 16 are state listed species including burrowing owls, greater prairie chickens, marbled godwits and yellow rails. A total of 43 Species of Greatest Conservation Need are found in the IBA with relatively high numbers of American bittern, upland sandpiper, Le Conte's sparrow, and bobolink. This area also has fall migratory sandhill crane roosts with 2,000 to 6,000 birds documented and is within the important northwest Minnesota sandhill crane breeding range.
- Camp Ripley-Pillsbury-Lake Alexander IBA – This IBA supports the greatest known concentration of nesting red-shouldered hawks (*Buteo lineatus*, a state listed Special Concern Species) in the state. Habitat consists of relatively large blocks of upland deciduous and riparian forests. In addition, 228 species of birds have been documented here since monitoring started in 1991, including 28 species of warblers (and one of the most northerly reports of the hooded warbler [*Setophaga citrina*]). Other listed species that occur in this IBA include bald eagle, trumpeter swan, yellow rail, and Louisiana waterthrush (*Parkesia motacilla*). Other important features within this IBA are the 21 miles of the Mississippi River and 27 miles of major tributaries (Crow Wing and Gull rivers), that provide important riparian corridors and migration pathways.
- Chippewa Plains IBA – This IBA is a vast area of large lakes (Winnibigoshish, Leech, Cass, and Pokegama), rivers, and streams, as well as large tracts of upland and lowland forests. The Mississippi River, which flows through the IBA, provides a large river ecosystem complemented by smaller river systems throughout the IBA. Chippewa Plains is important for migrating waterfowl, with 160,000 ring-necked ducks and 30,000 lesser scaup (*Aythya affinis*) recorded in 2011. Nesting waterbirds include ring-billed (*Larus delawarensis*) and herring gulls (*Larus argentatus*), American white pelicans (*Pelecanus erythrorhynchos*), common terns (*Sterna hirundo*), and Minnesota's only site for Caspian terns (*Hydroprogne caspia*).
- McGregor IBA – This state priority IBA has important habitat for many birds that includes wetlands, lowland forests, upland deciduous forests, open brushlands, and open grasslands. McGregor IBA is probably best known for the fall ring-necked duck migration but also has a variety of nesting birds such as American bittern, yellow rail, sora, black tern, sandhill crane;

12 species of nesting warblers; trumpeter swan; bald eagle; American woodcock; wood thrush; black-billed cuckoo; LeConte's sparrow; and bobolink.

- St Louis River Estuary IBA - This IBA contains an extensive riverine system with numerous bays, wetlands, and forested areas along its adjacent shoreline. The St. Louis River Estuary is a freshwater ecosystem that is one of the largest tributaries draining into the largest, by surface area, lake in the world. This IBA is an important migratory stopover for 31 species of waterfowl and 27 species of shorebirds along with large numbers of waterbirds, raptors, and songbirds that move along the western shore of Lake Superior.

5.2.4.2.5 Transportation by Truck

The truck alternative would require an area of approximately 50 acres for construction and operation of a truck loading facility, and upgrades to existing access roads near Gretna. These facilities would be located in Canada and as such are not addressed as part of this environmental review.

In the United States, truck facilities near Clearbrook would require approximately 50 acres to construct and operate offloading facilities, and approximately 5 acres for road access. Truck facilities near the terminal in Superior would require approximately 50 acres to construct and operate a truck offloading facility, and 34 acres of semi-disturbed land at the Superior terminal.

Fisheries and Aquatic Habitat

Small drainages occur in the area near Clearbrook, Minnesota. Several intermittent streams originate within the potential location for a new facility. No conservation lands or AMAs occur in the vicinity.

The potential location for a new facility near the Superior terminal is entirely wetlands, primarily forested and scrub/shrub wetlands.

Wildlife and Wildlife Habitat

The land cover around Clearbrook, Minnesota, includes deciduous and evergreen forests, woody and emergent wetlands, and hay/pasture and cultivated croplands, which provide habitat for white-tailed deer, small mammals, and birds.

The vegetation near Superior, Wisconsin is deciduous forest with patches of woody wetlands and scrub/shrub wetlands that provide habitat and food for many breeding birds as well as hunting areas for birds of prey, such as barn owls and kestrel. No conservation lands or wildlife refuges occur in the vicinity of the Superior terminal.

Along the truck route from northwest Minnesota to Clearbrook, the land cover is mostly cultivated farmland with remnant prairie patches. From Clearbrook to Superior, land cover is dominated by woody and emergent wetlands along with some hay and cultivated croplands.

The truck route crosses through several wildlife areas, with Chippewa National Forest being the largest, and also crosses several IBAs.

- Glacial Ridge IBA – This IBA includes a large complex of prairie grasslands and wetlands at the southern extent of Minnesota's Aspen Parkland region which is characterized by a mosaic of prairie, sedge wetlands, and aspen groves. Glacial Ridge is one of the top sites in Minnesota

for prairie birds, particularly species dependent on wet prairie and sedge wetlands. Of the 164 species recorded here, 16 are state listed species including burrowing owls, greater prairie chickens, marbled godwits and yellow rails. A total of 43 Species of Greatest Conservation Need are found in the IBA with relatively high numbers of American bittern, upland sandpiper, Le Conte's sparrow, and bobolink. This area also has fall migratory sandhill crane roosts with 2,000 to 6,000 birds documented and is within the important northwest Minnesota sandhill crane breeding range.

- Chippewa Plains IBA – This IBA is a vast area of large lakes (Winnibigoshish, Leech, Cass, and Pokegama), rivers, and streams, as well as large tracts of upland and lowland forests. The Mississippi River, which flows through the IBA, provides a large river ecosystem complemented by smaller river systems throughout the IBA. Chippewa Plains is important for migrating waterfowl, with 160,000 ring-necked ducks and 30,000 lesser scaup (*Aythya affinis*) recorded in 2011. Nesting waterbirds include ring-billed (*Larus delawarensis*) and herring gulls (*Larus argentatus*), American white pelicans (*Pelecanus erythrorhynchos*), common terns (*Sterna hirundo*), and Minnesota's only site for Caspian terns (*Hydroprogne caspia*).
- St Louis River Estuary IBA - This IBA contains an extensive riverine system with numerous bays, wetlands, and forested areas along its adjacent shoreline. The St. Louis River Estuary is a freshwater ecosystem that is one of the largest tributaries draining into the largest, by surface area, lake in the world. This IBA is an important migratory stopover for 31 species of waterfowl and 27 species of shorebirds along with large numbers of waterbirds, raptors, and songbirds that move along the western shore of Lake Superior.

5.2.4.2.6 Existing Line 3 Supplemented by Rail

The existing conditions for continued use of existing Line 3 supplemented by rail transport are similar to those described above for continued use of the existing Line 3 pipeline and the rail alternative.

5.2.4.2.7 Existing Line 3 Supplemented by Truck

The existing conditions for continued use of existing Line 3 supplemented by truck transport are similar to those described above for continued use of the existing Line 3 pipeline and the truck alternative.

5.2.4.3 Impact Assessment

5.2.4.3.1 Applicant's Preferred Route (from Neche to Superior)

The potential impacts of construction and operation of the Applicant's preferred route are described below.

Construction Impacts

Clearing and grading would be required for construction of the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including six pipe yards in Minnesota. Construction activities that may affect fish, wildlife, and their habitats could include clearing, grading, dewatering, trenching, blasting, access road construction, waterbody crossings, surface water withdrawals and discharges (e.g., for hydrostatic testing), fueling and use of hazardous materials, facilities construction, and restoration or reclamation of construction areas.

Fisheries and Aquatic Habitat

Construction of the Applicant's preferred route would require 192 stream crossings in Minnesota, 25 in North Dakota, and 10 in Wisconsin. The surface waters crossed support warmwater, coolwater, and coldwater trout fisheries.

Surface Water Crossing Methods and Measures Proposed as Part of the Project

Surface water crossings would be designed as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow to create the shortest possible crossing length. The Applicant would determine and obtain approval for specific crossing methods based on factors such as waterbody size, sensitivity, water levels, soil/sediment stability installation, and anticipated season of installation (Appendix G). The Applicant would cross waterbodies using the most environmentally appropriate and feasible method based on consultation among the Applicant, appropriate regulatory agencies, and engineering personnel. Methods that may be used include the wet open-cut method, dry open-cut methods (dam-and-pump and flume), the guided bore method, or the HDD method. These methods are summarized below:

- The wet open-cut method involves trenching through the waterbody while the water continues to flow through the construction work area. The wet trench method has the greatest potential for impacts on fisheries and aquatic habitat.
- The dam-and-pump method is used to cross sensitive waterbodies with low gradients and low-flow or meandering channels. It involves installing temporary dams across the waterbody both upstream and downstream of the crossing location, with pumps and piping used to carry streamflow around the construction area. The construction area located between the two dams is then dewatered utilizing pumps. This method results in less sedimentation and turbidity than the wet open-cut method.
- The flume method can be used on relatively shallow and narrow waterbodies that do not have large rocks or bedrock at the trench line and have a relatively straight channel. Similar to the dam-and-pump method, two dams and pumps are used to dewater the work area. One or more pipes (flumes) extend the course of the waterbody through both dams, carrying streamflow through the construction area. This method results in less sedimentation and turbidity than the wet open-cut method.

- A guided bore could be used to cross ditches adjacent to roads or railroads. The guided bore method involves digging a pit on each side of the waterbody, boring a tunnel from one pit to the other, and installing the pipe in the tunnel. Dewatering and sheet-piling are needed to maintain the integrity of the excavated pits. This method typically results in no sediment release to surface water.
- HDD involves drilling under the surface water and installing the pipeline without physical disturbance of the surface water. HDD crossings are advantageous because they do not disturb streambeds or streambanks and they maintain stream flow and fish passage. However, they require ATWS on both sides of the crossing, which involves vegetative clearing, soil disturbance, and subsequent restoration activities. This method would be used to cross the most environmentally sensitive areas such as sensitive fishery resources and impaired waters. Unless there is a streambed collapse above the boring hole or a release of drilling fluid occurs (see Section 5.2.1.2), use of this crossing method would not alter or remove aquatic habitat and would not affect fisheries.

The currently planned crossing methods for the Applicant's preferred route are listed in Appendix G. Crossing method has not been identified for crossings in North Dakota or Wisconsin. AMAs crossed by or within 0.5 mile of the Applicant's preferred route are listed in Table 5.2.4-6.

Table 5.2.4-6. Aquatic Management Areas Crossed by the Applicant's Preferred Route in Minnesota (acres)

Aquatic Management Area	Construction Work Area[a]	Permanent Right-of-Way[b]	Within 0.5 Mile of Centerline[c]
Blackhoof River AMA	<0.1	<0.1	44.4
La Salle Creek AMA	0.4	0.2	27.4
Spire Valley AMA	<0.1	<0.1	56.2
Straight River AMA	<0.1	<0.1	16.6
TOTAL	**0.4**	**0.2**	**144.6**

Source: Minnesota DNR 2016h.

[a] Enbridge-provided footprint for construction work area, including additional temporary workspaces and access roads

[b] Enbridge-provided footprint for permanent right-of-way, including primary access roads, pump stations, and mainline valves

[c] Acres of Aquatic Management Area (AMA) within 0.5 mile of the centerline of the Applicant's preferred route

To avoid or reduce impacts on fisheries and aquatic habitat during construction, the Applicant would implement the measures described in its Environmental Protection Plan (Appendix E), including the following:

- Prepare a list of waterbodies to be crossed and the type of crossing method to be used for each crossing, as a part of obtaining Section 401/404 permits from USACE for all surface water crossings.
- Comply with the seasonal restrictions and other requirements in the Section 401/404 permits to limit impacts on aquatic resources.

- Complete the crossings as quickly as possible to allow suspended sediment levels to return to pre-construction levels after in-stream work is completed.
- Cross waterbodies using the most environmentally appropriate and feasible method based on consultation among the Applicant, appropriate regulatory agencies, and engineering personnel. Methods that may be used include the wet open-cut method, dry open-cut methods (dam-and-pump and flume), the guided bore method, or the HDD method.
- Develop and implement BMPs in collaboration with state and federal agencies to avoid and minimize potential impacts associated with water crossing methods (e.g., use of silt or straw as sediment runoff barriers and use of construction mats to minimize ground pressure and soil compaction).
- Implement erosion and sediment control measures and limit the duration of construction in waterbodies, including the measures listed in Section 1.9 of the Applicant's Environmental Protection Plan (Appendix E) (e.g., temporary stabilization, erosion control blankets, mulch, cat tracking, and temporary slope breakers).
- Comply with Minnesota DNR guidance on water crossing by avoiding in-water work during the exclusion periods: from September 1 through April 15 or September 15 through April 30 for coldwater fisheries (trout) stream crossings, and from March 15 to June 15 or April 1 to June 30 for coolwater and warmwater fisheries stream crossings, depending on the Minnesota DNR region in which the work occurs.
- Suspend temporary water intake hoses or structures above the stream or lake bottom and equip the intakes with screens or equivalent devices to prevent fish uptake.
- Install trench breakers at all waterbody crossings, as appropriate, to prevent diversion of water into upland portions of the pipeline trench and to keep accumulated trench water out of the waterbody.
- Wash and dry equipment designated for use within waterbodies prior to use; purge and clean all pumps before proceeding from one crossing location to the next if designated noxious weeds or invasive aquatic species (e.g., zebra mussels and Eurasian milfoil) are known to be present in the area. Follow all permit requirements to prevent the spread of invasive species.
- Maintain a 20-foot-wide buffer of undisturbed herbaceous vegetation at all streambanks during the initial clearing and complete any in-stream trenching within 24 hours of initiation at minor waterbodies and within 48 hours at intermediate or major waterbodies (not including HDD crossings).
- Comply with the measures in the Environmental Protection Plan (Appendix E) to avoid or minimize impacts due to the unanticipated release of drilling fluids used in HDD crossings. These measures include (1) planned response actions if releases of drilling mud were to occur in waterbodies or upland areas; (2) containment, clean-up, and notification procedures; and (3) steps to be taken to restore affected areas.
- Discharge hydrostatic waters in a manner that avoids discharge into surface waters with commercially or recreationally important species, and in compliance with the stipulations of permits required for both intake and discharge. This would include seasonal restrictions and limitations associated with infested waters.

General Potential Impacts on Fisheries and Aquatic Habitat from Surface Water Crossings

Streambank alteration. Construction of the Applicant's preferred route would require clearing of vegetation from the construction work area. Removal of large trees and other woody vegetation near waterbodies would result in loss of shading, nutrients, and habitat features for fish at waterbody crossings. In addition, this change in streambank features would alter aquatic habitats used by fish for cover, spawning, and foraging. Loss of riparian cover can result in increased water temperatures, which can be detrimental to coldwater species such as trout or salmon.

The amount of vegetation that would be permanently removed adjacent to surface waters would be restricted to the permanent right-of-way at waterbody crossings, and streambanks would be restored with appropriate vegetation. Revegetation would take longer for forested areas in the construction work areas adjacent to the permanent right-of-way as compared to prairie or agricultural areas. Therefore, vegetation clearing for construction of the Applicant's preferred route in grassy or agricultural streambank areas would result in indirect, short-term, and negligible to minor impacts on fisheries and aquatic habitats; for forested or other woody streambank areas would be long-term and minor to major, depending on existing surface water conditions. Removal of vegetation along waterbodies also can create conditions for bank destabilization and further erosion, which would result in direct temporary to short-term minor impacts on species residing in the immediate vicinity while the Applicant undertakes measures to stabilize the banks. For example, erosion can suffocate eggs and other aquatic species.

As a part of the crossing construction process, riverbeds and streambeds would be restored to pre-construction condition, with no impediments to water flow anticipated, and streambanks would be restored to pre-construction grades when practicable. If the slope of the bank is determined to be unstable, it would be reshaped to prevent slumping. The use of open-cut crossings during pipeline construction would result in short- to long-term minor impacts on channel morphology and stability, which in turn would result in short-to long-term minor impacts on fisheries and aquatic habitats.

The wet open-cut crossing method would result in greater amounts of sedimentation than the other methods. As currently planned, only 16 of the surface water crossings would be accomplished using the wet open-cut method. Crossings using the dam-and-pump and flume methods would increase sedimentation, but less than the wet open-cut method. The guided bore and HDD methods would not result in increased sedimentation if conducted successfully. However, if a frac-out were to occur, the consequences can be major because of the release of materials into already sensitive or impaired waters (more information about frac-outs below).

Increased sedimentation and turbidity can degrade aquatic habitat by filling in inter-gravel spaces and pool habitats, which reduces spawning habitat, rearing habitat, and benthic invertebrate production. Reduced productivity of aquatic invertebrates can result in reduced food available for insectivorous fish. Mussels are particularly vulnerable to suffocation from in-stream construction activities. Fine sediments introduced by these processes can suffocate fish eggs and newly hatched larvae living in gravel, resulting in reduced survival. In addition, sediments can abrade the sensitive gill membranes of young and adult fish, resulting in injury or death; and can reduce ability of fish to locate prey or escape predation, leading to increased energy expenditure for foraging and increased mortality. Large concentrated sediment plumes can cause sediment accumulation within the gills of young and adult fish, which can lead to suffocation and increased mortality of fish that are not able to move away from sediment plumes fast enough to find refuge.

Disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation. The increase in sedimentation is not expected to be substantial, and the impact on fisheries and aquatic habitat from increases in sedimentation associated with surface water crossings would be temporary to short term and minor. With successful use of the guided bore or HDD crossing methods, sedimentation would not increase and fisheries and aquatic habitats would not be affected. If a frac-out were to occur, the impacts would be short to long-term and major.

Removal of Large In-stream Structures. At some surface water crossings, large in-water structures (e.g., large woody debris and boulders) may have to be removed during construction of the crossing. These structures would be replaced after completion of the crossing, and stream hydrodynamics would transport sediments from upstream to the disturbed area until equilibrium is reestablished. This construction activity would result in a temporary to short-term, negligible to minor impact on aquatic habitat.

Direct Impacts on Fisheries. Trenching and backfilling, damming, and other in-stream construction activities could result in direct or indirect injury or mortality of fish. Mussels are particularly vulnerable to crushing from in-stream construction activities. However, fish would likely respond to the increased in-stream activities by leaving the construction area and avoiding direct impacts. Small fish species and juvenile individuals of larger fish species may be injured or killed by entrainment, which results when a fish gets trapped within hoses or pipes being used to dewater construction areas or divert surface waters around construction areas. Fish entrainment can be reduced by screening the ends of pipes and pump hoses, smaller fish may still be injured or killed by being impinged, trapped against, the screening due to suction and water pressure. The potential direct impacts of in-stream construction on aquatic species would be temporary and minor.

Leaks or Small Spills. Spills and leaks of fuel or other hazardous liquids could occur during vehicle and equipment operation, during refueling and lubricating of construction equipment, and from leaks from storage containers or equipment working in or near streams. To protect surface water resources, NPDES permits would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles. The Applicant would store petroleum products, hazardous chemicals, and lubricating oils; conduct refueling, maintenance, and lubricating operations; and perform concrete coating activities in upland areas more than 100 feet from surface waters (Appendix E). Although these and other similar measures would be implemented, small leaks or spills could reach surface waters and would alter water quality in the area of the release and for short distances downstream. Because such releases would likely be small and rapidly dispersed, the impacts on fisheries and aquatic habitats are expected to be temporary to short term and minor.

Potential impacts on fisheries and aquatic habitats from an unanticipated release of crude oil are discussed in Chapter 10.

Unanticipated Release of Drilling Fluids. For HDD crossings, there is a risk of escape of drilling fluids (frac-out) into rivers at crossings. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or “frac-out” of this drilling fluid to occur when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Although bentonite clay is non-toxic, drilling mud can smother aquatic wildlife and increase turbidity in affected surface waters. The consequences of a frac-out are amplified in waters where this technique is used, because these waters are

already identified as sensitive or impaired. Additives may be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only non-hazardous additives approved by Minnesota PCA under permit conditions would be used, and a Material Safety Data Sheet for the drilling fluid would be maintained onsite. If a frac-out occurred near the streambank, bank stability may be compromised. Construction personnel would monitor the crossing to detect releases of drilling mud.

The HDD operator would constantly monitor drilling fluid pressures during pilot hole operations and, if a loss in fluid pressure or circulation were identified, the operator would notify onsite construction observers who would visually monitor the portion of the drill path where the drill tool is located to determine whether a drilling mud release occurred. If a release occurred, the Applicant would implement containment, response, and clean-up procedures as outlined in the Environmental Protection Plan (Appendix E) to limit the potential for drilling mud to reach surface water. These procedures include containment using straw bales, sandbags, pumps and hoses, vacuum trucks; response activities, including adjusting drill rates and pump volumes or stopping drilling, removal of mud with pumps and appropriate storage away from the waterbody prior to disposal; and coordination with appropriate agencies to discuss additional containment or clean-up requirements. If a frac-out occurred and went undetected or was not quickly contained, impacts on surface water quality as well as on fisheries and aquatic habitat could be long-term and major. However, with implementation of the Applicant-proposed measures to respond to a drilling mud release during HDD construction, the impact of a release could be short term to long-term and major, depending on the nature of the release and resources near the location of the crossing.

Hydrostatic Test Water Withdrawal and Discharge. The Applicant would withdraw water for hydrostatic testing, dust control, trench dewatering, and HDD installation. Hydrostatic testing would require approximately 11 to 17 million gallons of water for each construction spread that would be obtained from lakes, streams, or groundwater wells. The Applicant is currently evaluating transferring water from one test section to another in order to minimize the total quantity of water needed to complete the hydrostatic test. The volume of water appropriation needed for dust control, trench dewatering, and HDD installation has not been determined. Prior to construction, the Applicant would obtain a water appropriation permit from Minnesota DNR.

Withdrawals from surface waters for construction could result in entrainment of small fish, eggs, and macroinvertebrates during extraction; however, intakes would be equipped with a screen or equivalent device to prevent uptake of aquatic species. Smaller fish and invertebrates may still be injured or killed by being impinged, trapped against, the screening due to suction and water pressure. Spawning fish could be displaced through decreased water levels, fish eggs could desiccate if water levels drop too low, or eggs may experience delayed development due to impaired water quality. Larval and juvenile fish could be affected through entrainment during water withdrawal, decreased survival under conditions of poor water quality, and reduced prey availability.

As stipulated in permit requirements, the Applicant would select appropriation sites that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely affect trout streams, calcareous fens, or other significant environmental resources. If water is withdrawn from surface water, hose intakes would be equipped with screens to prevent entrainment of aquatic species, and adequate waterbody flow rates and volumes would be maintained to protect aquatic life and allow for downstream uses as required by the water use permit (Appendix E).

Hydrostatic test water would be discharged from a test section in one of two ways: (1) into well-vegetated upland areas using controlled-flow velocity with a dewatering structure such as a silt fence and straw bales or into geotextile filter bags that are used to avoid soil erosion, sediment transport, and bottom scouring; or (2) into the waterbody from which it was withdrawn to prevent the spread of invasive species or degradation in water quality; the discharge rate would not exceed the permitted applicable discharge rate (Appendix E). Water would be treated as specified in the NPDES permit prior to discharge; and the Applicant would monitor pH, dissolved oxygen levels, and any other parameters required by the permit, as described in Appendix D of the Environmental Protection Plan (Appendix E). Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. If inter-basin transfers of water occur, there is also the potential to introduce and spread aquatic nuisance species; however, hydrostatic waters would be discharged through a filtering device to the source waterbody and following all requirements of acquired permits.

With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures described above, impacts on fisheries and aquatic habitats from water appropriation and discharge during construction would be temporary and minor

Impacts on Management Units and Managed Species

Aquatic Management Areas. LaSalle Creek would be crossed using the HDD method; this would affect 0.4 acre of the La Salle Creek AMA. The LaSalle Creek AMA is 28 acres and provides angling opportunities (as described below, LaSalle Creek is also a designated trout stream). This would be the second pipeline to cross this AMA; an existing pipeline crossing is at the southern extent of this AMA. Woody vegetation would be removed from the construction work area during construction and, depending on the crossing method used, the habitat quality of LaSalle Creek adjacent to the crossing location may be reduced. The crossing of La Salle Creek has the potential to introduce invasive species and result in the loss of habitat and reduction of habitat quality. However, these impacts are expected to be short term, and negligible to minor as little habitat would be lost in the construction work area and BMPs would be in place to prevent the spread of invasive species.

The Applicant's preferred route would come within 0.5 mile of three other AMAs but would not directly disturb these areas. AMAs represent good-quality aquatic habitats with functional adjacent uplands.

Other Management Units. Thirty-nine sensitive aquatic resources are present within 0.5 mile of the Applicant's preferred route, including five lakes rated for Fish IBI, 10 Lakes of Biological Significance, one Sentinel Lake, 21 trout streams, one trout lake, and one lake managed for muskellunge.

The Applicant's preferred route would not cross any of the five lakes rated for Fish IBI that occur within 0.5 mile; therefore, no impacts are anticipated. One of the lakes, Portage Lake, is also a designated Sentinel Lake; the construction work area of the Applicant's preferred route would be directly adjacent to Portage Lake. BMPs would be in place to prevent erosion or other impacts on this lake during construction. The disturbance area would be restored to pre-construction conditions once the construction is complete. Little habitat would be lost due to construction, and BMPs would be in place to reduce impacts on aquatic habitats as described above, so the resultant impact is expected to be short term and negligible to minor.

Of the 10 LBS within 0.5 mile of the Applicant's preferred route (Appendix L Fish and Wildlife Table L-2), one unnamed, moderate-ranked wetland would be within the construction work area. None of these LBS would be crossed by the route centerline. This could result in the introduction of invasive species, loss of habitat, and reduction of habitat quality. However, the impacts would be direct, short-term and negligible to minor, as little habitat would be removed and BMPs would be in place to prevent spread of invasive species.

No hatcheries are within 0.5 mile of the Applicant's preferred route, and none are immediately downstream of a water crossing along the Applicant's preferred route. The nearest hatchery is the Spire Valley trout hatchery, which is located about 0.65 mile upstream of a crossing; the hatchery's water supply is dependent on artesian groundwater quantity and quality. As a result, construction of the Applicant's preferred route would not affect the hatchery.

Twenty-one trout streams are within 0.5 mile of the Applicant's preferred route; the Applicant's preferred route crosses 6 of those trout streams (Table 5.2.4-7). One trout lake (Marion Lake in Cass County) is within 0.5 mile of the Applicant's preferred route but is not within the construction work area.

Trout streams are sensitive to erosion, sedimentation, and changes to riparian vegetation in areas adjacent to the streams because those habitats provide shade and cooling. Pipeline construction could alter groundwater connectivity or flow resulting in warming of the stream and reduced habitat suitability for trout and their invertebrate prey. Trout streams may have groundwater discharge zones or wetland seepage areas on hillsides or slopes with deep organic soils that could be disrupted during construction. Destabilization of these soils could result in long-term increases to nutrients and sediments in the streams. Removal of vegetation along small trout streams could result in less large woody vegetation in the stream. However, riparian vegetation would be removed only from the construction work area adjacent to the trout stream and only if either wet or dry open-cut crossing methods are used. If HDD methods are used for crossing clearing of vegetation could be limited to the 50-foot permanent right-of-way. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way, which could lead to permanent major thermal effects on trout streams. If tributaries to trout streams are crossed, some downstream impacts from sedimentation could occur, depending on the distance to the trout stream. The Applicant's preferred route would cross the Moose Horn River downstream of a protected trout stream and upstream of a tributary (King Creek) to a protected trout stream. As noted in Section 5.2.1.1, the impacts of sedimentation on surface water crossings and the impact of pipeline crossings for the Applicant's preferred route on water quality would be temporary to short term and minor. As a result of these considerations, and with selection of the most appropriate crossing method and application of appropriate BMPs, the resultant impacts on trout streams from construction of the Applicant's preferred route would be permanent to short-term and minor to major, depending on the crossing.

Table 5.2.4-7. Number of Trout Streams Crossed by the Applicant's Preferred Route in Minnesota and Wisconsin

Trout Streams – (Kittle Number or WBIC)[a]	Approximate Milepost	Con[b]	Op[c]	ATWS[d]	Access Roads
Blackhoof River (S-001-003)	MN 408.1	1	1	--	--
King Creek (M-050-046-029-023)	MN 344.2	1	1	--	--
LaSalle Creek (M-163)	MN 171.4	--	--	--	--
LaSalle Creek (M-163)	MN 171.7	1	1	--	--
Pine River, South Fork (M-106-013)	MN 232.7	--	--	--	--
Red River (WBIC 2845800)	WI 366.7	--	--	--	--
Spring Brook (M-106-004-002-001)	MN 265.3	1	1	--	--
Straight River (M-096-035-002-002)	MN 198.3	1	1	--	--
Unnamed stream (M-050-046-029-023-002)	MN 344.8	--	--	--	--
Unnamed stream (M-050-046-029-029)	MN 406.3	--	--	--	--
Unnamed stream (M-106-013-008)	MN 232.4	--	--	--	--
Unnamed stream (S-001.9-009)	MN 313.4	--	--	--	--
Unnamed stream (S-001.9-011)	MN 364.2	--	--	--	--
Unnamed stream (S-001-003-027.8)	MN 408.1	--	--	--	--
Unnamed stream (S-001-003-028)	MN 352.1	--	--	--	--
Unnamed stream (S-001-003-029)	MN 352.3	1	1	--	--
Unnamed stream (S-001-003-030)	MN 352.7	--	--	--	--
Unnamed stream (S-001-003-030-001)	MN 408.7	--	--	--	--
Unnamed stream (S-001-003-030-001-B001)	MN 408.8	--	--	--	--
Unnamed stream (S-002-008-001)	MN 339.9	--	--	--	--
Unnamed stream (S-002-008-001-005)	MN 361.8	--	--	--	--
TOTAL		**6**	**6**	**--**	**--**

Sources: Minnesota DNR 2015c; Wisconsin DNR 2016e.

Notes:

[a] Water Body Identification Code (WBIC) is used to identify waterbodies in Wisconsin. Kittle number is used to identify waterbodies in Minnesota.

[b] Con = Enbridge-provided footprint for construction work area

[c] Op = Enbridge-provided footprint for permanent right-of-way

[d] ATWS = additional temporary workspace (includes pipe yards)

"--" = no occurrence

Wildlife and Wildlife Habitat

General Potential Impacts

Construction would include clearing and grading of the construction work area, ATWS, temporary and permanent access roads, and the sites of MLVs, new and expanded pump stations, and cathodic protection sites. Other construction activities that could affect wildlife and wildlife habitats include trenching, dewatering, blasting, waterbody crossings, surface water withdrawals and discharges (e.g., for hydrostatic testing), fueling and use of hazardous materials, facility construction, and restoration or reclamation of temporary construction areas. Wildlife may be affected directly by construction activities or indirectly from disturbances caused by human activity and noise associated with construction activities. Although only a narrow band of habitat would be directly altered by construction, indirect effects would occur over a wider area.

As noted above, the Applicant would incorporate measures into the Project to avoid or minimize construction impacts on fisheries and fisheries habitat, and many of those measures would help to avoid or minimize impacts on wildlife and wildlife habitats. In addition to those measures identified previously, the Applicant would implement the following measures to avoid or reduce impacts on wildlife and wildlife habitats:

- Confine clearing activities to the approved construction work areas and adhere to erosion control specifications to minimize impacts on vegetation, aquatic resources, and wildlife.
- Fell trees toward previously cleared construction areas to prevent damage to adjacent trees.
- Upon completion of pipeline installation and backfilling and construction of facilities, revegetate disturbed areas in accordance with the Environmental Protection Plan (Appendix E) unless otherwise directed by landowners or land managing agencies.
- Restore cleared areas and reseed with an appropriate seed mix (e.g., Minnesota BWSR-approved mixes) to minimize the duration of vegetative disturbance.
- Slope the ends of open trenches to provide ramps for wildlife that fall into the trench (e.g., small animals such as rodents, amphibians, and snakes) to escape.
- Handle, store, and dispose of food and general waste generated during construction to reduce attraction for opportunistic scavengers such as raccoons, crows, and gulls that could prey on other wildlife in the area.
- Handle, store, and dispose of all solid waste and hazardous materials in accordance with stipulations of permits and as presented in the Environmental Protection Plan.

Construction of the Applicant's preferred route would result in clearing 1,764 acres of forested habitats as well as 2,028 acres of cultivated crop land. Forest and cultivated crops account for approximately 68 percent of the vegetation affected by construction. Additionally, 687 acres of woody and emergent herbaceous wetlands would be disturbed by construction.

The areas cleared would remain clear of brush, trees, and vegetation until restoration is completed. This would result in the loss of habitat for some species, including those species that use tree and shrub habitats for cover, forage, and nesting. The effects on wildlife habitat generally would be short term and minor, except in areas where woody vegetation is removed or wetlands affected. In those areas, the impact would be long-term to permanent and minor to major, because of the long recovery period for

forested areas and the sensitivity of wetlands to disturbance. Woody vegetation would be permanently excluded from the permanent right-of-way of the pipeline but would be allowed to recover in the construction work area outside of the permanent right-of-way. This loss of habitat would affect small mammals, amphibians, reptiles, and other small animals to a greater extent than large animals (e.g., deer and large birds), which have larger territories and can avoid the active construction areas. As a result, the impact on wildlife from the loss of habitat would range from temporary to permanent and minor for small wildlife species, and short term and minor for larger species.

Clearing, grading, trenching, and the use of construction vehicles and equipment would result in direct impacts on some common animals, particularly small and mid-sized mammals, reptiles, amphibians, and invertebrates. Members of these species would be affected more than large wildlife because of their relative lack of mobility compared to that of larger animals (e.g., deer and coyotes). Burrows and dens could be destroyed or abandoned during clearing and excavation, resulting in displacement or loss of young, and loss of foraging or cover habitat during rearing seasons. Burrowing animals would be expected to return and recolonize the right-of-way after construction; however, compacted areas, such as temporary work areas, may become less suitable habitat because they would no longer be conducive to burrowing (Lauzon et al. 2002). In addition, nests could be destroyed or abandoned, resulting in loss of eggs and young, and loss of foraging or cover habitat during nesting seasons. Although open trenches would be sloped at the ends, some small animals may become trapped in open trenches and may not survive. As a result of these considerations, it anticipated that the direct impact of these activities on wildlife would be temporary to short term and minor.

Many animals would be temporarily displaced from the active construction areas and adjacent areas because of clearing activities, noise, and human disturbance. Human disturbance could influence wildlife behavior or cause displacement of species that are less tolerant of human intrusion or more sensitive to noise, and intraspecific competition could increase stress among some individuals. Noise disturbance from construction activities also could lead to nest abandonment and subsequent depredation of eggs or young. The indirect effects of construction disturbance may include reduced foraging time and increased alerting behaviors, which could result in increased energy expenditure and potentially lower survival or reproduction. These indirect impacts would be reduced with implementation of the BMPs incorporated into the Project as described above. In addition, nearby habitat could provide cover and suitable escape habitat for many of the common wildlife species that would be displaced, and mobile animals could return to the area after completion of construction and restoration activities, if appropriate habitats are available. Consequently, the impact of these displacements during construction would be temporary to short term and minor.

The Applicant may be required to trap beavers or alter or remove beaver dams to lower water elevations within the construction corridor prior to construction. Because beavers would likely move back to the area once construction is complete (Wisconsin DNR 2005), these activities would result in a temporary to short-term and negligible to minor impact on beavers and on the altered waterbodies. Removal of a beaver dam may require a separate Public Waters Work Permit and, depending on the location, may not be permitted where beaver dams maintain control of basin water levels.

Disturbed areas would be susceptible to invasion by noxious and invasive species, which could result in degradation of wildlife habitat. However, implementation of BMPs to address invasive species would reduce the potential establishment and spread of noxious weeds, resulting in short-term and negligible to minor impacts.

During construction and clearing of the right-of-way, vehicle emission by-products (e.g., polycyclic aromatic hydrocarbons, aldehydes, carbon monoxide, nitrogen oxides, ozone, and sulfur oxides) could contaminate soil and vegetation in the areas immediately adjacent to the construction vehicles and equipment. The construction period at any location would be relatively short and would occur only during daytime hours—except for HDD crossings of surface waters, which would occur for 24 hours per day, and the level of contamination in vegetation is not expected to be substantial. Although it is possible that species such as pollinators and herbivores that inhabit the areas where vegetation is exposed to these contaminants could be affected, the impact would be short-term and negligible.

Potential Impacts on Management Units and Managed Species

Table 5.2.4-8 lists the wildlife conservation lands potentially affected by the Applicant's preferred route. Construction of the Applicant's preferred route would result in habitat loss or alteration of approximately 513 acres within WMAs and state forests, including approximately 15 acres of the Grayling Marsh WMA and approximately 3 acres of the Lawler WMA. Loss or alteration of habitats could adversely affect both game and nongame wildlife that use these WMAs until vegetation has recovered. The resultant impact on the WMAs would be short to long-term depending on the existing habitat types and minor to major depending on the landscape context of these public areas to the areas around them.

Construction would also occur on land within eight state forests, resulting in the loss and alteration of forest habitat as well as forest fragmentation. Because the recovery of forested areas in the temporary construction work area (i.e., the disturbed areas outside of the permanent right-of-way) would take decades, the impact would be long-term to permanent but minor to major, based on the relatively small area affected compared to the nearby forested areas and habitat fragmentation.

Table 5.2.4-8. Wildlife Conservation Lands Potentially Affected by the Applicant's Preferred Route

Designation Type and Name	Con[a] Acres	Op[b] Acres	Facilities		Total[c]	
			Con Acres	Op Acres	Con Acres	Op Acres
North Dakota						
Resource Management Area						
Pembina County Waterfowl Production Area	5.5	2.3	NA	NA	5.5	2.3
North Dakota subtotal	***5.5***	***2.3***	***NA***	***NA***	***5.5***	***2.3***
Minnesota						
Habitat or Species Management Area						
Grayling Marsh Wildlife Management Area	14.1	6.4	0.6	--	14.8	6.4
Lawler Wildlife Management Area	2.9	1.5	--	--	2.9	1.5
Lowe Wildlife Management Area	--	--	--	--	--	--
McGregor Wildlife Management Area	--	--	--	--	--	--
Mud Lake Wildlife Management Area	--	--	--	--	--	--
Salo Marsh Wildlife Management Area	--	--	--	--	--	--
State Forest Lands						
Badoura	--	--	--	0.4	--	0.4

Table 5.2.4-8. Wildlife Conservation Lands Potentially Affected by the Applicant's Preferred Route

Designation Type and Name	Con[a] Acres	Op[b] Acres	Facilities		Total[c]	
			Con Acres	Op Acres	Con Acres	Op Acres
Fond du Lac	--	--	--	--	--	--
Foothills	42.3	18.6	11.8	1.1	54.1	19.7
Hill River	102.9	48.3	5.0	6.0	107.9	54.2
Huntersville	96.9	42.9	11.9	7.4	108.9	50.3
Land O'Lakes	130.2	58.1	25.9	5.2	156.2	63.4
Mississippi Headwaters	25.1	10.7	3.8	6.7	28.9	17.4
Paul Bunyan	--	--	--	--	--	--
Savanna	8.7	4.6	0.2	0.1	9.0	4.6
Waukenabo	15.8	8.3	0.5	0.7	16.2	8.9
White Earth	--	--	--	1.5	--	1.5
Minnesota subtotal	***439.1***	***199.4***	***59.7***	***29.1***	***498.9***	***228.5***
Wisconsin						
Protective Management Area – Land, Lake, or River						
Statewide Natural Area	8.6	3.5	NA	NA	8.6	3.5
Recreation Management Area						
North Country National Scenic Trail	--	--	NA	NA	--	--
Wisconsin subtotal	***8.6***	***3.5***	***NA***	***NA***	***NA***	***3.5***
TOTAL	**453.2**	**205.2**	**59.7**	**29.1**	**512.9**	**234.3**

Source: USGS GAP 2016.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area in Minnesota. In North Dakota and Wisconsin, estimated construction work area in acres based on 120-foot-wide construction work area centered on route, including the 50-foot-wide permanent right-of-way.

[b] Op= Enbridge-provided footprint in Minnesota. Estimated permanent impact area in acres based on 50-foot-wide permanent right-of-way centered on route in North Dakota and Wisconsin.

[c] Total: Con = sum of pipeline construction work area, additional temporary workspaces (including pipe yards), and temporary access roads; Op = sum of pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

"--" = no occurrence

NA = not available

The Applicant's preferred route would cross the McGregor IBA. Construction during the nesting season (beginning May 1 for most birds of conservation concern) could result in the loss of bird eggs and young. The Applicant would work with Minnesota DNR and USFWS to develop measures that would avoid and minimize disturbance of migratory birds. The impact on the IBA and breeding birds within the IBA from removal of vegetation would be short- to long-term and minor based on to the relatively small area affected compared to the acreage of the unaffected portion of the IBA.

The route would not cross the Itasca State Park IBA, and the pipeline corridor would be co-located with an existing pipeline for most of the length near this IBA. As a result, no impacts are expected on this IBA; if noise and disturbance affected some species within the IBA, the impact would be temporary and negligible.

Raptor habitat could be compromised by removal of trees from the construction work area and extra workspaces in adjacent areas. Many of these species require large, unfragmented habitats. In addition, because most raptors reuse nest structures for many years, loss of nest structures would require a pair to find a new nest tree and build a new nest. If suitable new nest trees are not available within established territories, new territories would need to be established. These processes would lead to increased energy demands during nesting and could lead to reduced or lost reproduction in subsequent years. Most migratory birds begin nesting from mid-April through late July; however, bald eagles may nest as early as February (Minnesota DNR 2016x). Construction during the nesting season (beginning May 1 for most birds of conservation concern) could result in loss of bird eggs and young. The Applicant would work with USFWS to develop measures to avoid and minimize destruction of migratory birds. Raptor nests identified during 2014 to 2016 surveys would be avoided when possible. If removal of one of these nests is unavoidable, a permit and consultation with USFWS and Minnesota DNR may be required.

Two colonial waterbird nesting sites (rookeries) occur within 0.5 mile of the Applicant's preferred route; both sites provide habitat for great blue heron. Waterbirds can be vulnerable to development, particularly when appropriate replacement habitat is not available and disturbance, even though a number of the species are not rare. Direct impacts may occur from the loss of nesting habitat; indirect impacts could occur from disturbance to adults, nests, young due to construction. Wildlife agencies often recommend a buffer of no impact around the colony and/or season restrictions on construction. The Shell River rookery is about 1,220 feet, from the closest construction work area. The impact on this rookery is expected to be indirect, temporary, and negligible to minor, depending on the time of year construction takes place. The Mahtowa rookery is about 340 feet from the closest construction work area. Because construction activities are expected to occur within a distance that would affect the Mahtowa colony, the Applicant should consult with Minnesota DNR and USFWS, to establish construction BMPs and timeframes to minimize impacts on the rookeries. A permit may be required. The impact of construction within this buffer zone would be temporary to long-term and could be minor to major, depending on the construction activities conducted.

Impacts from Habitat Fragmentation

Habitat fragmentation is caused when contiguous habitats are divided into separate fragments. Large-block habitats (habitats larger than 100 acres) are susceptible to impacts from fragmentation, particularly large, mature core or interior forested areas that serve as habitat for migratory birds and other wildlife. Construction of linear projects such as pipelines can cause habitat fragmentation as well as changes in vegetation cover. Potential fragmentation effects on wildlife habitat include a decrease in total habitat area, amount of interior habitat, biodiversity (richness), and connectivity. Fragmentation may also cause an increase in amount of edge habitat, increase the risk of invasive species spread, and isolate some habitat types. The reduction in habitat connectivity can disrupt behavior and movement of species, alter population dynamics, reduce the chance of recolonization in extirpated island habitats, and decrease genetic diversity. Forest-nesting birds are particularly vulnerable to habitat fragmentation effects resulting from linear construction projects. Habitat fragmentation leads to increased predation, increased competition by generalist species, and changes in microclimate and vegetation which may result in extirpation and reduced reproductive success for area-sensitive species.

The Applicant's preferred route is co-located with other pipelines, utilities, or roads along most of its length. However, between Clearbrook and Carlton nine segments (between approximately MPs 215.0 and 352.0) are not co-located with other infrastructure. Within this span, 21 large-block forested and wetland habitats would be crossed and fragmented by construction of the Applicant's preferred route. This would occur along approximately 38 miles of the Applicant's preferred route, or approximately 11 percent of the route in Minnesota and 17 percent of the route between Clearbrook and Carlton. These habitat "patches" that would be crossed include primarily forested and woody wetland habitats, with the largest patch crossed approximately 4,500 acres over approximately 7 miles, and the smallest patch crossed is about 130 acres over less than 1 mile. Impacts on wildlife from habitat fragmentation would be indirect, permanent, and minor to major, depending on the habitat type and species present. If construction activities directly bisect interior habitats or reduce the distance between interior habitats and the adjacent habitat edges, effectively increasing "edge effect" and ecotone pressures on the interior habitat. Wildlife species sensitive to habitat fragmentation could experience permanent and major habitat loss and displacement impacts. These impacts would be greatest in the least disturbed areas.

Operations Impacts

The following sections describe the potential impacts of normal operation of the Applicant's preferred route. Impacts from an accidental release of crude oil during operation are addressed in Chapter 10.

Fisheries and Aquatic Habitat

Overall operations impacts on aquatic habitat (174 crossings), trout streams (6 crossings), Lakes of Biological Significance (1 lake), and AMAs (0.2 acres) would be short-term and negligible to minor. In areas where streambanks are cleared of forested or woody vegetation, thermal effects could occur resulting in long-term major impacts on aquatic areas.

General Impacts

The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance.

Permanent removal of riparian vegetation within the permanent right-of-way in areas adjacent to waterbody crossings would result in localized alterations in habitat, streambank stability loss and erosion, and the potential for increased sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would consult Minnesota DNR and Minnesota PCA make repairs and improvements following recommendations of these agencies. With implementation of these measures, localized changes to topography or vegetation would result in short-term minor impacts in the vicinity of the alteration.

Permanent removal of riparian vegetation in areas adjacent to some waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent, negligible to minor increases in temperature at these locations. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way. This could lead to permanent thermal effects on trout streams. During normal operation, no other measurable changes to water quality in surface waters would be expected, with no impacts on most fisheries or aquatic habitats.

Minor accidental fuel and lubricant leaks and spills could be released from maintenance and inspection vehicles using the permanent right-of-way and nearby areas. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection

Plan (Appendix E). If minor leaks or spills during operations reach surface waters, negligible to minor changes to surface water quality would result, and the subsequent temporary impacts on fisheries and aquatic habitats would be negligible to minor.

Chemical control methods (i.e., herbicides) to control invasive vegetation species during operations could be used near waterbodies. The Applicant would implement its noxious weed plans that include methods to prevent and reduce the introduction and spread of noxious weeds and invasive species, and would implement BMPs for herbicide applications. Only herbicides and surfactants labeled for aquatic use would be used within 50 feet of any waterbody (Appendix E). In addition, herbicide use would be based on the invasive species present from monitoring and the minimum herbicide would be used the treat the species present. These actions would reduce potential impacts on aquatic species from herbicides reaching surface waters with runoff. As a result, the use of herbicides would result in temporary negligible impacts on fisheries and aquatic habitats.

Impacts from Integrity Management Digs

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. In upland areas, these integrity digs could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time. The Applicant would implement measures to minimize runoff to surface water during and after these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing as described above. The impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be temporary to short to long-term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During repair or replacement of pipe as part of the Integrity Management Program, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. As described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, the impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts

During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody vegetation from regrowing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be permanent in the area of the construction work area that is outside of the permanent right-of-way because of the long period of time required for forest habitat to regenerate. Within the permanent right-of-way, the impact of this loss would be permanent and minor to major.

Differences in vegetation cover between the permanent right-of-way and the surrounding landscape can act as a barrier for some species, such as squirrels and small mammals, while acting as a travel corridor for others, such as raccoons and coyotes. Small mammals that do attempt to cross the cleared right-of-way in previously forested areas could be exposed to increased predation by coyotes, foxes, or birds. Trees and shrubs along rivers and creeks provide high-value wildlife habitat. Furbearers such as muskrats, mink, otter, weasels, and beaver use river edge habitats, and permanent removal of trees and large shrubs along the 50-foot-wide permanent right-of-way would create a break in cover that could increase exposure to terrestrial predators like foxes and coyotes as well as predatory birds. Losses of tree and shrub habitats used by small mammals and birds for cover, forage, and nesting would be a permanent and minor impact because the permanent right-of-way would be maintained free of trees and large shrubs.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on common wildlife for each occurrence; but the mowing would be repeated periodically over the life of the Project.

The maintained permanent right-of-way may be used as travel corridors by some big game animals and humans. Increased human use could lead to disturbance and hunting pressure on game animals, resulting in minor permanent effects on wildlife (Hinkle et al. 2002).

The permanent right-of-way may become attractive to some small species as well. For example, during operations, there may be some warming of the soil above the pipeline, and that may attract rabbits, badgers, and burrowing rodents, especially during winter months. Small mammals attracted to the permanent right-of-way could be exposed to increased predation by coyotes, foxes, or birds. The pipeline right-of-way could also attract migratory waterfowl during early spring if it becomes snow free before surrounding habitats, which has been demonstrated during the early spring melt, when early vegetation emergence near roadways and the buried portion of the Trans Alaska Pipeline in Northern Alaska attracts waterfowl, shorebirds, and ptarmigan (Trans Alaska Pipeline System Owners 2001). Migratory birds attracted to the permanent right-of-way could be exposed to increased predation by coyotes, foxes, or other predators. These effects would be permanent but minor.

Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. The use of chemical controls can adversely affect wildlife species, particularly amphibians because of their sensitivity to chemical exposure. However, implementation of BMPs for use of herbicides that include measures such as only using herbicides when necessary and using aquatic formulations within 50 feet of water, and prevention of the spread of noxious species would minimize the potential for impacts, and the impact on wildlife and wildlife habitats is expected to be temporary to short term and minor.

Impacts on Management Units and Managed Species

The Applicant's preferred route would cross the McGregor IBA, permanently affecting about 25 acres. IBAs represent relatively intact areas that are important to birds. Maintenance of the permanent right-of-way could reduce populations of species sensitive to habitat disturbance and could indirectly result in a permanent and minor effect on breeding birds within the McGregor IBA.

Impacts from Habitat Fragmentation

During operation, the habitat fragmentation along the permanent right-of-way would continue, as described under construction impact, and could reduce populations of some forest interior species (e.g., birds, mammals, and amphibians). Forest-nesting birds are particularly vulnerable to habitat fragmentation effects of linear construction projects. Forest-nesting songbird abundance, diversity, and reproduction rates have been shown to become depressed from the fragmentation associated with linear developments (Jalkotzy et al. 1997). Linear corridors also increase songbird nest predation and parasitism (e.g., by brown-headed cowbirds), by fragmenting forest habitats and increasing access to nests. As a result, habitat fragmentation during operation of the Applicant's preferred route would cause permanent minor to major impacts on wildlife, depending on the location and species.

Impacts from Integrity Management Digs

The integrity management digs described above (see operations impacts for fisheries and aquatic habitat) would result in changes to the permanent right-of-way that would be similar to those during construction.

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. In upland areas, these integrity digs would result in a loss of vegetation in localized areas for relatively short periods of time. The Applicant would restore the affected areas to conditions present prior to initiating the integrity dig. The impacts would be similar to those during construction of the pipeline, but over a substantially smaller area and without impacts on forested areas because the areas affected by integrity digs essentially would be limited to the permanent right-of-way. As a result, the impacts on wildlife and wildlife habitat would be short-term and negligible to minor but would occur periodically over the life of the Project.

5.2.4.3.2 Continued Use of Existing Line 3 Pipeline

Continued use of the existing Line 3 pipeline would involve continuing use of the existing Line 3 pipeline in Minnesota at its current operating capacity of approximately 390,000 barrels per day (bpd) (see Chapter 4 for further information).

Construction Impacts

Continued use of the existing Line 3 pipeline would not result in construction-related impacts on fisheries, aquatic habitat, wildlife, or wildlife habitat because the pipeline is in place and operational.

Operations Impacts

Operations activities for the existing Line 3 pipeline would include continued vegetation maintenance along the permanent right-of-way to remove woody vegetation and maintain the right-of-way in an herbaceous vegetative state. All portions of the permanent right-of-way have been in place for decades, and the impacts of operation along the permanent right-of-way that are currently occurring would continue without substantial change.

The Applicant would continue to conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would consult Minnesota DNR and Minnesota PCA and make repairs and improvements following recommendations of these agencies. With implementation of these measures, localized changes to topography or vegetation would result in short-term minor impacts in the vicinity of the alteration.

Excavation and replacement of sections of the pipeline as part of the Applicant's ongoing Integrity Management Program and to allow visual inspection of the pipeline route would also continue. The impacts of these integrity digs on fisheries, aquatic habitats, wildlife, and wildlife habitats would be the same as currently experienced for each dig location. However, the need for integrity digs would increase as the pipe continues to age and require repair or replacement of pipe segments. Consequently, the impacts would occur over a wider area annually than currently takes place. The impacts associated with integrity digs range from short to long-term and are minor to major, depending on the location, habitats affected and whether repair or replacement are needed.

5.2.4.3.3 System Alternative SA-04

The methods implemented by the Applicant to avoid or minimize impacts during construction and operation of SA-04 would be the same as those described above for the Applicant's preferred route. The types of potential impacts on fisheries and aquatic resources and wildlife and wildlife habitat from construction and operation of SA-04 would also be similar as those described above for the Applicant's preferred route. Consequently, some discussions in this section refer to the impact analysis presented above for the Applicant's preferred route.

Construction Impacts

Fisheries and Aquatic Habitat

Construction of SA-04 would require 636 stream crossings in North Dakota, Minnesota, Iowa, and Illinois. The majority of crossings would occur in Iowa (Table 5.2.4-9). SA-04 would not cross any trout streams.

Surface water crossings would be designed as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow to create the shortest possible crossing length. The Applicant would determine and obtain approval for specific crossing methods based on factors such as waterbody size, sensitivity, water levels, soil/sediment stability installation, and anticipated season of installation. See Appendix G for a complete discussion of crossing methods. Crossing methods have not yet been determined for the crossings associated with SA-04.

Table 5.2.4-9. Number of Stream Crossings by Crossing Type for System Alternative SA-04

Waterbody Type/Flow	North Dakota	Minnesota	Iowa	Illinois	Total
Artificial path	10	6	5	16	37
Canal/ditch	17	71	--	3	91
Connector	--	1	--	--	1
Lake/pond – intermittent	--	--	4	--	4
Lake/pond – perennial	5	3	4	1	13
Stream/river – intermittent	74	81	152	77	384
Stream/river – perennial	13	10	54	19	96
Swamp/marsh	2	--	4	4	10
TOTAL	**121**	**172**	**223**	**120**	**636**

Source: USGS 2017. Also see maps in Appendix A.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

"--" = no occurrence

General Potential Impacts on Fisheries and Aquatic Habitat from Surface Water Crossings

SA-04 would cross 636 waterbodies. Construction of SA-04 would result in impacts similar to those identified for the Applicant's preferred route, including streambank alteration, removal of large in-stream structures, direct impacts on fish and fisheries, leaks or small spills of fuel or other hazardous liquids, unanticipated releases of drilling fluids, and risks associated with hydrostatic water withdrawal and discharge. Each of these impacts is discussed in detail above in Section 5.2.4.3.1. Impacts on aquatic habitat would generally be temporary to short-term and negligible to minor. In areas where streambanks are cleared of forested or woody vegetation, thermal effects could occur resulting in long-term minor to major impacts.

Impacts on Management Units and Managed Species

Construction of SA-04 would affect 0.2 acre of the Mayhew Creek FMA in Blue Earth County, Minnesota (Minnesota DNR 2016w). As for the Applicant's preferred route, the Applicant would incorporate BMPs into construction to avoid or minimize impacts; as a result, the impacts of construction of SA-04 from loss of habitat and reduction of habitat quality would be short-term and negligible to minor. The Applicant would implement BMPs to prevent the spread of invasive species, with the resultant impact expected to be at most short-term and negligible to minor.

Construction of SA-04 would affect a freshwater mussel bed site in the Minnesota River (Minnesota DNR 2016e). Impacts on AMAs and mussel beds from construction of SA-04 would depend on the type of waterbody crossing method used and could include introduction of invasive species, loss of habitat, and reduction of habitat quality. Wet open-cut construction through the Minnesota River could permanently

destroy part of the mussel bed, expose mussels to increased turbidity and sedimentation, and result in mortality. These impacts are expected to be permanent and minor to major, depending on how much habitat would be lost in construction areas and the species present. BMPs would be in place to reduce impacts on fisheries and aquatic habitats, as described above for the Applicant's preferred route. Successful use of the HDD crossing method would avoid impacts on mussels and mussel beds, but see information about unintended drilling fluid releases in Section 5.2.4.3.1 above. If an HDD crossing is not an option, mussel surveys, collection, temporary storage, and replacement of mussels could be required, depending on the particular mussel bed.

No trout streams would be crossed by SA-04 in Minnesota, although two trout streams in Nicollet County, Minnesota, occur within 0.5 mile of this alternative (Seven Mile Creek [M-055-071.5] and an unnamed stream [M-055-071.5-002]) (Minnesota DNR 2015c). These trout streams would not be affected by construction of SA-04, as the streams would not be crossed by the pipeline route.

Wildlife and Wildlife Habitat

General Potential Impacts

The majority of vegetative cover that would be affected by construction of SA-04 is hay/pasture and cultivated cropland. Construction activities on cultivated cropland would temporarily displace and disturb white-tailed deer, small mammals, and birds that typically forage in these areas. These areas would be reclaimed as hay/pasture and cultivated cropland following construction, resulting in temporary to permanent minor to major impacts on these habitats and the wildlife species that inhabit these areas. Mowing, ground disturbance, and vegetation removal for construction can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young resulting in short-term minor impacts on common wildlife.

About 98 acres of evergreen, deciduous and mixed forested habitats (Table 5.2.4-10) and 55 acres of woody wetlands would be removed during construction of SA-04. Most of this area is in the Dakota Tallgrass Prairie WMA in North Dakota (94 percent) (Table 5.2.4-11). Impacts on forest and prairie habitats would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. For the prairie habitats, BMPs would be in place to reduce impacts on wildlife and wildlife habitats, and construction areas would be revegetated using native seed mixes (e.g., BWSR mixes) or as required by the land administrator. Consequently, impacts are expected to be temporary to short term and minor. Forested areas would be permanently removed from the permanent right-of-way but would be allowed to regenerate in portions of the temporary construction work area that are outside of the permanent-right-of-way. As a result, impacts on wildlife habitat and the wildlife using the forested habitat would be permanent and minor to major, depending on the specific area affected.

Table 5.2.4-10. Vegetation Cover Potentially Affected by System Alternative SA-04 (acres)

Vegetation Cover Class	Construction Work Area[a]	Permanent Right-of-Way[b]
Evergreen forest	0.7	0.3
Deciduous forest	96.8	40.2
Mixed forest	0.7	0.3
Shrub/scrub	--	--
Grassland/herbaceous	172.5	71.9
Hay/pasture	103.5	42.9
Cultivated crops	10,051.0	4,209.5
Woody wetlands	55.0	22.8
Emergent herbaceous wetlands	83.7	34.6
Barren land	20.7	8.6
TOTAL	**10,584.6**	**4,431.1**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the pipeline route,

"--" = no occurrence

Table 5.2.4-11. Wildlife Conservation Lands Potentially Affected by System Alternative SA-04

Designation Type and Name	Construction Work Area[a]		Permanent Right-of-Way[b]	
	Acres	Number	Acres	Number
North Dakota				
Habitat or Species Management Areas				
Dakota Tallgrass Prairie Wildlife Management Area	794.8	1	331.1	1
Resource Management Areas				
Pembina County Waterfowl Production Area	10.4	3	4.7	3
Not Designated				
Pembina County Waterfowl Production Area	5.0	2	2.5	2
North Dakota subtotal	***810.2***	***6***	***338.3***	***6***
Minnesota				
Habitat or Species Management Areas				
Lyle-Austin Wildlife Management Area	0.3	1	0.1	1
Resource Management Areas				
Morris Wetland Management District Waterfowl Production Area	0.3	2	0.1	1
Private Conservation Lands				
Conservation Reserve Enhancement Program	26.0	8	10.8	8
Reinvest in Minnesota Wetlands Reserve Program	5.0	2	2.1	2
Minnesota subtotal	***31.6***	***13***	***13.1***	***12***
Illinois				
National Wildlife Refuges				
Upper Mississippi River Wildlife and Fish Refuge	0.2	1	0.1	1
Protective Management Areas				
Coon Creek	0.2	1	0.1	1
Mississippi River	4.1	1	1.7	1
State Parks				
Hennepin Canal	0.9	1	0.4	1
Illinois subtotal	***5.4***	***5***	***2.2***	***5***
TOTAL	**847.1**	**24**	**353.7**	**23**

Source: USGS GAP 2016.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

Represents GAP Status 1, 2, and 3 only; these lands have permanent protection from conversion of natural land cover that provides wildlife habitat

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way

[b] Estimated operations impact area in acres based on a 50-foot-wide right-of-way centered on the route

Potential Impacts on Management Units and Managed Species

Alternative SA-04 would affect about 847 acres within 24 lands managed for conservation of wildlife, including WMAs in North Dakota, Minnesota, and Illinois. One state park (Hennepin Canal) would be crossed by SA-04. Impacts on these conservation areas would be short to long-term depending on the existing habitat types and minor to major depending on the landscape context of these public areas to areas around them.

Construction of SA-04 would affect lands within five IBAs. Each of these IBAs is described in Section 5.2.4.2.3. Construction would result in removal of habitats across or near these areas and could reduce populations of those species sensitive to habitat loss or alteration and species that rely on large, intact habitats. This could result in permanent and minor to major effects on breeding birds within the IBAs.

Potential Impacts from Habitat Fragmentation

System alternative SA-04 would be constructed along existing pipeline or utility corridors throughout its entire length and would not substantially contribute to fragmentation of large-block habitats.

Operations Impacts

Fisheries and Aquatic Habitat

Overall operations impacts on aquatic habitat (636 crossings) and AMAs (0.2 acres) would be short-term and negligible to minor. In areas where streambanks are cleared of forested or woody vegetation, thermal effects could occur resulting in long-term major impacts on aquatic areas.

General Impacts

The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. Permanent removal of riparian vegetation within the permanent right-of-way in areas adjacent to waterbody crossings would result in localized alterations in habitat, streambank stability loss and erosion, and the potential for increased sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would consult Minnesota DNR and Minnesota PCA and make repairs and improvements following recommendations of these agencies. With implementation of these measures, localized changes to topography or vegetation would result in short-term minor impacts in the vicinity of the alteration.

Permanent removal of riparian vegetation in areas adjacent to some waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent, negligible to minor increases in temperature at these locations. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way. This could lead to permanent thermal effects on trout streams. During normal operation, no other measurable changes to water quality in surface waters would be expected, with no impacts on most fisheries or aquatic habitats.

Minor accidental fuel and lubricant leaks and spills could be released from maintenance and inspection vehicles using the permanent right-of-way and nearby areas. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). If minor leaks or spills during operations reach surface waters, negligible to minor

changes to surface water quality would result, and the subsequent temporary impacts on fisheries and aquatic habitats would be negligible to minor.

Chemical methods (i.e., herbicides) to control invasive vegetation species during operations could be used near waterbodies. The Applicant would implement its noxious weed plans that include methods to prevent and reduce the introduction and spread of noxious weeds and invasive species, and would implement BMPs for herbicide applications. Only herbicides and surfactants labeled for aquatic use would be used within 50 feet of any waterbody (Appendix E). In addition, herbicide use would be based on the invasive species present from monitoring and the minimum herbicide would be used the treat the species present. These actions would reduce potential impacts on aquatic species from herbicides reaching surface waters with runoff. As a result, the use of herbicides would result in temporary and negligible impacts on fisheries and aquatic habitats.

Impacts on Management Units and Managed Species

Operation of SA-04 would permanently affect 0.2 acre of the Mayhew Creek FMA in Blue Earth County, Minnesota (Minnesota DNR 2016w). These impacts are expected to be short-term and negligible to minor as the pipeline would be subsurface and vegetation would recover outside of the permanent right-of-way.

Impacts from Integrity Management Digs

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. In upland areas, these integrity digs could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time. The Applicant would implement measures to minimize runoff to surface water during and after these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing, as described above. Impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be short to long-term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During repair or replacement of pipe as part of the Integrity Management Program, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control would vary depending on the situation. As described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, the impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts

During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody vegetation from regrowing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be permanent in the area of the construction work area outside of the permanent right-

of-way because of the long period of time required for forest habitat to regenerate. Within the permanent right-of-way, the impact would be permanent and minor to major.

Differences in vegetation cover between the permanent right-of-way and the surrounding landscape can act as a barrier for some species, such as squirrels and small mammals, while acting as a travel corridor for others, such as raccoons and coyotes. Small mammals that do attempt to cross the cleared right-of-way in previously forested areas could be exposed to increased predation by coyotes, foxes, or birds. Trees and shrubs along rivers and creeks provide high-value wildlife habitat. Furbearers such as muskrats, mink, otter, weasels, and beaver use river edge habitats; and permanent removal of trees and large shrubs along the 50-foot-wide permanent right-of-way would create a break in cover that could increase exposure to terrestrial predators like foxes and coyotes as well as predatory birds. Losses of tree and shrub habitats used by small mammals and birds for cover, forage, and nesting would be a permanent and minor impact because the permanent right-of-way would be maintained free of trees and large shrubs.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on common wildlife for each occurrence; but the mowing would be repeated periodically over the life of the Project.

The maintained permanent right-of-way may be used as travel corridors by some big game animals and humans. Increased human use could lead to disturbance and hunting pressure on game animals, resulting in minor permanent effects on wildlife (Hinkle et al. 2002).

The permanent right-of-way may become attractive to some small species as well. For example, during operations, there may be some warming of the soil above the pipeline, and that may attract rabbits, badgers, and other burrowing rodents, especially during winter months. Small mammals attracted to the permanent right-of-way could be exposed to increased predation by coyotes, foxes, or birds. The pipeline right-of-way could also attract migratory waterfowl during early spring if it becomes snow free before surrounding habitats, which has been demonstrated during the early spring melt, when early vegetation emergence near roadways and the buried portion of the Trans Alaska Pipeline in Northern Alaska attracts waterfowl, shorebirds, and ptarmigan (Trans Alaska Pipeline System Owners 2001). Migratory birds attracted to the permanent right-of-way could be exposed to increased predation by coyotes, foxes, or other predators. These effects would be permanent but minor.

Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. The use of chemical controls can adversely affect wildlife species, particularly amphibians because of their sensitivity to chemical exposure. However, implementation of BMPs for use of herbicides, which include measures such as only using herbicides when necessary and using aquatic formulations within 50 feet of water, and prevention of the spread of noxious species would minimize the potential for impacts, and the impact on wildlife and wildlife habitats is expected to be temporary to short-term and minor.

Impacts on Management Units and Managed Species

The Applicant's preferred route would cross several wildlife management units. Maintenance of the permanent right-of-way could reduce populations of species sensitive to habitat disturbance, and could cause permanent, minor to major effect on wildlife and wildlife habitat in the management areas, including breeding birds within the IBAs.

Impacts from Habitat Fragmentation

Because SA-04 would be within or adjacent to existing utility corridors for all of its length, no impacts related to fragmentation of large tracts of wildlife habitat would occur.

Impacts from Integrity Management Digs

The integrity management digs described above (see operations impacts for fisheries and aquatic habitat) would result in changes to the permanent right-of-way that would be similar to those during construction.

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. In upland areas, these integrity digs would result in loss of vegetation in localized areas for relatively short periods of time. The Applicant would restore the affected areas to conditions present prior to initiating the integrity dig. The impacts would be similar to those occurring during construction of the pipeline, but over a substantially smaller area, and without impacts on forested areas because the areas affected by the integrity digs would be limited to the permanent right-of-way. Consequently, impacts on wildlife and wildlife habitat would be short-term and negligible to minor but would occur periodically over the life of the Project.

5.2.4.3.4 Transportation by Rail

Near the existing Enbridge terminal at Clearbrook, the rail alternative would require as much as 200 acres to construct and operate an offloading facility and 60 acres to reactivate an abandoned rail line. Near the existing Enbridge terminal at Superior, Wisconsin, construction would require as much as 100 acres for offloading facilities and an additional 3 acres to establish a new rail spur.

Construction Impacts

Fisheries and Aquatic Habitat

Aquatic species and aquatic habitat would be affected by clearing and grading activities for development of the offloading facilities in both Clearbrook and Superior. The direct and indirect potential impacts would be similar to those described above for construction of the Applicant's preferred route, including the potential for habitat degradation from increases in stormwater runoff, erosion, and sedimentation, and the potential for injury or mortality of individual fish and other aquatic species. Degradation of water quality also could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities. A SWPPP and a stormwater NPDES permit would be required for construction of facilities. Adhering to stipulations of the permit and the SWPPP, along with implementation of other BMPs, would minimize the potential for stormwater to carry eroded materials or contaminants into nearby surface waters and therefore minimize impacts on fisheries and aquatic habitats. The prevention and management of spills during construction would be managed according to SPCC plans that would be required for each facility. As a result, potential impacts on fisheries and aquatic habitats from construction of rail offloading facilities would be temporary to short-term and negligible.

Development of rail facilities likely would require water for common construction purposes, such as dust control, but large volumes would not be needed (e.g., for hydrostatic testing) because the existing tanks at the terminals likely would be used to store the delivered crude oil. Although the source of construction water is not known, it is anticipated that construction water could be obtained from sources other than surface waters (e.g., from a public water supply). Consequently, impacts on aquatic habitat and species from appropriation and discharge of large amounts of water are not expected to occur.

Wildlife and Wildlife Habitat

The habitat around the Clearbrook, Minnesota terminal includes deciduous and evergreen forests, woody and emergent wetlands and hay/pasture and cultivated croplands that provides habitat for white-tailed deer, small mammals, and birds. Vegetation cover near the Superior terminal is primarily deciduous forest and scrub/shrub wetlands. Wildlife and wildlife habitat would be affected by clearing and grading activities for development of offloading facilities at both locations. The loss of habitat would be permanent where the offloading facilities and new rail spur are sited. Larger species would be able to re-locate to nearby areas but may not survive if those areas are at habitat-carrying capacity. The loss of wildlife habitat would result in permanent but minor impacts based on the relatively large area of similar habitat in the areas surrounding the facilities.

Clearing of vegetation and downed woody debris in deciduous habitats could have temporary minor impacts on species with small home ranges such as salamanders because it could result in mortality of these small species.

Operations Impacts

Fisheries and Aquatic Habitat

New facilities would create permanent impervious surfaces that would affect stormwater runoff at these locations. However, the offloading facilities would be designed to comply with NPDES permits and other permitting requirements that control runoff from industrial sites. Although the increase in impermeable surfaces would alter runoff patterns, with adherence to permitting requirements, a substantial increase in stormwater runoff and erosion would not be anticipated and would not be expected to carry eroded materials or contaminants to nearby surface waters. Consequently, the potential impacts on the associated fisheries and aquatic habitats would be permanent but negligible to minor.

Although the route that would be traveled by the unit trains exists, operation of unit trains would increase the amount of materials dropping from the trains to the railroad bed above the current level. Material reaching the railroad bed could include materials from brake pad consumption, lubrication, and fuel drips and leaks. The increase above current conditions is expected to be minor and typical of transport of cargo by rail. If petrochemicals reach areas of the railroad bed adjacent to surface waters, it is possible that the petrochemicals could migrate to the surface water. However, the quantity of materials leaking during normal operation would be small, and the associated impact on surface water quality likely would be temporary and minor. As a result, the impacts on fisheries and aquatic habitats would be temporary to permanent and negligible to minor.

Potential impacts on fisheries and aquatic habitat from an unanticipated release of crude oil are discussed in Chapter 10.

Wildlife and Wildlife Habitat

The principle impact of the rail transport alternative on wildlife during operation would be collisions with trains. This would be a permanent minor to major impact on common highly mobile wildlife such as white-tailed deer, mid-sized mammals, and birds. Major impacts could occur if collision deaths affect population management of species such as white-tailed deer. The train route currently passes through and near WMAs, including IBAs. No changes in impacts on wildlife habitats or wildlife management units are anticipated from operation of trains on the existing rail lines but the operation of the terminal would result in permanent minor impacts on wildlife habitat because the area would be maintained free of vegetation.

Potential impacts on wildlife and wildlife habitat from an unanticipated release of crude oil from a unit train are discussed in Chapter 10.

5.2.4.3.5 Transportation by Truck

Transportation of crude oil by truck would require development of offloading facilities and new road access. In the United States, truck offloading facilities would require approximately 50-acre sites at the existing terminals in Clearbrook, Minnesota, and in Superior, Wisconsin. New road access would require permanent conversion of approximately 5 acres of agricultural land, semi-disturbed land, and wetlands at the Clearbrook terminal; and 34 acres of semi-disturbed land at the Superior terminal.

The truck alternative would also require construction of a new loading facility and a new access road near Gretna, Canada. This EIS does not address construction or operation of those facilities.

Construction Impacts

Fisheries and Aquatic Habitat

Aquatic species and aquatic habitat would be affected by clearing and grading activities for development of the offloading facilities in both Clearbrook and Superior. Direct and indirect potential impacts would be similar to those described above for construction of the Applicant's preferred route, including the potential for habitat degradation from increases in stormwater runoff, erosion, and sedimentation, and the potential for injury or mortality of individual fish and other aquatic species. Degradation of water quality also could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities. A SWPPP and a stormwater NPDES permit would be required for construction of facilities. Adhering to stipulations of the permit and the SWPPP, along with implementation of other BMPs would minimize the potential for stormwater to carry eroded materials or contaminants into nearby surface waters and therefore minimize impacts on fisheries and aquatic habitats. The prevention and management of spills during construction would be managed according to SPCC plans that would be required for each facility. As a result, potential impacts on fisheries and aquatic habitats from construction of truck offloading facilities would be temporary to short-term and negligible.

Development of the truck offloading facilities would likely require water for common construction purposes, such as dust control, but large volumes would not be needed (e.g., for hydrostatic testing) because the existing tanks at the terminals likely would be used to store the delivered crude oil. Although the source of construction water is not known, it is anticipated that construction water could be obtained from sources other than surface waters (e.g., from a public water supply). Consequently, impacts on aquatic habitat and species from appropriation and discharge of large amounts of water are not expected to occur.

Wildlife and Wildlife Habitat

The habitat around the Clearbrook, Minnesota terminal includes deciduous and evergreen forests, woody and emergent wetlands and hay/pasture and cultivated croplands that provides habitat for white-tailed deer, small mammals, and birds. Vegetation cover near the Superior terminal is primarily deciduous forest and scrub/shrub wetlands. Wildlife and wildlife habitat would be affected by clearing and grading activities for development of truck offloading facilities at both locations. Clearing of vegetation and downed woody debris in deciduous habitats could negatively affect species with small home ranges such as salamanders resulting in minor impacts including mortality of common species.

The loss of habitat would be permanent where the offloading facilities and new roadway are sited. Larger species would be able to re-locate to nearby areas but may not survive if those areas are at habitat-carrying capacity. The loss of wildlife habitat would result in impacts that would be permanent but minor based on the relatively large area of similar habitat in the areas surrounding the facilities.

Operations Impacts

Fisheries and Aquatic Habitat

New facilities would create permanent impervious surfaces that would affect stormwater runoff at these locations. However, the offloading facilities would be designed to comply with NPDES permits and other permitting requirements that control runoff from industrial sites. Although the increase in impermeable surfaces would alter runoff patterns, with adherence to permitting requirements, a substantial increase in stormwater runoff and erosion would not be anticipated and would not be expected to carry eroded materials or contaminants to nearby surface waters. Consequently, the potential impacts on the associated fisheries and aquatic habitats would be permanent but negligible to minor.

Although the trucks would transport crude oil along existing highways that are currently used by trucks and other vehicles, operation of the truck alternative would increase the amount of materials dropping from the trucks to the roadway above the current level. Material reaching the railroad bed could include materials from brakepad consumption, lubrication, and fuel drips and leaks. The increase above current conditions is expected to be minor and typical of transport of cargo by truck. If petrochemicals reach areas of the roadway adjacent to surface waters, it is possible that the petrochemicals could migrate to the surface water. However, the quantity of materials leaking during normal operation would be small, and the associated impact on surface water quality likely would be temporary and minor. As a result, impacts on fisheries and aquatic habitats would be temporary to permanent and negligible to minor.

Potential impacts on fisheries and aquatic habitat from an unanticipated release of crude oil are discussed in Chapter 10.

Wildlife and Wildlife Habitat

The principle impact of operation of the truck transport alternative on wildlife would be collisions with trucks. This would be a permanent minor to major impact on common highly mobile wildlife such as white-tailed deer, mid-sized mammals, and birds. Major impacts could occur if collision deaths affect population management of species such as white-tailed deer. The highways used by the trucks route currently pass through and near WMAs, including IBAs. No changes in impacts on wildlife habitats or wildlife management units are anticipated from operation of trucks on the existing roadways, but the operation of the terminal would result in permanent minor impacts on wildlife habitat because the area would be maintained free of vegetation.

Potential impacts on wildlife and wildlife habitat from an unanticipated release of crude oil from trucks are discussed in Chapter 10.

5.2.4.3.6 Existing Line 3 Supplemented by Rail

Impacts on fisheries, aquatic habitat, wildlife, and wildlife habitat from the combined used of the existing Line 3 infrastructure and the rail alternative would be the same as described above for continued use of existing Line 3 plus those of the rail alternative. Because fewer trains would be required for transport, potential impacts on wildlife from collisions with trains could be reduced. No

changes in impacts, beyond those already addressed in this section, would be expected by using a combination of these alternatives.

5.2.4.3.7 Existing Line 3 Supplemented by Truck

Impacts on fisheries, aquatic habitat, wildlife, and wildlife habitat from the combined used of the existing Line 3 infrastructure and the truck alternative would be the same as described above for continued use of existing Line 3 in addition to those of the truck alternative. Because fewer trucks would be required for transport, potential impacts on wildlife from collisions with trucks would be reduced. No changes in impacts, beyond those already addressed in this section, would be expected by using a combination of these alternatives.

5.2.4.4 Summary and Mitigation

5.2.4.4.1 Summary

Construction and operation of the Applicant's preferred route or any of the CN Alternatives could result in impacts on aquatic habitat, fish, wildlife habitat, and wildlife, ranging from no impact to permanent major impacts. Impacts would likely occur in forested areas and wetlands where habitat fragmentation would be most noticeable as well as in areas where large trees are permanently removed along stream banks. Impacts would also occur where colonial waterbird nesting trees are removed or where freshwater mussel beds are destroyed. Table 5.2.4-12 presents a summary of construction- and operations-related impacts on aquatic habitat, fish, wildlife habitat, and wildlife for the Applicant's preferred route and CN Alternatives.

Avoidance and impact minimization measures that would influence the duration and magnitude of impacts include Applicant-proposed measures, measures proposed by Minnesota DNR, and measures that would be included in state and federal permits. All stream crossings and measureable disturbance to wildlife (e.g., beaver dams, colonial nesting waterbirds, raptor nests) or aquatic species (e.g., fish, mussels) would be reviewed and approved by the authorizing agency prior to construction and may include requirements for further surveys or additional mitigation. Many of the avoidance and mitigation measures and the standard BMPs described for the Applicant's preferred route would be applicable to the CN Alternatives. Because the existing Line 3 pipeline was constructed previously and is operating, it was not considered under construction impacts.

Fisheries and Aquatic Habitat

Construction Impacts

A large potential impact on aquatic habitat due to construction would result from clearing vegetation along stream banks, in-water disturbance from construction of the Applicant's preferred route or SA-04 pipelines across surface water where the wet or dry open-cut crossing methods are used, and if a frac-out occurred during the HDD method in sensitive or impaired waters. In comparison, the rail alternative, truck alternative, and combination alternatives would have temporary to short-term and negligible to minor effects on aquatic habitats due to creation of new impervious surfaces and altered runoff.

Table 5.2.4-12. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Aquatic habitat loss or reduction of aquatic habitat quality from construction activities, including hydrostatic testing	Generally temporary to short-term/ negligible to minor impacts Long-term/minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 174 stream crossings	No impact	Generally temporary to short-term/negligible to minor impacts Long-term/minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 636 stream crossings	Temporary to short-term/negligible impacts	Temporary to short-term/negligible impacts	Temporary to short-term/negligible impacts	Temporary to short-term/negligible impacts
Trout stream habitat loss or reduction of aquatic habitat quality from surface water crossings	Short-term/minor impacts Long-term/major thermal impacts *(where streambanks are cleared of forested or woody vegetation)* • 6 trout stream crossings	No impact	No impact	No impact	No impact	No impact	No impact
Loss of habitat and reduction of habitat quality in Minnesota Lakes of Biological Significance	Short-term/ negligible impacts • 1 MN Lake of Biological Significance	No impact	No impact	No impact	No impact	No impact	No impact

Table 5.2.4-12. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Loss of habitat and reduction of habitat quality in Aquatic Management Areas (AMAs) or Fisheries Management Areas (FMAs)	Short-term/ negligible to minor impacts • 0.4 acre of AMA disturbance	No impact	Short-term/ negligible to minor impacts • 0.2 acre of FMA disturbance	No impact	No impact	No impact	No impact
Loss of habitat and reduction of habitat quality of freshwater mussel bed; mortality of mussels	No impact	No impact	Permanent minor to major impacts, depending on crossing method • 1 freshwater mussel bed disturbed	No impact	No impact	No impact	No impact
Potential for injury, mortality, or disturbance of aquatic species affecting fisheries	Temporary/minor to major impacts	No impact	Temporary/minor to major impacts	Temporary to short-term/negligible impacts	Temporary to short-term/negligible impacts	Temporary to short-term/negligible impacts	Temporary to short-term/negligible impacts
Loss of habitat or reduction of wildlife habitat quality from construction activities and vegetation clearing	Temporary to permanent/minor to major impacts from clearing of the right-of-way • 4,917 acres of habitat, primarily forest and forested wetland	No impact	Temporary to permanent/minor to major impacts from clearing of the right-of-way • 10,585 acres of habitat, primarily agricultural	Permanent/minor impacts • Approximately 363 acres of habitat cleared for offloading facility, reactivation of abandoned line, and building new rail spur	Permanent/minor impacts from clearing • Approximately 100 acres of habitat • Approximately 40 acres of new roads	Permanent/ minor impacts • Approximately 363 acres of habitat cleared for offloading facility, reactivation of abandoned line, and building new rail spur	Permanent/minor impacts from clearing • Approximately 100 acres of habitat • Approximately 40 acres of new roads

Table 5.2.4-12. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Loss of habitat or reduction of wildlife habitat quality in wildlife conservation areas from vegetation clearing	Short-term to long-term/minor impacts from clearing of the right-of-way • 512.9 acres of wildlife conservation areas	No impact	Long-term/minor impacts from clearing of the right-of-way • 847 acres of wildlife conservation areas	No impact	No impact	No impact	No impact
Disturbance or loss of colonial waterbird nesting sites	Temporary/minor to major impacts on the Mahtowa rookery depending on season	No Impact	Impact unknown	No impact	No impact	No impact	No impact
Loss of habitat or reduction of wildlife habitat quality from habitat fragmentation	Permanent/major impacts on primarily forests and wetlands • 38 miles of habitat fragmented • 21 large-block habitats (>100 acres) crossed	No impact	No impact Pipeline would be co-located with existing corridors	No impact	No impact	No impact	No impact
Potential for injury, mortality, or disturbance of wildlife species	Temporary to short-term/minor impacts	No impact	Temporary minor impacts	Temporary minor impacts	Temporary minor impacts	Temporary minor impacts	Temporary minor impacts

Table 5.2.4-12. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Operations Impacts							
Aquatic habitat loss or reduction of aquatic habitat quality from maintenance activities, integrity digs, or small leaks and spills	Short-term to long-term/ minor to major impacts Long-term/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 174 stream crossings	Temporary/minor impacts	Short-term to long-term/ minor to major impacts • 636 stream crossings	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts	Temporary to permanent/ negligible to minor impacts
Trout stream habitat loss or reduction of aquatic habitat quality from right-of-way maintenance at surface water crossings	Short-term/minor impacts Long-term/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 6 trout stream crossings	No impact	No impact	No impact	No impact	No impact	No impact
Loss of habitat and reduction of habitat quality in Minnesota Lakes of Biological Significance	Short-term/ negligible impacts • 1 MN Lake of Biological Significance	No impact	No impact	No impact	No impact	No impact	No impact

Table 5.2.4-12. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Loss of habitat and reduction of habitat quality in Aquatic Management Areas (AMAs) or Fisheries Management Areas (FMAs)	Short-term/ negligible to minor impacts • 0.2 acre of AMA disturbance	No impact	Short-term/ negligible to minor impacts • 0.2 acre of FMA disturbance	No impact	No impact	No impact	No impact
Potential for injury, mortality, or disturbance of aquatic species affecting fisheries	Temporary to long-term/minor impacts	Temporary/minor impacts	Temporary to long-term/minor impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts
Loss of habitat or reduction of wildlife habitat quality from maintenance of cleared vegetation	Permanent/minor to major impacts from maintenance of the right-of-way • 2,197 acres of habitat	Short-term/minor impacts	Permanent/minor to major impacts from maintenance of the right-of-way • 4,431 acres of habitat	Permanent/minor impacts • Approximately 363 acres of habitat cleared for offloading facility, reactivation of abandoned line, and building new rail spur	Permanent/minor impacts from clearing • Approximately 100 acres of habitat • Approximately 40 acres of new roads	Permanent/minor impacts • Approximately 363 acres of habitat cleared for offloading facility, reactivation of abandoned line, and building new rail spur	Permanent/minor impacts from clearing • Approximately 100 acres of habitat • Approximately 40 acres of new roads

Table 5.2.4-12. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Loss of habitat or reduction of wildlife habitat quality in wildlife conservation areas from vegetation clearing	Short-term to long-term/minor impacts from maintenance of the right-of-way • 234.3 acres of wildlife conservation areas	No impact	Short-term/minor impacts from maintenance of the right-of-way • 354 acres of wildlife conservation areas	No impact	No impact	No impact	No impact
Loss of habitat or reduction of wildlife habitat quality from habitat fragmentation	Permanent/minor to major impacts on primarily forests and wetlands • 21 large-block habitats (>100 acres) crossed	No impact	No impact • Pipeline would be co-located with existing corridors	No impact	No impact	No impact	No impact
Potential for injury, mortality, or disturbance of wildlife species	Short-term/minor impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities	Temporary/minor impacts	Short-term/minor impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities	Permanent/minor to major impacts from noise and collisions with wildlife	Permanent/minor to major impacts from collisions with wildlife	Permanent/minor to major impacts from noise and collisions with wildlife	Permanent/minor to major impacts from collisions with wildlife

The Applicant's preferred route would cross fewer surface waters (174) than SA-04 (558), but would cross sensitive trout streams whereas SA-04 would not. In addition, the Applicant's preferred route would pass through substantially more forested habitat than SA-04, which would require removal of woody vegetation that provides shade and stability along some streams. This could result in long-term major impacts on trout streams due to the potential for thermal changes. However, impacts on aquatic habitat, including trout streams, could be temporary to short-term and minor if the crossing method with least disturbance is used and BMPs are in place to reduce impacts. Proper restoration of stream banks after construction of stream crossings, which includes restoring the channel longitudinal profile, channel cross sections, and bankfull elevations as well as revegetating the banks are recommended by permitting agencies, would prevent additional sedimentation as well as changes to the width, depth, and temperature of all streams, including trout streams. Improper restoration of stream crossings could result in sedimentation that leads to wider, shallower, warmer streams. Stream restoration should include the restoration of pre-construction dimension, pattern and profile to the stream channel as well as restoration of the vegetative boundary condition of the streambanks to ensure channel stability and stability of the pipeline crossing. Floodplain connectivity should not be altered by the stream crossing. Ecological processes of a healthy riparian corridor, such as the recruitment of large woody debris for in-stream habitat should be restored to pre-construction conditions or enhanced when possible.

SA-04 would traverse predominantly agricultural land and grasslands. Bank stability and temperature at stream crossings would be affected less by vegetation removal in areas such as these where streams and species have adapted to a more open canopy than the canopies along the Applicant's preferred route. One known freshwater mussel bed occurs within the Minnesota River along the SA-04 route and could be permanently destroyed or damaged by construction if one of the open-cut crossing methods is used. The magnitude of the effects would depend on how much habitat would be lost and the species present.

The waters within the ROIs of the two new pipeline routes provide habitat for species of fish specific to those waters, including important managed recreational species such as muskellunge and trout. Trout streams are particularly sensitive to erosion, sedimentation, and changes to the riparian corridor. Any changes in groundwater connectivity or flow as a result of a pipeline crossing can result in warming of the stream, which may negatively affect habitat suitability for trout and the ecology of invertebrate insects, which form the base of the food web. Fish in the vicinity of surface water crossings along both routes likely would respond to the increased in-stream activities by leaving the construction area and avoiding direct impacts; however, injuries or mortality could occur resulting in temporary and minor impacts for common species in the area. The construction of the rail, truck, and combined alternatives would not require in-stream construction and therefore would have temporary to short-term and negligible impacts on common fish species, primarily due to increased runoff, and no impact on trout streams.

With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on fisheries and aquatic habitats from water appropriation and discharge during pipeline construction would be temporary and minor for the Applicant's preferred route and SA-04. Water used for construction of the offloading and access facilities for the rail and truck alternatives may not be obtained from surface waters; if it is, the withdrawals and discharges are expected to be temporary and minor.

Operations Impacts

The continued use of the existing Line 3 pipeline would not result in changes to the basic existing vegetation management activities for the permanent right-of-way of Line 3 or changes to most other right-of-way maintenance activities. Except for the increase in impacts resulting from the substantial increase in integrity management excavations that would be required for the Line 3 pipeline as addressed below, the impacts of right-of-way maintenance during operation would not be expected to change from the current level.

Vegetation maintenance during operations would require removal of riparian vegetation from the permanent right-of-way of each of the three pipeline alternatives, including areas adjacent to waterbody crossings. The resultant impacts on aquatic habitat would be greatest for the Applicant's preferred route and SA-04 because they would require new stream crossings; there would be no change in the conditions within the streams crossed by the Line 3 pipeline due to vegetation maintenance. The impacts for the new pipelines would be long-term to permanent and minor to major at heavily wooded crossing locations, and short- to long-term and minor to major at crossings within grasslands or croplands. The Applicant's preferred route has substantially fewer stream crossings than SA-04, a fact that can be attributed to the length of the route included in the analysis. Total impact would be additive and distributed along the routes. Where alternatives cross trout streams the impact during operation would be permanent and major due to the increase in temperature; vegetation maintenance of the CN Alternatives would not affect trout streams.

The primary impacts on fisheries and aquatic habitat during operation of the truck or rail offloading facilities in Clearbrook and Superior would be associated with minor changes to stormwater runoff that could reach nearby surface waters. However, the implementation of BMPs and the measures stipulated in the required permits would minimize the potential for stormwater to carry eroded materials or contaminants into nearby surface waters and would therefore minimize impacts on fisheries and aquatic habitats. As a result, the potential impacts would be permanent but negligible to minor, and would affect fewer streams than the new pipeline alternatives.

If minor leaks or spills occur during normal operations for the Applicant's preferred route or SA-04 reach surface waters, there would be negligible to minor changes to surface water quality, and the resultant impacts on fisheries and aquatic habitats would be temporary and negligible to minor. Similarly, normal operation of the rail and truck alternatives would result in a minor increase of the amount of materials dropping from the train or truck engines to the railbed or roadway above the current level. The increase is expected to be typical of the increased number of trains and trucks transporting cargo, with the resultant impacts likely to be temporary and negligible to minor.

For all route options, the Applicant would implement noxious weed plans that include methods to prevent and reduce the introduction and spread of noxious weeds and invasive species, and would implement BMPs for herbicide applications to minimize impact on aquatic and terrestrial resources. As a result, the use of herbicides would result in temporary negligible impacts on fisheries and aquatic habitats. No additional impact would be associated with the continued use of the existing Line 3 pipeline because all portions of the permanent right-of-way have been in place for decades, and the impacts of operation along the permanent right-of-way that are currently occurring would continue without substantial change.

During operation of the pipeline route options, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline at surface water crossings using the wet open-cut or dry open-cut method to access the pipe. For each integrity dig, impacts would be short-term and minor, and would occur periodically over the life of the Project. Continued use of the existing Line 3 would require substantially more integrity digs than the two new pipeline routes due to its advanced age. If pipe segments within surface water crossings need repair or replacement, the pipe may be removed using one of the open-cut methods, which would result in impacts similar to those of construction within surface waters. Because the pipelines for both the Applicant's preferred route and SA-04 would be new, these pipelines would likely require substantially fewer excavations than the Line 3 pipeline.

Wildlife and Wildlife Habitat

Construction Impacts

Construction of SA-04 would affect substantially more than the Applicant's preferred route, with about 10,585 acres of land affected by the former and 4,917 acres of land affected by the latter, but note that the footprint was analyzed for the Applicant's preferred route and that only the Neche to Superior portion of the Applicant's preferred route were analyzed for the CN. Both of these routes would affect land within wildlife management units and Audubon IBAs. Clearing and grading during construction of the offloading facilities for the rail and truck alternatives would affect substantially less wildlife habitat than either of the new pipeline alternatives.

The Applicant's preferred route would pass through habitats that are mainly forested uplands and woody wetlands. In comparison, the majority of habitats affected by construction of SA-04 would have vegetative cover of hay/pasture and cultivated cropland. The impacts of altering or removing these habitats would range from temporary to permanent and minor to major, depending on the specific areas crossed.

Because SA-04 would be co-located with existing pipelines for much of its length, construction of the route would result in less habitat fragmentation compared to the Applicant's preferred route. A total of 38 miles of the Applicant's preferred route permanently fragments 21 large-block habitats.

Construction of the Applicant's preferred route or SA-04 could affect colonial nesting waterbirds if nesting trees need to be removed. No colonial waterbird nesting sites are known to be present in the vicinity of the rail or truck alternative facilities.

For all CN Alternatives, clearing, grading, trenching (for pipelines), and use of construction vehicles and equipment would directly affect some animals, particularly small and mid-sized mammals, reptiles, amphibians, and invertebrates. Members of these species would be affected more than large wildlife because of their relative lack of mobility compared to that of larger animals (e.g., deer and coyotes). The impact of these activities on common wildlife species would be temporary to short-term and minor.

Many animals would be temporarily displaced from the construction work areas and adjacent areas for all CN Alternatives except for the alternative of continued use of the existing Line 3 pipeline. Nearby habitat may provide cover and suitable escape habitat for many of the displaced species, and the more mobile animals could return to the construction work areas after completion of construction and restoration activities, if appropriate habitats are available. These displacements would result in impacts that would generally be temporary to short-term, although permanent at aboveground facilities.

Operations Impacts

The types of impacts associated with operations of the pipeline alternatives differ substantially from those associated with the rail and truck alternatives and the combination alternatives. While the rail and truck alternatives would require substantially fewer acres of permanent vegetation removal compared to the Applicant's preferred route and SA-04, the large number of trains or trucks required would result in increased wildlife mortality from collisions with trains and trucks. This would be a permanent minor to major impact on common highly mobile wildlife such as white-tailed deer, mid-sized mammals, and birds.

For the Applicant's preferred route and SA-04, impacts of right-of-way maintenance within general wildlife habitat, conservation lands, and IBAs would be short-term to permanent and minor to major, depending on the type of habitat present. Maintenance activities could reduce populations of species sensitive to habitat disturbance and could result in permanent, minor effects on breeding birds. These impacts would occur along greater distances for SA-04 based on its greater length compared to the Applicant's preferred route. The routes that would be used by the trains and trucks currently pass through and near WMAs, including IBAs, and no changes in impacts on wildlife habitats or wildlife management units are anticipated from operation of trains or trucks along the existing rail lines and highways.

The maintained permanent rights-of-way may be used as travel corridors by some big game animals and humans and may become attractive to some small species. This could result in permanent and minor effects on common wildlife. Implementation of BMPs to prevent the spread of noxious weeds and invasive species would minimize colonization of these species within or near the rights-of-way with invasive plants.

Continued use of the existing Line 3 would require substantially more integrity digs each year than the two new pipelines due to the advanced age of the Line 3 pipeline. Because of the greater length of the SA-04 route compared to that of the Applicant's preferred route, the probability of the need for integrity digs would be greater for that route. The impacts of excavations would be similar to those occurring during construction of the pipeline but would affect a substantially smaller area.

5.2.4.4.2 Mitigation

In addition to the measures the Applicant would incorporate into the Project to avoid or minimize impacts, including stipulations in the permits required for the Project, Minnesota DNR identified the following measures to reduce impacts on fisheries and wildlife:

- Use the HDD method or a method appropriate for the individual crossing at all crossings of tributaries that are upstream of trout streams.
- Cover open-vent pipe ends with screens at cathodic protection systems to prevent birds and small mammals from becoming trapped in the pipe.
- During maintenance mowing of the permanent right-of-way, the mower blade height should be set at 6 to 8 inches above the ground to reduce injury and mortality impacts on small animals and to prevent erosion.
- If construction activities occur within the recommended buffer distance of 984 feet from the Mahtowa or other heron rookeries during the nesting season from April through August, the Applicant must consult with Minnesota DNR and USFWS to develop BMPs to reduce potential disturbance and impacts.

- Wider vegetated buffers during construction near trout streams (100 feet vs. the standard 50 feet).
- Reducing construction work area width.

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5.2.5 Unique Natural Resources

This section describes potential effects on animals and plants that are protected under federal and state regulations (termed "unique natural resources") from construction and operation of the Applicant's preferred route and the CN Alternatives. In general, the types of impacts that would occur to *individual* protected animals and plants would be comparable to those described for other animals and plants presented in Sections 5.2.3 and 5.2.4. However, the magnitude of impacts on protected *populations* may be more severe than on the more common species because of their limited population size, distribution, and life history, which may warrant consideration of additional measures to minimize impacts.

The analysis of impacts on unique natural resources from construction and operation of the Applicant's preferred route and CN Alternatives considered the potential for injury, mortality, or disturbance to the following:

- Federally listed threatened and endangered species;
- State-listed threatened, endangered, and special concern species;
- Species of Greatest Conservation Need (SGCN);
- Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites;) and
- Scientific and Natural Areas (SNAs).

This first section describes the existing conditions for unique natural resources that may be affected by construction and operation of the Applicant's preferred route and the CN Alternatives. The potential Project-related impacts on these resources due to construction and operation of the Applicant's preferred route are then described, along with measures the Applicant would implement to minimize impacts. Next, the potential impact of unique natural resources due to construction and operation are addressed for each CN Alternative (continued use of the existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, and existing Line 3 supplemented by rail or truck). A summary and comparison of potential Project-related impacts are included at the end of the section, along with potential mitigation measures to be considered. Potential impacts on unique natural resources from an unanticipated crude oil release are addressed in Chapter 10.

5.2.5.1 Regulatory Context and Methodology

5.2.5.1.1 Regulatory Context

The regulatory context for evaluating unique natural resources includes the federal ESA and state-level rules and regulations, including endangered species acts and protections afforded SGCNs, MBS Sites, and SNAs. Birds protected under the MBTA and BGEPA are discussed in Section 5.2.4. This section provides information for regulatory agencies to assess potential impacts on unique natural resources.

Federally Listed Species

The federal ESA (16 U.S. Code 1531 et seq.; 50 CFR Parts 17 and 222) includes provisions for protection and management of species that are federally listed as threatened or endangered and the designated

critical habitat[13] for these species. "Endangered species" are species that are in danger of extinction throughout all or a significant portion of their range. "Threatened species" are species that are likely to become endangered throughout all or a significant portion of their range. A "proposed species" is any species that is proposed in the *Federal Register* for listing as a threatened or endangered species under the ESA. A "candidate species" is any species for which USFWS has sufficient information on biological status and threats to propose the species for listing as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Candidate species receive no statutory protection under the ESA. Section 7 of the ESA directs federal departments and agencies to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any threatened, endangered, or proposed species—or result in the destruction or adverse modification of their designated critical habitat.

According to the ESA, it is illegal to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct" with regard to an endangered or threatened species. In addition, the body parts and products of endangered or threatened species cannot be imported, exported, or sold.

As part of the EIS preparation process, the federal lead agency must consult with USFWS under Section 7 of the ESA to examine potential effects in order to ensure that the proposed project is not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat. USACE is currently preparing a Biological Assessment for the Line 3 Replacement Project in response to Enbridge's application for a CWA 404 Individual Permit. Thus, the USFWS determination on whether the Project would jeopardize the continued existence of any federally listed species or would result in destruction or adverse modification of their critical habitat has yet to be made.

If any federally listed species is likely to be adversely affected, but the project does not jeopardize the existence of a species or adversely modify critical habitat, USFWS will develop a Biological Opinion (BO) identifying the proposed project activities, action area, anticipated impacts, and Reasonable and Prudent Measures (RPMs). RPMs are the actions USFWS believes are necessary to minimize the proposed project's effect on federally listed species. The Applicant would comply with RPMs identified by USFWS to protect federally listed species.

State-Listed Species

The states that would be crossed by the Applicant's preferred route or any of the CN Alternatives are North Dakota, Minnesota, Illinois, Iowa, and Wisconsin. Minnesota, Iowa, Illinois, and Wisconsin each administer a state-level ESA (Table 5.2.5-1). North Dakota defers to species listed under the federal ESA. The state-level ESAs allow for state-level identification and classification of native species with a need for protection or management to ensure their survival as free-ranging populations and to define the process by which listing, management, recovery, and de-listing of a species can be achieved.

[13] "Critical habitat" is a term defined and used in the federal ESA. It is a specific geographic area(s) that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species but that will be needed for its recovery (https://www.fws.gov/sacramento/es/critical-habitat/Home/es_critical-habitat.htm).

Table 5.2.5-1. State Regulations Concerning Endangered Species

State	Administering Agency	Regulation
North Dakota (no state mandate)	U.S. Fish and Wildlife Service	Federal Endangered Species Act
Minnesota	Minnesota Department of Natural Resources	Minnesota's Endangered Species Statute
Iowa	Iowa Department of Natural Resources	Threatened and Endangered Species Program
Illinois	Illinois Department of Natural Resources/ Endangered Species Protection Board	Illinois Endangered Species Protection Act
Wisconsin	Wisconsin Department of Natural Resources	Wisconsin's Endangered Species Laws

Under the state ESAs, "endangered species" are those species that are native to the state and are seriously threatened with extinction throughout all or a significant portion of their range within the state. "Threatened species" are species native to the state that are likely to become endangered species in the foreseeable future throughout a significant portion of their range within the state without cooperative management or removal of threats. "Species of special concern" are any species native to the state that are not endangered or threatened but are extremely uncommon, or have unique or highly specific habitat requirements and deserve careful monitoring of their status.

State-listed endangered and threatened species are protected under state law. Similar to federal species, formal determinations on the level of impact and appropriate conservation measures to adequately protect state-listed species will be finalized by the applicable state agencies (Table 5.2.5-1).

Species of Greatest Conservation Need

The State and Tribal Wildlife Grant Program provides federal grant funds to state agencies for developing and implementing a State Wildlife Action Plan to benefit wildlife species and their habitats. The State Wildlife Action Plans identify SGCN—species that have experienced significant population declines. Threats to these species also are described in the plans and include such factors as habitat loss or fragmentation, competition from non-native species, and stressors related to climate change. The action plans identify the habitats and actions needed to restore or maintain viable populations of these species. While the State Wildlife Action Plans share a common framework, they are tailored to each state's unique wildlife, habitat, and conservation needs. State Wildlife Action Plans provide a catalyst for scientists, conservationists, and communities to come together to pursue common conservation goals. SGCNs in and of themselves have no regulatory protection. However, each state typically includes state and federally listed species on their list of SGCNs. The designation of SGCN applies only to animals; plants are not included in this designation.

Minnesota's 2015 Wildlife Action Plan identifies 346 SGCN and their conservation needs, and outlines proactive conservation actions (Minnesota DNR 2016a). All state and federally listed species that occur in Minnesota are automatically SGCN. Additional non-listed species are SGCN based on specific criteria and expert opinion. Approximately 16 percent of Minnesota's 2,000 wildlife species are considered SGCN. Minnesota's Wildlife Action Plan includes a habitat-based approach that focuses on sustaining and enhancing terrestrial and aquatic habitats for SGCN in the context of larger landscapes. To facilitate

implementation of this approach, the plan identifies a Wildlife Action Network (WAN). The WAN represents the diversity of quality habitats, including terrestrial and aquatic habitats that support SGCN. Areas within the Wildlife Action Network are given an overall score from Low to High based on SGCN richness, SGCN population viability scores, prioritized Sites of Biodiversity Significance, Lakes of Biological Significance, and Stream Indices of Biological Integrity. Areas ranked high are those where multiple high-scoring metrics overlap.

Minnesota Biological Survey Sites of Biodiversity Significance

The MBS (part of Minnesota DNR), surveys for rare species and native plant communities throughout the state. After fieldwork, MBS ecologists assign a biodiversity significance rank to each survey site to assist with guiding conservation and management. MBS Sites have no legal protection within Minnesota. However, they may contain state-listed species and rare wetlands that are protected under the state ESA and the Minnesota WCA, respectively.

The MBS Sites data were used to describe occurrences of high-diversity habitats, which are likely to support rare animals and plants (Minnesota DNR 2016h). The rankings used by the MBS (outstanding, high, moderate, and below) are based on the size and condition of the native plant communities, the presence of rare species, and the landscape context for the site (Minnesota DNR 2016b). “Outstanding” sites contain the highest quality examples of the rarest native plant communities; the best occurrences of the rarest species; and/or the largest, most ecologically intact, or functional landscapes (Minnesota DNR 2016b). “High” sites contain high-quality examples of rare native plant communities, very good occurrences of the rarest species, and/or important functional landscapes (Minnesota DNR 2016b). “Moderate” sites contain moderately disturbed examples of native plant communities, occurrences of rare species, and/or landscapes with strong recovery potential (Minnesota DNR 2016b). “Below” sites lack occurrences of natural features and rare species or do not meet the criteria to be assigned a higher rank (Minnesota DNR 2016b). “Below” sites may include areas of local conservation value, such as native plant and animal habitat, animal movement corridors, open spaces, buffer zones for higher quality natural areas, and areas with high restoration potential (Minnesota DNR 2016b). The guidelines for assigning biodiversity significance ranks to MBS Sites are publicly available (Minnesota DNR 2016c).

Scientific and Natural Areas

Minnesota’s SNAs are state lands that preserve ecological and geological diversity, including rare species, native plants, and significant geological features (Minnesota DNR 2016d). These natural areas are given the highest level of protection and the utmost consideration in assessing potential impacts from nearby projects. Given the ecological significance of these SNAs in Minnesota, most of these areas likely are also identified as MBS Sites. Multiple SNAs in each landscape region are protected in order to capture genetic diversity and prevent the loss of important species, communities, and features (Minnesota DNR 2016d).

The Protected Areas Database of the United States (PAD-US) is a national inventory of protected open space (USGS GAP 2016c). Lands designated as Research Educational Lands or Research Natural Areas within PAD-US were considered analogous to Minnesota SNAs for comparison purposes with the other states crossed by the CN Alternatives.

5.2.5.1.2 Methodology

Impacts were evaluated by considering the areas directly and indirectly affected by construction and operation of the Applicant's preferred route and the CN Alternatives. The potential for effects on rare animals and plants was evaluated (1) directly through a review of available NHIS elemental occurrence locations and species-specific survey data; and (2) indirectly through a review of species' ranges from sources such as the USFWS Information for Planning and Conservation (IPaC) system, USFWS species lists, and habitat assessments such as the USGS GAP, the WAN, the MBS Sites, and state SNAs. These data sources and analysis methods are described below.

For federally listed species, the initial review was conducted at the county level, to identify federally listed species that could be present within the counties crossed by the Applicant's preferred route, existing Line 3, SA-04, and truck and rail routes. The ROI within Minnesota, for the Applicant's preferred route and SA-04 evaluated the 50-foot-wide permanent right-of-way, a 120-foot-wide construction work area, and to a distance of one mile on both sides of the permanent right-of-way. The ROI for truck, and train routes evaluated the area within a 1 mile distance from the centerline of the truck and trail routes. Alternatives that cross counties in North Dakota, South Dakota, Iowa, Illinois, or Wisconsin maintain at county wide ROI. The ROI is reduced in Minnesota to provide more detailed and specific review, which is possible because of the availability of NHIS data within the State. For the state-listed species for the pipeline alternatives, the ROI for the evaluation encompassed the area within a distance of 0.5 mile from the centerline of pipeline routes; this is the area that could be directly or indirectly affected by construction and operation of these alternatives. A discrete ROI was not established for the rail and truck alternatives because specific locations of new facilities were not available. Instead, the expected locations for new construction of rail or truck infrastructure (e.g., offloading facilities, new spur roads, and new rail access) were evaluated qualitatively by reviews of (1) the Clearbrook and Superior terminal areas; (2) undeveloped sites nearby that would be affected by construction and operation; and (3) NHIS data for Minnesota and Wisconsin. Site-specific IPaC and NHIS data were not used to analyze potential operations impacts from increased rail and truck traffic to the Clearbrook and Superior terminals.

Federally Listed Species

As noted, the ROI for federally listed species was established as the area within the anticipated permanent right-of-way and within 1 mile of the permanent right-of-way for the Applicant's preferred route and SA-04, and within approximately 1 mile of rail and truck routes and offloading facilities and new access rails and roads at Clearbrook and Superior. Descriptions of federally protected species within the ROI were based on data from the USFWS IPaC online system and USFWS County Distribution Species Lists. IPaC identifies USFWS-listed endangered, threatened, candidate, and proposed species that occur within specific locations. Federally listed species with the potential to be affected by construction and operations activities were identified within the ROI based on data from IPaC, USFWS County Distribution Species Lists, and NHIS data for the pipeline alternatives, new facilities and new access roads for the rail and truck alternatives, and the rail and truck routes.

In addition to reviews of IPaC reports (USFWS 2016), USFWS County Distribution Species Lists, and NHIS data to determine the presence or absence of federally listed species along the Applicant's preferred route, species-specific surveys collected by Merjent, Inc. on behalf of the Applicant were reviewed. Those data are presented in the following reports:

- 2013–2016 Dakota Skipper and Poweshiek Skipperling Habitat Assessment (Merjent 2016a),

- 2013–2016 Minnesota Protected Flora Field Survey (Merjent 2016c),
- 2014 Dakota Skipper Survey (Merjent 2014a),
- 2014 Northern Long-Eared Bat Acoustic Survey (Merjent 2014b),
- 2015 Northern Long-Eared Bat Acoustic Survey (Merjent 2015c),
- 2015 Northern Long-Eared Bat Mist-Net and Telemetry Survey (Merjent 2015d),
- 2015 Butterfly[14] Survey Report (Merjent 2015a),
- 2016 Northern Long-Eared Bat Acoustic Survey (Merjent 2016b),
- Minnesota Protected Mussel Desktop Habitat Assessment (Merjent 2014c), and
- 2014 Minnesota Protected Mussel Field Survey Report (Rev 0) (Merjent 2015b).

State-Listed Species

Known occurrences of state-listed endangered, threatened, and special concern species within the ROIs were identified from NHIS data provided by each state. The area within 0.5 mile from pipeline route centerlines was used to focus the analyses on those species most likely to be affected by the Applicant's preferred route, SA-04, and existing Line 3.

To document existing conditions and to identify species that may be affected by the proposed activities, the NHIS data were queried for known occurrences of state-listed species within a 0.5 mile radius of the centerlines of the Applicant's preferred route and the CN Alternatives. New facilities and new access for the rail and truck alternatives were evaluated qualitatively by onscreen review of the Minnesota and Wisconsin NHIS data for an area of approximately 0.5 to 1 mile around the Clearbrook and Superior terminals. In addition to the NHIS data, Merjent performed habitat assessments and field surveys for state-listed mussels and plants along the Applicant's preferred route (Merjent 2014c, 2015b, 2016c). These data were incorporated into evaluations.

For the impact assessment, state-listed species documented within 0.5 mile radius were considered potentially affected by Project activities. Given the extensive surveys conducted for mussels and plants along the Applicant's preferred route, potential impacts on these species are anticipated only if they have been documented within the construction footprint of the Applicant's preferred route.

For the SA-04 alternative and the portions of the Applicant's preferred route in North Dakota and Wisconsin, construction impacts were assessed using a 120-foot-wide construction work area centered on the routes. As more detailed information is available for the Applicant's preferred route within Minnesota, construction impacts within Minnesota were assessed based on footprints provided by the Applicant that delineate the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations.

For comparison purposes between the Applicant's preferred route and the CN Alternatives, operations impacts were assessed using a 50-foot-wide permanent right-of-way centered on the routes. Operations impacts for the existing Line 3 were estimated based on species occurrence for the Applicant's preferred route from the North Dakota border to Clearbrook, Minnesota; species occurrence for RA-07 from

[14] Dakota skipper and Poweshiek skipperling

Clearbrook to Carlton, Minnesota; and species occurrence for the Applicant's preferred route from Carlton, Minnesota, to the terminal at Superior, Wisconsin.

New facilities and new access rails and roads for the rail and truck alternatives were evaluated for potential effects by desktop review of available NHIS data.

For the pipeline options, animals were considered potentially affected when they occurred within the ROI for the pipelines, while plants generally were considered affected when they occurred within construction and operation areas. Train and truck transportation routes were evaluated for potential increases in collision mortality effects on those animals identified as occurring within the ROIs for the new rail and truck facilities and the existing Line 3 pipeline route.

Species of Greatest Conservation Need

Gap Analysis Program Species Models

GAP species distribution models identify suitable habitat for individual species within the species' known distribution range. GAP species models use a national wildlife habitat relational database based on habitat associations described in published literature (USGS GAP 2016b). The models are created at 30-meter resolution using core habitat datasets, including detailed land cover, elevation, and hydrological characteristics (e.g., salinity, water type, and water velocity). Birds of conservation concern (BCCs) identified from IPaC searches were used to select the GAP bird species models that were included in this analysis. Protected or rare species lists were compiled for each state that would be crossed by the Applicant's preferred route, existing Line 3, SA-04, and the rail and truck alternatives based on the state lists for threatened, endangered, and special concern species to identify amphibian, reptile, and mammal species models to be included in this analysis. These lists then were compared to species' GAP ranges (USGS GAP 2016a) to identify species that could occur within the regions crossed by the Applicant's preferred route and the CN Alternatives. Then the selected GAP species distribution models were combined to identify habitats used by one or more of the identified species within the ROI. The combined GAP species models identify used habitats and species richness hotspots within the ROIs for the Applicant's preferred route, existing Line 3, the SA-04 route, and rail and truck alternatives in North Dakota, Minnesota, Iowa, Illinois, and Wisconsin.

Project-specific GAP species models were completed for birds, mammals, amphibians, and reptiles. Of the SGCN list generated for the ROI, models were available for 47 bird species,[15] 15 mammal species, and 21 combined amphibian and reptile species (herptiles). GAP species models used in the analyses are listed in Appendix M (Table M-4). Separate summaries were generated for mammals, birds, and herptiles. The areas rated medium and high by the GAP species models have an increased potential to be used by more SGCN, and impacts on these areas could affect habitats used by multiple protected or rare species. This indirectly indicates the potential for an alternative to affect multiple protected or rare species. Based on the modeling, areas affected by the Applicant's preferred route and the CN Alternatives were summarized according to the area of GAP habitat rated as low, medium, and high use by each vertebrate group, as provided in Table 5.2.5-2.

[15] The state list of birds includes over 130 species that could occur in the state. However, inclusion on these lists did not ensure occurrence within the ROI. Therefore, IPaC data were used to identify the occurrence of federally listed BCCs (USFWS 2008) to select habitat-based models for the GAP bird model (Appendix M, Table M-5).

Table 5.2.5-2. GAP Protected or Rare Vertebrate Species Ranges for Determining Low, Medium, and High Species Occurrence

Vertebrate Groups	Range of Species at Risk		
	Low	Medium	High
Mammals	1 to 3	4 to 6	7 to 9
Birds	1 to 6	7 to 12	13 to 19
Amphibians and reptiles (herptiles)	1 to 2	3 to 6	7 to 11

Sources: Cardno modeling based on USGS GAP 2016a, 2016b.

Note:

Categories determined roughly by proportion of species: Low = 33% of total number, Medium = 33% of total number, and High = 33% of total number.

The combined GAP models indicate habitat areas potentially used by one or more protected or rare vertebrate species. The areas rated medium and high have an increased potential to affect habitats used by multiple protected or rare species. This indirectly indicates the potential for the Applicant's preferred route and CN Alternatives to affect multiple protected or rare species.

Minnesota's Wildlife Action Network

To document existing conditions, WAN habitats were identified within 0.5 mile of the pipeline route centerlines and around new rail and truck access and offloading facilities.

For comparison purposes between the Applicant's preferred route and the SA-04 alternative, construction impacts were assessed using a 120-foot-wide construction work area centered on the routes. As more detailed information is available for the Applicant's preferred route within Minnesota, construction impacts within Minnesota were also assessed based on footprints provided by the Applicant that delineate the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations.

For comparison purposes between the Applicant's preferred route and the CN Alternatives, operations impacts were assessed using a 50-foot-wide permanent right-of-way centered on the routes.

The proportion of WAN habitats in the areas affected by the pipeline routes then were compared to the proportion of WAN habitats present within the ROIs.

New rail and truck access and offloading facilities were qualitatively evaluated based on review of likely locations for these facilities with GAP species models and WAN habitats where available within the United States or Minnesota, respectively.

Minnesota Biological Survey Sites of Biodiversity Significance

MBS Sites have not been finalized for northern Minnesota within regions that would be crossed by the Applicant's preferred route. To fill this gap, the Minnesota DNR provided a GIS layer of Preliminary MBS Sites in Minnesota. Native plant communities with conservation status ranks are also discussed in Section 5.2.3. MBS Sites were evaluated based on the areas of direct construction and operation impacts identified through overlay of Project data on this map. Direct impacts for the Applicant's preferred route were based on refined footprints provided by the Applicant that identify the

construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations within Minnesota. Line 3 impacts were estimated by combining the operations permanent right-of-way for the Applicant's preferred route from the North Dakota border to Clearbrook, RA-07 from Clearbrook to Carlton, and the Applicant's preferred route from Carlton to the Wisconsin border in Minnesota. Construction impacts for SA-04 (and the Applicant's preferred route in North Dakota and Wisconsin) were estimated by overlaying a standardized 120-foot-wide construction work area centered on the routes. Operations impacts were estimated by overlaying a standardized 50-foot-wide permanent right-of-way on the MBS Sites map. The affected areas were quantified and the proportion of affected areas with MBS Sites then were compared to the proportion of available MBS Sites within 0.5 mile from the route centerlines. New rail and truck access and offloading facilities were qualitatively evaluated based on an onscreen review of likely locations for these facilities at Clearbrook in relation to MBS Sites in Minnesota.

Scientific and Natural Areas

SNAs were identified using Minnesota SNA data and areas analogous to SNAs using PAD-US, which aggregates information related to state-protected and conservation lands (USGS GAP 2016c).).

5.2.5.2 Existing Conditions

5.2.5.2.1 Applicant's Preferred Route

Federally Listed Species

Four federally listed threatened and endangered species may occur within the ROI for the Applicant's preferred route. The Canada lynx (*Lynx canadensis*) and the gray wolf (*Canis lupus*), and the rusty patch bumble bee (*Bombus affinis*) could be present within the ROI of the Applicant's preferred route, and the northern long-eared bat (*Myotis septentrionalis*) has been documented within the ROI of the Applicant's preferred route (Table 5.2.5-3).

Table 5.2.5-3. Potential Occurrences of Federally Protected Species within the Counties and One Mile Region of Interest for the Applicant's Preferred Route

Listed Species (Common and Scientific Names)	Federal Status	APR (Listed Species, State and County of Occurrence)		NHIS Records of Occurrence within One Mile ROI (Minnesota Counties Only)
		State	Counties	
Whooping crane (*Grus americana*)	Endangered	North Dakota	Pembina	NA
Gray wolf (*Canis lupus*)	Endangered	North Dakota	Pembina	NA
		Wisconsin	Douglas	NA
Northern long-eared bat (*Myotis septentrionalis*)	Threatened	North Dakota	Pembina	NA
		Minnesota	Kittson, Marshall, Pennington, Red Lake, Polk, Clearwater, Hubbard, Wadena, Cass, Crow Wing, Aitkin, Carlton	22 records consisting of individuals and roost trees
		Wisconsin	Douglas	NA

Table 5.2.5-3. Potential Occurrences of Federally Protected Species within the Counties and One Mile Region of Interest for the Applicant's Preferred Route

Listed Species (Common and Scientific Names)	Federal Status	APR (Listed Species, State and County of Occurrence)		NHIS Records of Occurrence within One Mile ROI (Minnesota Counties Only)
		State	Counties	
Gray wolf (*Canis lupus*)	Threatened	Minnesota	Kittson, Marshall, Pennington, Red Lake, Polk, Clearwater, Hubbard, Wadena, Cass, Crow Wing, Aitkin, Carlton	NA
Canada lynx (*Lynx canadensis*)	Threatened	Minnesota	Marshall, Clearwater, Cass, Aitkin, Carlton	NA
		Wisconsin	Douglas	NA
Piping plover (*Charadrius melodus*)	Endangered	Wisconsin	Douglas	NA
Rufa red knot (*Calidris canutus rufa*)	Threatened	Wisconsin	Douglas	NA
Kirtland's warbler (*Setophaga kirtlandii*)	Endangered	Wisconsin	Douglas	NA
Dakota skipper (*Hesperia dacotae*)	Threatened	Minnesota	Kittson, Polk	No Records
Poweshiek skipperling (*Oarisma poweshiek*)	Endangered	Minnesota	Kittson, Marshall, Pennington, Red Lake, Polk,	No Records
Rusty patch bumble bee (*Bombus affinis*)	Endangered	Minnesota	Clearwater	NA
Western prairie fringed orchid (*Platanthera praeclara*)	Threatened	Minnesota	Kittson, Pennington, Red Lake, Polk	No Records
Fassett's locoweed (*Oxytropis campestris var. chartacea*)	Threatened	Wisconsin	Douglas	NA

APR = Applicant's preferred route

State-Listed Species

Endangered and Threatened Species

The following state-listed endangered or threatened animals have been documented within the ROI of the Applicant's preferred route: northern long-eared bat (*Myotis septentrionalis*), wood turtle (*Glyptemys insculpta*), pugnose shiner (*Notropis anogenus*), and fluted shell (*Lasmigona costata*) (Table 5.2.5-4). The occurrences of northern long-eared bats are within Minnesota, where this bat is listed as a species of special concern. The Applicant completed mussel field surveys in 2014 at 16 sites along the Applicant's preferred route in Minnesota (including the known fluted shell location), and no state-listed threatened or endangered mussels were found (Merjent 2015b).

Twenty-one state-listed endangered or threatened plants have been documented within the ROI, with 13 of these plants identified as potentially occurring within construction work areas (Table 5.2.5-5).

Table 5.2.5-4. Known Occurrences of State-Protected Animal Species within the Region of Interest for the Applicant's Preferred Route

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences[b]		
			Con	Op	Within 0.5 Mile
Mammals					
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	WI/T IL/T	16	15	27
Amphibians and Reptiles					
Wood turtle (*Glyptemys insculpta*)	Found in moderate- to fast-flowing clear streams or rivers associated with forested riparian corridors, which provide primary overwintering, courtship, basking, and foraging habitat. Typically inhabited waterways possess a sand, gravel, or cobble substrate with limited silt or muck. Nesting occurs in well-drained open or sparsely vegetated sandy soils, typically within 200 feet of suitable aquatic habitat. Nesting habitat includes native dry prairies, moderately sloughing sand banks, sandbars, agricultural fields, or areas of disturbed sandy soils that support no or sparse ground layer vegetation.	WI/T MN/T	--	--	1
Fish					
Pugnose shiner (*Notropis anogenus*)	Found in glacial lakes and streams with an abundance of submerged vegetation. Prefers low-velocity waters with a substrate of sand, mud, or gravel. Shallow waters in warm months and deeper waters in cold months.	MN/T	1	1	1
Mollusks					
Fluted-shell mussel (*Lasmigona costata*)	Streams or river beds. Likely spawns from June to July.	MN/T	1	1	1

Sources: Minnesota DNR 2016e; North Dakota GFP 2016; Wisconsin DNR 2016.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

[a] State/Status: T = Threatened, MN = Minnesota, IA = Iowa, IL = Illinois, WI = Wisconsin

[b] Minnesota only: Con = sum of pipeline construction work area, ATWS, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves.

North Dakota and Wisconsin: Con = occurrences based on 120-foot-wide construction work area centered on the pipeline. Op = occurrences based on 50-foot-wide permanent right-of-way centered on the pipeline.

"--" = no occurrence

Table 5.2.5-5. Known Occurrences of State-Protected Plant Species within the Region of Interest for the Applicant's Preferred Route

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences[b]		
			Con	Op	Within 0.5 Mile
Nonvascular Plants					
A species of liverwort [Woollywort] (*Trichocolea tomentella*)	Damp, shaded rocks in forested rich peatland and wet forest. May through September, or anytime ground is not covered by snow.	MN/T	--	--	1
Vascular Plants					
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	MN/T	1	1	2
Bog bluegrass (*Poa paludigena*)	Perched upon wet substrates (e.g., moss, fallen trees) in spring-fed swamps. Specifically, occurs within *Fraxinus nigra-Betula lutea* swamps along the base of steep bluffs and at the head of the spring that feeds into the swamp. Blooms in late May to early June.	MN/T	1	1	1
Bristle-berry (*Rubus fuller*)	Open sandy sites with a high water table. Blooms mid-June to mid-July; fruits in August.	MN/T	--	--	1
Butternut (*Juglans cinerea*)	Full sunlight on well-drained soils of bottomlands and floodplains.	MN/E	1	1	1
Clinton's bulrush (*Trichophorum clintonii*)	Rocky river ledges, argillaceous soils, clearings of fir forests, and prairie and open woods. Reproductive structures are present from early May through the end of June in southern Minnesota, and in late May through June in northern Minnesota.	MN/T	--	--	1
Clustered bur-reed (*Sparganium glomeratum*)	Cold ditches and pools within sedge meadows, willow-alder thickets and, occasionally, tamarack stands on the Lake Superior clay plain. Blooms late June through late July, and fruits late July through early September.	WI/T	1	1	4
Gray ragwort (*Packera cana*)	Northern plains, including the upper slopes of dry prairie remnant hills in sandy or gravelly soil. Flowers from May to June.	MN/E	--	--	1
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in spring, and flowers mid-summer.	MN/T	1	1	1
Handsome sedge (*Carex formosa*)	Typically occurs in or at the edge of limey swamps, seeps, or bottomland forests but known to occur in moist, rich upland forests. Also can occur in disturbed habitats such as road edges and disturbed prairies. Blooms throughout June and fruits throughout July.	MN/E	1	--	2
Marsh-grass-of-Parnassus (*Parnassia palustris*)	Rich or spring fens; calcareous fens, wet meadows, clay seepage bluffs. Blooms August to September.	WI/T	--	--	1

Table 5.2.5-5. Known Occurrences of State-Protected Plant Species within the Region of Interest for the Applicant's Preferred Route

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences[b]		
			Con	Op	Within 0.5 Mile
Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	In woods and on hummocks in swamps, and in cool to warm, mostly rich, subacid soils. May be found in open fields at the northern end of its range. Site elevations range from near sea level to 3,600 feet.	MN/T	3	2	5
Neat spike-rush (*Eleocharis nitida*)	Occurs only near Superior on wet exposed clay in ditches and openings in alder thickets and marshes. Blooms in June, and fruits in late June through early September.	WI/E	2	2	5
Purple-flowered bladderwort (*Utricularia purpurea*)	Adjacent to boggy shorelines in small- to medium-size lakes with high water quality. Flowers from mid-July to September.	MN/E	--	--	1
Red saltwort (*Salicornia rubra*)	Salt flats, saline swales, alkaline depressions, and exposed shores of alkaline lakes. Flowers from late July into August.	MN/T	1	--	1
Seaside crowfoot [Alkali buttercup] (*Ranunculus cymbalaria*)	Salted roadsides near Superior; and sandy or muddy shores, marshes, ditches, and harbors along Lake Michigan. Blooms May to August.	WI/T	2	2	4
Small yellow water crowfoot (*Ranunculus gmelinii*)	Creeks, streams, ponds associated with cool forested swamps, marshes, or groundwater seeps. Blooms July to August.	WI/E	2	2	3
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	MN/T	2	2	6
Sweet colt's foot (*Petasites sagittatus*)	Cold marshes and swamp openings. Blooming occurs throughout May; fruiting occurs throughout June.	WI/T	5	5	8
Tea-leaved willow (*Salix planifolia* ssp. *planifolia*)	Near Lake Superior, including on bedrock shorelines in the Apostle Islands. Blooming occurs throughout May; fruiting occurs throughout June.	WI/T	--	--	1
Whorled nutrush (Scleria verticillata)	Restricted to the least disturbed calcareous fens in the prairie region. Blooms late June through late July.	MN/T	--	--	1

Sources: Minnesota DNR 2016e; Wisconsin DNR 2016; North Dakota GFP 2016; Merjent 2016b.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

[a] State/Status: E = Endangered, T = Threatened, MN = Minnesota, IA = Iowa, IL = Illinois, WI = Wisconsin

[b] Minnesota only: Con = sum of pipeline construction work area, ATWS, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves;

North Dakota and Wisconsin: Con = occurrences based on 120-foot-wide construction work area; Op = occurrences based on 50-foot-wide permanent right-of-way

"--" = no occurrence

Occurrences of state-listed threatened and endangered species based on NHIS database locations and rare plant surveys for the Applicant's preferred route are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants). State-listed species that also are federally listed are included in these tables when they have been documented as elemental occurrences within NHIS data.

Special Concern Species

The number of state-listed special concern species with occurrences within the ROI include 5 invertebrates, 14 vertebrates, and 14 plants. Occurrences of state-listed special concern species based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants).

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined GAP models indicate habitat areas potentially used by one or more protected or rare vertebrate species; habitat areas that would experience the greatest impact are depicted in Figures 5.2.5-1 to 5.2.5-3. The areas rated medium and high have an increased potential to affect habitats used by multiple protected or rare species. Much of the area within the ROI is rated medium and high for mammals (41 percent, 4 to 7 species); while little is rated medium and high for birds (15 percent, 7 to 19 species), or amphibians and reptiles (less than 1 percent, 3 to 11 species). This indirectly indicates the potential for the Applicant's preferred route to affect multiple protected or rare species.

Minnesota's Wildlife Action Network

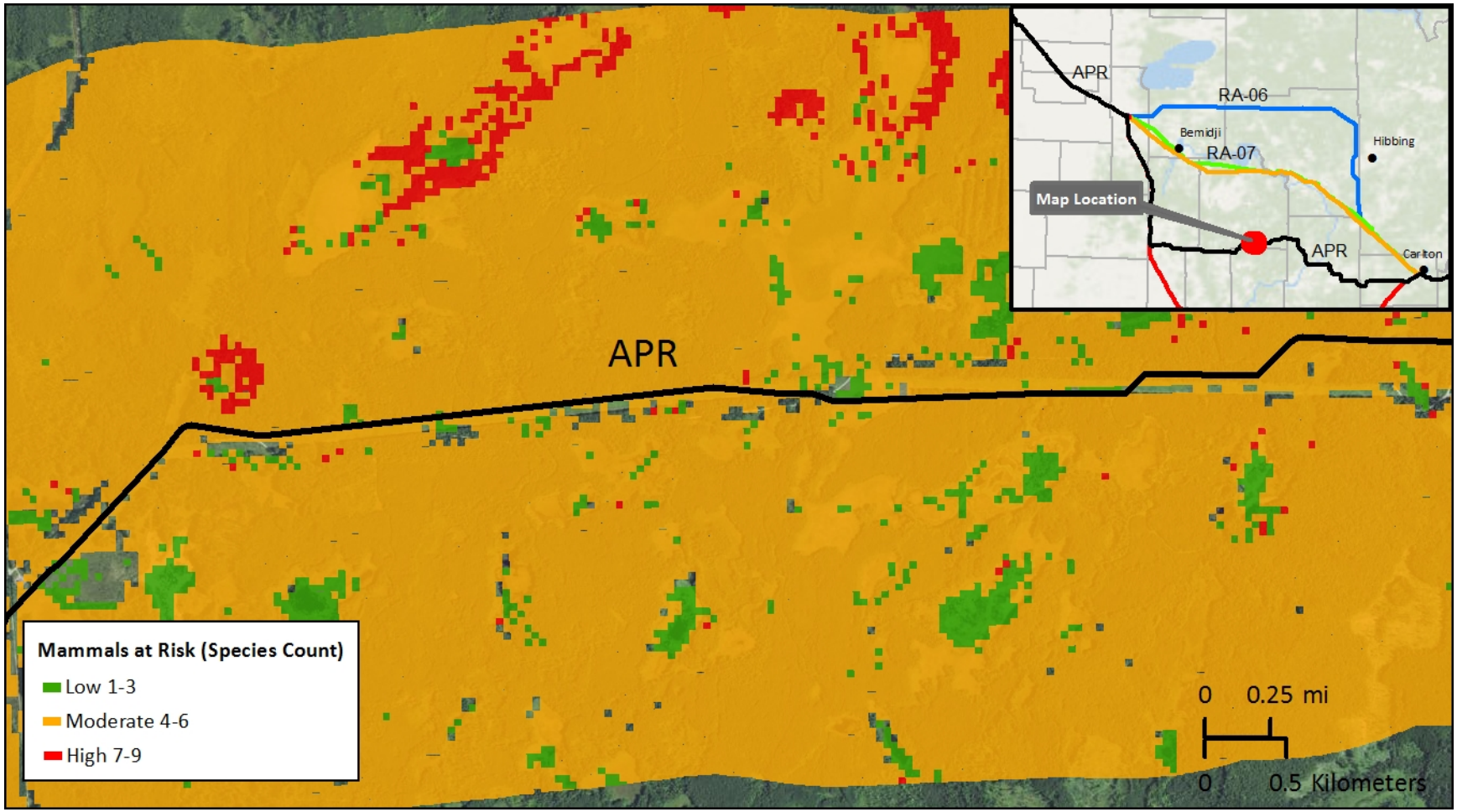
The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota crossed by the Applicant's preferred route (Minnesota DNR 2016f). As shown in Figure 5.2.5-4, the Applicant's preferred route would cross through habitats within the WAN that could be used by multiple SGCNs. Approximately 30 percent of the area within the ROI is within the WAN.

Minnesota Biological Survey Sites of Biodiversity Significance

The Applicant's preferred route would cross through areas with MBS Sites (Figure 5.2.5-5); areas scoring outstanding, high, and moderate could include habitats used by rare animals and plants. Approximately 21 percent of the area within the ROI is rated as an outstanding (less than 1 percent), high (3 percent), or moderate (17 percent) MBS Site.

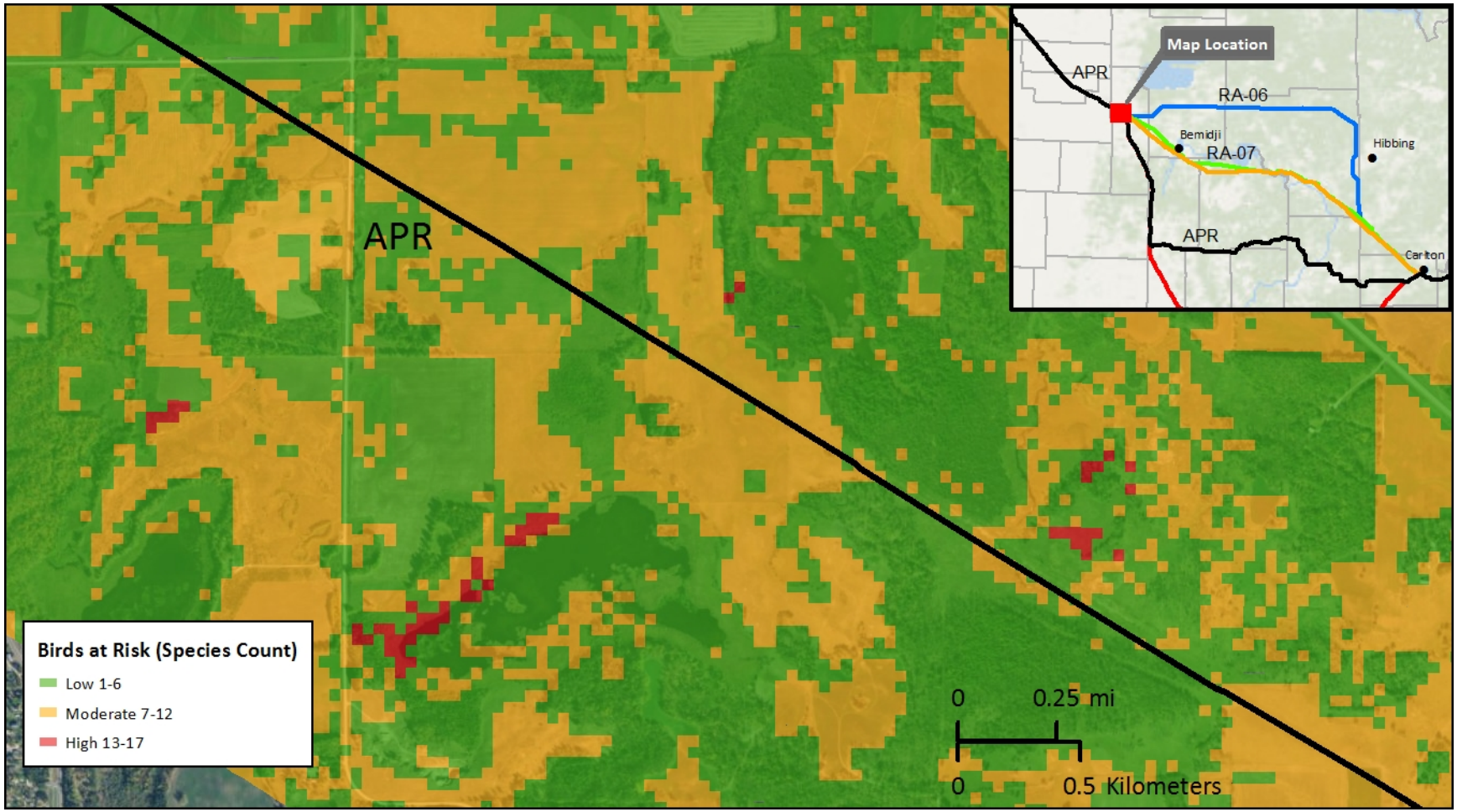
Scientific and Natural Areas

A review of PAD-US and Minnesota's SNAs indicated that no SNAs are located within the ROI.



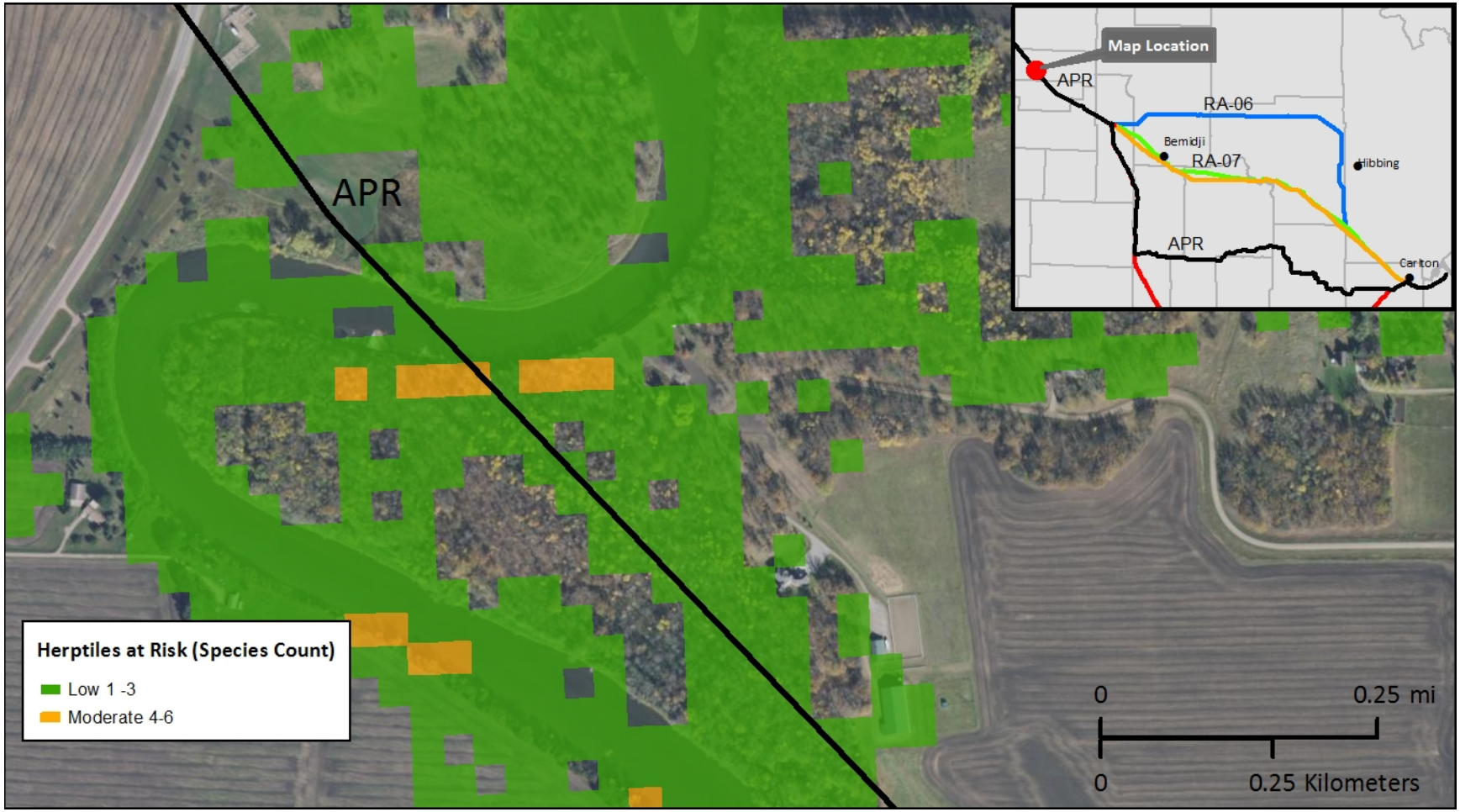
Source: Cardno analysis based on USGS GAP 2016a, 2016b.

Figure 5.2.5-1. GAP Analysis Program Protected or Rare Mammal Habitats



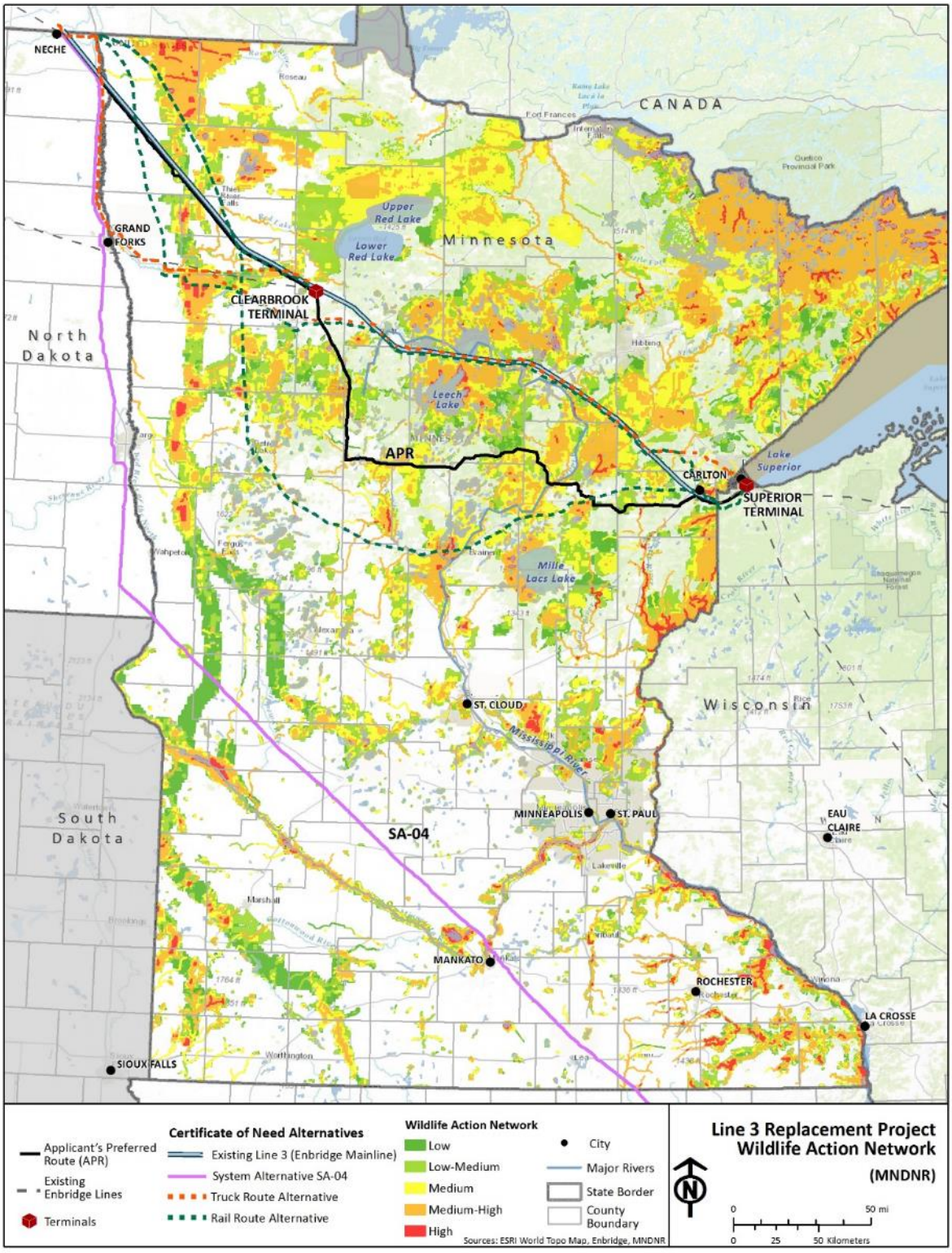
Source: Cardno analysis based on USGS GAP 2016a, 2016b.

Figure 5.2.5-2. GAP Analysis Program Protected or Rare Bird Habitats



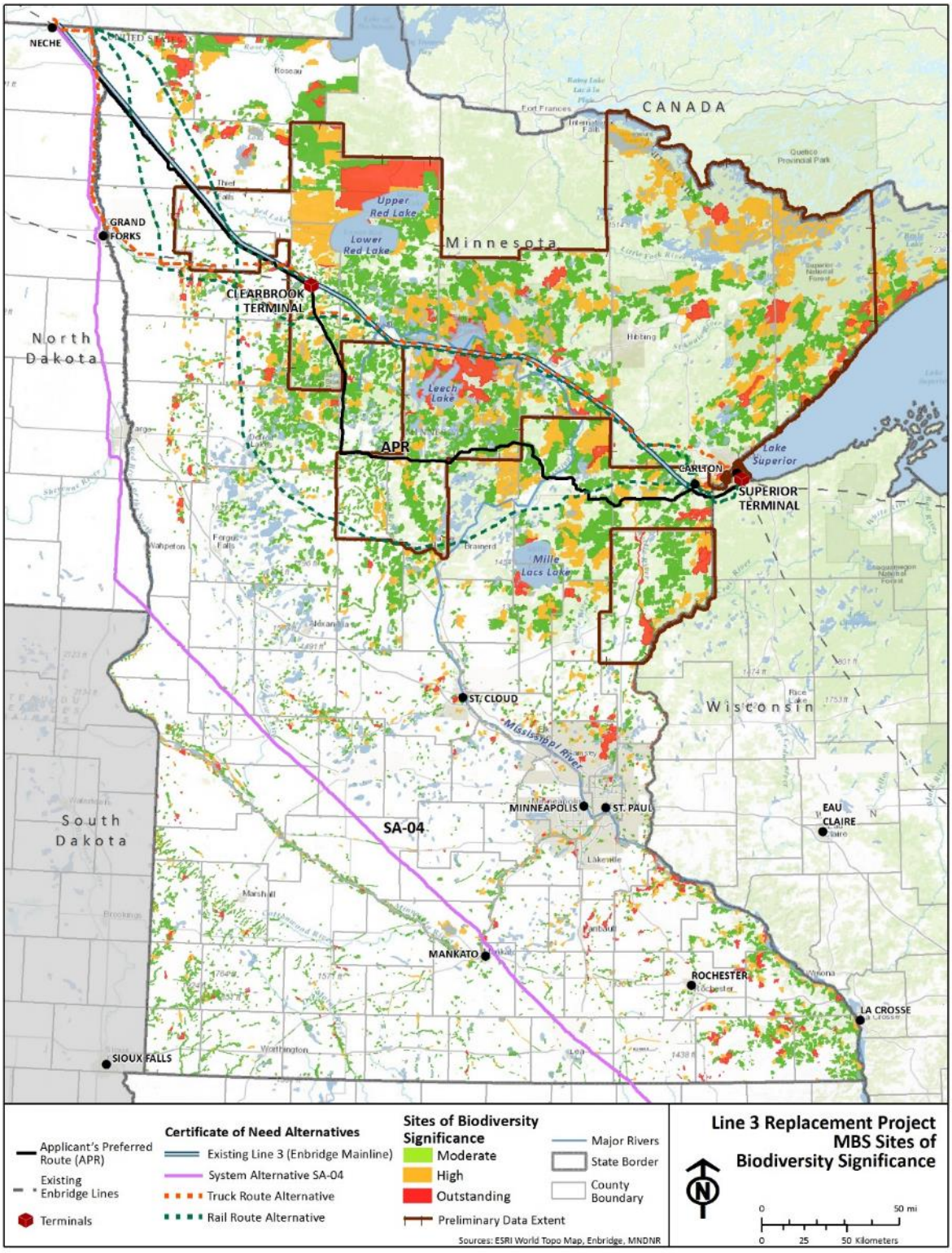
Source: Cardno analysis based on USGS GAP 2016a, 2016b.

Figure 5.2.5-3. GAP Analysis Program Protected or Rare Amphibian and Reptile (Herptile) Habitats



Source: Minnesota DNR 2016f.

Figure 5.2.5-4. Minnesota Wildlife Action Network Habitats



Source: Minnesota DNR 2016b.

Figure 5.2.5-5. Minnesota Biological Survey Sites of Biodiversity Significance

5.2.5.2.2 Continued Use of Existing Line 3

Federally Listed Species

Three federally listed threatened and endangered species are likely to occur within the ROI for the existing Line 3 pipeline route. No candidate species are likely to occur along the existing Line 3 pipeline.

State-Listed Species

Endangered and Threatened Species

State-listed endangered or threatened animals that have been documented within the ROI for the existing Line 3 pipeline include the northern long-eared bat, wood turtle, and fluted-shell (Table 5.2.5-6). The northern long-eared bat occurrences are located within Minnesota, where this bat is considered a special concern species.

A total of 15 threatened and 3 endangered plants have been documented within the ROI (Table 5.2.5-7). Eight of the 18 state-listed threatened and endangered plants occurring within the ROI also are known to occur within the permanent pipeline right-of-way (three in Minnesota – beaked spikerush [*Eleocharis rostellata*], hair-like beak rush [*Rhynchospora capillacea*], and sterile sedge [*Carex sterilis*]; and five in Wisconsin – clustered bur-reed [*Sparganium glomeratum*], neat spike-rush [*Eleocharis nitida*], seaside crowfoot [*Ranunculus cymbalaria*], small yellow-water crowfoot [*Ranunculus gmelinii*], and sweet colt's foot [*Petasites sagittatus*]) (Table 5.2.5-7). Occurrences of state-listed threatened and endangered animals and plants based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants). State-listed species that are also federally listed are included in these tables when they have been documented as elemental occurrences within NHIS data.

Special Concern Species

State-listed special concern species with occurrences within the ROI for the existing Line 3 pipeline include four invertebrates and nine vertebrates. The invertebrates include a caddisfly *Anabolia ozburni*, and three mussels – black sandshell (*Ligumia recta*), creek heelsplitter (*Lasmigona compressa*), and pink heelsplitter (*Potamilus alatus*). The vertebrates include three bats – big brown bat *(Eptesicus fuscus*), little brown myotis (*Myotis lucifugus*), and northern long-eared bat; and six birds – Connecticut warbler (*Oporornis agilis*), Le Conte's sparrow (*Ammodramus leconteii*), Nelson's sparrow (*Ammodramus nelsoni*), short-eared owl (*Asio flammeus*), trumpeter swan (*Cygnus buccinator*), and yellow rail (*Coturnicops noveboracensis*). Twelve of the 17 state special concern plants occurring within the ROI also are known to occur within the permanent pipeline right-of-way (10 in Minnesota – barren strawberry *[Waldsteinia fragarioides* var. *fragarioides*], blunt sedge [*Carex obtusata*], false mountain willow [*Salix pseudomonticola*], few-flowered spiderush [*Eleocharis quinqueflora*], least moonwort [*Botrychium simplex*], Mingan moonwort [*Botrychium minganense*], northern single-spike sedge [*Carex scirpoidea*], pale moonwort [*Botrychium pallidum*], small white lady's-slipper [*Cypripedium candidum*], and St. Lawrence grapefern [*Botrychium rugulosum*]; and 2 in Wisconsin – mamillate spike-rush [*Eleocharis mamillata*], and Vasey's rush [*Juncus vaseyi*]). Occurrences of state special concern species based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants).

Table 5.2.5-6. Known Occurrences of State-Protected Animals within the Region of Interest and Permanent Right-of-Way for the Existing Line 3 Pipeline

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences	
			Operations[b]	Within 0.5 Mile
Mammals				
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	WI/T[c]	1	3
Amphibians and Reptiles				
Wood turtle (*Glyptemys insculpta*)	Found in moderate- to fast-flowing clear streams or rivers associated with forested riparian corridors, which provide primary overwintering, courtship, basking, and foraging habitat. Typically inhabited waterways possess a sand, gravel, or cobble substrate with limited silt or muck. Nesting occurs in well-drained open or sparsely vegetated sandy soils, typically within 200 feet of suitable aquatic habitat. Nesting habitat includes native dry prairies, moderately sloughing sand banks, sandbars, agricultural fields, or areas of disturbed sandy soils that support no or sparse ground layer vegetation.	WI/T	--	1
Mollusks				
Fluted-shell mussel (*Lasmigona costata*)	Streams or river beds. Likely spawns from June to July.	MN/T	1	1

Sources: Minnesota DNR 2016e; Wisconsin DNR 2016; Merjent 2016b.

Notes:

[a] State/Status: T = Threatened, MN = Minnesota, WI = Wisconsin

[b] Operations: occurrence based on 50-foot-wide permanent right-of-way centered on the pipeline.

[c] Occurrences are within Minnesota where northern long-eared bats are listed as a Species of Concern

"--" = no occurrence

Table 5.2.5-7. Known Occurrences of State-Protected Plants along the Existing Line 3 Pipeline

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences	
			Operations[b]	Within 0.5 Mile
Vascular Plants				
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	MN/T	1	2
Clustered bur-reed (*Sparganium glomeratum*)	Cold ditches and pools within sedge meadows, willow-alder thickets and, occasionally, tamarack stands on the Lake Superior clay plain. Blooms late June through late July, and fruits late July through early September.	WI/T	1	4
Goblin fern (*Botrychium mormo*)	Rich leaf mold on shaded forest floors in mature maple-basswood and maple-basswood-beech forests. Plants emerge from the ground in June, and sporangia open in late September.	MN/T	--	1
Gray ragwort (*Packera cana*)	Northern plains, including the upper slopes of dry prairie remnant hills in sandy or gravelly soil. Flowers from May to June.	MN/E	--	1
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in spring, and flowers mid-summer.	MN/T	1	2
Handsome sedge (*Carex formosa*)	Typically occurs in or at the edge of limey swamps, seeps, or bottomland forests but known to occur in moist, rich upland forests. Also can occur in disturbed habitats such as road edges and disturbed prairies. Blooms throughout June and fruits throughout July.	MN/E	--	2
Hidden-fruited bladderwort (*Utricularia geminiscapa*)	Wetlands, including bogs, fens, lakes, ponds, and river or lake shores. Blooms July through August.	MN/T	--	1
Marsh-grass-of-Parnassus (*Parnassia palustris*)	Rich or spring fens; calcareous fens, wet meadows, clay seepage bluffs. Blooms August to September.	WI/T	--	1
Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	In woods and on hummocks in swamps, and in cool to warm, mostly rich, sub-acid soils. May be found in open fields at the northern end of its range. Site elevations range from near sea level to 3,600 feet.	MN/T	--	1
Neat spike-rush (*Eleocharis nitida*)	Occurs only near Superior on wet exposed clay in ditches and openings in alder thickets and marshes. Blooms in June, and fruits in late June through early September.	WI/E	2	5

Table 5.2.5-7. Known Occurrences of State-Protected Plants along the Existing Line 3 Pipeline

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences	
			Operations[b]	Within 0.5 Mile
Ram's head orchid (*Cypripedium arietinum*)	Cool, dense white cedar, balsam, and spruce swamps; nearly pure sand over limestone beach cobble or bedrock, mulched with conifer needles; and in mesic soil of sandy loam or clay under the partial shade of conifer or mixed forest. Prefers cool, sub-acid or neutral soil, loam, or sand in upland sites and nutrient-poor peat in lowland sites. Flowers from late May through mid-June.	MN/T	--	1
Red saltwort (*Salicornia rubra*)	Salt flats, saline swales, alkaline depressions, and exposed shores of alkaline lakes. Flowers from late July into August.	MN/T	--	1
Seaside crowfoot (*Ranunculus cymbalaria*)	Salted roadsides near Superior; and sandy or muddy shores, marshes, ditches, and harbors along Lake Michigan. Blooms May to August.	WI/T	2	4
Small yellow-water crowfoot (*Ranunculus gmelinii*)	Cold brooks and springs; and shallow water and muddy shores of ditches, streams, and lakes.	WI/T	2	3
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	MN/T	2	6
Sweet-colt's foot (*Petasites sagittatus*)	Cold marshes and swamp openings. Blooming occurs throughout May; fruiting occurs throughout June.	WI/T	5	8
Tea-leaved willow (*Salix planifolia* ssp. *planifolia*)	Near Lake Superior, including on bedrock shorelines in the Apostle Islands. Blooming occurs throughout May; fruiting occurs throughout June.	WI/T	--	1
Whorled nutrush (*Scleria verticillata*)	Restricted to the least disturbed calcareous fens in the prairie region. Blooms late June through late July.	MN/T	--	1

Sources: Minnesota DNR 2016e; Wisconsin DNR 2016; North Dakota GFP 2016; Merjent 2016b.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

[a] State/Status: E = Endangered, T = Threatened, MN = Minnesota, WI = Wisconsin

[b] Minnesota Only: Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves

Wisconsin: Op = occurrences based on 50-foot-wide permanent right-of-way centered on the pipeline.

"--" = no occurrence

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined GAP models indicate habitat areas potentially used by one or more protected or rare vertebrate species. The areas rated medium and high have an increased potential to affect habitats used by multiple protected or rare species. Much of the area within the ROI for the existing Line 3 is rated medium and high for mammals (49 percent, 4 to 9 species); while little is rated medium and high for birds (12 percent, 7 to 19 species) or amphibians and reptiles (less than 1 percent, 3 to 11 species). This indirectly indicates the potential for continued use of existing Line 3 to affect multiple protected or rare species.

Minnesota's Wildlife Action Network

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota crossed by the existing Line 3 pipeline (Minnesota DNR 2016f). As shown in Figure 5.2.5-4, the existing Line 3 pipeline crosses habitats within the WAN that could be used by multiple SGCNs. Approximately 32percent32 percent of the area within the ROI is within WAN.

Minnesota Biological Survey Sites of Biodiversity Significance

The existing Line 3 pipeline crosses areas with MBS Sites (Figure 5.2.5-5); areas scoring outstanding, high, and moderate could include habitats used by rare animals and plants. Approximately 19 percent of the area within the ROI is identified as an outstanding (2 percent), high (4 percent), or moderate (13 percent) rated MBS Site.

Minnesota Scientific and Natural Areas

Review of PAD-US indicated that no SNAs are located within the ROI (USGS GAP 2016c). Review of Minnesota's SNAs identified one SNA that occurs within ROI, the Wawina Peatland SNA (Minnesota DNR 2016d, 2016g). Natural areas are distinguished by undisturbed plant communities, rare or endangered species habitat, seasonal habitat, natural geologic formations and features, and plant communities undergoing natural succession (Minnesota DNR 2016d). The Wawina Peatland SNA is a large patterned peatland complex with ovoid island patterns, a featureless water track, raised bog, and crested raised bog (Minnesota DNR 2016g). This SNA is located approximately 0.4 mile northeast of the existing Line 3 pipeline. A Burlington Northern Santa Fe (BNSF) rail line lies between the SNA and the existing Line 3 pipeline.

5.2.5.2.3 System Alternative SA-04

Federally Listed Species

Six federally listed species, three threatened and three endangered, are known to occur in the North Dakota counties crossed by SA-04. Five federally listed species, four threatened and one endangered, are known to occur within the Minnesota Counties transected by SA-04. NHIS data does not indicate records of federally listed threatened, endangered, or candidate animal or plant species, were identified within the ROI for the segment of SA-04 in Minnesota. Thirteen federally listed species, six threatened and seven endangered, are known to occur within the Iowa Counties crossed by SA-04. Fifteen federally listed species, one candidate, seven threatened, and seven endangered, are known to occur within the Illinois counties crossed by SA-04. A number of the federally listed species are found in multiple states and counties along the ROI for SA-04. A total of twenty three federally listed plant and animal species,

10 threatened, 12 endangered, and one candidate, are known to occur within counties transected by SA-04 (Table 5.2.5-8).

Table 5.2.5-8. Potential Occurrences of Federally Protected Species within the Counties and One Mile Region of Interest for SA-04

Listed Species (Common and Scientific Names)	Federal Status	SA-04 (Listed Species State and County Occurrence)		NHIS Records of Occurrence within One Mile ROI (Minnesota Counties Only)
		State	Counties	
Whooping crane (*Grus americana*)	Endangered	North Dakota	Cass, Grand Forks, Pembina, Richland, Traill, Walsh	NA
Gray wolf (*Canis lupus*)	Endangered	North Dakota	Cass, Grand Forks, Pembina, Richland, Traill, Walsh	NA
Northern long-eared bat (*Myotis septentrionalis*)	Threatened	North Dakota	Cass, Grand Forks, Pembina, Richland, Traill, Walsh	NA
		Minnesota	Traverse, Stevens, Swift, Kandiyohi, Chippewa, Renville, Sibley, Le Sueur, Nicollet, Blue Earth, Waseca, Freeborn, Mower	No Records
		Iowa	Winneshiek, Howard, Mitchell, Worth, Cerro Gordo, Chickasaw, Floyd, Clayton, Fayette, Bremer, Dubuque, Delaware, Buchanan, Black Hawk, Jackson, Jones, Linn, Clinton, Cedar, Scott, Muscatine	NA
		Illinois	Carroll, Whiteside, Rock Island, Henry, Lee, Bureau, La Salle, Grundy, Will	NA
Indiana bat (*Myotis sodalis*)	Endangered	Iowa	Cedar, Muscatine, Scott	NA
		Illinois	Bureau, Carroll, Grundy, Henry, La Salle, Lee, Rock Island, Whiteside,	NA
Eastern massasauga (*Sistrurus catenatus*)	Threatened	Iowa	Muscatine	NA
		Illinois	Will	NA

Table 5.2.5-8. Potential Occurrences of Federally Protected Species within the Counties and One Mile Region of Interest for SA-04

Listed Species (Common and Scientific Names)	Federal Status	SA-04 (Listed Species State and County Occurrence)		NHIS Records of Occurrence within One Mile ROI (Minnesota Counties Only)
		State	Counties	
Higgins eye pearlymussel (*Lampsilis higginsii*)	Endangered	Iowa	Clayton, Clinton, Jackson, Jones, Linn, Muscatine, Scott, Dubuque	NA
		Illinois	Carroll, Rock Island, Whiteside	NA
Spectaclecase mussel (*Cumerlandia monodonta*)	Threatened	Iowa	Muscatine, Scott	NA
		Illinois	Rock Island	NA
Sheepnose mussel (*Plethobasus cyphyus*)	Endangered	Iowa	Muscatine, Scott	NA
		Illinois	Rock Island, Whiteside, Will	NA
Scaleshell (*Leptodea leptodon*)	Endangered	Illinois	Grundy	NA
Iowa Pleistocene snail (*Discus macclintocki*)	Endangered	Iowa	Jackson, Fayette, Dubuque, Clinton, Clayton	NA
Dakota skipper (*Hesperia dacotae*)	Threatened	North Dakota	Richland	NA
		Minnesota	Chippewa	No Records
Poweshiek skipperling (*Oarisma poweshiek*)	Endangered	North Dakota	Richland	NA
		Minnesota	Chippewa	No Records
		Iowa	Howard, Cerro Gordo	NA
Rusty patch bumble bee (*Bombus affinis*)	Endangered	Iowa	Clayton, Black Hawk, Winneshiek	NA
Hine's emerald dragonfly (*Somatochlora hineana*)	Endangered	Illinois	Will	NA
Rattlesnake-master borer moth (*Papaipema eryngii*)	Candidate	Illinois	Grundy, Will	NA

Table 5.2.5-8. Potential Occurrences of Federally Protected Species within the Counties and One Mile Region of Interest for SA-04

Listed Species (Common and Scientific Names)	Federal Status	SA-04 (Listed Species State and County Occurrence)		NHIS Records of Occurrence within One Mile ROI (Minnesota Counties Only)
		State	Counties	
Western prairie fringed orchid (*Platanthera praeclara*)	Threatened	North Dakota	Richland	NA
		Minnesota	Mower	No Record
		Iowa	Winneshiek, Howard, Mitchell, Worth, Cerro Gordo, Chickasaw, Floyd, Clayton, Fayette, Bremer, Dubuque, Delaware, Buchanan, Black Hawk, Jackson, Jones, Linn, Clinton, Cedar, Scott, Muscatine	NA
Prairie bush clover (*Lespedeza leptostachya*)	Threatened	Minnesota	Renville, Mower	No Records
		Iowa	Winneshiek, Howard, Mitchell, Worth, Cerro Gordo, Chickasaw, Floyd, Clayton, Fayette, Bremer, Dubuque, Delaware, Buchanan, Black Hawk, Jackson, Jones, Linn, Clinton, Cedar, Scott, Muscatine	NA
		Illinois	Lee	NA
Northern monkshood (*Aconitum noveboracensel*)	Threatened	Iowa	Jackson, Dubuque, Delaware, Clayton	NA
Eastern prairie fringed orchid (*Platanthera leucophaea*)	Threatened	Iowa	Jackson, Jones	NA
		Illinois	Carroll, Bureau, Grundy, Henry, Lee, Rock Island, Whiteside, Will	
Decurrent false aster (*Boltonia decurrens*)	Threatened	Illinois	Bureau, La Salle	NA
Lakeside daisy (*Hymenopsis herbacea*)	Threatened	Illinois	Will	NA
Mead's milkweed (*Asclepias meadii*)	Threatened	Illinois	Will	NA
Leafy-prairie clover (*Dalea foliosa*)	Endangered	Illinois	Will, La Salle	NA

State-Listed Species

Endangered and Threatened Species

State-listed endangered or threatened animals and plants that have been documented within the ROI for SA-04 include 13 invertebrates – 2 arthropods and 11 mussels; 17 vertebrates – 1 bat, 5 birds, 3 reptiles, and 8 fish; and 22 plants (Tables 5.2.5-9 and 5.2.5-10). Of the 22 state-listed plants occurring within the ROI, three endangered plants – false mallow (*Malvastrum hispidum*), plains sedge (*Carex heliophila*), and quillwort (*Isoetes butleri*); and one threatened plant – broomrape (*Orobanche ludoviciana*) occur within the construction work area in Illinois (Table 5.2.5-10). Occurrences of state-listed threatened and endangered species based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants). State-listed species that are also federally listed are included in these tables when they have been documented as elemental occurrences within NHIS data.

Special Concern Species

State-listed special concern species that occur within the ROI for SA-04 include 9 invertebrates – 6 arthropods, and 3 mussels; 12 vertebrates – 6 birds, 2 reptiles, and 4 fish; and 20 plants. Of the 20 special concern plants within the ROI, 3 plants – buffalo grass (*Buchloe dactyloides*), plains wild indigo (*Baptisia bracteata* var. *glabrescens*), and small white lady's-slipper occur within construction work areas. State special concern species that are also federally listed are included in tables when they have been documented by state NHIS data. Occurrences of state special concern species based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants).

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined GAP models indicate habitat areas potentially used by one or more protected or rare vertebrate species. The areas rated medium and high have an increased potential to affect habitats used by multiple protected or rare species. Little of the area within the ROI is rated medium and high for mammals (1 percent, 4 to 9 species), birds (6 percent, 7 to 19 species), or amphibians and reptiles (16 percent, 3 to 11 species). This indirectly indicates the potential for the SA-04 route to affect multiple protected or rare species.

Minnesota's Wildlife Action Network

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota crossed by SA-04 (Minnesota DNR 2016f). As shown in Figure 5.2.5-4, the route would cross through habitats within the WAN that could be used by multiple SGCNs. Approximately 1 percent of the area within the ROI is within the WAN (much of the SA-04 route crosses through states other than Minnesota).

Table 5.2.5-9. Known Occurrences of State-Protected Animal Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Mammals					
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	IL/T	1	1	2
Birds					
Burrowing owl (*Athene cunicularia*)	Nests and lives underground in gently sloping open, treeless areas, with low, sparse vegetation. Breeds in spring.	MN/E	1	1	1
Chestnut –collared longspur (*Calcarius ornatus*)	Occurs almost exclusively in relatively dry, moderately grazed prairie. Nests are constructed in a depression on the ground, usually under a clump of grass, and lined with soft grasses and animal hair.	MN/E	--	--	1
King rail (*Rallus elegans*)	Generally associated with freshwater marshes but can adapt to a variety of habitats that support vegetation and are frequently wet. Nesting begins first week of May, and hatching occurs by the end of July (approx.).	IL/E	--	--	1
Loggerhead shrike (*Lanius ludovicianus*)	Associated with open areas containing shrub/brush and scattered thorny plant species. Eggs are laid from late March through mid-April; however, it may continue through early July.	MN, IL/E	--	--	3
Upland sandpiper (*Batramia longicauda*)	Prefers hayfields and pastures, but are found in open grasslands in the absence of preferred habitat. Nesting begins in May, and hatching occurs mid-June to July.	IL/E	--	--	1
Amphibians and Reptiles					
Blandings turtle (*Emydoidea blandingii*)	Found in productive, clean, shallow waters with abundant aquatic vegetation and soft, muddy bottoms over firm substrates. Extensive marshes bordering rivers provide excellent habitat. Nests in grasses and sedge close to water. Females nest in late May and June, and hatching occurs 2 to 4 months later.	MN, IA/T IL/E	1	1	5
Ornate box turtle (*Terrapene ornata*)	Underground burrows of grasslands. Breeds between April and October, and nesting occurs mainly in July.	IA/T IL/T	1	1	3

Table 5.2.5-9. Known Occurrences of State-Protected Animal Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Plains hog-nosed snake (*Heterodon nasicus*)	Habitat includes areas with sandy or gravelly soils, such as prairies, sandhills, and river floodplains. Females lay eggs from May to August (mainly in June and July), and hatching occurs approximately 2 months later.	IL/T	--	--	1
Fish					
American brook lamprey (*Lampetra appendix*)	Gravel-sand riffles, runs of creeks, and small to medium rivers with strong flow. Spawns in spring.	IA/T	--	--	1
Banded killifish (*Fundulus diaphanous*)	Quiet waters of lakes, ponds, and sluggish streams, usually over sand, gravel, or detritus-covered bottoms where there are patches of submerged aquatic plants. Spawns in late spring and summer.	IL/T	--	--	1
Black buffalo (*Ictiobus niger*)	Freshwater streams, rivers, and lakes that possess strong currents and deep waters. Spawns from April through mid-June.	MN/T	1	1	1
Blacknose shiner (*Notropis heterolepis*)	Runs and pools of creeks and small to medium, shallow flowing rivers with variable bottom, including sand, gravel, mud, rubble, and occasionally boulders. Spawns in June or July.	IL/E	1	1	1
Greater redhorse (*Moxostoma valenciennesi*)	Moderate to fast-flowing, medium-sized to large rivers. May also occur in river reservoirs and large lakes. Prefers clear water with substrates of clean sand, gravel, or boulders; cannot tolerate siltation. Spawns in May or June.	IL/E	--	--	2
Pallid shiner (*Hybopsis amnis*)	Quiet waters over sandy-silty bottoms in medium to large rivers. Often found at ends of sand and gravel bars. Spawns in late May through July.	IL/E	--	--	1
River redhorse (*Moxostoma carinatum*)	Found in deep pools with moderate current over bedrock or gravel substrate; cannot tolerate siltation. Spawns in April and May.	IL/T	--	--	1
Slender madtom (*Noturus exilis*)	Riffles of small- to medium-sized, permanent, spring-fed creeks, with moderate to swift currents and bottoms of rock or gravel interspersed with sand. Spawns in spring and summer.	MN/E	--	--	1

Table 5.2.5-9. Known Occurrences of State-Protected Animal Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Arthropods					
Redveined (Red-tailed) prairie leafhopper (*Aflexia rubranura*)	Dry to mesic prairies where the host plant, prairie dropseed, is found. Females insert their eggs into the stems of prairie dropseed in late summer, and eggs likely hatch in late May.	IL/T			1
Regal fritillary (*Speyeria idalia*)	Grassland habitats, including moist tallgrass prairies, wet fields and meadows, virgin grasslands, old fields, and floodplain forest openings and edges. Mate in mid-June through early July. Eggs are laid in late summer through early fall.	IL/T	1	1	1
Mollusks					
Black sandshell (*Ligumia recta*)	Rivers, lakes, and large streams with a good current and sandy mud, firm sand, or gravel substrates. Likely spawns mid-July through August.	IL/T	1	1	2
Butterfly (*Ellipsaria lineolata*)	Large rivers with swift currents in sand or gravel substrates. Females brood their young long-term from August through July before they are released as glochidia.	MN, IA/T	--	--	1
Creeper (*Strophitus undulatus*)	Small to medium-sized streams and occasionally large rivers in mud, sand, or gravel. Females brood their young long term, with eggs fertilized in summer and glochidia released the following spring.	IA/T	--	--	2
Ellipse (*Venustaconcha ellipsiformis*)	Headwater reaches of rivers in gravel riffles and silty areas along streambanks. Females brood their young long term before they are released as glochidia in mid-summer.	MN, IA/T	--	--	2
Fluted-shell mussel (*Lasmigona costata*)	Streams or river beds. Likely spawns from June to July.	MN/T	--	--	1
Higgins eye (*Lampsilis higginsii*)	Only occurs in the Mississippi River and the lower portion of some of its large tributaries, where it occupies stable substrates varying from sand to boulders. Females are gravid in May and September.	IL/E	1	1	1
Monkeyface (*Quadrula metanevra*)	Medium to large rivers and streams with mixed sand and gravel or gravel areas. Spawns in spring.	MN/T	1	1	1
Mucket (*Actinonaias ligamentina*)	Medium to large rivers with coarse sand and gravel substrates.	MN/T	2	2	4

Table 5.2.5-9. Known Occurrences of State-Protected Animal Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Pistolgrip (*Tritogonia verrucosa*)	Medium or large-sized rivers with sand and gravel substrates for burrowing. Spawns in spring and releases larvae in summer.	MN/E	1	1	1
Spike (*Elliptio dilatata*)	Small to large rivers, reservoirs, and lakes with sand and gravel substrates. Usually associated with outlet habitats dominated by swift currents when found in lakes. Spawns in early to mid-May.	MN/T	1	1	3
Yellow sandshell (*Lampsilis teres*)	Occupies a variety of aquatic habitats; however, the preferred habitat is along the banks of muddy or silty rivers. Spawns in summer and release larvae the following spring.	MN, IA/E	1	1	4

Sources: Minnesota DNR 2016e; Illinois DNR 2016; Iowa DNR 2016a; North Dakota GFP 2016.

Notes:

[a] State/Status: E = Endangered, T = Threatened, MN = Minnesota, IA = Iowa, IL = Illinois

[b] Con = occurrences based on 120-foot-wide construction work area centered on the pipeline

[c] Op = occurrences based on 50-foot-wide permanent right-of-way centered on the pipeline

"--" = no occurrence

Table 5.2.5-10. Known Occurrences of State-Protected Plant Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Vascular Plants					
Blue sage (*Salvia azurea*)	Dry soils in black soil and gravel prairie habitats, limestone glades, and roadsides. Spiked inflorescent flowers bloom in the late summer and fall. Avoided as a food source by mammals it is a pollen and nectar source for insects.	IL/T	--	--	1
Bog birch (*Betula pumila*)	Calcareous fens and moist prairies habitats which have a low elevation, high moisture regime and are mostly sunny. Plant flowers in the springtime with colorful foliage in the autumn.	IA/T	--	--	1
Broomrape (*Orobanche ludoviciana)*	Sandy soil in prairie habitats. Parasitic on members of the aster family.	IL/T	1	--	1
Dwarf grape fern (*Botrychium simplex*)	Grassy meadow habitat. Succulent stem and single leaf are similar to other grape fern varieties so species is typically identified from its large spores.	IL/E	--	--	1
Edible valerian (*Valeriana edulis var. ciliate*)	Calcareous fens, wet meadows, and moist prairies habitats which have a high moisture regime and are mostly sunny. Propagation through seed dispersal via wind or mammals; flowers from May to September.	MN/T	--	--	2
Flax-leaved aster (*Aster linariifolius*)	Sandy and rocky soils in prairies, savannas, stable sand dunes, sandstone glades, and woodland habitats with sparse groundcover. Blooms in mid-fall for approximately one month.	IA/T	--	--	2
False mallow (*Malvastrum hispidum*)	Dry soil in prairies and rocky and gravelly barrens, usually near limestone outcrops, occasionally in open alluvial ground in valleys and along gravel bars, and flowers in the summer.	IL/E	1	1	1
Hair-like beak rush (Beakrush) (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring, and flowers mid-summer.	IA/T	--	--	1
Hedge hyssop (*Gratiola quartermaniae*)	High moisture regime areas such as floodplain forests, soggy meadows, gravelly seeps, and mud depressions in woodland habitats. Annual plant which blooms in late spring and propagates through reseeding to form colonies.	IL/E	--	--	1
Leafy prairie clover (*Dalea foliosa*)	Prefers prairie remnant sites with thin soils over limestone substrate, wet spring and fall seasons, and dry summers. Blooms in mid- to late summer.	IL/E	--	--	1
Meadow beauty (*Rhexia virginica*)	Prefers moist sandy soils in wet prairies and fen habitats. Typically blooms in mid-July through August.	IA/T	--	--	2

Table 5.2.5-10. Known Occurrences of State-Protected Plant Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Pale green orchid (*Platanthera flava*)	Prefers wet meadows or swales in savannas habitats along transitional edges with direct sunlight. Can also be found on margins of shallow marshy lakes. Orchid blooms in spring but germination requires specific conditions.	IA/E	--	--	3
Plains sedge (*Carex heliophila*)	On slopes and hilltops of dry to dry-mesic prairies with well-drained soils formed in glacial till.	IL/E	1	1	1
Quillwort (*Isoetes butleri*)	Seasonally wet calcareous soils of limestone glades, barrens, sandstone outcrops, and shallow depressions in dolomite prairie that are wet in spring and dry in summer. Species is visible/identifiable from May to June.	IL/E	2	1	3
Richardson's rush (*Juncus alpinoarticulatus*)	Prefers moist sandy soils in sandbar and swale habitats along the Missouri River. It is an obligatory wetland rush.	IL/T	--	--	1
Slender arrow grass (*Triglochin palustris*)	Primarily located in fens and some wet prairie habitats, this grass produces hydrocyanic acid and can be poisonous if ingested.	IA/T	--	--	1
Slender sandwort (*Minuartia patula*)	Found in wet dolomite prairie habitat. These prairies have high magnesium soils due to dolomite bedrock near the soil surface. Blooms in the spring.	IL/T	--	--	1
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	MN/T	--	--	1
Sullivant's milkweed (*Asclepias sullivantii*)	Solely found in mesic tallgrass prairie habitats. Blooms in mid-July and is an important food source for pollinators. Fruits in August.	MN/T	--	--	1
Tuberous Indian-plantain (*Arnoglossum plantagineum*)	Prefer moist prairies but can be found in few bluff prairies where the soil is drier. Blooms in the summer. Germination through seed only.	MN/T	--	--	1
Whorled nutrush [Low nut rush] (*Scleria verticillata*)	Restricted to the least disturbed calcareous fens in the prairie region. Blooms late June through late July.	IA/T	--	--	1

Table 5.2.5-10. Known Occurrences of State-Protected Plant Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04

Common and Scientific Name	Preferred Habitat	State/ Status[a]	Occurrences		
			Con[b]	Op[c]	Within 0.5 Mile
Wild quinine (*Parthenium integrifolium*)	Located in remnant prairie and savanna habitats with a moderate moisture regime. This long-lived, herbaceous perennial blooms from June to September. Propagation through seed dispersal via wind or mammals.	MN/E	--	--	1

Sources: Minnesota DNR 2016e; Illinois DNR 2016; Iowa DNR 2016a; North Dakota GFP 2016.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Notes:

[a] State/Status: E = Endangered, T = Threatened, MN = Minnesota, IA = Iowa, IL = Illinois

[b] Con = occurrences based on 120-foot-wide construction work area centered on the pipeline

[c] Op = occurrences based on 50-foot-wide permanent right-of-way centered on the pipeline

"--" = no occurrence

Minnesota Biological Survey Sites of Biodiversity Significance

The SA-04 pipeline would cross through areas with MBS Sites (Figure 5.2.5-5); areas scoring outstanding, high, and moderate could include habitats used by rare animals and plants. Approximately 1 percent of the area within the ROI is identified as an outstanding (0.2 percent), high (0.3 percent), or moderate (0.5 percent) rated MBS Site (most of SA-04 crosses through habitats outside of Minnesota).

Minnesota Scientific and Natural Areas

A review of PAD-US and Minnesota's SNAs indicated that no SNAs are located within the ROI.

5.2.5.2.4 Transportation by Rail

This section addresses the existing conditions along the rail routes and in the general area near the Clearbrook and Superior terminals where rail offloading facilities and new rail access likely would be constructed.

Federally Listed Species

Eleven federally listed plant and animal species, seven threatened and four endangered species are known to occur within the Minnesota and Wisconsin counties included in the Transportation by Rail alternative. The Transportation by Rail alternative consisted of three distinct segments, North Dakota Border to Clearbrook terminal, North Dakota Border to Superior South, and North Dakota Border to Superior North. NHIS data identified three occurrences of Poweshiek skipperling (endangered) within the one mile ROI for North Dakota Border to Clearbrook terminal. NHIS data (Minnesota counties only) identified three occurrences of Poweshiek skipperling and eight occurrences of northern long-eared bat within one mile ROI for North Dakota Border to Superior South. Within the 1-mile ROI for the rail route from the North Dakota Border to Superior North (Minnesota counties only) there are document occurrences of two Poweshiek skipperling, two Dakota skipper, 36 western prairie fringed orchid, and one northern long-eared bat in the NHIS database. Gray wolf and Canada lynx occurrence data are not available in the NHIS database, and due to the size and mobility of individuals of both species, if they are known to occur within a county crossed by a Transportation by Rail segment they would be considered to be within the 1-mile ROI.

State-Listed Species

Endangered and Threatened Species

No state-listed endangered or threatened animals are likely to occur within the general locations of rail offloading facilities and new access facilities in Clearbrook and Superior (Minnesota DNR 2016e; North Dakota GFP 2016; Wisconsin DNR 2016). Four state-listed plants are likely to occur in the general area where new offloading and access facilities would be constructed (Table 5.2.5-11). Occurrences of state-listed threatened and endangered species based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants).

Table 5.2.5-11. Potential Occurrences of State-Protected Plants within the Region of Interest for the Transportation by Rail Alternative

Common and Scientific Name	Preferred Habitat	State/Status[a]
Vascular Plants		
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	MN/T
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in spring, and flowers mid-summer.	MN/T
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region.	MN/T
Sweet colt's-foot (*Petasites sagittatus*)	Cold marshes and swamp openings.	WI/T

Sources: Minnesota DNR 2016e; Wisconsin DNR 2016.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

[a] State/Status: T = Threatened, MN = Minnesota, WI = Wisconsin

Special Concern Species

Based on a review of available presence/absence information, no special concern animals are likely to occur within the general location of rail offloading and new access facilities for the rail alternative (Minnesota DNR 2016e; North Dakota GFP 2016; Wisconsin DNR 2016). Three Minnesota special concern plants – few-flowered spikerush (*Eleocharis quinqueflora*), McCalla's willow (*Salix maccalliana*), and twig rush (*Cladium mariscoides*) are potentially present within the likely construction area for the rail alternative facilities (Appendix M, Table M-3).

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined GAP models indicate habitat areas potentially used by one or more protected or rare vertebrate species. The areas rated medium and high have an increased potential to affect habitats used by multiple protected or rare species. The area in the vicinity of the Clearbrook terminal, where new rail facilities and access likely would be constructed, is a mix of mostly rated low for all species, with about 10 to 20 percent rated medium for mammals (1 to 6 species) and birds (1 to 12 species); and about 10 percent of low habitat suitability for amphibians and reptiles (1 to 2 species). A larger proportion of the area surrounding the new rail access between Clearbrook and Gully is rated medium for birds (7 to 12 species). The area in the vicinity of the Superior terminal where new rail facilities and access would be constructed is rated primarily high and medium for mammals (4 to 9 species), low for birds (1 to 6 species), and low for amphibians and reptiles (1 to 2 species). This indirectly indicates the potential for transportation by rail to affect multiple protected or rare species.

Minnesota's Wildlife Action Network

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota within or near access routes and offloading facilities for the rail alternative (Minnesota DNR 2016f). The WAN applies only to facilities at Clearbrook, Minnesota; and no WAN habitats occur in the vicinity of the

Clearbrook terminal. Approximately 2.5 miles of the new rail access route between Clearbrook and Gully crosses through WAN habitats, with 56 percent in low-medium and 44 percent in medium ranked WAN habitats.

Minnesota Biological Survey Sites of Biodiversity Significance

Three unnamed MBS Sites preliminarily ranked as moderate occur near the Clearbrook terminal in the general location where rail facilities are likely to be constructed. These sites include a 48-acre forested area with a pond north of the terminal, a 144-acre site that includes Steenerson and Deep Lake just east of the terminal, and a 319-acre forested and wetland area south of the terminal. The new rail access between Clearbrook and Gully would cross near three additional moderate ranked MBS Sites: the 501-acre Gully 36 site north of the route near Gully; a 65-acre unnamed site south of the route crossed by the Lost River near Gonvick; and a 164-acre wetland and wooded unnamed site north of the route, west of Clearbrook.

Minnesota Scientific and Natural Areas

A review of PAD-US and Minnesota's SNAs indicated that no SNAs occur in the area around the Clearbrook or Superior terminals where new rail facilities are likely to be constructed.

5.2.5.2.5 Transportation by Truck

Federally Listed Species

The Transportation by Truck alternative consisted of two distinct segments—Gretna, North Dakota, to the Clearbrook terminal and Gretna to the Superior terminal. Eight federally listed plant and animal species, five threatened and three endangered, are known to occur within the North Dakota and Minnesota counties included in the Transportation by Truck segment from Gretna to the Clearbrook terminal. Twelve federally listed plant and animal species, seven threatened and five endangered, are known to occur within the North Dakota, Minnesota, and Wisconsin counties included in the Transportation by Truck segment from Gretna to the Superior terminal. Gray wolf and Canada lynx occurrence data are not available in the NHIS database, and due to the size and mobility of individuals of both species, if they are known to occur within a county crossed by a Transportation by Truck segment they would be considered to be within the 1-mile ROI.

State-Listed Species

Endangered and Threatened Species

No state-listed endangered or threatened animals are likely to occur within the general locations for truck offloading facilities and new access roads at Clearbrook or Superior (Minnesota DNR 2016e; North Dakota GFP 2016; Wisconsin DNR 2016). Four state-listed plants are likely to occur in the area where new offloading and the access roads would be constructed (Table 5.2.5-12). Occurrences of state-listed threatened and endangered species based on NHIS database locations are summarized in Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants). State-listed species that are also federally listed are included in these tables when they have been documented as elemental occurrences within NHIS data.

Table 5.2.5-12. Potential Occurrences of State-Protected Plants within the Region of Interest for the Transportation by Truck Alternative

Common and Scientific Name	Preferred Habitat	State / Status[a]
Vascular Plants		
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	MN/T
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring, and flowers mid-summer.	MN/T
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region.	MN/T
Sweet colt's-foot (*Petasites sagittatus*)	Cold marshes and swamp openings.	WI/T

Sources: Minnesota DNR 2016e; Wisconsin DNR 2016; North Dakota GFP 2016.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

[a] State/Status: T = Threatened, MN = Minnesota, WI = Wisconsin

Special Concern Species

Based on a review of available presence/absence information, no special concern animals are likely to occur within the general location of truck offloading and new access facilities for the truck alternative (Minnesota DNR 2016e; North Dakota GFP 2016; Wisconsin DNR 2016). Three Minnesota special concern plants—few-flowered spikerush, McCalla's willow, and twig rush—potentially are present within the construction area for the truck alternative facilities (Appendix M, Table M-3).

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined GAP models indicate habitat areas potentially used by one or more protected or rare vertebrate species. The areas rated medium and high have an increased potential to affect habitats used by multiple protected or rare species. The area around the Clearbrook terminal, where new truck facilities and access roads likely would be constructed, is a mix of mostly low rated habitat for all species, with about 10 to 20 percent medium for mammals (1 to 6 species) and birds (1 to 12 species), and about 10 percent of low habitat suitable for amphibians and reptiles (1 to 2 species). The area in the vicinity the Superior terminal where new truck facilities and access roads likely would be constructed is rated primarily high and medium for mammals (4 to 9 species), low for birds (1 to 6 species), and low for amphibians and reptiles (1 to 2 species). This indirectly indicates the potential for transportation by truck to affect multiple protected or rare species.

Minnesota's Wildlife Action Network

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota within or near access routes and offloading facilities for the truck alternative (Minnesota DNR 2016f). The WAN applies only to facilities at Clearbrook, Minnesota; and no WAN habitats are present in the vicinity of the Clearbrook terminal.

Minnesota Biological Survey Sites of Biodiversity Significance

Three unnamed MBS Sites preliminarily ranked moderate occur near the Clearbrook terminal where truck facilities are likely to be constructed. These sites include a 48-acre forested area with a pond north of the terminal, a 144-acre site that includes Steenerson and Deep Lake just east of the terminal, and a 319-acre forested and wetland area south of the terminal.

Minnesota Scientific and Natural Areas

A review of PAD-US and Minnesota's SNAs indicated that no SNAs occur in the area around the Clearbrook and Superior terminals where new truck facilities are likely to be constructed.

5.2.5.2.6 Existing Line 3 Supplemented by Rail

Existing conditions for continued use of the existing Line 3 pipeline supplemented by rail transport are similar to those described above for continued use of the existing Line 3 pipeline and the transportation by rail alternative.

5.2.5.2.7 Existing Line 3 Supplemented by Truck

Existing conditions for continued use of the existing Line 3 pipeline supplemented by truck transport are similar to those described above for continued use of the existing Line 3 pipeline and the transportation by truck alternative.

5.2.5.3 Impact Assessment

Potential impacts on unique natural resources from construction of the Applicant's preferred route, SA-04, and transportation by rail and truck include the following:

- Injury or loss of aquatic invertebrates and fish from waterbody crossing construction;
- Injury or loss of terrestrial invertebrates, small mammals, bird and reptile eggs and young, and plants from vegetation clearing, trench excavation, and vehicle operations;
- Loss or alteration of forage and cover habitats during vegetation clearing, site grading, and trenching;
- Disturbance from construction noise and activity; and
- Exposure to small leaks and drips from construction equipment and vehicles.

Potential impacts on unique natural resources from operation of the Applicant's preferred route and the CN Alternatives include the following:

- Habitat loss or continued disturbance from pipeline right-of-way vegetation management,
- Continued habitat loss or alteration during excavation for pipeline inspection and repair,
- Continued disturbance from noise and activity at facilities, and
- Collision injury or mortality during rail and truck transits.
- Potential barrier effects created by increased rail and truck transit.

The potential for effects on unique natural resources depends on whether the protected unique natural resources occur near facilities, infrastructure, activities, and habitat changes associated with the Applicant's preferred route and CN Alternatives; and whether these conditions may result in injury, harm, or disturbance.

5.2.5.3.1 Applicant's Preferred Route (from Neche to Superior)

Federally Listed Species

Federally listed threatened and endangered species that could occur within the North Dakota, Minnesota, and Wisconsin counties crossed by the Applicant's preferred route and could be affected by construction and operation include three mammals – Canada lynx (*Lynx canadensis)*, gray wolf (*Canis lupus*), and northern long-eared bat; three birds – Kirtland's warbler (*Setophaga kirtlandii*), piping plover (*Charadrius melodus*), and whooping crane (*Grus americana*); three invertebrates – Dakota skipper (*Hesperia dacotae*), Poweshiek skipperling (*Oarisma poweshiek*), and rusty patched bumble bee (*Bombus affinis*); and two plants – Fassett's locoweed (*Oxytropis campestris* var. *chartacea*) and western prairie fringe orchid (*Platanthera praeclara*) (Table 5.2.5-3).

Construction Impacts

If present, the Canada lynx could be disturbed by construction noise and activity that likely would cause lynx to move to other areas, possibly returning after construction activities stop. Disturbance effects likely would be minor and temporary, unless den sites are disturbed. Most den sites, which are used from April to June, are unlikely to occur within the cleared work area because den sites usually are located around downed logs and windfall trees in the forest interior. Most tree clearing for pipeline construction, ATWS, access roads, and facility sites would occur next to previously cleared utility corridors that are not likely to support den sites. The habitat fragmentation analysis in Section 6.3.4 identifies 17 forested large-block habitats between MPs 215.0 and 352.0 that could support Canada lynx and den sites.

Foraging and reproductive activities for gray wolves could be affected by exposure to Project-related noise and increased human activity. Construction of a pipeline likely would displace a few gray wolves and alter used habitats, especially if packs currently use the existing pipeline rights-of-way in the area as travel corridors. If dens are present in the vicinity of the construction work area, construction-related disturbance could reduce pup survival. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Typical conservation measures to reduce impacts on the gray wolf include:

- Stop construction activities if the contractor or Environmental Inspector observes a gray wolf or possible den site within the construction corridor, or if USFWS notifies the Applicant of a gray wolf sighting within 1 mile of the construction work area; the stop work order for that area of construction should continue until the wolves leave the area.
- Report any wolf sightings immediately to USFWS, USACE, and state resource agencies (e.g., Minnesota DNR).

Minnesota NHIS reported 13 occurrences of the northern long-eared bat within the construction work area for the Applicant's preferred route (Minnesota DNR 2016e). Current use of the Applicant's preferred route by northern long-eared bats was confirmed by surveys performed by Merjent from 2014 to 2016 (2015c, 2015d, and 2016b). The Applicant conducted acoustic and telemetry surveys within suitable habitats during 2014 and 2015 to determine the summer presence or absence and locations of maternity

or roost trees used by northern long-eared bats. Northern long-eared bats were confirmed at acoustic survey sites in Aitkin, Carlton, Cass, Crow Wing, Hubbard, and Wadena counties in Minnesota, and in Douglas County in Wisconsin (Merjent 2014b, 2015c). In 2015, mist-net and telemetry surveys were completed at 13 sites along the Applicant's preferred route. Northern long-eared bats were captured at nine sites in Aitkin, Carlton, Cass, and Wadena counties in Minnesota. A total of 14 roosts, including 9 maternity roost trees, were identified (2 trees in Carlton County and 7 in Cass County) (Merjent 2015d). In 2016, acoustic surveys were conducted at six sites along the Applicant's preferred route in Aitkin, Clearwater, Polk, and Red Lake counties, Minnesota, to determine probable absence or presence. No acoustic positives were detected, and northern long-eared bats are considered absent from all six survey sites (Merjent 2016b).

Impacts on individuals or colonies of bats may occur if clearing or construction occurs when bats are using summer roosts. Northern long-eared bats could be disturbed by noise or human presence, causing them to abandon occupied tree cavities. Bats could be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. Because the population of northern long-eared bats is declining from white-nose syndrome and destruction of habitat among other factors, the protection of these bats—and particularly of groups of bats in maternity colonies—is of critical importance.

Conservation measures were included in the ESA 4(d) rule[16] to reduce potential impacts on northern long-eared bats. Under the final 4(d) rule, incidental take involving tree removal in the white nose syndrome zone, which includes the Applicant's preferred route, is not prohibited if the following two conservation measures are followed:

- Maintain a year-round 0.25-mile-radius buffer (which is equivalent to 125.7 acres) around known northern long-eared bat hibernacula.
- Protect known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree, equivalent to 1.6 acres, during the pup season from June 1 to July 31.

Kirtland's warblers nest in jack pine forests in Wisconsin and Michigan, and they migrate along the southeast coast of the United States to overwinter in the Bahamas. They are known to occur during the breeding season in the vicinity of Superior, Wisconsin. Several jack pine woodlands occur in the vicinity of the Applicant's preferred route (Table 5.2.5-3), and five occurrences are within the construction work area. Whether these jack pine woodlands provide suitable habitat for Kirtland's warblers is unknown. Vegetation clearing during the nesting season could result in loss of eggs or young.

Great Lakes piping plovers inhabit shorelines of the Great Lakes. Critical habitat for this species has been designated in Douglas County, Wisconsin. The Applicant's preferred route would end at the Superior terminal in Douglas County. Piping plovers nest on open, sparsely vegetated sandy habitats such as sand spits or sand beaches found on Great Lakes islands and mainland shorelines. While it is possible that piping plovers could use developed habitats near the pipeline route in the Superior area, it is unlikely

[16] Regulations identified by USFWS that are deemed "necessary and advisable" for protection and conservation of a threatened species.

that these habitats would provide important nesting areas. Therefore, construction would be unlikely to affect piping plovers.

Whooping cranes from the non-essential, experimental eastern population that winters in Florida migrate to breeding areas in Wisconsin and could occur in the ROI for the Applicant's preferred route during spring and fall migrations. Noise and activity during construction can displace whooping cranes from stopover habitats during foraging or in in wetlands or riverine habitats during roosting. Whooping cranes generally depart from wintering grounds during late March to mid-April and return from breeding grounds beginning in mid-September. The eastern population travels north through Georgia, Tennessee, Kentucky, Indiana, and Illinois to Wisconsin. During migration, whooping cranes use croplands and shallow wetlands for stop-over foraging and roosting habitats. The Aransas-Wood Buffalo Park whooping crane population migrates between wintering grounds in Aransas NWR to breeding grounds in Wood Buffalo National Park in northern Alberta. The migration corridor for this population crosses through central Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota and is generally west of the Applicant's preferred route in North Dakota. If present in the ROI during migration periods, potential impacts could include disturbance to foraging or roosting birds from pipeline construction (USFWS 2009).

If present, the Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee could be affected by construction activities that disturb native vegetation. These activities would disrupt egg laying and foraging during spring and summer, and could crush dormant larvae during fall and winter. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these butterflies and bees, and remove forage plants.

The Applicant completed a desktop and field assessment of potentially suitable native prairie habitat for the Dakota skipper and Poweshiek skipperling along the Applicant's preferred route. Dakota skippers and Poweshiek skipperling are not currently known to occur in Pembina County, North Dakota, and the desktop review did not identify any suitable habitats along the Applicant's preferred route in North Dakota. Potentially suitable Dakota skipper and Poweshiek skipperling habitat was documented at three locations along the route in Polk County, and potentially suitable habitat for Poweshiek skipperling was documented at two locations in Pennington County, Minnesota. Suitable habitats were found in small, isolated pockets that ranged in size from 0.4 to 1.8 acres. Presence/absence surveys were conducted in 2015 at a subset of USFWS selected locations identified in the 2013/2014 habitat assessment. Sites were selected based on habitat quality and size (Merjent 2015a). Surveys did not identify the presence of Dakota skipper or Poweshiek skipperling at the three suitable habitat locations in Pennington and Polk counties (Merjent 2015a). Presence/absence surveys have not been performed based on the revised 2016 habitat assessment (Merjent 2016a). While it is possible that the Dakota skipper and Poweshiek skipperling could occur within the ROI, based on the results of the habitat survey and earlier presence/absence survey, it is unlikely that these prairie-dependent insects would be affected by construction activities.

The Applicant's preferred route would not cross any current high use areas for rusty patched bumble bee, and construction is not likely to directly or indirectly affect any individuals or current high use areas. The Applicant's preferred route crosses through current potential low use areas where rusty patched bumble bees may disperse from current high use areas or where their occurrence is uncertain. The rusty patched bumble bee may benefit from opportunities to conserve the species within the dispersal area, and USFWS may recommend surveys.

Applicable conservation measures that would benefit the rusty patched bumble bee within this dispersal area include restoration and maintenance of high-quality habitat through control of invasive species and restoration, including a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Fassett's locoweed and western prairie fringed orchids (*Platanthera praeclara*) have the potential to occur within the Applicant's preferred route; however, there are no known occurrences of either species within the construction work area. If these plants were to occur, direct impacts could include trampling and destruction during construction from clearing and grubbing, grading, and trenching. Indirect effects from construction could include conversion of shoreline habitat (for locoweed) and already fragmented prairie habitat (orchid) into other habitat types and the spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction.

Impacts on prairie soils from construction would be long term and could require a substantial amount of recovery time, which could affect any western prairie fringed orchids present. Surveys were not performed for Fassett's locoweed, but based on known habitat types, there is limited potential for them to occur within the construction work area. If they were to occur, effects could include trampling, destruction, or conversion of shoreline habitats. From 2013 to 2016, the Applicant completed habitat analyses and field surveys of potentially suitable western prairie fringed orchid habitat, and no orchids were located during these surveys (Merjent 2016e). Potentially suitable habitat was identified at one location, but no western prairie fringed orchids were found. Therefore, it is unlikely that western prairie fringed orchids would be affected by construction of the Applicant's preferred route.

Summary

Measures to avoid or reduce construction impacts on the three federally listed animals and plants that could occur along the Applicant's preferred route would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf could experience temporary minor disturbance associated with construction activities. Northern long-eared bats and occupied bat maternity roots are known to occur in the ROI. With implementation of BMPs and general conservation measures, impacts from construction would be temporary and minor. Given the limited distribution within the ROI of Kirtland's warbler, piping plover, whooping crane, Poweshiek skipperling, and rusty patched bumble bee, construction impacts likely would be temporary to short term and negligible. Dakota skippers could be affected by construction at one site, potentially resulting in short-term minor impacts on suitable habitat. However, the potential destruction of some Dakota skippers could require development of additional avoidance and conservation measures. Effects on federally listed plants are not likely because of the scarcity of appropriate habitat and/or species presence.

Operations Impacts

Project-related noise and increased human activity during operations and maintenance activities could interrupt foraging and reproductive activities for the gray wolf and Canada lynx. Such disturbance could be caused by public and private use of all-terrain vehicles and snow machines along the permanent right-of-way, in addition to increased lynx-human interactions, resulting in permanent minor impacts on Canada lynx.

The use of all-terrain vehicles and snow machines along the permanent right-of-way also could reduce wolf habitat suitability. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Based on the highly mobile nature of wolves, the transient nature of the disturbance, and wolves' use of a variety of habitats, the operations-related impacts on wolves would be temporary and minor over the life of the Project.

Operations impacts on the northern long-eared bat could include continued habitat loss or alteration and disturbance from noise and activity at aboveground facilities during pipeline inspection overflights or ground surveillance and during right-of-way maintenance activities. Human activities during operations typically would occur during daylight hours; therefore, operations activities would not interrupt foraging activities. However, each incident would result in a temporary minor impact that would occur periodically over the life of the Project. Operation of pipeline pump stations would increase nearby noise levels over existing ambient levels. As described in Section 6.2.2, however, sound level increases would comply with Minnesota Noise Standards and would decrease over distance. Pump station footprints would be devoid of trees; while bats could forage in the vicinity, they would not roost at the pump stations. Unless a roost site is near a pump station, the effect on long-eared bats from operation of pump stations is expected to be permanent and negligible.

If operation and maintenance activities occur in the vicinity of Superior during the Kirtland's warbler breeding season (May through September), foraging and reproductive activities could be affected by noise and increased human activity. In addition, vegetation clearing during the nesting season could result in loss of eggs or young. As described above, piping plovers also could occur near facilities in Superior. It is unlikely that Kirtland's warblers or piping plovers would use these human-developed habitats around the terminal for more than occasional visits; therefore, operations impacts on these species likely would be permanent and negligible. Migrant whooping cranes would not be affected by pipeline operation. As described for construction, Dakota skipper and Poweshiek skipperling are unlikely to occur along the Applicant's preferred route. Operations activities, especially periodic mowing to prevent growth of trees and shrubs, could affect adults, eggs, caterpillars, or larvae directly if the species come in direct contact with equipment, personnel, or chemicals. These effects could include death, reduced reproduction, or displacement. Although these species could be present along the route, based on the results of the habitat survey and presence/absence survey, it is unlikely that these prairie-dependent insects would be affected by operations activities. Consequently, impacts would be at most negligible but permanent. One site with suitable habitat and Dakota skipper presence was identified during surveys. Impacts on this site and the Dakota skipper during operation would be permanent and minor.

The Applicant's preferred route would not cross any current high use area for rusty patched bumble bee, and operations are not likely to directly or indirectly affect any individuals or current high use areas. The Applicant's preferred route crosses through current potential low use areas where rusty patched bumble bees may disperse from a current high use area or where their occurrence is uncertain. Opportunities to conserve the rusty patched bumble bee may benefit the species within the dispersal area, and USFWS may recommend surveys. Applicable conservation measures that would benefit the rusty patched bumble bee within this dispersal area include the following:

- Limiting vegetation management in high-quality habitat during the active season (March through September).
- Leaving one or more areas unmowed for the entire year in vegetation management areas.

- Using a minimum of 8 to 10 inches cutting height to prevent disturbance of overwintering queens or nesting sites.
- Carefully applying and targeting pesticide use to control pests and invasive species, including:
  - Using the least toxic options and following label directions to ensure proper use.
  - Applying as locally and directly as possible; avoiding broadcast application that may be harmful to the rusty patched bumble bee or their nectar plants in areas where the species is likely to be found.

Ensuring that field crews recognize target weeds to avoid adverse effects on important native plants (USFWS 2017). If present, federally listed Fassett's locoweed and western prairie fringed orchids that persist within the permanent right-of-way could be permanently affected by vegetation maintenance activities; however, given the lack of appropriate habitat and known occurrences, impacts likely would be negligible.

Summary

The Canada lynx could experience permanent minor impacts associated with operations and maintenance activities. The gray wolf, due to its transient nature, would experience temporary minor impacts. Impacts on northern long-eared bats would be permanent and negligible, and operations-related impacts on the Dakota skipper at the one suitable habitat site would be minor and permanent. Given the limited distribution and habitat types that could be used by Kirtland's warbler, piping plover, Poweshiek skipperling, and rusty patched bumble bee, operations impacts would be permanent and negligible. Migrant whooping cranes would not be affected by pipeline operation, nor would operations affect federally listed plants because of the scarcity of appropriate habitat and species presence.

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened species that could occur within the ROI for the Applicant's preferred route and could be affected by construction and operation include one mammal – northern long-eared bat, one fish – pugnose shiner (*Notropis anogenus*), one reptile – wood turtle, and one invertebrate – fluted-shell mussel (Table 5.2.5-4). Potential impacts on the northern long-eared bat are discussed above for federally listed endangered and threatened species. Of the 21 state-listed endangered and threatened plants known to occur within the ROI, 13 potentially occur within the construction work area (Table 5.2.5-5).

Construction Impacts

Two aquatic animal species have been documented in the ROI for the Applicant's preferred route: the pugnose shiner and the fluted-shell mussel. Both species have been reported within the construction work area for the Applicant's preferred route. The pugnose shiner coincides with the construction work area in one location, and the fluted-shell mussel coincides with the construction work area in one location. The Applicant surveyed for mussels at sixteen sites along the Applicant's preferred route, and no state-protected mussels were found (Merjent 2015b).

If present at the time of construction, the pugnose shiner and fluted-shell mussel could be affected by in-stream construction or construction activities that take place in the adjacent uplands. Both species are vulnerable to any deterioration in water quality, especially increased siltation. Disturbance to the

stream bottom could crush or suffocate the fluted-shell mussel and would temporarily increase turbidity that could reduce feeding efficiency and damage these sensitive aquatic animals. HDD is proposed for both of the stream crossings where these two species have been documented, so any impacts due to in-stream construction would be avoided. Increased turbidity and siltation could still occur due to surface runoff from construction work areas. Stringent erosion and sediment control practices would minimize these potential effects. Contaminated construction equipment and water used for hydrostatic testing could introduce invasive aquatic animals such as zebra and quagga mussels that could displace and reduce habitat quality for aquatic animals. To minimize the potential for introduction of invasive species, the Applicant would implement an invasive species minimization plan. In addition, environmental inspectors would monitor construction activities to ensure compliance with permit conditions and the invasive species plan, reducing the potential for introduction of invasive species during construction.

The wood turtle inhabits aquatic habitats and adjacent uplands. Although there are no known occurrences of this species within the construction footprint, the wood turtle has been documented within the ROI and could be encountered within the construction footprint. If wood turtles were present, construction could result in direct mortality of turtles or destruction of nests; turtles could be crushed by machinery, buried under excavated soil, or trapped in trenches. In areas with suitable habitat and known occurrences of wood turtles, EIs could monitor the trench and ensure that no turtles become entrapped prior to pipeline burial. Stream-disturbing activities and impacts as described above for the pugnose shiner and fluted-shell mussel also would affect aquatic habitats potentially used by wood turtles. Stringent erosion and sediment control practices would minimize these potential effects. Any destruction, degradation, or fragmentation of floodplain also has the potential to negatively affect this species in the long term. Given the limited overlap with wood turtle range and habitat, construction likely would result in temporary to long-term, minor impacts on wood turtles.

Fourteen Minnesota-listed and seven Wisconsin-listed endangered and threatened plants occur within or near the Applicant's preferred route and could be affected during construction and operations (Table 5.2.5-5; see Appendix M, Table M-3).

Minnesota-listed plants were documented at 19 survey sites along the Applicant's preferred route. The Applicant would avoid all state-listed plants at 12 of these sites (Table 5.2.5-13) because they occur outside of the construction work area or by implementing avoidance strategies, including but not limited to, workspace area reductions or modifications, exclusion fencing, and minor route centerline adjustments.

Table 5.2.5-13. Avoidance of Minnesota Endangered and Threatened Plant Populations for the Applicant's Preferred Route

Survey Site	County	Common and Scientific Name	Status	How Avoided
North Dakota Border to Clearbrook				
L3R_03	Kittson	Red saltwort (*Salicornia rubra*)	Threatened	Applicant modified workspace to avoid all 91 individuals of red saltwort.[a]
L3R_04	Kittson/Marshall	Red saltwort (*Salicornia rubra*)	Threatened	All 14,949 individuals of red saltwort are outside of workspace.[a]
L3R_08	Pennington	Sterile sedge (*Carex sterilis*)	Threatened	All individuals of sterile sedge are outside of workspace.
L3R_11	Red Lake	Clinton's bulrush (*Trichophorum clintonii*)	Threatened	All individuals of Clinton's bulrush are outside of workspace.
L3R_12	Polk	Whorled nutrush (*Scleria verticillata*)	Threatened	All 787 individuals of whorled nutrush are outside of workspace.[b]
L3R_14a	Clearwater	Handsome sedge (*Carex formosa*)	Endangered	Applicant modified workspace to avoid 11 individuals of handsome sedge. Applicant would use exclusion fencing to avoid one individual of handsome sedge within workspace.[b]
Clearbrook to Carlton				
L3X_22/23/58	Cass	Butternut (*Juglans cinerea*)	Endangered	Applicant developed and adopted a route deviation to avoid all 24 individual butternut trees.[c]
		Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	There are 19 individuals of narrow triangle moonwort outside of the workspace.[d, e] Other individuals of this species would be affected.
L3X_25	Cass	Purple-flowered bladderwort (*Utricularia purpurea*)	Endangered	All individuals of purple flowered bladderwort are outside of workspace.
L3X_105	Cass	A bristle-berry (*Rubus fuller*)	Threatened	All individuals of a bristle-berry[f] are outside of workspace.

Table 5.2.5-13. Avoidance of Minnesota Endangered and Threatened Plant Populations for the Applicant's Preferred Route

Survey Site	County	Common and Scientific Name	Status	How Avoided
L3X_81a	Aitkin	Narrow triangle moonwort *(Botrychium lanceolatum* ssp. *angustisegmentum)*	Threatened	All individuals of narrow triangle moonwort are outside of workspace.
		Bog bluegrass (*Poa paludigena*)	Threatened	Large numbers of bog bluegrass are outside of workspace. Other individuals of this species would be affected.
L3X_29	Carlton	A liverwort (*Trichocolea tomentella*)	Threatened	All individuals of *T. tomentella* are outside of workspace.
L3X_64	Carlton	Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	All individuals of narrow triangle moonwort are outside of workspace.[g]

Source: Minnesota DNR 2017b.

Note:

No Minnesota endangered or threatened plant populations were identified in the Carlton-to-Wisconsin border for the Applicant's preferred route.

[a] Number of individuals avoided is based on 2015 population count data. At survey site L3R_03, no individuals were observed during 2016 population counts.

[b] Number of individuals avoided is based on 2016 population count data.

[c] The avoidance of all butternut trees at survey site L3X_22/23/58 is based on 2013 survey data. The Applicant would install exclusion fencing at a 25-foot radius around one individual to avoid impacts on the root zone. This tree, approximately 25 feet tall with a 7-inch diameter at breast height, is within 7 feet of the construction workspace and within 12 feet of additional temporary workspace. The tree size was measured on August 23, 2016. On the same site visit, there was no evidence of butternut canker (a lethal fungal disease) for this tree.

[d] Number of individuals avoided is based on a combination of 2015 and 2016 population count data.

[e] Applicant would fence individuals that are outside of the workspace but within 5 feet of the workspace edge to facilitate avoidance during construction.

[f] This species was tentatively identified on June 20, 2016. Upon revisit on August 23, 2016, to confirm the species identification based on characteristics of mature primocanes, the individuals were no longer present due to logging of the area.

[g] No individuals were observed within workspace or within 5 feet of the edge of workspace during 2016 population counts.

Populations of six Minnesota-listed plants at seven survey sites are within the construction work area for the Applicant's preferred route and would not be avoided (Table 5.2.5-14). The Applicant would consult with Minnesota DNR to complete the Endangered Species permit process for takings at these sites ("takings" include picking, digging, or destroying). If there are no feasible alternatives to takings, the Applicant would propose compensatory mitigation to reduce the impact to an acceptable level. The amount of compensation required would depend on the degree of impact on each plant species (e.g., loss of the entire population at a site versus the loss of a few individuals) and the statewide significance of the population at the affected site. The types of acceptable compensatory mitigation for taking endangered or threatened plants in Minnesota could include:

- Funding state acquisition and protection of another site where the species occurs that is currently unprotected and vulnerable to destruction,
- Funding additional survey work to locate other sites, and/or
- Funding research to improve Minnesota DNR's understanding of the habitat requirements or protection needs of the species.

Of the seven Wisconsin-listed endangered and threatened plants, multiple populations of five plants may occur within the construction work area and could be destroyed. Similar Endangered Species permits for takings and compensatory mitigation may be required by Wisconsin DNR if takings are not avoidable for the threatened clustered bur-reed, seaside crowfoot, and sweet colt's foot, and for the endangered neat spike-rush and small yellow water crowfoot.

If the populations of six Minnesota-listed plants and five Wisconsin-listed plants cannot be avoided, construction could result in permanent major impacts on those populations. These impacts could be offset by compensatory mitigation.

Summary. Measures to avoid or reduce construction impacts on state-protected animals and plants would be developed in consultation with the appropriate state agencies to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species. Given their limited distribution and the proposed construction methods, the pugnose shiner, fluted-shell mussel, and 10 state-listed plants within the construction work area would not be affected. Impacts on the wood turtle could be temporary to long-term minor impacts. Eleven state-listed plants are known to occur within the construction work area, and effects on these plants are expected to be major and permanent. All state-listed animals and plants within the ROI also could be indirectly affected by habitat loss and alteration.

Table 5.2.5-14. Potential Construction Impacts on Minnesota Endangered and Threatened Plant Populations for the Applicant's Preferred Route

Survey Site	County	Common and Scientific Name	Status [a]	Number of Avoided Individuals	Number of Affected Individuals
North Dakota Border to Clearbrook					
L3R_07	Marshall	Sterile sedge (*Carex sterilis*)	Threatened	268[b]	47[c]
L3R_12	Polk	Sterile sedge (*Carex sterilis*)	Threatened	657[d]	292
		Beaked spikerush (*Eleocharis rostellata*)	Threatened	14,665[d]	5,036
		Hair-like beak rush (*Rhynchospora capillacea*)	Threatened	18	106
L3R_14	Clearwater	Handsome sedge (*Carex formosa*)	Endangered	62[c, d]	3[c]
Clearbrook to Carlton					
L3X_99	Cass	Bog bluegrass (*Poa paludigena*)	Threatened	10 (3,500)[c, e]	4[c]
L3X _22/23/58	Cass	Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	19[b]	1 + 40[f, g]
L3X _C1	Cass	Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	-	20[f]
L3X _81a	Aitkin	Bog bluegrass (*Poa paludigena*)	Threatened	45 (7,000)[e]	242[c]
		Bog bluegrass (*Poa paludigena*)	Threatened	257 (8,000)[e]	961[c]
		Bog bluegrass (*Poa paludigena*)	Threatened	1,173 (5,000)[e]	744[c]

Source: Minnesota DNR 2017b.

Note:

No Minnesota endangered or threatened plant populations were identified in the Carlton-to-Wisconsin border for the Applicant's preferred route.

[a] Status refers to Minnesota listing.

[b] Number of individuals is based on a combination of 2015 and 2016 population counts.

[c] Number of individuals is based on 2016 population count data.

[d] The Applicant would fence individuals that are outside of the workspace but within 5 feet of the workspace edge to facilitate avoidance during construction.

[e] First number is based on number of individuals avoided within site boundary used for 2016 population count. Second number (in parentheses) is based on estimated size of population beyond site boundary during 2016 occurrence surveys;

[f] Number of individuals is based on 2015 population count data.

[g] The Applicant would avoid all individual butternut trees at this site with the understanding that some individuals of narrow triangle moonwort (which have a shorter time to maturity and are less imperiled) would be affected as a result.

Operations Impacts

Pipeline operation activities include maintenance mowing of the permanent right-of-way, excavation for visual inspection and repair or replacement of pipeline sections, and invasive species control. Vegetation management that prevents riparian trees and large shrubs from reestablishing within the permanent right-of-way could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals in adjacent waterbodies. The application of herbicides in the vicinity of waterways also has the potential to negatively affect water quality and, consequently, aquatic species. Because the pugnose shiner and fluted-shell mussel are known to occur in the ROI for the Applicant's preferred route, these species could experience a permanent, although negligible, impact during operations. Upland vegetation management could crush nests and wood turtles, causing a permanent minor impact on the species. State-listed plants that persist within the permanent right-of-way after construction could be permanently affected by vegetation management activities, including herbicide application; however, given the potential for avoidance of these plants, the overall impact would be permanent and minor. All state-listed animals and plants in the ROI also could be indirectly affected by habitat loss and alteration.

Special Concern Species

State-listed animals of special concern that could be affected by construction and operation of the Applicant's preferred route include nine vertebrates: three bats – big brown bat, little brown myotis, and northern long-eared bat; prairie vole (*Microtus ochrogaster*); eight birds – Connecticut warbler, greater prairie-chicken (*Tympanuchus cupido*), Le Conte's sparrow, Nelson's sparrow, northern goshawk (*Accipiter gentilis*), red-shouldered hawk (*Buteo lineatus*), short-eared owl, and trumpeter swan; one amphibian – four-toed salamander (*Hemidactylium scutatum*); one fish – least darter (*Etheostoma microperca*); and five invertebrates – a caddisfly *Anabolia ozburni*, a jumping spider (*Marpissa formosa*), and three mussels – black sandshell, creek heelsplitter, and pink heelsplitter (Appendix M, Tables M-1 and M-2).

Fourteen state-listed plants of special concern could be affected by construction and operation, including blunt sedge, false mountain willow, few-flowered spikerush, least moonwort, mamillate spike-rush, McCalla's willow, northern single-spike sedge, northwestern sticky aster (*Canadanthus modestus*), slender naiad (*Najas gracillima*), small white lady's slipper, Torrey's mannagrass (*Torreyochloa pallida*), twig rush, Vasey's rush, and white adder's mouth (*Malaxis monophyllos* var. *brachypoda*) (Appendix M, Table M-3).

Construction Impacts

Construction could affect special concern bats as a result of tree clearing during summer, if occupied maternity or roost trees are cut when bats are using them (as described above for the northern long-eared bat). NHIS data and surveys identified that both big brown bats and little brown myotis occur within the construction work area. Application of the conservation measure that protect the northern long-eared bat also would protect these bats.

Of the special concern birds, the Applicant's preferred route would have the greatest potential to affect the greater prairie-chicken during the lek (the period when males assemble in an area termed a "lek" and engage in competitive displays) and nesting period. As many as nine potential nesting areas could occur within the construction work area. Disturbance during the lek could interrupt breeding and make nesting birds and eggs more vulnerable to predation by foxes, skunks, and raptors. Other special concern birds that have been documented during breeding within the construction work area include

Nelson's sparrow and short-eared owl. Construction during the breeding season could result in the loss of eggs or young for these birds, resulting in short-term major impacts.

Construction of waterbody crossings for the Applicant's preferred route has the potential to affect the following aquatic animals that have been documented to be within the ROI: *Anabolia ozburni*, black sandshell, creek heelsplitter, pink heelsplitter, and least darter. Dry or wet open-cut stream crossings can result in injury or death and short-term increased turbidity impacts if these animals are present at the stream crossing during construction. Of these special concern aquatic animals, black sandshell, creek heelsplitter, and least darters would occur at the crossing locations. Construction impacts on these aquatic animals would be short term and negligible to major, depending on animal presence and the type of waterbody crossing method used. Construction through mature upland forests and fish-free wetlands also could affect the four-toed salamander that is present within the ROI.

Eleven of the 14 state-listed plants of special concern have been documented to occur within the construction work area for the Applicant's preferred route, including blunt sedge, false mountain willow, few-flowered spikerush, least moonwort, mamillate spike-rush, McCalla's willow, northern single-spike sedge, slender naiad, small white lady's slipper, Torry's mannagrass, and Vasey's rush. These plants could be destroyed by construction if populations cannot practicably be avoided. Avoidance could include methods discussed above for state-listed plants. If the plant cannot be avoided, construction could result in permanent major impacts on 11 state-listed special concern plants.

Operations Impacts

Pipeline operation would include vegetation management and pipeline inspections that could require excavation and repair or replacement of sections of the pipeline. These activities could affect the four-toed salamander if the species is present within the permanent right-of-way. Pipeline operation would include noise from pump stations, which could but is not likely to, affect special concern birds during nesting. Maintenance mowing during the nesting season could cause nest abandonment and directly destroy nests, eggs, and young of ground-nesting birds, including those of the greater prairie-chicken, Nelson's sparrow, and short-eared owl. This could result in permanent major impacts on these special concern species. Habitat would be permanently altered by vegetation management, resulting in permanent minor impacts on special concern species that occur in the permanent right-of-way.

If special concern plants continue to persist within the permanent right-of-way, vegetation management and periodic excavation of pipeline sections for repair or replacement could affect them. Most of these plants would be unlikely to persist within the permanent right-of-way; consequently, if impacts do occur, they would be short term and minor.

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined region-wide GAP species model data show the total area used by one or more protected or rare species. The distribution of low, medium, and high use areas for protected or rare mammal species indicates that 41 percent of the area within the ROI for the Applicant's preferred route could support medium to high use by these mammals (4 or more species). This relatively high proportion may reflect the widespread use of this area by Canada lynx. By comparison, 17 percent of the area within the ROI for federally listed species could support medium to high use by protected or rare birds (7 or more species). A total of 27 BCCs were identified as occurring within the ROI from the North Dakota border to Superior,

Wisconsin (Appendix M, Table M-5). The Applicant's preferred route is primarily low use for protected or rare amphibians and reptiles (Table 5.2.5-15).

Table 5.2.5-15. GAP Species Models – Habitat Use Areas for Protected and Rare Mammals, Birds, Amphibians, and Reptiles within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route (acres)

GAP Species Groups	Con[a]	Op[a]	Total		Within 0.5 Mile
			Con[b]	Op[b]	
Mammals[c]					
Low	2,487	1,099	3,101	1,247	130,256
Medium	1,474	664	1,705	757	81,340
High	128	62	148	69	8,458
Subtotal	***4,090***	***1,845***	***4,954***	***2,092***	***220,054***
Proportion of medium and high	**39%**	**39%**	**37%**	**39%**	**41%**
Birds[d]					
Low	3,778	1,694	4,601	1,916	205,570
Medium	776	362	1,012	439	35,711
High	0	0	0	0	239
Subtotal	***4,554***	***2,056***	***5,614***	***2,356***	***241,520***
Proportion of medium and high	**17%**	**18%**	**18%**	**19%**	**15%**
Amphibians and Reptiles[e]					
Low	1,117	506	1,328	581	64,727
Medium	<1	<1	<1	<1	18
High	0	0	0	0	-
Subtotal	***1,117***	***506***	***1,328***	***581***	***67,745***
Proportion of medium and high	**0%**	**0%**	**0%**	**0%**	**0%**

Sources: USGS GAP 2016a, 2016b.

[a] Con = Applicant-provided footprints for construction work area (note 120-foot-wide work area for North Dakota and Wisconsin); Op = 50-foot-wide permanent right-of-way centered on the pipeline

[b] Total: Con = sum of pipeline construction work area, additional temporary workspaces, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves

[c] Mammals – Low = 1 to 3 species, Medium = 4 to 6 species, High = 7 to 9 species

[d] Birds – Low = 1 to 6 species, Medium = 7 to 12 species, High = 13 to 19 species

[e] Amphibians and Reptiles – Low = 1 to 2 species, Medium = 3 to 6 species, High = 7 to 11 species

Construction Impacts

General construction impacts and measures to avoid or reduce impacts on rare and protected species addressed in the GAP models would be the same as those described above for federally and state-listed vertebrate fauna. Mammals could be disturbed by construction noise and activity that likely would cause larger mammals to move to other areas, possibly returning after construction activities stop; while smaller, less mobile mammals could be crushed and killed. Overall, effects likely would be short term

and minor. Given the low proportion of medium use areas for birds and low overall use for herptiles within the construction areas, impacts on these groups from construction would be short term and minor to negligible.

Operations Impacts

Vegetation management within the permanent right-of-way would prevent the reestablishment of trees and large shrubs. Animals that dependent on closed canopies for cover and habitat may avoid the permanent right-of-way. Therefore, the permanent right-of-way may act as a barrier to travel for some animals, such as amphibians, reptiles, and small mammals, and may result in fragmenting SGCN habitat. Habitat fragmentation can increase edge habitats favored by some animals and avoided by others; it can create a barrier to movements for some animals while facilitating movements of others, especially predators. Forest-nesting songbird abundance, diversity, and reproduction rates can be depressed by fragmentation associated with linear developments (Jalkotzy et al. 1997).

Minnesota's Wildlife Action Network

Approximately 28 percent of the Applicant's preferred route would affect WAN habitats (Table 5.2.5-16). Most WAN habitats (78 percent) that would be affected by construction and operation of the Applicant's preferred route are rated low-medium and medium, and no WAN habitats affected by the Applicant's preferred route are rated high. Most of the 97 miles (about 77 percent) of the Applicant's preferred route that crosses WAN habitats in Minnesota would occur within existing utility or transportation corridors. About 23 miles (23 percent) would cross a new right-of-way, potentially contributing to fragmentation of these WAN habitats. Therefore, overall impacts on WAN habitats would be minor and permanent from habitat loss and alteration in addition to potential fragmentation (fragmentation is described in greater detail in Section 5.2.4).

Table 5.2.5-16. Impacts on the Wildlife Action Network in Minnesota within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route (acres)

Wildlife Action Network Rating	Con[a]	Op[a]	Total		Within 0.5 Mile
			Con[b]	Op[b]	
Low	228.6	100.5	272.9	107.6	10,166.3
Low-medium	598.2	268.9	727.2	299.4	28,181.8
Medium	407.5	187.0	487.8	225.4	21,413.2
Medium-high	57.6	30.1	72.9	36.3	4,270.1
High	0.0	0.0	0.0	0.0	0.0
WAN TOTAL	**1,291.8**	**586.6**	**1,560.9**	**665.1**	**64,031.5**
Minnesota total	***4,555.2***	***2,057.0***	***4,934.1***	***2,057.1***	***215,882.3***
Proportion in WAN	***28.4%***	***28.5***	***31.6%***	***32.3%***	***29.7%***

Source: Minnesota DNR 2016f.

Notes:

Values in the table may not sum to totals and subtotals because of rounding.

[a] Con = Applicant-provided footprint for construction work area; Op = Applicant-provided footprint for permanent right-of-way.

[b] Con = sum of pipeline construction work area, additional temporary workspaces, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves;

WAN = Wildlife Action Network

Minnesota Biological Survey Sites of Biodiversity Significance

Construction would affect an estimated 877 acres of MBS Sites, and operations would affect an estimated 403 acres of MBS Sites (Table 5.2.5-17). Outstanding and high rated MBS Sites that would be affected by construction are described in Table 5.2.5-18. The overall abundance of MBS Sites along the Applicant's preferred route is 16 percent for construction compared to the overall abundance of 21 percent within the ROI, suggesting that the route would not disproportionately affect MBS Sites.

Table 5.2.5-17. Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity Significance for the Applicant's Preferred Route in Minnesota (acres)

Site of Biodiversity Significance Rating	Con[a]	Op[a]	Total[b]		Within 0.5 Mile
			Con	Op	
Outstanding	5.8	3.0	7.4	4.6	1,045.4
High	66.0	33.4	77.6	39.7	6,192.3
Moderate	672.1	312.0	791.9	358.8	37,061.6
MBS SITE TOTAL	**743.9**	**418.2**	**876.9**	**403.2**	**44,299.2**
Minnesota total	***4,555.2***	***2,057.1***	***4,934.1***	***2,057.1***	***215,882.3***
Proportion in MBS Sites	***16.3%***	***20.3%***	***17.8%***	***19.6%***	***20.5%***

Source: Minnesota DNR 2016h.

Notes:

Values in the table may not sum to totals and subtotals because of rounding.

[a] Con = Applicant-provided footprint for construction work area; Op = Applicant-provided footprint for permanent right-of-way.

[b] Con = sum of pipeline construction work area, additional temporary workspaces pipe yards, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves;

MBS Site = Minnesota Biological Survey Site of Biodiversity Significance

Table 5.2.5-18. Minnesota Biological Survey Sites of Outstanding and High Biodiversity Significance within the Construction Work Area for the Applicant's Preferred Route in Minnesota

County	MBS Site Rank Impact	Description	Native Plant Communities Crossed	Conservation Status Rank	North Dakota Border to Clearbrooka (acres)	Clearbrook to Carltona (acres)
Pennington	Norden 18 Outstanding Impact – widening of existing corridor	A long, narrow depression with rich fen and disturbed emergent marsh bordered by oak woodland on steep, sandy slopes.	Northern mixed cattail marsh	S2 – Imperiled	3.5	--
Hubbard	La Salle Creek High Impact – greenfield crossing	High-quality rare native plant communities immediately adjacent to La Salle Creek. The steep, forested valley slopes are mostly dominated by red and jack pine. The valley is a unique geological feature and has some of the most interesting terrain in this part of the state.	White Pine – white spruce – paper birch forest	S2 – Imperiled	--	0.6
			Sedge meadow	S4 or S5 – Not rare	--	0.5
			Black ash – (red maple) seepage swamp	S1S2 – Between critically imperiled and imperiled	--	5.1
			Extremely rich tamarack swamp	S4 – Not rare	--	1.9
Carlton	Automba 1 High Impact – widening of existing corridor	Excellent quality wetlands and good quality uplands.	Aspen – birch – basswood forest	S4 – Not rare	--	0.6
			Poor black spruce swamp	S5 – Not rare	--	0.9
			Northern mesic hardwood forest	S4 – Not rare	--	8.0
			Alder – (maple – loosestrife) swamp	S5 – Not rare	--	3.2
			Poor tamarack – black spruce swamp	S4 – Not rare	--	1.5
			Northern rich tamarack swamp (western basin)	S4 or S5 – Not rare	--	1.2
			Northern very wet ash swamp	S4 – Not rare	--	1.0
			Rich tamarack – (alder) swamp	S5 – Not rare	--	11.3

Notes:

[a] Applicant provided footprints for construction work area plus additional temporary workspaces. No outstanding or high MBS Sites are crossed between Carlton and the Wisconsin border.

MBS Site = Minnesota Biological Survey Site of Biodiversity Significance

"--" = no occurrence

Utility corridors can be effective barriers to animal movements, especially small mammals, amphibians, and reptiles. Approximately 61 miles of the Applicant's preferred route would be constructed within new rights-of-way, creating a new corridor. Of this new corridor, 17 miles (28 percent) would cross moderate, high, and outstanding ranked MBS Sites, potentially fragmenting habitats within 14 MBS Sites (Table 5.2.5-19). Habitat fragmentation can increase edge habitats favored by some animals and avoided by others, and can create a barrier to movements for some animals while facilitating movements of others, especially predators. Forest-nesting songbird abundance, diversity, and reproduction rates can be depressed by fragmentation associated with linear developments (Jalkotzy et al. 1997).

Table 5.2.5-19. Estimated Fragmentation Impacts on Minnesota Biological Survey Sites of Biodiversity Significance for the Applicant's Preferred Route in Minnesota

Site of Biodiversity Significance Rating	Minnesota Biological Survey Site of Biodiversity Significance	Length Crossed (miles)
High	Unnamed	0.5
	Automba 1	<0.1
	La Salle Creek	0.6
Moderate	Unnamed	1.5
	Atkinson 36	0.4
	Automba 7	3.3
	Beaver 24	3.3
	Daggett Brook	0.5
	Draper Tower Forest	1.3
	Macville 31	3.2
	McGregor 8	0.9
	Spalding 3	0.5
	Venoah Lake	0.2
	White Elk East	0.3
	White Elk Lake	0.4
TOTAL		**16.9**

Source: Minnesota DNR 2016h.

Construction Impacts

Construction of the Applicant's preferred route would affect an estimated 877 acres of MBS Sites. Of these 877 acres, 7 acres (1 percent) would be in areas ranked outstanding, 78 acres (9 percent) would be in areas ranked high, and 792 acres (90 percent) would be in areas ranked moderate. These 877 acres would be directly affected by construction activities that may result in adverse modification of habitats present.

Construction activities would result in destruction of native plant communities (and rare plants) within the construction footprint. In turn, this would decrease the habitat available for rare animals that depend on the MBS Site. Depending on whether the corridor goes through the edge or the interior of the MBS Site and whether there is an existing utility corridor, construction activities could decrease the

size of the MBS Site, fragment the MBS Site, or widen an existing corridor. Utility corridors can be effective barriers to animal movements, especially small mammals, amphibians, and reptiles. The wider the corridor, the more animals likely to be affected. Construction activities also may temporarily affect the hydrology of wetlands within the construction work area.

Construction activities also would affect the portions of MBS Sites that are adjacent to the construction work area. Potential impacts due to surface runoff from the construction work area include increased sedimentation and the introduction or spread of invasive species. Sedimentation can affect surrounding uplands or wetlands, as well as waterways in the vicinity of the construction.

The Applicant has committed to preparation of the following plans, procedures, and general vegetation protection measures during construction to minimize impacts:

- Co-locate the construction within and near existing utility corridors to minimize environmental impacts;
- Co-locate the Project with existing rights-of-way where feasible;
- Minimize and confine all construction equipment and vehicles to the approved designated construction work area and additional temporary workspaces;
- Develop and adhere to Project-specific construction methods and procedures for vegetation clearing methods, including treatment of existing vegetation, topsoil segregation, storage, and reapplication;
- Restore preconstruction contours and using slope breakers, sediment barriers, mulch, geotextile fabric, and other erosion control devices to stabilize the disturbed areas during the vegetative regrowth phase and reduce runoff into the adjacent environment;
- Design and plan Project pipeline construction (e.g., parking, access, temporary work areas) to reduce environmental impacts on sensitive plant communities;
- Inspect and clean all equipment prior to bringing it to the site to prevent the introduction and spread of invasive species; and
- Use weed free mulch, topsoil, and seed mix.

Impacts on MBS Sites from construction activities would be short term (i.e., until vegetation cover is reestablished) and major given their occurrence along the Applicant's preferred route.

Operations Impacts

Operations would continue to affect an estimated 403 acres of MBS Sites. Vegetation maintenance to remove trees and large shrubs within the pipeline permanent right-of-way would reduce the habitat availability for rare animals. This would result in a permanent minor habitat loss and a permanent barrier or impediment to travel for some animals.

In addition, the pipeline corridor can provide easier access to more remote MBS Sites and may result in increased human use of the corridor and MBS Sites. This can negatively affect the ecological integrity of these MBS Sites by causing habitat degradation (e.g., operation of off-road vehicles in native plant communities) or by increasing the spread of invasive species.

Long-term vegetation management during operation would result in a major permanent change to MBS Sites.

5.2.5.3.2 Continued Use of the Existing Line 3 Pipeline

Continued use of the existing Line 3 pipeline would not involve construction impacts as the pipeline is already built and in operation. Impacts on unique natural resources would be limited to continued operation of the pipeline, as discussed below.

Although most impacts would not increase above the level currently experienced, the number of integrity digs required for continued operation would increase, with an estimated 267 integrity digs per year required over the next 15 years. The impacts associated with the increased number of integrity digs would be expected to increase beyond those currently experienced, as described below.

Federally Listed Species

Federally listed threatened and endangered species that could occur within the ROI for the existing Line 3 pipeline and could be affected by operation include three mammals – Canada lynx, gray wolf, and northern long-eared bat; four birds – Kirtland's warbler, piping plover, red knot (*Calidris canutus rufa*), and whooping crane; three invertebrates - Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee; and two plants – Fassett's locoweed and western prairie fringe orchid (Table 5.2.5-6).

If federally listed species persist within the permanent pipeline right-of-way, impacts could continue from ongoing operations such as mowing for vegetation management, equipment maintenance, invasive species control, and pipeline integrity excavations. These activities could result in direct mortality of non-mobile species if they are present during the activity. Increased noise and human disturbance could cause more mobile animals to leave the area; however, they would be expected to return when the activity ceases.

Project-related noise and human activity from operations and maintenance activities could continue to interrupt foraging and reproductive activities of Canada lynx and gray wolf. Disturbances, such as public and private use of all-terrain vehicles and snow machines along the right-of-way, could affect lynx-human interactions. The periodic impacts on Canada lynx would be expected to continue to be temporary and minor, and would occur for the life of the Project.

The use of all-terrain vehicles and snow machines along the right-of-way could continue to reduce wolf habitat suitability. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Based on the highly mobile nature of wolves, the transient nature of the disturbance, and wolves' use of a variety of habitats, each occurrence would result in a temporary and minor impact, but impacts would occur periodically over the life of the Project.

Operations could continue to affect the northern long-eared bat from habitat loss or alteration, disturbance from noise and human activity at aboveground facilities, and pipeline inspection overflights or ground surveillance. Human activities during operations, including increased integrity digs, typically occur during daylight hours; therefore, operations activities would not interrupt foraging activities. The resultant periodic impacts on the northern long-eared bat would continue to be temporary and negligible but would occur over the life of the Project. Operation of pipeline pump stations would be the same as current conditions and would not result in any additional impacts on northern long-eared bats.

Operations and maintenance activities in the vicinity of Superior, Wisconsin, that occur during the Kirtland's warbler breeding season (May through September) could affect foraging and reproductive activities. Vegetation clearing for integrity digs during the nesting season could result in loss of eggs or young. As described above, piping plovers could occur near facilities in Superior, although it is unlikely that piping plovers would use the developed habitats around the terminal; therefore, operations impacts would not be expected to increase beyond the current level, and potential impacts would be negligible. Operations activities would continue to have no effect on migrant red knots or whooping cranes.

Operations activities, especially periodic mowing to prevent growth of trees and shrubs, could directly affect adults, eggs, caterpillars, or larvae if Dakota skipper, Poweshiek skipperling, or rusty patched bumble bee come in direct contact with equipment, personnel, or chemicals. These effects could include death, reduced reproduction, or displacement. While it is possible that these species could occur, it is unlikely that the prairie-dependent Dakota skipper or Poweshiek skipperling would be affected by operations activities.

The existing Line 3 pipeline crosses current high use areas for rusty patched bumble bee. Operations, including vegetation management and excavation for pipeline repair or replacement, could directly affect individuals and current high use areas. The following conservation measures would minimize take of the rusty patched bumble bee within this high use area. Implementation of these measures would result in a minor permanent impact on the species:

- Limiting vegetation management in high-quality habitat during the active season (March through September).
- Leaving one or more areas unmowed for the entire year in vegetation management areas.
- Using a minimum of 8 to 10 inches cutting height to prevent disturbance of overwintering queens or nesting sites.
- Carefully applying and targeting pesticide use to control pests and invasive species, including:
    - Using the least toxic options and following label directions to ensure proper use.
    - Applying as locally and directly as possible, and avoiding broadcast application that may be harmful to the rusty patched bumble bee or their nectar plants in areas where the species is likely to be found.
    - Ensuring that field crews recognize target weeds to avoid adverse effects on important native plants (USFWS 2017).

If the federally listed Fassett's locoweed and western prairie fringed orchids persist within the permanent right-of-way, they could continue to be permanently affected by vegetation maintenance activities and by the increased level of integrity digs. However, given the disturbed nature of the existing right-of-way, these species are unlikely to be present, and no increase in ongoing impacts is anticipated.

If the regulatory agencies determine that impacts on federally listed animals and plants would be greater than those currently occurring during operation of the Line 3 pipeline, the Applicant would consult with USFWS to develop measures to avoid or reduce those impacts and to ensure that any additional unavoidable impacts would not jeopardize the continued existence of species protected by the ESA.

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened species that could occur within the ROI and could be affected by operation include one mammal – northern long-eared bat, one invertebrate – fluted-shell mussel, and one reptile – wood turtle (Table 5.2.5-7). Potential impacts on the northern long-eared bat are discussed above for federally listed endangered and threatened species. Of the 18 state-listed endangered and threatened plants known to occur within the ROI, 8 potentially occur within the permanent right-of-way and could be affected by operations. These include three in Minnesota – beaked spikerush, hair-like beak rush, and sterile sedge; and five in Wisconsin –clustered bur-reed, neat spike-rush, seaside crowfoot, small yellow-water crowfoot, and sweet colt's foot.

Continued operations impacts for the existing Line 3 would include ongoing vegetation management and pipeline integrity digs. If excavation of the stream crossing where the fluted-shell mussel has been reported to occur was required, short-term turbidity increases and potential destruction of individual mussels could occur. Vegetation management and pipeline excavation could continue to result in injury or mortality of wood turtle eggs or adults if these activities coincided with occupied habitats. The increased number of integrity digs per year required to continue operation of the existing Line 3 would increase the potential for impacts to occur.

If the regulatory agencies determine that impacts on state-listed animals and plants would be greater than those currently occurring during operation of the Line 3 pipeline, measures to avoid or reduce impacts would be developed in consultation with the appropriate state agencies to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species. Given the increased need for excavation to repair or replace the pipeline (with an estimated 267 integrity digs required per year over the next 15 years), the potential exists for the excavations to coincide with state-listed species occurrences, resulting in minor permanent impacts on the fluted-shell mussel, wood turtle, and some state-listed plants. If state-listed plants occur where work is proposed, a take permit would be required. If there are no feasible alternatives to takings, compensatory mitigation could be required to offset the impact.

Special Concern Species

State-listed special concern species that could continue to be affected by operation of the existing Line 3 pipeline include nine vertebrates: three bats– big brown bat, little brown myotis and northern long-eared bat; six birds – Connecticut warbler, Le Conte's sparrow, Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail; and four invertebrates: a caddisfly *Anabolia ozburni* and three mussels – black sandshell, creek heelsplitter, and pink heelsplitter (Appendix M, Tables M-1 and M-2).

Seventeen state-listed plants of special concern that could be affected by continued operation of the existing Line 3 pipeline include barren strawberry, blunt sedge, English sundew (*Drosera anglica*), false mountain willow, few-flowered spikerush, Lapland buttercup (*Ranunculus lapponicus*), least moonwort, mamillate spike-rush, McCalla's willow, mingan moonwort, northern single-spike sedge, northwestern sticky aster, pale moonwort, small white lady's slipper, St. Lawrence grapefern, twig rush, and Vasey's rush (Appendix M, Table M-3).

Of the three bats of special concern, only the northern long-eared bat has been reported to occur within the Line 3 permanent right-of-way; potential operations impacts on this species is addressed above for federally listed species.

Vegetation management and pipeline excavation could result in injury or mortality of state-listed bird eggs and nests if these activities coincided with occupied habitats during the breeding season. Of the six birds occurring within the ROI, four – Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail are known to occur within the permanent right-of-way. These species could experience an increase in impacts above the current level because of the increased number of integrity digs required for continued operation of the pipeline. The impact of each integrity dig would be temporary to short term and minor but would occur periodically over the life of the Project. If excavation of the stream crossings where the caddisfly and mussels are present is required for repair or replacement of a pipeline segment, the excavation would result in the loss of some individuals, and the increase in turbidity could affect caddisflies and mussels in the area. The impacts are expected to be temporary to short term and minor for each occurrence.

Special concern plants that persist within the permanent right-of-way could continue be affected directly or indirectly by vegetation management and pipeline repair or replacement if these activities coincided with populations of these plants. Twelve of the 17 plants of special concern occurring within the ROI also are known to occur within the permanent pipeline right-of-way (10 in Minnesota – barren strawberry, blunt sedge, false mountain willow, few-flowered spikerush, least moonwort, mingan moonwort, northern single-spike sedge, pale moonwort, small white lady-s slipper, and St. Lawrence grapefern; and 2 in Wisconsin – mamillate spike-rush and Vasey's rush [Appendix M, Table M-3]). Given the increased need for excavation to repair or replace pipe segments, the excavations have the potential to affect state-listed special concern plants. If there are no feasible alternatives to the integrity digs, these plants could be disturbed. Because these rare plants have, in many instances, persisted or reestablished after construction of multiple pipelines through the Mainline corridor shared by the existing Line 3 pipeline, impacts are likely to be short term and negligible.

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined region-wide GAP species model data show the areas used by one or more protected or rare species. The distribution of low, medium, and high use areas for protected or rare mammal species indicates that 49 percent of the permanent right-of-way for the existing Line 3 pipeline could support medium to high use by these mammals (4 or more species). This relatively high proportion may reflect the widespread use of this area by Canada lynx, wolves, and several species of bats. By comparison, 14 percent of the permanent right-of-way for the existing Line 3 pipeline may support medium to high use by protected or rare birds (7 or more species). A total of 26 BCCs were identified as occurring within the ROI for federally listed species from the North Dakota border to Superior, Wisconsin (Appendix M, Table M-5). The Line 3 permanent right-of-way contains minimal habitats used by protected or rare amphibians and reptiles (Table 5.2.5-20).

The permanent right-of-way contains an estimated 1,797 acres of habitats used by one or more protected and rare mammal species, 1,987 acres used by one or more protected and rare bird species, and 393 acres used by one or more protected and rare amphibian and reptile species (Table 5.2.5-20). All of the existing Line 3 permanent right-of-way that crosses through these GAP habitats is within the Applicant's existing mainline pipeline corridor. Impacts on these habitats and animals from ongoing operations, should they persist within the permanent pipeline right-of-way, could result from mowing for vegetation management, pipeline maintenance, and invasive species control. The increased number of required integrity digs could increase impacts on these habitats. Operations activities could continue to result in direct mortality of non-mobile animals, if animals are present while the activity is occurring,

with the potential for an increase in impacts based on the increased number of integrity digs. The increased noise and human disturbance from the increase in integrity digs could cause more mobile species to leave the area than currently occurs; however, these individuals would be expected to return when the activity ceases.

Table 5.2.5-20. GAP Species Models – Habitat Use Areas for Protected and Rare Mammals, Birds, Amphibians, and Reptiles within the Permanent Right-of-Way and Region of Interest for the Existing Line 3 Pipeline (acres)

GAP Species Groups	Operations[a]	Within 0.5 Mile
Mammals[b]		
Low	923	96,274
Medium	700	72,508
High	174	20,225
Subtotal	***1,797***	***189,007***
Proportion of medium and high	**49%**	**49%**
Birds[c]		
Low	1,715	184,674
Medium	271	24,202
High	0	239
Subtotal	***1,987***	***209,115***
Proportion of medium and high	**14%**	**12%**
Amphibians and Reptiles[d]		
Low	393	**46,391**
Medium	0	**17**
High	0	**0**
Subtotal	***393***	***46,407***
Proportion of medium and high	**0%**	**0%**

Sources: USGS GAP 2016a, 2016b.

[a] Estimated operations impact area based on 50-foot-wide permanent right-of-way centered on the pipeline

[b] Mammals – Low = 1 to 3 species, Medium = 4 to 6 species, High = 7 to 9 species

[c] Birds – Low = 1 to 6 species, Medium = 7 to 12 species, High = 13 to 19 species

[d] Amphibians and Reptiles – Low = 1 to 2 species, Medium = 3 to 6 species, High = 7 to 11 species

Minnesota's Wildlife Action Network

Approximately 608 acres (35 percent) of the permanent right-of-way for the Line 3 pipeline contains WAN habitats (Table 5.2.5-21). Most WAN habitats (75 percent) that are currently affected are rated low-medium and medium, and no WAN habitats affected by the Line 3 pipeline are rated high. All of the Line 3 pipeline permanent right-of-way that crosses through WAN habitats in Minnesota is located within the Applicant's existing Mainline pipeline corridor. Operations activities such as vegetation management and integrity digs for pipeline repair and replacement could continue to result in direct mortality of non-mobile animals and plants, if these species are present during the activity. The increase

in integrity digs could increase the impacts on these habitats. The increased noise and human disturbance from the increase in integrity digs could cause more mobile species to leave the area than currently occurs; however, these individuals would be expected to return when the activity ceases.

Table 5.2.5-21. Impacts on Wildlife Action Network Habitats within the Permanent Right-of-Way and Region of Interest for the Existing Line 3 Pipeline in Minnesota (acres)

Wildlife Action Network Rating	Operations[a]	Within 0.5 Mile
Low	81.0	8,872.3
Low-medium	346.3	34,009.4
Medium	106.8	14,474.3
Medium-high	73.8	8,810.8
High	0	30.2
WAN TOTAL	**607.8**	**66,197.0**
Minnesota total	***1,742.5***	***210,080.0***
Proportion in WAN	***34.9%***	***31.5%***

Source: Minnesota DNR 2016f.

Notes:

[a] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

WAN = Wildlife Action Network

Minnesota Biological Survey Sites of Biodiversity Significance

Operations currently occur within an estimated 305 acres of moderate to outstanding MBS Sites (Table 5.2.5-22). Most MBS Sites (76 percent) that occur within the permanent right-of-way for the Line 3 pipeline are rated high for biodiversity. All of the Line 3 pipeline permanent right-of-way that crosses MBS Sites in Minnesota is within the Applicant's existing Mainline pipeline corridor. Continuing operations activities such as vegetation management and integrity digs for pipeline repair and replacement could continue to result in direct mortality of plants. The increase in integrity digs could increase the impacts on MBS Sites. Long-term vegetation management and increase in integrity digs during operation would result in a minor permanent change to MBS Sites.

Table 5.2.5-22. Estimated Operations Impacts on Minnesota Biological Survey Sites of Biodiversity Significance for the Existing Line 3 Pipeline in Minnesota (acres)

Site of Biodiversity Significance Rating	Operations[a]	Within 0.5 Mile
Outstanding	24.9	4,196.7
High	233.1	9,203.0
Moderate	46.9	26,918.8
MBS SITE TOTAL	**304.9**	**40,318.5**
Minnesota total	***1,742.5***	***210,080.0***
Proportion in MBS Sites	***17.5%***	***19.2%***

Source: Minnesota DNR 2016h.

Notes:

[a] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline.

MBS Site = Minnesota Biological Survey Site of Biodiversity Significance

Minnesota Scientific and Natural Areas

The Wawina Peatland SNA (Minnesota DNR 2016d, 2016g) occurs within the ROI. The boundary for this SNA is approximately 0.4 mile northeast of the Line 3 pipeline, and a BNSF rail line lies between the SNA and the Line 3 pipeline. The continued use of the Line 3 pipeline would not affect this SNA.

5.2.5.3.3 System Alternative SA-04

Federally Listed Species

Federally listed threatened and endangered species that could occur within the ROI and could be affected by construction and operation of SA-04 include three mammals – gray wolf, Indiana bat *(Myotis sodalist*), and northern long-eared bat; two birds –red knot and whooping crane; one reptile – eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*); seven invertebrates – Dakota skipper, Hine's emerald dragonfly (*Somatochlora hineana*), Poweshiek skipperling, Higgins eye mussel (*Lampsilis higginsii*), Iowa Pleistocene snail (*Discus macclintocki*), sheepnose mussel (*Plethobasus cyphyus*), and spectaclecase mussel (*Cumberlandia monodonta*); and eight plants – decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), lakeside daisy (*Hymenoxys herbacea*), leafy prairie clover (*Dalea foliosa*), Mead's milkweed (*Asclepias meadii*), northern wild monkshood (*Aconitum noveboracensel*), prairie bush-clover (*Lespedeza leptostachya*), and western prairie fringe orchid (Table 5.2.5-9). One candidate for listing as threatened or endangered, the rattlesnake-master borer moth (*Papaipema eryngii*), also potentially occurs within the ROI and could be affected by construction and operation.

Construction Impacts

Foraging and reproductive activities of gray wolves could be affected by exposure to Project-related noise and increased human activity. Construction of a pipeline likely would displace a few gray wolves and alter used habitats, especially if packs currently use the existing rights-of-way as travel corridors. If dens are present in the vicinity, construction-related disturbance could reduce pup survival. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Typical conservation measures to reduce impacts on the gray wolf include:

- Stop construction activities if the contractor or Environmental Inspector observes a gray wolf or possible den site within the construction corridor, or if USFWS notifies the Applicant of a gray wolf sighting within 1 mile of the construction work area; the stop work order for that area of construction should continue until the wolves leave the area.
- Report any wolf sightings immediately to USFWS, USACE, and state resource agencies (e.g., Minnesota DNR).

Indiana bats have the potential to occur along approximately 103 miles of the Illinois portion of SA-04; the rest of the route is outside of their known range (USFWS 2015). If these bats are present in the construction work area, impacts could occur if clearing or construction occurs when bats are using summer roosts. Bats could be disturbed by noise or human presence, causing them to abandon occupied tree cavities; or they could be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. Although short-term minor to major impacts could result from construction, implementation of measures to avoid cutting occupied roost or maternity trees when bats may be present would result in temporary and minor impacts.

Impacts on individuals or colonies of northern long-eared bats may occur if clearing or construction occurs when bats are using summer roosts. Northern long-eared bats could be disturbed by noise or human presence, causing them to abandon occupied tree cavities. Bats could be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. Because the population of northern long-eared bats is declining from white-nose syndrome and destruction of habitat, among other factors, the protection of these bats—and particularly of groups of bats in maternity colonies—is of critical importance.

Conservation measures that would reduce potential impacts on northern long-eared bats include:

- Maintain a year-round 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known northern long-eared bat hibernacula.
- Protect known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree, equivalent to 1.6 acres, during the pup season from June 1 to July 31.

The rufa red knot may use wetlands, cultivated fields, or waterbodies in the ROI as migratory stopover habitat. Construction activities have the potential to disturb rufa red knots, especially if disturbance coincides with important migration stopover locations. Noise or presence of humans and equipment during construction could cause rufa red knots to startle and flush from wetlands or fields, or cause them to avoid the area. Short-term impacts on wetlands and cultivated fields from clearing during construction could affect the availability of foraging and sheltering habitats. However, the abundance of wetlands in the vicinity of the SA-04 route suggests that short-term impacts on a small number of these habitats would not limit the overall availability of stopover habitat for rufa red knots, and impacts on an individual bird's survival or reproductive capacity would be negligible. The following conservation measures would reduce impacts on the rufa red knot:

- Stop construction if the contractor or Environmental Inspector observes a rufa red knot within 1 mile of the construction work area, or if USFWS notifies the Applicant of a rufa red knot sighting within 1 mile; the stop order should continue construction until the birds have left the area.
- Report any sightings of rufa red knot within the construction work area immediately to USFWS. The Applicant must provide EIs with preconstruction training in identification of rufa red knots and have photos of the species onsite to aid in identification.
- Restore wetlands crossed by the pipeline to preconstruction contours to avoid long-term impacts on the rufa red knot's migratory stopover habitat.

Whooping cranes could occur in the ROI for SA-04 during spring and fall migrations. Noise and activity during construction could displace whooping cranes from stopover habitats during foraging or in wetlands or riverine habitats during roosting. Whooping cranes generally depart from wintering grounds during late March to mid-April and return from breeding grounds beginning in mid-September. The eastern population travels north through Georgia, Tennessee, Kentucky, Indiana, and Illinois to Wisconsin. During migration, whooping cranes use croplands and shallow wetlands for stopover foraging and roosting habitats. The Aransas-Wood Buffalo Park whooping crane population migrates between wintering grounds in Aransas NWR to breeding grounds in Wood Buffalo National Park in northern Alberta. The migration corridor for this population crosses through central Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota. Potential construction impacts could include disturbance to

foraging or roosting birds during migration periods (USFWS 2009). Potential foraging and roosting habitats for whooping cranes could occur along SA-04 in North Dakota and Illinois, although it is unlikely that Project activities would coincide with the occurrence of whooping cranes. If their occurrence did overlap construction, effects on whooping cranes would be temporary and minor.

The eastern massasauga rattlesnake could occur in the ROI along the Minnesota and Illinois portions of SA-04, within wetlands and adjacent upland areas. For construction, this represents 3 percent of the overall construction work area in Minnesota and less than 1 percent in Illinois. Construction activities such as vegetation clearing, grading, and trenching could result in direct mortality of the species if the species is present during the activity. During winter, massasaugas hibernate in the aquatic environment and could be affected by fluctuating water levels associated with dewatering, trenching, surface water withdrawals and discharges, and surface water crossings. If water fluctuations occur in winter in the vicinity of massasaugas hibernacula, they could result in direct mortality due to exposure to sub-freezing temperatures and dehydration (Johnson et al. 2000). If massasaugas are present and fluctuations occur, the overall impact would be temporary and minor.

If present, the Dakota skipper, Poweshiek skipperling, and rattlesnake-master borer moth could be affected by construction activities that disturb native vegetation. These activities would disrupt egg laying and foraging during spring and summer, and could crush dormant larvae during fall and winter. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these butterflies and moths, and would remove forage plants for the species. While it is possible that these invertebrates could be present along the construction work area, no habitat or presence/absence surveys have been conducted. Direct construction impacts on these populations would be temporary. The SA-04 route is sited to follow existing pipeline, transmission line, or road corridors; consequently, potential impacts, habitat loss, and habitat fragmentation would be minimized. If these species are present, impacts from construction activities would be temporary to short term and minor.

The Hine's emerald dragonfly could occur in the ROI in Illinois; however, the SA-04 route does not pass through, or come near, any of the counties in which the dragonfly is believed to occur (Cook, DuPage, and Will counties); therefore, it is unlikely these dragonflies or their habitats would be affected by pipeline construction.

If present, protected mussels could be affected by construction activities that increase turbidity and sedimentation, which could bury them. In addition, mussels may be crushed or suffocated by open-cut construction methods for surface water crossings. The spread of invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugensis* respectively) also could smother native mussels if introduced during construction. The Higgins eye, sheepnose, and spectaclecase mussels (*Cumberlandia monodonta*) occur primarily in large rivers in the upper Mississippi River drainage. Although the waterbody crossing methods are not known for SA-04, large rivers where these mussels are most probably present likely would be crossed by HDD, and no impacts on mussel-occupied substrates would occur. Trenched crossings through mussel-occupied rivers would result in increased turbidity and could result in direct disturbance of the mussel beds. These disturbances are expected to be minor, localized, and temporary. Therefore, impacts on federally listed mussel populations from construction would range from no effect to short-term and negligible impacts.

Federally listed plants potentially occurring within the ROI include six prairie-dependent species—decurrent false aster, eastern prairie fringed orchid, leafy prairie-clover (*Dalea foliosa*), Mead's

milkweed, prairie bush-clover, and western prairie fringed-orchid. One federally listed native prairie plant—the leafy prairie-clover—has been identified within the ROI but is outside of the construction work area where it could be directly affected by construction. If federally listed plants occurred within the construction work area, direct impacts could include trampling and destruction during grubbing, grading, and trenching. Indirect effects could include conversion of already fragmented prairie habitat into other habitat types and the spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction.

Impacts on prairie soils from construction would be long term and could require a substantial amount of recovery time, which could affect any prairie-dependent plants present. The lakeside daisy may occur on limestone or dolomite outcrops crossed by the construction work area in Illinois. If these habitats are crossed and the lakeside daisy occurs, local reintroduced populations could be damaged.

The Iowa pleistocene snail and northern wild monkshood occur on algific (cold air) talus (loose rock) slopes, which are usually north-facing; they occur where air circulates over underground ice, producing a constant stream of cold moist air through vents to the slope. These rare karst cold microclimate habitats support rare plants and animals. Potential algific talus slope habitats occur in Iowa and Illinois. Natural heritage data for the area within the ROI in Iowa and Illinois did not indicate that any of these rare habitats would be crossed by the construction work area of SA-04. If any algific talus slope habitats are crossed, these federally listed species and the geologic conditions that support them could be damaged, and additional avoidance measures likely would be required.

Summary

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The gray wolf could experience temporary minor effects associated with construction activities in North Dakota. Indiana and northern long-eared bats could experience construction impacts on occupied maternity roost trees along the SA-04 route. With implementation of general conservation measures, impacts on these bats during construction would be temporary and minor. Red knot and whooping crane could occur within the construction work area during spring and fall migrations, but it is unlikely that construction would disturb these birds or affect significant foraging or roosting habitat along the SA-04 route. Consequently, no impacts on these birds are expected. Although construction could affect the eastern massasauga rattlesnake, with implementation of standard conservation measures, impacts would be minor and temporary. Construction through occupied remnant prairie habitats, if they are present within the construction work area, could result in permanent major effects on prairie-dependent insects and plants. If determined to be present, these federally listed insects and plants could be injured or destroyed; this likely would require development of additional avoidance or conservation measures. Most large rivers where federally listed mussels are likely to occur would be crossed using HDD, which would result in no effects on protected mussels. Construction through rocky outcrops occupied by the lakeside daisy could result in permanent major impacts on this federally protected plant if the daisy occurs at these habitats in Illinois. If algific talus slopes supporting the Iowa Pleistocene snail or the northern wild monkshood area are crossed by the SA-04 route, these species and the microhabitat that supports them would experience permanent major impacts that likely would require avoidance and conservation measures. There is no indication that the SA-04 route crosses any algific talus slopes; therefore, no impacts are expected.

Operations Impacts

Project-related noise and increased human activity during operation and maintenance activities could interrupt gray wolf foraging and reproductive activities. Post-construction disturbances, such as public and private use of all-terrain vehicles and snow machines along the right-of-way, could reduce wolf habitat suitability. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Based on the highly mobile nature of wolves, the transient nature of the disturbance, and wolves' use of a variety of habitats, impacts on wolves from operations would be temporary and minor over the life of the Project.

Operations impacts on the Indiana bat and northern long-eared bat could include continued habitat loss or alteration and disturbance from noise and activity at aboveground facilities, during pipeline inspection overflights or ground surveillance, and during right-of-way maintenance activities. Human activities during operation would typically occur during daylight hours; therefore, operations activities would not interrupt foraging activities and impacts would be permanent and negligible. Operation of pipeline pump stations could increase nearby noise levels over existing ambient levels; however, as described in Section 6.2.2, sound level increases would comply with Minnesota Noise Standards and would decrease over distance. Pump station footprints would be devoid of trees, so while bats could forage in the vicinity, they would not roost at the pump station sites. Unless roost sites are near a pump station, the effects on bats from operation of pump stations would be permanent and negligible.

Operations activities such could result in direct mortality to the eastern massasauga rattlesnake if they are present within the areas where mowing and integrity digs occur. However, vegetation management activities, if managed correctly, also could benefit the eastern massasauga rattlesnake by opening up and maintaining basking areas along the right-of-way. The following conservation measures identified by Johnson et al. (2000) could reduce mortality of the eastern massasauga rattlesnake associated with operation of SA-04:

- Raise mowers so that vegetation is cut no lower than 4 to 6 inches above the ground.
- Mow during periods when snakes are less active, preferably before snakes become active in spring or after activity has ceased.
- Mow during periods of the day when snakes are inactive, mainly between 11 am and 3 pm during summer.

Migrant red knot and whooping cranes could be in the area during operation activities. Given the occurrence of stopover habitat along the route, they would not be limited by habitat availability during intermittent pipeline operation and would not be affected.

Habitat and occurrence surveys have not been completed for native prairie-dependent insects – Dakota skipper, Poweshiek skipperling, and rattlesnake-master borer moth; and plants – decurrent false aster, eastern prairie fringed orchid, leafy prairie-clover, Mead's milkweed, prairie bush-clover, and western prairie fringed orchid. Maintenance activities, especially periodic mowing, have the potential to affect adults, eggs, caterpillars, or larvae directly if the species come in contact with equipment, personnel, or chemicals. These effects could include death, reduced reproduction, or displacement. While it is possible that these species could occur, it is not likely; therefore, potential impacts on prairie-dependent insects and plants would be permanent but at most negligible.

No operations impacts on the federally listed mussels are likely. However, if a segment of pipe needs repair or replacement at a surface water crossing that was constructed using the wet or dry open-cut

method, an impact on mussels is possible similar to that described above for construction. No operation impacts on the Iowa Pleistocene snail or the northern wild monkshood are expected.

If they persisted in the permanent right-of-way, federally listed native prairie plants could be permanently affected by vegetation maintenance activities. One federally listed native prairie plant – the leafy prairie-clover was identified within the ROI for SA-04 but was outside of the construction work area and permanent right-of-way. Rare plant habitat and presence/absence surveys have not been completed for the SA-04 route. If federally listed plants occur within the construction work area, additional avoidance and conservation measures could be required.

Summary

All federally listed animals and plants occurring in the ROI could be indirectly affected by habitat loss and alteration resulting from maintenance of the permanent right-of-way. However, the SA-04 pipeline would follow existing rights-of-way that previously have experienced disturbance from maintenance activities. The gray wolf, due to its transient nature, would experience temporary minor impacts that could occur throughout the life of the Project. Impacts on bats would be permanent and negligible. With implementation of appropriate conservation measures, impacts on the eastern massasauga rattlesnake would be short term and minor. Prairie-dependent insects and plants would be unlikely to be affected by operations activities and would experience permanent and at most negligible impacts. Listed mussels, the Iowa Pleistocene snail, and the northern wild monkshood would not be affected by operation of SA-04.

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened species that could be affected by construction and operation of SA-04 include 17 vertebrates, 13 invertebrates, and 22 plants (Tables 5.2.5-10 and 5.2.5-11; Appendix M, Tables L-1 to L-3).

State-listed vertebrates include one mammal – the northern long-eared bat; five birds – burrowing owl (*Athene cunicularia*), chestnut-collared longspur (*Calcarius ornatus*), king rail (*Rallus elegans*), loggerhead shrike (*Lanius ludovicianus*), and upland sandpiper (*Batramia longicauda*); three reptiles – Blanding's turtle (*Emydoidea blandingii*), ornate box turtle (*Terrapene ornata*), and plains hog-nosed snake (*Heterodon nasicus)*; and eight fish – American brook lamprey (*Lampetra appendix*), banded killifish (*Fundulus diaphanous*), black buffalo(*Ictiobus niger*), blacknose shiner (*Notropis heterolepis*), greater redhorse (*Moxostoma valenciennesi*), pallid shiner (*Hybopsis amnis*), river redhorse (*Moxostoma carinatum*), and slender madtom (*Noturus exilis*). Potential impacts on the northern long-eared bat are addressed for federally listed endangered and threatened species. The state-listed invertebrates are dominated by aquatic mollusks, but the redveined prairie leafhopper (*Aflexia rubranura*) and regal fritillary butterfly (*Speyeria idalia*) also could be affected during construction (Table 5.2.5-10; Appendix M, Table M-1).

Botanical surveys were not conducted along SA-04. Based on Minnesota DNR NHIS data (Minnesota DNR 2016e), there are no known occurrences of Minnesota-protected plants within the SA-04 construction work area.

Construction Impacts

State-listed birds that could be affected by construction of SA-04 include the burrowing owl, chestnut-collared longspur, king rail, loggerhead shrike, and upland sandpiper.

The eastern extent of the summer breeding range for the burrowing owl includes North Dakota, South Dakota, and the western edge of Minnesota. One NHIS-documented occurrence of burrowing owls in Minnesota is within the ROI and is likely in the construction work area. Burrowing owls occur in open grasslands, especially prairies and savanna, where they nest in abandoned burrows of prairie dogs and ground squirrels. If construction occurs through this area and burrowing owls are present, construction could destroy burrow structures; if construction occurs during the nesting season (from mid-March through September) and burrowing owls are present, it could disrupt breeding and destroy eggs or young within the burrows. Construction activities near active nest burrows could result in abandonment of active nests (Klute et al. 2003). If construction occurs outside of the nesting season, impacts on burrowing owls would be negligible based on their limited known occurrence and habitat availability.

Chestnut-collared longspurs also are ground-nesting, prairie-dependent birds that occur in a few western Minnesota counties. They arrive in Minnesota around April 15 from wintering areas in the southern United States and northern Mexico. Nests are constructed on the ground under a clump of grass. One occurrence of the species is documented in Traverse County, Minnesota, within the ROI; although the site may no longer be occupied. The construction work area for SA-04 occurs within an existing pipeline corridor outside of the prairie habitat where this sighting occurred, and construction is not likely to result in habitat loss or disturbance to the chestnut-collared longspur.

The king rail's breeding range extends from southeast North Dakota through Illinois; they do not occur in northern North Dakota. There is one NHIS-documented occurrence of a king rail in Illinois within the ROI, but there are no known occurrences within the construction work area. King rails are ground nesters associated with freshwater marshes but can adapt to a variety of habitats that support vegetation and are frequently wet. If the species is present, construction occurring in these habitat types during the nesting season from May through July could disrupt breeding and destroy eggs, while construction post-hatch could kill or disrupt young within nests. If construction occurs outside of the nesting season, impacts on king rails would be negligible based on their limited known occurrence within the construction area.

The entire extent of SA-04 occurs in the loggerhead shrike's summer breeding range. However, there are only three NHIS-documented occurrences of loggerhead shrikes within the ROI, with no known occurrences within the construction work area. Loggerhead shrikes nest in trees or brush associated with open areas containing upland grasslands and agricultural areas; they use both native and non-native grasslands. Loggerhead shrikes could be disturbed by noise or human presence, causing them to abandon occupied nests. If nest trees or shrubs are cut down, eggs or young could be injured or killed. Based on their limited known occurrence in the ROI, impacts on loggerhead shrikes would be at most temporary and negligible during construction, if construction occurs during the breeding season. If construction occurs outside of the breeding season, loggerhead shrikes would not be affected.

The entire extent of SA-04 occurs in the upland sandpiper's summer breeding range. However, there is only one NHIS-documented occurrence of an upland sandpiper within the ROI, and no known occurrences within the construction work area. Upland sandpipers are ground-nesting birds that prefer hayfields and pastures, but they also occur in open grasslands in the absence of preferred habitat. Construction in these habitat types during the nesting season from May through July could disrupt breeding and destroy eggs, while construction post-hatch could kill or disrupt the young within nests. If

construction occurs outside of the nesting season, impacts on upland sandpipers would be temporary and negligible based on their limited known occurrence within the construction area.

Reptiles that could be affected by construction of SA-04 include Blanding's turtle, ornate box turtle, and plains hog-nosed snake.

Blanding's turtles do not occur in North Dakota but could occur along the rest of SA-04. There are five NHIS-documented occurrences of Blanding's turtles within the ROI and one occurrence within the construction work area. Blanding's turtles use a variety of wetland types as well as upland areas. They overwinter in bottom mud of marshes, ponds, and streams; use wetlands upon emergence from overwintering sites. Due to their year-round residence, construction activities occurring near wet habitat types, regardless of season, could crush and kill turtles. Uplands are also used for basking, periods of dormancy, and traveling between wetlands. Blanding's turtles may be affected through direct fatalities or habitat disturbance/destruction due to dewatering, excavation, fill, or other construction activities associated with the Project. Any added mortality can be detrimental to populations of Blanding's turtles, as these turtles have a low reproduction rate that depends upon a high survival rate to maintain population levels. Minnesota DNR recommendations to minimize disturbance include, but are not limited to, the following measures: avoid filling or dewatering wetlands during the winter, implement stringent erosion control methods, use wildlife-friendly erosion control methods, and monitor for turtles during construction. Provided the implementation of applicable measures, construction-related impacts on Blanding's turtles would be short term and minor.

The ornate box turtle could occur along the Illinois and Iowa portions of SA-04; this turtle does not occur in Minnesota or North Dakota. Within Illinois and Iowa, there are three NHIS-documented occurrences within the ROI; within Illinois, one of these occurrences is within the construction work area. Ground-disturbing construction activities in sandy dune habitat could affect nests, resulting in abandonment or mortality of both adults and young. Construction activities also could result in the loss of foraging habitat. Turtles may be injured or killed by collisions with construction vehicles. The following conservation measures identified by Iowa DNR (2016b) could reduce impacts on the ornate box turtle. Assuming that these measures are followed, construction impacts on the ornate box turtle would be negligible.

- Watch sand dunes between May 29 and June 12 from 9 pm to 2 am to identify the presence of nest-building turtles. If turtles are identified within the construction work area, work with Iowa DNR to protect nests.
- Construction and operation vehicles should be aware of road crossing locations for ornate box turtles between April and September.

The plains hog-nosed snake could occur along the entire extent of the SA-04 pipeline. There is one NHIS documented occurrence of a plains hog-nosed snake within the ROI; however, no occurrences have been documented within the construction work area. Habitats used by this species include open, sparsely vegetated areas with sandy or gravelly soils, such as prairies, sandhills, and river floodplains. Females lay eggs from May to August (mainly in June and July), and hatching occurs approximately 2 months later. This snake overwinters in underground burrows. Because of their year-round residence, construction activities occurring near their preferred habitat types, regardless of season, could crush and kill plains hog-nosed snakes. Construction-related impacts would be short term and minor.

State-protected fish that could be affected by construction of SA-04 include the American brook lamprey, banded killifish, black buffalo, blacknose shiner, greater redhorse, pallid shiner, river redhorse, and slender madtom. For each of these species, at least one known NHIS-documented occurrence is within the ROI, and some known occurrences are within the construction area. While these species occupy different habitat types, general impacts from construction activities in the vicinity of surface waters would be similar for all of them; therefore, this assessment does not separate potential effects by species.

Use of open-cut crossings of streams where these state-listed fish occur could result in mortality of these species. Fine sediments introduced during open-cut crossings can suffocate fish eggs and newly hatched larvae living in gravel. The sediments also can abrade the sensitive gill membranes of young and adult fish, resulting in injury or death. Sedimentation can cause reductions in prey availability or the ability of fish to locate prey or escape predation, leading to increased energy expenditure for foraging and increased mortality. Removal of water from waterbodies for hydrostatic testing can result in entrainment of small fish, eggs, and macroinvertebrates during extraction. Spawning fish could be affected through decreased water levels, displaced spawning habitat, and water quality degradation. Fish eggs could desiccate if water levels drop too low, or the eggs could become entrained within test water. They may experience delayed development due to impaired water quality. Larval and juvenile fish could be affected through entrainment during water withdrawal, decreased survival under conditions of poor water quality, and reduced prey availability. Contaminated construction equipment and water used for hydrostatic testing could introduce invasive aquatic animals such as zebra and quagga mussels that could displace and reduce habitat quality for these species. Hydrostatic waters would be discharged in a manner that avoids the use of waterbodies with commercially or recreationally important species as intake sources. Impacts on fish due to water crossings would be temporary to short term because of the localized nature of the activity.

Construction effects on invertebrates for SA-04 would be similar to those described for the Applicant's preferred route. Disturbance to the stream bottom during surface water crossings could crush or suffocate mussels, and would temporarily increase turbidity that could reduce feeding efficiency and damage these sensitive aquatic animals that are in the vicinity of the crossing. Contaminated construction equipment and water used for hydrostatic testing could introduce invasive aquatic animals such as zebra and quagga mussels that could displace and reduce habitat quality for aquatic animals. EIs would monitor construction activities, ensuring compliance with permit conditions and reducing the potential for introduction of invasive species from contaminated equipment.

If state-protected insects are present, they could be affected by construction activities that disturb native vegetation. These activities would disrupt egg laying and foraging during spring and summer, and could crush dormant larvae during fall and winter. These insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill the redveined prairie leafhopper and regal fritillary butterfly, as well as removing forage plants for these species. Overall, given the limited presence of native prairie in the construction work area, impacts on invertebrates during construction of SA-04 would be temporary and minor.

Of the 22 state-listed endangered or threatened plants that occur within the ROI, four – broomrape, false mallow, plains sedge, and quillwort occur within the construction work area for SA-04. The listed plants in the construction footprint could be destroyed during grubbing, grading, and trenching; and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To

minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction.

Permanent major impacts on the broomrape, false mallow, plains sedge, and quillwort could occur because of their occurrence within the construction work area. Rare plants surveys have not been completed for the SA-04 route, and additional state-listed plants may occur within construction work areas if suitable habitat is present. However, given the habitat conversion that has occurred in the southern and western portion of Minnesota, there is limited suitable habitat for these species in this part of the state. All of the Minnesota protected plants found in the ROI are associated with native prairie or calcareous fens, and there are only two known occurrences of native prairie remnants in the construction work area (a delineated native prairie remnant within a moderate rated MBS Site in Traverse County and a native prairie remnant in a railroad right-of-way in Mower County). As such, it may be possible to avoid most impacts on Minnesota state-listed threatened or endangered plants. If state-protected plants are present, the plants would be affected by construction. Measures to avoid or reduce construction impacts on state-listed animals and plants would be developed in consultation with the appropriate state agencies, if required, to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species.

Aquatic species and insects would experience temporary minor impacts from construction. Provided measures to minimize disturbance are implemented, impacts on the Blanding's turtles and plains hog-nosed snake would be short-term and minor. Implementation of conservation measures would reduce impacts on the box turtle to temporary and negligible. Due to the limited occurrence of state-listed birds or suitable habitats along SA-04, impacts on state-listed birds would be temporary and negligible.

Operations Impacts

Vegetation management that prevents trees and large shrubs from reestablishing within the permanent right-of-way adjacent to streams could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. Maintenance activities in and around surface waters also could crush Blanding's turtle adults, nests, and eggs. Upland maintenance activities and vehicle use could crush ground-nesting bird eggs and young (burrowing owl, chestnut-collared longspur, king rail, and upland sandpiper), and ornate box turtle and plains hog-nosed snake nests and eggs, as well as adult turtles and invertebrates. State-listed plants that persist within the permanent right-of-way could be permanently affected by vegetation management activities. Given their limited distribution within this area, overall impacts would be minor. All state-listed species could be indirectly affected by habitat loss and alteration resulting from maintenance of the permanent right-of-way. However, SA-04 would follow existing rights-of-way that have been periodically disturbed by maintenance activities. Given the limited potential for occurrence of state-listed species and the identified conservation measures, impacts from operation on state-listed endangered and threatened species would be expected to be negligible to minor and permanent.

Special Concern Species

State-listed special concern species that could be affected by construction and operation of SA-04 include 12 vertebrates, 9 invertebrates, and 20 plants (as listed in Appendix M, Tables M-1 to M-3). State-listed special concern vertebrates include six birds – Acadian flycatcher (*Empidonax virescens*), bald eagle (*Haliaeetus leucocephalus*), cerulean warbler (*Setophaga cerulean*), greater prairie-chicken, Louisiana waterthrush (*Parkesia motacilla*), and marbled godwit (*Limosa fedoa*); two reptiles – North American racer (*Coluber constrictor*) and smooth softshell (*Apalone mutica*); and four fish – blue sucker

(*Cycleptus elongatus*), least darter (*Etheostoma microperca*), Ozark minnow (*Notropis nubilus*), and redfin shiner (*Lythrurus umbratilis*)(Appendix M, Table M-2). State-listed special concern invertebrates include six arthropods – two jumping spiders (*Marpissa formosa* and *Phidippus pius*), Iowa skipper (*Atrytone arogos iowa*), leadplant flower moth (*Schinia lucens*), red-tailed prairie leafhopper (*Aflexia rubranura*), and regal fritillary; and three mussels – black sandshell, creek heelsplitter, and round pigtoe (*Pleurobema sintoxia*) (Appendix M, Table M-1).

Twenty state-listed special concern plants could be affected by construction and operation of SA-04, including a lichen *Buellia nigra*, American ginseng (*Panax quinquefolius*), buffalo grass, cleft phlox (*Phlox bifida*), cutleaf ironplant (*Xanthisma spinulosum var. spinulosum*), flat top white aster (*Aster pubentior*), grassleaf rush (*Juncus marginatus*), green dragon (*Arisaema dracontium*), Kentucky coffee tree (*Gymnocladus dioica*), nodding wild onion (*Allium cernuum*), plains wild indigo, rattlesnake master (*Eryngium yuccifolium*), sage willow (*Salix candida*), small fringed gentian (*Gentianopsis procera*), small white lady's slipper, snow trillium (*Trillium nivale*), soft rush (*Juncus effusus*), swamp thistle (*Cirsium muticum*), valerian (*Valeriana edulis var. ciliata*), and white wild indigo (*Baptisia lactea* var. *lactea*). Of the 20 special concern plants, three occur within the construction work area: buffalo grass, plains wild indigo, and small white lady's slipper (Appendix M, Table M-3).

Construction Impacts. Of the special concern birds, construction of SA-04 would have the greatest potential to affect the bald eagle. This species potentially occurs within the construction work area during the nesting period. Other special concern birds that occur within the ROI during breeding could be affected by disturbance from activities within the construction work areas. Vegetation clearing and grading during breeding could cause loss of eggs or young of these birds, resulting in short-term major impacts if these special concern birds nest within the construction work area.

Reptiles that could be affected by construction of SA-04 include the North American racer and the smooth softshell turtle. There are two NHIS-documented occurrences in the ROI for the North American racer and one occurrence of the smooth softshell. North American racers occupy a variety of habitats in southeastern Minnesota, including forested hillsides, bluff prairies, grasslands, and open woods. These snakes emerge from hibernation during late April; breed in May and early June; and lay eggs under rotting logs, in stumps, or in mammal burrows in late June or early July. Snakes could be injured or killed during vegetation clearing and grading, run over by vehicles, or trapped and buried within the pipeline trench. Inspecting and removing wildlife from the trench prior to backfilling would reduce injuries to snakes.

Smooth softshell turtles inhabit large rivers and use sandy beaches for nesting habitat. Eggs are laid on sandbars and riverbanks from June to early July. Most large rivers would be crossed using the HDD method; consequently, suitable habitats and individual smooth softshell turtles would not likely be affected. Construction of HDD crossings during nesting could disrupt nesting if the entry or exit pits are installed within sandy areas used by the turtles; however, most pits likely would be excavated at a sufficient distance from the water to avoid those areas. Impacts on smooth softshell turtles during construction would be short term and negligible.

Construction of waterbody crossings has the potential to affect aquatic animals, including mussels—black sandshell, creek heelsplitter, round pigtoe and fish—blue sucker, least darter, Ozark minnow, and redfin shiner that have been documented within the ROI for the Applicant's preferred route and could occur within surface waters crossed by SA-04. Construction of surface water crossing using the wet or dry open-trench methods could result in injury or death, in addition to short-term increases of turbidity and sedimentation. Of these special concern aquatic animals, black sandshell, round pigtoe, blue sucker, least darter, and Ozark minnow likely would occur at the crossing locations. Construction impacts on

these aquatic animals would be short term and negligible to major, depending on animal presence and the type of crossing method used.

Vegetation clearing and site grading through native grassland habitats could destroy the prairie-dependent jumping spiders (Marpissa formosa and Phidippus pius), Iowa skipper, leadplant flower moth, red-tailed prairie leafhopper, and regal fritillary. These insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. High-quality native prairie habitats are not expected to occur within the SA-04 construction work area because it is co-located with existing pipelines, transmission lines, or roads; however, surveys for native prairie habitats and butterflies have not been completed for the SA-04 route. Overall, construction impacts on prairie-dependent invertebrates are expected to be short term, until vegetation cover is reestablished, and minor.

Eleven of the 14 state-listed plants of special concern (blunt sedge, false mountain willow, few-flowered spikerush, least moonwort, mamillate spike-rush, McCalla's willow, northern single-spike sedge, slender naiad, small white lady's slipper, Torry's mannagrass, and Vasey's rush) have been documented within the construction work area and could be destroyed by construction if populations cannot practicably be avoided. Avoidance could include the methods described above for state-listed plants. If not avoidable, construction could result in permanent major impacts on 11 state-listed special concern plants.

Operations Impacts. Operation activities include mowing for vegetation management, periodic excavation for pipeline visual inspection and repair or replacement, and invasive species control. Vegetation management that prevents trees and large shrubs from reestablishing within the permanent right-of-way adjacent to streams could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. Upland vegetation and maintenance activities and vehicle use could crush ground-nesting bird eggs and young (greater prairie-chicken, Louisiana waterthrush, and marbled godwit), and North American racer nests and eggs, as well as invertebrates. State-listed special concern plants that persist within the permanent right-of-way could be permanently affected by vegetation management activities; however, overall impacts likely would be minor. All state-listed special concern animals and plants could be indirectly affected by habitat loss and alteration resulting from maintenance of the permanent right-of-way; however, SA-04 would follow existing pipeline, transmission line, and road corridors. Given the potential for occurrence of state-listed special concern species and the identified conservation measures, impacts from operation are expected to be short term and negligible to minor.

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The combined region-wide GAP species model data show the areas used by one or more protected or rare species. The distribution of low, medium, and high use areas for protected or rare mammal species indicates that 1 percent of the construction work area and permanent right-of-way for SA-04 could support medium to high use by these mammals (4 or more species). By comparison, 5 and 6 percent of the construction work area and permanent right-of-way for SA-04, respectively, may support medium to high use by protected or rare birds (7 or more species); and 17 percent of both the construction work area and permanent right-of-way contains habitats used by protected or rare amphibians and reptiles (Table 5.2.5-23). A total of 35 BCCs were identified as occurring within the ROI for SA-04 (Appendix M, Table M-5).

Table 5.2.5-23. GAP Species Models – Habitat Use Areas for Protected and Rare Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04 (acres)

GAP Species Groups	Construction[a]	Operations[b]	Within 0.5 Mile
Mammals[c]			
Low	9,029	3,773	298,935
Medium	46	19	3,629
High	-	-	-
Subtotal	***9,076***	***3,792***	***402,564***
Proportion of medium and high	**1%**	**1%**	**1%**
Birds[d]			
Low	10,913	4,556	477,784
Medium	617	247	27,908
High	19	8	1,151
Subtotal	***11,549***	***4,812***	***506,843***
Proportion of medium and high	**6%**	**5%**	**6%**
Amphibians and Reptiles[e]			
Low	3,310	1,378	149,625
Medium	669	278	29,137
High	5	2	377
Subtotal	***3,984***	***1,658***	***179,139***
Proportion of medium and high	**17%**	**17%**	**16%**

Sources: USGS GAP 2016a, 2016b.

Notes:

[a] Estimated construction impact area based on 120-foot-wide construction work area

[b] Estimated operations impact area based on 50-foot-wide right-of-way centered on the pipeline

[c] Mammals – Low = 1 to 3 species, Medium = 4 to 6 species, High = 7 to 9 species

[d] Birds – Low = 1 to 6 species, Medium = 7 to 12 species, High = 13 to 19 species

[e] Amphibians and Reptiles – Low = 1 to 2 species, Medium = 3 to 6 species, High = 7 to 11 species

Construction Impacts. General construction impacts and measures to avoid or reduce impacts on rare and protected species addressed in the GAP models would be the same as those described above for federally and state-listed vertebrate fauna. Mammals, birds, amphibians, and reptiles could be disturbed by construction noise and activity that likely would cause larger animals to move to other areas, possibly returning after construction activities stop; while smaller, less mobile animals could be crushed and killed. Overall, the effects likely would be short term and minor. Given the low proportion of medium use areas for amphibians, reptiles, and birds and the low overall use for mammals within the construction areas, impacts on these groups from construction would be short term and negligible to minor.

Operations Impacts. The permanent right-of-way would be maintained clear of trees and tall shrubs. Due to periodic vegetation management, protected and rare animals that depend on closed canopies may avoid the permanent right-of-way. The herbaceous cover within the right-of-way may act as a barrier to travel for some small animals, fragmenting habitats. However, SA-04 would follow existing rights-of-way where similar maintenance activities have affected the rights-of-way, limiting the magnitude of the impacts from maintenance of the SA-04 permanent right-of-way. Given the limited areas of high protected and rare species use crossed by SA-04, impacts on habitats used by these animals from operations would be permanent and negligible.

Minnesota's Wildlife Action Network

Approximately 8 percent of the ROI within Minnesota is within the WAN. Most WAN habitats that would be affected by construction and operation of SA-04 are rated low, low-medium, and medium-high (Table 5.2.5-24). All 19 miles of SA-04 crossings of WAN habitats would occur within existing pipeline corridors. Given the limited amount of total WAN area affected, overall impacts on habitats within the WAN from habitat loss and alteration would be permanent and minor (see Section 5.2.4 for additional details).

Table 5.2.5-24. Wildlife Action Network Impacts within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04 in Minnesota (acres)

Wildlife Action Network Rating	Construction[a]	Operations[b]	Within 0.5 Mile
Low	123.4	51.4	5,348.3
Low-medium	50.8	21.2	2,628.0
Medium	39.6	16.5	1,806.8
Medium-high	53.5	22.3	2,075.6
High	9.5	3.9	536.6
WAN TOTAL	**276.7**	**115.3**	**12,422.3**
Minnesota total	***3,650.9***	***1,521.2***	***160,230.0***
Proportion in WAN	***7.6%***	***7.6%***	***8%***

Source: Minnesota DNR 2016f.

Notes:

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline

WAN = Wildlife Action Network

Minnesota Biological Survey Sites of Biodiversity Significance

Construction would affect an estimated 25 acres of MBS Sites, and operations would affect an estimated 10 acres of these designated lands (Table 5.2.5-25). Potential impacts on these sites from construction and operation would be the same as those described for the Applicant's preferred route and could result in permanent habitat alteration. Given the small proportion of MBS Sites potentially affected and co-location of the SA-04 route with existing pipeline, transmission line, and road corridors, impacts from construction and operation likely would be permanent and minor.

Table 5.2.5-25. Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity Significance within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for System Alternative SA-04 in Minnesota (acres)

Site of Biodiversity Significance Rating	Construction[a]	Operations[b]	Within 0.5 Mile
Outstanding	1.3	0.5	284.7
High	5.0	2.1	467.3
Moderate	18.4	7.6	869.3
MBS SITE TOTAL	**24.7**	**10.3**	**1,621.3**
Minnesota total	***3,650.9***	***1,521.2***	***160,230.0***
Proportion in MBS Sites	***0.2%***	***0.2%***	***1.0%***

Source: Minnesota DNR 2016h.

Notes:

Values in the table may not sum to totals and subtotals because of rounding.

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline

MBS Site = Minnesota Biological Survey Sites of Biodiversity Significance

5.2.5.3.4 Transportation by Rail

Transportation of crude oil by rail would require development of offloading facilities, including new rail access and upgrades of existing rail access to Clearbrook and Superior. Clearing of vegetation and ground disturbance associated with preparing sites for development and construction of these permanent facilities would affect unique natural resources. Rail offloading facilities would require the following:

- Clearing from 100 to 200 acres adjacent to the existing Clearbrook terminal in Minnesota;
- Clearing approximately 100 acres in Superior, Wisconsin, adjacent to the existing Enbridge terminal;
- Reestablishment of 10 miles of track on an existing railbed between Clearbrook and Gully, Minnesota; and
- Construction of a less than 0.5-mile interconnection between existing rail lines in Superior, Wisconsin.

In the United States, operations would include use of the offloading facilities and new and upgraded access routes, and use of existing rail routes from the U.S-Canada border to the Clearbrook and Superior terminals. Approximately 10 unit trains of 110 tanker cars would be required each day to transport the proposed volume.

Federally Listed Species

Federally listed threatened and endangered species that could occur within or near the new facilities and new rail access routes and that could be affected by construction and operation of the rail alternative include three mammals – Canada lynx, gray wolf, and northern long-eared bat; three birds –

Kirtland's warbler, piping plover, and whooping crane; three invertebrates - Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee; and one plant – western prairie fringe orchid.

Construction Impacts

If present, the Canada lynx could be disturbed by construction noise and activity that likely would cause lynx to move to other areas, possibly returning after construction activities stop. Disturbance effects likely would be temporary and minor unless den sites are disturbed. Den sites, which are used from April to June, are unlikely to occur near the Clearbrook and Superior terminals where new offloading and rail access facilities would be constructed.

Foraging and reproductive activities of gray wolves could be affected by exposure to Project-related noise and increased human activity. Construction of the new rail offloading and access facilities could alter habitats used by wolves. If dens are present in the vicinity, construction-related disturbance could reduce pup survival. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Typical conservation measures to reduce construction impacts on the gray wolf include:

- Stop construction activities if the contractor or Environmental Inspector observes a gray wolf or possible den site within the construction area, or if USFWS notifies the Applicant of a gray wolf sighting within 1 mile of the construction work area; the stop work order should continue until the wolves leave the area.
- Report any wolf sightings immediately to USFWS, USACE, and state resource agencies (e.g., Minnesota DNR).

With implementation of conservation measures, gray wolves would not be affected by construction of the new rail facilities and access at Clearbrook and Superior, or the effects would be temporary and minor.

Minnesota and Wisconsin NHISs report no occurrences of the northern long-eared bat for the area around the Clearbrook and Superior terminals or where new rail offloading facilities and rail access are likely to be constructed (Minnesota DNR 2016e; Wisconsin DNR 2016). The Applicant conducted acoustic surveys within suitable habitats around the Clearbrook and Superior terminals during 2014 and 2015 to determine the summer presence or absence of northern long-eared bats. No northern long-eared bats were confirmed at 14 acoustic survey sites around the Clearbrook terminal in Clearwater County, Minnesota, or at one site near the Superior terminal in Douglas County, Wisconsin (Merjent 2014b, 2015c).

Impacts on individuals or colonies of bats may occur if clearing or construction occurs when bats are using summer roosts. Northern long-eared bats could be disturbed by noise or human presence, causing them to abandon occupied tree cavities. Bats could be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. If northern long-eared bats were found to roost near these sites, applicable conservation measures could include:

- Maintain a year-round 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known northern long-eared bat hibernacula.
- Protect known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree, equivalent to 1.6 acres, during the pup season from June 1 to July 31.

Northern long-eared bats are not expected to occur near the new rail offloading and access facilities. With implementation of applicable conservation measures, effects on northern long-eared bats would not occur or would be negligible and minor.

Kirtland's warblers nest in jack pine forests in Wisconsin and Michigan and migrate along the southeast coast of the United States to overwinter in the Bahamas. Vegetation clearing for construction of new facilities during the nesting season could result in loss of eggs or young. The warblers are known to be present during the breeding season in the vicinity of Superior. No jack pine woodlands appear to occur in the vicinity of the new rail offloading and access facilities near Clearbrook or Superior. Because Kirtland's warblers are not expected to occur near the facilities, they would not be affected during facility construction.

Great Lakes piping plovers inhabit shorelines of the Great Lakes. Critical habitat for this species has been designated in Douglas County, Wisconsin. The new rail offloading and access facilities would be constructed near the Superior terminal in Douglas County. Piping plovers nest on open, sparsely vegetated sandy habitats such as sand spits or sand beaches found on Great Lakes islands and mainland shorelines. While it is possible that piping plovers could occur near facilities in Superior, it is unlikely that they would use these developed habitats; therefore, construction would be unlikely to affect piping plovers.

Whooping cranes from the eastern population that winters in Florida migrate to breeding areas in Wisconsin and could occur near the Superior terminal during the spring and fall migrations. Noise and activity during construction can displace whooping cranes from stopover habitats during foraging or in wetlands or riverine habitats during roosting. Whooping cranes generally depart from wintering grounds during late March to mid-April and return from breeding grounds beginning in mid-September. During migration, whooping cranes use croplands and shallow wetlands for stopover foraging and roosting habitats. The Aransas-Wood Buffalo Park whooping crane population migrates between wintering grounds in the Aransas NWR to breeding grounds in the Wood Buffalo National Park in northern Alberta. The migration corridor for this population crosses through central Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota and is generally west of the Clearbrook terminal. Potential impacts could include disturbance to foraging or roosting birds from construction during migration periods (USFWS 2009). Whooping cranes are unlikely to occur near the Clearbrook or Superior terminal areas and are not likely to be affected by construction.

If present, the Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee could be affected by construction activities that disturb native vegetation. Vegetation clearing and grading would disrupt egg laying and foraging during spring and summer, and could crush dormant larvae during fall and winter. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these butterflies and bees, and could remove forage plants. Habitat and presence/absence surveys have not been completed for the area surrounding the Clearbrook and Superior terminals. There may be some native prairie plant species persisting in the hay/pasture vegetation in the vicinity of the Clearbrook terminal that could provide habitat for these species. Two moderate rated northern dry sand-gravel prairie native plant communities are in the vicinity of the rail access route between Clearbrook and Gully. If suitable habitat for prairie-dependent insects are present, these habitats could be lost because of fill for construction of the offloading and rail access facilities. If these habitats are suitable for Dakota skipper, Poweshiek skipperling, or rusty patched bumble bee, loss of these habitats would result in a permanent and minor impact.

The new rail facilities near the Clearbrook terminal would not cross any current high use areas for rusty patched bumble bee, and construction is not likely to directly or indirectly affect any individuals or current high use areas. The new rail facilities would be located within a current potential low use area where rusty patched bumble bees may disperse from a current high use area or where their occurrence is uncertain. The rusty patched bumble bee may benefit from conservation measures implemented within the dispersal area, and USFWS may recommend surveys. Applicable conservation measures that would benefit the rusty patched bumble bee within this dispersal area include restoration and maintenance of high-quality habitat through control of invasive species and restoration, including providing a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Fassett's locoweed has the potential to occur near the Superior terminal, although there are no NHIS reports for the plant in this area. If Fassett's locoweed occurred within the construction area, direct impacts could include trampling and destruction during clearing and grading for site preparation. Indirect effects from construction could include conversion of shoreline habitat (locoweed) into other habitat types and the spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Surveys were not performed for Fassett's locoweed; however, based on known habitat associations, there is limited potential for the plant to occur within the construction areas around the Superior terminal. If this plant was found to occur, additional avoidance measures may be required, and effects likely would be permanent and negligible.

Summary

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf could experience temporary minor effects associated with construction activities for the rail alternative. Northern long-eared bats and occupied maternity roots are not known to occur near the Clearbrook and Superior terminals. With implementation of general conservation measures, impacts from construction would be temporary and minor. Kirtland's warbler, piping plover, and whooping crane are not likely to be affected by construction for the rail alternative. Native prairie plants that could provide habitat for the native prairie-dependent Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee may persist within hay/pasture vegetation in the vicinity of the Clearbrook terminal. If suitable habitat for these butterflies and bumble bees occurs within these grassland, and the habitat was lost during construction, the impact would be permanent and minor. Effects on the federally listed Fassett's locoweed would be negligible based on the lack of appropriate habitat and species presence.

Operations Impacts

Project-related noise and increased human activity during operation of offloading facilities could interrupt mammalian and avian foraging and reproductive activities that occur in the vicinity of the facilities. These effects would be temporary and minor.

The northern long-eared bat, Kirtland's warbler, piping plover, and whooping crane are not likely to be affected by operations for the rail alternative. The increase in train traffic could increase barrier effects and wildlife collision mortality (Dorsey 2011) on Canada lynx and gray wolf, which could represent a permanent major impact.

State-Listed Species

Endangered and Threatened Species

There are no state-listed endangered and threatened vertebrates or invertebrates that could be affected by construction or operation of the rail alternative; four state-listed plants could be affected (Appendix M, Tables M-1 to Table M-3).

Construction Impacts. The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot could occur near the Clearbrook and Superior terminals where new rail offloading and access facilities would be constructed (Appendix M, Table M-3). Listed plants present in the construction footprint could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Impacts on state-listed plants in the construction work area would be permanent and major if these plants occur within the facility footprints. Taking of state-listed endangered or threatened plants would require consultation with the appropriate state DNR for a take permit, which may require compensatory mitigation to offset unavoidable losses.

Operations Impacts. The 10 loaded trains per day required for transport of crude oil for the Project (see Section 4.2.6) would not be expected to affect state-listed plant species.

Special Concern Species

There are no state-listed special concern vertebrates or invertebrates that could be affected by construction and operation of the transportation by rail alternative; 3 special concern plants could be affected (Appendix M, Tables M-1 to M-3).

Construction Impacts. State-listed special concern plants with the potential to occur in the areas of the offloading facilities and new rail access include few flowered spikerush, McCalla's willow, and twig rush (Appendix M, Table M-3). Special concern plants in the construction footprint could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Impacts on special concern plants in the construction work area would be permanent and major if these plants are present within the facility footprints.

Operations Impacts. The 10 loaded trains per day required for transport of crude oil for the Project (see Section 4.2.6) would not be expected to affect state-listed special concern plant species.

Species of Greatest Conservation Need

Gap Analysis Program Species Models and Minnesota Wildlife Action Network

Construction Impacts. General construction impacts and measures to avoid or reduce impacts on protected and rare animals addressed in the GAP models would be the same as those described above for federally and state-listed vertebrate fauna. Overall, GAP models indicate no use by amphibians and reptiles and low and medium use by birds and mammals for offloading facilities and associated access at the Clearbrook terminal. GAP mammal models indicate that the area near the Superior terminal is high

use by protected and rare mammals and low and medium use by birds, amphibians, and reptiles. If present, protected and rare animals could be injured or disturbed by construction activity and noise. Disturbance effects likely would be minor and temporary.

Given that most facilities would be in areas with no high use habitats for birds, amphibians, and reptiles, construction impacts on these habitats would be minor based on lack of use by special-status species, although permanent. Construction of facilities at Superior could affect habitats used by seven or more protected and rare mammals, which could cause permanent, major permanent impacts if those species are present, although NHIS data did not identify any state-listed mammals near this location.

The Minnesota WAN applies to facilities at Clearbrook, and no WAN habitats occur near the terminal. Therefore, no WAN habitats would be affected by construction of the Clearbrook terminal offloading facilities.

Operations Impacts. The principal impact on unique natural resources from the substantial increase in rail traffic would be increased wildlife collisions. Rail transportation routes extend through areas ranging from no to high use based on the GAP models for mammals, birds, amphibians, and reptiles. The increase in collision mortality for these animals could result in impacts ranging from negligible to major that would continue for the life of the Project.

Minnesota Biological Survey Sites of Biodiversity Significance

Three MBS Sites preliminarily rated as moderate occur near the Clearbrook terminal where rail facilities are likely to be constructed, and the route of the rail connection between Clearbrook and Gully is near three additional moderate rated MBS Sites. Construction of new rail offloading facilities likely would avoid the MBS sites near the Clearbrook terminal, with no impacts resulting. Because construction of the new rail connection would be within a previous rail corridor on an existing rail bed, impacts on these MBS Sites also are unlikely.

5.2.5.3.5 Transportation by Truck

Transportation of crude oil by truck would require development of offloading facilities and new road access. Truck offloading facilities would require an approximately 50-acre site at locations in Clearbrook, Minnesota, and Superior, Wisconsin. New road access would require approximately 5 acres in Clearbrook and 34 acres in Superior. In the United States, operations would include use of the offloading facilities and new and improved road access, and use of the existing highway system from the U.S-Canada border to the Clearbrook and Superior terminals. Transportation of the proposed volume of crude oil by truck would require up to approximately 4,000 loaded tanker trucks per day and 4,000 tanker trucks per day returning empty.

Federally Listed Species

Federally listed threatened and endangered species that could occur within or near the new facilities and new truck access routes and that could be affected by construction and operation of the truck alternative include three mammals – Canada lynx, gray wolf, and northern long-eared bat; three birds – Kirtland's warbler, piping plover, and whooping crane; one invertebrate – rusty patched bumble bee; and one plant – Fassett's locoweed.

Construction Impacts

If present, the Canada lynx could be disturbed by construction noise and activity that likely would cause lynx to move to other areas, possibly returning after construction activities stop. Disturbance effects likely would be temporary and minor unless den sites are disturbed. Den sites, which are used from April to June, are unlikely to occur near the Clearbrook and Superior terminals where new offloading and truck access facilities would be constructed.

Foraging and reproductive activities for gray wolves could be affected by exposure to construction noise and increased human activity. Construction of the new facilities could alter used habitats used by gray wolves. If dens are present in the vicinity, construction-related disturbance could reduce pup survival. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Typical conservation measures to reduce construction impacts on the gray wolf include:

- Stop construction activities if the contractor or Environmental Inspector observes a gray wolf or possible den site within the construction area, or if USFWS notifies the Applicant of a gray wolf sighting within 1 mile of the construction work area; the stop work order should continue until the wolves leave the area.
- Report any wolf sightings immediately to USFWS, USACE, and state resource agencies (e.g., Minnesota DNR).

With implementation of conservation measures, gray wolves would not be affected by construction of the new truck facilities and access roads, or the impact would be temporary and negligible to minor.

Minnesota and Wisconsin NHIS report no occurrences of the northern long-eared bat for the areas near the Clearbrook and Superior terminals where new truck offloading facilities and truck access are likely to be constructed (Minnesota DNR 2016e, Wisconsin DNR 2016). The Applicant conducted acoustic surveys within suitable habitats around the Clearbrook and Superior terminals for the Applicant's preferred route during 2014 and 2015 to determine the summer presence or absence of northern long-eared bats. No northern long-eared bats were confirmed at 14 acoustic survey sites around the Clearbrook terminal or at one site near the Superior terminal (Merjent 2014b, 2015c).

Impacts on individuals or colonies of bats may occur if clearing or construction occurs when bats are using summer roosts. Northern long-eared bats could be disturbed by noise or human presence, causing them to abandon occupied tree cavities. Bats could be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. If northern long-eared bats were found to roost near these sites, applicable conservation measures would include:

- Maintain a year-round 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known northern long-eared bat hibernacula.
- Protect known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree, equivalent to 1.6 acres, during the pup season from June 1 to July 31.

Northern long-eared bats are not expected to occur near the new rail offloading and access facilities. With implementation of applicable conservation measures, northern long-eared bats would not be affected, or the impact would be negligible and minor.

Kirtland's warblers nest in jack pine forests in Wisconsin and Michigan and migrate along the southeast coast of the United States to overwinter in the Bahamas. Vegetation clearing for construction of new facilities during the nesting season could result in loss of eggs or young. They are known to occur during the breeding season in the vicinity of Superior. No jack pine woodlands appear to occur in the vicinity of the new truck offloading and access facilities near Clearbrook or Superior, and Kirtland's warblers are not expected to occur near the facilities. Therefore, the warblers would not be affected by facility construction.

Great Lakes piping plovers inhabit shorelines of the Great Lakes. Critical habitat for this species has been designated in Douglas County, Wisconsin. New truck offloading and access facilities would be constructed near the Superior terminal in Douglas County. Piping plovers nest on open, sparsely vegetated sandy habitats such as sand spits or sand beaches found on Great Lakes islands and mainland shorelines. While it is possible that piping plovers could occur near facilities in Superior, it is unlikely that they would use these developed habitats; therefore, construction would be unlikely to affect piping plovers.

Whooping cranes from the eastern population that winters in Florida migrate to breeding areas in Wisconsin and could be present near the Superior terminal during spring and fall migrations. Noise and activity during construction can displace whooping cranes from stopover habitats during foraging or in wetlands or riverine habitats during roosting. Whooping cranes generally depart from wintering grounds during late March to mid-April and return from breeding grounds beginning in mid-September. During migration, whooping cranes use croplands and shallow wetlands for stopover foraging and roosting habitats. The Aransas-Wood Buffalo Park whooping crane population migrates between wintering grounds in the Aransas NWR to breeding grounds in the Wood Buffalo National Park in northern Alberta. The migration corridor for this population crosses through central Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota and is located generally west of the Clearbrook terminal where new truck offloading and access would be constructed. Potential impacts could include disturbance to foraging or roosting birds from construction during migration periods (USFWS 2009). Whooping cranes are unlikely to occur near the Clearbrook or Superior terminal areas and are not likely to be affected by construction.

If present, the rusty patched bumble bee could be affected by construction activities that disturb native vegetation. Vegetation clearing and grading would disrupt egg laying and foraging during spring and summer, and could crush dormant larvae during fall and winter. These prairie-dependent bumble bees depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these ground-nesting bees and remove forage plants. Habitat and presence/absence surveys have not been completed for the area surrounding the Clearbrook and Superior terminals. Native prairie plants that could provide habitat for the bees may persist in the hay/pasture vegetation in the vicinity of the Clearbrook terminal where facilities could be constructed. If suitable habitat for prairie-dependent rusty patched bumble bees is present, it could be lost due to fill or clearing required for construction. Loss of suitable habitat would result in a permanent minor impact.

The new truck facilities near the Clearbrook terminal would not cross any current high use areas for rusty patched bumble bee, and construction is not likely to directly or indirectly affect any individuals or current high use areas. The new facilities would, however, be within a current low potential area where rusty patched bumble bees may disperse from a current high use area or where their occurrence is uncertain. The rusty patched bumble bee may benefit from conserve measures implemented within the dispersal area, and USFWS may recommend surveys. Applicable conservation measures that would benefit the rusty patched bumble bee within this dispersal area include restoration and maintenance of high-quality habitat

through control of invasive species and restoration, including a providing a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Fassett's locoweed has the potential to occur near the Superior terminal, although there are no NHIS reports for the plant in this area. If Fassett's locoweed occurred within the construction area, direct impacts could include trampling and destruction during construction during clearing and grading for site preparation. Indirect effects from construction could include conversion of shoreline habitat into other habitat types and the spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Surveys were not performed for Fassett's locoweed, but based on known habitat associations, there is limited potential for the species to occur within the construction areas around the Superior terminal. If this plant was present, additional avoidance measures may be required. Consequently, there would be no impact, or the impact would be permanent and negligible.

Summary

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf could experience temporary, negligible to minor effects associated with construction activities. Northern long-eared bats and occupied maternity roots are not known to occur near the Clearbrook and Superior terminals. If there is an occurrence, with implementation of BMPs and general conservation measures, potential impacts from construction would be temporary and minor. Kirtland's warbler, piping plover, and whooping crane are not likely to be affected by the truck alternative. Native prairie plants that could provide habitat for the native prairie-dependent rusty patched bumble bee may persist within hay/pasture vegetation in the vicinity of the Clearbrook terminal. If suitable habitat for bumble bees occurs within these grasslands, the habitats could be lost, potentially resulting in a permanent minor impact. Effects on the federally listed Fassett's locoweed would be negligible based on the lack of appropriate habitat and species presence.

Operations Impacts

The principal impact on federally listed animals from such a large increase in truck traffic would be increased wildlife collisions, which could represent a major permanent impact for Canada lynx and gray wolf.

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened species that could be affected by construction and operation of the truck alternative includes no vertebrates, no invertebrates, and four plants. See also Appendix M (Table M-1, invertebrates; Table M-2, vertebrates; and Table M-3, plants).

Construction Impacts. The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals where new truck offloading and access facilities would be constructed (Appendix M, Table M-3). Listed plants in the construction footprint could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and

Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Impacts on plants in the construction work area would be permanent and major if they are present within the facility footprints. Take of state-listed endangered or threatened plants would require consultation with the appropriate state DNR for a take permit, which may require compensatory mitigation to offset unavoidable losses.

Operations Impacts. All of the state-listed species in the area are plants, and those plants would not be affected by operation of the truck alternative.

Special Concern Species

There are no state-listed special concern animals that could be affected by construction or operation of the truck alternative; three plants could be affected as listed in Appendix M, Tables M-1 to M-3.

Construction Impacts. State-listed special concern plants with the potential to occur in the likely areas for new offloading facilities and new truck access roads include few flowered spikerush, McCalla's willow, and twig rush (Appendix M, Table M-3). Special concern plants in the construction footprint could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. If these plants are present in the construction footprints, the potential impact would be permanent and major.

Operations Impacts. All of the state-listed special concern species in the area are plants, and those plants would not be affected by operation of the truck alternative.

Species of Greatest Conservation Need

Gap Analysis Program Species Models and Minnesota Wildlife Action Network

Construction Impacts. General construction impacts and measures to avoid or reduce impacts on protected and rare animals addressed in the GAP models would be the same as those described above for federally and state-listed vertebrate fauna. Overall, GAP models indicate no use by amphibians and reptiles and low and medium use by birds and mammals for the areas planned for offloading facilities and associated access at the Clearbrook terminal. GAP mammal models indicate that the area near the Superior terminal includes high use by protected and rare mammals, and low and medium use by birds, amphibians, and reptiles. If present, protected and rare animals could be injured or disturbed by construction activity and noise. Disturbance effects likely would be minor and temporary.

Given that most facilities would be in areas with no high use habitats for birds, amphibians, and reptiles, construction impacts on these habitats would minor although permanent. Construction of facilities at Superior could affect habitats used by seven or more protected and rare mammals, which could result in permanent and major impacts—although NHIS data did not identify any state-listed mammals near this location.

The Minnesota WAN applies to facilities at Clearbrook; however, no WAN habitats occur around the terminal. Therefore, no WAN habitats would be affected by construction of truck offloading facilities near the Clearbrook terminal.

Operations Impacts. The principal operations impact on unique natural resources from the large increase in truck traffic would be increased wildlife collisions. Truck transportation routes would cross areas ranging from no to high use based on the GAP models for mammals, birds, amphibians, and reptiles. The increase in collision mortality for wildlife would result in potential impacts that would be permanent and negligible to major.

Minnesota Biological Survey Sites of Biodiversity Significance

Three MBS Sites preliminarily rated as moderate occur near the Clearbrook terminal where truck facilities are likely to be constructed. Construction of new truck offloading facilities likely would be able to avoid the MBS Sites near the Clearbrook terminal, with the result of no impact.

5.2.5.3.6 Existing Line 3 Supplemented by Rail

The potential construction- and operations-related impacts on unique biological resources associated with continued use of the existing Line 3 pipeline supplemented by transportation of crude oil by train would be similar to the impacts reported above for each of the components of this alternative. Information on the species and habitats potentially affected by this alternative and the potential impacts are summarized below.

Federally Listed Species

Federally listed threatened and endangered species that could occur within or near the existing Line 3 pipeline and that could be affected by construction and operation of the facilities and routes for the rail alternative include three mammals – Canada lynx, gray wolf, and northern long-eared bat; four birds – Kirtland's warbler, piping plover, red knot, and whooping crane; three invertebrates - Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee; and two plants – Fassett's locoweed and western prairie fringe orchid (Tables 5.2.5-6 and 5.2.5-12).

Construction Impacts

The Line 3 pipeline has been built and is in operation; therefore, no construction impacts are associated with that component of the alternative. The Canada lynx and gray wolf could experience temporary, minor effects associated with construction of new rail offloading and access facilities at the existing Clearbrook and Superior terminals. Northern long-eared bats and occupied maternity roosts are not known to occur near the terminals. With implementation of general conservation measures for northern long-eared bats, impacts from construction would be temporary and minor. Kirtland's warbler, piping plover, and whooping crane are not likely to be affected by construction of rail facilities. Native prairie plants that could provide habitat for the native prairie-dependent Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee may persist within hay/pasture vegetation in the vicinity of the Clearbrook terminal. If suitable habitat for these butterflies and bumble bees occurs within these grasslands, it could be lost, potentially resulting in a permanent and minor impact. Effects on the federally listed Fassett's locoweed would be negligible based on the lack of appropriate habitat and species presence.

Operations Impacts

If federally listed species persist within the permanent Line 3 pipeline right-of-way, impacts on those species from ongoing operations, such as mowing for vegetation management, equipment maintenance, invasive species control, right-of-way monitoring and inspections, and pipeline integrity excavations, would continue. Vegetation maintenance and the increase in required integrity digs to maintain the aging pipeline (an estimated 267 integrity digs per year over the next 15 years) could result

in direct mortality of non-mobile species, including the Dakota skipper, Poweshiek skipperling, rusty patched bumble bee, Fassett's locoweed, and western prairie fringed orchid if species are present during the activity. Increased noise and human disturbance at offloading facilities could cause more mobile animals, including Canada lynx, gray wolf, northern long-eared bat, Kirtland's warbler, pipeline plover, red knot, and whooping crane to leave the area; however, they would be expected to return when the activity ceases.

Implementation of this combined alternative would reduce Project-related rail traffic from 10 unit trains per day to 6 unit trains per day. Nevertheless, this would be an increase in rail traffic over current conditions and could result in permanent and major impacts on the federally listed gray wolf and Canada lynx because of the increased potential for collisions of trains with wildlife. Impacts on all other federally listed animals and plants would not occur or would be permanent and minor.

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened species that could occur within the ROI for the existing Line 3 pipeline and that could be affected by construction and operation in the vicinity of the Clearbrook and Superior terminals where new rail offloading facilities and access would be constructed include one mammal – northern long-eared bat, one invertebrate – fluted-shell mussel, and one reptile – wood turtle. Potential impacts on the northern long-eared bat are discussed for federally listed endangered and threatened species. Of the 18 state-listed endangered and threatened plants known to occur within the ROI for the existing Line 3 pipeline, eight species potentially occur within the permanent right-of-way and could be affected by continued maintenance activities. These consist of three in Minnesota – beaked spikerush, hair-like beak rush, and sterile sedge; and five in Wisconsin –clustered bur-reed, neat spike-rush, seaside crowfoot, small yellow-water crowfoot, and sweet colt's foot. The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals, where new rail offloading and access facilities would be constructed for the rail alternative (Appendix M, Table M-3).

Construction Impacts

Listed plants in the construction footprint for rail offloading and access facilities could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. If listed plants are present in the construction work area, construction impacts would be permanent and major. Takings of state-listed endangered or threatened plants would require consultation with the appropriate state DNR for a take permit, which may require compensatory mitigation to offset unavoidable losses.

Operations Impacts

Pipeline operations that could affect state-listed species include ongoing vegetation management, right-of-way monitoring and inspection, and pipeline excavation for repair or replacement of pipe segments. If excavation of pipe segments is required at surface water crossings where the fluted-shell mussel is present, destruction of the mussels could occur, and increased turbidity and sedimentation also could affect the mussels. Vegetation management and pipeline excavation could result in injury or mortality of wood turtle eggs or adults if these activities coincided with turtle presence in the habitats.

Listed plants that persist within the permanent right-of-way could be affected directly or indirectly by maintenance activities. With the increased need for excavation to repair or replace the existing Line 3 pipeline, there is a potential for the excavations to affect state-listed plants. If state-listed plants occur where work is proposed, a take permit would be required. If there are no feasible alternatives to takings, compensatory mitigation could be used to offset the impact.

Where railways cross suitable habitat, increased train traffic has the potential to affect the wood turtle by increasing the risk of fatalities due to collision. The remaining state-listed species in the vicinity of the rail facilities are plants that would not be affected by increased rail traffic.

Special Concern Species

State-listed special concern species that could be affected by construction and operation of existing Line 3 supplemented by rail include nine vertebrates: three bats – big brown bat, little brown myotis and northern long-eared bat; six birds – Connecticut warbler, Le Conte's sparrow, Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail; and four invertebrates: a caddisfly *Anabolia ozburni*, and three mussels – black sandshell, creek heelsplitter and pink heelsplitter (Appendix M, Tables M-1 and M-2).

Seventeen state-listed plants of special concern that could be affected by operation of the combined rail alternative include barren strawberry, blunt sedge, English sundew, false mountain willow, few-flowered spikerush, Lapland buttercup, least moonwort, mamillate spike-rush, McCalla's willow, mingan moonwort, northern single-spike sedge, northwestern sticky aster, pale moonwort, small white lady's slipper, St. Lawrence grapefern, twig rush, and Vasey's rush (Appendix M, Table M-3). The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals (Appendix M, Table M-3).

Construction Impacts. The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals where new rail offloading and access facilities would be constructed for the rail alternative (Appendix M, Table M-3). Listed plants in the construction footprint could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. If listed plants are present in the construction work area, construction impacts would be permanent and major. Takings of state-listed endangered or threatened plants would require consultation with the appropriate state DNR for a take permit, which may require compensatory mitigation to offset unavoidable losses.

Operations Impacts. Of the three bats of special concern, only the northern long-eared bat has been reported to occur within the permanent right-of-way for the existing Line 3. Vegetation management and pipeline excavation within the permanent right-of-way is unlikely to affect bats, as no roost trees would be present there. Vegetation management and pipeline excavation could continue to result in injury or mortality of bird eggs and nests, if they are present when maintenance activities occur during the breeding season. Of the six birds occurring within the ROI for the existing Line 3 pipeline, four – Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail are also known to occur within the permanent right-of-way. If excavation of pipe segments is required at surface water crossings where the fluted-shell mussel or caddisflies are present, destruction of the mussels or caddisflies could occur, and increased turbidity and sedimentation also could affect these species.

Special concern plants that persist within the permanent right-of-way for the existing Line 3 could be affected directly or indirectly by vegetation management and pipeline repair or replacement. Twelve of the 17 plants of special concern occurring within the ROI for the existing Line 3 pipeline also are known to occur within the permanent pipeline right-of-way (10 in Minnesota – barren strawberry, blunt sedge, false mountain willow, few-flowered spikerush, least moonwort, mingan moonwort, northern single-spike sedge, pale moonwort, small white lady-s slipper, and St. Lawrence grapefern; and 2 in Wisconsin – mamillate spike-rush and Vasey's rush [Appendix M, Table M-3]). Given the increased need for excavation to repair or replace aging pipe segments, the excavations could coincide with occurrences of state-listed special concern plants. If special concern plants are present during maintenance activities and there are no feasible alternatives, they could be disturbed. Because these rare plants have, in many instances, persisted or reestablished after construction of other pipelines through this shared corridor, impacts are likely to be short term and negligible.

The increased train traffic could increase collisions with and mortality of special concern birds, including the Connecticut warbler, Le Conte's sparrow, Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail. These birds would be most susceptible if they nest in habitats near the train tracks. The remaining state-listed species in the vicinity of the rail facilities are plants that would not be affected by increased rail traffic.

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The distribution of low, medium, and high use areas for protected or rare mammal species indicates that 49 percent of permanent right-of-way for the existing Line 3 pipeline could support medium to high use by these mammals (4 or more species). This relatively high proportion may reflect the widespread use of this area by Canada lynx, wolves, and several species of bats. By comparison, 14 percent of the permanent right-of-way for the existing Line 3 pipeline may support medium to high use by protected or rare birds (7 or more species). A total of 26 BCCs were identified as occurring within 1 mile of the existing Line 3 pipeline from the Canada-North Dakota border to Superior, Wisconsin (Appendix M, Table M-5). Little of the Line 3 permanent right-of-way contains habitats used by protected or rare amphibians and reptiles.

Overall, GAP models indicate no use by amphibians and reptiles, and low and medium use by birds and mammals for offloading facilities and associated access at the Clearbrook terminal. GAP mammal models indicate that the area near the Superior terminal is high use by protected and rare mammals, and low and medium use by birds, amphibians, and reptiles.

Construction Impacts. General construction impacts and measures to avoid or reduce impacts on protected and rare animals addressed in the GAP models would be the same as those described above for federally and state-listed vertebrate fauna. If present, protected and rare animals could be injured or disturbed by construction activity and noise. Disturbance effects likely would be minor and temporary. Given that most facilities would be in areas with no high use habitats for birds, amphibians, or reptiles, construction impacts on these habitats would be permanent and minor, based on lack of use. Construction of facilities at Superior could affect habitats used by seven or more protected and rare mammals. If any of these species are present, construction could cause permanent major impacts—although NHIS data did not identify any state-listed mammals near this location.

Operations Impacts. The permanent right-of-way for the existing Line 3 pipeline contains an estimated 1,797 acres of habitats used by one or more protected and rare mammal species; 1,987 acres used by

one or more protected and rare bird species; and 393 acres used by one or more protected and rare amphibian and reptile species. All of the existing Line 3 pipeline permanent right-of-way that crosses these GAP habitats is located within the existing Enbridge Mainline pipeline corridor. If these habitats and animals persist within the permanent pipeline right-of-way, they could be affected by ongoing maintenance activities, particularly by the increased number of integrity digs. Maintenance activities could result in direct mortality of non-mobile animals if animals are present during the activity. Increased noise and human disturbance could cause more mobile species to leave the area; however, they would be expected to return when the activity ceases.

The principal impact on unique natural resources from the increase in rail traffic would be an increased probability of wildlife collisions. Rail transportation routes would cross areas ranging from no to high use, based on the GAP models for mammals, birds, amphibians, and reptiles; the impact of the increase in collision mortality for these animals would be permanent and negligible to major.

Minnesota's Wildlife Action Network

Approximately 608 acres (35 percent) of the permanent right-of-way for the existing Line 3 pipeline contains WAN habitats. Most WAN habitats (75 percent) that are affected by operation of the Line 3 pipeline are rated low-medium and medium, and no WAN habitats that would be affected by continued operation of the existing Line 3 pipeline are rated high. All of the Line 3 permanent right-of-way that crosses through WAN habitats in Minnesota is located within the existing Enbridge Mainline pipeline corridor. Maintenance activities such as vegetation management and integrity digs for pipeline repair and replacement could result in direct mortality of non-mobile animals and plants, if these species are present while the activity is occurring—particularly the increase in the number of integrity digs above current levels. These activities also would affect the habitats of these species. Increased noise and human disturbance could cause more mobile species to leave the area; however, they would be expected to return when the activity ceases.

The Minnesota WAN applies to facilities at Clearbrook, Minnesota; however, no WAN habitats would be affected as none occur around the terminal.

Minnesota Biological Survey Sites of Biodiversity Significance

Continued operation of the Line 3 pipeline would occur within an estimated 305 acres of moderate to outstanding MBS Sites. Most MBS Sites (76 percent) that occur within the permanent right-of-way for the existing Line 3 are rated high for biodiversity. All of the Line 3 permanent right-of-way that crosses through MBS Sites in Minnesota is located within the existing Enbridge Mainline pipeline corridor. Maintenance activities such as vegetation management and integrity digs for pipeline repair and replacement could result in direct mortality of plants; in particular, the increase in the number of integrity digs above current levels in could affect these MBS Sites. Long-term vegetation management and increased integrity digs during operation would result in a minor permanent change to MBS Sites.

Three MBS Sites preliminarily rated as moderate occur near the Clearbrook terminal where rail facilities are likely to be constructed, and the rail connection between Clearbrook and Gully would cross near three additional moderate rated MBS Sites. Construction of new rail offloading facilities likely would be able to avoid the MBS Sites near the Clearbrook terminal, resulting in no impact. The new rail connection would be constructed on an existing rail bed along a previously used rail corridor and is unlikely to affect the three adjacent MBS Sites.

Minnesota Scientific and Natural Areas

The Wawina Peatland SNA (Minnesota DNR 2016d, 2016g) is within the ROI for the existing Line 3 pipeline. The boundary for this SNA is located approximately 0.4-mile northeast of the Line 3 pipeline; a BNSF rail line lies between the SNA and Line 3. Continued use of the Line 3 pipeline would not affect this SNA.

5.2.5.3.7 Existing Line 3 Supplemented by Truck

The potential construction- and operations-related impacts on unique biological resources associated with continued use of the existing Line 3 pipeline supplemented by transportation of crude oil by truck would be similar to the impacts reported above for each of the components of this combined alternative. Information on the species and habitats potentially affected by this alternative and the impacts that may occur are summarized below.

Federally Listed Species

Federally listed threatened and endangered species that could occur within or near the existing Line 3 pipeline and that could be affected by construction and operation of facilities and routes for the truck alternative include three mammals – Canada lynx, gray wolf, and northern long-eared bat; four birds – Kirtland's warbler, piping plover, red knot, and whooping crane; three invertebrates – Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee; and two plants – Fassett's locoweed and western prairie fringe orchid (Tables 5.2.5-6 and 5.2.5-14).

Construction Impacts

The Line 3 pipeline has been built and is in operation; therefore no construction impacts are associated with that component of the combined alternative. The Canada lynx and gray wolf could experience temporary minor effects associated with construction of new truck offloading and access facilities at the existing Clearbrook and Superior terminals. Northern long-eared bats and occupied maternity roosts are not known to occur near the Clearbrook and Superior terminals. With implementation of general conservation measures for northern long-eared bats, impacts related to construction would be temporary and minor. Kirtland's warbler, piping plover, and whooping crane are not likely to be affected by construction of truck offloading facilities or access roads. Native prairie plants that could provide habitat for the native prairie-dependent rusty patched bumble bee may persist within hay/pasture vegetation in the vicinity of the Clearbrook terminal. If suitable habitat for these butterflies and bumble bees occurs within these grasslands, it could be lost, potentially resulting in a permanent minor impact. Effects on the federally listed Fassett's locoweed would be negligible based on the lack of appropriate habitat and species presence.

Operations Impacts

If federally listed species persist within the permanent right-of-way for the existing Line 3, impacts on those species could continue from ongoing operations such as mowing for vegetation management, equipment maintenance, invasive species control, right-of-way monitoring and inspections, and pipeline integrity excavations. Vegetation maintenance and the increase in integrity digs (an estimated 267 integrity digs per year over the next 15 years) could result in direct mortality of non-mobile species, including the Dakota skipper, Poweshiek skipperling, rusty patched bumble bee, Fassett's locoweed, and western prairie fringed orchid, if these species are present while the activity is occurring. Increased noise and human disturbance at offloading facilities could cause more mobile animals, including Canada lynx, gray wolf, northern long-eared bat, Kirtland's warbler, pipeline plover, red knot, and whooping crane, to leave the area; however, they would be expected to return when the activity ceases.

Implementation of this combined alternative would reduce Project-related truck traffic from 4,000 loaded tanker trucks per day to 1,947 trucks per day. Nevertheless, this represents a substantial increase in truck traffic over current conditions that could result in permanent and major impacts on the federally listed gray wolf and Canada lynx because of the increased potential for collisions of trucks with wildlife. Impacts on all other federally listed animals and plants would not occur or would be permanent and minor.

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened species that could occur within the ROI for the existing Line 3 pipeline and that could be affected by construction and operation in the vicinity of the Clearbrook and Superior terminals where new truck offloading facilities and access roads would be constructed include one mammal – northern long-eared bat, one invertebrate – fluted-shell mussel, and one reptile – wood turtle. Potential impacts on the northern long-eared bat are discussed for federally listed endangered and threatened species. Of the 18 state-listed endangered and threatened plants known to occur within the ROI for the Line 3 pipeline, 8 potentially occur within the permanent right-of-way and could be affected by operations. These include three in Minnesota – beaked spikerush, hair-like beak rush, and sterile sedge; and five in Wisconsin –clustered bur-reed, neat spike-rush, seaside crowfoot, small yellow-water crowfoot, and sweet colt's foot. The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals where new truck offloading and access facilities would be constructed (Appendix M, Table M-3).

Construction Impacts

Listed plants present in the construction footprint for truck offloading facilities and access roads could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. If listed plants are present in the construction work area, construction impacts would be permanent and major. Takings of state-listed endangered or threatened plants would require consultation with the appropriate state DNR for a take permit, which may require compensatory mitigation to offset unavoidable losses.

Operations Impacts

Pipeline operations for the existing Line 3 that could affect state-listed species include ongoing vegetation management, right-of-way monitoring and inspection, and pipeline excavation for repair or replacement of pipe segments. If excavation of pipe segments is required at surface water crossings where the fluted-shell mussel is present, destruction of the mussels could occur, and increased turbidity and sedimentation also could affect the mussels. Vegetation management and pipeline excavation could result in injury or mortality of wood turtle eggs or adults, if these activities coincided with occupied habitats.

Listed plants that persist within the permanent right-of-way could be affected directly or indirectly by maintenance activities. With the increased need for excavation to repair or replace the Line 3 pipeline, there is a potential for the excavations to affect state-listed plants. If this is the case, a take permit would be required. If there are no feasible alternatives to takings, compensatory mitigation could be required to offset the impact.

The principal impact on state-listed animals from the increase in truck traffic associated with this combined alternative would be increased wildlife collisions. This could represent a major permanent impact for state-listed species. Wood turtles are likely to be hit by trucks if they are on the roadway. If routes cross occupied habitats with no provision for turtles to avoid crossing roads, the projected increase in traffic could increase road kills. The remaining state-listed species in the vicinity of new truck facilities are plants that would not be affected by truck traffic.

Special Concern Species

State-listed special concern species that could be affected by construction and operation of the alternative include nine vertebrates: three bats – big brown bat, little brown myotis and northern long-eared bat; six birds – Connecticut warbler, Le Conte's sparrow, Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail; and four invertebrates: a caddisfly *Anabolia ozburni*, and three mussels – black sandshell, creek heelsplitter and pink heelsplitter (listed in Appendix M, Tables M-1 and M-2).

Seventeen state-listed plants of special concern that could be affected by operation of the combined alternative include barren strawberry, blunt sedge, English sundew, false mountain willow, few-flowered spikerush, Lapland buttercup, least moonwort, mamillate spike-rush, McCalla's willow, mingan moonwort, northern single-spike sedge, northwestern sticky aster, pale moonwort, small white lady's slipper, St. Lawrence grapefern, twig rush, and Vasey's rush (Appendix M, Table M-3). The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals where new truck offloading and access facilities would be constructed (Appendix M, Table M-3).

Construction Impacts. The state-protected plants beaked spikerush, hair-like beak rush, sterile sedge, and sweet colt's-foot have the potential to occur near the Clearbrook and Superior terminals where new truck offloading and access road facilities would be constructed (Appendix M, Table M-3). Listed plants present in the construction footprint could be destroyed during construction activities, and their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. If listed plants are present in the construction work area, construction impacts would be permanent and major. Takings of state-listed endangered or threatened plants would require consultation with the appropriate state DNR for a take permit, which may require compensatory mitigation to offset unavoidable losses.

Operations Impacts. Of the three bats of special concern, only the northern long-eared bat has been reported to occur within the permanent right-of-way for existing Line 3. Vegetation management and pipeline excavation within the Line 3 permanent right-of-way is unlikely to affect bats, as no roost trees would be present within the permanent right-of-way. Vegetation management and pipeline excavation could continue to result in injury or mortality of bird eggs and nests, if maintenance activities are conducted during the breeding season and they are present. Of the six birds occurring within the ROI for the existing Line 3 pipeline, four – Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail are known to occur within the permanent right-of-way. If excavation of pipe segments is required at surface water crossings where the fluted-shell mussel or caddisflies are present, destruction of the mussels or caddisflies could occur, and increased turbidity and sedimentation also could affect these species.

Special concern plants that persist within the permanent right-of-way could be affected directly or indirectly by vegetation management and pipeline repair or replacement. Twelve of the 17 plants of special concern occurring within the ROI for the existing Line 3 pipeline also are known to occur within

the permanent pipeline right-of-way (10 in Minnesota – barren strawberry, blunt sedge, false mountain willow, few-flowered spikerush, least moonwort, mingan moonwort, northern single-spike sedge, pale moonwort, small white lady-s slipper, and St. Lawrence grapefern; and 2 in Wisconsin – mamillate spike-rush, and Vasey's rush [Appendix M, Table M-3]). Given the increased need for excavation to repair or replace aging pipe segments, the excavations could coincide with occurrences of state-listed special concern plants. If this is the case and there are no feasible alternatives, these plants could be disturbed. Because these rare plants have, in many instances, persisted or reestablished after construction of other pipelines through this corridor, impacts are likely to be short term and negligible.

The increased truck traffic could increase collisions with and mortality of special concern birds, including the Connecticut warbler, Le Conte's sparrow, Nelson's sparrow, short-eared owl, trumpeter swan, and yellow rail. These birds would be most susceptible if they nest in habitats near the highways. The increase in collision mortality could represent a permanent major impact on these state-listed species. The remaining state-listed species in the vicinity of the truck facilities are plants that would not be affected by truck traffic.

Species of Greatest Conservation Need

Gap Analysis Program Species Models

The distribution of low, medium, and high use areas for protected or rare mammal species indicates that 49 percent of the permanent right-of-way for the existing Line 3 pipeline could support medium to high use by these mammals (4 or more species). This relatively high proportion may reflect the widespread use of the area by Canada lynx, wolves, and several species of bats. By comparison, 14 percent of the permanent right-of-way for the Line 3 pipeline may support medium to high use by protected or rare birds (7 or more species). A total of 26 BCCs were identified as occurring within 1 mile of the Line 3 pipeline from the Canada-North Dakota border to Superior, Wisconsin (Appendix M, Table M-5). Little of the Line 3 permanent right-of-way contains habitats used by protected or rare amphibians and reptiles ().

Overall, GAP models indicate no use by amphibians and reptiles and low and medium use by birds and mammals for offloading facilities and associated access roads at the Clearbrook terminal. GAP mammal models indicate that the area near the Superior terminal is high use by protected and rare mammals, and low and medium use by birds, amphibians, and reptiles.

Construction Impacts. General construction impacts and measures to avoid or reduce impacts on protected and rare animals addressed in the GAP models would be the same as those described for federally and state-listed vertebrate fauna. If present, protected and rare animals could be injured or disturbed by construction activity and noise. Disturbance effects likely would be minor and temporary. Given that most facilities would be in areas with no high use habitats for birds, amphibians, and reptiles, construction impacts on these habitats would be permanent and minor, based on lack of use. Construction of truck facilities at Superior could affect habitats used by seven or more protected and rare mammals. If any of these species are present, construction could cause permanent, major permanent impacts—although NHIS data did not identify any state-listed mammals near this location.

Operations Impacts. The permanent right-of-way for the existing Line 3 pipeline contains an estimated 1,797 acres of habitats used by one or more protected and rare mammal species; 1,987 acres used by one or more protected and rare bird species; and 393 acres used by one or more protected and rare amphibian and reptile species. All of the Line 3 pipeline permanent right-of-way that crosses these GAP habitats is located within the existing Enbridge Mainline pipeline corridor. If these habitats and animals

persist within the permanent pipeline right-of-way, they could be affected by ongoing maintenance activities, particularly by the increased number of integrity digs. Maintenance activities could result in direct mortality of non-mobile animals, if animals are present while the activity is occurring. Increased noise and human disturbance could cause more mobile species to leave the area; however, they would be expected to return when the activity ceases.

The principal impact on unique natural resources from such a large increase in truck traffic would be increased wildlife collisions. Truck transportation routes would cross areas ranging from no to high use for mammals, birds, amphibians, and reptiles, based on the GAP models. The increase in collision mortality for these animals would be a permanent and negligible to major impact.

Minnesota's Wildlife Action Network

Approximately 608 acres (35 percent) of the permanent right-of-way for the existing Line 3 pipeline contains WAN habitats. Most WAN habitats (75 percent) that are affected by operation of the existing Line 3 are rated low-medium and medium, and no WAN habitats affected by Line 3 are rated high. All of the Line 3 permanent right-of-way that crosses WAN habitats in Minnesota is located within the existing Enbridge Mainline pipeline corridor. Maintenance activities, such as vegetation management and integrity digs for pipeline repair and replacement, could result in direct mortality of non-mobile animals and plants, if these species are present while the activity is occurring—particularly the increased number of integrity digs above current levels. These activities also would affect the habitats of these species. Increased noise and human disturbance could cause more mobile species to leave the area; however, they would be expected to return when the activity ceases.

The Minnesota WAN applies to facilities at Clearbrook, Minnesota; however, no WAN habitats would be affected as none occur around the terminal.

Minnesota Biological Survey Sites of Biodiversity Significance

Continued operation of the existing Line 3 pipeline would occur within an estimated 305 acres of moderate to outstanding MBS Sites. Most MBS Sites (76 percent) that occur within the permanent right-of-way for the Line 3 pipeline are rated high for biodiversity. All of the Line 3 permanent right-of-way that crosses MBS Sites in Minnesota is located within the existing Enbridge Mainline pipeline corridor. Maintenance activities such as vegetation management and integrity digs for pipeline repair and replacement could result in direct mortality of plants; in particular, the increased number of integrity digs above current levels could affect these MBS Sites. Long-term vegetation management and increased integrity digs during operation would result in a minor permanent change to MBS Sites.

Three MBS Sites preliminarily rated as moderate occur near the Clearbrook terminal where truck facilities are likely to be constructed. Construction of new truck offloading facilities likely would be able to avoid the MBS Sites near the Clearbrook terminal, with the result of no impact.

Minnesota Scientific and Natural Areas

The Wawina Peatland SNA (Minnesota DNR 2016d, 2016g) is within the ROI for the existing Line 3 pipeline. The boundary for this SNA is approximately 0.4-mile northeast of Line 3; a BNSF rail line lies between the SNA and Line 3. Continued use of the existing Line 3 pipeline would have no effect on this SNA.

5.2.5.4 Summary and Mitigation

5.2.5.4.1 Summary

Potential effects on protected and conservation concern species were evaluated directly based on occurrence identified from IPaC searches, NHIS data, and field survey data. Potential effects on species of conservation concern were also evaluated indirectly through abundance, distribution, and habitat-based models for rare species, including the Gap Analysis Program, and the WAN and MBS Sites in Minnesota. The potential for effects on federally and state-protected and conservation concern animals and plants depends on whether they occur near the alternatives; whether they would be present when activities that may injury, harm, or disturb them would occur; and whether typical conservation measures would effectively prevent impacts. Table 5.2.5-25 presents a summary of construction- and operations-related impacts on unique resources for the Applicant's preferred route and CN Alternatives.

The data and analyses regarding unique natural resources presented in this EIS can be used by the regulatory agencies to assess potential impacts on unique natural resources. In addition, the USACE is preparing a Biological Assessment for the Project that would be used by USFWS as part of its determination on whether the Project would jeopardize the continued existence of any federally listed species or would result in destruction or adverse modification of their critical habitat. Potential effects on protected species would require avoidance and conservation measures with a potential for requirements for formal ESA consultation and federal and state incidental take permits where unavoidable impacts are likely to occur.

Construction impacts could include injury or loss of aquatic and terrestrial invertebrates, amphibians and reptiles, small mammals, bird eggs and young, and plants; loss or alteration of forage and cover habitats; and disturbance from noise and activity. Operations effects could include permanent habitat loss or alteration and continued disturbance from noise and activity at aboveground facilities and from pipeline inspection overflights, ground surveillance, and pipeline integrity excavation. Creation of new pipeline rights-of-way may contribute to fragmentation of habitats creating barriers to movements for amphibians, reptiles, and small mammals; facilitated movements for some predators; new edge habitats; and potential reduction in the abundance and diversity of forest nesting birds. Potential direct injury or mortality of protected animals may be avoided or minimized through typically required conservation measures, although reduction in habitat quality resulting from facility and pipeline construction may indirectly impact protected animals due to a permanent reduction in the habitats suitability to support some protected species.

Construction Impacts

Construction activities have the potential to disturb special-status animals, plants, and habitats due to increased noise and human activity, the use of construction equipment, and vegetation removal. Injury, mortality, or disturbance of special-status species and alteration of habitat types could also occur as a result of these activities.

Construction noise and increased human activity likely would cause more mobile species (e.g., larger mammals, bats, birds) to move to other areas, possibly returning after construction activities stop. If these disturbances were to occur during sensitive reproductive periods it could cause them to abandon their young or nesting/denning area, resulting in a decrease in survival and possible reproductive failure of individual mating pairs. Less mobile species that occur within the construction work area would not be able to avoid construction activities and could be crushed and killed.

Surface water crossings could affect aquatic species that are present. Disturbance to the stream bottom due to the use of dry or wet open-cut crossing methods could crush or suffocate aquatic species and/or their nests and would temporarily increase turbidity that could reduce feeding efficiency and damage these sensitive aquatic animals in the vicinity. Contaminated construction equipment and water used for hydrostatic testing could introduce invasive aquatic animals such as zebra and quagga mussels that could displace and reduce habitat quality for aquatic animals. Waterbodies crossed using the HDD crossing method would avoiding direct mortality, injury, and habitat impact on special-status aquatic species.

Vegetation removal could injure or kill special-status species if they are present when clearing or construction activities occur. Mobile special-status animals would be likely to move to other areas, while less mobile species could be crushed and killed. Direct loss of protected plants may occur during construction and changes to soils and surrounding vegetation communities may leave habitats unsuitable after construction. Avoidance may be possible once precise locations are determined through surveys, such as those completed for the Applicant's preferred route. Some protected and special concern plants may be preserved and continue to persist within pipeline rights-of-way. In general, construction of aboveground facility sites and the establishment of pipeline rights-of-way would alter existing habitat types (including WAN and MBS sites) and increase fragmentation.

Construction of the Applicant's preferred route, SA-04, or the rail and truck alternatives would have the potential to affect threatened and endangered species. Based on distribution and NHIS records, SA-04 has a greater potential to affect more federally and state-protected animals, while the Applicant's preferred route has a greater potential to affect more state-protected plants. The suite of federally and state-protected animals differs between the Applicant's preferred route and SA-04 because of their divergent routes and the different ecosystems they cross. SA-04there are more federally and state-protected animals in the ROI of the than the ROI of the Applicant's preferred route, partially due to the greater length of the SA-04 and the increased diversity of habitats along SA-04. Whether that translates into greater potential for impacts depends upon the suitability of the habitats crossed and the measures implemented to minimize disturbance, especially given the larger amount and higher quality of habitat along Minnesota portion of the Applicant's preferred route. For the populations of state-listed plants that cannot be avoided during construction, the impacts could be permanent and major. These impacts could be offset by compensatory mitigation.

Indirect habitat evaluations for vertebrate species based on GAP species models for the new pipeline alternatives indicate that SA-04 would affect more than twice the area of habitats identified as suitable for mammals, birds, amphibians, and reptiles of conservation concern compared to the Applicant's preferred route. This supports the overall conclusion from the IPaC and NHIS occurrence data that the potential for impacts on protected animals would increase for the new pipeline construction options. Among these vertebrate groups, however, the proportion of the suitable habitats used by the most species of conservation concern varies. A higher proportion of the area is used by mammals and birds for the Applicant's preferred route, and a higher proportion of the area is used by amphibians and reptiles for the SA-04 route (Table 5.2.5-18 and Table 5.2.5-26). Overall, SA-04 has the potential to affect more protected species. With implementation of BMPs and appropriate species-specific conservation measures for new pipeline construction, direct and indirect impacts on federally and state-listed vertebrates primarily would be temporary disturbance, short-term habitat loss, and permanent habitat alteration—resulting in overall minor impacts.

Considering the potential impacts on unique natural resources within the portions of the new pipeline routes only within Minnesota, however, leads to the opposite conclusion. A review of construction impact

areas indicates that the Applicant's preferred route would affect 5 times more WAN (habitat for SGCN) and 30 times more MBS Sites than SA-04. This is consistent with the overall increase in numbers of occurrences and species for state-protected plants for the Applicant's preferred route compared to SA-04. In addition, the Applicant's preferred route potentially would contribute to fragmentation within new pipeline rights-of-way across 23 miles of WAN habitats and across 17 miles of moderate to outstanding rated MBS Sites.

Direct impacts on federally and state-protected vertebrates from construction of rail and truck offloading and access facilities are expected to be negligible to minor for construction. Construction of these facilities for the rail and truck alternatives would potentially affect several state-protected and special concern plants.

Operations Impacts

Pipeline right-of-way maintenance activities during operation would include mowing, equipment maintenance, invasive species control, right-of-way monitoring, and integrity digs to repair or replace pipe segments. Vegetation maintenance that removes riparian trees and large shrubs could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. Activities in and around water, as well as upland vegetation maintenance could result in direct mortality of less mobile species through crushing, if species are present while the activity is occurring. State-listed plants that persist within the permanent right-of-way after construction could be permanently affected by vegetation maintenance activities.

All special-status species within the ROI could be indirectly affected by habitat loss and alteration due to maintenance activities. Maintained pipeline rights-of-way could act as a barrier to travel for some animals such as amphibians, reptiles, and small mammals, fragmenting habitat for SGCNs. Habitat fragmentation can increase edge habitats favored by some animals and avoided by others; and can create a barrier to movements for some animals while facilitating movements of others, especially predators.

With implementation of BMPs and appropriate species-specific conservation measures for operations of new pipeline, most impacts due to pipeline operations would be temporary disturbance and permanent habitat alteration, resulting in overall minor impacts for both the Applicant's preferred route and SA-04.

The effects of continued use of the existing Line 3 pipeline on protected and rare animals and plants would be the same as ongoing Line 3 operations, although the increased number of integrity excavations required for the aging pipeline would increase the potential for disturbance to protected or rare animals and plants, if they continue to persist within the permanent right-of-way. However, habitats along the route have been previously altered by construction of multiple pipelines and the long-term maintenance of the Line 3 permanent right-of-way and are unlikely to support a diversity or abundance of threatened or endangered species.

The primary potential impact for the rail and truck alternatives would be increased rail and truck wildlife collisions, which could affect protected and rare mammals, birds, reptiles, and insects. Incremental increases in rail and truck traffic may result in increased collision mortality, especially for protected prairie-dependent insects that may persist in remnant prairie patches along rail lines, for protected reptiles where highways cross suitable habitat, and for protected wide-ranging mammals such as wolves and Canada lynx where rail and truck routes cross their ranges.

5.2.5.4.2 Mitigation

In addition to the Applicant-proposed measures described above, which would be incorporated into the Project, the Applicant would comply with conditions specified in permits required for the Project. Typical conservation measures to reduce impacts on unique resources are identified above in the discussions for the specific species. These measures likely would be required by the applicable agencies, and additional mitigation for potential impacts could be required.

Actions identified by Minnesota DNR to further minimize disturbance to MBS Sites include, but are not limited to, the following:

- Do not park equipment or stockpile supplies within MBS Sites,
- Do not place spoil within MBS Sites,
- Limit construction activities to frozen ground conditions, and
- Revegetate disturbed soil with native species suitable to the local habitat as soon after construction as possible.

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Federally Protected Species							
Construction Impacts							
Potential for injury, mortality, or disturbance	Minor/temporary impacts • 3 mammals Minor/short-term impacts • 1 insect Negligible/ temporary to short-term impacts • 3 birds • 2 insects No impact • 2 plants 11 species total	Minor/temporary impacts • 3 mammals	Minor/temporary impacts • 3 mammals • 1 reptile • 3 insects Negligible/ permanent impacts • 6 plants No impact • 2 birds • 1 insect • 4 mollusks • 2 plants 21 species total, plus 1 candidate	Minor/temporary impacts • 3 mammals Minor/permanent impacts • 3 insects No impact • 3 birds • 1 plant 10 species total	Minor/temporary impacts • 3 mammals Minor/permanent impacts • 1 insects No impact • 3 birds • 1 plant 8 species total	Minor/temporary impacts • 3 mammals Minor/permanent impacts • 3 insects No impact • 3 birds • 1 plant 10 species total	Minor/temporary • 3 mammals Minor/permanent • 1 insects No impact • 3 birds • 1 plant 8 species total

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Operations Impacts							
Potential for injury, mortality, or disturbance of federal ESA species	Minor/permanent impacts • 1 mammal Minor/short-term impacts • 1 mammal Minor/permanent impacts • 1 insect Negligible/ permanent impacts • 1 mammal, • 2 birds, • 2 insects • 2 plants No impact • 1 bird 11 species total	Minor/permanent impacts • 1 mammal Minor/short-term • 1 mammal Negligible/ permanent impacts • 1 mammal, • 2 birds • 3 insects • 2 plants No impact • 2 birds 12 species total	Minor/short-term impacts • 1 mammal, • 1 reptile Negligible/ permanent impacts • 2 mammals, • 4 insects • 6 plants No impact • 2 birds, • 4 mollusks • 2 plants 21 species total, plus 1 candidate	Major/permanent impacts • 2 mammals Minor/permanen t impacts • 3 insects Minor/temporary impacts • 1 mammal No impact • 3 birds • 1 plant 10 species total	Major/permanent impacts • 2 mammals Minor/permanent impacts • 1 insects Minor/temporary impacts • 1 mammal No impact • 3 birds • 1 plant 8 species total	Major/permanent impacts • 2 mammals Minor/permanent impacts • 3 insects Minor/temporary impacts • 1 mammal No impact • 3 birds • 1 plant 10 species total	Major/permanent impacts • 2 mammals Minor/permanent impacts • 1 insects Minor/temporary impacts • 1 mammal No impact • 3 birds • 1 plant 8 species total

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
State-listed Endangered or Threatened Species							
Construction Impacts							
Mammals	1 species (northern long-eared bat) See federal species	1 species (northern long-eared bat) See federal species	1 species See federal species	--	--	See Existing Line 3	See Existing Line 3
Birds	--	--	5 species Temporary/ negligible	--	--	--	--
Herptiles	1 species (wood turtle) Temporary to long-term/minor	1 species (wood turtle)-	3 species Temporary to long-term/negligible to minor	--	--	See Existing Line 3	See Existing Line 3
Fish	1 species (pugnose shiner) Temporary to short-term/negligible	--	8 species Temporary/minor	--	--	--	--
Mussels	1 species (fluted-shell mussel) Permanent/ negligible	1 species --	11 species Temporary/minor	--	--	See Existing Line 3	See Existing Line 3
Insects	--	--	2 species Temporary/minor	--	--	--	--

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Plants	11 species (6 Minnesota, 5 Wisconsin) Permanent/major 10 species No impact	8 species --	4 species Permanent/major 18 species No impact	4 species Permanent/major	4 species Permanent/major	8 species (3 Minnesota, 5 Wisconsin) Permanent/major 10 species No impact	8 species (3 Minnesota, 5 Wisconsin) Permanent/major 10 species No impact
Operations Impacts							
Mammals	1 species (northern long-eared bat) See federal species	1 species (northern long-eared bat) See federal species	1 species See federal species	--	--	See Existing Line 3	See Existing Line 3
Birds	--	--	5 species Permanent/ negligible	--	--	--	--
Herptiles	1 species (wood turtle) Permanent/minor	1 species (wood turtle) Permanent/minor	3 species Permanent/ negligible	--	--	See Existing Line 3	See Existing Line 3
Fish	1 species (pugnose shiner) Permanent/ negligible	--	8 species Permanent/ negligible	--	--	--	--
Mussels	1 species (fluted-shell mussel) Permanent/ negligible	1 species Permanent/ negligible	11 species Permanent/ negligible	--	--	See Existing Line 3	See Existing Line 3

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Insects	--	--	2 species Permanent/ negligible	--	--	--	--
Plants	11 species (6 Minnesota, 5 Wisconsin) Permanent/minor 10 species No impact	8 species Permanent/minor 10 species No Impact	4 species Permanent/minor 18 species No impact	4 species No impact	4 species Perm/negligible	8 species (3 Minnesota, 5 Wisconsin) Permanent/minor 10 species No impact	8 species (3 Minnesota, 5 Wisconsin) Permanent/minor 10 species No impact
Species of Concern							
Construction Impacts							
Mammal	4 species Short-term/minor	1 species --	--	--	--		
Birds	1 species Short-term/major	6 species --	6 species Short-term/major	--	--	See Existing Line 3	See Existing Line 3
Herptiles	1 species Short-term/ negligible to major	--	2 species Short-term to permanent/ negligible to major	--	--	--	--
Fish	1 species Short-term/ negligible to major	--	4 species Short-term/ negligible to minor	--	--	--	--

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Mussels	3 species Short-term/ negligible to major	3 species --	3 species Short-term/ negligible to minor	--	--	--	--
Insects	2 species	1 species --	6 species Short-term/minor	--	--	See Existing Line 3	See Existing Line 3
Plants	11 species Permanent/major 3 species No impact	17 species --	11 species Permanent/major 3 species No impact	3 species Permanent/major	3 species Permanent/major	See Existing Line 3	See Existing Line 3
Operations Impact							
Mammal	4 species Short-term/minor	1 species See federal species 2 species No impact	--	--	--	See Existing Line 3	See Existing Line 3
Birds	1 species Short-term/major	6 species Temporary to short-term/minor	6 species Short-term/ negligible to minor	--	--	See Existing Line 3	See Existing Line 3
Herptiles	1 species Short-term/ negligible to major	--	2 species Short-term/ negligible to minor	--	--	--	--
Fish	1 species Short-term/ negligible to major	--	4 species Short-term/ negligible to minor	--	--	--	--
Mussels	3 mussels Short-term/ negligible to major	3 species Temporary to short-term/minor	3 species Short-term/ negligible to minor	--	--	See Existing Line 3	See Existing Line 3

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Insects	-	1 species Temporary to short-term/minor	6 species Short-term/ negligible to minor	--	--	See Existing Line 3	See Existing Line 3
Plants	11 species Short-term/minor 3 species No impact	17 species Short-term/ negligible	11 species Permanent/major 3 species No impact	3 species No impact	3 species Permanent/major	See Existing Line 3	See Existing Line 3
Species in Greatest Conservation Need – GAP Models							
Mammal Habitat	Con: 4,954 acres *Op: 2,092 acres*	Con: - *Op: 1,797 acres*	Con: 9,076 acres *Op: 3,792 acres*	Clearbrook Con: low/medium *Op: low/medium* Superior Con: high/medium *Op: high/medium*	Clearbrook Con: low/medium *Op: low/medium* Superior Con: high/medium *Op: high/medium*	Clearbrook Con: low/medium *Op: Line 3 + Rail* Superior Con: high/medium *Op: Line 3 + Rail*	Clearbrook Con: low/medium *Op: Line 3 + Truck* Superior Con: high/medium *Op: Line 3 + Truck*
Bird Habitat	Con: 5,614 acres *Op: 2,356 acres*	Con: - *Op: 1,987 acres*	Con: 11,549 acres *Op: 4,812 acres*	Clearbrook Con: low/medium *Op: low/medium* Superior Con: low/medium *Op: low/medium*	Clearbrook Con: low/medium *Op: low/medium* Superior Con: low/medium *Op: low/medium*	Clearbrook Con: low/medium *Op: Line 3 + Rail* Superior Con: low/medium *Op: Line 3 + Rail*	Clearbrook Con: low/medium *Op: Line 3 + Truck* Superior Con: low/medium *Op: Line 3 + Truck*

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Herptile Habitat	Con: 1,328 acres *Op: 581 acres*	Con: - *Op: 393 acres*	Con: 3,984 acres *Op: 1,658 acres*	Clearbrook Con: none *Op: none* Superior Con: low/medium *Op: low/medium*	Clearbrook Con: none *Op: none* Superior Con: low/medium *Op: low/medium*	Clearbrook Con: none *Op: Line 3 + Rail* Superior Con: low/medium *Op: Line 3 + Rail*	Clearbrook Con: none *Op: Line 3 + Truck* Superior Con: low/medium *Op: Line 3 + Truck*
	Short-term/ negligible to minor *Short-term/ negligible to minor*	- *Short-term/ negligible to minor*	Short-term/ negligible to minor *Short-term/ negligible to minor*	Permanent/minor *Permanent/minor*	Permanent/minor *Permanent/minor*	Permanent/minor *Op: Line 3 + Rail*	Permanent/minor *Op: Line 3 + Truck*
Species in Greatest Conservation Need – MN Wildlife Action Network							
SGCN Habitat	23 miles new corridor Con: 1,561 acres *Op: 665 acres*	0 mi. new corridor Con: -- *Op: 608 acres*	0 mi. new corridor Con: 277 acres *Op: 115 acres*	--	--	See Existing Line 3	See Existing Line 3
	Permanent/major *Permanent/minor*	-- *Permanent/minor*	Permanent/minor *Permanent/minor*	--	--	See Existing Line 3	See Existing Line 3
Minnesota Biological Survey Sites of Biodiversity Significance							
	17 miles in new corridor	0 mi. new corridor	0 mile in new corridor	--	--	See Existing Line 3	See Existing Line 3
Outstanding	Con: 7 acres *Op: 5 acres*	-- *Op: 25 acres*	Con: 1 acre *Op: <1 acres*	-- --	-- --	See Existing Line 3	See Existing Line 3
High	Con: 78 acres *Op: 40 acres*	-- *Op: 233 acres*	Con: 5 acres *Op: 2 acres*	-- --	-- --	See Existing Line 3	See Existing Line 3
Total	Con: 877 acres *Op: 403 acres*	- *Op: 305 acres*	Con: 25 acres *Op: 10 acres*	-- --	-- --	See Existing Line 3	See Existing Line 3

Table 5.2.5-26. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact / Category	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
	Permanent/major *Permanent/major*	- *Permanent/minor*	Permanent/minor *Permanent/minor*	-- --	-- --	See Existing Line 3	See Existing Line 3
Minnesota SNA and Analogous PAD-US							
	No impact	No impact	No impact	No impact	No impact	No impact	No impact

ESA = Endangered Species Act, GAP = GAP Analysis Program, MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance, SGCN = Species of Greatest Conservation Need, SNA = Scientific and Natural Area, WAN = Wildlife Action Network

5.2.5.5 References

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5.2.6 Public Lands

Public lands are lands managed or held by federal, state, and county governments for a variety of public benefits—including preservation of natural areas, wildlife habitat, timber, mineral resources, water resources and other natural resources, recreation areas, and other public interests. Because construction and operation of the Applicant's preferred route and the CN Alternatives may affect the future use of federal, state, and county land, the public lands analysis assessed:

- Potential impacts on public lands, including compatibility of the Project with designated uses of specific public lands.

In addition to the analysis of compatibility with the designated use of public lands in this section, impacts on the public resources contained within public lands are generally described (e.g., vegetation, wildlife, and recreation) although not correlated to specific public lands, and the measures that would be implemented to minimize potential impacts on those resources can be found in several other sections within Chapter 5, including Sections 5.2.1, 5.2.3, 5.2.4, and 5.3.2.

This section first describes the existing type and quantity of public lands for the Applicant's preferred route and each of the CN Alternatives (continued use of existing Line 3, SA-04, transportation by rail, transportation by truck, and existing Line 3 supplemented by rail or truck). Potential impacts on public lands from construction and operation of the Applicant's preferred route and the CN Alternatives are discussed next. A summary and comparison of the impacts for the Applicant's preferred route and CN Alternatives are included at the end of the section.

5.2.6.1 Regulatory Context and Methodology

5.2.6.1.1 Regulatory Context

Regulations governing public lands vary significantly depending on the specific purpose for which the lands were obtained and the government entity responsible for its management. The following section describes the general structure of public land ownership (federal, state, and county) and identifies the authorizing agency and major relevant regulatory provisions. Federal land would be crossed by one or more of the Applicant's preferred route and CN Alternatives in North Dakota, Minnesota, and Illinois; no federal or state lands would be crossed in Iowa. While the Applicant's preferred route and CN Alternatives would collectively cross five states, state-owned/managed lands would only be crossed in Minnesota.

5.2.6.1.2 Methodology

The ROI for the analysis of impacts on public lands was the construction and operations footprint for the Applicant's preferred route and each of the CN Alternatives. All federal, state, and county land directly crossed by construction and operations areas within the ROI was assessed for the Applicant's preferred route and CN Alternatives. The analysis was undertaken by first identifying and inventorying in GIS all public lands in the counties crossed by the Applicant's preferred route and the CN Alternatives. The following construction and operation footprints were overlaid to quantify resources affected by construction and operation:

- The route and estimated footprints for the pipeline and associated facilities for the Applicant's preferred route,

- The 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for system alternative SA-04,
- The permanent right-of-way for the existing Line 3 pipeline, and
- The estimated footprints of required facilities and existing potential routes for the rail and truck alternatives.

Public land within the ROI for the Applicant's preferred route and CN Alternatives were identified using GIS datasets and layers in the following data source:

- Protected Areas Database of the United States (PAD-US).

Where data were available, ownership and identification of the authorizing agency for each land type is provided, along with a discussion of compatibility with the relevant regulatory provisions.

5.2.6.2 Existing Conditions

This section identifies public lands that could be affected by the Applicant's preferred route and CN Alternatives. Appendix A includes maps of the federal and state lands within the ROI.

Federal Land

Federal lands are lands in the United States for which ownership is claimed by the U.S. federal government. The primary purpose of federal land is to benefit the people of the United States with conservation of the natural resources as a priority; most federally owned lands are open to the public for recreational use. Primary federal landholders of the land that would be crossed by the Applicant's preferred route and CN Alternatives include the Department of the Interior (DOI), which includes agencies such as BLM, USFWS, NPS, and the Department of Agriculture—which includes the USFS. The types of land in federal ownership in this analysis include forests that are managed by USFS, refuge land managed by USFWS, National Heritage Parks managed by NPS, and other land managed by BLM. Compatibility of the Project with designated uses varies by authorizing agencies; therefore, a general discussion of the responsible agency based on land ownership and any associated regulatory provisions is provided. When multiple federal properties that are operated by more than one federal agency or bureau would be crossed by a project, an application would be filed with BLM.

State Land

State lands are lands that are held under state management. State lands that would be crossed by the Applicant's preferred route and CN Alternatives include state WMAs, state AMAs, and state forests. These lands are administered by each state's respective DNR. Compatibility of the Project with designated uses varies by authorizing agencies; therefore, a general discussion of the responsible agency based on land ownership and any associated regulatory provisions is provided.

In certain instances, more than one government agency may have an interest in a specific piece of land; thus, additional regulatory authorizations would be needed. For example, if the State of Minnesota purchased and designated land as a WMA but used federal grant money as part of that purchase, the federal government has different and additional regulatory processes for considering proposed encroachments such as pipelines.

County Land

County lands are lands that are held in trust for the public, for which ownership is claimed by county governments. As with federal and state land, their primary purpose is to benefit the public. These lands typically include county parks, forests and other special management areas. Compatibility of the Project with designated uses varies by authorizing agencies; therefore, a general discussion of the responsible agency based on land ownership and any associated regulatory provisions is provided.

Counties in Minnesota may acquire land through tax forfeiture. Some of this land is then sold or exchanged; if the lands are classified as conservation lands, they may be retained and managed for designated conservation purposes or as forestry land. Some lands bordering lakes and streams cannot be sold by the counties.

5.2.6.2.1 Applicant's Preferred Route

Federal Land

The Applicant's preferred route would cross approximately 5 acres of federal land. In North Dakota, the Applicant's preferred route would cross:

- Pembina County Waterfowl Production Area – The waterfowl production area is considered a wildlife refuge and is managed by USFWS. The land is primarily used for bird and wildlife resource management and is open for public access and general wildlife-dependent recreation. Therefore, the Applicant would be required to comply with designated uses and regulatory provisions established through USFWS as the authorizing agency to protect wildlife.

In Minnesota, the Applicant's preferred route would cross:

- North Country National Scenic Trail – The North Country National Scenic Trail stretches across seven states from New York to North Dakota (North Country Trail Association 2016). The National Scenic Trail program is administered through NPS. It includes trails that are 100 miles or longer and provides non-motorized recreational opportunities. At the location of the proposed crossing, the trail is administered by Hubbard County. However, compatibility of the Project with designated uses would be determined by the authorizing agency, which is NPS, and ultimately DOI. In 2015, the House Committee on Natural Resources passed a bill granting the secretary of DOI the power to negotiate rights-of-way for gas pipelines through national park lands.

State Land

All of the state land that would be crossed by the Applicant's preferred route is in Minnesota. The route would cross 17 acres in two WMAs (Grayling Marsh WMA (14 acres) and Lawler WMA (3 acres)), approximately 0.4 acre of the La Salle Creek AMA, and 422 acres in eight state forests:

- Foothills State Forest (42 acres),
- Hill River State Forest (103 acres),
- Huntersville State Forest (97 acres),
- Land O'Lakes State Forest (130 acres),

- Mississippi Headwaters State Forest (25 acres),
- Paul Bunyan State Forest (less than 0.1 acre),
- Savanna State Forest (9 acres), and
- Waukenabo State Forest (16 acres).

These forests, WMAs, and AMA are managed by Minnesota DNR as multiple use areas. They are primarily used for fish and wildlife resource protection, forestry, and recreation. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR. Table 5.2.6-1 provides the total acres of state land that would be crossed by the Applicant's preferred route. The total amount of state land in the ROI for the Applicant's preferred route is 526 acres (including ATWS, access roads, and valves) (Table 5.2.6-1).

Table 5.2.6-1. State Lands Crossed by the Applicant's Preferred Route (acres)

State	Construction Work Area	Permanent Right-of-Way	ATWS	Temp Access Road	Perm Access Road	Valves[a]	Con Total[b]	Op Total[b]
North Dakota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Minnesota	439.6	199.4	32.1	27.6	27.0	0.2	525.5	226.6
Wisconsin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**439.6**	**199.4**	**32.1**	**27.6**	**27.0**	**0.2**	**525.5**	**226.6**

Source: PAD-US – USGS 2016.

Notes:

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route.

[a] Includes valve sites and valve driveways. Because valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated from double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations

Perm = permanent; Temp = temporary

Although not directly affected by pipeline construction or standard operations, the Applicant's preferred route would pass directly east of Itasca State Park, and an existing road that passes through the park would be used as an access road. This state park is one of Minnesota's flagship state parks, with over 500,000 annual visits. The park was established in 1891 to preserve remnant stands of virgin pine and to protect the basin that is the source of the Mississippi River.

County Land

Table 5.2.6-2 provides the county land that would be crossed by the Applicant's preferred route in Minnesota. It is likely that county land would be crossed in North Dakota and Wisconsin; however, data for these states were not available at the time of this assessment. In total, approximately 548 acres of county land would be within the ROI for the construction work area of the Applicant's preferred route, with an additional 102 acres disturbed for ATWS, access roads, and MLVs. While the exact designated use of this land is unknown, it is likely to be land in county parks or forests; therefore, compatibility with designated uses would be determined by the relevant county governments.

Table 5.2.6-2. County Lands Crossed by the Applicant's Preferred Route (acres)

State, County	Construction Work Area	Permanent Right-of-Way	ATWS	Temp Access Road	Perm Access Road	Valves[a]	Con Total[b]	Op Total[b]
North Dakota	NA	NA	NA	NA	NA	NA	NA	NA
Minnesota								
Carlton	128.1	53.4	4.7	1.3	1.6	0.0	135.7	55.0
Cass	273.7	114.0	21.5	17.7	27.1	0.0	340.0	141.1
Clearwater	26.8	11.1	3.1	0.0	0.0	0.1	30.0	11.2
Hubbard	119.1	49.6	7.0	10.1	7.8	0.0	144.0	57.4
Subtotal	***547.7***	***228.1***	***36.3***	***29.1***	***36.5***	***0.1***	***649.7***	***264.7***
Wisconsin	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	**547.7**	**228.1**	**36.3**	**29.1**	**36.5**	**0.1**	**649.7**	**264.7**

Source: County-owned parcels were identified using the "owner" name within each county's GIS parcel data. Because parcel data and owner naming conventions vary from county to county, DOC-EERA identified county-owned parcels as best as possible. Note that Red Lake County had no GIS parcel data, and Aitkin County had no ownership information on their parcel data; therefore, these counties were not included in the analysis.

Notes:

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route.

[a] Includes valve sites and valve driveways. Because valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated from double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations

Perm = permanent; Temp = temporary

NA = data not available at the time of the analysis

5.2.6.2.2 Continued Use of Existing Line 3

Federal Land

A portion of the existing Line 3 lies within the boundaries of the Chippewa National Forest, and the easement covers about 37 acres. The Chippewa National Forest is managed by USFS and includes 666,952 acres of managed forest, 1,300 lakes and ponds, 925 miles of rivers, 440,000 acres of wetlands, and 25 watersheds (USFS 2017). The forest is managed to protect forest and water resources and provides a variety of recreational opportunities. Because the existing Line 3 is already in operation, it is already being regulated by USFS and has been permitted to comply with designated uses.

State Land

A portion of the existing Line 3 lies within three state forests (Bowstring [170 acres], Fond du Lac [15 acres], and Mississippi Headwaters [32 acres]) and two AMAs (Clearwater River AMA [0.1 acre] and Little Otter Creek AMA [2 acres]). Because the existing Line 3 is already in operation, it is already being regulated by Minnesota DNR and has been permitted to comply with designated uses.

County Land

A portion of the existing Line 3 lies within county land: Beltrami (0.7 acre), Carlton (4 acres), Cass (1 acre), Clearwater (2 acres), Hubbard (26 acres), Itasca (0.2 acre), and St. Louis (0.3 acre). Because the existing Line 3 is already in operation, it is already being regulated by the local county-level authorities and has been permitted to comply with designated uses.

5.2.6.2.3 System Alternative SA-04

Federal Land

Table 5.2.6-3 lists the total amount of federal land that would be crossed by SA-04. Public land that would be crossed in North Dakota incudes:

- Dakota Tallgrass Prairie WMA – This federal management area was established in 2000 to preserve tallgrass prairie habitat, primarily through the purchase of perpetual grassland easements (USFWS 2016); however, it is also open to the public for recreational use. USFWS administers the Dakota Tallgrass Prairie WMA; therefore, the Applicant would be required to comply with the designated uses and regulatory provisions established by USFWS as the authorizing agency. Non-federal oil and gas operations on NWRs and the associated regulatory provisions are contained within 50 CFR 29C and 29D.
- Pembina County Waterfowl Production Area – This waterfowl production area is managed by USFWS as part of the NWR system. The land is primarily used for bird and wildlife resource management; and is open for public access and general wildlife-dependent recreation such as hunting, wildlife watching and photography. Therefore, the Applicant would be required to comply with the designated uses and regulatory provisions established by USFWS as the authorizing agency.

Table 5.2.6-3. Federal Lands Crossed by System Alternative SA-04 (acres)

State	Construction Work Area	Permanent Right-of-Way
North Dakota	800.2[a]	331.2[b]
Minnesota	0.3	0.1
Iowa	0.0	0.0
Illinois	176.5	73.6[e]
TOTAL	**977.0[a,b]**	**404.9[a,b]**

Source: PAD-US – USGS 2016.

Notes:

[a] Includes acreages of the Dakota Tallgrass Prairie Wildlife Management Area that are not owned by the U.S. Fish and Wildlife Service.

[b] Includes acreages of the Illinois and Michigan Canal National Heritage Area that are not owned by the National Park Service.

In Illinois, SA-04 would cross:

- The Upper Mississippi River National Wildlife and Fish Refuge – This refuge also is part of the NWR system and is managed by USFWS. As with other land managed by the USFWS, it is primarily used for fish and wildlife resource management, and is open for public access and general recreation. Therefore, the Applicant would be required to comply with the designated uses and regulatory provisions established by USFWS as the authorizing agency.
- The Illinois and Michigan Canal in Illinois – This is a registered National Heritage Area administered by NPS. The actual origin site of the Illinois and Michigan Canal has been converted into a nature park that integrates history, ecology, and art to communicate the canal's importance in the development of Chicago. The former brownfield site has been converted to a landscape that provides passive recreational uses. Compatibility of the Project with designated uses would be determined by the authorizing agency (NPS), and ultimately DOI. As previously noted, the House Committee on Natural Resources passed a bill in 2015 granting the secretary of DOI the power to negotiate rights-of-way for gas pipelines through national park lands.

State Land

Table 5.2.6-4 lists the total amount of state land within the ROI for SA-04. Small areas of state land would be crossed by SA-04 in Minnesota and Illinois. In Minnesota, SA-04 would cross:

- Lyle-Austin WMA – This WMA is managed by Minnesota DNR to provide recreational opportunities for hunters, trappers, and wildlife watchers. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR.

Table 5.2.6-4. State Lands Crossed by System Alternative SA-04 (acres)

State	Construction Work Area[a]	Permanent Right-of-Way[a]
North Dakota	0.0	0.0
Minnesota	0.3	0.1
Iowa	0.0	0.0
Illinois	0.9	0.4
TOTAL	**1.2**	**0.5**

Source: PAD-US – USGS 2016.

Notes:

[a] Acres for the construction work area and the permanent right-of-way are based on a 120-foot-wide construction footprint and a 50-foot-wide permanent right-of-way.

In Illinois, SA-04 would cross:

- Hennepin Canal State Trail – This regional trail runs 105 miles along the towpath of the old Hennepin Canal. The trail offers many opportunities for recreation, including hiking, biking, and fishing. It is administered by Illinois DNR; therefore, compatibility of the Project with designated uses would be determined during easement negotiations with Illinois DNR as the authorizing agency.

County Land

While it is likely that SA-04 would cross county land, data had not been obtained at the time of this assessment. As for the Applicant's preferred route, although the exact designated use of this land is unknown, it is likely to be land in county parks or forests. Therefore, compatibility with designated uses would be determined by the relevant county governments.

5.2.6.2.4 Transportation by Rail

The rail alternative includes construction of a new offloading facility in Clearbrook, Minnesota; an offloading facility in Superior, Wisconsin; and replacement and upgrades of existing rail infrastructure. The land that would be permanently converted for facility construction is not currently designated as public land. It is mostly mixed-use, industrial, and agricultural land.

5.2.6.2.5 Transportation by Truck

The truck alternative includes constructing a new offloading facility in Clearbrook, Minnesota; an offloading facility in Superior, Wisconsin; and new local access roads to these facilities. The land that would be permanently converted for facility construction and expansion is not currently designated as public land. It is mostly mixed-use, industrial, and agricultural land. The routes on existing highways most likely traveled by the trucks would not pass through public land areas, except for the second leg of the route that begins on U.S. Highway 2 in Bagley and continues all the way to Superior. The route crosses through the Mississippi Headwaters State Forest in Minnesota.

5.2.6.3 Impact Assessment

The impact assessment focuses on the compatibility of construction and operation of the Applicant's preferred route and CN Alternatives with designated uses of specific federal, state and county public lands. In addition to the analysis of compatibility with the designated use of public lands in this section, impacts on the public resources contained within public lands (e.g., vegetation, wildlife, and recreation) and the measures that would be implemented to minimize potential impacts on those resources can be found in several other sections in Chapter 5, including Sections 5.2.1, 5.2.3, 5.2.4, and 5.3.2.

5.2.6.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

The Applicant's preferred route would cross approximately 5 acres of federal land, 440 acres of state land and 548 acres of county land during construction. These lands include state forests, and state-managed WMAs and AMAs. The only federal lands that would be crossed by the Applicant's preferred route would be the Pembina Waterfowl Production Area in Pembina County, North Dakota and the North Country National Scenic Trail in Hubbard County, Minnesota.

Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a variety of factors such as land use type, topography, weather, and other environmental conditions. Limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. However, the affected area would represent a relatively small area in proportion to the total amount of public land within the specific forest or resource area that remains undisturbed or unaffected. Given that construction impacts would be limited to small areas within the overall forest and resource area, and that the original use of these larger areas would be maintained during construction, it is likely that construction of the pipeline would result in a temporary, minor to negligible impact related to compatibility with the designated uses of these public lands. Removal of forested habitat would be a long term impact and depending on the route and the forest the magnitude could be major.

Operations Impacts

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation along public lands. During operation, the permanent right-of-way for the Applicant's preferred route would include 2 acres of federal land, 199 acres of state land, and 228 acres of county land. The permanent right-of-way would be periodically cleared of vegetation, and no trees would be permitted to grow. With the exception of the 37 acres of county land and 27 acres of state lands that would be permanently converted to permanent access roads and MLV sites (Tables 5.2.6-1 and 5.2.6-2), the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. Therefore, the public land could continue to be managed for its designated uses, and impacts associated with operation are likely to be long-term but negligible to minor. The exception to this would be on forested land where the management objective is timber production, and no trees would be permitted to grow within the permanent right-of-way of the pipeline corridor. However, given the amount of affected land in state forests compared to the overall forested land that remains available for timber production, it is likely that operation of the pipeline would result in a permanent but minor impact related to compatibility with the designated use of forested land for timber production.

5.2.6.3.2 Continued Use of Existing Line 3

Construction Impacts

There would be no impacts related to compatibility of the pipeline with the designated uses of public lands from continuing use of the existing Line 3 pipeline because it is already built.

Operations Impacts

Impacts associated with operation of the existing Line 3 would be mainly limited to restricted use during times when inspections and repair digs or other maintenance activities are being conducted on the line. Impacts during continued operations related to compatibility of the pipeline with designated uses of public lands are expected to be negligible, temporary, localized, and limited to the permanent right-of-way. Because the permanent right-of-way already has been cleared of trees, no further loss of forested vegetation would be expected.

5.2.6.3.3 System Alternative SA-04

Construction Impacts

During construction, SA-04 would cross 977 acres of federal land and 1 acre of state land (0.3 acre in Minnesota, 0.9 acre in Illinois). Federal land crossed includes the Dakota Tallgrass Prairie WMA and the Illinois and Michigan Canal National Heritage Area. State land crossed consists of the Lyle-Austin WMA in Minnesota and the Hennepin Canal State Trail in Illinois. While it is likely that SA-04 also would cross county land, these data had not been obtained at the time of the assessment.

Operations Impacts

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation along public lands. During operation, the permanent right-of-way for the SA-04 route includes 405 acres of federal land and 0.5 acre of state land (0.1 acre in Minnesota, 0.4 acre in Illinois). With the exception of public lands that would be permanently converted to permanent access roads and MLV sites, the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. Therefore, the public land could continue to be managed for its designated uses, and impacts associated with operation are likely to be long-term and negligible to minor.

5.2.6.3.4 Transportation by Rail

Construction Impacts

There would be no impacts related to the compatibility of construction of loading/offloading facilities with the designated use of public lands for new or improved rail access because proposed locations for these facilities are not on public lands.

Operations Impacts

There would be no impacts related to the compatibility of transportation of crude oil via rail with the designated uses of public lands. The rail route would follow existing rail lines that are already in operation. Any additional rail traffic from increased volume would be passing through areas that are already accustomed to noise and visual disturbances from ongoing rail operations.

5.2.6.3.5 Transportation by Truck

Construction Impacts

There would be no impacts related to the compatibility of construction of loading/offloading facilities or new roads with the designated uses of public lands because proposed locations for these facilities are not on public lands.

Operations Impacts

There would be no impacts related to the compatibility of transportation of crude oil via truck with the designated uses of public lands. The truck route would follow existing truck routes that are already in operation. Any additional traffic from increased volume would be passing through areas that are already accustomed to noise and visual disturbances from preexisting traffic.

5.2.6.3.6 Existing Line 3 Supplemented by Rail

Construction Impacts

No impacts would be associated with compatibility of the pipeline with designated uses of public lands from continuing use of the existing Line 3 pipeline because it is already built.

No impacts related to compatibility with the designated use of public lands would be associated with construction of loading/offloading facilities for new or improved rail access because proposed locations for these facilities are not on public lands.

Operations Impacts

No impacts related to the compatibility of continued operation of Line 3 with designated uses of public lands are expected unless integrity maintenance digs are required within the permanent right-of-way on public lands. Impacts of integrity digs are expected to be temporary, localized, and limited to the permanent right-of-way, thereby resulting in a negligible impact on public lands (depending on the location of the dig). Shipment of crude oil via rail is not expected to affect compatibility with designated uses of public lands.

5.2.6.3.7 Existing Line 3 Supplemented by Truck

Construction Impacts

There would be no impacts related to compatibility of the pipeline with designated uses of public lands from continued use of the existing Line 3 pipeline because it is already built.

No impacts related to compatibility with the designated use of public lands would be associated with construction of loading/offloading facilities and new roads because proposed locations for these facilities are not on public lands.

Operations Impacts

No impacts are expected concerning compatibility of continued operation of the existing Line 3 with designated uses of public lands unless integrity maintenance digs are required within the permanent right-of-way in public lands. Impacts of integrity digs are expected to be temporary, localized, and limited to the permanent right-of-way, thereby resulting in a negligible impact on public lands. Continued shipment of crude oil via truck would not be expected to affect compatibility with the designated uses of public lands.

5.2.6.4 Summary and Mitigation

5.2.6.4.1 Summary

Table 5.2.6-5 presents the results of the analysis of potential compatibility impacts on public lands from construction and operation of the Applicant's preferred route and the CN Alternatives. The results show that the duration and magnitude of construction impacts related to compatibility with designated uses of public land range from no impact to negligible or minor temporary to long-term impacts. The low level of impacts occurs for two reasons. The limitation of designated use represents a small portion of the overall land designated for public use in most affected areas, and any impacts on these lands would be restored following construction. Therefore, any impacts related to compatibility of the pipeline with the designated uses of the land would be limited to the duration of construction (4 to 6 weeks) and full restoration of the site. Following restoration, the land would be able to be maintained for its original designated use, with the exception of changes in habitat associated with the permanent right-of-way. Construction of the Applicant's preferred route would have the largest impact in terms of total land area on state-owned land (i.e., forests) in Minnesota, whereas the SA-04 route would have the largest total impact on federally owned land (mostly within an NWR in North Dakota).

During operations, impacts related to compatibility of the pipeline with designated uses would be long-term to permanent and negligible to major. Except for public lands that would be permanently converted to permanent access roads and MLV sites, the pipeline itself would be buried so there would be minimal ongoing restriction to surface use, except at valve locations. Therefore, the public land could continue to be managed for its designated uses, and impacts associated with operation are likely to be long-term and negligible to minor. The exception to this would be on forested land where the management objective is timber production and no trees would be permitted to grow within the permanent right-of-way of the pipeline corridor. Given the area of land affected relative to the public land that remains available for timber production, it is likely that continued operation of the pipelines would result in a permanent, but minor impact related to compatibility with the designated use of forested land for timber production. Operation of the rail and truck alternatives would not be expected to affect public lands because they would use preexisting truck and rail routes with ongoing volumes of rail and truck traffic. Operation of the existing Line 3 would result in temporary negligible impacts related to the compatibility of the pipeline with public lands during integrity maintenance digs if they occur on public lands.

5.2.6.4.2 Mitigation

As previously noted, crossing through public lands would prompt authorizing agencies to ensure that the Applicant's preferred route or a CN Alternative complies with the designated uses of the land; therefore, the various agencies would require mitigation, and the Applicant would need to coordinate with the authorizing agency.

With implementation of the Applicant-proposed measures and compliance with conditions specified in required permits, no mitigation has been identified to further minimize impacts on federal, state, and county lands—with the exception of forested land within the permanent right-of-way, which would not be allowed to re-establish. A potential mitigation would be to purchase and dedicate private forest land to timber production as an offset, or to compensate the state, federal, or county government for any merchantable timber lost.

Table 5.2.6-5. Summary of Potential Impacts Related to Compatibility of the Applicant's Preferred Route and Certificate of Need Alternatives with Designated Uses of Public Land

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Federal land	Temporary/negligible to minor impacts • 5 acres	No impact	Temporary/negligible to minor impacts • 977 acres	No impact	No impact	No impact	No impact
State land	Temporary to Long term/negligible to minor impacts • 440 acres	No impact	Temporary/negligible to minor impacts • 1 acre	No impact	No impact	No impact	No impact
County land	Temporary/negligible to minor impacts • 548 acres	No impact	Not available	Not available	Not available	Not available	Not available
Operations impacts							
Federal land	Long-term to permanent/negligible to minor impacts • 2 acres	Temporary/ negligible impacts	Long-term to permanent/negligible to minor impacts • 405 acres	No impact	No impact	Temporary/ negligible impacts	Temporary/ negligible impacts
State land	Long-term to permanent/negligible to minor impacts • 199 acres	Temporary/ negligible impacts	Long-term to permanent/negligible to minor impacts • 0.5 acre	No impact	No impact	Temporary/ negligible impacts	Temporary/ negligible impacts
County land	Long-term to permanent/negligible to minor impacts • 228 acres	Temporary/ negligible impacts	Not available	Not available	Not available	Temporary/ negligible impacts	Temporary/ negligible impacts

5.2.6.5 References

North Country Trail Association. 2016. Trail association website. https://northcountrytrail.org/trail/. Accessed on December 11, 2016.

U.S. Fish and Wildlife Service (USFWS). 2016. Dakota Tallgrass Prairie. https://www.fws.gov/refuge/Dakota_Tallgrass_Prairie/about.html. Accessed on December 9, 2016.

U.S. Forest Service (USFS). 2017. Chippewa National Forest. Forest Facts. https://www.fs.usda.gov/detail/chippewa/about-forest/?cid=fsm9_016551. Accessed on January 28, 2017.

U.S. Geological Survey (USGS). 2016. Gap Analysis Program. May 2016. Protected Areas Database of the United States (PAD-US), Version 1.4 Combined Feature Class.

5.2.7 Air Quality

Construction and operation of the Applicant's preferred route and CN Alternatives may affect air quality through the emission of air pollutants that, directly or indirectly, enter the atmosphere and contribute to increased levels of air pollution. Air quality is defined by the ambient concentration of certain pollutants (i.e., criteria pollutants) in the atmosphere determined by EPA to be of concern to the health and welfare of the general public and the environment.

Construction causes air pollution primarily through emissions from construction equipment (i.e., non-road engines), mobile sources (i.e., vehicles), and construction-related activities (i.e., burning, blasting, and road travel). This analysis evaluates air quality impacts from construction of the Applicant's preferred route and CN Alternatives by assessing:

- Air pollutant emissions, including GHG emissions, generated by construction; and
- Stored carbon releases from tree clearing within the construction work areas.

Under normal operations, oil pipelines emit small amounts of fugitive emissions. More significant emissions may result from storage tanks at terminals and pump stations that utilize internal combustion engines. However, the pump stations for the Applicant's preferred route would use electric drive motors that do not directly emit air pollutants, but do create air emissions indirectly from the electricity generation required to operate them. This analysis evaluates air impacts from operations of the Applicant's preferred route and CN Alternatives by assessing:

- Air pollutant emissions, including GHG emissions, from pipeline, rail, and truck operations;
- The social cost of carbon (SCC), which provides an estimate of potential climate change damages based on GHG emissions; and
- Loss of carbon of carbon sequestration potential within the pipeline rights-of-way (i.e., carbon sequestration).
- Possible GHG emissions associated with upstream (production) or downstream (combustion) GHG emissions

This section first describes the existing condition for air quality within an area along the Applicant's preferred route and CN Alternatives where air quality could be affected by construction and operation. Next, this section evaluates the potential impacts of construction and operation on the existing air quality and compares these impacts for the Applicant's preferred route and CN Alternatives.

Chapter 10 addresses the impacts on air quality resulting from a crude oil release.

5.2.7.1 Regulatory Context and Methodology

5.2.7.1.1 Regulatory Context

Air Quality Standards

Air quality standards have been established at both the federal and state level to protect and enhance air quality for each of the primary pollutants of concern, called "criteria pollutants." They include carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone, suspended particulate matter less than or equal to 10 microns in diameter (PM-10), fine particulate matter less than or equal to 2.5 microns in diameter (PM-2.5), and lead. These pollutants are subject to both primary and secondary National Ambient Air Quality Standards (NAAQS). Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

State air quality standards cannot be less stringent than the NAAQS. The states potentially affected by the Applicant's preferred route and CN Alternatives include North Dakota, Minnesota, Wisconsin, Iowa, and Illinois. All of these states have adopted ambient air quality standards that are the same or more stringent than the NAAQS. Table 5.2.7-1 lists the NAAQS for the six criteria pollutants.

Table 5.2.7-1. National Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Averaging Time	National Ambient Air Quality Standards	
		Primary	Secondary
PM-10	24-hour	150 µg/m^3	150 µg/m^3
PM-2.5	Annual	12 µg/m^3	15 µg/m^3
	24-hour	35 µg/m^3	--
SO_2[a]	3-hour	--	0.5 ppm
	1-hour	75 ppb	--
NO_2	Annual	53 ppb	53 ppb
	1-hour	100 ppb	--
Ozone	8-hour	0.070 ppm	0.070 ppm
CO	8-hour	9 ppm	--
	1-hour	35 ppm	--
Lead	Rolling 3-month average	0.15 µg/m^3	0.15 µg/m^3

Source: EPA 2016a.

Notes:

The primary annual (0.03 ppm) and 24-hour (0.14 ppm) SO_2 NAAQS have been revoked by the U.S. Environmental Protection Agency (EPA) since 2010. However, the State of Minnesota still adopts these standards. According to EPA, these previous annual and 24-hour SO_2 standards will additionally remain in effect in: (1) any area for which it has not yet been 1 year since the effective date of designation under the current (2010) standards; and (2) any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved, and which is designated as nonattainment under the previous SO_2 standards or is not meeting the requirements of a State Implementation Plan under the previous SO_2 standards (40 Code of Federal Regulations 50.4[3]).

Minnesota has promulgated ambient air quality standards (MAAQS) for H2S, Ozone, CO, SO2, PM10, PM2.5, NO2, Pb, TSP (Minnesota Rules 7009.0080)

CO = carbon monoxide, NO_2 = nitrogen dioxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, ppb = parts per billion, ppm = parts per million, SO_2 = sulfur dioxide, µg/m^3 = micrograms per cubic meter

"--" = no standard

Attainment of Air Quality Standards

EPA determines air quality attainment status based on whether the air quality in an area meets (attains) the NAAQS. Areas that do not meet the NAAQS for a specific criteria pollutant are designated as nonattainment areas for that pollutant. Areas with insufficient data are designated as attainment/unclassified areas and are treated as attainment areas. Areas that were previously designated as nonattainment but have achieved compliance with an NAAQS are designated as maintenance for 20 years after the effective date of attainment, assuming that they remain in compliance with the standard. Neither the Applicant's preferred route nor the CN Alternatives would pass through any air quality nonattainment or maintenance areas, except for a portion of the truck route from the Gretna pump station to the Superior terminal that goes through Duluth, Minnesota. This area is designated as maintenance with respect to CO emissions (8-hour and 1-hour ambient air quality standards) (EPA 2016b).

Air Quality Control Regions

Air quality control regions are categorized as Class I, Class II, or Class III. Class I areas (commonly called "pristine areas") were established primarily as national parks and wilderness areas above a certain size and receive special protections under the Clean Air Act to help maintain pristine air quality.[17] The closest distances to Class I areas within states that would be intersected by the Applicant's preferred route and CN Alternatives are listed in Table 5.2.7-2. The table includes the Fond du Lac Reservation because the Fond du Lac Band of Lake Superior Chippewa is currently seeking re-designation from a Class II to a Class I area. Neither the Applicant's preferred route nor SA-04 would pass through a Class I area; however, the rail and truck alternative routes would pass through the Fond du Lac Reservation.

Table 5.2.7-2. Closest Distance to Class I Areas for the Applicant's Preferred Route and Certificate of Need Alternatives (miles)

Class I Area	Distance to Applicant's Preferred Route	Distance to System Alternative SA-04	Distance to Rail Alternative Route	Distance to Truck Alternative Route
Voyageurs National Park, Minnesota	110.8	184.8	82.7	82.5
Boundary Waters Canoe Area, Minnesota	87.6	216.3	68.4	68.5
Fond du Lac Reservation, Minnesota *(pending re-designation as Class I)*	2.0	162.8	0.0	0.0
Theodore Roosevelt National Park, North Dakota	305.4	296.6	295.3	279.4
Lostwood National Wilderness Area, North Dakota	225.4	225.4	240.1	223.8
Rainbow Lake Wilderness Area, Wisconsin	38.4	195.0	38.6	40.9
Forest County Potawatomi Community Reservation, Wisconsin	184.1	245.6	183.6	186.1

Sources: Jackson 2014; Minnesota PCA 2016; North Dakota DoH 2010; Wisconsin DNR 2015.

[17] Class II areas include all attainment and not classifiable areas not designated as Class I areas and are allowed higher levels of added pollution than Class I areas. Indian tribes that have received Treatment in the Same Manner as State designations can re-designate Class II tribal lands to Class I. Class III areas, allowing even higher levels of added pollutants, are intended for heavily industrialized zones and can be designated only on request. There are currently no Class III areas in the United States.

Air Quality Permitting Requirements

Air permits may be required for a project, depending on the quantity of specific project emissions. In general, federal permits are required for larger emitters and are implemented nationwide under a consistently applied permitting program. These federal permits may be issued by states when authority has been delegated to the state. State permits are those air permits required by state rules and statutes. These permits are the result of state-specific strategies approved by the federal government to regulate minor sources of air emissions and to attain compliance with broader air quality federal laws and regulations.

Oil pipelines under normal operations emit fugitive emissions in small amounts that do not require an air permit. Pipeline associated facilities, such as storage tanks at terminals and pump stations that utilize internal combustion engines to power pipeline pumps, do commonly require air permits. For the Applicant's preferred route, all pump stations use electric drive motors and do not emit air pollutants. However, they do create air emissions indirectly due to the additional electricity generation required to operate them. Note that although pipeline construction causes air pollution through emissions from non-road engines and mobile sources; these emissions do not count towards permitting triggers and therefore do not require air permits. Air permits also are not required for operation of rail equipment or trucks (i.e., mobile sources). Such equipment is subject to emissions performance standards that apply uniformly to specific types of equipment. The federal government has used such standards to reduce diesel particulate, nitrogen oxide (NOx), and volatile organic compound (VOC) emissions from trucks and railroad locomotives.

5.2.7.1.2 Methodology

Construction and operation of the Applicant's preferred route and CN Alternatives would result in emissions that may affect local air quality. The ROI for the air quality analysis consisted of the airsheds (i.e., geographical regions that share the same air supply and are subject to the same air pollutants) through which pipeline and existing rail and truck routes pass. Because of the large regional nature of airsheds, the Applicant's preferred route and the CN Alternatives generally would occur within the same airsheds.

Potential impacts on air quality within the ROI from construction and operations of the Applicant's preferred route and the CN Alternatives were assessed as follows:

- Direct construction emissions data were obtained from the Applicant for one pipeline construction spread. The data were used to assess total construction emissions for the Applicant's preferred route (7 spreads) and SA-04 route (15 spreads).
- Direct operations emissions data were obtained from the Applicant for the Applicant's preferred route (based on 8 electric pump stations and 27 MLV sites) and SA-04 (based on 16 pump stations and 52 MLV sites).
- Direct operations emissions for the rail and truck alternatives were assessed using projected rail ton-miles per year truck miles per year, respectively.
- Indirect greenhouse gas (GHG) emissions for the Applicant's preferred route and the SA-04 route from generation of electricity by the existing local utilities for electric pump station operations were calculated using pump station electricity consumption data supplied from the Applicant and GHG emission factors from EPA's Emissions and Generation Resource Integrated Database (eGRID).

- The amounts of carbon that potentially would be released back into the atmosphere during tree removal within the construction work areas were estimated using the average carbon density of trees within the Northern Lake States as developed by the USFS.
- The loss of carbon sequestration for areas along the permanent right-of-way that would remain cleared were estimated using the average annual carbon accumulation associated with trees within the Northern Lake States as developed by the Chicago Climate Exchange.
- The SCC values were assessed using a 3-percent discount rate developed by the Interagency Working Group to provide an estimate of potential climate change damages for the Applicant's preferred route and CN Alternatives based on total direct and indirect GHG emissions.

5.2.7.2 Existing Conditions

5.2.7.2.1 Applicant's Preferred Route and Certificate of Need Alternatives

Climate/Meteorology

Air quality is substantially influenced by climate and meteorological conditions; therefore, prevalent weather patterns are a major factor in both short-term and long-term air quality conditions. The Applicant's preferred route and the trucking and rail alternative routes would be located in portions of North Dakota, Minnesota, and Wisconsin; SA-04 would be in portions of North Dakota, Minnesota, Iowa, and Illinois. These areas are located within the humid continental climate, which is noted for its variable weather patterns and large temperature ranges. Representative climate data are presented in Table 5.2.7-3.

Table 5.2.7-3. Representative Climate Data

Measurement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cavalier, Pembina County, North Dakota												
Average low temperature (°F)	-7	0	13	29	41	51	56	53	43	31	15	0
Average high temperature (°F)	12	20	32	51	68	75	79	78	67	53	33	18
Average precipitation (inches)	0.4	0.4	0.7	1.1	2.2	3.2	3.3	2.6	1.8	1.5	0.7	0.4
Mean snowfall (inches)	6.7	5.5	5.9	2.0	0.4	0.0	0.0	0.0	0.1	1.6	5.9	6.6
Bagley, Clearwater County, Minnesota												
Average low temperature (°F)	-8	-1	13	28	42	51	55	53	42	31	16	0
Average high temperature (°F)	13	21	34	52	67	74	78	77	67	54	33	19
Average precipitation (inches)	0.6	0.5	0.9	1.4	2.7	4.4	4.1	3.5	2.9	2.4	1.0	0.6
Mean snowfall (inches)	9.6	5.3	7.7	3.5	0.2	0.0	0.0	0.0	0.0	1.0	5.0	9.4
Superior, Douglas County, Wisconsin												
Average low temperature (°F)	1	8	18	31	39	48	57	58	48	38	24	9
Average high temperature (°F)	20	26	35	47	57	68	75	73	65	53	37	25
Average precipitation (inches)	1.0	0.5	1.4	1.6	2.3	3.7	3.7	3.7	3.7	1.9	1.4	0.8
Mean snowfall (inches)	9.6	5.5	9.0	2.2	0.2	0.0	0.0	0.0	0.0	0.2	4.6	11.2
Alta Visa, Chickasaw County, Iowa												
Average low temperature (°F)	7	14	25	37	48	58	62	60	51	40	26	13
Average high temperature (°F)	24	31	43	58	71	80	83	81	73	61	42	28
Average precipitation (inches)	1.1	1.0	2.2	3.8	4.4	4.9	4.6	4.9	3.3	2.6	2.5	1.4
Mean snowfall (inches)	8.5	6.7	8.1	2.4	0.0	0.0	0.0	0.0	0.0	0.2	3.9	9.0
Joliet, Will County, Illinois												
Average low temperature (°F)	17	21	29	39	49	60	64	63	55	43	33	21
Average high temperature (°F)	31	36	47	61	71	81	84	82	76	64	49	35
Average precipitation (inches)	1.8	1.8	2.3	3.5	4.1	3.9	4.3	4.2	3.0	2.8	3.1	2.2
Mean snowfall (inches)	8.9	7.4	2.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	10.0

Sources: Intellicast 2016; WeatherDB 2017.

°F = degrees Fahrenheit

Existing Air Quality

To characterize the background air quality for the ROI when no site-specific monitoring data were available, data were obtained from air quality monitoring stations located within the states and counties nearest to the Applicant's preferred route and CN Alternatives. A summary of the available background air quality data showing criteria pollutant concentrations for 2015 is presented in Table 5.2.7-4. The table shows that ambient air quality for all criteria pollutants is below the NAAQS for all areas that would be crossed by the Applicant's preferred route and CN Alternatives. The only pollutant concentration that approaches the standards is the 8-hour ozone concentration for all of the states.

Table 5.2.7-4. Representative Background Air Quality Data

Pollutant (Averaging Time)	Monitoring Station Location				
	Cass County, North Dakota	Anoka County, Minnesota	Milwaukee County, Wisconsin	Scott County, Iowa	Champaign County, Illinois
PM-10 (24-hour, 2nd max)	75 µg/m^3 (50% of NAAQS)	54 µg/m^3 (36% of NAAQS)	44 µg/m^3 (29% of NAAQS)	135 µg/m^3 (90% of NAAQS)	--
PM-2.5 (Annual, mean)	7.2 µg/m^3 (60% of NAAQS)	6.6 µg/m^3 (55% of NAAQS)	9.6 µg/m^3 (80% of NAAQS)	9.9 µg/m^3 (83% of NAAQS)	8.7 µg/m^3 (73% of NAAQS)
PM-2.5 (24-hour, 98%)	20 µg/m^3 (57% of NAAQS)	16 µg/m^3 (46% of NAAQS)	28 µg/m^3 (80% of NAAQS)	27 µg/m^3 (77% of NAAQS)	19 µg/m^3 (54% of NAAQS)
SO_2 (1-hour, 99%)	2 ppb (3% of NAAQS)	4 ppb (5% of NAAQS)	13 ppb (17% of NAAQS)	7 ppb (9% of NAAQS)	12 ppb (16% of NAAQS)
NO_2 (Annual, mean)	4 ppb (8% of NAAQS)	7 ppb (13% of NAAQS)	15 ppb (28% of NAAQS)	6 ppb (11% of NAAQS)	--
NO_2 (1-hour, 98%)	31 ppb (31% of NAAQS)	44 ppb (44% of NAAQS)	46 ppb (46% of NAAQS)	41 ppb (41% of NAAQS)	--
Ozone (8-hour, 4th max)	0.057 ppm (81% of NAAQS)	0.064 ppm (91% of NAAQS)	0.068 ppm (97% of NAAQS)	0.063 ppm (90% of NAAQS)	0.065 ppm (93% of NAAQS)
CO (8-hour, 2nd max)	0.7 ppm (8% of NAAQS)	0.9 ppm (10% of NAAQS)	0.7 ppm (8% of NAAQS)	0.8 ppm (9% of NAAQS)	0.3 ppm (3% of NAAQS)
CO (1-hour, 2nd max)	0.8 ppm (2% of NAAQS)	1.2 ppm (3% of NAAQS)	1.1 ppm (3% of NAAQS)	1.2 ppm (3% of NAAQS)	0.3 ppm (1% of NAAQS)
Lead (Max 3-month avg)	--	0.01 µg/m^3 (7% of NAAQS)	--	--	--

Source: EPA 2016c.

Notes:

Table results depict the data from the monitoring site within the county with the highest pollutant level, including exceptional events data.

Air pollution levels measured at a particular monitoring site are not necessarily representative of the air quality for an entire county or urban area.

Air quality standards for some pollutants (e.g., PM-2.5, lead) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standards. In those cases, the site-level statistics may differ from the monitor-level statistics.

CO = carbon monoxide, NAAQS = national ambient air quality standard, NO_2 = nitrogen dioxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, ppb = parts per billion, ppm = parts per million, SO_2 = sulfur dioxide, µg/m^3 = micrograms per cubic meter

"--" = no available data.

EPA developed the Air Quality Index to provide a simple, uniform way to report daily air quality conditions taking into account all of the criteria air pollutants measured within a geographic area. The Applicant's preferred route would not be located near any of the areas noted for unhealthy air quality. SA-04 would come within 7 miles of Fargo, North Dakota, for which 3 days were cited as unhealthy for sensitive groups in 2015. The rail alternative route to the Superior terminal would intersect Bemidji and Brainerd, Minnesota, and comes within 3 miles of Duluth, Minnesota; and the truck route to the Superior terminal would intersect Bemidji and Duluth, Minnesota. Each of these cities were cited as having air quality conditions that were unhealthy for sensitive groups for 2 days in 2015 (EPA 2016d).

Greenhouse Gases

GHGs occur in the atmosphere both naturally and as a result of human activities, such as burning fossil fuels. GHGs are gases that trap heat in the atmosphere and include carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases. CO_2 is the reference gas for climate change, so measures of non-CO_2 GHGs are converted into a CO_2 equivalent (CO_2e).[18]

EPA's authority to regulate GHGs through the Clean Air Act was clarified in the U.S. Supreme Court decision in 2007. The Supreme Court ruled that GHGs meet the definition of air pollutants under the existing Clean Air Act and must be regulated if these gases could be reasonably anticipated to endanger public health or welfare. Responding to the Court's ruling, EPA finalized an endangerment finding in December 2009 and began regulating GHGs. Based on overwhelming scientific evidence, EPA found that GHGs were responsible for contributing to climate change which results in a threat to public health and welfare. Specifically, the impacts of climate change that will cause harm to human health and welfare of current and future generations include but are not limited to increased drought; more heavy downpours and flooding; more frequent and intense heat waves and wildfires; greater sea level rise; more intense storms; and harm to water resources, agriculture, wildlife, and ecosystems (Center for Climate and Energy Solutions 2016).

In 2009, President Obama pledged to reduce U.S. GHG emissions to approximately 17 percent below 2005 levels by 2020. In June 2013, the President outlined the Climate Action Plan—the steps his administration would take to cut carbon pollution, help prepare the United States for the impacts of climate change, and continue to lead international efforts to address global climate change (Executive Office of the President 2013). In a progress report released in June 2015, the President stated that the United States is half-way to reaching its 2020 goal (Executive Office of the President 2015). U.S. GHG emissions in 2014 were 9 percent below the 2005 level of 7,350 million metric tons of CO_2e (EPA 2016e). Building on this progress, the President announced that the United States would commit to further reducing its carbon emissions to approximately 26 to 28 percent below 2005 levels by 2025 (Executive Office of the President 2015).

In 2014, approximately 76 percent of the United States' GHG emissions were from fossil fuel combustion (EPA 2016e). Furthermore, fossil fuel-fired power plants are the largest source of emissions, making up

[18] CO_2e gives you the equivalent number of tons of CO_2 emissions associated with an emission of another GHG. CO2-equivalence is usually calculated using the Global Warming Potentials (GWPs) developed for each GHG by the Intergovernmental Panel on Climate Change. GWPs are a measure of the infrared energy that a gas traps in the troposphere, typically over 100 years, compared to CO_2 (U.S. Environmental Protection Agency 2013). As an example, methane, which is a common GHG, is widely represented as having a 100-year GWP of 25 (i.e., for the same weight, the comparative effect of methane on climate change is 25 times greater than CO_2 over a 100-year period).

31 percent of U.S. total GHG emissions (EPA 2016f). To reduce carbon pollution from existing power plants, EPA issued the final Clean Power Plan on August 3, 2015 (EPA 2016g). The ultimate goal of the Clean Power Plan is to reduce carbon pollution from the power sector by 32 percent below 2005 levels by 2030. Under the plan, states are required to develop and implement plans to ensure that the power plants in their state—individually, together, or in combination with other measures—achieve the performance rate goals for CO_2 for 2030 and for interim years 2022-2029 that are listed in the Final Rule. Under the Clean Power Plan Final Rule, states can opt to adopt state-level mass-based goals (in tons of statewide emissions for electric generating units) or rate-based goals (lbs/MWH). Table 5.2.7-5 shows the final emission rate goal under the final Clean Power Plan for each of the states intersected by the Applicant's preferred route and CN Alternatives. Note that EPA uses 2012 as the baseline year for a fixed percentage of reductions. On March 28, 2017, President Trump signed an executive order that directs EPA to "as appropriate" initiate rulemaking to suspend, revise, or rescind the Clean Power Plan and related actions. Although the plan is currently subject to challenge in the D.C. Circuit and has been stayed by the Supreme Court, the executive order directs the Department of Justice to inform the D.C. Circuit of EPA's plans and ask the court to put those challenges on hold while EPA takes action to rescind or revise the rule.

Table 5.2.7-5. Final Clean Power Plan Emission Performance Goals

State	2012 Adjusted Baseline Emission Rate [a] (lb CO_2/MWh)	2030 State Goal (lb CO_2/MWh)	CO_2 Percent Reduction for Existing Fossil Fuel-Fired Electric Generating Units
North Dakota	2,368	1,305	45%
Minnesota	2,082	1,213	42%
Iowa	2,195	1,283	42%
Illinois	2,149	1,245	42%
Wisconsin	1,996	1,776	41%

Source: EPA 2015a.

Notes:

[a] Emission rate is in units of adjusted output-weighted-average pounds of CO_2 per net MWh from all existing fossil fuel-fired electric generating units, excluding those located on tribal lands within the state.

CO_2 = carbon dioxide, lb = pounds, MWh = megawatt hours

5.2.7.3 Impact Assessment

This section of the analysis assesses the temporary air quality effects associated with construction of the pipeline and associated facilities and the permanent air quality effects resulting from facility operations for the Applicant's preferred route and each of the CN Alternatives.

5.2.7.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Air quality impacts associated with construction would include emissions from fossil fuel-fired construction equipment engines, fugitive dust from ground disturbance and transportation, and emissions associated with burning wood debris in construction work areas. Table 5.2.7-6 shows the

estimated construction emissions for the Applicant's preferred route, which would be constructed in 7 spreads (7 separate sections).

Fossil fuel-fired construction equipment is a source of combustion emissions, including NOx, CO, VOCs, SO_2, PM-10, PM-2.5, and small amounts of hazardous air pollutants. Construction equipment also emits GHGs. Gasoline and diesel engines must comply with the EPA mobile source regulations in 40 CFR Part 85 for on-road engines and 40 CFR Part 89 for non-road engines. These regulations are designed to minimize emissions and require a maximum sulfur content in diesel fuel of 15 parts per million.

Table 5.2.7-6. Estimated Construction Emissions for the Applicant's Preferred Route

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
On- and off-road diesel equipment combustion emissions	8.6	123.5	121.0	0.2	5.3	5.0	23,690.0	0.5
On- and off-road gasoline equipment combustion emissions	1.10	2.34	15.3	1.2	0.2	0.2	2,105.0	0.0
Fugitive emissions from paved roads	0.0	0.0	0.0	0.0	59.1	14.5	0.0	0.0
Fugitive emissions from unpaved roads	0.0	0.0	0.0	0.0	8.4	0.8	0.0	0.0
Emissions from open burning of wood debris	0.0	0.0	272.7	0.0	26.6	26.6	141.0	0.0
Blasting emissions[a]	0.0	0.2	0.3	0.003	0.0005	0.00003	0.0	0.0
Subtotal per spread	***9.7***	***126.0***	***409.3***	***1.4***	***99.6***	***47.1***	***25,936.0***	***0.5***
TOTAL EMISSIONS[b]	**67.7**	**880.8**	**2,863.3**	**9.8**	**697.3**	**329.6**	**181,552.0**	**3.7**

Source: Enbridge 2017.

Notes:

[a] Blasting would be required for only one 1,500-foot section in Spread 7.

[b] Total emissions represent emissions from 7 construction spreads.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

Fugitive dust is a source of respirable airborne PM, including PM-10 and PM-2.5 that could result from blasting, open burning, and mobile source traffic on paved and unpaved roads. The amount of dust generated is a function of construction activity, silt and moisture content of the soil, wind speed, frequency of precipitation, vehicle traffic, vehicle types, and roadway characteristics. State regulations typically require measures to prevent fugitive dust from becoming airborne and leaving the property boundary. The Applicant would minimize dust generated from construction activities by wetting soils on the right-of-way and limiting working hours in residential areas as needed (Enbridge 2016a).

Because the pipeline would be constructed in 7 spreads, total emissions would not be concentrated in any one location but would occur incrementally along the pipeline route. Further, each spread of

pipeline activity moves along the route daily during construction; therefore, emissions would be minimal at any specific location, and typical meteorological conditions likely would cause rapid dispersal. As a result, air emissions from construction would result in localized minor, intermittent and temporary impacts. Because air permitting is not triggered by temporary construction phase emissions, dispersion modeling to ensure compliance with ambient air quality standards would not be required.

Stored Carbon Releases

A "carbon sink" is a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compounds for an indefinite period. Trees, like other green plants, are carbon sinks that use photosynthesis to convert CO_2 into sugar, cellulose, and other carbon-containing carbohydrates that they use for food and growth. They are able to lock up large amounts of carbon in their wood, on the forest floor and in forest soils and they continue to add carbon as they grow. When a tree is harvested and converted into forest products, a part of the CO_2 it has stored over a lifetime is retained within its cellular structure. When trees die and decompose or are burned, some of the stored carbon remains as forest litter and soils, but much of the rest is released back into the atmosphere as CO_2 (New York DEC 2016).

Construction along the Applicant's preferred route could require removal of trees from up to 1,682 acres of forested land in the construction work area. Of this, 702 acres would remain permanently without trees, while the forest would be allowed to regrow on the other 981 acres. Within the Northern Lake States, USFS estimated the carbon density of forested lands for six forest types: aspen-birch, elm-ash-cottonwood, maple-beech-birch, oak-hickory, spruce-fir, and white-red-jack pine (Smith et al. 2006). The average for the six forest types is 30.2 metric-tons of carbon per acre. Consequently, the amount of carbon that potentially would be released back into the atmosphere during construction tree removal of 1,682 acres is estimated at approximately 205,500 tons of CO_2e. Regrowth of the forest on the 981 acres outside of the pipeline right–of-way eventually would more than halve this loss in the long run after forest regrowth, bringing net CO_2 emissions from forest clearance down to a level of about 85,658 tons. Note that the annual loss of carbon sequestration is quantified below as an operations impact.

Operations Impacts

Table 5.2.7-7 shows the estimated operations emissions for the Applicant's preferred route based on 8 electric pump stations and 27 MLV sites. Air quality impacts associated with operations would predominantly involve emissions from piping components (e.g., pumps, valves, and flanges) at the pump stations and MLVs, and emissions associated with potential increased throughput of a terminal's external floating roof storage tanks. The external floating roof tank design is such that evaporative losses from the stored crude oil are limited to losses from the rim seal system and deck fittings (standing storage loss) and any exposed crude oil on the tank walls (working loss). Indirect GHG emissions resulting from power generation to supply electrical energy to the pump stations are considered in the following section.

The external floating roof storage tanks at the existing Clearbrook terminal are subject to New Source Performance Standards (NSPS) in 40 CFR 60 Subpart Kb, "Standards of Performance for Volatile Organic Liquid Storage Vessels." Subpart Kb regulates VOC emissions and establishes controls based on the vapor pressure of the stored liquid. The Clearbrook terminal currently operates under a minor source Option A Registration Permit, which is a state of Minnesota permit, solely because an NSPS applies and no federal or state permitting thresholds are exceeded (i.e., applicability to NSPS Subpart Kb requires a State air permit under Minn. R. 7007.0250). The increased throughput associated with the Applicant's preferred route would cause potential emissions of VOCs at the Clearbrook terminal that exceed the

100-tons-per-year major source threshold, triggering a Title V operating permit. The Applicant would obtain a synthetic-minor individual state permit in order to limit VOC emissions and retain status as a minor source (Enbridge 2016a). Dispersion modeling to ensure compliance of the Clearbrook terminal with ambient air quality standards has not been completed and would likely not be triggered by this permit change. Furthermore, operational emissions would consist primarily of VOCs, which are a precursor to the criteria pollutant, ozone. VOC emissions cannot practically be modeled to show a source's ozone formation given the regional transport nature of the pollutant.

Table 5.2.7-7. Estimated Operations Emissions for the Applicant's Preferred Route

Emission Source Description	Direct Emissions (tons per year)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	2.9	0.0	0.0	0.0	0.0	0.0	0.04	0.09
Mainline valve fugitive emissions from piping components	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.004
Clearbrook terminal fugitive emissions from pumps, piping components, sump tanks, and pig traps	0.5	0.0	0.0	0.0	0.0	0.0	0.006	0.02
Additional Clearbrook terminal storage tank withdrawal losses from pipeline throughput[a]	17.5	0.0	0.0	0.0	0.0	0.0	372.2	1.2
Fugitive emissions from unpaved roads	0.0	0.0	0.0	0.0	0.1	0.01	0.0	0.0
Vehicle combustion emissions	0.002	0.004	0.03	0.002	0.0004	0.0004	3.6	0.0
Additional Superior terminal storage tank withdrawal losses from pipeline throughput[b]	--	--	--	--	--	--	--	--
TOTAL EMISSIONS	**21.0**	**0.004**	**0.03**	**0.002**	**0.1**	**0.01**	**375.9**	**1.3**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 8 pump stations and 27 mainline valve sites.

[a] Only those emissions associated with the proposed increase in throughput of the Clearbrook terminal are included as part of the Project's operations emissions (i.e., existing operations emissions are equivalent to the existing environment).

[b] The Applicant is currently working on an application for an air permit to accommodate the proposed increase in throughput of the Superior terminal.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

The existing Superior terminal has both internal and external floating roof storage tanks that are subject to NSPS in 40 CFR 60 Subpart Kb, "Standards of Performance for Volatile Organic Liquid Storage Vessels." The Superior terminal also has diesel engines subject to NSPS in 40 CFR 60 Subpart IIII for

stationary compression ignition internal combustion engines and the National Emission Standards for Hazardous Air Pollutants (NESHAPs) in 40 CFR 63 Subpart ZZZZ for reciprocating internal combustion engines. The Superior terminal currently operates as a Title I Prevention of Significant Deterioration and Title V major source. Currently, the Applicant is working on an application for an air permit to accommodate the potential increased throughput of the terminal (Wisconsin DNR 2016). The Wisconsin permitting agency may require dispersion modeling to determine compliance of the Superior terminal with ambient air quality standards, depending on the resulting emissions increase and permit triggered.

As a result of the permitting and federal NSPS and NESHAP requirements, it would be expected that permanent operations of the Applicant's preferred route would result in minor, localized air quality impacts; and GHG emissions would contribute to global climate change.

Loss of Carbon Sequestration

Trees, like other green plants, are carbon sinks that use photosynthesis to convert CO_2 into sugar, cellulose, and other carbon-containing carbohydrates that they use for food and growth. The process by which carbon sinks remove CO_2 from the atmosphere is known as "carbon sequestration." Although forests do release some CO_2 from natural processes such as decay and respiration, a healthy forest typically stores carbon at a greater rate than it releases carbon (New York DEC 2016). The actual rate of carbon sequestration is highly variable and depends on several factors, including the species of tree, age of the tree, climate, forest density, and soil conditions.

Following construction, 981 acres of previously cleared forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 702 acres along the permanent right-of-way would remain cleared. The nature of the proposed tree removal is to permanently convert forested land within the permanent right-of-way and aboveground facility sites to a non-forested land use, which would result in a permanent loss of carbon sequestration.

Within the Northern Lake States, the Chicago Climate Exchange estimated the annual carbon accumulation on forested lands for six forest types: aspen-birch, elm-ash-cottonwood, maple-beech-birch, oak-hickory, spruce-fir, and white-red-jack pine (Chicago Climate Exchange 2009). For these forest types, 1.6 metric tons of CO_2 is annually sequestered in the non-soil components of the forest. Thus the annual carbon sequestration foregone annually on the 702 acres that are permanently deforested would be 1,260 tons.

Indirect Greenhouse Gas Emissions

In addition to the direct operations emissions presented in Table 5.2.7-7 (376 tons of CO_2e per year) and an annual loss of an estimated 1,262 tons of CO_2-*e* of sequestration, the Project would result in indirect GHG emissions at power generation facilities that supply energy to power the pump stations needed for the line.

The pump stations for the project would be powered by electricity from existing local electric utilities, which would produce indirect air emissions (i.e., emissions not from the Applicant's preferred route itself, but from power plant emissions that generate the electricity the Project uses). The projected power consumption from operations of all pump stations would be 533,249 megawatt-hours (MWh) per year (Enbridge 2016b). This estimate includes the power consumption for the existing Line 3 pump

stations. GHG emissions for electricity use for the power control area for each of the proposed pump stations were calculated using EPA's eGRID GHG emission factors:

- 1,894 pounds of CO_2e per MWh for the Otter Tail Power Company for the Donaldson, Viking, Plummer, and Clearbrook terminal pump stations; and
- 1,836 pounds of CO_2e per MWh for the Great River Energy for the Two Inlets, Backus, Palisade, and Cromwell pump stations.

Based on this data, the maximum indirect GHG emissions from pump station operations would be 497,112 tons of CO_2e per year (EPA 2015b). The maximum indirect GHG emissions from pump station operations associated only with the increased throughput would be 452,497 tons of CO_2e per year, after removing 44,615 tons of CO_2e per year that is associated with the existing Line 3 and considered part of the baseline in the existing environment (Enbridge 2017). The criteria pollutant emissions associated with the electric generating facilities would be authorized by applicable permits, ensuring compliance with ambient air quality standards. These facilities would also be subject to the GHG reduction requirements in the Clean Power Plan.

Social Cost of Carbon

The potential increased GHG emissions associated with the Project would contribute incrementally to global climate change, in conjunction with other regional, national and global sources of GHG emissions; when aggregated together on a global scale, emissions can have large cumulative effect on climate change.

EPA and other federal agencies use the SCC to estimate the climate benefits of rulemakings. The SCC is the total cost to society arising from man-made emissions of CO_2 and other GHGs. It is typically measured in U.S. dollars per metric ton of CO_2 or CO_2e. The SCC is meant to be a comprehensive estimate of climate change damages. It includes changes in net agricultural productivity; human health; property damages from increased flood risk; and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. Given current modeling and data limitations, however, it does not include all important damages. Nonetheless, EPA (2016h) reports that the SCC is a useful measure to assess the benefits of CO_2 reductions.

Table 5.2.7-8 presents four SCC values developed by the Interagency Working Group, a group comprised of scientific and economic experts from the White House and federal agencies, including: Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy, EPA, and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, accounts for higher-than-expected impacts from temperature change farther out in the tails of the SCC distribution (White House 2015). The Interagency Working Group acknowledges that a 3-percent discount rate is the central (average) value (White House 2015). Thus, a 3-percent discount rate was used in this analysis.

Table 5.2.7-8. Social Cost of Carbon (in 2007 dollars per metric-ton CO_2)

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95th Percentile
2015	$11	$36	$56	$105
2020	$12	$42	$62	$123
2025	$14	$46	$68	$138
2030	$16	$50	$73	$152
2035	$18	$55	$78	$168
2040	$21	$60	$84	$183
2045	$23	$64	$89	$197
2050	$26	$69	$95	$212

Source: Whitehouse 2015.
CO_2 = carbon dioxide

Table 5.2.7-9 calculates the SCC using the 3-percent discount rate for the direct and indirect GHG emissions of the Applicant's preferred route over the 30-year life of the Project.

Table 5.2.7-9. Social Cost of Carbon (Fossil GHG Emissions) for the Applicant's Preferred Route (in 2007 dollars)

Year	30-Year SCC for Direct GHG Emissions[a]	30-Year SCC for Indirect GHG Emissions	30-Year SCC for Direct and Indirect GHG Emissions
30-Year Project life (2020 to 2049)	$558,917	$672,806,234	$673,365,150

[a] Estimate does not include emissions associated with lost carbon sequestration
GHG = greenhouse gas, SCC = social cost of carbon

Life-Cycle Greenhouse Gas Emissions

The Project is part of a larger crude oil extraction, production, refining, and consumption system that is affected by changes in the availability and price of transportation to get crude oil from the point of extraction to the refineries that process the oil into refined products. An increase in the availability of options for transport via pipeline, for example, could lower the overall cost of transporting crude oil to market, improving its market prospects.

Similarly, increased upstream activity induced by the project could ultimately result in increased end-use of refined products, because, for example, gasoline becomes more abundant and cheaper as a result additional extraction and cheaper pipeline transport.

Addressing the GHG impact of these types of upstream and downstream changes requires a look at GHG emissions at each stage of the life-cycle of the crude oil—extraction to combustion and everything in between. The analysis below first addresses the question of whether and how much a single project like the Line 3 Replacement Project could affect upstream and downstream activity and then investigates

the magnitude of life-cycle GHG emissions associated with potential upstream and downstream changes.

Potential for Upstream and Downstream Effects

Whether and how much a single project like the Line 3 Replacement Project would affect upstream and downstream depends on market dynamics that cannot be predicted with certainty. However, the potential for the additional heavy crude that the Project would accommodate to alter upstream and downstream activity was explored using information presented by the U.S. Energy Information Administration (EIA) in its most recent Annual Energy Outlook (AEO) and similar assessments in two other EISs for oil pipelines.

Each AEO includes long-term energy projections for the United States. AEO 2017 presents projections for U.S. energy markets through 2050 based on eight modeled cases (Reference, Low and High Economic Growth, Low and High Oil Price, Low and High Oil and Gas Resource and Technology, and No Clean Power Plan Implementation cases) (EIA 2017). These projections are not predictions of what will happen, but are modeled projections of what may happen given certain assumptions and methods. The Reference case projection includes consideration of continued improvement in known technologies as well as economic and demographic trends that are consistent with the current central views of leading economic forecasters and demographers.

AEO 2017 states that *overall* energy consumption, including petroleum products, is projected to remain relatively flat in the Reference case, rising 5 percent from the 2016 level by 2040. U.S. petroleum consumption was projected to remain below the 2005 level (about 21 million barrels per day [bpd], the highest recorded to date) through 2040 for all cases evaluated. The range of projections is bounded by the High Oil Price Economic Growth Case (about 15 million bpd) and the Low Oil Price Economic Growth Case (about 20 million bpd). EIA (2017) expects that petroleum consumption will remain relatively flat due to the increases in energy efficiency that would offset growth in the transportation and industrial sectors.

These findings are consistent with the projections reported in the Draft Supplemental EIS for the Line 67 Expansion, which states that "U.S. demand for liquids, including petroleum products and natural gas plant liquids among others, is generally believed to have plateaued at the consumption level in 2015, with some variance depending on price developments" (DOS 2017). In addition, the Final Supplemental EIS for the Keystone XL Project reported that "Approval or denial of any one crude oil transport project…remains unlikely to significantly impact the rate of extraction in the oil sands, or the continued demand for heavy crude oil at refineries in the United States" (DOS 2014).

Based on a review of these studies, it is difficult to determine with certainty that no upstream or downstream changes would occur as a result of the Project, therefore the following analysis describes life-cycle GHG emissions that could result if upstream or downstream changes did occur.

Life-Cycle Emission Estimates

A life-cycle analysis for GHGs tracks the total production of GHGs from their extraction from the earth to the end-use combustion of refined petroleum products or byproducts. Life-cycle stages for crude oil generally include the following (DOS 2017; NETL 2008):

- Life-Cycle Stage #1: Raw Material Acquisition

  - Begins with extraction of raw feedstocks (e.g., crude oil) from the earth and any partial processing of the raw materials that may occur.
  - Feedstocks include foreign and domestic crude oil, natural gas liquids, unfinished oils, and unconventional hydrocarbons (e.g., oil sands).

- Life-Cycle Stage #2: Raw Material Transport
  - Begins at the end of extraction/processing of the raw materials and ends at the entrance to the petroleum refineries.
  - Feedstocks are transported from both domestic and foreign sources to U.S. and foreign refineries.

- Life-Cycle Stage #3: Liquid Fuels Production/Refining
  - Begins at the entrance of the petroleum refinery with the receipt of crude oil (and other feedstock inputs) and ends at the entrance to the petroleum pipeline used to transport the liquid fuels to the bulk fuel storage depot.
  - Petroleum refinery operations are both foreign and domestic.
  - Emissions associated with acquisition and production of indirect fuel inputs such as purchased power and steam, purchased fuels such as natural gas and coal, and fuels produced in the refinery and subsequently consumed therein are included in this stage.
  - Emissions associated with onsite and offsite hydrogen production are included in this stage, including emissions associated with raw material acquisition for hydrogen plant feedstock and fuel.
  - Production of oxygenates is excluded from the analysis.

- Life-Cycle Stage #4: Product Transportation and Refueling
  - Begins at the exit of the domestic or foreign petroleum refinery and ends with dispensing the fuel into the vehicle/aircraft.
  - Includes the operation of the bulk fuel storage depot for gasoline and diesel and the airport fuel storage tanks.
  - Includes the operation of liquid fuel tanker trucks used to transfer the gasoline/diesel from the depot to the vehicle fueling stations and the transport of jet fuel from the airport fuel storage tanks to the aircraft by a refueling truck.

- Life-Cycle Stage #5: Combustion
  - Begins at the vehicle/aircraft fuel tank and ends with the combustion of the liquid fuel.
  - Includes emissions from combustion of coke sold as fuel for offsite use

Emissions at each stage of the life-cycle differ for different types of crude. For example, oil extracted from the Western Canadian Sedimentary Basin (WCSB) like the heavy crudes that would be carried by the Line 3 Replacement, require greater energy input for extraction and upgrading than U.S. light crudes, and therefore create more GHG emissions at each stage during production. The Department of State's Line 67 Expansion Project EIS contains a detailed review of the life-cycle stages, sources of life-

cycle GHG emissions, and sources of uncertainty in life-cycle GHG emissions for the types of oil that would be transported on both the 67 Expansion and the Line 3 Replacement (DOS 2017). That document is incorporated by reference here, and a summary of the relevant per-barrel life-cycle GHG emissions is provided in Table 5.2.7-10. While Line 3 currently carries light WCSB crude, the Project would be capable of carrying both light and heavy WCSB crude.

While Table 5.2.7-10 provides a comparison of per-barrel life-cycle GHG emissions, the total magnitude of the life-cycle GHG impact of the Project depends on whether the expanded capacity of the Project induces entirely new upstream production and downstream consumption (no displacement) or simply replaces other sources of oil. If oil transported on the Line 3 Replacement pipeline does displace other sources of crude oil to refineries, the total life-cycle GHG impact of the displacement depends on how much oil is displaced and of what type.

Table 5.2.7-10. Average Life-Cycle Greenhouse Gas Emissions for Various Crude Oils

Crude Oil Type	Life-Cycle GHG Emission Estimatea (kg CO2-e/barrel of crude oil)
Heavy WCSB	584-632[b]
Light WCSB	513
Average U.S. Refinery Mix	521[c]
Venezuelan Heavy	558
Mexican Heavy	513
Iraqi Medium	484
Arab Medium	468
Canadian Conventional	464
U.S. Light Tight Oil	512
U.S. CO_2 EOR Medium	512
Nigerian Light	501
Iraqi Medium	484
Arab Medium	468

Notes:

[a] Average from studies evaluated in DOS 2017

[b] Upper end of range represents results of GREET modeling conducted by DOS 2017

[c] Result of GREET modeling conducted by DOS 2017

EOR = enhanced oil recovery; WCSB = Western Canada Sedimentary Basin

The life-cycle GHG emission estimates provided below draw on the values in Table 5.2.7-10 to bookend the possible outcomes from full displacement to zero displacement. Baseline life-cycle GHG emissions for existing Line 3 are shown in Table 5.2.7-11, assuming current throughput of 390,000 bpd of WCSB light crude. Post-Project life-cycle GHG emissions were calculated assuming a worst case throughput of 760,000 bpd of WCSB heavy crude. Under these assumptions, if no displacement occurs, the Line 3 Replacement Project would result in 760,000 bpd of new WCSB heavy crude entering the market,

resulting in a 193 million ton CO_2-*e*/year incremental increase in emissions. If, rather the heavy crude transported on this line displaces lighter crude, for example the 390,000 bpd of WCSB light crude that the existing Line 3 provides to market as well as 370,000 bpd of another light crude (U.S. light tight), the result would be a 35 million ton CO_2-*e*/year incremental increase in emissions. If the heavy crude transported on the Line 3 Replacement pipeline displaces other heavy Canadian crude (market-wide supply and demand are unaffected by the Project), no change in upstream and downstream emissions would occur. Using the SCC estimates described above, the 30-year cost associated with the Project life-cycle emissions could range up to $120 billion.

Table 5.2.7-11. Average Life-Cycle Greenhouse Gas Emissions for Various Crude Oils

Scenario	Annual Life-Cycle GHG Emissions (million tons CO2-e)	Incremental Annual Life-Cycle GHG Emissions (million tons CO2-e)	30-Year SCC for Incremental Life-Cycle GHG Emissions (2007 dollars)
Existing Line 3 (390,000 bpd WCSB light)	80.5	0	0 billion
Line 3 Replacement (760,000 bpd WCSB Heavya) - No displacement	273.5	193	287 billion
Line 3 Replacement (760,000 bpd WCSB Heavy) - Displaces 390,000 bpd WCSB Heavy & 370,000 U.S. Light Tight Oil	115.5	35	52 billion

[a] Western Canada Sedimentary Basin (WCSB) heavy value based on GREET Modeling (DOS 2017)

Note that there are assumptions and data limitations in the characterization of life-cycle GHG emissions that vary between studies. As a result, the GHG emissions can differ substantially from one study to the next. Since the studies reviewed do not consistently disclose the details of their analysis, and often rely on proprietary models and data, a thorough assessment of the reasons for this variability is not possible (Brandt et al. 2015; Cooney 2014; Ghandi et al. 2015; Keesom et al. 2009; NETL 2008, 2009; TIAX LLC and Math Pro Inc. 2009).

Applicant-Proposed Measures to Minimize Greenhouse Gas Emissions

Enbridge has indicated that the Project would use measures to reduce emissions of GHGs and save energy during construction and operation, such as the use of locally sourced pipe, establishment of field offices and worker camps in construction areas to reduce travel time of personnel, use of buses to transport workers to work sites to reduce the number of vehicles on the roads, and use of local accommodations and trade services wherever possible (Enbridge 2016f). During operations, the Applicant proposes to use high-efficiency pumps and motors to transport crude oil through the pipeline, which would minimize power requirements over the long term. The Applicant has also invested in renewable and alternative energy projects in Canada and the United States that will reduce GHG emissions (such as removing all cast-iron pipes from its natural gas delivery system) and increase energy conservation efforts (such as building new facilities to recognized green building certification standards).

5.2.7.3.2 Continued Use of Existing Line 3

Construction Impacts

Because existing Line 3 is already constructed and in operation, no initial construction activities are required. Therefore, there would be no construction impacts on air quality from continued use of the existing Line 3 pipeline. Construction activities related to future pipeline repairs, known as "integrity digs," are addressed under operations impacts below.

Stored Carbon Releases

Because no construction or tree removal would be associated with continued use of the existing Line 3, there would be no associated carbon releases.

Operations Impacts

Continued use of the existing Line 3 would continue transport of crude oil at the current average rate of 390,000 bpd, which is reduced from the operating capacity of the pipeline when it initially began operations. Air emissions associated with continued operations are ongoing and considered part of the existing environment; no incremental additional air emissions would occur.

Integrity digs to uncover and repair/replace pipeline sections would continue to occur along the pipeline. They involve construction activities similar to the initial pipeline construction but affect only a short segment of pipeline and last for a short period of time. Air quality impacts from integrity digs at any one location would be negligible, localized, and intermittent and temporary. Total air quality impacts from the integrity program would be negligible to minor and long-term.

Loss of Carbon Sequestration

Although the specific locations of integrity digs are not known, it was assumed that they would not involve permanent tree removal. Thus, no associated loss of carbon sequestration would be associated with continued use of the existing Line 3.

Life-Cycle Greenhouse Gas Emissions

Continued use of existing Line 3 would not induce upstream or downstream changes in emissions. Current, baseline level of life-cycle emissions per barrel of crude oil for existing Line 3 are provided in Table 5.2.7-11.

5.2.7.3.3 System Alternative SA-04

In general, the air quality impacts associated with construction and operation of SA-04 would be similar to those described above for the Applicant's preferred route.

Construction Impacts

Construction emissions would be a direct function of pipeline length because the same construction equipment would be used for SA-04 and the Applicant's preferred route. Table 5.2.7-12 shows the estimated construction emissions for SA-04, assuming that it would be constructed in 15 spreads. The Applicant-proposed measures to minimize air impacts described for the Applicant's preferred route also would be implemented for the system alternative; consequently, the air quality impacts during construction would be minor and temporary.

Table 5.2.7-12. Estimated Construction Emissions for the System Alternative SA-04

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
On- and off-road diesel equipment combustion emissions	8.6	123.5	121.0	0.2	5.3	5.0	23,690.0	0.5
On- and off-road gasoline equipment combustion emissions	1.10	2.34	15.3	1.2	0.2	0.2	2,105.0	0.0
Fugitive emissions from paved roads	0.0	0.0	0.0	0.0	59.1	14.5	0.0	0.0
Fugitive emissions from unpaved roads	0.0	0.0	0.0	0.0	8.4	0.8	0.0	0.0
Emissions from open burning of wood debris	0.0	0.0	272.7	0.0	26.6	26.6	141.0	0.0
Blasting emissions[a]	--	--	--	--	--	--	--	--
Subtotal per spread	***9.7***	***125.8***	***409.0***	***1.4***	***99.6***	***47.1***	***25,936.0***	***0.5***
TOTAL EMISSIONS	**145.1**	**1,887.0**	**6,135.0**	**21.0**	**1,494.3**	**706.4**	**389,040.0**	**8.0**

Source: Enbridge 2017.

Notes:

Total emissions represent emissions from 15 construction spreads (absent blasting).

[a] Blasting emissions have not been quantified.

CO = carbon monoxide, GHG = greenhouse gas, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Stored Carbon Releases

During construction, SA-04 could require removal of trees from 99 acres of forested land in the construction work area that, when removed, would release GHGs. Using the same emission factor of 30.2 metric-tons of carbon per acre as used for the Applicant's preferred route, the amount of carbon that potentially would be released back into the atmosphere during construction tree removal is estimated at 12,033 tons of CO_2e.

Operations Impacts

Table 5.2.7-13 estimates the operations emissions for SA-04 based on 16 pump stations and 52 MLV sites. The table includes indirect GHG emissions from the purchase of electricity for pump station operations determined as a function of the pipeline length. Unlike the Applicant's preferred route, SA-04 would not go through the Clearbrook or Superior terminals. Instead, the pipeline would end at the Joliet terminal in Illinois. Similar to the Applicant's preferred route, operations of SA-04 would result in minor permanent impacts on air quality, and GHG emissions could contribute to global climate change. Note that the emissions from vehicle combustion and unpaved roads have not been quantified.

Table 5.2.7-13. Estimated Operations Emissions for the System Alternative SA-04

Emission Source Description	Direct Emissions (tons per year)								Indirect Emissions (tons per year)[a]
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs	GHGs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	6.5	0.0	0.0	0.0	0.0	0.0	0.1	0.2	N/A
Mainline valve fugitive emissions from piping components	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.007	N/A
Fugitive emissions from unpaved roads[b]	--	--	--	--	--	--	--	--	N/A
Vehicle combustion emissions[b]	--	--	--	--	--	--	--	--	N/A
Joliet terminal storage tank withdrawal losses from pipeline throughput and fugitive emissions from pumps, piping components, sump tanks, pig traps, and emergency generator	67.8	0.4	0.1	0.03	0.02	0.02	850.2	3.1	N/A
Pump stations indirect emissions from being powered by electricity from existing local electric utilities	--	--	--	--	--	--	--	--	946,670.5
TOTAL EMISSIONS	**74.5**	**0.4**	**0.1**	**0.03**	**0.02**	**0.02**	**850.3**	**3.3**	**946,670.5**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 16 pump stations and 52 mainline valve sites.

[a] Because the projected power consumption from the pump stations and locations of pump stations are unknown, indirect GHG emissions for the 795 mile SA-04 were calculated based on 452,497 tons of CO_2e per year for the Applicant's preferred action over 380 total miles (i.e., 1,191 tons of CO_2e per year per mile).

[b] Air emissions from vehicles and unpaved roads have not been quantified for operations for SA-04.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, N/A = not applicable, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Loss of Carbon Sequestration

Following construction of SA-04, 57 acres of previously cleared forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 41 acres along the permanent right-of-way would remain cleared and would not provide any future carbon sequestration. Using the same emission factor of 1.6 metric-tons of CO_2 per acre per year as used for the Applicant's preferred route, the amount of carbon that 41 acres would have sequestered is estimated at 74 tons of CO_2e per year.

Social Cost of Carbon

Table 5.2.7-14 calculates the SCC using the 3-percent discount rate for the direct and indirect GHG emissions for SA-04 over the 30-year life of the Project.

Table 5.2.7-14. Social Cost of Carbon (Fossil GHG Emissions) for the System Alternative SA-04 (in 2007 dollars)

Year	30-Year SCC for Direct GHG Emissions*	30-Year SCC for Indirect GHG Emissions	30-Year SCC for Direct and Indirect GHG Emissions
30-Year Project life (2020 to 2049)	$1,264,290	$1,407,581,446	$1,408,845,737

GHG = greenhouse gas, SCC = social cost of carbon

* Estimate does not include emissions associated with lost carbon sequestration

Life-Cycle Greenhouse Gas Emissions

Like the Applicant's preferred route, SA-04 would be part of a larger crude oil extraction, production, refining, and consumption system that is affected by changes in the availability and price of transportation to get crude oil from the point of extraction to the refineries that process the oil into refined products. Similar to the Applicant's preferred route, SA-04 could stimulate additional upstream production and downstream consumption, or it could simply displace existing supplies of crude oil to the market. The possible outcomes and associated life-cycle GHG emissions for SA-04 are the same as those described in Section 5.2.7.3.1 for the Applicant's preferred route. Specifically, if no displacement occurs, system alternative SA-04 would result in 760,000 bpd of new WCSB crude entering the market, resulting in a 193 million ton CO2-*e*/year incremental increase in emissions. If, instead, the heavy crude transported on this line displaced lighter crude, for example the 390,000 bpd of WCSB light crude that the existing Line 3 provides to market as well as 370,000 bpd of another light crude (U.S. light tight), the result would be a 35 million ton CO2-*e*/year incremental increase in emissions. If the heavy crude transported on SA-04 displaced other heavy Canadian crude (market-wide supply and demand are unaffected by the Project), no change in upstream and downstream emissions would occur. Using the SCC estimates described above, the 30-year cost associated with the Project life-cycle emissions could range up to $120 billion.

5.2.7.3.4 Transportation by Rail

Construction Impacts

In order to transport crude oil via rail, temporary storage and offloading facilities likely would need to be constructed in Clearbrook and Superior. Air quality impacts associated with construction of the facilities would include emissions from fugitive dust and from fossil fuel-fired construction equipment. Although these emissions have not been quantified, construction is a temporary activity and associated air emissions likely would be negligible, localized, and intermittent.

Stored Carbon Releases

Because the specific location and configuration of temporary storage and offloading facilities are not known, the acreage of tree removal and associated release of carbon cannot be estimated. However, both the Clearbrook and Superior terminal locations are located in developed areas with limited forestation, so it was assumed that no carbon releases would be associated with construction of the storage and offloading facilities.

Operations Impacts

Transporting up to 760,000 bpd of crude oil would require up to 10 loaded trains per day (88,000 barrels for a full train of 110 tank cars). Assuming that 48 percent of the oil would be delivered to the Clearbrook terminal (129 miles one-way) and 52 percent of the oil would be delivered to the Superior terminal (355 to 382 miles one-way), total traffic is estimated to be 20,280,822,131 rail ton-miles per year (round trip loaded and empty). The emissions associated with transport of crude oil via rail are shown in Table 5.2.7-15. Note that emissions from operation of the storage and offloading facilities have not been quantified. It also should be noted that the rail route to the Superior terminal would intersect Bemidji and Brainerd, Minnesota, which were cited as having air quality conditions that were unhealthy for sensitive groups for 2 days in 2015.

Table 5.2.7-15. Estimated Operations Emissions Associated with Transportation by Rail

Facility	Direct Emissions (tons per year)						
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs
Rail combustion emissions	556.8	15,111.5	1,487.0	179.9	373.5	359.9	568,472.8

Source: Minnesota Department of Commerce 2015.

Notes:

Rail transportation emissions are calculated for 20,280,822,131 rail ton-miles per year, derived from five fully loaded trains to the Clearbrook terminal and five fully loaded trains to the Superior terminal, with empty trains on the return. The weight for a loaded train (110 tank cars at 143 tons each and 4 locomotives at 200 tons each) was estimated at 16,530 tons, and the weight of an empty train (110 tank cars at 45.5 tons each and 4 locomotives at 200 tons each) was estimated at 5,805 tons.

Air emissions for operation of storage and offloading facilities that would be required for transportation via rail have not been determined.

CO = carbon monoxide, GHG = greenhouse gas, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

Loss of Carbon Sequestration

Because the specific location and configuration of temporary storage and offloading facilities are not known, the acreage of trees on forested land permanently cleared and unavailable for carbon sequestration cannot be estimated. However, both the Clearbrook and Superior terminal locations are in developed areas with limited forestation, so it was assumed that no loss of carbon sequestration would be associated with operation of the storage and offloading facilities.

Social Cost of Carbon

Using the 3-percent discount rate for the GHG emissions shown in Table 5.2.7-8 the SCC for the rail alternative over a 30-year period would be $845,248,443 (in 2007 dollars).

5.2.7.3.5 Transportation by Truck

Construction Impacts

In order to transport via truck, temporary storage and offloading facilities would likely need to be constructed in Clearbrook and Superior. Air quality impacts associated with construction of the facilities would include emissions from fugitive dust and from fossil fuel-fired construction equipment. Although these emissions have not been quantified, construction is a temporary activity and associated air emissions likely would be negligible, localized, and intermittent.

Stored Carbon Releases

Because the specific location and configuration of temporary storage and offloading facilities are not known, the acreage of tree removal and associated release of carbon cannot be estimated. However, both the Clearbrook and Superior terminal locations are in developed areas with limited forestation, so it was assumed that no carbon releases would be associated with construction of the storage and offloading facilities.

Operations Impacts

Absent a pipeline, transporting up to 760,000 bpd of crude oil would require up to 4,000 loaded tanker trucks per day and 4,000 returning empty tanker trucks per day (190 barrels per truck). Assuming that 48 percent of the oil would be delivered to the Clearbrook terminal (179 miles one-way) and 52 percent of the oil would be delivered to the Superior terminal (360 miles one-way), total traffic is estimated at 797,802,400 truck miles per year. Table 5.2.7-16 quantifies the operations emissions associated with transport of crude oil via truck. Note that emissions from operation of the facilities (loading and offloading) have not been quantified. It also should be noted that the truck route from the Gretna pump station to the Superior terminal goes through Duluth, Minnesota, which is designated as a maintenance area with respect to CO emissions (8-hour and 1-hour ambient air quality standards) and which has been cited for 2 days in 2015 for having air quality conditions that were unhealthy to sensitive groups. The truck route to the Superior terminal would also intersect Bemidji, Minnesota, which also was cited as having air quality conditions that were unhealthy for sensitive groups for 2 days in 2015.

Table 5.2.7-16. Estimated Operations Emissions Associated with Transportation by Truck

Facility	Direct Emissions (tons per year)						
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs
Truck combustion emissions	1,825.6	5,647.3	8,987.0	17.1	98.1	93.8	1,506,291.3
Fugitive emissions from paved roads	0.0	0.0	0.0	0.0	30,441.7	7,464.3	0.0
TOTAL EMISSIONS	**1,825.6**	**5,647.3**	**8,987.0**	**17.1**	**30,509.8**	**7,558.1**	**1,506,291.3**

Source: Minnesota Department of Commerce 2015.

Notes:

Truck transportation emissions are calculated for 797,802,400 truck miles per year, derived from 1,920 round trips to the Clearbrook terminal and 2,080 round trips to the Superior terminal each day.

Air emissions for operation of storage and offloading facilities that would be required for transportation via truck have not been determined.

CO = carbon monoxide, GHG = greenhouse gas, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compound

Loss of Carbon Sequestration

Because the specific location and configuration of temporary storage and offloading facilities are not known, the acreage of trees on forested land permanently cleared and unavailable for carbon sequestration cannot be estimated. However, both the Clearbrook and Superior terminal locations are in developed areas with limited forestation, so it was assumed that no loss of carbon sequestration would be associated with operation of the storage and offloading facilities.

Social Cost of Carbon

Using the 3-percent discount rate for the GHG emissions over a 30-year period, the SCC for the truck alternative would be $2,239,668,011 (in 2007 dollars).

Life-Cycle Greenhouse Gas Emissions

In this EIS the analysis of alternative transportation modes (train and by truck) assumes demand exists and is driving the use of these alternative modes of transport. Under this assumption, the alternative transport scenarios do not have the potential to stimulate upstream or downstream changes. Therefore, no change in production/consumption and associated life-cycle emissions is anticipated for these alternative transport modes.

5.2.7.3.6 Existing Line 3 Supplemented By Rail

Construction Impacts

No new construction would occur with continued use of the existing Line 3 pipeline. Impacts on air quality from construction of rail facilities would be the same as those described above for the rail alternative.

Operations Impacts

Under this alternative, the operations impacts would be identical to those described above for the continued use of existing Line 3 combined with approximately half of the emissions for the rail alternative because the number of train transits would be reduced as shown in Table 5.2.7-17.

Table 5.2.7-17. Estimated Operations Emissions Associated with Continued Use of Existing Line 3 Supplemented by Rail

Facility	Direct Emissions (tons per year)						
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs
Continued use of existing Line 3[a]	--	--	--	--	--	--	--
Transportation by rail[b]	278.4	7,555.8	743.5	90.0	186.7	179.9	284,236.4
TOTAL EMISSIONS	**278.4**	**7,555.8**	**743.5**	**90.0**	**186.7**	**179.9**	**284,236.4**

Notes:

[a] Air emissions associated with integrity digs for continued use of existing Line 3 have not been quantified.

[b] Air emissions associated with rail transportation are calculated at half of the emissions of the rail alternative; note that air emissions for operation of storage and offloading facilities that would be required for transportation via rail have not been determined.

CO = carbon monoxide, GHG = greenhouse gas, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO2 = sulfur dioxide, VOCs = volatile organic compound

"--" = Emissions not estimated.

Social Cost of Carbon

Using the 3-percent discount rate for the GHG emissions over a 30-year period, the SCC for the truck alternative would be $422,624,221 (in 2007 dollars).

Life-Cycle Greenhouse Gas Emissions

In this EIS the analysis of alternative transportation modes (train and by truck) assumes demand exists and is driving the use of these alternative modes of transport. Under this assumption, the alternative transport scenarios do not have the potential to stimulate upstream or downstream changes. Therefore, no change in production/consumption and associated life-cycle emissions is anticipated for these alternative transport modes.

Continued use of existing Line 3 would not induce upstream or downstream changes in emissions. Current, baseline level of life-cycle emissions for existing Line 3 are provided in Table 5.2.7-11.

5.2.7.3.7 Existing Line 3 Supplemented By Truck

Construction Impacts

No new construction would occur with continued use of the existing Line 3 pipeline. Impacts on air quality from construction of truck facilities would be the same as those described above for the transportation by truck alternative.

Operations Impacts

Under this alternative, the impacts would be identical to those described above for the continued use of existing Line 3 combined with approximately half of the emissions for the truck alternative because the number of truck transits would be reduced as shown in Table 5.2.7-18.

Table 5.2.7-18. Estimated Operations Emissions Associated with Continued Use of Existing Line 3 Supplemented by Truck

Facility	Direct Emissions (tons per year)						
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs
Continued use of existing Line 3[a]	--	--	--	--	--	--	--
Transportation by truck[b]	912.8	2,823.6	4,493.5	8.5	15,254.9	3,799.1	753,145.6
TOTAL EMISSIONS	**912.8**	**2,823.6**	**4,493.5**	**8.5**	**15,254.9**	**3,799.1**	**753,145.6**

Notes:

[a] Air emissions associated with integrity digs for continued use of existing Line 3 have not been quantified.

[b] Air emissions associated with truck transportation are calculated at half of the emissions of the truck alternative; note that air emissions for operation of storage and offloading facilities that would be required for transportation via truck have not been determined.

CO = carbon monoxide, GHG = greenhouse gas, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compound

"--" = Emissions not estimated.

Social Cost of Carbon

Using the 3-percent discount rate for the GHG emissions over a 30-year period, the SCC for the truck alternative would be $1,119,833,958 (in 2007 dollars).

Life-Cycle Greenhouse Gas Emissions

In this EIS the analysis of alternative transportation modes (train and by truck) assumes demand exists and is driving the use of these alternative modes of transport. Under this assumption, the alternative transport scenarios do not have the potential to stimulate upstream or downstream changes. Therefore, no change in production/consumption and associated life-cycle emissions is anticipated for these alternative transport modes.

Continued use of existing Line 3 would not induce upstream or downstream changes in emissions. Current, baseline level of life-cycle emissions for existing Line 3 are provided in Table 5.2.7-11.

5.2.7.4 Summary and Mitigation

5.2.7.4.1 Summary

Overall construction impacts on air quality would be minor, localized, and intermittent and temporary for the Applicant's preferred route and SA-04. This is primarily due to the nature of pipeline construction where the construction activity moves along the pipeline route, thus limiting the exposure of residents and resources in any one area. Construction impacts on air quality due to rail or truck storage and offloading facilities in Clearbrook and Superior would be temporary and negligible. Finally, there are no predicted construction air quality impacts associated with continued use of the existing Line 3 because no construction would be required.

Table 5.2.7-19 provides the construction emissions (for those that can be quantified) for the Applicant's preferred route and the CN Alternatives. When comparing the Applicant's preferred route and SA-04, SA-04 would generate approximately twice the total amount of construction emissions than the

Applicant's preferred route because it is twice as long. However, emission rates at any specific location would be the same for either route.

Table 5.2.7-19. Construction Emissions for the Applicant's Preferred Route and Certificate of Need Alternatives

Route/Certificate of Need Alternative	Direct Emissions (tons)							Stored Carbon Releases (tons)
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	GHGs
Applicant's preferred route	67.7	880.8	2,863.3	9.8	697.3	329.6	181,552.0	85,658
Continued use of existing Line 3[a]	--	--	--	--	--	--	--	--
System alternative SA-04	145.1	1,887.0	6,135.0	21.0	1,494.3	706.4	389,040.0	12,033.1
Transportation by rail[b]	--	--	--	--	--	--	--	--
Transportation by truck[b]	--	--	--	--	--	--	--	--
Continued use of existing Line 3 supplemented by rail[b]	--	--	--	--	--	--	--	--
Continued use of existing Line 3 supplemented by truck[b]	--	--	--	--	--	--	--	--

Notes:

[a] No construction emissions would be associated with continued operation of the existing Line 3.

[b] Construction emissions associated with building rail and truck storage and offloading facilities have not been quantified.

CO = carbon monoxide, GHGs = greenhouse gases, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

During construction, both the Applicant's preferred route and SA-04 would require removal of trees that, when removed, would release GHGs. The Applicant's preferred route would affect more forested lands than SA-04 and thus would release more GHGs. The rail and truck alternatives would be expected to require very little to no tree removal for construction of storage and offloading facilities, and thus would not be expected to release GHGs. Because continued use of the existing Line 3 would involve no construction, it would not affect trees or their potential to release GHGs.

Air quality impacts during operations of the Applicant's preferred route and CN Alternatives would all be minor and permanent, with the exception of continued use of the existing Line 3. Continued use of existing Line 3 would result in air emissions from the ongoing integrity program; the impacts on air quality would be negligible to minor and long term. Overall, air quality impacts from continued use of

existing Line 3 would be less than other alternatives because it is already in operation and no new pumping capacity would be installed.

Table 5.2.7-20 presents the operations emissions (for those that can be quantified) for the Applicant's preferred route and CN Alternatives. For the pipeline alternatives, the table includes indirect GHG emissions from electricity purchased for operation of the pump stations and the associated SCC for direct and indirect GHG emissions. When comparing the Applicant's preferred route and the other CN Alternatives, the Applicant's preferred route would generate the least direct air emissions along the Project route (pipeline route right-of-way or transportation route) and would have the least effect on air quality. Direct air emissions for rail and truck transportation would be significantly higher along the rail and truck routes than those for the pipeline routes. Because the pipeline alternatives would use electric power pumps for pipeline operation, as does existing Line 3, no significant new point source emissions for power generation would be created for the Applicant's preferred route, SA-04, or continued use of existing Line 3. Instead, generation of electricity to operate the pumps would be spread through the state's existing local electric utility grid. Other emissions during operations of the pipeline alternatives would consist of small, limited sources. Because SA-04 is significantly longer than the Applicant's preferred route, the total energy requirements and related emissions are more than double.

It should be noted that, under normal circumstances, air emissions from additional truck traffic on interstate freeways would be unlikely to decrease local air quality. However, during inclement weather conditions, where traffic delays and congestion may occur, trucks idling during delays may cause temporary increases in localized pollutant concentrations. This effect also may temporarily occur in the vicinity of the Clearbrook and Superior terminals, where up to 2,080 trucks per day would be queuing to enter the terminal and discharge their cargo. Furthermore, it is unknown how the truck traffic would affect the CO maintenance in Duluth, Minnesota.

During operations, both the Applicant's preferred route and SA-04 would require previously forested land along the permanent rights-of-way to remain cleared of trees. These trees, if not removed, would sequester GHGs. The Applicant's preferred route would affect more forested lands than SA-04 and thus would remove more sequestration potential. Although specific locations have not been identified, the rail and truck alternatives and integrity digs associated with continued use of existing Line 3 would be expected to require very little to no permanent tree removal, and thus would not affect overall sequestration.

Table 5.2.7-21 summarizes the construction- and operations-related impacts on air quality that would be expected for the Applicant's preferred route and CN Alternatives. No effects on achievement of the NAAQS would be expected to occur from operation of the Applicant's preferred route or any of the CN Alternatives, with the potential exception of truck emissions in the vicinity of the Clearbrook or Superior terminals and passing through Duluth, Minnesota. Construction and operation of the Applicant's preferred route and CN Alternatives would directly contribute to global GHG emissions and associated climate change, which collectively could lead to a threat to public health and welfare. For further information about the impacts of climate change, refer to Chapter 12.

5.2.7.4.2 Mitigation

Beyond the Applicant-proposed measures described above for the Applicant's preferred route, additional measures to reduce impacts on air quality could include:

- Burning small and dry brush piles only;

- Operating construction equipment as far as possible from sensitive receptors (e.g., residences, schools, and hospitals);
- Limiting construction equipment idling to the extent practical when not in use; and
- Following equipment manufacturer-recommended operations and good combustion practices, including not tampering engines to increase horsepower and using ultra-low sulfur diesel.

Further mitigation for GHG emissions could include compensatory measures such as:

- Investment in new terrestrial carbon storage programs (forest establishment, other types of vegetation restoration)
- Purchase of GHG offset credits
- Investment in renewable energy development
- Contributing resources to regional and local climate adaptation programs.

Table 5.2.7-20. Operations Emissions and Social Cost of Carbon for the Applicant's Preferred Route and Certificate of Need Alternatives

Route/Certificate of Need Alternative	Direct Emissions (tons per year)							Indirect Emissions (tons per year)	30-Year SCC for Direct and Indirect GHG Emissions[a]	Loss of Carbon Sequestration (tons per year)
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	GHGs		GHGs
Applicant's preferred route	21.0	0.004	0.03	0.002	0.1	0.01	375.9	452,496.6	$673,365,150	1,262.3
Continued use of existing Line 3[b]	--	--	--	--	--	--	--	--	--	--
System alternative SA-04[c]	74.5	0.4	0.1	0.03	0.02	0.02	850.3	946,670.5	$1,408,845,737	74.3
Rail alternative[d]	556.8	15,111.5	1,487.0	179.9	373.5	359.9	568,472.8	--	$845,248,443	--
Truck alternative[d]	1,825.6	5,647.3	8,987.0	17.1	30,509.8	7,558.1	1,506,291.3	--	$2,239,688,011	--
Continued use of existing Line 3 with rail[d]	278.4	7,555.8	743.5	90.0	186.7	179.9	284,236.4	--	$422,624,221	--
Continued use of existing Line 3 with truck[d]	912.8	2,823.6	4,493.5	8.5	15,254.9	3,799.1	753,145.6	--	$1,119,833,958	--

Notes:

[a] Social cost of carbon is quantified in 2007 dollars.

[b] Air emissions associated with integrity digs for continued use of existing Line 3 have not been quantified.

[c] Air emissions from vehicles and unpaved roads for SA-04 have not been quantified.

[d] Air emissions for operation of storage and offloading facilities that would be required for transportation via rail or truck have not been determined.

CO = carbon monoxide, GHGs = greenhouse gases, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SCC = social cost of carbon, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Table 5.2.7-21. Summary of Potential Impacts on Air Quality for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Direct and indirect emissions	Temporary/minor impacts	No impact	Temporary/minor impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts
GHGs	GHG emissions contribute to overall global climate change	No impact	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change
Operations Impacts							
Direct and indirect emissions	Permanent/minor impacts	Temporary/ negligible impacts (*from activities associated with pipeline integrity work at any one location)* Long-term/ negligible to minor impacts *(for the integrity program)*	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts
GHGs	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change

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5.3 SOCIOECONOMIC ENVIRONMENT

The states and counties crossed by the Applicant's preferred route and CN Alternatives contribute to regional and statewide economies through the production of a variety of goods and services. Project actions have the potential to affect these economies (both positively and negatively). This section discusses the existing conditions and assesses potential Project-related impacts with respect to commodity production; recreation and tourism; and employment, income, and tax revenues.

5.3.1 Commodity Production

The primary commodities produced along the Applicant's preferred route and the CN Alternatives that would be affected by construction or operations of the Project include agricultural commodities, forestry products, and mining production. Construction of Project facilities and permanent maintenance of a cleared right-of-way during operations may displace some capacity for production of these commodities.

The analysis of impacts on commodity production during construction and operation of the Applicant's preferred route and CN Alternatives considered the following issues:

- Disturbance and loss of agricultural land and lost yields,
- Restrictions in agricultural commodity distribution by rail,
- Disturbance and loss of forested land and timber resources, and
- Disturbance and loss of land used for mining and commodity reserves.

The above issues do not apply to the Applicant's preferred route and each CN Alternative uniformly. Reduction in land available for agricultural, forest, and mining production primarily relates to the Applicant's preferred route and to SA-04, where extensive new pipeline construction would occur. Continued use of the existing Line 3 and transportation by rail or truck would not require construction of new right-of-way, and alternative transportation modes would affect only minimal land area for loading and offloading facilities. A summary and comparison of the impacts for the Applicant's preferred route and CN Alternatives are included at the end of the section.

5.3.1.1 Regulatory Context and Methodology

5.3.1.1.1 Regulatory Context

Commodity production is commonly regulated by state-level laws and statutes that protect agricultural, timber, and mineral resources.

North Dakota

There are no state-specific laws or statutes for forest or farmland preservation in North Dakota; however, North Dakota Century Code § 38-08 lays out the mineral rights and protection for development of minerals.

Minnesota

Several Minnesota statutes provide for the protection and management of land used to produce commodities. Minnesota Statutes § 17.80 – 17.84 set the state policy on agricultural land preservation

and conservation. One of the main goals is "[…] to minimize the disruption of agricultural production in accordance with local social, economic and environmental considerations of the agricultural community." Minnesota Statute § 89.002 establishes the policies for managing forest resources of state forest lands, providing for the responsible and sustainable use of forest products. The provision for leasing State-owned lands and mineral rights for nonferrous metallic minerals and other minerals, other than iron ore, is found in Minnesota Statutes § 93.25. Furthermore, state-owned lands and mineral rights administered by the Commissioner of Natural Resources may be leased for peat, sand, gravel, stone, clay, and rock under Minnesota Statute § 92.50.

Iowa

Iowa Statute § 352.5 establishes methods for preserving agricultural lands for agricultural production, while Iowa Statute § 479B.20 establishes land restoration standards for agricultural lands both during and after pipeline construction. Iowa Statute § 427C.2 sets forth the procedures for establishing a forest reservation. Iowa Administrative Code 208 "provides for the reclamation and conservation of land affected by the mining of gypsum, clay, stone, sand, gravel, or other ores or mineral solids, except coal, and thereby to preserve natural resources, protect and perpetuate the taxable value of property, and protect and promote the health, safety, and general welfare of the people of this state."

Illinois

In Illinois, the Farmland Preservation Act establishes procedures whereby the Illinois Agriculture Department works with other state agencies, planning commissions, and county governments to help reduce the extent to which farmland is affected by conversion or development. Department policy is not designed to limit or stop development, but to minimize its impact on agricultural land—both in terms of acres lost and secondary impacts that may adversely affect farming operations. In addition, Illinois Compiled Statutes § 505.2 sets forth "the policy of the State to conserve, protect and to encourage the development and improvement of its agricultural lands for the production of food and other agricultural products." Illinois Compiled Statutes § 1537.2 establishes the procedures through which forests are managed, and Illinois DNR manages active mineral leases through Illinois Compiled Statutes § 67.1700.

Wisconsin

Wisconsin Statutes § 91.01 – 91.86 set the state policy on agricultural land preservation and conservation. Section 26.35 identifies privately owned forests that are likely to produce highly valued timber products, and Section 26.42 establishes a "forestry diversification program [that] shall promote and assist the development and use of industrial and commercial products from forestry products." Mining and mineral rights are administered under Wisconsin Statutes § 107.00 – 1107.25.

5.3.1.1.2 Methodology

The ROI for the analysis of impacts on commodities consists of all land currently used in the production of agricultural, timber, or mineral products—or land with the potential to be used for these purposes—that could be disturbed or removed from production by the Applicant's preferred route and CN Alternatives in North Dakota, Minnesota, Iowa, Illinois, and Wisconsin. This includes the permanent right-of-way and the broader construction work area. Impacts on commodity production were evaluated by:

- Using GIS data resources to identify and inventory all land in the ROI currently being used, or with the potential to be used, in the production of agricultural, timber, or mineral production in the counties crossed by the Applicant's preferred route and CN Alternatives.

- Construction and operations impacts for the Applicant's preferred route were estimated by overlaying construction and operations footprints provided by the Applicant on GIS layers of commodity production lands.
- Construction and operations impacts from continued use of the existing Line 3 pipeline were qualitatively addressed along the existing Line 3 right-of-way for integrity digs and subsequent pipeline repair, and the potential for these actions to occur on commodity production land, especially agricultural land.
- Construction impacts for system alternative SA-04 were estimated by overlaying a standardized 120-foot-wide construction work area centered on the SA-04 route. Operations impacts were estimated by overlaying a standardized 50-foot-wide permanent right-of-way centered on the SA-04 route on GIS layers of commodity production lands.
- Although the precise routes and facility locations for the rail and truck alternatives are not known, construction and operations impacts for the rail and truck alternatives were qualitatively evaluated based on commodity production lands in the vicinity of the Clearbrook and Superior terminals, where offloading facilities could be constructed, and assumptions on the routes that trains and trucks may use to transport oil to those terminals (Figure 4.2-2).
- For the acreages of land identified for each commodity type that would be disturbed or lost, a range of estimates of lost yield and market value of the affected commodities (where applicable) was provided, along with a qualitative statement of the duration and magnitude of impacts on the productivity of commodity lands associated with construction and operation of the Applicant's preferred route and the CN Alternatives.

Various state and federal database layers were obtained to identify agricultural land, forested land, and mineral resources. Acreages of agricultural and forested lands were obtained using the National Land Cover Database 2011 Classification System (Homer et al. 2015). Acreages of farmland soil were obtained using the NRCS database to identify prime farmland and farmlands of statewide importance (NRCS 2011). For mining, acreages of active lease land and acreages of land with potential sand and gravel deposits were obtained from Minnesota DNR and USGS. Based on the geographic extent of impacts on the land used in the production of each commodity, a qualitative assessment of the relative magnitude (i.e., negligible, minor, or major) and duration (temporary, short term, or long term) of the impacts in terms from disturbance/loss of agricultural, timber, and mining lands is provided.

5.3.1.2 Existing Conditions

Agricultural land is defined in this EIS as cultivated cropland and grassland, and includes activities such as crop harvesting, livestock grazing, dairy production, and organic farming. It also includes land with areas of soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops (i.e., "prime farmland"); or areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods (i.e., farmland of statewide importance). Collectively, these soils are referred to as "farmland soils." Farmland soils can include agricultural land as defined above or land that is not currently being used for agricultural production but has high potential for future productivity.

Commercially productive forested land is land that is actively managed for the sustainable harvest of timber and includes the following land cover types: deciduous, evergreen, and mixed forest. This land is

currently being used in the production of timber or has timber resources that could be harvested in the future. The timber industry is an important part of the economies of Minnesota and Wisconsin.

Mineral resources in the states that would be crossed by the Applicant's preferred route and CN Alternatives include non-metallic (e.g., sand, gravel, and crushed stone) and metallic minerals (e.g., iron ore, nickel, and titanium). Access to reliable transportation for export of commodities produced in Minnesota and its neighboring states is also critical to achieving the highest economic yield for the commodities produced.

5.3.1.2.1 Applicant's Preferred Route

Agricultural Land

Table 5.3.1-1 presents the agricultural land and soil characterized as prime farmland or farmland of statewide significance located within the ROI for the Applicant's preferred route. The construction work area includes approximately 2,150 acres classified as prime farmland or farmland of statewide importance and approximately 2,284 acres classified as agricultural land. An additional approximately 487 acres of farmland soil and 554 acres of agricultural land are within the footprint of ATWS, access roads, valve sites, and pump stations. As the designation is based on soil characteristics and not land use, some of the farmland soil may be in active production, while some may not be actively farmed. In total, approximately 2,636 acres of farmland soil, and 2,838 acres of agricultural land are located within the ROI for the Applicant's preferred route (Table 5.3.1-1).

To illustrate this acreage in terms of market value, Table 5.3.1-2 presents the total dollar value of the yield (i.e., the average yield per acre per year multiplied by the acres crossed) by crop type. In total, the market value of the crops that could be grown on affected lands for the Applicant's preferred route is approximately $938,000 (including footprints for the ATWS, pump stations, valve sites, and access roads).

Forested Land

Table 5.3.1-3 presents the total acres of forested land crossed by the Applicant's preferred route. In total, approximately 1,859 acres of forested land is present within the ROI for the Applicant's preferred route (including footprints for the ATWS, pump stations, valve sites, and access roads).

Table 5.3.1-4 presents the current market value of the timber within the ROI for the Applicant's preferred route, which is approximately $354,000 based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008; Minnesota DNR 2008).

Table 5.3.1-1. Agricultural Land and Farmland Soils Crossed by the Applicant's Preferred Route (Acres)

Agricultural Land Type	North Dakota[a]		Minnesota[b]		Wisconsin[a]		Construction Work Area Subtotal		ATWS	Temp. Access Roads	Perm. Access Roads	Pump Stations	Valves[c]	Total[d]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Agricultural Land															
Cultivated crops	363	151	1336	575	<1	<1	1699	726	327	2	20	20	2	2,070	768
Grass/pasture-land	5	2	577	259	3	1	585	262	121	1	45	16	1	768	323
Agricultural land subtotal	***368***	***153***	***1,913***	***833***	***3***	***1***	***2,284***	***988***	***448***	***3***	***65***	***36***	***3***	***2,838***	***1,092***
Farmland															
Prime farmland	122	51	862	378	0	0	984	429	181	8	60	4	1	1,238	495
Farmland of statewide importance	4	2	1046	455	116	48	1,165	505	134	12	67	17	3	1398	592
Farmland soils subtotal	***126***	***53***	***1,907***	***833***	***116***	***48***	***2,150***	***934***	***315***	***19***	***127***	***21***	***4***	***2,636***	***1,087***

Sources: Homer et al. 2015 for agricultural land; NRCS 2011 for prime farmland and farmland of statewide importance.

Notes:

Values in the table may not sum to subtotals and totals due to rounding.

[a] Con = 120-foot-wide construction footprint, Op = 50-foot-wide permanent right-of-way

[b] Enbridge-provided footprints: Con = construction work area, Op = operations right-of-way

[c] Includes valve sites and valve driveways. Since valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated due to double counting.

[d] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations

Table 5.3.1-2. Market Value of Crops Crossed by the Applicant's Preferred Route ($2016 Thousands)

Crop Type	North Dakota		Minnesota		Wisconsin		Construction Work Area Subtotal		ATWS	Temp Access Roads	Perm Access Roads	Pump Stations	Valves	Total[c]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Alfalfa	$0.0	$0.0	$49.1	$21.9	$0.0	$0.0	$49.1	$21.9	$6.3	$0.1	$2.7	$2.6	$0.3	$61.1	$27.5
Barley	$4.6	$2.0	$6.7	$2.7	$0.0	$0.0	$11.3	$4.7	$1.5	$0.0	$0.0	$1.6	$0.2	$14.6	$6.5
Buckwheat	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Corn	$12.6	$5.1	$59.7	$25.3	$0.1	$0.1	$72.4	$30.5	$10.9	$0.1	$0.6	$0.2	$3.0	$87.3	$34.3
Dry beans	$5.4	$2.2	$33.6	$14.3	$0.0	$0.0	$39.0	$16.5	$2.9	$0.2	$2.0	$0.2	$1.2	$45.5	$19.9
Oats	$0.4	$0.1	$1.6	$0.7	$0.0	$0.0	$2.0	$0.8	$0.1	$0.0	$0.2	$0.2	$0.1	$2.5	$1.3
Other hay/ non alfalfa	$0.1	$0.0	$7.3	$3.2	$0.0	$0.0	$7.4	$3.2	$0.7	$0.0	$0.4	$0.1	$2.3	$10.9	$6.1
Potatoes	$0.0	$0.0	$31.0	$11.5	$0.0	$0.0	$31.0	$11.5	$7.7	$0.0	$1.2	$0.0	$0.0	$39.9	$12.7
Rye	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Soybeans	$47.7	$19.9	$253.8	$108.7	$0.0	$0.0	$301.5	$128.6	$37.3	$0.0	$3.2	$2.4	$32.8	$377.2	$166.8
Spring wheat	$23.8	$9.9	$96.6	$41.1	$0.0	$0.0	$120.4	$51.0	$20.9	$0.0	$1.1	$0.4	$1.2	$144.1	$53.8
Sugarbeets	$23.7	$9.9	$92.6	$37.3	$0.0	$0.0	$116.3	$47.2	$22.3	$0.0	$0.2	$0.3	$0.6	$139.6	$48.3
Sunflower	$2.4	$1.0	$4.7	$1.9	$0.0	$0.0	$7.1	$2.9	$1.1	$0.0	$0.0	$0.0	$0.1	$8.3	$3.1
Winter wheat	$0.0	$0.0	$6.3	$2.8	$0.0	$0.0	$6.3	$2.8	$0.8	$0.0	$0.1	$0.0	$0.0	$7.2	$2.9
TOTAL	**$120.7**	**$50.2**	**$642.9**	**$271.4**	**$0.2**	**$0.1**	**$763.8**	**$321.7**	**$112.6**	**$0.5**	**$11.6**	**$8.1**	**$41.7**	**$938.2**	**$383.0**

Source: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

Values in the table may not sum to subtotals and totals due to rounding.

Table 5.3.1-3. Forested Land Crossed by the Applicant's Preferred Route (Acres)

Forested Land Type	North Dakota		Minnesota		Wisconsin		Construction Work Area Subtotal		ATWS	Temp Access Roads	Perm Access Roads	Pump Stations	Valves	Total[c]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Deciduous forest	2	1	1,349	594	65	28	1,416	622	97	31	73	2	2	1,621	699
Evergreen forest	1	0	176	71	1	0	177	71	18	4	15	1	1	215	88
Mixed forest	0	0	18	8	1	1	19	8	1	0	2	0	0	23	10
TOTAL	**3**	**1**	**1,543**	**673**	**67**	**29**	**1,612**	**701**	**116**	**35**	**89**	**3**	**3**	**1,859**	**797**

Source: Homer et al. 2015.

Table 5.3.1-4. Market Value of Forested Land Crossed by the Applicant's Preferred Route ($2016 Thousands)

Forested Land	North Dakota		Minnesota		Wisconsin		Construction Work Area Subtotal		ATWS	Temp Access Roads	Perm Access Road	Pump Stations	Valves	Total	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Deciduous forest	$0.3	$0.1	$257.2	$113.2	$12.4	$5.2	$269.8	$118.6	$18.4	$5.9	$13.8	$0.5	$0.4	$308.9	$133.2
Evergreen forest	$0.1	$0.1	$33.5	$13.5	$0.2	$0.1	$33.8	$13.6	$3.5	$0.7	$2.8	$0.1	$0.1	$41.0	$16.6
Mixed forest	$0.0	$0.0	$3.5	$1.5	$0.1	$0.1	$3.6	$1.6	$0.3	$0.0	$0.4	$0.0	$0.0	$4.3	$2.0
TOTAL	**$0.4**	**$0.2**	**$294.1**	**$128.2**	**$12.7**	**$5.4**	**$307.2**	**$133.8**	**$22.2**	**$6.7**	**$17.0**	**$0.6**	**$0.5**	**$354.2**	**$151.8**

Sources: Minnesota DNR 2008; USFS 2008.

Mineral Lands

Table 5.3.1-5 presents the total estimated acres of land with active mining areas within the ROI for the Applicant's preferred route. Table 5.3.1-6 presents the acres that contain undeveloped sand, gravel, and mineral resources. These resources include glacial lake sediments with potential commercially important deposits of sand and gravel. Less than 1 acre of land within active mineral areas is located within the ROI in Minnesota, and no land within active mineral areas are located within the ROI in North Dakota or Wisconsin.

In total, approximately 513 acres of land with potentially valuable sand and gravel resources is located within the ROI for the Applicant's preferred route (including footprints for the ATWS, pump stations, valve sites, and access roads) (Table 5.3.1-6).

Table 5.3.1-5. Active Mineral Areas Crossed by the Applicant's Preferred Route (Acres)

Name	North Dakota		Minnesota		Wisconsin		Applicant's Preferred Route Total	
	Con	Op	Con	Op	Con	Op	Con	Op
Active metallic and non-metallic leases	0.0	0.0	0.5	<0.1	0.0	0.0	0.5	<0.1

Source: Minnesota DNR 2016.

Table 5.3.1-6. Land with Potential Sand and Gravel Resources Crossed by the Applicant's Preferred Route (Acres)

Resource Type	North Dakota		Minnesota		Wisconsin		Construction Work Area Subtotal		ATWS	Temp Access	Perm Access Roads	Pump Stations	Valves	Total	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Glacial lake sediment (sand and gravel) total	0	0	442	191	0	0	442	191	63	0.0	7	0	1	513	200

Source: USGS 2006.

5.3.1.2.2 Continued Use of Line 3

The existing Line 3 permanent right-of-way includes approximately 752 acres of active agricultural land (cropland and grass/pastures) but does not contain any timber commodities, as trees are not permitted within pipeline permanent right-of-way. Similarly, mining is not permitted in the permanent right-of-way for the existing Line 3 pipeline.

5.3.1.2.3 System Alternative SA-04

Agricultural Land

Table 5.3.1-7 presents the agricultural land crossed by system alternative SA-04. In total, approximately 10,155 acres of agricultural land within the ROI and 4,281 acres of agricultural land within the anticipated permanent right-of-way is currently used in production of agricultural products. Approximately 5,167 acres of farmland soil is within the ROI and approximately 2,156 acres of farmland soil are located within the permanent right-of-way. Farmland soil may or may not be in active production of agricultural goods.

Table 5.3.1-7. Agricultural Land Crossed by System Alternative SA-04 (acres)

Land/Soil Type	Construction Work Area	Permanent Right-of-Way
Cultivated crops	10,051	4,210
Grass/pastureland	104	72
Agricultural land subtotal	***10,155***	***4,281***
Prime farmland	4,479	1,868
Farmland of statewide importance	688	287
Farmland soil subtotal	***5,167***	***2,156***

Sources: Homer et al. 2015 for agricultural lands; NRCS 2011 for prime farmland and farmland of statewide importance

Table 5.3.1-8 presents the total dollar value of the recent annual yield (i.e., the average yield per acre per year multiplied by the acres crossed) by crop type. In total, crops in the construction work area for system alternative SA-04 provide a total market value of approximately $5.2 million, with the majority (83 percent) coming from corn and soybean production. The current total market value of the yield of crops within the permanent right-of-way for SA-04 is approximately $2.1 million (Table 5.3.1-8).

Table 5.3.1-8. Market Value of Crops Crossed by System Alternative SA-04 ($2016)

Crop Type	Construction Work Area	Permanent Right-of-Way
Alfalfa	$22,209	$9,229
Barley	$21,498	$9,361
Corn	$2,599,370	$1,084,209
Dry beans	$129,445	$55,644
Durum wheat	$19	$8
Oats	$1,240	$493
Potatoes	$48,373	$20,161
Soybeans	$1,576,581	$659,211
Spring wheat	$155,902	$65,680
Sugarbeets	$434,946	$181,921
Sunflower	$18,506	$7,769
Winter wheat	$2,265	$984
TOTAL	**$5,010,355**	**$2,094,674**

Source: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

Forested Land

Table 5.3.1-9 presents the total acres of forested land in the construction work area for SA-04. Nearly all of the approximately 99 acres of forested land in the construction work area is deciduous forest (i.e., maple, many oaks, and elm, aspen, and birch). Approximately 40 acres of forested land would be located within the permanent right-of-way for SA-04.

Table 5.3.1-9. Forested Land Crossed by System Alternative SA-04 (acres)

Forest Land Type	Construction Work Area	Permanent Right-of-Way
Deciduous forest	97	40
Evergreen forest	1	<1
Mixed forest	1	<1
TOTAL	**99**	**40**

Source: Homer et al. 2015.

Table 5.3.1-10 presents the current market value of the timber within the construction work area for SA-04, which is approximately $19,000. This is based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008; Minnesota DNR 2008).

Table 5.3.1-10. Market Value of Forested Land Crossed by System Alternative SA-04 ($2016)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	$18,450	$7,662
Evergreen forest	$133	$57
Mixed forest	$133	$57
TOTAL	**$18,717**	**$7,776**

Source: Homer et al. 2015.

Notes:

Assumes that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40

[a] 120-foot-wide construction footprint

[b] 50-foot-wide permanent right-of-way

Mineral Lands

No land with active mineral areas is located within the construction work area for SA-04 in Minnesota or Illinois. Approximately 31 acres of land with known oil and gas resources present (“trust land”), occurs in the construction work area for SA-04 in North Dakota. In Iowa, 0.4 acre of land with active coal mining is located in the construction work area for SA-04, along with 2,393 acres of land with potential sand and gravel resources (USGS 2006), of which 840 acres is located within the permanent right-of-way.

5.3.1.2.4 Transportation by Rail

While no specific locations have been identified, some agricultural and forested lands are present in the immediate vicinity of the Clearbrook and Superior terminals that could be affected by construction of rail offloading facilities and new or expanded rail lines. No active mines are in the immediate vicinity of the Clearbrook or Superior terminals.

The existing rail system currently carries approximately 25 percent by weight and value of all freight transiting through Minnesota (MNDOT 2015, Figure B.1 Mode Share by Weight and B.2 Mode Share by Value). This includes unit train crude oil shipments from the Bakken Oil fields to the Twin Cities area (on the order of 39 trains weekly on Burlington Northern Santa Fe) and shipments from Canadian sources. Crude oil shipments are only one type of commodity that relies on rail transportation; general freight, food and farm products, chemicals, equipment, metallic ores, coal, metallic products, and hazardous materials are routinely shipped by rail.

Farm product commodities are a significant component of state rail freight traffic. Approximately 4 million tons entered Minnesota in 2012, and these shipments are forecasted to approximately double to 8 million tons by 2040. Farm products outbound from Minnesota by rail likewise are expected to increase between 2012 and 2040, growing from 12 million to approximately 26 million tons (MNDOT 2015, Figure B.1). Overall, commodity transportation by rail is expected to grow from its current level of approximately 250 million tons per year in 2012 to approximately 470 million tons per year in 2040. By 2040, farm products are forecasted to be the largest outbound commodity class by weight (MNDOT 2015, Figure B.1).

Among all commodity types shipped by rail, grain commodities are particularly sensitive to the availability of rail transportation. Grain shipments must be scheduled to consider cyclical factors, including harvest periods, storage, and international market prices, to maximize economic yield. Competition with other commodities for rail capacity and congestion in the rail system can affect commodity shipments and economic yield.

5.3.1.2.5 Transportation by Truck

While no specific locations have been identified, some agricultural and forested lands are present in the immediate vicinity of new truck offloading facilities and associated road access at the Clearbrook and Superior terminals. No active mines are present in the immediate vicinity of the Clearbrook or Superior terminals.

5.3.1.2.6 Existing Line 3 Supplemented by Rail

The existing conditions for continued use of existing Line 3 supplemented by rail are identical to those described for continued use of the existing Line 3 pipeline and the rail alternative.

5.3.1.2.7 Existing Line 3 Supplemented by Truck

The existing conditions for continued use of existing Line 3 supplemented by truck are identical to those described for continued use of the existing Line 3 pipeline and the truck alternative.

5.3.1.3 Impact Assessment

Potential impacts on land used in the production of commodities from construction and operation of the Applicant's preferred route and CN Alternatives include impacts on agricultural productivity and commercial forestry through the loss of both current and future productivity from removal of crops, disruption of farmland soils, and clearing of trees. This also could affect the corresponding economies, depending on the total market value of the commodities lost and the overall size of the relevant commodity market in the counties crossed. Land that is currently being mined for mineral resources could temporarily be disrupted during construction, and land containing undeveloped potential mineral resources would not be accessible within the permanent right-of-way. The extent and magnitude of these impacts are influenced by the overall geographic scope of the impact and whether the land would recover or be available for future production. Use of the regional rail system to transport crude oil also may affect distribution of commodities to regional distribution points.

The duration of potential Project impacts on commodity production along new pipeline rights-of-way could range from temporary during active construction to permanent (e.g., aboveground facilities, a new corridor through forested areas). During construction, the greatest impacts on commodity production would be caused by clearing of vegetation. Operations impacts would be limited to the addition of aboveground facilities and reduced production from the permanent removal of trees on cleared forested land. In general, agricultural areas would return to their preconstruction condition relatively quickly, whereas forested lands would not be permitted to regrow within the permanent right-of-way.

5.3.1.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Impacts of construction activities on agricultural land (i.e., cropland and hay/pastures) include removal of crops and grasslands and deferral of production of commodities on lands under active cultivation. Construction activities such as clearing, trench excavation and backfilling, and vehicular traffic also could affect farmland soils (including prime farmland and farmland of statewide importance) through compaction, erosion, interference with drainage, and soil mixing. To prevent soil compaction, drainage alteration, and damage to crops, operation of equipment on agricultural lands would be limited to access routes agreed upon with landowners. Approximately 2,284 acres of agricultural land would be affected along the Applicant's preferred route. Construction of the Applicant's preferred route would cross approximately 2,150 acres of farmland soils (Table 5.3.1-1). The Applicant would implement measures to avoid and minimize potential impacts on soil productivity in accordance with the Agricultural Protection Plan (Appendix F). These measures include erosion control, topsoil segregation, rock removal, and measures to avoid compaction or loosen compacted soils. In temporary construction work areas and along the permanent right-of-way, agricultural activity typically would be prevented for one growing season, resulting in short-term minor losses to agricultural productivity.

The Agricultural Protection Plan (Appendix F) provides additional measures that would be applied specifically to organic agricultural lands, such as organic-certified farms or farms that are in active transition to organic-certified status, in order to address the unique management and certification requirements of these operations. Two organic farms have been identified within the construction footprint of the Applicant's preferred route. Both organic farms are located east of Clearbrook in Minnesota, and both landowners have signed easement agreements (Enbridge 2016). The Applicant

would continue to work with affected landowners to identify organic farms that have not yet been identified and would implement measures in the Agricultural Protection Plan accordingly.

The current market value of crops within the construction work area for the Applicant's preferred route is approximately $764,000; and the total value is approximately $938,000 including the value of crops within the footprint of ATWS, access roads, valve sites, and pump stations (Table 5.3.1-2). This amount represents less than 1 percent of the total market value of agricultural products in the counties that would be crossed by the Applicant's preferred route. Applicant-proposed measures to reduce these impacts include compensating all landowners for lost crops and any documented damage that may be caused by construction activities. Considering the relatively small market value of agricultural commodity losses and the Applicant-proposed measures to compensate landowners and reduce damage to soils, construction of the Applicant's preferred route would result in a temporary negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Lands and Timber Resources

During construction, trees from forested areas would be cleared within the construction work area, which would result in loss of timber production. The Applicant would compensate each state's respective DNR for any merchantable timber loss on state-managed forested lands, and compensation on private lands would be agreed upon by the Applicant and the landowner during easement acquisition.

Following construction activities, trees would not be allowed to re-establish within the permanent right-of-way, but would be allowed to regenerate naturally within the remainder of the construction work areas, temporary access roads, and ATWS. However, the area within the temporary construction work area for the Applicant's preferred route could take up to 50 years to regenerate harvestable timber. Construction activities likely would result in long-term to permanent minor impacts on land used for timber production. Based on the value of the annual lost growth, the present value of the future growth foregone is approximately $2.5 million, with the majority of the impact occurring in Minnesota. When compared to the present value of the timber harvest market over the same time period (50 years, $662 million), the impact of construction on the associated local timber industry is likely to be long term to permanent and minor.

Disturbance and Loss of Land used for Mining

The only active mining lease along the Applicant's preferred route is in Minnesota, where less than 1 acre of land with active mineral leases would be crossed by the Applicant's preferred route; therefore, impacts on productivity would be temporary and negligible. In addition, approximately 513 acres of land with potentially valuable sand and gravel resources is located within the construction footprint for the Applicant's preferred route (Table 5.3.1-6). These resources are in a relatively undeveloped state and are located at an average depth below the surface of between 5 and 450 feet (USGS 2006). Construction activities would temporarily prevent development of these resources for the duration of construction, but mineral resources outside of the permanent right-of-way and permanent facilities would be available for extraction after construction was complete. Impacts from construction on future exploration or mining of resources in the construction work areas are likely to be temporary and negligible. If future discovery of metallic mineral resources occurs where the pipeline crosses state lands, realignment of the pipeline would be handled under standard licensing clauses.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

During operation, the easement for the permanent right-of-way would include 988 acres of agricultural land (cropland and grass/pastureland), the majority of which would be located along the existing Mainline corridor and would return to agricultural use post construction. Following final restoration, agricultural activities would be able to resume on agricultural lands, with the exception of land within the permanent footprint of pump stations, MLVs, and permanent access roads that would be converted to industrial/developed land uses. Approximately 104 acres of agricultural land in Minnesota would be converted to industrial/developed land from permanent access roads, pump stations, and valves (Table 5.3.1-1). Enbridge has not proposed aboveground facilities in North Dakota or Wisconsin. As part of easement negotiations, landowners would be compensated for loss of the land. Conversion of 104 acres of agricultural land compared to the 2,838 acres of agricultural land within the ROI results in a permanent negligible impact.

The current market value of crops on agricultural land that would be converted to other land uses (permanent access roads, valves, and pump stations) is approximately $61,400 (Table 5.2.1-2). The present value of this annual loss into perpetuity would be approximately $2.1 million. The annual loss of commodities from agricultural land removed from agricultural use relative to the overall value of agricultural products sold in the affected counties would be small; therefore, the impact on the local agricultural economy would be permanent and negligible.

The permanent right-of-way easement for the Applicant's preferred route includes approximately 429 acres of prime farmland and 505 acres of farmland of statewide importance (Table 5.3.1-1). Approximately 153 acres of prime farmland and farmland of statewide importance would be permanently converted to other land uses in Minnesota for permanent access roads, pump stations, and valves and would no longer be available for current or future production (Table 5.3.1-1). Following final restoration, the remaining lands disturbed during construction would continue to be available for current and future agricultural uses. Conversion of 153 acres of prime farmland compared to the 2,636 acres of prime farmland within the ROI results in a permanent negligible impact.

Disturbance and Loss of Forested Lands and Timber Resources

To provide for ongoing pipeline inspection and maintenance, forested lands would not be allowed to reestablish within the permanent right-of-way. The permanent right-of-way easement for the Applicant's preferred route includes approximately 797 acres of forested land, of which approximately 87 percent is deciduous forest (Table 5.3.1-3). This land would be permanently restricted from use for commercial timber production. The Applicant would compensate Minnesota DNR for any merchantable timber loss on state-managed forested lands, and compensation on private lands would be agreed upon by the Applicant and the landowner during easement acquisition (Enbridge 2016). Conversion of 797 acres of forested land compared to the 1,858 acres of forested land within the ROI results in a permanent minor to moderate impact (Table 5.3.1-3).

The current market value of this timber is approximately $152,000 (Table 5.3.1-4). Assuming that this annual loss is continued into perpetuity, the present value of the foregone production is approximately $5.1 million, compared to the present value of annual timber harvest in Minnesota into perpetuity, which is approximately $1.6 billion. Permanent conversion of 797 acres of forested land during operation of the Applicant's preferred route therefore would result in a permanent minor impact on the local timber economy.

Disturbance and Loss of Land Used for Mining

Operation of the pipeline is not expected to affect land with active mineral leases. Approximately 200 acres of land (including pump stations, access roads, and valves) with potential sand and gravel resources are located within the permanent right-of-way in Minnesota and would be removed from future mining activities. These resources are in a relatively undeveloped state, and the resource potential is unknown. Permanent conversion of 200 acres of land with potential sand and gravel resources compared to the 513 acres of land within the ROI, as well as the relatively undeveloped state of the resources, results in a permanent negligible impact (Table 5.3.1-6).

5.3.1.3.2 Continued Use of Existing Line 3

Construction Impacts

Continued use of existing Line 3 would not require any future construction or conversion of agricultural lands or lands of prime farming soils. Therefore, there would be no construction impacts on current or future commodity production.

Operations Impacts

The existing Line 3 operations right-of-way includes over 752 acres of active crop and pasture land but does not contain any timber or mineral commodities, as timber production and mining activities are not permitted within this area. Agricultural lands within the existing Enbridge Mainline corridor could be affected by ongoing integrity maintenance digs and subsequent pipeline repair activities, which could prevent crop production in these areas by removing existing crops or reducing the productivity of agricultural soils. Such impacts would be short term, localized, and minor as agricultural land would return to agricultural use after one growing season.

5.3.1.3.3 System Alternative SA-04

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

The types of construction impacts in agricultural areas for SA-04 would be similar to those described for the Applicant's preferred route, including removal of crops and grasslands, reduction in the productivity of soils from soil erosion and interference with agricultural drainage (if present), mixing of topsoil and subsoil, and compaction and rutting of soil. Approximately 10,155 acres of agricultural land would be affected along the SA-04 route. Construction of SA-04 also would cross 4,479 acres of prime farmland soils and 688 acres of farmland of statewide importance (Table 5.3.1-7). It was assumed that the Applicant's Agricultural Protection Plan (Appendix F) would be implemented to reduce impacts on agricultural land. Applicant-proposed measures include erosion control, topsoil segregation, rock removal, measures to avoid compaction or loosen compacted soils, and compensation to all landowners for lost crops. In temporary construction work areas and along the permanent right-of-way, agricultural activity typically would be prevented for one growing season, resulting in short-term minor losses of agricultural land currently being used for agricultural production.

The current market value of crops within the construction work area for SA-04 is approximately $5.0 million (Table 5.3.1-8). This amount represents less than 1 percent of the total market value of agricultural products in the counties that would be crossed by the system alternative (U.S. Department

of Agriculture, National Agricultural Statistics Service, 2016); therefore, it is likely that construction of the SA-04 route would result in a temporary, negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Lands and Timber Resources

The types of construction impacts in forested areas would be similar to those described for the Applicant's preferred route, including loss of timber production from clearing of trees in the construction work areas. Approximately 99 acres of forested land would be affected along the SA-04 route (Table 5.3.1-9). Clearing trees within forested lands would result in long-term to permanent impacts within the construction work area. Over time (decades), natural growth and succession would restore the temporary construction work area to a forested community. Construction activities would result in long-term to permanent, minor impacts on land used for timber production.

The value of the annual lost growth of forested land within the construction work area is approximately $19,000 (Table 5.3.1-10). Assuming that this value is lost annually over 50 years, the present value of the future growth foregone is approximately $158,000, with the majority of the impact occurring in Minnesota. When compared to the present value of the timber harvest market over the same time period (50 years, $662 million), the impact of construction on the associated local timber industry is likely to be long term and negligible.

Disturbance and Loss of Land Used for Mining

No active mineral areas are located within the ROI for SA-04 in Minnesota or Illinois; therefore, no impacts on mining would occur in these states. Approximately 31 acres of land with known oil and gas resources occurs within the ROI for SA-04 in North Dakota and 0.4 acre of land with active coal mining is located in the ROI for SA-04 in Iowa, along with 2,393 acres of land with potential sand and gravel resources. Construction activities would temporarily prevent development of these resources for the duration of construction, but mineral resources outside of the permanent right-of-way and permanent facilities could be available for extraction after construction was complete. Construction-related impacts on potential exploration or mining of resources in the construction work area are likely to be temporary and negligible. If future discovery of metallic mineral resources occurs where the pipeline crosses state lands, realignment of the pipeline would be handled under standard licensing clauses.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

During operation, the easement for the permanent right-of-way would include 4,281 acres of agricultural land, which would continue to be used for agricultural purposes post construction (Table 5.3.1-7). Following final restoration, agricultural activities would be able to resume across this land, with the exception of land used for aboveground facilities (pump stations, MLVs, and permanent access roads) that would be permanently converted to industrial/developed land uses. The exact amount of agricultural land that would be converted to industrial/developed land has not been determined for SA-04 but would be no more than approximately 128 acres for MLVs and pump stations. As part of easement negotiations, landowners likely would be compensated for the loss of this land. Conversion of 128 acres of agricultural land compared to the 10,155 acres of agricultural land within the ROI results in a permanent negligible impact. Although the exact crop yield and dollar value is unknown, as with the Applicant's preferred route, it is likely that conversion of this land would result in a permanent but negligible impact on the local agricultural economy.

The permanent right-of-way for SA-04 includes 1,868 acres of prime farmland and 287 acres of farmland of statewide importance (Table 5.3.1-7). Following final restoration, agricultural activities on farmland soil would be able to resume across this land, resulting in no additional impacts during continued operation of the pipeline. As with agricultural land, the exact amount of farmland soil that would be converted to industrial/developed land has not been developed but would be no more than approximately 128 acres for MLVs and pump stations. Conversion of 128 acres of farmland soils compared to the 4,478 acres of farmland soils within the ROI results in a permanent negligible impact.

Disturbance and Loss of Forested Lands and Timber Resources

To provide for ongoing inspection, monitoring, and maintenance, forested lands would not be allowed to reestablish within the permanent right-of-way. The permanent right-of-way easement for SA-04 would include approximately 40 acres of forested land, nearly all of which is deciduous forest. This land would be permanently removed from the ability to commercially produce timber for use in the wood product industries. Conversion of 40 acres of forested land compared to the 98 acres of forested land within the ROI results in a permanent minor impact on land that could be used in the production of timber products.

The current market value of this timber is approximately $8,000 (Table 5.3.1-10). Assuming that this annual loss is continued into perpetuity, the present value of the foregone production is approximately $256,000, compared to the present value of annual timber harvest in Minnesota into perpetuity ($1.6 billion). Although permanent, given the size of the dollar value loss relative to the overall size of the timber harvest, permanent conversion of this land would result in a permanent negligible impact on the local timber economy.

Disturbance and Loss of Land Used for Mining

Operation of the pipeline is not expected to affect land in active mineral areas. Approximately 840 acres of land with potential sand and gravel resources would be located within the permanent right-of-way for SA-04 in Minnesota; this land would be removed from future mining activities. These resources are in a relatively undeveloped state and their resource potential is unknown. However, the width of the right-of-way is a small area relative to the expanse of areas with mineral resource potential. Conversion of 840 acres of land with potential sand and gravel resources compared to the 2,393 acres of land with potential sand and gravel resources within the ROI, as well as the relatively undeveloped state of the resources, results in a permanent negligible impact.

5.3.1.3.4 Transportation by Rail

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Less than 200 acres of agricultural land (hay/pasture and cultivated crops) is present in the areas adjacent to the Clearbrook and Superior terminals that would likely be considered for development of the rail offloading facilities and new or expanded rail lines. Impacts of construction activities on agricultural land would include permanent removal of crops and grasslands, resulting in permanent minor losses to agricultural land. The market value of the crops that could be grown on this land is expected to be negligible.

Disturbance and Loss of Forested Lands and Timber Resources

Some forested land (evergreen forest and deciduous forest) is present in the general areas that are likely to be considered for development of rail offloading facilities and new or expanded rail lines; these areas would be permanently cleared for development of facilities. Such clearing likely would result in permanent minor impacts on land used for timber production.

Disturbance/Loss of Land Used for Mining

No active mining areas have been identified within the areas that are likely to be developed for rail offloading facilities and new or expanded rail lines. As no information has been found on potential sand and gravel resources in these areas, impacts from construction for the rail alternative could be permanent and negligible.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

While no specific locations have been identified, the development of rail loading/offloading facilities and new rail lines near Neche, Clearbrook, and Superior would permanently convert up to 200 acres of land used for agriculture to industrial/developed use. This would result in a loss of commodity production in these areas of agricultural lands. Since the amount of land required for rail facilities is small compared to the amount of agricultural land in the region that is currently in agricultural use, or is suitable for agricultural use, potential impacts on agricultural land from operation of the rail alternative are anticipated to be permanent and minor. The market value of the crops that could be grown on this land is expected to be negligible.

In addition to direct impact from lost production resulting from expansion of the rail yards, an indirect impact from the loss of economic value from delays in transport of agricultural commodities by rail.

Transportation of crude oil from near Gretna to Clearbrook and Superior would involve loading and dispatch of 10 unit trains (each train consisting of 110 rail cars) per day onto the rail network in Minnesota. These unit trains would be dedicated to a single service and would return empty from Clearbrook and Superior. Since the overall round trip to Clearbrook or Superior would take more than a single day, some multiple of the 10 trains per day loaded and dispatched would be required to provide the required service. The unit trains would be required to operate on Class 1 rail lines because of their weight and cargo type. Likely routes for these transits have been identified in the description of alternatives (see Chapter 4).

It is likely that the increase in traffic (some multiple of 10 trains per day) operating on the rail system may cause congestion during certain periods. Congestion may develop as a result of seasonal demands for rail capacity. For example, the record 2008/2009 grain harvest in Western Canada saw shippers increase demand for rail cars and experience delays in delivery of their cargos to ports (Freight Monitor 2014). The U.S. Surface Transportation Board also has developed a concern over rail congestion and its potential to affect agricultural production, and has initiated an oversight proceeding (STB 2014).

In view of the underlying projections for increased use of the rail system for commodity transportation, the importance of the timely movement of commodities to market distribution points, and the incremental rail traffic required for the rail alternative, rail system congestion would likely occur. These impacts could affect commodity producers. Although they may be temporary (either seasonal in

response to commodity shipment schedules or resolved through capacity additions to the rail system), impacts from delays in transport of agricultural commodities by rail would be minor to major.

An analysis of rail system operations to determine the specific constraints to rail system infrastructure or operations is not possible within the context of this analysis.

Disturbance and Loss of Forested Lands and Timber Resources

The forested land present in the general areas likely to be considered for development of rail loading and offloading facilities and new or expanded rail lines would be permanently converted to industrial/developed use, resulting in loss of potential timber production indefinitely. Since the amount of land required for rail facilities is small compared to the amount of forested land in the region, impacts on forested land and timber resources from operation of this alternative are anticipated to be permanent and minor.

Disturbance and Loss of Land Used for Mining

While land used for mining has not been determined within the areas that could be developed for rail facilities and new or expanded rail lines, the amount of land required for such facilities compared to the amount of land in the region containing mineral resources is small. Potential impacts on land used for mining from operation of the rail alternative therefore are expected to be permanent and negligible.

5.3.1.3.5 Transportation by Truck

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Up to 140 acres of agricultural land (hay/pasture and cultivated crops) is present in the general areas likely to be considered for development of new truck offloading facilities and associated road access. Impacts of construction activities on agricultural land include removal of crops and grasslands and prevention of the production of commodities on agricultural land, resulting in permanent minor losses to agricultural land. The market value of the crops that could be grown on this land is expected to be negligible.

Disturbance and Loss of Forested Lands and Timber Resources

Some forested land (evergreen forest and deciduous forest) is present in the general areas likely to be considered for development of new truck offloading facilities and associated road access. These areas would be cleared for development of facilities. Construction of the transportation by truck alternative likely would result in permanent, minor impacts on land used for timber production.

Disturbance and Loss of Land Used for Mining

While land used for mining has not been identified within the areas that could be developed for truck facilities and access roads, the amount of land required for such facilities compared to the amount of land in the region containing mineral resources is small. Potential impacts on land used for mining from construction of the truck alternative therefore are expected to be permanent and negligible.

Operations Impacts

The use of tanker trucks required to transport the oil would result in millions of highway miles driven by tank trucks per year, adding congestion to highways and increasing risks to public safety.[19] The increased volume of trucks on local highways that already carry a substantial volume of commercial traffic could lead to delays in the movement of commodities (agriculture, timber, and mining) by truck to market. Overall, operations under the truck alternative would be expected to result in a minor permanent impact on commodity production.

Disturbance and Loss of Agricultural Land and Lost Yields

While no specific locations have been identified, development of truck offloading facilities and access roads would permanently convert up to 140 acres of land used for agriculture to industrial/developed use. This would result in loss of commodity production on these areas of agricultural lands. Since the amount of land required for truck facilities is small compared to the amount of agricultural land in the region that is currently in agricultural use, or is suitable for agricultural use, potential impacts on agricultural land from operation of this alternative are anticipated to be permanent and minor. The market value of the crops that could be grown on this land is expected to be negligible.

Disturbance and Loss of Forested Lands and Timber Resources

The forested land present in the general areas likely to be considered for development of truck loading and offloading facilities and access roads would be permanently converted to industrial/developed use, resulting in an indefinite loss of potential timber production. Since the amount of land required for truck facilities is small compared to the amount of forested land in the region, impacts on forested land and timber resources from operation of the truck alternative are anticipated to be permanent and minor.

Disturbance and Loss of Land Used for Mining

While land used for mining has not been determined within the areas that could be developed for truck facilities and access roads, the amount of land required for such facilities compared to the amount of land in the region containing mineral resources is small. Potential impacts on land used for mining from operation of the truck alternative therefore are expected to be permanent and negligible.

5.3.1.3.6 Existing Line 3 Supplemented by Rail

Impacts associated with continued use of the existing Line 3 supplemented by rail would be the same as those described above for continued use of the existing Line 3 and the rail alternative. This combined alternative would require the same installation of additional rail offloading facilities as described above, thus the impacts would be the same as those described for the rail alternative—with the exception that fewer trains would be needed to transport the oil. This would substantially reduce the potential for railway congestion. The overall impact of this alternative on commodity production would be minor and permanent.

[19] Transporting 760,000 bpd of oil by tanker truck would require 4,000 tanker trucks per day; 1,920 trucks would travel from near Gretna to the Clearbrook terminal, and 2,080 trucks would travel from near Gretna to the Superior terminal (see Section 4.2.6.2).

5.3.1.3.7 Existing Line 3 Supplemented by Truck

Impacts associated with continued use of the existing Line 3 supplemented by truck would be the same as those described above for continued use of the existing Line 3 and the truck alternative. This combined alternative would require the same installation of additional loading and offloading truck facilities as described for the truck alternative and would result in similar impacts, except that fewer trucks would be required to transport the oil. This would substantially reduce the potential for highway congestion. The overall impact of this alternative on commodity production would be minor and permanent.

5.3.1.4 Summary and Mitigation

5.3.1.4.1 Summary

The analysis of potential impacts on commodities from construction and operation of the Applicant's preferred route and CN Alternatives is summarized in Table 5.3.1-11. Overall, there would be negligible to minor impacts on agricultural commodities along the Applicant's preferred route and all of the CN Alternatives — with one exception. The added rail traffic carrying crude oil could cause congestion in the rail system at times when agricultural commodities seek to move to regional distribution points. Such congestion may delay commodity delivery. Because the analysis was not able to evaluate rail system operations, the potential for this impact to occur has been identified but cannot be quantified. Although impacts may be temporary (either seasonal in response to commodity shipment schedules or resolved through capacity additions to the rail system), delays in transport of agricultural commodities by rail would result in minor to major impacts.

The duration of impacts on agricultural lands and farmland soils ranged from short term or temporary for the Applicant's preferred route and SA-04, to long-term or permanent for impacts from land converted to rail/truck offloading facilities for the alternatives involving truck or rail—for both the construction and operations phase (with the exception that continued use of the existing Line 3 has no construction-related impacts). Agricultural lands would experience only short term impacts because once construction is completed, cultivation can be initiated or resume, even within the permanent right-of-way. In contrast, impacts on forested lands would be long term or permanent because reforestation would be restricted or forest replacement would require a long time. No active mines would be affected by construction or operation of the Applicant's preferred route or the CN Alternatives.

While overall impacts are negligible to minor, comparison of the Applicant's preferred route and the CN Alternatives to each other reveal some differences in effects.

Acres of agricultural or forested lands that would be affected for the rail and truck alternatives or continued use of the existing Line 3 supplemented by rail or truck are minimal (on the order of 100–200 acres), and no agricultural or forested lands would be affected by continued use of the existing Line 3. Therefore, any of these alternatives would substantially avoid impacts on commodity production for both the construction and operations phases.

The Applicant's preferred route and SA-04 would involve construction over long distances and therefore would affect commodity production. There would be some short-term or limited impacts on agricultural production, primarily deferral of a crop for a growing season that would be offset with monetary compensation by the Applicant. Consequently, there would be little or no economic loss. Unlike impacts on agricultural production, impacts on forested land were found to be long term or permanent;

therefore, the difference in acreage of forest lands affected by the route options is more significant. For both the construction and operations phases, the Applicant's preferred route would affect substantially greater acreage of forested lands than SA-04. This includes lands cleared for construction but allowed to re-forest and lands cleared and restricted from future forest production. The Applicant's preferred route would result in long-term impacts on 1,612 acres of forested land within the construction work area and permanent impacts on 797 acres of forested land (701 acres of forested land within the permanent right-of-way and 96 acres lost to pump stations, valves, and permanent access roads). SA-04 would cause long-term impacts on 98 acres of forested land within the construction work area and permanent impacts on 41 acres of forested land within the permanent right-of-way. Forestry resources would be least affected by continued use of the existing Line 3, the rail or truck alternatives, and continued use of Line 3 supplemented by either rail or truck. Effects on forestry resources would be measurably increased by the SA-04 route and the Applicant's preferred route.

The other commodity considered was mining resources. As noted, neither the Applicant's preferred route nor any of the CN Alternatives would affect active mining except SA-04, where only 0.4 acre would be affected. Unmined sand and gravel resources could be affected by construction and operation along the Applicant's preferred route and SA-04. The Applicant's preferred route could restrict future development of 513 acres of potential sand and gravel reserves during construction and would restrict the potential future development of 200 acres of these resources. SA-04 would affect 2,393 acres of potential sand and gravel resources during construction and would permanently restrict future development of 840 acres. However, given the depth of these reserves and limited information on their potential to become viable sand and gravel resources, impacts are considered to be negligible. Impacts on mining resources would be least affected by continued use of the existing Line 3, the rail or truck alternative, and continued use of the existing Line 3 supplemented by either rail or truck.

Overall effects on commodities would be minimized by continued use of the existing Line 3, the truck alternative, or use of the existing Line 3 supplemented by truck. The Applicant's preferred route and SA-04 would increase effects because they would require construction and a permanently cleared right-or-way. The CN Alternatives, including rail transportation, could affect commodity economics if congestion in the rail system occurred as described.

5.3.1.4.2 Mitigation

The Applicant proposes several measures to minimize or avoid impacts on commodity production that are discussed in the Agricultural Protection Plan (Appendix F). Beyond these Applicant-proposed measures, no mitigation has been identified.

Table 5.3.1-11. Summary of Potential Impacts on Commodity Production for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route[a]	Continued Use of Existing Line 3	System Alternative SA-04[b]	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Disturbance and loss of agricultural land	Short-term/minor impacts • 2,284 acres of agricultural land Short- to long-term/minor impacts • 2,150 acres of farmland soils	No impact	Short-term/minor impacts • 10,155 acres of agricultural land Short- to long-term/minor impacts • 5,167 acres of farmland soils	Permanent/minor impacts • <200 acres of agricultural land	Permanent/minor impacts • <140 acres of agricultural land	Permanent/minor impacts • <200 acres of agricultural land	Permanent/minor impacts • <140 acres of agricultural land
Lost agricultural land yields	Temporary/ negligible impacts • $764,000 market value of crops	No impact	Temporary/ negligible impacts • $5.1 million	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts
Disturbance and loss of forested lands and timber resources	Long-term to permanent/minor impacts • 1,612 acres of forested areas • $2.5 million market value of timber	No impact	Long-term to permanent/minor impacts • 98 acres of forested areas • $158,000 market value of timber	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts

Table 5.3.1-11. Summary of Potential Impacts on Commodity Production for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route[a]	Continued Use of Existing Line 3	System Alternative SA-04[b]	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Disturbance and loss of land used for mining	Temporary/ negligible impacts • 513 acres of land with potential sand and gravel resources No impact on active mines	No impact	Temporary/ negligible impacts • 2,393 acres of land with potential sand and gravel resources • 0.4 acre of active coal mine area in Iowa	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts	Temporary/ negligible impacts
Operations Impacts							
Disturbance and loss of agricultural land	Permanent/ negligible impacts • 104 acres of agricultural land • 153 acres of farmland soils	Short-term/minor impacts • 752 acres of agricultural land	Permanent/ negligible impacts • 128 acres of agricultural land • 128 acres of farmland soils	Permanent/minor impacts • <200 acres of agricultural land	Permanent/minor impacts • <140 acres of agricultural land	Permanent/minor impacts • <200 acres of agricultural land	Permanent/minor impacts • <140 acres of agricultural land
Lost agricultural land yields	Permanent/ negligible impacts • $61,400 market value of crops	Short-term/ negligible impacts	Permanent/negligible impacts within facilities footprint No additional lost yield on land within the permanent easement	Permanent/ negligible impacts • Increased rail congestion that could affect commodity producers	Permanent/ negligible impacts • Increased highway congestion that could affect commodity producers	Permanent/ negligible impacts • Increased rail congestion that could affect commodity producers	Permanent/ negligible impacts • Increased highway congestion that could affect commodity producers

Table 5.3.1-11. Summary of Potential Impacts on Commodity Production for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route[a]	Continued Use of Existing Line 3	System Alternative SA-04[b]	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Disturbance and loss of forested lands and timber resources	Permanent/minor impacts • 797 acres of forested areas • $5.1 million market value of timber	No impact	Permanent/ minor impacts • 41 acres of forested areas • $7,700 market value of timber	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts
Disturbance and loss of land used for mining	Permanent/ negligible impacts • 200 acres of land with sand and gravel resources No impact on active mines	No impact	Permanent/ negligible impacts • 840 acres of land with sand and gravel resources • 0.4 acre of active coal mine area in Iowa	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts

[a] Enbridge-provided footprints: Construction = construction work area; Operation = operations permanent right-of-way

[b] Construction = 120-foot-wide construction footprint (except RA-07 is 205 feet wide), Operations = 50 foot-wide permanent right-of-way

5.3.1.5 References

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5.3.2 Recreation and Tourism

Recreational activities contribute to the local economy through the influx of tourists, purchases of gear and related equipment, and trip-related spending (e.g., gas, lodging, and food).

The issues of concern related to recreation and tourism are the loss of recreation-based spending and the associated effects on the recreational economies in the counties that would be crossed. This potential loss could come from a decrease in recreation-based visitation because of access limitations, such as trail closings or road detours, during construction and operation of the Project. This section assesses the potential for construction and operation of the Applicant's preferred route and CN Alternatives to affect the recreation economy. Impacts on recreation and tourism that could occur during construction and operation include:

- Limitations to recreation access, and
- Changes to the recreational economy.

This section first describes the existing conditions within an area along the Applicant's preferred route and each of the CN Alternatives where recreation and tourism could be affected by construction or operation of the Project. Impacts on access to recreation resources and effects on the recreation economy are assessed and compared to each other for the Applicant's preferred route and the CN Alternatives (continued use of the existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, and existing Line 3 supplemented by rail or truck). Potential impacts on recreation and tourism associated with an unanticipated release of crude oil are discussed in Chapter 10.

5.3.2.1 Regulatory Context and Methodology

5.3.2.1.1 Regulatory Context

The Applicant's preferred route and CN Alternatives involve actions in North Dakota, Minnesota, Iowa, Illinois, and Wisconsin. The applicable regulations for each state are summarized below.

North Dakota

Several regulations in the North Dakota Century Code addresses pipelines; however, no specific regulations concern the impact of pipelines on access to recreational lands or impacts on recreation-based economies in the state.

Minnesota

Minnesota Administrative Rules Part 7853.0130, Subpart B provides the criteria the Commission must consider in assessing the need for the Project, including "the effect of the proposed facility upon the natural and socioeconomic environments compared to the effects of reasonable alternatives." Impacts on recreation and tourism are part of the socioeconomic environment the Commission considers in their decision about whether there are more reasonable and prudent alternatives to the proposed Project (Minn. R. 7853.0130, Subp. B) and whether the benefits outweigh the consequences of granting a CN for the proposed Project (Minn. R. 7853.0130, Subp. C).

In addition, Minnesota Administrative Rules Part 7853.0600, Subpart 2(J) requires listing of "state critical areas, state WMAs; state scientific and natural areas; state wild, scenic, and recreational rivers; state

parks; state scenic wayside parks; state recreational areas; state forests; state trails; state canoe and boating rivers; state zoos, and designated trout lakes through which the route passes, as mapped on the inventory of significant resources by the State Planning Agency."

Iowa

Iowa Administrative Code Chapter 479(B) gives the Iowa utilities board primary authority over the routing of pipelines. No specific regulation in the chapter addresses recreational land or recreation-based economies. Iowa Statute 199—13 provides the standards related to hazardous liquid pipelines. There is only mention of recreational facilities under Iowa Statute 199—24.4(476A), which regulates electric power generation and transmission lines. Section 3, "Community Impact" in the "Application for a Certificate—Contents," states that the applicant shall include "an identification and analysis of the effects the construction, operation and maintenance of the proposed facility have on the site impact area including, but not limited to, the following: a. A forecast of the permanent impact of the construction, operation, and maintenance of the proposed facility on commercial and industrial sectors, housing, land values, labor market, health facilities, sewage and water, fire and public protection, *recreational facilities*, schools and transportation facilities." (emphasis added)

Illinois

Under the Public Utilities Act in Illinois, § 15-401,"Licensing" states that "in its determination of public convenience and necessity for a proposed pipeline or facility designed or intended to transport crude oil and any alternate locations for such proposed pipeline or facility, the Commission shall consider, but not be limited to, the following: … (3) any evidence presented by the Department of Natural Resources regarding the impact of the proposed pipeline or facility on any conservation areas, forest preserves, wildlife preserves, wetlands, or any other natural resource."

Wisconsin

There is no specific provision for recreational land under Wisconsin Statute § 295.53(3)(a). However, the Statutes state the following under Subchapter 2 for Oil and Gas: "In the environmental impact report, the applicant shall provide a description of the proposed mining project, the present environmental conditions in the area and the anticipated environmental impacts of the proposed mining project, the *present socioeconomic conditions* in the area and the *anticipated socioeconomic impacts* of the proposed mining project, details of any wetlands mitigation program under s. 295.60 (8), any measures for navigable waters under s. 295.605 (4), any proposed changes to the forest designations specified in sub. (4)(c), and the alternatives to the proposed mining project." (emphasis added)

5.3.2.1.2 Methodology

The ROI for the analysis of recreation and tourism impacts is twofold. It narrowly focuses on the public recreational lands and recreational waterbodies directly crossed by construction and operations areas for the Applicant's preferred route and the CN Alternatives in order to qualitatively assess how Project-related changes would affect recreation-based visitation. It broadly includes the counties through which the Applicant's preferred route and the CN Alternatives pass to assess whether the Project-related changes would affect county-level recreational visitation and subsequently the local recreation-based economy. The counties where Project-related impacts would occur represent the relevant local recreational economies that are likely to be the most sensitive to Project-related actions.

The analysis was undertaken by first identifying and inventorying in GIS all public recreational lands, trails, and waterbodies in the counties crossed by the Applicant's preferred route and the CN Alternatives. The following construction and operations footprints were overlaid to quantify resources affected by construction and operation:

- The route and estimated footprints for the pipeline and associated facilities for the Applicant's preferred route,
- The 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for system alternative SA-04,
- The permanent right-of-way for the existing Line 3 pipeline, and
- The estimated footprints of required facilities and existing potential routes for the rail and truck alternatives.

The geographic extent (in acres) of restricted access to recreational land, including recreational waterbodies, land-based trails, and scenic byways, from the construction work areas, permanent rights-of-way, and associated aboveground facilities was determined by analyzing the number of crossings and crossing methods described by the Applicant. The analysis assumed that access would be restricted to the affected resource over the entire construction work area for the duration of construction. The analysis assumed that access would be restricted during operations along the permanent right-of-way for pipelines and at any aboveground facilities associated with pipelines, continued operations of existing Line 3, and rail and truck transportation.

Current statistics on visitation to the specific recreation areas identified in this analysis and any associated recreational spending were not available; consequently, quantitative estimates of economic impacts could not be developed. However, a qualitative assessment was developed to assess the magnitude of the associated loss of tourism that may result from the disruption of recreational activities and characterize the direction and magnitude of potential impacts on the regional recreation/tourism economy at the county level.

The methodology for assessing potential impacts on the local recreational economy in each affected county in the ROI involved (1) identifying physical impacts on land and water primarily used for recreational purposes; (2) assessing whether the magnitude and duration of access restrictions were likely to change recreational visitation at the county level; and (3) evaluating whether the change would be large enough to affect the local recreational economy (i.e., county-level recreation-based tourism spending). For a physical access restriction to measurably affect the recreational economy of a county, a significant amount of people would have to stop taking trips or take substantially fewer trips within the county as a whole instead of choosing to recreate at another site within the county or recreating at the affected site, but in a different area.

Recreational land and waterbodies within the ROI for the Applicant's preferred route and CN Alternatives were identified using GIS datasets and layers in the following federal- and state-level data sources:

- Protected Areas Database of the United States (PAD-US),
- DNR water trails,
- DNR snowmobile trails,

- DNR state-designated trails,
- DNR hunter walking trails, and
- State-designated trout streams.

5.3.2.2 Existing Conditions

This section identifies recreational resources that could be affected by the Applicant's preferred route and CN Alternatives. Changes to these resources could reduce or restrict recreational use, which could affect recreational spending at the county level. This section does not discuss current recreational use or spending at the county level since publicly available, accurate, and consistent data were not available for each of the resources discussed. For context, an estimate of the approximate acreages or total size of the resources are provided where appropriate for the Applicant's preferred route and each CN Alternative.

Parks and Forests

Recreational use of parks, forests, and special management areas includes a variety of outdoor activities such as camping, hiking, skiing, horseback riding, off-road vehicle riding, snowmobiling, boating, bicycling, fishing, hunting, and wildlife watching. Parks include all parks or protected areas that are managed by state or federal agencies. Similarly, forests include forested land that is protected and maintained by state and federal agencies primarily for recreational enjoyment. Recreational activities in parks and forests can take place in developed areas that include a variety of recreational facilities (e.g., parking, trails, restroom, campsites, and boat launches) or in areas that are less developed, with few to no facilities.

Special Management Areas

Special management areas include other protected areas or areas set aside for conservation. For this analysis, special management areas include areas open to the public for recreation, such as wildlife refuges, WMAs, and other public management areas. These areas, considered as undeveloped open lands, are available for informal recreational use with limited modern facilities. Typically, these special management areas are used to hunt, fish, trap, or watch wildlife.

State-Designated Land-Based Trails

State-designated land-based trails include multi-use trails, hunter walking trails, and state-managed snowmobile trails. These trails are designated for a variety of recreational uses, such as walking, jogging, hiking, bicycling, horseback riding, hunting, and snowmobile use.

State-Designated Water Trails and Trout Streams

Water trails are marked routes on navigable waterways (e.g., rivers, lakes, canals, and coastlines) for people using small, non-motorized boats (e.g., kayaks, canoes, rafts, and rowboats). State-designated trout streams provide an important source of recreational activity for anglers.

Scenic Byways

Under the National Scenic Byways Program, the Secretary of Transportation designates scenic byways, recognized as "roadways having outstanding qualities of scenic, historic, cultural, natural, recreational, and archeological qualities" (23 U.S. Code 162, TEA-21). As of 2010, 151 byways in 46 states were

recognized as America's Byways that represent the most scenic and rarest of landscapes, culture, and history preserved in the United States.

The following sections describe the existing conditions for recreational resources within the ROI for the Applicant's preferred route and CN Alternatives.

5.3.2.2.1 Applicant's Preferred Route

This section describes existing conditions in North Dakota, Minnesota, and Wisconsin for the following: parks, forests, and special management areas; state-designated land-based tails; state-designated water trails and trout streams; and scenic byways. Information enabling comparison of the CN Alternatives to the Applicant's preferred route is provided below.

Parks, Forests, and Special Management Areas

Table 5.3.2-1 lists by county the miles and acres of parks, forests, and special management areas (both state and federal) that would be crossed by the Applicant's preferred route. The Applicant's preferred route would not cross any federal or state parks but would cross the federally-owned Pembina County Waterfowl Production Area and the North Country National Scenic Trail. In addition, it would cross approximately 33 miles of state land, all in Minnesota. The total amount of land used for recreational purposes in the ROI for the Applicant's preferred route is 531 acres; the total land available for recreation in the forests and WMAs that would be crossed is 715,273 acres (Table 5.3.2-1).

State-Designated Land-Based Trails

The Applicant's preferred route would cross three state-designated multi-use trails in Minnesota, one trail in Wisconsin (58th Street Trail), and no trails in North Dakota (see Figure 5.3.2-1). Two of the trails in Minnesota would be crossed once (Paul Bunyan State Trail in Cass County and Willard Munger State Trail in Carlton), while a hunter walking trail would be crossed twice in Aitkin County. The Applicant's preferred route would also cross one snowmobile trail in North Dakota, 19 snowmobile trails in Minnesota, and no snowmobile trails in Wisconsin.

State-Designated Water Trails and Trout Streams

The Applicant's preferred route would cross five state-designated canoe and boating trails in Minnesota and no water trails in North Dakota or Wisconsin. Four of the rivers (Red River of the North in Kittson County, Red Lake River in Pennington County, Crow Wing River in Wadena County, and the Pine River in Cass County) would be crossed once, and the Mississippi River would be crossed two times (once in Clearwater County and again in Aitkin County) (see Figure 5.3.2-1). For context, there are 35 water trails in Minnesota. Each of the rivers that would be crossed range in length from 60 miles (Pine River) to over 500 miles (Red River of the North).

The Applicant's preferred route would cross six state-designated trout streams in Minnesota (King Creek and an unnamed stream in Carlton County, Straight River in Hubbard County, Spring Brook in Cass County, Blackhoof River in Carlton County, and LaSalle Creek in Hubbard County) and no trout streams in Wisconsin or North Dakota. For context, Minnesota has 687 designated trout streams, totaling 3,782 miles.

Table 5.3.2-1. Parks, Forests, and Special Management Areas Crossed by the Applicant's Preferred Route

State/County	Name	Total Size (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)	ATWS	Temp Access Road	Perm Access Road	Valves[a]	Con Total[b]	Op Total[b]
North Dakota											
None	None	0	0.0	0	0	0	0	0	0	0	0
Minnesota											
Aitkin County	Grayling Marsh WMA	9,627	1.1	14	6	1	0	0	0	15	6
Aitkin County	Lawler WMA	235	0.3	3	2	0	0	0	0	3	2
Cass County	Foot Hills State Forest	46,896	3.1	42	19	5	7	1	0	55	20
Aitkin County	Hill River State Forest	124,204	8.0	103	48	5	0	6	0	114	54
Wadena County	Huntersville State Forest	33,963	7.1	97	43	8	4	7	0	116	50
Cass County	Land O'Lakes State Forest	49,890	9.6	130	58	9	17	5	0	161	63
Hubbard County	Mississippi Headwaters State Forest	45,290	1.8	25	11	4	0	7	0	36	17
Hubbard County	Paul Bunyan State Forest	150,113	0.0	0	0	0	0	0	0	0	0
Aitkin County	Savanna State Forest	238,954	0.8	9	5	0	0	0	0	9	5
Aitkin County	Waukenabo State Forest	15,461	1.4	16	8	1	0	1	0	17	9
Pembina County	Pembina County Production Area	640	0.4	5	2	0	0	0	0	5	2
Subtotal		***715,273***	***33.6***	***444***	***202***	***33***	***28***	***27***	***0***	***531***	***228***

Table 5.3.2-1. Parks, Forests, and Special Management Areas Crossed by the Applicant's Preferred Route

State/County	Name	Total Size (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)	ATWS	Temp Access Road	Perm Access Road	Valves[a]	Con Total[b]	Op Total[b]
Wisconsin											
None	None	0	0.0	0	0	0	0	0	0	0	0
TOTAL	**-**	**715,273**	**33.6**	**444**	**202**	***33***	***28***	***27***	**0**	**531**	**228**

Source: USGS GAP 2016.

Notes:

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route and a 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for system alternative SA-04.

[a] Includes valve sites and valve driveways. Because valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated from double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations

Perm = permanent; Temp = temporary; WMA = wildlife management area



Figure 5.3.2-1 State-Designated Multi-Use, Canoe and Boating Trails Crossed by the Applicant's Preferred Route and Certificate of Need Alternatives

Scenic Byways

In North Dakota, there are 10 scenic byways; Minnesota has 21 (8 of which are national byways), and Wisconsin has 4. Each highway crosses several of the finest cultural, historic, recreational, and scenic locations. The Applicant's preferred route would cross one national byway in Minnesota (the Great River Road) twice, once in Clearwater County and again in Aitkin County, and three state-designated byways in Minnesota (Lake Country in Hubbard County, Veterans Memorial in Carlton County, and King of Trails). The route would not cross any designated byways in North Dakota or Wisconsin (see Figure 5.3.2-2).

5.3.2.2.2 Continued Use of Existing Line 3

Parks, Forests, and Special Management Areas

The existing Line 3 pipeline crosses federally owned land, including the Chippewa National Forest, and state forests and WMAs in Minnesota. The route crosses Bowstring State Forest, Fond du Lac State Forest, Mississippi Headwaters State Forest, Clearwater River WMA, and Little Otter Creek WMA.

State-Designated Land-Based Trails

The existing Line 3 pipeline does not cross any state-designated multi-use trails in North Dakota or Minnesota and crosses one multi-use trail in Wisconsin. The existing Line 3 pipeline crosses one snowmobile trail in North Dakota, 16 snowmobile trails in Minnesota, and no snowmobile trails in Wisconsin.

State-Designated Water Trails and Trout Streams

The existing Line 3 crosses four state-designated canoe and boating trails in Minnesota and no water trails in North Dakota or Wisconsin. Three of the rivers (Red River of the North in Kittson County, Red Lake River in Pennington County, and St. Louis River in St. Louis County) are crossed once, and the Mississippi River is crossed two times (once in Clearwater County and again in Aitkin County).

The existing Line 3 crosses three state-designated trout streams in Minnesota (Clearwater River in Beltrami County, Necktie River in Hubbard County, and Little Otter Creek in Carlton County) and no trout streams in Wisconsin or North Dakota.

Scenic Byways

The existing Line 3 crosses one national byway in Minnesota (the Great River Road) three times, once in Beltrami County and twice in Cass County, and two state-designated byways in Minnesota (Edge of the Wilderness in Itasca County and Veterans Memorial in Carlton County). It does not cross any designated byways in North Dakota or Wisconsin.



Figure 5.3.2-2. Scenic Byways Crossed by the Applicant's Preferred Route and Certificate of Need Alternatives

5.3.2.2.3 System Alternative SA-04

Parks, Forests, and Special Management Areas

SA-04 would cross 55 miles of federal land and about 1 mile of state land (a state park trail and a special management area). The geographic extent of the construction work area of SA-04 includes crossing 55 miles of a federal special management area and 1 mile of a state management area in North Dakota and 12.1 miles of a federal special management area in Illinois. The total amount of land within the construction work area includes approximately 972 acres of federal special management areas and 6.3 acres of state special management areas. The majority (795 acres) of this land is within the Dakota Tallgrass Prairie Wildlife Area in Richland County, North Dakota (refer to Table 5.3.2-2). The remaining land area (177 acres) is in Illinois along the Illinois and Michigan Canal. Of the parks and special management areas crossed by SA-04, approximately 42 percent (408 acres) would be located within the permanent right-of-way. The majority of this land (334 acres) is in North Dakota. The total amount of land used for recreational purposes in the ROI for SA-04 is 978 acres; the total land available for recreation in the forests and WMAs that would be crossed is 432,800 acres (Table 5.3.2-2).

State-Designated Land-Based Trails

SA-04 would cross one state-designated multi-use trail in Minnesota (Sakatah Singing Hills State Trail in Blue Earth County), three trails in Illinois (Great River Trail in Rock Island County, Hennepin Canal Feeder in Whiteside County, and Illinois and Michigan (I&M) Canal Path in LaSalle County), and one trail in Iowa (Clinton-Camanche Mississippi River Trail in Clinton County) (refer to Table 5.3.2-2). SA-04 would cross 15 snowmobile trails in North Dakota and 10 in Minnesota.

State-Designated Water Trails and Trout Streams

SA-04 would cross three state-designated canoe and boating trails in Minnesota (Cedar River in Mower County, Chippewa River in Swift County, and Minnesota River in Nicollet County) and four in Iowa (Little Cedar River in Mitchell County, Little Wapsipinicon River in Fayette County, Mississippi River in Clinton County, and Wapsipinicon River in Chickasaw County) (see Figure 5.3.2-1).

SA-04 would cross an unnamed trout stream three times and the Seven Mile Creek once, both located in Nicollet County in Minnesota. SA-04 does not cross any trout streams in Iowa, North Dakota, or Illinois.

Scenic Byways

SA-04 would cross three national byways in Iowa and on the border of Iowa and Illinois (Grant Wood, Great River Road, and Green River Road) (see Figure 5.3.2-2).

Table 5.3.2-2. Parks, Forests, and Special Management Areas Crossed by System Alternative SA-04 (acres)[a]

State/County	Name	Total Area (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)
North Dakota					
Richland County	Dakota Tallgrass Prairie Wildlife Management Areas	185,000	54.9	795	331
Pembina County	Pembina County Waterfowl Production Area	640	0.4	5	2
Subtotal		***185,640***	***55.3***	***800***	***333***
Illinois					
Whiteside County	Hennepin Canal State Park	6,030	<0.1	1	0
LaSalle, Grundy, Will	Illinois and Michigan Canal	1,130	12.1	177	74
Morrison	Upper Mississippi River National Wildlife Refuge	240,000	<0.1	0	0
Subtotal		***247,160***	***12.1***	***178***	***74***
TOTAL-		**432,800**	**67.4**	**978**	**407**

Source: USGS GAP 2016.

Notes:

Values in the table may not sum to totals and subtotals because of rounding.

The SA-04 route would not cross parks, forests, or special management areas in Iowa.

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route and a 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way used for system alternative SA-04.

[a] Access road, additional temporary workspaces (ATWS), and valve information is not available because the exact location of permanent facilities has not been determined for SA-04.

5.3.2.2.4 Transportation by Rail

The rail alternative includes construction of a new offloading facility in Clearbrook, Minnesota; an offloading facility in Superior, Wisconsin; and upgrades and expansion of existing rail infrastructure. The land that would be permanently converted for facility construction and expansion is not currently designated for recreational purposes (i.e., state forest, park, or special management area). It is mostly mixed-use, industrial, and agricultural land. However, the likely rail transportation routes pass through areas used for recreation, as shown in Figure 5.3.2-1 and 5.3.2-2. These areas include several rivers such as the Red Lake River in Polk and Pennington counties, the Mississippi River in Beltrami and Cass counties, the St. Louis River in St. Louis and Carlton counties, and the Otter Trail River in Otter Trail County. Rail routes also include several smaller streams that are designated for trout fishing such as Union Creek in Wadena County, the Crow Wing River in Morrison County, the Red River and Moose Horn River in Carlton County, and Whitley's Creek in Crow Wing County. Rail routes pass through two

popular tourist destinations (the Detroit Lakes and Brainerd Lakes). The rail route would intersect the Paul Bunyan State Trail in Beltrami and Crow Wing counties, as well as the Willard Munger State Trail in Carlton County. The route also would intersect the Great River Road, a national scenic byway in several locations (Beltrami, Crow Wing, Cass, and Itasca counties), and the Veteran's Memorial highway in Carlton County. The route would come within 1,000 feet of the Lake Country Highway in Becker County.

5.3.2.2.5 Transportation by Truck

The truck alternative includes constructing a new offloading facility in Clearbrook, Minnesota; an offloading facility in Superior, Wisconsin; and new local access roads to these facilities. The land that would be permanently converted for facility construction and is mostly mixed-use, industrial, and agricultural land, and does not have land designated for recreational use. The roads likely to be traveled by trucks transporting crude oil for this alternative are located in areas used for recreation, as shown in Figure 5.3.2-1 through 5.3.2-3. These areas include the Red Lake River in Polk County and the International Historic Highway, a state-designated scenic byway also in Polk County, which would be crossed by the first leg of the truck route (Interstate 29). The second leg of the route begins on US Highway 2 in Bagley and continues all the way to Superior. The route crosses through the Mississippi Headwaters State Forest, the Paul Bunyan State Trail, the Great River Road Scenic Byway, and the Mississippi River in Beltrami County. It also runs parallel to the Necktie River, a trout fishing stream in Hubbard County, and crosses over Cass Lake in Cass County to intersect with the Great River Road and Mississippi River again in Cass County. The truck route runs parallel to the Mississippi River again in Itasca County and the St. Louis River in St. Louis County. In St. Louis County, it crosses 10 trout streams and the Saginaw Grade State Trail.

5.3.2.2.6 Existing Line 3 Supplemented by Rail

The existing conditions for the combined existing Line 3 and rail alternative are similar to those described above for continued use of the existing Line 3 pipeline and the rail alternative.

5.3.2.2.7 Existing Line 3 Supplemented by Truck

The existing conditions for the combined existing Line 3 and truck alternative are similar to those described above for continued use of the existing Line 3 pipeline and the truck alternative.

5.3.2.3 Impact Assessment

5.3.2.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas

Based on a review of relevant maps and satellite imagery, it was determined that most state forest land within the construction work areas does not include developed recreational areas (i.e., areas with facilities such as parking, campsites, boat launches, and hiking trails). This is also true for the WMAs because they are primarily designated for undeveloped recreational use. Generally, the land affected by construction of the pipeline consists of open public land available for informal recreation and does not include any developed areas, with the exception of off-road trails, all-terrain vehicles trails, and snowmobile trails.

During construction, impacts on parks, forests, and special management areas within the construction work areas include removal of existing vegetation, grading, excavation, pipeline installation, and reconstruction (for trails). Access to the affected land would be limited or restricted during this time. The Applicant may need to temporarily close or restrict access to non-motorized and off-road trails within state forests during construction of the pipeline across any trails. Enbridge would cross trails using either the bore or open-cut methods. With use of a bore crossing, no impacts on the trail are expected. If the open-cut method is used, Enbridge would complete pipeline installation activities across trails within 48 hours.

Construction in any location could last for several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; therefore, limited use, access restrictions, as well as noise and visual disturbance could occur during this timeframe. When construction activities are completed, recreational activities on the affected acres could resume as normal. Additional detail on noise and visual disturbance is provided in Sections 6.2.2 and 6.2.3, respectively.

At the county level, the majority of the land disturbed during construction (158 acres) would occur in state forests and WMAs in Aitkin County (Table 5.3.2-1). Based on a review of forest and WMA maps, the disturbed land represents a very small portion (less than 1 percent) of the total amount of land that remains available in each forest and WMA that would be crossed by the pipeline. In total, over 388,000 acres of land in the same forests and WMAs in Aitkin County would not be affected and would remain available for recreation during construction. This is also true in Pembina County, North Dakota, in the Pembina County Waterfowl Production Area (5 acres affected of 640 acres), in Cass County (216 acres of 96,876 total), Wadena County (116 acres out of 33,963 total), and Hubbard County (36 acres of 45,290 total). Therefore, impacts on access to forests and WMAs are anticipated to be temporary and minor, because restrictions would be confined to small portions of the total land available for recreation, and any closures would be limited to these areas during and immediately following construction.

State-Designated Land-Based Trails

For a short time during pipeline installation, construction-related activities would affect public access and use of land-based trails where the pipeline crosses the trail. The Applicant proposes to use the bore or open-cut method at trail crossings. If the latter is used, trail use at the intersection with the pipeline would be suspended for 48 hours during construction. After completion of pipeline installation, the Applicant would restore the trail surface to allow passage.

Based on a review of the trail route map for the 120-mile Paul Bunyan and the 90-mile Willard Munger state trails, the pipeline crossing would occur in areas with no designated public access or facilities. The crossing of the Paul Bunyan State Trail would occur near the middle of the trail just south of Backus, which does not include any public access points or recreational facilities. The pipeline would also cross the Willard Munger State Trail just north of Mahtowa, in an area with no public access points or recreational facilities. Construction-related impacts on these trails likely would result in a temporary restriction on recreational access during pipeline installation where the pipeline crosses over. Based on the overall length of the trails and alternative locations to access them, a temporary negligible impact on the recreational access of state trails is likely.

For the Hunter Walking Trail, the Applicant has stated that access would be maintained during the hunting season. Noise and visual disturbance may continue to affect the recreational experience in the

affected areas during construction; however, restrictions in access at the pipeline crossing would no longer be necessary. Therefore, impacts on the recreational access to the Hunter Walking Trail would be temporary and negligible. Overall, impacts on the recreational access of state-designated land-based trails are anticipated to be temporary and negligible, since impacts are confined to the area where the pipeline crosses the trail and any restrictions to access at these intersections would be limited to during and immediately following construction.

State-Designated Water Trails and Trout Streams

The Applicant's preferred route would cross five state-designated canoe and boating trails and five state-designated trout streams in Minnesota. No water trails or trout streams would be crossed by the Applicant's preferred route in North Dakota or Wisconsin. This assessment focuses on state-designated water trails as these are expected to have the highest number of visitors and would result in larger impacts on county tourism if use was disrupted.

For the Red River of the North in Kittson County, the Red Lake River in Pennington County, the Crow Wing River in Wadena County, and the Mississippi River in Clearwater and Aitkin counties, the Applicant has proposed using HDD crossing methods to prevent any disturbance of the river during construction. Therefore, public use of these rivers would not be interrupted, resulting in no impacts.

The Applicant does not propose using HDD methods to cross the Pine River. Depending on the crossing method, impacts may include temporary limits on access where the pipeline crosses over, construction noise, and downstream turbidity. Public use and access to the Pine River where the pipeline crosses over would be temporarily interrupted to allow installation of the pipeline. After the pipeline is installed, river users would be allowed to cross the construction area. Based on a review of the trail route map, the pipeline crossing would occur near the end of the trail (on or around River Mile 45 of 59 miles), which does not include any public access points or recreational facilities. Construction-related impacts on the Pine River likely would result in a temporary restriction on recreational access during pipeline installation where the pipeline crosses over. Based on the overall length of the Pine River and alternative sites to access the river, a temporary negligible impact on recreational access to the Pine River is likely.

For trout streams, the Straight River is the only waterbody for which the Applicant has specified the use of HDD crossing methods, and no impacts on recreational use of this waterbody are expected. Crossing methods for King Creek, Spring Brook, Blackhoof River, and the unnamed stream are unknown. Depending on the crossing type, impacts could include temporary limits on access. Restrictions would be limited to where the pipeline crosses over, resulting in temporary negligible impacts on recreational access to these streams.

The Applicant has proposed to develop a site-specific crossing plan for La Salle Creek. The Applicant also has consulted with Minnesota DNR regarding lessons learned related to construction methods and alignment at La Salle Creek by other third-party pipeline operators, including the potential for an unanticipated release of drilling fluid used during HDDs (i.e., a frac-out) (Enbridge 2016). The construction method and alignment at the La Salle Creek crossing have been modified as a result of Minnesota DNR's concerns.

Overall, restrictions on recreational use of trout streams are likely to be temporary and limited to the duration of pipeline installation. In addition, the Applicant has proposed no in-channel work during peak trout season in each waterbody. Because impacts on these streams would be temporary and would not

occur during designated trout fishing seasons, temporary negligible impacts on recreational access to trout streams are anticipated.

Scenic Byways

The Applicant's preferred route would cross scenic byways (the Great River Road, the Lake Country, and Veterans Memorial byways) using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction would not disrupt use of the byways, resulting in no impacts. Impacts associated with aesthetic changes along scenic byways are discussed in Section 6.2.3.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas

Construction could disrupt the activities or alter the recreational experience of people who regularly use the affected areas for specific recreational purposes. These impacts would be temporary and minor, and would be limited to small portions of the overall recreational area. (See discussion above for "Recreational Access Limitations.") A review of state forest and WMAs maps revealed that the majority of the land crossed by the Applicant's preferred route does not include developed recreational areas (e.g., facilities and trails), which are more likely to attract visitors from outside of the area. Therefore, it is likely that impacts would be limited to local people who live in and around the immediate area.

During construction, local recreational users could re-locate to undisturbed areas throughout each of the state forests and WMAs, given the overall size of these areas relative to the area affected by the construction footprint (531 acres of land disturbed for construction of 715,273 acres of total land available) (Table 5.3.2-1). Construction-related impacts would likely result in a temporary, negligible impact on the number of recreation-based trips people take to state forests and WMAs because construction impacts would be temporary (several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions) and limited to areas with little opportunities for developed recreation. In addition, a variety of substitute or alternative sites both within the affected forest or WMA and in the county as a whole would be available to recreational users. Given the temporary nature of the activity and the opportunity to recreate in a variety of other places within each affected state forest and WMA, a loss of recreation-based visitation sufficiently large to measure in terms of recreational spending at the county-level is not expected. The impact on the recreational economies in each of the counties that would be crossed is expected to be temporary and negligible.

State-Designated Land-Based Trails

Construction-related impacts are likely to be confined to a specific segment of the affected trails for only a short period of time, and general access to the trails would not be restricted. Consequently, the change in overall recreation-based visitation to trails at the county level would not be large enough to measurably affect the amount of recreation-based tourism spending in any one county. Potential impacts on the recreational economy at the county level would be temporary and negligible.

State-Designated Water Trails and Trout Streams

Only the Pine River would be affected temporarily by construction of the Applicant's preferred route where the pipeline crosses the waterbody. Therefore, construction-related impacts on the recreational use of state-designated water trails likely would not be large enough to measure in terms of recreational spending at the county-level. Potential impacts on the recreational economies in the counties that would be crossed would be temporary and negligible.

As previously stated, impacts on trout streams would not occur during designated trout fishing seasons; therefore, impacts on the recreational use of trout streams likely would be temporary and negligible. Subsequently, temporary negligible impacts on the recreational economy at the county level are expected.

Scenic Byways

The Applicant's preferred route would cross scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. Therefore, there would be no impacts on the recreational economy.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access to parks, forests, and special management areas would not be restricted or limited as a result of maintenance mowing and inspections during operations. Aboveground facilities, MLVs, and permanent access roads also would not limit recreational access to parks, forests, or special management areas. Therefore, no impacts on recreational use of parks, forests, or special management areas are expected from operation of the pipeline for the Applicant's preferred route.

State-Designated Land-Based Trails

Access and use of state-designated trails that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection activities during operations. Aboveground facilities, MLVs, and permanent access roads would not limit recreational access to state-designated land-based trails. Therefore, no impacts on recreational use of land-based trails are expected during operation of the pipeline.

State-Designated Water Trails and Trout Streams

Access and use of state-designated canoe routes and other waterbodies that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection activities during operations. Aboveground facilities, MLVs, and permanent access roads would not affect recreation use of water trails and trout streams. Therefore, no impacts on recreational use of state-designated water trails or trout streams are expected during operations.

Scenic Byways

Access and use of federally and state-designated scenic highways that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection activities during operations. Aboveground facilities, MLVs, and permanent access roads would not affect recreational use. Therefore, no impacts on recreational use of scenic byways are expected during operations.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas

Because there would be no impacts on recreational use of forests or special management areas during operations for the Applicant's preferred route, there would be no impacts on the recreational economy in any of the affected counties.

State-Designated Land-Based Trails

Because there would be no impacts on recreational use of land-based trails during operations, there would be no impacts on the recreational economy in any of the affected counties.

State-Designated Water Trails and Trout Streams

Because there would be no impacts on recreational use of state designated water trails and trout streams during operations for the Applicant's preferred route, there would be no impacts on the recreational economy in any of the affected counties.

Scenic Byways

Because there would be no impacts on recreational use of scenic byways during operations for the Applicant's preferred route, there would be no impacts on the recreational economy in any of the affected counties.

5.3.2.3.2 Continued Use of Existing Line 3

Construction Impacts

No construction would be required for continued use of the existing Line 3, with no associated construction-related impacts on recreation and tourism resources.

Operations Impacts

Limitations to Recreation Access

Potential impacts on the use of recreational land or waterbodies could occur from integrity digs and subsequent pipeline repair if these activities occurred at crossings of recreational lands, including forests, land-based trails, and water trails. Impacts could include temporary access restrictions for the duration of inspections and repair work, which would occur only within the permanent right-of-way (except for access roads). The limited areal extent of such work and its short duration would result in no impacts on temporary, localized, and negligible impacts on recreational access depending on the location of the digs.

Changes to the Recreational Economy

Because of the localized areas that could be affected by integrity digs and their limited duration, no impacts are expected on the local recreational economy during continued operation of the existing Line 3 pipeline.

5.3.2.3.3 System Alternative SA-04

Construction Impacts

As discussed in Section 4.3.1, SA-04 would be constructed and operated in the same manner as the Applicant's preferred route. However, the route would be within the jurisdiction of other states and other local governments for approximately 544 miles, or 68 percent of the total route. The system alternative is over twice the length of the Applicant's preferred route and would cross more recreational land and waterbodies than the Applicant's preferred route.

Limitations to Recreation Access

Parks, Forests, and Special Management Areas

After reviewing satellite imagery and maps, it was determined that recreational use in the areas crossed by SA-04 in North Dakota and Minnesota is likely limited to more informal recreation, such as hunting, wildlife watching, fishing, and trapping. The geographic extent of the construction work area primarily crosses open land with limited modern facilities (795 acres within the Dakota Tallgrass Prairie WMA). The remaining areas crossed (115 acres) occur in Illinois along the Illinois and Michigan Canal, which provides recreational uses in mostly developed areas, including boating, camping, fishing, and hiking.

At the county level, the majority of the land disturbed during construction (795 acres) would occur in a WMA within Richland County, North Dakota (Table 5.3.2-2). However, a review of national wildlife refuge maps revealed that the disturbed land represents a very small portion (less than one-half of a percent) of the total amount of land that remains available in the WMA. In total, over 185,000 acres of land would remain unaffected and available during construction within the Dakota Tallgrass WMA in Richland County. This is also true in Pembina County, North Dakota within the Pembina County Waterfowl Production Area (5 acres affected of 640 total); in Whiteside County (1 acre of 6,030 total); and in LaSalle, Grundy and Will Counties in Illinois (177 acres of 1,130 total). Impacts on access to parks, forests, and special management areas are anticipated to be temporary and minor because access limitations would be confined to small portions of the total land available for recreation, and any closures would be limited to these areas during and immediately following construction.

State-Designated Land-Based Trails

The SA-04 route would cross the Sakatah Singing Hills State Trail in Minnesota, three trails in Illinois (Great River Trail, Hennepin Canal Feeder, and I&M Canal Path), and the Clinton-Camanche Multi-Purpose Regional Trail l in Iowa. Based on a review of the trail route map for the Sakatah Singing Hills trail, the pipeline crossing would occur at the end of the 39-mile trail, just east of Mankato, in an area with no designated public access points or recreational facilities. The pipeline also crosses the 66-mile Great River trail in Illinois just south of Albany in a location that does not include any public access points or recreational facilities. This is also true for the Hennepin Canal Feeder, a 155-mile trail, also in Illinois. SA-04 crosses the west side of the 62-mile I&M Canal Path trail near the Marseilles Dam, affecting the trail head.

Construction impacts in recreation areas would be similar to those described for the Applicant's preferred route, including temporary restrictions on public access and use of land-based trails where the pipeline crosses over for a short time during pipeline installation. Based on the limited number of crossings and temporary nature of the impacts, it is likely that construction-related impacts on the recreational use of land-based trails along the SA-04 route would be temporary and negligible.

State-Designated Water Trails and Trout Streams

The SA-04 route would cross three state-designated canoe and boating trails in Minnesota (Cedar River, Chippewa River, and Minnesota River) and four in Iowa (Little Cedar River, Little Wapsipinicon River, Mississippi River, and Wapsipinicon River). Although the crossing methods have not been identified, they were assumed to be similar to those described for the Applicant's preferred route. For most rivers, the Applicant has proposed using HDD crossing methods to prevent any disturbance of the river during construction. Public use of these rivers would not be interrupted when HDD is used. Where the Applicant does not propose using HDD methods, impacts may include temporary limits on access where the pipeline crosses over. Based on the limited number of crossings and overall lengths of the rivers relative to where they intersect with the pipeline (i.e., offering ample opportunities for public access) it is expected that construction would result in temporary, negligible impacts on recreational access.

In Minnesota, the SA-04 route would cross two trout streams; no trout streams would be crossed in Iowa, Illinois, or North Dakota. Although the crossing methods are unknown, they were assumed to be similar to those described for the Applicant's preferred route. HDD crossings would result in no impacts, and other crossing methods could include temporary limits on access where the pipeline crosses over. Furthermore, the Applicant has proposed no in-channel construction during trout season. Based on the limited number of crossings of trout streams (only two and only in Minnesota), it is likely that construction-related impacts on the recreational use of trout streams would be temporary and negligible.

Scenic Byways

SA-04 would cross three national byways in Iowa and on the border of Iowa and Illinois (Grant Wood, Great River Road, and Green River Road) (see Figure 5.3.2-2). The Applicant would cross each of the scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction would not disrupt use of the byways along SA-04, resulting in no impacts on recreational access.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas

Construction of a pipeline along the SA-04 route could disrupt access to recreation sites and could affect the activities or alter the recreational experience of people who regularly use the affected areas for specific recreational purposes. These impacts would likely be temporary and localized, and limited to small portions of the overall recreational site (i.e., 978 acres of 382,750 acres available). A review of relevant maps and satellite imagery revealed that the majority of the land crossed by the route does not include developed recreational areas (e.g., facilities and trails) that are more likely to attract visitors from outside of the area. It is likely, therefore, that impacts would be limited to local people who live in and around the immediate area. During construction, it also is likely that local recreational users could re-locate to undisturbed areas throughout each of the state forests, parks and WMAs, given the overall size of these areas relative to the area affected by the construction footprint. Overall, construction-related impacts on the recreational economy would be temporary and negligible because (1) construction would move through an area relative quickly (several days to several weeks) and would be limited to areas with very little opportunities for developed recreation; and (2) a variety of substitute or alternative sites—within the affected park, forest, or WMA and in the county as a whole—would be available for recreational users.

Given the temporary nature of the construction activity and the opportunity to recreate in a variety of other places in the county, it is not expected that the loss of recreation-based visitation would be large enough to measure in terms of recreational spending at the county-level, resulting in a temporary, negligible impact on the recreational economies in each of the counties crossed.

State-Designated Land-Based Trails

Since construction-related impacts would be confined to specific segments of trails and general access to trails would not be limited, the change in overall recreation-based visitation to trails at the county level would not be large enough to measurably affect the amount of recreation-based tourism dollars the county receives. Subsequently, this would result in a temporary and negligible impact on the recreational economy at the county level.

State-Designated Water Trails and Trout Streams

Because of the limited number of crossings with associated impacts and the temporary nature of the impacts, it is likely that construction-related impacts on the recreational use of state-designated water trails would not be large enough to measure in terms of recreational spending at the county-level, resulting in a temporary negligible impact on the recreational economy.

Based on the limited number of trout stream crossings (only two and only in Minnesota), it is likely that construction-related impacts on the recreational use of trout streams would be temporary and negligible, with a corresponding temporary and negligible impact on the recreational economy of the affected counties.

Scenic Byways

The Applicant would cross each of the scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction impacts on scenic byways would not affect the recreational economy of the affected counties.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas

Operation of the SA-04 pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Recreation access would not be restricted or limited as a result of these activities. Aboveground facilities, MLVs, and permanent access roads would not limit recreational access to state parks, forests, or special management areas. Therefore, no impacts on recreational use of parks, forests, and special management areas are expected during operation of the pipeline.

State-Designated Land-Based Trails

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access and use of state-designated trails that would be crossed by the SA-04 route would not be affected during operational activities. Aboveground facilities, MLVs, and permanent access roads would not affect recreational access to state-designated land-based trails. Therefore, no impacts on recreational use of land-based trails are expected during operation.

State-Designated Water Trails and Trout Streams

Access and use of state-designated canoe routes and other waterbodies that would be crossed by the SA-04 route would not be affected during maintenance mowing and inspection operation activities. Aboveground facilities, valves, and permanent access roads would not affect the recreational use of state-designated water trails and trout streams. Therefore, no impacts on recreational use of state designated water trails and trout streams are expected during continued operation of the pipeline.

Scenic Byways

Access and use of federally and state-designated scenic highways that would be crossed by the SA-04 route would not be affected during maintenance mowing and inspection operation activities. Aboveground facilities, MLVs, and permanent access roads would not affect recreational use of scenic byways. Therefore, no impacts on recreational use of scenic byways are expected during operation.

Changes to the Recreational Economy

Parks, Forests and Special Management Areas

Since recreational use of parks, forests, and special management areas would not be affected during operations, there would be no impacts on the recreational economy in any of the counties crossed.

State-Designated Land-Based Trails

Since recreational use of state-designated land-based trails would not be affected during operations, there would be no impacts on the recreational economy in any of the counties crossed.

State-Designated Water Trails and Trout Streams

Since recreational use of state designated water trails and trout streams would not be affected during operations, there would be no impacts on the recreational economy in any of the counties crossed.

Scenic Byways

Because recreational use of scenic byways would not be affected during operations, there would be no impacts on the recreational economy in any of the counties crossed.

5.3.2.3.4 Transportation by Rail

Construction Impacts

Limitations to Recreation Access

The rail alternative includes construction of a new offloading facility in Clearbrook, Minnesota; an offloading facility in Superior, Wisconsin; and upgrades and expansion of existing rail infrastructure. The land that would be permanently converted for facility construction and expansion is not currently designated for recreational purposes. It is mostly mixed-use, industrial, and agricultural land. Therefore, construction activities associated with transportation by rail would not affect recreational use.

Changes to the Recreational Economy

Because none of the new or expanded loading/offloading facilities or railway spurs would be constructed on land used for recreational purposes, construction activities for the transportation by rail alternative would not affect the local recreational economy.

Operations Impacts

Limitations to Recreation Access

Continued shipment of crude oil via rail would not be expected to affect recreational use of parks, forests, special management areas, land-based trails, water trails, trout streams, or scenic byways. Consequently, no impact on overall recreational visitation would result. However, one of the rail routes (Superior South) crosses through the Detroit Lakes and the Brainerd Lakes areas, which are popular vacation destinations for people inside and outside of Minnesota. An increase from 3 to 10 unit trains per day would increase the average daily gate down-time and obstruction of local traffic at rail crossings. Gate down-time is a function of train speeds, which vary by both regulation and rail system operational requirements (waiting on passing tracks, dispatch within various segments of each route, and train crew work schedules). As discussed in Section 5.3.3, gate down-time ranges from 2.3 minutes at 50 mph typical in rural areas to 3.0 minutes at 35 miles per hour, which may be typical in populated areas. In rural areas with little roadway traffic, the increase in blockage of at-grade crossings would have a minor effect but would be a permanent impact on people who visit these areas on vacation. Therefore, with respect to access to these areas as a tourist destination, it is expected that operation of the rail line to transport crude oil would result in a permanent, minor impact.

Changes to the Recreational Economy

While the increased rail traffic is likely to have a permanent, minor impact on access to two popular tourist destinations because of an increase in blockage of at-grade crossings, it is not expected that this would deter people from choosing these areas as a vacation destination. Therefore, it is expected that continued operation of the rail line would have a permanent, negligible impact on the recreational economy in Becker or First Island counties.

5.3.2.3.5 Transportation by Truck

Construction Impacts

Limitations to Recreation Access

The truck alternative includes construction of a new offloading facility in Clearbrook, Minnesota; an offloading facility in Superior, Wisconsin; and new local access roads to these facilities. The land that would be permanently converted for facility construction and expansion is not currently designated for recreational purposes. It is mostly mixed-use, industrial, and agricultural land. Therefore, construction activities associated with transportation by truck would not affect recreational use.

Changes to the Recreational Economy

Because construction associated with the truck alternative would not affect recreational use, there would be no construction-related impact on the recreational economies in the counties crossed.

Operations Impacts

Limitations to Recreation Access

Shipment of crude oil via truck would not be expected to affect access to the recreational use of parks, forests, special management areas, land-based trails, or waterbodies, thereby causing no impact on overall recreational access. The increase in traffic along major truck routes and the increase in future traffic density (see Section 5.3.3.3.5) indicate that the potential for congestion along portions of the route may result in minor permanent impacts and major temporary impacts on traffic movement, thus

affecting the mobility of people who drive on these truck routes. If the increased volume of tanker trucks leads to congestion along intersections with scenic byways or leads commuters to use scenic byways to avoid the truck routes, the potential exists for permanent, negligible impacts on motorists along the scenic byways. A variety of alternate scenic highways do not intersect with potential truck routes, and trucks transporting crude oil primarily would travel on major interstates and avoid scenic byways. Therefore, it is likely that transportation of oil by truck would result in a permanent negligible impact on access to scenic byways.

Changes to the Recreational Economy

Shipment of crude oil via truck would not be expected to affect recreational use of parks, forests, special management areas, land-based trails, or waterbodies, thereby causing no impact on recreational economies at the county level. The potential permanent negligible impact on the access to some scenic byways would not be large enough to measurably affect the amount of recreation-based tourism spending at the county-level. Subsequently, this would result in a permanent, negligible impact on the recreational economy at the county level.

5.3.2.3.6 Existing Line 3 Supplemented by Rail

Construction Impacts

Limitations to Recreation Access

No construction-related impacts on recreation and tourism would result from continued use of the existing Line 3 pipeline because it is already built. As previously noted, none of the new or expanded loading/offloading facilities for rail transport would be constructed on land used for recreational purposes. Therefore, construction impacts from continued use of the existing Line 3 pipeline supplemented by transportation by rail would not affect recreational access.

Changes to the Recreational Economy

No construction-related impacts on recreation and tourism would result from continued use of the existing Line 3 pipeline because it is already built. As previously noted, none of the new or expanded loading/offloading facilities or railway spurs would be constructed on land used for recreational purposes. Therefore, construction impacts from continued use of the existing Line 3 pipeline supplemented by transportation by rail would not affect the recreational economy at the county level.

Operations Impacts

Limitations to Recreation Access

No impacts on the use of recreational land or waterbodies would be associated with continued operations of the existing Line 3 pipeline unless integrity maintenance digs are required at crossings of recreational lands. Impacts on recreation and tourism during integrity digs and subsequent excavation and repair work for continued use of Line 3 would be the same as those described above for the existing Line 3 alternative. Impacts of integrity digs are expected to be temporary, localized, and limited to the permanent right-of-way, resulting in no impact to a negligible impact (depending on the location of the dig) on recreational access.

Shipment of crude oil via rail would not be expected to affect recreational use of parks, forests, special management areas, land-based trails, water trails, trout streams, or scenic byways. Consequently, no impact on overall recreational access would result, with the exception of the increase in blockage of at-

grade crossings in the Detroit and Brainerd Lakes areas. The impact would be minor but a permanent impact on people who visit these areas on vacation.

Changes to the Recreational Economy

Due to the small areas that could be affected by integrity digs during continued operation of the Line 3 pipeline and their temporary duration, no impacts are expected on the local recreational economy. In addition, rail transport would not be expected to affect recreational use of parks, forests, special management areas, land-based trails, water trails, trout streams, or scenic byways. Consequently, no impact on overall recreational visitation or on recreational economies at the county level would result. While the increased rail traffic is likely to have a permanent minor impact on access to two popular tourist destinations caused by increased blockage of at-grade crossings, it is not expected that people would be deterred from choosing these areas as a vacation destination. Consequently, continued operation of the rail line is expected to result in a permanent, negligible impact on the recreational economy in either Becker or First Island counties.

5.3.2.3.7 Existing Line 3 Supplemented by Truck

Construction Impacts

Limitations to Recreation Access

Continued use of the existing Line 3 pipeline would not result in construction-related impacts on state parks, forests, special management areas, state-designated land-based trails, water trails, trout streams or scenic byways because it is already built. As previously noted, none of the new or expanded loading/offloading facilities for truck transport would be constructed on land used for recreational purposes. Therefore, construction-related impacts associated with transportation by truck would not affect recreational access.

Changes to the Recreational Economy

Continued use of the existing Line 3 pipeline would not result in construction-related impacts on the local recreational economy because it is already built. Subsequently, construction for the truck alternative would not affect the recreational economy.

Operations Impacts

Limitations to Recreation Access

No impacts on access to recreational land or waterbodies would be associated with continued operations of the existing Line 3 unless integrity maintenance digs are required at crossings of recreational lands. Continued operation of the existing Line 3 could affect recreational land from integrity digs along the existing pipeline. Impacts of integrity digs are expected to be temporary, localized, and limited to the permanent right-of-way, thereby resulting in no impacts on temporary negligible impacts on recreational use. If the increased volume of tanker trucks leads to congestion along intersections with scenic byways, the quality of the experience for motorists could be reduced. However, the volume of trucks under this alternative would be less than under transportation by truck alone and is not anticipated to result in such congestion. Consequently, impacts the recreational access to scenic byways would be permanent but negligible.

Changes to the Recreational Economy

Due to the small areas that could be affected by integrity digs during continued operation of the Line 3 pipeline and their temporary duration, no impacts are expected on the local recreational economy. In addition, truck transport would not be expected to affect recreational use of parks, forests, special management areas, land-based trails, water trails, trout streams, or scenic byways, thereby causing no impact on recreational economies at the county level. Transportation by truck could result in a permanent negligible impact on recreational use of scenic byways from potential (but unlikely) increased congestion. Because it is unlikely that this impact would be large enough to measure in terms of recreational spending at the county-level, the impact on local recreational economies would be permanent but negligible.

5.3.2.4 Summary and Mitigation

5.3.2.4.1 Summary

Table 5.3.2-3 presents the results of the analysis of potential impacts on access to recreational resources and subsequent impacts on recreational economies at the county-level from construction and operation of the Applicant's preferred route and the CN Alternatives. The Applicant's preferred route and system alternative SA-04 would have temporary and minor impacts on recreational access to state forests and WMAs, but these impacts would not be large enough to measure in terms of recreational spending at the county level. Impacts on the recreational economies for the two pipeline routes would be temporary and negligible. The affected recreation areas represent a small (less than one-half of a percent) portion of the total land area that remains available for recreational use. This is also true for impacts on state-designated land, water-based trails, and scenic byways. Based on the limited number of crossings compared to the overall trail/route length, the Applicant's proposed crossing methods, and plans to limit construction during designated hunting and fishing seasons, both the Applicant's preferred route and SA-04 would result in temporary negligible impacts on no impacts on access to these resources and therefore on recreational spending at the county level. Construction impacts from all of the other CN Alternatives would not affect recreational access to the described resources.

The analysis also found that recreational economies would not be affected unless construction for integrity digs on recreational land occurred during operations along the existing Line 3. Therefore, depending on the location of the digs, there would either be no impact or temporary and negligible impacts.

Recreation access would not be affected during operation of pipelines; therefore, the recreational economy would not be affected in the counties that would be crossed during operations. A potential exception is if the increased volume of trucks on the road or rail traffic would affect access to scenic byways or vacation destinations such as the Brainerd Lakes or Detroit Lakes areas. It is unlikely that this impact would deter people from using scenic byways altogether or keep them from vacationing in the Brainerd Lakes or Detroit Lakes areas. Therefore, operations for the rail and truck alternatives would result in permanent but negligible impacts on the recreational economies. This finding is also true for operations associated with the combined rail/truck alternatives.

5.3.2.4.2 Mitigation

Given the findings that impacts on recreational access and recreational economies would be negligible to minor, no mitigation measures were identified to further reduce impacts.

Table 5.3.2-3. Summary of Potential Impacts on Recreation and Tourism for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Line 3 Supplemented by Rail	Line 3 Supplemented by Truck
Construction Impacts							
Recreation access limitations to parks, forests, and special management areas during construction	Temporary/minor impacts • 526 acres	No impact	Temporary/minor impacts • 978 acres	No impact	No impact	No impact	No impact
Recreation access limitations to state-designated trails and trout streams during construction	Temporary/ negligible impacts • 20 snowmobile/ ATV trail crossings • 4 land trail crossings • 1 water trail crossing • 6 trout stream crossings No impact • HDD crossing methods • 4 water trails	No impact	Temporary/ negligible impacts • 25 snowmobile/ ATV trail crossings • 5 land trail crossings • 7 water trail crossings • 2 trout stream crossings	No impact	No impact	No impact	No impact
Recreation access limitations to scenic byways	No impact	No impact	No impact	No impact	No impact	No impact	No impact

Table 5.3.2-3. Summary of Potential Impacts on Recreation and Tourism for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Line 3 Supplemented by Rail	Line 3 Supplemented by Truck
Changes to the recreational economy during construction	Temporary/no impact to negligible impacts	No impact	Temporary/no impact to negligible impacts	No impact	No impact	No impact	No impact
Operations Impacts							
Recreation access limitations to parks, forests, and special management areas during operations	No impact	Temporary/no impact to negligible impacts during integrity digs	No impact	No impact	No impact	Temporary/no impact to negligible impacts during integrity digs	Temporary/no impact to negligible impacts during integrity digs
Recreation access limitations to state-designated trails and trout streams during operations	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Recreation access limitations to scenic byways	No impact	No impact	No impact	No impact	Permanent/ negligible impacts	No impact	Permanent/ negligible impacts
Recreation access limitations to tourist destinations	No impact	No impact	No impact	Permanent/minor impacts	No impact	Permanent/minor impacts	No impact
Changes to the recreational economy during operations	No impact	No impact	No impact	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts

ATV = all-terrain vehicle

5.3.2.5 References

U.S. Geological Survey, Gap Analysis Program (USGS GAP). 2016. Protected Areas Database of the United States (PAD-US). Version 1.4 Combined Feature Class. May.

5.3.3 Population

Population in the vicinity of the Applicant's preferred route and the CN Alternatives may be affected by construction of new facilities and operation of new or existing facilities. The population analysis focuses on how populations may be affected by the direct increase in Project-related workers. It does not consider indirect population changes from increased local economic activities. Such indirect changes in growth are expected to be limited because the Project-related workforce is transitory. The analysis of effects on local populations includes changes in local workforces and disruption to local populations by the following potential impacts:

- Increases in local workforces from the influx of non-local workers temporarily or permanently moving to an area to support construction or operations. Changes in workforce population may affect demand on emergency services, increase traffic congestion from commuting, and the availability of housing;
- Disruptions to high-population areas and other populated areas in proximity to construction work areas from noise, dust, and vibrations from construction and operations equipment; disruptions to traffic and services such as water and gas during construction, and permanent displacement of residences and structures during operations.
- Increased disturbance of population areas along existing rail and highway routes from additional train and truck use of rail lines and highways, and their effects on local infrastructure.

Potential impacts on populations from pipeline crude oil releases are discussed in Chapter 10.

This section first describes the existing populations within an area along the Applicant's preferred route and each of the CN Alternatives where populations could be affected by construction and operation of the Applicant's preferred route or one of the CN Alternatives (the ROI). The potential impacts of construction and operation for the Applicant's preferred route and the CN Alternatives on those populations are assessed next. A summary and comparison of potential impacts are included at the end of the section, followed by potential mitigation measures to reduce impacts.

5.3.3.1 Regulatory Context and Methodology

5.3.3.1.1 Regulatory Context

In Minnesota, the Commission must consider the existence and density of populated areas when routing a crude oil pipeline in the state (Minn. R. 7852.1900, Subp. 3[a]). North Dakota, Illinois, and Iowa do not have a state-specific environmental review process or any regulations that specifically address population in the determination of energy infrastructure. No specific standards related to the proximity of populated areas to pipeline facilities were identified other than compliance with local planning and zoning ordinances. See Section 6.2.1 for a discussion of planning and zoning.

5.3.3.1.2 Methodology

The analysis for impacts on population is broken into two components: impacts associated with the non-local workforce re-locating to communities near the Project, and impacts associated with construction and operation of the pipeline near densely populated areas.

The additional pipeline workforce may affect communities during construction or operation if existing infrastructure and services are not adequate. Additionally, routing a pipeline through population centers or areas of high population density is difficult because these areas have more infrastructure in place such as roads, structures, and utilities. A greater number of people potentially would be affected by noise, dust, population increase, and traffic during construction in these areas, which may exacerbate the magnitude and duration of impacts compared to less populated areas.

Non-Local Workforce

The net change to local populations from the influx of non-local workers was assessed by:

- Gathering current population statistics from the U.S. Census Bureau for the counties that would be crossed by the Applicant's preferred route and the CN Alternatives;
- Estimating the total population increase that could result from workers moving to the counties with their families;
- Identifying the areas where the total population increase in a county could be 10 percent or more, and the expected impacts of the increase; and
- Qualitatively assessing impacts related to population increases based on the percent and duration of change in population.

The ROI for the assessment of non-local workforce effects is the counties that are crossed by the Applicant's preferred route and the CN Alternatives (continued use of existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, and Line 3 supplemented by rail or truck). County-level data provide a summary of populations potentially affected by the influx of the construction workforce. Workers re-locating to the area would commute to work from various communities near, but not necessarily along, the pipeline route. The counties crossed by the pipeline reflect a reasonable estimate for where the workers are likely to re-locate and the level of current population that would be affected.

Populated Areas

Impacts on high-population areas and other populated areas that may occur from construction and operation of the Project were assessed by:

- Overlaying the Applicant's preferred route and the CN Alternatives on a map of high consequence areas that includes highly populated areas and other populated areas;
- Recording the total miles of populated areas crossed by the Applicant's preferred route and the CN Alternatives, and the total area of populated areas that would fall within 1,250 feet of the construction work area;
- Identifying all populated areas within the ROI; and
- Assessing the nature, extent, duration, and magnitude of impacts on populated areas and any measures to minimize potential impacts.

The ROI for the review of populated areas consists of the area within 1,250 feet of the construction footprint for the Applicant's preferred route and the CN Alternatives. For this analysis, "populated

areas," as defined by the U.S. Census Bureau, consist of incorporated areas or legal entities and census-designated places, which are statistical entities.

Data for populated areas within 1,250 feet of the routes were derived from the U.S. Census Bureau's Master Address File / Topologically Integrated Geographic Encoding and Referencing Database (U.S. Census Bureau 2015). Impacts on these areas were quantified in terms of the number of populated areas crossed, the extent of the pipeline crossing in these populated areas (i.e., miles crossed by the pipeline centerline), and the populated area (acreage) within 1,250 feet of construction. These metrics are intended to capture the number of communities most affected and the degree to which each community would be affected. The miles of an area crossed by the pipeline centerline quantifies the relative extent of impact, but does not reflect impacts on locations adjacent to the pipeline. Using a 1,250-foot buffer accounts for areas that may be affected by noise, dust, vibration, and increased traffic from construction (typical construction noise would most likely be within acceptable levels at a distance of 1,250 feet, as discussed in Section 6.2.2).

5.3.3.2 Existing Conditions

Populated areas and population density within those areas for the counties crossed by the Applicant's preferred route and CN Alternatives in Minnesota are shown in Figure 5.3.3-1.

5.3.3.2.1 Applicant's Preferred Route

The Applicant's preferred route would cross 14 counties in three states (Figure 5.3.3-1). The population density of all of the potentially affected counties is below the statewide average in all three states, which would indicate that the counties are primarily rural with few large population centers. The county with the highest population density is Crow Wing County in Minnesota, with 64 people per square mile (U.S. Census Bureau 2015). The population density of Minnesota as a whole is 69 people per square mile. The county with the lowest population density is Kittson County, also in Minnesota. Crow Wing County has the highest total population of all the counties, with 63,428 people; and Red Lake County in Minnesota has the lowest, with 4,055 people. The total population for the counties that would be crossed is 301,084 people. County population estimates for 2010 and 2015, the percentage population change between those years, and the population density for all counties crossed by the Applicant's preferred route are presented in Appendix N.

Table 5.3.3-1 lists the populated areas that occur along the Applicant's preferred route. For each populated area, the table also gives its population, the length of the route centerline that passes through the populated area, and the total acreage of populated areas that would be located within 1,250 feet of the construction work area. For the Applicant's preferred route, the total number of people in the populated areas that would be crossed is 92,535 people, the total miles of populated areas crossed would be approximately 10 miles, and the total acreage of populated areas within 1,250 feet would be approximately 3,314 acres.

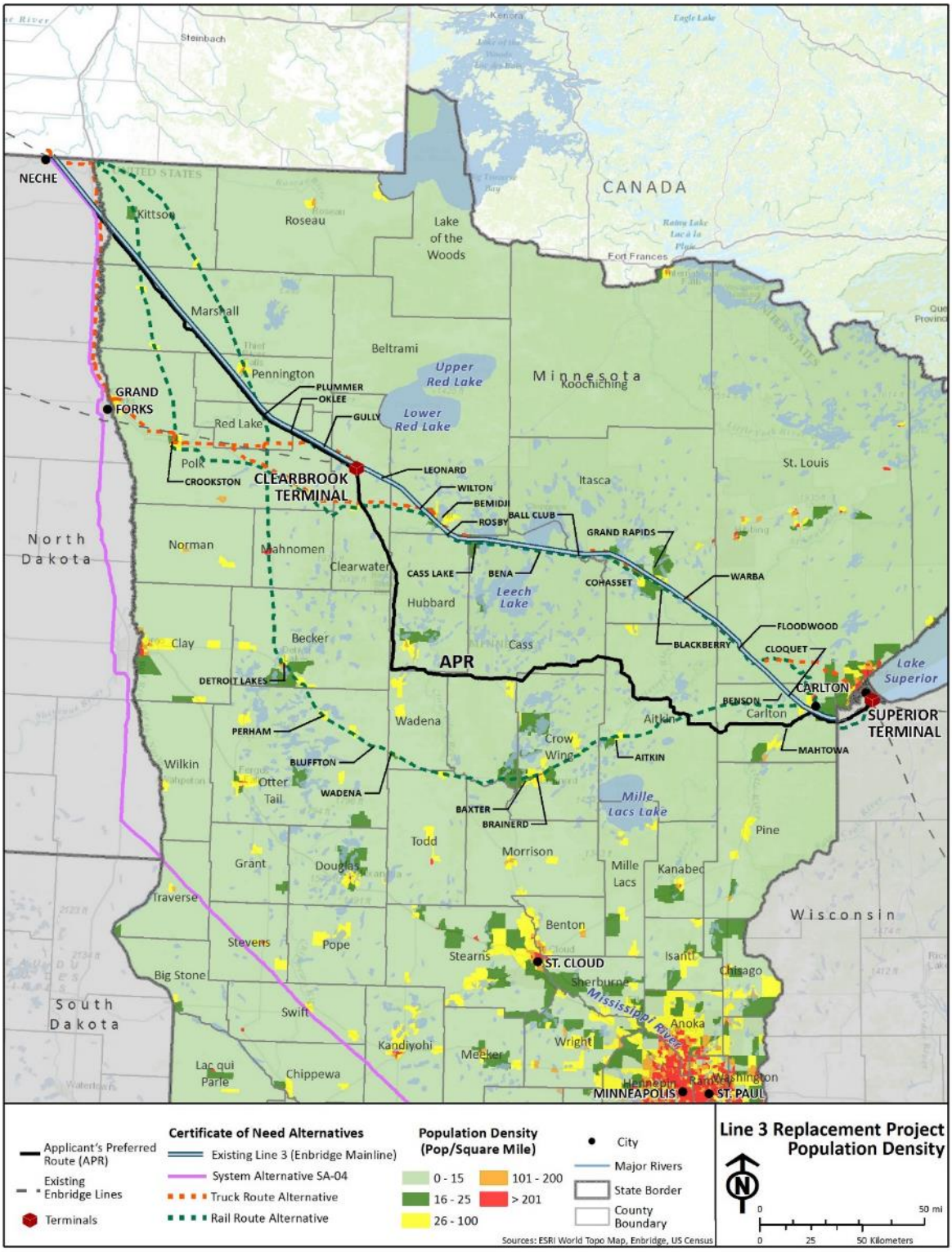

Figure 5.3.3-1. Population Density in the Counties Crossed by the Applicant's Preferred Route and the Certificate of Need Alternatives in Minnesota

Table 5.3.3-1. Populated Areas near the Applicant's Preferred Route

Populated Area	Population[a]	Miles of Populated Area Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
North Dakota			
None	None	None	None
Subtotal	***0.0***	***0.0***	***0***
Minnesota			
Gonvick	282	0.0	0
Gully	66	0.0	12
Oklee	435	0.8	215
Plummer	292	2.0	606
Trail	46	0.7	217
Clearbrook	518	0.0	70
Mahtowa	370	2.9	792
Mule Lake	--	0.0	3
Outing	--	0.0	41
Waukenabo	316	0.0	2
Carlton	862	0.0	84
Chub Lake	--	0.0	6
Wrenshall	399	0.1	79
Duluth	86,265	1.0	256
Subtotal	***89,851***	***6.5***	***2,383***
Wisconsin			
Superior	2,166	2.7	930
Subtotal	***2,166***	***2.7***	***930***
TOTAL	**92,017**	**9.9**	**3,313**

[a] Source: U.S. Census Bureau 2010.

"--" = these areas are not census-designated areas; therefore, population information is not available.

5.3.3.2.2 Continued Use of Existing Line 3

The existing Line 3 pipeline lies within the Enbridge Mainline corridor that follows a similar route to the Applicant's preferred route, except where the routes diverge between Clearbrook and Carlton in Minnesota (Figure 5.3.3-1).

Table 5.3.3-2 presents the number of people within the populated areas near the existing Line 3, the miles of populated areas that would be crossed by the pipeline centerline, and the total acreage of populated areas that would be located within 1,250 feet of the pipeline right-of-way.

Table 5.3.3-2. Populated Areas near the Existing Line 3 Pipeline

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
North Dakota			
None	None	None	None
Subtotal	***0.0***	***0.0***	***0.0***
Minnesota			
Gonvick	282	0.0	0
Gully	66	0.0	12
Oklee	435	0.8	215
Plummer	292	2.0	606
Trail	46	0.7	217
Ball Club	342	1.8	492
Bemidji	13,431	4.7	1,749
Bena	116	0.8	250
Big Lake	10,060	0.9	304
Blackberry	--	1.6	402
Cass Lake	770	1.6	566
Chub Lake	--	0.0	2
Cloquet	12,124	0.1	41
Cohasset	2,698	3.4	1,126
Coleraine	1,970	3.3	1,051
Deer River	930	0.0	9
Floodwood	528	0.4	173
Grand Rapids	10,869	4.6	1,509
Grant Creek	--	0.0	18
La Prairie	665	0.0	17
Leonard	41	0.2	54

Table 5.3.3-2. Populated Areas near the Existing Line 3 Pipeline

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
Midge Lake	--	0.0	15
Pinewood	--	0.0	39
Portage Lake	--	0.0	18
Rosby	--	0.6	155
Warba	181	1.0	344
Wilton	204	1.6	561
Zemple	93	1.1	311
Chub Lake	--	0.0	6
Wrenshall	399	0.1	79
Duluth	86,265	1.0	256
Subtotal	*142,807*	***32.3***	***10,596***
Wisconsin			
Superior	2,166	2.7	930
Subtotal	**2,166**	**2.7**	**930**
TOTAL	***144,973***	***35.0***	***11,526***

[a] Source: U.S. Census Bureau 2010.

"--" = these areas are not census-designated areas; therefore, population information is not available.

The total number of people in the populated areas near the existing Line 3 pipeline is 144,973 people, the total miles of populated areas crossed is approximately 35 miles, and the total acreage of populated areas within 1,250 feet is approximately 11,526 acres.

5.3.3.2.3 System Alternative SA-04

The route for SA-04 would cross 35 counties in four states (Figure 5.3.3-2). The total population of the counties that would be crossed by SA-04 is 1,887,320 people. The population in the counties along the SA-04 route ranges from a low of 3,401 people in Traverse County, Minnesota, to a high of 677,560 people in Will County, Illinois. The population densities are typically higher in counties along the SA-04 route compared to the counties along the Applicant's preferred route. The overall population density for counties along the SA-04 route is 73 people per square mile. County population estimates for 2010 and 2015, the percentage population change between those years, and the population density for all counties crossed by SA-04 are presented in Appendix N.

Table 5.3.3-3 presents the population of populated areas near SA-04, the miles of populated areas that would be crossed by the pipeline centerline, and the total acreage of populated areas that would be located within 1,250 feet of the construction footprint.

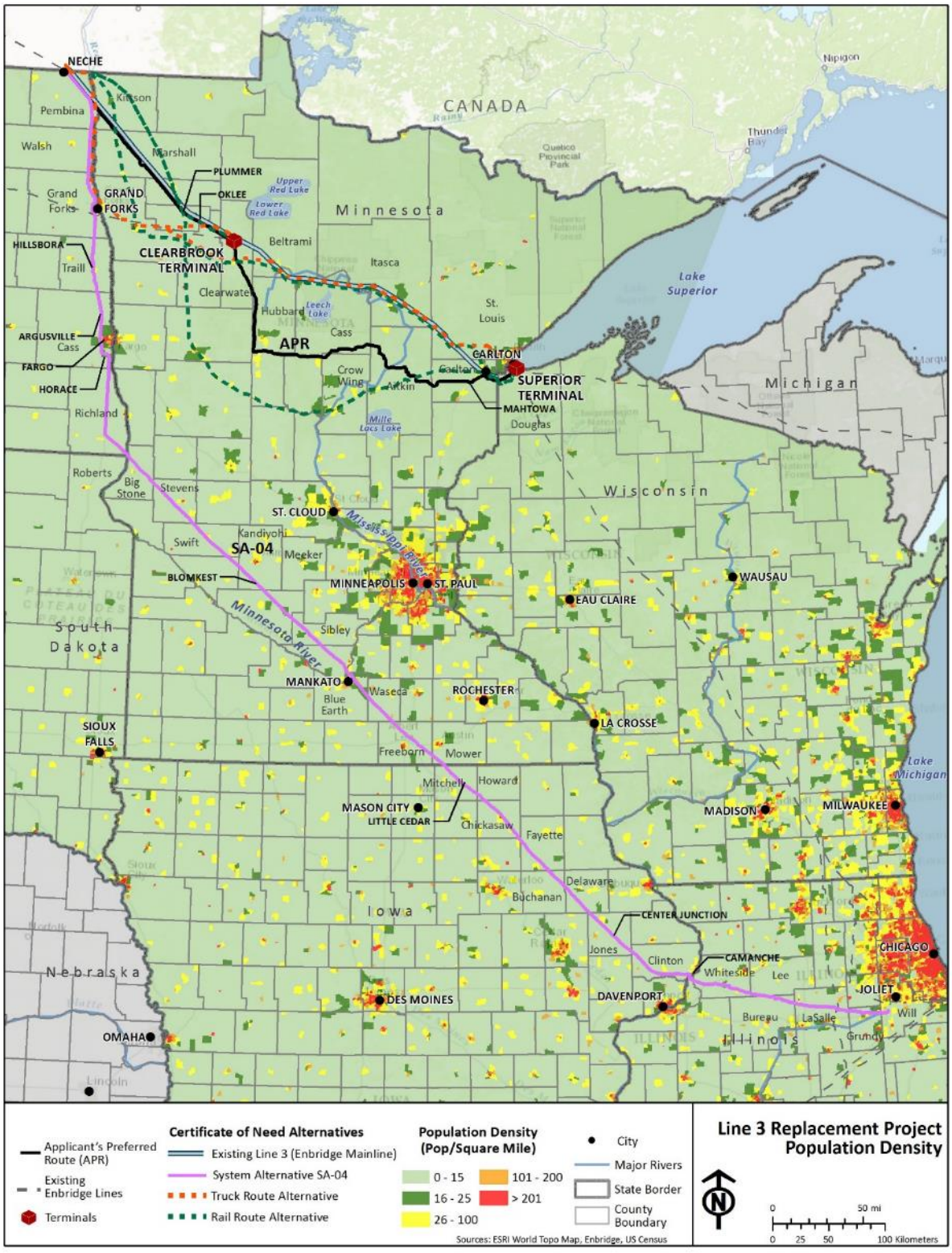

Figure 5.3.3-2. Population Density in the Counties Crossed by System Alternative SA-04

Table 5.3.3-3. Populated Areas near System Alternative SA-04

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
North Dakota			
Argusville	475	2.0	643
Drayton	824	0.0	104
Fargo	105,549	1.1	323
Gardner	74	0.8	234
Grand Forks	52,838	1.0	338
Grandin	173	0.0	28
Hillsboro	1,603	0.7	184
Horace	2,430	3.6	940
Manvel	360	0.0	43
West Fargo	25,830	0.0	256
Subtotal	***190,156***	***9.2***	***3,093***
South Dakota			
White Rock	3	0.0	0
Subtotal	***3***	***0.0***	***0***
Minnesota			
Benson	3,240	0.0	7
Blomkest	157	0.1	61
Eagle Lake	2,422	1.0	73
Hector	1,151	0.0	14
Lyle	551	0.0	49
Mankato	39,309	0.0	341
Subtotal	***46,830***	***1.2***	***546***
Iowa			
Aurora	185	0.0	1
Camanche	4,448	3.5	898
Center Junction	111	0.1	58
Little Cedar	60	0.4	129
Subtotal	***4,804***	***4.0***	***1,086***
Illinois			
Morris	13,636	0.2	64
Mendota	7,372	0.0	0

Table 5.3.3-3. Populated Areas near System Alternative SA-04

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
Channahon	12,560	3.6	1,151
Subtotal	***33,568***	***3.8***	***1,215***
TOTAL	**275,361**	**18.2**	**5,939**

[a] Source: U.S. Census Bureau 2010.

The total population of the populated areas within 1,250 feet of SA-04 is 275,361 people, the total miles of populated areas crossed would be approximately 18 miles, and the total acreage of populated areas within 1,250 feet of the construction footprint would be 5,939 acres.

5.3.3.2.4 Transportation by Rail

The rail alternative includes construction of a new offloading facility in Clearbrook, Minnesota, an offloading facility in Superior, Wisconsin, and upgrades and expansion of existing rail infrastructure. The likely routes for transportation by rail and counties crossed are shown in Figure 5.3.3-1. During operations, unit trains traveling between near Gretna and Clearbrook or Superior would transit through some populated areas and require closure of at-grade crossings during train passage. The increased number of train passages would increase the amount of time each day that rail crossings would be obstructed and movement of vehicular traffic blocked.

Table 5.3.3-4 lists populated areas and the size of the local population located near potential construction sites for rail loading, rail offloading, and rail improvement sites.

Table 5.3.3-4. Populated Areas near Potential Construction Sites for Transportation by Rail

Populated Area	Population[a]	Construction Type
Thief River Falls, Minnesota	8,573	Rail line improvement
Plummer, Minnesota	292	Rail line improvement
Oklee, Minnesota	435	Rail line improvement
Trail, Minnesota	46	Rail line improvement
Gully, Minnesota	66	Rail line improvement/new rail line
Gonvick, Minnesota	282	New rail line
Clearbrook, Minnesota	518	Loading facility/new rail line
Superior, Wisconsin	2,166	Offloading facility/new rail line
TOTAL	**12,378**	

[a] U.S. Census Bureau 2010.

Tables 5.3.3-5 through 5.3.3-7 list the population centers and the size of the local population through which likely rail routes to Clearbrook and Superior would pass. Depending on their proximity to the rail line, portions of these populations could experience increases in noise and dust from passing trains. Increased rail traffic also would extend the amount of time each day that local at-grade crossings would be blocked by passing trains and local traffic movements would be obstructed. Table 5.3.3-8 shows the number of rural and urban at-grade crossings along each potential route. For at-grade crossings, the Federal Railroad Administration's designation of a "population center" is different from the designation of a "populated area" by the U.S. Census Bureau (see table notes). Annual crossing incidents also are shown in Table 5.3.3-8.

Table 5.3.3-5. Populated Areas near the Northern Rail Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
Minnesota			
Ball Club	342	1.2	418
Bemidji	13,431	4.7	1,911
Bena	116	0.3	239
Blackberry	--	0.0	542
Brookston	141	1.1	2238
Carlton	862	1.3	361
Cass Lake	770	1.2	487
Cloquet	12,124	7.3	2,179
Cohasset	2,698	5.0	1,523
Coleraine	1,970	1.6	508
Crookston	7,891	2.9	968
Deer River	930	0.9	324
Donaldson	42	1.5	374
Duluth	86,265	1.2	381
Ebro	64	0.4	237
Erksine	503	0.9	255
Floodwood	528	0.8	238
Fosston	1,527	0.7	365
Grand Rapids	10,869	3.9	1,149
Hallock	104	2.9	582
Humboldt	45	0.4	68
Kennedy	193	0.8	241
La Prairie	665	1.3	382
Lengby	86	0.5	132

Table 5.3.3-5. Populated Areas near the Northern Rail Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
McIntosh	625	1.1	287
Mentor	153	1.5	453
Midge Lake	--	0.0	34
Portage Lake	--	0.0	2
Rosby	--	0.0	211
Scanlon	991	1.1	296
Shevlin	176	1.2	338
Solway	96	1.0	307
Stephen	658	0.8	224
Thomson	159	0.0	3
Warba	181	2.1	601
Warren	1,563	1.6	469
Wilton	204	2.2	641
Wrenshall	399	0.8	223
Zemple	93	0.0	51
Subtotal	***147,464***	***56.2***	***20,242***
Wisconsin			
Argyle	436	1.0	310
Bagley	210	1.8	518
Superior	2,166	2.2	619
Subtotal	***2,812***	***5.0***	***1,447***
TOTAL	**150,276**	**61.2**	**21,689**

[a] Source: U.S. Census Bureau 2010.

"--" = these areas are not census-designated areas; therefore, population information is not available.

Table 5.3.3-6. Populated Areas near the Southern Rail Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
Minnesota			
Aitkin	2,165	0.8	475
Aldrich	48	0.8	202
Baxter	7,610	5.1	1,553
Bejou	89	0.7	150
Bluffton	207	1.5	455
Brainerd	13,590	2.8	928
Brooks	141	1.5	406
Callaway	234	0.8	205
Carlton	862	1.1	330
Cloquet	12,124	0.0	316
Cromwell	234	2.0	614
Deerwood	532	1.8	516
Detroit Lakes	52,334	2.7	994
Erskine	503	0.0	82
Fond Du Lac	--	0.0	172
Frazee	1,350	1.1	424
Halma	61	1.2	309
Karlstad	760	1.7	439
Lake Bronson	229	0.8	231
Lancaster	340	0.9	356
Mahnomen	1,214	1.3	330
McGregor	391	1.2	359
Motley	671	1.2	335
New York Mills	1,199	1.0	291
Newfolden	368	0.9	277
Ogema	184	1.3	355
Perham	2,985	1.7	562
Pillager	469	0.8	175
Plummer	292	1.7	505
Staples	2,981	1.3	441
Strandquist	69	0.5	116
Tamarack	94	1.6	490

Table 5.3.3-6. Populated Areas near the Southern Rail Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
Thief River Falls	8,573	1.8	679
Thomson	159	0.0	3
Verndale	602	1.1	342
Wadena	4,088	2.2	679
Waubun	400	0.5	163
Winger	220	0.8	217
Wrenshall	399	0.8	223
Wright	127	0.0	461
Duluth	86,265	1.2	381
Subtotal	***205,036***	***50.20***	***16,080***
Wisconsin			
Superior	2,166	2.2	619
Subtotal	***2,166***	***2.2***	***619***
TOTAL	**207,202**	**52**	**16,699**

[a] Source: U.S. Census Bureau 2010.

"--" = these areas are not census-designated areas; therefore, population information is not available.

Table 5.3.3-7. Populated Areas near the Clearbrook Rail Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
Minnesota			
Clearbrook	518	0.7	232
Gonvick	282	1.1	372
Gully	66	0.5	138
Halma	61	1.2	309
Karlstad	760	1.7	439
Lake Bronson	229	0.8	231
Lancaster	340	0.9	356
Newfolden	234	0.9	277
Oklee	435	0.8	251
Plummer	292	1.7	505
Strandquist	69	0.5	116
Thief River Falls	8,573	1.8	679
Trail	46	1.3	357
TOTAL	**11,905**	**13.9**	**4,260**

[a] Source: U.S. Census Bureau 2010.

Table 5.3.3-8. At-Grade Crossings along Potential Rail Routes

Route	Route Length (miles)	Population Centers along the Route[a]	Population Center At-Grade Crossings[b]	Rural At-Grade Crossings[b]	Average Annual Crossing Incidents[c]
Northern route	354.8	11	198	291	1.6
Southern route	381.7	10	261	303	3.2
Clearbrook route	129.3	1	11	238	0.6

[a] Concentrations of more than 1,500 people. Source: Minnesota State Demographic Center City 2016.

[b] Source: Federal Railroad Administration, Office of Safety 2017

[c] Average of January 2012 through December-2016. Source: Federal Railroad Administration, Office of Safety 2016

5.3.3.2.5 Transportation by Truck

The truck alternative would include constructing a new offloading facility in Clearbrook, Minnesota, expanding an offloading facility in Superior, Wisconsin, and constructing new local access roads to these facilities. The likely routes for transportation by truck to each destination and the counties that would be crossed are shown in Figure 5.3.3-1. During operations, increased use of freeways and state highways would occur between near Gretna and Clearbrook or Superior. Increased use of local roads also would occur in the vicinity of the Clearbrook and Superior terminals.

Table 5.3.3-9 lists the populated areas and their populations that are located near potential construction sites for the truck alternative. Two populated areas were identified, one in Minnesota and one in Wisconsin—each with populations below 2,200 people. Tables 5.3.3-10 and 5.3.3-11 list the populations and the populated areas through which likely truck routes to Clearbrook and Superior would pass.

Table 5.3.3-9. Populated Areas near Potential Constructions Sites for Transportation by Truck

Populated Area	Population[a]	Construction Type
Clearbrook, Minnesota	518	Loading facility/new truck route
Superior, Wisconsin	2,166	Loading facility/new truck route
TOTAL	**4,076**	

[a] Source: U.S. Census Bureau 2010.

Table 5.3.3-10. Populated Areas near the Clearbrook Truck Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
North Dakota			
Drayton	824	0.0	129
Grand Forks	52,838	4.0	1,127
Manvel	360	<0.1	15
Neche	371	0.7	104
Pembina	592	0.0	86
Subtotal	***54,985***	***4.7***	***1,462***
Minnesota			
Clearbrook	518	0.26	144
Crookston	7,891	2.1	551
East Grand Forks	8,601	0.0	106
Fisher	435	0.0	59
Gonvick	282	1.2	3586
Gully	66	0.0	39
Trail	46	1.1	315
Subtotal	***17,839***	***4.7***	***1,567***
TOTAL	**72,824**	**9.4**	**3,029**

[a] Source: U.S. Census Bureau 2010.

Table 5.3.3-11. Populated Areas near the Superior Truck Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
North Dakota			
Drayton	824	0.0	129
Grand Forks	52,838	4.0	1,127
Manvel	360	0.0	15
Neche	371	0.7	104
Pembina	592	0.0	86
Subtotal	***54,985***	***4.7***	***1,461***
Minnesota			
Bagley	1,392	2.0	5912
Ball Club	342	1.1	414
Bemidji	13,431	6.7	2333
Bena	116	0.7	240
Blackberry	--	2.4	536
Cass Lake	770	3.0	784
Cohasset	2,698	4.9	1,493
Coleraine	1,970	1.7	534
Crookston	7,891	2.1	551
Deer River	930	0.8	290
East Grand Forks	8,601	0.0	106
Erskine	503	0.8	245
Fisher	435	0.0	59
Floodwood	528	0.8	210
Fosston	1,527	0.9	405
Grace Lake	--	0.0	109
Grand Rapids	10,869	3.9	1,157
Hermantown	9,414	3.2	980
La Prairie	665	1.3	419
McIntosh	625	1.1	294
Mentor	153	1.7	449
Midge Lake	--	1.5	317
Rosby	--	0.6	212
Shevlin	176	1.3	342

Table 5.3.3-11. Populated Areas near the Superior Truck Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Route Centerline	Populated Areas within 1,250 Feet of Route (acres)
Solway	96	1.0	307
Warba	181	2.3	585
Wilton	204	2.2	555
Duluth	86,265	8.7	2,634.0
Subtotal	***149,782***	***57***	***22,472***
Wisconsin			
Superior	2166	2.7	930
Subtotal	***2,166***	***2.7***	***930***
TOTAL	**206,933**	**64.4**	**24,863**

[a] Source: U.S. Census Bureau 2010.

"--" = these areas are not census-designated areas; therefore, population information is not available.

The Minnesota Department of Transportation reports road usage in two ways; annual average daily traffic (AADT) and heavy commercial annual average daily traffic (HCAADT). AADT is the total number of vehicles (in both directions) using a segment of the highway network on a daily basis while HCAADT is that portion of AADT that are trucks and other commercial vehicles. AADT and HCAADT along the routes from near Gretna to either Clearbrook or Superior are shown on Table 5.3.3-12. One-way traffic was assumed to be one-half of the values shown in Table 5.3.3-12.

Table 5.3.3-12. Existing Daily Traffic Levels – Truck Routes

Route	Annual Average Daily Traffic (AADT) (Vehicles per day-2010 to 2013)	Heavy Commercial Annual Average Daily Traffic (HCAADT) (Vehicles per day-2012)
Clearbrook – Highway 2	3,050	359
Superior – Highway 2	6,677	598

Source: Minnesota Department of Transportation 2017

5.3.3.3 Impact Assessment

An influx of workers to the area during construction may create excess demand for housing; traffic congestion; or strain on government services such as police, fire, hospitals, and schools. Construction of pipelines or other facilities can cause disruptions to populated areas from noise, dust, and vibrations from construction and operations equipment; disruptions to traffic and services such as water and gas; and displacement of residences and structures. Areas with greater populations and amenities (e.g., hotels and restaurants) may be able to absorb an influx of temporary workers more readily than areas with lower populations and fewer amenities. Conversely, the more populated the area, the more people

would be affected by construction (i.e., greater density of roads, residents, and businesses). Construction of facilities to support transportation by rail are truck could cause similar disruptions to local populations.

Additional rail and truck traffic also could cause congestion or temporary obstruction of local roadways during some portion of each day. The effects of increased rail traffic were assessed in relation to increased gate down-time and blockage of at-grade rail crossings in rural and urban settings. The effects of increased truck traffic were assessed in relation to increased traffic density at various traffic speeds, as traffic speeds would vary between rural and urban settings.

5.3.3.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Non-Local Workforce

Enbridge estimates that each construction spread would require about 600 workers, resulting in a total maximum workforce of 4,200 workers across seven different construction spreads between Neche, North Dakota, and Superior, Wisconsin. While it is likely that Enbridge would use some local workers, it was assumed as a conservative estimate that all workers would be non-local and would need to re-locate to the area during construction. Additionally, some workers could be accompanied by their families. However, given the transitory nature of pipeline construction, it is unlikely that all workers would re-locate with their families. According to the U.S. Census Bureau (2014), the average number of persons per household in the United States is about 3. If each of the non-local workers brought their families, the total increase in population across the entire route could be 12,600 people. This represents an increase to the current population of about 4 percent within all counties that would be crossed by the Applicant's preferred route.

In the event that two construction spreads occurred adjacent to each other during construction, a maximum of 1,200 workers could be present in a county at a given time. In the largest county crossed by the Applicant's preferred route (Crow Wing County, Minnesota), it would represent a 2-percent increase in population. In the smallest county crossed by the route (Red Lake County, Minnesota), it would represent 30 percent of the county's total population. Pembina County in North Dakota (17 percent) and Kittson County (27 percent), Marshall County (13 percent), and Clearwater County (14 percent) in Minnesota all would experience increases over 10 percent of their current population. Added population would create more traffic on roadways, as workers may need to commute from surrounding counties under the worst-case scenario. This could result in congestion on the roads and within the service industry area (e.g., restaurants and gas stations).The added population also could increase demand for emergency services, as discussed in Section 6.2.5. However, this increased need is expected to be temporary and minor.

As discussed in Section 6.2.4, the total housing available is expected to be adequate.

Overall, impacts related to the non-local workforce are expected to be minor and temporary but they could be major and temporary at times under some worst-case scenarios, such as when two spreads are located within the same county or if a high number of workers are accompanied by their families. Population increases of more than 10 percent would be considered a major impact.

Populated Areas

Overall, relatively few populated areas would be crossed by the Applicant's preferred route, and the areas that would be crossed have small populations. The 16 populated areas identified within 1,250 feet of the construction work area are more likely to be affected by pipeline construction because of the higher density of people, structures, and infrastructure.

As described in Section 6.2.2, calculations show that typical construction noise attenuates to levels below the daytime noise standards at 1,250 feet from the noise source. Applicant-proposed measures to limit noise during construction include limiting construction to daylight hours, maintaining equipment in good working order, limiting transportation to areas of active construction, and using manufacturer-supplied silencers when available. Detailed noise and vibration analyses are given in Section 6.2.2, and additional mitigation is identified there to further reduce noise or vibration impacts.

During construction, increased dust can be harmful or bothersome to people located near work areas. Construction-related dust is discussed in Section 5.2.7. Applicant-proposed measures to minimize dust include wetting construction areas and roadways.

The potential for displaced structures is increased when a pipeline is routed through populated areas. Structures in the permanent right-of-way would be need to be removed or re-located during construction. Section 6.2.4 further discusses the displacement of residences. Enbridge has reached agreements with landowners for all structures identified within the permanent right-of-way for the Applicant's preferred route.

Populated areas have a higher density of roads and driveways than more rural areas, and generally more traffic and more people could be affected by traffic congestion associated with movement of construction workers and equipment or road closures. To minimize traffic impacts, Enbridge has proposed to cross all paved roads using the bore technique or HDD. These methods would prevent road closures by tunneling underneath the road surface. Impacts on roads are further discussed in Section 6.2.5.

Interruptions to utility services would be more likely in areas of dense population because of the amount of infrastructure, with potential effects on more people. Applicant-proposed measures to minimize the potential for service interruptions from construction include consulting with all utility companies prior to construction and using the One-Call system prior to excavation, to ensure that all adjacent pipelines and underground utilities are properly marked prior to construction. Utilities are further discussed in Section 6.2.5.

Since relatively few populated areas would be crossed by the Applicant's preferred route, and the areas that would be crossed have small populations, impacts on populated areas during construction would be temporary and minor with implementation of the Applicant-proposed measures described above.

Operations Impacts

Non-Local Workforce

Enbridge estimates that operation of the pipeline would require few workers along the pipeline route. Therefore, there would be no influx of non-local workers, and populations of local communities would not be affected.

Populated Areas

During operations, populated areas may be affected through restrictions placed on land within the permanent right-of-way, such as prohibition of structures. This could prevent further development (both residential and commercial) within an easement; populated areas with more miles crossed by the pipeline centerline would have more land with this restriction. For the Applicant's preferred route, approximately 10 miles of populated areas would be crossed. While the restrictions would apply to the permanent right-of-way, existence of the permanent right-of-way would not restrict access across the easement or use of the easement. Typically, the pipeline would be buried at least 48 inches underground, and standard operations would not constitute a safety concern. Potential impacts associated with an accidental release of crude oil and associated emergency response procedures are discussed in Chapter 10.

Standard maintenance of the permanent right-of-way would include periodic mowing to prevent woody vegetation from interfering with inspection of the right-of-way or encroaching on the pipeline itself. In populated areas, mowing activity may be noticed by more people, but it would be infrequent and transitory.

Overall, operational impacts on populated areas would be negligible but permanent.

5.3.3.3.2 Continued Use of Existing Line 3

Construction Impacts

No construction impacts on populated areas would result from continued use of the existing Line 3 pipeline because it is already built.

Operations Impacts

Non-Local Workforce

No change in the local workforce is anticipated under continued operation of the existing Line 3 for normal operations. For pipeline maintenance, Enbridge estimates that about 267 pipeline integrity digs would be required per year. While the level of effort required for integrity digs and subsequent maintenance or repair would vary, the work is not expected to require additional personnel beyond the current workforce. Therefore, there would be no influx of non-local workers, and populations of local communities would not be affected.

Populated Areas

Integrity digs including pipeline excavation and repair have the potential to affect populations from noise, dust, and vibrations from maintenance and operations equipment. However, integrity digs are typically small, short timeframe construction projects. With implementation of Enbridge's existing BMPs to minimize noise, vibration, and dust, impacts would be temporary, minor, and localized.

5.3.3.3.3 System Alternative SA-04

Construction Impacts

Non-Local Workforce

Based on Enbridge's estimate that seven spreads would be needed to construct the 380-mile Applicant's preferred route, 14 to 15 spreads likely would be needed to construct the 795-mile long SA-04 route. This could result in a maximum of 9,000 workers relocating to the Project area. Given the transitory nature of pipeline construction, it is unlikely that all workers would re-locate with their families. However, if each of those workers was accompanied by their family members, a total influx of 27,000 people could re-locate to the Project area, which would represent a 1.4-percent increase to the total population of counties crossed by SA-04.

In counties where two construction spreads were located next to each other, non-local workers could total 1,200 people. In the smallest county crossed by the Applicant's preferred route (Traverse County, Minnesota), this would represent 35 percent of the county's total population. Pembina (17 percent), Walsh (11 percent), and Trail (15 percent) counties in North Dakota; Stevens (12 percent) and Swift (13 percent) counties in Minnesota; and Howard (13 percent) and Mitchell (11 percent) counties in Iowa would experience increases over 10 percent of their current population.

Added population would create more traffic on roadways and emergency services, as discussed in Section 6.2.5. Temporary housing in the counties with the highest population increases may become unavailable, requiring some workers to commute from surrounding counties under a worst-case scenario. However, the total housing available in the counties crossed by SA-04 is expected to be adequate. As with the Applicant's preferred route, overall impacts associated with non-local workers are expected to be minor and temporary in most areas crossed by SA-04. In some counties where an influx of workers would increase the local population by more than 10 percent, impacts could be major but temporary for the length of time it takes for one construction spread to be completed.

Populated Areas

The 24 populated areas identified within 1,250 feet of the construction work area are more likely to be affected by pipeline construction because of the higher density of people, structures, and infrastructure. The types of impacts felt in these areas would be similar to those described for the Applicant's preferred route, including noise, dust, increases in traffic, and potential disruption of local utilities. Impacts on populated areas would be greater for SA-04 than for the Applicant's preferred route because of the increased population and number of populated areas affected along SA-04. However, with implementation of measures similar to the Applicant-proposed measures summarized in Section 5.3.3.1, impacts during construction would likely be temporary and minor.

Operations Impacts

Non-Local Workforce

Operation of the pipeline would require few workers along the pipeline route; therefore, a minimal influx of non-local workers would not affect the populations of local communities.

Populated Areas

During operations, populated areas may be affected by restrictions placed on land within the permanent right-of-way. The exact location and amount of land that would be converted to industrial/developed

land for pump stations and valve sites is unknown but likely would be a larger amount than required for the Applicant's preferred route given the overall greater length of the SA-04 pipeline. Based on the length of SA-04 relative to the length of the Applicant's preferred route, disruptions to populated areas from restrictions placed on land within the permanent right-of-way likely would be greater. Standard maintenance of the permanent right-of-way would include periodic mowing to prevent woody vegetation from interfering with inspection of the right-of-way or encroaching on the pipeline itself. In populated areas, mowing activity may be noticed by more people, but it would be infrequent and transitory. Overall, operations impacts on populated areas would be negligible but permanent.

5.3.3.3.4 Transportation by Rail

Construction Impacts

Non-Local Workforce

The number of workers required to construct rail facilities is expected to be small (less than 100 temporary jobs). Because a measurable increase in population is unlikely in construction areas, impacts would be negligible and temporary.

Populated Areas

Populated areas located near construction for new or improved rail lines and rail facilities would experience similar construction impacts on those described for the Applicant's preferred route, including increased noise and dust from construction work. However, unlike pipeline construction, construction of the rail facilities would be more localized; would occur adjacent to existing industrial facilities; and would last for a longer period of time in one location, rather than moving linearly. People and businesses near construction sites may experience relatively greater impacts because of the higher population, but overall construction impacts would be temporary and minor.

Operations Impacts

Non-Local Workforce

During operation, transporting crude oil by rail is not likely to result in a substantial increase in workers re-locating to the area, either temporarily or permanently. It is likely that the majority of rail facility operators would be hired from the local workforce. If additional rail facility operators were required, the number of non-workers re-locating to the area would not likely measurably increase local populations in the ROI. Therefore, operations impacts related to changes in local workforces would be negligible and permanent.

Populated Areas

Impacts on populated areas during operation of the rail alternative include noise from trains and train horns in areas along rail tracks, and delays at road crossings when barriers are lowered to allow trains to pass. It is noted that these are existing impacts for populations located along active rail lines, but these impacts would be new to areas with inactive rail lines and with rail crossings that are currently inactive but would need to be re-instated as a result of the increased volume of oil. The rail alternative includes approximately 10 unit trains traveling along three possible rail routes. Therefore, a populated area along one of those routes could experience an increase of between 3 and 10 unit trains per day (each unit train comprises approximately 110 tank cars). In total, 10 populated areas along the Northern rail route, 11 populated areas along the Southern rail route, and 1 populated area along the Clearbrook rail route would be within 1,250 feet of the rail line (see Tables 5.3.3-5 to 5.3.3-7). For these areas, an increase in

noise and rail traffic could result in a permanent and minor to major impact, depending on the actual number of trains that would pass by each day.

An increase in 3 to 10 unit trains per day would increase the average daily gate down-time and obstruction of local traffic at rail crossings. The passing time for a unit train and the maximum gate closure time per day are shown in Table 5.3.3-13. Gate down-time is a function of train speeds, which vary by both regulation and rail system operational requirements (waiting on passing tracks, dispatch within various segments of each route and train crew work schedules). As Table 5.3.3-13 shows, that gate down-time ranges from 2.3 minutes at 50 mph typical in rural areas to 3.0 minutes at 35 mph, which may be typical in populated areas. These time intervals represent a potential cumulative increase of 23 to 30 minutes of additional blockage per day, but as a series of discrete events. In rural areas with little roadway traffic, the increase in blockage of at-grade crossings would have a minor effect but would be a permanent impact. In populated areas and in areas near the Clearbrook and Superior terminals, train speeds would be reduced, in some cases to speeds less than 35 mph, with a corresponding increase in blockage of at-grade crossings. In these areas, minor to major, permanent impacts on local traffic movement could occur. Table 5.3.3-8 shows that few population centers are located along potential rail routes; therefore, the number of high population areas potentially affected by major permanent impacts may be limited.

Table 5.3.3-13. At-Grade Crossing – Gated Down-Time by Train Speed

Train Speed[a]	Gate Down-Time[b]	Daily Access Limitation[c]	Speed Limit Description[a]
50 mph	2.3 minutes	23 minutes per day	Rural – all trains with 20 or more crude oil tank cars
40 mph	2.7 minutes	27 minutes per day	Crude oil trains with DOT-111 tank cars moving through High Threat Urban Areas
35 mph	3.0 minutes	30 minutes per day	Urban limited speed – shale crude oil trains through municipalities with populations of 100 thousand people or more

[a] Location speeds for trains based on their size and the populations traversed were established by the Federal Rail Administration/PHMSA Final Rule May 2015: Docket No. PHMSA-2012-0082 (HM-251).

[b] The gate down-time assumes a 110-unit train with 4 locomotives and 2 buffer cars equals 7,800-foot train length. Also assumed there would be a 30 second delay from when the gates descend until the train approaches the crossing

[c] The daily access limitation is the cumulative increase over a single day for all 10 trains.

5.3.3.3.5 Transportation by Truck

Construction Impacts

Non-Local Workforce

Similar to the rail alternative, the number of workers required for construction of truck facilities and roads is expected to be small and substantially lower than those needed for the Applicant's preferred route and SA-04. Because a measurable increase in population is unlikely in construction areas, impacts are expected to be negligible and temporary.

Populated Areas

Construction impacts at the truck offloading facilities would be similar to construction impacts for the rail alternative and would be associated with typical construction activities such as noise, dust, and traffic. Unlike pipeline construction, construction of the truck facilities would be more localized; would occur adjacent to existing industrial facilities; and would last for a longer period of time in one location, rather than moving linearly. With implementation of standard measures for dust suppression and noise reduction during construction, impacts on populated areas in the immediate vicinity of the construction sites would be temporary and minor.

Operations Impacts

Non-Local Workforce

During operation, transporting crude oil by truck is not likely to result in a substantial number of workers re-locating to a specific area, temporarily or permanently however, a workforce of approximately 4,000 truck drivers would be required in the region. If additional truck drivers and fleet maintenance personnel were required, the number of non-local workers re-locating to the area still would not be likely to measurably increase local populations in the ROI. Therefore, impacts related to changes in local workforces would be negligible and permanent.

Populated Areas

Additional trucks on regional highways and local roads associated with the truck alternative could significantly increase traffic density and generate potential traffic congestion along routes between the loading facility at Gretna and the offloading facilities at Clearbrook and Superior. As described in Section 4.2.6, to transport the proposed 760,000 bpd of oil carried by the Line 3 Replacement pipeline would require that approximately 4,000 tanker trucks per day be loaded and dispatched from Gretna. On average, approximately 1,920 trucks would travel each day from Gretna to the Clearbrook terminal and unload, and 2,080 loaded trucks would travel each day from Gretna to the Superior terminal.

Table 5.3.3-12 shows that AADT along the major highway route is 3,050 AADT to Clearbrook and 4,671 to Superior for traffic in both directions. The addition of 4,000 tanker truck trips per day in both directions (approximately 8,000 truck trips) would more than double daily traffic. Table 5.3.3-12 shows that the HCAADT is 359 vehicles to Clearbrook and 598 to Superior. The addition of tanker truck traffic to these routes could represent a three- to five-fold increase in heavy commercial traffic.

Changes in potential traffic density along truck routes as an indicator of increased congestion were assessed by estimating the average spacing between trucks and the additional trucks per mile at various speeds (Table 5.3.3-14).

At typical freeway speeds (65 mph), traffic density would increase by approximately 5 vehicles per mile on routes used jointly by trucks going to Clearbrook or to Superior, and approximately 3 trucks per mile for routes used by trucks traveling solely to one destination or the other. During inclement winter weather, freeway speeds likely would be reduced, thus increasing the traffic density. It also should be noted that, although the evaluation is based on average spacing between trucks, spacing is more likely to be random due to variation in the dispatch rate, truck speed, traffic over specific route segments, and weather conditions.

Table 5.3.3-14. Average Truck Spacing on Clearbrook and Superior Routes

Average Speed	Clearbrook Route[a] (1,920 trucks per day)		Superior Route[b] (2,080 trucks per day)		Joint Route (4,000 trucks per day)	
	Average Trucks/Mile[c]	Average Spacing (Feet)[d]	Average Trucks/Mile[c]	Average Spacing (Feet)[d]	Average Trucks/Mile[c]	Average Spacing (Feet)[d]
65 mph	2.5	2,112	2.7	1,956	5.3	996
45 mph	3.3	1,600	3.9	1,354	7.4	714
20 mph	8.1	652	8.8	600	16.7	317

[a] Assumes one round trip per day to Clearbrook (179 miles each way)

[b] Assumes one round trip every 2 days to Superior (360 miles each way)

[c] Assuming trucks would be dispatched over a 12 hour period each day, calculated the number of trucks dispatched per hour and divided by the average speed to get the average trucks per mile.

[d] Average spacing calculated by taking the average speed and dividing by the number of trucks dispatched per hour.

The increase in AADT and HCAADT along major truck routes and the increase in future traffic density indicate that the potential for congestion along portions of the route may result in minor permanent impacts and major temporary impacts on traffic movement, thus affecting the mobility of residents along truck routes.

Traffic density on state and county highways at lower speeds (45 mph) would increase between approximately 3 to 4 trucks per mile of traffic per day to accommodate the same number of trucks per day. Along State Highway 92 in particular, the addition of truck traffic to the Clearbrook terminal would cause a significant increase in AADT. It is likely that congestion on this truck route segment would result in major permanent impacts on the mobility of the local population without mitigation.

Traffic in urban areas on access roads off the freeway network near the Clearbrook or Superior terminals would typically operate at lower speeds (in the range of 20 mph). In these areas, the increase in traffic density could average from approximately 8 to 9 trucks per mile. A typical tractor-tailor combination may be approximately 65 feet long. This means that crude oil trucks would use approximately 585 lineal feet or 10 percent of the available roadway (a single lane). This assumes, however, that the trucks maintain average spacing. At lower speeds and maneuvering in stop-and-go traffic, density increases significantly, likely resulting in major local traffic impacts in the areas of the Clearbrook and Superior terminal accompanied by a reduction in local population access and safety. Such impacts would be major and permanent.

5.3.3.3.6 Existing Line 3 Supplemented by Rail

Impacts associated with continued use of the existing Line 3 pipeline supplemented by rail would be similar to the impacts described for each individual component of this alternative (see Sections 5.3.3.2 and 5.3.3.4). Impacts associated with construction of additional rail facilities would be similar to those described for the rail alternative, and the number of non-local workers from outside the local population is not expected to affect the overall population. Under this alternative, the volume of rail traffic would not increase as much as it would for transportation by rail alone. The lower rail traffic cause less noise-related impacts and fewer traffic delays at railroad crossings during operations, resulting in minor,

permanent impacts on populated areas along the rail routes. The number of integrity digs along the existing line would remain the same, resulting in localized minor temporary impacts on populated areas.

5.3.3.3.7 Existing Line 3 Supplemented by Truck

Impacts associated with continued use of the existing Line 3 pipeline supplemented by truck transportation would be similar to the impacts described for each individual component of the alternative (see Sections 5.3.3.2 and 5.3.3.5). Construction impacts associated with truck offloading facilities would be similar to those described for the truck alternative. No impact is expected from the number of non-local workers from outside the local population. Although the volume of truck traffic would be reduced, the additional number of trucks required for the truck alternative would increase traffic along the major routes between loading and offloading facilities. This would create a minor to major permanent impact on populations that travel along similar routes. This combined alternative therefore would result in minor to major, permanent impacts from traffic during operations.

5.3.3.4 Summary and Mitigation

5.3.3.4.1 Summary

Table 5.3.3-15 summarizes the impacts on populated areas for the Applicant's preferred route and each of the CN Alternatives. The potential change in the local workforce during construction of pipelines or offloading facilities and rail upgrades for rail and truck transportation would be temporary and would cause negligible impacts on housing availability or public services. Permanent changes in the local workforce during operations would be very small and have no effect on local housing availability or demand for public services.

Disruption to local populations during construction would be temporary and minor for the Applicant's preferred route and all of the CN Alternatives. The Applicant's preferred route and SA-04 would require extended construction operations that would expose a larger population to construction activities than continued operation of existing Line 3 (no construction) or the rail and truck alternatives, which would require limited construction.

During operations, the Applicant's preferred route, SA-04, and continued use of the existing Line 3 would result in negligible to minor, permanent population disruption impacts. The rail and truck alternatives and the alternatives that combine rail and truck with continued operation of the existing Line 3 could result in minor to major impacts on population mobility—especially in more populated areas, where rail obstruction of at-grade crossings would be increased, and where road traffic congestion could occur from the significant increase in tanker trucks transiting to the Clearbrook and Superior terminals.

When comparing the Applicant's preferred route and the CN Alternatives, continued use of the existing Line 3 would have the least effects on local populations because it would require no changes. However, it would not provide the same capacity for crude oil transfer as the Applicant's preferred route or the other CN Alternatives. Of the remaining options, the Applicant's preferred route would cause minor workforce and population disruption impacts as would system alternative SA-04. Because it is approximately one-half the length of SA-04, those impacts would be reduced for the Applicant's preferred route. The rail, truck, and combined rail/truck with continued use of the existing Line 3 may cause potentially major disruption impacts on local populations from reduced mobility.

5.3.3.4.2 Mitigation

Beyond the Applicant-proposed measures described for the Applicant's preferred route, mitigation measures to address potential major impacts of traffic congestion for the rail and truck alternatives could include:

- Freeways – Construct additional freeway lanes, off ramps and other traffic flow features in congested areas to reduce traffic density.
- Highways – Upgrade (widening) or add lanes to existing state and county highways to increase traffic flow and reduce traffic density. Construction of additional lane capacity or dedicated truck-only lanes on State Highway 92 near Clearbrook may be required.
- Populated areas – Construct dedicated access roads to the terminal facilities.

Table 5.3.3-15. Summary of Potential Impacts on Population for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route[a]	Continued Use of Existing Line 3[a]	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Changes in Population from Non-Local Workforce							
Percentage increase in local population across all counties	Temporary/minor impacts • 4.2 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*	No impact • 0.0 percent	Temporary/minor impacts • 1.4 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts	Temporary/ negligible impacts
Populated Areas							
Number of populated areas crossed or within 1,250 feet of construction work area	Temporary/minor impacts • 15 populated areas	No impact • 32 populated areas	Temporary/minor impacts • 24 populated areas	Temporary/minor impacts • Northern route – 42 populated areas • Southern route – 42 populated areas • Clearbrook route – 13 populated area	Temporary/minor impacts • Clearbrook route – 12 populated areas • Superior route – 33 populated areas	Temporary/minor impacts • Northern route – 42 populated areas • Southern route – 42 populated areas • Clearbrook route – 13 populated areas	Temporary/minor impacts • Clearbrook route – 12 populated areas • Superior route – 33 populated areas

Table 5.3.3-15. Summary of Potential Impacts on Population for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route[a]	Continued Use of Existing Line 3[a]	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Total population of populated areas crossed	Temporary/minor impacts • 92,017	No impact • 144,973	Temporary/minor impacts • 275,361	Temporary/minor impacts • Southern route – 207,202 • Northern route – 150,276 • Clearbrook route – 11,905	Temporary/minor impacts • Clearbrook route – 72,824 • Superior route – 206,933	Temporary/minor impacts • Southern route – 207,329 • Northern route – 150,276 • Clearbrook route – 11,905	Temporary/minor impacts • Clearbrook route – 72,824 • Superior route – 206,933
Total area of populated areas crossed or within 1,250 feet of construction work area (acres)	Temporary/minor impacts • 3,313 acres	No impact • 11,526 acres	Temporary/minor impacts • 5,939 acres	Temporary/minor impacts • Southern route – 16,699 acres • Northern route – 21,689 acres • Clearbrook route – 4,260 acres	Temporary/minor impacts • Clearbrook route – 3,029 acres • Superior route – 24,863 acres	Temporary/minor impacts • Southern route – 17,159 acres • Northern route – 19,669 acres • Clearbrook route – 4,260 acres	Temporary/minor impacts • Clearbrook route – 3,029 acres • Superior route – 24,863 acres

Table 5.3.3-15. Summary of Potential Impacts on Population for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route[a]	Continued Use of Existing Line 3[a]	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Operations Impacts							
Changes in Population from Non-Local Workforce							
Increase in local population across all counties	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Populated Areas							
Miles of populated areas crossed by pipeline centerline; effects on local populations	Temporary/minor impacts • 9.9 miles	Temporary/minor impacts • 35 miles	Temporary/minor impacts • 18.2 miles	Temporary/minor impacts • Southern route – 52 miles • Northern route – 61.2 miles • Clearbrook route - 13.9 miles	Temporary/minor impacts • Clearbrook route – 9.4 miles • Superior route – 64.4 miles	Temporary/minor impacts • Southern route – 52 miles • Northern route – 61 miles • Clearbrook route – 13.9 miles	Temporary/minor impacts • Clearbrook route– 9.4 miles • Superior route – 64.4 miles
Operations impacts on traffic in populated areas	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/minor impacts in rural areas Permanent/minor to major impacts in urban areas	Permanent/minor to major impacts in rural areas Permanent/major impacts in urban areas	Permanent/minor impacts in rural areas Permanent/minor to major impacts in urban areas	Permanent/minor to major impacts in rural areas Permanent/major impacts in urban areas

5.3.3.5 References

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5.3.4 Employment, Income, and Tax Revenues

Employment and income statistics provide insight into local economic conditions. Changes in employment and income influence the level of tax revenues received by local and state governments, making tax revenues another important indicator of how well an economy is doing. Following are the issues addressed in this section related to employment, income, and tax revenue associated with construction and operation of the Applicant's preferred route and CN Alternatives:

- Construction-related employment, payroll spending, and expenditures on materials, supplies and equipment;
- Operations-related employment and payroll spending;
- Income tax revenue from workers during construction and operation; and
- Property taxes paid by the Applicant during operation.

This section first describes the regulatory context and methods used in the assessment of impacts, followed by a description of relevant economic conditions within the counties along the pipeline routes and where the rail and truck terminals would be sited; these counties could experience changes in employment, income, and tax revenue as a result of construction and operation of the Project. Section 5.3.4.3 addresses the potential impacts on employment, income, and tax revenue from construction and operation of the Applicant's preferred route and CN Alternatives (system alternative SA-04, continued use of the existing Line 3, transportation by rail, transportation by truck, continued use of the existing Line 3 pipeline supplemented by rail, and continued use of the existing Line 3 supplemented by truck). A summary and comparison of the impacts are presented in Section 5.3.4.4.

5.3.4.1 Regulatory Context and Methodology

5.3.4.1.1 Regulatory Context

Minnesota Administrative Rules Part 7853.0130 lists "the effect of the proposed facility upon the natural and socioeconomic environments compared to the effects of reasonable alternatives" as one of several criteria to be considered for determining whether to grant a CN. Impacts on employment, income, and tax revenues are part of the socioeconomic environment the Commission considers in their decision about whether there are more reasonable and prudent alternatives to the proposed Project (Part 7853.0130 B) and whether the benefits outweigh the consequences of granting a CN for the proposed Project (Part 7853.0130 C).

North Dakota, Iowa, Illinois, and Wisconsin do not have state-specific environmental review processes. Impacts associated with any project would be assessed through the individual state's permit application process. More specifically, these states have not established regulations that require assessment of socioeconomic impacts associated with proposed pipeline or transportation projects.

5.3.4.1.2 Methodology

The assessment for this EIS addressed the impacts on employment, income, and tax revenues from construction and operation of the Applicant's preferred route and CN Alternatives. This assessment consisted of the following:

- Describing the existing economic conditions in the counties affected by the Applicant's preferred route and CN Alternatives using county-level employment, income, and tax revenues (where available); and
- Determining potential impacts on the economic baseline by using employment numbers and construction related expenditures provided by the Applicant to provide a qualitative discussion of the relative magnitude (i.e., negligible, minor, or major) of Project-related changes to county-level employment and income levels, and to quantitatively estimate the potential increase in income tax revenue by county.

The ROI for this analysis consists of the counties crossed by the Applicant's preferred route and CN Alternatives. County-level data provide a reasonable base for defining a local economy and determining economic impacts in each of the counties affected by the Applicant's preferred route and CN Alternatives.

The data obtained to describe the existing economic conditions in the ROI counties included county-level employment, income, and tax revenues (where available). Potential direct and indirect impacts on the economic baselines in the ROI were determined using employment numbers and construction-related expenditures provided by the Applicant and estimates from other sources for other CN applications. This information was used to develop a qualitative analysis of the relative magnitude and expected changes to county-level employment and income levels, and to estimate the potential increase in income tax revenue by county.

The employment and income statistics used to describe the economic baseline, or existing conditions, are based on median household income from the U.S. Census Bureau and per capita income, total labor force numbers, and employment rates from the U.S. Bureau of Labor Statistics. Median household income is commonly used to describe a household's economic status, or to track economic trends, whereas per capita household income is often used to measure the standard of living within a geographic area. Labor force numbers represent the total number of people (15 years and older) who are currently employed or unemployed but looking for work, while the unemployment rate represents the percentage of the labor force that is currently unemployed. All data are from the most recent survey years available when this EIS was prepared, unless otherwise noted.

Existing conditions for tax revenues were based on available data from the Office of the Auditor for each state in the ROI. These revenues included total government revenue and the portion of revenue from property taxes. Construction of a pipeline would generate tax revenues in the form of property taxes paid by the Applicant for the life of the Project. Rail and truck offloading terminals would also generate property taxes. Property tax revenue would be based on the appraised value of the pipeline easement or the rail or truck offloading terminals and state and local tax rates. Enbridge has appealed the amount of property taxes it paid between 2012 and 2016, alleging that the Minnesota Department of Revenue overvalued the value of the pipeline property, resulting in overpayment of taxes to counties and Minnesota. The appeal has not been settled at the time this document was prepared. For pipelines, this revenue would be additive to the amount that the existing landowner currently pays and is additional revenue to the local and state governments. For the purposes of this analysis, changes in property tax revenues from construction of the Applicant's preferred route and CN Alternatives (where applicable) are discussed in terms of relative magnitude and are assumed to be incurred only during operation.

While most states (including those crossed by the Applicant's preferred route and CN Alternative pipeline routes) do not have local or county-level income taxes, county governments receive income tax

appropriations from the state. Individual states determine the amount each county receives. For the pipelines in this analysis, existing income tax figures are reported at the state level. Output from a national IMPLAN model (an economic input-output model) and the number of miles of pipeline per county were used to allocate the potential change in state income taxes from the alternatives and allocated to each county in the ROI.

The total amount of estimated labor income to each state was generated using the IMPLAN output and each state's share of the total pipeline (in miles). Income tax revenue was derived using each state's respective income tax rate. This figure then was allocated to each county in the ROI based on the number of miles of pipeline in each county for the Applicant's preferred route and the SA-04 route. For the rail and truck transport alternatives, assumptions related to construction expenditures provided in Chapter 4 were used as inputs into IMPLAN. Per-county estimates were not provided for the rail and truck alternatives because it is not known how each state would distribute the income generated by the terminal facilities. Per-county estimates were also not provided for the existing Line 3 since it is already in place, and information about the current level of income taxes generated by the pipeline were not readily available.

5.3.4.2 Existing Conditions

5.3.4.2.1 Applicant's Preferred Route

Employment and Income

The Applicant's preferred route would extend across 14 counties in three states. Summary statistics on employment and income for the counties that would be crossed by the route are listed in Table 5.3.4-1. The per capita income ranges from a low of $32,836 to a high of $52,326 (all in Minnesota), and the median household income ranges from a low of $38,706 to a high of $53,492 (also in Minnesota). Throughout the ROI, the median household income is below the median household income in each state, and only two counties (Kittson County in Minnesota and Douglas County in Wisconsin) are above their respective state averages for per capita personal income.

Crow Wing County in Minnesota has the highest share of the total labor force in the ROI at 21 percent, followed by Douglas County in Wisconsin at 15 percent, and Carlton County in Minnesota at 11 percent. Based on the labor force and the unemployment rates for each county, more than 6,800 individuals are estimated to be unemployed in the region. Unemployment rates are highest in Kittson and Clearwater counties in Minnesota, at approximately 7 percent each.

Table 5.3.4-1. Employment and Income Conditions in Counties Crossed by the Applicant's Preferred Route

State/County	Per Capital Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015)[a]	Unemployment Rate (August 2015)[a]
North Dakota				
Pembina	$50,665	$51,673	3,649	3.1%
Minnesota				
Kittson	$52,326	$48,950	2,543	7.0%
Marshall	$47,271	$53,373	5,574	4.9%
Pennington	$48,980	$47,436	8,933	3.4%
Red Lake	$45,722	$47,253	2,259	3.9%
Polk	$42,157	$51,085	16,795	3.8%
Clearwater	$36,512	$45,158	4,493	6.7%
Hubbard	$36,338	$46,466	9,847	4.5%
Wadena	$32,836	$38,706	6,236	4.6%
Cass	$42,349	$45,620	14,690	5.1%
Crow Wing	$37,863	$49,244	32,402	3.9%
Aitkin	$36,363	$42,085	6,757	4.4%
Carlton	$36,801	$53,492	17,328	4.2%
Subtotal/Average	***Average = $41,293***	***Average = $47,406***	***Total = 127,857***	***Average = 4.7%***
Wisconsin				
Douglas	$38,603	$44,946	23,101	4.5%
TOTAL/AVERAGE	**Average = $41,770**	**Average = $47,535**	**Total = 154,607**	**Average 4.6%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

Tax Revenues

Table 5.3.4-2 list the existing conditions for total government revenue and the portion of revenue from property taxes for all of the counties that would be crossed by the Applicant's preferred route. For many of these counties, property taxes are an important source of income. In Minnesota, Pennington and Red Lake counties have the highest share of their total revenue from property taxes (86 and 74 percent, respectively). While the majority of states (including those crossed by the pipeline) do not have local and county-level income taxes, county governments receive income tax appropriations from the state. Individual states determine the amount each county receives. In the 2015 tax year, taxable income in Minnesota generated $11 billion in income tax revenue. North Dakota generated $722 million in income tax revenue, and Wisconsin generated $8 billion (U.S. Census 2015).

Table 5.3.4-2. Government Revenue in Counties Crossed by the Applicant's Preferred Route

State/County	Portion of Pipeline through the County	Government Revenue ($2015 thousands)	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
North Dakota				
Pembina	3%	$4,498	$2,310	51%
Minnesota				
Kittson	4%	$12,209	$3,346	27%
Marshall	10%	$17,237	$5,463	32%
Pennington	5%	$8,289	$7,153	86%
Red Lake	4%	$2,977	$2,198	74%
Polk	4%	$55,276	$20,562	37%
Clearwater	11%	$12,209	$3,346	27%
Hubbard	12%	$18,828	$6,142	33%
Wadena	2%	$31,732	$12,200	38%
Cass	12%	$21,289	$7,675	36%
Crow Wing	1%	$50,103	$20,332	41%
Aitkin	14%	$71,060	$35,583	50%
Carlton	11%	$35,408	$11,457	32%
Subtotal	***90%***	***$336,617***	***$135,457***	***40%***
Wisconsin				
Douglas	7%	$55,803	$16,397	30%
TOTAL	**100%**	**$396,918**	**$154,164**	**39%**

[a] Sources: Minnesota – Minnesota Office of the State Auditor 2015, North Dakota – Office of the State Auditor Pembina County 2013; Wisconsin – Douglas County Wisconsin 2016; adjusted to $2015 based on the consumer price index where necessary;

5.3.4.2.2 Continued Use of Existing Line 3 Pipeline

Employment and Income

Table 5.3.4-3 provides the employment and income statistics for the counties located along the pipeline corridor for the existing Line 3 pipeline The per capita income ranges from a low of $35,078 to a high of $52,326 (all in Minnesota), and the median household income ranges from a low of $43,990 to a high of $53,492 (also in Minnesota). The median household income is below the median household income in each state in the ROI, and only two counties (Kittson County in Minnesota and Douglas County in Wisconsin) are above their respective state averages for per capita personal income.

Table 5.3.4-3. Employment and Income Conditions in Counties Crossed by the Existing Line 3 Pipeline

State/County	Per Capital Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015)[a]	Unemployment Rate (August 2015)[a]
North Dakota				
Pembina	$50,665	$51,673	3,649	3.1%
Minnesota				
Kittson	$52,326	$48,950	2,543	7.0%
Marshall	$47,271	$53,373	5,574	4.9%
Pennington	$48,980	$47,436	8,933	3.4%
Red Lake	$45,722	$47,253	2,259	3.9%
Polk	$42,157	$51,085	16,795	3.8%
Clearwater	$36,512	$45,158	4,493	6.7%
Beltrami	$35,078	$43,990	23,451	4.1%
Hubbard	$36,338	$46,466	9,847	4.5%
Cass	$42,349	$45,620	14,690	5.1%
Itasca	$36,367	$47,122	22,967	5.8%
Aitkin	$36,363	$42,085	6,757	4.4%
St. Louis	$39,861	$47,138	8,569	3.4%
Carlton	$36,801	$53,492	17,328	4.2%
Subtotal/Average	***Average = $41,240***	***Average = $47,628***	***Total = 144,206***	***Average = 4.7%***
Wisconsin				
Douglas	$38,603	$44,946	23,101	4.5%
TOTAL/AVERAGE	***Average = $41,693***	***Average = $47,719***	***Total = 170,956***	***Average = 4.6%***

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

Tax Revenues

Table 5.3.4-4 summarizes the existing conditions for total government revenue and the portion of revenue from property taxes for all of the counties along the existing Line 3 pipeline corridor. While the majority of states (including those crossed by the Line 3 pipeline) do not have local and county-level income taxes, county governments receive income tax appropriations from the state. Individual states determine the amount distributed to each county. In the 2015 tax year, taxable income in Minnesota generated $11 billion in income tax revenue. North Dakota generated $722 million in income tax revenue, and Wisconsin generated $8 billion (U.S. Census Bureau 2015).

Table 5.3.4-4. Existing Government Revenue in Counties Crossed by the Existing Line 3 Pipeline

State/County	Portion of Pipeline through the County	Government Revenue ($2015 thousands)	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
North Dakota				
Pembina	8%	$4,498	$2,310	51%
Minnesota				
Kittson	5%	$12,209	$3,346	27%
Marshall	11%	$17,237	$5,463	32%
Pennington	6%	$8,289	$7,153	86%
Red Lake	4%	$2,977	$2,198	74%
Polk	4%	$55,276	$20,562	37%
Clearwater	6%	$18,828	$6,142	27%
Beltrami	7%	$72,476	$26,651	37%
Hubbard	2%	$18,828	$6,142	33%
Cass	10%	$21,289	$7,675	36%
Itasca	15%	$94,707	$28,855	30%
Aitkin	<1%	$71,060	$35,583	50%
St. Louis	8%	$278,021	$111,234	40%
Carlton	7%	$35,408	$11,457	32%
Subtotal	***86%***	***$706,605***	***$272,461***	***39%***
Wisconsin				
Douglas	7%	$55,803	$16,397	30%
TOTAL	**100%**	**$766,906**	**$291,168**	**38%**

[a] Sources: Minnesota – Minnesota Office of the State Auditor 2015, North Dakota – Office of the State Auditor Pembina County 2013; Wisconsin – Douglas County Wisconsin 2016; adjusted to $2015 based on the consumer price index where necessary

5.3.4.2.3 System Alternative SA-04

Employment and Income

System alternative SA-04 would cross 35 counties in 4 states. Table 5.3.4-5 provides the employment and income statistics for the counties that would be crossed by SA-04. The median household income ranges from a low of $46,074 in Chickasaw County in Iowa to a high of $76,101 in Will County, Illinois. In North Dakota, median household incomes in Cass, Richland, and Trail counties are above the state average, while only Le Sueur County in Minnesota is above the state average. In Iowa, all counties with the exception of Chickasaw are above the state average for median household income; in Illinois, Grundy and Will counties are above the state average.

Table 5.3.4-5. Employment and Income Conditions in Counties Crossed by System Alternative SA-04

State/County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015)[a]	Unemployment Rate (August 2015)[a]
North Dakota				
Cass	$53,552	$53,055	95,774	1.8%
Grand Forks	$46,129	$47,105	37,764	1.8%
Pembina	$50,665	$51,673	3,649	3.1%
Richland	$45,487	$56,462	8,767	2.0%
Traill	$51,420	$53,704	4,542	2.2%
Walsh	$46,728	$49,838	5,616	2.8%
Subtotal/Average	***Average = $48,997***	***Average = $51,973***	***Total = 156,112***	***Average 2.3%***
Minnesota				
Blue Earth	$43,168	$51,037	40,002	2.5%
Chippewa	$44,722	$51,583	7,065	3.3%
Freeborn	$41,371	$45,622	16,512	3.1%
Kandiyohi	$49,060	$52,104	24,435	2.7%
Le Sueur	$44,197	$60,367	15,739	3.2%
Mower	$42,364	$47,679	20,691	2.5%
Nicollet	$44,646	$60,033	20,662	2.2%
Renville	$51,844	$52,061	9,179	3.2%
Sibley	$43,865	$56,383	8,876	3.1%
Stevens	$52,226	$51,241	5,981	2.0%
Swift	$53,874	$49,810	5,474	6.6%
Traverse	$55,225	$48,807	1,929	2.4%
Waseca	$46,847	$53,893	10,073	3.2%
Subtotal/Average	***Average = $47,185***	***Average = $52,355***	***Total = 186,618***	***Average = 3.1%***
Iowa				
Bremer	$44,610	$61,691	14,080	2.9%
Buchanan	$42,757	$56,459	11,169	2.4%
Chickasaw	$50,531	$46,074	6,535	3.6%
Clinton	$40,161	$49,907	24,525	4.4%
Delaware	$44,894	$54,865	10,797	2.6%
Fayette	$40,294	$45,496	10,871	3.4%
Howard	$45,956	$47,355	5,356	3.1%
Jones	$40,524	$54,327	10,834	3.3%

Table 5.3.4-5. Employment and Income Conditions in Counties Crossed by System Alternative SA-04

State/County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015)[a]	Unemployment Rate (August 2015)[a]
Mitchell	$47,161	$47,381	5,447	2.1%
Subtotal/Average	***Average = $44,099***	***Average = $51,506***	***Total = 99,614***	***Average 3.1%***
Illinois				
Bureau	$38,446	$49,979	16,999	7.6%
LaSalle	$39,582	N/A	58,052	8.0%
Lee	$37,895	$52,065	18,012	5.9%
Rock Island	$40,332	$48,282	71,527	7.1%
Grundy	$47,930	$65,887	25,400	6.8%
Will	$46,823	$76,101	355,617	6.0%
Whiteside	$39,483	$53,482	28,574	6.3%
Subtotal/Average	***Average = $41,499***	***Average = $57,633***	***Total = 574,181***	***Average = 6.8%***
TOTAL/AVERAGE	**Average = $45,445**	**Average = $53,367**	**Total = 1,016,525**	**Average = 3.8%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

Tax Revenues

Table 5.3.4-6 summarizes the existing conditions for total government revenue and the portion of revenue from property taxes for all of the counties that would be crossed by SA-04. While the majority of states (including those crossed by the pipeline) do not have local and county-level income taxes, county governments receive income tax appropriations from the state. Individual states determine the amount distributed to each county. In the 2015 tax year, taxable income in North Dakota generated $722 million in income taxes, while Minnesota generated $11 billion, Iowa generated $3.9 billion, and Illinois generated $19.9 billion (U.S. Census Bureau 2015).

Table 5.3.4-6. Government Revenue in Counties Crossed by System Alternative SA-04

State/County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
North Dakota				
Cass	6%	$92,833	$35,718	39%
Grand Forks	5%	$41,977	$22,024	53%
Pembina	5%	$4,498	$2,310	51%
Richland	7%	$17,123	$8,057	47%
Traill	4%	$10,668	$3,817	36%
Subtotal	***27%***	***$167,099***	***$71,926***	***43%***
Minnesota				
Walsh	3%	$13,704	$5,212	38%
Blue Earth	2%	$77,593	$29,775	38%
Chippewa	1%	$18,655	$8,781	47%
Freeborn	4%	$44,800	$19,900	44%
Kandiyohi	2%	$73,422	$30,087	41%
Le Sueur	0%	$31,769	$15,500	49%
Mower	1%	$45,039	$18,100	40%
Nicollet	2%	$34,250	$17,604	51%
Renville	3%	$10,307	$6,344	62%
Sibley	3%	$29,015	$11,944	41%
Stevens	4%	$14,234	$6,718	47%
Swift	3%	$20,594	$9,155	45%
Traverse	3%	$12,044	$4,528	38%
Waseca	2%	$23,542	$12,825	55%
Subtotal	***33%***	***$448,968***	***$196,473***	***44%***
Iowa				
Bremer	0.2%	$21,842	$7,435	34%
Buchanan	2%	$16,425	$6,948	42%
Chickasaw	4%	$13,380	$5,112	38%
Clinton	5%	$30,602	$17,421	57%
Delaware	3%	$16,017	$8,224	51%
Fayette	3%	$17,021	$7,242	43%
Howard	1%	$13,639	$4,715	35%
Jones	4%	$18,954	$7,294	38%

Table 5.3.4-6. Government Revenue in Counties Crossed by System Alternative SA-04

State/County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Mitchell	3%	$16,402	$6,216	38%
Subtotal	***25.2%***	***$164,282***	***$70,607***	***43%***
Illinois				
Bureau	2%	$14,917	$5,306	36%
LaSalle	6%	$58,534	$23,701	40%
Lee	1%	$19,011	$7,173	38%
Grundy	1%	$28,144	$13,437	48%
Will	1%	$182,751	$65,615	36%
Rock Island	1%	$77,001	$25,836	34%
Whiteside	4%	$29,935	$9,210	31%
Subtotal	***16%***	***$410,293***	***$150,278***	***37%***
TOTAL	**100%**	**$1,190,642**	**$489,284**	**41%**

[a] Source: North Dakota – State of the North Dakota Office of the State Auditor; Minnesota - Minnesota Office of the State Auditor 2015, Iowa –State of Iowa Auditor of State; Illinois – County Comptroller; adjusted to $2015 based on the consumer price index where necessary.

5.3.4.2.4 Transportation by Rail

Employment and Income

Table 5.3.4-7 provides the employment and income statistics for the counties in which the rail offloading facilities and development of new or expanded rail lines would be sited.

Table 5.3.4-7. Employment and Income Conditions in Counties for Development of Rail Facilities

County, State	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015)[a]	Unemployment Rate (August 2015)[a]
Clearwater, Minnesota	$36,512	$45,158	4,493	6.7%
Douglas, Wisconsin	$38,603	$44,946	23,101	4.5%
TOTAL/AVERAGE	**AVERAGE = $37,558**	**AVERAGE = $45,052**	**TOTAL = 27,594**	**AVERAGE = 5.6%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

Tax Revenues

Table 5.3.4-8 summarizes the existing conditions for total government revenue and the portion of revenue from property taxes by county for all counties in the locations of rail facilities. Property taxes are an important source of income in these counties. Douglas County has the highest total government revenue while Clearwater has the highest share of its revenue from property taxes (33 percent). County governments receive income tax appropriations from states and individual states determine the amount distributed to each county. In the 2015 tax year, taxable income in Minnesota generated $11 billion, and Wisconsin generated $8billion (U.S. Census Bureau 2015).

Table 5.3.4-8. Government Revenue in Counties for Development of Rail Facilities

State/County	Government Revenue ($2015 thousands)	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Clearwater, Minnesota	$18,828	$6,142	33%
Douglas, Wisconsin	$55,803	$16,397	30%
TOTAL	**$74,631**	**$22,539**	**30%**

[a] Sources: Minnesota – Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary; Wisconsin – Douglas County Wisconsin 2016

5.3.4.2.5 Transportation by Truck

Employment and Income

Table 5.3.4-9 provides the employment and income statistics for the counties where construction or upgrades would occur for development of truck offloading facilities and access roads.

Table 5.3.4-9. Employment and Income Conditions in Counties for Development of Truck Facilities

County, State	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015)[a]	Unemployment Rate (August 2015)[a]
Clearwater, Minnesota	$36,512	$45,158	4,493	6.7%
Douglas, Wisconsin	$38,603	$44,946	23,101	4.5%
TOTAL/AVERAGE	**Average = $37,558**	**Average = $45,052**	**Total = 27,594**	**Average = 5.6%**

[a] Source: U. S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

Tax Revenues

Table 5.3.4-10 summarizes the existing conditions for total government revenue and the portion of revenue from property taxes by county for all of the counties in which truck offloading and related facilities would be sited. Property taxes are an important source of income in these counties. Douglas County has the highest total government revenue while Clearwater has the highest share of its revenue from property taxes (33 percent). While the majority of states (including those where the facilities would be constructed) do not have local and county-level income taxes, county governments receive income tax appropriations from the state. Individual states determine the amount distributed to each county. In the 2015 tax year, taxable income in Minnesota generated $11 billion, and Wisconsin generated $8 billion (U.S. Census Bureau 2015).

Table 5.3.4-10. Government Revenue in Counties for Development of Truck Facilities

State/County	Government Revenue ($2015 thousands)	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Clearwater, Minnesota	$18,828	$6,142	33%
Douglas, Wisconsin	$55,803	$16,397	30%
TOTAL	**$74,631**	**$22,539**	**30%**

[a] Sources: Minnesota – Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary; Wisconsin – Douglas County Wisconsin 2016.

5.3.4.3 Impact Assessment

Construction and operation of the Applicant's preferred route and most of the CN Alternatives (except for aspects of the existing Line 3 pipeline alternative since that pipeline is in place and operating) would increase employment, income, and tax revenue. Direct impacts on employment would be driven by the large number of construction personnel. Although it is expected that the workers would not live in the counties where construction would occur, they may temporarily re-locate to these counties during construction or spend money locally which could result in temporary county-level income changes in supporting industries. Tax revenues would increase due to the increase in labor income (i.e., taxable income), sales tax on the purchase of goods locally, and property taxes. Construction would also have a temporary indirect influence on economic conditions due to employment and income for service industries supporting construction activities (e.g., the hotel industry, fueling services, and the food service industry).

5.3.4.3.1 Applicant's Preferred Route (from Neche to Superior)

Construction Impacts

Employment and Income

Construction of the Applicant's preferred route is expected to require up to a maximum of 4,800 workers across 7 different construction spreads over an 8-month period. As noted above, this impact assessment is based on the assumption that all workers would re-locate to the area during construction. Based on this assumption, it is likely that direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However,

it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

In addition to direct Project-related employment and payroll spending, a large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel, hardware, and parts. The Applicant estimated the material costs for construction of its preferred route in Minnesota to be $438.9 million. According to the IMPLAN model results, the top 10 industries (as defined in the model) that would be positively affected by construction-related spending are construction services for new, non-residential structures, food services and drinking places, real estate businesses), wholesale trade business (businesses engaged in wholesaling merchandise such as agriculture and mining), architectural and engineering services, offices of health practitioners, private hospitals, employment services, and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

If the Applicant employs some local residents during construction, there would be a greater influence on employment, unemployment, and per capita income at the county level along the route and the temporary, positive impact would be greater.

Tax Revenues

Construction of the Applicant's preferred route would generate state and local taxes from a variety of sources. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., the wages paid to construction workers). In other words, regardless of where a construction worker lives, a portion of their wages would be subject to Minnesota state income taxes since the construction occurs in Minnesota over an extended period of time. In addition, if the industries indirectly affected by construction hire additional staff to accommodate the increased business as described above, the wages paid to those workers would also increase state and county tax revenues. As noted, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments as determined by the state. Table 5.3.4-11 presents the estimated increase in the state

income tax that would be appropriated to each county in the ROI based on the portion of total length of the pipeline through each county. Based on these estimates, Aitkin County would receive the highest increase in income tax revenue at $15 million. Specifically, the State of Minnesota would receive approximately $98 million in income tax receipts, which is less than 1 percent of the amount that Minnesota currently receives in income tax revenue. This positive impact on income tax revenues would be temporary and minor to major (i.e., depending on the allocation to each individual county) and likely would be limited to the duration of the construction timeframe.

Table 5.3.4-11. Estimated Income Tax Generated from Construction-Related Income for the Applicant's Preferred Route

State/County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
North Dakota		
Pembina	27.6	$2.4
Minnesota		
Kittson	15.4	$4.5
Marshall	36.3	$10.7
Pennington	19.7	$5.8
Red Lake	15.7	$4.6
Polk	14.0	$4.1
Clearwater	42.2	$12.4
Hubbard	44.6	$13.1
Wadena	7.1	$2.1
Cass	47.4	$12.0
Crow Wing	4.8	$1.4
Aitkin	51.6	$15.2
Carlton	41.0	$12.1
Subtotal	***339.8***	***$98.0***
Wisconsin		
Douglas	13.2	$3.5
TOTAL	**380.5**	**$103.9**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

Operations Impacts

Employment and Income

The Applicant stated that the existing operations staff would be able to operate the Project and that few additional employees would be hired to assist the staff. As a result, operation of the pipeline would have no measureable impact on local employment, per capita household income, median household income, or unemployment in the ROI.

Tax Revenues

Since there would be few additional staff members hired for operation of the Project, there would be very little change in income tax or sales tax revenues due to increased spending by permanent operational staff. Therefore, the impact on income tax and sales tax revenues would be permanent, but at most negligible.

Property tax revenues would be the largest source of ongoing revenue to the counties along the route. Local and state governments would continue to collect annual property taxes from the Applicant based on the assessed value of the pipeline easements for the life of the Project. This would result in permanent, major positive impacts on property tax revenues for the counties along the route.

5.3.4.3.2 Continued Use of Existing Line 3

Construction Impacts

There would be no construction impacts on employment, income, or tax revenue from the continued use of the existing Line 3 pipeline because it is already built.

Operation Impacts

Continued use of existing Line 3, including continuation of ongoing integrity maintenance, would not be expected to alter current employment, income, or tax revenue. Any integrity digs and subsequent maintenance or repairs would likely be completed by the existing workforce or local contractors and no new land or easements would need to be purchased. Therefore, no impacts on employment, income, or tax revenue would be expected associated with continued operations.

5.3.4.3.3 System Alternative SA-04

Construction Impacts

Employment and Income

For the purposes of the analysis, it was assumed that system alternative SA-04 would be constructed and operated in the same manner as the Applicant's preferred route. Based on the Applicant's estimate that 7 spreads would be needed to construct the Applicant's 380-mile-long preferred route, it was estimated that 14 to 15 spreads would be needed to construct the 795-mile-long system alternative SA-04. If all of the workers were hired from outside the Project area, a conservatively high estimate of 9,000 workers would temporarily re-locate to the Project area. Based on the assumptions that the additional workers would not be local, as described above, direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and

trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. Construction of SA-04 would have the largest increase of local spending on goods and services of all alternatives due to the 9,000 workers (i.e., 4,200 more workers than for the Applicant's preferred route). These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, and unemployment, and within each county along the route.

A large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel, hardware, and parts. According to the IMPLAN model results, the top 10 industries (as defined in the model) that would be positively affected by construction-related spending are construction services for new, non-residential structures, food services and drinking places, real estate businesses, wholesale trade business (i.e., businesses engaged in wholesaling merchandise such as agriculture and mining), architectural and engineering services, offices of health practitioners, private hospitals, employment services, and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

Tax Revenues

Impacts on tax revenues from construction of SA-04 would be similar to those discussed for the Applicant's preferred route. At the state and local level, property taxes paid by the Applicant would be the primary source of tax revenue. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., the wages paid to construction workers). This increase in income tax revenues would be highest for SA-04 compared to the Applicant's preferred route as a result of the greater number of workers required for construction. If the industries indirectly affected by construction hire additional staff to accommodate the increased business as described above, the wages paid to those workers would also increase state and county tax revenues. As stated earlier, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments. Individual states determine the amount allocated to each county. Table 5.3.4-12 presents the estimated increase in state income tax for each state that would be crossed by SA-04. This amount was then allocated to each county that would be crossed by SA-04 based on the portion of pipeline through each county. Based on the IMPLAN output and total miles per county, it is estimated that Minnesota would receive the highest share of income tax revenue at approximately $75 million, followed by Iowa at approximately $63 million. These figures represent less than a 1-percent change to

the current overall level of income tax in each state (approximately $9 billion in Minnesota and $4 billion in Iowa). As a result, the impact would be positive, but temporary and minor to major (i.e., depending on the allocation in each individual county).

Table 5.3.4-12. Estimated Income Tax Generated from Construction-Related Income for System Alternative SA-04

State/County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
North Dakota		
Cass	46.3	$4.0
Grand Forks	39.5	$3.4
Pembina	37.4	$3.2
Richland	54.6	$4.7
Traill	31.0	$2.7
Walsh	24.6	$2.1
Subtotal	***233.5***	***$20.1***
Minnesota		
Blue Earth	18.2	$5.4
Chippewa	8.3	$2.5
Freeborn	29.7	$8.8
Kandiyohi	19.2	$5.7
Le Sueur	1.9	$0.6
Mower	8.5	$2.5
Nicollet	20.0	$6.0
Renville	23.1	$6.9
Sibley	22.2	$6.6
Stevens	31.6	$9.4
Swift	27.4	$8.2
Traverse	21.3	$6.3
Waseca	19.6	$5.8
Subtotal	***251.0***	***$74.7***
Iowa		
Bremer	1.6	$0.5
Buchanan	12.9	$4.3
Chickasaw	29.1	$9.7
Clinton	38.3	$12.8
Delaware	20.4	$6.8

Table 5.3.4-12. Estimated Income Tax Generated from Construction-Related Income for System Alternative SA-04

State/County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
Fayette	23.1	$7.7
Howard	5.4	$1.8
Jones	32.1	$10.7
Mitchell	24.9	$8.3
Subtotal	***187.9***	***$62.6***
Illinois		
Bureau	17.9	$3.2
LaSalle	31.8	$4.3
Lee	8.9	$1.6
Grundy	20.0	$3.6
Will	4.8	$0.9
Rock Island	4.9	$0.9
Whiteside	34.7	$6.2
Subtotal	***123***	***$20.7***
TOTAL	**795.4**	**$178.1**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

Operations Impacts

Employment and Income

For the purposes of the analysis, it was assumed that SA-04 would be operated in the same manner as the Applicant's preferred route. Based on Enbridge's estimate that very few permanent workers would be needed for operation of the preferred route, it is expected that SA-04 would similarly require few operational staff. Based on the small number of permanent jobs, it is likely that operation of the pipeline would result in no impact on the per capita household income, median household income, or unemployment rates in the ROI.

Tax Revenues

Since there is likely to be a small number of permanent operational staff, it is also likely that operation of the pipeline would result in a permanent, negligible impact on tax revenues associated with payroll spending (i.e., income taxes) in the ROI.

Property tax revenues are likely to be the largest source of ongoing revenue to the counties in the ROI. Local and state governments would continue to collect annual property taxes from the Applicant for the

life of the Project based on the assessed value of the pipeline easements for SA-04. Therefore, it is likely that positive impacts on property taxes from operation would be permanent and major.

5.3.4.3.4 Transportation by Rail

The rail alternative would require construction of a rail loading facility and a new rail line connection near Gretna, Canada. These facilities would be located in Canada and as such are not addressed as part of this analysis.

In the United States, this alternative would require construction and operation of a new rail offloading facility near the existing Enbridge terminals in Clearbrook, Minnesota. As described in Chapter 4, the rail alternative would also require upgrades to existing rail facilities near Clearbrook, in Clearwater County. The alternative would also require expansion of the existing facility at the Enbridge terminal in Superior, and up to 0.5 mile of new rail spur in Douglas County, Wisconsin.

Construction Impacts

Employment and Income

Construction of the offloading facility and associated facilities for the rail alternative is estimated to generate from 50 to 100 temporary construction jobs based on similar types of rail-related construction projects. It also was assumed, based on the information in Chapter 4 that it would cost between $85 and $125 million to construct the terminal facilities.

For this analysis, it was assumed that the construction workforce would not be hired locally. Based on this assumption, it is likely that direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and grading); hiring of local residents for those or other positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the ROI (Clearwater and Douglas counties) would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the counties. This would result in a temporary, negligible to minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

In addition to direct Project-related employment and payroll spending, a large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on industries receiving the expenditures. The actual magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent in each county.

Tax Revenues

Income tax revenues generated from these activities would be determined at the state level (i.e., in Minnesota and Wisconsin) and allocated at the county level as determined by the state. Based on the

IMPLAN output, it is likely that construction of the terminals and related facilities would generate approximately $2.5 million for Minnesota, and $2.2 million for Wisconsin. This positive impact on income tax revenues to the counties would be temporary and minor.

It was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

Operations Impacts

Employment and Income

It is possible that the increased volume of rail traffic could lead to the addition of several hundred permanent jobs, such as railroad operators, technicians during operations, and general laborers to facilitate offloading of tank cars. It is likely that many of the workers hired for operation would not be housed within the ROI (e.g., much of the train operation staff would likely work from the Gretna loading facilities). At the county level, it is unlikely that the increase in permanent jobs would affect per capita income, mean household income levels, or unemployment rates; the increase would be small relative to the overall income and labor force in the county, resulting in permanent negligible impacts.

Tax Revenues

Depending on the number of local jobs, there could be a direct, permanent, minor impact on income taxes from the increase in direct permanent employment at the facilities There would also be a permanent, minor indirect impact on income taxes from spending in industries in the ROI that support the rail industry.

Property tax revenues would be based on the increase in value of the new and expanded facilities. These new taxes are expected to result in a permanent, minor impact on tax revenues for the two counties.

5.3.4.3.5 Transportation by Truck

The truck alternative would require construction and operation of a truck loading facility near Gretna, Canada. These facilities would be located in Canada and as such are not addressed as part of this analysis.

In the United States, this alternative would require construction of offloading and related facilities at and near the Enbridge terminals at Clearbrook and Superior. At both sites, small sections of additional roadways would be required for access. In Clearwater County, it may be also necessary to construct a new roadway and upgrade area highways. In Douglas County it would be necessary construct an alternate truck route to the Superior terminal.

Construction Impacts

Employment and Income

Construction of the offloading facility and associated facilities for the truck alternative is estimated to generate from 30 to 50 temporary construction jobs based on similar types of construction projects. For this analysis, it was assumed that the construction workforce would not be hired locally. Based on this assumption, it is likely that direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of

the non-technical work could be accomplished by local residents (e.g., clearing and grading); hiring of local residents for those or other positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the ROI (Clearwater and Douglas counties) would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the counties. This would result in a temporary, negligible to minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, and unemployment, and within each county along the route.

In addition to direct Project-related employment and payroll spending, a large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on industries receiving the expenditures. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent in each county.

Tax Revenues

Income tax revenues generated from these activities would be determined at the state level (i.e., in Minnesota and Wisconsin) and allocated at the county level as determined by the state. Based on the IMPLAN output, it is likely that construction of the terminal facilities would generate approximately $2.5 million for Minnesota, and $2.2 million for Wisconsin. This positive impact on income tax revenues to the counties would be temporary and minor.

It was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would have no impact on property taxes at the county level.

Operations Impacts

Employment and Income

Transport of oil via tanker trucks would require up to 4,000 trucks per day. If local workers were hired to operate and maintain the facilities or work directly for the truck line, a positive, permanent impact would result from an increase in labor income and employment in the surrounding county. However, it is likely that the truck drivers hired to transport the oil would come from outside of the ROI and therefore would have a permanent negligible impact on per capita income, median household income, and unemployment rates at the county level.

Tax Revenues

Depending on the number of local jobs, there could be a direct permanent minor impact on income taxes from the increase in direct permanent employment at the facilities, as well as a permanent indirect minor impact on income taxes from spending in industries that support the truck industry. Each of the 4,000 trucks would need to refuel at gas stations along the truck routes. This could result in a permanent minor increase in tax revenue generated from the state gas tax, depending on where and how often the trucks need to refuel.

Property tax revenues would be based on the increase in value of the new and expanded facilities. These new taxes are expected to result in a permanent, minor impact on tax revenues for the two counties.

5.3.4.3.6 Existing Line 3 Supplemented by Rail

Construction Impacts

As previously indicated, no impacts on employment, income, or tax revenue would be expected associated with continued use of the existing Line 3. With respect to supplemental rail transport, it was assumed that the same upgrades of rail facilities described above for transportation by rail would be required at the Clearbrook and Superior terminals; therefore, the construction impacts would be the same as described for the rail alternative.

Operations Impacts

Continued use of existing Line 3, including continuation of ongoing integrity maintenance, would not be expected to alter current employment, income, or tax revenue. Therefore, no impacts on employment, income, or tax revenue would be expected associated with continued operations.

Overall, fewer trains would be used to transport crude oil than under the Transportation-by-Rail alternative which would reduce the number of new permanent jobs compared to the rail alternative. Therefore, it is unlikely that the additional permanent jobs would affect per capita income, mean household income levels, or unemployment rates at the county level, as the increase would be small relative to the overall income and labor force in the county.

Impacts on tax revenues would be the same as described for the rail alternative, with a smaller permanent, minor impact on income taxes from the direct impact of employment related to operation of the facilities and the indirect impact of spending in industries that support the rail industry. Property taxes would likely be similar to those of the rail transport alternative, although it is possible that the offloading facilities would be smaller than for the rail transport alternative, which would result in a lower property value for the facilities.

5.3.4.3.7 Existing Line 3 Supplemented by Truck

Construction Impacts

As previously indicated, no impacts on employment, income, or tax revenue would be expected associated with continued use of existing Line 3. With respect to supplemental truck transport, it was assumed that the same upgrades of transport facilities described above for transportation by truck would be required at the Clearbrook and Superior terminals; therefore, the construction impacts would be the same as described for the truck alternative.

Operations Impacts

Continued use of existing Line 3, including continuation of ongoing integrity maintenance, would not be expected to alter current employment, income, or tax revenue. Therefore, no impacts on employment, income, or tax revenue would be expected associated with continued operations.

Overall, fewer trucks would be used to transport crude oil than under the Transportation-by-Truck alternative, which would reduce the number of trucks per day compared to the truck alternative and is

likely to add fewer permanent jobs. Therefore, it is unlikely that the additional permanent jobs would affect per capita income, mean household income levels, or unemployment rates at the county level, as the increase would be small relative to the overall income and labor force in the county.

Impacts on tax revenues would be the same as described for the truck alternative, with a smaller permanent, minor impact on income taxes from the direct impact of employment related to operation of the facilities and the indirect impact of spending in industries that support the rail industry. Property taxes would likely be similar to those of the truck transport alternative, although it is possible that the offloading facilities would be smaller than for the truck transport alternative, which would result in a lower property value for the facilities.

5.3.4.4 Summary and Mitigation

5.3.4.4.1 Summary

The potential impacts on employment, income, and tax revenue from construction and operation of the Applicant's preferred route and CN Alternatives were assessed. These evaluations considered construction-related employment, payroll spending, and expenditures on materials, supplies and equipment; operation-related employment and payroll spending, income tax revenue from workers during construction and operation, and property taxes paid by the Applicant during operation. The ROI for this analysis consists of the counties where construction would occur for the Applicant's preferred route and CN Alternatives, as well as those counties crossed by Line 3. Table 5.3.4-13 provides a summary list of the potential impacts of construction and operation of the alternatives, including the anticipated duration and magnitude of the impacts.

Construction Impacts

The construction workforce needed for new pipeline construction (SA-04 and the Applicant's preferred route) would be much greater than for the rail or truck alternatives. Because Line 3 pipeline is in place and operating, there would not be any construction-related changes in employment or income for that alternative. The construction workforce for any of the alternatives would not have a direct effect on employment and income at the county level, assuming the workforce would not be local. If the Applicant employs some local residents during construction, there would be a greater influence on employment, unemployment, and per capita income at the county level that could result in a temporary, positive but negligible impact.

During construction, there could be an increase in hiring in secondary industries (i.e., the industries that support the construction industry). The impact of that increase in employment for each alternative, except the alternative of continued use of Line 3, would have temporary, negligible impacts on employment and income at the county level, with greater impacts occurring with construction of any of the new pipeline alternatives due to their substantially greater construction workforces as compared to those of the rail and truck alternatives.

Construction-related tax revenues would be largely due to income taxes paid at the state level and apportioned to the counties crossed by the pipeline, as well as sales and use taxes on construction-related goods and services. Tax revenues generated during construction are likely to be temporary and minor to major for all alternatives except continued use of Line 3.

The increase in tax revenues during construction is likely to be the greatest for construction of any of the new pipeline alternatives due to the size of the workforce and the amount of time required to complete

construction activities. SA-04 would have the largest positive effects on employment, income, and tax revenue since it would require the largest construction workforce.

Operations Impacts

Operation of the pipelines would require a small number of new hires since a new pipeline system would be operated primarily by the existing operations staff for the Enbridge Mainline. Therefore, operation would not result in a measureable effect on county-level income and employment levels. In addition, the small number of permanent staff required to operate a new pipeline would not be large enough to change tax revenues at the county-level. Continued operation of the Line 3 pipeline would not require additional staff. Property taxes for the pipelines would be substantial and would result in a permanent, major impact on county-level tax revenues. The impact on property taxes would likely be much greater for SA-04 due to its greater length.

Operation of the rail offloading facility and the truck offloading facility would not require a substantial number of workers. Although the increased volume of rail traffic could lead to the addition of several hundred permanent jobs, it is likely that many of the workers hired to operate the trains would not be housed within the ROI but spread across the region. Similarly, transport of oil via tanker trucks would require a substantial number of truck drivers, but it is likely that many of the truck drivers hired to transport the oil would come from outside of the ROI. Therefore, operation of the rail and truck transport alternatives would have a permanent negligible impact on per capita income, median household income, and unemployment rates at the county level.

Depending on the number of local jobs for the rail and truck alternatives, there could be a direct permanent negligible impact on income taxes from the increase in direct permanent employment at the rail and truck offloading facilities, as well as a permanent indirect minor impact on income, sales, and use taxes from spending in industries that support the truck industry. This impact would be greater for the truck transport alternative due to refueling needs along the truck routes.

Property tax revenues would be based on the increase in value of the new and expanded offloading facilities. These new taxes are expected to result in a permanent, minor impact on tax revenues for the two counties. The total property taxes generated by the rail and truck alternatives would be substantially less than those of the pipeline alternatives.

The impacts of operating the combined alternatives of continued use of the Line 3 and rail transport or continued use of the Line 3 and truck transport would be essentially the same as those for the rail and truck alternatives. However, with the use of the Line 3 pipeline, there would be fewer jobs for train and truck operations.

5.3.4.4.2 Mitigation

The only major impacts of the Applicant's preferred route or CN Alternatives on employment, income, and tax revenue would be associated with increases in tax revenue including temporary increases in local tax during construction for the pipeline alternatives, and permanent increases in property tax revenue for the new pipeline alternatives. It is anticipated that SA-04 would result in generating about twice as much property tax as the Applicant's preferred route since the SA-04 pipeline would be over twice as long. No mitigation measures have been identified to address impacts on employment, income, or tax revenues.

Table 5.3.4-13. Summary of Potential Impacts on Employment, Income, and Tax Revenue for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Employment, unemployment, per capita income, median household income	Temporary/ negligible to minor impacts • 4,800 workers (*all workers assumed non-local*) • Increase in income/jobs in secondary industries that support construction	No impact	Temporary/ negligible to minor impacts • 9,000 workers *(all workers assumed non-local)* • Increase in income/jobs in secondary industries that support construction	Temporary/ negligible impacts • 50 to 100 workers *(all workers assumed non-local)* • Increase in income/jobs in secondary industries that support construction	Temporary/ negligible impacts • 30 to 50 workers *(all workers assumed non-local)* • Increase in income/jobs in secondary industries that support construction	Temporary/ negligible impacts • 50 to 100 workers *(all workers assumed non-local)* • Increase in income/jobs in secondary industries that support construction	Temporary/ negligible impacts • 30 to 50 workers *(all workers assumed non-local)* • Increase in income/jobs in secondary industries that support construction
Property tax revenue during construction	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Income tax revenue during construction	Temporary/minor to major impacts • $104 million	No impact	Temporary/minor to major impacts • $178 million	Temporary/minor impacts • $5 million	Temporary/minor impacts • $5 million	Temporary/minor impacts • $5 million	Temporary/minor impacts • $5 million
Operations Impacts							
Employment, unemployment, per capita income, median household income	No impact	No impact	No impact	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts	Permanent/ negligible impacts

Table 5.3.4-13. Summary of Potential Impacts on Employment, Income, and Tax Revenue for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Property tax revenue during operations	Permanent/major impacts	No impact	Permanent/major impacts • Longest route, highest property tax revenue	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts
Income tax revenue during operations	Permanent/ negligible impacts	No impact	Permanent/ negligible impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts

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5.4 CULTURAL RESOURCES

Cultural resources include the locations of human activity, occupation, or usage that contain materials, structures, or landscapes that were used, built, or modified by people. They also include the institutions that form and maintain communities and link them to their surroundings. Cultural resources consist of archaeological resources (e.g., sites and isolated finds), historic resources (e.g., buildings and structures), and sacred places (including traditional cultural properties and traditional cultural landscapes). Cultural resources also include tribal, usufructuary rights resources both within reservation boundaries and ceded lands by treaty (e.g., traditional hunting and fishing areas) and treaty areas, which are discussed in detail in Chapter 9. For the purposes of this discussion, these resources are referred to collectively as cultural resources.

The cultural resources addressed in this section are limited to direct and indirect impacts on archaeological and historic resources. This section first describes the existing conditions for the cultural resources within an area along the Applicant's preferred route and each of the CN Alternatives where these resources could be affected by construction and operation of the Project. Potential impacts on cultural resources are discussed and compared for the Applicant's preferred route and the CN Alternatives (continued use of the existing Line 3, system alternative SA-04, transportation by rail, transportation by truck, and Line 3 supplemented by rail or truck). None of the impacts or mitigation measures described in this chapter reflect how American Indians describe impacts on the landscape and tribal resources within reservation boundaries and ceded lands (see Chapter 9). Potential impacts on cultural resources from an accidental release of crude oil are discussed in Chapter 10.

5.4.1 Regulatory Context and Methodology

The regulatory context and data availability varies across the states that would be collectively crossed by the Applicant's preferred route and the CN Alternatives (Minnesota, North Dakota, Iowa, Illinois, and Wisconsin).

5.4.1.1 Regulatory Context

5.4.1.1.1 North Dakota

North Dakota Century Code

The North Dakota Century Code (NDCC) outlines the policies of the state of North Dakota regarding cultural resources. The State Historical Society of North Dakota (SHSND) is the agency responsible for protecting historic properties and cultural resources within North Dakota. The Historic Preservation Division is within the SHSND. Through the director, this division is responsible for preservation and interpretation of antiquities on the state level.

NDCC 55-03 outlines the permitting process for cultural resources investigations. A permit to investigate, excavate, or otherwise record cultural resources on state land and to excavate cultural resources on private land is required under NDCC 55-03-01.1. NDCC 55-10 outlines the preservation of historic sites and antiquities, which are within the public's interest (see NDCC 55-10-01). It also established the North Dakota State Historic Sites Registry.

NDCC 23-06-27 protects unmarked human burial sites, human remains, and burial goods located on state lands and makes it a felony to knowingly disturb, or fail to report disturbance to, such locations without authority of law.

North Dakota Administrative Code

The North Dakota Administrative Code (NDAC) outlines the criteria for listing cultural resources in the State Historic Sites Registry (NDAC 40-02-01). However, the SHSND uses the National Register of Historic Places (NRHP) to record and maintain lists of resources worthy of preservation (see below for a discussion of the NRHP). The NDAC outlines the process for obtaining a permit to conduct archaeological investigations (NDAC 40-02-02). Prehistoric and historic human burial sites, human remains, and burial goods are protected under NDAC 40-02-03.

5.4.1.1.2 Minnesota

Minnesota Field Archaeology Act of 1963

The Minnesota Field Archaeology Act of 1963 (Minn. Stat. 138.31-42) allows the State of Minnesota to reserve the exclusive right of field archaeology on state sites in order to protect and preserve archaeological sites on state lands. It prohibits unlicensed field archaeology on state sites and discourages unlicensed field archaeology on privately owned lands. Based on the Field Archaeology Act, it is a gross misdemeanor for a person to willfully conduct unlicensed archaeology on state sites; willfully deface, injure, destroy, displace, or remove any object or data belonging to the State; or willfully interfere with evidence or work on any state site or other site for which a license has been issued. Persons having knowledge of the location of archaeological sites are encouraged to communicate such information to the State Archaeologist.

The Field Archaeology Act also outlines the duties of the Minnesota's Office of the State Archaeologist (OSA), which include consultation with the Minnesota Indian Affairs Council (MIAC). The MIAC shares legal responsibility for monitoring and enforcing laws that protect Indian human remains and associated burial items. The MIAC reviews archaeological license applications to conduct fieldwork to determine if a burial or cemetery are within the project area. The authority for the MIAC is contained in Minnesota Statute 138.31.

Under the Field Archaeology Act, the Minnesota OSA shares some duties with the Minnesota Historical Society (MHS), but the Minnesota OSA is not affiliated with the MHS or the State Historic Preservation Officer (SHPO). The Minnesota OSA and the MHS/SHPO operate independently but cooperatively with regard to their shared duties.

Minnesota DNR, MNDOT, and all other state agencies whose activities may be affected are required to cooperate with MHS and the State Archaeologist to carry out the provisions of the Field Archaeology Act. Under the Field Archaeology Act, state agencies must supply MHS and the State Archaeologist with a development plan when known or suspected sites on lands under their jurisdiction may be affected by implementation of the plan. The Minnesota Environmental Quality Board submits copies of Environmental Assessment Worksheets to the MHS/SHPO for comment on potential effects of privately funded developments, such as the proposed Project, on historic properties in Minnesota (Minnesota SHPO 2005).

Minnesota Historic Sites Act

The Minnesota Historic Sites Act (Minn. Stat. 138.661-669) established the Minnesota Historic Sites Network. The sites are significant state resources that MHS is preserving, developing, interpreting, and maintaining for public use, benefit, and access.

The Minnesota Historic Sites Act also created the State Register of Historic Places, which is an inventory of outstanding properties possessing historical, architectural, archaeological, and aesthetic values that are of paramount importance in the development of the state. These historic properties represent and reflect elements of the state's cultural, social, economic, religious, political, architectural, and aesthetic heritage. These properties are separate from the Minnesota Historic Sites Network and are not operated by MHS for historical interpretive or public use and access purposes.

Historic properties are selected for inclusion in the State Register of Historic Places based on any of the following criteria:

1. The quality of significance in American history, architecture, archaeology, engineering, and culture that is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association;
2. Association with events that have made a significant contribution to the broad patterns of our history;
3. Association with the lives of persons significant in our past;
4. Embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
5. The yielding or likelihood of yielding information pertinent in prehistory or history.

The Minnesota Historic Sites Act outlines the responsibility of the State in protecting the physical features and historic character of properties designated in the Minnesota Historic Sites Network, State Register of Historic Places, or in the NRHP. Before carrying out any undertaking that would affect designated or listed properties, or funding or licensing an undertaking by other parties, the state department or agency must consult with the MHS to determine appropriate treatments and to seek ways to avoid and mitigate any adverse effects on designated or listed properties.

Minnesota Private Cemeteries Act

The Minnesota Private Cemeteries Act (Minn. Stat. 307.08) sets forth the equal treatment and respect for human dignity of all human burials, human remains, and human burial grounds without reference to their ethnic origins, cultural backgrounds, or religious affiliations. This applies to all human burials, human remains, or human burial grounds found on or in all public or private lands or waters in Minnesota. This also includes all remains found outside of recorded cemeteries or unplatted graves or burials found within recorded cemeteries and in contexts that indicate antiquity greater than 50 years. If such burials are not Indian or their ethnic identity cannot be ascertained, as determined by the State Archaeologist, they shall be dealt with in accordance with provisions established by the State Archaeologist and other appropriate authority.

When a known or suspected burial is involved with a development project under review by the SHPO, the SHPO copies the Minnesota OSA with appropriate correspondence. MHS has no role in the authentication process.

Minnesota State Historic Preservation Office

The Minnesota SHPO is a department of MHS. While the SHPO's principal responsibilities are defined in the National Historic Preservation Act (NHPA) Section 110, the SHPO also has historic preservation

duties under Minnesota state law. The SHPO acts for MHS in the review of state agency projects that may affect state archaeological sites including projects. The proposed Project is a private project, and is not a state project. Therefore, the Applicant has the responsibility of consulting with the SHPO.

The SHPO is responsible for maintaining an inventory of historic properties; identifying and nominating properties to the NRHP; implementing a statewide historic preservation plan; administering a federal grants program; assisting federal, state, and local governments with historic preservation duties; and working with state and federal agencies to ensure that historic properties are considered by planning and development.

As defined in 36 CFR 800, the SHPO plays a central role in the Section 106 process and "advises and assists federal agencies in carrying out their 106 responsibilities." The SHPO ensures that agencies make "a reasonable and good faith effort" to consider the effects of their undertakings on historic properties. "Historic properties" for the purposes of Section 106 are defined as sites, districts, buildings, structures, or objects that are included in or are eligible for listing in the NRHP. Historic properties also can be defined as any locations that are part of the historic fabric of the state; this includes unevaluated properties and, under state law, even properties that may not be eligible for listing in the NRHP.

Minnesota archaeological laws do not set standards for site significance and do not discuss integrity, but the SHPO evaluates affected sites using NRHP criteria and suggests treatments of significant state sites that are consistent with Section 106.

Minnesota Governor's Executive Order 13-10

The Minnesota Governor's Executive Order 13-10 directs state government agencies to implement new tribal consultation policies aimed at improving relationships and collaboration with Minnesota's 11 tribal governments. It provides for consultation, coordination, and cooperation between the State and the 11 Indian tribes.

5.4.1.1.3 Iowa

Iowa Administrative Code, Chapter 263B

Iowa Administrative Code (Iowa AC) Chapter 263B requires the University's Board of Regents to appoint a State Archaeologist, who is a faculty member of the Department of Anthropology at the University of Iowa. Established in 1959 and implemented under Chapter 685 (see below), the Office of the State Archaeologist (Iowa OSA) conducts archaeological research and public programs around the state, preserves ancient burial sites (150 years old or older), and examines and reinters ancient human remains (University of Iowa 2016a). The Iowa OSA also maintains the state archaeological repository, and manages data on all recorded archaeological sites in Iowa (University of Iowa 2016a).

Iowa Administrative Code, Chapter 303

Chapter 303 outlines the administrative responsibility of state agencies in agreement with the Department of Cultural Affairs under Chapter 28E for historical sites. Chapter 303.4 established a State Historical Society Board of Trustees. The State Historical Society preserves and provides access to Iowa's historical resources through a variety of statewide programs, exhibitions, and projects while serving as an advocate for Iowa's past and connector to the future (Iowa Department of Cultural Affairs 2016).

Iowa Administrative Code, Chapter 685

The Iowa OSA's responsibilities are implemented under Iowa Administrative Code (Iowa AC) 685, Chapter 1. As part of their responsibility, the Iowa OSA has developed procedural guidelines for treatment of burial places (Iowa AC 685, Ch. 11), confidentiality of archaeological site records (Iowa AC 685, Ch. 14; see also Iowa AC Ch. 22.7 [21]), the curation of archaeological specimens and associated records (Iowa AC 685, Ch. 7), and submittal of site records (Iowa AC 685, Ch. 12).

Iowa Administrative Code, Chapter 716.5

The intentional disturbance of burials is a violation of Iowa state law. Under Chapter 716.5, such disturbance is prosecutable as an aggravated misdemeanor.

Iowa State Historic Preservation Office

The Iowa SHPO is within the State Historical Society of Iowa. The Iowa SHPO identifies, preserves, and protects Iowa's historic and prehistoric resources. It administers state and federal historic preservation programs, and maintains a survey and inventory collection of historic properties in Iowa. The SHPO also issues guidelines for archaeological investigations in Iowa.

5.4.1.1.4 Illinois

Historic Preservation Act (20 ILCS 3410)

The Historic Preservation Act (20 Illinois Compiled Statutes [ILCS] 3410) created the Illinois Historic Sites Advisory Council, which reviews nominations to the NRHP.

Historic Preservation Agency Act (20 ILCS 3405)

The Historic Preservation Agency Act created the Illinois Historic Preservation Agency (IHPA). The IHPA protects historic, architectural, and archaeological sites as part of the public planning process within Illinois. The IHPA carries out their duties in accordance with Section 106 of the NHPA and the Illinois State Agency Historic Resource Preservation Act (see below).

Illinois State Agency Historic Resource Preservation Act (20 ILCS 3420)

The Illinois State Agency Historic Resources Preservation Act of 1990 (20 ILCS 3420) outlines procedures for the identification and protection of cultural resources that may be affected by projects that are funded by, licensed by, or permitted by state agencies. The Act was amended in 1991 to limit archaeological surveys for state agency permit and license reviews to projects in high-probability zones across the state and to locations of previously recorded sites. These zones are corridors extending up to 500 feet beyond both edges of the major river drainages in the state. Based on previous surveys and excavations, it is known that these areas have the highest probabilities for containing archaeological sites, especially burial mounds. The SA-04 route would be located across major river drainages in Illinois.

Archaeological and Paleontological Resources Protection Act (20 ILCS 3435)

The Archaeological and Paleontological Resources Protection Act (20 ILCS 3435) was passed to ensure that cultural resources on state or local public lands are protected. Formal permits are required to conduct archaeology on public lands.

The IHPA is responsible for the protection of archaeological and paleontological resources. The act also provides strict penalties for vandalism and theft of archaeological and paleontological resources.

The Illinois State Museum and the IHPA maintain a statewide file of known archaeological and paleontological sites.

Human Skeletal Remains Protection Act

The Human Skeletal Remains Protection Act (20 ILCS 3440) protects marked or unmarked human burials without reference to ethnic origins, cultural backgrounds, or religious affiliations. This law states that all human graves in unregistered cemeteries that are older than 100 years are protected by the State of Illinois. It is illegal to intentionally disturb these burials or burial markers, including Indian mounds. In the case of accidental discovery of human remains, whoever makes the discovery is required by state law to notify the county coroner immediately so that the coroner can determine whether the remains are part of a crime scene.

Illinois State Archaeologist

The Illinois State Archaeologist was established under Public Act 098-0346, to provide current information on the results of archaeological-related research and scientific inquiries to the public at large, communities, scientists, industry, and government agencies (University of Illinois 2016). The duties of the State Archaeologist include preservation, data collection and management, education, and research (University of Illinois 2016).

5.4.1.1.5 Wisconsin

Wisconsin Historical Society and State Historic Preservation Officer (Wisc. Stat. 44.01-02, 44.31-32)

The Wisconsin Historical Society (WHS) is designated as an official agency and trustee of the state and is charged with the preservation and care of Wisconsin's heritage and cultural resources under Wisconsin State Legislature Statutes (Wisc. Stat.) Chapter 44.01-02. The WHS is authorized with carrying out a historic preservation program for the "preservation or rehabilitation of historic properties." Wisc. Stat. Chapter 44.32, Subchapter II states that the director of the WHS or his or her designee shall serve as the SHPO whose duty among others includes identifying and nominating properties of historic significance.

Wisconsin State Historic Preservation Program and Archaeology Program (Wisc. Stat. 44.48(2))

Wisc. Stat. Chapter 44.48(2) authorizes the WHS to establish and administer a state archaeology program, in order to carry out specified archaeological surveys, studies, excavations or other activities in designated regions of the state.

Wisconsin State Register of Historic Places (Wisc. Stat. 44.36-41)

The Wisconsin State Register of Historic Places was established under Wisc. Stat. 44.36 to provide an inventory of districts, sites, buildings, structures and objects which are significant in national, state or local history, architecture, archaeology, engineering and culture.

Under Wisc. Stat. 44.41, each state agency that owns a listed property must develop a long-term plan for the management, preservation, and improvement of the property that to the greatest extent possible result in the preservation of the property.

Field Archaeology (Wisc. Stat. 44.47)

The Field Archaeology section of Wisc. Stat. 44.47 asserts that the State of Wisconsin reserves the exclusive right of field archaeology on state sites, and establishes regulations for field archaeology on sites owned by political subdivisions, in order to protect and preserve archaeological and scientific information, matter and objects. Further, it states that it is a declaration of legislative intent that persons practicing field archaeology on private owned land are encouraged to pursue their field archaeology in accordance with this Wisc. Stat. 44.47, and that the looting of all archaeological remains be strongly discouraged.

Burial Sites Preservation (Wisc. Stat. 157.70)

Chapter 157.70, Subchapter III of the Wisc. Stat. protects both catalogued and uncatalogued burial sites from disturbance, and outlines procedures necessary if any activity is thought to be disturb the burial site. The director of the WHS must be immediately notified if a person knows or has reasonable grounds to believe that a burial site or the cataloged land contiguous to a cataloged burial site is being disturbed or may be disturbed. Wisc. Stat. 157.70(10) details penalties to be imposed on any individual who fails to report the disturbance of a burial, intentionally disturbs a burial site, or allows for disturbance of a burial site to transpire without the authorization of the director of the WHS.

Wisconsin State Archaeologist (Wisc. Stat. 44.47)

The Wisconsin State Archaeologist was established under Wisc. Stat. 44.47 to sponsor, engage in, and direct fundamental research of Wisconsin archaeology, and encourage and coordinate archaeological research and investigation undertaken within the state. In addition to administering the state archaeology program, the State Archaeologist also approves permits for field archaeological research, cooperates with other state agencies which have authority in areas where archaeological site are located, encourages the preservation of archaeological sites located on privately owned property, and protects objects of archaeological significance discovered by field archaeology at state sites or discovered during the course of any public construction or demolition work on state sites.

5.4.1.1.6 Federal Regulations

National Historic Preservation Act

The NHPA of 1966 (16 U.S. Code 470 et seq.) as amended, requires federal agencies to identify and manage historic properties that are under their jurisdiction, and encourages the preservation of historic properties through consultation and cooperation with state and local governments, Indian tribes, and private individuals. The NHPA outlines the role of the federal government has in preserving historic properties, considering the effects of its actions, advancing the purposes of the Act, and avoiding activities that would be contrary to its purpose. The NHPA also outlines the roles of the Advisory Council on Historic Preservation, SHPOs, and Tribal Historic Preservation Officers (THPOs).

Section 106 of the NHPA (16 U.S. Code 470f, and 36 CFR 800) requires that any federal or federally assisted project, any project requiring federal licensing or permitting, or any project on federal lands consider the effect of the undertaking on historic properties listed in or eligible for listing in the NRHP. Under the NHPA, federal agencies must evaluate effects on all historic properties that are eligible for or listed in the NRHP before a project is approved. Under Section 106, agencies are required to consult Indian tribes at all stages of project development if an undertaking may affect a historic property with religious or cultural significance to a group, even if the undertaking is outside reservation boundaries.

National Register of Historic Places

The NRHP (16 U.S. Code 470a), created under the NHPA of 1966 described above, is the federal list of historic, archaeological, and cultural resources worthy of preservation. Resources listed in the NRHP include districts, sites, buildings, structures, and objects that are significant in American history, prehistory, architecture, archaeology, engineering, and culture. The NRHP is maintained and expanded by the National Park Service (NPS) on behalf of the Secretary of the Interior. In North Dakota, the SHPO at the SHSND administers the NRHP program. To guide the determination of eligibility of properties for inclusion in the NRHP, the NPS developed the NRHP Criteria for Evaluation (36 CFR 60.4). These criteria are standards by which properties are evaluated for listing in the NRHP. The criteria consider the level of significance in American history, architecture, archaeology, and culture and are applied to districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association. To be listed in the NRHP or to be considered eligible for listing in the NRHP, a district, site, building, structure, or object must meet one of the following criteria:

- Criterion A: Are associated with events that have made a significant contribution to the broad patterns of our history; or
- Criterion B: Are associated with the lives of persons significant in our past; or
- Criterion C: Embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components make lack individual distinction; or
- Criterion D: Has yielded, or may be likely to yield, information important in prehistory or history.

Archaeological sites are primarily assessed under Criterion D. Buildings and other resources that are less than 50 years old do not meet the NRHP criteria unless they are of exceptional importance under Criterion Consideration G, as described in the NPS Bulletin No. 22, "How to Evaluate and Nominate Potential National Register Properties That Have Achieved Significance Within the Last 50 Years."

Amendments to NHPA Section 106 specify that properties of religious and cultural significance (including traditional cultural properties [TCPs]) may be determined to be eligible for inclusion on the NRHP.

5.4.1.2 Methodology

The ROI for this impact analysis encompasses the areas along the Applicant's preferred route and the CN Alternatives where cultural resources could be directly or indirectly disturbed during Project-related construction or operations. The ROI for the Applicant's preferred route, includes the construction work area, permanent right-of-way, ATWS, access roads, and aboveground facilities, including 0.5 mile on either side of the pipeline centerline for archaeological resources, and 1 mile on either side of the pipeline centerline for historic resources. The ROI for SA-04 and the existing Line 3 also included 0.5 mile on either side of the pipeline centerline for archaeological resources and 1 mile on either side of the pipeline centerline for historic resources. The ROI for the transportation by rail and the transportation by truck alternatives includes archaeological resources and historic resources that are within 0.5 mile of the offloading facility locations at the Clearbrook and Superior terminals. While the exact location of these rail or truck offloading facilities is not known, it was assumed they would be located adjacent to the terminals and associated with existing rail and truck infrastructure.

For Minnesota, existing data were obtained from MHS for historic and archaeological resources within the ROI. Cultural resources were identified in these files that are eligible for listing, listed, or nominated but currently unevaluated for listing in the Minnesota State Historic Sites Network and the Minnesota State Register of Historic Places. Historic and archaeological data were also obtained from the North Dakota and Wisconsin SHPOs for the Applicant's preferred route and the CN Alternatives that would extend into those states. For SA-04, historic and archaeological data were also obtained from the respective SHPOs for Iowa (Iowa Archaeological Site File and I-Sites) and Illinois (Illinois Inventory of Archaeological Sites [IAS] and the Historic Architectural and Archaeology Resources Geographic Information System [HARGIS]).

The data collected included site number, site/property type, site location, date of recordation, historic context, and associated reports. Site leads, which are resources that are located on historic maps (e.g., rural schools) but have not been recently surveyed and have not been officially recorded, and as such, are not included in these analyses. The types of cultural resources were input into a geographic information system (GIS) and overlaid with the Applicant's preferred route and CN Alternatives where available. Potential impacts on cultural resources for the Applicant's preferred route and CN Alternatives were considered where construction or operation of the routes could cause disturbance, loss, or modification of the resource.

Additionally, surveys for archaeological resources were completed for the Applicant's preferred route in Minnesota, the information from which is included in this analysis. Surveys were not completed for historic resources in Minnesota. Additionally, the Applicant did not conduct any surveys for cultural resources for any CN Alternative. DOC-EERA's consultation with SHPO is ongoing, and the results of the consultation concerning determinations of eligibility, Project effects, and any necessary treatment for impacts are not yet available. The results of DOC-EERA's consultation with Minnesota SHPO will be updated in the Final EIS.

Information concerning sacred places is not available through SHPO databases but may be available through consultation with affected Indian tribes in Minnesota, North Dakota, Iowa, Illinois, and Wisconsin. Details on tribal consultation and coordination can be found in Chapter 9 and Appendix P.

5.4.2 Existing Conditions

This section describes the existing cultural resource conditions for archaeological and historic resources in the ROI for the Applicant's preferred route and the CN Alternatives. Additional information on tribal resources and historic treaties is provided in Chapter 9.

5.4.2.1 Minnesota

There are 11 federally recognized Indian tribes in Minnesota. The Ojibwe (Chippewa) tribes in Minnesota are: Bois Forte (Nett Lake), Fond du Lac, Grand Portage, Leech Lake, Mille Lacs, Red Lake, and White Earth. The Dakota Communities (Sioux) in the state are: Lower Sioux, Prairie Island, Shakopee-Mdewakanton, and Upper Sioux. The members of the Minnesota Chippewa Tribe include: Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs, and White Earth.

All recognized tribes have a Tribal Historic Preservation Officer (THPO). The THPOs have assumed Section 106 responsibilities for archaeological sites and TCPs, as well as other duties; however, the SHPO has retained Section 106 responsibility for buildings, structures, and landscapes within these

reservations. Agencies and contractors need to consult both the THPOs and the SHPO about federal undertakings within these reservations.

5.4.2.2 North Dakota

The Applicant's preferred route and the CN Alternatives would cross through the Northern Red River Study Unit of North Dakota. Additionally, SA-04 crosses through the Southern Red River Study Unit and the Sheyenne River Study Unit.

Five federally recognized American Indian tribes are in North Dakota: the Three Affiliated Tribes of the Fort Berthold Reservation (the Mandan, Hidatsa and Arikara Nation), the Spirit Lake Nation, the Standing Rock Sioux Tribe, the Turtle Mountain Band of Chippewa Indians, and the Sisseton-Wahpeton Oyate of the Lake Traverse Reservation. Four of the tribes in North Dakota have THPOs: the Three Affiliated Tribes of the Fort Berthold Reservation, the Spirit Lake Nation, the Standing Rock Sioux Tribe, and the Turtle Mountain Tribe of Chippewa (NATHPO 2016).

The Trenton Indian Service Area is an Indian community located partially within North Dakota and partially in Montana (North Dakota IAC 2010). Some tribes who have traditional and ceded lands within North Dakota now live on reservations in other states. These tribes may hold interests in the area of the ROI.

5.4.2.3 Iowa

The SA-04 route crosses through eastern Iowa.

There is one federally recognized tribe in Iowa, the Sac and Fox Tribe of the Mississippi in Iowa (National Conference of State Legislatures 2016). The Sac and Fox Tribe (also called the Meskwaki Nation of Iowa), purchased land in Iowa to establish the Meskwaki Indian Settlement on July 13, 1857. Other tribes who have traditional and ceded lands within Iowa now live on reservations in other states. These tribes may hold interests in the ROI.

There are no THPOs in the state of Iowa (NATHPO 2016).

5.4.2.4 Illinois

The SA-04 route extends from Iowa into northern Illinois.

There are no federally recognized Indian tribes in Illinois and no THPOs in the state of Illinois (NATHPO 2016). However, there are tribes who have traditional and ceded lands within Illinois but now live on reservations in other states. These tribes may hold interests in the ROI.

5.4.2.5 Wisconsin

The Applicant's preferred route and all of the CN Alternatives except SA-04 would cross into Wisconsin. Wisconsin is home to 11 federally recognized tribes (National Conference of State Legislatures 2016):

- Bad River Band of the Lake Superior Tribe of Chippewa Indians of the Bad River Reservation
- Forest County Potawatomi Community
- Ho-Chunk Nation of Wisconsin
- Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin

- Lac du Flambeau Band of Lake Superior Chippewa Indians of the Lac du Flambeau Reservation of Wisconsin
- Menominee Indian Tribe of Wisconsin
- Oneida Tribe of Indians of Wisconsin
- Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin
- St. Croix Chippewa Indians of Wisconsin
- Sokaogon Chippewa Community
- Stockbridge Munsee Community

Additionally, the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) in Wisconsin represents 11 Ojibwe tribes in Minnesota, Wisconsin, and Michigan with off-reservation hunting, fishing, and gathering treaty rights (GLIFWC n.d.). Nine of the 11 Wisconsin tribes have formal THPO designations (the Sokaogon Chippewa Community and St Croix Band of Lake Superior Chippewa do not) (WHS 2017a).

There may be resources of value to these tribes in the ceded territory, and hence these tribes may hold interests in the ROI.

5.4.2.6 Applicant's Preferred Route

5.4.2.6.1 Archaeological Resources

Based on data from the North Dakota SHPO provided in 2017, 16 previous studies were conducted for cultural resources within the ROI of the Applicant's preferred route in that state. Of these, 13 studies were previously conducted within the construction work area and 12 were within the permanent right-of-way. Based on the 2017 North Dakota SHPO data, the Applicant's preferred route in North Dakota has 15 archaeological resources within the ROI, 4 of which would be located within both the construction work area and permanent right-of-way (Table 5.4.2-2). These sites primarily consist of chipped stone and ceramics.

For the Applicant's preferred route in Minnesota, the Applicant conducted eight archaeological surveys (Phase I) and site evaluations (Phase II) between May 2013 and 2016 (Table 5.4.2-1). Three of the eight reports were available at MHS at the time of this study. As part of the Applicant's surveys, a total of 89 sites was recorded, of which 63 sites were documented in the Applicant's survey area for the Applicant's preferred route. Of the 63 sites, 59 sites were newly identified and 4 sites were revisited. The 63 sites recorded by the surveys conducted by the Applicant include 46 pre-contact archaeological sites, 16 historic archaeological sites, and one site that includes artifacts from both a historic period and a pre-contact period.

Table 5.4.2-1. Archaeological Investigations in Minnesota Conducted by the Applicant

Survey Date	Survey Type	Reference	Archaeological Resources Recorded	Counties	Miles Surveyed	Acres Surveyed
May – November 2013	Phase I	Mueller et al. January 2015	48	Aitkin, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Polk, and Red Lake	358	20,845
April – October 2014	Phase I and Phase II	Watson et al. 2014 Addendum	9	Polk, Crow Wing, Clearwater, Red Lake, Cass, Hubbard, Wadena, Aitkin, and Carlton	Unknown	3,800
May – November 2014	Phase I	Mueller and Terry March 2015	18	Kittson, Marshall, Pennington, Red Lake, Polk, and Clearwater	119	8,263
June – August 2015 [a]	Phase I	Mueller and Terry October 2015	2	Aitkin, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Polk, and Red Lake	Unknown	1,617
August – November 2015 [a]	Phase I	Mueller et al. 2016 Addendum	4	Aitkin, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Polk, and Red Lake	Unknown	1,347
June – July 2015[a]	Phase II	Watson et al. September 2015	5	Polk, Clearwater, Hubbard, and Carlton	Unknown	N/A
June – August 2015 [a]	Phase I	Mueller and Terry October 2015	2	Kittson, Marshall, Pennington, Red Lake, Polk, and Clearwater	119	8,409
August – November 2015 [a]	Phase I	Mueller et al. February 2016 Addendum	1	Polk	Unknown	69

[a] Report not available at Minnesota Historical Society.

The 46 pre-contact archaeological sites recorded in the Applicant's surveys in Minnesota (23 of which were single artifact lithic sites) include 22 lithic-only scatter sites, 1 pottery-only scatter site, and 12 multi-material artifact scatters (e.g., lithics, faunal remains, fire modified rock, charcoal, pottery). The Applicant recommended to Minnesota SHPO that 33 sites were not eligible for listing in the NRHP, 11 sites required further testing before they could be evaluated for the NRHP, and 2 were eligible for listing in the NRHP. SHPO has concurred with some of these findings.

Of the 16 historic archaeological sites recorded in the Applicant's surveys in Minnesota, 12 were newly identified and 4 were previously recorded. Thirteen of the historic archaeological sites were artifact scatters that included artifacts such as faunal remains, metal, glass, and ceramic fragments. The other three historic archaeological sites that did not have artifact scatters included one historic family cemetery, one homestead that included a concrete foundation and two pits, and one railroad spur. The Applicant recommended to SHPO that 14 of the historic archaeological sites were not eligible for listing

in the NRHP, and 1 site required further testing for NRHP eligibility. The last historic archaeological site (the Harrington Homestead Cemetery) is already protected under the Minnesota Statute 307.08.

The Applicant's surveys in Minnesota found one site that included artifacts both from a historic period and a pre-contact period. This site included lithics, faunal remains, fire-modified rocks, wood or charcoal, pottery, metal, and glass. The Applicant recommended that the site was not eligible for listing in the NRHP.

Based on data obtained from MHS on November 17, 2016, 53 previously recorded archaeological resources are located within the archaeological resources ROI for the Applicant's preferred route in Minnesota (Table 5.4.2-1). Of these 53 archaeological resources in the ROI, 9 would be located within the construction work area, four of which are in the permanent right-of-way (Table 5.4.2-1). Additionally, three archaeological sites would be located within the ATWS for the Applicant's preferred route.

Data obtained from WHS on March 29, 2017 found six previously recorded archaeological resources located within the archaeological resources ROI for the Applicant's preferred route in Wisconsin (Table 5.4.2-1). Four of these Wisconsin archaeological resources are historic-era cemeteries that are located outside the construction work area. The remaining two archaeological sites, including a dam/historic earthwork site and a pre-contact lithic scatter, would be within the construction work areas. The lithic scatter would also be within the permanent right-of-way.

5.4.2.6.2 Historic Resources

As stated above, 16 surveys were conducted for cultural resources within the ROI of the Applicant's preferred route. Based on data from the North Dakota SHPO provided in 2017, there are no historic resources located within the ROI of the Applicant's preferred route in North Dakota.

The Applicant did not conduct surveys for historic resources in Minnesota. Based on data obtained from MHS on November 17, 2016, 80 previously recorded historic resources are located within the ROI for the Applicant's preferred route. These historic resources include structures, buildings, NPS buildings, and bridges. No historic resources would be located within the construction work area (Table 5.4.2-1).

Data obtained from WHS on March 29, 2017, found 48 previously recorded historic resources located within the historic resources ROI for the Applicant's preferred route in Wisconsin (Table 5.4.2-2). These include a farmstead, foundry, houses and outbuildings, a garage, a refinery, churches, an airport hangar, structures, and a car manufacturing plant. One historic resource was identified within the construction work area but would be outside the permanent right-of-way.

Table 5.4.2-2. Previously Recorded Archaeological and Historic Resources within the Region of Interest of the Applicant's Preferred Route

Route	Number of Resources in Region of Interest Area	Number of Resources in Construction Work Area	Number of Resources in Permanent Right-of-Way
North Dakota			
Archaeological Resources	15	4	4
Historic Resources	0	0	0
Minnesota			
Archaeological Resources	53	9	4
Historic Resources	80	0	0
Wisconsin			
Archaeological Resources	6	2	1
Historic Resources	48	1	0

5.4.2.7 Continued Use of Existing Line 3

5.4.2.7.1 Archaeological Resources

Based on data from the North Dakota SHPO, 16 previous studies have been conducted for cultural resources within the ROI of the existing Line 3. Of these, 13 studies were within the construction work area and 12 were within the permanent right-of-way. Based on North Dakota SHPO data, the existing Line 3 in North Dakota has 15 archaeological resources within the ROI, of which 4 would be located within both the construction work area and permanent right-of-way (Table 5.4.2-3). These sites primarily consist of chipped stone and ceramics.

Based on data obtained from MHS on November 17, 2016, 107 previously recorded archaeological sites have been identified within the ROI for the existing Line 3 pipeline in Minnesota (Table 5.4.2-3). Of these, 7 sites would be in the construction work area and 5 would be in the permanent right-of-way.

Based on data obtained from WHS on March 29, 2017, 6 previously recorded archaeological resources are located within the archaeological resources ROI for the existing Line 3 pipeline in Wisconsin (Table 5.4.2-3). These include four archaeological resources that are historic-era cemeteries, a dam/historic earthwork site, and a pre-contact lithic scatter.

Table 5.4.2-3. Previously Recorded Archaeological and Historic Resources in the Region of Interest of Existing Line 3 Pipeline

Route	Number of Sites in Region of Interest	Number of Sites in Construction Work Area	Number of Sites in Permanent Right-of-Way
North Dakota			
Archaeological Resources	15	4	4
Historic Resources	0	0	0
Minnesota			
Archaeological Resources	107	7	5
Historic Resources	166	3	1
Wisconsin			
Archaeological Resources	6	2	1
Historic Resources	48	1	0

Source: I-Sites 2017; IAS 2017; IHPA 2017; MHS 2016; North Dakota SHPO 2017; University of Iowa 2017; WHS 2017.

5.4.2.7.1 Historic Resources

There have been 16 surveys conducted for cultural resources within the ROI of the existing Line 3 pipeline in North Dakota. Based on data from the North Dakota SHPO, there are no historic resources located within the ROI of the existing Line 3 pipeline in North Dakota.

Based on data obtained from MHS on November 17, 2016, 166 previously recorded historic resources are located in the ROI, of which 3 sites would be in the construction work area and 1 would be in the permanent right-of-way (Table 5.4.2-3).

Based on data obtained from WHS on March 29, 2017, there are 48 previously recorded historic resources located within the historic resources ROI for the existing Line 3 pipeline in Wisconsin. These include a farmstead, foundry, houses and outbuildings, garage, refinery, churches, airport hangar, structures, and a car manufacturing plant.

5.4.2.8 System Alternative SA-04

5.4.2.8.1 Archaeological Resources

Based on the North Dakota SHPO records, a total of 156 studies have been conducted within the 1-mile ROI for historic resources of SA-04. Of these studies, 126 were conducted within the 0.5-mile ROI for archaeological resources, 51 were conducted within the construction work area, and 46 were conducted within the permanent right-of-way.

A total of 32 archaeological resources are located within the 0.5-mile ROI in North Dakota (Table 5.4.2-4). Of these, five archaeological resources would be located in the construction work area, four of which would be located in the permanent right-of-way. These 32 resources include isolated finds of chipped stone, cultural material scatters (including projectile points and chipped stone), railroads, and trails.

Based on data obtained from MHS on November 17, 2016, one previously recorded archaeological resource is located within the archaeological resources study area for SA-04 (Table 5.4.2-4) in Minnesota and there are no previously recorded archaeological resources within the construction work area for SA-04 in Minnesota.

A search in the ROI was conducted within the Iowa Archaeological Site File by the Site Records Manager. A total of 138 studies were conducted within the ROI, of which 67 studies were in the construction work area, and 59 in the permanent right-of-way. A total of 98 archaeological resources would be located in the 0.5-mile ROI for SA-04 in Iowa (Table 5.4.2-4). These include 35 sites in the construction work area, 27 of which would be in the permanent right-of-way. These resources include prehistoric scatters, lithic scatters, lithic workshops, isolated finds, open habitations, structure/building remains, abandoned town sites, and historic scatters.

Based on data obtained from IAS on March 29, 2017, 136 previously recorded archaeological sites were identified within the ROI in Illinois, including 4 cemeteries. Of the 136 archaeological sites in the ROI, 9 sites would be located within the construction work area. Of the 9 archaeological sites in the construction work area, 8 sites would be within the permanent right-of-way. Two archaeological sites located within the permanent right-of-way remain unevaluated by the Illinois SHPO for listing in the NRHP, including a pre-contact village site and pre-contact campsite. The other six sites have been determined not eligible for listing in the NRHP. No cemeteries were identified within either the construction work area or the permanent right-of-way.

5.4.2.8.2 Historic Resources

Based on North Dakota SHPO data, a total of 359 historic resources are located within the ROI in North Dakota (Table 5.4.2-4). No historic resources are within the construction work area or the permanent right-of-way. Historic resources in North Dakota include bridges, farmsteads, barns, churches, and outbuildings. NRHP listings for the ROI in North Dakota were reviewed. Two NRHP-listed resources are located within the study area of SA-04: the Amos and Lillie Plummer House in Hillsboro and the Drayton United Methodist Church in Drayton (NPS 2013). For SA-04, there are no NRHP-listed resources within the construction work area in North Dakota.

Based on data obtained from MHS on November 17, 2016, three previously recorded historic resources are within the ROI for SA-04 (Table 5.4.2-4) in Minnesota, but none would be located within the construction work area or the permanent right-of-way for SA-04.

Based on I-Sites (University of Iowa 2017), a total of 208 historic studies have been previously conducted in the ROI in Iowa. There are 222 previously recorded historic resources located within the ROI in Iowa (Table 5.4.2-4). The previously recorded resources include 29 cemeteries and 42 bridges. The remainder of the resources are primarily associated with farms. Of the 222 resources, 219 resources remain undetermined for NRHP eligibility (Office of the State Archaeologist 2017). Three NRHP-listed resources are within the ROI: Stoe Creek Bridge, the Richardson-Jakway House, and Dr. Martin H. Calkins House and Office (NPS 2013). No historic properties would be located within the construction work area or the permanent right-of-way in Iowa.

According to HARGIS (IHPA 2017), there are 77 previously recorded historic resources located within the ROI in Illinois (Table 5.4.2-4). Four of these resources are listed in the NRHP: the Wood-Tellkamp House (201181), the First Congregational Church of LaMoille (201032), the Allen School (201034), and the Marseilles Lock and Dam Historic District (04000165) (IHPA 2017, NPS 2013). Two additional historic

resources, the Bridge over Baker Run (154875) and the Bridge over Masters Creek (153691), have been determined eligible for the NRHP (IHPA 2017). No historic resources would be located in either the construction work area or the permanent right-of-way for SA-04 in Illinois.

Table 5.4.2-4. Previously Recorded Archaeological and Historic Resources for System Alternative SA-04

Route Segment	Number of Sites in Study Area	Number of Sites in Construction Work Area	Number of Sites in Permanent Right-of-Way
North Dakota			
Archaeological Resources	32	5	4
Historic Resources	359	0	0
Minnesota			
Archaeological Resources	1	0	0
Historic Resources	3	0	0
Iowa			
Archaeological Resources	98	35	27
Historic Resources	222	0	0
Illinois			
Archaeological Resources	136	9	8
Historic Resources	77	0	0

Source: I-Sites 2017; IAS 2017; IHPA 2017; MHS 2016; North Dakota SHPO 2017; University of Iowa 2017; WHS 2017.

5.4.2.9 Transportation by Rail

In the United States, the rail offloading facility would require between 100 and 200 acres of land that is identified as agricultural lands and wetlands near Clearbrook, Minnesota, along with reestablishment of 10 miles of existing track in Clearbrook.

The rail offloading facility near Superior, Wisconsin, would require approximately 100 acres adjacent to the existing Enbridge terminal and construction of a less-than-1-mile interconnection between existing rail lines in Superior.

5.4.2.9.1 Archaeological Resources

There are four archaeological sites within the ROI for the Clearbrook offloading facility. These sites include post-contact surface features and artifact scatters and pre-contact single artifacts. There are six archaeological sites within the ROI for the Superior facility and connection. Four of these are cemeteries.

5.4.2.9.2 Historic Resources

There are 12 historic resources within the ROI for the Clearbrook offloading facility. There are 47 historic resources within the ROI for the Superior facility, including houses, farms, outbuildings, a church, an airport, and foundries, among other buildings, structures, and objects.

5.4.2.10 Transportation by Truck

In the United States, truck facilities near Clearbrook would require approximately 50 acres to construct and operate offloading facilities, and approximately 5 acres for road access. Truck facilities near the terminal in Superior would require approximately 50 acres to construct and operate a truck offloading facility, and an additional 34 acres to establish a truck route. Specific locations for these facilities have not been identified, but each facility would be located in a general area adjacent to the terminals where the truck facilities (or the rail offloading facilities) would be expected to be constructed, and the ROI for both archaeological and historic resources is the same for both the truck and rail alternatives. Thus, the resources within the ROI are the same as well.

5.4.2.10.1 Archaeological Resources

There are four known archaeological sites within the ROI for the Clearbrook offloading facility. Two of the sites are post-contact surface features and two are pre-contact single artifacts. There are six archaeological sites within the ROI for the Superior facility and connection. Four of these are cemeteries.

5.4.2.10.2 Historic Resources

There are 12 known historic resources within the ROI near Clearbrook, Minnesota. All of these resources are buildings or structures and include houses, a bank, a warehouse, a grain elevator, and a train station. There are 47 historic resources within the ROI for the Superior facility, including houses, farms, outbuildings, a church, an airport, and foundries as well as other buildings, structures, and objects.

5.4.2.11 Existing Line 3 Supplemented by Rail

The existing conditions for the existing Line 3 supplemented by rail alternative are identical to those described above for continued use of the existing Line 3 pipeline and transportation by rail alternatives.

5.4.2.12 Existing Line 3 Supplemented by Truck

The existing conditions for the existing Line 3 supplemented by truck alternative are identical to those described above for continued use of the existing Line 3 pipeline and transportation by truck alternatives.

5.4.3 Impact Assessment

Impacts occur when an undertaking alters, directly or indirectly, the characteristics of a cultural resource that qualify it for inclusion in the State Register of Historic Places or the State Historic Site Network in a manner that diminishes the historical integrity of the property.

The Project would cause impacts on cultural resources during construction and operations. These impacts affect the ability of a cultural resource to convey its significance and may affect its integrity, visibility, accessibility, and research potential. The duration of impact could range from temporary to permanent, depending on the type of impact and type of cultural resource. The magnitude of impact

could range from negligible to major, depending on the type of cultural resource that would be affected and its location relative to the construction work area or permanent right-of-way.

Direct impacts are the physical disturbances of an action (e.g., construction, operation, or restoration) on a resource that occur at the same time and place as the action within the footprint of the physical disturbance. The types of direct impacts on cultural resources during construction and operation may include the following:

- Physical destruction of or damage to a cultural resource/historic property;
- Alteration of a cultural resource/historic property;
- Removal of a cultural resource/ historic property from its historic location;
- Change of the character of the cultural resource's/ historic property's use or of physical features as they relate to historical setting; and/or
- Neglect of a cultural resource/ historic property that causes its deterioration (except where such neglect and deterioration are recognized qualities of a sacred place).

The level of impact would depend on the type of archaeological resource and its eligibility for listing in the State Register of Historic Places or the State Historic Site Network, as well as its significance to affected Indian tribes (e.g., a sacred place). For example, a lithic scatter may be more likely to be vandalized than a rock cairn or a railroad spur, which would cause a higher magnitude of impacts on the vandalized archaeological site. A site that is eligible for listing in the State Register of Historic Places would experience a higher magnitude of impacts than a site that is not eligible for the same register based on the site's importance to the affiliated culture or state. Single artifacts and surface site expressions may have a lower potential to yield information important to prehistory than a deeply stratified site containing faunal remains, hearths, and charcoal. As such, impacts on the former would be less than on a site with high research potential. The level of impact also would vary depending on the location of the construction-related activity and the type of soil, bedrock, and vegetation. For example, vegetation removal may cause damage to surface sites more than deeply buried sites. Compaction may cause impacts on shallow sites and not affect deeply buried sites. If an archaeological site is directly affected, the impact would be permanent and would range in magnitude from minor to major.

It is likely that currently unknown archaeological resources located within the construction work area could be inadvertently discovered during ground-disturbing activities. To reduce impacts on currently unknown archaeological resources, an Unanticipated Discovery Plan (Appendix O) would be implemented during construction. Impacts on inadvertently discovered archaeological resources would be similar to those described for previously recorded resources.

Contamination of archaeological resources could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities for the Applicant's preferred route or CN Alternatives. These spills would be managed according to SPCC Plans. Direct impacts on archaeological resources due to contamination and disturbance from cleanup activities would be permanent, depending on the type and location of resource and would range in magnitude from minor to major. Direct impacts on historic resources would range from temporary to permanent and negligible to major, depending on the type and location of resource.

Indirect impacts may change the character of the property's use or physical features within the property's setting that contribute to its historic significance and integrity. Indirect impacts during construction and operations may include:

- Permanent change in viewshed of a historic resource;
- Limited or altered access to a historic resource, whereby the resource may be neglected and fall into ruin, or conversely, access to a historic resource may be facilitated, causing vandalism to increase;
- Introduction of visual, atmospheric, or audible elements that diminish integrity;
- Temporary construction-related impacts including dust, noise, vibration, and visual intrusions caused by heavy equipment.

Indirect impacts from construction activities, such as visual, auditory, and atmospheric changes, would be temporary. Evidence of construction would be visible during and for a short period after construction. Indirect impacts could be caused by changes to the surrounding landscape from clearing, excavation, construction equipment, and personnel. These impacts would typically be minor for cultural resources; however, some cultural resources may experience major impacts as a result of viewshed changes or inaccessibility. The changes in viewshed and accessibility would decrease over time. During revegetation, the visual impact from pipeline construction would typically be minor but may last several years or even decades (e.g., trees).

Since only the Applicant's preferred route was surveyed, the analyses for the remaining alternatives are based on the archival review of existing site data. As such, it is possible that a greater number of cultural resources are present within the ROI, construction work area, and permanent right-of-way for the alternatives that have not been documented.

5.4.3.1 Applicant's Preferred Route

5.4.3.1.1 Construction Impacts

Impacts on Archaeological Resources

There are 16 known archaeological sites within the construction work area of the Applicant's preferred route (Table 5.4.2-2). Construction-related activities such as excavation, grading, rutting, compaction, and removing vegetation would directly affect these archaeological resources. Damage to an archaeological resource could occur from clearing and grading of the pipeline alignment, construction work area, temporary workspaces, access roads, pump stations, and materials staging areas. There could be an increased risk of erosion, vandalism, and looting of an archaeological resource from removal of protective vegetative cover, and compaction of archaeological resources could occur from movement of heavy machinery and transport of pipe sections, which may alter site stratigraphy and artifact morphology. In addition, impacts could be associated with Project-related spills including contamination or disturbance during cleanup activities, or encountering existing contamination (see Section 5.2.2).

Direct impacts on archaeological sites during construction would be permanent and minor to major depending on the type of resource. American Indians would consider any impact on archaeological resources to be permanent and irreversible. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and the affected public (see Section 5.4.4). Indirect impacts during construction would be temporary, localized, and negligible to minor.

Temporary impacts, including vibration, changes in noise and air quality, and visual intrusions, may occur during construction.

Impacts on Historic Resources

There are a total of 128 known historic resources within the ROI for the Applicant's preferred route, one of which would be within the construction work area in Wisconsin (Table 5.4.2-3). Construction-related direct impacts on this known historic resource would occur and could include destruction and alteration to the resource, moving of associated historic features, as well as visual changes. These direct impacts would be permanent and minor to major.

Indirect temporary impacts may occur on the remaining 127 historic resources within the ROI, including dust, vibration, and intrusion related to construction equipment, as well as construction-related noise. These indirect impacts would be temporary and negligible to minor. Indirect visual intrusions due to vegetative clearing would be long-term and negligible to minor. Indirect impacts from the construction of aboveground facilities would be permanent and negligible to major. The viewshed contains existing pipeline rights-of-way and transmission lines, and the changes in viewshed would decrease over time from revegetation within temporary construction work areas and to a lesser degree the permanent right-of-way.

5.4.3.1.2 Operations Impacts

Impacts on Archaeological Resources

Disturbed areas would be restored and stabilized to the extent practicable after pipeline installation. Such restoration is unlikely to cause damage to cultural resources beyond what may occur during construction. Inspection, monitoring, and maintenance activities are unlikely to affect the four archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction, and as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur (see Section 5.2.2 and Chapter 10); however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Impacts on Historic Resources

Operations impacts are unlikely to directly impact historic resources, as no known historic resources are located within the permanent right-of-way. Indirect temporary impacts may occur on the 80 historic resources within the ROI during pipeline operations. These indirect impacts would primarily consist of the presence of MLVs, pump stations, and maintenance crews and would be temporary to permanent and negligible to minor.

Indirect visual intrusions from the new pipeline would be permanent as the viewshed contains existing pipeline rights-of-way and transmission lines, and the changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

5.4.3.2 Continued Use of Existing Line 3

5.4.3.2.1 Construction Impacts

There would be no construction impacts on archaeological and historic resources from continued use of the existing Line 3 pipeline because it is already built.

5.4.3.2.2 Operations Impacts

Impacts on Archaeological Resources

No direct impacts on the 5 archaeological resources within the permanent right-of-way are expected with continued use of the existing Line 3 because the Enbridge Mainline corridor has been extensively disturbed from previous pipeline construction, operations, and maintenance and it is not expected that ground disturbance would occur in new areas during integrity digs.

Inspection, monitoring, and maintenance activities are unlikely to affect the archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction, and as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur (see Section 5.2.2 and Chapter 10); however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources are avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Impacts on Historic Resources

No direct impacts on known historic resources are expected with continued use of the existing Line 3 because the Enbridge Mainline corridor has been extensively disturbed from previous pipeline construction, operations, and maintenance and it is not expected that ground disturbance would occur in new areas during integrity digs. Maintenance activities may indirectly impact the single historic resource within the permanent right-of-way or the remaining 165 historic resources in the ROI (3 of which are in the construction work area), comparable to those described for new pipeline construction, including dust, vibration, and intrusion related to maintenance equipment and personnel. Indirect impacts would be temporary and negligible to minor.

5.4.3.3 System Alternative SA-04

5.4.3.3.1 Construction Impacts

Impacts on Archaeological Resources

A total of 49 known archaeological resources would be within the construction work area for SA-04 (Table 5.4.2-4). Construction-related impacts would be the same as described above for archaeological resources within the Applicant's preferred route. Direct impacts would be permanent and minor to major; indirect impacts would be temporary and negligible to minor. However, a greater number of archaeological resources would be affected by SA-04 than by the Applicant's preferred route. Additionally, there is a greater chance of encountering unknown archaeological resources given that surveys have not been conducted along this alternative. American Indians would consider any impact on archaeological resources to be permanent and irreversible.

Impacts on Historic Resources

There are no known historic resources within the construction work area for SA-04; however, there are 661 known historic resources in the ROI (Table 5.4.2-3). There would be no construction-related direct impacts on historic resources expected as there are no known historic resources located within the construction work area. Construction-related activities may cause indirect impacts on historic resources located in the ROI. These indirect impacts would be similar to those described for the Applicant's preferred route, resulting from pipeline construction, aboveground facilities, staging areas, and access roads. These indirect impacts would be temporary to permanent and negligible to major.

5.4.3.3.2 Operations Impacts

Impacts on Archaeological Resources

Disturbed areas would be restored and stabilized to the extent practicable after pipeline installation. Such restoration is unlikely to cause damage to the 39 known archaeological resources within the permanent right-of-way beyond what may occur during construction. Inspection, monitoring, and maintenance activities are unlikely to affect the archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction, and as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur (see

Section 5.2.2 and Chapter 10); however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Impacts on Historic Resources

Operations are unlikely to cause direct impacts on historic resources as no known historic resources are located within the permanent right-of-way. Operations-related activities may cause indirect impacts on the 661 known historic resources located in the ROI. These indirect impacts would be similar to those described for the Applicant's preferred route including visual intrusions, viewshed changes, dust, noise and vibration caused from maintenance equipment and personnel. Indirect impacts would be temporary to permanent and negligible to minor.

5.4.3.4 Transportation by Rail

5.4.3.4.1 Construction Impacts

Impacts on Archaeological Resources

There are four known archaeological sites within the ROI for Clearbrook and six known archaeological sites within the ROI for Superior, which may be directly affected during construction of offloading facilities and associated access. Direct impacts could result from grading, vegetation removal, leak containment, and any inadvertent exposure of contaminated sediments. Construction activity may expose archaeological resources to looting and vandalism. These impacts would be permanent and may range in magnitude from minor to major, depending on the specific resource. It is likely that measures would be taken to avoid known important archaeological resources during construction of facilities associated with this alternative, and plans would likely be in place to address unanticipated discoveries of archaeological resources. American Indians would consider any impact on archaeological resources to be permanent and irreversible.

Indirect impacts would primarily be related to visual, auditory, and air quality changes during construction which may affect the setting or significant qualities of archaeological resources. It is expected these impacts would be temporary and negligible to minor.

Impacts on Historic Resources

There are 12 known historic resources within the ROI for Clearbrook, all of which are in the town. There are 47 historic resources within the ROI for Superior. Construction-related direct impacts could occur, including destruction and alteration, moving of associated historic features, as well as visual changes. These direct impacts, if they did occur, could be permanent and minor to major.

Indirect impacts would occur during construction of the new spur lines and loading/offloading facilities. These indirect impacts may include temporary construction-related impacts such as viewshed changes, noise, vibration, and dust, which would be negligible to minor. Long-term indirect impacts would result from vegetation removal, which could be negligible to minor. Permanent indirect impacts may include visual or auditory changes that affect the setting or significant qualities of historic resources, which would be minor to major. Construction activity also may temporarily prevent access to historic resources for a short time while construction and reclamation activities are ongoing, which would result in indirect temporary impacts that are negligible to minor.

5.4.3.4.2 Operations Impacts

Impacts on Archaeological Resources

Operation of the transportation by rail alternative includes operation of the offloading facilities and associated access adjacent to the Clearbrook and Superior terminals and use of existing rail lines. It would not involve any new ground disturbance. Therefore, direct impacts are not anticipated.

Direct impacts associated with Project-related spills or encountering existing contamination could occur (see Section 5.2.2 and Chapter 10); however, no additional impacts would be expected to archaeological resources that would have already been disturbed during construction. Regular inspection of rail cars for leaks would minimize the potential for such contamination; however, contamination could be permanent and minor to major, depending on the type of archaeological resource and soil permeability.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Known archaeological resources in proximity to these rail lines may be indirectly affected by dust and vibration, although these impacts are currently occurring from existing rail traffic. It is expected that operation of the transportation by rail alternative would result in temporary negligible to minor indirect impacts on archaeological resources.

Impacts on Historic Resources

During operation of the transportation by rail alternative, trains hauling crude oil would use existing rail lines to access offloading facilities and associated access at the Clearbrook and Superior terminals. These operations would not involve ground disturbance. As such, direct impacts on historic resources are not anticipated. However, minor spills along existing and newly constructed rail lines have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. Regular inspection of rail cars for leaks would minimize the potential for such contamination, and impacts would likely be temporary and minor; although some contamination could be permanent and negligible to major, depending on the type of cultural resource.

Indirect impacts related to access to a historic resource or changes to its visual, auditory, and air quality setting may result from an increase in rail traffic. However, historic resources along existing lines are already subject to rail traffic, and as such, these indirect impacts would be temporary and negligible to minor.

5.4.3.5 Transportation by Truck

5.4.3.5.1 Construction Impacts

Impacts on Archaeological Resources

There are four known archaeological sites within the ROI for Clearbrook and six known archaeological sites within the ROI for Superior, which may be directly affected during construction of offloading facilities and associated access. Direct and indirect impacts could occur from construction of new offloading sites and access routes. Construction would require clearing and grading adjacent to the Clearbrook and Superior terminals. Direct impacts could result from grading, vegetation removal, leak containment, and any inadvertent exposure of contaminated sediments. Construction activity may expose archaeological resources to looting and vandalism. These impacts would be permanent, and may range in magnitude from minor to major, depending on the specific resource. It is likely that measures would be taken to avoid known important archaeological resources during construction of facilities associated with this alternative, and plans would likely be in place to address unanticipated discoveries of archaeological resources. In areas with existing routes, direct impacts on archaeological resources would likely be minimal if no ground disturbance was involved. American Indians would consider any impact on archaeological resources to be permanent and irreversible.

Indirect impacts would primarily be related to visual, auditory, and air quality changes during construction which may affect the setting or significant qualities of archaeological resources. These impacts would be temporary and negligible to minor. Cultural resources along existing routes are already subject to truck traffic. However, the increase in truck traffic could indirectly impact the visual, auditory, and air quality setting of, or access to, archaeological resources. These indirect impacts would be temporary and negligible to minor.

Impacts on Historic Resources

There are 12 known historic resources within the ROI for Clearbrook, all of which are in the town. There are 47 historic resources within the ROI for Superior. Construction-related direct impacts could occur, including destruction and alteration, moving of associated historic features, as well as visual changes. These direct impacts would be permanent and minor to major.

Indirect impacts would occur during construction of the new offloading sites and access routes. These indirect impacts may include temporary construction-related impacts such as viewshed changes, noise, vibration, and dust, which would be negligible to minor. Long-term indirect impacts would result from vegetation removal, which could be negligible to minor. Permanent indirect impacts may include visual or auditory changes that affect the setting or significant qualities of historic resources, which would be minor to major. Construction activity also may temporarily prevent access to historic resources for a short time while construction and reclamation activities are ongoing, which would result in indirect temporary impacts that are negligible to minor.

5.4.3.5.2 Operations Impacts

Impacts on Archaeological Resources

Operation of the transportation by truck alternative includes use of existing roads and highways and offloading facilities and associated access adjacent to the Clearbrook and Superior terminals. Operations would not involve ground disturbance.

Direct impacts associated with Project-related spills or encountering existing contamination could occur (see Section 5.2.2 and Chapter 10); however, no additional impacts would be expected to archaeological resources that would have already been disturbed during construction. Regular inspection of trucks for leaks would minimize the potential for such contamination; however, contamination could be permanent and minor to major, depending on the type of archaeological resource and soil permeability.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Known archaeological resources in proximity to these roads may be indirectly affected by dust and vibration, although these impacts are currently occurring from existing traffic. It is expected that operation of the transportation by truck alternative would result in temporary negligible to minor indirect impacts on archaeological resources.

Impacts on Historic Resources

During operation of the transportation by truck alternative, trucks hauling crude oil would use existing roads and highways and offloading facilities and associated access at the Clearbrook and Superior terminals. Operations would not involve ground disturbance. As such, direct impacts on historic resources are not anticipated. However, minor spills have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. These impacts would be temporary to permanent and negligible to major.

Historic resources in proximity to these roads (e.g., bridges) may be indirectly affected by dust and noise. However, these impacts are currently occurring from existing traffic, and as such, these indirect impacts would be temporary and negligible to minor.

5.4.3.6 Existing Line 3 Supplemented by Rail

5.4.3.6.1 Construction Impacts

Impacts on Archaeological Resources

There would be no construction impacts on archaeological resources from continued use of the existing Line 3 pipeline because it is already built. Impacts related to the construction of facilities and access required for the transportation by rail alternative would be the same as described above for that alternative, including damage to archaeological resources from construction activities, exposure of resources to vandalism/looting, contamination from spills of hazardous materials, and unanticipated discoveries of archaeological resources. Direct impacts would be permanent, and may range in magnitude from minor to major, depending on the specific resource. Indirect impacts would primarily be related to visual, auditory, and air quality changes during construction which may affect the setting or significant qualities of archaeological resources. Indirect impacts would be temporary and negligible to minor. American Indians would consider any impact on archaeological resources to be permanent and irreversible.

Impacts on Historic Resources

There would be no construction impacts on historic resources from continued use of the existing Line 3 pipeline because it is already built. Impacts related to the development of facilities required for the transportation by rail alternative would be the same as described above for that alternative, including damage to historic resources from construction activities, contamination from spills of hazardous materials, and viewshed changes. Direct impacts would be permanent, and may range in magnitude from minor to major, depending on the specific resource.

Indirect impacts would occur during construction of new spur lines and loading/offloading facilities and may include visual, auditory, air quality, access changes to historic resources. These indirect impacts would be temporary and negligible to minor. Permanent indirect impacts may include visual or auditory changes that affect the setting or significant qualities of historic resources, which would be minor to major.

5.4.3.6.2 Operations Impacts

Impacts on Archaeological Resources

No impacts on archaeological resources are expected with continued use of the existing Line 3 because the Enbridge Mainline corridor has been extensively disturbed from previous pipeline construction, operations, and maintenance and it is not expected that ground disturbance would occur in new areas during integrity digs. Direct impacts associated with Project-related spills or encountering existing contamination could occur (see Section 5.2.2 and Chapter 10); however, no additional impacts would be expected to archaeological resources that would have already been disturbed during construction. Regular inspection of rail cars for leaks would minimize the potential for such contamination; however, contamination could be permanent and minor to major, depending on the type of archaeological resource and soil permeability.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Known archaeological resources in proximity to these rail lines may be indirectly affected by dust and vibration, although these impacts are currently occurring from existing rail cars. It is expected that this alternative would result in temporary negligible to minor indirect impacts on archaeological resources.

Impacts on Historic Resources

No direct impacts on historic resources are expected with continued use of the existing Line 3 because the Enbridge Mainline corridor has been extensively disturbed from previous pipeline construction, operations, and maintenance and it is not expected that ground disturbance would occur in new areas during integrity digs. However, minor spills along existing and newly constructed rail lines have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. Regular inspection of rail cars for leaks would minimize the potential for such contamination, and impacts would likely be temporary and minor; although some contamination could be permanent and negligible to major, depending on the type of cultural resource and soil permeability.

If maintenance activities occurred near historic resources, impacts at those locations within the permanent right-of-way would be comparable to those described for new pipeline construction, including dust, vibration, and intrusion related to construction equipment, and construction-related noise. These indirect impacts would be considered temporary and negligible to minor.

During operation of the transportation by rail alternative, trains hauling crude oil would use existing rail lines to the offloading facilities at Clearbrook and Superior. Impacts related to increases in rail traffic could include limited access to a historic resource or it's visual, auditory, and air quality setting. However, historic resources along existing lines are already subject to rail traffic, resulting in permanent negligible to minor impacts.

5.4.3.7 Existing Line 3 Supplemented by Truck

5.4.3.7.1 Construction Impacts

Impacts on Archaeological Resources

There would be no construction impacts on archaeological resources from continued use of the existing Line 3 pipeline because it is already built.

Direct impacts related to the construction of offloading facilities and associated access required for the transportation by truck alternative would be the same as described above for that alternative, including damage to archaeological resources from construction activities, exposure of resources to vandalism/looting, contamination from spills of hazardous materials, and unanticipated discoveries of archaeological resources. Direct impacts would be permanent, and could range in magnitude from minor to major, depending on the specific resource. Indirect impacts would primarily be related to visual, auditory, and air quality changes during construction which may affect the setting or significant qualities of archaeological resources. Indirect impacts would be temporary and negligible to minor. American Indians would consider any impact on archaeological resources to be permanent and irreversible.

Impacts on Historic Resources

There would be no construction impacts on historic resources from continued use of the existing Line 3 pipeline because it is already built. Impacts related to the development of facilities required for the transportation by truck alternative would be the same as described above for that alternative, including damage to historic resources from construction activities, contamination from spills of hazardous materials, and viewshed changes. Direct impacts would be permanent, and may range in magnitude from minor to major, depending on the specific resource.

Indirect impacts would occur during construction of offloading facilities and associated access and may include visual, auditory, air quality, access changes to historic resources. These indirect impacts would be temporary and negligible to minor. Permanent indirect impacts may include visual or auditory changes that affect the setting or significant qualities of historic resources, which would be minor to major.

5.4.3.7.2 Operations Impacts

Impacts on Archaeological Resources

No impacts on archaeological resources are expected with continued use of the existing Line 3 because the Enbridge Mainline corridor has been extensively disturbed from previous pipeline construction, operations, and maintenance and it is not expected that ground disturbance would occur in new areas during integrity digs. Direct impacts associated with Project-related spills or encountering existing contamination could occur (see Section 5.2.2 and Chapter 10); however, no additional impacts would be expected to archaeological resources that would have already been disturbed during construction. Regular inspection of trucks for leaks would minimize the potential for such contamination; however, contamination could be permanent and minor to major, depending on the type of archaeological resource and soil permeability.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would

likely require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 5.4.4).

If new ground disturbance occurs during the lifespan of the Project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction, and thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources are avoided during construction, or if they are adjacent to the construction work area, then new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Known archaeological resources in proximity to these roads may be indirectly affected by dust and vibration, although these impacts are currently occurring from existing traffic. It is expected that this alternative would result in temporary negligible to minor indirect impacts on archaeological resources.

Impacts on Historic Resources

No direct impacts on historic resources are expected with continued use of the existing Line 3 because the Enbridge Mainline corridor has been extensively disturbed from previous pipeline construction, operations, and maintenance. However, minor spills have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. Regular inspection of rail cars for leaks would minimize the potential for such contamination, and impacts would likely be temporary and minor; although some contamination could be permanent and negligible to major, depending on the type of cultural resource and soil permeability.

If maintenance activities occurred near historic resources, impacts at those locations within the existing right-of-way would be comparable to those described for new pipeline construction, including dust, vibration, and intrusion related to construction equipment, and construction-related noise. These indirect impacts would be considered temporary and negligible to minor.

Historic resources in proximity to the roads used to transport crude oil (e.g., bridges) may be indirectly affected by dust and noise. However, these impacts are currently occurring from existing traffic, and as such, these indirect impacts would be temporary and negligible to minor.

5.4.4 Summary and Mitigation

5.4.4.1 Summary

Construction and operation of the Applicant's preferred route and CN Alternatives could impact archaeological and historic resources. Based on the current information, impacts on archaeological and historic resources could range from negligible to major during construction and operations (Table 5.4.4-1).

During construction, impacts on archaeological resources would be permanent and could range from minor to major for the Applicant's preferred route and each CN Alternative (except continued use of Line 3, which has already been constructed). American Indians would consider any impact on archaeological resources to be permanent and irreversible.

The types of archaeological resources across the ROI for the Applicant's preferred route and CN Alternatives, primarily comprised of individual lithic artifacts or lithic scatter. The number of archaeological resources that may be directly or indirectly affected during construction would be relatively comparable across the Applicant's preferred route and CN Alternatives (10 to 16 resources)

with the exception of SA-04, which could directly impact up to 49 archaeological resources (Table 5.4.4-1). Substantially more historic resources could be directly affected within the construction footprints by the rail and truck alternatives, including those supplemented by existing Line 3, than either the Applicant's preferred route or SA-04. The historic resources in the ROI for the rail or truck alternatives around Clearbrook and Superior include houses, farms, outbuildings, and a church. Conversely, there are substantially greater numbers of historic resources that could be indirectly affected within the ROI for SA-04 and the Applicant's preferred route than for the rail and truck alternatives, including those supplemented by existing Line 3 (Table 5.4.4-1).

During operations, there would typically not be direct impacts on cultural resources due to no ground disturbance beyond the previously disturbed construction footprint so impacts on new cultural resources would not be expected unless there were extenuating circumstances (e.g., minor spills/leaks, erosion). SA-04 has substantially more archaeological resources in its operational footprint than the Applicant's preferred route or other CN Alternatives (Table 5.4.4-1). The rail and truck alternatives, including those supplemented by existing Line 3, could have more historic resources within their operational footprints than the Applicant's preferred route, existing Line 3, or SA-04. However, there could be substantially more historic resources indirectly affected during operations within the ROI for SA-04 than the Applicant's preferred route or the other CN Alternatives.

5.4.4.2 Mitigation

It may be possible to avoid known cultural resources in the construction work area, which would include fencing around the site boundary or designated buffer and incorporation of an archaeological monitor during ground-disturbing activities. Archaeological and/or tribal monitoring could be implemented in sensitive areas during construction to further minimize impacts.

Prior to construction, the need for minimization and mitigation for impacts on archaeological and historic resources would be discussed with MHS, SHPO, the State Archaeologist, affected Indian tribes, and other affected parties. Minimization may include avoidance, site staking, and archaeological and tribal monitoring during construction. Mitigation may include data recovery excavations of significant archaeological sites, intensive recordation of historic resources, ethnographic studies, and guaranteed access, among others.

Table 5.4.4-1. Summary of Potential Impacts on Cultural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Construction Impacts							
Previously recorded archaeological resources	Direct: Permanent/minor to major impacts • 16 resources Indirect: Temporary/ negligible to minor • 16 resources	N/A (Already constructed)	Direct: Permanent/minor to major impacts • 49 resources Indirect: Temporary/ negligible to minor • 49 resources	Direct: Permanent/minor to major impacts • 10 resources Indirect: Temporary/ negligible to minor • 10 resources	Direct: Permanent/minor to major impacts • 10 resources Indirect: Temporary/ negligible to minor • 10 resources	Direct: Permanent/minor to major impacts • unknown resources Indirect: Temporary/ negligible to minor • unknown resources	Direct: Permanent/minor to major impacts • unknown resources Indirect: Temporary/ negligible to minor • unknown resources
Previously recorded historic resources	Direct: Permanent/ minor to major impacts • 1 resource Indirect: Temporary to permanent/ negligible to major impacts • 128 resources	N/A (Already constructed)	Direct: No impacts • 0 resources Indirect: Temporary to permanent/ negligible to major impacts • 661 resources	Direct: Permanent/ minor to major impacts • 59 resources Indirect: Temporary to permanent/ negligible to major impacts • 59 resources	Direct: Permanent/ minor to major impacts • 59 resources Indirect: Temporary to permanent/ negligible to major impacts • 59 resources	Direct: Temporary to permanent/ negligible to major impacts • unknown resources Indirect: Temporary to permanent/ negligible to minor impacts • unknown resources	Direct: Temporary to permanent/ negligible to major impacts • unknown resources Indirect: Temporary to permanent/ negligible to minor impacts • unknown resources

Table 5.4.4-1. Summary of Potential Impacts on Cultural Resources for the Applicant's Preferred Route and Certificate of Need Alternatives

Impact	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Rail Alternative	Truck Alternative	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Operations Impacts							
Previously recorded archaeological resources	Direct: Permanent/ minor to major impacts • 9 resources Indirect: Temporary/ negligible to minor impacts • 9 resources	Direct: Permanent/ minor to major impacts • 5 resources Indirect: Temporary/ negligible to minor impacts • 5 resources	Direct: Permanent/ minor to major impacts • 39 resources Indirect: Temporary/ negligible to minor impacts • 39 resources	Direct: Permanent/ minor to major impacts • 4 resources Indirect: Permanent/ negligible to minor impacts • 4 resources	Direct: Permanent/ minor to major impacts • 4 resources Indirect: Temporary/ negligible to minor impacts • 4 resources	Direct: Permanent/ minor to major impacts • unknown resources Indirect: Temporary/ negligible to minor impacts • 138	Direct: Permanent/ minor to major impacts • unknown resources Indirect: Temporary/ negligible to minor impacts • 138
Previously recorded historic resources	Direct: No impacts • 0 resources Indirect: Temporary to permanent/ negligible to minor impacts • 128 resources	Direct: No impact • 1 resource Indirect: Temporary to permanent/ negligible to minor impacts • 166 resources	Direct: No impact • 0 resources Indirect: Temporary to permanent/ negligible to minor impacts • 661 resources	Direct: Temporary to permanent/ minor to major impacts • 12 resources Indirect: Temporary to permanent/ negligible to minor impacts • 12 resources	Direct: Temporary to permanent/ minor to major impacts • 12 resources Indirect: Temporary to permanent/ negligible to minor impacts • 12 resources	Direct: Temporary to permanent/ negligible to major impacts • unknown resources Indirect: Temporary to permanent/ negligible to minor impacts • 273	Direct: Temporary to permanent/ negligible to major impacts • unknown resources Indirect: Temporary to permanent/ negligible to minor impacts • 273

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Chapter 6
Existing Conditions, Impacts, and Mitigation – Route Permit

6.1 INTRODUCTION

This chapter assesses potential construction and operations impacts for the Applicant's preferred route and each of the route alternatives identified in Section 4.3. As discussed in Section 4.3, the Minnesota Public Utilities Commission (Commission) must determine the route of the Line 3 Replacement Project (Project) if they grant a Certificate of Need (CN) for the Project. The objectives of the analysis in this chapter are to (1) provide relevant information for a comparison of the proposed Project and each route alternative; and (2) determine whether any of the alternative routes may offer significant benefits through lower impacts to inform the Commission's decision.

The proposed Project begins near Neche, North Dakota, and terminates at Superior, Wisconsin. However, because the Commission has routing authority only over the portion of the route in Minnesota the route permit analysis is concerned only with the portion of the Project located in Minnesota. All route alternatives in Minnesota are variants on the segment of the Applicant's preferred route between Clearbrook and Carlton; the North Dakota border-to-Clearbrook segment and the Carlton-to-Wisconsin border segments are virtually identical for all route alternatives (Table 6.1-1). This chapter describes the existing conditions and assesses potential impacts for the proposed Project through Minnesota. In addition, the impact assessment highlights the potential impacts for the Applicant's preferred route and each route alternative where they diverge from a common alignment along the Clearbrook-to-Carlton segment.

In accordance with criteria for pipeline route selection in Minnesota Administrative Rules § 7852.1900, the environmental review in this chapter is structured to assess the impacts of the proposed Project and route alternatives associated with the following:

- Human settlement, existence and density of populated areas, existing and planned future land uses, and management plans;
- The natural environment, public and designated lands, including but not limited to natural area, wildlife habitats, water, and recreational lands;
- Lands of historical, archaeological, and cultural significance;
- Economies within the route, including agricultural, commercial or industrial, forestry, recreational, and mining operations;
- Pipeline cost and accessibility;
- Use of existing rights-of-way and right-of-way sharing or paralleling;
- Natural resources and features;

- The extent to which human or environmental effects are subject to mitigation by regulatory control;
- Cumulative potential effects of related or anticipated future pipeline construction; and
- Relevant applicable policies, rules, and regulations of other state and federal agencies and local governmental land use laws.

Table 6.1-1. Length of the Applicant's Preferred Route and Route Alternatives across Minnesota (miles)

Segment	Applicant's Preferred Route	Route Alternative RA-03-AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota border to Clearbrook terminal[a]	109.1	110.2	110.2	110.2	110.2
Clearbrook terminal to Carlton	220.9	275.1	196.8	167.7	164.8
Carlton to Wisconsin border	9.6	9.6	9.6	9.6	9.6
TOTAL	**339.7**	**394.9**	**316.6**	**287.5**	**284.6**

[a] Differences in length are due to assumptions for where the route options enter the Clearbrook terminal.

The impact assessment in this chapter covers each of the criteria listed above that the Commission is required to consider in determining a route for the proposed Project. This chapter evaluates potential impacts on various resources, focusing on issues of concern for each resource identified based on:

- Relevant regulatory requirements;
- Input during scoping from the public, agencies, non-governmental organizations, and tribal representatives;
- Consultation with knowledgeable resource management agencies and tribal resource representatives; and
- Professional judgment, in part based on other impact assessments in recent energy infrastructure environmental impact statements (EISs) and agency guidance (DOS 2009; FERC 2013a, 2013b; DOE 2015; Wisconsin DNR 2016).

The following sub-sections are presented for each resource:

- Regulatory Context and Methodology
- Existing Conditions
- Impact Assessment
- Summary and Mitigation

The general contents of each of the sub-sections in this chapter are described below, and a summary of the route permit analysis in this chapter is provided in Section 6.9. The analysis of route segment

alternatives is described in Chapter 7. The analysis of potential impacts associated with crude oil releases is presented in Chapter 10. Cumulative potential effects are discussed in Chapter 12.

6.1.1 Regulatory Context and Methodology

The regulatory context describes the framework of laws, regulations, ordinances, and policies intended to protect and manage an affected resource with regard to impacts associated with the Applicant's preferred route and route alternatives. As described in Chapter 3, these regulations are implemented by a variety of federal, state, and local jurisdictions.

For each affected resource, the impact assessment methodology is described. This includes identifying the region of interest (ROI) for the resource (the geographic scope), the specific data sets acquired and analyzed, the analytical methods and assumptions used, and the quantitative or qualitative metrics for assessing impacts relative to each issue of concern. The ROI incorporates the geographic extent of the Applicant's preferred route in Minnesota as presented in Chapter 2, and the Applicant's preferred route and the route alternatives in the Clearbrook-to-Carlton segment as described in Chapter 2 and Section 4.3. The extent of the ROI beyond the physical footprint of each route option varies among resources according to the characteristics of the resource and the Project-related effects that could occur (e.g., potential effects on vegetation would be localized while effects on air quality may be localized and regional).

6.1.2 Existing Conditions

The existing conditions within the ROI for each affected resource are described for the Applicant's preferred route and each route alternative. Sources of data used to characterize existing conditions were identified based on a review of publically available geospatial datasets; federal, state, and local government reports, assessments, and planning documents; and input during the scoping process, including input from the public, tribes, agencies, and non-governmental organizations. In addition, data available as part of Enbridge's application, Enbridge's April 2016 Environmental Assessment Worksheet (EAW), and responses to data requests from the Minnesota Department of Commerce Energy, Environmental Review and Analysis (DOC-EERA) were considered. Literature addressing the potential impacts of Project construction and operations was reviewed. Information was evaluated for its relevancy in assessing Project-related impacts based on the data collection methods used and the geographic extent, study duration and age, detail, and usefulness of the data in characterizing existing conditions. Project-specific mileposts included in Chapter 6 resource sections and figures are based on the Applicant's preferred route and all route alternatives starting at milepost (MP) 0.0 near Neche, North Dakota, and extending to Superior, Wisconsin. Maps depicting a range of existing resource conditions and data associated with land ownership and physical features are provided in Appendix A.

6.1.3 Impact Assessment

Resource-specific impact assessment methods are described in each resource section of this chapter. The impact assessments focus on direct impacts from construction and operation of the Project, describe the nature of the impacts, and provide quantifiable estimates of those direct impacts where feasible and meaningful. Examples of direct impacts include habitat fragmentation due to permanent loss of woody vegetation within the permanent right-of-way and contributions to climate change from greenhouse gas (GHG) emitted as a result of fossil fuel combustion in construction equipment. Indirect impacts, which may result from or be influenced by the Project later in time or further removed from direct Project activities, are described where appropriate. Examples of indirect impacts include

economic growth, reduced productivity in wildlife due to stress, and direct impacts on aesthetics from vegetation removal indirectly affecting recreational use.

Within each resource section, the nature of impacts are discussed and the impacts are characterized in terms of their geographic extent, duration, and magnitude or severity. Impact duration was characterized as *temporary, short term, long term,* or *permanent*. Impact duration was considered temporary if the impact would occur only during and immediately following construction activity (e.g., turbidity due to instream construction). Impacts were considered short term if the resource recovery would last up to 3 years following construction (e.g., vegetation clearing in pastures). Impacts were considered long term if resource recovery would require more than 3 years but would occur during the life of the Project (e.g., clearing of trees in temporary construction work areas). Impacts were considered permanent if they would last for the life of the Project (e.g., clearing of trees within the permanent right-of-way). See Table 6.1-2.

Table 6.1-2. Definitions of Impact Duration

Term	Definition
Temporary	Impacts that would occur during and immediately following construction
Short term	Impacts that would continue for up to 3 years after construction
Long term	Impacts that would last more than 3 years but would recover during the life of the proposed Project or alternative
Permanent	Impacts that would last for at least the duration of the proposed Project or alternative

Categories of impact magnitude or severity for the purposes of this EIS include *negligible*, *minor*, and *major*. Impacts were considered negligible if they have the potential to occur but would not generally be measurable or noticeable. They were considered minor if they were expected to be evident but below resource-specific standards or metrics, such as those used in other recent linear infrastructure EISs in the region (e.g., Great Northern Transmission Line, Alberta Clipper, Wisconsin Sandpiper/Line 3 Replacement) and requirements by the Federal Energy Regulatory Commission for interstate natural gas pipelines crossing wetlands, waterbodies, or uplands (DOS 2009; FERC 2013a, 2013b; DOE 2015; Wisconsin DNR 2016). Impacts were considered major if they were expected to potentially exceed the resource-specific standards or metrics, with consideration of the geographic extent and duration. See Table 6.1-3.

Table 6-1-3. Definition of Impact Magnitude

Term	Definition
Negligible	Impacts could potentially occur, but not expected to be measureable or noticeable
Minor	Impacts are evident, but expected to be below resource-specific standards or metrics
Major	Impacts are evident and expected to exceed resource-specific standards or metrics

In each resource area, available datasets and metrics were reviewed to identify “factors” that provide an indication of how a given resource could be affected. For example, presence of different vegetation types, noxious weeds, native plants, and old growth forest were all identified as factors that could be

examined to understand how vegetation resources as a whole could be affected. In most cases impacts were assessed by mapping available data for each of the relevant factors and overlaying information on the construction and operations footprints for the Applicant's preferred route and route alternatives. These overlays were reviewed in order to identify the location, type, and condition of resources within and adjacent to the construction/operational features. In addition, methods of construction and operations, including Applicant-proposed measures to minimize impacts, were reviewed. Together, the spatial analysis and review of construction and operation methods were used to determine the nature, duration, and magnitude of impacts for the Applicant's preferred route and each route alternative.

The footprint of the proposed Project was defined based on the Project applications and additional information provided by Enbridge. This information is summarized in Chapter 2, which includes the Applicant-proposed measures to limit or avoid impacts during construction and operations. The impact analysis for each resource assumes that the Applicant-proposed measures would be implemented regardless of the route (e.g., construction activities along the RA-06 route would adhere to Enbridge's Environmental Protection Plan [Appendix E]).

As described in Chapter 2, Enbridge provided the location and land requirements of the proposed Project during construction and operation including the construction work area along the pipeline route, additional temporary workspaces (ATWS), temporary and permanent access roads, temporary contractor and material/pipe storage yards (yards), and aboveground facilities in Minnesota. Enbridge provided DOC-EERA with geo-referenced geographic information system (GIS) shapefiles of these features. Over 80 percent of the 5,604 acres that would be disturbed during construction of the entire Project would be associated with the construction work area along the pipeline (typically 120 feet wide). The remaining land disturbance primarily would be associated with temporary construction, including ATWS (9 percent), access roads (5 percent), and yards (4 percent). During operation, 62 percent of the land disturbed during construction of the entire Project (3,480 acres) would return to preconstruction uses, and the majority of the permanent operations-related land disturbance would be associated with maintenance of the permanent right-of-way (97 percent, or 2,057 acres). The remaining 3 percent would be associated with aboveground facilities, including access (67 acres). Each resource section in this chapter discusses the impacts of construction and operations for the Applicant's preferred route based on this detailed geo-referenced information.

As discussed in Section 4.3, each route alternative would follow the same centerline as the Applicant's preferred route from Neche, North Dakota, to Clearbrook, Minnesota; and from Carlton, Minnesota, to Superior, Wisconsin (Table 6.1-1). The only segment where the route alternatives would materially vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. As the impacts for the route alternatives are already being described for the alignment that they share with the Applicant's preferred route (i.e., the impact analysis for the Applicant's preferred route in Chapter 5 and in this chapter), the environmental analysis of the route alternatives in this chapter is limited to the pipeline segment where the route alternatives would vary from the Applicant's preferred route (i.e., the Clearbrook-to-Carlton segment). For some socioeconomic resources, the impact analysis was based on county-level data (e.g., income, tax revenue); for those impact analyses, the ROIs for the route alternatives extend across Carlton County to the Wisconsin border (less than 10 miles from where the routes would re-converge with the Applicant's preferred route in Carlton County).

The available data for the route alternatives are not as extensive or complete as those for the Applicant's preferred route—in part, because no one has designed or engineered those alternatives. For route alternatives, a quantitative analysis for each route alternative was conducted using the digital centerline

identified during scoping; no corresponding geo-referenced information was provided on aboveground facilities, ATWS, access roads, or yards. Along the centerline for each route alternative, a standard construction work area was applied to assess the impacts associated with pipeline construction. For three of the four route alternatives (RA-03AM, RA-06, and RA-08), the standard construction work area was 120 feet wide. For RA-07, a 205-foot-wide construction work area was used to quantify the extent of the acreage affected along existing Line 3 between Clearbrook and Carlton in order to allow removal of the existing Line 3 and installation of the new pipeline in the same trench, as described in Section 4.3.4. Using these standard construction work areas allowed quantification of construction and operations impacts on land cover, habitat, and resources along the route alternatives based on publically available information on existing conditions. Using the relative proportion of land requirements for the Applicant's preferred route, the 120-foot-wide construction footprint equates to approximately 80 percent of the overall construction acreage that would be required to construct the route alternatives, and a 205-foot-wide construction work area would compose over 85 percent of the overall construction footprint (besides the construction work area along the centerline, acreage affected during construction would be associated with unidentified ATWS, access roads, yards, and aboveground facilities). The 50-foot-wide permanent right-of-way along each route alternative would account for 97 percent of the operations footprint of the route (based on the relative proportion of the land requirements for the Applicant's preferred route). Without knowing the precise locations of aboveground facilities and secondary construction features (e.g., ATWS, yards, and temporary access roads) potential impacts were qualitatively assessed by applying the assumptions used in the evaluation of the Applicant's preferred route. For example, although the exact locations for pump stations are not known for any of the route alternatives, they average about 8 acres each for the proposed Project and would be expected to be located in open upland areas where feasible—although specific locations or land cover types are not known. If a route alternative is approved, field surveys, landowner and agency coordination, and site-specific engineering along the approved route would be conducted to refine routing; develop specialized construction methods; and locate aboveground facilities, access roads, and yards.

6.1.4 Summary and Mitigation

Each resource discussion in this chapter concludes with a general summary of the anticipated impacts on the resource for the Applicant's preferred route and the route alternatives between Clearbrook and Carlton based on the nature, extent, duration, and magnitude of potential impacts.

As discussed in Section 6.1.3, the quantitative results for the route alternative impact analysis include only standard construction work areas along the alternative centerlines (120 feet or 205 feet wide) and the 50-foot-wide permanent right-of-way, underestimating the overall construction footprint by up to 20 percent because no specific location or design information is available for secondary facilities (aboveground facilities, access roads, ATWS, and yards). To allow for a more direct comparison between the Applicant's preferred route and the route alternatives, impacts for all routes (Applicant's preferred and route alternatives) are presented in the summary sub-section are based on Enbridge's refined construction work area (typically 120 feet wide, or 205 feet in the case of RA-07) and 50-foot-wide permanent right-of-way. By not including aboveground facilities, access roads, ATWS, and yards, impacts for all routes are underestimated by approximately 3 percent (operations) to 20 percent (construction). It is expected that the majority of the acreage of aboveground facilities, access roads, ATWS, and yards would be located in upland open lands. From an overall acreage perspective, the 3- to 20-percent underestimate does not substantially alter the general relationship between the relative impacts among the route options.

The primary shortcoming of the above approach for the environmental analysis is associated with Enbridge's proposal to reduce the width of the construction work area for the Applicant's preferred route in some wetlands and waterbodies (from 120 feet to 95 feet, or 21 percent) based on site-specific field investigations and engineering. No design engineering has been conducted for the route alternatives. For context, theoretically reducing the construction width in wetlands from 120 to 95 feet for route alternatives would result in the Applicant's preferred route and RA-03AM affecting virtually the same total wetland acreage during construction, and the remaining route alternatives affecting substantially greater acreage than either of those two (over 40 percent more for RA-06, RA-07, and RA-08). For the analysis of surface water, the issue is recognized but is less integral, as the impact assessment for surface waters is not driven by the acreage of waterbody crossings as much as identifying and minimizing the impacts of in-water disturbance on water quality, aquatic habitat, and fisheries (see Section 6.3.1.2). As noted above, if a route alternative is approved, it is expected that field surveys and engineering would result in refinements to the route, the width of the construction footprint, and construction methods to further avoid and minimize impacts on wetlands and waterbodies.

The summary sub-section for each resource includes a summary table to highlight impacts on the resources among route options. The summary sub-section also identifies potential mitigation, as appropriate, to further avoid and minimize impacts. Mitigation may include expanding best management practices (BMPs), initiating agency/landowner coordination, and identifying possible permit conditions (Section 3.6 summarizes the permits and approval processes for the Project).

6.1.5 References

Federal Energy Regulatory Commission (FERC). 2013a. Upland erosion control, revegetation, and maintenance plan. May. Washington, DC.

_____. 2013b. Wetland and Waterbody Construction and Mitigation Procedures. May. Washington, DC.

U.S Department of Energy (DOE). 2015. Great Northern Transmission Line Final Environmental Impact Statement. (DOE/EIS0499.) Prepared by the U.S Department of Energy, Office of Electricity Delivery and Energy Reliability and the Minnesota Department of Commerce, Energy Environmental Review and Analysis. October. Washington, DC.

U.S. Department of State (DOS). 2009. Final Environmental Impact Statement for the Alberta Clipper Pipeline Project. U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs. June. Washington, DC.

Wisconsin Department of Natural Resources (Wisconsin DNR). 2016. Final Environmental Impact Statement Enbridge Sandpiper and Line 3 Replacement Projects. August.

6.2 HUMAN SETTLEMENT

6.2.1 Planning and Zoning

Land use planning and zoning regulations are used by county and local jurisdictions to regulate the pattern of development to ensure that adjacent land uses are compatible with one another. They also ensure that the pattern of development allows for efficient incorporation of publicly provided infrastructure, including roads, utility systems, and public services. Land use planning and zoning regulations also minimize potential impacts on the public from floods, unstable slopes (landslides), and other natural events that may cause loss of life and property, in addition to protecting important natural resources. Where projects fail to conform with local land use plans and zoning ordinances, where established, they can disrupt orderly community development.

The following analysis evaluates compatibility with land use, planning and zoning to identify where the pipeline construction and operation may disrupt orderly community development. The analysis considers land uses adjacent to each of the potential routes, based on a review of county and local comprehensive plans and zoning ordinances, floodplain and shoreland overlay districts, existing land use (for jurisdictions without planning and zoning ordinances),[1] and a general review of watershed district goals.

The analysis of impacts on planning and zoning from construction and operation of the Applicant's preferred route and the route alternatives considers the following issues:

- Compatibility with county and local comprehensive plans and zoning ordinances;
- Compatibility with floodplain and shoreland overlay district regulations;
- Compatibility with existing land use for jurisdictions without planning and zoning ordinances; and
- Compatibility with watershed district goals.

This section first describes the different types of existing or planned land use (per existing plans and zoning requirements and current uses) along the Applicant's preferred route and each of the route alternatives that could be affected by construction and operation of an oil pipeline. Potential Project-related impacts of construction and operation are then discussed and compared across each of the routing options.

6.2.1.1 Regulatory Context and Methodology

6.2.1.1.1 Regulatory Context

Planning and zoning regulations are authorized by Minnesota Statutes, Chapter 394. Under these statutes, counties and municipalities may develop comprehensive land use plans and establish zoning permit authorities. In county land use plans and zoning ordinances, specific areas within a jurisdiction are designated for one of a number of "allowable" uses. These designations include the type and

[1] For counties or local jurisdictions that have not established comprehensive land use plans or zoning ordinances, existing land use patterns have been reviewed. This review covers all land crossed by construction and operation of the Applicant's preferred route and the route alternatives, but is meant to supplement the review of comprehensive plans and zoning ordinances, especially for areas with no zoning information.

intensity of allowable use. Most, but not all of the counties that are crossed by the pipeline routes have established land use plans or zoning ordinances. Local governments can further regulate the types of development or activity that can occur in special use areas called overlay districts, for example shoreland and floodplain[2] overlay districts that restrict development in floodways and near waterbodies. Minnesota also has 46 watershed districts,[3] local special-purpose units of government that manage water drainage and flow in the watershed in partnership with the state, counties, cities, and soil and water conservation districts.

A route permit from the Commission would supersede local government approvals including land use and zoning approvals (Minn. Stat. § 216G.02, Subd. 4); however, the Commission must consider the Project's compliance with local laws, plans, and ordinances when making a decision for the route permit (Minn. Stat. § 216G.02, Subd. 3[b][4]).

6.2.1.1.2 Methodology

The degree of compatibility with local land use plans and zoning ordinances, overlay districts, existing land use, and water resource management plans was evaluated by:

- Inventorying and reviewing existing comprehensive plans and zoning ordinances including shoreland and floodplain ordinances, and existing land uses for the counties crossed by the Applicant's preferred route and each of the route alternatives;
- Overlaying the Applicant's preferred route and route alternatives on zoning maps provided by counties and on existing land uses from the National Land Cover Database (NLCD) to measure:
  - Miles each zone crossed by the route centerline, and
  - Acreage of each land use type within the construction work area and within the permanent right-of-way;
- Reviewing water resource management plans in watershed districts crossed by the Applicant's preferred route and route alternatives;
- Identifying the number of miles of each watershed district crossed by the each route's centerline; and
- Identifying those areas where the Applicant's preferred route or route alternatives were not consistent with or did not meet the requirements of existing local plans and zoning ordinances, overlay districts, or watershed districts.

The ROI is comprised of counties and watershed districts that are crossed by the Applicant's preferred route and route alternatives. The ROI included 4 watershed districts and 21 counties, 19 of which have a comprehensive land use plan or other relevant land use ordinance, and 12 have a comprehensive plan and a specific development code or ordinance outlining land use and zoning. The specific assessment of compatibility of the pipeline with land use plans and zoning ordinances, overlay districts, and watershed district goals is focused on the land crossed by the centerline of the Applicant's preferred route or the

[2] Floodplain maps produced by the Federal Emergency Management Agency (FEMA), known as Flood Insurance Rate Maps, are used to identify floodplain areas. Any development or activity proposed to occur within a floodplain must meet FEMA guidelines (structures flood-proofed to some level), and some activities are prohibited.

[3] Watershed Districts were authorized by the Minnesota Legislature in 1955 when it passed the Watershed Act, Minnesota Statute 103D

route alternatives. The assessment of compatibility of the pipeline with current land use plans is focused on the land disturbed for construction and the land within the permanent right-of-way for each alternative.

Data for the analysis was obtained from county land use zoning GIS layers, county websites, Federal Emergency Management Agency (FEMA) flood maps, watershed district websites, the NLCD, and GIS data for the construction and operational footprint of the Applicant's preferred route and the route centerlines for the route alternatives supplied by the Applicant.

Land use and zoning designations and the miles of each zone or land type crossed were determined by overlaying each route's centerline on zoning information. Because the potential routes cross counties that have a wide variety of zoning designations, zoning designations were reviewed and grouped into standardized "land use zone" categories to allow for comparison. "Shoreland" areas were identified based on overlay districts provided by counties.[4] Where no zoning data were available "the open water land use" category from the NLCD was used to estimate shoreland areas. Floodplain areas were determined based on 100-year floodplain as outlined in the FEMA flood maps. Impacts on floodplains are discussed in detail in Section 6.3.1.4. Existing land use and the acreage of each land use crossed were determined by overlaying each route's construction and operation footprint on spatial land use data (NLCD).

The analysis of the Applicant's preferred route includes the entire route: (1) the segment from the North Dakota-Minnesota border to Clearbrook, Minnesota; (2) the segment from Clearbrook to Carlton, Minnesota; and (3) the segment from Carlton to the Wisconsin border. Because the first and last segments are the same for each of the routes, the analysis for the alternatives to the Applicant's preferred route is focused on the segment from Clearbrook to Carlton, Minnesota, where the route alternatives diverge from the Applicant's preferred route.

6.2.1.2 Existing Conditions

6.2.1.2.1 Applicant's Preferred Route

Table 6.2.1-1 lists the land use zones crossed by the Applicant's preferred route in each county where land use designations exist. The most common land use zone crossed by the Applicant's preferred route is agricultural land, followed by public/municipal land. A total of approximately 7 miles of shoreland would be crossed by Applicant's preferred route, all east of Clearbrook.

Table 6.2.1-2 lists the acreages of each land use type located within the construction (con) and operation (op) footprint of the Applicant's preferred route. The most common land use type present is agricultural.

The Applicant's preferred route would cross four watershed districts for a total of approximately 134 miles: the Middle-Snake-Tamarac rivers, Red Lake, Two Rivers, and Wild Rice watershed districts (Table 6.2.1-3). These watershed districts are all located in northwestern/western Minnesota. Red Lake Watershed District is the primary watershed district crossed, at about 76 miles.

[4] Shoreland designated as land located within 1,000 feet of the high water level of a lake, pond, or flowage, and land located within 300 feet of a river or stream or the landward extent of the floodplain, whichever is greater per Minn. Stat. § 103F.205, Subd. 4.

Table 6.2.1-1. Land Use Zoning Categories Crossed by the Applicant's Preferred Route (miles)

Segment/County	Agriculture/ Forestry	Residential	Commercial	Industrial	Public/ Municipal	Conservation/ Recreation	Shoreland	Other
North Dakota Border to Clearbrook								
Kittson County[a]	15.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marshall County	NA	NA	NA	NA	NA	NA	NA	NA
Pennington County	NA	NA	NA	NA	NA	NA	NA	NA
Red Lake County	NA	NA	NA	NA	NA	NA	NA	NA
Polk County	NA	NA	NA	NA	NA	NA	NA	NA
Clearwater County	NA	NA	NA	NA	NA	NA	NA	NA
Subtotal	***15.4***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***
Clearbrook to Carlton								
Clearwater County	NA	NA	NA	NA	NA	NA	NA	NA
Hubbard County	NA	NA	NA	NA	NA	NA	NA	NA
Wadena County	7.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Cass County	11.8	7.2	0.0	0.0	28.5	0.0	0.0	0.0
Crow Wing County[b]	0.0	1.9	0.0	0.0	2.6	0.0	0.4	0.0
Aitkin County	16.0	0.0	0.5	0.0	10.3	18.0	6.7	0.0
Carlton County	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	***66.2***	***9.1***	***0.5***	***0.0***	***41.4***	***18.0***	***7.4***	***0.0***

Table 6.2.1-1. Land Use Zoning Categories Crossed by the Applicant's Preferred Route (miles)

Segment/County	Agriculture/ Forestry	Residential	Commercial	Industrial	Public/ Municipal	Conservation/ Recreation	Shoreland	Other
Carlton to Wisconsin Border								
Carlton County	8.8	0.0	0.0	0.5	0.0	0.0	0.3	0.0
Subtotal	***8.8***	***0.0***	***0.0***	***0.5***	***0.0***	***0.0***	***0.3***	***0.0***
TOTAL	**90.5**	**9.1**	**0.5**	**0.5**	**41.4**	**18.0**	**7.7**	**0.0**

Sources: GIS zoning layers from Aitkin, Carlton, Cass, and Wadena counties.

Notes:

NA = Zoning data not available for this county.

Each county has a different zoning ordinance, and zones differ between the counties. Zoning categories in this table are an approximation of similar zones. The specific zones for each county that make up each category are listed below:

Agriculture/Forestry = Wadena, General Agriculture, Transitional Agriculture, and Mixed Ag and Forestry; Cass, Agricultural/Forestry; Carlton, Agricultural/Forest Management and Agriculture/Rural Residential; Aitkin, Farm Residential.

Residential = Cass, Rural Residential 2.5 and Rural Residential 5; Crow Wing, Rural Residential – 10 and Rural Residential – 20; Wadena, Residential.

Commercial = Wadena, Highway Service Business District; Cass, Commercial.

Industrial = Carlton, Limited Industrial.

Public/Municipal = Cass, Public Land or within City Limits; Crow Wing, Public Lands; Aitkin, Public.

Conservation/Recreation = Aitkin, Open; Carlton, Commercial Recreation.

Shoreland = Wadena, shoreland overlay district; Crow Wing, shoreland District; Aitkin, shoreland; Carlton, shoreland.

Other = Cass, Unknown.

[a] Estimates for Kittson County are not based on a GIS layer but on a review of the Land Use Ordinance.

[b] Estimates for Crow Wing County are not based on a GIS layer but on a review using the online GIS tool for Crow Wing County.

Table 6.2.1-2. Land Use Types Crossed by the Applicant's Preferred Route (acres)

Segment/ Facility	Agricultural[a]		Developed[b]		Forested[c]		Open Land[d]		Open Water[e]		Wetlands[f]		Total	
	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Pipeline Segment														
North Dakota border to Clearbrook	1,285.5	552.9	63.3	28.8	57.0	26.6	34.1	15.8	3.7	2.3	68.8	35.2	1,512.5	661.7
Clearbrook to Carlton	561.6	251.6	94.0	45.5	1,446.5	631.0	307.7	151.0	6.4	3.8	490.6	254.2	2,906.8	1,337.1
Carlton to Wisconsin border	65.7	28.8	7.5	3.4	39.7	14.9	17.3	8.5	0.0	0.0	5.8	2.7	136.0	58.2
Subtotal	***1,912.8***	***833.3***	***164.8***	***77.7***	***1,543.2***	***672.5***	***359.1***	***175.4***	***10.2***	***6.1***	***565.2***	***292.0***	***4,555.2***	***2,057.0***
Other Facilities														
Additional temporary workspaces and pipe yards	447.6	0.0	45.4	0.0	116.4	0.0	55.7	0.0	2.5	0.0	36.6	0.0	704.2	0.0
Access roads	67.7	67.7	44.8	44.8	123.5	123.5	22.5	22.5	0.6	0.6	20.1	20.1	279.2	279.2
Mainline valves and pump stations	38.9	38.9	10.2	10.2	5.5	5.5	5.8	5.8	0.0	0.0	6.6	6.6	67.0	67.0
Subtotal	***554.2***	***106.6***	***100.4***	***55.0***	***245.4***	***129.0***	***83.9***	***28.2***	***3.1***	***0.6***	***63.3***	***26.7***	***1,050.4***	***346.2***
TOTAL	**2,466.9**	**939.9**	**265.3**	**132.7**	**1,788.6**	**801.5**	**443.1**	**203.6**	**13.2**	**6.7**	**628.5**	**318.7**	**5,605.6**	**2,403.2**

Notes:

[a] Agricultural Land = NLCD land use types: Cultivated and Hay/Pasture.

[b] Developed Land = NLCD land use types: Developed, High Intensity; Developed, Med Intensity; Developed, Low Intensity; and Developed, Open Space.

[c] Forested Land = NLCD land use types: Deciduous Forest, Evergreen Forest, and Mixed Forest.

[d] Open Land = NLCD land use types: Barren Land, Herbaceous, and Scrub/Shrub.

[e] Open Water = NLCD land use types: Open Water.

[f] Wetlands = NLCD land use types: Woody Wetlands and Emergent Herbaceous Wetlands.

Enbridge-provided footprints: Con = construction work area, Op = permanent right-of-way.

Table 6.2.1-3. Watershed Districts Crossed by the Applicant's Preferred Route (miles)

Segment	Middle-Snake-Tamarac Rivers Watershed District	Red Lake Watershed District	Two Rivers Watershed District	Wild Rice Watershed District	Total
North Dakota border to Clearbrook	36.6	56.4	16.1	0.0	109.1
Clearbrook to Carlton	0.0	19.6	0.0	5.4	25.0
Carlton to Wisconsin border	0.0	0.0	0.0	0.0	0.0
TOTAL	**36.6**	**76.0**	**16.1**	**5.4**	**134.1**

6.2.1.2.2 Route Alternatives

Route Alternative RA-03AM

Table 6.2.1-4 lists the land use zones crossed by RA-03-AM, between Clearbrook and Carlton, in each county where land use designations exist. The most common land use zone crossed by RA-03AM is agriculture/forestry. A total of approximately 4 miles of shoreland would be crossed by RA-03AM.

Table 6.2.1-5 lists the acreages of each land use type located within the construction (con) and operation (op) footprint of RA-03-AM. The most common land type present is agricultural.

Table 6.2.1-6 lists the miles of each watershed district crossed by RA-03AM. The route alternative would cross through approximately 19 miles of the Red Lake Watershed District and approximately 5 miles of the Wild Rice Watershed District.

Route Alternative RA-06

Table 6.2.1-7 lists the land use zones crossed by RA-06, between Clearbrook and Carlton, in each county where land use designations exist. The most common land use zone crossed by RA-06 is public/municipal land, followed closely by agriculture/forestry land. RA-06 would cross approximately 1 mile of shoreland.

Table 6.2.1-8 lists the acreages of the land use types located within the construction (con) and operation (op) footprint of RA-06. The most common land type present is forest. Additionally, RA-06 would cross 52 miles of the Red Lake Watershed District.

Route Alternative RA-07

RA-07 involves removal of the existing Line 3 and replacement in the existing trench, which is located entirely in the middle of the Enbridge Mainline corridor right-of-way. Enbridge has easements for the land in this corridor and past, current, and foreseeable future land use in this corridor is pipeline right-of-way.

Route Alternative RA-08

The most common zone type crossed by RA-08 is public/municipal land (Table 6.2.1-9). The next most common zone type is agriculture/forestry land. RA-08 would cross 0.6 mile of shoreland (Table 6.2.1-10).

Table 6.2.1-10 lists the acreages of the land use types located within the construction (con) and operation (op) footprint of RA-08. The most common land type crossed present is wetlands. Additionally, RA-08 would cross through 13 miles of the Red Lake Watershed District.

Table 6.2.1-4. Land Use Zoning Categories Crossed by Route Alternative RA-03AM (miles)

County	Agriculture/ Forestry	Residential	Commercial	Industrial	Public/ Municipal	Conservation/ Recreation	Shoreland	Other
Clearwater County	NA	NA	NA	NA	NA	NA	NA	NA
Hubbard County	NA	NA	NA	NA	NA	NA	NA	NA
Wadena County	33.9	0.1	0.5	0.0	0.0	0.0	1.3	0.0
Todd County	10.3	1.6	0.3	0.0	0.0	0.0	0.5	0.0
Morrison County	43.7	0.5	0.0	0.3	0.0	0.4	1.8	0.0
Benton County	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mille Lacs County	13.5	0.0	0.0	0.0	0.9	1.2	0.0	0.0
Kanabec County	NA	NA	NA	NA	NA	NA	NA	NA
Pine County	NA	NA	NA	NA	NA	NA	NA	NA
Carlton County	23.9	0.0	0.4	0.1	0.0	0.1	0.0	0.0
TOTAL	**130.8**	**2.2**	**1.2**	**0.4**	**0.9**	**1.7**	**3.7**	**0.0**

Sources: GIS Zoning layers from Benton, Carlton, Mille Lacs, Morrison, Todd, and Wadena counties.

Notes:

NA = Zoning data are not available for this county.

Each county has a different zoning ordinance, and zones differ between the counties. Zoning categories in this table are an approximation of similar zones. The specific zones for each county that make up each category are listed below:

Agriculture/Forestry = Wadena, General Agriculture, Transitional Agriculture, and Mixed Ag and Forestry; Carlton, Agricultural/Forest Management and Agriculture/Rural Residential; Todd, Agriculture/Forestry – 1 and Agriculture/Forestry – 2; Morrison, Agriculture; Mille Lacs, Agricultural Residential.

Residential = Wadena, Residential; Todd, Residential – 2 and Residential – 10; Morrison, Residential and Rural Residential; Benton, Rural Service District.

Commercial = Wadena, Highway Service Business District; Todd, Commercial.

Industrial = Carlton, Limited Industrial; Morrison, Manufacturing – Industrial.

Public/Municipal = Mille Lacs, Bock and Milaca.

Conservation/Recreation = Morrison, Mississippi Headwaters; Mille Lacs, Wild and Scenic River District – Recreational and West Branch of Rum River – Transition District; Carlton, Commercial Recreation.

Shoreland = Wadena, shoreland overlay district; Carlton, shoreland; Todd, shoreland; Morrison, shoreland.

Table 6.2.1-5. Land Use Types Crossed by Route Alternative RA-03AM (Clearbrook to Carlton) (acres)

Land Use Type	Construction	Operations
Agricultural[a]	1,611.1	676.8
Developed[b]	385.8	157.8
Forested[c]	1,137.7	470.5
Open Land[d]	339.6	143.5
Open Water[e]	17.0	7.1
Wetlands[f]	509.1	211.2
TOTAL	**4,000.4**	**1,666.9**

Notes:

[a] Agricultural Land = NLCD land use types: Cultivated and Hay/Pasture.

[b] Developed Land = NLCD land use types: Developed, High Intensity; Developed, Med Intensity; Developed, Low Intensity; and Developed, Open Space.

[c] Forested Land = NLCD land use types: Deciduous Forest, Evergreen Forest, and Mixed Forest.

[d] Open Land = NLCD land use types: Barren Land, Herbaceous, and Scrub/Shrub.

[e] Open Water = NLCD land use types: Open Water.

[f] Wetlands = NLCD land use types: Woody Wetlands and Emergent Herbaceous Wetlands.

Construction = 120-foot-wide construction footprint, Operations = 50-foot-wide permanent right-of-way.

Table 6.2.1-6. Watershed Districts Crossed by Route Alternative RA-03AM (miles)

Route Segment	Middle-Snake-Tamarac Rivers Watershed District	Red Lake Watershed District	Two Rivers Watershed District	Wild Rice Watershed District	TOTAL
Clearbrook to Carlton	0.0	19.4	0.0	5.4	24.8

Table 6.2.1-7. Land Use Zoning Categories Crossed by Route Alternative RA-06 (miles)

County	Agriculture/ Forestry	Residential	Commercial	Industrial	Public/ Municipal	Conservation/ Recreation	Shoreland	Other
Clearwater County	NA	NA	NA	NA	NA	NA	NA	NA
Beltrami County	NA	NA	NA	NA	NA	NA	NA	NA
Itasca County	31.1	0.2	0.0	10.0	63.3	0.0	0.0	3.4
Aitkin County	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0
St. Louis County	18.0	0.0	0.0	0.0	0.0	0.0	0.7	6.0
Carlton County	14.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
TOTAL	**63.1**	**0.2**	**0.0**	**10.0**	**63.3**	**0.8**	**1.3**	**9.4**

Sources: GIS Zoning layers from Aitkin, Carlton, St. Louis, and Itasca counties.

Notes:

NA = Zoning data not available for this county.

Each county has a different zoning ordinance, and zones differ between the counties. Zoning categories in this table are an approximation of similar zones. The specific zones for each county that make up each category are listed below:

Agriculture/Forestry = Carlton, Agricultural/Forest Management and Agriculture/Rural Residential; Aitkin, Farm Residential; Itasca, Farm Residential; St. Louis, Forest Agriculture Management.

Residential = Beltrami, Rural, Moderate Density Residential, Multiple Family, Suburban Residential (Sewered), and Suburban Residential (Unsewered).

Commercial = Beltrami, Low Density Commercial.

Industrial = Carlton, Limited Industrial; Itasca, Light Industrial/Commercial and Industrial.

Public/Municipal = Aitkin, Public; Itasca, Municipal and Public.

Conservation/Recreation = Aitkin, Open; Carlton, Commercial Recreation; Beltrami, Conservation.

Shoreland = Aitkin, Shoreland; Carlton, Shoreland; St. Louis, Shoreland Mixed Use.

Other = Itasca (blank); St. Louis, Multiple Use Non-Shoreland and Non-Jurisdiction Area.

Table 6.2.1-8. Land Use Types Crossed by Route Alternative RA-06 (Clearbrook to Carlton) (acres)

Land Use Type	Construction	Operations
Agricultural[a]	256.7	107.4
Developed[b]	65.4	26.4
Forested[c]	1,107.3	460.9
Open Land[d]	354.2	148.6
Open Water[e]	81.8	33.7
Wetlands[f]	996.3	415.3
TOTAL	2,861.8	1,192.4

Notes:

[a] Agricultural Land = NLCD land use types: Cultivated and Hay/Pasture.

[b] Developed Land = NLCD land use types: Developed, High Intensity; Developed, Med Intensity; Developed, Low Intensity; and Developed, Open Space.

[c] Forested Land = NLCD land use types: Deciduous Forest, Evergreen Forest, and Mixed Forest.

[d] Open Land = NLCD land use types: Barren Land, Herbaceous, and Scrub/Shrub.

[e] Open Water = NLCD land use types: Open Water.

[f] Wetlands = NLCD land use types: Woody Wetlands and Emergent Herbaceous Wetlands.

Construction = 120-foot-wide construction footprint, Operations = 50-foot-wide permanent right-of-way.

Table 6.2.1-9. Land Use Zoning Categories Crossed by Route Alternative RA-08 (miles)

County	Agriculture/ Forestry	Residential	Commercial	Industrial	Public / Municipal	Conservation/ Recreation	Shoreland	Other
Clearwater County	NA	NA	NA	NA	NA	NA	NA	NA
Beltrami County	0.0	4.6	0.6	0.0	0.0	0.3	0.0	0.0
Hubbard County	NA	NA	NA	NA	NA	NA	NA	NA
Cass County	2.1	1.9	0.0	0.0	30.3	0.0	0.0	0.0
Itasca County	20.4	0.5	0.0	0.5	23.6	0.0	0.0	1.1
Aitkin County	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0
St. Louis County	16.9	0.0	0.0	0.0	0.0	0.0	0.0	5.8
Carlton County	13.3	0.0	0.0	0.4	0.0	0.0	0.6	0.0
TOTAL	**52.7**	**7.0**	**0.6**	**1.0**	**58.5**	**0.3**	**0.6**	**6.8**

Sources: GIS Zoning layers from Aitkin, Beltrami, Carlton, Cass, Itasca, and St. Louis counties.

Notes:

Beltrami County zoning data cover only the Greater Bemidji Area.

NA = Zoning data not available for this county.

Each county has a different zoning ordinance, and zones differ between the counties. Zoning categories in this table are an approximation of similar zones. The specific zones for each county that make up each category are listed below:

Agriculture/Forestry = Cass, Agricultural/Forestry; Carlton, Agricultural/Forest Management and Agriculture/Rural Residential; Aitkin, Farm Residential; Itasca, Farm Residential; St. Louis, Forest Agriculture Management.

Residential = Cass, Rural Residential 2.5 and Rural Residential 5; Itasca, Rural Residential; Beltrami, Rural, Moderate Density Residential, Multiple Family, Suburban Residential (Sewered), and Suburban Residential (Unsewered).

Commercial = Beltrami, Low Density Commercial; Cass, Commercial.

Industrial = Carlton, Limited Industrial; Itasca, Light Industrial/Commercial and Industrial.

Public/Municipal = Cass, Public Land or within City Limits; Aitkin, Public; Itasca, Municipal and Public.

Conservation/Recreation = Aitkin, Open; Carlton, Commercial Recreation; Beltrami, Conservation.

Shoreland = Aitkin, Shoreland; Carlton, Shoreland; St. Louis, Shoreland Mixed Use.

Other = Itasca (blank); St. Louis, Multiple Use Non-Shoreland and Non-Jurisdiction Area; Cass, Unknown.

Table 6.2.1-10. Land Use Types Crossed by Route Alternative RA-08 (Clearbrook to Carlton) (acres)

Land Use Type	Construction	Operation
Agricultural[a]	335.6	141.4
Developed[b]	86.3	35.2
Forested[c]	772.8	319.8
Open land[d]	207.9	87.4
Open water[e]	25.3	10.3
Wetlands[f]	969.7	404.9
TOTAL	**2,397.6**	**999.0**

Notes:

[a] Agricultural Land = NLCD land use types: Cultivated and Hay/Pasture.

[b] Developed Land = NLCD land use types: Developed, High Intensity; Developed, Med Intensity; Developed, Low Intensity; and Developed, Open Space.

[c] Forested Land = NLCD land use types: Deciduous Forest, Evergreen Forest, and Mixed Forest.

[d] Open Land = NLCD land use types: Barren Land, Herbaceous, and Scrub/Shrub.

[e] Open Water = NLCD land use types: Open Water.

[f] Wetlands = NLCD land use types: Woody Wetlands and Emergent Herbaceous Wetlands.

Construction = 120-foot-wide construction footprint, Operation = 50-foot-wide permanent right-of-way.

6.2.1.3 Impact Assessment

6.2.1.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Compatibility with Comprehensive Plans and Zoning Ordinances

Review of the relevant comprehensive plans and zoning ordinances found that pipelines are not listed as an allowed use for any of the zones that would be crossed by the Applicant's preferred route or the route alternatives.

Agriculture/Forestry

The Applicant's preferred route crosses approximately 91 miles of land zoned as agriculture/forestry in Kittson, Wadena, Cass, Aitkin, and Carlton counties (Table 6.2.1-1). A typical goal associated with this zone is to preserve the resource, whether farmland or forested land. Preserving farmland in its designated use prevents encroachment of development that could remove the farmland from production. Preserving forestry land could fulfill many goals including timber production, recreation, habitat protection, and even water quality. Usually only limited residential development is permitted in these zones. Construction of an oil pipeline would be incompatible with some of these goals, either temporarily or long-term. Impacts on agricultural land would be temporary; a growing season in the construction footprint would be lost, after which the land would revert to agricultural use, resulting in minor temporary impacts. For forested land, however, impacts would be greater; trees cleared from construction work areas would take a long time (up to many decades in some cases) to regenerate to preexisting conditions. Impacts on forested land uses would be minor to major and long-term for land zoned as forestry in the temporary construction

areas and major and permanent for land in the permanent right-of-way. Impacts on agricultural and forestry land are also discussed in Sections 6.3.3 and 6.5.1.

Residential

A total of approximately 9 miles of land zoned as residential would be crossed by the Applicant's preferred route in Cass and Crow Wing counties (Table 6.2.1-1). Two primary goals are associated with residential land: to provide an appropriate place to live and to prevent incompatible/nuisance development. Variations in land zoned as residential may dictate the minimum lot size and dwelling types allowed which aid planners to regulate population density. Specific zones the Applicant's preferred route would cross are Rural Residential 2.5 and Rural Residential 5 in Cass County, and Rural Residential 10 and Rural Residential 20 in Crow Wing County. (The numbers in the zone name represent the minimum lot size in acres; so the lot sizes for a single residence would be 2.5 acres, 5 acres, 10 acres, or 20 acres, respectively.) Impacts on land zoned as residential would be temporary for areas outside the permanent right-of-way because construction work areas would be restricted from development for a short period of time since construction moves through an area relatively quickly, after which these areas would be restored and no further restrictions on development would be in place. Areas within the permanent right-of-way would be permanently restricted from development and this would subtract from the land available for residential use. The large lot sizes would likely have adequate areas that could still be developed for residential use, resulting in minor and permanent impacts on land zoned as residential.

Commercial

The Applicant's preferred route crosses 0.5 mile of land zoned for commercial use in Aitkin County. The goal of commercial land is to provide areas for stores and businesses. Construction near stores and businesses could temporarily interrupt this use by restricting access to businesses or parking areas and creating extra traffic in the area. Noise and dust also could be a nuisance to businesses. The Applicant would cross all paved roads without disturbing the surface, which would help to maintain access and traffic flows (see Section 6.2.5). The Applicant also would use dust and noise suppression when possible (see Sections 6.3.7 and 6.2.2, respectively). With implementation of the Applicant-proposed measures, the impacts on commercial-zoned land from construction would be minor and temporary. Land in the permanent right-of-way would be permanently restricted from commercial development and would reduce the overall amount of commercial-zoned land available. Impacts would be minor because of the small amount of commercial land to be crossed and the reduction of impacts from the Applicant-proposed measures. Impacts would be permanent because after construction the land within the permanent right-of-way would be restricted from development for the life of the Project.

Industrial

The Applicant's preferred route crosses 0.5 mile of industrial land in Carlton County. An industrial zone is intended for manufacturing or other production facilities and these areas typically require major transportation routes and/or appropriate access to handle the inflow of materials and the outflow of products. Construction of a pipeline in industrial areas could lead to traffic interruptions which could affect the facilities in this zone. However, the Applicant's proposal to bore underneath or use horizontal directional drilling (HDD) to drill underneath paved roads would prevent traffic and associated industrial disruptions (see Section 6.2.5). With implementation of the Applicant-proposed measures, impacts on industrial land outside the permanent right-of-way would be negligible to minor and temporary. Impacts would be negligible to minor because of the small amount of industrial land to be crossed and the reduction of impacts from the Applicant-proposed measures. Impacts would be temporary because after construction areas outside the permanent right-of-way would not be restricted from development. Areas within the permanent right-of-way would be restricted from any development. This would be a

minor impact because of the small amount of land affected, but it would be permanent because no development in the right-of-way would be permitted for the life of the Project.

Public/Municipal

Public and municipal land can have many different goals, depending on the specific land type, but typically this land is to be used for public benefit. Development on land zoned as public/municipal typically requires additional approvals outside of a zoning permit. These additional approvals and the specific goals of public lands are further discussed in Section 6.3.6.

The Applicant's preferred route crosses approximately 41 miles of public/municipal land in Cass, Crow Wing, and Aitkin counties. Most of this land is state forest land administered by Minnesota Department of Natural Resources (Minnesota DNR). Construction in public or municipal land would disrupt uses in this zone. The impact would be minor to major and temporary to permanent depending on the specific land type and ownership. Goals and impacts would vary across the different public land types and these are discussed further in Section 6.3.6.

Conservation/Recreation

The Applicant's preferred route would cross 18 miles of land zoned as conservation/recreation in Aitkin County. The specific zone name in Aitkin County is "open land"; this land use is applied to areas of floodplains, swamp lands, and other areas unsuitable or unsafe for development. The use of the area as open land would be temporarily affected by construction activities such as clearing vegetation, grading the land, and trenching for placement of the pipe. These impacts would be minor and temporary. Following construction and restoration impacts would remain minor because the pipeline would be buried and would not affect surface use.

Shoreland

The Applicant's preferred route would cross approximately 8 miles of land zoned as shoreland in Wadena, Crow Wing, Aitkin, and Carlton counties. The Shoreland zone is based on a special overlay district designed to limit and regulate development near waterbodies. The goals and impacts of overlay districts are further discussed in the overlay districts section below. Construction in the Shoreland zone would not meet the goal of limiting development near waterways, and removal of vegetation from the construction areas would be a minor temporary impact.

Compatibility with Overlay Districts

The goals of the shoreland overlay districts are to "provide guidance for the wise development of shorelands of public waters and, thus, preserve and enhance the quality of surface waters; preserve the economic and natural environmental values of shorelands; and provide for the wise use of water and related land resources" (Minn. Stat. § 103F.201). Conditions that are placed on construction in shoreland areas may include maintenance of a buffer of vegetation between construction and the edge of waterbodies, or other requirements to preserve vegetation and trees where possible. In areas where the Applicant's preferred route would cross waterways, pipeline construction may require clearing trees and vegetation from the edge of the water. A total of 192 surface waters would be crossed by the Applicant's preferred route (see Section 6.3.1.2). As discussed further in Section 6.3.1.2, impacts on some waterbodies would be reduced through the use of bore crossings and HDD crossings where vegetation buffers and streambanks could be left intact. Generally construction in the shoreland area and across stream banks is not compatible with the goals of shoreland overlay districts and would be a minor permanent impact. Overall the impacts in shoreland areas would be minor because of the small amount of land along waterbodies that would be affected and although trees would not be allowed,

other vegetation would be planted. The impacts would be permanent because trees and woody vegetation would not be allowed to regrow in the permanent right-of-way. Impacts in shoreland areas are further discussed in Sections 6.3.1.2, 6.3.1.3, and 6.3.1.4.

Floodplain overlay districts are designated to reduce the quantity of development in floodplains and restrict the type of development to reduce losses from flooding and keep floodways clear for the movement of flood waters. Pipelines are generally a conditional use permitted in floodplain overlay districts, although not all floodplain ordinances specifically list them as a conditional use. The conditions for construction may include protecting spoil piles from erosion and storing materials and equipment outside the floodplain if it could not be moved in the time available after a flood warning. Construction activities would temporarily alter floodplain topography, resulting in minor alterations to water flows in the event of a flood in the area but are unlikely to block or restrict flows, reduce the area within a floodplain that carries floodwaters, or increase flood elevations upstream (see Section 6.3.1.4 for further information). Thus, the uses of floodplains in the floodplain overlay districts would not likely change due to pipeline construction, resulting in minor and temporary impacts. Floodplains are further discussed in Section 6.3.1.4.

Compatibility with Existing Land Use

Construction of the Applicant's preferred route would affect a little over 5,600 acres of land in Minnesota. About 2,467 acres of the total affected acreage would be agricultural land and about 1,789 acres would be forested land. Developed land, open land, wetlands, and open water would account for about 1,350 acres of impacts.

Agricultural

Compatibility with agricultural land is discussed for the agriculture/forestry zone above. The temporary removal of land from agricultural production during construction would be a minor temporary impact because agricultural land would lose a growing season in the construction footprint, after which the land would be returned to agricultural land use.

Developed Land

As mentioned in the discussions above for residential, commercial, and industrial zones, construction activities in developed lands may be incompatible with existing uses in developed land. With implementation of the Applicant-proposed measures described for those zones, impacts from construction in developed areas would be temporary and minor because of the limited area that would be affected by construction and the short construction period. However, land in the permanent right-of-way would be restricted from future development which would be a minor permanent impact.

Forested Land

Compatibility of the Applicant's preferred route with forested land is discussed above for the agriculture/forestry zone. Forested land also may fall under the public/municipal zone, especially for areas of state or national forests. Construction of the Applicant's preferred route is generally not compatible with forested land because of the requirement to remove trees from construction work areas and the permanent right-of-way. The 1,789 acres of forested land affected would be a major long-term impact for areas in the temporary construction areas and would be major and permanent for areas within the permanent right-of-way.

Open Land

Open land may correspond most closely with the conservation/recreation zone type. Construction activities in open land would temporarily be incompatible with goals of preserving undeveloped natural areas or scenic resources and enhancing recreation opportunities. Construction of a pipeline in open land would temporarily disturb approximately 359 acres of open land until restoration is complete. This would be a minor temporary impact because of the small change to the land area that would be affected; after construction, open lands would be restored and the buried pipeline would not affect surface use.

Open Water

Typically, the open water land use category is not a planned zone. From a planning and zoning perspective, pipeline construction in these areas would be compatible with the open water land use category. During construction in waterways, minor temporary impacts could occur to surface waters from sedimentation and potential spills of small quantities of hazardous materials used during construction, as discussed in Section 6.3.1.2. However, Applicant-proposed measures would be implemented to reduce such impacts, which would be temporary until construction is complete and the waterbody revegetated.

Wetlands

Wetlands most closely correspond with the Shoreland zone in local comprehensive plans. During construction of the Applicant's preferred route, construction activities in wetlands would not be compatible with preservation goals and would be a minor to major impact, which may be a temporary to long-term impact. After construction, the wetlands in some cases would revert to their original state; however, some wetlands, such as forested and scrub/shrub wetlands would be cleared of woody vegetation and would remain altered. Wetlands are discussed further in Section 6.3.1.3.

Compatibility with Watershed District Goals

The goals of watershed districts are broad and far reaching, involving all aspects of water within their districts, including but not limited to improving water quality, managing drainage systems, providing flood protection, enhancing recreational opportunities, and providing for wildlife habitat. The compatibility of construction of the Applicant's preferred route with these goals is largely related to the potential impacts of construction on water resources in the watershed. During construction of a pipeline, removal of vegetation in construction work areas and working in and around wetlands and waterbodies may result in impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water. Removal of vegetation in and around waterbodies could eliminate or reduce some of these benefits (and associated watershed district goals), and may reduce the scenic integrity of shoreland areas. The Applicant has proposed measures to limit impacts on water resources as described in the Environmental Protection Plan (Appendix E), including temporary erosion control measures and BMPs for waterbody crossings as described in Section 6.3.1.2. The Applicant-proposed measures would reduce construction impacts on water resources which would help to meet the watershed districts' goals of conserving watershed functions and limiting impacts on water quality from development. With implementation of Applicant-proposed measures, pipeline construction would result in minor temporary impacts on waterbodies and watershed district goals.

Operations Impacts

Compatibility with Comprehensive Plans and Zoning Ordinances

County and local comprehensive plans generally have long-term goals. While short-term impacts from construction may temporarily interrupt desired land uses, long-term effects of pipeline operation may represent greater impacts, as detailed below.

Agriculture/Forestry

Operation of the Applicant's preferred route would be compatible with the goal of preserving agricultural land because farming would be permitted in the right-of-way after construction, resulting in no compatibility impacts on land zoned as agricultural during operations. However, the goal of preserving forested land would not be compatible with operation of the Applicant's preferred route because no trees would be allowed within the permanent right-of-way, resulting in a loss of forested land and an impact that would be major and permanent.

Residential

The presence of buried oil pipeline in residential areas would partially limit development of residential land during operation as no structures would be permitted over the permanent right-of-way. However, these residential areas are zoned for development on large land parcels (2.5- to 10-acre plots), and land outside the permanent right-of-way would be available for such development. The loss of a 50-foot-wide permanent right-of-way corridor to residential development would represent a minor permanent impact on residential land use.

Commercial

The presence of a buried oil pipeline would limit development of commercial land within the permanent right-of-way during operation because no structures would be permitted for development in this area. However, only a small amount of land is zoned as commercial (0.5 mile) crossed by the permanent right-of-way, and land outside the permanent right-of-way would be available for commercial development. The loss of a 50-foot-wide permanent right-of-way corridor to commercial development would represent a minor permanent impact on commercial use.

Industrial

The presence of buried oil pipeline would partially limit development of industrial land within the permanent right-of-way during operation because no structures would be permitted for development in this area. However, only a small amount of land is zoned as industrial (0.5 mile) crossed by the permanent right-of-way, and land outside the permanent right-of-way would be available for industrial development. The loss of a 50-foot-wide permanent right-of-way corridor to industrial development would represent a minor permanent impact on commercial use.

Public/Municipal

The majority of land zoned for public/municipal use crossed by the Applicant's preferred route is state forest land as described above. This land does not fall under the local planning and zoning authority as it is controlled by Minnesota State. The loss of forest from clearing trees would be a major permanent impact within the permanent right-of-way which would be maintained free of trees and woody vegetation. For purposes of local government planning and zoning, the land would remain public; however, goals and impacts would vary across the different public land types and these are discussed further in Section 6.3.6. Other public uses may be permitted to resume after construction is complete.

Conservation/Recreation

Operation of the Applicant's preferred route in areas zoned for conservation/recreation would be compatible with recreation in that the permanent right-of-way would be revegetated and would revert to its original use. The only conservation/recreation-zoned land that would be crossed by the Applicant's preferred route would be in Aitkin County. The specific zone in Aitkin County is the open land zone and pipeline construction in open land is generally compatible because the pipeline would be buried and out of sight. Land in this land use zone that is used for conservation purposes, however, would be periodically disturbed by maintenance mowing in the permanent right-of-way, which would result in minor, permanent impacts.

Shoreland

During operations, the Applicant's preferred route would largely be compatible with shoreland goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions, with the exception of the permanent right-of-way at the water's edge where trees would not be allowed to grow along the banks. The goal of preserving vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation which would preserve other goals of water quality and bank stability, for example. Operation of the Applicant's preferred route in shoreland areas would be a minor permanent impact on shoreland goals.

Compatibility with Overlay Districts

The Applicant's preferred route would largely be compatible with shoreland overlay district goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions. Where the pipeline crosses waterbodies, the permanent right-of-way abutting the water's edge would be maintained clear of trees and large woody vegetation and the goal of preserving buffers and shade trees along waterbodies would be partially prevented. However, the permanent right-of-way would be planted with other vegetation that would preserve other goals of maintaining water quality and bank stability, for example. Impacts and mitigation associated with water resources are further discussed in Section 6.3.1. Operation of the Applicant's preferred route in shoreland overlay districts would be a minor permanent impact on overlay district goals.

Because the pipeline would be buried underground and the ground cover conditions would be restored, the Applicant's preferred route would be compatible with floodplain overlay district requirements during operation. The buried pipeline would not be an obstruction in the floodplain and would not affect the water channel or flood levels.

Compatibility with Existing Land Use

During operation, the permanent footprint of the Applicant's preferred route would cover approximately 940 acres of agricultural land, 802 acres of forested land, 319 acres of wetlands, 204 acres of open land, 133 acres of developed land, and 7 acres of open water. This analysis reviews the compatibility of the Applicant's preferred route in Minnesota with these adjacent land uses during operation. The reason for this analysis is to supplement the review of compliance with zoning regulations. For areas without zoning information, however, the analysis covers all the land crossed by the Applicant's preferred route including land with zoning information.

Agricultural

Operation of the Applicant's preferred route would be compatible with the use of agricultural land because farming would occur in the right-of-way after construction, resulting in no compatibility impacts on land used for agriculture during operations.

Developed Land

The presence of buried oil pipeline in developed areas would partially limit residential, commercial, and industrial development in these areas during operation as no structures would be permitted over the permanent right-of-way. However, only a small amount of land is zoned as developed (approximately 133 acres) within the permanent right-of-way, and land outside the permanent right-of-way would be available for development. The loss of a 50-foot-wide permanent right-of-way corridor to residential, commercial, and industrial development would represent a minor permanent impact on developed land use.

Forested Land

Forested land also may fall under the public/municipal zone, especially for areas of state or national forests. Operation of the Applicant's preferred route would be least compatible with preservation of forested land because trees would not be permitted in the permanent right-of-way. The loss of approximately 802 acres of forest land from clearing trees would be a major permanent impact within the permanent right-of-way, which would be maintained free of trees and woody vegetation.

Open Land

Open land may correspond most closely with the conservation/recreation zone type. Maintenance vegetation mowing in the permanent right-of-way would be incompatible with goals of preserving undeveloped natural areas, but would be consistent with goals of providing public use of open areas. For this analysis, the approximately 204 acres of open land that would be maintained during operations is considered to be a minor permanent impact as these areas could continue to be used as open space after restoration is complete.

Open Water

Typically, the open water land use category is not a planned zone. From a planning and zoning perspective, pipeline operation in open water areas would be compatible with the open water land use category because open waters crossed by the Applicant's preferred route would remain in their current use, and there would be no impacts.

Wetlands

Wetlands would most closely correspond with the Shoreland zone in local comprehensive plans. Because the pipeline would be buried beneath waterbodies, operations of the Applicant's preferred route would generally not affect wetland functions, with the exception of the permanent right-of-way where trees and large woody vegetation would not be allowed to grow. Preservation of wetland vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation which would preserve other wetland functions such as water quality and bank stability. Operation of the Applicant's preferred route in wetland areas would be minor and long-term as wetlands would generally return to functionality. Wetlands are further discussed in Section 6.3.1.3.

Compatibility with Watershed District Goals

During operation of the Applicant's preferred route, the pipeline would be compatible with watershed district goals such as improving water quality, managing drainage systems, providing flood protection, enhancing recreational opportunities, and providing for wildlife habitat. During operation of a pipeline, maintenance of vegetation in the permanent right-of-way in and around wetlands and waterbodies may result in minor impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water. Removal of large woody vegetation in and around waterbodies could reduce some of these benefits (and associated watershed district goals), and may reduce the scenic integrity of shoreland areas, although other vegetation would be retained which would provide many of these benefits. Generally, operation of an oil pipeline in wetland areas would be consistent with wetland land uses, resulting in minor temporary impacts.

6.2.1.3.2 Route Alternatives (from Clearbrook to Carlton)

Table 6.2.1-11 presents the amount and categories of land zoned for specific uses for the Applicant's preferred route and route alternatives from Clearbrook to Carlton.

Route Alternative RA-03AM

Construction Impacts

Compatibility with Comprehensive Plans and Zoning Ordinances

The types of land use impacts and the compatibility of pipeline construction within land use zones for RA-03AM would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1-11.

Agriculture/Forestry. Impacts on agricultural land would consist of prevention of crops on agricultural land for one growing season in the construction work areas, after which the land would revert to agricultural use, resulting in minor temporary impacts. For forested land, impacts would be greater as trees would be cleared from construction work areas would take a long period of time (up to many decades in some cases) to regenerate to preexisting conditions, resulting in minor to major and long-term impacts on forestry land in construction workspace areas and major permanent impacts in the permanent right-of-way.

Residential. Impacts on approximately 2 miles of land zoned as residential would be temporary for areas outside the permanent right-of-way because construction work areas would be restricted from development for a short period of time because construction moves through an area relatively quickly, after which these areas would be restored and no further restrictions on development would be in place. Areas within the permanent right-of-way would be permanently restricted from development; this would subtract from the land available for residential use, resulting in minor and permanent impacts on land zoned as residential.

Table 6.2.1-11. Amount and Types of Land Zoning and Uses for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Comprehensive Plans and Zoning Ordinances (miles of zoned land in construction work areas)					
Agriculture/forestry	66.2	**130.8**	63.1	58.4	52.7
Residential	9.1	2.2	0.2	**9.3**	7.0
Commercial	0.5	**1.2**	0.0	0.7	0.6
Industrial	0.0	0.3	**10.0**	1.0	0.9
Public/municipal	41.4	0.9	**63.3**	52.7	58.5
Conservation/recreation	**18.0**	1.7	0.8	1.1	0.3
Shoreland	**7.4**	3.7	1.3	1.3	0.6
Other	0.0	0.0	**9.4**	6.8	6.8
Watershed Districts Crossed (miles of land in construction work areas)					
Watershed districts crossed	25.0	24.8	**52.4**	15.6	13.3
Existing Land Uses (acres of land in construction work spaces)					
Agricultural	561.6	**1,611.1**	256.7	401.8	335.6
Developed	94.0	**385.8**	65.4	272.9	86.3
Forested	**1,446.5**	1,137.7	1,107.3	1,146.4	772.8
Open land	307.7	339.6	354.2	**692.0**	207.9
Open water	6.4	17.0	**81.8**	34.5	25.3
Wetlands	490.6	509.1	996.3	**1,592.0**	969.7

Table 6.2.1-11. Amount and Types of Land Zoning and Uses for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Operations Impacts					
Existing Land Uses (acres of land in permanent right-of-way)					
Agricultural	251.6	**676.8**	107.4	111.5	141.4
Developed	45.5	**157.8**	26.4	69.5	35.2
Forested	**631.0**	470.5	460.9	242.0	319.8
Open land	151.0	143.5	148.6	**193.6**	87.4
Open water	3.8	7.1	**33.7**	9.6	10.3
Wetlands	254.2	211.2	**415.3**	390.3	404.9

Note:

Bold font indicates the route option with the greatest amount of acres or miles for the zone or land area crossed.

Commercial. Construction near stores and businesses could temporarily interrupt commercial land uses by restricting access to businesses or parking areas, creating extra traffic in the area and creating noise and dust nuisances. However, with implementation of the Applicant-proposed measures as described for the Applicant's preferred route, the impacts on commercial-zoned land from construction would be minor and temporary. Land in the permanent right-of-way would be permanently restricted from commercial development and would reduce the overall amount of commercial-zoned land available. Impacts would be minor because of the small amount of commercial land to be crossed (approximately 1 mile) and reduction of impacts from the Applicant-proposed measures. Impacts would be permanent because after construction the land within the permanent right-of-way would be restricted from development for the life of the Project.

Industrial. Construction of a pipeline in industrial areas could lead to traffic interruptions that could disrupt access to the inflow of materials and the outflow of products for facilities in this zone. With implementation of the Applicant-proposed measures as described for the Applicant's preferred route, impacts on industrial land outside the permanent right-of-way would be negligible to minor and temporary. Impacts would be negligible to minor because of the small amount of industrial land to be crossed (0.3 mile) and the reduction of impacts from the Applicant-proposed measures. Impacts would be temporary because after construction, areas outside the permanent right-of-way would not be restricted from development. Areas within the permanent right-of-way would be restricted from any development. This would be a minor impact because of the small amount of land affected but it would be permanent as no development in the right-of-way would be permitted for the life of the Project.

Public/Municipal. Typically, this land is to be used for public benefit, and construction in land zoned for public or municipal use would temporarily minor to major disruptions of such uses. In RA-03 AM, the public/municipal land is 0.9 mile of municipal land in Mille Lacs County. For purposes of local government planning and zoning, the land would remain public; however, goals and impacts would vary and no development would be permitted in the permanent right-of-way. This would be a minor impact because of the small amount of land, but it would be permanent as no development would be allowed in the right-of-way for the life of the Project.

Conservation/Recreation. Conservation/recreation-zoned land crossed by RA-03AM consists of 0.4 mile of Mississippi Headwaters land in Morrison County, approximately 1 mile of Wild and Scenic River District zone along the Rum River in Mille Lacs County, and 0.1 mile of commercial recreation-zoned land in Carlton County. The use of these land use types would be temporarily affected by construction activities such as clearing vegetation, grading the land, and trenching for placement of the pipe. These impacts would vary depending on the specific land type. Impacts in Mississippi Headwaters and the Wild and Scenic Rivers District would see similar impacts as those described for Shoreland zones of the Applicant's preferred route and in Section 6.3.1. Specific waterbody crossing methods have not been identified for RA-03AM, but mitigation measures along the route would be similar to those being proposed for the Applicant's preferred route and may include steps to avoid or reduce impacts on sensitive areas such as using guided bore or HDD waterbody crossing methods. Without specific plans for crossings in these areas we assume that impacts would be similar to those in the Applicant's preferred route for Shoreland zones and the shoreland overlay district and would be minor and permanent. The small amount of land affected and the likelihood of Applicant-proposed mitigation measures would make the impact minor. However, trees and other woody vegetation would not be allowed to regrow in the permanent right-of-way, which would be a permanent impact.

Shoreland. Construction in Shoreland zones would not meet the goal of limiting development near waterways. RA-03AM would cross approximately 4 miles of Shoreland zones. Removal of vegetation from the construction areas would be a minor temporary impact as all disturbed areas would be revegetated, but trees and woody vegetation would not be allowed to regrow within the permanent right-of-way.

Compatibility with Overlay Districts

Conditions that are placed on construction in shoreland areas may include maintenance of a vegetation buffer between construction and the edge of waterbodies, or other requirements to preserve vegetation and trees where possible. In areas where the pipeline would cross waterways, construction may require clearing trees and vegetation from the edge of the water, which is generally not compatible with the goals of shoreland overlay districts. Impacts would be minor because of the small amount of land along waterbodies that would be affected, and although trees would not be allowed, other vegetation would be planted. The impacts would be permanent because trees and woody vegetation would not be allowed to regrow in the right-of-way.

Floodplain overlay districts are designated to reduce the quantity of development in floodplains and restrict the type of development to reduce losses from flooding and retain adequate area within a floodplain to carry floodwaters. Construction activities would temporarily alter floodplain topography, but the uses of floodplains in the floodplain overlay districts would not likely change as a result of pipeline construction, resulting in minor and temporary impacts. Floodplains are further discussed in Section 6.3.1.4.

Compatibility with Existing Land Use

The types of land use impacts and the compatibility of pipeline construction within land use zones for RA-03AM would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1-11.

Agricultural. Compatibility with agricultural land is discussed for the agriculture/forestry zone above. The temporary removal of approximately 1,611 acres of land from agricultural production during construction would be a minor temporary impact because agricultural land would lose a growing season in the construction footprint, after which the land would be returned to agricultural land use.

Developed Land. As mentioned in the discussions above for residential, commercial, and industrial zones, construction activities in developed lands may be incompatible with existing uses in developed land. With implementation of the Applicant-proposed measures described for those zones, impacts from construction in developed areas would be temporary and minor because of the limited area that would be affected by construction (approximately 386 acres) and the short construction period; however, land in the permanent right-of-way would be restricted from future development, which would be a minor permanent impact.

Forested Land. Compatibility of the Applicant's preferred route with forested land is discussed above for the agriculture/forestry zone. Forested land also may fall under the public/municipal zone, especially for areas of state or national forests. Construction of RA-03AM is generally not compatible with forested land because of the requirement to remove trees from construction work areas. The approximately 1,138 acres of forested land affected would be a major long-term impact for areas in the temporary construction areas and a major permanent impact for areas within the permanent right-of-way where trees would not be permitted to regrow.

Open Land. Open land may correspond most closely with the conservation/recreation zone type. Construction activities in open land would temporarily be incompatible with goals of preserving undeveloped natural areas or scenic resources and enhancing recreation opportunities. Construction of a pipeline in open land would temporarily disturb approximately 340 acres of open land until restoration is complete. This would be a minor temporary impact because of the small area that would be affected and after construction, open lands would be restored.

Open Water. Pipeline construction in open water areas would be compatible with this land use category. During construction in waterways, minor temporary impacts could occur to surface waters from sedimentation and potential spills of small quantities of hazardous materials used during construction as discussed in Section 6.3.1.2. However, Applicant-proposed measures would be implemented to reduce such impacts which, would be temporary until construction is complete and the waterbody revegetated.

Wetlands. During construction of RA-03AM, construction activities in wetlands would not be compatible with preservation goals and impact would be minor to major, which may be temporary to long-term. After construction, the wetlands in some cases would revert to their original state; however some wetlands, such as forested and scrub/shrub wetlands would be cleared of woody vegetation and would remain altered. Wetlands are discussed further in Section 6.3.1.3.

Compatibility with Watershed District Goals

During construction of a pipeline, removal of vegetation in construction work areas and working in and around wetlands and waterbodies may result in impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water.

Removal of vegetation in and around waterbodies during construction could result in impacts on water resources in watersheds. This could affect watershed district goals of retaining good water quality by keeping banks stabilized and preventing erosion and may reduce the scenic integrity of shoreland areas. Applicant-proposed measures, including temporary erosion control measures and BMPs for waterbody crossings, would reduce construction impacts on water resources. These measures would help to meet the watershed districts' goals of conserving watershed functions and limiting impacts on water quality from development. With implementation of Applicant-proposed measures, pipeline construction would result in minor temporary impacts on waterbodies and watershed district goals.

Operations Impacts

The types of land use impacts and the compatibility of pipeline operations within land use zones for RA-03AM would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1-11.

Compatibility with Comprehensive Plans and Zoning Ordinances

County and local comprehensive plans generally have long-term goals. While short-term impacts from construction may temporarily interrupt desired land uses, long-term effects of operation of the pipeline may represent greater impacts, as detailed below.

Agriculture/Forestry. Operation of an oil pipeline would be compatible with the goal of preserving agricultural land because farming would be permitted in the right-of-way after construction, resulting in no compatibility impacts on land zoned as agricultural during operations. The goal of preserving forested

land would not be compatible with operation of the proposed Project, however, because no trees would be allowed within the permanent right-of-way, resulting in a loss of forested land and an impact that would be major and permanent.

Residential. The presence of buried oil pipeline in residential areas would partially limit development of residential land during operation as no structures would be permitted over the permanent right-of-way. However, land outside the permanent right-of-way would be available for such development. The loss of a 50-foot-wide permanent right-of-way corridor to residential development would represent a minor permanent impact on residential land use.

Commercial. The presence of buried oil pipeline would limit development of commercial land within the permanent right-of-way during operation because no structures would be permitted for development in this area. However, only a small amount of land is zoned as commercial within the permanent right-of-way, and land outside the permanent right-of-way would be available for commercial development. The loss of a 50-foot-wide permanent right-of-way corridor to commercial development would represent a minor permanent impact on commercial use.

Industrial. The presence of buried oil pipeline would partially limit development of Industrial land within the permanent right-of-way during operation because no structures would be permitted for development in this area. However, only a small amount of land is zoned as industrial within the permanent right-of-way, and land outside the permanent right-of-way would be available for industrial development. The loss of a 50-foot-wide permanent right-of-way corridor to industrial development would represent a minor permanent impact on commercial use.

Public/Municipal. RA-03AM crosses approximately 1 mile of public/municipal land. The land zoned for public/municipal use crossed by RA-03AM is municipal land as described above. For purposes of local government planning and zoning, the land would remain public; however, goals and impacts would vary across the different public land types, which is discussed further in Section 6.3.6. Other public uses may be permitted to resume after construction is complete; however, no development would be permitted in the permanent right-of-way. Because of the small amount of land affected this would be a minor impact but it would last throughout the lifetime of the Project, so it would be permanent.

Conservation/Recreation. Operation of RA-03AM in areas zoned conservation within Mississippi Headwaters and the Wild and Scenic River District would generally be compatible with the Project because the pipeline would be buried and vegetation would be replanted in any disturbed areas. Trees and woody vegetation would not be allowed to revegetate in the permanent right-of-way, which could affect the viewshed of the scenic river area. Crossing methods have not been determined; but in special interest areas, less impactful crossing methods such as boring and HDD would be considered. The elimination of trees from the permanent right-of-way may conflict with goals of conservation in these zones and would be a minor permanent impact. Impacts in land zoned as commercial recreation would be similar to impacts in commercial land and would result in the loss of the ability to develop land within the permanent right-of-way. The small amount of land affected (0.1 mile) would make this a minor but permanent impact.

Shoreland. During operations, RA-03AM would largely be compatible with shoreland goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions, with the exception of the permanent right-of-way at the water's edge where trees would not be allowed to grow along the banks. The goal of preserving vegetation buffers and shade trees along waterbodies

would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation which would preserve other goals of water quality and bank stability, for example. Operation of RA-03AM in shoreland areas would be a minor permanent impact on shoreland goals.

Compatibility with Overlay Districts

RA-03AM would largely be compatible with shoreland goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions. Where the pipeline crosses waterbodies, the permanent right-of-way abutting the water's edge would be maintained clear of trees and large woody vegetation and the goal of preserving buffers and shade trees along waterbodies would be partially prevented. However, the permanent right-of-way would be planted with other vegetation which would preserve other goals of maintaining water quality and bank stability, for example. Impacts and mitigation associated with water resources are further discussed in Section 6.3.1. Operation of RA-03AM in shoreland overlay districts would be a minor permanent impact on overlay district goals.

Because the pipeline would be buried underground and the groundcover conditions would be restored, the Project would be compatible with floodplain overlay requirements during operation. The buried pipeline would not be an obstruction in the floodplain and would not affect the water channel or flood levels.

Compatibility with Existing Land Use

During operation, the permanent footprint of RA-03AM would cover approximately 677 acres of agricultural land, 471 acres of forested land, 211 acres of wetlands, 144 acres of open land, 158 acres of developed land, and 7 acres of open water. This analysis reviewed the compatibility of RA-03AM with these adjacent land uses to supplement the zoning compatibility analyses of areas without zoning information, but the study included all areas crossed by RA-03AM.

Agricultural. Operation of RA-03AM would be compatible with the use of agricultural land because farming would occur in the right-of-way after construction, resulting in no compatibility impacts on land used for agriculture during operations.

Developed Land. The presence of buried oil pipeline in developed areas would partially limit residential, commercial, and industrial development in these areas during operation because no structures would be permitted over the permanent right-of-way. However, only a small amount of land is zoned as developed (approximately 158 acres) within the permanent right-of-way, and land outside the permanent right-of-way would be available for development. The loss of a 50-foot-wide permanent right-of-way corridor to residential, commercial, and industrial development would represent a minor permanent impact on developed land use.

Forested Land. Forested land may also fall under the public/municipal zone, especially for areas of state or national forests. Operation of RA-03AM would be least compatible with preservation of forested land because trees would not be permitted in the permanent right-of-way. The loss of approximately 471 acres of forest land from clearing trees would be a major permanent impact within the permanent right-of-way which would be maintained free of trees and woody vegetation.

Open Land. Open land may correspond most closely with the conservation/recreation zone type. Maintenance mowing of vegetation in the permanent right-of-way would be incompatible with goals of preserving undeveloped natural areas, but would be consistent with goals of providing public use of

open areas. For this analysis, the approximately 144 acres of open land that would be maintained during operations is considered to be a minor permanent impact, as these areas could continue to be used as open space after restoration is complete.

Open Water. Typically, the open water land use category is not a planned zone. From a planning and zoning perspective, pipeline operation in open water areas would be compatible with the open water land use category because open waters crossed by RA-03AM would remain in their current use, and there would be no impacts.

Wetlands. Wetlands would most closely correspond with the Shoreland zone in local comprehensive plans. During operations, because the pipeline would be buried beneath waterbodies and would generally not affect wetland functions, with the exception of the permanent right-of-way where trees and large woody vegetation would not be allowed to grow. Preservation of wetland vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation that would preserve other wetland functions such as water quality and bank stability. Operation of RA-03AM in wetland areas would be minor and long-term as wetlands would generally return to functionality. Wetlands are further discussed in Section 6.3.1.3.

Compatibility with Watershed District Goals

During operation of RA-03AM, the pipeline would be compatible with watershed district goals, including erosion control and water quality, for example. During operation of a pipeline, maintenance of vegetation in the permanent right-of-way in and around wetlands and waterbodies may result in minor impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water. Removal of large woody vegetation in and around waterbodies could reduce some of these benefits (and associated watershed district goals), and may reduce the scenic integrity of shoreland areas, although other vegetation would be retained that would provide many of these benefits. Generally, operation of an oil pipeline in wetland areas would be consistent with wetland land uses, resulting in minor temporary impacts.

Route Alternative RA-06

Construction Impacts

The types of land use impacts and the compatibility of pipeline construction within land use zones for RA-06 would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1-11.

Compatibility with Comprehensive Plans and Zoning Ordinances

Agriculture/Forestry. Impacts on agricultural land would consist of prevention of crops on agricultural land for one growing season in the construction work areas, after which the land would revert to agricultural use, resulting in minor temporary impacts. For forested land, impacts would be greater as trees cleared from construction work areas would take a long period of time (up to many decades in some cases) to regenerate to preexisting conditions, resulting in minor to major and long-term impacts on forestry land in construction workspace areas and major permanent impacts in the permanent right-of-way.

Residential. Impacts on 0.2 mile of land zoned as residential would be temporary for areas outside the permanent right-of-way because construction work areas would be restricted from development for a short period of time as construction moves through an area relatively quickly, after which these areas would be restored and no further restrictions on development would be in place. Areas within the permanent right-of-way would be permanently restricted from development, and this would subtract from the land available for residential use. The small amount of residential land crossed would leave adequate areas that could still be developed for residential use, resulting in minor and permanent impacts on land zoned as residential.

Industrial. Construction of a pipeline in industrial areas could lead to traffic interruptions that could disrupt access to the inflow of materials and the outflow of products for facilities in this zone. With implementation of the Applicant-proposed measures as described above for the Applicant's preferred route, impacts on land zoned for industrial use would be minor because of the amount of industrial land to be crossed (10 miles) and temporary because after construction areas outside the permanent right-of-way would not be restricted from development. Areas within the permanent right-of-way would be restricted from any development. This would be a minor impact because of the small amount of land affected, but it would be permanent as no development in the right-of-way would be permitted for the life of the Project.

Public/Municipal. Typically, this land is to be used for public benefit, and construction in land zoned for public or municipal use would temporarily cause minor to major disruptions of such uses. Public/municipal land is the largest zoning category crossed by RA-06 with approximately 63 miles crossed. For purposes of local government planning and zoning, the land would remain public; however, goals and impacts would vary across the different public land types and no development would be permitted in the permanent right-of-way. Impacts on specific public land types are discussed further in Section 6.3.6.

Conservation/Recreation. RA-06 would cross 0.8 mile of conservation/recreation-type zoning (see Table 6.2.1-11). The specific land is zoned open land in Aitkin County and is designated for areas of floodplains, swamp lands, and other areas unsuitable or unsafe for development. The use of the area as open land would be temporarily affected by construction activities such as clearing vegetation, grading the land, and trenching for placement of the pipe. These impacts would be minor and temporary. However, following construction and restoration, impacts would be negligible because the pipeline would be buried and would not affect surface use.

Shoreland. Construction in Shoreland zones would not meet the goal of limiting development near waterways, and RA-06 would cross approximately 1 mile of Shoreland zones in St. Louis and Carlton counties. Construction in the Shoreland zone would not meet the goal of limiting development near waterways, and removal of vegetation from the construction areas would be a minor temporary impact. Impacts on overlay districts are discussed further below.

Compatibility with Overlay Districts

Conditions that are placed on construction in shoreland areas may include maintenance of a buffer of vegetation between construction and the edge of waterbodies or other requirements to preserve vegetation and trees where possible. In areas where the pipeline would cross waterways, construction may require clearing trees and vegetation from the edge of the water, which is generally not compatible with the goals of shoreland overlay districts. A total of 137 surface waters would be crossed by RA-06 (see Section 6.3.1.2). As discussed further in Section 6.3.1.2, impacts on some waterbodies would be

reduced through the use of bore crossings and HDD crossings where vegetation buffers and streambanks could be left intact, as well as other Applicant-proposed measures. Generally construction in the shoreland area and across stream banks is not compatible with the goals of shoreland overlay districts and would be a minor permanent impact. Overall the impacts in shoreland areas would be minor because of the small amount of land along waterbodies that would be affected and although trees would not be allowed, other vegetation would be planted. The impacts would be permanent because trees and woody vegetation would not be allowed to regrow in the right-of-way. Impacts in shoreland areas are further discussed in Sections 6.3.1.2, 6.3.1.3, and 6.3.1.4.

Floodplain overlay districts are designated to reduce the quantity of development in floodplains and restrict the type of development in order to reduce losses from flooding and retain adequate area within a floodplain to carry floodwaters. Construction activities would temporarily alter floodplain topography but the uses of floodplains in floodplain overlay districts would not likely change as a result of pipeline construction, resulting in minor and temporary impacts. Floodplains are further discussed in Section 6.3.1.4.

Compatibility with Existing Land Use

Agricultural. Compatibility with agricultural land is discussed for the agriculture/forestry zone above. The temporary removal of approximately 257 acres of land from agricultural production during construction would be a minor temporary impact because agricultural land would lose one growing season in the construction footprint, after which the land would be returned to agricultural land use.

Developed Land. As mentioned in the discussions above for residential, commercial, and industrial zones, construction activities in developed lands may be incompatible with existing uses in developed land. With implementation of the Applicant-proposed measures described for those zones, impacts from construction in developed areas would be temporary and minor because of the limited area that would be affected by construction (approximately 65 acres) and the short construction period; however, land in the permanent right-of-way would be restricted from future development, which would be a minor permanent impact.

Forested Land. Compatibility of RA-06 with forested land is discussed above for the agriculture/forestry zone. Forested land also may fall under the public/municipal zone type, especially for areas of state or national forests. Construction of RA-06 is generally not compatible with forested land because of the requirement to remove trees from construction work areas. The approximately 1,107 acres of forested land affected would be a major long-term impact for areas in the temporary construction areas and a major permanent impact for areas within the permanent right-of-way where trees would not be permitted to regrow.

Open Land. Open land may correspond most closely with the conservation/recreation zone type. Construction activities in open land would temporarily be incompatible with goals of preserving undeveloped natural areas or scenic resources and enhancing recreation opportunities. Construction of RA-06 in open land would temporarily disturb approximately 354 acres of open land until restoration is complete. This would be a minor temporary impact because of the small area that would be affected and after construction, open lands would be restored.

Open Water. Pipeline construction in open water areas would be compatible with this land use category. RA-06 would cross approximately 82 acres of open water during construction. During construction in waterways, minor temporary impacts could occur to surface waters from sedimentation

and potential spills of small quantities of hazardous materials used during construction, as discussed in Section 6.3.1.2. However, Applicant-proposed measures would be implemented to reduce such impacts, which would be temporary until construction is complete and the waterbody revegetated.

Wetlands. During construction of RA-06, construction activities in wetlands would not be compatible with preservation goals and would be a minor to major impact, which may be temporary or long-term. A total of approximately 996 acres of wetlands would be crossed during construction. After construction, wetlands in some cases would revert to their original state; however some wetlands, such as forested and scrub/shrub wetlands would be cleared of woody vegetation and would remain altered. Wetlands are discussed further in Section 6.3.1.3.

Compatibility with Watershed District Goals

During construction of a pipeline, removal of vegetation in construction work areas and working in and around wetlands and waterbodies may result in impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water.

Removal of vegetation in and around waterbodies during construction could result in impacts on water resources in watersheds that could affect watershed district goals of retaining good water quality by keeping banks stabilized and preventing erosion, and may reduce the scenic integrity of shoreland areas. The Applicant-proposed measures, including temporary erosion control measures and BMPs for waterbody crossings, would reduce construction impacts on water resources and help to meet the watershed districts' goals of conserving watershed functions and limiting impacts on water quality from development. With implementation of Applicant-proposed measures, pipeline construction would result in minor temporary impacts on waterbodies and watershed district goals.

Operations Impacts

The types of land use impacts and the compatibility of pipeline operations within land use zones for RA-06 would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1-11.

Compatibility with Comprehensive Plans and Zoning Ordinances

County and local comprehensive plans generally have long-term goals. While short-term impacts from construction may temporarily interrupt desired land uses, long-term effects of operation of the pipeline may represent greater impacts, as detailed below.

Agriculture/Forestry. Operation of an oil pipeline would be compatible with the goal of preserving agricultural land because farming would be permitted in the right-of-way after construction, resulting in no compatibility impacts on land zoned as agricultural during operations. The goal of preserving forested land would not be compatible with operation of the proposed Project, however, because no trees would be allowed within the permanent right-of-way, resulting in a loss of forested land and an impact that would be major and permanent.

Residential. The presence of buried oil pipeline in residential areas would partially limit development of residential land during operation as no structures would be permitted over the permanent right-of-way. However, land outside the permanent right-of-way would be available for such development. The loss of a 50-foot-wide, 0.2-mile-long, permanent right-of-way corridor to residential development would represent a minor permanent impact on residential land use from RA-06.

Industrial. The presence of buried oil pipeline would partially limit development of industrial land within the permanent right-of-way during operation because no structures would be permitted for development in this area. However, only a small amount of land is zoned as industrial (10 miles) within the permanent right-of-way, and land outside the permanent right-of-way would be available for industrial development. The loss of a 50-foot-wide permanent right-of-way corridor to industrial development would represent a minor permanent impact on industrial use.

Public/Municipal. RA-06 crosses approximately 63 miles of public/municipal land, all in Itasca County. The majority of land zoned for public/municipal use crossed by RA-06 is state forest land as discussed further in Section 6.3.6. The loss of forest from clearing trees would be a major permanent impact along the permanent right-of-way, which would be maintained free of trees and woody vegetation. For purposes of local government planning and zoning, the land would remain public. However, goals and impacts would vary across the different public land types; these are discussed further in Section 6.3.6. Other public uses may be permitted to resume after construction is complete.

Conservation/Recreation. Operation of RA-06 in areas zoned for conservation/recreation would be compatible with recreation in that the permanent right-of-way would be revegetated and would revert to its original use. The only conservation/recreation-zoned land that would be crossed by RA-06 would be in Aitkin County. The specific zone crossed in Aitkin County is the open land zone, and pipeline construction in open land is generally compatible as the pipeline would be buried and out of sight. Additionally, because of the small amount of land that would be affected (0.8 mile), RA-06 would lead to negligible impacts.

Shoreland. During operations, RA-06 would largely be compatible with shoreland goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions, with the exception of the permanent right-of-way at the water's edge where trees would not be allowed to grow along the banks. The goal of preserving vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation, which would preserve other goals of water quality and bank stability, for example. Operation of RA-06 in shoreland areas would be a minor permanent impact on shoreland goals.

Compatibility with Overlay Districts

RA-06 would largely be compatible with shoreland goals during operation since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions. Where the pipeline crosses waterbodies, the permanent right-of-way abutting the water's edge would be maintained clear of trees and large woody vegetation and the goal of preserving buffers and shade trees along waterbodies would be partially prevented. However, the permanent right-of-way would be planted with other vegetation which would preserve other goals of maintaining water quality and bank stability, for example. Impacts and mitigation associated with water resources are further discussed in Section 6.3.1. Operation of RA-06 in shoreland overlay districts would be a minor permanent impact on overlay district goals.

Because the pipeline would be buried underground and the ground cover conditions would be restored, the Project would be compatible with floodplain overlay requirements during operation. The buried pipeline would not be an obstruction in the floodplain and would not affect the water channel or flood levels.

Compatibility with Existing Land Use

During operation, the permanent footprint of RA-06 would cover approximately 107 acres of agricultural land, 461 acres of forested land, 415 acres of wetlands, 149 acres of open land, 26 acres of developed land, and 34 acres of open water. This analysis reviews the compatibility of the Project with these adjacent land uses during operation.

Agricultural. Operation of RA-06 would be compatible with the use of agricultural land because farming would occur in the right-of-way after construction, resulting in no compatibility impacts on land used for agriculture during operations.

Developed Land. The presence of buried oil pipeline in developed areas would partially limit residential, commercial, and industrial development in these areas during operation as no structures would be permitted over the permanent right-of-way. However, only a small amount of land is zoned as developed (approximately 26 acres) within the permanent right-of-way, and land outside the permanent right-of-way would be available for development. The loss of a 50-foot-wide permanent right-of-way corridor to residential, commercial, and industrial development would represent a minor permanent impact on developed land use.

Forested Land. Forested land also may fall under the Public/Municipal zone, especially for areas of state or national forests. Operation of RA-06 would be least compatible with preservation of forested land because trees would not be permitted in the permanent right-of-way. The loss of approximately 461 acres of forest land from clearing trees would be a major permanent impact along the permanent right-of-way which would be maintained free of trees and woody vegetation.

Open Land. Open land may correspond most closely with the Conservation/Recreation zone type. Maintenance vegetation mowing in the permanent right-of-way would be incompatible with goals of preserving undeveloped natural areas, but would be consistent with goals of providing public use of open areas. For this analysis, the approximately149 acres of open land that would be maintained during operations is considered to be a minor permanent impact as these areas could continue to be used as open space after restoration is complete.

Open Water. Typically the Open Water land use category is not a planned zone. From a planning and zoning perspective, pipeline operation in open water areas would be compatible with the open water land use category because open waters crossed by RA-06 would remain in their current use and there would be no impacts.

Wetlands. Wetlands would most closely correspond with the Shoreland zone in local comprehensive plans. During operations, because the pipeline would be buried beneath waterbodies and would generally not affect wetland functions, with the exception of the permanent right-of-way where trees and large woody vegetation would not be allowed to grow. Preservation of wetland vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation which would preserve other wetland functions such as water quality and bank stability. Operation of RA-06 in wetland areas would be minor and long-term as wetlands would generally return to functionality. Wetlands are further discussed in Section 6.3.1.3.

Compatibility with Watershed District Goals

During operation of RA-06, the pipeline would be compatible with watershed district goals, including erosion control and water quality, for example. During operation of a pipeline, maintenance of vegetation in the permanent right-of-way in and around wetlands and waterbodies may result in minor impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water. Removal of large woody vegetation in and around waterbodies could reduce some of these benefits (and associated watershed district goals), and may reduce the scenic integrity of shoreland areas, although other vegetation would be retained which would provide many of these benefits. Generally, operation of an oil pipeline in wetland areas would be consistent with wetland land uses, resulting in minor temporary impacts.

Route Alternative RA-07

Construction Impacts

As noted above, RA-07 involves removal of the existing Line 3 and replacement in the existing trench, which is located entirely in the middle of the Enbridge Mainline corridor right-of-way. Enbridge has easements for the land in this corridor and past, current, and foreseeable future land use in this corridor is pipeline right-of-way. The 205-foot anticipated construction work area for this alternative would extend somewhat beyond the existing Mainline corridor, but impacts on land use/planning and zoning are expected to be temporary negligible as this construction activity would occur on the margin of the existing Mainline corridor.

Operations Impacts

RA-07 involves removal of the existing Line 3 and replacement in the existing trench, which is located entirely in the middle of the Enbridge Mainline corridor right-of-way. Enbridge has easements for the land in this corridor and past, current, and foreseeable future land use in this corridor is pipeline right-of-way. Continued use of this corridor would leave existing land-use in the corridor unchanged.

Route Alternative RA-08

Construction Impacts

The types of land use impacts and the compatibility of pipeline construction within land use zones for RA-08 would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1-11.

Compatibility with Comprehensive Plans and Zoning Ordinances

Agriculture/Forestry. Impacts on agricultural land would consist of prevention of crops on agricultural land for one growing season in the construction work areas, after which the land would revert to agricultural use, resulting in minor temporary impacts. For forested land, impacts would be greater as trees would be cleared from construction work areas would take a long period of time (up to many decades in some cases) to regenerate to preexisting conditions, resulting in minor to major and long-term impacts on forestry land in construction workspace areas and major permanent impacts in the permanent right-of-way.

Residential. Impacts on 7 miles of land zoned as residential would be temporary for areas outside the permanent right-of-way because construction work areas would be restricted from development for a short period of time as construction moves through an area relatively quickly, after which these areas

would be restored and no further restrictions on development would be in place. Areas within the permanent right-of-way would be permanently restricted from development and this would subtract from the land available for residential use. The small amount of residential land crossed would leave adequate areas that could still be developed for residential use, resulting in minor and permanent impacts on land zoned as residential.

Commercial. Construction near stores and businesses could temporarily interrupt commercial land uses by restricting access to businesses or parking areas, creating extra traffic in the area, and creating noise and dust nuisances. However, with implementation of the Applicant-proposed measures as described for the Applicant's preferred route, the impacts on commercial-zoned land from construction would be minor and temporary. Land in the permanent right-of-way would be permanently restricted from commercial development and would reduce the overall amount of commercial-zoned land available. Impacts would be minor because of the small amount of commercial land to be crossed (0.7 mile) and the reduction of impacts from the Applicant-proposed measures. Impacts would be permanent because after construction the land within the permanent right-of-way would be restricted from development for the life of the Project.

Industrial. Construction of a pipeline in industrial areas could lead to traffic interruptions which could disrupt access to the inflow of materials and the outflow of products for facilities in this zone. With implementation of the Applicant-proposed measures as described for the Applicant's preferred route, impacts on land zoned for industrial use would be negligible to minor because of the small amount of industrial land to be crossed (1 acre) and temporary because after construction areas outside the permanent right-of-way would not be restricted from development. Areas within the permanent right-of-way would be restricted from any development. This would be a minor impact because of the small amount of land affected but it would be permanent as no development in the right-of-way would be permitted for the life of the Project.

Public/Municipal. This land is to be used for public benefit, and construction in land zoned for public or municipal use would temporarily minor to major disruptions of such uses. RA-08 would cross approximately 59 miles of Public/Municipal land in Cass and Itasca counties. For purposes of local government planning and zoning, the land would remain public; however, no development would be allowed in the permanent right-of-way and goals and impacts would vary across the different public land types. The various public land types crossed are discussed further in Section 6.3.6.

Conservation/Recreation. The use of this land use type would be temporarily affected by construction activities such as clearing vegetation, grading the land, and trenching for placement of the pipe. RA-08 would cross 0.3 mile of conservation/recreation-type zoning (see Table 6.2.1-11). The specific land is zoned "Conservation" in Beltrami County. The goals of conservation would not generally be compatible with a pipeline; however, the small amount of land that would be affected would make this a minor impact. Following construction and restoration impacts would be negligible because the pipeline would be buried and would not affect surface use.

Shoreland. Construction in Shoreland zones would not meet the goal of limiting development near waterways, and RA-08 would cross approximately 0.6 mile of Shoreland zones in Carlton County. Construction in the Shoreland zone would not meet the goal of limiting development near waterways, and removal of vegetation from the construction areas would be a minor temporary impact. Impacts on overlay districts are discussed further below.

Compatibility with Overlay Districts

Conditions that are placed on construction in shoreland areas may include maintenance of a buffer of vegetation between construction and the edge of waterbodies, or other requirements to preserve vegetation and trees where possible. In areas where the pipeline would cross waterways, construction may require clearing trees and vegetation from the edge of the water, which is generally not compatible with the goals of shoreland overlay districts. A total of 106 surface waters would be crossed by RA-08 (see Section 6.3.1.2). As discussed further in Section 6.3.1.2, impacts on some waterbodies would be reduced through the use of bore crossings and HDD crossings where vegetation buffers and streambanks could be left intact, as well as other Applicant-proposed measures. Generally, construction in the shoreland area and across stream banks is not compatible with the goals of shoreland overlay districts and would be a minor permanent impact. Overall the impacts in shoreland areas would be minor because of the small amount of land along waterbodies that would be affected and although trees would not be allowed, other vegetation would be planted. The impacts would be permanent because trees and woody vegetation would not be allowed to regrow in the right-of-way. Impacts in shoreland areas are further discussed in Sections 6.3.1.2, 6.3.1.3, and 6.3.1.4.

Floodplain overlay districts are designated to reduce the quantity of development in floodplains and restrict the type of development in order to reduce losses from flooding and retain adequate area within a floodplain to carry floodwaters. Construction activities would temporarily alter floodplain topography but the uses of floodplains in the floodplain overlay districts would not likely change as a result of pipeline construction, resulting in minor and temporary impacts. Floodplains are further discussed in Section 6.3.1.4.

Compatibility with Existing Land Use

Agricultural. Compatibility with agricultural land is discussed for the Agriculture/Forestry zone above. The temporary removal of approximately 336 acres of land from agricultural production during construction would be a minor temporary impact because agricultural land would lose a growing season in the construction footprint, after which the land would be returned to agricultural land use.

Developed Land. As mentioned in the discussions above for Residential, Commercial, and Industrial zones, construction activities in developed lands may be incompatible with existing uses in developed land. With implementation of the Applicant-proposed measures described for those zones, impacts from construction in developed areas would be temporary and minor because of the limited area that would be affected by construction (approximately 86 acres) and the short construction period; however, land in the permanent right-of-way would be restricted from future development which would be a minor permanent impact.

Forested Land. Compatibility of RA-08 with forested land is discussed above for the Agriculture/ Forestry zone. Forested land also may fall under the Public/Municipal zone, especially for areas of state or national forests. Construction of RA-08 is generally not compatible with forested land because of the requirement to remove trees from construction work areas. The approximately 773 acres of forested land affected would be a major long-term impact for areas in the temporary construction areas and a major permanent impact for areas within the permanent right-of-way where trees would not be permitted to regrow.

Open Land. Open land may correspond most closely with the Conservation/Recreation zone type. Construction activities in open land would temporarily be incompatible with goals of preserving undeveloped natural areas or scenic resources and enhancing recreation opportunities. Construction of

a pipeline in open land would temporarily disturb approximately 208 acres of open land until restoration is complete. This would be a minor temporary impact because of the small area that would be affected and after construction, open lands would be restored.

Open Water. Pipeline construction in open water areas would be compatible with this land use category. During construction in waterways, minor temporary impacts could occur to surface waters from sedimentation and potential spills of small quantities of hazardous materials used during construction, as discussed in Section 6.3.1.2. However, Applicant-proposed measures would be implemented to reduce such impacts which would be temporary, until construction is complete and the waterbody revegetated.

Wetlands. During construction of RA-08, construction activities in wetlands would not be compatible with preservation goals and would be a minor to major impact, which may be a temporary to long-term impact. After construction, the wetlands in some cases would revert to their original state; however some wetlands, such as forested and scrub/shrub wetlands would be cleared of woody vegetation and would remain altered. Wetlands are discussed further in Section 6.3.1.3.

Compatibility with Watershed District Goals

During construction of a pipeline, removal of vegetation in construction work areas and working in and around wetlands and waterbodies may result in impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water.

Removal of vegetation in and around waterbodies during construction could result in impacts on water resources in watersheds which could affect watershed district goals of retaining good water quality by keeping banks stabilized and preventing erosion, and may reduce the scenic integrity of shoreland areas. The Applicant-proposed measures outlined in Section 6.3.1.2, including temporary erosion control measures and BMPs for waterbody crossings would reduce construction impacts on water resources which would help to meet the watershed districts' goals of conserving watershed functions and limiting impacts on water quality from development. With implementation of Applicant-proposed measures, pipeline construction would result in minor temporary impacts on waterbodies and watershed district goals.

Operations Impacts

The types of land use impacts and the compatibility of pipeline operations within land use zones for RA-08 would be the same as those discussed above for the Applicant's preferred route. The difference would be in the amount of land that would be affected, as shown in Table 6.2.1.11.

Compatibility with Comprehensive Plans and Zoning Ordinances

County and local comprehensive plans generally have long-term goals. While short-term impacts from construction may temporarily interrupt desired land uses, long-term effects of operation of the pipeline may represent greater impacts, as detailed below.

Agriculture/Forestry. Operation of an oil pipeline would be compatible with the goal of preserving agricultural land because farming would be permitted in the right-of-way after construction, resulting in no compatibility impacts on land zoned as agricultural during operations. The goal of preserving forested land would not be compatible with operation of the proposed Project, however, as no trees would be allowed within the permanent right-of-way, resulting in a loss of forested land and an impact that would be minor to major and permanent.

Residential. The presence of buried oil pipeline in residential areas would partially limit development of residential land during operation as no structures would be permitted over the permanent right-of-way. However, land outside the permanent right-of-way would be available for such development. The loss of a 50-foot-wide permanent right-of-way corridor to residential development would represent a minor permanent impact on residential land use.

Commercial. The presence of buried oil pipeline would limit development of commercial land within the permanent right-of-way during operation as no structures would be permitted for development in this area. However, only a small amount of land is zoned as commercial (0.6 acre) within the permanent right-of-way, and land outside the permanent right-of-way would be available for commercial development. The loss of a 50-foot-wide permanent right-of-way corridor to commercial development would represent a minor permanent impact on commercial use.

Industrial. The presence of buried oil pipeline would partially limit development of Industrial land within the permanent right-of-way during operation as no structures would be permitted for development in this area. However, only a small amount of land is zoned as industrial (0.9 acre) within the permanent right-of-way, and land outside the permanent right-of-way would be available for industrial development. The loss of a 50-foot-wide permanent right-of-way corridor to industrial development would represent a minor permanent impact on commercial use.

Public/Municipal. The majority of land zoned for public/municipal use crossed by RA-08 is state forest land as described further in Section 6.3.6. The loss of forest from clearing trees would be a major permanent impact along the permanent right-of-way which would be maintained free of trees and woody vegetation. For purposes of local government planning and zoning, the land would remain public, however, goals and impacts would vary across the different public land types and these are discussed further in Section 6.3.6. Other public uses may be permitted to resume after construction is complete.

Conservation/Recreation. Operation of RA-08 in areas zoned for conservation/recreation would be compatible with recreation in that the permanent right-of-way would be revegetated and would revert to its original use. Land in this land use zone that is used for conservation purposes, however, would be periodically disturbed by maintenance mowing in the permanent right-of-way, but the small amount of land affected (0.3 mile) would result in negligible impacts.

Shoreland. During operations, RA-08 would largely be compatible with shoreland goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions, with the exception of the permanent right-of-way at the water's edge where trees would not be allowed to grow along the banks. The goal of preserving vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation which would preserve other goals of water quality and bank stability, for example. Operation of RA-08 in shoreland areas would be a minor permanent impact on shoreland goals.

Compatibility with Overlay Districts

RA-08 would largely be compatible with shoreland goals since the pipeline would be buried beneath waterbodies and would generally not affect shoreland functions. Where the pipeline crosses waterbodies, the permanent right-of-way abutting the water's edge would be maintained clear of trees and large woody vegetation and the goal of preserving buffers and shade trees along waterbodies would be partially prevented. However, the permanent right-of-way would be planted with other vegetation

which would preserve other goals of maintaining water quality and bank stability, for example. Impacts and mitigation associated with water resources are further discussed in Section 6.3.1. Operation of RA-08 in shoreland overlay districts would be a minor permanent impact on overlay district goals.

Because the pipeline would be buried underground and the ground cover conditions would be restored, the Project would be compatible with floodplain overlay requirements during operation. The buried pipeline would not be an obstruction in the floodplain and would not affect the water channel or flood levels.

Compatibility with Existing Land Use

During operation, the permanent footprint of RA-08 would cover approximately 141 acres of agricultural land, 320 acres of forested land, 405 acres of wetlands, 10 acres of open land, 35 acres of developed land, and 10 acres of open water. This analysis reviews the compatibility of the Project with these adjacent land uses during operation.

Agricultural. Operation of RA-08 would be compatible with the use of agricultural land because farming would occur in the right-of-way after construction, resulting in no compatibility impacts on land used for agriculture during operations.

Developed Land. The presence of buried oil pipeline in developed areas would partially limit residential, commercial, and industrial development in these areas during operation as no structures would be permitted over the permanent right-of-way. However, only a small amount of land is zoned as developed (approximately 35 acres) within the permanent right-of-way, and land outside the permanent right-of-way would be available for development. The loss of a 50-foot-wide permanent right-of-way corridor to residential, commercial, and industrial development would represent a minor permanent impact on developed land use.

Forested Land. Forested land also may fall under the Public/Municipal zone, especially for areas of state or national forests. Operation of RA-08 would be least compatible with preservation of forested land because trees would not be permitted in the permanent right-of-way. The loss of approximately 320 acres of forest land from clearing trees would be a major permanent impact along the permanent right-of-way which would be maintained free of trees and woody vegetation.

Open Land. Open land may correspond most closely with the Conservation/Recreation zone type. Maintenance vegetation mowing in the permanent right-of-way would be incompatible with goals of preserving undeveloped natural areas, but would be consistent with goals of providing public use of open areas. For this analysis, the approximately 87 acres of open land that would be maintained during operations is considered to be a minor permanent impact as these areas could continue to be used as open space after restoration is complete.

Open Water. Typically the Open Water land use category is not a planned zone. From a planning and zoning perspective, pipeline operation in open water areas would be compatible with the open water land use category because open waters crossed by RA-08 would remain in their current use, and there would be no impacts.

Wetlands. Wetlands would most closely correspond with the Shoreland zone in local comprehensive plans. During operations, because the pipeline would be buried beneath waterbodies and would generally not affect wetland functions, with the exception of the permanent right-of-way where trees

and large woody vegetation would not be allowed to grow. Preservation of wetland vegetation buffers and shade trees along waterbodies would be partially restricted in the permanent right-of-way in these areas. However, the right-of-way would be planted with other vegetation which would preserve other wetland functions such as water quality and bank stability. Operation of RA-08 in wetland areas would be minor and long-term as wetlands would generally return to functionality. Wetlands are further discussed in Section 6.3.1.3.

Compatibility with Watershed District Goals

During operation of RA-08, the pipeline would be compatible with watershed district goals, including erosion control and water quality, for example. During operation of a pipeline, maintenance of vegetation in the permanent right-of-way in and around wetlands and waterbodies may result in minor impacts on water resources in watersheds, as discussed further in Section 6.3.1. Vegetation in watershed areas acts to slow water runoff, stabilize banks, prevent erosion, and enhance scenic views from the water. Removal of large woody vegetation in and around waterbodies could reduce some of these benefits (and associated watershed district goals), and may reduce the scenic integrity of shoreland areas, although other vegetation would be retained which would provide many of these benefits. Generally, operation of an oil pipeline in wetland areas would be consistent with wetland land uses, resulting in minor temporary impacts.

6.2.1.4 Summary and Mitigation

6.2.1.4.1 Summary

Table 6.2.1-12 presents a summary of potential impacts related to compatibility with planning and zoning regulations and land use for the Applicant's preferred route and route alternatives between Clearbrook and Carlton. Review of the relevant comprehensive plans and zoning ordinances found that pipelines are not listed as an allowed use for any of the zones that would be crossed by the Applicant's preferred route or the route alternatives.

The length of Shoreland zone and watershed district crossed and acres of open water crossed are shown in Table 6.2.1-11, which gives an estimated relative area of concern for protection of resources. The Applicant's preferred route crosses the most miles of Shoreland zone at approximately 8 miles, and RA-08 crosses the least at 0.6 mile. RA-06 crosses the most miles of watershed districts (approximately 52 miles), and RA-08 crosses the least (approximately 13 miles). Although not considered an allowed use for any of the overlay plans considered (shorelands, floodplains, and watershed districts) potential pipeline effects on the overlay plan goals were found to be no impact or minor in all cases. Overall, the impacts in shoreland areas would be minor because of the small amount of land along waterbodies that would be affected and although trees would not be allowed, other vegetation would be planted. The impacts would be permanent because trees and woody vegetation would not be allowed to regrow in the right-of-way. Because the pipeline would be buried underground and the ground cover conditions would be restored, the Project would be compatible with floodplain overlay requirements during operation. The buried pipeline would not be an obstruction in the floodplain and would not affect the water channel or flood levels.

Effects of a pipeline on all other land use classifications were found to be no impact or minor and temporary to permanent impact.

Table 6.2.1-11 shows that forestry land use is the predominant designation for the Applicant's preferred route, RA-06, and RA-07; agricultural land is the predominant designation for RA-03AM; and wetlands is the predominant designation for RA-08. While agricultural use is typically compatible with the presence of a pipeline, forestry use is not. Forestry would be the most affected of any of the land use designations because some portion of the forested lands would be removed for construction and would remain cleared along the permanent right-of-way during operations. Major impacts are anticipated where land in forestry use/zoning would be cleared, based on the reduction in forestry use. The permanent right-of-way of the Applicant's preferred route crosses the largest amount of forested land during operation (631 acres). The least amount of forested land is crossed by the permanent right-of-way of RA-07 (242 acres). The remaining three route alternatives range from approximately 320 to 471 acres of forested land crossed.

6.2.1.4.2 Mitigation

Replanting appropriate tree species for restoration within forested areas cleared for construction to reduce the recovery time and prevent changes in watershed hydrology and runoff impacts that could alter stream geomorphology could mitigate the incompatibility with forest uses and zoning.

With implementation of Applicant-proposed measures related to sediment and erosion control, streambank restoration, and waterbody crossings, no further mitigation has been identified to minimize impacts related to planning and zoning.

Table 6.2.1-12. Summary of Potential Impacts related to Compatibility with Planning and Zoning Regulations and Land Use for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Compatibility with comprehensive plans and zoning ordinances	Temporary to permanent/ (negligible to minor) to major	Temporary to permanent/ (negligible to minor) to major	Temporary to permanent/ negligible to major	Temporary to permanent/ negligible to major	Temporary to permanent/ negligible to major
Compatibility with overlay districts	Temporary to permanent/ minor impacts	Temporary to permanent/ minor impacts	Temporary to permanent/ minor impacts	Temporary to permanent/ minor impacts	Temporary to permanent/ minor impacts
Compatibility with existing land use	Temporary to permanent/ minor to major impacts	Temporary to permanent/ minor to major impacts	Temporary to permanent/ minor to major impacts	Temporary to permanent/ minor to major impacts	Temporary to permanent/ minor to major impacts
Compatibility with watershed district goals	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts
Operations Impacts					
Compatibility with comprehensive plans and zoning ordinances	No impact to permanent/ major impacts	No impact to permanent/ major impacts	No impact to permanent/ major impacts	No impact to permanent/ major impacts	No impact to permanent/ major impacts
Compatibility with overlay districts	No impact to minor/ permanent impact	No impact to minor/ permanent impact	No impact to minor/ permanent impacts	No impact to minor/ permanent impacts	No impact to minor/ permanent impacts
Compatibility with existing land use	No impact to permanent/ major impacts	No impact to permanent/ major impacts	No impact to permanent/ major impacts	No impact to permanent/ major impacts	No impact to permanent/ major impacts
Compatibility with watershed district goals	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts

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6.2.2 Noise and Vibration

Occupants of residences, schools, churches, and hospitals/medical centers can be sensitive to changes in noise levels (referred to as "sensitive receptors"). The associated buildings also could be susceptible to vibration damage. Pipeline construction can temporarily increase nearby noise levels and cause ground-borne vibration over existing ambient levels at nearby receptors, and operation of pipeline pump stations can increase nearby noise levels over existing ambient levels.

The following analysis of impacts on sensitive resources from noise and vibration during construction and operation of the Applicant's preferred route and route alternatives considered the following:

- Exceedance of Minnesota Noise Standards for residential and other sensitive uses;
- Exceedance of Federal Transit Administration (FTA) noise impact criteria; and
- Exceedance of FTA construction vibration damage criteria for extremely susceptible buildings.

This section first describes the existing conditions for noise and vibration along the Applicant's preferred route and route alternatives where sensitive receptors could be affected by construction and operation. Next, the section evaluates the potential impacts on receptors sensitive to noise and buildings susceptible to vibration damage, and compares these impacts for each of the five routing options (the Applicant's preferred route, RA-03-AM, RA-06, RA-07, and RA-08). Chapter 10 addresses the noise impacts resulting from a crude oil release. An assessment of noise impacts on wildlife is included in Section 6.3.4.

For better understanding of this subject, noise and vibration terminologies and descriptors are included below.

Noise Terminology

Sound is mechanical energy transmitted by pressure waves in media such as air or water (FTA 2006). When the sound level becomes excessive, annoying, or unwanted, it is referred to as "noise." Noise may be continuous (constant noise at a steady level), steady (constant noise with a fluctuating level), impulsive (having a high peak of short duration), stationary (occurring from a fixed source), intermittent (at intervals of high and low levels), or transient (occurring at different levels).

Noise levels are quantified using decibels (dB), which are units of sound pressure. The A-weighted sound level, expressed as dBA, is an expression of the relative loudness of sounds in air as perceived by the human ear. Therefore, A-weighted sound levels are usually used to quantify audible sound and its effect on people (Environmental Protection Agency (EPA) 1978). On the dBA scale, normal conversation falls at about 60 to 65 dBA and sleep disturbance occurs at about 40 to 45 dBA.

Existing ambient noise levels, or background noise levels, are the sounds from natural and artificial sources at the receptors currently. The magnitude and frequency of background noise at any given location may vary considerably over the course of a day or night and throughout the year. The variations are caused in part by weather conditions, seasonal vegetative cover, and human activity. Two common measures used to relate the time-varying quality of environmental noise levels to known effects on people are the 24-hour equivalent sound level ($L_{eq(24)}$) and the day-night sound level (L_{dn}).

- The $L_{eq(24)}$ is the level of steady sound with the same total energy as the time-varying sound, averaged over a 24-hour period.
- The L_{dn} is the $L_{eq(24)}$ with 10 dBA added to the nighttime sound levels between the hours of 10:00 pm and 7:00 am to account for people's tendency to be more sensitive to sound during nighttime hours.

Where the nature of a new sound is similar to the ambient noise level, an increase of 3 dBA is barely detectable by the human ear and an increase of 5 dBA is considered clearly noticeable. Increases of 10 dBA are perceived as a doubling of noise (i.e., twice as loud). Table 6.2.2-1 provides examples of common activities and their associated noise levels in dBA. Table 6.2.2-2 contains examples of outdoor day-night noise levels.

Table 6.2.2-1. Common Activities and Associated Noise Levels

Activity	Noise Level (dBA)
Loud live band music	110
Truck 50 feet away	80
Gas lawnmower 100 feet away	70
Normal conversation indoors	60
Moderate rainfall on vegetation	50
Refrigerator	40
Bedroom at night	25

Source: Caltrans 2009.

dBA = A-weighted decibel(s).

Table 6.2.2-2. Examples of Outdoor Noise Levels for Various Land Uses

Outdoor Location	Noise Levels (L_{dn} in dBA)
Apartment next to freeway	88
Core commercial, heavier industry	75
Urban row housing on major avenue	68
Lighter industry	60
Wooded residential	51
Agricultural cropland	44
Rural residential	39
Open space (wetland, forest, open land, abandoned land)	35

Sources: Caswell and Jakus 1977; EPA 1978.

dBA = A-weighted decibel(s), L_{dn} = day-night sound level expressed in dBA.

Vibration Terminology

Ground-borne vibration consists of oscillating motion within the ground and is typically caused by construction activities such as blasting, pile driving, and operating heavy construction equipment. The effects of ground-borne vibration are typically no more than a nuisance; however, at extreme vibration levels, buildings can be damaged. Ground-borne vibration can be felt outdoors, but it is typically more of an annoyance to people when they are indoors (FTA 2006). This is because the associated effects of a shaking building are more noticeable indoors, where people tend to be moving less and thus are more likely to perceive vibration. Induced ground-borne noise is an effect of ground-borne vibration and occurs only indoors, because it is produced from noise radiated from the motion of the walls and floors of a room or the rattling of windows or dishes on shelves.

Two forms of vibration velocity are used to evaluate the effects of vibration. Peak particle velocity (PPV) is referred to as "vibration velocity amplitude", which is an instantaneous measure; vibration velocity decibels (VdB) are referred to as "vibration velocity level," which is an average measure typically calculated over a 1-second period. Table 6.2.2-3 shows common vibration sources with their associated estimated VdB and PPV at a relative distance from the source.

Table 6.2.2-3. Typical Levels of Ground-Borne Vibration Associated with Construction Activities

Vibration Source	Distance from the Source (feet)	Vibration Velocity Level (VdB)	Peak Particle Velocity (in/sec)
Pile driver (impact type)	25	104–112	0.644–1.518
Pile driver (sonic or vibratory type)	25	93–105	0.170–0.734
Large bulldozer	25	87	0.089
Caisson drilling	25	87	0.089
Jackhammer	25	79	0.035
Loaded trucks	25	86	0.076
Small bulldozer	25	58	0.003
Blasting	50	100	0.300[a]

Sources: FTA 2006; Lucca 2003.

Notes:

[a] Peak particle velocity measured at 50 feet distance from blast area and 4 pounds charge weight of explosive.

in/sec = inch(es) per second, VdB = vibration velocity decibels referenced to 1×10^{-6} in/sec.

6.2.2.1 Regulatory Context and Methodology

6.2.2.1.1 Regulatory Context

Minnesota regulates daytime (7:00 am to 10:00 pm) and nighttime (10:00 pm to 7:00 am) noise levels based on the land use activity at the location of the receiver (e.g., residential, commercial, or industrial land uses) (Minn. R. 7030.0040). These noise standards are expressed as a range of acceptable noise levels (dBA) within a 1-hour period: L_{50} is the noise level (dBA) that cannot be exceeded more than 50 percent of the time within 1 hour, while L_{10} is the dBA that cannot be exceeded more than 10 percent of the time within 1 hour. Table 6.2.2-4 describes Minnesota's applicable noise standards.

Table 6.2.2-4. Minnesota Noise Standards

Noise Area Classification	Daytime (dBA)		Nighttime (dBA)	
	L_{50}	L_{10}	L_{50}	L_{10}
Residential and other sensitive uses (e.g., educational, medical, cultural and designated recreational areas)	60	65	50	55
Non-residential uses (e.g., commercial areas, transportation facilities, and governmental services)	65	70	65	70
Non-residential uses (e.g., industrial/manufacturing areas, utilities, and highways/streets)	75	80	75	80

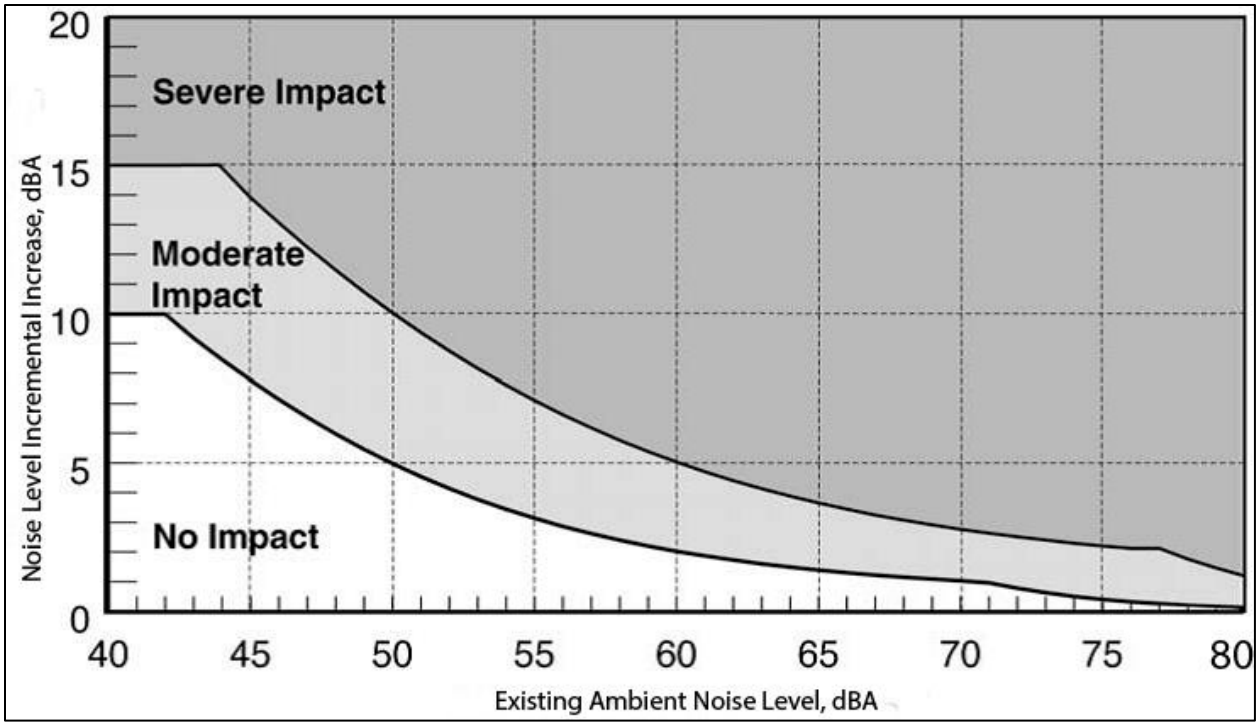
Source: Minnesota PCA 2000.

dBA = A-weighted decibel(s), L10 = the dBA that may be exceeded 10 percent of the time within 1 hour, L50 = the dBA that may be exceeded 50 percent of the time within 1 hour.

FTA regulations and criteria are not enforceable or otherwise directly applicable to a pipeline project. However, the FTA's noise impact criteria for combined noise increases (Figure 6.2.2-1) can be used to provide a qualitative description of long-term impacts from increases in ambient sound levels (i.e., the criteria are not suggested for use in defining short-term noise impacts that occur during construction). FTA impacts are categorized as no impact, moderate impact, or severe impact based on general community reactions to noise at varying levels. The criteria are based on the land use category of the receiving properties, including:

- Category 1 land uses are tracts of land where quiet is an essential element in their intended purpose and includes lands set aside for serenity and quiet, such as outdoor amphitheaters and concert pavilions, and National Historic Landmarks, where outdoor interpretation usually occurs.
- Category 2 land uses are residences and buildings where people normally sleep. For Category 2 receiving properties, the FTA criteria include consideration of the potential for sleep disturbance.
- Category 3 land uses are institutional land uses with primary daytime and evening uses, including schools, libraries, theaters, and churches. Certain historical sites and parks are also included.

Based on the FTA impact criteria, locations with low existing ambient noise levels can be exposed to greater incremental increases in overall noise before impacts would occur, and locations with higher existing ambient noise levels can be exposed to lesser incremental increases in overall noise before impacts would occur (Figure 6.2.2-1).



Source: FTA 2006.

Notes:

Noise level incremental increases should be calculated in terms of $L_{eq(h)}$ for Categories 1 and 3 land uses, and L_{dn} for Category 2 land uses, where $L_{eq(h)}$ is the hourly equivalent sound level.

dBA = A-weighted decibel(s).

Figure 6.2.2-1. Federal Transit Administration Impact Criteria for Combined Noise Level Increases

When assessing the effects of vibration, the FTA states that vibration should be assessed quantitatively in cases where there is a significant potential for impact from construction activities such as blasting, pile driving, vibratory compaction, demolition, and drilling or excavation in proximity to sensitive structures. The FTA construction vibration damage criteria are listed in Table 6.2.2-5.

Table 6.2.2-5. Construction Vibration Damage Criteria

Building Category	Vibration Velocity Level (VdB)	Peak Particle Velocity (in/sec)
Reinforced-concrete, steel or timber (no plaster)	102	0.500
Engineered concrete and masonry (no plaster)	98	0.300
Non-engineered timber and masonry buildings	94	0.200
Buildings extremely susceptible to vibration damage	90	0.120

Source: FTA 2006.

in/sec = inch(es) per second, VdB = vibration velocity decibels referenced to 1 × 10-6 in/sec.

6.2.2.1.2 Methodology

The ROI for the noise and vibration impacts analysis includes the sensitive receptors located near the proposed construction work areas that may be affected by noise from construction-related activities and equipment, and the sensitive receptors located near the proposed pump stations that may be affected by noise from pump station operations. Impacts on receptors sensitive to noise and buildings susceptible to vibration damage were assessed by:

- Using GIS data supplied by the Applicant and data available from the U.S. Geological Survey (USGS) National Structures Dataset to identify the locations of sensitive receptors and associated buildings near the Applicant's preferred route and route alternatives (Enbridge 2014; USGS ESRI 2014).
- Calculating noise levels generated by construction-related activities and equipment at various distances from the proposed construction work areas. Where the calculated noise levels could potentially exceed the Minnesota Noise Standards for residential and other sensitive uses, the number of potentially affected sensitive receptors was quantified.
- Calculating noise levels generated by operation of pump stations at the nearest sensitive receptors, and comparing results with the Minnesota Noise Standards for residential and other sensitive uses.
- Calculating the increased noise levels associated with operation of pump stations over the existing ambient levels at the nearest sensitive receptor locations, and comparing the results with the FTA impact criteria for Category 2 land uses.
- Calculating vibration levels generated by construction-related activities and equipment at the nearest sensitive receptor building locations. Where the calculated vibration levels would exceed the FTA construction vibration damage criteria for buildings that are extremely susceptible to vibration damage, the number of potentially affected sensitive receptors was quantified.

6.2.2.2 Existing Conditions

Sensitive receptors near the proposed construction work areas may be affected by both noise and vibration from construction-related activities and equipment, and sensitive receptors near the proposed pump stations may be affected by noise from operations. The existing ambient noise levels for these receptors along the alternative routes are described below.

6.2.2.2.1 Applicant's Preferred Route

The Applicant's preferred route within Minnesota would generally be co-located with existing pipelines or other linear infrastructure rights-of-way. Between Clearbrook and Carlton, the Applicant's preferred route would be 73 percent co-located. The land use along the Applicant's preferred route west of Clearbrook is primarily agricultural, while the land use east of Clearbrook is mainly forested land. Both of these land use types typically generate relatively low noise levels (Section 6.2.2.1). Existing ambient noise levels in areas that would be crossed by the Applicant's preferred route are estimated at 35 to 44 dBA L_{dn} (Table 6.2.2-2; EPA 1978). The estimated background vibration velocity level along the Applicant's preferred route is estimated at 52 VdB (representative of typical background vibration), which is below the threshold of perception for humans of approximately 65 VdB (FTA 2006).

Table 6.2.2-6 summarizes the existing ambient noise levels at the sensitive receptors nearest the pump stations for the Applicant's preferred route. These existing ambient (preconstruction) noise levels were determined by surveys completed by the Applicant (Enbridge 2016a). Because noise decreases with distance, the noise level at the nearest sensitive receptor to each of the proposed pump stations would experience the greatest impact.

Table 6.2.2-6. Sensitive Receptors and Existing Ambient Noise Levels near Proposed Pump Stations for the Applicant's Preferred Route in Minnesota

Pump Station	Distance from Pump Station to Nearest Sensitive Receptor (feet)	Existing Ambient Noise Level at Nearest Sensitive Receptor (dBA)
Donaldson	1,850	41.1
Plummer	1,350	38.2
Viking	2,550	34.9
Clearbrook	1,850	36.5
Two Inlets	1,000	38.6
Palisade	1,150	35.6
Backus	750	42.2
Cromwell	1,650	33.4

Source: Enbridge 2016a.
dBA = A-weighted decibel(s).

6.2.2.2.2 Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to noise and vibration for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Route alternative RA-03AM between Clearbrook and Carlton would be 95 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-03AM are primarily agricultural and forest, which typically generate relatively low noise levels. Since the land uses are similar to those along the Applicant's preferred route, the existing ambient noise and vibration levels were assumed to be within the same range (35 to 44 dBA L_{dn} and 52 VdB).

Based on the spacing of pump stations along the Applicant's preferred route, it was assumed that six pump stations would be required along the route of RA-03AM between Clearbrook and Carlton. However, the existing conditions near the six pump stations cannot be specified because the locations of pump stations for RA-03AM have not been determined.

Route Alternative RA-06

Route alternative RA-06 between Clearbrook and Carlton would primarily establish a new right-of-way corridor, with only 20 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-06 are primarily agricultural and forest, which typically generate relatively low

noise levels. Since the land uses are similar to those along the Applicant's preferred route, the existing ambient noise and vibration levels were assumed to be within the same range (35 to 44 dBA L_{dn} and 52 VdB).

Based on the spacing of pump stations along the Applicant's preferred route, it was assumed that four pump stations would be required along the route of RA-06 between Clearbrook and Carlton. However, the existing conditions near the four pump stations cannot be specified because the locations of pump stations for RA-06 have not been determined.

Route Alternative RA-07

Route alternative RA-07 between Clearbrook and Carlton would be 100 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-07 are primarily agricultural and forest, which typically generate relatively low noise levels. Since the land uses are similar to those along the Applicant's preferred route, the existing ambient noise and vibration levels were assumed to be within the same range (35 to 44 dBA L_{dn} and 52 VdB).

Based on the spacing of pump stations along the Applicant's preferred route, it was assumed that four pump stations would be required along the route of RA-07 between Clearbrook and Carlton. It was assumed that existing pump stations along the Enbridge Mainline corridor could be upgraded to accommodate new pumps for RA-07. However, which existing pump stations would be upgraded has not been determined. Thus, the existing conditions near the four existing pump stations cannot be specified.

Route Alternative RA-08

Route alternative RA-08 between Clearbrook and Carlton would be 100 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-08 are primarily agricultural and forest, which typically generate relatively low noise levels. Since the land uses are similar to those along the Applicant's preferred route, the existing ambient noise and vibration levels were assumed to be within the same range (35 to 44 dBA L_{dn} and 52 VdB).

Based on the spacing of pump stations along the Applicant's preferred route, four pump stations would be required along the route of RA-08 between Clearbrook and Carlton. It was assumed that existing pump stations along the Enbridge Mainline corridor could be upgraded to accommodate new pumps for RA-08. However, which existing pump stations would be upgraded has not been determined. Thus, the existing conditions near the four existing pump stations cannot be specified.

6.2.2.3 Impact Assessment

Project-related noise effects generally fall into two categories: temporary effects resulting from the use of construction equipment and activities, and permanent effects resulting from pump station operations. Vibration, as it relates to potential for building damage, would result primarily from construction equipment and activities, causing temporary effects.

Noise impacts from construction were determined for typical construction equipment, HDD, and blasting. Construction noise levels are temporary and are rarely steady; they fluctuate depending on the number and type of equipment in use at any given time. In addition, construction-related sound levels experienced at a sensitive receptor near the construction activity are a function of distance; other noise

sources; and the presence and extent of vegetation, structures, and intervening topography between the noise source and the sensitive receptor.

Pipeline construction generally proceeds several hundred feet to 1 mile per day. Because of the assembly-line method of construction, active pipeline construction in any one area would generally last from 1 week to 30 days. As a result, noise impacts on nearby sensitive receptors would typically be localized, intermittent, and temporary. Construction of associated facilities generally takes longer to complete, but noise impacts would still be expected to be localized, intermittent, and temporary. The nighttime noise levels normally would be unaffected because typical construction would be limited to daylight hours. For this analysis, noise impacts for typical construction equipment were calculated using noise levels generated by two bulldozers, two dump trucks, one generator, one front-end loader, two excavators, one light plant, and a drill rig (Federal Highway Administration (FHWA) 2006). This is a typical scenario for construction equipment that could be operating at roughly the same time and location during a construction phase.

Noise impacts from HDD and blasting also were considered. HDD is used to install the pipeline crossing under waterbodies and railroad tracks, and is typically a 24-hour-per-day operation. For this analysis, noise impacts were calculated using noise levels generated by HDD at the entry point and at the exit point, with equipment not operating concurrently at both locations. HDD equipment at the entry point includes one drill rig, one mud pump, one generator, one air compressor, one crane, one pump generator, and two excavators; HDD equipment at the exit point includes one mud pump, one generator, one pump generator, and two excavators (FHWA 2006). This is a typical scenario for the construction equipment that could be operating at roughly the same time and location.

Noise impacts produced during blasting would be instantaneous and would vary based on a number of factors, such as the type and amount of explosives used, distance of the receptor to the blast site, below-ground depth of explosives, and noise minimization measures applied. However, typical construction blasting noise levels have been documented at about 94 dBA at a distance of 50 feet (FHWA 2006).

Noise impacts from operation of the pipeline primarily would originate from the pump stations. Crude oil traveling through the buried pipeline would not be expected to emit audible noise above the surface or a perceptible level of vibration. Furthermore, noise and vibration levels from operation of the Clearbrook terminal would not be expected to increase beyond the existing levels, and noise and vibration levels from routine inspection and maintenance activities would not be expected to result in perceptible noise or vibration level increases at the nearest sensitive receptors.

6.2.2.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Noise levels for typical construction equipment at various distances from the construction work area were calculated and compared to the Minnesota Noise Standards. Typical construction noise attenuates to compliance levels with the daytime noise standards at 1,250 feet from the noise source. A total of 911 sensitive receptors are located less than 1,250 feet from the construction work area for the Applicant's preferred route and may experience noise at levels that exceed the daytime Minnesota Noise Standards, resulting in major temporary and intermittent impacts. Note that the calculations utilized an acoustical usage factor to estimate the fraction of time each piece of equipment is operating at full power (i.e., its loudest condition) during an hour to account for intermittent operation. Actual

noise levels and the resulting number of affected sensitive receptors may differ than those predicted if the number, type, and usage of equipment varies. The Applicant proposes to minimize typical construction-related noise impacts by limiting pipeline construction activities to daylight hours, maintaining equipment in good working order, limiting transportation to areas of active construction, and using manufacturer-supplied silencers when available (Enbridge 2016b). As explained in detail in Section 6.2.4, the Applicant also proposes to remove or re-locate any residence located within the permanent pipeline right-of-way.

For the Applicant's preferred route, HDD would be used at 21 locations, and blasting likely would be required between MP 354.6 and MP 356.6 (Enbridge 2016a, 2016b). The noise levels for HDD and blasting were calculated at 0.5 mile (2,640 feet) from the activity, and results were compared with the Minnesota Noise Standards. The noise from HDD attenuates to levels in compliance with the nighttime noise standards at 2,640 feet; therefore, a total of 81 sensitive receptors located less than 0.5 mile (2,640 feet) from an HDD site may experience noise at levels that exceed the standard, resulting in major intermittent and temporary impacts. Note that the calculations utilized an acoustical usage factor to estimate the fraction of time each piece of equipment is operating at full power (i.e., its loudest condition) during an hour to account for intermittent operation. Actual noise levels and the resulting number of affected sensitive receptors may differ than those predicted if the number, type, and usage of equipment varies. The Applicant proposes to limit noise impacts by maintaining equipment in good working order and using manufacturer-supplied silencers when available (Enbridge 2016b).

The Applicant anticipates the need for four blasting events, each covering 400 feet (Enbridge 2016a). In any 1 day, there would be only one blasting event (Enbridge 2016a). Three sensitive receptors are less than 0.5 mile (2,640 feet) from potential blasting locations. However, blasting would comply with the daytime noise standard at both 0.5 mile (2,640 feet) and 0.3 mile (1,758 feet), the distance of the nearest sensitive receptor, resulting in negligible, temporary impacts. Note that blasting also produces concussion waves within the lower inaudible frequency range of human hearing, which can cause annoyance to humans and damage to structures. The Applicant incorporated the lower frequencies into calculations, and results at the nearest sensitive receptor were below the value established by the U.S. Bureau of Mines for potential to cause damage to buildings (Enbridge 2016a). The Applicant would prepare a site-specific blasting plan to address safety, use, storage, and transportation of explosives. The plan would include public and agency notification protocols.

Table 6.2.2-7 compares vibration velocity impact levels from construction equipment and activities with the FTA vibration velocity damage criteria at the nearest sensitive receptor. Results indicate that vibration from HDD and blasting would not be above the damage criteria at any sensitive receptor. However, vibration from typical construction equipment could be above the damage criteria for sensitive receptors located within the construction work area, depending on their proximity to the source. As stated in Section 6.2.4, seven residences are within the construction work area for the Applicant's preferred route (excluding one residence located within the permanent right-of-way that would be removed or re-located). The exact placement of typical construction equipment within the construction work area is unknown. If construction equipment is operated less than 20 feet from sensitive receptors, calculations indicate that vibration from typical construction equipment could exceed FTA's damage criteria, resulting in major intermittent and temporary impacts.

Table 6.2.2-7. Construction Vibration Levels and Impacts for the Applicant's Preferred Route in Minnesota

Construction Activity	Distance to Nearest Sensitive Receptor[a] (feet)	Construction Vibration Velocity Level (VdB)	Vibration Velocity Level Damage Criteria[a] (VdB)	Construction Peak Particle Velocity (in/sec)	Peak Particle Velocity Damage Criteria[b] (in/sec)	Compliance with FTA Criteria
North Dakota Border to Clearbrook						
Typical construction equipment	95	69.6	90	0.012	0.120	Yes
Horizontal directional drilling	578	46.1		0.001		Yes
Blasting	--	--		--		--
Clearbrook to Carlton						
Typical construction equipment	20	89.9	90	0.120	0.120	Yes
Horizontal directional drilling	275	55.8		0.002		Yes
Blasting	1,758	53.6		0.001		Yes
Carlton to Wisconsin Border						
Typical construction equipment	89	70.5	90	0.013	0.120	Yes
Horizontal directional drilling	--	--		--		--
Blasting	--	--		--		--

Sources: FHWA 2006; FTA 2006.

Notes:

[a] Nearest sensitive receptor is the closest residence, school, church, and hospital/medical center. For typical construction equipment, distance is measured from the right-of-way centerline to the nearest receptor.

[b] Damage criteria selected for buildings extremely susceptible to vibration damage as worst-case assessment per Table 6.2.2-5.

FTA = Federal Transit Administration, in/sec = inch(es) per second, VdB = vibration velocity decibels referenced to 1×10^{-6} in/sec.

Operations Impacts

Table 6.2.2-8 identifies the noise levels at the closest sensitive receptor from operation of pump stations. Results indicate that all pump stations would produce noise levels at the nearest sensitive receptors in compliance with the more restrictive nighttime Minnesota Noise Standards resulting in negligible permanent impacts. The Applicant's design measures restrict the noise levels around neighboring dwellings and industrial facilities to 40 dBA, measured at a distance of 50 feet from the affected structure, unless state regulations allow higher noise levels. If noise is determined to be above the Minnesota Noise Standards, the Applicant would be required to implement design measures to come into compliance with those standards, such as placement of pumps and motors inside a building. Additional noise measures proposed by the Applicant may include insulation, acoustic louvers, and acoustic silencers. The Applicant also has committed to conducting post-construction noise surveys at each of the nearest sensitive receptors to ensure compliance with the Minnesota Noise Standards (Enbridge 2016b).

Table 6.2.2-8. Noise Levels and Impacts from Pump Station Operations for the Applicant's Preferred Route in Minnesota

Pump Station	Nearest Sensitive Receptor Distance (feet)	Existing Ambient Noise Level[a] (dBA)	Estimated Operations Noise (dBA)		Combined Noise, Ambient + Operations (dBA)		Increased Noise over Ambient Noise Level (dBA)	Minnesota Noise Standards[b] (dBA)		Compliance with Minnesota Noise Standards	FTA Impact Criteria
			L_{50}	L_{10}	L_{50}	L_{10}		L_{50}	L_{10}		
North Dakota Border to Clearbrook											
Donaldson	1,850	41.1	28.2	28.2	41.3	41.3	0.2	50	55	Yes	No impact
Plummer	900	38.2	35.1	35.1	39.9	39.9	1.7			Yes	No impact
Viking	2,900	34.9	23.5	23.5	35.2	35.2	0.3			Yes	No impact
Clearbrook to Carlton											
Clearbrook	2,950	36.5	23.1	23.1	36.7	36.7	0.2	50	55	Yes	No impact
Two Inlets	1,000	38.6	33.9	33.9	39.9	39.9	1.3			Yes	No impact
Palisade	1,250	35.6	31.8	31.8	37.1	37.1	1.5			Yes	No impact
Backus	750	42.2	37.0	37.0	43.3	43.3	1.1			Yes	No impact
Cromwell	1,650	33.4	29.3	29.3	34.8	34.8	1.4			Yes	No impact

Source: Enbridge 2016a.

Notes:

No pump stations would be located in the Carlton-to-Wisconsin-border segment.

[a] Existing ambient noise levels identified from Table 6.2.2-6.

[b] Nighttime noise standard selected as applicable to residential and other sensitive uses (e.g., educational, medical, cultural, and designated recreational areas) per Table 6.2.2-4.

dBA = A-weighted decibel(s), FTA = Federal Transit Administration, in/sec = inch(es) per second, L_{10} = the dBA that may be exceeded 10 percent of the time within 1 hour, L_{50} = the dBA that may be exceeded 50 percent of the time within 1 hour, VdB = vibration velocity decibels referenced to 1×10^{-6} in/sec.

Table 6.2.2-8 also shows the increase in noise levels at the closest sensitive receptor from operation of pump stations. Results are compared to the FTA impact criteria for combined noise level increases for Category 2 land uses (Figure 6.2.2-1) in order to assess the magnitude of predicted impacts. According to this analysis, the increases in noise at the nearest sensitive receptor from operation of each of the pump stations would result in no impact on sensitive receptors. "No impact" by FTA definition is when introduction of a proposed project would result in insignificant increases in the number of people highly annoyed by the new noise (FTA 2006). It should be noted that the FTA criteria are based on general community reactions to noise at varying levels and are used to supplement the analyses based on regulatory levels.

6.2.2.3.2 Route Alternatives (from Clearbrook to Carlton)

As calculated for the Applicant's preferred route, typical construction noise levels for route alternatives RA-03AM, RA-06, RA-07, and RA-08 would attenuate to compliance with the daytime Minnesota Noise Standards at 1,250 feet from the noise source. This distance is considered valid for all route alternatives because the same construction equipment would be used for each route. Table 6.2.2-9 shows the number of sensitive receptors along the Clearbrook-to-Carlton segment that may be affected by noise from the route alternatives. Note that the noise calculations utilized an acoustical usage factor to estimate the fraction of time each piece of equipment is operating at full power (i.e., its loudest condition) during an hour to account for intermittent operation. Actual noise levels and the resulting number of affected sensitive receptors may differ than those predicted if the number, type, and usage of equipment varies.

Table 6.2.2-9 also identifies the number of sensitive receptor associated buildings located within the construction work areas along the Clearbrook-to-Carlton segment that may be affected by vibration from the route alternatives. Although the exact placement of typical construction equipment within the construction work areas is unknown, calculations indicate that vibration from typical construction equipment operating less than 20 feet from noise-sensitive receptors may not comply with the FTA's damage criteria (Table 6.2.2-5).

The noise and vibration impacts generated during HDD installation and blasting along the route alternatives also are expected to be comparable to the noise and vibration levels of these activities along the Applicant's preferred route. Because the locations of any HDD or blasting activities along the route alternatives have not been determined, it is not possible to quantify the number of sensitive receptors that could be affected by these activities.

Table 6.2.2-9. Number of Sensitive Receptors Affected by Typical Construction Noise and Vibration for the Route Alternatives between Clearbrook and Carlton

Route	Number of Sensitive Receptors within 1,250 Feet of Construction Work Area (Noise)	Number of Sensitive Receptors within the Construction Work Area (Vibration)
Route alternative RA-03AM	1,507	13
Route alternative RA-06	328	2
Route alternative RA-07	1,271	40
Route alternative RA-08	749	6

Sources: Enbridge 2014; USGS ESRI 2014.

Notes:

The number of sensitive receptors within the construction work area excludes receptors located within the permanent right-of-way that would be removed or re-located.

The noise generated during HDD installation and blasting along the route alternatives is expected to be comparable to the noise of these activities along the Applicant's preferred route. Because the locations of any HDD or blasting activities along the route alternatives have not been determined, it is not possible to quantify the number of noise-sensitive receptors that could be affected by these activities.

Route Alternative RA-03AM

Construction Impacts

As indicated in Table 6.2.2-9, a total of 1,507 sensitive receptors are located less than 1,250 feet from the construction work area for RA-03AM and may experience noise from typical construction equipment at levels that exceed the daytime Minnesota Noise Standards, resulting in major intermittent and temporary impacts. The Applicant-proposed measures to minimize noise impacts during construction identified for the Applicant's preferred route also would be implemented for the route alternatives.

Vibration from typical construction equipment could be above the damage criteria for 13 sensitive receptors located within the construction work area for RA-03AM. If construction equipment is operated less than 20 feet from these sensitive receptors, calculations indicate that vibration could exceed FTA's damage criteria, resulting in major intermittent and temporary impacts.

Because the locations of any HDD or blasting activities along the route alternatives have not been determined, it is not possible to quantify the number of sensitive receptors that could be affected by noise or vibration from these activities.

Operations Impacts

The locations of pump stations along RA-03AM have not been determined; thus, the impacts for the nearest sensitive receptors affected by operation of pump stations cannot be quantified.

Route Alternative RA-06

Construction Impacts

As indicated in Table 6.2.2-9, 328 sensitive receptors are located less than 1,250 feet from the construction work area for RA-06 and may experience noise from typical construction equipment at levels that exceed the daytime Minnesota Noise Standards, resulting in major intermittent and temporary impacts. The Applicant-proposed measures to minimize noise impacts during construction identified for the Applicant's preferred route also would be implemented for the route alternatives.

Vibration from typical construction equipment could be above the damage criteria for two sensitive receptors located within the construction work area for RA-06. If construction equipment is operated less than 20 feet from these sensitive receptors, calculations indicate that vibration could exceed FTA's damage criteria, resulting in major intermittent and temporary impacts.

Because the locations of any HDD or blasting activities along the route alternatives have not been determined, it is not possible to quantify the number of sensitive receptors that could be affected by noise or vibration from these activities.

Operations Impacts

The locations of pump stations along RA-06 have not been determined; thus, the impacts for the nearest sensitive receptors affected by operation of pump stations cannot be quantified.

Route Alternative RA-07

Construction Impacts

As indicated in Table 6.2.2-9, 1,271 sensitive receptors are located less than 1,250 feet from the 205-foot-wide construction work area for RA-07 and may experience noise from typical construction equipment at levels that exceed the daytime standard, resulting in major intermittent and temporary impacts. The Applicant-proposed measures to minimize noise impacts during construction identified for the Applicant's preferred route also would be implemented for the route alternatives.

Vibration from typical construction equipment could be above the damage criteria for 40 sensitive receptors located within the construction work area for RA-07. If construction equipment is operated less than 20 feet from these sensitive receptors, calculations indicate that vibration could exceed FTA's damage criteria, resulting in major intermittent and temporary impacts.

Because the locations of any HDD or blasting activities along the route alternatives have not been determined, it is not possible to quantify the number of sensitive receptors that could be affected by noise or vibration from these activities.

Operations Impacts

The four pump stations along RA-07 that would be upgraded have not been identified; thus, the impacts for the nearest sensitive receptors affected by operation of pump stations cannot be quantified.

Route Alternative RA-08

Construction Impacts

As indicated in Table 6.2.2-9, 749 sensitive receptors are located less than 1,250 feet from the construction work area for RA-08 and may experience noise from typical construction equipment at levels that exceed the daytime standard, resulting in major intermittent and temporary impacts. The Applicant-proposed measures to minimize noise impacts during construction identified for the Applicant's preferred route also would be implemented for the route alternatives.

Vibration from typical construction equipment could be above the damage criteria for six sensitive receptors located within the construction work area for RA-08. If construction equipment is operated less than 20 feet from these sensitive receptors, calculations indicate that vibration could exceed FTA's damage criteria, resulting in major intermittent and temporary impacts.

Because the locations of any HDD or blasting activities along the route alternatives have not been determined, it is not possible to quantify the number of sensitive receptors that could be affected by noise or vibration from these activities.

Operations Impacts

The pump stations along RA-08 that would be upgraded have not been identified; thus, the impacts for the nearest sensitive receptors affected by operation of pump stations cannot be quantified.

6.2.2.4 Summary and Mitigation

Summary

The impacts associated with noise and vibration from construction and operation of the Applicant's preferred route and the route alternatives between Clearbrook and Carlton are summarized in Table 6.2.2-10.

Construction noise would be temporary and intermittent along the Applicant's preferred route and the route alternatives. As shown in Table 6.2.2-10, the fewest sensitive receptors are located within 1,250 feet of the construction work area for RA-06 that may be affected by typical construction equipment noise, followed closely by the Applicant's preferred route and RA-08; considerably greater numbers of sensitive receptors potentially would be affected by typical construction equipment noise associated with RA-03AM and RA-07. HDD and blasting locations have not been identified for the route alternatives; thus, their associated noise impacts on noise-sensitive receptors cannot be compared with those for the Applicant's preferred route.

Even with implementation of the Applicant-proposed measures and additional potential mitigation measures described below, it is possible for typical construction noise and noise from specialized construction methods (e.g., HDD), although intermittent and of short duration, to exceed Minnesota Noise Standards for some sensitive receptors along the Applicant's preferred route and route alternatives. Specifically, noise from construction for any route would depend on the number, type, and usage of the equipment and its distance to noise-sensitive receptors. The resulting impact would be negligible for those sensitive receptors located far from the noise source and major (although intermittent and temporary) for nearby sensitive receptors.

Table 6.2.2-10 also identifies the sensitive receptor associated buildings located within the construction work areas along the Applicant's preferred route and route alternatives. If typical construction equipment is operated less than 20 feet from the sensitive receptors, calculations indicate that vibration could exceed FTA's damage criteria, resulting in major intermittent and temporary impacts. With implementation of mitigation described below, construction-related vibration from typical construction would be minor to negligible for sensitive receptors along any route. HDD and blasting locations have not been identified for the route alternatives; thus, their associated vibration impacts cannot be compared with those for the Applicant's preferred route.

Because the location of potential new and upgraded pump stations have not been determined for the route alternatives, the associated impacts on the nearest sensitive receptors cannot be assessed and compared with those of the Applicant's preferred route. The Applicant-proposed measures for the Applicant's preferred route also would be implemented for the route alternatives. Consequently, noise from pump station operations, although permanent, is expected to be negligible for all routes and is not expected to result in noise levels above the Minnesota Noise Standards or to affect any noise-sensitive receptor for any route.

Mitigation

In addition to the Applicant-proposed measures described above, the Applicant can further mitigate noise impacts from typical construction equipment when less than 1,250 feet from a sensitive receptor, as presented by FTA (2006), as follows:

- Equipping construction equipment with residential-grade mufflers, and/or constructing noise barriers or walled enclosures between noisy activities or clusters of noisy equipment and sensitive receivers as much as practical.
- Siting equipment on the construction lot as far away from sensitive receivers as possible.
- Combining noisy operations to occur in the same time period. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately.
- Posting signage with contact phone number to notify sensitive receptors of pending and active construction.

The Applicant could mitigate potential vibration impacts by:

- Locating construction equipment at least 20 feet from a sensitive receptor.

Table 6.2.2-10. Summary of Potential Noise and Vibration Impacts for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Noise from typical construction equipment exceeding daytime Minnesota Noise Standards	Temporary and intermittent/major impacts • 524 sensitive receptors	Temporary and intermittent/major impacts • 1,507 sensitive receptors	Temporary and intermittent/major impacts • 328 sensitive receptors	Temporary and intermittent/major impacts • 1,271 sensitive receptors	Temporary and intermittent/major impacts • 749 sensitive receptors
Noise from HDD exceeding nighttime Minnesota Noise Standards	Temporary and intermittent/major impacts • 35 sensitive receptors	*HDD locations are not available for the route alternatives. Therefore, the number of affected sensitive receptors and resulting noise impacts cannot be quantified.*			
Noise from blasting exceeding daytime Minnesota Noise Standards	Temporary/negligible impacts • 0 sensitive receptors above standard	*Blasting locations are not available for the route alternatives. Therefore, the number of affected sensitive receptors and resulting noise impacts cannot be quantified.*			
Vibration from typical construction equipment exceeding FTA damage criteria	Temporary and intermittent/major impacts without mitigation • 5 sensitive receptors	Temporary and intermittent/major impacts without mitigation • 13 sensitive receptors	Temporary and intermittent/major impacts without mitigation • 2 sensitive receptors	Temporary and intermittent/major impacts without mitigation • 40 sensitive receptors	Temporary and intermittent/major impacts without mitigation • 6 sensitive receptors
Vibration from HDD and blasting exceeding FTA damage criteria	Temporary/negligible impacts • 0 sensitive receptors above criteria	*HDD and blasting locations are not available for the route alternatives. Therefore, the affected sensitive receptors and resulting vibration impacts cannot be quantified.*			

Table 6.2.2-10. Summary of Potential Noise and Vibration Impacts for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Operations Impacts		
Noise from pump stations exceeding nighttime Minnesota Noise Standards and FTA impact criteria	Permanent/negligible impacts • 0 sensitive receptors above standards and criteria	*New and upgraded pump station locations are not available for route alternatives. Therefore, the resulting noise impacts at the nearest sensitive receptors cannot be quantified.*

6.2.2.5 References

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6.2.3 Aesthetics/Visual Resources

The aesthetic or visual quality of the landscape is of importance as a resource to residents, tourists, and other users of a given area. The value of the resource varies with the type of land cover, topography, and availability of locations where a viewshed can be observed. Changes in the land cover (e.g., removal of forested areas or development) and introduction of man-made facilities (e.g., a pipeline and its associated facilities) into a viewshed may change the quality of the visual experience. Certain areas have higher sensitivity to changes in a viewshed. These include parks, forests, and other special management areas; Indian reservations; scenic byways, scenic rivers, and trails; and residences.

The analysis of impacts on aesthetics and visual resources from construction and operation of the Applicant's preferred route and the route alternatives considers the following issues:

- Removal of existing vegetation, grading, and the presence of construction workers and equipment in a viewshed;
- Presence of permanent aboveground facilities in a viewshed; and
- Maintenance clearing along rights-of-way and access roads.

This section describes the existing aesthetic/visual resources within an area along the construction work area for the Applicant's preferred route and each of the route alternatives where receptors (viewshed users) could be affected by construction and operation of the Project. The potential impacts of Project-related construction and operation on aesthetics and visual resources are considered, and potential impacts are assessed. Potential impacts for each route option (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08) also are assessed and compared to each other. A summary and comparison of potential impacts are included at the end of the section. Chapter 10 addresses impacts on aesthetics and visual resources resulting from crude oil releases.

6.2.3.1 Regulatory Context and Methodology

6.2.3.1.1 Regulatory Context

Aesthetic or visual resources were considered relative to the general guidance of Minnesota Statute 116D, which identifies the State's responsibility to "assure for all the people of the state safe, healthful, productive, and aesthetically and culturally pleasing surroundings." Specific regulations that define standards governing allowable effects on the quality of the visual environment have not been established in Minnesota. As discussed below, guidance on methodologies for undertaking such assessments are available.

6.2.3.1.2 Methodology

Guidance by the U.S. Forest Service (USFS) and the Service's Scenic Management System (SMS) was used as a basis for understanding the quality of, location of, and potential impacts on aesthetic resources. The SMS provides a framework for consistently evaluating and managing landscapes and thus maintaining aesthetically and culturally pleasing surroundings (USFS 1995). The SMS uses the following key elements when evaluating landscapes:

- **Scenic Attractiveness.** Scenic value can be divided into one of three classes based on whether landscapes are distinctive, typical, or indistinctive.

- **Scenic Integrity.** The scenic integrity of a landscape is ranked on a scale of very high to unacceptably low. The rank is determined based on the intactness of or degree of disruption to the landscape character.
- **Landscape Visibility.** The visibility of a landscape relates first to the importance of a landscape to the viewer and second to the distance between the viewer and the landscape.
- **Constituent Analysis.** The importance of landscapes to the constituents is expressed as a concern level of low to high.
- **Seen Areas and Distance Zones.** Distance zones of immediate foreground, foreground, middleground, and background are used to understand the relative sensitivity of a landscape based on its distance from the observer.

Through County Visual Quality committees, Minnesota has developed visual sensitivity classifications for highways, roads, designated recreation trails, lakes, and rivers in forested areas. These areas are collectively referred to as "travel routes and areas" for the purposes of this EIS. Visual sensitivity classes have been determined for 16 counties in northeast and central Minnesota (Minnesota DNR 2016b). The rating system consists of three classes: high scenic quality (*most sensitive*), moderate scenic quality (*moderately sensitive*), and low scenic quality (l*ess sensitive*). Similar to the USFS methods of analyzing visual resources, the ranking system used in Minnesota reflects the type and volume of users in determining sensitivity. For example, low-sensitivity areas may include public, low-volume local forest roads and non-recreational lakes and rivers. High sensitivity is given to travel routes and areas with significant public use and high user concern for visual resources (Minnesota DNR 2016b).

Impacts on aesthetics and visual resources and the alterations to viewsheds that may occur from construction and operation of the Applicant's preferred route and route alternatives were evaluated by:

- Following guidance by the USFS SMS framework described above for consistently evaluating landscapes.
- Identifying existing land use and the potential locations of sensitive viewers, using available GIS information. Data included the locations and distribution of forested areas, agricultural and open areas, scenic byways, special management areas, and Indian reservations. These data sets provide information about landscape visibility and the locations of sensitive areas, including areas of high use and areas of high viewer sensitivity. Special attention was given to Project areas that would cross through forested areas or be co-located with existing rights-of-way because those factors can greatly influence the magnitude of visual impacts.
- Using GIS to identify visual sensitivity classes (described above) for travel routes and areas crossed by the Applicant's preferred route and the route alternatives.
- Comparing the number of residences that occur within sensitive viewsheds near construction activities, permanent facilities, and landscape changes. Residences and residential areas represent areas where the importance of surrounding landscapes to the constituents, as well as the number of users, is likely to be moderate to high.

The ROI for this analysis includes all areas of high use and high user concern within the viewshed of a pipeline route or aboveground facilities. This can include parks, forests, and other special management areas; Indian reservations; scenic byways, scenic rivers, and trails; and the built environment. The "viewshed" was considered to be the immediate foreground (or 300 feet) from the edge of the

construction work area and within 0.25 mile of aboveground facilities. Given the land cover and topography of the area, viewers within the immediate foreground would represent the most sensitive viewers. For permanent aboveground facilities of any appreciable size, viewers within 0.25 mile would represent the most sensitive viewers.

6.2.3.2 Existing Conditions

6.2.3.2.1 Applicant's Preferred Route

The majority of land that would be crossed by the Applicant's preferred route is forested land, followed by agricultural land, wetlands, and open land. Approximately 82 percent of the Applicant's preferred route is co-located with existing rights-of-way, which are generally maintained in a cleared condition or may be in agricultural production. This includes 100 percent of the route from the North Dakota border to Clearbrook, 73 percent of the route from Clearbrook to Carlton, and 89 percent of the route from Carlton to the Wisconsin border. (Land use along the Applicant's preferred route and each of the route alternatives is described in detail in Section 6.2.1.3.2 [Table 6.2.1-11].)

The Applicant's preferred route would not cross any Indian reservation lands. The acreage of special management areas, including Wildlife Management Areas (WMAs) and state forests that would be crossed by the pipeline route, is provided in Table 6.2.3-1.

Table 6.2.3-1. Special Management Areas Crossed by the Applicant's Preferred Route in Minnesota

Route Segment	Special Management Area	Acres within Construction Work Area
North Dakota border to Clearbrook	None	0.0
Clearbrook to Carlton	Grayling Marsh Wildlife Management Area	14.1
	Lawler Wildlife Management Area	2.9
	Foot Hills State Forest	42.3
	Hill River State Forest	102.9
	Huntersville State Forest	96.9
	Land O'Lakes State Forest	130.2
	Mississippi Headwaters State Forest	25.1
	Paul Bunyan State Forest	<0.1
	Savanna State Forest	8.7
	Waukenabo State Forest	15.8
Carlton to Wisconsin border	None	0.0

Scenic byways are part of the National Scenic Byways Program under the U.S. Department of Transportation (USDOT) and the FHWA. Scenic byways are created to recognize archaeological, cultural, historic, natural, recreational, and scenic qualities. From the North Dakota border to Clearbrook, no scenic byways would be crossed. Between Clearbrook and Carlton, the Great River Road Scenic Byway

and Lake Country Scenic Byway each would be crossed twice. The Great River Road Scenic Byway is a multi-state scenic byway that follows the Mississippi River through Arkansas, Illinois, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Tennessee, and Wisconsin. The Great River Road Scenic Byway recognizes several historical developments, including the Underground Railroad, and offers numerous historic sites and cultural artifacts to travelers (FHWA 2016). From Carlton to Superior, the Project would cross the Veterans Memorial Scenic Byway once.

The Mississippi River, which is classified as a State Water Trail, would be crossed twice by the Applicant's preferred route. The Applicant's preferred route also would cross snowmobile and all-terrain vehicle trails, which often are found in scenic areas with potentially high use.

The visual sensitivity classification for travel routes and areas crossed by the Applicant's preferred route are provided in Table 6.2.3-2, and the number of residences that would be near construction and operation of the pipeline is provided in Table 6.2.3-3. Note that the USFS SMS defines the area within 300 feet of the observer as the immediate foreground (USFS 1995).

Table 6.2.3-2. Visual Sensitivity Classifications of Travel Routes and Areas Crossed by the Applicant's Preferred Route in Minnesota

Segment	Visual Sensitivity Classification			TOTAL
	Low	Moderate	High	
North Dakota border to Clearbrook[a]	0	1	8	**9**
Clearbrook to Carlton	23	21	95	**139**
Carlton to Wisconsin border	4	2	7	**13**

[a] A portion of the route would cross counties without complete visual sensitivity classifications.

Table 6.2.3-3. Residences near the Applicant's Preferred Route

Segment	Residences within Construction Work Area	Residences within 300 Feet of Construction Work Area[a]
North Dakota border to Clearbrook	0	30
Clearbrook to Carlton	6	78
Carlton to Wisconsin border	2	16

[a] Residences within 300 feet of the construction work area include those within the construction work area.

6.2.3.2.2 Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to aesthetics and visual resources for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Route alternative RA-03AM would be 95 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-03AM are primarily agricultural and forested land. RA-03AM would not cross any Indian reservation lands. The acreage of special management areas, including national wildlife refuges (NWRs), WMAs, and state forests, that would be crossed by the RA-03AM route is provided in Table 6.2.3-4.

Table 6.2.3-4. Special Management Areas Crossed by Route Alternative RA-03AM

Special Management Area	Acres within Construction Work Area
Mississippi Headwaters State Forest	25.7
Crane Meadows National Wildlife Refuge	25.4
Neitermeier Wildlife Management Area	5.4
Lake Alexander Woods Scientific and Natural Area	1.0

The following scenic byways would be crossed by RA-03AM:

- Great River Road Scenic Byway (two crossings),
- Lake Country Scenic Byway (two crossings), and
- St. Croix Scenic Byway (two crossings).

Several scenic rivers and water trails, including the Kettle River, Rum River, and Mississippi River, would be crossed by RA-03AM. This route would cross the Mississippi River multiple times, including once near Lake Itasca, considered the headwaters of the Mississippi, and again approximately 5 miles north of Little Falls, Minnesota (Minnesota DNR 2016a). The permanent right-of-way for RA-03AM would cross 6 miles of snowmobile and all-terrain vehicle trails, including crossing the Munger State Trail several times between Hinckley and Carlton, Minnesota.

RA-03AM would cross 177 travel routes and areas classified by Minnesota for visual sensitivity, including:

- 20 low visual sensitivity travel routes and areas,
- 19 medium visual sensitivity travel routes and areas, and
- 138 high visual sensitivity travel routes and areas.

Some travel routes and areas crossed by RA-03AM have not been classified for visual sensitivity.

Sixteen residences would be within the construction work area, and 368 residences would be within 300 feet of the construction work area.

Route Alternative RA-06

Route alternative RA-06 between Clearbrook and Carlton would primarily establish a new right-of-way corridor, with only 20 percent of the route co-located with existing pipelines or other linear

infrastructure rights-of-way. Land uses along RA-06 are primarily agricultural and forested land. The acreage of special management areas, including national and state forests, that would be crossed by the pipeline route is provided in Table 6.2.3-5.

Table 6.2.3-5. Special Management Areas Crossed by Route Alternative RA-06

Special Management Area	Acres within Construction Work Area
Chippewa National Forest	86.1
George Washington State Forest	458.1
Big Fork State Forest	294.4
Fond du Lac State Forest	36.5

RA-06 would cross 13 miles of the Fond du Lac Reservation, requiring approximately 79 acres for the permanent right-of-way and 189 acres for the construction work area.

RA-06 would require one crossing of the National Forest Avenue of Pines Scenic Byway and the Edge of the Wilderness Scenic Byway, which offer scenic natural views to travelers along with recreation and interpretive sites. RA-06 would not cross the Mississippi River but would cross the Big Fork River State Water Trail (Minnesota DNR 2016a). The permanent right-of-way for RA-06 would cross less than 1 mile of snowmobile and all-terrain vehicle trails, and would require approximately 2 miles of crossings to accommodate the construction work area.

RA-06 would cross 102 travel routes and areas classified by Minnesota for visual sensitivity, including:

- 22 low visual sensitivity travel routes and areas,
- 16 medium visual sensitivity travel routes and areas, and
- 46 high visual sensitivity travel routes and areas.

Nine residences would be within the construction work area, and 76 residences would be within 300 feet of the construction work area.

Route Alternative RA-07

Route alternative RA-07 would be 100 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-07 are primarily agricultural and forest land. The acreage of special management areas, in this case only state forests, that would be crossed by the pipeline route is provided in Table 6.2.3-6.

RA-07 would cross approximately 56 miles of Indian reservation land, requiring that approximately 338 acres be established as a permanent right-of-way and affecting approximately 1,383 acres during construction (Table 6.2.3-7).

Table 6.2.3-6. Special Management Areas Crossed by Route Alternative RA-07

Special Management Area	Acres within Construction Work Area
Bowstring State Forest	408.5
Fond du Lac State Forest	36.5
Mississippi Headwaters State Forest	77.3
Chippewa National Forest	87.7

Table 6.2.3-7. Indian Reservations Crossed by Route Alternative RA-07

Indian Reservation	Centerline (miles)	Acres within Permanent Right-of-Way	Acres within Construction Work Area
Fond du Lac Reservation	13.0	78.7	321.5
Leech Lake Reservation	42.7	258.8	1,061.0
TOTAL	**55.7**	**337.5**	**1,382.5**

RA-07 would require two crossings of the Great River Road Scenic Byway and one crossing of the Edge of the Wilderness Scenic Byway, which offer scenic natural views to travelers along with recreation and interpretive sites. RA-07 would cross the Mississippi River twice, once near Bemidji and again at Ball Club, approximately 20 miles west of Grand Rapids (Minnesota DNR 2016a). RA-07 also would cross the Paul Bunyan State Trail near Bemidji, the Heartland State Trail near Cass Lake, and the Taconite State Trail at the north end of Grand Rapids, Minnesota. The permanent right-of-way for RA-07 would cross approximately 3 miles of snowmobile and all-terrain vehicle trails during operation, and would require approximately 7 miles of crossings to accommodate the construction work area.

RA-07 would cross 144 travel routes and areas classified by Minnesota for visual sensitivity, including:

- 31 low visual sensitivity travel routes and areas,
- 27 medium visual sensitivity travel routes and areas, and
- 66 high visual sensitivity travel routes and areas.

Forty residences would be within the construction work area, and 237 residences would be within 300 feet of the construction work area.

Route Alternative RA-08

Route alternative RA-08 would be 100 percent co-located with existing pipelines or other linear infrastructure rights-of-way. Land uses along RA-08 are primarily agricultural and forested land. The acreage of special management areas, including WMAs and state forests, that would be crossed by the pipeline route is provided in Table 6.2.3-8.

Table 6.2.3-8. Special Management Areas Crossed by Route Alternative RA-08

Special Management Area	Acres within Construction Work Area
Chippewa National Forest	84.4
Bemidji Slough Wildlife Management Area	4.1
Swan River Deer Yard Wildlife Management Area	7.4
Bowstring State Forest	410.0
Fond du Lac State Forest	35.5
Mississippi Headwaters State Forest	68.2
Welsh Lake State Forest	15.4
Savanna State Forest	38.2

RA-08 would cross approximately 61 miles of Indian reservation land, requiring that approximately 339 acres be established as a permanent right-of-way and affecting approximately 813 acres during construction (Table 6.2.3-9).

Table 6.2.3-9. Indian Reservations Crossed by Route Alternative RA-08

Indian Reservation	Centerline (miles)	Acres within Permanent Right-of-Way	Acres within Construction Work Area
Fond du Lac Reservation	13.0	78.1	187.5
Leech Lake Reservation	48.0	260.8	625.7
TOTAL	**61**	**338.9**	**813.2**

RA-08 would require two crossings of the Great River Road Scenic Byway and one crossing of the Edge of the Wilderness Scenic Byway, which offer scenic natural views to travelers along with recreation and interpretive sites. RA-08 would cross the Mississippi River twice, once near Bemidji and again at Ball Club, approximately 20 miles west of Grand Rapids. RA-08 also would cross the Paul Bunyan State Trail near Bemidji, the Heartland State Trail near Cass Lake, and the Taconite State Trail at the north end of Grand Rapids, Minnesota (Minnesota DNR 2016a). The permanent right-of-way for RA-08 would cross 3 miles of snowmobile and all-terrain vehicle trails during operation, and would require approximately 11 miles of crossings to accommodate the construction work area.

RA-08 would cross 150 travel routes and areas classified by Minnesota for visual sensitivity, including:

- 28 low visual sensitivity travel routes and areas,
- 25 medium visual sensitivity travel routes and areas, and
- 75 high visual sensitivity travel routes and areas.

Nine residences would be within the construction work area, and 168 residences would be within 300 feet of the construction work area.

6.2.3.3 Impact Assessment

Potential impacts on aesthetic resources from construction and operation of the Project include impacts on landscape visibility, scenic integrity, and scenic attractiveness through visual scarring, removal of trees and vegetation, and construction activity. The extent and magnitude of these impacts are influenced by the existing scenic integrity, the landscape visibility, and the importance of a landscape to its observers. The duration of potential Project impacts on visual resources along the pipeline rights-of-way could range from a couple of days during active construction to permanent (e.g., aboveground facilities or a new cleared corridor through forested areas). During construction, the greatest impacts would be caused by clearing of vegetation, as well as the presence of workers and construction equipment. Operations impacts would be limited to the addition of aboveground facilities and changes in viewsheds, primarily because of cleared forested land.

6.2.3.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

The majority of the Applicant's preferred route would be located within or adjacent to existing rights-of-way, with a small portion of the route creating a new right-of-way. Consequently, the visual integrity along the co-located portions of the route has been previously affected by installation of similar linear infrastructure projects. Most new right-of-way would be established between Clearbrook and Carlton (approximately 60 miles, 27 percent of the route). Construction of the route would affect about 562 acres of agricultural land and 308 acres of open land, where views of construction equipment and personnel would be visible from longer distances. Impacts on visual resources associated with the construction work area include removal of existing vegetation, grading, and the presence of construction workers and equipment.

For the Applicant's preferred route, 1,447 acres of forested land would be cleared between Clearbrook and Carlton during construction. Cleared forested areas would alter the landscape integrity and viewed areas, particularly for viewers adjacent to or crossing the right-of-way. Trees outside the permanent right-of-way would be allowed to regrow; however, they would take decades to reestablish and may not return to preconstruction conditions during the life of the Project.

The Applicant's preferred route would not cross any Indian reservations and therefore would not result in visual impacts on reservations during construction. The route would require construction work areas located within special management areas; the greatest impact would be 131 acres of construction work area within the Land O'Lakes State Forest. The Mississippi River, which is classified as a State Water Trail, would be crossed twice.

In addition, the right-of-way would cross 95 travel routes and areas designated as having a high visual sensitivity (Table 6.2.3-4). These crossings may include scenic roads, trails, and rivers. The Applicant's preferred route would cross eight state forests, affecting a total of 439 acres of state forested land during construction. The construction work area would be within 300 feet of 124 residences, of which 78 residences are between Clearbrook and Carlton.

Overall, visual impacts would be greatest where the pipeline route crosses or parallels roads, trails, or residences. The duration of visual impacts would be short-term along the construction work area in or near open lands; special management areas; scenic byways, scenic rivers, and trails; and residences. Impacts would be minor because they would be limited to the period of construction until vegetation

has reestablished. In areas where trees would be cleared, visual impacts would be permanent and minor. The Applicant has reduced the extent of potential impacts by co-locating most of the Applicant's preferred route and route alternatives with existing rights-of-way.

Operations Impacts

Operations impacts for the Applicant's preferred route would be associated mainly with aboveground facilities and permanent forest clearing along the right-of-way and access roads. Cleared forested land outside the permanent right-of-way would be allowed to reestablish. Within the right-of-way, forests would remain permanently cleared, altering the landscape integrity and viewed areas and resulting in permanent minor impacts on viewsheds near the 631 acres of forested land maintained as a right-of-way. These impacts would be strongest where they are in the immediate foreground for sensitive observers. Permanent impacts on scenic integrity along the right-of-way are not expected in areas of open and agricultural land, where the vegetation along the right-of-way would be restored. The presence of permanent aboveground facilities near residences would cause a greater visual impact, whereas the presence of permanent aboveground facilities in open land may affect viewers from a greater distance. In partially cleared forested areas, the impacts would be limited to observers at pipeline crossings or residents in proximity to the permanent right-of-way; however, these impacts would be permanent. Residents with immediate foreground views of permanent aboveground facilities and cleared forested areas are a highly sensitive viewer group.

The Applicant's preferred route would require 8 pump stations and 27 mainline valves (MLVs). In general, impacts on scenic integrity from MLVs are expected to be minimal because of the scale of the MLV and small size of each site (typically less than 0.1 acre) and because they would be located within the permanent right-of-way. Pump stations would result in greater visual impact as they are typically much larger and contain several buildings, piping, and other large structures. Of the eight pump stations proposed for the Applicant's preferred route, four would be located between Clearbrook and Carlton. The Cromwell pump station would be constructed in open land, with little other development nearby. Two residences are within 0.3 mile of the proposed pump station, and direct views of the site are possible from both residences. This represents a permanent major impact on the viewshed of the residents. The Palisade pump station would be constructed in mainly forested land. The area surrounding the site is dominated by mature woody vegetation, creating a natural buffer to nearby residences and viewers. Both the Backus and Two Inlets pump stations would be constructed in open land. The Backus pump station would be constructed adjacent to a ranch and would be visible to its residents. The Two Inlets pump station would be within 0.2 mile of two residences, each with a partial view of the permanent structure. For each of these residences, this would be a permanent minor impact on the viewshed.

Of the remaining four pump stations located between the North Dakota border and Clearbrook, three would be upgrades to existing pump stations and one is an upgrade at the existing Clearbrook terminal. The additional buildings and structures associated with the upgrades would cause visual impacts, especially where placed apart from existing pump stations. Visual impacts associated with pump station upgrades would be less than those for new pump stations because of the presence of similar structures in nearby viewsheds. The Donaldson pump station upgrade would be located on open land with adjacent agricultural fields. Several agricultural outbuildings that are located nearby likely would have views of the Donaldson pump station upgrade. The closest residence is approximately 0.8 mile east and is somewhat shielded by vegetation, but the pump station addition may be visible from the property. This would result in a permanent negligible impact on the viewshed for residents. The Viking pump

station upgrade would be on agricultural land; the nearest residence is approximately 0.5 mile south of the pump station. Due to intervening agricultural fields, the Viking pump station upgrade likely would be visible from this residence. This would result in a permanent negligible impact on the viewshed for residents. Other nearby residences are farther away, and intervening vegetation would block views of the proposed pump station upgrade. The Plummer pump station upgrade would be constructed in mainly forested land. Two residences are located within 0.5 mile of the pump station upgrade, but the pump station would be visible only from one because of intervening vegetation. This could result in a permanent minor impact on the viewshed for residents. The Clearbrook pump station upgrade would be located approximately 0.3 mile southeast of the town of Clearbrook on partially agricultural, partially forested land. Forested land would block potential views from the town. Seven residences are located within 0.5 mile of the proposed pump station upgrade. Forested areas and other buildings would block views of the pump station from a majority of these residences. The proposed upgrade may be visible from one to three of the nearby residences, which would result in a permanent negligible to minor impact on the viewshed for nearby residents.

6.2.3.3.2 Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

The majority of RA-03AM (95 percent) would be located within or adjacent to existing rights-of-way, with a small portion of the route creating a new right-of-way. Consequently, the visual integrity along the co-located portions of the route has been previously affected by installation of similar linear infrastructure projects. Construction of the route would affect about 1,611 acres of agricultural land and 340 acres of open land, where views of construction equipment and personnel would be visible from longer distances. Impacts on visual resources associated with the construction work area include removal of existing vegetation, grading, and the presence of construction workers and equipment.

Construction of RA-03AM would require clearing 1,138 acres of forested land. Cleared forested areas would alter the landscape integrity and viewed areas, particularly for viewers adjacent to or crossing the right-of-way. Trees outside the permanent right-of-way would be allowed to regrow; however, they would take decades to reestablish and may not return to preconstruction conditions during the life of the Project.

RA-03AM would not cross any Indian reservations and therefore would not result in visual impacts on reservations during construction. Three scenic byways would be crossed by RA-03AM, as would scenic rivers and water trails, including the Kettle River, Rum River, and the Mississippi River, and snowmobile and all-terrain vehicle trails. The route would require construction work areas located within special management areas (although much less than for the Applicant's preferred route); the greatest impact would be 26 acres of construction work area within the Mississippi Headwaters State Forest.

RA-03AM would cross 93 travel routes and areas with a high visual sensitivity classification and would be located within 300 feet of 368 residences. The scenic attractiveness and scenic integrity in these areas of moderate to high constituent concern would be affected by the presence of construction equipment and clearing of vegetation in the construction work area.

Overall, visual impacts would be greatest where the pipeline route crosses or parallels roads, trails, or residences. Visual impacts along the construction work area in open lands; special management areas; scenic byways, scenic rivers, and trails; and residences would be temporary to short-term and minor as

impacts would be limited to the period of construction until vegetation has reestablished. In areas where trees would be cleared, visual impacts would be permanent and minor. Visual impacts would be minimized in areas where the pipeline construction occurs along existing rights-of-way, which are generally maintained in a cleared condition.

Operations Impacts

Similar to the operations impacts discussed for the Applicant's preferred route, permanent impacts on aesthetic resources for RA-03AM would include those from forest clearing and the presence of aboveground facilities. Cleared forested land outside the permanent right-of-way would be allowed to reestablish, which may require decades. Within the permanent right-of-way, forests would remain permanently cleared, altering the landscape integrity and viewed areas and resulting in permanent minor impacts on viewsheds near the 469 acres of forested land maintained as a right-of-way. Maintenance clearing in non-forested areas would occur throughout the life of the Project. Impacts from maintenance clearing would be temporary and negligible, as the work crews would be small and the cleared vegetation likely would be similar to the surrounding areas.

Given the spacing between the proposed pump stations for the Applicant's preferred route, it was assumed that RA-03AM would require six pump stations, which may result in more residences within the immediate foreground of pump stations. Pump stations typically are constructed in areas of agricultural or open land, away from residential and urban areas. As such, it is not likely that residences would be located within the immediate foreground of the pump stations, and impacts are expected to be permanent and negligible to minor.

Route Alternative RA-06

Construction Impacts

Only 20 percent of RA-06 route would be adjacent to existing rights-of-way; much of the route would require construction of new right-of-way. Construction of a new right-of-way would increase the magnitude of impacts on the viewshed, as it would necessitate additional grading, vegetation removal, and construction of facilities. Construction of the route would affect about 257 acres of agricultural land and 354 acres of open land, where views of construction equipment and personnel would be visible from longer distances. Impacts on visual resources associated within the construction work area include removal of existing vegetation, grading, and the presence of construction workers and equipment.

Construction of RA-06 would require clearing 1,107 acres of forested land. Cleared forested areas would alter the landscape integrity and viewed areas, particularly for viewers adjacent to or crossing the right-of-way. Trees outside the permanent right-of-way would be allowed to regrow; however, they would take decades to reestablish and may not return to preconstruction conditions during the life of the Project.

RA-06 would cross the Fond du Lac Reservation. Where facilities cross Indian reservations, tribal members often express a high concern level for landscapes within those reservations and in the areas outside the reservation that are ceded lands with tribal use rights for hunting, fishing, subsistence, and spiritual use. Chapter 9 addresses impacts on Indian reservations and tribal resources.

Two scenic byways would be crossed by RA-06. Although RA-06 would not cross the Mississippi River, it would cross the Big Fork River State Water Trail (Minnesota DNR 2016a). The greatest impact would be a total of 458 acres of construction work areas within the George Washington State Forest.

RA-06 would cross 46 travel routes and areas with a high visual sensitivity classification, and would be located within 300 feet of 76 residences. The scenic attractiveness and scenic integrity in these areas of moderate to high constituent concern would be affected by the presence of construction equipment and clearing of vegetation in the construction work area.

Overall, visual impacts would be greatest where the pipeline route crosses or parallels roads, trails, or residences. Visual impacts along the construction work area to open lands; special management areas; scenic byways, scenic rivers, and trails; and residences would be short-term and minor as impacts would be limited to the period of construction until vegetation has reestablished. In areas where trees would be cleared, visual impacts would be permanent and minor. Visual impacts would be less in areas where the pipeline construction occurs along existing rights-of-way, which are generally maintained in a cleared condition; however, RA-06 is co-located for only 20 percent of the route.

Operations Impacts

Similar to the operations impacts discussed for the Applicant's preferred route, permanent impacts on aesthetic resources for RA-06 would be primarily those from forest clearing and the presence of aboveground facilities. Cleared forested land outside the permanent right-of-way would be allowed to reestablish, which may require decades. Within the right-of-way, forests would remain permanently cleared, altering the landscape integrity and viewed areas, and resulting in permanent minor impacts on viewsheds near the 444 acres of forested land maintained as a right-of-way. Maintenance clearing in non-forested areas would occur throughout the life of the Project. Impacts from maintenance clearing would be temporary and negligible, as the work crews would be small and the cleared vegetation likely would be similar to the surrounding areas.

Given the spacing between the proposed pump stations for the Applicant's preferred route, it was assumed that RA-06 would require four pump stations. Pump stations typically are constructed in areas of agricultural or open land, away from residential and urban areas. As such, it is not likely that residences would be located within the immediate foreground of the pump stations, and impacts are expected to be permanent and negligible to minor.

Route Alternative RA-07

Construction Impacts

All of RA-07 would be located within and adjacent to existing rights-of-way. RA-07 would include removal and reinstallation of a pipeline in the same location as the existing Line 3 for a portion of the route and would require a slightly wider construction work area (205 feet). Since RA-07 involves replacement of the existing Line 3, most impacts would be within the existing permanent right-of-way. The remainder of the construction work area would be within the footprint of the former construction work area for Line 67, limiting the extent of impacts on aesthetic resources in the affected area. Impacts on visual resources associated with the construction work area include removal of existing vegetation, grading, and the presence of construction workers and equipment. Construction of the route would affect about 402 acres of agricultural land and 692 acres of open land, where views of construction equipment and personnel would be visible from longer distances.

Construction of RA-07 would require clearing 1,146 acres of forested land. Cleared forested areas would alter the landscape integrity and viewed areas, particularly for viewers adjacent to or crossing the right-of-way. Trees outside the permanent right-of-way would be allowed to regrow; however, they would

take decades to reestablish and may not return to preconstruction conditions during the life of the Project.

RA-07 construction would cross the Fond du Lac Reservation and the Leech Lake Reservation. Where facilities cross Indian reservations, tribal members often express a high concern level for landscapes within those reservations and in the areas outside the reservation that are ceded lands with tribal use rights for hunting, fishing, subsistence, and spiritual use. Chapter 9 addresses impacts on Indian reservations and tribal resources.

Because three scenic byways would be crossed, a greater portion of the landscape crossed by RA-07 may have high scenic attractiveness and a high constituent concern level. Construction, including grading and vegetation removal, likely would be visible from crossings with scenic byways, as well as from crossings with trails, rivers, and other visual resource areas. Vegetation clearing, grading, and the presence of construction workers and equipment would detract from scenic attractiveness and integrity at the locations of the crossings. Visual impacts associated with the presence of construction equipment and construction activities primarily would be limited to the construction period. Impacts from vegetation clearing during construction would largely be short-term and minor, except the forested land along the RA-07 route, where impacts would be long-term to permanent, but minor because any tree clearing would be along existing cleared rights-of-way.

Construction of RA-07 would cross 66 travel routes and other areas in high visual sensitivity areas, and 237 residences would be within 300 feet of the construction work area. Because of their proximity to the construction work area and the extended durations of their views, observers associated with these residences are considered highly sensitive to the nearby landscape impacts—including the presence of construction workers and equipment, removal of vegetation, and construction of aboveground facilities.

Overall, visual impacts would be greatest where the pipeline route crosses or parallels roads, trails, or residences. The duration of visual impacts would be short-term along the construction work area to open lands; special management areas; scenic byways, scenic rivers, and trails; and residences. Impacts would be minor because they would be limited to the period of construction until vegetation has reestablished. In areas where trees would be cleared, visual impacts would be permanent and minor. Visual impacts would be minimized because all pipeline construction for RA-07 would occur along existing rights-of-way, and all new tree clearing would result in only a widening of the existing right-of-way.

Operations Impacts

Similar to the operations impacts discussed for the Applicant's preferred route, permanent impacts on aesthetic resources for RA-07 would be primarily those from forest clearing and the presence of aboveground facilities. Cleared forested land outside the permanent right-of-way would be allowed to reestablish, which may require decades. Within the right-of-way, forests would remain permanently cleared, altering the landscape integrity and viewed areas, and resulting in permanent minor impacts on viewsheds near the 242 acres of forested land maintained as a right-of-way. Maintenance clearing in non-forested areas would occur throughout the life of the Project. Impacts from maintenance clearing would be temporary and negligible, as the work crews would be small and the cleared vegetation likely would be similar to the surrounding areas.

Given the spacing between the proposed pump stations for the Applicant's preferred route, it was assumed that RA-07 would require four pump stations. Pump stations typically are constructed in areas of agricultural or open land, away from residential and urban areas. As such, it is not likely that

residences would be located within the immediate foreground of the pump stations, and impacts are expected to be permanent and negligible to minor.

Route Alternative RA-08

Construction Impacts

All of RA-08 would be located within or adjacent to existing rights-of-way. Route alternative RA-08 would result in construction impacts mainly on wetlands and forested land. The primary visual impact would result from removal of existing vegetation, which would detract from scenic integrity and alter landscape visibility. Construction of the route would affect about 336 acres of agricultural land and 207 acres of open land, where views of construction equipment and personnel would be visible from longer distances. Construction of RA-08 would require clearing 1,798 acres of forested land. Cleared forested areas would alter the landscape integrity and viewed areas, particularly for viewers adjacent to or crossing the right-of-way. Trees outside the permanent right-of-way would be allowed to regrow; however, they would take decades to reestablish and may not return to preconstruction conditions during the life of the Project.

Construction of the RA-08 right-of-way would affect both the Fond du Lac Reservation and the Leech Lake Reservation. Where facilities cross Indian reservations, tribal members often express a high concern level for landscapes within those reservations and in the areas outside the reservation that are ceded lands with tribal use rights for hunting, fishing, subsistence, and spiritual use. Chapter 9 addresses impacts on Indian reservations and tribal resources.

Because of the proximity of the Mississippi River, RA-08 would cross the Great River Road Scenic Byway twice and would cross the Veterans Memorial Scenic Byway and the Edge of the Wilderness Scenic Byway. In the region of the Mississippi River between Bemidji and Grand Rapids, RA-08 would cross two different state trails.

The RA-08 route would cross 75 travel routes and areas in high visual sensitivity areas, and the construction work area would be within 300 feet of 168 residences. Because of their proximity to the construction work area and the extended durations of their views, observers associated with these residences are considered to be highly sensitive to the nearby landscape impacts—including the presence of construction workers and equipment, removal of vegetation, and construction of aboveground facilities. As a result of the three scenic byway crossings, a greater portion of the landscape crossed by RA-08 may have high scenic attractiveness and a high constituent concern level. Construction likely would be visible from crossings with scenic byways as well as crossings with trails, rivers, and other visual resource areas. Construction equipment and vegetation clearing would detract from scenic attractiveness and integrity at the locations of the crossings.

Overall, visual impacts would be greatest where the pipeline route crosses or parallels roads, trails, or residences. The duration of visual impacts would be short-term along the construction work area to open lands; special management areas; scenic byways, scenic rivers, and trails; and residences. Impacts would be minor as they would be limited to the period of construction until vegetation has reestablished. RA-08 would requiring clearing the greatest amount of forested land, where visual impacts would be permanent and minor. Visual impacts would be minimized because all pipeline construction would occur along existing rights-of-way, which are generally maintained in a cleared condition.

Operations Impacts

Similar to the operations impacts discussed for the Applicant's preferred route, permanent impacts on aesthetic resources for RA-08 would be limited to those from forest clearing and the presence of aboveground facilities. Cleared forested land outside the permanent right-of-way would be allowed to reestablish. Within the right-of-way, forests would remain permanently cleared, altering the landscape integrity and viewed areas, resulting in permanent minor impacts on viewsheds near the 320 acres of forested land maintained as a right-of-way. Maintenance clearing in non-forested areas would occur throughout the life of the Project. Impacts from maintenance clearing would be temporary and negligible, as the work crews would be small and the cleared vegetation likely would be similar to the surrounding areas.

Given the spacing between the proposed pump stations for the Applicant's preferred route, it was assumed that RA-08 would require four pump stations. Pump stations typically are constructed in areas of agricultural or open land, away from residential and urban areas. As such, it is not likely that residences would be located within the immediate foreground of the pump stations, and impacts are expected to be permanent and negligible to minor.

6.2.3.4 Summary and Mitigation

6.2.3.4.1 Summary

Impacts on aesthetic resources would vary among all routes, both in the magnitude and duration of impacts. Potential impacts on visual resources for the Applicant's preferred route and each of the route alternatives are summarized in Table 6.2.3-10. Impacts on visual resources along most of each route option would be minor and short-term, as vegetation regrowth would diminish the visibility of clearing and grading. However, certain areas have higher viewer concern and greater scenic attractiveness. These areas are associated with features such as residences, scenic byways, and special management areas. Construction of RA-03AM would affect the greatest amount of agricultural land and open land, where views of construction equipment and personnel would be visible from longer distances. The Applicant's preferred route and RA-03AM are the only routes that would not cross any Indian reservations.

All of the routes would cross scenic byways multiple times (Table 6.2.3-10). RA-03AM would cross four scenic byways and would cross three of the scenic byways twice. RA-03AM would cross the highest number of features in areas of high visual sensitivity. RA-06, although affecting the least amount of forested land compared to the other routes, would result in relatively larger impacts on aesthetic resources given the limited amount of the route that is co-located with existing rights-of-way and the number of visually sensitive resources that would be crossed (e.g., reservation lands and a national forest). RA-06 also would cross the least travel routes and areas with a high visual sensitivity classification and would cross the fewest special management areas. RA-03AM would cross more travel routes and areas with a high visual sensitivity classification and scenic byways, and more residences are located within both the construction work area and permanent right-of-way for RA-03AM. The Applicant's preferred route would cross the highest number of special management areas.

The impact on residences within the immediate foreground of the construction work area would be similar across routes, although the number of residences affected varies (Table 6.2.3-6). The fewest residences are located within 300 feet of the construction work area for the Applicant's preferred route and RA-06, while RA-03AM would have the most. Generally, construction impacts on visual resources would be temporary to short-term and minor, as impacts would be limited to the period of construction

until vegetation has reestablished. However, because of the proximity of some receptors—especially residences—to active construction in the immediate foreground, impacts during construction could be major for some observers.

During operation, aboveground facilities represent the biggest visual impact on residences. Several residences near the Cromwell and Two Inlets pump stations would have direct views of the pump station sites. Based on the assumptions described in Section 4.3, two additional pump stations would be needed along RA-03AM compared to the Applicant's preferred route and the other route alternatives. This could result in more residences within view of pump stations along RA-03AM, resulting in permanent impacts on their viewsheds.

6.2.3.4.2 Mitigation

To minimize impacts on residents and visitors with immediate foreground views of construction activities, identified mitigation measures could include:

- Require Enbridge to coordinate in advance with residents and building owners in the construction work area.
- Require Enbridge to complete construction in areas near residences as quickly as safely practical to minimize the duration of potentially major visual impacts on these receptors.

To minimize permanent aesthetic impacts on residents and visitors with views of pump stations, identified mitigation measures could include:

- Require Enbridge to develop a visual screening plan in order to minimize visual impacts on residents with views of the pump stations, regardless of the route option that is selected.

Table 6.2.3-10. Summary of Potential Impacts on Aesthetics and Visual Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Viewsheds with existing linear infrastructure, with lower visual sensitivity to removal of existing vegetation, grading, and presence of construction activities	73 percent co-location	95 percent co-location	20 percent co-location	100 percent co-location	100 percent co-location
Land types with larger viewsheds and higher sensitivity to removal of existing vegetation, grading, and presence of construction activities	Short-term/minor impacts • 562 acres of agricultural land • 308 acres of open land Permanent/minor impacts • 1,447 acres of forested land	Short-term/minor impacts • 1,611 acres of agricultural land • 340 acres of open land Permanent/minor impacts • 1,138 acres of forested land	Short-term/minor impacts • 257 acres of agricultural land • 354 acres of open land Permanent/minor impacts • 1,107 acres of forested land	Short-term/minor impacts • 402 acres of agricultural land • 692 acres of open land Permanent/minor impacts • 1,146 acres of forested land	Short-term/minor impacts • 336 acres of agricultural land • 207 acres of open land Permanent/minor impacts • 1,798 acres of forested land
Indian reservations affected by removal of existing vegetation, grading, and presence of construction activities	None crossed	None crossed	79 acres	337 acres	339 acres

Table 6.2.3-10. Summary of Potential Impacts on Aesthetics and Visual Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Special management areas and scenic areas with higher sensitivity to removal of existing vegetation, grading, and presence of construction activities	Short-term/minor impacts • 439 acres of special management areas • 4 scenic byway crossings • 2 scenic river/state river trail crossings • 1 mile of trail crossings	Short-term/minor impacts • 57 acres of special management areas • 6 scenic byway crossings • 4 scenic river/state river trail crossings • 6 miles of trail crossings	Short-term/minor impacts • 875 acres of special management areas • 2 scenic byway crossings • 2 scenic river/state river trail crossings • 1 mile of trail crossings	Short-term/minor impacts • 610 acres of special management areas • 3 scenic byway crossings • 3 scenic river/state river trail crossings • 3 miles of trail crossings	Short-term/minor impacts • 663 acres of special management areas • 3 scenic byway crossings • 3 scenic river/state river trail crossings • 3 miles of trail crossings
High visual sensitivity classification travel routes and areas affected by removal of existing vegetation, grading, and presence of construction activities	Short-term/minor impacts • 95 crossings	Short-term/minor impacts • 138 crossings	Short-term/minor impacts • 46 crossings	Short-term/minor impacts • 66 crossings	Short-term/minor impacts • 75 crossings
Residences affected by removal of existing vegetation, grading, and presence of construction activities	Short-term/minor impacts • 6 residences within the construction work area • 78 residences within 300 feet of construction work area	Short-term/minor impacts • 16 residences within the construction work area • 368 residences within 300 feet of construction work area	Short-term/minor impacts • 9 residences within the construction work area • 76 residences within 300 feet of construction work area	Short-term/minor impacts • 40 residences within the construction work area • 237 residences within 300 feet of construction work area	Short-term/minor impacts • 9 residences within the construction work area • 168 residences within 300 feet of construction work area
Operations Impacts					
Viewshed alteration from clearance of trees in forested areas to maintain the pipeline right-of-way	Permanent/minor impacts • 631 acres cleared	Permanent/minor impacts • 469 acres cleared	Permanent/minor impacts • 444 acres cleared	Permanent/minor impacts • 242 acres cleared	Permanent/minor impacts • 320 acres cleared

Table 6.2.3-10. Summary of Potential Impacts on Aesthetics and Visual Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Landscape and viewshed alteration from presence of mainline valves (MLVs)	Permanent/negligible impacts	*Locations of MLVs have not been determined for the route alternatives. Therefore, the affected areas and receptors affected cannot be quantified.* In general, impacts on scenic integrity from MLVs are expected to be minimal because of the scale of the MLV and small size of each site (typically less than 0.1 acre) and because they would be located within the permanent right-of-way.			
Landscape and viewshed alteration from presence of pump stations	Permanent/negligible to minor impacts, except for one pump station Permanent/major impacts • 2 residences (Cromwell pump station)	*Locations of pump stations have not been determined for the route alternatives. Therefore, the affected areas and receptors affected cannot be quantified.* Pump stations typically are constructed in areas of agricultural or open land, away from residential and urban areas. As such, it is not likely that residences would be located within the immediate foreground of the pump stations, and impacts are expected to be permanent and negligible to minor. If a pump station was located in proximity to a large number of residences, the permanent impacts would be minor to major. Given the spacing between the proposed pump stations for the Applicant's preferred route, it was assumed that RA-06, RA-07, and RA-08 would require four pump stations. RA-03AM would require six pump stations.			

6.2.3.5 References

Federal Highway Administration (FHWA). 2016. America's Byways: Minnesota. http://www.fhwa.dot.gov/byways/states/MN. Accessed on November 20, 2016.

Minnesota Department of Natural Resources (Minnesota DNR). 2016a. Minnesota State Trails. http://www.dnr.state.mn.us/state_trails/index.html. Accessed on November 26, 2016.

_____. 2016b. Visual Sensitivity Classifications. http://dnr.state.mn.us/forestry/visual_sensitivity/index.html. Accessed on November 27, 2016.

U.S. Forest Service (USFS). 1995. Landscape Aesthetics: A Handbook for Scenery Management. http://www.fs.fed.us/cdt/carrying_capacity/landscape_aesthetics_handbook_701_no_append.pdf. Accessed on November 27, 2016.

6.2.4 Housing

Some portions of the Applicant's preferred route and route alternatives would affect housing near the proposed pipeline. The analysis of impacts on housing during construction and operation of the Applicant's preferred route and the route alternatives considers the following issues:

- The availability of housing to meet increased demand from the non-local construction and operations workforce,
- Access limitations or safety concerns caused by construction or operation of the pipeline near residences, and
- Changes in property values of homes during construction or operation from the presence of a pipeline easement.

This section first describes the existing conditions within an area along the Applicant's preferred route and route alternatives where housing could be affected by construction and operation of the Project. Potential Project-related impacts of construction and operation on existing housing are then discussed and compared for each of the five routing options (Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08). Chapter 10 addresses the impacts on housing resulting from an unanticipated release of crude oil.

6.2.4.1 Regulatory Context and Methodology

6.2.4.1.1 Regulatory Context

The criteria considered by the Commission for route permit determination (Minn. R. 7852.1900, Subp. 3) includes consideration of human settlement and takes into account the State's goals to minimize human settlement and other land use conflicts (Minn. Stat. § 216E.03, Subp. 7). The availability of and impacts on housing stock are key components of human settlement.

6.2.4.1.2 Methodology

The analysis of impacts on housing during construction and operations of the Applicant's preferred route and the route alternatives considers housing availability, residence access and safety, and property values.

Housing Availability

Impacts on housing availability and the ability of communities to absorb the influx of workers that would be required for the Project were assessed. Impacts related to housing availability were evaluated by:

- Identifying existing housing availability in counties that would be crossed by the Applicant's preferred route and each of the route alternatives, including residential housing units and motel and hotel units;
- Comparing those results with an estimate of the potential demand for housing units created by the incoming workforce; and
- Assessing the magnitude of potential impacts based on the amount of available housing in each county relative to the expected demand, especially if availability was less than the expected demand.

The existing conditions for housing availability were determined from data on available housing rentals from the U.S. Census Bureau and commercial data on hotel and motel availability in Minnesota. Using these data, the total number of available housing units was estimated along each of the pipeline routes. Using estimates for the number of workers required for construction, a worst-case estimate of demand was calculated, assuming that all the workers would be from outside the area and would require local housing. If the available housing units were greater than the worst-case estimate for housing demand, housing was considered adequate and no impact would result. For operation and maintenance of the pipeline, it was assumed that workers would be located at the Applicant's regional maintenance facilities and operations centers.

The ROI for the analysis consisted of all counties crossed by the Applicant's preferred route and route alternatives. County-level data provide an approximation of housing availability in the areas crossed by the pipeline for purposes of this EIS. However, it should be noted that workers could commute from nearby counties that would not be crossed by the pipeline; and, in large counties, the available housing may be beyond a reasonable commuting distance. Because of the nature of pipeline work, many workers are used to commutes of an hour or more because the work location moves along the route as construction progresses.

Access and Safety

Impacts related to access and safety on residents near the construction work area were assessed. Access to residences may be affected if construction closes roads temporarily. This also may affect safety by limiting the access of emergency service vehicles and personnel to respond to an emergency. In addition, as the pipeline is being constructed, the open trench and construction area may represent a hazard for residents living nearby. Impacts related to access and safety during construction and operations were evaluated by:

- Overlaying the Applicant's preferred route and the route alternatives onto a GIS layer of residence locations;
- Identifying any residences or residential structures within the permanent right-of-way, within the construction work area, or within an area 50 feet outside of the construction work area for the Applicant's preferred route and each of the route alternatives, and
- Identifying permanent easements along the permanent right-of-way for operations and maintenance activities that would affect landowners.

The analysis used an ROI that extends 50 feet beyond the construction work area. While residences at farther distances could be affected by construction of the Project, those within 50 feet of the work area are likely to experience impacts more directly because of their proximity to construction work. Data used for the access and safety analysis were a combination of GIS datasets, including pipeline route layers provided by Enbridge and the USGS National Structures dataset. Because impacts on individual homes would be similar, the number of residences in proximity, and not necessarily their type, was reported for the analysis. A higher number of affected residences would result in a higher level of impact.

Property Values

Impacts on property values from construction and operation of the Applicant's preferred route and the route alternatives were assessed by:

- Estimating the existing residential property values using U.S. Census Bureau data for the median value of owner-occupied housing units at the county level, and
- Conducting a literature review of relevant studies of historical home sale data that were prepared to assess impacts on residential home values near pipelines or similar projects.

The ROI used for existing home values consisted of the counties crossed by the Applicant's preferred route and the route alternatives. Studies considered in the literature review included a range of properties up to 1 mile away from a permanent pipeline right-of-way.

6.2.4.2 Existing Conditions

6.2.4.2.1 Applicant's Preferred Route

U.S. Census Bureau data (2010, 2015) indicate that a total of 35,072 housing units and 672 vacant housing units were available to rent in the counties that would be crossed by the Applicant's preferred route between the North Dakota border and Clearbrook (Table 6.2.4-1). Between Clearbrook and Carlton, 118,732 total available housing units and 1,604 vacant housing units were available to rent in the counties crossed by the Applicant's preferred route. From Carlton to the North Dakota border, the Applicant's preferred route would be entirely within Carlton County, where 15,719 housing units and 2,177 vacant housing units were available to rent according to the U.S. Census Bureau (2010, 2015).

Several hotels and motels are located in the counties crossed by the Applicant's preferred route and route alternatives. There are 285 hotels and motels in the counties crossed by the Applicant's preferred route, including 256 between Clearbrook and Carlton. The average number of units per hotel or motel in Minnesota was 79 in 2016 (Explore Minnesota 2016). This equates to an estimated total of 20,224 individual rooms in the counties crossed by the Applicant's preferred route between Clearbrook and Carlton.

Eight homes are located within the proposed construction work area of the Applicant's preferred route, and 19 residences are located within 50 feet of the construction work area.

For the portion of the Applicant's preferred route between Clearbrook and Carlton, six residences are within the construction work area and an additional seven residences are within 50 feet of the construction work area. One residence is located in the permanent right-of-way and would require removal or re-location. Home values in counties along the Applicant's preferred route have a wide degree of variability. Table 6.2.4-1 lists the median value of owner-occupied housing units for the affected counties. The lowest median home value is $68,100 in Kittson County, while the highest median home value is $177,400 in Crow Wing County.

Table 6.2.4-1. Housing in Counties Crossed by the Applicant's Preferred Route in Minnesota

County	Total Housing Units[a]	Median Value of Owner-Occupied Housing Units[a]	Vacant Housing Units[a]	Rental Vacancy Rate[a]	Vacant Housing Units Available for Rent[b]	Hotels and Motels[c]
Minnesota	**2,364,149**	**$185,200**	**248,812**	**4.6%**	**48,091**	**2,175**
North Dakota Border to Clearbrook						
Kittson County	2,609	$68,100	692	6.6%	69	0
Marshall County	4,810	$90,500	738	8.3%	80	1
Pennington County	6,304	$113,400	482	7.4%	115	11
Red Lake County	1,960	$89,200	239	14.7%	47	2
Polk County	14,629	$130,500	1,987	3.6%	233	12
Clearwater County	4,760	$115,000	1,221	4.1%	128	3
Subtotal	***35,072***	***$101,117***	***5,359***	***7.5%***	***672***	***29***
Clearbrook to Carlton						
Hubbard County	14,578	$171,300	5,838	3.3%	158	43
Wadena County	6,925	$115,500	1,188	5.5%	127	16
Cass County	24,934	$172,800	12,058	4.2%	202	62
Crow Wing County	40,516	$177,400	13,862	3.9%	750	80
Aitkin County	16,060	$165,400	8,423	6.1%	161	12
Carlton County	15,719	$158,400	2,177	3.9%	206	14
Subtotal	***118,732***	***$160,133***	***43,546***	***4.5%***	***1,604***	***227***
TOTAL/AVERAGE	**153,804**	**$130,625**	**48,905**	**6.0%**	**2,276**	**256**

Notes:

The Clearbrook to Carlton section includes data up to the Wisconsin border.

[a] Source: U.S. Census Bureau, 2010–2014 American Community Survey.

[b] Source: U.S. Census Bureau, 2010 Census.

[c] Source: HotelMotels.info (2016).

6.2.4.2.2 Route Alternatives

Route alternatives RA-03AM, RA-06, RA-07, and RA-08 vary from the alignment of the Applicant's preferred route between the Clearbrook terminal and Carlton in Minnesota. Therefore, the existing conditions relevant to housing for each of the route alternatives are described only for the segment between Clearbrook and Carlton.

Route Alternative RA-03AM

According to the U.S. Census Bureau (2010, 2015), there are 120,028 housing units in the counties that would be crossed by RA-03AM between Clearbrook and Carlton, and 1,717 vacant housing units are

available to rent (Table 6.2.4-2). There are 135 hotels and motels located in the counties crossed by RA-03AM, with an estimated total of 10,665 rooms.

Sixteen homes are located within the proposed construction work area of RA-03AM, and an additional 39 residences are located within 50 feet of the construction work area. Three residences are located in the permanent right-of-way and would require removal or re-location, or an adjustment of the route centerline within the 750-foot route width to avoid the homes.

The median value values of owner-occupied housing units in counties along RA-03AM are listed in Table 6.2.4-2. The lowest median home value is $115,500 in Wadena County, and the highest median home value is $171,300 in Hubbard County.

Table 6.2.4-2. Housing in Counties Crossed by Route Alternative RA-03AM (Clearbrook to Carlton)

County	Total Housing Units[a]	Median Value of Owner-Occupied Housing Units[a]	Vacant Housing Units[a]	Rental Vacancy Rate[a]	Vacant Housing Units Available for Rent[b]	Hotels and Motels[c]
Hubbard County	14,578	$171,300	5,838	3.3%	158	43
Wadena County	6,925	$115,500	1,188	5.5%	127	16
Todd County	12,933	$129,700	2,982	7.8%	200	4
Morrison County	15,808	$152,200	2,314	2.3%	202	17
Benton County	16,273	$155,500	807	5.3%	445	1
Mille Lacs County	12,736	$141,900	2,487	4.7%	173	20
Kanabec County	7,810	$139,000	1,554	4.5%	97	3
Pine County	17,246	$141,600	5,630	4.1%	109	17
Carlton County	15,719	$158,400	2,177	3.9%	206	14
TOTAL/AVERAGE	**120,028**	**$145,011**	**24,977**	**4.6%**	**1,717**	**135**

[a] Source: U.S. Census Bureau, 2010–2014 American Community Survey.

[b] Source: U.S. Census Bureau, 2010 Census.

[c] Source: HotelMotels.info (2016).

Route Alternative RA-06

According to the U.S. Census Bureau (2010, 2015), there are 182,768 housing units in the counties that would be crossed by RA-06 between Clearbrook and Carlton, and 2,894 vacant housing units are available to rent (Table 6.2.4-3). There are 193 hotels and motels located in the counties crossed by RA-06, with an estimated total of 15,247 rooms.

Nine homes are located within the proposed construction work area of RA-06, and an additional eight residences are located within 50 feet of the construction work area. Seven residences are located in the permanent right-of-way and would require removal or re-location or an adjustment of the route centerline within the 750-foot route width to avoid the homes.

The median value values of owner-occupied housing units in counties along RA-06 are listed in Table 6.2.4-3. The lowest median home value is $137,200 in St. Louis County, and the highest median home value is $165,400 in Aitkin County.

Table 6.2.4-3. Housing in Counties Crossed by Route Alternative RA-06 (Clearbrook to Carlton)

County	Total Housing Units[a]	Median Value of Owner-Occupied Housing Units[a]	Vacant Housing Units[a]	Rental Vacancy Rate[a]	Vacant Housing Units Available for Rent[b]	Hotels and Motels[c]
Beltrami County	20,635	$147,200	3,842	7.8%	302	26
Itasca County	27,145	$152,000	8,324	5.4%	303	71
Aitkin County	16,060	$165,400	8,423	6.1%	161	12
St. Louis County	103,209	$137,200	18,176	3.8%	1,922	70
Carlton County	15,719	$158,400	2,177	3.9%	206	14
TOTAL/AVERAGE	**182,768**	**$152,040**	**40,942**	**5.4%**	**2,894**	**193**

[a] Source: U.S. Census Bureau, 2010–2014 American Community Survey.

[b] Source: U.S. Census Bureau, 2010 Census.

[c] Source: HotelMotels.info (2016).

Route Alternative RA-07

According to the U.S. Census Bureau (2010, 2015), there are a total of 222,280 housing units in the counties that would be crossed by RA-07 between Clearbrook and Carlton, and 3,254 vacant housing units are available to rent (Table 6.2.4-4). There are 298 hotels and motels located in the counties crossed by RA-07, with an estimated total of 23,542 rooms.

Forty homes are located within the proposed construction work area of RA-07, and an additional 16 residences are located within 50 feet of the construction work area. No residences would need to be removed from the permanent right-of-way.

The median value values of owner-occupied housing units in counties along RA-07 are listed in Table 6.2.4-4. The lowest median home value is $137,200 in St. Louis County, and the highest median home value is $172,800 in Cass County.

Table 6.2.4-4. Housing in Counties Crossed by Route Alternative RA-07 and RA-08 (Clearbrook to Carlton)

County	Total Housing Units[a]	Median Value of Owner-Occupied Housing Units[a]	Vacant Housing Units[a]	Rental Vacancy Rate[a]	Vacant Housing Units Available for Rent[b]	Hotels and Motels[c]
Beltrami County	20,635	$147,200	3,842	7.8%	302	26
Hubbard County	14,578	$171,300	5,838	3.3%	158	43
Cass County	24,934	$172,800	12,058	4.2%	202	62
Itasca County	27,145	$152,000	8,324	5.4%	303	71
Aitkin County	16,060	$165,400	8,423	6.1%	161	12
St. Louis County	103,209	$137,200	18,176	3.8%	1,922	70
Carlton County	15,719	$158,400	2,177	3.9%	206	14
TOTAL/AVERAGE	**222,280**	**$157,757**	**58,838**	**4.9%**	**3,254**	**298**

[a] Source: U.S. Census Bureau, 2010–2014 American Community Survey.

[b] Source: U.S. Census Bureau, 2010 Census.

[c] Source: HotelMotels.info (2016).

Route Alternative RA-08

Route alternative RA-08 would pass through the same counties as described above for RA-07 (Table 6.2.4-4); therefore, conditions for housing availability would be the same (222,280 total housing units; 3,254 housing units available to rent; and 298 hotels and motels, with an estimated total of 23,542 rooms).

Nine homes are located within the proposed construction work area of RA-08, and an additional 20 residences are located within 50 feet of the construction work area. Three residences would need to be removed or re-located from the permanent right-of-way or an adjustment of the route centerline within the 750-foot route width would need to be made to avoid these homes.

The median values of owner-occupied housing units in counties along RA-08 are listed in Table 6.2.4-4. The lowest median home value is $137,200 in St. Louis County, and the highest median home value is $172,800 in Cass County.

6.2.4.3 Impact Assessment

6.2.4.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Housing Availability

The Applicant estimates that the maximum total construction workforce would be approximately 4,200 workers across seven separate construction spreads in Minnesota, with each spread expected to total between 500 and 600 workers. It is likely that Enbridge would hire a portion of its workers from outside the counties through which the routes pass; however, to analyze the worst-case impacts it was assumed that all 4,200 workers would be non-local and would re-locate to the vicinity of the pipeline route during construction. In the counties crossed by the Applicant's preferred route, a total of 2,276 housing units (Table 6.2.4-1) are estimated to be vacant and available to rent, in addition to 256 hotels and motels (Table 6.2.4-1) with an estimated 20,224 rooms. If the entire workforce of 4,200 workers were to re-locate to the area, and assuming that they would occupy hotels and motels or rental units, they would use approximately 19 percent of the available temporary housing in these counties. Although some counties have limited temporary housing available (e.g., Kittson, Marshall, and Red Lake counties), adequate housing is available in surrounding counties, so workers could reasonably find housing in an area from which they could commute to the pipeline worksite.

The Applicant's preferred route between Clearbrook and Carlton would require four separate construction spreads. In the counties between Clearbrook and Carlton, approximately 11 percent of the available temporary housing would be required to accommodate a worst-case scenario of all four spreads with a maximum of 2,400 workers requiring housing at the same time. It is likely that only a single spread would be located in one county at any given time, reducing the number of workers that would need to find housing in the same area.

Impacts on housing availability during construction of the Applicant's preferred route would be temporary impacts limited to the construction period. These temporary impacts are expected to be minor given the relatively small percentage of available housing that would be required to accommodate workers even under a worst-case scenario.

Residential Access and Safety

During construction, access to residences may be restricted at times when the pipeline crosses driveways or other local roads. In some instances, construction would disturb the road surface to make room for construction equipment and the open trench. This could represent an inconvenience to local residents during the construction period. However, the construction period generally would be limited to a number of days at any one location.

The pipeline would cross paved roads by boring underneath the road or using HDD. These crossing methods prevent road closures by passing under the road without requiring disturbance to the road itself. Unpaved roads would be crossed using the open-cut method. Where road closures would occur, Enbridge would ensure emergency access for residences and neighborhoods at all times during construction and would coordinate construction schedules with affected homeowners. Detours with appropriate signage would be used where possible. When no detour is available, one lane would be kept open except for the brief period when the pipe is lowered into the trench. Fencing would be used in areas where the trench or construction site poses a risk to the public. Enbridge has indicated that they would complete all open-cut road crossings within 3 days. Given Enbridge's use of bore crossings and

HDDs across paved roads, as well as assurance that residences and emergency services would continue to have access on roads that are open cut, impacts related to residential access and safety would be temporary and minor for the 19 homeowners within 50 feet of construction (seven between Clearbrook and Carlton). For the eight residences within the construction work area (six between Clearbrook and Carlton), impacts may be more substantial because workers, construction equipment, and the pipeline trench would be in proximity to the residence, and use of the surrounding property would be limited. Therefore, residences within the construction work area would experience a temporary major impact related to safety and access.

Property Values

For homeowners who would be affected by construction, Enbridge would negotiate easements along the construction work area, which would address compensation for impacts resulting from construction of the pipeline and any hindrances created by the easement. Enbridge would be responsible for any construction-related damages and for returning affected property to its original condition to help maintain property value. Impacts on property values during construction would be temporary but could be major for homeowners attempting to sell their homes during construction.

Operations Impacts

Housing Availability

Operation and maintenance of the pipeline would require few additional workers, and those workers would be located at the Applicant's regional maintenance facilities and operations centers. Operations and maintenance would not require significant numbers of workers along the pipeline route and would not affect housing availability in the counties crossed by the Project.

Residential Access and Safety

During operation, the pipeline would be underground, and standard operations and maintenance would not pose any access or safety threats. Safety associated with accidental releases of crude oil is discussed in Chapter 10. Residential structures were identified within the permanent right-of-way for the Applicant's preferred route. Because no barns, homes, or other structures would be allowed within the permanent right-of-way, Enbridge would need to remove or re-locate those structures, as negotiated with the landowner. Enbridge has identified 18 structures within the permanent right-of-way that would need to be removed and has reached an agreement with each of the affected landowners. Because Enbridge has negotiated agreements with each of the landowners, no impacts on structures in the permanent right-of-way would occur.

For aboveground facilities, the Applicant's preferred route would require 27 MLVs, 4 new pump stations, and upgrades to 4 existing pump stations. Operation of the aboveground facilities would not affect an individual's ability to access their home; however, a landowner would no longer have access to the 0.1-acre MLV site on their property, which would be enclosed by a fence. Given the overall size of the parcel, this would be a minor but permanent impact related to access. The expanded area of existing pump stations and any new pump stations would be enclosed by a fence to exclude the public. Enbridge would purchase the pump station sites from the landowner to eliminate any landowner access issues.

Property Values

A review of relevant literature gave no conclusive evidence that an oil/gas pipeline and easement would negatively affect surrounding property values. A collection of studies are available characterizing impacts related to proximity to a hazardous or potentially hazardous site, proximity to oil and natural

gas pipelines, and oil pipeline ruptures. Table 6.2.4-5 summarizes the results of the literature review. Ultimately, the findings were inconclusive, disputed, or showed no relationship between pipeline easements and home values. Given the lack of a conclusive, quantitative relationship between property values and proximity to pipelines it is not possible to estimate the potential for impacts of operation of the Project on property values.

Table 6.2.4-5. Summary of Property Values Literature Review

Citation	Summary	Conclusions
Wilde et al. (2012)	A literature review by Gnarus Advisors on the effects of pipelines on property values. Published in the Journal of Real Estate Literature in 2012.	Gnarus Advisors found, "There is no credible evidence based on actual sales data that proximity to pipelines reduces property values."
Allen, Williford, & Seale (2001)	Study sponsored by the Interstate Natural Gas Association of America (INGAA) reviewed home sales in neighborhoods that were crossed by pipelines of various diameter.	The study found no evidence that the presence of a pipeline on a property significantly altered its sales price, and surrounding development was not impeded.
Fruits (2008)	Study on the impacts of the South Mist Pipeline Expansion on property values in Oregon. Included price modeling using over 10,000 property transactions within 1 mile of the pipeline.	The study found that the pipeline had "no statistically significant or economically significant relationship with residential property values."
PGP Valuation (2008)	Study conducted by PGP Valuation and released by Palomar Gas Transmission, LLC on the effects of the SMPE pipeline on property values in Oregon. Study used sales data for 18 properties that were affected by the pipeline right-of-way easements and compared them with sales of comparable unencumbered properties.	PGP Valuation concluded that natural gas pipelines had no measurable long-term impact on property values. The study also found that variations in short-term values were not substantial or were nonexistent, and that residential properties were not affected by the pipeline easement any more or less than other property types.
Diskin et al. (2011)	The study analyzed sales data from approximately 1,000 residential properties in Arizona to determine whether proximity to a natural gas pipeline affected real estate sales prices.	The study was unable to identify a systematic relationship between proximity to a pipeline and sales price or property value.
Integra Realty Resources (IRR) (2016)	INGAA released a study conducted by IRR on the impacts on property values of several natural gas transmission pipelines.	The study concluded that the presence of the pipeline had no measurable effect on sales prices and that the size of the pipeline had no effect on sales prices.
Simons et al. (2001)	The study reviewed the impacts on property values of an oil spill or release by looking at sales data in the immediate vicinity of an oil spill.	The study showed a negative impact on some properties for a limited time following the release.

6.2.4.3.2 Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

Route alternative RA-03AM is about 50 miles longer than the Applicant's preferred route between Clearbrook and Carlton; therefore, construction of the route may require an additional spread (a total of five spreads) in this segment. If the entire workforce were to re-locate to the area (a maximum of 3,000 workers), and assuming that they would occupy hotels and motels or rental units, they would use approximately 24 percent of the available temporary housing in the counties crossed by RA-03AM. Although some counties have limited temporary housing available (e.g., Benton County), adequate housing is available in surrounding counties, so workers could reasonably find housing in an area from which they could commute to the pipeline worksite. Additionally, it is likely that only a single spread would be located in one county at any given time, reducing the number of workers that would need to find housing in the same area. Impacts on housing availability during construction of RA-03AM would be temporary impacts limited to the construction period. These temporary impacts are expected to be minor given the relatively small percentage of available housing that would be required to accommodate workers even under a worst-case scenario.

During construction, access to residences may be restricted at times when the pipeline crosses driveways or other local roads. In some instances, construction would disturb the road surface to make room for construction equipment and the open trench. This could represent an inconvenience to local residents during construction of RA-03AM. Given Enbridge's use of bore crossings and HDDs across paved roads, as well as assurance that residences and emergency services would continue to have access on roads that are open cut, impacts related to residential access and safety would be temporary and minor for the 39 homeowners within 50 feet of construction. For the 16 residences within the construction work area, impacts may be more substantial because workers, construction equipment, and the pipeline trench would be in proximity to the residence, and use of the surrounding property would be limited. Therefore, residences within the construction work area would experience a temporary major impact related to safety and access.

For homeowners who would be affected by construction of RA-03AM, construction-related damages may affect property value unless repairs return the property to its previous condition. Impacts on property values during construction would be temporary but could be major for homeowners attempting to sell their homes during construction.

Operations Impacts

Operation of the pipeline would not require significant numbers of workers along RA-03AM and would not affect housing availability in the counties through which the route alternative passes.

Impacts associated with access and safety for RA-03AM during operation would be similar to those described for the Applicant's preferred route. The permanent right-of-way for RA-03AM would intersect three residences and Enbridge would need to remove or re-locate those structures, as negotiated with the landowner, or the centerline of the route would need to be adjusted within the 750-foot route width to avoid the homes. Removal of the structures represents a major permanent impact for those affected. During operation, the pipeline would be underground, and standard operations and maintenance would not pose any residential access or safety threats.

As described above, a review of relevant literature gave no conclusive evidence that an oil/gas pipeline and easement would affect surrounding property values. Given the lack of a conclusive, quantitative relationship between property values and proximity to pipelines it is not possible to estimate the potential for impacts of operation of RA-03AM on property values.

Route Alternative RA-06

Construction Impacts

Because RA-06 is similar in length to the Applicant's preferred route between Clearbrook and Carlton, it likely would require the same number of construction spreads (about four spreads, totaling a maximum of 2,400 workers). If the entire workforce were to re-locate to the area, and assuming that they would occupy hotels and motels or rental units, they would use approximately 13 percent of the available temporary housing in the affected counties. Additionally, it is likely that only a single spread (between 500 and 600 workers) would be located in one county at any given time, reducing the number of workers that would need to find housing in the same area. Impacts on housing availability during construction of RA-06 would be temporary impacts limited to the construction period. These temporary impacts are expected to be minor given the relatively small percentage of available housing that would be required to accommodate workers even under a worst-case scenario.

During construction, access to residences may be restricted at times when the pipeline crosses driveways or other local roads. In some instances, construction would disturb the road surface to make room for construction equipment and the open trench. This could represent an inconvenience to local residents during construction of RA-06. Given Enbridge's use of bore crossings and HDDs across paved roads, as well as assurance that residences and emergency services would continue to have access on roads that are open cut, impacts related to residential access and safety would be temporary and minor for the eight homeowners within 50 feet of construction. For the nine residences within the construction work area, impacts may be more substantial because workers, construction equipment, and the pipeline trench would be in proximity to the residence, and use of the surrounding property would be limited. Therefore, residences within the construction work area would experience a temporary major impact related to safety and access.

For homeowners who would be affected by construction of RA-06, construction-related damages may affect property value unless repairs return the property to its previous condition. Impacts on property values during construction would be temporary but could be major for homeowners attempting to sell their homes during construction.

Operations Impacts

Operation of the pipeline would not require significant numbers of workers along RA-06 and would not affect housing availability in the counties surrounding the Project.

Impacts associated with residential access and safety for RA-06 during operation would be similar to those described for the Applicant's preferred route. The permanent right-of-way for RA-06 would cross seven residences and Enbridge would need to remove or re-locate those structures, as negotiated with the landowner, or the centerline of the route would need to be adjusted within the 750-foot route width to avoid the homes. Removal of the structures represents a major, permanent impact for those affected. During operation, the pipeline would be underground, and standard operations and maintenance would not pose any residential access or safety threats.

As described above, a review of relevant literature gave no conclusive evidence that an oil/gas pipeline and easement would affect surrounding property values. Given the lack of a conclusive, quantitative relationship between property values and proximity to pipelines it is not possible to estimate the potential for impacts of operation of RA-06 on property values.

Route Alternative RA-07

Construction Impacts

Route alternative RA-07 is similar in length to the Applicant's preferred route between Clearbrook and Carlton. Therefore, it is likely to require the same number of construction spreads (about four totaling a maximum of 2,400 workers). Additional laborers may be needed to complete both the removal of the existing Line 3 and construction of the new Line 3. In addition, a longer construction period would be required to complete both removal and replacement, so laborers would be present, occupying housing in the affected counties for a longer period of time. If the entire workforce of 2,400 workers were to re-locate to the area, and assuming that they would occupy hotels and motels or rental units, they would use approximately 9 percent of the available temporary housing in the affected counties. Even if the required number of workers was doubled to address removal and replacement, less than 20 percent of the available housing would be occupied by these workers. Additionally, it is likely that only a single spread would be located in one county at any given time, reducing the number of workers that would need to find housing in the same area. Impacts on housing availability during construction of RA-07 would be temporary impacts limited to the construction period. These temporary impacts are expected to be minor given the relatively small percentage of available housing that would be required to accommodate workers, even under a worst-case scenario.

During construction, access to residences may be restricted at times when the pipeline crosses driveways or other local roads. In some instances, construction would disturb the road surface to make room for construction equipment and the open trench. This could represent an inconvenience to local residents during construction of RA-07, particularly given the extended construction time required to first remove the existing line and then put the new line in place. Given Enbridge's use of bore crossings and HDDs across paved roads, as well as assurance that residences and emergency services would continue to have access on roads that are open cut, impacts related to residential access and safety would be temporary and minor to major for the 16 homeowners within 50 feet of construction. For the 40 residences within the construction work area, impacts may be more substantial because workers, construction equipment, and the pipeline trench would be in proximity to the residence, and use of the surrounding property would be limited. Therefore, residences within the construction work area would experience a temporary minor to major impact related to safety and access.

For homeowners who would be affected by construction of RA-07, construction-related damages may affect property value unless repairs return the property to its previous condition. Impacts on property values during construction would be temporary but could be major for homeowners attempting to sell their homes during construction.

Operations Impacts

Operation of the pipeline would not require significant numbers of workers along RA-07 and would not affect housing availability in the counties surrounding the Project.

Impacts associated with access and safety for RA-07 during operation would be similar to those described for the Applicant's preferred route. Because the permanent right-of-way for RA-07 would not

intersect any residences, no impact from removal of homes and permanent structures or displacement of residents would occur. During operation, the pipeline would be underground, and standard operations and maintenance would not pose any residential access or safety threats.

As described above, a review of relevant literature gave no conclusive evidence that an oil/gas pipeline and easement would affect surrounding property values. Given the lack of a conclusive, quantitative relationship between property values and proximity to pipelines it is not possible to estimate the potential for impacts of operation of RA-07 on property values. If a relationship does exist between property values and proximity to pipelines, however, the location of RA-07, within the existing Mainline corridor would make it very unlikely that RA-07 would affect existing property values.

Route Alternative RA-08

Construction Impacts

Because RA-08 is similar in length to the Applicant's preferred route between Clearbrook and Carlton, it is likely to require the same number of construction spreads (about four spreads totaling a maximum of 2,400 workers). If the entire workforce were to re-locate to the area, and assuming that they would occupy hotels and motels or rental units, they would use approximately 9 percent of the available temporary housing in the affected counties. It is likely that only a single spread (between 500 and 600 workers) would be located in one county at any given time, reducing the number of workers that would need to find housing in the same area. Impacts on housing availability during construction of RA-08 would be temporary impacts limited to the construction period. These temporary impacts are expected to be minor given the relatively small percentage of available housing that would be required to accommodate workers even under a worst-case scenario.

During construction, access to residences may be restricted at times when the pipeline crosses driveways or other local roads. In some instances, construction would disturb the road surface to make room for construction equipment and the open trench. This could represent an inconvenience to local residents during construction of RA-08. Given Enbridge's use of bore crossings and HDDs across paved roads, as well as assurance that residences and emergency services would continue to have access on roads that are open cut, impacts related to residential access and safety would be temporary and minor for the 20 homeowners within 50 feet of construction. For the nine residences within the construction work area, impacts may be more substantial because workers, construction equipment, and the pipeline trench would be in proximity to the residence, and use of the surrounding property would be limited. Therefore, residences within the construction work area would experience a temporary major impact related to safety and access.

For homeowners who would be affected by construction of RA-08, construction-related damages may affect property value unless repairs return the property to its previous condition. Impacts on property values during construction would be temporary but could be major for homeowners attempting to sell their homes during construction.

Operations Impacts

Operation of the pipeline would not require significant numbers of workers along RA-08 and would not affect housing availability in the counties surrounding the Project.

Impacts associated with access and safety for RA-08 during operation would be similar to those described for the Applicant's preferred route. The permanent right-of-way for RA-08 would intersect

three residences and Enbridge would need to remove or re-locate those structures, as negotiated with the landowner, or the centerline of the route would need to be adjusted within the 750-foot route width to avoid the homes. Removal of the structures represents a major, permanent impact for those affected. During operation, the pipeline would be underground, and standard operations and maintenance would not pose any residential access or safety threats.

As described above, a review of relevant literature gave no conclusive evidence that an oil/gas pipeline and easement would affect surrounding property values. Given the lack of a conclusive, quantitative relationship between property values and proximity to pipelines it is not possible to estimate the potential for impacts of operation of RA-08 on property values. If a relationship does exist between property values and proximity to pipelines, however, the location of RA-08, along the existing Mainline corridor would make it very unlikely that RA-08 would affect existing property values.

6.2.4.4 Summary and Mitigation

6.2.4.4.1 Summary

Table 6.2.4-6 summarizes the potential impacts of construction and operations on housing availability, residential access and safety, and property values for the Applicant's preferred route and each of the route alternatives. Overall, the affected counties for all routes contain sufficient available housing to absorb the non-local workforce, and none of the routes represents an advantage over the others in terms of housing. For all routes, impacts on housing availability during construction would be minor and temporary. During operations, there would be no impact on housing availability for any route option.

Residents within or adjacent to the construction work area for each route option would experience temporary minor to major impacts from restricted access and construction safety hazards. Route alternative RA-06 would affect the fewest residences within 50 feet of the construction work area and therefore would result in the least impacts on residential access and safety, while RA-07 would affect the most residences within 50 feet of the construction work area. Residences within the construction work area would be subject to a variety of impacts, including potential limits on access.

For homeowners who experience construction-related damages, property value could be affected unless repairs return the property to its previous condition. Impacts on property values during construction would be temporary but could be major for homeowners attempting to sell their homes during construction.

Operation of the pipeline could result in displacement of residents with homes located within the permanent right-of-way. Homes and associated structures located within the permanent right-of-way would be removed or re-located, or the route centerline would need to be adjusted within the 750-foot route width, because no structures are permitted within the permanent right-of-way. Enbridge has reached agreements with the landowners for all structures, including residences, identified within the permanent right-of-way for the Applicant's preferred route. Overall, RA-06 represents the largest potential permanent impact on residences, with seven residential structures located within the permanent right-of-way; while RA-07 would represent the least impact, as no residences are located within the existing Mainline corridor where RA-07 would run.

A review of relevant literature gave no conclusive evidence that an oil/gas pipeline and easement would negatively affect surrounding property values. A collection of studies is available that characterizes impacts related to proximity to a hazardous or potentially hazardous site, proximity to oil and natural

gas pipelines, and proximity to oil pipeline ruptures. Ultimately, the findings were inconclusive, disputed, or showed no relationship between pipeline easements and home values. Given the lack of a conclusive, quantitative relationship between property values and proximity to pipelines, it is not possible to estimate the potential for impacts from operation of the project on property values. If a relationship does exist between property values and proximity to pipelines, however, the location of RA-07 in the existing Mainline corridor and RA-08 along this corridor would make it very unlikely that either of these routing options would affect existing property values.

6.2.4.4.2 Mitigation

Identified mitigation includes reduce impacts associated with restricted access and construction safety hazards on residences within 50 feet of the construction work area includes:

- Developing site-specific construction plans for all residences within 50 feet of the construction work area. These plans could include the use of safety fences, designated access routes, and limitations on construction activity.

If one of the route alternatives is selected as the preferred route, identified mitigation for residences located within the permanent right-of-way includes:

- Negotiating compensation for impacts resulting from construction of the pipeline and any hindrances created by the easement.
- Refining the route centerline to avoid residences where agreements with landowners cannot be reached.

Table 6.2.4-6. Summary of Potential Impacts on Housing for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Use of available temporary housing in affected counties to meet increased demand from the non-local workforce	Temporary/minor impacts • 11 percent of available temporary housing	Temporary/minor impacts • 24 percent of available temporary housing	Temporary/minor impacts • 13 percent of available temporary housing	Temporary/minor impacts • 9 percent of available temporary housing	Temporary/minor impacts • 9 percent of available temporary housing
Access limitations or safety concerns for residences within the construction work area	Temporary/minor to major impacts • 6 residences	Temporary/minor to major impacts • 16 residences	Temporary/minor to major impacts • 9 residences	Temporary/minor to major impacts • 40 residences	Temporary/minor to major impacts • 9 residences
Access limitations or safety concerns for additional residences within 50 feet of the construction work area	Temporary/minor to major impacts • 7 residences	Temporary/minor to major impacts • 39 residences	Temporary/minor to major impacts • 8 residences	Temporary/minor to major impacts • 16 residences	Temporary/minor to major impacts • 20 residences
Changes in property values of homes during construction of a pipeline	Temporary/major impacts (*if homeowner is attempting to sell home during construction*)	Temporary/major impacts (*if homeowner is attempting to sell home during construction*)	Temporary/major impacts (*if homeowner is attempting to sell home during construction*)	Temporary/major impacts (*if homeowner is attempting to sell home during construction*)	Temporary/major impacts (*if homeowner is attempting to sell home during construction*)
Operations Impacts					
Availability of housing to meet increased demand from the non-local workforce	Operations and maintenance would not require significant numbers of workers along the pipeline route and would not affect housing availability.				
Access limitations or safety concerns from removal of structures within permanent right-of-way	No impact (*Negotiated agreements with landowners of* 18 *structures requiring removal or re-location*)	Permanent/major impacts • 3 residences require removal or re-location	Permanent/major impacts • 7 residences require removal or re-location	No impact	Permanent/major impacts • 3 residences require removal or re-location

Table 6.2.4-6. Summary of Potential Impacts on Housing for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Access limitations or safety concerns from restricted property access	Permanent/negligible impacts • Restricted access to 0.1-acre mainline valve site	*Locations of permanent structures and access roads have not been determined for the route alternatives. Therefore, the location and number of properties affected cannot be quantified.*			
Changes in property values of homes during operation of a pipeline	Available studies were inconclusive; therefore, it is not possible to accurately estimate the potential for impacts of operation of the Project on property values.				

6.2.4.5 References

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6.2.5 Transportation and Public Services

This section addresses potential impacts on transportation and public services in the areas crossed by the Applicant's preferred route and route alternatives. The analysis considered the potential for the following:

- Road closures, increased traffic, and road damage resulting from pipeline construction or operation;
- Disruption of rail travel and airport operation due to pipeline construction or operation;
- Disruption of utilities during construction and operation, including local, intrastate, and interstate utilities and transmission lines; and
- Increased need for emergency services during construction and operations.

This section first describes the existing conditions within an area along the Applicant's preferred route and each of the route alternatives where transportation and public services could be affected by construction and operation of the Project. The potential construction- and operations-related impacts on transportation, utilities, and public services for the routing options (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08) are addressed next. The impact analysis focuses on the segment of the Applicant's preferred route and route alternatives between Clearbrook and Carlton, as described below. A summary and comparison of the impacts for the five routing options are included at the end of the section.

6.2.5.1 Regulatory Context and Methodology

6.2.5.1.1 Regulatory Context

Project construction would require permits from the Minnesota Department of Transportation (MNDOT) to cross state roads and to create access points onto state highways and county roads from private lands. At road and highway crossings, the Applicant would be subject to county, town, or city regulations that apply to roadways (Minn. Stat. § 222.37) during construction, operation, and maintenance of the pipeline route.

Federal Aviation Administration (FAA) regulations in 14 CFR 77 describe the standards used for determining obstructions to air navigation, navigational aids, or navigational facilities. Those regulations require that any construction project that includes structures with a height of 200 feet or more above ground level or above the established airport elevation (whichever is higher), within 3 nautical miles of an airport, comply with criteria presented in its regulations. The Applicant is not proposing to construct facilities that fall under those criteria; therefore, this issue is not further addressed in this EIS.

FAA regulations also state that the responsible party would have to notify FAA if construction would exceed a defined slope that, depending on various factors, could extend 20,000 feet from the nearest runway. For the purposes of this EIS, airports within 20,000 feet of an alternative route were identified.

The Minnesota Gopher State One-Call system (GSOC) requires notification 48 hours in advance of proposed excavations to allow time to inform utility operators with underground facilities near the excavation areas of the pending excavation (Minn. Stat. 216D.02). In addition, GSOC requires that white markings be placed to define the entire area where excavation would occur.

6.2.5.1.2 Methodology

Construction and operation of the Project have the potential to affect transportation and public services. The following methods were used to identify the relevant existing conditions:

- GIS datasets were used to identify major and minor roads, railways, and utility lines that would be crossed by the Applicant's preferred route and route alternatives, and airports within 20,000 feet of the routes and aboveground facilities;
- The annual average daily traffic (AADT) was estimated for major roads crossed by the route options, using available data for major roadways in the state; and
- Online datasets were used to identify the number of police, fire, and medical services available in counties crossed by the Applicant's preferred route and route alternatives.

Using these data, impacts were evaluated as follows:

- Crossing methods used for each road and railway were compared and qualitatively assessed, and the magnitude of the impacts on traffic due to access loss and traffic increases was determined;
- The estimated traffic from construction workers and vehicles was compared to the AADT estimates for major roads crossed by the route options to determine the magnitude of impacts on traffic;
- The potential impacts on the availability of emergency services were considered by using the number of available services to develop a qualitative assessment of the relative magnitude of potential Project-related needs for those services; and
- The potential effects and the magnitude of those effects on utilities were considered based on the number of service lines crossed by the route options.

The Applicant's preferred route and all of the route alternatives have the same route between the North Dakota border and Clearbrook, and from Carlton to the Wisconsin border. Therefore, comparison of impacts among the route options focused on the segments of the routes between Clearbrook and Carlton.

The ROI for the impact assessment on roads, railroads, and utilities consists of the actual crossing locations of the infrastructure crossed by the Applicant's preferred route and the route alternatives. The ROI for the analysis of potential impacts on regional airports consists of airports within 20,000 feet of the construction work areas and aboveground facilities. The ROI for impacts of construction traffic on local traffic is all major roads crossed by the Applicant's preferred route and the route alternatives.

Potential impacts on emergency services were reviewed at the county level, with the ROI consisting of the counties crossed by each of the route options. Data for Clearwater County were included in the assessment of the common route for the Applicant's preferred route and route alternatives between the North Dakota border and Clearbrook. The ROI for public services for the remainder of the Applicant's preferred route and route alternatives included all counties crossed by the routes, except for Clearwater County. Because the impact analysis for public services was based on county data, comparisons were made using data for existing conditions in all of Clearwater County, in which Clearbrook is located, and all of Carlton County, in which Carlton is located.

6.2.5.2 Existing Conditions

An overview of the transportation network within Minnesota that would be crossed by the Applicant's preferred route and route alternatives is shown in Figure 6.2.5-1.

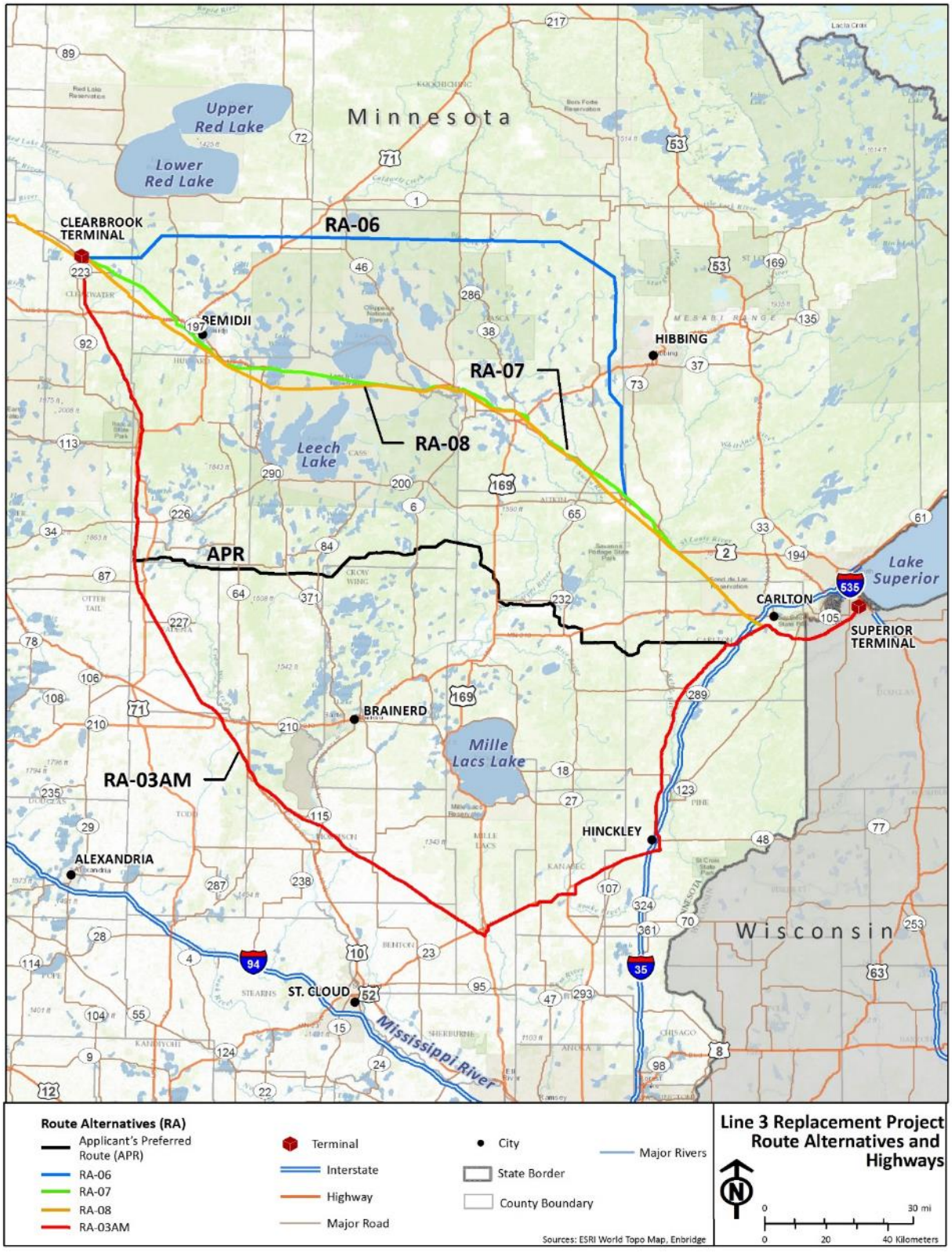

Figure 6.2.5-1. Roads and Highway Infrastructure along Route Alternatives

6.2.5.2.1 Applicant's Preferred Route

Roads and Highways

The Applicant's preferred route lies roughly in the area north of Interstate 94, east of Interstate 29, and west of Interstate 35 (Figure 6.2.5-1). U.S. highways in the area include Highways 2, 10, 59, 71, 75, and 169. Several other state and local highways are also in the area. The Applicant's preferred route would require 144 road and highway crossings from the North Dakota border to Clearbrook, 163 road and highway crossings between Clearbrook and Carlton, and 12 road and highway crossings from Carlton to the Wisconsin border. Table 6.2.5-1 lists the numbers of road and highway crossings for the Applicant's preferred route along with crossings of railroads, pipelines, and electrical transmission lines.

Table 6.2.5-1. Number of Infrastructure Crossings by the Applicant's Preferred Route in Minnesota

Route	Roads and Highways	Railroads	Pipelines	Electrical Transmission Lines
North Dakota border to Clearbrook	12	5	15	12
Clearbrook to Carlton	163	2	25	42
Carlton to Wisconsin border	144	1	13	3

MNDOT calculates AADT for most township, county, state, and interstate roads within Minnesota. Table 6.2.5-2 presents the AADT for major federal and state roads crossed by the Applicant's preferred route (MNDOT 2015).

Railroads, Utilities, and Airports

The Applicant's preferred route would require eight passenger and freight railroad crossings; these include five railroad crossings from the North Dakota border to Clearbrook, two crossings between Clearbrook and Carlton, and one crossing between from Carlton and the Wisconsin Border (Figure 6.2.5-2).

The number of utility lines crossed by the Applicant's preferred route are listed in Table 6.2.5-1. These include 57 electric transmission line crossings and 53 pipeline crossings. The pipelines may be transporting natural gas, oil, or refined products. Other utility types that were not identified but would likely be crossed include sewer lines and water lines. Between Clearbrook and Carlton, the route would cross 42 electrical transmission lines and 25 pipelines (Figures 6.2.5-3 and 6.2.5-4).

Thief River Falls Regional Airport in Pennington County is within 20,000 feet of the Applicant's preferred route in the area between the North Dakota border and Clearbrook.

Table 6.2.5-2. Annual Average Daily Traffic Estimates for Major Roads Crossed by the Applicant's Preferred Route

Road/Highway	Annual Average Daily Traffic (vehicles per day)
North Dakota Border to Clearbrook	
State Highway 1	970
State Highway 11	1,900
State Highway 32	4,200
State Highway 59	2,750
State Highway 75	550
State Highway 92	600
Clearbrook to Carlton	
Interstate 35	16,400
U.S. Highway 71	2,000
U.S. Highway 2	5,900
State Highway 169	2,050
State Highway 210	3,750
State Highway 223	295
State Highway 34	3,400
State Highway 371	4,850
State Highway 6	1,300
State Highway 64	1,800
State Highway 65	5,200
State Highway 73	1,450
State Highway 84	1,300
Carlton to Wisconsin Border	
State Highway 23	265

Source: MNDOT 2015.



Figure 6.2.5-2. Railroads along Route Alternatives



Figure 6.2.5-3. Pipelines and Utilities along Route Alternatives

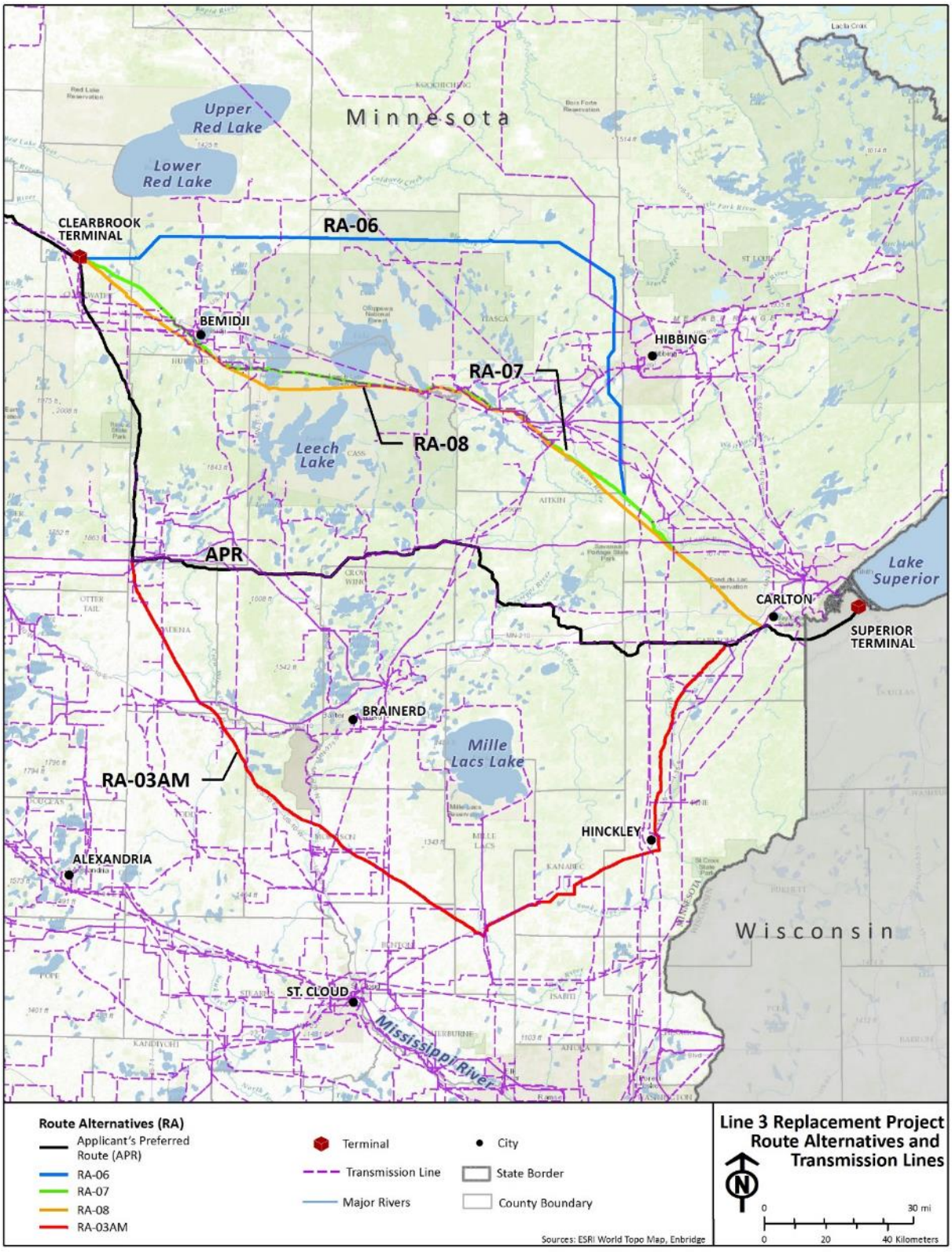

Figure 6.2.5-4. Transmission Lines along Route Alternatives

Emergency Services

Law enforcement agencies, fire departments, and hospitals within the ROI for the Applicant's preferred route are listed in Table 6.2.5-3. Although Red Lake County does not have a hospital, the county is relatively small and surrounded by two counties (Pennington and Polk) that collectively have three hospitals.

Table 6.2.5-3. Emergency Services in Counties Crossed by the Applicant's Preferred Route

County	Law Enforcement Agencies[a,b]	Fire Departments[a]	Hospitals[c]
North Dakota Border to Clearbrook			
Kittson County	3	5	1
Marshall County	3	7	1
Pennington County	3	3	1
Red Lake County	2	1	0
Polk County	8	10	2
Clearwater County	5	2	1
Subtotal	***24***	***28***	***6***
Hubbard County to Wisconsin Border			
Hubbard County	5	5	1
Wadena County	5	3	2
Cass County	6	6	1
Crow Wing County	8	10	4
Aitkin County	3	3	1
Carlton County	6	15	2
Subtotal	***33***	***42***	***11***

[a] Source: Capitol Impact 2016.

[b] Law enforcement agencies include police departments, sheriff's offices, coroners, medical examiners, and state agencies.

[c] Source: American Hospital Directory 2016.

6.2.5.2.2 Route Alternatives

As noted above, the only area where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to transportation and public services for the route alternatives between Clearbrook and Carlton are described below; for county-wide assessments, the comparison is for counties outside of Clearwater County since that county is addressed for the segment from the North Dakota border to Clearbrook, which is in Clearwater County.

Route Alternative RA-03AM

Roads and Highways

Portions of RA-03AM parallel State Route 23 (Figure 6.2.5-1). This route alternative would require a total of 329 road and highway crossings between Clearbrook and Carlton. The AADT for major roads and highways that would be crossed by the route are listed in Table 6.2.5-4.

Table 6.2.5-4. Annual Average Daily Traffic Estimates for Major Roads Crossed by Route Alternative RA-03AM

Road/Highway	Annual Average Daily Traffic (vehicles per day)
Interstate 35	16,400
U.S. Highway 71	2,000
U.S. Highway 2	5,900
State Highway 115	1,200
State Highway 169	15,400
State Highway 18	2,250
State Highway 223	295
State Highway 227	1,450
State Highway 23	5,500
State Highway 25	2,000
State Highway 27	2,450
State Highway 34	3,400
State Highway 371	11,600
State Highway 47	1,300
State Highway 48	9,500
State Highway 73	2,050
State Highway 87	1,000

Source: MNDOT 2015.

Railroads, Utilities, and Airports

RA-03AM would require 11 passenger and freight railroad crossings between Clearbrook and Carlton (Figure 6.2.5-2). Portions of RA-03AM are parallel and near the routes of the Minnesota Pipe Line Company pipeline, the Magellan Refined Products pipeline, and/or the Northern Natural Gas pipeline. The route crosses 59 electric transmission line crossings and 47 pipeline crossings; the pipelines may be transporting natural gas, oil, or refined products (Figures 6.2.5-3 and 6.2.5-4). No airports occur within the ROI for RA-03AM.

Emergency Services

Law enforcement agencies, fire departments, and hospitals within the ROI for RA-03AM are listed in Table 6.2.5-5.

Table 6.2.5-5. Emergency Services in Counties Crossed by Route Alternative RA-03AM

County	Law Enforcement Agencies[a,b]	Fire Departments[a]	Hospitals[c]
Hubbard County	5	5	1
Wadena County	5	3	2
Todd County	7	7	2
Morrison County	6	8	1
Benton County	4	3	0
Mille Lacs County	6	4	1
Kanabec County	3	2	1
Pine County	2	8	2
Carlton County	6	15	2
TOTAL	**44**	**55**	**12**

[a] Source: Capitol Impact 2016.

[b] Law enforcement agencies include police departments, sheriff's offices, coroners, medical examiners, and state agencies.

[c] Source: American Hospital Directory 2016.

Route Alternative RA-06

Roads and Highways

Route alternative RA-06 would require a total of 112 road and highway crossings between Clearbrook and Carlton (Figure 6.2.5-1). The AADT of major roads and highways that would be crossed by the route are listed in Table 6.2.5-6.

Table 6.2.5-6. Annual Average Daily Traffic Estimates for Major Roads Crossed by Route Alternative RA-06

Road/Highway	Annual Average Daily Traffic (vehicles per day)
Interstate 35	16,400
U.S. Highway 71	1,200
U.S. Highway 2	3,800
State Highway 169	7,700
State Highway 210	4,450
State Highway 38	1,000
State Highway 46	580
State Highway 6	330
State Highway 65	270
State Highway 72	1,350
State Highway 73	1,650
State Highway 89	1,650

Source: MNDOT 2015.

Railroads, Utilities, and Airports

RA-06 would require four passenger and freight railroad crossings between Clearbrook and Carlton (Figure 6.2.5-2). The route would have 22 electric transmission line crossings and 29 pipeline crossings; the pipelines may be transporting natural gas, oil, or refined products (Figures 6.2.5-3 and 6.2.5-4). No airports occur within the ROI for RA-06.

Emergency Services

Law enforcement agencies, fire departments, and hospitals within the ROI for RA-06 are listed in Table 6.2.5-7.

Table 6.2.5-7. Emergency Services in Counties Crossed by Route Alternative RA-06

County	Law Enforcement Agencies[a,b]	Fire Departments[a]	Hospitals[c]
Beltrami County	4	4	3
Itasca County	9	11	3
Aitkin County	3	3	1
St. Louis County	21	50	8
Carlton County	6	15	2
TOTAL	**43**	**83**	**17**

Notes:

[a] Source: Capitol Impact 2016.

[b] Law enforcement agencies include police departments, sheriff's offices, coroners, medical examiners, and state agencies.

[c] Source: American Hospital Directory 2016.

Route Alternative RA-07

Roads and Highways

Route alternative RA-07 would require a total of 185 road and highway crossings between Clearbrook and Carlton (Figure 6.2.5-1). The AADT of major roads and highways that would be crossed by the route are listed in Table 6.2.5-8.

Table 6.2.5-8. Annual Average Daily Traffic Estimates for Major Roads Crossed by Route Alternative RA-07

Road/Highway	Annual Average Daily Traffic (vehicles per day)
Interstate 35	16,400
U.S. Highway 2	5,800
State Highway 169	12,200
State Highway 197	5,700
State Highway 210	4,450
State Highway 223	295
State Highway 371	5,700
State Highway 38	4,300
State Highway 65	870
State Highway 73	1,650

Source: MNDOT 2015.

Railroads, Utilities, and Airports

RA-07 would require seven passenger and freight railroad crossings between Clearbrook and Carlton (Figure 6.2.5-2). The route would have 43 electric transmission line crossings and 42 pipeline crossings; the pipelines may be transporting natural gas, oil, or refined products (Figures 6.2.5-3 and 6.2.5-4). The Bemidji Regional Airport is within the ROI for RA-07.

Emergency Services

Law enforcement agencies, fire departments, and hospitals within the ROI for RA-07 are listed in Table 6.2.5-9.

Table 6.2.5-9. Emergency Services in Counties Crossed by Route Alternative RA-07

County	Law Enforcement Agencies[a,b]	Fire Departments[a]	Hospitals[c]
Beltrami County	4	4	3
Hubbard County	5	5	1
Cass County	6	6	1
Itasca County	9	11	3
Aitkin County	3	3	1
St. Louis County	21	50	8
Carlton County	6	15	2
TOTAL	**54**	**94**	**19**

Notes:

[a] Source: Capitol Impact 2016.

[b] Law enforcement agencies include police departments, sheriff's offices, coroners, medical examiners, and state agencies.

[c] Source: American Hospital Directory 2016.

Route Alternative RA-08

Roads and Highways

Route alternative RA-08 would require a total of 162 road and highway crossings between Clearbrook and Carlton (Figure 6.2.5-1). The roads and highways that would be crossed by the route have a minimum AADT of 5 vehicles and a maximum AADT of 16,400 vehicles (Table 6.2.5-10, MNDOT 2015).

Table 6.2.5-10. Annual Average Daily Traffic Estimates for Major Roads Crossed by Route Alternative RA-08

Road/Highway	Annual Average Daily Traffic (vehicles per day)
Interstate 35	16,400
U.S. Highway 2	5,800
State Highway 169	12,200
State Highway 200	640
State Highway 210	4,450
State Highway 223	295
State Highway 371	3,600
State Highway 38	4,300
State Highway 65	870
State Highway 71	8,600
State Highway 73	1,650

Source: MNDOT 2015.

Railroads, Utilities, and Airports

RA-08 would require five passenger and freight railroad crossings between Clearbrook and Carlton (Figure 6.2.5-2). The route would have 36 electric transmission line crossings and 41 pipeline crossings; the pipelines may be transporting natural gas, oil, or refined products (Figures 6.2.5-3 and 6.2.5-4). The Bemidji Regional Airport is within the ROI for RA-08.

Emergency Services

Law enforcement agencies, fire departments, and hospitals within the ROI for RA-08 are listed in Table 6.2.5-11.

Table 6.2.5-11. Emergency Services in Counties Crossed by the Route Alternative RA-08

County	Law Enforcement Agencies[a,b]	Fire Departments[a]	Hospitals[c]
Beltrami County	4	4	3
Hubbard County	5	5	1
Cass County	6	6	1
Itasca County	9	11	3
Aitkin County	3	3	1
St. Louis County	21	50	8
Carlton County	6	15	2
TOTAL	**54**	**94**	**19**

[a] Source: Capitol Impact 2016.

[b] Law enforcement agencies include police departments, sheriff's offices, coroners, medical examiners, and state agencies.

[c] Source: American Hospital Directory 2016.

6.2.5.3 Impact Assessment

The impact analysis conducted for transportation and public services for the Applicant's preferred route and the route alternatives considered the potential for the following:

- Road closures, increased traffic, and road damage caused by pipeline construction or operation;
- Disruption of rail travel and airport operation due to pipeline construction or operation;
- Disruption of utilities during construction and operation, including local, intrastate, and interstate utilities and transmission lines; and
- Increased need for emergency services during construction and operations.

6.2.5.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Roads and Highways

The Applicant proposes to cross all paved roads using either the guided bore or HDD method. The guided bore method involves boring with an auger through the material under the road from an excavated pit on one side of the road to an excavated pit on the other side (see Section 2.7.2.8). The HDD method is similar, requiring an excavated pit on each side of the crossing, but it uses a computer-controlled drill to create the hole for pipe installation under the rail bed (see Section 2.7.2.8). Use of either method would avoid road closures. Although presence of the construction crews and vehicles in the areas adjacent to the crossings may cause some drivers to reduce their speed, the resultant impacts on transportation on paved roads due to pipeline crossings would be temporary and negligible.

Construction across unpaved roads would require temporary road closures since they would be crossed using the open-cut method, similar to construction of the main portion of the route across land. Where

open-cut methods are used, detours would be established to route around road closures. If no detour is available, at least one lane would be kept open, except for the limited time when the pipe is being installed. Disturbances at the open-cut road crossings would typically be limited to 1 day. The Applicant would implement measures such as creating detours, posting warnings, providing traffic control personnel, and installing safety signs to minimize the impacts on local traffic. Because most unpaved roads are in rural areas, detours and delays during temporary closures could result in longer driving times, causing a temporary minor impact on road users. Impacts on local access from road closures are addressed in Section 6.2.4.3.

Traffic along roads within the ROI may also be affected by the increased traffic volume from construction workers and construction equipment vehicles. Construction would be conducted along construction spreads, with the Applicant's preferred route requiring a total of seven spreads. Each spread would have a peak workforce of 500 to 600 workers. At that point of construction, work would be distributed along the work spread; as a result, not all workers would be in the same area at the same time. The Applicant stated that construction workers would either (1) drive directly to the work site and park near ATWS or along the road shoulder; or (2) drive to construction yards and be bussed or carpool to the work site. At the peak of construction, the Applicant expects a maximum of approximately 590 total trips per day per construction spread (there would be four construction spreads between Clearbrook and Carlton). Most workers would use major roadways to travel to and from the construction area, as well as some county and local roads to access the right-of-way. However, not all roads crossed by the route would be used as access points for workers. For major roads crossed by the route, AADT ranges from 265 to 16,400 vehicle per day (Table 6.2.5-2). Since workers would be distributed among the individual construction spreads, it is unlikely that any single road would be subject to an increase of 500 to 600 workers at a given time. For roads with low traffic counts, users may notice the increase in the number of vehicles; however, the impact on traffic is likely to be temporary and minor since impacts would be limited to the construction period and traffic increases are not expected to result in delays or safety concerns.

During construction at pump stations, all workers would be in a single location, which would result in localized increases in traffic volumes, particularly during the morning and evening commuting times for the construction workers. The Applicant estimated that construction of each pump station would require about 81 to 86 total vehicle trips per day. Each pump station would be near an existing road. County Road 74 near the Clearbrook pump station has the lowest estimated traffic count, with approximately 65 vehicles per day (MNDOT 2015). While construction at the Clearbrook pump station would more than double the number of vehicles during the morning and evening commutes, the road should be able to accommodate the increase of 86 total vehicle trips per day without causing substantial impacts on traffic. Although many variables influence the efficiency or level of service for a section of road, the typical base saturation flow rate (or maximum capacity) for a highway is 1,900 cars per hour per lane (TRB 2000). Even if the 81 to 86 vehicle trips were to occur in the same peak hour, which is not likely, this would only represent roughly 5 percent of the roadway's capacity. Therefore, with the short duration and small change in traffic relative to the roadway capacity, impacts on traffic during construction of pump stations are expected to be temporary and minor.

Construction may cause deterioration of road surfaces from the increased worker vehicle traffic and construction vehicles with heavy loads. Construction vehicles also could track dirt and debris onto the road surface. The Applicant would implement measures to minimize debris tracking, including requiring contractors to remove the debris within 24 hours. The Applicant also committed to restoring all road surfaces to preexisting conditions. With post-construction restoration and proposed measures to

minimize debris tracking during the construction period, the impact on road surfaces due to construction of the Applicant's preferred route would be temporary and minor.

Railroads, Utilities, and Airports

The Applicant's preferred route would cross eight railroads (Table 6.2.5-2). All active railroads would be crossed using the guided bore or HDD method. As noted above, both methods require an excavated pit on each side of the crossing; the crossings would be bored or drilled under the rail bed from one pit to the other. The use of either method would result in no impacts on the railroad or its uses.

The Applicant's preferred route would cross pipelines, utilities, and transmission lines. The Applicant would consult with all underground utility companies prior to construction and use the GSOC system prior to excavation to ensure that utility owners or operators are informed of the planned construction and that potentially affected pipelines and underground utilities are properly marked. With these safeguards in place, accidental damage to the utilities is not likely and disruption of service is not expected; therefore, impacts on utilities are not expected. However, it is possible that not all of the locations of local utility lines are known by the local communities or counties. If utility lines are accidentally damaged, disruption to service could result. The Applicant would be required to repair damaged utilities to allow the provider to restore service. In the event of a disruption, impacts on local residents would be temporary and major.

Before initiating crossings under overhead electrical transmission lines, the Applicant would consult with the owners or operators to ensure that all appropriate safety measures have been implemented. These measures would address aspects of construction such as the distance from the lines, the equipment used, and the methods of moving pipe segments. Implementation of these measures would avoid disruption of service, damage to the utilities, and worker injuries. With these measures in place, impacts on and from overhead electrical transmission lines are expected to be temporary and, at most, negligible.

Because the Thief River Falls Airport is within 20,000 feet of the Applicant's preferred route (in the area between the North Dakota/Minnesota Border and Clearbrook), the Applicant may be required to notify the FAA of the planned construction (Section 6.2.5.1.1). If notification is required, the Applicant would then be required to comply with FAA regulations for construction of facilities near airports. Through compliance with FAA regulations, no impacts on the Thief River Falls Airport would occur due to construction of the Applicant's preferred route.

Emergency Services

A variety of police and fire services are available in each county within the ROI. For larger counties that have high population centers, the number of these available services are higher, while the more rural counties generally have fewer services available. Potential Project-related impacts on these services include an increased need for police services to assist with traffic control at road crossings and to provide help or consultation regarding security, as well as an overall increased need for police services because of the increased population from the construction workforce. In some counties with fewer police departments and fewer officers available, the need for additional police to aid in traffic control during road closures may cause a minor and temporary impact on the departments. For emergency services, such as fire and medical, impacts would be associated with a general increased need due to the increase in overall population from the workforce in addition to potential injuries or accidents from construction. The number of emergency services departments in each county crossed by the Applicant's preferred route appears to be sufficient to absorb the potential increased need for their services

(Table 6.2.5-2). Although Red Lake County does not have a hospital, workers with injuries resulting from construction in this county could travel to surrounding hospitals in nearby counties. Overall, the temporary influx of workers to the Project area and the normal operations of day-to-day activities associated with construction would cause a temporary and negligible to minor impact on emergency services in the ROI.

Operations Impacts

Roads and Highways

The proposed pipeline would be underground, and normal pipeline operation would not affect the local transportation systems. Maintenance of the pipeline would require few additional workers, and those workers would be located at the Applicant's existing regional maintenance facilities and operations centers. Therefore, traffic along roads and highways in the counties crossed by the Applicant's preferred route would experience little increases in traffic due to operation and would not be measurably affected.

Maintenance activities would primarily consist of routine vegetation maintenance along the permanent right-of-way. Maintenance equipment and vehicles may briefly use local roads for access and egress to and from the right-of-way; this would have little effect on traffic.

During operation, the Applicant would implement its Integrity Management Program, which may require excavation to repair or replace segments of pipe at roadway crossings. In some cases, it could require removal of pipe that was installed under roadways crossed using the guided bore or HDD method. The impacts of those activities would be similar to those of constructing the crossings, and the Applicant would restore the roadways to their original condition if damaged. Therefore, impacts on roads and highways as a result of these maintenance activities would be temporary and negligible but would occur periodically over the life of the Project.

Railroads, Utilities, and Airports

No impacts on railroads would be expected during operation and maintenance of the pipeline. If a segment of pipe under the rail bed needs to be repaired or replaced it would be accomplished by excavating a pit to remove the pipe that was installed using the guided bore or HDD method and would not affect operation of the railroad.

If integrity digs are required along the route, the Applicant would to consult with utility companies and use the Minnesota GSOC system to ensure that all adjacent pipelines and underground utilities are properly marked. As for construction of the pipeline, disruption of service is not expected, and no impact on utilities during maintenance is expected. However, if an unmarked utility line is damaged during maintenance excavations, the Applicant would repair the damage and to allow the provider to restore service. In the event of a disruption, the impact on local users of the utility would be temporary and major.

Operation of the Project would not affect the Thief River Falls Airport.

Emergency Services

Operation would require a small number of new hires since the pipeline system could be operated and maintained primarily by the existing staff that operates and maintains the Line 3 pipeline. Therefore, there would not be a measurable impact on emergency services.

Impacts on emergency services in the event of an accidental release of crude oil are addressed in Chapter 10.

6.2.5.3.2 Route Alternatives (Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

Roads and Highways

Between Clearbrook and Carlton, RA-03AM would require the most road and highway crossings (329 crossings). Similar to construction of the Applicant's preferred route, paved roads would likely be crossed using the guided bore method, resulting in no road closures. Although presence of the construction crews and vehicles in the areas adjacent to the crossings may cause some drivers to reduce their speed, the resultant impacts on transportation on paved roads due to pipeline crossings would be temporary and negligible.

Construction across unpaved roads would require temporary road closures since they would be crossed using the open-cut method, similar to construction of the main portion of the route across land. Where open-cut methods are used, crossings would typically be completed in 1 day. With the Applicant-proposed measures of detours, warnings, traffic control, and safety signs, the impacts on local traffic would be minimized. Because most unpaved roads along RA-03AM are in rural areas, detours and delays during temporary closures could result in longer driving times, causing a temporary minor impact on road users. Impacts on local access from road closures along RA-03AM are addressed in Section 6.2.4.3 (Housing).

Traffic along roads within the ROI may also be affected by the increased traffic volume from construction workers and construction equipment vehicles. Construction of RA-03AM would most likely be conducted along five construction spreads between Clearbrook and Carlton. Similar to construction of the Applicant's preferred route, there could be a maximum of approximately 590 total vehicle trips per day per construction spread during peak construction. Most workers would use major roadways to travel to and from the construction area, as well as some county and local roads to access the right-of-way. However, not all roads crossed by the route would be used as access points for workers. For major roads crossed by the route, AADT ranges from 295 to 16,400 vehicle per day (Table 6.2.5-4). Since workers would be distributed among individual construction spreads, it is unlikely that any single road would be subject to an increase of 590 vehicle trips at a given time. For roads with low traffic counts, users may notice the increase in the number of vehicles; however, the impact on traffic is likely to be temporary and minor.

During construction of the six pump stations that would be needed for RA-03AM, approximately 81 to 86 total vehicle trips per day would be added to roads and highways used for access. Since the locations of pump stations have not been determined for RA-03AM, the impacts on local traffic during construction of the six pump stations cannot be quantitatively assessed. However, it is anticipated that most roads could accommodate the increase of 86 total vehicle trips per day without causing substantial impacts on traffic. As noted above for the Applicant's preferred route, the typical base saturation flow rate (or maximum capacity) for a highway is 1,900 cars per hour per lane (TRB 2000). Even if the 81 to 86 vehicle trips were to occur in the same peak hour, which is not likely, this would only represent a small percentage of the capacity of most roadways along the route. Therefore, impacts on traffic during construction of pump stations for RA-03AM are expected to be temporary and minor.

Construction may cause deterioration of road surfaces from the increased worker vehicle traffic and construction vehicles with heavy loads. Construction vehicles also could track dirt and debris onto the road surface. The Applicant would implement measures to minimize debris tracking, including requiring contractors to remove the debris within 24 hours. The Applicant also committed to restoring all road surfaces to preexisting conditions. Therefore, the impact on road surfaces due to construction of RA-03AM would be temporary and minor.

Railroads, Utilities, and Airports

Between Clearbrook and Carlton, RA-03AM would require the most railroad crossings (11). All active railroads would be crossed using either the guided bore or HDD method. As noted above, both methods require an excavated pit on each side of the crossing; the crossings would be bored or drilled under the rail bed from one pit to the other. The use of either method would result in no impacts on the railroad or its uses.

The RA-03AM route would require constructing 47 pipeline crossings, 59 electrical transmission line crossings, and other local utility crossings. The Applicant would consult with all underground utility companies prior to construction and use the GSOC system prior to excavation to ensure that utility owners or operators are informed of the planned construction and that potentially affected pipelines and underground utilities are properly marked. With these safeguards in place, accidental damage to the utilities is not likely and disruption of service is not expected; therefore, impacts on utilities are not expected. However, it is possible that not all of the locations of local utility lines are known by the local communities or counties. If utility lines are accidentally damaged, disruption to service could result. The Applicant would be required to repair damaged utilities to allow the provider to restore service. In the event of a disruption, impacts on local residents would be temporary and major.

Before initiating crossings under overhead electrical transmission lines, the Applicant would consult with the owners or operators to ensure that all appropriate safety measures have been implemented. These measures would address aspects of construction such as the distance from the lines, equipment used, and methods of moving pipe segments. Implementation of these measures would avoid disruption of service, damage to the utilities, and worker injuries. With these measures in place, impacts on and from overhead electrical transmission lines are expected to be temporary and, at most, negligible.

Because no airports are within 20,000 feet of RA-03AM, construction of this route alternative would not affect airports.

Emergency Services

Multiple law enforcement agencies and fire departments are present in each county crossed by RA-03AM. Impacts on emergency services for the route alternatives would be similar to those described for the Applicant's preferred route, including an increased need for police services to assist with traffic control at road crossings and to provide help or consultation regarding security, as well as a general increased need for police services because of the increased population from the construction workforce. For emergency services, such as fire and medical, impacts would be associated with an increased need due to the increase in overall population from the workforce in addition to potential injuries or accidents from construction. The number of emergency services departments in each county crossed by RA-03AM appears to be sufficient to absorb the potential increased need for these services (Table 6.2.5-3). Although Benton County does not have a hospital, workers with injuries resulting from construction in this county could travel to nearby hospitals in surrounding counties. Overall, the

temporary influx of workers during construction of RA-03AM would result in a temporary and minor impact on emergency services in the ROI.

Operations Impacts

Roads and Highways

Maintenance activities would primarily consist of routine vegetation maintenance along the permanent right-of-way of RA-03AM. Maintenance equipment and vehicles may briefly use local roads for access and egress to and from the right-of-way; this would have little effect on traffic and would therefore not affect traffic.

During operation, the Applicant would implement its Integrity Management Program, which may require excavation to repair or replace segments of pipe at roadway crossings. In some cases, it could require removal of pipe that was installed under roadways crossed using the guided bore or HDD method. The impacts of those activities would be similar to those of constructing the crossings, and the Applicant would restore the roadways to their original condition. Therefore, impacts on roads and highways as a result of these maintenance activities for RA-03AM would be temporary and negligible but would occur periodically over the life of the Project.

Railroads, Utilities, and Airports

No impacts on railroads would be expected during operation and maintenance of the pipeline. If a segment of pipe under the rail bed needs to be repaired or replaced it would be accomplished by excavating a pit to remove the pipe that was installed using the guided bore or HDD method and would not affect operation of the railroad.

If integrity digs are required along the route, the Applicant would consult with utility companies and use the Minnesota GSOC system to ensure that all adjacent pipelines and underground utilities are properly marked. As for construction of the pipeline, disruption of service is not expected, and no impact on utilities during maintenance is expected. However, if an unmarked utility line is damaged during maintenance excavations, the Applicant would repair the damage and to allow the provider to restore service. In the event of a disruption, the impact on local users of the utility would be temporary and major.

Because no airports are within 20,000 feet of RA-03AM, operation and maintenance of this route alternative would not affect any airports.

Emergency Services

Operation would require a small number of new hires since the pipeline system could be operated and maintained primarily by the existing staff that operates and maintains the Line 3 pipeline. Therefore, there would not be a measurable impact on emergency services.

Impacts on emergency services in the event of an accidental release of crude oil are addressed in Chapter 10.

Route Alternative RA-06

Construction Impacts

Roads and Highways

Between Clearbrook and Carlton, RA-06 would require the fewest road and highway crossings (112 crossings). Similar to construction of the Applicant's preferred route, paved roads would be crossed using either the guided bore or HDD method, resulting in no road closures. Although presence of the construction crews and vehicles in the areas adjacent to the crossings may cause some drivers to reduce their speed, the resultant impacts on transportation on paved roads due to pipeline crossings would be temporary and negligible.

Construction across unpaved roads would require temporary road closures since they would be crossed using the open-cut method, similar to construction of the main portion of RA-06 across land. Where open-cut methods are used, crossings would typically be completed in 1 day. With the Applicant-proposed measures of detours, warnings, traffic control, and safety signs, impacts on local traffic patterns would be minimized. Because most unpaved roads along RA-06 are in rural areas, detours and delays during temporary closures could result in longer driving times, causing a temporary minor impact on road users. Impacts on local access from road closures along RA-06 are addressed in Section 6.2.4.3.

Traffic along roads within the ROI may also be affected by the increased traffic volume from construction workers and construction equipment vehicles. Construction of RA-06 would most likely be conducted along four construction spreads between Clearbrook and Carlton. Similar to construction of the Applicant's preferred route, there could be a maximum of approximately 590 daily vehicle trips per construction spread during peak construction. Most workers would use major roadways to travel to and from the construction area, as well as some county and local roads to access the right-of-way. However, not all roads crossed by the route would be used as access points for workers. For major roads crossed by the route, AADT ranges from 330 to 16,400 vehicle per day (Table 6.2.5-6). Since workers would be distributed among individual construction spreads, it is unlikely that any single road would be subject to an increase of 590 trips at a given time. For roads with low traffic counts, users may notice the increase in the number of vehicles; however, the impact on traffic is likely to be temporary and minor.

During construction of the four pump stations that would be needed for RA-06, approximately 81 to 86 vehicle trips per day would be added to roads and highways used for access. Since the locations of pump stations have not been determined for RA-06, the impacts on local traffic during construction of the four pump stations cannot be qualitatively assessed. However, it is anticipated that most roads could accommodate the increase of 86 total vehicle trips per day without causing substantial impacts on traffic. As noted above for the Applicant's preferred route, the typical base saturation flow rate (or maximum capacity) for a highway is 1,900 cars per hour per lane (TRB 2000). Even if the 81 to 86 vehicle trips were to occur in the same peak hour, which is not likely, this would only represent a small percentage of the capacity of most roadways along the route. Therefore, impacts on traffic during construction of pump stations for RA-06 are expected to be temporary and minor.

Construction may cause deterioration of road surfaces from the increased worker vehicle traffic and construction vehicles with heavy loads. Construction vehicles could also track dirt and debris onto the road surface. The Applicant would implement measures to minimize debris tracking, including requiring contractors to remove the debris within 24 hours. The Applicant also committed to restoring all road

surfaces to preexisting conditions. Therefore, the impact on road surfaces due to construction of RA-06 would be temporary and minor.

Railroads, Utilities, and Airports

Between Clearbrook and Carlton, RA-06 would require the fewest railroad crossings (four). All active railroads would be crossed using either the guided bore or HDD method. As noted above, both methods require an excavated pit on each side of the crossing; the crossings would be bored or drilled under the rail bed from one pit to the other. The use of either method would result in no impacts on the railroad or its uses.

The RA-06 route would require constructing 29 pipeline crossings, 22 electrical transmission line crossings, and other local utility crossings. The Applicant would consult with all underground utility companies prior to construction and use the GSOC system prior to excavation to ensure that utility owners or operators are informed of the planned construction and that potentially affected pipelines and underground utilities are properly marked. With these safeguards in place, accidental damage to the utilities is not likely and disruption of service is not expected; therefore, impacts on utilities are not expected. However, it is possible that not all of the locations of local utility lines are known by the local communities or counties. If utility lines are accidentally damaged, disruption to service could result. The Applicant would be required to repair damaged utilities to allow the provider to restore service. In the event of a disruption, impacts on local residents would be temporary and major.

Before initiating crossings under overhead electrical transmission lines, the Applicant would consult with the owners or operators to ensure that all appropriate safety measures have been implemented. These measures would address aspects of construction such as the distance from the lines, the equipment used, and the methods of moving pipe segments. Implementation of these measures would avoid disruption of service, damage to the utilities, and worker injuries. With these measures in place, impacts on and from overhead electrical transmission lines are expected to be temporary and, at most, negligible.

Because no airports are within 20,000 feet of RA-06, construction of this route alternative would not affect airports.

Emergency Services

Multiple law enforcement agencies and fire departments are present in each county crossed by RA-06. Impacts on emergency services due to construction of this route alternative would be similar to those described for the Applicant's preferred route, including an increased need for police services to assist with traffic control at road crossings and to provide help or consultation regarding security, as well as a general increased need for police services because of the increased population from the construction workforce. For emergency services, such as fire and medical, impacts would be associated with an increased need due to the increase in population from the workforce in addition to potential injuries or accidents from construction. The number of emergency services departments in each county crossed by RA-06 appear to be sufficient to absorb the potential increased need for their services (Table 6.2.5-7). Overall, the temporary influx of workers during construction of RA-06 would result in a temporary and minor impact on emergency services in the ROI.

Operations Impacts

Roads and Highways

Maintenance activities would primarily consist of routine vegetation maintenance along the permanent right-of-way of RA-06. Maintenance equipment and vehicles may briefly use local roads for access and egress to and from the right-of-way; this would have little effect and thus no impact on traffic.

During operation, the Applicant would implement its Integrity Management Program, which may require excavation to repair or replace segments of pipe at roadway crossings. In some cases, it could require removal of pipe that was installed under roadways crossed using the guided bore or HDD method. The impacts of those activities would be similar to those of constructing the crossings, and the Applicant would restore the roadways to their original condition. Therefore, impacts on roads and highways as a result of these maintenance activities for RA-06 would be temporary and negligible but would occur periodically over the life of the Project.

Railroads, Utilities, and Airports

No impacts on railroads would be expected during operation and maintenance of the pipeline. If a segment of pipe under the rail bed needs to be repaired or replaced it would be accomplished by excavating a pit to remove the pipe that was installed using the guided bore or HDD method and would not affect operation of the railroad.

If integrity digs are required along the route, the Applicant would consult with utility companies and use the Minnesota GSOC system to ensure that all adjacent pipelines and underground utilities are properly marked. As for construction of the pipeline, disruption of service is not expected, and no impact on utilities during maintenance is expected. However, if an unmarked utility line is damaged during maintenance excavations, the Applicant would repair the damage and to allow the provider to restore service. In the event of a disruption, the impact on local users of the utility would be temporary and major.

Because no airports are within 20,000 feet of RA-06, operation and maintenance of this route alternative would not affect any airports.

Emergency Services

Operation would require a small number of new hires since the pipeline system could be operated and maintained primarily by the existing staff that operates and maintains the Line 3 pipeline. Therefore, there would not be a measurable impact on emergency services.

Impacts on emergency services in the event of an accidental release of crude oil are addressed in Chapter 10.

Route Alternative RA-07

Construction Impacts

Roads and Highways

Between Clearbrook and Carlton, RA-07 would require 185 road and highway crossings. Similar to construction of the Applicant's preferred route, paved roads would be crossed using the guided bore or HDD method, resulting in no road closures. Although presence of the construction crews and vehicles in

the areas adjacent to the crossings may cause some drivers to reduce their speed, the resultant impacts on transportation on paved roads due to pipeline crossings would be temporary and negligible.

Construction across unpaved roads would require temporary road closures since they would be crossed using the open-cut method, similar to construction of the main portion of the route across land. Where open-cut methods are used, crossings would typically be completed in 1 day. With the Applicant-proposed measures of detours, warnings, traffic control, and safety signs, impacts on local traffic patterns would be minimized. Because most unpaved roads along RA-07 are in rural areas, detours and delays during temporary closures could result in longer driving times, causing a temporary minor impact on road users. Impacts on local access from road closures along RA-07 are addressed in Section 6.2.4.3.

Traffic along roads within the ROI may also be affected by the increased traffic volume from construction workers and construction equipment vehicles. Construction of RA-07 would most likely be conducted along four construction spreads between Clearbrook and Carlton. Similar to construction of the Applicant's preferred route, there could be a maximum of approximately 590 daily vehicle trips per construction spread during peak construction. Most workers would use major roadways to travel to and from the construction area, as well as some county and local roads to access the right-of-way. However, not all roads crossed by the route would be used as access points for workers. For major roads crossed by the route, AADT ranges from 330 to 16,400 vehicle per day (Table 6.2.5-8). Since workers would be distributed among individual construction spreads, it is unlikely that any single road would be subject to an increase of 590 trips at a given time. For roads with low traffic counts, users may notice the increase in the number of vehicles; however, the impact on traffic is likely to be temporary and minor.

Because construction of RA-07 would require upgrading existing pump stations rather than constructing new pump stations, the estimated number of construction workers required and the associated number of vehicle trips per day that would be added to roads and highways has not been determined. In addition, the location of pump stations has not been determined for RA-07, so the impacts on local traffic during construction of the pump station upgrades cannot be quantitatively assessed. However, even if the upgrades require the same number of construction workers as the new pump stations noted above, it is anticipated that most roads could accommodate the increase of 86 total vehicle trips per day without causing substantial impacts on traffic. As noted above for the Applicant's preferred route, the typical base saturation flow rate (or maximum capacity) for a highway is 1,900 cars per hour per lane (TRB 2000). Even if the 81 to 86 vehicle trips were to occur in the same peak hour, which is not likely, this would only represent a small percentage of the capacity of most roadways along the route. Therefore, impacts on traffic during construction of pump stations for RA-07 are expected to be temporary and minor.

Construction may cause deterioration of road surfaces from the increased worker vehicle traffic and construction vehicles with heavy loads. Construction vehicles also could track dirt and debris onto the road surface. The Applicant would implement measures to minimize debris tracking, including requiring contractors to remove the debris within 24 hours. The Applicant also committed to restoring all road surfaces to preexisting conditions. Therefore, the impact on road surfaces due to construction of RA-07 would be temporary and minor.

Railroads, Utilities, and Airports

Between Clearbrook and Carlton, RA-07 would require the seven railroad crossings. All active railroads would be crossed using either the guided bore or HDD method. As noted above, both methods require an

excavated pit on each side of the crossing; the crossings would be bored or drilled under the rail bed from one pit to the other. The use of either method would result in no impacts on the railroad or its uses.

RA-07 would require constructing 42 pipeline crossings, 43 electrical transmission line crossings, and other local utility crossings. The Applicant would consult with all underground utility companies prior to construction and use the GSOC system prior to excavation to ensure that utility owners or operators are informed of the planned construction and that potentially affected pipelines and underground utilities are properly marked. With these safeguards in place, accidental damage to the utilities is not likely and disruption of service is not expected; therefore, impacts on utilities are not expected. However, it is possible that not all of the locations of local utility lines are known by the local communities or counties. If utility lines are accidentally damaged, disruption to service could result. The Applicant would be required to repair damaged utilities to allow the provider to restore service. In the event of a disruption, impacts on local residents would be temporary and major.

Before initiating crossings under overhead electrical transmission lines, the Applicant would consult with the owners or operators to ensure that all appropriate safety measures have been implemented. These measures would address aspects of construction such as the distance from the lines, the equipment used, and the methods of moving pipe segments. Implementation of these measures would avoid disruption of service, damage to the utilities, and worker injuries. With these measures in place, impacts on and from overhead electrical transmission lines are expected to be temporary and, at most, negligible.

Because the Bemidji Regional Airport is within 20,000 feet of the RA-07 route, the Applicant may be required to notify the FAA of the planned construction (Section 6.2.5.1.1). If notification is required, the Applicant would then be required to comply with FAA regulations for construction of facilities near airports; as a result, no impacts on the Bemidji Regional Airport are expected due to construction of RA-07.

Emergency Services

Multiple law enforcement agencies and fire departments are present in each county crossed by RA-07. Impacts on emergency services for the route alternatives would be similar to those described for the Applicant's preferred route, including an increased need for police services to assist with traffic control at road crossings and to provide help or consultation regarding security, as well as a general increased need for police services because of the increased population from the construction workforce. For emergency services, such as fire and medical, impacts would be associated with an increased need due to the increase in overall population from the workforce in addition to potential injuries or accidents from construction. The number of emergency services departments in each county crossed by RA-07 appear to be sufficient to absorb the potential increased need for their services (Table 6.2.5-5). Overall, the temporary influx of workers during construction of RA-07 would result in a temporary and minor impact on emergency services in the ROI.

Operations Impacts

Roads and Highways

Maintenance activities would primarily consist of routine vegetation maintenance along the permanent right-of-way of RA-07. Maintenance equipment and vehicles may briefly use local roads for access and egress to and from the right-of-way; this would have little effect on traffic and would therefore not affect traffic.

During operation, the Applicant would implement its Integrity Management Program, which may require excavation to repair or replace segments of pipe at roadway crossings. In some cases, it could require removal of pipe that was installed under roadways crossed using the guided bore or HDD method. The impacts of those activities would be similar to those of constructing the crossings, and the Applicant would restore the roadways to their original condition. Therefore, impacts on roads and highways as a result of these maintenance activities for RA-07 would be temporary and negligible but would occur periodically over the life of the Project.

Railroads, Utilities, and Airports

No impacts on railroads would be expected during operation and maintenance of the pipeline. If a segment of pipe under the rail bed needs to be repaired or replaced it would be accomplished by excavating a pit to remove the pipe that was installed using the guided bore or HDD method and would not affect operation of the railroad.

If integrity digs are required along the route, the Applicant would consult with utility companies and use the Minnesota GSOC system to ensure that all adjacent pipelines and underground utilities are properly marked. As for construction of the pipeline, disruption of service is not expected, and no impact on utilities during maintenance is expected. However, if an unmarked utility line is damaged during maintenance excavations, the Applicant would repair the damage and to allow the provider to restore service. In the event of a disruption, the impact on local users of the utility would be temporary and major.

Operation of the RA-07 pipeline would not affect the Bemidji Regional Airport.

Emergency Services

Operation would require a small number of new hires since the pipeline system could be operated and maintained primarily by the existing staff that operates and maintains the Line 3 pipeline. Therefore, there would not be a measurable impact on emergency services.

Impacts on emergency services in the event of an accidental release of crude oil are addressed in Chapter 10.

Route Alternative RA-08

Construction Impacts

Roads and Highways

Between Clearbrook and Carlton, RA-08 would require 162 road and highway crossings. Similar to construction of the Applicant's preferred route, paved roads would be crossed using the guided bore method, resulting in no road closures. Although presence of the construction crews and vehicles in the areas adjacent to the crossings may cause some drivers to reduce their speed, the resultant impacts on transportation on paved roads due to pipeline crossings would be temporary and negligible.

Construction across unpaved roads would require temporary road closures since they would be crossed using the open-cut method, similar to construction of the main portion of the route across land. Where open-cut methods are used, crossings would typically be completed in 1 day. With the Applicant-proposed measures of detours, warnings, traffic control, and safety signs, impacts on local traffic patterns would be minimized. Because most unpaved roads along RA-08 are in rural areas, detours and

delays during temporary closures could result in longer driving times, causing a temporary minor impact on road users. Impacts on local access from road closures along RA-08 are addressed in Section 6.2.4.3 (Housing).

Traffic along roads within the ROI may also be affected by the increased traffic volume from construction workers and construction equipment vehicles. Construction of RA-08 would most likely be conducted along four construction spreads between Clearbrook and Carlton. Similar to construction of the Applicant's preferred route, there could be a maximum of approximately 590 daily vehicle trips per construction spread during peak construction. Most workers would use major roadways to travel to and from the construction area, as well as some county and local roads to access the right-of-way. However, not all roads crossed by the route would be used as access points for workers. For major roads crossed by the route, AADT ranges from 295 to 16,400 vehicle per day (Table 6.2.5-10). Since workers would be distributed among individual construction spreads, it is unlikely that any single road would be subject to an increase of 590 trips at a given time. For roads with low traffic counts, users may notice the increase in the number of vehicles; however, the impact on traffic is likely to be temporary and minor.

During construction of the four pump stations that would be needed for RA-08, approximately 81 to 86 vehicle trips per day would be added to roads and highways used for access. Since the locations of pump stations have not been determined for RA-08, the impacts on local traffic during construction of the four pump stations cannot be quantitatively assessed. However, it is anticipated that most roads could accommodate the increase of 86 total vehicle trips per day without causing substantial impacts on traffic. As noted above for the Applicant's preferred route, the typical base saturation flow rate (or maximum capacity) for a highway is 1,900 cars per hour per lane (TRB 2000). Even if the 81 to 86 vehicle trips were to occur in the same peak hour, which is not likely, this would only represent a small percentage of the capacity of most roadways along the route. Therefore, impacts on traffic during construction of pump stations for RA-08 are expected to be temporary and minor.

Construction may cause deterioration of road surfaces from the increased worker vehicle traffic and construction vehicles with heavy loads. Construction vehicles also could track dirt and debris onto the road surface. The Applicant would implement measures to minimize debris tracking, including requiring contractors to remove the debris within 24 hours. The Applicant also committed to restoring all road surfaces to preexisting conditions. Therefore, the impact on road surfaces due to construction of RA-08 would be temporary and minor.

Railroads, Utilities, and Airports

Between Clearbrook and Carlton, RA-08 would require five railroad crossings. All active railroads would be crossed using either the guided bore or HDD method. As noted above, both methods require an excavated pit on each side of the crossing; the crossings would be bored or drilled under the rail bed from one pit to the other. The use of either method would result in no impacts on the railroad or its uses.

RA-08 would require constructing 41 pipeline crossings, 36 electrical transmission line crossings, and other local utility crossings. The Applicant would consult with all underground utility companies prior to construction and use the GSOC system prior to excavation to ensure that utility owners or operators are informed of the planned construction and that potentially affected pipelines and underground utilities are properly marked. With these safeguards in place, accidental damage to the utilities is not likely and disruption of service is not expected; therefore, impacts on utilities are not expected. However, it is possible that not all of the locations of local utility lines are known by the local communities or counties.

If utility lines are accidentally damaged, disruption to service could result. The Applicant would be required to repair damaged utilities to allow the provider to restore service. In the event of a disruption, impacts on local residents would be temporary and major.

Before initiating crossings under overhead electrical transmission lines, the Applicant would consult with the owners or operators to ensure that all appropriate safety measures have been implemented. These measures would address aspects of construction such as the distance from the lines, the equipment used, and the methods of moving pipe segments. Implementation of these measures would avoid disruption of service, damage to the utilities, and worker injuries. With these measures in place, impacts on and from overhead electrical transmission lines are expected to be temporary and, at most, negligible.

Because the Bemidji Regional Airport is within 20,000 feet of the RA-08 route, the Applicant may be required to notify the FAA of the planned construction (Section 6.2.5.1.1). If notification is required, the Applicant would then be required to comply with FAA regulations for construction of facilities near airports; as a result, no impacts on the Bemidji Regional Airport are expected due to construction of RA-08.

Emergency Services

Multiple law enforcement agencies and fire departments are present in each county crossed by RA-08. Impacts on emergency services for the route alternatives would be similar to those described for the Applicant's preferred route, including an increased need for police services to assist with traffic control at road crossings and to provide help or consultation regarding security, as well as a general increased need for police services because of the increased population from the construction workforce. For emergency services, such as fire and medical, impacts would be associated with an increased need due to the increase in overall population from the workforce in addition to potential injuries or accidents from construction. The number of emergency services departments in each county crossed by RA-08 appear to be sufficient to absorb the potential increased need for their services (Table 6.2.5-6). Overall, the temporary influx of workers during construction of RA-08 would result in a temporary and minor impact on emergency services in the ROI.

Operations Impacts

Roads and Highways

Maintenance activities would primarily consist of routine vegetation maintenance along the permanent right-of-way of RA-08. Maintenance equipment and vehicles may briefly use local roads for access and egress to and from the right-of-way; this would have little effect on traffic and would therefore not affect traffic.

During operation, the Applicant would implement its Integrity Management Program, which may require excavation to repair or replace segments of pipe at roadway crossings. In some cases, it could require removal of pipe that was installed under roadways crossed using the guided bore or HDD method. The impacts of those activities would be similar to those of constructing the crossings, and the Applicant would restore the roadways to their original condition. Therefore, impacts on roads and highways as a result of these maintenance activities for RA-08 would be temporary and negligible but would occur periodically over the life of the Project.

Railroads, Utilities, and Airports

No impacts on railroads would be expected during operation and maintenance of the pipeline. If a segment of pipe under the rail bed needs to be repaired or replaced it would be accomplished by excavating a pit to remove the pipe that was installed using the guided bore or HDD method and would not affect operation of the railroad.

If integrity digs are required along the route, the Applicant would to consult with utility companies and use the Minnesota GSOC system to ensure that all adjacent pipelines and underground utilities are properly marked. As for construction of the pipeline, disruption of service is not expected, and no impact on utilities during maintenance is expected. However, if an unmarked utility line is damaged during maintenance excavations, the Applicant would repair the damage and to allow the provider to restore service. In the event of a disruption, the impact on local users of the utility would be temporary and major.

Operation of the Project would not affect the Bemidji Regional Airport.

Emergency Services

Operation would require a small number of new hires since the pipeline system could be operated and maintained primarily by the existing staff that operates and maintains the Line 3 pipeline. Therefore, there would not be a measurable impact on emergency services.

Impacts on emergency services in the event of an accidental release of crude oil are addressed in Chapter 10.

6.2.5.4 Summary and Mitigation

6.2.5.4.1 Summary

Table 6.5.2-12 summarizes the potential construction- and operations-related impacts on transportation and public services for the Applicant's preferred route and route alternatives. The types of impacts on transportation would be comparable across route options; the primary differences are the number of crossings (i.e., of roads, railroads, and utilities) for each route option.

Construction Impacts

Roads and Highways

Although impacts on individual unpaved roads are expected to be temporary and minor, the number of roads affected would be different among the route options. RA-03AM would affect the most roads (a total of 329, with some of those paved), followed by RA-07 (185 total road crossings), the Applicant's preferred route and RA-08 (163 and 162 total crossings, respectively), and RA-06 (112 total crossings). In addition, traffic impacts would occur along an additional area for RA-03AM because it would require five construction work spreads between Clearbrook and Carlton compared to four spreads for the other alternatives.

Railroads, Utilities, and Airports

All railroads would be crossed using either the guided bore or HDD method. The use of either method would result in no impacts on railroad bed or rail traffic.

Although impacts on utilities are not expected, the more utilities crossed, the greater the potential for accidental damage. RA-03AM would cross the most utilities (106), followed by RA-07 (85), RA-08 (77), the Applicant's preferred route (67), and RA-06 (52).

Emergency Services

Overall, the temporary influx of workers during construction would result in temporary and minor impacts on emergency services in the ROI for all route options, although the increase in service needs may be slightly higher for RA-03AM, with about 3,000 workers along the route compared to the 2,400 workers for the other route options.

Operations Impacts

Roads and Highways

The number of roads affected by construction would be different among the route options, with RA-03AM having the most road crossings and RA-06 the least.

Railroads, Utilities, and Airports

No impacts on railroads, utilities or airports would be expected during operation and maintenance, regardless of route.

Emergency Services

Emergency services would not be affected, regardless of route.

6.2.5.4.2 Mitigation

The following mitigation measures could be implemented by the Applicant to minimize impacts on transportation:

- Where temporary road closures are required to construct a road crossing, maintain at least one open lane during peak-traffic periods; and
- If roadway congestion occurs on roadways used to access the sites of pump stations or to access the work sites of the pipeline route, provide traffic control by police or sheriff departments.

Table 6.2.5-12. Summary of Potential Impacts on Transportation and Public Services for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Road closures, increased traffic, and road damage caused by construction	Temporary/minor impacts • 163 road crossings • 4 construction spreads	Temporary/minor impacts • 329 road crossings • 5 construction spreads	Temporary/minor impacts • 112 road crossings • 4 construction spreads	Temporary/minor impacts • 185 road crossings • 4 construction spreads	Temporary/minor impacts • 162 road crossings • 4 construction spreads
Disruption of rail or airport travel during construction Disruption of utility service during construction	Temporary/negligible to major impacts • 25 pipeline crossings Temporary/negligible impacts • 42 transmission line crossings Temporary/negligible impacts • 1 airport within 20,000 feet	Temporary/negligible to major impacts • 47 pipeline crossings Temporary/negligible impacts • 59 transmission line crossings	Temporary/negligible to major impacts • 29 pipeline crossings Temporary/negligible impacts • 22 transmission line crossings	Temporary/negligible to major impacts • 42 pipeline crossings, Temporary/negligible impacts • 43 transmission line crossings Temporary/negligible impacts • 1 airport within 20,000 feet	Temporary/negligible to major impacts • 41 pipeline crossings Temporary/negligible impacts • 36 transmission line crossings Temporary/negligible impacts • 1 airport within 20,000 feet
Increased need for emergency services (police, fire, and hospitals) during construction	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts
Operations Impacts					
Roads and highways	Temporary/negligible impacts	Temporary/negligible impacts	Temporary/negligible impacts	Temporary/negligible impacts	Temporary/negligible impacts
Utilities	No impact	No impact	No impact	No impact	No impact
Railroads and airports	No impact	No impact	No impact	No impact	No impacts
Impacts on emergency services (police, fire, and hospitals)	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts

6.2.5.5 References

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6.3 NATURAL RESOURCES

Project actions have the potential to affect the natural environment. This section describes the existing conditions for the Applicant's preferred route and the route alternatives, and assesses their potential impacts on water resources, geology and soils, flora and fauna, and air quality.

6.3.1 Water Resources

This section describes water resources, including groundwater, surface water, wetlands, and floodplains, located along the Applicant's preferred route and route alternatives in Minnesota. The analysis focuses on major groundwater aquifers and wells; surface waterbodies, including streams, rivers, and lakes, and their designations; public waters wetlands; wild rice lakes; calcareous fens; wetland reserve programs; and floodplains designated by FEMA. The potential impacts of pipeline construction and operation are described, and comparisons are provided between the Applicant's preferred route and the four route alternatives (RA-03AM, RA-06, RA-07, and RA-08) between Clearbrook and Carlton.

6.3.1.1 Groundwater

Groundwater resources are relied on as sources for drinking water, irrigation, and industrial use (USGS 1992). Groundwater can be sourced from shallow surficial aquifers or from deeper confined aquifers. Activities that reduce the quantity of available water or introduce contaminants into these aquifers can affect groundwater resources and the people and industries that rely on them. The analysis of potential impacts on groundwater resources during construction of the Applicant's preferred route and route alternatives considered the following:

- Changes in groundwater availability (from withdrawals for hydrostatic testing and other construction activities including "French drain" effects of the pipeline);
- Increases in total suspended solid (TSS) concentrations during trenching and excavation activities in shallow aquifers;
- Degradation of shallow groundwater quality from blasting, spills, or contamination;
- Degradation of groundwater quality in potable supply wells, sole source aquifers, or other designated groundwater protection areas; and
- Degradation of water quality from drilling mud releases during HDD crossings.

Potential operations-related impacts on groundwater addressed in this section include:

- The potential for groundwater availability changes due to repair and maintenance activities and the risk of French drain effects; and
- Contamination resulting from small fuel and lubricant leaks and spills from maintenance and inspection vehicles.

This section first describes the existing conditions for groundwater resources within an area along the Applicant's preferred route and each of the route alternatives where groundwater could be affected by construction and operation activities. The potential impacts on groundwater resources from construction and operation of the Applicant's preferred route are considered next. Potential impacts on groundwater resources for each route alternative are assessed and then compared to each other and to the Applicant's preferred route between Clearbrook and Carlton as the impacts from North Dakota to

Clearbrook and from Carlton to Wisconsin will be the same for all route alternatives. A summary and comparison of the impacts for the five route options (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08) are included at the end of the section. Chapter 10 addresses the impacts on groundwater resources resulting from an unanticipated release of crude oil.

6.3.1.1.1 Regulatory Context and Methodology

Regulatory Context

A number of regulatory programs in Minnesota control activities with the potential to affect the quantity or quality of groundwater resources. These programs and their relevance to the construction and operation of a pipeline are summarized in Table 6.3.1.1-1. They also are described in greater detail below.

Table 6.3.1.1-1. Minnesota Regulatory Requirements for Protection of Groundwater

Unit of Government	Type of Application	Reason Required
Minnesota Department of Natural Resources	Water Appropriation Permit for withdrawals exceeding 10,000 gpd or 1 million gallons/year	Authorizes withdrawal and use of groundwater from private or municipal wells for hydrostatic testing, dust control, horizontal directional drilling, and trench dewatering.
	Calcareous Fen Management Plans	Impacts on calcareous fens are managed by the Minnesota Department of Natural Resources under approved calcareous fen management plans.[a]
Minnesota Department of Health	Drinking water supply management area – wellhead protection area consultation	Ensures that pipeline construction and operation are compatible with goals of relevant drinking water supply management area and wellhead protection area plans.
Minnesota Pollution Control Agency	National Pollutant Discharge Elimination System/State Disposal System Permit 401 Certification for 404 ACOE permit	Groundwater discharge/construction dewatering to groundwater interface

Sources: Minnesota DNR 2017a; Minnesota DH 2014; Minnesota PCA n.d.[a].

Notes:

[a] Calcareous fens are discussed in Wetlands, Section 5.2.1.3.

gpd = gallons per day

Minnesota Statutes Chapter 103G addresses management of groundwater quantity and groundwater withdrawals. Based on this authority, Minnesota DNR requires all water users withdrawing more than 10,000 gallons per day or 1 million gallons per year to apply for a Water Appropriations Permit. In its review of applications and issuance of permits, Minnesota DNR may consider the potential impact of the proposed withdrawal on the quantity of local groundwater resources and on unique ecosystems, like fens, which are sensitive to even minor changes in local hydrology.[5] In the case of pipeline projects like the Line 3 Replacement Project, Water Appropriations Permits are necessary because large volumes of

[5] Minnesota Administrative Rules Part 6115.0670.

water are needed for hydrostatic testing of the pipeline (see Section 2.7.1.13 for a description of hydrostatic testing).

Minnesota Statutes Chapter 103H addresses groundwater quality by establishing that the goal of the state is to maintain groundwater in its natural condition, free from any degradation caused by human activities. Minnesota Administrative Rules Part 7850.0221 establishes the water quality standards for domestic consumption, which are applicable to all groundwater resources in the state. The Minnesota Pollution Control Agency (Minnesota PCA) monitors groundwater quality; the agency has various programs in place to prevent pollution of groundwater and to remediate where groundwater has been contaminated. In addition, the Minnesota Department of Health (Minnesota DH) has authority under Minnesota Statutes § 103I, Subdivision 5, and Minnesota Administrative Rules Parts 4720.5100 to 4720.5590 to implement wellhead protection programs. These programs prevent contamination of public and non-public community water supply wells by effectively managing potential contaminant sources in the areas that contribute water to the public water supply well (wellhead protection areas). Drinking water supply management areas (DWSMAs) are delineated around these wellhead protection areas. Within a DWSMA, the water-supply provider conducts an inventory of potential contamination sources and develops management practices and monitoring strategies to mitigate well contamination. Minnesota DH consults with other agencies during environmental review and permitting of activities in these wellhead protection areas to ensure that risks are considered and minimized during environmental review and are managed through permit conditions.

Methodology

The ROI for groundwater analysis consists of the pipeline corridor and a 1,000-foot buffer on either side of the centerline of the Applicant's preferred route and route alternatives. Operations impacts for the Applicant's preferred route were estimated based on the footprint for the permanent right-of-way provided by the Applicant. Operations impacts for the route alternatives were estimated by overlaying a standardized 50-foot-wide permanent right-of-way centered on the route.

Impacts on groundwater resources were identified based on common pipeline construction methods; peer-reviewed literature; agency documents, including permit requirements and guidance manuals; Applicant-submitted documents, including the November 2016 EAW and associated construction BMP plans (Enbridge 2016a); and the experience and professional judgment of the hydrogeologists involved in developing this analysis.

Identification of groundwater resources potentially affected by the Project was completed by reviewing reports and data from USGS, Minnesota Geological Survey (MGS), Minnesota DNR, Minnesota PCA, Minnesota DH, Minnesota Department of Agriculture (Minnesota DA), and the U.S. Environmental Protection Agency (EPA). Minnesota DH, Minnesota DNR, and Minnesota PCA provided data and guidance for these analyses.

Impacts related to groundwater resources were evaluated by overlaying the ROI for the Applicant's preferred route and the route alternatives with the following Minnesota data sources:

- Aquifer locations and type, including sole source aquifers;

- Wellhead protection areas;[6] and
- Domestic and public water supply wells.

  A Public Water Supply (PWS) in Minnesota by definition must serve 25 or more people for at least 60 days of the year as defined by the Federal Safe Drinking Water Act. PWSs are broken down into community and noncommunity:

  - Community PWS (Municipal and Non-Municipal). Provides water to the public in their primary living space—where people live and sleep—(e.g., homes, apartments, nursing homes, prisons, mobile home parks).
  - Noncommunity PWS. Provides water to the public in places other than their homes—where people work, gather, and play.

    Two types are:

    - Transient Noncomm PWS. Facilities that serve at least 25 people at least 60 days of the year, but do not serve the same 25 people over 6 months of the year (e.g., restaurants, campgrounds, hotels, and churches).
    - Nontransient Noncomm PWS. Facilities that serve at least 25 of the same people over 6 months of the year (e.g., schools, offices, factories, and daycare centers).
- Minnesota DA's Water Table Aquifer Vulnerability.
- Minnesota DNR's Watershed Health Assessment Framework groundwater contamination susceptibility index.
- Minnesota PCA's and Minnesota DA's "What's in My Neighborhood?" (WIMN) databases and EPA's Facility Registry Service (EPA-listed contaminated sites).
- Drinking water supply management areas.[7]
- Minnesota DNR's Minnesota pollution sensitivity of near-surface materials.
- Minnesota DNR's Minnesota pollution sensitivity of bedrock surface.

6.3.1.1.2 Existing Conditions

The following discussion details the existing groundwater conditions in the vicinity of the Applicant's preferred route and the route alternatives, including aquifer types, characteristics of the materials that make up the aquifers, water yield, and water quality.

Aquifers are underground layers of permeable rock, sediment, or soil that yield usable amounts of water. Two types of aquifers provide water: unconfined and confined aquifers. When the top of the aquifer is not overlain by impermeable layers that restrict the vertical movement of water, the aquifer is unconfined. The upper surface of groundwater in this type of aquifer is referred to as the "water table."

[6] A wellhead protection area is the surface and subsurface area surrounding a public water supply well or well-field that is regulated to prevent contamination; any potential contaminants are likely to move toward this area and reach the well or well-field capture zone.

[7] A drinking water supply management area is the surface and subsurface area surrounding a public water supply well that is approved by Minnesota DH and completely contains the scientifically calculated wellhead protection area; these areas are managed by the entity identified in a Wellhead Protection Plan.

When there is a layer of low-permeability material between the top of the aquifer and overlying sediments, that restricts vertical movement of water, the aquifer is confined. The low-permeability layers are called confining units, or aquitards, and are mainly composed of silt and clay. Confined and unconfined aquifers occur beneath the Applicant's preferred route and the route alternatives.

Confined and unconfined aquifers occur in both glacial and bedrock materials. Glacial aquifers consist of unconsolidated sediments deposited and reworked by glaciers that range in depth from just below to several hundred feet below the land surface. Bedrock aquifers underlie the glacial materials and consist of deeper consolidated bedrock layers such as limestone or sandstone.

Applicant's Preferred Route

Glacial Aquifers

A general description of glacial aquifers as well as those crossed by the Applicant's preferred route is included in Section 5.2.1.1.2.

Bedrock Aquifers

There are generally two types of bedrock aquifers that occur beneath the surficial glacial-type aquifers along the Applicant's preferred route. The first type are aquifers that consist of hard and very old igneous and metamorphic rocks, where groundwater occurs mostly in fractures that may not yield usable quantities of water.

The second type of bedrock aquifer consists of thick, laterally extensive sequences of sandstone, limestone, and dolostone of sedimentary origin. This type of bedrock aquifer tends to be more productive than the first type. Similar to confined glacial aquifers, the majority of this type of bedrock aquifer often is isolated from overlying surficial aquifers by confining units, which decreases it vulnerability to contamination from land surface activities. The exception to this is karst aquifers, which are vulnerable to contamination. A karst aquifer is a type of bedrock aquifer that usually consists of limestone but can consist of dolostone or sandstone. Aquifers composed of these pH basic rock types are prone to chemical weathering and dissolution from the slight acidity of precipitation and groundwater, which can result in the formation of fractures, joints, sinkholes, cavities, caves, and void spaces that allow movement of large volumes of surface water into and through the aquifer. These aquifers often are the source of abundant springs and seeps. These characteristics also allow contamination to spread rapidly within the aquifer. Karst aquifers are susceptible to collapse of the aquifer matrix, which can be triggered by construction activities on the land surface and can lead to formation of sinkholes in unconsolidated sediments that overlie the bedrock. Paleozoic limestones and some Precambrian sandstones found in southeastern and eastern Minnesota are susceptible to dissolution and result in karst topography. Bedrock in these areas is often less than 50 feet deep and is considered vulnerable to contamination (Minnesota DNR 2016). No karst aquifers are believed to be present along the Applicant's preferred route.

With the exception of shallow bedrock (either igneous/metamorphic or sedimentary, which is not common along the Applicant's preferred route) and karst bedrock, bedrock aquifers are not expected to be affected by pipeline construction and operation because they exist at depths averaging from 300 to 400 feet, which is well below pipeline construction depths. These deeper bedrock aquifers often are overlain by thick confining layers, which protect them from disturbance by human activities on the land surface. There are a few areas in Carlton and Pine counties where Precambrian fractured bedrock depth

is less than 50 feet and therefore these aquifers are more susceptible to pipeline construction and operation. The bedrock aquifers crossed by the Applicant's preferred route are listed in Table 5.2.1.1-2.

Sole Source Aquifers

The Applicant's preferred route would not cross any aquifers designated by EPA as sole source aquifers.

Domestic Wells, Public Wells, Wellhead Protection Areas, and DWSMAs

Domestic (private) drinking water wells and their sensitivity were identified within an established 1,000-foot-wide buffer of the centerline for the Applicant's preferred route (Table 6.3.1.1-2.) The method of determining low, moderate, high, or very high geologic sensitivity for a well considers the thickness of fine-grained geologic material (clay or shale) overlying an aquifer that is penetrated by a well. Hydrogeologic sensitivity is a qualitative measure of the ability of near-surface materials to transmit contaminants vertically to the water table and is ranked as follows by Minnesota DH:

- Low – fine-grained materials such as clays and clay-silt mixtures;
- Moderate – clay-silt-sand mixtures, sandy or silty tills, and colluvium;
- High – sands and sandy mixtures; and
- Very high – gravels or coarse sands mixed with gravel.

From Clearbrook to Carlton, 164 domestic supply wells are within the within the ROI for the Applicant's preferred route, and 42 of these wells have a high or very high geological sensitivity rating. Two unverified and three verified locations for public supply/non community transient wells are located in the ROI for the Applicant's preferred route. Two public supply wellhead protection areas are located in the ROI, and have different geological sensitivity ratings (Table 6.3.1.1-2 and Figure 6.3.1.1-1). None of the wells are located within the construction work area or permanent right-of-way.

From Clearbrook to Carlton, the Applicant's preferred route would cross 0.6 acre of wellhead protection areas and 172 acres of DWSMAs (Table 6.3.1.1-2 and Figure 6.3.1.1-2).

Minnesota Water Table Aquifer Vulnerability, Groundwater Contamination Susceptibility, and Pollution Sensitivity of Near-Surface Materials

Water table aquifers are most vulnerable to contamination because they lack confining layers and directly interact with the land surface. Minnesota ranks water table aquifer vulnerability based on the overlapping time of water travel from the landsurface to groundwater. The vulnerability of the aquifer is inversely proportional to the time of travel. In areas of higher sensitivity, contaminants may reach the groundwater within hours to months; in areas of lower sensitivity, surface contamination may take months to years to travel into groundwater.

Table 6.3.1.1-2. Wells, Wellhead Protection Areas, and Drinking Water Supply Management Areas Crossed by the Applicant's Preferred Route

Segment	Domestic Wells and Sensitivity (number)					Wellhead Protection Areas and Sensitivity (number)					Wellhead Protection Area (acres)	DWSMA (acres)
	Low	Moderate	High	Very High	Total	Low	Moderate	High	Very High	Total	Low	Moderate
North Dakota-Minnesota border to Clearbrook (for APR and all route alternatives)	12	1	1	--	North Dakota-Minnesota border to Clearbrook	12	1	1	--	North Dakota-Minnesota border to Clearbrook	12	1
Clearbrook to Carlton (APR only)	87	35	25	17	Clearbrook to Carlton	87	35	25	17	Clearbrook to Carlton	87	35
Carlton to Minnesota-Wisconsin border (for APR and all route alternatives)	16	1	3	1	Carlton to Minnesota-Wisconsin border	16	1	3	1	Carlton to Minnesota-Wisconsin border	16	1
TOTAL	**115**	**37**	**29**	**18**	**TOTAL**	**115**	**37**	**29**	**18**	**TOTAL**	**115**	**37**

Sources: Minnesota DH n.d. 2014, 2016.

Notes:

Number of wells and acres of wellhead protection areas and drinking water supply management areas (DWSMAs) within a 1,000-foot buffer on either side of the route centerline.

APR = Applicant's preferred route.

"--" = no occurrence.

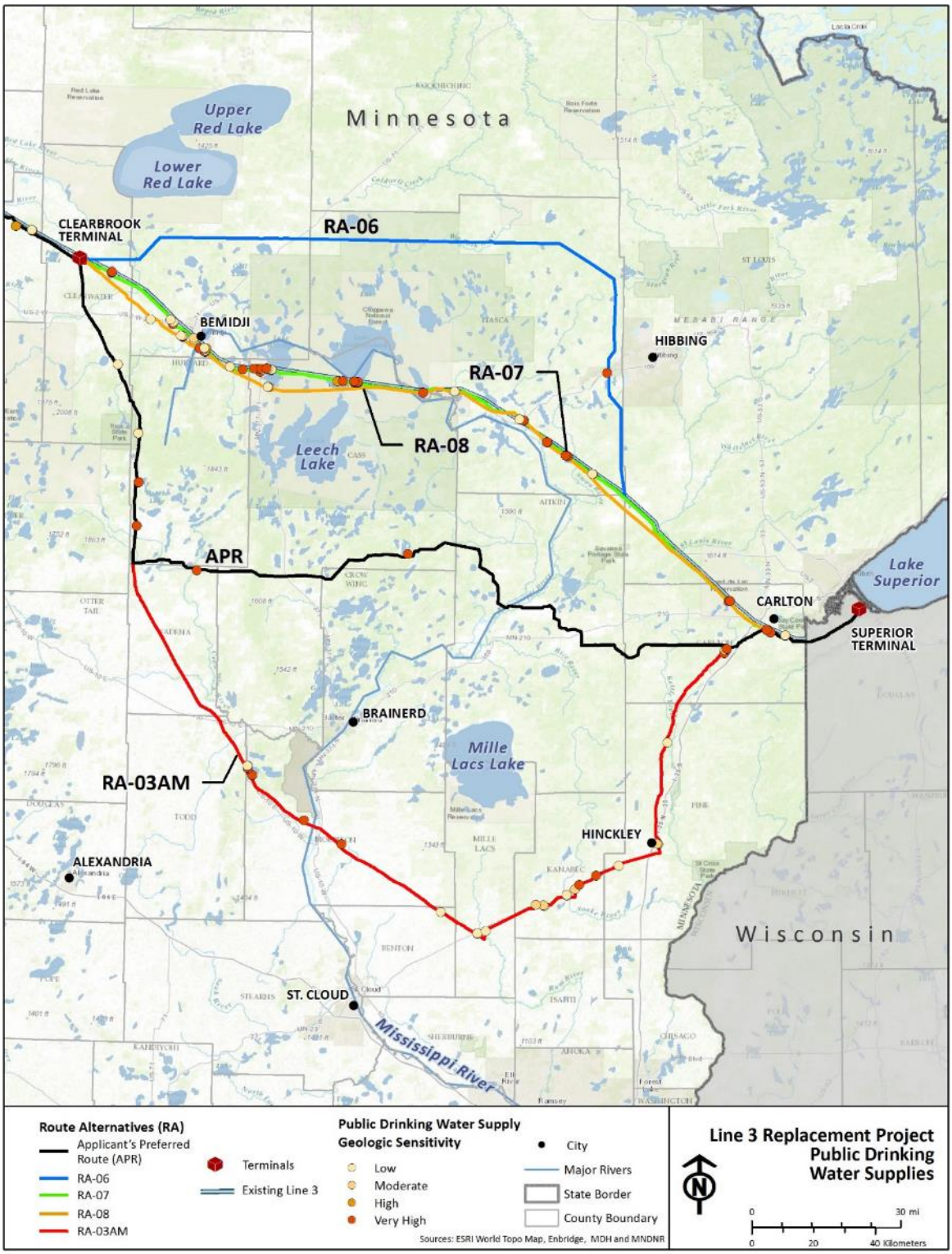

Figure 6.3.1.1-1. Public Wells in the Region of Interest for the Applicant's Preferred Route and Route Alternatives

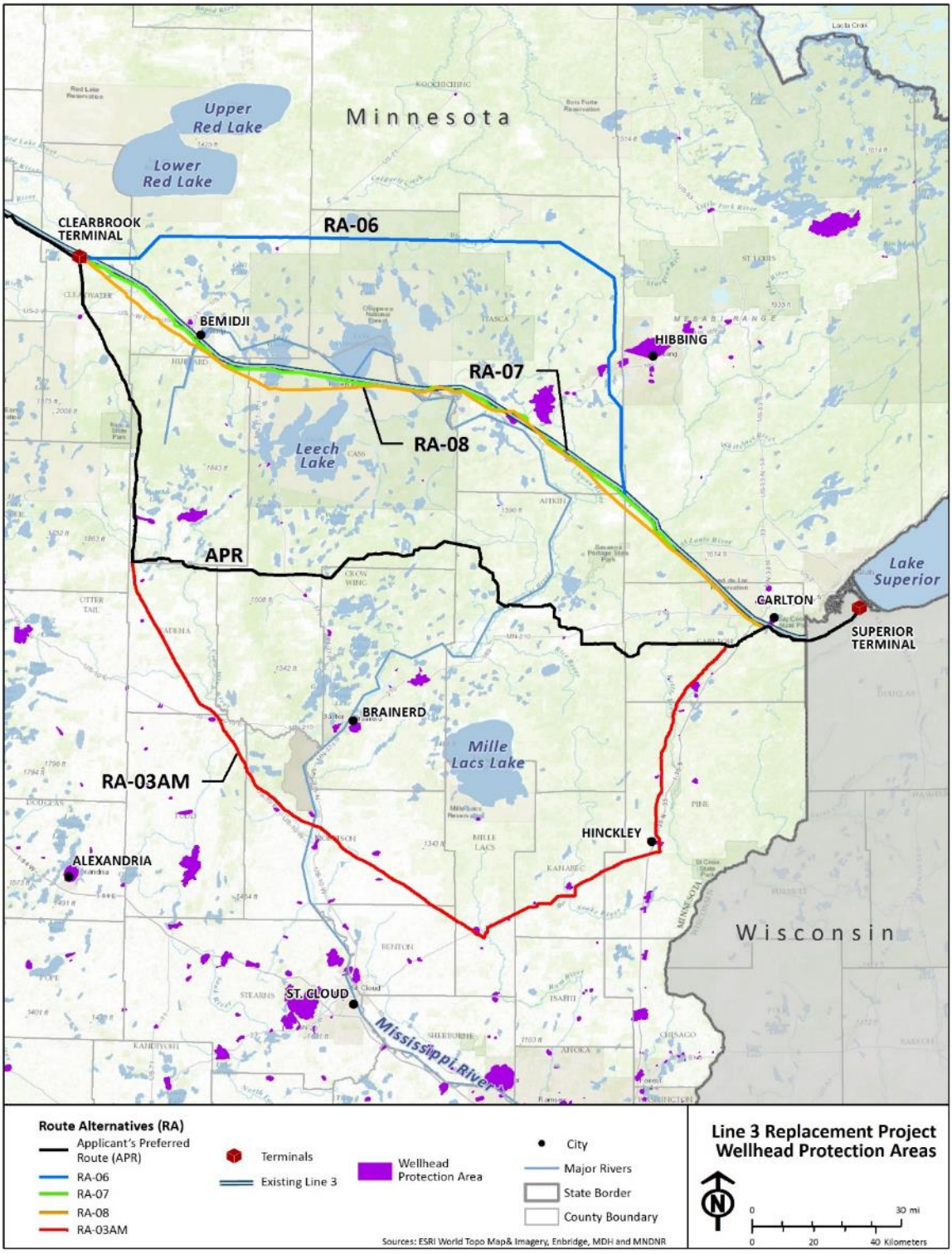

Figure 6.3.1.1-2. Wellhead Protection Areas near the Applicant's Preferred Route and Route Alternatives

Minnesota also evaluates the vulnerability of groundwater based on the shape, type, and relative position of surface and subsurface geology (i.e., the geomorphic setting), which controls the flow paths of water and dissolved elements above and below the surface. Sandiness, permeability, depth to rock outcrops, fracturing and permeability of bedrock, flow-restricting layers, and surface and subsurface connections all affect how vulnerable groundwater is to contamination. Areas of highest ground water contamination susceptibility are in central, north-central, and east-central Minnesota and the southeastern corner of the state, in areas dominated by sand and gravel aquifers or in areas with karstic bedrock. Additionally, Minnesota DNR classifies the sensitivity to pollution of near-surface materials, which is an estimate of the time it takes for water to travel through the unsaturated zone to reach the water table, which is assumed to be 10 feet below land surface. Transmission rates are based on soil type and the texture of surficial geologic units. Generally, areas of coarse-grained material are modeled as higher sensitivity to pollution compared to areas of fine-grained material. As with water table aquifer vulnerability rankings, transmission time in areas of high pollution sensitivity may be hours to months; in areas of low pollution sensitivity, transmission time may be months to years.

There is one area in Carlton County with shallow Precambrian bedrock that is fractured and used for domestic well supply. Minnesota DNR (2016, Minnesota Hydrogeology Atlas series HG-01) has classified the pollution sensitivity of the bedrock surface of parts of Minnesota and this includes these aquifers. The pollution sensitivity of the bedrock surface characterizes the relative rate of vertical travel time of a contaminant that moves conservatively with or within water from the land surface to the buried bedrock surface. The classification includes very high, high, moderate, low, and very low sensitivity. The Applicant's preferred route crosses 753 acres of high vulnerability bedrock surface and 947 acres of very high vulnerability bedrock surfaces in Carlton County.

From North Dakota to Carlton, the Applicant's preferred route would cross 25,751 acres of high vulnerability water table aquifers, 26,382 acres of high groundwater contamination susceptibility, 16,290 acres of high pollution sensitivity, and 1,700 acres of high to very high sensitivity Precambrian bedrock aquifers (Table 6.3.1.1-3). No karst topography would be crossed by the Applicant's preferred route within the ROI from Clearbrook to Carlton.

Table 6.3.1.1-3. Groundwater Sensitivity beneath the Applicant's Preferred Route (acres)

Segment	High Water Table Aquifer Vulnerability	High Groundwater Contamination Susceptibility	High Pollution Sensitivity	Precambrian Bedrock Aquifers with High to Very High Sensitivity
North Dakota-Minnesota border to Clearbrook	7,026.8	--	637.6	--
Clearbrook to Carlton	18,215.1	26,381.5	15,474.9	1,700
Carlton to Minnesota-Wisconsin border	508.7	--	177.9	
TOTAL	**25,750.6**	**26,381.5**	**16,290.4**	**1,700**

Sources: Minnesota DA 2015; Minnesota DNR 2016, 2017b.

Notes:

Acres are within a 1,000-foot buffer on either side of the route centerline.

"--" = no occurrence.

Contaminated Sites

Between Clearbrook and Carlton, four EPA-listed contaminated sites and 62 WIMN sites are within the ROI for the Applicant's preferred route (Table 6.3.1.1-4).

Table 6.3.1.1-4. Contaminated Sites within the Region of Interest for the Applicant's Preferred Route

Segment	Minnesota PCA "What's in My Neighborhood" Sites	Minnesota DA "What's in My Neighborhood" Sites[a]
North Dakota-Minnesota border to Clearbrook	36	9
Clearbrook to Carlton	62	4
Carlton to Minnesota-Wisconsin border	3	--
TOTAL	**101**	**13**

Source: Minnesota PCA n.d.[b].

Notes:

Sites within a 1,000-foot buffer on either side of the route centerline.

[a] Does not include Minnesota DA contingency clean-up sites.

"--" = no occurrence.

Route Alternatives

Glacial Aquifers

A general description of glacial aquifers, as well as those crossed by route alternatives, is included in Section 5.2.1.1.2.

Similar to the Applicant's preferred route, shallow bedrock is not common along the route alternatives. Depths of bedrock along these alignments average from 300 to 400 feet with the exception of some areas of shallow fractured Precambrian bedrock aquifers in parts of Pine and Carlton Counties. Bedrock aquifers crossed by the route alternatives include the Red River-Winnipeg aquifer, Cretaceous aquifer, Precambrian Undifferentiated aquifer, and Proterozoic aquifer. These aquifers are generally described in Section 5.2.1.1.2.

Bedrock Aquifers

The bedrock aquifers crossed by the route alternatives are listed in Table 5.2.1.1-2. In addition to these aquifers, RA-06, RA-07, and RA-08 cross the Biwabik Iron-Formation aquifer. This Precambrian-age aquifer is composed of chert and iron materials, and it generally underlies glacial materials. However, it outcrops[8] above the land surface in north-central Minnesota. The yields of this aquifer ranges from 250 to 1,000 gallons per minute (gpm). This aquifer is one of the most productive aquifers for the Mesabi Iron Range and is a primary source of drinking water for many municipalities. Dissolved solids range from 100 to 300 milligrams per liter (mg/L), and the water can contain high concentrations of iron, manganese, and silica. This aquifer is susceptible to contamination where surficial materials are thin, at outcrops, and in mine

[8] An outcrop is a visible exposure of bedrock on the land surface.

pits. Groundwater flow in this aquifer occurs as regional flow along bedding planes and large fracture networks, as localized flow in discrete fractures near wells, or as a combination of both.

Route Alternative RA-03AM

Sole Source Aquifers

The RA-03AM route would not cross any aquifers designated by EPA as a sole source aquifer.

Domestic Wells, Public Wells, Wellhead Protection Areas, and DWSMAs

From Clearbrook to Carlton, 396 domestic supply wells are within the ROI for the RA-03AM route; 55 of these have a high or very high geological sensitivity rating. Of the 10 public supply wells, 4 have a high or very high geological sensitivity rating (Table 6.3.1.1-5 and Figure 6.3.1.1-1 above). Five of these domestic wells are within the construction work area, and two are within the permanent right-of-way for the RA-03AM route.

The RA-03AM route would cross 329.5 acres of wellhead protection area acres and 849 acres of DWSMAs between Clearbrook and Carlton (Table 6.3.1.1-5 and Figure 6.3.1.1-2 above).

Table 6.3.1.1-5. Wells, Wellhead Protection Areas, and Drinking Water Supply Management Areas Crossed by Route Alternative RA-03AM

Domestic Wells and Sensitivity (number)					Public Wellhead Protection Areas and Sensitivity (number)					Wellhead Protection Area (acres)	DWSMA (acres)
Low	Moderate	High	Very High	Total	Low	Moderate	High	Very High	Total		
242	99	24	31	396	1	2	2	--	5	329.5	849

Sources: Minnesota DH n.d. 2014, 2016.

Notes:

Number of wells and acres of wellhead protection areas and drinking water supply management areas (DWSMAs) within a 1,000-foot buffer on either side of the route centerline.

Counts for the North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border segments are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-2.

"--" = no occurrence.

Minnesota Water Table Aquifer Vulnerability, Groundwater Contamination Susceptibility, and Pollution Sensitivity of Near-Surface Materials

From Clearbrook to Carlton, the RA-03AM route would cross 25,928 acres of high vulnerability water table aquifers; 25,152 acres of high groundwater contamination susceptibility; and 25,588 acres of high pollution sensitivity. The RA-03AM route also would cross 2,917 acres of karst topography and 2,547 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers within the ROI (Table 6.3.1.1-6).

Table 6.3.1.1-6. Groundwater Sensitivity beneath Route Alternative RA-03AM (acres)

High Aquifer Vulnerability	High Groundwater Contamination Susceptibility	High Pollution Sensitivity	Karst Topography	Bedrock Aquifers with High to Very High Sensitivity
25,927.6	25,152.3	25,587.7	2,916.6	5,463.7

Sources: Minnesota DA 2015; Minnesota DNR 2016, 2017b.

Notes:

Acres within a 1,000-foot buffer on either side of the route centerline.

Acres for the North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border segments of the route are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-3.

Contaminated Sites

Between Clearbrook and Carlton, 70 EPA-listed contaminated sites and 182 WIMN sites (179 Minnesota PCA and 3 Minnesota DA) are within the ROI for RA-03AM.

Route Alternative RA-06

Sole Source Aquifers

The RA-06 route would not cross any aquifers designated by EPA as a sole source aquifer.

Domestic Wells, Public Wells, Wellhead Protection Areas, and DWSMAs

From Clearbrook to Carlton, 40 domestic supply wells are within the ROI for the RA-06 route; 4 of these have a high or very high geological sensitivity rating. No public supply wells are within the RA-06 ROI (Figure 6.3.1.1-1). Three domestic wells are within the construction work area, and two are within the permanent right-of-way for the RA-06 route. The RA-06 route would cross 56 acres of wellhead protection areas and 131 acres of DWSMAs (Table 6.3.1.1-7 and Figure 6.3.1.1-2 above).

Table 6.3.1.1-7. Wells, Wellhead Protection Areas, and Drinking Water Supply Management Areas Crossed by Route Alternative RA-06

Domestic Wells and Sensitivity (number)					Public Wellhead Protection Area and Sensitivity (number)					Wellhead Protection Area (acres)	DWSMA (acres)
Low	Moderate	High	Very High	Total	Low	Moderate	High	Very High	Total		
33	3	1	3	40	--	--	--	1	1	55.9	130.9

Sources: Minnesota DH n.d. 2014, 2016.

Notes:

Number of wells and acres of wellhead protection areas and drinking water supply water management areas (DWSMAs) within a 1,000-foot buffer on either side of the route centerline.

Counts for the North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border segments are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-2.

"--" = no occurrence.

Minnesota Water Table Aquifer Vulnerability, Groundwater Contamination Susceptibility, and Pollution Sensitivity of Near-Surface Materials

From Clearbrook to Carlton, the RA-06 route would cross 5,806 acres of high vulnerability water table aquifers; 305 acres of high groundwater contamination susceptibility, and 3,134 acres of high pollution sensitivity. The RA-06 route also would cross 512 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers within the ROI. The RA-06 route would not cross any areas of known karst topography (Table 6.3.1.1-8).

Table 6.3.1.1-8. Groundwater Sensitivity beneath Route Alternative RA-06 (acres)

High Aquifer Vulnerability	High Groundwater Contamination Susceptibility	High Pollution Sensitivity	Bedrock Aquifers with High to Very High Sensitivity
5,806.2	304.6	3,134.0	511.5

Sources: Minnesota DA 2015; Minnesota DNR 2016, 2017b.

Notes:

Acres within a 1,000-foot buffer on either side of the route centerline.

Acres for the North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border segments of the route are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-3.

Contaminated Sites

Between Clearbrook and Carlton, 13 EPA-listed contaminated sites and 72 WIMN sites (71 Minnesota PCA and 1 Minnesota DA) are within the ROI for RA-06.

Route Alternative RA-07

Sole Source Aquifers

The RA-07 route would not cross any aquifers designated by EPA as a sole source aquifer.

Domestic Wells, Public Wells, Wellhead Protection Areas, and DWSMAs

From Clearbrook to Carlton, 183 domestic supply wells are within the ROI for the RA-07 route; 19 of these have a high or very high geological sensitivity rating. Of the 23 public supply wells, 8 have a high or very high geological sensitivity rating (Figure 6.3.1.1-1). Two of these domestic wells are within the construction work area, and one is within the permanent right-of-way for the RA-07 route. The RA-07 route would cross 536 acres of wellhead protection areas and 754 acres of DWSMAs (Table 6.3.1.1-9 and Figure 6.3.1.1-2 above).

Table 6.3.1.1-9. Wells, Wellhead Protection Areas, and Drinking Water Supply Management Areas Crossed by Route Alternative RA-07

Domestic Wells and Sensitivity (number)					Public Wellhead Protection Areas and Sensitivity (number)					Wellhead Protection Area (acres)	DWSMA (acres)
Low	Moderate	High	Very High	Total	Low	Moderate	High	Very High	Total		
118	46	10	9	**183**	1	2	1	--	**4**	4,426	5,155

Sources: Minnesota DH n.d. 2014, 2016.

Notes:

Number of wells and acres of wellhead protection areas and drinking water supply management area (DWSMAs) within a 1,000-foot buffer on either side of the route centerline.

Counts for North Dakota-Minnesota border to Clearbrook and Carlton to Minnesota-Wisconsin border are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-2.

"--" = no occurrence.

Minnesota Water Table Aquifer Vulnerability, Groundwater Contamination Susceptibility, and Pollution Sensitivity of Near-Surface Materials

From Clearbrook to Carlton, the RA-07 route would cross 21,141 acres of high vulnerability water table aquifers, 19,833 acres of high groundwater contamination susceptibility, and 15,355 acres of high pollution sensitivity. The RA-07 route also would cross 512 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers within the ROI. The RA-07 route would not cross any areas of known karst topography (Table 6.3.1.1-10).

Table 6.3.1.1-10. Groundwater Sensitivity beneath Route Alternative RA-07 (acres)

High Aquifer Vulnerability	High Groundwater Contamination Susceptibility	High Pollution Sensitivity	Bedrock Aquifers with High to Very High Sensitivity
21,141.1	19,832.6	15,354.6	512

Sources: Minnesota DA 2015; Minnesota DNR 2016, 2017b.

Notes:

Acres within a 1,000-foot buffer on either side of the route centerline.

Acres for the North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border segments of the route are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-3.

"--" = no occurrence.

Contaminated Sites

Between Clearbrook and Carlton, 92 EPA-listed contaminated sites and 120 WIMN sites (119 Minnesota PCA and 1 Minnesota DA) are within the ROI for RA-07.

Route Alternative RA-08

Sole Source Aquifers

The RA-08 route would not cross any aquifers designated by EPA as a sole source aquifer.

Domestic Wells, Public Wells, Wellhead Protection Areas, and DWSMAs

From Clearbrook to Carlton, 162 domestic supply wells are within the ROI for the RA-08 route; 11 of these have a high or very high geological sensitivity rating. There are seven public supply wells, of which six have a high or very high geological sensitivity rating (Table 6.3.1.1-11 and Figure 6.3.1.1-1 above). One of these domestic wells is within the construction work area, and one is within the permanent right-of-way for the RA-08 route. The RA-08 route would cross 672 acres of wellhead protection areas and 810 acres of DWSMAs (Table 6.3.1.1-11 and Figure 6.3.1.1-2 above).

Table 6.3.1.1-11. Wells, Wellhead Protection Areas, and Drinking Water Supply Management Areas Crossed by Route Alternative RA-08

Domestic Wells and Sensitivity (number)					Public Wellhead Protection Areas and Sensitivity (number)					Wellhead Protection Area (acres)	DWSMA (acres)
Low	Moderate	High	Very High	Total	Low	Moderate	High	Very High	Total		
105	46	5	6	**162**	--	1	1	--	**2**	672	810

Sources: Minnesota DH n.d. 2014, 2016.

Notes:

Number of wells and acres of wellhead protection areas and drinking water supply management areas (DWSMAs) within a 1,000-foot buffer on either side of the route centerline.

Counts for North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-2.

"--" = no occurrence.

Minnesota Water Table Aquifer Vulnerability, Groundwater Contamination Susceptibility, and Pollution Sensitivity of Near-Surface Materials

From Clearbrook to Carlton, the RA-08 route would cross 16,889 acres of high vulnerability water table aquifers, 20,012 acres of high groundwater contamination susceptibility, and 11,699 acres of high pollution sensitivity. The RA-08 route also would cross 512 acres of very high to high sensitivity Precambrian shallow fractured bedrock aquifers within the ROI. The RA-08 route would not cross any areas of known karst topography (Table 6.3.1.1-12).

Table 6.3.1.1-12. Groundwater Sensitivity Beneath Route Alternative RA-08 (acres)

High Aquifer Vulnerability	High Groundwater Contamination Susceptibility	High Pollution Sensitivity	Bedrock Aquifers with High to Very High Sensitivity
16,888.9	20,012.4	11,699.1	512

Sources: Minnesota DA 2015; Minnesota DNR 2016, 2017b.

Notes:

Acres within a 1,000-foot buffer on either side of the route centerline.

Acres for the North Dakota-Minnesota border-to-Clearbrook and the Carlton-to-Minnesota-Wisconsin border segments of the route are the same as those presented for the Applicant's preferred route in Table 6.3.1.1-3.

"--" = no occurrence.

Contaminated Sites

Between Clearbrook and Carlton, 50 EPA-listed contaminated sites and 101 WIMN sites (99 Minnesota PCA and 2 Minnesota DA) are within the ROI for RA-08.

6.3.1.1.3 Impact Assessment

This section contains the impact analysis conducted for the Applicant's preferred route and the route alternatives. The analysis assessed potential impacts on groundwater resources in the ROI for the route options, as described in Section 6.3.1.2.1, related to the following concerns:

- Changes in groundwater availability (from withdrawals for hydrostatic testing and other construction activities, including French drain effects of the pipeline);
- Increases in TSS concentrations during trenching and excavation activities in shallow aquifers;
- Degradation of shallow groundwater quality from blasting, spills, or contamination;
- Degradation of groundwater quality in potable supply wells, sole source aquifers, or other designated groundwater protection areas; and
- Degradation of water quality from drilling mud releases during HDD crossings.

Potential operations-related impacts on groundwater addressed in this section include:

- The potential for groundwater availability changes due to maintenance and repair activities and the risk of French drain effects, and
- Contamination resulting from small fuel and lubricant leaks and spills from maintenance and inspection vehicles.

Many pipeline construction activities have the potential to affect groundwater quantity and quality. These activities include water withdrawals and discharges (e.g., for hydrostatic test water), dewatering and trenching, blasting, access road construction, waterbody crossings, and fueling and use of hazardous materials. The following sections address potential impacts on groundwater from these activities for the Applicant's preferred route and route alternatives. After the discussion of construction impacts, the potential impacts of operations on groundwater resources are addressed for the Applicant's preferred route and each route alternative.

The construction and operations activities that may affect groundwater resources are the same for the Applicant's preferred route and each of the route alternatives. The impacts vary with the length of the alternatives and the groundwater resources present along each specific route.

As noted in Section 6.1, impacts have been assessed for the entire length of the Applicant's preferred route in Minnesota and for the portion of the route from Clearbrook to Carlton. Impacts have been assessed for each of the route alternatives between Clearbrook and Carlton.

Applicant's Preferred Route (in Minnesota)

Construction Impacts

Changes in Groundwater Availability from Withdrawals

The Applicant would withdraw water for construction activities such as dust control, HDD installation, and hydrostatic testing of the pipeline. Approximately 120 million gallons of water would be requested through water appropriation permits submitted to Minnesota DNR for hydrostatic testing of the 340 miles of the Applicant's preferred route in Minnesota. Approximately 78 million gallons of this total would be requested for hydrostatic testing of the 221 miles of the route in Minnesota between Clearbrook and Carlton (Enbridge 2016b). The Applicant would source water from surface water and private and public wells; the proportion of water that would be obtained from groundwater versus surface water has not been determined. As stipulated in permit requirements, the Applicant would select appropriation sites that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. These permits would require identification of, and rationale for choosing, specific water sources, requested maximum pumping rates, and maximum annual volumes of water to be used; monitoring of pumping rates during appropriation with an approved device or method; and reporting of daily, monthly, and/or yearly appropriation amounts. The rate and total volumes of water withdrawn would be measured with a flow meter and would not exceed the rate and amount specified in the permits (Appendix E).

Dewatering of the pipeline trench may be required before the pipe is lowered into it. Dewatering also may be necessary at road boring sites adjacent to wetlands, in areas where excessive volumes of groundwater flow into the trench as a result of seepage or artesian flow, or at locations where increased visibility or physical access is necessary. Trench dewatering is considered a water appropriation permit activity by Minnesota DNR and must be included in permit applications. In areas where an aquifer that is under artesian conditions is exposed by the trench, the volume of inflowing water could cause rapid flooding of the trench and the bottom or sides to become unstable. In these areas, the pipeline trench may have a French drain effect, allowing water to migrate down the trench. Soil borings would be advanced to the design depth of the pipeline in these areas to determine whether a confining layer may be breached (Enbridge 2016). To protect against subsurface water flow along the pipe after the trench is backfilled, the Applicant would install trench breakers from the bottom of the trench to near the top of the trench, completely surrounding the pipe. The trench breakers would be constructed of bags filled with rock-free subsoil or sand; and their locations would be based on field conditions, including the degree and length of slope, presence of down-slope sensitive resource areas such as wetlands and waterbodies, and proximity to other features such as roads and railroads (Appendix E). Once construction in the area is completed and the trench was backfilled, groundwater levels likely would return to preconstruction levels because shallow aquifers readily receive recharge from precipitation and surface water inflow. With adherence to water appropriation permit conditions and implementation of Applicant-proposed measures, impacts on groundwater availability from water withdrawals would be temporary and minor.

Increases in Total Suspended Solid Concentrations in Groundwater

During trenching, excavation, and backfilling, the water table in surficial aquifers would be exposed in some areas. As a result, TSS concentrations in water in the trench or excavated area could increase. The Applicant would use temporary erosion and sediment controls, including, slope breakers, sediment barriers, stormwater diversions, trench breakers, and mulch, to minimize sedimentation in water

resources during construction. The Applicant also would limit the amount of excavated open trench to a maximum of 3 days of anticipated welding production per spread, per pipe to minimize the potential for erosion and sedimentation (Appendix E). In addition, the relatively slow groundwater flow rate and fine-grained nature of glacial sediments would likely filter out TSS from infiltrating groundwater. Thus, impacts associated with increases in TSS concentrations in groundwater in aquifers near trenched and excavated areas would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination

The quality of shallow groundwater may be degraded from blasting; small spills and leaks of lubricants, oil, or other hazardous chemicals used during construction; or disturbance of existing contamination. Blasting is likely to be necessary only in Carlton County, Minnesota, near the Wisconsin border where surface bedrock is present. The Applicant has identified one location at MP 354.6 where bedrock outcrops at the surface for approximately 0.3 mile; and four blasting events would be required to install the pipeline (Enbridge 2016b). This location is within the Clearbrook-to-Carlton segment of the Applicant's preferred route. Blasting has been carried out in this segment previously for installation of the existing pipelines in the Enbridge Mainline system corridor.

Where blasting would occur, rock would be removed to a depth of 7 feet, which may be above the elevation of the water table in many areas. If the water table is exposed by blasting, potential turbidity, sedimentation, or chemical contamination would be localized and likely would be diluted or attenuated before it could travel very far into the aquifer. Prior to construction, the Applicant would develop a site-specific Blasting Plan, which would include measures for transporting, storing, handling, detonating, and disposing of blasting materials to protect groundwater resources (see Section 6.3.2.1.1 for blasting regulations).

Groundwater may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. Areas of high aquifer vulnerability, high groundwater contamination susceptibility, or high pollution sensitivity are inherently more susceptible to groundwater contamination during construction activities. To protect groundwater resources, the Applicant would store petroleum products, hazardous chemicals, and lubricating oils; conduct refueling, maintenance, and lubricating operations; and perform concrete coating activities in areas greater than 100 feet from water supply wells and would use secondary containment (Appendix E). Concrete wash water, grindings, and slurry disposal would be limited to a designated area. Rinse water, used in conjunction with a cleaning pig to remove any accumulated construction debris, dirt, and dust prior to hydrostatic testing, would be treated and disposed of or discharged in accordance with applicable National Pollutant Discharge Elimination System (NPDES) permit conditions. Excess HDD drilling mud would be disposed of offsite at an approved disposal facility. In addition to these prevention measures, the Applicant would be responsible for cleaning up small spills through procedures outlined in the Environmental Protection Plan (Appendix E), including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities. Prevention and response procedures for a large oil spill are discussed in Chapter 10.

If any contaminated soils or groundwater were encountered during construction, they would be handled and disposed of in accordance with applicable regulations, the Environmental Protection Plan, and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction. This plan would describe site assessment and response actions that would be implemented to manage

contaminated soils and groundwater (Enbridge 2016a). The Applicant would also follow Spill Prevention, Containment, and Control (SPCC) measures outlined in Appendix E to minimize the likelihood of spills and of contamination entering groundwater. With implementation of Applicant-proposed measures and adherence to the Blasting and Contaminated Soils Management plans, impacts on groundwater quality from small leaks and spills, blasting activities, and existing contamination would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Designated Protection Areas

Water supply wells, aquifers, and wellhead protection areas could be affected by construction activities, including groundwater withdrawals, minor spills of industrial chemicals and hazardous materials, and drilling mud releases during HDD installation—depending on how close the wells are to construction areas. No wells are located within the construction work area or permanent right-of-way for the Applicant's preferred route. However, if well interference occurred from pipeline construction, the Applicant would be required to participate in Minnesota DNR's well interference resolution process. Furthermore, the Applicant would work with landowners to develop site-specific plans for wells that could be affected by construction or request a variance from Minnesota DH. With adherence to the Applicant-proposed measures discussed above and below (e.g., water appropriation BMPs, erosion and sedimentation controls, SPCC measures, and HDD monitoring and clean-up procedures) construction impacts on groundwater in these sensitive areas and in wells would be temporary and minor.

The Applicant's preferred route would not cross any aquifers designated by EPA as a sole source aquifer. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings

HDD installation involves drilling under a waterbody and installing the pipeline without physical disturbance of the waterbody feature. This method would be used to cross environmentally sensitive areas such as certain wetlands, sensitive fishery resources, and impaired waters. Geotechnical surveys are conducted to determine which waterbodies exist in areas that are geologically suitable for HDD, based on properties such as depth to aquifer, aquifer flow properties, aquifer material type, strength, and deformational properties. Areas not conducive to HDD include soils containing cobbles, boulders, layers of gravel, or non-cohesive sands. The Applicant has proposed 19 HDD crossings along the entire length of the Applicant's preferred route in Minnesota and 12 crossings between Clearbrook and Carlton. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent rupture of the bore hole or "frac-out" and release of the drilling fluid. Such events can occur when pressurization of the drill hole increases beyond the containment capability of the overburden soil material, which allows the drilling fluid to flow to the ground surface. The general risks to groundwater associated with HDD construction methods include loss of drilling mud into surficial aquifers, which could lead to turbidity in nearby aquifers and wells. Partial or full loss of drilling mud may occur as a result of encountering loose, unstable zones of soil, which could temporarily restrict water movement in shallow aquifers. Areas of karst are more prone to this occurrence. A large subsurface drilling fluid escape that does not reach the surface may fill subsurface voids and potentially cause the upward displacement of water and materials, creating a "doming" effect until the water in the dome reaches equilibrium with the surrounding hydrology.

Additives may be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only non-hazardous additives approved under permit conditions would be used, and a Material Safety Data Sheet for the drilling fluid would be maintained onsite. Construction personnel would monitor the crossing to detect releases of drilling mud and would implement containment, response, and clean-up procedures

as outlined in the Applicant's Environmental Protection Plan (Appendix E) to minimize the potential for drilling mud to reach groundwater resources. If a frac-out occurred and went undetected or was not quickly contained, impacts on groundwater quality could be long-term and major. With implementation of the Applicant-proposed measures for drilling mud releases during HDD construction, impacts on groundwater quality would be temporary and minor.

Operations Impacts

Changes in Groundwater Availability

Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. These impacts would be prevented by proper installation of trench breakers during construction as described above and would be temporary and negligible.

Normal operation of the Applicant's preferred route would not require withdrawal or discharge of water. During the maintenance and repair activities over the duration of pipeline's operation, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control have not been developed. However, as described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures as described for construction, impacts on groundwater from withdrawals would be temporary and negligible.

Degradation of Groundwater Quality

Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. However, any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small, likely would remain on the land surface, and likely would not infiltrate into groundwater supplies. Therefore, any groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. The potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

Changes in Groundwater Availability from Withdrawals. Construction of RA-03AM would require approximately 11 to 17 million gallons of water for hydrostatic testing for each construction spread; construction of RA-03AM may require five construction spreads between Clearbrook and Carlton. Therefore, total water appropriation from groundwater or surface water sources would be approximately 55 to 85 million gallons. Water appropriation needs for dust control, trench dewatering, and HDD installation have not been determined. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources. Dewatering of the pipeline trench may be necessary during construction and also would require a water appropriation permit. The use of trench breakers avoid subsurface groundwater flow within the pipeline trench. If construction of

RA-03AM adheres to water appropriation permit conditions and uses appropriate BMPs as described for the Applicant's preferred route, impacts on groundwater availability from water withdrawals would be temporary and minor.

Increases in Total Suspended Solid Concentrations in Groundwater. Temporary erosion controls as described for the Applicant's preferred route would need to be implemented during excavation, trenching, and backfilling to prevent sediment transport into groundwater during construction. If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-03AM, impacts from increases in TSS concentrations and increased sedimentation in groundwater would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination. Shallow groundwater along RA-03AM may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. Handling, treatment/disposal, and discharge measures as described for the Applicant's preferred route would be necessary for fuels and hazardous chemicals, concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing. In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-03AM through procedures outlined in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route.

The need for blasting along RA-03AM is not known but may be required for very limited areas of bedrock at or near the land surface along the route. If blasting is necessary, the Applicant would need to develop a site-specific Blasting Plan, which would include measures to protect groundwater resources.

Construction in contaminated sites can cause existing contaminants to be released and enter groundwater resources. If any contaminated soils or groundwater are encountered during construction, they would be handled and disposed of in accordance with applicable regulations, the Environmental Protection Plan, and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction of RA-03AM. This plan would describe site assessment and response actions that would be implemented to manage contaminated soils and groundwater (Enbridge 2016a).

With use of appropriate BMPs as described for the Applicant's preferred route during construction of RA-03AM, impacts on shallow groundwater quality from blasting, small spills, or existing contamination during construction would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Designated Protection Areas. Water supply wells, aquifers, and wellhead protection areas could be affected by construction activities for RA-03AM. As noted above, five domestic wells are within the construction work area, and two are within the permanent right-of-way of the RA-03AM route. The Applicant would work with landowners to develop site-specific plans for wells that could be affected by construction, or request a variance from Minnesota DH. The Applicant also would be required to participate in Minnesota DNR's well interference resolution process if well interference occurred during pipeline construction. If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-03AM, construction impacts on drinking water wells and wellhead protection areas would be temporary and minor.

The RA-03AM route would not cross any aquifers designated by EPA as a sole source aquifer. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted to determine which waterbodies exist in areas along RA-03AM that are geologically suitable for HDD. If a route permit were to be issued for RA-03AM, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. If a frac-out occurred during construction of RA-03AM and went undetected or was not quickly contained, impacts on groundwater quality could be long-term and major. With implementation of measures described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-03AM, impacts on groundwater quality would be temporary and minor.

Operations Impacts

Changes in Groundwater Availability. Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. With proper installation of trench breakers and soil compaction during backfilling as described for the Applicant's preferred route, impacts on groundwater availability during pipeline operations would be temporary and negligible.

Normal operation of the RA-03AM route would not require withdrawal or discharge of water. During maintenance and repair activities over the duration of pipeline's operation, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control have not been developed. As described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures as described for construction, impacts on groundwater from water withdrawals would be temporary and negligible.

Degradation of Groundwater Quality. Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small, likely would remain on the land surface, and likely would not infiltrate into groundwater supplies. Therefore, any groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. Potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Route Alternative RA-06

Construction Impacts

Changes in Groundwater Availability from Withdrawals. Approximately 44 to 68 million gallons of water (11 to 17 million gallons per construction spread) would be required for hydrostatic testing during construction of RA-06 between Clearbrook and Carlton. Water appropriation needs for dust control, trench dewatering, and HDD installation have not been determined. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR requiring that water withdrawals have a minimal potential for impacts on groundwater resources. Dewatering of the pipeline line trench also may be necessary during construction, and trench breakers would need to be used to avoid subsurface groundwater flow within the pipeline trench. If construction of RA-06 adheres to water appropriation permit conditions and implements appropriate BMPs as described for the Applicant's

preferred route, impacts on groundwater availability from water withdrawals for RA-06 would be temporary and minor.

Increases in Total Suspended Solid Concentrations in Groundwater. Temporary erosion controls as described for the Applicant's preferred route would need to be implemented during excavation, trenching, and backfilling to prevent sediment transport into groundwater during construction. If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-06, impacts from increases in TSS concentrations and increased sedimentation in groundwater would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination. Similar to the Applicant's preferred route, shallow groundwater that is present along RA-06 may become contaminated during construction from small spills or leaks. Handling, treatment/disposal, and discharge measures as described for the Applicant's preferred route would be necessary for activities associated with construction of RA-06. The Applicant would be responsible for cleaning up small spills during construction of RA-06 through procedures outlined in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route.

The need for blasting along RA-06 is not known but may be required where bedrock is present at or near the land surface. If blasting was necessary, the Applicant would need to develop a site-specific Blasting Plan, which would include measures to protect groundwater resources.

Construction in contaminated sites can cause existing contaminants to be released and enter groundwater resources. If any contaminated soils or groundwater were encountered during construction, they would be handled and disposed of in accordance with applicable regulations; the Environmental Protection Plan; and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction of RA-06. The plan would describe site assessment and response actions that would be implemented to manage contaminated soils and groundwater (Enbridge 2016a).

If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-06, impacts on shallow groundwater quality from blasting, small spills, or existing contamination during construction would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Designated Protection Areas. Water supply wells, aquifers, and wellhead protection areas could be affected by construction activities of RA-06.

As noted above, three domestic wells are within the construction work area and two are within the permanent right-of-way for the RA-06 route. The Applicant would work with landowners to develop site-specific plans for wells that could be affected by construction, or request a variance from Minnesota DH. The Applicant also would be required to participate in Minnesota DNR's well interference resolution process if well interference occurred during pipeline construction.

If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-06, construction impacts on drinking water wells and wellhead protection areas would be temporary and minor.

The RA-06 route would not cross any aquifers designated by EPA as a sole source aquifer. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings. Specific locations for HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted to determine which waterbodies exist in areas along RA-06 that are geologically suitable for HDD. If a route permit is issued for RA-06, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. If a frac-out occurred during construction of RA-06 and went undetected or was not quickly contained, impacts on groundwater quality could be long-term and major. With implementation of measures described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-06, impacts on groundwater quality would be temporary and minor.

Operations Impacts

Changes in Groundwater Availability. Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. With proper installation of trench breakers and soil compaction during backfilling during construction as described for the Applicant's preferred route, impacts on groundwater availability during pipeline operations would be temporary and negligible.

Normal operation of the RA-06 route would not require withdrawal or discharge of water. However, during maintenance and repair activities over the duration of pipeline's operation, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control have not been developed. As described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures as described for construction, impacts on groundwater from withdrawals would be temporary and negligible.

Degradation of Groundwater Quality. Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small, likely would remain on the land surface, and likely would not infiltrate into groundwater supplies. Consequently, any groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. Potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Route Alternative RA-07

Construction Impacts

Changes in Groundwater Availability from Withdrawals. Construction of RA-07 would require approximately 44 to 68 million gallons of water (11 to 17 million gallons per construction spread) for hydrostatic testing during construction between Clearbrook and Carlton. Water appropriation needs for dust control, trench dewatering, and HDD installation have not been determined. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources. Dewatering of the pipeline trench also may be necessary during construction and would require a water appropriation permit. Trench breakers would need to be used to avoid subsurface groundwater flow within the pipeline trench. If construction of RA-07 adheres to water appropriation permit conditions

and uses appropriate BMPs as described for the Applicant's preferred route, impacts on groundwater availability from water withdrawals would be temporary and minor.

Increases in Total Suspended Solid Concentrations in Groundwater. Temporary erosion controls as described for the Applicant's preferred route would need to be implemented during excavation, trenching, and backfilling to prevent sediment transport into groundwater during construction. If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-07, impacts from increases in TSS concentrations and increased sedimentation in groundwater would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination. Shallow groundwater along RA-07 may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. Handling, treatment/disposal, and discharge measures as described for the Applicant's preferred route would be necessary for fuels and hazardous chemicals, concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing. In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-07 through procedures outlined in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route.

The need for blasting along RA-07 is not expected as it would entail removal and replacement of the pipeline in the same trench. If blasting were necessary, the Applicant would need to develop a site-specific Blasting Plan, which would include measures to protect groundwater resources.

Construction in contaminated sites can cause existing contaminants to be released and enter groundwater resources. If any contaminated soils or groundwater were encountered during construction, they would be handled and disposed of in accordance with applicable regulations; the Environmental Protection Plan; and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction of RA-07. The plan would describe site assessment and response actions that would be implemented to manage contaminated soils and groundwater (Enbridge 2016a).

With use of appropriate BMPs as described for the Applicant's preferred route during construction of RA-07, impacts on shallow groundwater quality from blasting, small spills, or existing contamination during construction would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Designated Protection Areas. Water supply wells, aquifers, and wellhead protection areas could be affected by construction activities for RA-07. Two domestic wells are within the construction work area, and one is within the permanent right-of-way for the RA-07 route. The Applicant would work with landowners to develop site-specific plans for wells that could be affected by construction, or request a variance from Minnesota DH. The Applicant also would be required to participate in Minnesota DNR's well interference resolution process if well interference occurred during pipeline construction. If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-07, construction impacts on drinking water wells and wellhead protection areas would be temporary and minor.

The RA-07 route would not cross any aquifers designated by EPA as a sole source aquifer. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted to determine which waterbodies exist in areas along RA-07 that are geologically suitable for HDD. If a route permit is issued for RA-07, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. If a frac-out occurred during construction of RA-07 and went undetected or was not quickly contained, impacts on groundwater quality could be long-term and major. With implementation of measures described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-07, impacts on groundwater quality would be temporary and minor.

Operations Impacts

Changes in Groundwater Availability. Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. With proper installation of trench breakers and soil compaction during backfilling during construction as described for the Applicant's preferred route, impacts on groundwater availability during pipeline operations would be temporary and negligible.

Normal operation of the RA-07 route would not require withdrawal or discharge of water. During maintenance and repair activities over the duration of pipeline operation, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control have not been developed. As described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures as described for construction, impacts on groundwater from withdrawals would be temporary and negligible.

Degradation of Groundwater Quality. Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small, likely would remain on the land surface, and likely would not infiltrate into groundwater supplies. Consequently, any groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. Potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

Route Alternative RA-08

Construction Impacts

Changes in Groundwater Availability from Withdrawals. Construction of RA-08 would require approximately 44 to 68 million gallons of water (11 to 17 million gallons per construction spread) for hydrostatic testing during construction between Clearbrook and Carlton. Water appropriation needs for dust control, trench dewatering, and HDD installation have not been determined. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources. Dewatering of the pipeline trench also may be necessary during construction and would require a water appropriation permit. Trench breakers would need to be used to avoid subsurface groundwater flow within the pipeline trench. If construction of RA-08 is adheres to water appropriation permit conditions

and uses appropriate BMPs as described for the Applicant's preferred route, impacts on groundwater availability from water withdrawals would be temporary and minor.

Increases in Total Suspended Solid Concentrations in Groundwater. Temporary erosion controls as described for the Applicant's preferred route would need to be implemented during excavation, trenching, and backfilling to prevent sediment transport into groundwater during construction. If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-08, impacts from increases in TSS concentrations and increased sedimentation in groundwater would be temporary and minor.

Degradation of Shallow Groundwater Quality from Blasting, Spills, or Contamination. Shallow groundwater along RA-08 may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. Handling, treatment/disposal, and discharge measures as described for the Applicant's preferred route would be necessary for fuels and hazardous chemicals, concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing. In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-08 through procedures outlined in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route.

The need for blasting along RA-08 is not known but may be required in some areas where bedrock is at or near the land surface. If blasting is necessary, the Applicant would need to develop a site-specific Blasting Plan, which would include measures to protect groundwater resources.

Construction in contaminated sites can cause existing contaminants to be released and enter groundwater resources. If any contaminated soils or groundwater were encountered during construction, they would be handled and disposed of in accordance with applicable regulations; the Environmental Protection Plan; and a Contaminated Soils Management Plan, which the Applicant would develop prior to construction of RA-08. The plan would describe site assessment and response actions that would be implemented to manage contaminated soils and groundwater (Enbridge 2016a).

If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-08, impacts on shallow groundwater quality from blasting, small spills, or existing contamination during construction would be temporary and minor.

Degradation of Groundwater Quality in Potable Supply Wells, Sole Source Aquifers, or Designated Protection Areas. Water supply wells, aquifers, and wellhead protection areas could be affected by construction activities for RA-08. One domestic well is within the construction work area, and one is within the permanent right-of-way for the RA-08 route. The Applicant would work with landowners to develop site-specific plans for wells that could be affected by construction, or request a variance from Minnesota DH. The Applicant also would be required to participate in Minnesota DNR's well interference resolution process if well interference occurred during pipeline construction.

If appropriate BMPs as described for the Applicant's preferred route are used during construction of RA-08, construction impacts on drinking water wells and wellhead protection areas would be temporary and minor.

The RA-08 route would not cross any aquifers designated by EPA as a sole source aquifer. Therefore, there would be no construction impacts on any sole source aquifer.

Degradation of Water Quality from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted to determine which waterbodies exist in areas along RA-08 that are geologically suitable for HDD. If a route permit is issued for RA-08, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. If a frac-out occurred during construction of RA-08 and went undetected or was not quickly contained, impacts on groundwater quality could be long-term and major. With implementation of measures described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-08, impacts on groundwater quality would be temporary and minor.

Operations Impacts

Changes in Groundwater Availability. Ongoing French drain effects could occur during pipeline operations in areas of groundwater upwelling. With proper installation of trench breakers and soil compaction during backfilling during construction, as described for the Applicant's preferred route, impacts on groundwater availability during pipeline operations would be temporary and negligible.

Normal operation of the RA-08 route would not require withdrawal or discharge of water. During maintenance and repair activities over the duration of pipeline operation, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control have not been developed. As described for pipeline construction, the Applicant would be required to obtain water appropriation permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permit conditions and implementation of Applicant-proposed measures as described for construction, impacts on groundwater from withdrawals would be temporary and negligible.

Degradation of Groundwater Quality. Small fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Further, the volume of such spills and leaks would be small, likely would remain on the land surface, and likely would not infiltrate into groundwater supplies. Consequently, any groundwater contamination from small leaks and spills during operation would be temporary and negligible to minor. Potential impacts on groundwater resources from a crude oil release are discussed in Chapter 10.

6.3.1.1.4 Summary and Mitigation

Summary

For all of the issues related to groundwater, the Applicant's preferred route would result in minor and temporary impacts during construction and negligible impacts during operations. The same finding was made for all of the route alternatives. Table 6.3.1.1-13 provides a summary and comparison of potential construction and operation impacts for the Applicant's preferred route and the route alternatives between Clearbrook and Carlton. Beyond the finding that impacts would be minor or negligible, the exposure of groundwater resources along each of the routes varied to some degree.

RA-03AM is the longest route and would cross the greatest acreage of high vulnerability water table aquifers, high pollution sensitivity areas, very high to high sensitivity Precambrian shallow fractured

bedrock aquifers and DWSMAs; the most WIMN sites; and the most domestic wells. RA-06 would cross the least acreage of high vulnerability water table aquifers, high contamination susceptibility, high pollution sensitivity, and DWSMAs, in addition to the least number of domestic and public wells. The Applicant's preferred route would cross the greatest acreage of high contamination susceptibility but the least number of EPA-listed contaminated sites and WIMN sites, and the fewest acres of wellhead protection areas. RA-07 and RA-08 are similar, but RA-08 would cross the greatest acreage of wellhead protection areas, and RA-07 would cross the greatest number of EPA-listed contaminated sites and public wells. Construction of RA-06 would appear to have the least impact on groundwater sources, followed by the Applicant's preferred route, RA-07 and RA-08, and lastly, RA-03AM.

With strict adherence to permit conditions and implementation of the Applicant-proposed measures, impacts on groundwater from construction of any of the route options would be temporary and minor during construction. Impacts between routes differ based on the acres of various groundwater sensitivity areas, DWSMAs, domestic and public wells, and contaminated sites crossed. During standard operations, negligible to minor and temporary impacts would be associated with ongoing French drain effects of the pipeline and small spills and leaks from pipeline inspection and maintenance.

Mitigation

Beyond the Applicant-proposed measures described above for the Applicant's preferred route, potential mitigation measures to minimize impacts on surface waters could include:

- If the owner of a potable supply well believed that the quality or yield of their water was negatively affected as a result of a pipeline construction-related activity, the Applicant could engage a third party to determine the nature and severity of the impact. If it was determined that impacts were related to construction, the Applicant could provide an alternate source of water to the well owner until the well water returned to preconstruction conditions. If the well water did not return to preconstruction conditions within a reasonable time period, the Applicant could compensate the landowner for installation of a new well or otherwise arrange for provision of a suitable water supply.
- To prevent the loss of drilling fluid from the borehole during HDD installation, the properties of drilling fluid may be augmented to aid in stabilizing the soils and in maintaining drilling fluid returns to the entry and exit pits. If circulation is lost, lost circulation materials can be used to seal around the borehole and prevent drilling fluid from escaping into the formation, and allow for reestablishment of drilling fluid returns to the entry and exit pits. Many types of lost circulation materials that are inert and environmentally benign are available for use during HDD installation. These can include wood fibers, cotton seed husks, ground walnut shells, and other natural materials. Special polymers that swell to several times their original size when introduced to water also can be used. These polymers are industrial-grade equivalents of food-grade polymers that are used to swell and absorb fluids in the food industry.

Table 6.3.1.1-13. Summary of Potential Impacts on Groundwater for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Changes in groundwater availability	Temporary/minor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing (44–68 million gallons)	Temporary/minor impacts • 5 spreads requiring water appropriation and discharge for hydrostatic testing (55–85 million gallons)	Temporary/minor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing (44–68 million gallons)	Temporary/minor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing (44–68 million gallons)	Temporary/minor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing (44–68 million gallons)
Increases in TSS concentrations during trenching and excavation activities in shallow aquifers	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts

Table 6.3.1.1-13. Summary of Potential Impacts on Groundwater for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Degradation of shallow groundwater quality	Temporary/minor impacts • Blasting 0.3 mile • 9 EPA-listed contaminated sites • 67 WIMN sites • 18,215 acres of high vulnerability aquifers • 26,382 acres of high contamination susceptibility • 15,475 acres of high pollution sensitivity • 1,700 acres of high and very high bedrock sensitivity • No known karst topography	Temporary/minor impacts • Need for blasting unknown • 70 EPA-listed contaminated sites • 182 WIMN sites • 25,928 acres of high vulnerability aquifers • 25,152 acres of high contamination susceptibility • 25,588 acres of high pollution sensitivity • 2,917 acres of karst topography • 2,547 acres of high and very high bedrock sensitivity	Temporary/minor impacts • Need for blasting unknown • 13 EPA-listed contaminated sites • 72 WIMN sites • 5,806 acres of high vulnerability aquifers • 305 acres of high contamination susceptibility • 3,134 acres of high pollution sensitivity • No known karst topography • 512 acres of high and very high bedrock sensitivity	Temporary/minor impacts • Need for blasting unknown, but not expected • 92 EPA-listed contaminated sites • 120 WIMN sites • 21,141 acres of high vulnerability aquifers • 19,833 acres of high contamination susceptibility • 15,355 acres of high pollution sensitivity • No known karst topography • 512 acres of high and very high bedrock sensitivity	Temporary/minor impacts • Need for blasting unknown • 50 EPA-listed contaminated sites • 101 WIMN sites • 16,889 acres of high vulnerability aquifers • 20,012 acres of high contamination susceptibility • 11,699 acres of high pollution sensitivity • No known karst topography • 446 acres of high and very high bedrock sensitivity
Degradation of groundwater quality in potable supply wells, sole source aquifers, or other designated groundwater protection areas	Temporary/minor impacts • No sole source aquifers • 164 domestic wells • 1 public well • 0.6 acre of wellhead protection areas • 172 acres of DWSMAs	Temporary/minor impacts • No sole source aquifers • 396 domestic wells • 10 public wells • 329 acres of wellhead protection areas • 849 acres of DWSMAs	Temporary/minor impacts • No sole source aquifers • 40 domestic wells • 0 public wells • 56 acres of wellhead protection areas • 131 acres of DWSMAs	Temporary/minor impacts • No sole source aquifers • 183 domestic wells • 23 public wells • 536 acres of wellhead protection areas • 754 acres of DWSMAs	Temporary/minor impacts • No sole source aquifers • 162 domestic wells • 7 public wells • 672 acres of wellhead protection areas • 810 acres of DWSMAs

Table 6.3.1.1-13. Summary of Potential Impacts on Groundwater for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Degradation of water quality from drilling mud releases during HDD crossings	Temporary/minor impacts (*if quickly contained*) to long-term/major (*if undetected or uncontained*) • 12 HDD crossings	Temporary/minor impacts (*if quickly contained*) to long-term/major (*if undetected or uncontained*) • Number of HDD crossings not determined for route alternatives			
Operations Impacts					
Changes in groundwater availability	Temporary/negligible impact	Temporary/negligible impact	Temporary/negligible impact	Temporary/negligible impact	Temporary/negligible impact
Changes in groundwater quality	Temporary/negligible to minor impacts • Minor leaks and spills	Temporary/negligible to minor impacts • Minor leaks and spills	Temporary/negligible to minor impacts • Minor leaks and spills	Temporary/negligible to minor impacts • Minor leaks and spills	Temporary/negligible to minor impacts • Minor leaks and spills

DWSMA = drinking water supply management area, EPA = U.S. Environmental Protection Agency, HDD = horizontal directional drill, WIMN = "What's in My Neighborhood"

6.3.1.1.5 References

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6.3.1.2 Surface Water

Surface water in the vicinity of the Applicant's preferred route and route alternatives consists of streams, rivers, lakes, wild rice waterbodies, and wetlands. Streams, rivers, lakes, and wild rice waterbodies are discussed in this section; wetlands are discussed in Section 6.3.1.3. This section identifies the surface waters that would be crossed, including their state and federal classifications or beneficial use designations. This section also assesses the potential for construction and operation of the Applicant's preferred route and route alternatives to affect those resources. The analysis of potential impacts on surface water resources during construction and operation of the Applicant's preferred route and route alternatives considered the following:

- Runoff and flows – increases in stormwater runoff and erosion, increases in total suspended solids concentrations and increased sedimentation, changes in stream flows from water withdrawals and discharges, and disruption of flow paths or local hydrologic connectivity;
- Surface water and aquatic habitat quality – degradation of surface water quality, degradation of aquatic habitat from instream and other construction activities, degradation of water quality and habitat from releases of drilling mud during HDD crossings;
- Channel morphology and stability – changes in channel morphology and stability caused by channel and streambank modifications; and
- Disturbance of wild rice waterbodies.

This section first describes the regulations relevant to assessing surface water impacts, the methods used to conduct the impact assessment, and the existing surface water conditions within the defined ROIs of the Applicant's preferred route and route alternatives. The potential impacts of construction and operation of the Applicant's preferred route and route alternatives on surface waters are considered next. A summary and comparison of the impacts for the route options between Clearbrook and Carlton are included at the end of the section, along with potential mitigation measures that could be used to minimize impacts.

Section 6.3.4 addresses surface water quality impacts that affect fish and wildlife and their habitats, including fisheries, Aquatic Management Areas, surface waters assigned an Index of Biotic Integrity, Lakes of Biological Significance, designated wildlife lakes, trout streams, and invasive species. This section and Section 6.3.4 should be considered together to provide an overall picture of the potential impacts of the Project on surface water.

Potential impacts on surface water from unanticipated crude oil releases are discussed in Chapter 10.

6.3.1.2.1 Regulatory Context and Methodology

Regulatory Context

Federal, state, and local agencies have oversight and permitting requirements for activities that may affect surface water use, flow, current, or quality. These permits include required actions and BMPs that would reduce potential impacts on surface water resources. Within Minnesota, Minnesota PCA implements federal water quality regulations via authority from EPA and manages the list of impaired surface waters based on the Clean Water Act (CWA) Section 303(d) list. Minnesota PCA also implements a permitting program to manage stormwater discharges in compliance with the NPDES and State Disposal System (SDS), administering joint NPDES/SDS permits. Minnesota DNR regulates public waters

and oversees permitting for public waterbody crossings and water appropriation. Local agencies also implement water quality requirements. In addition, regional watershed districts, of which there are 46 in the state, manage water drainage and flow and issue permits for activities that may affect waters within the watershed. Watershed districts are discussed further in Section 6.2.1. State and federal rules as they pertain to the Project are described below.

Minnesota Beneficial Use Designations

Surface waters in Minnesota are classified according to beneficial use designations, which identify how humans and terrestrial and aquatic wildlife use the waterbody. As required by the CWA, water quality standards must be set to protect the beneficial use(s) of a waterbody, and permits must be obtained for activities that may affect water quality. The seven beneficial use designations of Minnesota surface waters (defined in Minn. R. 7050.0140) are as follows:

- Class 1 – domestic consumption (i.e., drinking water);
- Class 2 – aquatic life and recreation;
- Class 3 – industrial or commercial use;
- Class 4 – agricultural use, irrigation (4A), and livestock and wildlife watering (4B);
- Class 5 – aesthetics and navigation;
- Class 6 – other uses and protection of border waters; and
- Class 7 – limited resource value waters.

Limited resource value waters are not fully protected for aquatic life because water quantities are intermittent or very low, existing aquatic life is severely limited, the waters have been irreversibly and significantly altered by human activity, and there are limited recreational opportunities. All surface waters are protected for Class 2 beneficial use unless the waterbody has been individually assessed and reclassified as a Class 7 limited resource value water. Minnesota Administrative Rules Part 7050.0470 lists the classifications of major surface waters in the state. If a waterbody is not listed there and is not a wetland, it is classified as a Class 2B, 3C, 4A, 4B, 5, and 6 water per Minnesota Administrative Rules Part 7050.0430. Thus, in practice, all surface waters of the state are protected for their associated beneficial use or all of the above uses other than drinking water (Minnesota PCA 2006). Minnesota Administrative Rules Part 7050.0222 further defines the water quality standards for the following subclasses of Class 2 waters:

- Class 2A – Coldwater fisheries, trout waters, suitable for all aquatic recreation and protected as a source of drinking water;
- Class 2Bd – Coldwater and warmwater fisheries, suitable for all aquatic recreation and protected as a source of drinking water;
- Class 2B – Coldwater and warmwater fisheries, suitable for all aquatic recreation but not protected for drinking water;
- Class 2C – Indigenous fish and associated aquatic community, suitable for boating but not protected for drinking water; and
- Class 2D – Wetlands – aquatic and terrestrial species, suitable for boating but not protected for drinking water.

State-Designated/Sensitive Surface Waters

Various Minnesota streams and lakes are designated as Class 2A trout streams, for which stringent water quality standards and fishing restrictions are implemented to maintain and propagate healthy communities of trout (Minn. R. 7050.0222 and 6264.0050). Minnesota PCA requires construction sites that discharge near trout streams to implement additional BMPs and enhanced runoff controls as part of the NPDES permit. In addition, all Minnesota surface waters in the Lake Superior Basin, other than Class 7 waters and designated Outstanding Resource Value Waters (ORVWs), are designated as Outstanding International Resource Waters (Minn. R. 7052.0300).

Nationwide Rivers Inventory

Rivers listed in the National Park Service's (NPS's) Nationwide Rivers Inventory (NRI) are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance (NPS 2011). Some NRI-listed rivers also are federally designated as Wild and Scenic Rivers, which are rivers or river segments with outstanding natural, cultural, and recreational values that are to be voluntarily protected in a free-flowing condition for the characteristics for which they were first designated. Minnesota also has state-designated Wild and Scenic River segments.

Impaired Surface Waters

Section 303(d) of the CWA requires that states review, establish, and revise water quality standards for all surface waters within the state. Each state, territory, and authorized tribe must biennially submit to EPA a list of surface waters that do not meet EPA-approved water quality standards. These waters are considered impaired and do not meet their designated beneficial use for reasons such as elevated contaminant levels, low dissolved oxygen, high temperature, or bacterial contamination. The law also requires that states establish priority rankings for waters on the list and develop total maximum daily loads (TMDLs) for these waters. Approximately 40 percent of Minnesota's surface waters are impaired for conventional pollutants. Projects that discharge near a waterbody that is impaired for phosphorous, turbidity, dissolved oxygen, and biotic impairment must meet special conditions required under the NPDES permit. In Minnesota, Minnesota PCA implements federal water quality regulations and identifies and manages the list of impaired surface waters.

When a waterbody is added to the Minnesota Impaired Waters List, a TMDL must be developed for it. A TMDL is the maximum amount of a pollutant a body of water can receive without violating water quality standards and an allocation of that amount to the pollutant sources. The TMDL development process identifies all sources of a pollutant and determines how much each source must reduce its contribution in order to meet the standard. Minnesota PCA organizes impaired surface waters into TMDL projects, which are then approved by EPA.

Minnesota uses a watershed approach, encompassing water quality assessment, watershed analysis, civic engagement, planning, implementation, and measurement of results, to address restoration and protection of the state's 80 major watersheds. On a 10-year cycle, a Watershed Restoration and Protection Strategy (WRAPS) report is completed for each watershed as a result of that work (Minnesota PCA 2016a). The water quality management cycles for the 80 major watersheds are staggered, with 8 to 10 watersheds beginning a new cycle each year. The WRAPS report includes a watershed TMDL study, TMDL implementation strategies for impaired waters, and protection study and implementation strategies for waters needing additional protection to prevent future water quality impairments (Minnesota PCA 2014b).

Navigable Waterways

The U.S. Army Corps of Engineers (USACE) has jurisdiction over navigable waterways in accordance with Section 10 of the Rivers and Harbors Act of 1899. Navigable waters of the United States are those that are subject to the ebb and flow of the tide or are presently used, have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Work in or affecting these waterways must be approved by USACE under the CWA Section 404 and Rivers and Harbors Act Section 10. CWA Section 401 Individual Water Quality Certification for the proposed Project in Minnesota is under the jurisdiction of USACE – St. Paul District and Minnesota PCA. Minnesota PCA is responsible for CWA Section 401 certification in Minnesota.

Public Waters

Public waters have been defined in Minnesota Law since 1897. The waters included in the definition have evolved and been refined over the years. Significant clarification was given to which waters were included as public waters in the Public Waters Inventory process conducted in the late 1970s through the early 1980s. Public waters are protected from destruction and degradation because of their value to the people of Minnesota for water supplies; groundwater recharge potential; retention of water to prevent and minimize downstream flooding and property damage; entrapment of nutrients and sediment; recreational activities such as boating, swimming, fishing and hunting, and navigation; and wildlife habitat areas for spawning, rearing, feeding, and nesting of wildlife.

Wild Rice Waterbodies

Various tribal, federal, state, and local laws and regulations are designed to manage and protect wild rice. These are associated with formal recognition of the significance of natural wild rice and its protection, management, and harvest. In Minnesota, wild rice and other aquatic vegetation growing in public waters is owned by the State, and a person may not acquire a property interest in or destroy wild rice except as allowed by law. Outside of tribal jurisdictions, Minnesota statutes and agency rules regulate the harvest of natural wild rice, including methods and timing of harvest. The Minnesota DNR Aquatic Plant Management Program prohibits removal of wild rice without an approved permit. Wild rice also is protected through shoreland protection laws and regulations, which are based on a system of classification for lakes and rivers that applies different zoning regulations depending on their classification.

Minnesota PCA is proposing amendments to Minnesota Administrative Rules Chapters 7001, 7050, 7052, and 7053. These amendments would refine how a wild rice waterbody is defined as well as acceptable sulfate levels. Since 1975, wild rice waterbodies have been defined as an area with a wild rice stem density of eight stems per square mile over 0.25 acre or four stems per square mile over 0.5 acre. Minnesota PCA proposes to change this to define a wild rice waterbody as an area that contains a self-perpetuating wild rice population with at least 8,000 stems over a lake or wetland surface or 800 stems over a river-mile reach. Minnesota PCA also is proposing refinement of the acceptable sulfate levels for identified wild rice waterbodies. A 2015 technical document showed that factors such as organic matter and iron concentration affect how much sulfate is converted to sulfide, which is toxic to wild rice (Minnesota PCA 2014c). Based on this, Minnesota PCA is proposing to determine acceptable sulfate levels on a site-by-site basis by the organic carbon and iron concentrations found at each wild rice waterbody (Minnesota PCA 2016a). These amendments have not been enacted and therefore were not used in the analyses in this EIS.

Tribal regulations related to the harvest and protection of wild rice within reservation boundaries vary from tribe to tribe and are managed by tribe-specific wild rice committees. In addition to tribal regulations, treaties and other agreements with the U.S. government have reserved off-reservation harvesting rights for certain tribes.

Methodology

Potential impacts on surface water and effects on sensitive surface waters from construction and operation of the Applicant's preferred route and route alternatives were assessed. Impacts on surface waters from pipeline construction would be largely due to waterbody crossing procedures, and potential impacts from normal pipeline operation typically are localized. Therefore, the ROI for the assessment of construction impacts on surface waters includes the construction work area for each surface water crossed by the Applicant's preferred route in Minnesota (typically 120 feet wide) as well as the area immediately downstream from the crossing for flowing surface waters, and in the immediate vicinity for crossings of non-flowing surface waters such as lakes and wild rice waterbodies. Similarly, the ROI for the assessment of construction impacts on surface waters for the route alternatives is based on a 120-foot-wide construction work area for RA-03AM, RA-06, and RA-08; a 205-foot-wide construction work area for RA-07; and the areas immediately downstream of flowing surface waters and in the immediate vicinity of non-flowing surface waters. The assessment of operations impacts is based on the location of the 50-foot-wide permanent pipeline right-of-way for all the route options, as well as areas immediately downstream of flowing surface waters and in the immediate vicinity of non-flowing surface waters.

Watersheds and surface waters within the ROIs for the Applicant's preferred route and route alternatives were identified using GIS datasets and layers in the following data sources:

- USGS National Hydrography Dataset;
- USACE Section 10 navigable waterways;
- NPS's NRI national datasets;
- Minnesota DNR's Public Waters Inventory;
- Minnesota-designated trout streams;
- Minnesota DNR-identified wild rice waterbodies; and
- Section 303(d)-listed impaired surface waters, TMDL, and WRAPS project boundaries.

The acreages of areas that could be affected by construction of the Applicant's preferred route were estimated by using maps depicting surface waters with an overlay of the construction work area and footprints of aboveground facilities provided by the Applicant. Except for RA-07, the acreages of areas that could be affected by construction of the route alternatives were estimated using maps depicting surface waters with an overlay of a 120-foot-wide construction work area centered on the pipeline route; for RA-07, a 205-foot-wide construction work area was used.

Acreages of wild rice waterbodies that could be affected were estimated using maps of the Minnesota DNR-identified wild rice waterbodies and rivers database (Minnesota DNR 2009), classified according to U.S. Fish and Wildlife Service (USFWS) Circular No. 39 (EPA 2002). These maps were overlaid with the construction work area and permanent right-of-way for the Applicant's preferred route; a 120-foot-wide construction work area for RA-03, RA-06, and RA-8; and a 205-foot-wide construction work area for

RA-07. Because some construction activities and indirect effects may occur within areas beyond the construction work areas, wild rice resources also were identified within 0.5 mile of the pipeline routes.

Potential impacts on surface waters were evaluated by:

- Identifying the existing conditions of surface waters that would be crossed, such as water quality and impairment, fishery resources (i.e., trout streams), beneficial use designations, state and federal classifications, and overall watershed health.
- Comparing the Applicant's proposed construction methods described in Chapter 2 and the special wetland construction methods described in the Applicant's November 2016 EAW and associated construction BMP plans (Enbridge 2016a) to peer-reviewed literature and agency documents, including permit requirements and guidance manuals, related to the proposed pipeline construction methods.
- Considering the potential for construction and operation of the Applicant's preferred route and route alternatives to affect the identified surface waters. The specific environmental concerns addressed in the impact analysis are listed in the introduction to Section 6.3.1.2.3.

Broader regional indicators of surface water quality were also reviewed to identify regional differences in existing conditions and extent of impacts. Due to unavailability of data from other states, this analysis was limited to Minnesota. These broad regional issues in Minnesota were evaluated by buffering GIS shapefiles the Applicant's preferred route and CN alternatives by one half mile and identifying intersections of features indicative of surface water quality, including trout streams, wild rice lakes, Lakes of Biological Significance (high and outstanding) and tullibee (cisco) lakes. Intersections of the same stream over 1 mile apart were counted as separate intersections.

6.3.1.2.2 Existing Conditions

Overview of Drainage Basins and Watersheds

A "drainage basin" is an area of land where all surface water from rain and snowmelt converges to a single point at a lower elevation, such as a river, lake, reservoir, or wetland. Drainage basins are made up of smaller watershed units. There are 10 major drainage basins and 80 major watersheds in Minnesota (Minnesota PCA n.d.). The Red River, Lake Superior, St. Croix River, and Upper Mississippi River basins are described in Section 5.2.1.2.2.

In addition to those basins crossed by the Applicant's preferred route, the Rainy River Basin would be crossed by one route alternative (RA-06). The Rainy River Basin encompasses a total area of 27,114 square miles, of which 11,244 square miles (41 percent) are in Minnesota, and 15,870 square miles (59 percent) are in Ontario, Canada. The basin is home to important forest and water resources: Voyageurs National Park and the Boundary Waters Canoe Area Wilderness, several of the state's most famous walleye fisheries, and many exceptional trout streams. The majority of the land within the basin is forested (Minnesota PCA 2001).

Overview of Wild Rice Waterbodies

Wild rice waterbodies are shallow bodies of water where rice, a persistent annual grass, reproduces each year from seed stock deposited in previous fall seasons. Wild rice beds are very attractive to migrating waterfowl, and many rice areas are traditional waterfowl staging and hunting areas. Because they are an important component of Minnesota's agricultural economy, they are protected in

Minnesota. Wild rice can be susceptible to disturbance in all habitats (lake, river, or wetland) and is sensitive to temperature changes, contaminants, and hydrology changes—all of which on their own or in combination could affect germination and production.

Applicant's Preferred Route

Drainage Basins and Watersheds

The Applicant's preferred route would cross the Red River, Upper Mississippi River, Lake Superior, and St. Croix River basins, which are described in Section 5.2.1.2.2. Table 6.3.1.2-1 presents the average watershed health scores, water quality scores, and affected watershed acres for the major drainage basins and watersheds that would be crossed by the Applicant's preferred route. Watershed biological indices scores are discussed in Section 6.3.4.

Surface Waters Crossed

Table 6.3.1.2-2 lists the surface waters that would be crossed by the Applicant's preferred route in Minnesota. The Applicant's preferred route would require 192 crossings of surface waters (109 crossings between Clearbrook and Carlton), including perennial and intermittent streams, rivers, ponds, and lakes; unnamed surface waters and non-jurisdictional ditches; rivers listed in the NRI; navigable waters; sensitive and specially designated surface waters; and impaired surface waters. See Appendix G for a listing of all proposed waterbody crossings.

The Applicant's preferred route crosses a total of 56 public waters in Minnesota. These include 4 public water ditches, 14 artificial paths, 25 perennial streams/rivers and 13 intermittent streams/rivers. Between Clearbrook and Carlton, the Applicant's preferred route crosses a total of 36 public waters. These include 3 public water ditches, 10 artificial paths, 18 perennial streams/rivers, and 5 intermittent streams/rivers.

Table 6.3.1.2-1. Major Drainage Basins and Watersheds Crossed by the Applicant's Preferred Route in Minnesota

Drainage Basin	Watershed	HUC-8	Average Watershed Health Score[a]	Water Quality Score[b]	Construction[c] (acres)	Operations[d] (acres)
Red River of the North	Tamarac River	09020311	44	63	463.9	197.8
	Snake River	09020309	46	66	242.2	105.7
	Grand Marais Creek	09020306	42	58	39.0	17.1
	Red Lake River	09020303	54	63	301.2	132.8
	Clearwater River	09020305	60	70	719.4	323.9
	Wild Rice River	09020108	57	77	72.0	38.1
Upper Mississippi River (Mississippi Headwaters)	Mississippi River – Headwaters	07010101	68	89	251.2	112.7
	Crow Wing River	07010106	61	79	664.1	299.8
	Pine River	07010105	67	95	551.9	244.2
	Leech Lake River	07010102	69	89	7.6	3.2
	Mississippi River – Grand Rapids	07010103	65	83	621.0	298.5
	Mississippi River – Brainerd	07010104	63	76	77.9	38.1
Lake Superior	Nemadji River	04010301	64	80	161.3	72.0
	St. Louis River	04010201	59	56	64.8	28.0
St. Croix River	Kettle River	07030003	64	76	318.0	149.8

Source: Minnesota DNR 2015a.

Notes:

[a] Average score is based on numerous indices comprising five main components: biology, connectivity, geomorphology, hydrology, and water quality. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values). The overall watershed health scores and five component scores are calculated on a scale from 0 to 100, with 100 representing a highest score.

[b] Water quality score based on indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations.

[c] Watershed acres that would be crossed by the construction work area.

[d] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016).

Table 6.3.1.2-2. Surface Waters Crossed by the Applicant's Preferred Route in Minnesota

Waterbody Type/Flow	Number of Crossings (PWI)
North Dakota Border to Clearbrook	
Artificial path	4
Canal/ditch	34
Connector	1
Lake/pond – perennial	2
Stream/river – intermittent	27
Stream/river – perennial	9
North Dakota border to Clearbrook subtotal	***77***
Clearbrook to Carlton	
Artificial path	11 (10)
Canal/ditch	15 (4)
Connector	3 (0)
Lake/pond – perennial	15 (0)
Stream/river – intermittent	40 (5)
Stream/river – perennial	25 (18)
Clearbrook to Carlton subtotal	***109 (36)***
Carlton to Wisconsin Border	
Lake/pond – perennial	1
Stream/river – intermittent	5
Carlton to Wisconsin border subtotal	***6***
TOTAL	**192**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

Also see maps in Appendix A.

PWI = Public Waters Inventory.

Sensitive/Specially Designated Surface Waters

The Applicant's preferred route would require nine crossings of Lake Superior Basin waters, which are designated as Outstanding International Resource Waters. Minnesota has designated the entire St. Croix River and its Kettle River tributary as ORVWs. The Applicant's preferred route would cross the Kettle River. Minnesota DNR has identified water resources crossed by the Applicant's preferred route that are sensitive due to their flow, steep slopes, beneficial use, or past construction activities on co-located projects or other factors. The Applicant and Minnesota DNR have communicated regarding these crossings, and the Applicant would prepare site-specific plans for the crossing of Mud Lake, LaSalle Creek, Hay Creek, and Straight River and two crossings of the Sandy River (and possibly others as determined by DNR) as part of its application for a License to Cross Public Waters.

The Applicant's preferred route would require six crossings of designated trout streams (Table 6.3.1.2-3). All trout stream crossings would occur in the Clearbrook-to-Carlton segment of the proposed route (maps with these trout streams are provided in Appendix A).

Table 6.3.1.2-3. Trout Streams Crossed by the Applicant's Preferred Route in Minnesota

Trout Stream	Crossing Milepost
Clearbrook to Carlton	
Blackhoof River (S-001-003)	352.1
King Creek (M-050-046-029-023)	344.2
LaSalle Creek (M-163)	170.1
Spring Brook (M-106-004-002-001)	265.3
Straight River (M-096-035-002-002)	198.3
Unnamed stream/river (perennial) (S-001-003-029)	352.3
TOTAL CROSSINGS	**6**

Source: Minnesota DNR 2015b.

Nationwide Rivers Inventory

The Applicant's preferred route would require seven crossings of NRI-listed rivers (Table 6.3.1.2-4). All of the rivers crossed have an Outstanding Resource Value (ORV) of scenery, recreation, or both. A recreational ORV signifies that recreational opportunities are, or have the potential to be, popular enough to attract visitors—or are unique or rare within the region; and visitors are willing to travel long distances to use the river resources for recreational purposes. A scenery ORV signifies that the landscape elements of landform, vegetation, water, color, and related factors result in notable or exemplary visual features or attractions. The route would not cross a federally or state-designated Wild and Scenic River segment, though it may cross tributaries or upstream locations on other sensitive/specially designated waters.

Table 6.3.1.2-4. Rivers Listed in the Nationwide Rivers Inventory Crossed by the Applicant's Preferred Route in Minnesota

River	Outstanding Resource Value	Crossing Milepost
North Dakota Border to Clearbrook		
Middle River	Scenery	62.3
Red Lake River	Scenery; recreation	91.9
Clearbrook to Carlton		
Clearwater River	Scenery	149.5
Shell River (two crossings)	Scenery	209.5 and 215.3
Crow Wing River	Scenery; recreation	217.4
Willow River	Scenery	292.8

Source: NPS 2011.

Notes:

No rivers listed in the Nationwide Rivers Inventory would be crossed by the Applicant's preferred route in the Carlton-to-Wisconsin border segment.

Also see maps in Appendix A.

Recreation: Recreational opportunities are, or have the potential to be, popular enough to attract visitors or are unique or rare within the region. Visitors are willing to travel long distances to use the river resources for recreational purposes.

Scenery: The landscape elements of landform, vegetation, water, color, and related factors result in notable or exemplary visual features and/or attractions.

Impaired Surface Waters

The Applicant's preferred route would require 13 crossings of impaired streams in Minnesota (Table 6.3.1.2-5) but would not cross any impaired lakes or wetlands. The Applicant's preferred route would cross three TMDL study areas, including:

- Big Sandy and Minnewawa Lakes TMDL study area (excess nutrients: phosphorus),
- Lake St. Croix Nutrient TMDL study area (excess nutrients: phosphorus), and
- Lower Wild Rice River TMDL study area (excess turbidity) (Minnesota PCA n.d.).

Table 6.3.1.2-5. Impaired Surface Waters Crossed by the Applicant's Preferred Route in Minnesota

Waterbody Name	Impaired Beneficial Use	Impairment	EPA Impairment Classification[a]	Crossing Milepost
North Dakota Border to Clearbrook				
Red River of the North	Fish consumption	Methylmercury	5	27.6
Tamarac River	Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments	5	54.4
Middle River	Aquatic life	Dissolved oxygen; turbidity; aquatic macroinvertebrate bioassessments	5	62.3
Black River	Aquatic life	Dissolved oxygen	5	82.6
Clearwater River	Aquatic consumption; aquatic life	Mercury in fish tissue; dissolved oxygen; turbidity	4A	103.0
Silver Creek	Aquatic recreation	Fecal coliform	5	135.9 / 135.3 / 135.6
Clearbrook to Carlton				
Clearwater River	Aquatic consumption; aquatic life	Mercury in fish tissue; dissolved oxygen	4A	149.5
Walker Brook	Aquatic life	Dissolved oxygen	5	151.4
Mississippi River	Aquatic life	Dissolved oxygen	5	165.1
Mississippi River	Aquatic consumption	Mercury in fish tissue	4A	296.7
Kettle River	Aquatic consumption	Mercury in fish tissue	5	338.2

Sources: Minnesota PCA 2014a, 2016b, 2016c.

Notes:

Also see maps in Appendix A.

No impaired rivers would be crossed by the Applicant's preferred route in the Carlton-to-Wisconsin border segment.

[a] U.S. Environmental Protection Agency (EPA) Impairment Classifications-

Category 4A: Waterbody is impaired or threatened, but a total maximum daily load (TMDL) study has been approved by EPA.

Category 5: Use assessment indicates an impaired status, and no TMDL plan has been completed.

Navigable Waterways

The Applicant's preferred route would require five crossings of navigable waterways, as shown in Appendix A. From the North Dakota border to Clearbrook, the navigable surface waters that would be crossed include:

- Red Lake River (MP 91.9), and
- Red River of the North (MP 27.6).

From Clearbrook to Carlton, the navigable surface waters that would be crossed include:

- Kettle River (MP 338.2),
- Sandy River (MP 305.9), and
- Mississippi River (MP 296.7).

Wild Rice Waterbodies

All wild rice waterbodies that would be crossed by the Applicant's preferred route occur between Clearbrook and Carlton. The areas of wild rice waterbodies that would be affected by construction and operation of the Applicant's preferred route are listed in Table 6.3.1.2-6. Fifteen wild rice waterbodies occur within 0.5 mile of the Applicant's preferred route. Five wild rice waterbodies could be affected by construction and operation of the Applicant's preferred route: Mud Lake, Hay Creek (HDD), Portage Lake, Peterson Lake, and Shell River (HDD). Wild rice waterbodies that would be crossed by the Applicant's preferred route are shown in Figure 6.3.1.2-1.

Table 6.3.1.2-6. Wild Rice Waterbodies Crossed by the Applicant's Preferred Route in Minnesota (acres)

Wild Rice Waterbody Type	Construction[a]	Operations[b]	Within 0.5 Mile of Centerline
Type 3 – Inland shallow fresh marshes	0.4	0.8	83.1
Type 4 – Inland deep fresh marshes	1.4	0.8	182.5
Type 5 – Inland open fresh water	3.1	1.7	475.0
Type 9 – Inland saline flats	0.0	0.0	2.6
TOTAL	**4.9**	**3.2**	**743.3**

Source: Minnesota DNR 2009b.

[a] Acres of wild rice waterbodies that would be crossed by the construction work area.

[b] Acres of wild rice waterbodies that would be crossed by the permanent right-of-way during operations.

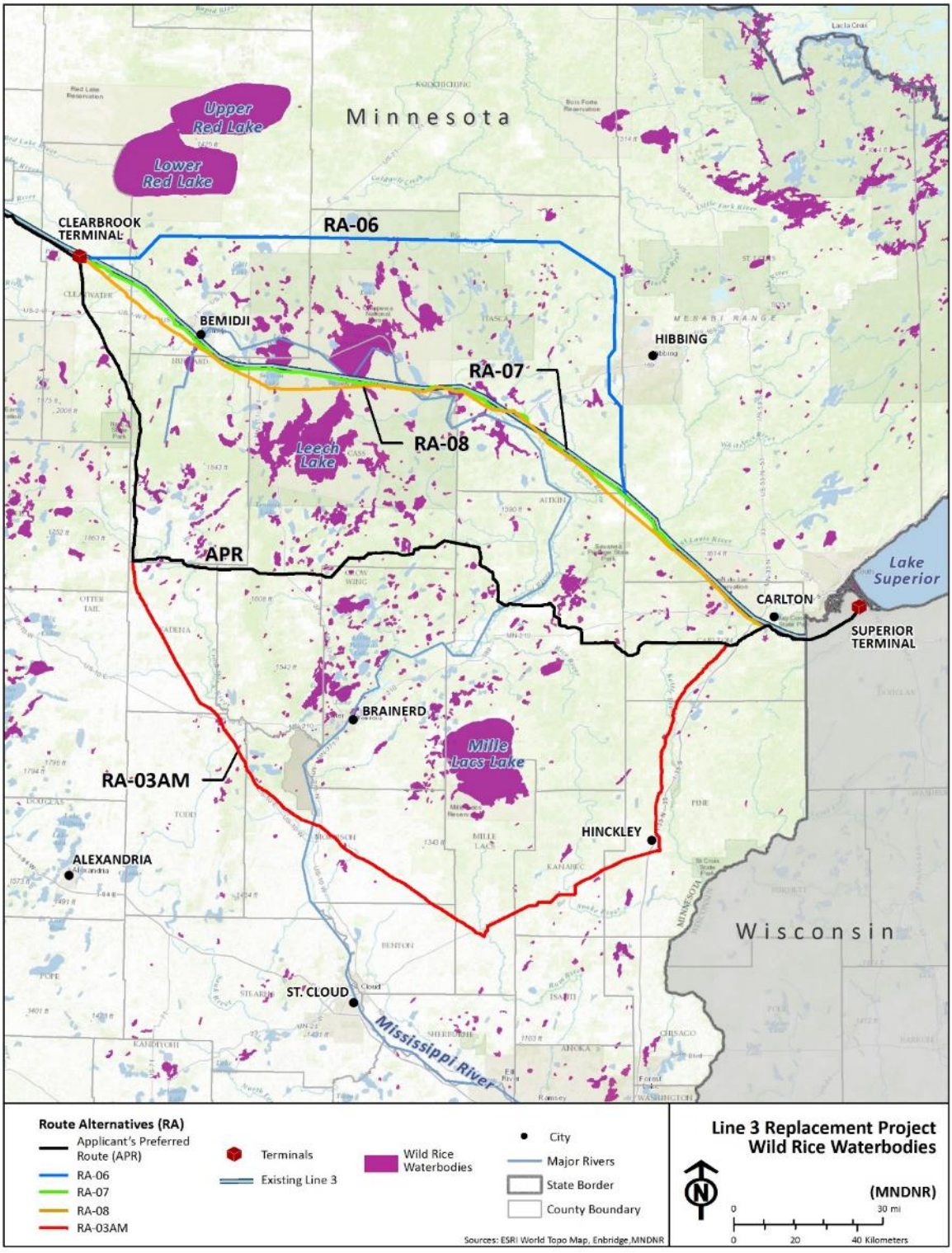
Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route in Minnesota is between Clearbrook and Carlton. The existing conditions relevant to surface water for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Drainage Basins and Watersheds

RA-03AM would cross the Red River, Upper Mississippi River, Lake Superior, and St. Croix River basins, which are described in Section 5.2.1.2.2. Table 6.3.1.2-7 presents the average watershed health scores, water quality scores, and affected watershed acres for the major drainage basins and watersheds that would be crossed by the RA-03AM route. Watershed biological indices scores are discussed in Section 6.3.4.



Sources: Minnesota DNR 2009a, 2009b.

Figure 6.3.1.2-1. Wild Rice Waterbodies near the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton

Table 6.3.1.2-7. Major Drainage Basins and Watersheds Crossed by Route Alternative RA-03AM

Drainage Basin	Watershed	HUC-8	Average Watershed Health Score[a]	Water Quality Score[b]	Construction[c] (acres)	Operations[d] (acres)
Clearbrook to Carlton						
Red River of the North	Tamarac River	09020311	44	63	474.8	197.8
	Snake River	09020309	46	66	778.0	105.7
	Grand Marais Creek	09020306	42	58	40.9	17.0
	Red Lake River	09020303	54	63	318.5	132.7
	Clearwater River	09020305	60	70	792.9	330.4
	Wild Rice River	09020108	57	77	80.0	33.5
Upper Mississippi River (Mississippi Headwaters)	Mississippi River – Headwaters	07010101	68	89	270.2	112.6
	Crow Wing River	07010106	61	79	681.6	284.0
	Long Prairie River	07010108	59	64	153.7	64.0
	Mississippi River – Brainerd	07010104	63	76	267.6	111.6
	Mississippi River – Sartell	07010201	58	63	291.2	132.7
	Redeye	07010107	64	83	267.6	111.5
	Rum	07010207	61	71	383.6	159.8
Lake Superior	Nemadji River	04010301	64	80	172.8	72.0
	St. Louis River	04010201	59	56	67.2	28.0
St. Croix River	Kettle River	07030003	64	76	701.9	17.0

Source: Minnesota DNR 2015a.

Notes:

[a] Average score is based on numerous indices comprising five main components: biology, connectivity, geomorphology, hydrology, and water quality. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values). The overall watershed health scores and five component scores are calculated on a scale from 0 to 100, with 100 representing a highest score.

[b] Water quality score based on indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations.

[c] Watershed acres that would be crossed by the construction work area.

[d] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016).

Surface Waters Crossed

Table 6.3.1.2-8 lists the surface waters crossed by RA-03AM. Route alternative RA-03AM would require 167 crossings of surface waters from Clearbrook to Carlton, including perennial, intermittent, and ephemeral streams; unnamed surface waters and non-jurisdictional ditches; rivers listed in the NRI; navigable waters; sensitive and specially designated surface waters; and impaired surface waters. See Appendix G for a listing of all proposed waterbody crossings.

From Clearbrook to Carlton, RA-03AM crosses a total of 60 public waters. These include 4 public water ditches, 13 artificial paths, 38 perennial streams/rivers and 4 intermittent streams/rivers, and 1 swamp/marsh.

Table 6.3.1.2-8. Surface Waters Crossed by Route Alternative RA-03AM

Waterbody Type/Flow	Number of Crossings (PWI)
Clearbrook to Carlton	
Artificial path	13 (13)
Canal ditch	31 (4)
Connector	6 (0)
Lake/pond – perennial	14 (0)
Stream/river – intermittent	62 (4)
Stream/river – perennial	41 (38)
Swamp/marsh – intermittent	? (1)
TOTAL	**167 (60)**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

PWI = Public Waters Inventory.

Sensitive/Specially Designated Surface Waters

Route alternative RA-03AM would require nine crossings of designated trout streams between Clearbrook and Carlton (Table 6.3.1.2-9). Maps with these trout streams are provided in Appendix A. RA-03AM would also cross the Kettle River, which is an ORVW.

Table 6.3.1.2-9. Trout Streams Crossed by Route Alternative RA-03AM

Trout Stream	Crossing Milepost
Clearbrook to Carlton	
Blackhoof River (S-001-003)	352.1
Cat River (M-096-028)	212.0 / 213.2
LaSalle Creek (M-163)	170.1
Mission Creek (M-050-044-006)	355.9
Straight River (M-096-035-002-002)	198.3
Unnamed Canal Ditch (M-096-018)	238.2
Unnamed stream/river (perennial) (M-096-020-001)	235.0
Unnamed stream/river (perennial) (S-001-003-029)	352.3
TOTAL CROSSINGS	**9**

Source: Minnesota DNR 2015b.

Nationwide Rivers Inventory

Between Clearbrook and Carlton, route alternative RA-03AM would cross one NRI-listed river: the Clearwater River with ORV-listed scenery at MP 149.5 (NPS 2011). RA-03AM also would cross state-designated Wild and Scenic Rivers sections of the Rum River and Kettle River.

Impaired Surface Waters

Between Clearbrook and Carlton, route alternative RA-03AM would require 14 crossings of impaired streams (Table 6.3.1.2-10) but would not cross any impaired lakes or wetlands. The route would cross six TMDL study areas, including:

- Lake St. Croix Nutrient TMDL study area (excess nutrients: phosphorus);
- Lower Wild Rice River TMDL study area (excess turbidity);
- Ann River watershed Bacteria, Nutrient, and Biota TMDL study area (excess nutrients (phosphorus), biota (fish and invertebrate), E. coli);
- Groundhouse River Fecal Coliform and Biota TMDL study area (excess fecal coliform and sediment levels);
- Long Prairie River Watershed TMDL study area (low dissolved oxygen); and
- Snake River Major Watershed (St. Croix Basin) WRAPS (excess nutrients: phosphorus), sediment, and bacteria) (Minnesota PCA n.d.).

Table 6.3.1.2-10. Impaired Surface Waters Crossed by Route Alternative RA-03AM

Waterbody Name	Impaired Beneficial Use	Impairment	EPA Impairment Classification[a]	Crossing Milepost
Clearbrook to Carlton				
Clearwater River	Aquatic consumption; aquatic life	Mercury in fish tissue; dissolved oxygen	4A	149.5
Walker Brook	Aquatic life	Dissolved oxygen	5	151.4
Mississippi River	Aquatic life	Dissolved oxygen	5	165.1
Skunk River	Aquatic recreation	Fecal coliform	5	286.8
South Fork Groundhouse River	Aquatic life	Aquatic macroinvertebrate bioassessments	4A	323.3
Groundhouse River	Aquatic life	Aquatic macroinvertebrate bioassessments	4A	328.5
Ann River	Aquatic life	Aquatic macroinvertebrate bioassessments	4A	332.7
Snake River	Aquatic consumption	Mercury in fish tissue	4A	334.9
Spring Brook	Aquatic life	Fishes bioassessments	5	337.0 / 338.0 / 335.2
Kettle River	Aquatic consumption	Mercury in fish tissue	5	384.6
Mud Creek	Aquatic life	Aquatic macroinvertebrate bioassessments; fishes bioassessments; *Escherichia coli*	4A	343.5
Grindstone River	Aquatic life	Fishes bioassessments	5	359.1

Sources: Minnesota PCA 2014a, 2016b, 2016c.

Notes:

Also see maps in Appendix A.

[a] U.S. Environmental Protection Agency (EPA) Impairment Classifications-
Category 4A: Waterbody is impaired or threatened, but a total maximum daily load (TMDL) study has been approved by EPA.
Category 5: Use assessment indicates an impaired status, and no TMDL plan has been completed.

Navigable Waterways

RA-03AM would require seven crossings of navigable waterways between Clearbrook and Carlton (USACE n.d.). The navigable surface waters that would be crossed include:

- Kettle River (MP 384.6),
- Grindstone River (MP 359.1),
- Snake River (MP 334.9),
- Ann River (MP 332.7),
- Groundhouse River (MP 328.5),
- Rum River (MP 314.3), and

- Mississippi River (MP 273.3).

Wild Rice Waterbodies

The areas of wild rice waterbodies that would be affected by construction and operation of RA-03AM are listed in Table 6.3.1.2-11 and shown in Figure 6.3.1.2-1 (above). Eleven wild rice waterbodies occur within 0.5 mile of RA-03AM. Six wild rice waterbodies could be affected by RA-03AM: Mud Lake, Hay Creek (HDD crossing), Portage Lake, Hayden Lake, Fox Lake, and Moose Horn River. Mud Lake, Portage Lake, Hayden Lake, and Fox Lake would be crossed within an existing pipeline corridor. Moose Horn River in Pine County, a wild rice waterbody not included in Minnesota DNR's 2009 database, also would be crossed by RA-03AM at MP 400.2, within an existing pipeline corridor.

Table 6.3.1.2-11. Wild Rice Waterbodies Crossed by Route Alternative RA-03AM (acres)

Wild Rice Waterbody Type	Construction[a]	Operations[b]	Within 0.5 Mile of Centerline
Clearbrook to Carlton			
Type 3 – Inland shallow fresh marshes	2.6	1.1	226.1
Type 4 – Inland deep fresh marshes	0.0	0.0	105.1
Type 5 – Inland open fresh water	4.9	2.1	513.4
TOTAL	**7.5**	**3.1**	**844.6**

Source: Minnesota DNR 2009b.

[a] Acres of wild rice waterbodies that would be crossed by the construction work area.

[b] Acres of wild rice waterbodies that would be crossed by the permanent right-of-way during operations.

Route Alternative RA-06

Drainage Basins and Watersheds

RA-06 would cross the Red River, Upper Mississippi River Lake Superior, and St. Croix River basins, which are described in Section 5.2.1.2.2; the Rainy River Basin is described at the beginning of this section. Table 6.3.1.2-12 presents the average watershed health scores, water quality scores, and affected watershed acres for the major drainage basins and watersheds that would be crossed by the RA-06 route. Watershed biological indices scores are discussed in Section 6.3.4.

Table 6.3.1.2-12. Major Drainage Basins and Watersheds Crossed by Route Alternative RA-06

Drainage Basin	Watershed	HUC-8	Average Watershed Health Score[a]	Water Quality Score[b]	Construction[c] (acres)	Operations[d] (acres)
Clearbrook to Carlton						
Red River of the North	Tamarac River	09020311	44	63	474.8	197.8
	Snake River	09020309	46	66	253.6	105.7
	Grand Marais Creek	09020306	42	58	40.9	17.0
	Red Lake River	09020303	54	63	318.5	132.7
	Upper/Lower Red Lake	09020302	73	76	556.9	232.2
	Clearwater River	09020305	60	70	703.6	293.2
Upper Mississippi River (Mississippi Headwaters)	Mississippi River – Headwaters	07010101	68	89	17.8	7.3
	Mississippi River – Grand Rapids	07010103	65	83	339.7	141.6
Rainy River	Big Fork River	09030006	78	97	651.0	271.3
	Little Fork River	09030005	69	77	268.3	111.8
Lake Superior	Nemadji River	04010301	64	80	93.9	39.1
	St. Louis River	04010201	59	56	863.7	359.8
St. Croix River	Kettle River	07030003	64	76	21.6	9.0

Source: Minnesota DNR 2015a.

Notes:

[a] Average score is based on numerous indices comprising five main components: biology, connectivity, geomorphology, hydrology, and water quality. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values). The overall watershed health scores and five component scores are calculated on a scale from 0 to 100, with 100 representing a highest score.

[b] Water quality score based on indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations.

[c] Watershed acres that would be crossed by the construction work area.

[d] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016).

Surface Waters Crossed

Table 6.3.1.2-13 lists the surface waters crossed by RA-06 from Clearbrook to Carlton. RA-06 would require 137 crossings of surface waters, including perennial, intermittent, and ephemeral streams; unnamed surface waters and non-jurisdictional ditches; rivers listed in the NRI; navigable waters; sensitive and specially designated surface waters; and impaired surface waters. See Appendix G for a listing of all proposed waterbody crossings.

From Clearbrook to Carlton, RA-06 crosses a total of 76 public waters. These include 2 public water ditches, 2 connectors, 17 artificial paths, 41 perennial streams/rivers and 8 intermittent streams/rivers, and 6 lakes/ponds.

Table 6.3.1.2-13. Surface Waters Crossed by Route Alternative RA-06

Waterbody Type/Flow	Number of Crossings (PWI)
Clearbrook to Carlton	
Artificial path	18 (17)
Canal/ditch	12 (2)
Connector	5 (2)
Lake/pond – perennial	16 (6)
Stream/river – intermittent	29 (8)
Stream/river – perennial	57 (41)
TOTAL	**137 (76)**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

PWI = Public Waters Inventory.

Sensitive/Specially Designated Surface Waters

Route alternative RA-06 would require eight crossings of designated trout streams between Clearbrook and Carlton (Table 6.3.1.2-14). Maps with these trout streams are provided in Appendix A. The RA-06 route crosses 37 Lake Superior Basin waters, which are considered to be Outstanding International Resource Waters.

Table 6.3.1.2-14. Trout Streams Crossed by Route Alternative RA-06

Trout Stream	Crossing Milepost
Clearbrook to Carlton	
Clearwater River (H-026-030-019)	149.2
Little Otter Creek (S-002-009-001)	304.2
O'Brien Creek (H-026-030-069-004) (3 crossings)	172.4 / 172.6 / 172.7
Unnamed stream/river (intermittent) (S-002-032-011)	283.6
Unnamed stream/river (perennial) (H-001-030-023-002-010-001-001)	243.6
Venning Creek (H-001-030-023-002-010)	242.7
TOTAL CROSSINGS	**8**

Source: Minnesota DNR 2015b.

Nationwide Rivers Inventory

Between Clearbrook and Carlton, RA-06 would cross two NRI-listed rivers: the Clearwater River with ORV-listed scenery at MP 149.2, and the Big Fork River with ORV-listed scenery and recreation at MP 223.4 (NPS 2011). The route would not cross a federally or state-designated Wild and Scenic River segment.

Impaired Surface Waters

Between Clearbrook and Carlton, RA-06 would require one crossing of Ruffy Brook, which has aquatic recreation beneficial uses and is impaired by fecal coliform (EPA Category 5) (Minnesota PCA 2014a, 2016b, 2016c). RA-06 would not cross any impaired lakes or wetlands. The route would cross the Lake St. Croix Nutrient TMDL study area once, which is impaired by excess nutrients (phosphorus) (Minnesota PCA n.d.).

Navigable Waterways

Route alternative RA-06 would cross the Big Fork River nine times (USACE n.d.) at the following mileposts:

- MP 214.5
- MP 215.2
- MP 223.4
- MP 210.0
- MP 215.9
- MP 203.9
- MP 212.6
- MP 204.2
- MP 205.6

Wild Rice Waterbodies

The areas of wild rice waterbodies that would be affected by construction and operation of RA-06 are listed in Table 6.3.1.2-15 and shown in Figure 6.3.1.2-1 (above). Five wild rice waterbodies occur within 0.5 mile of RA-06. Four wild rice waterbodies would be crossed by RA-06, all within new pipeline rights-of-way: Rice Lake, Coddington Lake, Dora Lake, and Big Fork River. Rice Lake in Beltrami County, a wild rice waterbody not included in Minnesota DNR's 2009 database, would be crossed by RA-06 at MP 160.0.

Table 6.3.1.2-15. Wild Rice Waterbodies Crossed by Route Alternative RA-06 (acres)

Wild Rice Waterbody Type	Construction[a]	Operations[b]	Within 0.5 Mile of Centerline
Clearbrook to Carlton			
Type 4 – Inland deep fresh marshes	0.0	0.0	74.9
Type 5 – Inland open fresh water	10.6	4.4	352.6
TOTAL	**10.6**	**4.4**	**427.5**

Source: Minnesota DNR 2009b.

[a] Acres of wild rice waterbodies that would be crossed by the construction work area.

[b] Acres of wild rice waterbodies that would be crossed by the permanent right-of-way during operations.

Route Alternative RA-07

Drainage Basins and Watersheds

RA-07 would cross the Red River, Upper Mississippi River Lake Superior, and St. Croix River basins, which are described in Section 5.2.1.2.2. Table 6.3.1.2-16 presents the average watershed health scores, water quality scores, and affected watershed acres for the major drainage basins and watersheds that would be crossed by the RA-03AM route. Watershed biological indices scores are discussed in Section 6.3.4.

Table 6.3.1.2-16. Major Drainage Basins and Watersheds Crossed by Route Alternative RA-07

Drainage Basin	Watershed	HUC-8	Average Watershed Health Score[a]	Water Quality Score[b]	Construction[c] (acres)	Operations[d] (acres)
Clearbrook to Carlton						
Red River of the North	Tamarac River	09020311	44	63	635.4	197.8
	Snake River	09020309	46	66	253.6	105.7
	Grand Marais Creek	09020306	42	58	40.9	17.0
	Red Lake River	09020303	54	63	318.5	132.7
	Clearwater River	09020305	60	70	864.0	306.5
Upper Mississippi River (Mississippi Headwaters)	Mississippi River – Headwaters	07010101	68	89	1341.3	327.5
	Leech Lake River	07010102	69	89	474.8	169.4
	Mississippi River – Grand Rapids	07010103	65	83	581.2	132.7
Lake Superior	Nemadji River	04010301	64	80	97.0	39.1
	St. Louis River	04010201	59	56	1,171.2	295.9
St. Croix River	Kettle River	07030003	64	76	42.3	9.0

Source: Minnesota DNR 2015a.

Notes:

[a] Average score is based on numerous indices comprising five main components: biology, connectivity, geomorphology, hydrology, and water quality. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values). The overall watershed health scores and five component scores are calculated on a scale from 0 to 100, with 100 representing a highest score.

[b] Water quality score based on indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations.

[c] Watershed acres that would be crossed by the construction work area.

[d] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016).

Surface Waters Crossed

Table 6.3.1.2-17 lists the surface waters crossed by RA-07 from Clearbrook to Carlton. RA-07 would require 81 crossings of surface waters, including perennial, intermittent, and ephemeral streams; unnamed surface waters and non-jurisdictional ditches; rivers listed in the NRI; navigable waters; sensitive and specially designated surface waters; and impaired surface waters. See Appendix G for a listing of all proposed waterbody crossings.

From Clearbrook to Carlton, RA-07 crosses a total of 34 public waters. These include 3 public water ditches, 1 connector, 5 artificial paths, 17 perennial streams/rivers, 6 intermittent streams/rivers, 1 lake/pond and 1 swamp/marsh.

Table 6.3.1.2-17. Surface Waters Crossed by Route Alternative RA-07

Waterbody Type/Flow	Number of Crossings (PWI)
Clearbrook to Carlton	
Artificial path	5 (5)
Canal/ditch	19 (3)
Connector	2 (1)
Lake/pond – perennial	6 (1)
Stream/river – intermittent	20 (6)
Stream/river – perennial	28 (17)
Swamp/marsh – intermittent	1 (1)
TOTAL	**81 (34)**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

PWI = Public Waters Inventory.

Sensitive/Specially Designated Surface Waters

Route alternative RA-07 would require six crossings of designated trout streams between Clearbrook and Carlton (Table 6.3.1.2-18). Maps with these trout streams are provided in Appendix A.

Table 6.3.1.2-18. Trout Streams Crossed by Route Alternative RA-07

Trout Stream	Crossing Milepost
Clearbrook to Carlton	
Clearwater River (H-026-030-019)	151.2
Little Otter Creek (S-002-009-001)	304.2
Necktie River (M-146-017-001)	176.4
Unnamed stream/river (intermittent) (M-146-017-001-001)	174.5
Unnamed stream/river (intermittent) (M-146-017-001-002)	173.3
Unnamed stream/river (perennial) (H-026-030-019-025.1)	151.1
TOTAL CROSSINGS	**6**

Source: Minnesota DNR 2015b.

Nationwide Rivers Inventory

Route alternative RA-07 would cross one NRI-listed river between Clearbrook and Carlton: the Clearwater River, with ORV-listed scenery at MP 151.2 (NPS 2011). The route would not cross a federally or state-designated Wild and Scenic River segment.

Impaired Surface Waters

Route alternative RA-07 would require two crossings of impaired streams between Clearbrook and Carlton (Table 6.3.1.2-19) but would not cross any impaired lakes or wetlands. The route would cross the Lake St. Croix Nutrient TMDL study area once, which is impaired by excess nutrients (phosphorus) (Minnesota PCA n.d.).

Table 6.3.1.2-19. Impaired Surface Waters Crossed by Route Alternative RA-07

Waterbody Name	Impaired Beneficial Use	Impairment	EPA Impairment Classification[a]	Crossing Milepost
Clearbrook to Carlton				
Ruffy Brook	Aquatic recreation	Fecal coliform	5	143.1
Swan River	Aquatic consumption	Mercury in fish tissue	4A	253.9

Sources: Minnesota PCA 2014a, 2016b, 2016c.

Notes:

Also see maps in Appendix A.

[a] U.S. Environmental Protection Agency (EPA) Impairment Classifications-

Category 4A: Waterbody is impaired or threatened, but a total maximum daily load (TMDL) study has been approved by EPA.

Category 5: Use assessment indicates an impaired status, and no TMDL plan has been completed.

Navigable Waterways

Route alternative RA-07 would cross the Mississippi River at MP 241.8.

Wild Rice Waterbodies

The areas of wild rice waterbodies that would be affected by construction and operation of RA-07 are listed in Table 6.3.1.2-20 and shown in Figure 6.3.1.2-1 (above). Eleven wild rice waterbodies occur within 0.5 mile of RA-07 (Table 6.3.1.2-20). One wild rice waterbody (White Oak Lake) is crossed by RA-07 within the existing pipeline corridor at the stream inlet to the lake basin portion of the wild rice lake boundary.

Table 6.3.1.2-20. Wild Rice Waterbodies Crossed by Route Alternative RA-07 (acres)

Wild Rice Waterbody Type	Construction[a]	Operations[b]	Within 0.5 Mile of Centerline
Clearbrook to Carlton			
Type 3 – Inland shallow fresh marshes	0.0	0.0	0.0
Type 4 – Inland deep fresh marshes	6.1	2.5	581.3
Type 5 – Inland open fresh water	0.0	0.0	840.7
TOTAL	**6.1**	**2.5**	**1,422.0**

Source: Minnesota DNR 2009b.

[a] Acres of wild rice waterbodies that would be crossed by the construction work area.

[b] Acres of wild rice waterbodies that would be crossed by the permanent right-of-way during operations.

Route Alternative RA-08

Drainage Basins and Watersheds

RA-08 would cross the Red River, Upper Mississippi River Lake Superior, and St. Croix River basins, which are described in Section 5.2.1.2.2. Table 6.3.1.2-21 presents the average watershed health scores, water quality scores, and affected watershed acres for the major drainage basins and watersheds that would be crossed by the RA-08 route. Watershed biological indices scores are discussed in Section 6.3.4.

Table 6.3.1.2-21. Major Drainage Basins and Watersheds Crossed by Route Alternative RA-08

Drainage Basin	Watershed	HUC-8	Average Watershed Health Score[a]	Water Quality Score[b]	Construction[c] (acres)	Operations[d] (acres)
Clearbrook to Carlton						
Red River of the North	Tamarac River	09020311	44	63	474.8	197.8
	Snake River	09020309	46	66	253.6	105.7
	Grand Marais Creek	09020306	42	58	40.9	17.0
	Red Lake River	09020303	54	63	318.5	132.7
	Clearwater River	09020305	60	70	714.5	297.7
Upper Mississippi River (Mississippi Headwaters)	Mississippi River – Headwaters	07010101	68	89	664.4	276.8
	Leech Lake River	07010102	69	89	536.7	223.6
	Mississippi River – Grand Rapids	07010103	65	83	388.3	161.8
Lake Superior	Nemadji River	04010301	64	80	93.8	39.1
	St. Louis River	04010201	59	56	631.6	263.3
St. Croix River	Kettle River	07030003	64	76	22.9	9.3

Source: Minnesota DNR 2015a.

Notes:

[a] Average score is based on numerous indices comprising five main components: biology, connectivity, geomorphology, hydrology, and water quality. Index scores of 0 to 20 represent components that are heavily affected/low quality, scores of 40 to 60 represent moderately affected/moderate quality, and scores of 80 to 100 represent the least affected/high quality (scores of 20–40 and 60–80 are intermediate values). The overall watershed health scores and five component scores are calculated on a scale from 0 to 100, with 100 representing a highest score.

[b] Water quality score based on indices such as temperature, dissolved oxygen, pH, nutrient load, turbidity/sedimentation, and contaminant concentrations.

[c] Watershed acres that would be crossed by the construction work area.

[d] Watershed acres that would be crossed by the permanent right-of-way during operations.

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by the U.S. Geological Survey (2016).

Surface Waters Crossed

Table 6.3.1.2-22 lists the surface waters crossed by RA-08 from Clearbrook to Carlton. RA-08 would require 106 crossings of surface waters, including perennial, intermittent, and ephemeral streams; unnamed surface waters and non-jurisdictional ditches; rivers listed in the NRI; navigable waters; sensitive and specially designated surface waters; and impaired surface waters. See Appendix G for a listing of all proposed waterbody crossings.

From Clearbrook to Carlton, RA-08 crosses a total of 36 public waters. These include 1 public water ditch, 1 connector, 5 artificial paths, 21 perennial streams/rivers, 4 intermittent streams/rivers, and 1 lake/pond.

Table 6.3.1.2-22. Surface Waters Crossed by Route Alternative RA-08

Waterbody Type/Flow	Number of Crossings (PWI)
Clearbrook to Carlton	
Artificial path	6 (5)
Canal ditch	27 (1)
Connector	4 (1)
Lake/pond – perennial	11 (1)
Stream/river – intermittent	27 (4)
Stream/river – perennial	31 (21)
TOTAL	**106 (36)**

Source: USGS 2017.

Notes:

An artificial path is a feature that represents flow through a two-dimensional feature, such as a lake or a double-banked stream. An artificial path represents the flow of water into, through, and out of features (channel, estuary, lake/pond, playa, reservoir, swamp, marsh). A canal ditch specifies that it is artificial and that it is used to transport water, to drain or irrigate land, to connect two or more water bodies, or to serve as a waterway for watercraft. A connector establishes a known, but non-specific connection between two non-adjacent network segments that have flow.

Perennial waterbodies are those that hold water at all times, except in cases of extreme drought. Intermittent waterbodies are those that are wet only during part of the year, usually in spring, when rain and snowmelt saturate the ground surface.

Also see maps in Appendix A.

PWI = Public Waters Inventory.

Sensitive/Specially Designated Surface Waters

Route alternative RA-08 would require four crossings of designated trout streams between Clearbrook and Carlton (Table 6.3.1.2-23). Maps with these trout streams are provided in Appendix A.

Table 6.3.1.2-23. Trout Streams Crossed by Route Alternative RA-08

Trout Stream	Crossing Milepost
Clearbrook to Carlton	
Little Otter Creek (S-002-009-001)	301.4
Necktie River (M-146-017-001)	177.0
Unnamed stream/river (intermittent) (M-146-017-001-001)	173.9
Unnamed stream/river (intermittent) (M-146-017-001-002)	172.7
TOTAL CROSSINGS	**4**

Source: Minnesota DNR 2015b.

Nationwide Rivers Inventory

Route alternative RA-08 would cross one NRI-listed river between Clearbrook and Carlton: the Clearwater River, with ORV-listed scenery at MP 148.8 (NPS 2011). The route would not cross a federally or state-designated Wild and Scenic River.

Impaired Surface Waters

Route alternative RA-08 would require five crossings of impaired streams between Clearbrook and Carlton (Table 6.3.1.2-24) but would not cross any impaired lakes or wetlands. The route would cross the Lake St. Croix Nutrient TMDL study area once, which is impaired by excess nutrients (phosphorus) (Minnesota PCA n.d.).

Table 6.3.1.2-24. Impaired Surface Waters Crossed by Route Alternative RA-08

Waterbody Name	Impaired Beneficial Use	Impairment	EPA Impairment Classification[a]	Crossing Milepost
Clearbrook to Carlton				
Ruffy Brook (two crossings)	Aquatic recreation	Fecal coliform	5	144.1 / 144.3
Clearwater River	Aquatic consumption; aquatic life	Mercury in fish tissue; dissolved oxygen	4A	148.8
Swan River	Aquatic consumption	Mercury in fish tissue	4A	252.3
Mississippi River	Aquatic consumption	Mercury in fish tissue	4A	165.8

Sources: Minnesota PCA 2014a, 2016b, 2016c.

Notes:

Also see maps in Appendix A.

[a] U.S. Environmental Protection Agency (EPA) Impairment Classifications-

Category 4A: Waterbody is impaired or threatened, but a total maximum daily load (TMDL) study has been approved by EPA.

Category 5: Use assessment indicates an impaired status, and no TMDL plan has been completed.

Navigable Waterways

Route alternative RA-08 would cross the Mississippi River at MP 241.6 and Sucker Creek at MP 192.5 (USACE n.d.).

Wild Rice Waterbodies

The areas of wild rice waterbodies that would be affected by construction and operation of RA-08 are listed in Table 6.3.1.2-25 and shown in Figure 6.3.1.2-1 (above). Two wild rice waterbodies, Nushka Lake and White Oak Lake, would be crossed by RA-08; both crossings would be located within an existing pipeline corridor. White Oak Lake would be crossed by RA-08 at the stream inlet to the lake basin, while Nushka Lake would be crossed at the lake shoreline.

Table 6.3.1.2-25. Wild Rice Waterbodies Crossed by Route Alternative RA-08 (acres)

Wild Rice Waterbody Type	Construction[a]	Operations[b]	Within 0.5 Mile of Centerline
Clearbrook to Carlton			
Type 4 – Inland deep fresh marshes	9.8	4.1	948.2
Type 5 – Inland open fresh water	0.0	0.0	246.8
Type 9 – Inland saline flats	0.0	0.0	9.4
TOTAL	**9.8**	**4.1**	**1,204.5**

Source: Minnesota DNR 2009b.

[a] Acres of wild rice waterbodies that would be crossed by the construction work area.

[b] Acres of wild rice waterbodies that would be crossed by the permanent right-of-way during operations.

6.3.1.2.3 Regional Analysis of the Quality of Existing Surface Water Conditions

This analysis provides a summary of general quality comparisons of surface water conditions across Minnesota as well as more detailed potential effects on specific surface water resources along the Applicant's preferred route and the route alternatives.

The north-central and northeast portion of Minnesota consist of water resources that are generally the highest quality recreational water resources in the state. To describe the general regionwide or statewide difference in surface water resource quality across Minnesota, different general methods can be used, including the Minnesota PCA ecoregion concept to guide typical water quality conditions and Minnesota DNR's Watershed Health Assessment Framework. The quality of existing surface water conditions are discussed using each of these frameworks below.

- **Minnesota PCA Ecoregion Concept to Guide Typical Water Quality Conditions**. The state is divided into seven different ecoregions based on soils. Ecoregions have similar soil, geomorphology, land use and natural vegetation. The Northern Lakes and Forests (NLF) Ecoregion typically has the highest water quality compared to other ecoregions, especially those with areas more dominated by altered landscapes. Minnesota PCA offers a guide to typical water quality conditions in these seven ecoregions, "large expanses of land containing a geographically distinct collection of plants, animals, natural communities and environmental conditions."[9]
- **Minnesota DNR Watershed Health Assessment Framework.** Another approach used to describe surface water quality conditions across landscapes in Minnesota is the Watershed Health Assessment Framework (WHAF) Tool, developed by Minnesota DNR, which uses the science of watershed health. The **science** of watershed health is based on a whole-system approach. Ecological processes interact to provide services such as clean air and water, available groundwater, and diverse plant and animal communities. The science of health explores how all the parts system work together to provide a "healthy watershed." In order to explore the watershed system in a consistent, systematic way, the ecological processes have been divided into five different components: biology, connectivity, geomorphology,

[9] https://www.pca.state.mn.us/quick-links/eda-guide-typical-minnesota-water-quality-conditions.

hydrology, and water quality. A suite of **watershed health index scores** have been calculated that represent many of the important ecological relationships within and between the components. These scores are built on statewide GIS data that are compared consistently across Minnesota to provide a baseline health condition report for each of the 81 major watersheds in the state. The Watershed Health Assessments consist of health scores that rank the condition of Minnesota's watersheds from 0 (poor health condition, red) to 100 (good health condition, green). Watershed report cards indicate poorer water quality related to altered land use indicators as depicted in this analysis[10] (Appendix J-1).

The ecoregion approach used to assess water quality by Minnesota PCA and the WHAF Tool developed by Minnesota DNR are useful in describing existing surface water conditions across Minnesota. In general, the north-central and northeast forested portions of Minnesota are the least impaired and have the highest quality surface water resources; areas in the west and south agricultural portions of the state have the most impaired surface water resources and are of poorer quality.

Specifically, the data indicate that there are higher quality resources in the NLF ecoregion of the state. Lower nutrients (mainly phosphorus) and chlorophyll-a (algae) and greater transparency are indicative of lakes in this ecoregion. Streams in this ecoregion exhibit lower nutrients, turbidity, and fecal coliform, as well as lower temperature and biological oxygen demand conditions. A spatial distribution of lakes and streams depicted in Appendices J-2 and J-3, which show lakes and streams relative to pipeline routes across the state. There are a large number of lakes and streams in north-central and northeast Minnesota, and they are of the highest quality when comparing ecoregion data.

Three watersheds were assessed to represent potential pipeline routing areas throughout the state: the Pine River watershed (north-central), Chippewa River (west) and Le Sueur River (south). The watershed health index scores indicate that the best health scores are represented in the Pine River and the worst scores in the Chippewa and Le Sueur River watersheds accordingly. Further, in general, statewide maps indicate better health scores across the north and east and poorer scores across the south and west, as depicted by analysis of the five different components: biology, connectivity, geomorphology, hydrology, and water quality (Appendix J-1). Water quality scores for the Applicant's preferred route and route alternatives are provided in Tables 6.3.1.2-7, 6.3.1.2-12, 6.3.1.2-16, and 6.2.1.3-21).

Trout Streams

Several trout streams are intersected by the route alternatives. Often because of their non-impaired or minimally impaired watersheds and their locations, soils, and geologic setting within the state, these streams represent high-quality, cold, oxygenated water necessary for trout survival. RA-06, RA-07, RA-08, RA-03AM, and the Applicant's preferred route intersect within 0.5 mile of 17 to 24 designated trout streams or protected tributaries to designated trout streams (Table 6.3.2.1-26).

[10] http://www.dnr.state.mn.us/whaf/index.html.

Table 6.3.2.1-26. High-Quality Surface Water Resources Intersected within 0.5 Mile of Route Centerline for the Applicant's Preferred Route and Route Alternatives

High-Quality Surface Water Resource	Applicant's Preferred Route	Route Alternatives			
		RA-06	RA-07	RA-08	RA-03AM
Trout streams	17	24	17	16	17
Wild rice lakes	17	5	11	9	11
Lakes of high and outstanding biological significance	8	4	12	9	4
Tulibee lakes	4	1	9	10	3

Wild Rice Lakes

Minnesota has more acres of natural wild rice (*Zizania palustris*) than any other state in the country. Wild rice has been historically documented in 45 of Minnesota's 87 counties and in all corners of the state. Anecdotal information suggests an even broader distribution prior to European settlement. Wild rice is an important social and cultural component for Native American tribes and rural Minnesota communities.

A Minnesota DNR assessment found over 1,200 lakes and rivers in 54 counties that currently contain or historically had wild rice. Over 64,000 acres of wild rice (out of roughly 2 million basin acres) were found on these waters. More than half of the acreage was found in Aitkin, Cass, Crow Wing, Itasca, and St. Louis counties.

Large numbers of wild rice lakes exist in the NLF ecoregion, and this is represented by several lakes bisected by each of the routes in this ecoregion (Table 6.3.2.1-26).

Lakes of Biological Significance (High and Outstanding)

Lakes of Biological Significance were identified and classified by Minnesota DNR subject matter experts on objective criteria for four community types (aquatic plants, fish, amphibians, and birds). Unique plant or animal presence was the primary measure of a lake's biological significance. Lakes were rated and grouped for each of the following communities: aquatic plants, fish, birds, and amphibians. Lakes were assigned one of three biological significance classes (outstanding, high, or moderate). This assessment viewed outstanding and high sites as they are representative of the highest quality conditions. Many Minnesota lakes have not been sampled for plants or animals, so this list of lakes will be periodically revised as additional biological data become available.

There are a large number of lakes with high and outstanding biological significance in the NLF ecoregion. RA-06, RA-07, RA-08, RA-03AM and the Applicant's preferred route all cross some of these lakes in this ecoregion (Table 6.3.2.1-26).

Tullibee Lakes

Minnesota has about 650 tullibee lakes, more than any other state in the lower 48. Many of these waters are prized by anglers because tullibee (also known as cisco, or lake herring in Lake Superior) provide a high-energy feast for walleye, northern pike, muskellunge, and lake trout. Changes in land use

and climate are causing many lakes to lose tullibee. Keeping forested land intact can help maintain water quality in lakes with tullibee and other coldwater species. The Tullibee Lake Watershed Forest Stewardship Project[11] is engaging owners of private woodlands and other conservation partners to protect vulnerable waters in north-central Minnesota (Table 6.3.2.1-26).

Other Spatial Indicators of the Quality of Surface Water

Ditches

An evaluation was also done on the number of public water ditches crossed by the routes. High numbers of ditches is an indication of landscape alteration that adversely affects water resources, thus diminishing the quality of water resources in the area. An image of the total number of ditches, including private, in the vicinity of the Applicant's preferred route and route alternatives is depicted on a statewide map in Appendix J-4.

Perennial Cover

Areas that tend to rate low in perennial cover, terrestrial habitat quality, and connectivity have poorer overall health index scores as depicted in watershed health scores for the Pine, Chippewa, and Le Sueur River watersheds (Appendix J-5).

Wetlands

The northern routes (RA-06, RA-07, and RA-08) extend through areas containing a large number of wetlands, many of which are peat wetlands. Minnesota's 6 million acres of peatlands represent a major component of the state's natural heritage. In a worldwide context, the patterned peatlands in Minnesota are extremely valuable for the study of ecological and developmental processes in peatlands as noted in *Recommendations for the Protection of Ecologically Significant Peatlands in Minnesota* (Minnesota DNR 1984). The number of wetlands statewide is also depicted in viewing watershed health scores under "Loss of Hydrologic Storage, Wetland Loss" in (Appendices J-6 and J-7).

Walleye Lakes

Walleye lakes are spatially represented to indicate the location of these waters relative to the pipeline routes. Walleyes and walleye fishing are an important heritage to all Minnesotans and can be an indicator of ecological condition of lakes. Walleye lakes are fairly dispersed across the state; however, habitat suitable for reproduction and self-sustaining populations has a much higher presence in the high-quality waters representative of the NLF ecoregion.

Applicant's Preferred Route – Clearbrook to Carlton

The Applicant's preferred route follows a route south of Clearbrook, following an existing pipeline right-of-way, and then follows an existing transmission line corridor easterly toward Carlton. The northern routes (RA-06, RA-07, RA-08, and the Applicant's preferred route) all pass through a large number of streams, lakes, wetlands, and accompanying resources—all of which are generally of high quality. The Applicant's preferred route intersects a similar amount of resources as the route alternatives; however, the Applicant's preferred route has the potential to affect the highest number of wild rice lakes (17). Among other notable resources, this route passes 17 trout streams and 8 lakes of high and outstanding

[11] http://www.dnr.state.mn.us/tullibeelake.html.

biodiversity significance as well as 4 tullibee lakes. See Table 6.2.1.2-26 for a comparison of resources intersected.

RA-03AM – Clearbrook to Carlton

RA-03AM follows a route south of Clearbrook following an existing pipeline right-of-way and continues southeast toward Staples, Little Falls, and Milaca and then northeast toward Mora, Hinckley, Moose Lake, and Carlton. This route avoids areas of highest quality surface water resources in areas of north-central and northeast Minnesota. Notable in this route are similar amounts of trout stream and designated trout stream tributaries (17) as well as wild rice lakes (11). There are fewer tullibee lakes (3) and lakes of high and outstanding biodiversity significance (4) than most other northern routes. The longer length of this route increases the potential of intersecting more resources.

When reviewing Minnesota PCA's ecoregion concept for assessing lake water quality as well as Minnesota DNR WHAF data, there is a trend toward poorer water quality associated with more intensive land use in the southern portion of this route. This is noted in water quality conditions in the North Central Hardwood Forests as compared to the NLF ecoregion and WHAF health scores as well as layers depicting ditches, perennial cover, or loss of hydrologic storage from wetlands. See Table 6.2.1.2-26 for a comparison of resources intersected.

RA-06 – Clearbrook to Carlton

This route is the most northerly route around the Chippewa National Forest. The northern routes (RA-06, RA-07, RA-08, and the Applicant's preferred route) all pass through a large number of streams, lakes, wetlands and accompanying resources all of which are generally of high quality. Though there are fewer lakes of high and outstanding biodiversity intersected by RA-06, there are 5 wild rice lakes and a large number of trout streams and trout stream tributaries within this route (24). This route also passes four lakes of high and outstanding biodiversity significance and one tullibee lake. The large amount of undisturbed upland and wetland forest cover helps maintain healthy surface water conditions in this route area. See Table 6.2.1.2-26 for a comparison of resources intersected.

RA-07 – Clearbrook to Carlton

This route follows the existing pipeline corridor southeast to Carlton nearest U.S. Highway 2 until it leaves the highway and follows a southeasterly route toward Carlton. In evaluating the overall quality resources in the northern routes as well as trout streams, wild rice lakes, and lakes of high and outstanding biodiversity significance, this route has similar high-quality resources and potential effects when compared to other northern routes. Among notable resources, this route passes 17 trout streams, 11 wild rice lakes, 12 lakes of high and outstanding biodiversity significance, and 9 tullibee lakes. The difference in this route is that it is within an existing corridor that has already had similar land use alterations from previous pipeline installations and operations as well as U.S. Highway 2 and railway. See Table 6.2.1.2-26 for a comparison of resources intersected.

RA-08 – Clearbrook to Carlton

This route follows the existing pipeline corridor southeast to Carlton near but more south of U.S. Highway 2 than RA-07 until it follows a southeasterly route toward Carlton. In evaluating the overall quality resources in the northern routes as well as trout streams, wild rice lakes, lakes of high and outstanding biodiversity significance and tullibee lakes, this route has similar potential effects when

compared to other northern routes. Notable resources, this route passes 16 trout streams, 9 wild rice lakes, 9 lakes of high and outstanding biodiversity significance and 10 tullibee lakes. Similar to RA-07, the difference is this route is that it is within an existing corridor that has already had similar land use alterations from previous pipeline installations and operations as well as U.S. Highway 2 and railway. See Table 6.2.1.2-26 for comparison of resources intersected.

6.3.1.2.4 Impact Assessment

This section addresses the impact analysis conducted for the Applicant's preferred route and the route alternatives. The analysis assessed potential impacts on surface waters in the ROIs for the route options, as described in Section 6.3.1.2.1, related to the following concerns:

- Runoff and flows – increases in stormwater runoff and erosion, increases in total suspended solids concentrations and increased sedimentation, changes in stream flows from water withdrawals and discharges, and disruption of flow paths or local hydrologic connectivity;
- Surface water and aquatic habitat quality – degradation of surface water quality, degradation of aquatic habitat from instream and other construction activities, degradation of water quality and habitat from releases of drilling mud during HDD crossings;
- Channel morphology and stability – changes in channel morphology and stability caused by channel and streambank modifications; and
- Disturbance of wild rice waterbodies.

Many pipeline construction activities have the potential to affect surface water flow and quality. These activities include clearing and grading, dewatering and trenching, blasting, access road construction, waterbody crossings, surface water withdrawals and discharges (e.g., for hydrostatic test water), fueling and use of hazardous materials, and restoration or reclamation of construction areas. The following sections address potential impacts on surface water from these activities for the Applicant's preferred route and route alternatives. After the discussion of construction impacts, the potential impacts of operations on surface waters are addressed for the Applicant's preferred route and each route alternative.

Applicant's Preferred Route (in Minnesota)

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required within the construction work area for the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including six pipe yards in Minnesota. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, the Applicant would comply with the requirements of applicable permit programs that are in place to manage potential impacts, as addressed below.

The Applicant would obtain NPDES permits for the pipeline, MLVs, pump stations, cathodic protection sites, access roads and ATWS, and pipe yards prior to construction. Minnesota PCA already has granted NPDES General Construction Stormwater Coverage permits for the pipe yard locations. NPDES permits would specify various stormwater and erosion control measures to be implemented, such as requiring

stormwater to be routed around exposed soil areas through conveyance channels and requiring stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible (Minnesota PCA 2013a). Prior to submitting an application for an NPDES permit, the Applicant would be required to develop a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP would provide a site description identifying the construction activities, where stormwater discharge would occur, and the receiving waters. The plan also would describe erosion and sediment controls to be implemented during construction, stormwater pollution management, waste disposal, maintenance and inspection practices, and any additional requirements. The permit application and SWPPP must be submitted for Minnesota PCA review at least 30 days before the start of construction activity.

The Applicant's Environmental Protection Plan (Appendix E) describes the Applicant-proposed measures that likely would be included in the SWPPP and as conditions in the NPDES permit. These include temporary sediment and erosion control measures to be used during construction, such as slope breakers, sediment barriers (e.g., silt fence, straw bales, and bio-logs), stormwater diversions, trench breakers, mulch, and erosion control blankets. These temporary controls would be placed across the entire construction work area at the base of slopes greater than 5 percent, where the base of the slope is less than 50 feet from surface waters, until the area is revegetated and there is no potential for scouring or sediment transport to surface waters. Trench breakers would be used at all waterbody crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep accumulated trench water out of the waterbody. Permanent berms, as approved in permit conditions, would be installed 100 to 250 feet apart on all slopes greater than 3 percent to prevent erosion and sedimentation into surface waters once construction is complete.

To further protect surface water resources, NPDES permits would require maintenance of a 50-foot-wide natural buffer downgradient of the construction site, or redundant sediment controls if a buffer is not feasible, when construction is within 50 feet of a surface water (Minnesota PCA 2013b). For any construction site within 1 mile of a special water, NPDES permits also would require that an undisturbed buffer zone extending not less than 100 feet from the water be maintained at all times. If the buffer zone cannot be maintained, redundant BMPs must be used to protect the special water (e.g., trout streams) (Minnesota PCA 2013a). Trout rely on coldwater habitats for survival, and exposure to sunlight from vegetation removal can cause adverse warming of the water. Therefore, construction NPDES permits prohibit removal of woody vegetation and replacement with grassy vegetation near trout streams unless the reasons are absolutely necessary and completely documented in the SWPPP (Minnesota PCA 2013c). Further, to minimize stormwater discharge into and temperature increases in trout streams, NPDES permits would require that impervious surfaces be minimized; discharges be made into vegetated areas or grass swales, avoiding impervious surfaces when possible; and infiltration or other volume reduction practices be used to reduce runoff in excess of pre-Project conditions (Minnesota PCA 2013d).

The NPDES permits also would require that soil stabilization be initiated immediately (i.e., by the end of the day following the day that land-disturbing activities have temporarily or permanently ceased) when construction activities would not resume for 14 days for most sites, for 7 days for sites that drain to special or impaired waters, and within 24 hours for sites where Minnesota DNR "work in water restrictions" apply during fish spawning timeframes. Further, the NPDES permits would require inspection of the entire construction site once every 7 days or within 24 hours of a rainfall event greater than 0.5 inch in 24 hours as measured by a rain gauge installed onsite, a weather station that is within 1 mile of the Project location, or a weather reporting system that provides site specific rainfall data from

radar summaries. All non-functioning stormwater and erosion control measures would be replaced or repaired within 24 hours of discovery.

By complying with these NPDES permit conditions and implementing the Applicant-proposed measures to minimize impacts, the impact of increases in stormwater runoff and erosion from clearing and grading due to construction would be short-term to long-term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, other construction activities such as blasting, trenching, waterbody crossings, establishment of ATWS, access road construction, and water discharges may result in increased suspended solids and sedimentation in surface waters crossed. The Applicant's temporary erosion controls, SWPPP requirements, and NPDES permit requirements described above would be implemented during these activities to prevent sediment transport into surface waters during construction. The Applicant anticipates the need for four blasting events from MP 354.6 to 356.6 in Carlton County, Minnesota, due to shallow bedrock. As noted above, blasting can cause increases in TSS and sedimentation in surface waters near the blast site. Prior to construction, the Applicant would develop a Blasting Plan, which would adhere to all stipulations set forth by federal (CFR Title 29, Part 1926 Safety and Health Regulations for Construction/Subpart U – Blasting and the Use of Explosives – Blasting) and state regulations (Minnesota Administrative Rules Chapter 7500) and would include measures to protect nearby surface waters from these impacts. Therefore, the impacts from four blasting events on TSS and sedimentation are expected to be temporary and negligible to minor.

During pipeline construction across a waterbody, the extent and duration of increased sedimentation and increased erosion potential depend on the soils, sediments, and topography of the crossing site and the crossing method used. As described in detail in Section 2.7.2, the types of methods that may be used include the wet open-cut crossing method, dry open-cut crossing methods (dam-and-pump and flume), and HDD or guided bore.

Construction of the pipeline across the waterbody using dry open-cut methods would occur in a dry area created by temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate to negligible levels in the downstream vicinity of the crossing. As a result, impacts on surface water quality due to increases in TSS concentrations and increased sedimentation in surface waters crossed using dry open-cut crossing methods would be temporary to short-term and minor.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel. Because excavated soils would be in direct contact with surface water, the Applicant would install sediment containment devices (e.g., in-water BMPs such as floating silt curtains) to contain the excavated material and minimize the potential for increased sedimentation. The in-water BMPs would remain in place until construction is completed. The NPDES permits would require inspection of surface waters, drainage ditches, and conveyance systems at least every 7 days (or within 24 hours following a rainfall event greater than 0.5 inch) for sediment and would require removal of any deposits within 7 days (Minnesota PCA 2013b). To reduce the potential for long-term erosion and sedimentation, disturbed areas at waterbody crossings would be restored to preconstruction contours after pipeline installation is completed. The Applicant would reestablish streambank vegetation using Minnesota Seed Mix 2 (described in Appendix C of the Applicant's Environmental Protection Plan [Appendix E]) or a native seed mix recommended by the Minnesota BWSR. If the Applicant maintains compliance with NPDES permit conditions and implements the Applicant-proposed measures, impacts on water quality due to increases

in TSS concentrations and increased sedimentation in surface waters crossed using the wet open-cut crossing method would be temporary to short-term to long-term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. The Applicant would withdraw water for hydrostatic testing, dust control, trench dewatering, and HDD installation. Hydrostatic testing would require approximately 120 million gallons of water (between 11 and 17 million gallons for each of seven construction spreads) (Enbridge 2016b) that the Applicant would obtain from lakes, streams, or groundwater wells. The proportion of water that would be obtained from groundwater versus surface water has not been determined. The Applicant is currently evaluating transferring water from one test section to another in order to minimize the total quantity of water needed to complete the hydrostatic test. Water appropriation needs for dust control, trench dewatering, and HDD installation have not been determined. Prior to construction, the Applicant would obtain a water appropriation permit from Minnesota DNR. These permits would require identification of and rationale for choosing specific surface water sources; requested maximum pumping rates and maximum annual volumes of water to be used; monitoring of pumping rates during appropriation with an approved device or method; and reporting of daily, monthly, and/or yearly appropriation amounts.

As stipulated in permit requirements, the Applicant would select appropriation sites that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely affect trout streams, calcareous fens, or other significant environmental resources. If water is withdrawn from surface water, hose intakes would be equipped with screens to prevent entrainment of aquatic species, and adequate waterbody flow rates and volumes would be maintained to protect aquatic life and allow for downstream uses as required by the water use permit (Appendix E).

Hydrostatic test water would be discharged from a test section in accordance with the NPDES permit in one of two ways: (1) into well-vegetated upland areas using controlled-flow velocity with a dewatering structure such as a silt fence and straw bales or into geotextile filter bags that are used to avoid soil erosion, sediment transport, and bottom scouring; or (2) into the waterbody from which it was withdrawn to prevent the spread of invasive species or degradation in water quality; the discharge rate would not exceed the permitted applicable discharge rate (Appendix E). Water would be treated as specified in the NPDES permit prior to discharge; and the Applicant would monitor pH, dissolved oxygen levels, and any other parameters required by the permit, as described in Appendix D of the Environmental Protection Plan (Appendix E). Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on stream flows from water appropriation and discharge during construction would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. "Hydrologic connectivity" is the water-mediated transport of matter, energy, and organisms within or between elements of the hydrologic cycle (the continuous movement of water on, above, and below the Earth's surface) (Pringle 2003). Pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, and channel and streambank modifications caused by waterbody crossings (discussed above). Hydrologic connectivity can be decreased if barriers are constructed to prevent the natural flow of water and can be increased if

natural barriers are removed. Disruption of hydrologic connectivity and the natural interaction between groundwater and surface water can affect water quality by altering the acidity, dissolved oxygen levels, and nutrient and contaminant loads in surface waters, thereby affecting the aquatic environment. It also can allow the spread of invasive species and prevent migration and reproduction of species.

With implementation of the Applicant-proposed measures described above to prevent or minimize erosion and sedimentation, to monitor stream flows during water appropriation and discharge, and to restore streambanks to their original attributes after construction, impacts on flow and hydrologic connectivity during construction along the construction work area would be temporary to permanent and minor to major. Potential impacts that are permanent and major would be associated with specific site features that are sensitive to disruption of hydrologic connectivity. Springs and other surface water features that are dependent on shallow groundwater have the potential for permanent and major impacts.

Construction would involve creation of both temporary and permanent access roads, which also could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that were widened and graded, to preconstruction conditions upon completion of construction. The restoration would include seeding disturbed areas with a suitable seed mix for the area. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads is expected to be short-term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low. The impact of contaminants on surface water quality therefore would be short-term to long-term and negligible to minor, continuing until vegetative cover is restored to approximate preconstruction conditions. For areas that will not be returned to preconstruction conditions the potential impact would be permanent and minor. These impacts are discussed further as operational impacts.

Trout rely on coldwater habitats for survival, and exposure to sunlight from vegetation removal can cause adverse warming of the water. Therefore, construction NPDES permits typically prohibit removal of woody vegetation and replacement with grassy vegetation near trout streams unless the reasons are absolutely necessary and completely documented in the SWPPP (Minnesota PCA 2013c). Further, to minimize stormwater discharge into and temperature increases in trout streams, NPDES permits typically require that impervious surfaces be minimized; discharges be made into vegetated areas or grass swales, avoiding impervious surfaces when possible; and infiltration or other volume reduction practices be used to reduce runoff in excess of pre-Project conditions (Minnesota PCA 2013d). By complying with these NPDES permit conditions and implementing the Applicant-proposed measures to minimize impacts, it is not likely that construction would affect water temperature in surface waters crossed.

During construction, surface water may become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals as a result of activities such as fuel storage, equipment refueling, and equipment maintenance. To protect surface water resources, NPDES permits would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes,

and a spill prevention and response plan for fueling and maintenance of vehicles (Minnesota PCA 2013b). The Applicant would store petroleum products, hazardous chemicals, and lubricating oils; conduct refueling, maintenance, and lubricating operations; and perform concrete coating activities in upland areas more than 100 feet from surface waters (Appendix E). Concrete wash water, grindings, and slurry disposal would be limited to a designated area and would not be discharged to surface waters. Rinse water, used in conjunction with a cleaning pig to remove any accumulated construction debris, dirt, and dust prior to hydrostatic testing, would be treated and disposed of or discharged in accordance with applicable permit conditions. During HDD installation, drilling mud and slurry would be stored away from the waterbody in a bermed sediment control structure, in tanks, or by other methods so that it would not flow into the waterbody. Excess drilling mud would be disposed of offsite at an approved disposal facility. In addition to these prevention measures, the Applicant would be responsible for cleaning up small spills through procedures outlined in their Environmental Protection Plan (Appendix E), including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities. With adherence to NPDES permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills would be temporary and minor.

Potential impacts on surface water due to an unanticipated crude oil release are discussed in Chapter 10.

As discussed above, 100-foot buffers would be required adjacent to special waters (e.g., the Mississippi River, St. Croix River, and trout streams) during construction and as a permanent feature post-construction, except where a water crossing or other encroachment is necessary. As required by NPDES permit stipulations, the reasons that the buffer encroachment would be necessary and reasons for the use of redundant BMPs and restoration activities must be included in the SWPPP.

For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. Aquatic life, human health, and/or recreational activities are already at risk in these surface waters, and further degradation of water quality may exacerbate an existing impairment, cause additional impairments, interfere with restoration activities, and delay attainment of water quality standards. NPDES permits would require identification of Section 303(d) waters with phosphorus, turbidity, dissolved oxygen, or biotic impairment within 1 mile of construction. If the impaired waters have an approved TMDL implementation plan, the plan must be incorporated into the SWPPP, and discharges must comply with specified TMDLs (Minnesota PCA 2013d). With adherence to the above NPDES permit conditions and implementation of Applicant-proposed measures, impacts of construction activities on Section 303(d)-listed surface waters would be temporary to short-term and negligible to minor.

Degradation of Aquatic Habitat from Instream Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. Stream crossings would be designed as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow, to create the shortest possible crossing length in order to minimize disturbance to the stream. The Applicant has proposed primary and alternative crossing methods for the Applicant's preferred route based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability installation, and anticipated season of installation (Appendix G). If a route permit is issued for a specific route, the Applicant would be required to obtain crossing permits from

Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. Minnesota DNR would consider various factors, including geological, topographic, hydrographic, geotechnical, and scour depth characteristics of each crossing, after final pipeline design in determining their approval for specific waterbody crossing methods.

In general, surface waters with stable banks in mineral soil and noticeable flow at the time of construction would be crossed using dry crossing methods, HDD, or guided bore. Surface waters that are dry during construction and selected surface waters that consist of ditches in peatland with no banks or impoundments (e.g., beaver dams and plugged culverts), with stagnant or no noticeable flow conditions, and that would not support dams necessary to isolate and dry the construction area, would be crossed using the wet open-cut method.

One of two types of dry crossing methods would be used for certain surface waters. The dam-and-pump method would be used for surface waters of low flow, those with meandering channels, and those for which fish passage is not a concern; the flume method would be used in narrow surface waters with defined banks and a straight channel across the construction work area that has a solid substrate (Appendix E provides additional details on water crossing methods). Dry crossing methods are advantageous because they limit sediment release and downstream transport, maintain stream flow, reduce the potential for trench sloughing, and provide a dry working environment for pipe installation. However, dry crossings take more time to complete than wet trenching, may require fish salvage, and create a short-term barrier to fish passage.

Crossings constructed using either dry open-cut crossing method would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry crossing method is expected to be temporary to short-term and minor for each crossing.

Wet open-cut crossings can be completed more rapidly than dry crossing methods and would result in a shorter duration of instream disturbance than dry crossings. This method also would be used where dry methods and HDD are not permitted. Wet crossings would require implementation of the erosion and sediment control measures discussed above. Instream construction activities for wet crossing methods would be completed within 24 hours for minor surface waters (i.e., those less than or equal to 10 feet wide at the water's edge at the time of crossing), within 48 hours for intermediate surface waters (i.e., those greater than 10 feet wide but less than 100 feet wide at the water's edge at the time of crossing), and as specified in applicable permits or by the Applicant for major surface waters (greater than 100 feet wide at the time of crossing). The erosion and sedimentation control measures discussed above would be implemented during and after wet open-cut crossings, and disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation. As a result, instream construction activities for wet open-cut crossings would cause short-term and minor impacts on aquatic habitat.

Guided bore crossings would be used at narrow wetlands and at shallow ditches adjacent to roads or railroads. Disturbance to the water in the ditch would be avoided because the guided bore method involves boring an auger from an excavated pit on one side of the ditch to an excavated pit on the other side. This method is not suitable in areas with a high water table, loose sand and gravel substrates, or steep slopes. It also requires excavations and ATWS on either side of the crossing and increases the

potential for streambank subsidence; if dewatering is required, sediment release is possible. However, successful bore crossings would result in no impact on aquatic habitat.

HDD crossings would be used to avoid impacts on certain sensitive surface waters, such as impaired waters and coldwater fishery resources; particularly deep, wide, or high-flow surface waters; and where appropriate based on subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks and they maintain stream flow and fish passage. However, they require ATWS on both sides of the crossing, which involves vegetative clearing, soil disturbance, and subsequent restoration activities. Woody vegetation in riparian areas typically would not be cleared for the purpose of ATWS unless approved by appropriate regulatory agencies, as stipulated in permits issued for the Applicant's preferred route (Appendix E). Installation of HDD crossings has the potential for inadvertent releases (discussed below). However, successful HDD crossings would cause no impact on aquatic habitat.

Degradation of Water Quality and Habitat from Drilling Mud Releases during HDD Crossings. When used in appropriate conditions and completed successfully, HDD Crossings have the potential to reduce the amount of sedimentation produced by conventional techniques (Golder 1998). Consequently, HDD can provide a cost effective and environmentally viable solution to water crossings. This appealing potential has encouraged its use in sensitive crossings such as wetlands and trout streams. Despite increased use over time a serious risk of inadvertent releases or "frac-outs" exists (Golder 1998).

Multiple conditions can lead to frac-outs, such as circulation losses when drilling into highly permeable gravels and inaccurate drilling of pilot holes. The amount of fluid released is related to variables such as the pressure exerted on the fluid by the hydraulic system. Finally, "the subsequent dispersion from the release point will then be a function of the energy, or sediment transport characteristics of the receiving waterbody" (Golder 1998).

Negative impacts from frac-outs include toxicity of drilling mud to aquatic organisms, the effects of spills or inadvertent releases of drilling fluid, and the disposal of drilling wastes. Slade (2000) reports "short-term effects of releasing drilling fluid into wetlands include temporary displacement of resident fauna, smothering of benthic organisms and plant root systems, increased turbidity of water quality, and effects on water chemistry and wetland hydrology." A release can reduce densities and emergence of adult benthic invertebrates; change hydrological and soil conditions; change fish physiology, behavior, and habitat suitability; and cause long-term impacts on the aquatic ecosystem (Golder 1998). Slade (2000) also identifies additional environmental considerations for the drill rig set-up with respect to water resources and sensitive areas: containment and storage placement of raw fluids, water appropriation and water storage areas, delineation of the "no fueling" areas, and disposal of drilling fluid and cuttings upon completion.

It can be difficult to predict the probability of an occurrence. Yet loss of circulation is common in HDD operations. Longer crossings and HDDs passing through glacial tills, boulders and gravels, have a higher risk of failure. Slade (2000) studied a pipeline construction project from Stockbridge to Freedom Junction Michigan (Enbridge). This was a 35-mile, 16-inch crude petroleum pipeline using 11 HDDs to cross through wetlands, streams, and state recreational areas. Results determined multiple relatively minor releases requiring less clean-up and two major frac-outs resulting in significant (volume, location, and ecology) issues.

It is important to consider the implications (on organisms, sediment, physical disturbance) of potential frac-outs and clean-up operations, identify the pros and cons of each type of crossing method, then match the appropriate technique to each crossing based on the site characteristics and conditions. Therefore, the Applicant would consider all of these factors when deciding what technique is applied to each site when using HDD[1] (see HDD contingency plan). The Applicant would follow BMPs to minimize potential impacts for all crossings during the Project.

Geotechnical surveys would be conducted to determine which surface waters to be crossed are geologically suitable for HDD. The Applicant has proposed HDD crossings at 19 locations (12 between Clearbrook and Carlton) to minimize construction impacts on certain surface waters (Table 6.3.1.2-27). The impact analysis includes the assumption that, if an HDD crossing has been proposed for a waterbody along the Applicant's preferred route, the same construction method would be used if the same waterbody is crossed by a route alternative. Other HDD crossings for surface waters crossed by route alternatives would be determined and permitted prior to construction.

During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or "frac-out" of this drilling fluid to occur when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Although bentonite clay is non-toxic, drilling mud can smother aquatic wildlife and increase turbidity in affected surface waters. Additives may be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only non-hazardous additives approved under permit conditions would be used, and a Material Safety Data Sheet for the drilling fluid would be maintained onsite. If a frac-out occurred near the streambank, bank stability may be compromised. Construction personnel would monitor the crossing to detect releases of drilling mud.

The HDD operator would constantly monitor drilling fluid pressures during pilot hole operations and, if a loss in fluid pressure or circulation were identified, the operator would notify onsite construction observers who would visually monitor the portion of the drill path where the drill tool is located to determine whether a drilling mud release occurred. If a release occurred, the Applicant would implement containment, response, and clean-up procedures as outlined in the Applicant's Environmental Protection Plan (Appendix E) to limit the potential for drilling mud to reach surface water. These procedures include containment using straw bales, sandbags, pumps and hoses, vacuum trucks; response activities, including adjusting drill rates and pump volumes or stopping drilling, removal of mud with pumps and appropriate storage away from the waterbody prior to disposal; and coordination with appropriate agencies to discuss additional containment or clean-up requirements. If the frac-out caused impacts on the streambank, the bank would be restored to the extent possible using the channel and streambank modification BMPs described above. Frac-outs would be reported to the Minnesota Duty Officer. If a frac-out occurred and went undetected or was not quickly contained, impacts on surface water quality could be long-term and major. However, with implementation of the Applicant-proposed measures to respond to a drilling mud release during HDD construction, the impact of a release could be short-term and minor.

Table 6.3.1.2-27. Proposed Horizontal Directional Drilling Crossings in Minnesota for the Applicant's Preferred Route and Route Alternatives

Waterbody	Milepost	Agency Designation	Minnesota PCA Classification	Route Option Crossing
North Dakota-Minnesota Border to Clearbrook				
Tamarac River	54.4	Section 303d impaired	1C, 2Bd, 3C	All routes
Middle River	62.3	NRI, Section 303d impaired	2B, 3C	All routes
Snake River	70.5	Public Water	2B, 3C	All routes
Red Lake River	91.9	NRI, Section 10	1C, 2Bd, 3C	All routes
Unnamed ditch	92.3	None	None	All routes
Clearwater River	103.0	Public Water, Section 303d impaired	2B, 3C	All routes
Red River of the North	ND 27.6	Public Water, Section 303d impaired, Section 10	1C, 2Bd,3C	All routes
Clearbrook to Carlton				
Clearwater River	149.5	Public Water, Section 303d impaired, NRI	2B, 3C	Applicant's preferred route; RA-03AM
Mississippi River	165.1	Public Water, Section 303d impaired	2B, 3C	Applicant's preferred route; RA-03AM
Hay Creek	187.8	Public Water, NRI, wild rice water	2B, 3C	Applicant's preferred route; RA-03AM
Straight River	198.3	Trout stream	1B, 2A, 3B	Applicant's preferred route; RA-03AM
Shell River	207.8	Wild rice water	2B, 3C	Applicant's preferred route
Unnamed stream/river perennial	209.5	Public Water	2B, 3C	Applicant's preferred route
Shell River	215.3	NRI	2B, 3C	Applicant's preferred route
Crow Wing River	317.4	Public Water, NRI	2B, 3C	Applicant's preferred route
Willow River	292.8	Public Water, NRI	2B, 3C	Applicant's preferred route
Mississippi River	296.7	Section 303d impaired, Section 10, Public Water	2B, 3C	Applicant's preferred route
Sandy River	305.9	Section 10, Public Water	2B, 3C	Applicant's preferred route
Sandy River	312.8	Public Water	2B, 3C	Applicant's preferred route

Source: Enbridge 2016a.

Notes:

No horizontal directional drilling is proposed to cross a surface water in the Carlton-to-Minnesota-Wisconsin border segment.

Minnesota PCA = Minnesota Pollution Control Agency, NRI = Nationwide Rivers Inventory

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. To minimize impacts on waterbodies, Minnesota Administrative Rules Part 6135.1100, Subp. 4 specifies that crossings should be placed at the narrowest section of a waterbody feasible; crossing of lakes should be avoided when possible, and they should be crossed under water (i.e., using guided bore or HDD) when necessary; and crossing on or under the beds of trout streams should be avoided unless there is no feasible alternative. The Applicant would adhere to these stipulations when feasible, and each waterbody crossing would be approved prior to construction.

As outlined in the Environmental Protection Plan (Appendix E), temporary erosion control measures would be implemented as necessary during waterbody crossing activities; and rock riprap, geotextile fabric, and other bioengineering techniques would be used to stabilize sites as needed. Following crossing construction, river beds and streambeds would be restored to preconstruction conditions, with no impediments to water flow; and streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. Finally, streambanks would be restored with appropriate vegetation. The use of open-cut crossings during pipeline construction would result in short-term to long-term and minor changes in channel morphology and streambank stability. Construction for HDD crossings would result in no impacts on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies

Five wild rice waterbodies would be crossed by the Applicant's preferred route, with about 5 acres of the delineated waterbody basins within the construction work area. Construction would occur across the edge of the basins within the existing pipeline corridor but not through the wild rice stands on Mud Lake, Peterson Lake, and Portage Lake (Appendix A). In addition, some or all of the wild rice areas occur along the margins of larger waterbodies where the Applicant would use site-specific waterbody crossing techniques, including HDD. HDD would be used to cross the unnamed wild rice waterbody at Hay Creek and the Shell River within the existing pipeline corridor. At this location and at other sites where HDD is used as the crossing method, the wild rice waterbodies would not be affected unless a frac-out occurs (see previous discussion of frac-outs).

Where HDD is not used, the wild rice waterbodies would be crossed using applicable wetland crossing methods for the water saturation conditions at the crossing (see Section 2.7.2 for a description of waterbody and wetland construction methods). Trenched crossing could remove the rice plants and disturb sediments, and could increase sedimentation within the remainder of the waterbody. Although the Applicant would restore the hydrology and soils of the affected wild rice waterbodies after construction, rice yield would be reduced in the portion of the waterbody directly affected by the repair or replacement activities for the first growing season after construction. To minimize impacts of construction through wild rice waterbodies, the Applicant would implement applicable measures identified in the Stream and River Crossing Requirements and Construction Methods in the Environmental Protection Plan (Appendix E). These plans contain measures to reduce or avoid impacts on wild rice during construction. Avoidance measures include use of a narrower construction work area, reseeding, monitoring, and use of timber mats, and incorporate any additional measures proposed by local and state agencies to reflect existing regional policies and procedures to protect wild rice. Wild rice stands also would be monitored for overall condition, function, and vegetative regrowth after construction until the permit conditions are met.

Although not anticipated, construction-related impacts on wild rice waterbodies could include longer than expected recovery time for native wild rice stands (i.e., impacts could affect rice waterbodies beyond the first growing season after construction), introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions—all of which could be detrimental to wild rice germination and production. These potential impacts would be reduced through Project-specific SPCC plans, invasive species management plans, and post-construction monitoring of vegetation for a period of time until permit conditions are met, as described in the Applicant's Environmental Protection Plan (Appendix E). With implementation of these measures, impacts on wild rice waterbodies are expected to be short-term and minor. However, if HDD frac-out, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions occur as a result of construction, impacts could be major.

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except in areas where new impervious surfaces are created, as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way therefore would be altered during the first few years of operation, resulting in impacts of increased runoff and erosion that would be short-term and negligible to minor. After vegetation is reestablished along the permanent right-of-way, surface water runoff and erosion would return to approximately preconstruction conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. Runoff characteristics in areas where woody vegetation has been permanently removed would result in permanent and minor changes in runoff.

Within Minnesota, expansion of the Clearbrook terminal, modification of three pump stations, construction of four new pump stations, and installation of 27 MLVs would add approximately 67 acres of impervious surfaces, with approximately 30.3 acres of that area between Clearbrook and Carlton. Stormwater retention ponds would be located at each pump station, consisting of an additional approximately 10 acres. The Applicant would be required to manage stormwater runoff at these new or expanded facilities in accordance with the stipulations of NPDES permits and SWPPPs as described above, which include the use of the stormwater retention ponds or other permanent stormwater controls. As a result, the potential impacts on surface water due to increased stormwater runoff from impervious surfaces would be permanent and negligible to minor.

During operation, the Applicant would implement their Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on stormwater runoff and erosion would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. During the first few years of operation, there may be a small increase in surface water runoff and erosion as revegetation continues, potentially resulting in increases in TSS and sedimentation in nearby surface waters. The impact of this increase on surface waters would be short-term and negligible to minor.

The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation within the permanent right-of-way in areas adjacent to waterbody crossings would result in localized alterations in habitat, streambank stability loss and erosion, and sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. With implementation of these measures, the impacts associated with the localized changes to topography or vegetation would result in short-term and minor impacts in the vicinity of the alteration.

During operation, the Applicant would implement their Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities would be similar to those experienced from construction, but over a much smaller area. The impacts on TSS and sedimentation in nearby surface waters would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the Applicant's preferred route would not require withdrawal or discharge of water. However, during repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. However, as described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures; and the volume of water would be substantially less than for construction. With adherence to permits and implementation of existing BMPs, alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity during in the areas excavated for pipe repair or replacement would be temporary to short-term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic

connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature and runoff characteristics at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. Water quality is not anticipated to materially change in the surface waters of the basins and watershed along the route, including impaired surface waters.

Minor accidental fuel and lubricant leaks and spills could be related to maintenance and inspection vehicles. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). Thus, minor leaks and spills would result in temporary and negligible to minor impacts on surface water quality. The potential impacts of an unanticipated crude oil release on surface water quality are addressed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs; if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities for using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications

Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river or streambed. This could result in a minor temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and negligible to minor for each crossing.

Using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short-term and minor for each crossing.

Disturbance of Wild Rice Waterbodies

The wild rice waterbodies crossed by HDD at Hay Creek and Shell River would not be affected during operations. Wild rice waterbodies crossed by other methods would not be affected by normal pipeline operation unless it is necessary to repair or replace a section of pipe within the waterbody as a part of the Applicant's Integrity Management Program. In that event, the impacts would be similar to those for the original crossing construction. Although the Applicant would restore the hydrology and soils of the affected portion of the wild rice waterbody after construction, rice yield could be reduced in the portion of the waterbody affected by the repair or replacement activities for the first growing season after completion of the activity. It is likely that only a portion of the approximately 3 acres of wild rice waterbodies within the permanent right-of-way for the Applicant's preferred route would require repair or replacement at any one time; therefore, these activities could result in short-term and negligible to minor impacts. However, if replacement of a section of pipe within the waterbody resulted in, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions impacts could be major.

Route Alternatives (from Clearbrook to Carlton)

The types of activities that could result in impacts during construction and operation of the route alternatives would be essentially the same as those described for the Applicant's preferred route. As a result, some of those activities are briefly mentioned below, with more details provided in the previous sections on construction and operation.

Route Alternative RA-03AM

Route alternative RA-03AM is the longest of the route alternatives. It would be 436 miles in total, with 395 miles in Minnesota, of which 275 miles would be from Clearbrook to Carlton. The RA-03AM route would require 167 waterbody crossings from Clearbrook to Carlton. Although the route requires the

largest number of waterbody crossings compared to the Applicant's preferred route and other route alternatives, it avoids the Minnesota Lakes region, thereby avoiding pipeline construction impacts on this region.

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required along the route alternative for construction of the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including pipe yards in Minnesota. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, the Applicant would comply with the requirements of applicable permit programs that are in place to manage potential impacts, as addressed below.

If RA-03AM is selected, the Applicant would obtain NPDES permits for the pipeline, MLVs, pump stations, cathodic protection sites, access roads and ATWS, and pipe yards prior to construction. NPDES permits would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible (Minnesota PCA 2013a). With compliance with NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route, impacts associated with increases in stormwater runoff and erosion from clearing and grading during construction would be short-term and minor. For areas that will not be returned to preconstruction conditions the potential impact would be permanent and minor. These impacts are discussed further as operational impacts.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, other construction activities such as blasting, trenching, waterbody crossings, ATWS and access road construction, and water discharges may cause increased suspended solids and sedimentation in the surface waters crossed. The Applicant-proposed measures for temporary erosion controls, SWPPP requirements, and NPDES permit requirements described for the Applicant's preferred route would be implemented during these activities to prevent sediment transport into surface waters during construction. During pipeline construction across a waterbody, the extent and duration of sedimentation and increased erosion potential depend on the soils, sediments, and topography of the crossing site and the proposed crossing method used.

RA-03AM would cross 167 surface waters; however, the specific crossing methods for surface waters have not been determined for the route. When using the dry crossing method, increases in TSS and sedimentation would be localized and temporary in surface waters crossed because construction of the pipeline across the waterbody would occur in a dry area created by the temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate to negligible levels downstream in the vicinity of the crossing. As a result, impacts would be temporary to short-term and minor.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel, and excavated soils would be in direct contact with surface water. With adherence to NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route,

impacts from increases in TSS concentrations and increased sedimentation in surface waters crossed using open-cut wet crossings would be temporary to short-term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of RA-03AM would require water withdrawal for hydrostatic testing, dust control, trench dewatering, and HDD installation, which would be sourced from lakes, streams, or groundwater wells. Approximately 55 to 85 million gallons (11 to 17 million gallons for each of five construction spreads between Clearbrook and Carlton) would be required for hydrostatic testing. The Applicant has not determined the volume of water appropriation needed for dust control, trench dewatering, and HDD installation. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR.

As stipulated in permit requirements, the Applicant would select appropriation sites along RA-03AM that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely affect trout streams, calcareous fens, or other significant environmental resources.

Hydrostatic test water would be discharged from a test section in one of two ways, as described for the Applicant's preferred route. Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on stream flows from water appropriation and discharge during construction would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. As described for the Applicant's preferred route, pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, and channel and streambank modifications caused by waterbody crossings. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation, to monitor stream flows during water appropriation and discharge, and to restore streambanks to their original attributes following construction, impacts on flow and hydrologic connectivity during construction of RA-03AM would be temporary to permanent and minor to major. Potential impacts that are permanent and major would be associated with specific site features that are sensitive to disruption of hydrologic connectivity. Springs and other surface water features that are dependent on shallow groundwater have the potential for permanent and major impacts.

In addition, construction would involve creation of temporary and permanent access roads, which could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that were widened and graded, to preconstruction conditions upon completion of construction. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads is expected to be short-term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low.

Surface water along RA-03AM could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. To protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles (Minnesota PCA 2013b). Similar treatment/disposal or discharge measures to those described for the Applicant's preferred route would be necessary for handling concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing.

In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-03AM through procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

In areas near sensitive or specially designated surface waters (e.g., the Clearwater River and trout streams), 100-foot buffers from the shoreline would be required during construction and as a permanent feature post-construction, except where a water crossing or other encroachment is necessary. For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. NPDES permits for construction of RA-03AM would require identification of Section 303(d) waters with phosphorus, turbidity, dissolved oxygen, or biotic impairment within 1 mile of construction. If the impaired waters have an approved TMDL implementation plan, the plan must be incorporated into the SWPPP, and discharges must comply with specified TMDLs (Minnesota PCA 2013d). With adherence to these NPDES permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills during construction would be temporary to short-term and negligible to minor.

Degradation of Aquatic Habitat from Instream Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. The specific crossing method for each crossing has not been determined for construction of RA-03AM but would be selected based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability, and anticipated season of installation. If a route permit is issued for RA-03AM, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. Minnesota DNR would consider various factors, including geological, topographic, hydrographic, geotechnical, and scour depth characteristics of each crossing, after final pipeline design in determining their approval for specific waterbody crossing methods.

Similar to construction of the Applicant's preferred route, dry and wet open-crossing crossing methods would be used. Each method has advantages and disadvantages for minimizing potential impacts on aquatic habitats. Assuming that erosion and sedimentation control measures would be the same as those discussed above for the Applicant's preferred route, and that disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation, using the dry or wet open-cut crossing methods would result in impacts on aquatic habitat that would be temporary to short-term and minor for each crossing.

If selected for certain crossings along RA-03AM (e.g., roads and ditches), successful guided bore crossings would result in no impacts on aquatic habitat, as described for the Applicant's preferred route. In addition, HDD crossings likely would be used to avoid impacts on certain sensitive surface waters such as impaired waters and coldwater fishery resources, and particularly deep, wide, or high-flow surface waters. The use of HDD crossings would be determined based on evaluations of subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks, and they maintain stream flow and fish passage. Construction of an HDD crossing is slower than a dry crossing, and there is the potential for inadvertent releases (discussed below). As described for the Applicant's preferred route, successful HDD crossings would result in no impacts on aquatic habitat during construction of RA-03AM.

Degradation of Water Quality and Habitat from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted along the route of RA-03AM to determine which surface waters would benefit from use of the HDD method and which of those surface waters are in areas that are geologically suitable for HDD. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or frac-out of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Risk of HDD frac-out is discussed above in the assessment of impacts on surface water and aquatic habitat quality from the Applicant's preferred route. If a frac-out occurred during construction of RA-03AM and went undetected or was not quickly contained, impacts on surface water quality could be long-term and major. However, with implementation of measures similar to those described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-03AM, the impact of a release on surface water quality and streambank structure would be short-term and minor.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. To minimize impacts on surface waters, Minnesota regulations regarding water crossings would be considered for selecting RA-03AM crossing methods (Minn. R. 6135.1100, Subp. 4). These regulations specify that crossings should be placed at the narrowest section of a waterbody feasible; crossing of lakes should be avoided when possible, and they should be crossed under water when necessary; and crossing on or under the beds of trout streams should be avoided unless there is no feasible alternative. The Applicant would adhere to these stipulations when feasible, and each waterbody crossing would be approved prior to construction. Similar to construction of the Applicant's preferred route, temporary erosion control measures during construction of RA-03AM would be implemented as necessary during waterbody crossing activities; and rock riprap, geotextile fabric, and other bioengineering techniques would be used to stabilize sites as needed. Following crossing construction, river beds and streambeds would be restored to approximately preconstruction conditions, with no impediments to water flow, and streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. Finally, streambanks would be restored with appropriate vegetation.

The use of open-cut crossings for pipeline construction, along with the Applicant-proposed measures described above, would result in short-term to long-term and minor impacts on channel morphology and streambank stability. Successful construction of HDD crossings, where implemented for construction of RA-03AM, would result in no impacts on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies. RA-03AM would cross about 8 acres of the six wild rice waterbodies crossed within the construction work area (see Table 6.3.1.2-11). Three of these crossings would be the same as for the Applicant's preferred route: Mud Lake, Hay Creek, and Portage Lake. Hayden Lake would be crossed at the basin inlet and Fox Lake would be crossed near the lake shoreline; both of these crossings would be within an existing pipeline corridor. Specific construction methods for crossing of wild rice waterbodies along RA-03AM have not been determined. Hay Creek would be crossed by the Applicant's preferred route using HDD. Where HDD is used as the crossing method, the wild rice waterbodies would not be affected unless a frac-out occurs (see above for information on frac-outs).

Where HDD is not used, the wild rice waterbodies would be crossed using applicable wetland crossing methods for the water saturation conditions at the crossing (see Appendix E for a description of crossing methods). Trenching would remove the vegetation and sediments and increase sedimentation within the remainder of the waterbody. Although the Applicant would restore the hydrology and soils of the affected wild rice waterbodies after construction, rice yield could be reduced in the portion of the waterbody affected for the first growing season after construction. To minimize impacts of construction through wild rice waterbodies, the Applicant would implement applicable measures identified in the Applicant's Environmental Protection Plan (Appendix E). This plan would identify wild rice areas by milepost and contain specific measures to reduce or avoid impacts on wild rice during construction. Avoidance measures would include use of a narrower construction work area, reseeding, monitoring, and use of timber mats, and would incorporate any additional measures proposed by local and state agencies to reflect existing regional policies and procedures to protect wild rice. Wild rice stands also would be monitored for overall condition, function, and vegetative regrowth after construction until the permit conditions are met. As a result, construction through wild rice waterbodies would result in short-term minor impacts on wild rice waterbodies.

Although not anticipated, construction-related impacts on wild rice waterbodies could include longer than expected recovery time for native wild rice stands, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions—all of which could be detrimental to wild rice germination and production. These potential impacts would be reduced through Project-specific SPCC plans, invasive species management plans, and post-construction monitoring of vegetation for a period of time until permit conditions are met, as described in the Applicant's Environmental Protection Plan (Appendix E). With implementation of these measures, impacts on wild rice waterbodies are expected to be short-term and minor. However, if HDD frac-out, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and alter

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except for areas where new impervious surfaces are created as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way therefore would be altered during the first few years of operation, resulting in impacts on runoff and erosion that would be short-term and negligible to minor. After vegetation is reestablished along the permanent right-of-way, surface water runoff and erosion would return to approximately preconstruction conditions. Areas of the permanent right-of-way that result in permanent vegetation changes, such as forested areas, would

result in permanent changes to runoff conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements.

The number, types, and locations of associated facilities that would be required for pipeline operation along each of the route alternatives have not been determined. However, based on the facility needs and spacing of the Applicant's preferred route, it was assumed that RA-03AM would require six pump stations and 23 MLVs. Assuming that approximately 8 acres are required for each pump station and 0.1 acre is required for each MLV, approximately 50 acres of newly impervious surfaces would be in place for RA-03AM for the life of the Project. The Applicant would be required to manage stormwater runoff at these new facilities in accordance with the stipulations of NPDES permits and SWPPPs as described above, which include the use of permanent stormwater control systems. As a result, the potential impacts on surface water due to increased stormwater runoff from impervious surfaces would be permanent and negligible to minor.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on stormwater runoff and erosion would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. As described above, during the first few years of operation, there may be a small increase in surface water runoff and erosion as revegetation continues, resulting in short-term and negligible to minor impacts related to increases in TSS and sedimentation. Similar to the Applicant's preferred route, the permanent right-of-way for RA-03AM in upland areas would be maintained in an herbaceous vegetative state during operation to allow access for inspection, monitoring, and maintenance. The permanent removal of large woody vegetation also would result in permanent but minor and localized alterations in habitat, streambank stability loss and erosion, and sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. As a result, the impacts of these integrity management activities would be similar to those experienced from construction, but over a much smaller area. The impacts on TSS and sedimentation in nearby surface waters would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project. In other portions of the permanent right-of-way, there would be a permanent but negligible impact related to increases in TSS and sediments in surface water.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the route would not require withdrawal or discharge of water. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. However, as described for pipeline

construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of existing BMPs, minor alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater runoff flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity in the areas excavated for pipe repair or replacement would be temporary to short-term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The permanent right-of-way for RA-03AM in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by the route alternative would not result in degradation of the average watershed health score or water quality score. As a result, water quality would not be changed in the surface waters of the basins and watershed along the route, including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Minor fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles operating along RA-03AM. However, any refueling, fuel storage, or vehicle maintenance would follow measures similar to those in the Applicant's proposed Environmental Protection Plan (Appendix E). Thus, minor leaks and spills would result in negligible to minor and temporary impacts on surface water quality. The potential impacts of an unanticipated crude oil release are discussed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those

described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs; if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve using one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river or stream bed. This could result in a minor temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and negligible to minor for each crossing.

Use of the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short-term and minor for each crossing.

Disturbance of Wild Rice Waterbodies. During operation, wild rice waterbodies would not be affected unless it is necessary to repair or replace a section of pipe within the waterbody. In that event, the impacts would be similar to those for the initial construction of the pipeline through the waterbody, as described under construction impacts for the Applicant's preferred route. Although the Applicant would restore the hydrology and soils of the affected portion of the wild rice waterbody after construction, rice yield could be reduced in the portion of the waterbody affected by the repair or replacement activities for the first growing season after completion of the activity. It is likely that only a portion of the approximately 3 acres of wild rice waterbodies within the permanent right-of-way would require repair or replacement at any one time; therefore, these activities could result in short-term and negligible to minor impacts. However, if replacement of a section of pipe within the waterbody resulted in,

introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions impacts could be major.

Route Alternative RA-06

Route alternative RA-06 would be 357 miles in total, with 317 miles in Minnesota, of which 197 miles would be from Clearbrook to Carlton. The RA-06 route would require 220 waterbody crossings in Minnesota and 137 from Clearbrook to Carlton. Because the RA-06 route is more northerly than the other route options, it avoids the Minnesota Lakes region and the Mississippi Headwaters. However, the route crosses 37 Lake Superior Basin waters, which are considered to be Outstanding International Resource Waters.

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required along the route alternative for construction of the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including pipe yards in Minnesota. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, the Applicant would comply with the requirements of applicable permit programs that are in place to manage potential impacts as addressed below.

If RA-06 is selected, the Applicant would obtain NPDES permits for the pipeline, MLVs, pump stations, cathodic protection sites, access roads and ATWS, and pipe yards prior to construction. NPDES permits would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible (Minnesota PCA 2013a). With compliance with NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route, construction of the alternative would result in impacts related to stormwater runoff and erosion that would be temporary to long-term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, other construction activities such as blasting, trenching, waterbody crossings, ATWS and access road construction, and water discharges may cause increased suspended solids and sedimentation in the surface waters crossed. The Applicant's temporary erosion controls, SWPPP requirements, and NPDES permit requirements described for the Applicant's preferred route would be implemented during these activities to prevent sediment transport into surface waters during construction. During pipeline construction across a waterbody, the extent and duration of sedimentation and increased erosion potential depend on the soils, sediments, and topography of the crossing site and the proposed crossing method used.

RA-06 would cross 137 surface waters; however, specific crossing methods for surface waters have not been determined for the route. When using the dry crossing method, increases in TSS and sedimentation would be localized and temporary in surface waters crossed because construction of the pipeline across the waterbody would occur in a dry area created by the temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate to negligible levels downstream in the vicinity of the crossing. As a result, impacts would be temporary to short-term and minor.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel, and excavated soils would be in direct contact with surface water. With adherence to NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route, impacts from increases in TSS concentrations and increased sedimentation in surface waters crossed using open-cut wet crossings would be temporary to short-term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of RA-06 would require water withdrawal for hydrostatic testing, dust control, trench dewatering, and HDD installation, which would be sourced from lakes, streams, or groundwater wells Approximately 44 to 68 million gallons of water (11 to 17 million gallons per construction spread) would be required for hydrostatic testing during construction of RA-06 between Clearbrook and Carlton. The Applicant has not determined the volume of water appropriation needed for dust control, trench dewatering, and HDD installation. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR.

As stipulated in permit requirements, the Applicant would select appropriation sites along RA-06 that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely affect trout streams, calcareous fens, or other significant environmental resources.

Hydrostatic test water would be discharged from a test section in one of two ways, as described for the Applicant's preferred route. Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on stream flows from water appropriation and discharge during construction would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. As described for the Applicant's preferred route, pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, and channel and streambank modifications caused by waterbody crossings. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation, to monitor stream flows during water appropriation and discharge, and to restore streambanks to their original attributes following construction, impacts on flow and hydrologic connectivity during construction of RA-06 would be temporary to permanent and minor to major. Potential impacts that are permanent and major would be associated with specific site features that are sensitive to disruption of hydrologic connectivity. Springs and other surface water features that are dependent on shallow groundwater have the potential for permanent and major impacts.

In addition, construction would involve creation of temporary and permanent access roads, which could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that were widened and graded, to preconstruction conditions upon completion of construction. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads is expected to be short-term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low. Surface water along RA-06 could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. However, to protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles (Minnesota PCA 2013b). Similar treatment/disposal or discharge measures to those described for the Applicant's preferred route would be necessary for handling concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing.

In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-06 through procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

In areas near sensitive or specially designated surface waters (e.g., the Clearwater River and trout streams), 100-foot buffers from the shoreline would be required during construction and as a permanent feature post-construction, except where a water crossing or other encroachment is necessary. For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. NPDES permits for construction of RA-06 would require identification of Section 303(d) waters with phosphorus, turbidity, dissolved oxygen, or biotic impairment within 1 mile of construction. If the impaired waters have an approved TMDL implementation plan, the plan must be incorporated into the SWPPP, and discharges must comply with specified TMDLs (Minnesota PCA 2013d). With adherence to these NPDES permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills during construction would be temporary to short-term and negligible to minor.

Degradation of Aquatic Habitat from Instream Construction Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. Crossing methods have not been determined for construction of RA-06 but would be selected based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability, and anticipated season of installation. If a route permit is issued for RA-06, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. Minnesota DNR would consider various factors, including geological, topographic, hydrographic, geotechnical, and scour depth characteristics of each crossing, after final pipeline design in determining their approval for specific waterbody crossing methods.

Similar to construction of the Applicant's preferred route, dry and wet open-crossing crossing methods would be used. Each method has advantages and disadvantages for minimizing potential impacts on aquatic habitats. Assuming that erosion and sedimentation control measures would be the same as those discussed above for the Applicant's preferred route, and that disturbed areas at crossings would

be restored and stabilized as soon as practical after pipeline installation, using the dry open-cut crossing method would result in impacts on aquatic habitat that would be temporary to short-term and minor for each crossing. For the wet open-cut method, the impact on aquatic habitat would be short-term to long-term and minor.

If selected for certain crossings along RA-06 (e.g., roads and ditches), successful guided bore crossings would result in no impacts on aquatic habitat, as described for the Applicant's preferred route. In addition, HDD crossings likely would be used to avoid impacts on certain sensitive surface waters, such as impaired waters and coldwater fishery resources; particularly deep, wide, or high-flow surface waters; and when appropriate based on subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks, and they maintain stream flow and fish passage. Construction of an HDD crossing is slower than a dry crossing, and there is the potential for inadvertent releases (discussed below). As described for the Applicant's preferred route, successful HDD crossings would result in no impacts on aquatic habitat during construction of RA-06.

Degradation of Water Quality and Habitat from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted along the route of RA-06 to determine which surface waters would benefit from use of the HDD method and which of those surface waters are in areas that are geologically suitable for HDD. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or frac-out of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Risk of HDD frac-out is discussed above in the assessment of impacts on surface water and aquatic habitat quality from the Applicant's preferred route. If a frac-out occurred during construction of RA-06 and went undetected or was not quickly contained, impacts on surface water quality could be long-term and major. However, with implementation of measures similar to those described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-06, the impact of a release on surface water quality and streambank structure would be short-term and minor.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. To minimize impacts on surface waters, Minnesota regulations regarding water crossings would be considered for selecting RA-06 crossing methods (Minn. R. 6135.1100, Subp. 4). These regulations specify that crossings should be placed at the narrowest section of a waterbody feasible; crossing of lakes should be avoided when possible, and they should be crossed under water when necessary; and crossing on or under the beds of trout streams should be avoided unless there is no feasible alternative. The Applicant would adhere to these stipulations when feasible, and each waterbody crossing would be approved prior to construction. Similar to construction of the Applicant's preferred route, temporary erosion control measures during construction of RA-06 would be implemented as necessary during waterbody crossing activities; and rock riprap, geotextile fabric, and other bioengineering techniques would be used to stabilize sites as needed. Following crossing construction, river beds and streambeds would be restored to approximately preconstruction conditions, with no impediments to water flow, and streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. Finally, streambanks would be restored with appropriate vegetation.

The use of open-cut crossings for pipeline construction, along with the Applicant-proposed measures described above, would result in short-term to long-term and minor impacts on channel morphology and streambank stability. Successful construction of HDD crossings, where implemented for construction of RA-06, would result in no impacts on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies. RA-06 would cross about 11 acres of the wild rice waterbodies within the construction work area (see Table 6.3.1.2-15). Specific construction methods for crossing of wild rice waterbodies along RA-06 have not been determined. Where HDD is used as the crossing method, the wild rice waterbodies would not be affected unless a frac-out occurs (see above for information on frac-outs).

Where HDD is not used, the wild rice waterbodies would be crossed using applicable wetland crossing methods for the water saturation conditions at the crossing (see Section 2.7.2 for a description of crossing methods). Trenching would remove the vegetation cover and sediments and increase sedimentation within the remainder of the waterbody. Although the Applicant would restore the hydrology and soils of the affected wild rice waterbodies after construction, rice yield could be reduced in the portion of the waterbody affected for the first growing season after construction. To minimize impacts of construction through wild rice waterbodies, the Applicant would implement applicable measures identified in the Applicant's Environmental Protection Plan (Appendix E). This plan would identify wild rice areas by milepost and contain specific measures to reduce or avoid impacts on wild rice during construction. Avoidance measures would include use of a narrower construction work area, reseeding, monitoring, and use of timber mats, and would incorporate any additional measures proposed by local and state agencies to reflect existing regional policies and procedures to protect wild rice. Wild rice stands also would be monitored for overall condition, function, and vegetative regrowth after construction until the permit conditions are met. As a result, construction through wild rice waterbodies using the wet open-cut crossing method would result in short-term and minor impacts on wild rice waterbodies.

Although not anticipated, construction-related impacts on wild rice waterbodies could include longer than expected recovery time for native wild rice stands, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions—all of which could be detrimental to wild rice germination and production. These potential impacts would be reduced through Project-specific SPCC plans, invasive species management plans, and post-construction monitoring of vegetation for a period of time until permit conditions are met, as described in the Applicant's Environmental Protection Plan (Appendix E). With implementation of these measures, impacts on wild rice waterbodies are expected to be short-term and minor. However, if HDD frac-out, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and alter

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except for areas where new impervious surfaces are created, as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way therefore would be altered during the first few years of operation, resulting in impacts on runoff and erosion that would be short-term and negligible to minor. After vegetation is reestablished along the permanent right-of-way,

surface water runoff and erosion would return to approximately preconstruction conditions. Areas of the permanent right-of-way that result in permanent vegetation changes, such as forested areas, would result in permanent changes to runoff conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements.

The number, types, and locations of associated facilities that would be required for pipeline operation along each of the route alternatives have not been determined. However, based on the facility needs and spacing of the Applicant's preferred route, it was assumed that RA-06 would require four pump stations and 16 MLVs. Assuming that approximately 8 acres are required for each pump station and 0.1 acre is required for each MLV, approximately 34 acres of newly impervious surfaces would be in place for RA-06 for the life of the Project. The Applicant would be required to manage stormwater runoff at these new facilities in accordance with the stipulations of NPDES permits and SWPPPs, as described above, which include the use of permanent stormwater control systems. As a result, the potential impacts on surface water due to increased stormwater runoff from impervious surfaces would be permanent and negligible to minor.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on stormwater runoff and erosion would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. As described above, during the first few years of operation, there may be a small increase in surface water runoff and erosion as revegetation continues, resulting in short-term and negligible to minor impacts related to increases in TSS and sedimentation. Similar to the Applicant's preferred route, the permanent right-of-way for RA-06 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access for inspection, monitoring, and maintenance. The permanent removal of large woody vegetation also would result in permanent but minor and localized alterations in habitat, streambank stability loss and erosion, and sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. As a result, the impacts of these integrity management activities would be similar to those experienced from construction, but over a much smaller area. The impacts on TSS and sedimentation in nearby surface waters would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project. In other portions of the permanent right-of-way, there would be a permanent but negligible impact related to increases in TSS and sediments in surface water.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the route would not require withdrawal or discharge of water. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and

backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. However, as described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of existing BMPs, minor alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity during in the areas excavated for pipe repair or replacement would be temporary to short-term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The permanent right-of-way of RA-06 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by the route alternative would not result in degradation of the average watershed health score or water quality score. As a result, water quality would not be changed in the surface waters of the basins and watershed along the route, including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Minor fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles operating along RA-06. However, any refueling, fuel storage, or vehicle maintenance would follow measures similar to those in the Applicant's proposed Environmental Protection Plan (Appendix E). Thus, minor leaks and spills would result in negligible to minor and temporary impacts on surface water quality. The potential impacts of an unanticipated crude oil release are discussed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs; if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities for using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river or stream bed. This could result in a minor temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and negligible to minor for each crossing.

Using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short-term and minor for each crossing.

Disturbance of Wild Rice Waterbodies. During operation, wild rice waterbodies would not be affected unless it is necessary to repair or replace a section of pipe within the waterbody. In that event, the impacts would be similar to those for the initial construction of the pipeline through the waterbody, as described under construction impacts for the Applicant's preferred route. Although the Applicant would restore the hydrology and soils of the affected portion of the wild rice waterbody after construction, rice yield could be reduced in the portion of the waterbody affected by the repair or replacement activities for the first growing season after completion of the activity. It is likely that only a portion of the approximately 4 acres of wild rice waterbodies within the permanent right-of-way would require repair

or replacement at any one time; therefore, these activities could result in short-term and negligible to minor impacts. However, if replacement of a section of pipe within the waterbody resulted in, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions impacts could be major.

Route Alternative RA-07

Route alternative RA-07 would be 328 miles in total, with 288 miles in Minnesota, of which 168 miles would be from Clearbrook to Carlton. The RA-07 route would require 164 waterbody crossings in Minnesota and 81 from Clearbrook to Carlton. RA-07 requires the fewest number of waterbody crossings. However, surface waters would be affected by the construction activities associated with removal of the existing Line 3 pipeline and installation of the new pipeline in the same trench. Removal and replacement would require a 205-foot-wide construction work area with all or almost all of the construction work area within the permanent right-of-way for the Enbridge Mainline and the previous construction work area for the Alberta Clipper pipeline.

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required along the route alternative for construction of the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including pipe yards in Minnesota. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters from the wider construction work area; however, the Applicant would comply with the requirements of applicable permit programs that are in place to manage potential impacts as addressed below.

If RA-07 is selected, the Applicant would obtain NPDES permits for the pipeline, MLVs, pump stations, cathodic protection sites, access roads and ATWS, and pipe yards prior to construction. NPDES permits would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible (Minnesota PCA 2013a). With compliance with NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route, construction of the route alternative would result in impacts on stormwater runoff and erosion that would be temporary to long-term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, other construction activities such as blasting, trenching, waterbody crossings, ATWS and access road construction, and water discharges may cause increased suspended solids and sedimentation in the surface waters crossed. The Applicant's temporary erosion controls, SWPPP requirements, and NPDES permit requirements described for the Applicant's preferred route would be implemented during these activities to prevent sediment transport into surface waters during construction. During pipeline construction across a waterbody, the extent and duration of sedimentation and increased erosion potential depend on the soils, sediments, and topography of the crossing site and the proposed crossing method used.

RA-07 would cross 81 surface waters; however, specific crossing methods for surface waters have not been determined for the route. When using the dry crossing method, increases in TSS and

sedimentation would be localized and temporary in surface waters crossed because construction of the pipeline across the waterbody would occur in a dry area created by the temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate to negligible levels downstream in the vicinity of the crossing. As a result, impacts would be temporary to short-term and minor.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel, and excavated soils would be in direct contact with surface water. With adherence to NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route, impacts from increases in TSS concentrations and increased sedimentation in surface waters crossed using open-cut wet crossings would be temporary to short-term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of RA-07 would require water withdrawal for hydrostatic testing, dust control, trench dewatering, and HDD installation, which would be sourced from lakes, streams, or groundwater wells. Approximately 44 to 68 million gallons of water (11 to 17 million gallons per construction spread) would be required for hydrostatic testing during construction between Clearbrook and Carlton. The Applicant has not determined the volume of water appropriation needed for dust control, trench dewatering, and HDD installation. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR.

As stipulated in permit requirements, the Applicant would select appropriation sites along RA-07 that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely affect trout streams, calcareous fens, or other significant environmental resources.

Hydrostatic test water would be discharged from a test section in one of two ways, as described for the Applicant's preferred route. Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on stream flows from water appropriation and discharge during construction would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. As described for the Applicant's preferred route, pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, and channel and streambank modifications caused by waterbody crossings. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation, to monitor stream flows during water appropriation and discharge, and to restore streambanks to their original attributes following construction, impacts on flow and hydrologic connectivity during construction of RA-07 would be temporary to permanent and minor to major. Potential impacts that are permanent and major would be associated with specific site features that are sensitive to disruption of hydrologic connectivity. Springs and other surface water features that are dependent on shallow groundwater have the potential for permanent and major impacts.

In addition, construction would involve creation of temporary and permanent access roads, which could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that

were widened and graded, to preconstruction conditions upon completion of construction. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads is expected to be short-term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low. Surface water along RA-07 could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. However, to protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles (Minnesota PCA 2013b). Similar treatment/disposal or discharge measures to those described for the Applicant's preferred route would be necessary for handling concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing.

In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-07 through procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

In areas near sensitive or specially designated surface waters (e.g., the Clearwater River and trout streams), 100-foot buffers from the shoreline would be required during construction and as a permanent feature post-construction, except where a water crossing or other encroachment is necessary. For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. NPDES permits for construction of RA-03AM would require identification of Section 303(d) waters with phosphorus, turbidity, dissolved oxygen, or biotic impairment within 1 mile of construction. If the impaired waters have an approved TMDL implementation plan, the plan must be incorporated into the SWPPP, and discharges must comply with specified TMDLs (Minnesota PCA 2013d). With adherence to these NPDES permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills during construction would be temporary to short-term and negligible to minor.

Degradation of Aquatic Habitat from Instream Construction Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. Crossing methods have not been determined for construction of RA-07 but would be selected based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability, and anticipated season of installation. If a route permit is issued for RA-07, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. Minnesota DNR would consider various factors, including geological, topographic, hydrographic, geotechnical, and scour depth characteristics of each

crossing, after final pipeline design in determining their approval for specific waterbody crossing methods.

Similar to construction of the Applicant's preferred route, dry and wet open-crossing crossing methods would be used. Each method has advantages and disadvantages for minimizing potential impacts on aquatic habitats. Assuming that erosion and sedimentation control measures would be the same as those discussed above for the Applicant's preferred route, and that disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation, using the dry and wet open-cut crossing methods would result in impacts on aquatic habitat that would be temporary to short-term and minor for each crossing.

If selected for certain crossings along RA-07 (e.g., roads and ditches), successful guided bore crossings would result in no impacts on aquatic habitat, as described for the Applicant's preferred route. In addition, HDD crossings likely would be used to avoid impacts on certain sensitive surface waters, such as impaired waters and coldwater fishery resources; particularly deep, wide, or high-flow surface waters; and when appropriate based on subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks, and they maintain stream flow and fish passage. Construction of an HDD crossing is slower than a dry crossing, and there is the potential for inadvertent releases (discussed below). As described for the Applicant's preferred route, successful HDD crossings would result in no impacts on aquatic habitat during construction of RA-07.

Degradation of Water Quality and Habitat from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted along the route of RA-07 to determine which surface waters would benefit from use of the HDD method and which of those surface waters are in areas that are geologically suitable for HDD. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or frac-out of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Risk of HDD frac-out is discussed above in the assessment of impacts on surface water and aquatic habitat quality from the Applicant's preferred route. If a frac-out occurred during construction of RA-07 and went undetected or was not quickly contained, impacts on surface water quality could be long-term and major. However, with implementation of measures similar to those described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-07, the impact of a release on surface water quality and streambank structure would be short-term and minor.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. To minimize impacts on surface waters, Minnesota regulations regarding water crossings would be considered for selecting RA-07 crossing methods (Minn. R. 6135.1100, Subp. 4). These regulations specify that crossings should be placed at the narrowest section of a waterbody feasible; crossing of lakes should be avoided when possible, and they should be crossed under water when necessary; and crossing on or under the beds of trout streams should be avoided unless there is no feasible alternative. The Applicant would adhere to these stipulations when feasible, and each waterbody crossing would be approved prior to construction. Similar to construction of the Applicant's preferred route, temporary erosion control measures during

construction of RA-07 would be implemented as necessary during waterbody crossing activities; and rock riprap, geotextile fabric, and other bioengineering techniques would be used to stabilize sites as needed. Following crossing construction, river beds and streambeds would be restored to approximately preconstruction conditions, with no impediments to water flow, and streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. Finally, streambanks would be restored with appropriate vegetation.

The use of open-cut crossings for pipeline construction, along with the mitigation measures described above, would result in short-term to long-term minor impacts on channel morphology and streambank stability. Successful construction of HDD crossings, where implemented for construction of RA-07, would result in no impacts on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies. RA-07 would cross about 6 acres of the wild rice waterbodies within the construction work area (see Table 6.3.1.2-20). Specific construction methods for crossing of wild rice waterbodies along RA-07 have not been determined. Where HDD is used as the crossing method, the wild rice waterbodies would not be affected unless a frac-out occurs (see above for information on frac-outs).

Where HDD is not used, the wild rice waterbodies would be crossed using applicable wetland crossing methods for the water saturation conditions at the crossing (see Section 2.7.2 for a description of the crossing methods). Trenching would remove the vegetation cover and sediments and increase sedimentation within the remainder of the waterbody. Although the Applicant would restore the hydrology and soils of the affected wild rice waterbodies after construction, rice yield could be reduced in the portion of the waterbody affected for the first growing season after construction. To minimize impacts of construction through wild rice waterbodies, the Applicant would implement applicable measures identified in the Applicant's Environmental Protection Plan (Appendix E). This plan would identify wild rice areas by milepost and contain specific measures to reduce or avoid impacts on wild rice during construction. Avoidance measures would include use of a narrower construction work area, reseeding, monitoring, and use of timber mats, and would incorporate any additional measures proposed by local and state agencies to reflect existing regional policies and procedures to protect wild rice. Wild rice stands also would be monitored for overall condition, function, and vegetative regrowth after construction until the permit conditions are met. As a result, construction through wild rice waterbodies using the wet open-cut crossing method would result in short-term and minor impacts on wild rice waterbodies.

Although not anticipated, construction-related impacts on wild rice waterbodies could include longer than expected recovery time for native wild rice stands, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions—all of which could be detrimental to wild rice germination and production. These potential impacts would be reduced through Project-specific SPCC plans, invasive species management plans, and post-construction monitoring of vegetation for a period of time until permit conditions are met, as described in the Applicant's Environmental Protection Plan (Appendix E). With implementation of these measures, impacts on wild rice waterbodies are expected to be short-term and minor. However, if HDD frac-out, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and alter

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except for areas where new impervious surfaces are created as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way would therefore be altered during the first few years of operation, resulting in impacts on runoff and erosion that would be short-term and negligible to minor. After vegetation is reestablished along the permanent right-of-way, surface water runoff and erosion would return to approximately preconstruction conditions. Areas of the permanent right-of-way that result in permanent vegetation changes, such as forested areas, would result in permanent changes to runoff conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements.

The number, types, and locations of associated facilities that would be required for pipeline operation along each of the route alternatives have not been determined. However, based on the facility needs and spacing of the Applicant's preferred route, it was assumed that RA-07 would require upgrading of existing pump stations along the Applicant's existing Line 3 corridor and 14 MLVs. Assuming that approximately 8 acres are required for each pump station and 0.1 acre is required for each MLV, approximately 1 acre of newly impervious surfaces would be in place for RA-07 for the life of the Project. The Applicant would be required to manage stormwater runoff at these new facilities in accordance with the stipulations of NPDES permits and SWPPPs as described above, which include the use of permanent stormwater control systems. As a result, potential impacts on surface water due to increased stormwater runoff from impervious surfaces would be permanent and negligible to minor.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on stormwater runoff and erosion would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. As described above, during the first few years of operation, there may be a small increase in surface water runoff and erosion as revegetation continues, resulting in short-term and negligible to minor impacts related to increases in TSS and sedimentation. Similar to the Applicant's preferred route, the permanent right-of-way for RA-07 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access for inspection, monitoring, and maintenance. The permanent removal of large woody vegetation also would result in permanent but minor and localized alterations in habitat, streambank stability loss and erosion, and sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. As a result, the impacts of these integrity management activities would be similar to those experienced from construction, but over a much smaller area. The impacts on TSS and

sedimentation in nearby surface waters would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project. In other portions of the permanent right-of-way, there would be a permanent but negligible impact related to increases TSS and sediments in surface water.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the route would not require withdrawal or discharge of water. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. However, as described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures and the volume of water would be substantially less than for construction. With adherence to permits and implementation of existing BMPs, minor alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity during in the areas excavated for pipe repair or replacement would be temporary to short-term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The permanent right-of-way of RA-07 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by the route alternative would not result in degradation of the average watershed health score or water quality score. As a result, water quality would not be changed in the surface waters of the basins and watershed

along the route, including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Minor fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles operating along RA-07. However, any refueling, fuel storage, or vehicle maintenance would follow measures similar to those in the Applicant's proposed Environmental Protection Plan (Appendix E). Thus, minor leaks and spills would result in negligible to minor and temporary impacts on surface water quality. The potential impacts of an unanticipated crude oil release are discussed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs; if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities for using the wet open-cut method would result in short-term and minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river or stream bed. This could result in a minor temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and negligible to minor for each crossing.

Using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short-term and minor for each crossing.

Disturbance of Wild Rice Waterbodies. During operation, wild rice waterbodies would not be affected unless it is necessary to repair or replace a section of pipe within the waterbody. In that event, the impacts would be similar to those for the initial construction of the pipeline through the waterbody, as described under construction impacts for the Applicant's preferred route. Although the Applicant would restore the hydrology and soils of the affected portion of the wild rice waterbody after construction, rice yield could be reduced in the portion of the waterbody affected by the repair or replacement activities for the first growing season after completion of the activity. It is likely that only a portion of the approximately 3 acres of wild rice waterbodies within the permanent right-of-way would require repair or replacement at any one time; therefore, these activities could result in short-term and negligible to minor impacts. However, if replacement of a section of pipe within the waterbody resulted in, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions impacts could be major.

Route Alternative RA-08

Route alternative RA-08 would be 325 miles in total, with 285 miles in Minnesota, of which 165 miles would be from Clearbrook to Carlton. The RA-08 route would require 189 waterbody crossings in Minnesota and 106 from Clearbrook to Carlton. The RA-08 route is similar to that of RA-07 but does not involve removal of the existing Line 3.

Construction Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. Clearing and grading would be required along the route alternative for construction of the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including pipe yards in Minnesota. Newly cleared areas and impervious surfaces could cause increased stormwater runoff and erosion into nearby surface waters; however, the Applicant would comply with the requirements of applicable permit programs that are in place to manage potential impacts as addressed below.

If RA-08 is selected, the Applicant would obtain NPDES permits for the pipeline, MLVs, pump stations, cathodic protection sites, access roads and ATWS, and pipe yards prior to construction. NPDES permits would specify various stormwater and erosion control measures to be implemented, such as requiring stormwater to be routed around exposed soil areas through conveyance channels and stormwater discharges to be directed from the site to vegetated areas in order to increase sediment removal and infiltrate stormwater on the site when feasible (Minnesota PCA 2013a). With adherence to NPDES permit stipulations and implementation of appropriate BMPs similar to those described for the Applicant's preferred route, construction of the alternative would result in impacts on stormwater runoff and erosion that would be temporary to long-term and minor.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. In addition to clearing and grading, other construction activities such as blasting, trenching, waterbody crossings, ATWS and access road construction, and water discharges may cause increased suspended solids and sedimentation in the surface waters crossed. The Applicant's temporary erosion controls, SWPPP requirements, and NPDES permit requirements described for the Applicant's preferred route would be implemented during these activities to prevent sediment transport into surface waters during construction. During pipeline construction across a waterbody, the extent and duration of sedimentation and increased erosion potential depend on the soils, sediments, and topography of the crossing site and the proposed crossing method used.

RA-08 would cross 106 surface waters; however, specific crossing methods for surface waters have not been determined for the route. When using the dry crossing method, increases in TSS and sedimentation would be localized and temporary in surface waters crossed because construction of the pipeline across the waterbody would occur in a dry area created by the temporary dams upstream and downstream of the work area. TSS and sedimentation would increase when flow is returned to the dry channel but would readily dissipate to negligible levels downstream in the vicinity of the crossing. As a result, impacts would be temporary to short-term and minor.

Wet open-cut methods involve excavation of the channel and banks in the wetted channel, and excavated soils would be in direct contact with surface water. With adherence to NPDES permit stipulations and use of appropriate BMPs similar to those described for the Applicant's preferred route, impacts from increases in TSS concentrations and increased sedimentation in surface waters crossed using open-cut wet crossings would be temporary to short-term and minor.

Changes in Stream Flows from Water Withdrawals and Discharges. Construction of RA-08 would require water withdrawal for hydrostatic testing, dust control, trench dewatering, and HDD installation, which would be sourced from lakes, streams, or groundwater wells. Approximately 44 to 68 million gallons of water (11 to 17 million gallons per construction spread) would be required for hydrostatic testing during construction between Clearbrook and Carlton. The Applicant has not determined the volume of water appropriation needed for dust control, trench dewatering, and HDD installation. Prior to construction, the Applicant would need to obtain a water appropriation permit from Minnesota DNR.

As stipulated in permit requirements, the Applicant would select appropriation sites along RA-08 that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely affect trout streams, calcareous fens, or other significant environmental resources.

Hydrostatic test water would be discharged from a test section in one of two ways as described for the Applicant's preferred route. Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on stream flows from water appropriation and discharge during construction would be temporary and minor.

Disruption of Flow Paths or Local Hydrologic Connectivity. As described for the Applicant's preferred route, pipeline construction may disrupt flow paths and groundwater-surface water interaction due to clearing and grading of riparian vegetation, water appropriation and discharge, and channel and streambank modifications caused by waterbody crossings. With implementation of measures similar to those described for the Applicant's preferred route to prevent erosion and sedimentation, to monitor stream flows during water appropriation and discharge, and to restore streambanks to their original attributes following construction, impacts on flow and hydrologic connectivity during construction of RA-08 would be temporary to permanent and minor to major. Potential impacts that are permanent and major would be associated with specific site features that are sensitive to disruption of hydrologic connectivity. Springs and other surface water features that are dependent on shallow groundwater have the potential for permanent and major impacts.

In addition, construction would involve creation of temporary and permanent access roads, which could affect hydrologic connectivity. The Applicant would restore temporary access roads, including roads that were widened and graded, to preconstruction conditions upon completion of construction. The Applicant would leave any improved roads intact if requested by the respective landowner. Impacts on hydrologic connectivity associated with temporary access roads is expected to be short-term and negligible to minor, depending on the location of the roads. Impacts from permanent access roads are discussed in the operations section below.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. Because only minor increases in stormwater runoff would occur during construction, the potential for stormwater to carry contaminants into surface waters is low. Surface water along RA-08 could become contaminated from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities such as fuel storage, equipment refueling, and equipment maintenance. However, to protect surface water resources, NPDES permits for construction of the route would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles (Minnesota PCA 2013b). Similar treatment/disposal or discharge measures to those described for the Applicant's preferred route would be necessary for handling concrete wash water, grindings, drilling mud and slurry, and rinse water generated by construction and hydrostatic testing.

In addition, the Applicant would be responsible for cleaning up small spills during construction of RA-08 through procedures similar to those described in the Environmental Protection Plan (Appendix E) for the Applicant's preferred route, including notifying proper personnel (e.g., the onsite spill coordinator) and agencies, stopping the work activity that caused the spill, using absorbent booms and pads to contain and recover released materials in water, and disposing of contaminated response materials at approved facilities.

In areas near sensitive or specially designated surface waters (e.g., the Clearwater River and trout streams), 100-foot buffers from the shoreline would be required during construction and as a permanent feature post-construction, except where a water crossing or other encroachment is necessary. For Section 303(d)-listed surface waters, which already have an impairment that prevents a beneficial use, degradation of water quality is of particular concern. NPDES permits for construction of RA-03AM would require identification of Section 303(d) waters with phosphorus, turbidity, dissolved oxygen, or biotic impairment within 1 mile of construction. If the impaired waters have an approved TMDL implementation plan, the plan must be incorporated into the SWPPP, and discharges must comply with specified TMDLs (Minnesota PCA 2013d). With adherence to these NPDES permit conditions and implementation of Applicant-proposed measures, impacts on surface water quality from small leaks and spills during construction would be temporary to short-term and negligible to minor.

Degradation of Aquatic Habitat from Instream Activities. Pipeline construction across surface waters has the potential to alter and degrade aquatic habitat through increased sedimentation and erosion, disruption or alteration of stream flow, and streambank disturbance. Crossing methods have not been determined for construction of RA-08 but would be selected based on various factors, including waterbody size, sensitivity (e.g., trout stream), water levels, soil/sediment stability, and anticipated season of installation. If a route permit is issued for RA-08, the Applicant would be required to obtain crossing permits from Minnesota DNR for all public waters, and the exact crossing method for each waterbody would be stated in the permits. Minnesota DNR would consider various factors, including

geological, topographic, hydrographic, geotechnical, and scour depth characteristics of each crossing, after final pipeline design in determining their approval for specific waterbody crossing methods.

Similar to construction of the Applicant's preferred route, dry and wet open-crossing crossing methods would be used. Each method has advantages and disadvantages for minimizing potential impacts on aquatic habitats. Assuming that erosion and sedimentation control measures would be the same as those discussed above for the Applicant's preferred route, and that disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation, using the dry and wet open-cut crossing methods would result in impacts on aquatic habitat that would be temporary to short-term and minor for each crossing.

If selected for certain crossings along RA-08 (e.g., roads and ditches), successful guided bore crossings would result in no impacts on aquatic habitat as described for the Applicant's preferred route. In addition, HDD crossings likely would be used to avoid impacts on certain sensitive surface waters, such as impaired waters and coldwater fishery resources; particularly deep, wide, or high-flow surface waters; and when appropriate based on subsurface substrate conditions and length of the drill path. HDD crossings are advantageous because they do not disturb streambeds or streambanks, and they maintain stream flow and fish passage. Construction of an HDD crossing is slower than a dry crossing, and there is the potential for inadvertent releases (discussed below). As described for the Applicant's preferred route, successful HDD crossings would result in no impacts on aquatic habitat during construction of RA-08.

Degradation of Water Quality and Habitat from Drilling Mud Releases during HDD Crossings. Specific locations to implement HDD crossings have not been determined for the route alternatives. Similar to the Applicant's preferred route, geotechnical surveys would need to be conducted along the route of RA-08 to determine which surface waters would benefit from use of the HDD method and which of those surface waters are in areas that are geologically suitable for HDD. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or frac-out of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Risk of HDD frac-out is discussed above in the assessment of impacts on surface water and aquatic habitat quality from the Applicant's preferred route. If a frac-out occurred during construction of RA-08 and went undetected or was not quickly contained, impacts on surface water quality could be long-term and major. However, with implementation of measures similar to those described for the Applicant's preferred route to respond to a drilling mud release during HDD construction along RA-08, the impact of a release on surface water quality and streambank structure would be short-term and minor.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Dry and wet open-cut waterbody crossing methods involve excavation of the streambed and potential changes to streambank stability and channel morphology. To minimize impacts on surface waters, Minnesota regulations regarding water crossings would be considered for selecting RA-08 crossing methods (Minn. R. 6135.1100, Subp. 4). These regulations specify that crossings should be placed at the narrowest section of a waterbody feasible; crossing of lakes should be avoided when possible, and they should be crossed under water when necessary; and crossing on or under the beds of trout streams should be avoided unless there is no feasible alternative. The Applicant would adhere to these stipulations when feasible, and each waterbody crossing would be approved prior to construction. Similar to construction of the Applicant's preferred route, temporary erosion control measures during

construction of RA-08 would be implemented as necessary during waterbody crossing activities; and rock riprap, geotextile fabric, and other bioengineering techniques would be used to stabilize sites as needed. Following crossing construction, river beds and streambeds would be restored to approximately preconstruction conditions, with no impediments to water flow, and streambanks would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. Finally, streambanks would be restored with appropriate vegetation.

The use of open-cut crossings for pipeline construction, along with the Applicant-proposed measures described above, would result in short-term to long-term and minor impacts on channel morphology and streambank stability. Successful construction of HDD crossings, where implemented for construction of RA-08, would result in no impacts on channel morphology or streambank stability.

Disturbance of Wild Rice Waterbodies. RA-08 would cross about 10 acres of the wild rice waterbodies within the construction work area (see Table 6.3.1.2-25). Specific construction methods for crossing of wild rice waterbodies along RA-08 have not been determined. Where HDD is used as the crossing method, the wild rice waterbodies would not be affected unless a frac-out occurs (see above for information on frac-outs).

Where HDD is not used, the wild rice waterbodies would be crossed using applicable wetland crossing methods for the water saturation conditions at the crossing (see Section 2.7.2 for a description of crossing methods). Trenching would remove the vegetation cover and sediments and increase sedimentation within the remainder of the waterbody. Although the Applicant would restore the hydrology and soils of the affected wild rice waterbodies after construction, rice yield could be reduced in the portion of the waterbody affected for the first growing season after construction. To minimize impacts of construction through wild rice waterbodies, the Applicant would implement applicable measures identified in the Applicant's Environmental Protection Plan (Appendix E). This plan would identify wild rice areas by milepost and contain specific measures to reduce or avoid impacts on wild rice during construction. Avoidance measures would include use of a narrower construction work area, reseeding, monitoring, and use of timber mats, and would incorporate any additional measures proposed by local and state agencies to reflect existing regional policies and procedures to protect wild rice. Wild rice stands also would be monitored for overall condition, function, and vegetative regrowth after construction until the permit conditions are met. As a result, construction through wild rice waterbodies using the wet open-cut crossing method would result in short-term minor impacts on wild rice waterbodies.

Although not anticipated, construction-related impacts on wild rice waterbodies could include longer than expected recovery time for native wild rice stands, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions—all of which could be detrimental to wild rice germination and production. These potential impacts would be reduced through Project-specific SPCC plans, invasive species management plans, and post-construction monitoring of vegetation for a period of time until permit conditions are met, as described in the Applicant's Environmental Protection Plan (Appendix E). With implementation of these measures, impacts on wild rice waterbodies are expected to be short-term and minor. However, if HDD frac-out, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and alter

Operations Impacts

Runoff and Flows

Increases in Stormwater Runoff and Erosion. After the pipeline is installed, revegetation of the permanent right-of-way may require up to several years to reestablish to approximately preconstruction conditions, except for areas where new impervious surfaces are created as addressed below. Runoff patterns along the non-impervious portions of the permanent right-of-way would therefore be altered during the first few years of operation, resulting in impacts on runoff and erosion that would be short-term and negligible to minor. After vegetation is reestablished along the permanent right-of-way, surface water runoff and erosion would return to approximately preconstruction conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements.

The number, types, and locations of associated facilities that would be required for pipeline operation along each of the route alternatives have not been determined. However, based on the facility needs and spacing of the Applicant's preferred route, it was assumed that RA-08 would require four pump stations and 14 MLVs. Assuming that approximately 8 acres are required for each pump station and 0.1 acre is required for each MLV, approximately 33 acres of newly impervious surfaces would be in place for RA-08 for the life of the Project. The Applicant would be required to manage stormwater runoff at these new facilities in accordance with the stipulations of NPDES permits and SWPPPs as described above, which include the use of permanent stormwater control systems. As a result, the potential impacts on surface water due to increased stormwater runoff from impervious surfaces would be permanent and negligible to minor.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. This could result in topographical changes and loss of vegetation in localized areas for relatively short periods of time, which would alter runoff patterns and could increase erosion. The Applicant would implement measures to minimize impacts during and after these activities, similar to the measures incorporated into the Project during construction. As a result, the impacts of these integrity management activities on stormwater runoff and erosion would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project.

Increases in Total Suspended Solids Concentrations and Increased Sedimentation. As described above, during the first few years of operation, there may be a small increase in surface water runoff and erosion as revegetation continues, resulting in short-term and negligible to minor impacts related to increases in TSS and sedimentation. Similar to the Applicant's preferred route, the permanent right-of-way for RA-08 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access for inspection, monitoring, and maintenance. The permanent removal of large woody vegetation also would result in permanent but minor and localized alterations in habitat, streambank stability loss and erosion, and sedimentation. Areas of the permanent right-of-way that result in permanent vegetation changes, such as forested areas, would result in permanent changes to runoff conditions. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would make the appropriate repairs and improvements. As a result, the impacts of these integrity management activities would be similar to those experienced from construction, but over a much smaller area. The impacts on TSS and sedimentation in nearby surface

waters would be short-term and negligible to minor for each local occurrence, but would occur periodically over the life of the Project. In other portions of the permanent right-of-way, there would be a permanent but negligible impact related to increases in TSS and sediments in surface water.

Changes in Stream Flows from Water Withdrawals and Discharges. Normal operation of the route would not require withdrawal or discharge of water. However, during the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. However, as described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of existing BMPs, minor alterations in stream flows from water appropriation and discharge would be temporary and negligible.

Disruption of Flow Paths or Local Hydrologic Connectivity. Integrity management digs would result in minor alterations of topography and stormwater flows at the excavation sites. With implementation of the Applicant-proposed measures described above to avoid changes to stormwater runoff and restore streambanks to their original attributes after work is completed, impacts on flow and hydrologic connectivity during in the areas excavated for pipe repair or replacement would be temporary to short-term and negligible to minor.

Permanent access roads during operation also could affect hydrologic connectivity. It is anticipated that permanent access roads would require local or state permits, which likely would require culverts to minimize the changes to hydrologic connectivity. Although the extent of the changes in those cases would depend on the topography of the area and the design of the roadway, the impact on hydrologic connectivity likely would be permanent and minor. For access roads without culverts, the extent of changes to hydrologic connectivity could be greater, again dependent on the topography of the area and the design of the roadway. Where those roadways are present, the impact on hydrologic connectivity likely would be permanent and minor.

Other permanent aboveground facilities, such as pump stations and MLVs, also would affect hydrologic connectivity. Due to the relatively small footprints of these facilities, it is anticipated that their presence would result in permanent but negligible to minor impacts.

Surface Water and Aquatic Habitat Quality

Degradation of Surface Water Quality. The permanent right-of-way of RA-08 in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. The permanent removal of riparian vegetation in areas adjacent to waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent but negligible to minor increases in temperature at these locations.

During normal operation, there would be no other measurable changes to water quality in surface waters. The minor changes within the major drainage basins and watersheds crossed by the route alternative would not result in degradation of the average watershed health score or water quality score. As a result, water quality would not be changed in the surface waters of the basins and watershed along the route, including impaired surface waters. Therefore, watershed surface water quality would not be affected during normal operation of the Project.

Minor fuel and lubricant leaks and spills could occur from maintenance and inspection vehicles operating along RA-08. However, any refueling, fuel storage, or vehicle maintenance would follow measures similar to those in the Applicant's proposed Environmental Protection Plan (Appendix E). Thus, minor leaks and spills would result in negligible to minor and temporary impacts on surface water quality. The potential impacts of an unanticipated crude oil release are discussed in Chapter 10.

Degradation of Aquatic Habitat from Instream Activities. Instream excavations may be required to repair or replace pipe segments buried beneath surface waters. This would result in impacts similar to those described for surface water crossings. The excavations to reach the pipe segments may be accomplished using the wet open-cut method or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would release sediments after the dams are removed and natural waterbody flow returns. However, the sediments would readily dissipate to negligible levels in the downstream area in the vicinity of the crossing. As a result, the potential impact on aquatic habitat of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and minor for each crossing.

If the wet open-cut method is used for integrity digs, the Applicant would implement the erosion and sediment control measures discussed above for construction of surface water crossings. These measures would be implemented during and after wet open-cut integrity digs; if streambanks are disturbed, they would be restored and stabilized as soon as practical after completion of the pipe repair or replacement. As a result, instream integrity dig activities for using the wet open-cut method would result in short-term minor impacts on aquatic habitat.

Changes in Channel Morphology and Stability Caused by Channel and Streambank Modifications. Excavation and repair or replacement of pipe may be required within surface waters or at the banks of surface waters. The excavations to reach the pipe segments may be accomplished using the wet open-cut method, or more likely would involve use of one of the dry open-cut methods.

Integrity management excavations accomplished using either of the dry open-cut crossing methods would involve backfilling of the trench, after the repair or replacement is made, to the approximate contours of the river or stream bed. This could result in a minor temporary change in channel morphology until the natural sedimentation processes of the waterbody return the affected area to essentially match the nearby morphology. If streambanks are affected by the digs, they would be restored to preconstruction grades when practicable. If the slope is determined to be unstable, the banks would be reshaped to prevent slumping. After reestablishing the grade, streambanks would be restored with appropriate vegetation. As a result, the potential impact on channel morphology and stability of using the dry open-cut method for instream integrity digs is expected to be temporary to short-term and negligible to minor for each crossing.

Using the wet open-cut method for instream integrity digs may require a longer period of time for natural sedimentation processes to accomplish the same result. If streambanks are affected by the digs, they would be restored as described above. As a result, the potential impact on channel morphology and stability of using the wet open-cut method for instream integrity digs is expected to be short-term and minor for each crossing.

Disturbance of Wild Rice Waterbodies. During operation, wild rice waterbodies would not be affected unless it is necessary to repair or replace a section of pipe within the waterbody. In that event, the impacts would be similar to those for the initial construction of the pipeline through the waterbody as

described under construction impacts for the Applicant's preferred route. Although the Applicant would restore the hydrology and soils of the affected portion of the wild rice waterbody after construction, rice yield could be reduced in the portion of the waterbody affected by the repair or replacement activities for the first growing season after completion of the activity. It is likely that only a portion of the approximately 4 acres of wild rice waterbodies within the permanent right-of-way would require repair or replacement at any one time; therefore, these activities could result in short-term negligible to minor impacts. However, if replacement of a section of pipe within the waterbody resulted in, introduction of contaminants, introduction of invasive aquatic plants and non-native strains of wild rice, and altered lakebed conditions impacts could be major.

6.3.1.2.5 Regional Analysis of Impacts on Quality of Existing Surface Water Conditions

For northern Minnesota streams, the conversion of forested perennial cover to grassland dominated cover can have an overall effect on local hydrology by effecting the smaller peak flows. This is the yearly bankfull flow that shapes the channel and builds the floodplain (Verry 2001). Removing permanent perennial cover along streams also reduces instream quality and habitat by increasing water temperatures, negatively affecting trout. Nutrient export from converted landscapes can also increase to lakes or streams when changing from forested to open grassland cover. The amount may be dependent on soil, slope, and other factors (Radomski 2005). The overall effects of changes in forest cover on hydrology, nutrient export, and temperature are dependent on the condition of the nearby watershed. The greater the landscape alteration, the more potential for these changes. Quantifiable estimates of impacts from land use change activities are available and have been used to predict hydrology and water quality changes to surface waters with the use of computer modeling programs.

Northern forested wetlands that are converted to open linear landscapes can allow for invasive species or other aggressive plants to develop monocultures and displace native vegetation. Corridors are often prone to infestations of narrowleaf (*Typha angustifolia*) or hybrid cattail (*Typha X glauca*), which are not listed as an invasive plant but have been an aggressive nuisance with previous pipeline development.

6.3.1.2.6 Summary and Mitigation

Summary

Impacts on surface waters, including streams, rivers, lakes, and wild rice waterbodies, watersheds, sensitive or specially designated surface waters, NRI rivers, impaired surface waters, and navigable waterways from construction of the Applicant's preferred route and the four route alternatives were assessed and found to be temporary and minor, with the exception of instances where a "frac-out" occurs while doing HDD boring. Impacts from operations were found to be potentially short-term to permanent and negligible to minor. The comparison of impacts among the alternatives focused on the pipeline routes between Clearbrook and Carlton, Minnesota, because all of the routes have the same alignments from Neche, North Dakota, to Clearbrook and from Carlton to Superior, Wisconsin.

Table 6.3.1.2-28 presents summary information on the impacts identified. For all route options, the types of impacts of construction and operations on surface water would be comparable at locations experiencing a change. However, the numbers and acreages of areas that would experience a change differ among the alternatives, as discussed below.

Construction Impacts

Construction of all route options would cause changes to runoff and flows that would result in temporary to short-term and minor impacts. Changes in water quality due to construction would result in impacts on surface water that would be temporary to short-term and negligible to minor for all route options, unless drilling fluids were released during HDD crossings and were uncontained or undetected. In this event, the impact could be long-term and major for all route options. The number of surface waters affected by crossings would differ among the alternatives: RA-07 would cross the fewest number of surface waters (81), followed by RA-08, the Applicant's preferred route, RA-06, and RA-03AM with 167 crossings (Table 6.3.1.2-28). RA-06 would affect the least number of impaired water crossings (1) and TMDL study areas (1), followed by RA-07, RA-08, the Applicant's preferred route, and RA-03AM with 14 crossings of impaired waters and crossings of 6 TMDL study areas (Table 6.3.1.2-28). These impacts on impaired or low-quality waterbodies may cause further degradation of the waterbody, exacerbate an existing impairment, cause additional impairments, interfere with restoration activities, and/or delay attainment of water quality standards. Impacts on high-quality waterbodies (e.g., trout streams, NRI-listed rivers, and wild rice waterbodies) may decrease the suitability of surface water as a habitat for sensitive species or degrade the existing beneficial use of the waterbody.

For channel morphology and stability, the construction impacts would be short-term to long-term and minor, except where the HDD or guided bore crossing method is used. At those locations, there would be no impact on channel morphology and stability. As noted above, the number of surface water crossings would range from 81 for RA-07 to 167 for RA-03AM (Table 6.3.1.2-28).

The construction impact on wild rice waterbodies for each location affected for each route option would be short-term and minor. The Applicant's preferred route would affect the least number of acres of wild rice waterbodies (4.9 acres), followed by RA-07, RA-03AM, RA-08, and RA-06 with 10.6 acres (Table 6.3.1.2-28).

Operations Impacts

As with construction, the types of impacts on surface water during operations would be the same at each location experiencing a change for all route options. Thus, the primary difference in impacts among the route options would be the extent of impacts and the types of resources affected. Operation would cause changes to runoff and flows from the presence of aboveground facilities, including permanent access roads; potential impacts would be temporary to permanent and minor. The increase in impervious surfaces that would cause these changes would range from 1.4 acres for RA-07 to between 30 and 50 acres for the other route options (Table 6.3.1.2-28). If integrity digs were required in or immediately adjacent to surface waters, changes in water quality from operation would result in temporary to short-term and negligible to minor impacts on surface water for all route options when they did occur and could occur periodically over the life of the Project. Permanent and minor increases in water temperature could occur from cleared vegetation around waterbodies.

Enbridge, in accordance with Minnesota PCA requirements, would designate at least one Environmental Inspector per 14,000-feet spread during pipeline construction.

Operation of all route options would result in impacts on channel morphology and stability and wild rice waterbodies that are expected to be temporary to short-term and negligible to minor due if they did occur, and would be associated with periodic integrity digs. The area of wild rice waterbodies potentially affected would be similar among the alternatives, ranging from 2.5 acres for RA-07 to 4.4 acres for RA-06; impacts would be short-term and negligible to minor (Table 6.3.1.2-27).

Mitigation

In addition to the Applicant-proposed measures to avoid or minimize impacts that would be incorporated into the Project, and the stipulations in permits required for the Project, Minnesota DNR identified the following mitigation measures for consideration by the Commission to further avoid and minimize impacts:

- Where riparian vegetation is removed at surface water crossings, revegetate the construction work area with a minimum 50-foot-wide buffer of woody vegetation to reduce runoff, erosion, water quality degradation, sunlight penetration, and water temperature warming, and increase bank stability.
- Longer term impacts of clearing in temporary work areas could be offset by reestablishing or enhancing the existing cover type within up to 500 feet of waterbodies, depending on topography.
- After construction on state forest lands or state Wildlife Management Areas, tree planting on all temporary workspaces could be accomplished to reduce erosion and runoff, as well as to ensure that forested areas within the riparian zone are restored to forest cover.
- Rock riprap should be considered or permitted only when infrastructure (public or private) is at risk. Natural channel design and bioengineering methods should be considered the primary means of streambed and streambank restoration and stabilization.

Table 6.3.1.2-28. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Increases in stormwater runoff and erosion from newly cleared areas and impervious surfaces	Short-term/minor impacts • 109 waterbody crossings	Short-term/minor impacts • 167 waterbody crossings	Short-term/minor impacts • 137 waterbody crossings	Short-term/minor impacts • 81 waterbody crossings	Short-term/minor impacts • 106 waterbody crossings
Increases in total suspended solids concentrations and increased sedimentation	Temporary to short-term/minor impacts • 109 waterbody crossings Temporary/negligible to minor impacts • 1 blasting location	Temporary to short-term/minor impacts • 167 waterbody crossings *Need for blasting not known*	Temporary to short-term/minor impacts • 137 waterbody crossings *Need for blasting not known*	Temporary to short-term/minor impacts • 81 waterbody crossings *Need for blasting not known*	Temporary to short-term/minor impacts • 106 waterbody crossings *Need for blasting not known*
Changes in stream flows from water withdrawals and discharges	Temporary/minor impacts • 4 construction spreads (11–17 million gallons per spread)	Temporary/minor impacts • 5 construction spreads (11–17 million gallons per spread)	Temporary/minor impacts • 4 construction spreads (11–17 million gallons per spread)	Temporary/minor impacts • 4 construction spreads (11–17 million gallons per spread)	Temporary/minor impacts • 4 construction spreads (11–17 million gallons per spread)
Disruption of flow paths or local hydrologic connectivity	Temporary to permanent/ negligible to majormajor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing • Wet open-cut crossings • Clearing and grading of riparian vegetation • Access road construction	Temporary to permanent/ negligible to majormajor impacts • 5 spreads requiring water appropriation and discharge for hydrostatic testing • Wet open-cut crossings • Clearing and grading of riparian vegetation • Access road construction	Temporary to permanent/ negligible to major impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing • Wet open-cut crossings • Clearing and grading of riparian vegetation • Access road construction	Temporary to permanent/ negligible to majormajor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing • Wet open-cut crossings • Clearing and grading of riparian vegetation • Access road construction	Temporary to permanent/ negligible to majormajor impacts • 4 spreads requiring water appropriation and discharge for hydrostatic testing • Wet open-cut crossings • Clearing and grading of riparian vegetation • Access road construction

Table 6.3.1.2-28. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Degradation of surface water quality	Temporary to short-term/ negligible to minor impacts • 13 impaired water crossings • 3 TMDL study area crossings	Temporary to short-term/ negligible to minor impacts • 14 impaired water crossings • 6 TMDL study area crossings	Temporary to short-term/ negligible to minor impacts • 1 impaired water crossing • 1 TMDL study area crossing	Temporary to short-term/ negligible to minor impacts • 2 impaired water crossings • 1 TMDL study area crossing	Temporary to short-term/ negligible to minor impacts • 5 impaired water crossings • 1 TMDL study area crossing
Degradation of aquatic habitat from instream activities	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*) • 6 trout stream crossings • 7 NRI-listed river crossings	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*) • 9 trout stream crossings • 1 NRI-listed river crossing	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*) • 8 trout stream crossings • 2 NRI-listed river crossings	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*) • 6 trout stream crossings • 1 NRI-listed river crossing	Temporary to short-term/minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*) • 4 trout stream crossings • 1 NRI-listed river crossing
Degradation of water quality and habitat from releases of drilling mud during HDD crossings Each drlling mud additive must be identified; specific location where additive will be used; water analysis of before and after any frac-out	Short-term/minor impacts (*if quickly contained*) to long-term/major impacts (*if undetected or uncontained*) • 12 HDD crossings	Short-term/minor impacts (*if quickly contained*) to long-term/major impacts (*if undetected or uncontained*) • *Number of HDD crossings not determined for route alternatives*			

Table 6.3.1.2-28. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Changes in channel morphology and stability caused by channel and streambank modifications	Short-term to long-term/ minor impacts (*from dry and wet open-cut crossings*); no impact (*from guided bore and HDD crossings*) • 12 HDD crossings; number of guided bore crossings not determined	Short-term to long-term/minor impacts from open-cut crossings; no impact from guided bore and HDD crossings • *Crossing types not determined for route alternatives*			
Disturbance of wild rice waterbodies	Short-term/minor impacts • 4.9 acres • 5 waterbodies	Short-term/minor impacts • 7.5 acres • 7 waterbodies	Short-term/minor impacts • 10.6 acres • 5 waterbodies	Short-term/minor impacts • 6.1 acres • 1 waterbody	Short-term/minor impacts • 9.8 acres • 2 waterbodies
Operations Impacts					
Increases in stormwater runoff and erosion	Short-term to permanent/ negligible to minor impacts • 30.3 acres of new impervious surfaces (4 pump stations, 18 MLVs)	Short-term to permanent/ negligible to minor impacts • 50.3 acres of new impervious surfaces (6 pump stations, 23 MLVs)	Short-term to permanent/ negligible to minor impacts • 33.6 acres of new impervious surfaces (4 pump stations, 16 MLVs)	Short-term to permanent/ negligible to minor impacts • 1.4 acres of new impervious surfaces (0 pump stations, 14 MLVs)	Short-term to permanent/ negligible to minor impacts • 33.4 acres of new impervious surfaces (4 pump stations, 14 MLVs)
Increases in total suspended solids concentrations and increased sedimentation	Short-term to permanent/ negligible to minor impacts • Removal of riparian vegetation • Increased erosion	Short-term to permanent/ negligible to minor impacts • Removal of riparian vegetation • Increased erosion	Short-term to permanent/ negligible to minor impacts • Removal of riparian vegetation • Increased erosion	Short-term to permanent/ negligible to minor impacts • Removal of riparian vegetation • Increased erosion	Short-term to permanent/ negligible to minor impacts • Removal of riparian vegetation • Increased erosion
Changes in stream flows from water withdrawals and discharges	Temporary/negligible impacts	Temporary/negligible impacts	Temporary/negligible impacts	Temporary/negligible impacts	Temporary/negligible impacts

Table 6.3.1.2-28. Summary of Potential Impacts on Surface Waters for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Disruption of flow paths or local hydrologic connectivity	Temporary to permanent/ negligible to minor impacts from access roads	Temporary to permanent/ negligible to minor impacts from access roads	Temporary to permanent/ negligible to minor impacts from access roads	Temporary to permanent/ negligible to minor impacts from access roads	Temporary to permanent/ negligible to minor impacts from access roads
Degradation of surface water quality	Temporary to permanent/ negligible to minor impacts • Minor leaks and spills during maintenance • Contaminants in runoff • Increased water temperature from cleared vegetation	Temporary to permanent/ negligible to minor impacts • Minor leaks and spills during maintenance • Contaminants in runoff • Increased water temperature from cleared vegetation	Temporary to permanent/ negligible to minor impacts • Minor leaks and spills during maintenance • Contaminants in runoff • Increased water temperature from cleared vegetation	Temporary to permanent/ negligible to minor impacts • Minor leaks and spills during maintenance • Contaminants in runoff • Increased water temperature from cleared vegetation	Temporary to permanent/ negligible to minor impacts • Minor leaks and spills during maintenance • Contaminants in runoff • Increased water temperature from cleared vegetation
Degradation of aquatic habitat from instream activities	Temporary to short-term/ minor impacts from integrity digs	Temporary to short-term/ minor impacts from integrity digs	Temporary to short-term/ minor impacts from integrity digs	Temporary to short-term/ minor impacts from integrity digs	Temporary to short-term/ minor impacts from integrity digs
Changes in channel morphology and stability caused by channel and streambank modifications	Temporary to short-term/ negligible to minor impacts from integrity digs	Temporary to short-term/ negligible to minor impacts from integrity digs	Temporary to short-term/ negligible to minor impacts from integrity digs	Temporary to short-term/ negligible to minor impacts from integrity digs	Temporary to short-term/ negligible to minor impacts from integrity digs
Disturbance of wild rice waterbodies	Short-term/negligible to minor impacts • 3.2 acres of wild rice waterbodies • 5 waterbodies	Short-term/negligible to minor impacts • 3.1 acres of wild rice waterbodies • 7 waterbodies	Short-term/negligible to minor impacts • 4.4 acres of wild rice waterbodies • 5 waterbodies	Short-term/negligible to minor impacts • 2.5 acres of wild rice waterbodies • 1 waterbody	Short-term/negligible to minor impacts • 4.1 acres of wild rice waterbodies • 2 waterbodies

6.3.1.2.7 References

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6.3.1.3 Wetlands

A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. Wetlands are defined in a variety of ways for federal, state, and local regulatory protection; however, the common factors that distinguish wetlands from other landforms or waterbodies are the presence of a hydrophytic (waterlogged) vegetation community, hydric soils,[12] and hydrology. All wetlands provide a variety of functions of social significance, including: surface water storage (flood control), shoreline stabilization (wave damage protection/shoreline erosion control), stream flow maintenance (maintaining aquatic habitat and aesthetic appreciation opportunities), groundwater recharge (some types replenish water supplies), sediment removal and nutrient cycling (water quality protection), aquatic productivity (fishing, shellfishing, and waterfowl hunting), production of trees (timber harvest), production of herbaceous growth (livestock grazing and haying), production of peaty soils (peat harvest), and wildlife habitat (hunting, trapping, plant/wildlife/nature photography, nature observation, and aesthetics) (EPA 2002, 2006).

The analysis of impacts on wetlands during construction of the Applicant's preferred route and route alternatives considered changes to wetland characteristics and functions by alteration or loss of the plant communities through removal or cover with fill, and by alteration or loss of the hydrologic conditions that maintain wetland plant communities and wetland soils. Construction and operations impacts considered included:

- Changes to forested and scrub/shrub wetland characteristics and functions;
- Changes to emergent wetland characteristics and functions;
- Changes to Minnesota Public Waters Wetland characteristics and functions;
- Changes to Minnesota calcareous fen characteristics and functions;
- Changes to Wetland Reserve Program wetland characteristics and functions; and
- Changes to wetland mitigation bank easements characteristics, functions, and availability.

This section first describes the existing wetlands, including Public Waters Wetlands, calcareous fen wetlands, and wetland conservation easements, within the area along the Applicant's preferred route and each route alternative where wetlands could be affected by construction and operation of the Project. The potential Project-related impacts of the Applicant's preferred route on wetlands during construction and operation then are discussed, along with measures the Applicant would implement to minimize impacts. Next, the potential impacts on wetlands during construction and operation are addressed for each route alternative (RA-03AM, RA-06, RA-07, and RA-08). A summary and comparison of the impacts are included at the end of the section, with potential mitigation measures to be considered.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

[12] A soil that forms under conditions of water saturation long enough during the growing season to develop anaerobic conditions in the upper part of the soil.

6.3.1.3.1 Regulatory Context and Methodology

Regulatory Context

General Wetlands

Federal and State Jurisdictional Wetlands

CWA Section 404 and Rivers and Harbors Act Section 10 Individual Permits and associated state CWA Section 401 Individual Water Quality Certification for the Project in Minnesota are under the jurisdiction of USACE – St. Paul District and Minnesota PCA. USACE requires that projects avoid impacts on wetlands to the extent practicable and that potential impacts have been minimized, and that compensation be provided for all remaining unavoidable impacts.

For CWA Section 401 certification, Minnesota PCA is responsible for non-reservation wetlands in Minnesota, Wisconsin DNR is responsible for wetlands in Wisconsin, and North Dakota DH's Division of Water Quality is responsible for wetlands in North Dakota. Permitting for route alternative RA-03AM would require obtaining a CWA Section 401 certification from Iowa DNR and Illinois DNR. Adherence to state-specific general construction and stormwater permit conditions, buffer laws, and other state and local resource protection measures also would be required, which would serve as a duplicative mechanism for oversight and protection of jurisdictional wetland resources.

In Minnesota, the Wetland Conservation Act (WCA) protects wetlands and applies to all wetlands except Public Waters Wetlands (described below). The WCA requires projects that affect wetlands to try to avoid the impact, minimize any unavoidable impacts, and replace any lost wetland functions. Responsibility for administration of the WCA is shared by local government units and Minnesota Board of Water and Soil Resources (Minnesota BWSR) (Minn. R. Ch. 8420) and is enforced by Minnesota DNR.

Compensatory Mitigation

Compensatory wetland mitigation may be required in federal and state-specific permitting for permanent impacts on forested, scrub/shrub, and emergent wetlands. The overall objective of compensatory wetland mitigation would be to compensate for wetland aquatic resource functions lost due to construction, taking into consideration what is available and feasible. Compensatory wetland mitigation would be consistent with applicable policies, regulations, and rules governing compensatory wetland mitigation for the purposes of Section 404 of the CWA, including, but not limited to:

- USACE, St. Paul District Draft Compensatory Mitigation Policy for Minnesota, dated January 23, 2009;
- Joint guidance between St. Paul District and Minnesota BWSR for Developing Mitigation Plan Performance Standards and Credit Release Schedules in Minnesota, dated December 16, 2015;
- USACE and EPA Final Rule Regarding Compensatory Mitigation for Losses of Aquatic Resources, dated April 10, 2008; and
- Minnesota Office of the Revisor of Statutes 7050.0186 Wetlands Standards and Mitigation, dated April 1, 2008 and wetland replacement regulations as described under the WCA.

Specially Designated Wetlands

Minnesota Public Waters Wetlands

Public Waters Wetlands are a subset of the State's jurisdictional wetlands regulated under Minnesota Statutes § 103G. Public Waters Wetlands are regulated as public waters under Minnesota DNR's License to Cross Public Waters program. Where Public Waters Wetlands occur, a License to Cross Public Waters would be required from Minnesota DNR.

Minnesota DNR is responsible for licensing utility crossings for any utility projects proposing to cross Public Waters Wetlands, ensuring that the crossing plans are reasonable, are practical, and will adequately protect public safety and promote the public welfare (Minn. Stat. § 84.415 and § 103G.315). The Applicant may request exemption from wetland replacement requirements (i.e., compensatory mitigation) under existing utility exemptions for those portions of the Project within Public Waters Wetlands that would be regulated under WCA standards (Minnesota WCA n.d.). Utility crossing licenses generally are required for installation of electrical, pipeline, and communication projects and are granted for a term of 25 or 50 years.

Minnesota Calcareous Fen Wetlands

Calcareous fens are wetlands characterized by a substrate of non-acidic peat and dependent on a constant supply of cold, oxygen-poor groundwater rich in calcium and magnesium bicarbonates. They are rare and typically occur on slight slopes where upwelling water eventually drains away and where surface water inputs are minimal.

Impacts on calcareous fens are regulated by Minnesota DNR under the WCA. Under this act, a calcareous fen may not be filled, drained, or otherwise degraded, wholly or partially, by any activity. If impacts are identified and deemed necessary by the Minnesota Commissioner of Natural Resources, a Fen Management Plan must be provided by the applicant (Minn. Stat. § 103G.223). Eight state-listed, rare plant species are known to be commonly found within calcareous fens; these plant species would be additionally protected under Minnesota's Endangered Species Act (Minn. Stat. § 84.0895).

Wetland Reserve Program

The Wetland Reserve Program, a voluntary federal program managed by the Natural Resources Conservation Service (NRCS), supported wetland conservation, restoration, and enhancement projects on private agricultural and pastoral land through easements and restoration cost-share agreements. The Wetland Reserve Program ran from 2009 and 2014 and has since been replaced by the Agricultural Act of 2014 Agricultural Conservation Easement Program, which has the same objectives and implementation tools.

Minnesota Wetland Mitigation Bank Easements

The Minnesota BWSR Mitigation Banking Program administered under the WCA (Minn. R. 8420.0700 to 8420.0820) facilitates applying for or purchasing wetland credits toward future wetland impacts. Minnesota BWSR oversees the program, with local government units involved in landowner application and monitoring. Minnesota created 10 wetland bank service areas. Bank credit ratio is reduced if the credit area used is in a different service area than the disturbance area (Minnesota BWSR 2016).

Methodology

As a part of the evaluation of potential impacts on wetlands and effects on specially designated wetland resources the following information sources were used:

- USFWS National Wetlands Inventory (NWI) database (USFWS 2016), classified using the Cowardin classification system (Cowardin et al. 1979);
- Minnesota DNR Public Waters Wetlands database (Minnesota DNR 2014), classified based on USFWS Circular No. 39 (EPA 2002);
- Minnesota DNR calcareous fens database (Minnesota DNR 2008), ranked based on the conservation status ranking (or "S-rank") methodology developed by NatureServe and its member natural heritage programs in North America (NatureServe 2016), and classified using Minnesota's native plant community classifications (Minnesota DNR 2005);
- USGS Protected Area Database – Wetland Reserve Programs (USGS 2016); and
- Minnesota wetland mitigation bank easements database (Minnesota BWSR 2015).

The ROI for the wetland evaluation encompasses the area that could be directly or indirectly affected by pipeline construction Federal and state jurisdictional wetlands occur in the ROI, including specially designated wetlands.

Potential wetland impacts from construction of the Applicant's preferred route were evaluated by overlaying the footprints of the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, MLV pads and driveways, and pump stations on the identified wetland maps. Typical wetland disturbance effects were based on the Applicant-proposed construction methods described in Chapter 2 and the special wetland construction methods described in the Applicant's November 2016 EAW (Enbridge 2016). Comparisons of construction impacts between alternatives were based on evaluation of the Applicant's preferred route, and evaluations of the impacts of alternative routes. A standardized 120-foot-wide construction work area was used for RA-03AM, RA-06, and RA-08; and a 205-foot-wide construction work area was used for RA-07. Comparisons of operations impacts were based on the Enbridge-provided footprint for the Applicant's preferred route permanent right-of-way and a standardized 50-foot-wide permanent right-of-way for each route alternative.

6.3.1.3.2 Existing Conditions

Wetland Types

Wetland types crossed by the route alternatives are grouped into three categories: forested wetland, scrub/shrub wetland, and emergent wetland.

General Wetlands

Forested wetlands are dominated by trees 20 feet or taller, including evergreen forest, deciduous forest, and mixed forest wetlands. Scrub/shrub wetlands are dominated by short or dwarfed trees and shrubs less than 20 feet tall, including tall and low-growing shrubs. Woody wetlands include both forested and scrub/shrub wetlands; the term "woody wetlands" is sometimes used in this EIS when discussing forested and scrub/shrub wetlands. Emergent wetlands that would be crossed by the Applicant's preferred route are dominated by erect, rooted, herbaceous wetland plants such as sedges, rushes, and

grasses. Most of the emergent prairie wetlands that were previously in the region have been converted to croplands. Federal and state jurisdictional wetlands occur along the pipeline route alternatives.

Detailed maps that show the locations of wetlands are in Appendix A.

Specially Designated Wetlands

Specially designated wetlands are identified as high-value wetland resources based on environmental and socioeconomic factors such as size, environmental function, and presence of high-value resources, habitat qualities, species diversity, and participation in federally and state-funded conservation programs. Specially designated wetlands and their values are of specific concern to state and local agencies. The specially designated wetlands addressed in this analysis are:

- Minnesota DNR's Public Waters Inventory – Public Waters Wetlands,
- Calcareous fen wetlands, and
- Wetlands enrolled in the NRCS or state Wetland Reserve Programs or the Minnesota BWSR Wetland Mitigation Banking Program.

Minnesota Public Waters Wetlands

Public Waters Wetlands are categorized by type. Public Waters Wetlands crossed by the Applicant's preferred route and route alternatives include wetland Types 3, 4, and 5 that are 10 acres or larger in unincorporated areas or 2.5 acres or larger in incorporated areas. Type 3 wetlands are inland, shallow fresh marshes; Type 4 wetlands are inland, deep fresh marshes; and Type 5 wetlands are open fresh water. Because of the size of these wetlands and their associated environmental and socioeconomic functions, they are afforded legal protection in Minnesota. Public Waters Wetlands identified near the pipeline routes are dominated by Type 3 wetlands.

Minnesota Calcareous Fen Wetlands

As noted above, calcareous fens are rare peat-accumulating wetlands formed as a result of groundwater upwelling through calcareous substrates; they are designated in Minnesota as Outstanding Resource Value Waters. Because of their regional rarity, biodiversity, and sensitivity to disturbance, calcareous fens are afforded legal protection in Minnesota.

Wetland Reserve Program and Minnesota Board of Water and Soil Resources Banking Program

Wetlands identified under the NRCS or state Wetland Reserve Programs and Minnesota BWSR Mitigation Banking Program include those wetlands that are a part of an existing federally funded or state-managed Wetland Reserve Program. These wetlands are of significance as they offer landowners the voluntary opportunity to protect, restore, enhance, and develop mitigation wetlands under a protective easement managed by NRCS (USGS 2016) or Minnesota BWSR (2015). Pipeline construction through or placement of facilities on wetland reserves or mitigation banks may prevent the wetland areas from being eligible for these programs. During pipeline operation, the permanent right-of-way and potentially some adjacent areas would be subject to disturbance (1) during activities associated with the Applicant's Integrity Management Program (e.g., excavation to repair or replace sections of pipe); and (2) during maintenance of the right-of-way (e.g., brush cutting, mowing).

Applicant's Preferred Route

General Wetlands

Wetlands within the ROI for the Applicant's preferred route are predominantly scrub/shrub wetlands. In Minnesota, approximately 524 acres of forested, scrub/shrub, and emergent wetlands occur within the construction footprint, and approximately 275 acres of wetlands occur within the permanent right-of-way and facility footprints (Table 6.3.1.3-1). Between Clearbrook and Carlton, approximately 445 acres of wetlands occur within the construction work area, and approximately 234of wetlands occur within the permanent right-of-way (Table 6.3.1.3-2).

Table 6.3.1.3-1. Estimated Acreages of Wetlands Crossed by the Applicant's Preferred Route in Minnesota (acres)

Wetland Classification	Construction[a]	Operations[a]	Total[b]	
			Construction	Operations
Forested wetland	141.1	66.3	147.5	70.6
Scrub/shrub wetland	214.5	115.7	224.6	122.0
Emergent wetland	143.8	79.2	151.6	82.5
TOTAL	**499.3**	**261.2**	**523.7**	**275.1**

Source: USFWS 2016.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Construction = Enbridge-provided footprint for construction work area; Operations = Enbridge-provided footprint for permanent right-of-way; additional temporary workspaces (ATWS), including pipe yards; and mainline valves (MLVs), including valve pads and driveways.

[b] Total Construction = sum of pipeline construction work area, ATWS, and temporary access roads; Operations = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs.

Table 6.3.1.3-2. Estimated Acreages of Wetlands Crossed by the Applicant's Preferred Route (Clearbrook to Carlton) (acres)

Wetland Classification	Construction[a]	Operations[b]
Forested wetland	132.8	61.9
Scrub/shrub wetland	200.6	108.4
Emergent wetland	111.8	64.0
TOTAL	**445.2**	**234.3**

Source: USFWS 2016.

[a] Construction work area = Enbridge-provided footprint for construction work area.

[b] Permanent right-of-way = Enbridge-provided footprint for permanent right-of-way.

Specially Designated Wetlands

Public Waters Wetlands crossed by the Applicant's preferred route include wetland Types 3 and 4 in Minnesota (Table 6.3.1.3-3).

Table 6.3.1.3-3. Estimated Acreages of Public Waters Wetlands Crossed by the Applicant's Preferred Route in Minnesota (acres)

Wetland Type	Construction[a]	Operations[a]	Total[b]	
			Construction	Operations
Type 3 – Inland shallow fresh marshes	2.1	1.7	2.1	1.7
Type 4 – Inland deep fresh marshes	0.6	0.2	0.7	0.2
TOTAL	**2.7**	**1.9**	**2.8**	**1.9**

Source: Minnesota DNR 2014.

[a] Construction = Enbridge-provided footprint for construction work area; Operations = Enbridge-provided footprint for permanent right-of-way.

[b] Construction = sum of pipeline construction work area, ATWS, and temporary access roads; Operations = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs.

One calcareous fen would be crossed by the Applicant's preferred route, and four others are near the route (Table 6.3.1.3-4 and Figure 6.3.1.3-1). All calcareous fens near the Applicant's preferred route are located on the portion of the route between the North Dakota border and Clearbrook, Minnesota. The fen near MP 122, named Gully 30, is approximately 63 feet from the route centerline (Figure 6.3.1.3-1). Calcareous fen surveys completed in 2010 identified the presence of Gully 30 during development of the Alberta Clipper pipeline. As part of the environmental review for the Alberta Clipper pipeline, a Gully 30 Fen Management Plan was developed in coordination with Minnesota DNR (Natural Resource Group 2009). As proposed, portions of the Applicant's preferred route would be co-located with the Alberta Clipper pipeline where Gully 30 and other nearby fens occur.

No wetlands enrolled in the NRCS Wetland Reserve Program are present near the Applicant's preferred route. No wetlands that are part of the Minnesota BWSR Mitigation Banking Program would be crossed by the Applicant's preferred route.

Table 6.3.1.3-4. Estimated Acreages of Calcareous Fen Wetlands near the Applicant's Preferred Route in Minnesota

Approximate Milepost	Distance from Route	Elemental Occurrence Identifier	Primary Description	MBS Native Plant Community Code	State Rank[a]	County
APR 72.0	796 feet	14377 Viking 18	Calcareous fen (northwestern)	OPp93a	S2	Marshall
APR 73.5	2,042 feet	15297 Viking 20	Calcareous fen (northwestern)	OPp93a	S2	Marshall
APR 81.0	525 feet	34586 Norden 18	Calcareous fen (northwestern)	OPp93a	S2	Pennington
APR 120.5	2,011 feet	35384 Chester 24	Calcareous fen (northwestern)	OPp93a	S2	Polk
APR 122.0	63 feet	35382 Gully 30	Calcareous fen (northwestern)	OPp93a	S2	Polk

Source: Minnesota DNR 2008.

Notes:

[a] State Rank: S1 = critically imperiled; S2 = imperiled; S3 = vulnerable to extirpation; S4 = apparently secure; S5 = secure, common, widespread, and abundant.

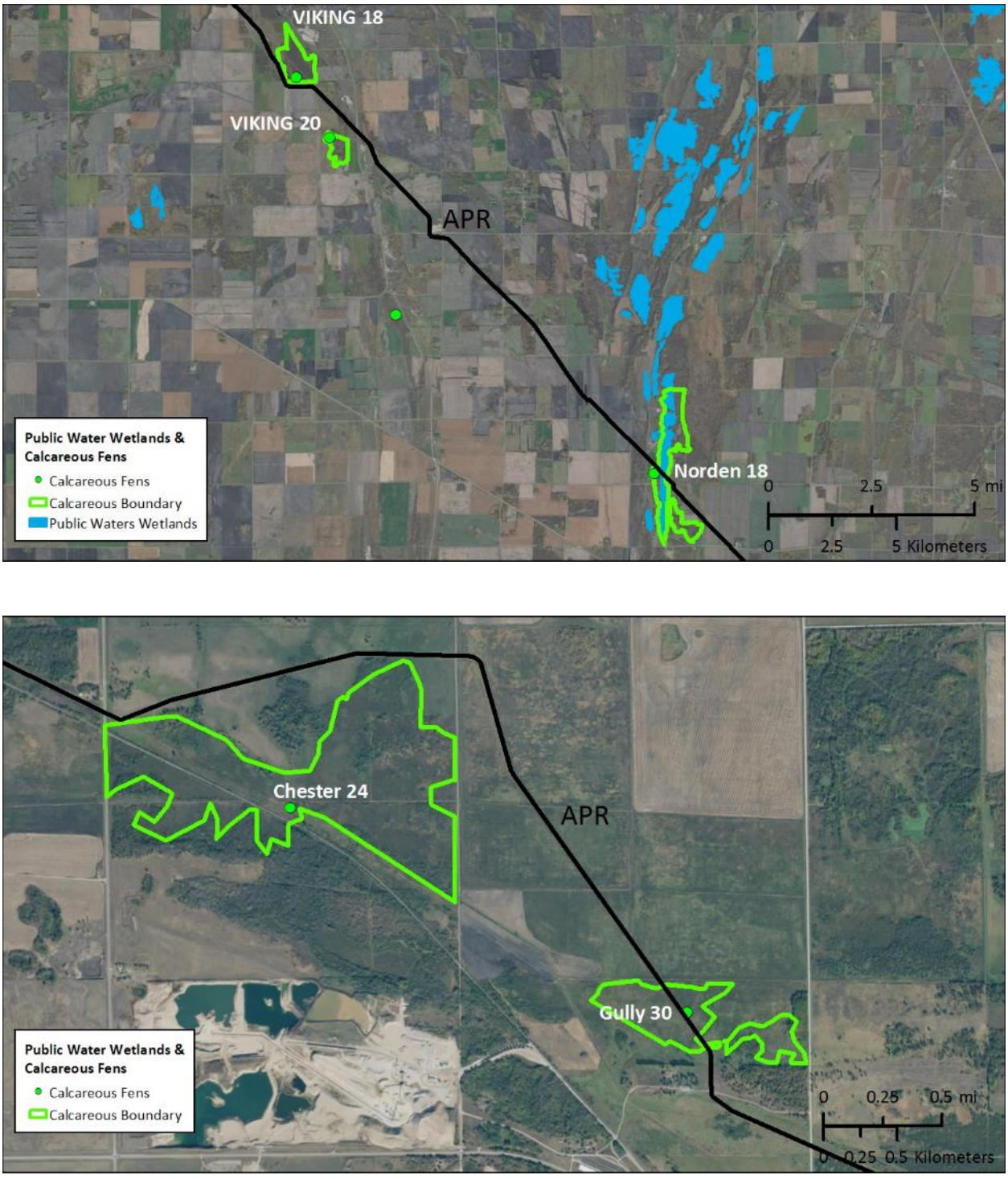
APR = Applicant's preferred route; MBS = Minnesota Biological Survey.

Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to wetlands for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Wetlands crossed by the construction work area for RA-03AM are listed in Table 6.3.1.3-5; about 80 percent of the wetlands crossed are emergent wetlands and scrub/shrub wetlands. For Public Waters Wetlands, only Type 3 – inland shallow fresh marshes would be crossed by the route, including approximately 8 acres within the construction work area and 3 acres within the permanent right-of-way (Table 6.3.1.3-6). No calcareous fens or wetlands enrolled in the NRCS Wetland Reserve Program have been identified along RA-03AM. Two Minnesota BWSR Mitigation Banking Program wetlands occur within 0.5 mile of RA-03AM. One of these (Number 3720) occurs within the construction work area and permanent right-of-way for the route (Figure 6.3.1.3-2; Table 6.3.1.3-7).



Sources: Minnesota DNR 2014, 2008.

Figure 6.3.1.3-1. Public Waters Wetlands and Calcareous Fens Crossed by the Applicant's Preferred Route

Table 6.3.1.3-5. Estimated Acreages of Wetlands Crossed by Route Alternative RA-03AM (Clearbrook to Carlton) (acres)

Wetland Classification	Construction[a]	Operations[b]
Forested wetland	116.2	48.2
Scrub/shrub wetland	205.6	83.9
Emergent wetland	233.9	96.6
TOTAL	**555.7**	**228.7**

Source: USFWS 2016.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Table 6.3.1.3-6. Estimated Acreages of Public Waters Wetlands Crossed by RA-03AM (Clearbrook to Carlton) (acres)

Wetland Type	Construction[a]	Operations[b]
Type 3 – Inland shallow fresh marshes	7.6	3.2
TOTAL	**7.6**	**3.2**

Source: Minnesota DNR 2014.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

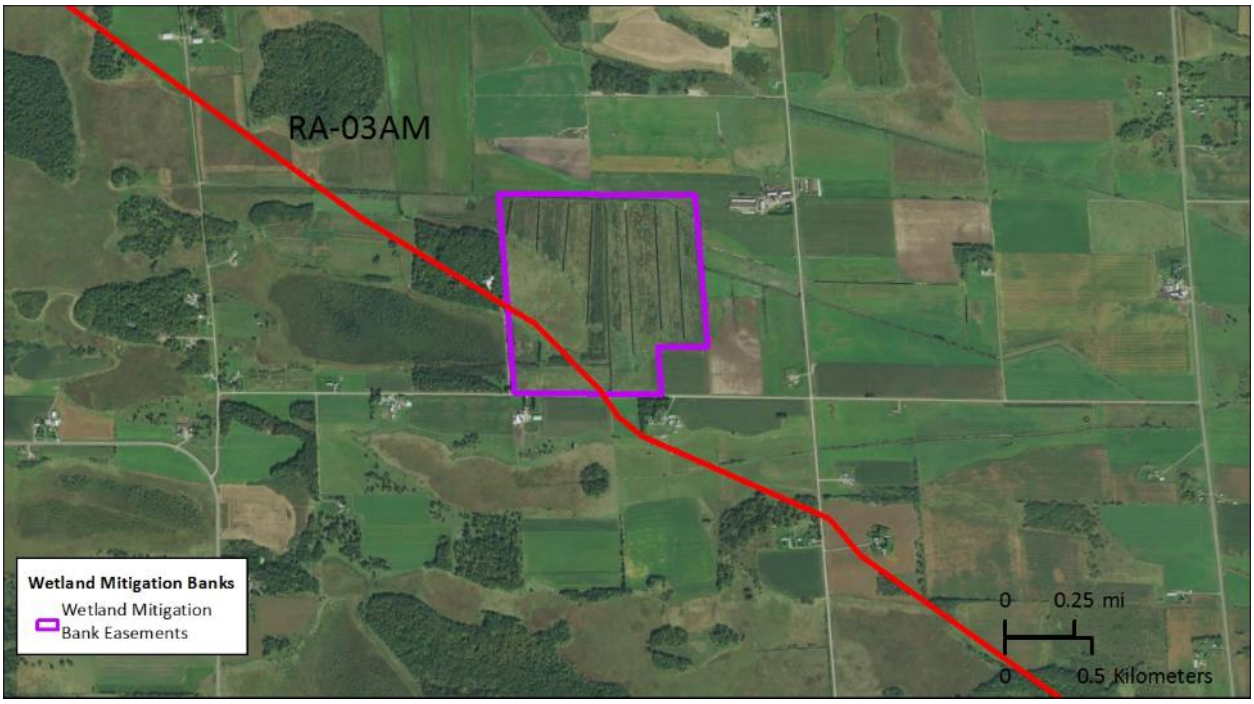
Table 6.3.1.3-7. Estimated Acreages of Wetland Mitigation Bank Easements Crossed by Route Alternative RA-03AM (Clearbrook to Carlton) (acres)

Wetland Mitigation Bank	Construction[a]	Operations[b]	Within 0.5 Mile
3720	4.7	1.9	145.1
4558	0.0	0.0	68.4
TOTAL	**4.7**	**1.9**	**213.6**

Source: Minnesota BWSR 2015.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.



Source: Minnesota BWSR 2015.

Figure 6.3.1.3-2. Wetland Mitigation Bank Crossed by Route Alternative RA-03AM

Route Alternative RA-06

Wetlands within the construction impact area of RA-06 are predominantly forested wetlands (Table 6.3.1.3-8). Types 3 and 4 Public Waters Wetlands would be crossed by the route during construction and occur within the permanent right-of-way (Table 6.3.1.3-9). No calcareous fens, wetlands enrolled in the NRCS Wetland Reserve Program, or Minnesota BWSR Mitigation Banking Program wetlands would occur within the construction work area or within 0.5 mile of RA-06.

Table 6.3.1.3-8. Estimated Acreages of Wetlands Crossed by Route Alternative RA-06 (Clearbrook to Carlton) (acres)

Wetland Classification	Construction[a]	Operations[b]
Forested wetland	541.1	227.9
Scrub/shrub wetland	252.5	104.2
Emergent wetland	126.4	52.7
TOTAL	**920.1**	**384.8**

Source: USFWS 2016.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Table 6.3.1.3-9. Estimated Acreages of Public Waters Wetlands Crossed by Route Alternative RA-06 (Clearbrook to Carlton) (acres)

Wetland Type	Construction[a]	Operations[b]
Type 3 – Inland shallow fresh marshes	1.1	0.4
Type 4 – Inland deep fresh marshes	2.1	0.8
TOTAL	**3.2**	**1.3**

Source: Minnesota DNR 2014.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Route Alternative RA-07

Wetlands within the construction impact area of RA-07 are predominantly forested wetlands (Table 6.3.1.3-10). No Public Waters Wetlands, calcareous fens, or wetlands enrolled in the NRCS Wetland Reserve would be crossed by the construction work area. Two Minnesota BWSR Mitigation Banking Program wetlands occur near RA-07, and one easement (Number 3734) occurs within the construction work area (Figure 6.3.1.3-3; Table 6.3.1.3-11).

Table 6.3.1.3-10. Estimated Acreages of Wetlands Crossed by Route Alternative RA-07 (Clearbrook to Carlton) (acres)

Wetland Classification	Construction[a]	Operations[b]
Forested wetland	594.9	124.1
Scrub/shrub wetland	445.7	119.5
Emergent wetland	154.0	37.4
TOTAL	**1,194.7**	**281.1**

Source: USFWS 2016.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

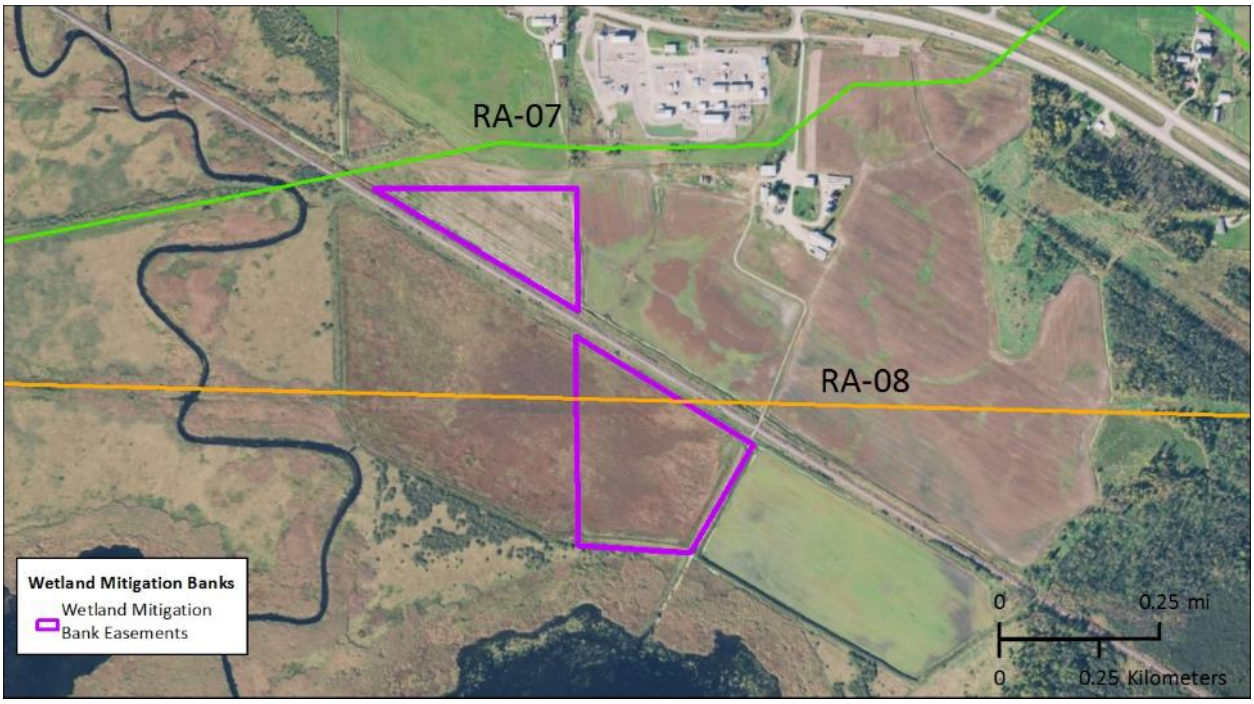
Table 6.3.1.3-11. Estimated Acreages of Wetland Mitigation Bank Easements near Route Alternative RA-07 (Clearbrook to Carlton) (acres)

Wetland Mitigation Banks	Construction[a]	Operations[b]	Within 0.5 miles
3734	0.3	0.0	26.8
5617	0.0	0.0	62.1
TOTAL	**0.3**	**0.0**	**88.9**

Source: Minnesota BWSR 2015.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.



Source: Minnesota BWSR 2015.

Figure 6.3.1.3-3. Wetland Mitigation Bank Crossed by Route Alternatives RA-07 and RA-08

Route Alternative RA-08

Wetlands within the construction work area of RA-08 are predominantly forested and scrub/shrub wetlands (Table 6.3.1.3-12). Types 3 and 5 Public Waters Wetlands would be crossed by the construction work area and would be maintained as part of the permanent right-of-way (Table 6.3.1.3-13). No calcareous fens or wetlands enrolled in the NRCS Wetland Reserve Program have been identified along RA-08 (Minnesota DNR 2008; USGS 2016). Two Minnesota BWSR Mitigation Banking Program wetlands occur near RA-08, and one wetland mitigation bank easement (Number 3734) occurs within the construction work area and permanent right-of-way (Figure 6.3.1.3-3; Table 6.3.1.3-14).

Table 6.3.1.3-12. Estimated Acreages of Wetlands Crossed by Route Alternative RA-08 (Clearbrook to Carlton) (acres)

Wetland Classification	Construction[a]	Operations[b]
Forested wetland	365.4	151.3
Scrub/shrub wetland	273.6	113.9
Emergent wetland	162.9	69.8
TOTAL	**802.0**	**335.0**

Source: USFWS 2016.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route

Table 6.3.1.3-13. Estimated Acreages of Public Waters Wetlands Crossed by Route Alternative RA-08 (Clearbrook to Carlton) (acres)

Wetland Type	Construction[a]	Operations[b]
Type 3 – Inland shallow fresh marshes	4.7	2.0
Type 5 – Inland open fresh water	0.7	0.3
TOTAL	**5.4**	**2.3**

Source: Minnesota DNR 2014.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Table 6.3.1.3-14. Estimated Acreages of Wetland Mitigation Bank Easements near Route Alternative RA-08 (Clearbrook to Carlton) (acres)

Wetland Mitigation Banks	Construction[a]	Operations[b]	Within 0.5 miles
3734	1.6	0.7	26.8
5617	0.0	0.0	91
TOTAL	**1.6**	**0.7**	**118.6**

Source: Minnesota BWSR 2015.

[a] Construction = estimated construction impact area in acres based on 120-foot-wide construction work area centered on the pipeline route, including the 50-foot-wide permanent right-of-way.

[b] Operations = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

6.3.1.3.3 Impact Assessment

This section addresses the potential impacts on wetlands during construction and operation of the Applicant's preferred route and the route alternatives. Wetland impacts specific to the Applicant's preferred route in Minnesota and the route alternatives between Clearbrook and Carlton are described below.

Generally, pipeline construction through wetlands can result in changes to vegetation, soils, hydrology, and wildlife habitats, including:

- Changes in wetland vegetation community composition, structure, and productivity due to modification of surface and subsurface flow patterns as a result of ground clearing and pipeline construction;
- Loss of sensitive plant species as a result of construction clearing and grading;
- Wetland soil disturbance as a result of mixing of topsoil and subsoil during trenching and backfilling;
- Changes to water-retaining substrates, thereby causing permanent alterations to their water-holding capacity;

- Alteration of surface and subsurface hydrology that is important for maintaining wetland communities and microhabitats as a result of trenching and backfilling during pipeline construction;
- Sedimentation of wetlands and fluctuations in wetland hydrology as a result of trenching, dewatering, and stockpiling activities;
- Reduction in wildlife habitat and forage productivity, and increased risk of soil erosion and weed invasion due to removal of vegetation;
- Potential spread of invasive species and noxious weed populations along the pipeline construction impact area; and
- Contamination from equipment drips or spills during refueling operations.

Generally, pipeline operations can affect wetlands by:

- Disturbance to reclaimed wetlands within the permanent right-of-way as a result of excavation to repair or replace sections of pipe as a part of the Applicant's Integrity Management Program, and as a result of right-of-way vegetation maintenance activities;
- Permanent modification of forested or scrub/shrub wetland plant community composition and structure in the permanent right-of-way as a result of vegetation management activities; and
- Establishment and spread of noxious weeds and invasive plants within the permanent right-of-way and at aboveground facilities due to ground disturbance as part of the Applicant's Integrity Management Program, and as a result of right-of-way vegetation maintenance activities.

All wetland changes would need to be approved by the authorizing agencies and are identified by milepost. In areas where permanent aboveground facilities are not proposed, construction of the pipeline through wetlands would result primarily in temporary to short-term and minor impacts on wetlands and their functions during and immediately following construction activities, until the site is reclaimed and vegetation cover is reestablished. Post-construction wetland reclamation and monitoring would be required for a period of time until reclamation standards and permit conditions are met, or otherwise could be offset through compensatory mitigation in an onsite or offsite location.

Construction impacts on wetlands would be minimized by construction methods, including reducing the width of the construction work area, cutting wetland vegetation at the soil surface to retain roots, using low ground-pressure equipment and timber mats to minimize compaction and rutting, segregating topsoil, and not mounding topsoil, as described below. The Applicant has committed to implementing the following BMPs during construction to minimize direct and indirect wetland impacts:

- Developing and adhering to the Project-specific Construction Methods and Procedures for Wetland and Waterbody Crossings and site-specific crossing plans (Enbridge 2016);
- Using wetland crossings designed and approved by engineers, reviewed onsite by the Project engineer, and approved by agencies for each crossing;
- Committing to selection of the most appropriate wetland and waterbody crossing techniques in consultation with appropriate agencies to determine site-specific approaches, including

open-cut (wet trench, push-pull with excavator, push-pull with swamphoe); dry crossing methods (dry trench, dam-and-pump, or flume); trench breakers; trenchless (auger bore HDD); and those described in the Enbridge November 2016 EAW (Enbridge 2016);

- Implementing mitigation measures to protect adjacent waterbodies during construction including, but not limited to, use of a vegetated buffer, slope breakers, sediment barriers (i.e., silt fencing and sediment curtains), filtration devices during dewatering, or trench breakers;
- Conducting wetland shoreline stabilization measures, including the erosion controls identified above and erosion control blankets, mulching, seeding (with Minnesota BWSR seed mixes or other agency-approved seed mix), cat tracking, placing temporary slope breakers, and placing riprap where necessary;
- Developing and adhering to the wetland-specific avoidance measures in the Applicant's Environmental Protection Plan (Appendix E);
- Reducing temporary construction work area beyond the 50-foot-wide permanent right-of-way in wetlands areas from 70 feet to 45 feet, except in areas where trench wall failure or other construction constraints have been identified as a concern;
- Restoring wetland vegetation cover types following construction, as outlined in the Environmental Protection Plan;
- Co-locating the Project with existing rights-of-way unless co-location would result in a greater impact on wetlands or other sensitive resources;
- Minimizing impacts on sensitive wetland soils during wet conditions by use of timber mats, low-ground-weight equipment, and other methods identified in the Environmental Protection Plan;
- Designing and planning Project pipeline routes and infrastructure to reduce environmental impacts on sensitive wetland resources;
- Developing measures to describe inadvertent drilling fluid release response measures in wetlands and adjacent wetlands;
- Placing petroleum products storage, refueling, maintenance, and lubricating operations a minimum of 100 feet from wetlands;
- Placing concrete wash water, grindings, and slurry away from wetlands with no allowable discharge of these waste products into wetlands or waterbodies;
- During trench dewatering, pumping discharge water at controlled discharge rates into a filtration device located in a well-vegetated area and in a manner to prevent the migration of silt-laden water into wetlands;
- Posting signage during construction noting sensitive environmental features and wetlands;
- Cutting off wetland vegetation at ground level and removing it from wetland areas;
- Stripping the top 1 foot of topsoil or the amount of topsoil present, whichever is less, over the trench line, segregating it, and replacing it in unsaturated wetlands;
- Not applying fertilizer, lime, or mulch in wetlands;
- Complying with USACE and state wetland permits, including compliance with permit conditions and long-term monitoring plans;

- Restoring wetlands to preconstruction contours;
- Maintaining wetland hydrology by using trench breakers in any area where the potential to drain, or partially drain, a wetland exists; sufficiently compacting the pipeline trench; and placing the pipeline on native material as opposed to gravel; and
- Using construction mats, as needed, to facilitate equipment access and pipeline installation and to minimize soil compaction and/or mixing.

Wetland impacts and associated water quality certifications would be permitted or approved by the authorizing agencies and would be identified by milepost. In areas where permanent aboveground facilities are not proposed, wetland impacts resulting from construction would be temporary and minor for emergent wetlands and long-term or permanent for scrub/shrub and forested wetlands. Post-construction wetland reclamation and monitoring would be required for a period of time until reclamation standards and permit conditions are met, or otherwise mitigated entirely through compensatory mitigation in an onsite or offsite location.

The assessments presented below are discussed within the following categories:

- General wetland impacts,
- Impacts on Minnesota Public Waters Wetlands,
- Impacts on Minnesota calcareous fen wetlands, and
- Impacts on federal and state Wetland Reserves and Minnesota BWSR Mitigation Bank easements.

Applicant's Preferred Route (in Minnesota)

Construction Impacts

General Wetlands

Pipeline construction through wetlands would result in impacts on wetland vegetation, soils, hydrology, and wildlife habitats. Construction activities may result in reduction of a wetland's ability to trap and slowly release surface water, rain, snowmelt, groundwater, and flood waters. Wetland soils would be disturbed by trenching and backfilling during pipeline construction. Impacts on wetlands outside the construction work area are not expected because sediment containment barriers would be used until construction is complete and vegetation cover has reestablished. Over time, provided that original contours are restored and hydrology is maintained, most affected wetland vegetation would regenerate and wetland function would return. In general, wetland construction impacts that do not result from placement of fill in wetlands would be returned to preconstruction contours and wetland conditions.

The Applicant's preferred route within Minnesota would affect approximately 499 acres of wetlands during pipeline construction (Table 6.3.1.3-1). Up to 356 acres of scrub/shrub and forested wetlands would be cleared during construction, after which woody vegetation would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Woody vegetation and all other wetland vegetation would be permanently removed from the areas where aboveground facilities (pump stations and MLVs) and access roads would be constructed.

Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation, resulting in long-term major impacts on both vegetation structure and wetland functions. Wetland habitats containing large mature woody growth would reestablish in temporary construction work areas within 3 to 50 years, depending on the vegetation community and vegetation structure (Jacobson 2006; Wenzel et al. 2012). Long-term to permanent major impacts on forested wetlands in the construction work area may require compensatory mitigation as these wetland types would be converted to other wetland types on a long-term or permanent basis. Forested wetlands may require from 35 to 50 years to achieve vegetation and wildlife habitat similar to mature forested wetlands (Wenzel et al. 2012).

Construction of the Applicant's preferred route would affect up to 144 acres of emergent wetlands. Emergent wetland vegetation would reestablish within 3 years as a community functionally similar to that of the wetland prior to construction (Jacobson 2006; Wenzel et al. 2012), provided that recommended wetland reclamation and revegetation efforts are implemented, disturbance to vegetation is minimized, and preconstruction wetland contours and wetland hydrology are maintained. In areas where the disturbance to vegetation is minimal and the root structures, preconstruction wetland contours, and wetland hydrology are maintained, the impacts would be short-term and minor. In areas where trenching occurs directly through a wetland, the impacts would be short-term to long-term and minor to major. Where emergent wetlands are cleared for construction of aboveground facilities and access roads (about 19 acres), impacts on these wetlands would be permanent and minor to major; however, these impacts could be offset by compensatory wetland mitigation.

Approximately 19 acres of wetlands could be affected by use as ATWS and pipe storage yards required for pipeline construction, resulting in short-term to long-term minor impacts, as these areas would be restored to wetlands after construction.

Crossings by HDD for selected waterbodies and associated wetlands generally would avoid direct impacts on wetland resources. Each crossing selected for HDD would be identified, and permitting would be carried out (including identification of BMPs) at each location. Fluid (water, bentonite clay, and possible additives) is used during drilling to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or "frac-out" of this drilling fluid when pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground. If a frac-out occurred within a wetland, the vegetation and soil would be compromised. During drilling, construction personnel would monitor the crossing to detect releases of drilling mud and would implement containment, response, and clean-up procedures as outlined in the Applicant's Environmental Protection Plan (Appendix E) to limit the potential for drilling mud to reach surface water. If a frac-out occurred and went undetected or was not quickly contained, impacts on wetlands could be long-term and major. However, with implementation of the Applicant-proposed measures to respond to a drilling mud release during HDD construction, the impact of a release could be short-term and minor. Successful construction of wetland crossings using HDD (i.e., the crossing is completed without a frac-out) would not affect wetlands.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. The Applicant's preferred route would affect 3 acres of Public Waters Wetlands during construction (Table 6.3.1.3-3; Figure 6.3.1.3-1). Impacts on Minnesota Public Waters Wetlands during construction would result from alteration of wetland vegetation, soils, and hydrology; however, these areas would be restored as wetlands after construction.

Minnesota DNR would be consulted regarding Public Waters Wetland crossings as part of the License to Cross Public Waters permitting process that would occur prior to construction. All impacts, BMPs, and proposed avoidance related to Public Waters Wetlands would be subject to conditions contained in a License to Cross Public Waters. Any dewatering of the trench that would be required for construction across Public Waters Wetlands would require a water appropriation permit. Implementation of the measures identified in the license would limit potential impacts on Public Waters Wetlands.

As part of permit requirements, the Applicant would identify and prepare site-specific crossing plans, avoid and minimize impacts on Public Waters Wetlands to the extent possible, and restore affected Public Waters Wetlands onsite. Restoration to the existing level of wetland function would likely take several years. As a result, the impacts on Public Waters Wetlands due to construction of the Applicant's preferred route would be short-term and minor.

Impacts on Minnesota Calcareous Fen Wetlands. Gully 30 could be affected by construction of the Applicant's preferred route (Table 6.3.1.3-4; Figure 6.3.1.3-1). All other calcareous fens within 0.5 mile of the Applicant's preferred route (Chester 24 and Viking 18) would be unaffected by construction, as the route would avoid crossing these fens. Potential impacts on Gully 30 include alteration of hydrology, introduction of contaminants, loss of rare or unique plant species, introduction of invasive species, and altered peat formation—all of which could be detrimental to the formation and proper function of a calcareous fen.

The results of calcareous fen surveys completed in 2010 during development of the Alberta Clipper pipeline identified the presence of a single calcareous fen (Gully 30), located 63 feet away from the centerline. As part of the environmental review for the Alberta Clipper project, a Gully 30 Fen Management Plan was developed in coordination with Minnesota DNR. As proposed, portions of the Applicant's preferred route are co-located with the Alberta Clipper pipeline, including the area where this fen occurs. If it is determined that impacts on this fen could not be practicably avoided by Project construction, construction would be subject to a Fen Management Plan approved by the Commissioner of Natural Resources of Minnesota DNR.

Prior to construction, the Minnesota DNR would be consulted to aid in the identification of potential impacts on and major mitigation measures for calcareous fens. Where calcareous fens are identified, Minnesota DNR would request preparation of a Fen Management Plan, which would identify impacts and BMPs specific to the affected fen. These BMPs would include the general BMPs identified to avoid major impacts on wetlands discussed above. Overall, it is expected that the Applicant's preferred route would result in a short-term to long-term minor impact on one calcareous fen wetland.

Impacts on Wetland Reserves. No NRCS Wetland Reserves (i.e., wetlands under a Wetland Reserve Program) or Minnesota BWSR mitigation bank easements occur within the construction work area of the Applicant's preferred route; therefore, no impacts on these wetland resources would occur (USGS 2016; Minnesota BWSR 2015). A state wetland reserve is located between the North Dakota border and Clearbrook, Minnesota. Impacts on this reserve are not expected as the reserve are not crossed by the Applicant's preferred route.

Operations Impacts

General Wetlands

Operation of the Applicant's preferred route would affect 261 acres of wetlands within the permanent right-of-way and associated facilities. About 19 acres of wetlands would be permanently converted to developed land for aboveground facilities (pump stations and MLVs) and access roads. The impacts on these wetlands would be permanent and minor to major; however, the impacts could be offset by compensatory wetland mitigation.

Impacts on wetlands could result from maintenance activities, including vegetation management and pipeline inspections that would occur for the life of the Project. Because trees and shrubs would not be allowed to reestablish within the permanent right-of-way, vegetation management in forested and scrub/shrub wetlands would represent a permanent major impact on emergent or early-stage scrub/shrub wetlands.

A total of 182 acres of forested and scrub/shrub wetlands converted during construction would be maintained as emergent wetlands within the pipeline permanent right-of-way for the life of the Project. Woody vegetation within the permanent right-of-way would be managed (cut every 3 to 5 years) to prevent large shrubs and trees from reestablishing over the pipeline to allow for visual inspection of the right-of-way. This loss of woody vegetation would result in permanent and major impacts on wetland structure and functions that may require compensatory mitigation.

A total of 79 acres of emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise maintained and would not be affected by mowing or maintenance activities. Routine vegetation management would use a rubber-tracked skid-steer vehicle, or similar, with specialized cutting equipment to minimize impacts on wetlands resulting in short-term minor impacts on emergent wetlands.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. If excavation is required within a wetland, impacts would likely be short-term and minor but could occur periodically over the life of the Project.

Operation of the Applicant's preferred route may increase the potential for the introduction and spread of noxious weeds and invasive plants for the life of the Project and beyond. The Environmental Protection Plan (Appendix E) and wetland permitting documents would describe measures to prevent the spread of noxious and invasive weeds in wetlands during wetland reclamation/revegetation and during pipeline monitoring and maintenance activities. The presence of noxious weeds and potential for spread of infestations within the Project area are addressed in Section 6.3.3.2.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

Specially Designated Wetlands

Impacts on Minnesota Public Waters Wetlands. Approximately 2 acres of Public Waters Wetlands occur within the permanent right-of-way for the Applicant's preferred route. Although operations impacts could result from vegetation management, it is unlikely that the shallow and deep fresh marshes crossed would require vegetation management because the shrubs are unlikely to grow as long as the marsh hydrology is maintained. The Public Waters Wetlands within the permanent right-of-way are

located between Clearbrook and Carlton in Minnesota. Any potential impacts would be expected to be short-term and minor, but would occur periodically over the life of the Project. In addition, pipeline maintenance activities could spread noxious weeds and invasive plants. The potential impact is expected to be short-term and minor after each maintenance activity, but would occur periodically over the life of the Project.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on Public Wetland Waters would be limited to the pipeline segment through the 2 acres of these wetlands and repeated repairs or replacement at those locations are unlikely. Impacts on the Public Waters Wetlands from integrity digs likely would be short-term and minor to major.

Impacts on Minnesota Calcareous Fen Wetlands. The Applicant's preferred route would cross the Gully 30 calcareous fen and has been routed to avoid the Chester 24 and Viking 18 calcareous fens that are crossed by the existing Line 3. All activities occurring near calcareous fens would be subject to BMPs identified in a Fen Management Plan, if one needed to be developed for the Project. Impacts on calcareous fens as a result of vegetation management activities during normal operation of the Project are not expected but would be short- to long-term and minor if they did occur, and could occur periodically over the life of the Project.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on calcareous fens would be limited to the pipeline segment through the Gully 30 fen, and repeated repairs or replacement at this location are unlikely. If excavation and repair at this locations were necessary, impacts would be similar to those for construction of the pipeline through the fen; the impact would be short- to long-term and minor but could occur periodically over the life of the Project.

Impacts on Wetland Reserves. Impacts on wetland reserves would not occur during operation of the pipeline because no wetland reserves or Minnesota BWSR mitigation bank easements are located within the permanent right-of-way.

Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

General Wetlands. Construction of RA-03AM would affect approximately 556 acres of wetlands in Minnesota (Table 6.3.1.3-5). About 116 acres of forested wetlands and 206 acres of scrub/shrub wetlands would be cleared during construction along the entire route (Table 6.3.1.3-5). After construction, woody vegetation would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation, resulting in long-term to permanent major impacts on both vegetation structure and wetland functions. Impacts on forested wetlands in the construction work area may require compensatory mitigation to offset long-term to permanent impacts.

About 234 acres of emergent wetlands would be affected by construction (Table 6.3.1.3-5). Disturbance to these wetlands would be minimized through implementation of BMPs and would be reclaimed after construction, but emergent vegetation communities would require several years to become fully

reestablished. As a result, the impact of construction on emergent wetlands would be short-term and minor at each wetland.

Footprints are not available for aboveground facilities for RA-03AM at this time. If facilities are sited on wetlands, impacts during construction would be permanent and major because the wetlands would be converted to developed land. Impacts on wetlands from facilities would be avoided and minimized, and unavoidable impacts could be offset with compensatory mitigation similar to the Applicant's preferred route.

Specially Designated Wetlands. Construction of RA-03AM would result in short-term minor impacts on approximately 8 acres of Public Waters Wetlands in Minnesota. The affected Public Waters Wetlands would be reclaimed as wetlands following construction. Impacts on Public Waters Wetlands would be subject to state-specific permitting requirements, and implementation of BMPs would be required for Project approval.

No impacts on calcareous fens would be associated with the RA-03AM route, as none were identified during the calcareous fen data review within the construction work area or permanent right-of-way for the route.

No impacts on wetland reserves would be associated with the RA-03AM route, as no Wetland Reserve Program wetlands were identified near the route. Two Minnesota BWSR wetland mitigation bank easements are within 0.5 mile of RA-03AM, one of which (Number 3720) would be affected by construction and operation of RA-03AM. The affected wetland mitigation bank easement in construction work areas would be reclaimed, resulting in approximately 5 acres of short-term minor impacts.

Operations Impacts

General Wetlands. General wetland impacts associated with operation of a pipeline along RA-03AM would be similar to those described for the Applicant's preferred route. Operation of RA-03AM could affect approximately 229 acres of wetlands within the permanent right-of-way (Table 6.3.1.3-5). Impacts could result from maintenance activities, including vegetation management that would occur for the life of the Project. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way to allow for visual inspection of the right-of-way. About 48 acres of previously forested wetlands and 84 acres of scrub/shrub wetland would be maintained as emergent wetlands for the life of the Project (Table 6.3.1.3-5). This loss of forested and scrub/shrub wetland communities would result in permanent and major impacts on wetland structure and functions that could require compensatory mitigation to offset permanent impacts.

Emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise managed and would not be affected by these activities. If emergent vegetation is affected by vegetation management activities, the impact is expected to be short-term and minor.

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. If excavation is required within a wetland, impacts likely would be short-term and minor, but could occur periodically over the life of the Project.

Operation of RA-03AM may increase the potential for introduction and spread of noxious weeds and invasive plants for the life of the Project. The Applicant would implement the procedures in the

Environmental Protection Plan (Appendix E), and wetland permitting documents would describe measures to prevent the spread of noxious and invasive weeds in wetlands. With implementation of those procedures, the potential impact of introduction and spread of noxious weeds and invasive plants would be short-term and minor.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on emergent wetlands as a result of these activities would likely be short-term and minor, but would occur periodically over the life of the Project.

Facility locations are unknown for the route alternatives. If wetlands are covered by aboveground facilities, they would be permanently converted to developed land. Any potentially unavoidable impacts would be permanent and major; however, the impacts could be offset by compensatory wetland mitigation.

Specially Designated Wetlands. Short-term minor impacts on Public Waters Wetlands within the permanent right-of-way would affect approximately 3 acres along the RA-03AM route (Table 6.3.1.3-6). These Public Waters Wetlands would be reclaimed and would remain as wetlands for the life of the Project but would be subject to ground disturbance and restoration efforts during maintenance activities requiring pipeline inspection.

No calcareous fens would be affected during operation of RA-03AM, as they do not occur within the permanent right-of-way for the route.

No impacts on wetland reserves would occur for the RA-03AM route, as no Wetland Reserve Program wetlands were identified near the route. A total of 2 acres of Minnesota BWSR wetland mitigation bank easements occur within the permanent right-of-way for RA-03AM; the resultant impact would be permanent and minor, as the wetlands would be reclaimed. All wetlands within the permanent right-of-way would become ineligible as conservation easements, as the wetlands would no longer be protected from future disturbance because of required routine vegetation management and integrity management activities. However, in-kind compensatory mitigation could be used to offset wetland losses.

Route Alternative RA-06

Construction Impacts

General Wetlands. Construction of RA-06 would affect approximately 920 acres of wetlands between Clearbrook and Carlton (Table 6.3.1.3-8). About 541 acres of forested wetlands and 253 acres of scrub/shrub wetlands would be cleared during construction along the Clearbrook-to-Carlton segment (Table 6.3.1.3-9). After construction, trees and shrubs would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation, resulting in long-term to permanent major impacts on both vegetation structure and wetland functions. Impacts on forested wetlands in the construction work area may require compensatory mitigation to offset long-term to permanent impacts. Wetlands affected by construction of RA-06 would be within a new pipeline corridor, and many of these wetlands would have experienced limited to no prior ground disturbance.

About 126 acres of emergent wetlands would be affected by construction of RA-06 (Table 6.3.1.3-8). Wetlands would be reclaimed after construction but would require several years for the emergent

vegetation community to become fully reestablished. The impact on emergent wetlands from construction would be short-term and minor at each affected wetland.

Footprints are not available for aboveground facilities for route alternative RA-06. If facilities are sited on wetlands, impacts from construction would be permanent and major because the wetlands would be converted to developed land. However, impacts on wetlands from facilities would be avoided and minimized, and unavoidable impacts could be offset with compensatory mitigation similar to the Applicant's preferred route.

Specially Designated Wetlands. Construction of RA-06 would result in short-term minor impacts on approximately 3 acres of Public Waters Wetlands in Minnesota (Table 6.3.1.3-9). The affected Public Waters Wetlands would be reclaimed as wetlands following construction, resulting in short-term minor impacts. Impacts on Public Waters Wetlands would be subject to state-specific permitting requirements, and implementation of BMPs would be required for Project approval.

No impacts on calcareous fens would be associated with RA-06 as none were identified during the calcareous fen data review within the construction work area or permanent right-of-way for the route.

No impacts on wetland reserves would be associated with RA-06, as no Wetland Reserve Program wetlands were identified near the route. No Minnesota BWSR wetland mitigation bank easements occur within 0.5 mile of RA-06; therefore, construction of RA-06 would not affect wetland mitigation bank easements.

Operations Impacts

General Wetlands. Operation of RA-06 could affect approximately 385 acres of wetlands within the permanent right-of-way (Table 6.3.1.3-8). The impacts could result from maintenance activities, including vegetation management that would occur within the permanent right-of-way for the life of the Project. Trees and shrubs would not be allowed to reestablish within the maintained right-of-way to allow for visual inspection of the right-of-way. Vegetation management would maintain previously forested and scrub/shrub wetlands as emergent or early-stage scrub/shrub wetlands. About 228 acres of forested wetlands and 104 acres of scrub/shrub wetlands would be maintained as emergent wetlands for the life of the Project (Table 6.3.1.3-8). This loss of forested wetland vegetation would result in permanent and major impacts on wetland structure and functions that could require compensatory mitigation to offset permanent major impacts.

A total of 53 acres of emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise maintained and would not be affected by mowing or maintenance activities. If emergent vegetation is affected by vegetation management activities, the impact is expected to be short-term and minor.

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. If excavation is required within a wetland, impacts likely would be short-term and minor, but could occur periodically over the life of the Project.

Operation of RA-06 may increase the potential for the introduction and spread of noxious weeds and invasive plants for the life of the Project. The Applicant would implement the procedures in the Environmental Protection Plan (Appendix E), and wetland permitting documents would describe

measures to prevent the spread of noxious and invasive weeds in wetlands. With implementation of those procedures, the potential impact of introduction and spread of noxious weeds and invasive plants would be short-term and minor.

Facility locations for RA-06 are unknown. If wetlands are covered by aboveground facilities they would be permanently converted to developed land. Any potentially unavoidable impacts would be permanent and major; however, the impacts could be offset by compensatory wetland mitigation.

Specially Designated Wetlands. Short-term minor impacts on Public Waters Wetlands within the permanent right-of-way would affect approximately 1 acre along the RA-06 route (Table 6.3.1.3-9). Although these Public Waters Wetlands would be reclaimed and would remain as wetlands for the life of the Project, they could be subject to ground disturbance and restoration efforts as a result of maintenance activities requiring pipeline inspection.

No calcareous fens would be affected during operation, as they do not occur within the permanent right-of-way for RA-06.

No wetland reserves or wetland mitigation bank easements would be affected by operation of RA-06.

Route Alternative RA-07

Construction Impacts

General Wetlands. Construction of RA-07 would affect approximately 1,195 acres of wetlands between Clearbrook and Carlton (Table 6.3.1.3-10). About 595 acres of forested wetlands and 446 acres of scrub/shrub wetlands would be cleared during construction along the entire route (Table 6.3.1.3-10). After construction, trees and shrubs would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation, resulting in long-term to permanent major impacts on both vegetation structure and wetland functions. Impacts on forested wetlands in the construction work area may require compensatory mitigation for loss of forested wetlands. Most of the wetlands that would be affected by removal of the existing Line 3 and replacement with new pipeline were disturbed during the original construction of the Line 3 pipeline, and were disturbed again during construction of additional pipelines through the Mainline corridor.

A total of 154 acres of emergent wetlands would be affected by construction of RA-07 (Table 6.3.1.3-10). Wetlands would be reclaimed after construction but would require several years to become fully reestablished. As a result, the impact of construction on emergent wetlands would be short-term and minor at each wetland. Many of these emergent wetlands were disturbed during the original construction of the Line 3 pipeline and were disturbed again during construction of additional pipelines through the Mainline corridor.

Footprints are not available for aboveground facilities for route alternative RA-07. If facilities are sited on wetlands, impacts from construction would be permanent and major because the wetlands would be converted to developed land. However, impacts on wetlands from facilities would be avoided and minimized, and unavoidable impacts could be offset with compensatory mitigation similar to the Applicant's preferred route.

Specially Designated Wetlands. Construction of RA-07 would not affect Public Waters Wetlands in Minnesota, as none occur within the construction work area.

No impacts on calcareous fens would be associated with the RA-07 route, as none were identified during the calcareous fen data review within the construction work area or permanent right-of-way for the route.

No impacts on federal or state wetland reserves would occur, as no Wetland Reserve Program wetlands were identified near RA-07. Two Minnesota BWSR wetland mitigation bank easements occur within 0.5 mile of RA-07, one of which (Number 3734) would be crossed by the construction expanded construction work area for RA-07. If it is not possible to avoid this easement, construction would result in short-term and minor impacts; however, the wetlands may become ineligible for the mitigation banking program.

Operations Impacts

General Wetlands. Operation of RA-07 would affect 281 acres of wetlands within the permanent right-of-way. The impacts would result from ongoing maintenance activities, including vegetation management that would occur for the life of the Project. Because trees and shrubs would not be allowed to reestablish within the maintained pipeline right-of-way, vegetation management would represent a long-term to permanent major impact because 124 acres of forested and 120 acres scrub/shrub wetlands would be maintained as emergent or early-stage scrub/shrub wetlands. This right-of-way is currently maintained through vegetation management; consequently, there would be no additional impacts.

A total of 37 acres of emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise maintained and would not be affected by these activities. If emergent vegetation is affected by vegetation management, the impact could be short-term and minor. There would be no additional impacts, however, as this right-of-way is currently managed for the existing Line 3 and adjacent pipelines.

About 124 acres of forested wetlands in the permanent right-of-way for RA-07 would be maintained as emergent wetlands for the life of the Project (Table 6.3.1.3-10). This loss of forested wetland vegetation could result in permanent and major impacts on wetland structure and functions that could require compensatory mitigation to offset long-term to permanent major impacts. As these impacts would be within the current Line 3 permanent right-of-way, these impacts may have been avoided previously through HDD or may already have received compensation.

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. Impacts on wetlands as a result of these activities would likely be short-term and minor but would occur periodically over the life of the Project, as is currently the case for Line 3.

Operation of RA-07 may increase the potential for introduction and spread of noxious weeds and invasive plants for the life of the Project. The Applicant would implement the procedures in the Environmental Protection Plan (Appendix E), and wetland permitting documents would describe measures to prevent the spread of noxious and invasive weeds in wetlands. With implementation of those procedures, the potential impact of introduction and spread of noxious weeds and invasive plants would be short-term and minor.

Facility locations are unknown. If wetlands were covered by aboveground facilities they would be permanently converted to developed land. Any potentially unavoidable impacts would be permanent and major; however, the impacts could be offset by compensatory wetland mitigation.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

Specially Designated Wetlands. No Public Waters Wetlands would be affected by operation of RA-07.

No calcareous fens would be affected during operation of RA-07, as none occur within the permanent right-of-way for the route.

No impacts on federal or state wetland reserves would be associated with RA-07, as no Wetland Reserve Program wetlands were identified near the route. No wetland mitigation bank easements would be affected by operation of RA-07.

Route Alternative RA-08

Construction Impacts

General Wetlands. Construction of RA-08 would affect approximately 802 acres of wetlands in Minnesota (Table 6.3.1.3-12). About 365 acres of forested wetlands and 274 acres of scrub/shrub wetlands would be cleared during construction along the Clearbrook-to-Carlton segment (Table 6.3.1.3-12). After construction, trees and shrubs would be allowed to reestablish within construction work areas outside of the permanent right-of-way. Until woody vegetation is reestablished, scrub/shrub and forested wetlands would be converted to emergent vegetation, resulting in long-term to permanent major impacts on both vegetation structure and wetland functions. Impacts on forested wetlands in the construction work area may require compensatory mitigation to offset long-term to permanent impacts. Many of these wetlands would have been previously disturbed during construction of other pipelines because RA-08 would be constructed within an existing pipeline corridor.

About 163 acres of emergent wetlands would be affected by construction of RA-08 (Table 6.3.1.3-12). Wetlands would be reclaimed after construction, but the emergent wetland community would require several years to become fully reestablished. As a result, the impact of construction on emergent wetlands within most of the construction impact area would be short-term and minor at each affected wetland. Many of these emergent wetlands would have been disturbed previously during construction of other pipelines because RA-08 would be constructed within an existing pipeline corridor.

Footprints are not available for aboveground facilities for route alternative RA-08. If facilities are sited on wetlands, impacts from construction would be permanent and major because the wetlands would be converted to developed land. However, impacts on wetlands from facilities would be avoided and minimized, and unavoidable impacts could be offset with compensatory mitigation similar to the Applicant's preferred route.

Specially Designated Wetlands. Construction of RA-08 would result in short-term minor impacts on approximately 5 acres of Public Waters Wetlands in Minnesota (Table 6.3.1.3-13). The affected Public Waters Wetlands would be reclaimed as wetlands following construction, resulting in short-term minor impacts. Impacts on Public Waters Wetlands would be subject to state-specific permitting requirements, and implementation of BMPs would be required for Project approval.

No impacts on calcareous fens would be associated with the RA-08 route, as none were identified during the calcareous fen data review within the construction work area or permanent right-of-way for the route.

No impacts on wetland reserves would be associated with the RA-08 route, as no Wetland Reserve Program wetlands were identified near the route. Two Minnesota BWSR wetland mitigation bank easements occur within 0.5 mile of RA-08, one of which (Number 3734) would be crossed by the construction work area for the route resulting in approximately 2 acres of impacts. These wetlands would be reclaimed, resulting in short-term and minor impacts; however, the wetlands may become ineligible for the mitigation banking program.

Operations Impacts

General Wetlands. Operation of RA-08 would affect approximately 335 acres of wetlands within the permanent right-of-way (Table 6.3.1.3-12). Wetland impacts would result from pipeline maintenance activities, including vegetation management that would occur for the life of the Project. Trees and shrubs would not be allowed to reestablish within the maintained right-of-way, to allow for visual inspection of the right-of-way. Vegetation management would represent a permanent conversion of previously forested and scrub/shrub wetlands to emergent or early-stage scrub/shrub wetlands. About 151 acres of forested wetlands and 114 acres of scrub/shrub wetlands would be maintained as emergent wetlands for the life of the Project (Table 6.3.1.3-12). This loss of forested and scrub/shrub wetland communities would result in permanent and major impacts on wetland structure and functions that could require compensatory mitigation to offset permanent impacts.

Emergent wetland vegetation in the permanent right-of-way generally would not be mowed or otherwise managed and would not be affected by mowing or management activities. If emergent wetlands are affected by management activities, the impacts on approximately 70 acres of emergent wetlands is expected to be short-term and minor.

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. If excavation is required within a wetland, impacts likely would be short-term and minor, but could occur periodically over the life of the Project.

Operation of RA-08 may increase the potential for the introduction and spread of noxious weeds and invasive plants for the life of the Project. The Applicant would implement the procedures in the Environmental Protection Plan (Appendix E), and wetland permitting documents would describe measures to prevent the spread of noxious and invasive weeds in wetlands. With implementation of those procedures, the potential impact of introduction and spread of noxious weeds and invasive plants would be short-term and minor.

Facility locations are unknown. If wetlands were covered by aboveground facilities, they would be permanently converted to developed land. Any potentially unavoidable impacts would be permanent and major; however, the impacts could be offset by compensatory wetland mitigation.

Potential impacts on wetlands due to an unanticipated crude oil release are discussed in Chapter 10.

Specially Designated Wetlands. Construction of RA-08 would result in short-term minor impacts on approximately 2 acres of Public Waters Wetlands in Minnesota (Table 6.3.1.3-13). The affected Public

Waters Wetlands would be reclaimed as wetlands following construction, resulting in short-term minor impacts. Impacts on Public Waters Wetlands would be subject to state-specific permitting requirements, and implementation of BMPs would be required for Project approval.

No calcareous fens would be affected during operation of RA-08, as none are located within the permanent right-of-way for the route.

No impacts on wetland reserves would be associated with RA-08, as no Wetland Reserve Program wetlands were identified near the route. Less than 1 acre in one Minnesota BWSR wetland mitigation bank easement would be affected by operation of RA-08 (Table 6.3.1.3-14), resulting in a permanent minor impact. In addition, the mitigation bank easement crossed by the permanent pipeline right-of-way may become ineligible for the easement program. The easement would not be protected from future disturbance, including pipeline excavation for repairs, which could occur from implementing the Applicant's Integrity Management Program.

6.3.1.3.4 Summary and Mitigation

Summary

Construction and operation of the Applicant's preferred route and any route alternative would result in permanent, major impacts on forested and scrub/shrub wetlands. Potential impacts on emergent wetlands and specially designated wetlands were found to range from no impact to short-term minor impacts for the Applicant's preferred route and all of the route alternatives (see Table 6.3.1.3-15).

Avoidance and minimization measures include Applicant-proposed measures and mitigation measures stipulated in pending state and federal permits. All wetland changes would be reviewed and approved by the appropriate authorizing agency prior to any construction being allowed. The Applicant has committed to provide compensatory wetland mitigation for permanent impacts on forested, scrub/shrub, and emergent wetlands as required in the federal and state-specific permits. The avoidance and minimization measures and standard BMPs described for the Applicant's preferred route also would apply to the route alternatives.

Beyond the general findings given above, a more detailed comparison of the Applicant's preferred route and the route alternatives shows that the effects on wetlands would vary between the Applicant's preferred route and the different route alternatives based primarily on the amount of forested and scrub/shrub wetland disturbed/filled during construction, the recovery period to reestablish forested wetlands and the permanent loss of forested wetlands to the permanently cleared right-of-way.

Construction Impacts

General Wetlands

Clearing trees and shrubs from forested and scrub/shrub wetlands would require many years for reestablishment of wetlands similar in structure and function to the original wetlands. For the route alternatives, the largest area of clearing of forested and scrub/shrub wetlands would occur for RA-07, RA-06, and RA-08 (Table 6.3.1.3-15). The overall long-term implications for these construction impacts on wetlands for these alternatives differ, however. Construction of RA-07 and RA-08 would represent an expansion along the edges of existing pipeline corridors; while construction of RA-06 would represent construction through a new corridor where many wetlands may not have been previously exposed to

ground disturbance. The smallest area of clearing of forested and scrub/shrub wetlands would occur for the Applicant's preferred route and RA-03AM (Table 6.3.1.3-15).

Emergent wetlands generally reestablish more quickly after pipeline construction. Fill impacts would result in a permanent loss of emergent wetlands but, for pipeline construction through emergent wetlands, vegetation cover and wetland functions would be restored within several years. RA-03AM contains the largest area of emergent wetlands within the construction work area, while the Applicant's preferred route contains the smallest area within the construction work area (Table 6.3.1.3-15).

Specially Designated Wetlands

All of the routes, except RA-07, would affect Public Waters Wetlands between Clearbrook and Carlton during construction (Table 6.3.1.3-15). RA-03AM and RA-08 would affect the largest areas of Public Waters Wetlands, while RA-06 and the Applicant's preferred route would affect the smallest areas.

Minnesota's calcareous fens represent a rare habitat that supports several plants that are protected as threatened or endangered. No calcareous fen wetlands would be crossed by any route between Clearbrook and Carlton. Similarly, no wetlands enrolled in either federal or state Wetland Reserve Programs would be crossed by any route between Clearbrook and Carlton.

Minnesota BWSR wetland mitigation bank easements would be affected by construction of RA-03AM, RA-07, and RA-08 between Clearbrook and Carlton. The easements crossed by both RA-03AM and RA-08 would be co-located with existing pipeline corridors. The mitigation bank easement affected by construction of RA-07 may be avoidable by adjustment of the construction work area width next to the easement. Because these easements already contain existing pipelines, it is unlikely that they would become ineligible for the mitigation bank program because of an additional pipeline, although restoration would be delayed by the new construction.

Operations Impacts

General Wetlands

Fill placed in wetlands for construction of aboveground facilities represents a permanent loss of wetlands. Because the locations for aboveground facilities have not been developed for the route alternatives, a quantified comparison is not possible. New aboveground facilities generally would be sited to avoid wetlands to the extent practicable, although some impacts may be unavoidable. Pipeline operation would continue to disturb wetlands through vegetation management that prevents trees and large shrubs from reestablishing to allow visual inspection of the permanent right-of-way. In addition, the Applicant's Integrity Management Program may require excavation to repair or replace sections of pipe that could occur within wetlands. The largest areas of previously forested and scrub/shrub wetlands that would be permanently maintained as emergent wetland would be associated with RA-06, RA-07, and RA-08 (Table 6.3.1.3-15). The overall long-term implications for these operations impacts on wetlands for these route alternatives differ. Operation of RA-07 would occur within a currently maintained right-of-way, RA-08 would represent an expansion along the edges of existing pipeline corridors, and construction of RA-06 would involve construction through an entirely new corridor where many wetlands may not have been previously exposed to ground disturbance. The smallest area of previously forested and scrub/shrub wetlands would be associated with the Applicant's preferred route and RA-03AM (Table 6.3.1.3-15). Portions of both of these routes would create new rights-of-way; and other portions would be co-located with existing pipelines, transmission lines, and roads. The Applicant's preferred route would have a greater length of new pipeline corridor than RA-03AM.

All of the routes between Clearbrook and Carlton, except RA-07, would continue to affect Public Waters Wetlands during operations (Table 6.3.1.3-15). RA-03AM and RA-08 would affect the largest areas of Public Waters Wetlands, while RA-06 and the Applicant's preferred route would affect the smallest areas.

No calcareous fens or wetlands enrolled in either federal or state Wetland Reserve Programs would be affected by any of the route alternatives between Clearbrook and Carlton during operation.

Mitigation

No Minnesota BWSR wetland mitigation bank easements would be affected during operation of the RA-03AM or RA-08 route. Operations impacts could result in short-term minor impacts on these wetlands within the permanent right-of-way. The easements crossed by both RA-03AM and RA-08 would be co-located with existing pipeline corridors. Because these easements already contain existing pipelines, it is unlikely that they would become ineligible for the mitigation bank program because of an additional pipeline, although restoration would be delayed by the new construction.

All routes would result in permanent major impacts on wetlands associated with conversion of forested and scrub/shrub wetlands to emergent wetlands. The total acreage of forested/scrub/shrub conversion would be greatest for RA-06 followed RA-08, RA-07, the Applicant's preferred route, and RA-03AM. The Applicant has committed to provide compensatory wetland mitigation for permanent impacts on forested, scrub/shrub, and emergent wetlands as required in the federal and state-specific permits. No additional mitigation measures have been identified.

Table 6.3.1.3-15. Summary of Potential Impacts on Wetlands for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Changes to forested and scrub/shrub wetland characteristics and functions	Long-term to permanent/major impacts • 133 acres forested wetlands • 201 acres scrub/shrub wetlands	Long-term to permanent/ major impacts • 116 acres forested wetlands • 206 acres scrub/shrub wetlands	Long-term to permanent/major impacts • 541 acres forested wetlands • 253 acres scrub/shrub wetlands	Long-term to permanent/ major impacts • 595 acres forested wetlands • 446 acres scrub/shrub wetlands	Long-term to permanent/major impacts • 365 acres forested wetlands • 274 acres scrub/shrub wetlands
Changes to emergent wetland characteristics and functions	Short-term/minor impacts • 112 acres	Short-term/minor impacts • 234 acres	Short-term/minor impacts • 126 acres	Short-term/minor impacts • 154 acres	Short-term/minor impacts • 163 acres
Changes to Public Waters Wetlands characteristics and functions	Short-term/minor impacts • 3 acres	Short-term/minor impacts • 8 acres	Short-term/minor impacts • 3 acres	No impact	Short-term/minor impacts • 5 acres
Changes to calcareous fen characteristics and functions	No impact	No impact	No impact	No impact	No impact
Changes to Wetland Reserve Program wetland characteristics and functions	No impact	No impact	No impact	No impact	No impact
Changes to wetland mitigation bank easements characteristics and functions	No impact	Short-term/minor impacts • 5 acres	No impact	Short-term/minor impacts • 0.3 acre	Short-term/minor impacts • 2 acres

Table 6.3.1.3-15. Summary of Potential Impacts on Wetlands for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Operations Impacts					
Forested and scrub/shrub wetlands permanently converted to emergent wetlands	Permanent/major impacts • 62 acres forested wetlands • 108 acres scrub/shrub wetlands	Permanent/major impacts • 48 acres forested wetlands • 84 acres scrub/shrub wetlands	Permanent/major impacts • 228 acres forested wetlands • 104 acres scrub/shrub wetlands	Permanent/major impacts • 124 acres forested wetlands • 120 acres scrub/shrub wetlands	Permanent/major impacts • 151 acres forested wetlands • 114 acres scrub/shrub wetlands
Potential changes to emergent wetland characteristics and functions	Short-term/minor impacts • 64 acres	Short-term/minor impacts • 97 acres	Short-term/minor impacts • 53 acres	Short-term/minor impacts • 37 acres	Short-term/minor impacts • 70 acres
Potential changes to Public Waters Wetlands characteristics and functions	Short-term/minor impacts • 2 acres	Short-term/minor impacts • 3 acres	Short-term/minor impacts • 1 acre	No impact	Short-term/minor impacts • 2 acres
Changes to calcareous fen characteristics and functions	No impact	No impact	No impact	No impact	No impact
Changes to Wetland Reserve Program wetland characteristics and functions	No impact	No impact	No impact	No impact	No impact
Wetland mitigation banks within the permanent right-of-way that would become ineligible as conservation easement	No impact	Permanent/minor impacts • 2 acres	No impact	No impact	Permanent/minor impacts • 1 acre

6.3.1.3.5 References

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6.3.1.4 Floodplains

Floodplains form diverse and high-quality habitats under natural conditions because of their proximity to waterbodies, intermittent flooding, rich soils, and wetland complexes. In addition, their naturally flat topography has resulted in historical development within these areas. Construction of facilities such as a pipeline in a floodplain may affect the ability of the floodplain to store excess water or may raise flood elevations upstream. Flood damage can occur when natural flooding processes are disturbed by altering a watercourse or building inappropriately in the floodplain itself (FEMA 2009).

The floodplain analysis considered both the potential impacts of the Applicant's preferred route and route alternatives on floodplains, and the potential impacts of flooding on Project elements in the floodplain. The analysis of impacts on floodplains during construction and operation of the Applicant's preferred route and route alternatives considered the following:

- Altering floodplain topography;
- Changing flow patterns of flood waters, thereby increasing flooding;
- Blocking or restricting flows;
- Reducing the area within a floodplain that carries floodwaters; and
- Increasing flood elevations upstream.

The analysis of impacts on facilities located within a floodplain and subjected to flooding for the Applicant's preferred route and route alternatives considered the following:

- Disruption of construction activities and loss of materials,
- Damage to equipment and facilities from inundation by floodwaters or flood scour, and
- Interruption of operations.

This section describes the existing conditions for floodplains along the Applicant's preferred route and route alternatives that could be affected by construction and operation of the Project. The potential impacts on floodplains or on the pipeline and associated facilities from flood events are compared for each of the five routing options (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08). Flood-related spill hazards and potential impacts on floodplains from crude oil releases are discussed in Chapter 10.

6.3.1.4.1 Regulatory Context and Methodology

Regulatory Context

Under Minnesota state law, a "floodplain" is the land adjoining lakes and rivers that would be inundated by a 100-year flood (i.e., a flood event expected to occur only once every 100 years). Flood Insurance Rate Maps (FIRMs) produced by the FEMA define the boundaries of floodplains and floodways. These maps indicate areas of the floodplain that are critical for conveying floodwaters (the floodway), the extent of the 100-year flood or special flood hazard areas (SFHAs) (areas subject to a 1-percent annual chance of a flood event), and areas subject to the 500-year flood (areas subject to a 0.2-percent annual chance of a flood).

Development in floodplains typically is regulated by local building, floodplain development, and shoreline permit regulations and ordinances, and FEMA's National Flood Insurance Program (NFIP).[13] Development within a floodplain can be permitted with implementation of proper floodplain management measures to minimize risk from potential flood hazards (Minn. R. Ch. 6120). See Section 5.2.1.4.1 for additional detail on the regulatory context for development within floodplains.

Methodology

Impacts on floodplains were assessed by:

- Using GIS to overlay onto FEMA 100-year flood maps the construction and operations footprints for the Applicant's preferred route and the route alternatives. FEMA has not developed flood maps for some counties.
- Calculating the number of waterbody crossings for areas where FEMA has not developed maps to approximate potential floodplains. Because not all waterbodies have designated floodplains (even where floodplains have been mapped), the number of waterbody crossings was considered only as an approximation of potential floodplain impacts for comparison purposes.
- Identifying any Project features that would be located within a FEMA-designated floodplain.

The ROI for the floodplains analysis consists of the pipeline rights-of-way, construction work areas, facilities, and access roads for the Applicant's preferred route and the route alternatives.

6.3.1.4.2 Existing Conditions

Applicant's Preferred Route

Approximately 12 miles (154 acres) of the construction work area along the Applicant's preferred route would occur within FEMA-mapped 100-year floodplains in counties for which FEMA flood maps are available (Table 6.3.1.4-1). The Applicant's preferred route would require 192 waterbody crossings in Minnesota. An additional 30 acres of ATWS and 4 acres of one access road also would be required within the SFHA for the Applicant's preferred route in Minnesota.

[13] The general purposes of the NFIP are to offer primary flood insurance to properties with significant flood risk and to reduce flood risk through the adoption of floodplain management standards. Generally, communities volunteer to participate in the NFIP to have access to flood insurance; in return, they are required to adopt minimum standards for construction within floodplains. To participate in the NFIP, local jurisdictions (typically cities or counties) must develop local floodplain regulations that meet the NFIP standards.

Table 6.3.1.4-1. Waterbodies and Floodplains Crossed by the Applicant's Preferred Route in Minnesota

Route Segment	Total Waterbody Crossings[a]	Special Flood Hazard Areas		
		Miles of Construction Work Area[b]	Acres of Construction Work Area[b]	Percent of FEMA Flood Map Coverage
North Dakota border to Clearbrook	75	6.3	91.7	89
Clearbrook to Carlton	111	5.6	62.7	26
Carlton to Wisconsin border	6	NA	NA	0

Notes:

[a] See Section 6.2.1.2 and Appendix G for details on waterbody crossings.

[b] For counties for which Federal Emergency Management Agency (FEMA) flood maps are available.

NA = FEMA flood maps are not available for Carlton County, which includes the right-of-way between Carlton and the Wisconsin border.

Between Clearbrook and Carlton, FEMA flood maps are available for only 26 percent of the Applicant's preferred route. Within this segment, approximately 5.6 miles (62.7 acres) of the construction work area would be located within SFHAs. An additional approximately 6.4 acres of ATWS and 1.8 acres of access roads also would be required within the SFHA. The route would require 111 waterbody crossings between Clearbrook and Carlton. The existing conditions relevant to floodplains along the Applicant's preferred route from Neche to Superior are described in Section 5.2.1.4.2.

For the Applicant's preferred route within Minnesota, 4 of the 8 pump stations and 16 of the 27 MLVs would be located in areas that have been mapped by FEMA. For areas with available FEMA flood mapping, no pump stations would be located in the 100-year floodplain; about 1 acre of a designated 100-year floodplain would be occupied by portions of three MLV sites, including an associated access road (Table 6.3.1.4-2). Of this total, approximately 0.4 acre associated with two MLVs would be located in the 100-year floodplain for the Clearbrook-to-Carlton segment.

Table 6.3.1.4-2. Permanent Aboveground Facilities and Access Roads within FEMA-Designated Special Flood Hazard Areas for the Applicant's Preferred Route in Minnesota

Feature	Acres[a]
Mainline valve access road	0.5
Mainline valve sites	0.5
TOTAL	**1.0**

Notes:

Special flood hazard areas represent the 100-year floodplain.

[a] Acreage reflects counties for which Federal Emergency Management Agency (FEMA) flood maps are available.

Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to floodplains for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

RA-03AM would be 275 miles long between Clearbrook and Carlton. Approximately 6.7 miles (97.2 acres) of the construction work area would be located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available (64 percent of the route is mapped). The route would require 167 waterbody crossings.

Based on the spacing of pump stations along the Applicant's preferred route, it was assumed that six pump stations would be required along the route of RA-03AM between Clearbrook and Carlton. The specific locations of permanent aboveground facilities and access roads have not been determined for the route alternatives; therefore, it is unknown whether any permanent facilities associated with RA-03AM would be sited within a FEMA-designated SFHA.

Route Alternative RA-06

Route alternative RA-06 would be 197 miles long between Clearbrook and Carlton. Approximately 0.5 mile (7.2 acres) of the construction work area would be located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available (56 percent of the route). The route would require 137 waterbody crossings between Clearbrook and Carlton.

Based on the spacing of pump stations along the Applicant's preferred route, it was assumed that four pump stations would be required along the route of RA-06 between Clearbrook and Carlton. The specific locations of permanent aboveground facilities and access roads have not been determined for the route alternatives; therefore, it is unknown whether any permanent facilities associated with RA-06 would be sited within a FEMA-designated SFHA.

Route Alternative RA-07

RA-07 would replace the existing Line 3 pipeline in the existing right-of-way, using a 205-foot-wide right-of-way. It would be approximately 168 miles long between Clearbrook and Carlton. Approximately 3.4 miles (85.2 acres) of the construction work area would be located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available (42 percent of the route). The route would require 81 waterbody crossings between Clearbrook and Carlton.

It was assumed that four existing pump stations would be upgraded along the route of RA-07 between Clearbrook and Carlton. The specific pump stations to be upgraded and their associated locations have not been determined. Because the specific locations of MLVs and access roads also have not been determined for the route alternatives, it is unknown whether any permanent facilities associated with RA-07 would be sited within a FEMA-designated SFHA.

Route Alternative RA-08

RA-08 would be 165 miles long between Clearbrook and Carlton. Approximately 3.4 miles (49.4 acres) of the construction work area would be located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available (40 percent of the route). The route would require 106 waterbody crossings between Clearbrook and Carlton.

It was assumed that four existing pump stations would be upgraded along the route of RA-08 between Clearbrook and Carlton. The specific pump stations to be upgraded and their associated locations have not been determined. Because the specific locations of MLVs and access roads also have not been determined for the route alternatives, it is unknown whether any permanent facilities associated with RA-08 would be sited within a FEMA-designated SFHA.

6.3.1.4.3 Impact Assessment

The floodplain analysis considered potential impacts of the Applicant's preferred route and route alternatives on floodplains and potential impacts of flooding on Project pipeline elements in the floodplain.

Applicant's Preferred Route (in Minnesota)

Construction Impacts

Construction activities, including land clearing, grading, trenching, and excavating, would occur within a FEMA-mapped 100-year floodplain for 12 miles (154 acres) of the construction work area along the Applicant's preferred route (from Clearbrook to Carlton, 6 miles (63 acres) of the construction work area would occur within a designated floodplain). One construction access road (totaling approximately 4 acres) also would be located in the 100-year floodplain. These activities would temporarily alter floodplain topography, resulting in minor alterations to water flows in the event of a flood in the area. Construction activities are unlikely to block or restrict flows, reduce the area within a floodplain that carries floodwaters, or increase flood elevations upstream. The Applicant would restore temporary roadways built within the floodplain to original ground conditions to avoid permanent impacts on floodplain flow pathways, connectivity, and function. Construction impacts on floodplains generally would be short-term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored. Construction and restoration would follow the plans contained in the Environmental Protection Plan (Appendix E), which would reduce potential impacts.

Impacts on Project elements from flooding could occur during pipeline construction in floodplains and at river crossings. Although the chance of a severe flood event occurring during the relatively short construction period would be low (because severe flood events occur infrequently), storm events could cause minor to major flooding and erosion at the construction site. Applicant-proposed measures to reduce flooding impacts include limiting the amount of open trench to 3 days, which would limit the amount of open trench and soil storage subject to flooding and storm events. Following construction through smaller waterbodies (less than 100 feet wide), the trench would be filled and recontoured within 24 to 48 hours of construction. Larger rivers would be crossed using site-specific methods, including HDD, which may involve placing more equipment in the floodplain (or immediately adjacent) during construction but would not result in temporary or permanent disturbance of the floodplain for the length of the drill. (See Section 2.7.2 for details on HDD crossings.) Impacts on construction activities and equipment in a flood event generally would be temporary and negligible to minor from disruption of construction activities and damage to equipment and structures from inundation by floodwaters.

Operations Impacts

Permanent facilities such as pump stations and MLVs would be constructed aboveground and operate for the duration of the Project. No pump stations or access roads would be located in a designated floodplain; where feasible, permanent facilities would be constructed outside of the 100-year floodplain. The siting of three MLVs within a designated floodplain (1 acre total for the Applicant's preferred route)

would not create a measurable impact because of their relatively small footprints. Aboveground facilities in floodplains would require floodplain development permitting, which likely would require measures to reduce impacts on floodwater conveyance (e.g., berm construction, raising the ground elevation above the floodplain) associated with permanent structures.

The pipeline would be constructed below ground surface, typically with a minimum of 48 inches of ground cover. Minimum burial depths required by USDOT are listed in Table 2.7-1. For waterbody crossings greater than 100 feet wide, the minimum burial depth is 48 inches below the channel bottom. Major river crossings (see Section 6.3.1.2 for details) would use HDD methods, generally resulting in pipeline placement 30 feet or more below the stream channel. The below ground pipeline would not affect floodplain function once construction and restoration activities have been completed. Impacts on operations activities and equipment from inundation by floodwaters in a flood event would generally be temporary and negligible to minor.

Route Alternatives (from Clearbrook to Carlton)

The types of potential impacts of the route alternatives on floodplains and the potential impacts of flooding on the route alternatives would be the same as described above for the Applicant's preferred route. The differences in impacts between route alternatives would depend on the amount of disturbance within floodplain areas. The number, type, and location of potential HDD crossings, wetlands, ATWS, access roads, and permanent aboveground facilities have not been determined for the route alternatives; therefore, potential impacts on floodplains associated with these developments for the route alternatives cannot be directly compared with those for the Applicant's preferred route.

Route Alternative RA-03AM

Construction Impacts

Construction activities, including land clearing, grading, trenching, and excavating, would occur within the approximately 6.7 miles (97.2 acres) of the construction work area for RA-03AM that is located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available. Impacts from these activities would be similar to those described for the Applicant's preferred route. Impacts generally would short-term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored.

Route alternative RA-03AM would cross the greatest area of designated floodplains and would require more waterbody crossings than all other route options between Clearbrook and Carlton. The greater number of waterbody crossings (167) for this route alternative increases the potential for channel migration and scour during a flood event to expose pipe. Construction activities also could be affected by flood events, including temporary negligible to minor disruption of construction activities and damage to equipment and structures from inundation by floodwaters.

Operations Impacts

After right-of-way restoration, the pipeline would not affect floodplain function because it would be buried to at least regulatory-minimum depths. Because the locations of permanent aboveground facilities have not been determined for route alternatives, associated impacts cannot be quantified. If located within a floodplain, aboveground facilities would require floodplain development permitting that likely would require measures to reduce impacts on floodwater conveyance associated with permanent structures. The greater number of waterbody crossings for this route alternative increases the potential for channel migration and scour during a flood event to expose pipe. Routine inspection of

the pipeline during operations should detect such conditions, which would be rectified during maintenance activities, resulting in temporary minor impacts. Impacts on operations activities and equipment from inundation by floodwaters in a flood event would generally be temporary and negligible to minor.

Route Alternative RA-06

Construction Impacts

Construction activities, including land clearing, grading, trenching, and excavating, would occur within the 0.5 mile (7.2 acres) of the construction work area for RA-06 that is located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available. Impacts from these activities would be similar to those described above for the Applicant's preferred route. Impacts generally would short-term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored. Construction activities also could be affected by flood events, including disruption of construction activities and damage to equipment and structures from inundation by floodwaters.

Operations Impacts

The impacts from operations and permanent facilities for RA-06 would be similar to those described above for RA-03AM, with fewer waterbody crossings (137) required.

Route Alternative RA-07

Construction Impacts

Construction activities, including land clearing, grading, trenching, and excavating, would occur within the 3.4 miles (85.2 acres) of the construction work area for RA-07 that is located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available. Impacts from these activities would be similar to those described above for the Applicant's preferred route. Impacts generally would short-term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored.

Construction activities also could be affected by flood events, including disruption of construction activities and damage to equipment and structures from inundation by floodwaters. RA-07 would require the least amount of waterbody crossings, with a corresponding reduced potential for exposure of the pipe caused by channel migration and scour during a flood event.

Operations Impacts

The impacts from operations and permanent facilities for RA-07 would be the similar to those described above for RA-03AM; however, the least number of waterbody crossings (81) would be required under this route alternative, with a corresponding reduced potential for exposure of the pipe caused by channel migration and scour during a flood event.

Route Alternative RA-08

Construction Impacts

Construction activities, including land clearing, grading, trenching, and excavating, would occur within the 3.4 miles (85.2 acres) of the construction work area for RA-08 that is located within a FEMA-mapped 100-year floodplain in the counties for which FEMA flood mapping is available. Impacts from these

activities would be similar to those described above for the Applicant's preferred route. Impacts generally would short-term and minor, persisting only until construction is completed and the natural land elevations and groundcover are restored.

Construction activities also could be affected by flood events, including disruption of construction activities and damage to equipment and structures from inundation by floodwaters. Compared to the Applicant's preferred route and RA-03AM, this route alternative has fewer waterbody crossings (106) where channel migration and scour during a flood event could expose pipe.

Operations Impacts

The impacts from operations and permanent facilities for RA-08 would be the similar to those described above for RA-03AM. Compared to the Applicant's preferred route and RA-03AM, this route alternative has fewer waterbody crossings where channel migration and scour during a flood event could expose pipe.

6.3.1.4.4 Summary and Mitigation

Summary

The assessment of potential floodplain impacts for the Applicant's preferred route and the route alternatives found that impacts would range from negligible to minor and temporary to short-term for construction, and from no impact to minor and temporary impacts for operations (Table 6.3.1.4-3).

The types of potential impacts on floodplains and the potential impacts of flooding would be the same for the Applicant's preferred route and route alternatives. The differences in impacts would depend on the amount of disturbance within floodplain areas. The length of pipeline route that crosses SFHAs is much lower for RA-06, reducing potential effects on floodplain function. During operations, the length of pipeline route exposed to interruption of operations caused by flooding would be significantly greater for route alternatives RA-03AM, RA-07, and RA-08.

Construction Impacts

Construction-related impacts on floodplains, including temporary alterations of topography that could change flow patterns of flood waters and increase flooding, would be temporary and minor; impacts would last until the disturbed areas are recontoured and vegetation is reestablished. Temporary impacts on floodplains would be greatest for routes with the greatest amount of disturbance from construction in floodplains and those with the most waterbody crossings. RA-03AM would require the most waterbody crossings (167), and RA-07 would require the fewest (81). The Applicant's preferred route is intermediate to the route alternatives, with 111 waterbody crossings required between Clearbrook and Carlton.

Construction activities also could be affected by flood events, including disruption of construction activities and damage to equipment and structures from inundation by floodwaters. Flood events could range from smaller, more frequent events with negligible to minor impacts to larger, less frequent events causing major disruption to equipment and activities within the floodplain.

Operations Impacts

The Applicant's preferred route in Minnesota includes less than 1 acre of permanent facilities that would be located within a FEMA-designated 100-year floodplain in areas for which FEMA mapping is available; these facilities would be allowed under state and local floodplain regulations if the appropriate permits are obtained. The location, number, and type of permanent aboveground facilities and the number and location of access roads have not been determined for the route alternatives; therefore, a comparison of impacts on floodplains from permanent facilities between alternatives is not possible.

Mitigation

Identified mitigation measures for the Applicant's preferred route and route alternatives could include:

- In areas without available FEMA-designated floodplains, require Enbridge to site all pump stations and MLVs outside of potential floodplains.

Table 6.3.1.4-3. Summary of Potential Floodplain Impacts for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Construction activities and equipment altering floodplain function	Short-term/minor impacts • 62.7 acres within SFHAs (26% of route mapped by FEMA) • 6.4 acres of ATWS within SFHAs • 1.8 acre of access roads within SFHAs • 111 waterbody crossings	Short-term/minor impacts • 97.2 acres within SFHAs (64% of route mapped by FEMA) • 167 waterbody crossings	Short-term/minor impacts • 7.2 acres within SFHAs (56% of route mapped by FEMA) • 137 waterbody crossings	Short-term/minor impacts • 85.2 acres within SFHAs (42% of route mapped by FEMA) • 81 waterbody crossings	Short-term/minor impacts • 49.4 acres within SFHAs (40% of route mapped by FEMA) • 106 waterbody crossings
Disruption of construction activities and loss of materials caused by flooding	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts
Damage to construction equipment and facilities from inundation by floodwaters or flood scour	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts
Operations Impacts					
Pipeline and permanent facilities altering floodplain function	No impact	*Locations of aboveground facilities are not known, but they could be constructed within floodplain areas.*			
Interruption of operations caused by flooding	Temporary/negligible to minor impacts • 5.6 miles within SFHAs (26% of route mapped by FEMA)	Temporary/negligible to minor impacts • 6.7 miles within SFHAs (64% of route mapped by FEMA)	Temporary/negligible to minor impacts • 0.5 mile within SFHAs (56% of route mapped by FEMA)	Temporary/negligible to minor impacts • 3.4 miles within SFHAs (42% of route mapped by FEMA)	Temporary/negligible to minor impacts • 3.4 miles within SFHAs (40% of route mapped by FEMA)

Table 6.3.1.4-3. Summary of Potential Floodplain Impacts for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Damage to operations equipment and facilities from inundation by floodwaters or flood scour	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts	Temporary/negligible to minor impacts

FEMA = Federal Emergency Management Agency, SFHA = special flood hazard area.

6.3.1.4.5 References

Federal Emergency Management Agency (FEMA). 2009. NFIP Floodplain Management Guidebook. Region 10. 5th Edition. March. https://www.fema.gov/media-library-data/20130726-1647-20490-1041/nfipguidebook_5edition_web.pdf. Accessed on December 9, 2012.

6.3.2 Geology and Soils

Geologic resources, such as soil and bedrock, can be affected by construction and operation; and geologic hazards such as landslides and subsidence and sinkholes can affect pipeline integrity. Activities that disturb sensitive soils, alter topography, or introduce geologic hazards can negatively affect geology and soil resources, and the people and industries that rely on them.

The construction-related geology and soils issues to be addressed include the following:

- Soil erosion,
- Soil compaction,
- Soil mixing,
- Soil contamination,
- Presence of shallow bedrock that may require blasting,
- Impacts on paleontological resources,
- Changes to topography, and
- Subsidence and sinkhole hazards.

The operations-related geology and soils impacts addressed in this section include:

- Permanent loss of soil cover,
- Soil erosion and compaction,
- Landslide hazards, and
- Subsidence and sinkhole hazards.

This section describes the existing conditions for the geology and soils within an area along the Applicant's preferred route and route alternatives where these resources could be affected by construction and operation of the Project. Potential impacts on geology and soils are discussed and compared across each of the five route options (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08). Potential impacts on geology and soils from an accidental release of crude oil are discussed in Chapter 10.

6.3.2.1 Regulatory Context and Methodology

6.3.2.1.1 Regulatory Context

The NPDES General Construction Stormwater Coverage Permit requires that permittees use approved protection measures to manage soil erosion and minimize soil compaction. The Applicant would be required to obtain an NPDES permit from Minnesota PCA prior to construction. In addition, Minnesota Statutes Chapter 103F, Soil Erosion Law prohibits activities that allow for excessive soil loss, as defined by NRCS guidelines. 29 Code of Federal Regulations (CFR) Part 1926, Subpart U regulates the storage and use of explosives for blasting of bedrock. Minnesota Administrative Rules Chapter 7500 also regulates the storage and use of explosives, and designates municipal supervision of compliance with federal blasting regulations. Other geologic resource guidance and regulations include design and engineering

protocols for dealing with site-specific geologic hazards (such as burial or reinforcement of pipelines to protect from landslides). Federal design and engineering specifications in 49 CFR Parts 192 and 193 ensure that pipeline facilities are protected from potential landslides and unstable slopes. Because no significant seismic hazard is present in the Project area, pipeline engineering requirements to address the seismic stability of the pipeline are not applicable to the Project (USGS 2016).

6.3.2.1.2 Methodology

To assess potential construction and operations impacts on geology and soils, and to assess the potential impacts of geologic hazards on Project elements, relevant geologic resources present along the Applicant's preferred route and the route alternatives were reviewed and inventoried. These resources included soils, shallow bedrock, paleontological resources, and topography. Soil types that may be sensitive to disturbance, including prime farmland, soils highly erodible by water or wind, hydric soils, compaction-prone soils, stony/rocky soils and coarse-textured soils, were identified from NRCS soil data, including both SSURGO and STATSGO2 data (NRCS 2016). Other data sources included maps and publications from USGS, MGS, and the Paleontology Portal. Potential geologic hazards, including landslide hazards and subsidence- and sinkhole-prone areas, also were identified and inventoried using maps and publications from USGS and MGS.

Data for the relevant geologic resources and geologic hazards were overlain in GIS with maps of the estimated construction and operations footprints for the Applicant's preferred route and the route alternatives to determine the locations and extent of potential impacts. Potential impacts on geologic resources for the Applicant's preferred route and route alternatives were considered where construction or operation of a route could cause disturbance, loss, or modification of the resource—and where estimated footprints for these actions intersected potential geologic hazards that could cause damage or injury.

The ROI for the geology and soils impact analysis consists of areas where soils, topography, and potentially bedrock would be disturbed during Project-related construction or operations in Minnesota. For the Applicant's preferred route, this includes pipeline construction work areas; permanent rights-of-way; temporary and permanent access roads; and locations of associated facilities outside the permanent right-of-way, such as pump stations. The footprint for route alternatives include a 120-foot-wide construction work area (except for RA-07, which would have a 205-foot-wide construction footprint; see Chapter 4) and a 50-foot-wide permanent right-of-way centered on the route alignments.

6.3.2.2 Existing Conditions

6.3.2.2.1 Applicant's Preferred Route

Soils

Section 5.2.2.2 provides a general discussion of soils across the ROI. Specific soil types and characteristics along the Applicant's preferred route were analyzed from soil maps prepared by NRCS, including both SSURGO and STATSGO2 data (NRCS 2016). Any soil type has the potential to be affected by pipeline development, but some soils are more susceptible than others to impacts such as erosion, compaction, and contamination. Soils that may be sensitive to disturbance are those designated as prime farmland, soils highly erodible by wind or water, hydric soils, compaction-prone soils, coarse-textured soils, and stony/rocky soils, as described in Section 5.2.2.2. Table 6.3.2-1 provides the miles of occurrence of these sensitive soils along the Applicant's preferred route in Minnesota.

Table 6.3.2-1. Sensitive Soils along the Applicant's Preferred Route in Minnesota (miles)

Soil Type	North Dakota-Minnesota Border to Clearbrook	Clearbrook to Carlton	Carlton to Minnesota-Wisconsin Border	Minnesota Total
Length	109.1	220.9	9.6	339.7
Prime farmland	77.4	60.3	0.8	138.5
Highly erodible soils (by water)	0.0	0.0	0.0	0.0
Highly erodible soils (by wind)	19.3	86.0	1.6	106.9
Hydric soils	65.2	68.4	0.3	133.9
Compaction-prone soils	23.0	0.0	1.2	24.1
Coarse-textured soils	1.7	39.2	1.5	42.5
Stony/rocky soils	0.1	1.4	0.0	1.5

Sources: NRCS 2016; Minnesota DNR 2016a.

As indicated in Table 6.3.2-1, sensitive soils along the Applicant's preferred route in Minnesota are summarized as follows:

- Prime farmlands are prevalent; approximately 139 miles of prime farmland would be crossed by the Applicant's preferred route in Minnesota, of which approximately 60 miles are within the Clearbrook to Carlton segment.
- Soils that are highly erodible by water are virtually absent, while soils prone to wind erosion are more common.
- Hydric soils are common, especially in wetland areas and near lakes. Compaction-prone soils are not very common. Both hydric soils and compaction-prone soils may require modified construction methods to avoid potential compaction by heavy machinery.
- Coarse-textured soils are common.
- Stony/rocky soils occur only in minor, isolated areas throughout the region. Because of their limited occurrence across the routes, stony/rocky soils are not anticipated to exacerbate the impact of soil disturbance, or impede pipeline installation or construction of other facilities, and therefore are not addressed further herein.

Subsurface Substrate

The characteristics of the subsurface substrate (soils and sediments deeper than the surficial soils discussed above) are important in determining the method of pipeline installation, particularly regarding the use of HDD methods for pipeline installation. Some subsurface sand and gravel layers are not conducive to HDD techniques, as the unconsolidated sediments are prone to collapse during drilling. Some of these deposits have been well mapped and serve as aquifers, as discussed in Section 6.3.1.1. Geotechnical drilling is required to determine the site-specific characteristics of these deposits in order to determine the feasibility of using HDD to install the pipeline.

Shallow Bedrock

The depth to bedrock across the ROI ranges from 0 to over 450 feet, with depths averaging approximately 200 feet along the Applicant's preferred route (MGS 2016). Where bedrock is present at or near the surface within the corridor for the Applicant's preferred route, blasting of the rock with explosives could be required for installation of buried pipeline. However, shallow bedrock is not common along most of the route. Some shallow bedrock is present in the eastern end of the ROI, including a 0.3-mile segment (approximately 1,500 feet) of the Applicant's preferred route in Carlton County, Minnesota, near the Wisconsin border.

Paleontology

The Applicant's preferred route intersects isolated sections of sedimentary rock formations that are likely to contain common marine invertebrate fossils. Along most of the length of the route, these layers are generally found at depths greater than 30 feet. Along the eastern end of the route in Carlton County, bedrock may be at the surface or near the surface, and common marine invertebrate fossils could be present in shallow bedrock. Pleistocene-age megafauna remains, such as wooly mammoths or mastodon, also could be found in the glacial sediments overlying bedrock; however, these remains are rare in the ROI.

Topography

The Upper Midwest consists of relatively flat terrain, and topographical variation is modest across the route. Elevations range from approximately 903 to 1,681 feet above sea level across the Applicant's preferred route (NED DEM 2016). The generally low relief across the Applicant's preferred route is punctuated in some areas by isolated ridges and hills, and some steep streambanks (Appendix A).

Landslide Hazards

Landslide hazard potential is generally low across the majority of the Applicant's preferred route. Near the eastern end of the route between Carlton and the Wisconsin border, 8 miles of the route intersect areas with a high susceptibility to landslides, mostly in isolated sections at stream crossings. Between Clearbrook and Carlton is an additional 0.4 mile of high landslide hazard (NPMS LSHR 2016; Enbridge 2016a).

Subsidence and Sinkhole Hazards

Karst conditions, which could lead to subsidence and sinkhole formation, are not believed to be present along the Applicant's preferred route (Minnesota DNR 2016b; USGS 2016).

6.3.2.2.2 Route Alternatives

Soils

Specific soil types and characteristics along the route alternatives were analyzed from soil maps prepared by NRCS, including both SSURGO and STATSGO2 data (NRCS 2016). Table 6.3.2-2 provides the miles of occurrence of these sensitive soils along the route alternatives between Clearbrook and Carlton.

Table 6.3.2-2. Sensitive Soils along the Route Alternatives between Clearbrook and Carlton (miles)

Soil Type	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Length	275.1	196.8	167.7	164.8
Prime farmland	44.0	76.7	31.6	38.9
Highly erodible soils (by water)	0.0	0.2	0.0	0.0
Highly erodible soils (by wind)	74.0	50.6	84.4	64.2
Hydric soils	53.3	86.2	62.1	69.4
Compaction-prone soils	0.0	7.4	2.3	2.6
Coarse-textured soils	43.5	8.0	37.0	19.3
Stony/rocky soils	1.4	0.3	2.8	5.9

Sources: NRCS 2016; Minnesota DNR 2016a.

Subsurface Substrate

The characteristics of the subsurface substrate along the route alternatives are generally similar to those along the Applicant's preferred route. Geotechnical drilling would be required to determine the site-specific characteristics of these deposits in order to determine appropriate methods of pipeline installation.

Route Alternative RA-03AM

Shallow Bedrock

Bedrock is likely present at or near the surface along some eastern segments of RA-03AM, most likely in Todd, Pine, and Carlton counties. Potential bedrock blasting sites have not yet been identified for the route.

Paleontology

RA-03AM would intersect short segments of shallow sedimentary rock that is likely to contain common marine invertebrate fossils. Pleistocene-age megafauna remains also could be found in the glacial sediments along RA-03AM; however, these remains are rare throughout the ROI.

Topography

The elevation for RA-03AM ranges from 617 to 1,681 feet above sea level. The generally low relief across the route alternative is punctuated in some areas by isolated ridges and hills, and some steep streambanks (Appendix A).

Landslide Hazards

Landslide hazard potential is generally low across the majority of RA-03AM. The route would pass through minor isolated segments of high landslide hazard for a total of 0.4 mile between Clearbrook and Carlton (NPMS LSHR 2016).

Subsidence and Sinkhole Hazards

Along approximately 30 miles of the eastern portion of the RA-03AM route, relatively shallow carbonate bedrock has the potential for karst conditions. For approximately 12 miles of that segment (where the route passes through Pine County), there is a higher probability for subsidence or sinkhole formation where bedrock is at or near the surface (Minnesota DNR 2016b; USGS 2016).

Route Alternative RA-06

Shallow Bedrock

Bedrock is present at or near the surface in substantial portions of RA-06 where it passes through Itasca County and possibly in shorter segments in Carlton County. Potential bedrock blasting sites have not been identified for RA-06.

Paleontology

RA-06 would intersect short segments of shallow sedimentary rock that is likely to contain common marine invertebrate fossils. Pleistocene-age megafauna remains also could be found in the glacial sediments along RA-06; however, these remains are rare throughout the ROI.

Topography

The elevation for RA-06 ranges from 617 to 1,542 feet above sea level. The generally low relief across the route alternative is punctuated in some areas by isolated ridges and hills, and some steep streambanks (Appendix A).

Landslide Hazards

Landslide hazard potential is generally low across the majority of the RA-06 route. The route would pass through minor isolated segments of high landslide hazard for a total of 0.3 mile between Clearbrook and Carlton (NPMS LSHR 2016).

Subsidence and Sinkhole Hazards

Karst conditions, which could lead to subsidence and sinkhole formation, are not believed to be present along the RA-06 route.

Route Alternative RA-07

Shallow Bedrock

Bedrock may be present at or near the surface in isolated segments of RA-07 where it crosses Itasca and Carlton counties. Potential bedrock blasting sites have not been identified for RA-07.

Paleontology

Route alternative RA-07 would intersect short segments of shallow sedimentary rock that is likely to contain common marine invertebrate fossils. Pleistocene-age megafauna remains also could be found in the glacial sediments along RA-07; however, these remains are rare throughout the ROI.

Topography

The elevation for RA-07 ranges from 617 to 1,474 feet above sea level (NED DEM 2016). The generally low relief across the route alternative is punctuated in some areas by isolated ridges and hills, and some steep streambanks (Appendix A).

Landslide Hazards

Landslide hazard potential is generally low across the majority of the RA-07 route. The route would pass through minor isolated segments of high landslide hazard for a total of 0.3 mile between Clearbrook and Carlton (NPMS LSHR 2016).

Subsidence and Sinkhole Hazards

Karst conditions, which could lead to subsidence and sinkhole formation, are not believed to be present along the RA-07 route.

Route Alternative RA-08

Shallow Bedrock

Bedrock may be present at or near the surface in isolated segments of RA-08 where it crosses Itasca and Carlton counties. Potential bedrock blasting sites have not been identified for RA-08.

Paleontology

RA-08 would intersect short segments of shallow sedimentary rock that is likely to contain common marine invertebrate fossils. Pleistocene-age megafauna remains also could be found in the glacial sediments along RA-08; however, these remains are rare throughout the ROI.

Topography

The elevation for RA-08 ranges from 617 to 1,499 feet above sea level (NED DEM 2016). The generally low relief across the route alternative is punctuated in some areas by isolated ridges and hills, and some steep streambanks (Appendix A).

Landslide Hazards

Landslide hazard potential is generally low across the majority of RA-08. The route would pass through minor isolated segments of high landslide hazard for a total of 0.3 mile between Clearbrook and Carlton (NPMS LSHR 2016).

Subsidence and Sinkhole Hazards

Karst conditions, which could lead to subsidence and sinkhole formation, are not believed to be present along the RA-08 route.

6.3.2.3 Impact Assessment

Impacts associated with the Applicant's preferred route in Minnesota and the route alternatives between Clearbrook and Carlton are described below.

6.3.2.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Pipeline construction activities that can affect geology and soils include trenching and backfilling, blasting, grading, installation of permanent roads and facilities, and the use of fuels and other hazardous materials. Construction likely would cause some disturbance to soils and topography. Where present, shallow bedrock and potential fossil remains could be destroyed through blasting or excavation. In addition, the presence of landslide hazards or subsidence and sinkholes would be a potential impact on Project area safety and infrastructure for the life of the Project. Impacts from pipeline construction

primarily would occur within construction work areas along the length of the route and at aboveground facilities, staging areas, and access roads.

Soil disturbance along the Applicant's preferred route during construction would total approximately 4,555 acres. Of the amount disturbed during construction, 2,057 acres would be maintained as permanent right-of-way and dedicated to aboveground facilities during operations. Between Clearbrook and Carlton, approximately 2,907 acres would be disturbed during construction and 1,337 acres would be disturbed during operations. Approximately 82 percent of the route in Minnesota and 73 percent of the route between Clearbrook and Carlton, Minnesota, would be co-located with existing infrastructure where prior disturbance to soils likely has occurred. Much of the remaining greenfield portion of the route has been disturbed by human activities, especially activities related to agriculture and timber harvesting.

Soil Erosion

Removal of crops, sod, and other vegetation during construction would leave soil exposed to erosion by wind and water. Heavy equipment operation on the exposed soil loosens soil and breaks up soil peds (i.e., aggregations of soil particles that make the soil surface more stable), making the soil more susceptible to erosion, especially during periods of heavy rainfall or windy conditions. Erosion could continue to be a minor impact for several years after construction is complete while plant communities stabilize in the disturbed ground. Any exposed soil would be subject to erosion by water or wind.

Soils highly prone to erosion by water are not encountered by the Applicant's preferred route in Minnesota. However, soils prone to erosion by wind intersect approximately 107 miles in Minnesota, including about 86 miles between Clearbrook and Carlton. Such soils may require protective measures during soil disturbance to avoid soil loss, such as the use of slope breakers and biodegradable erosion control blankets during construction, and mulch and revegetation to minimize potential long-term erosion. With implementation of such Applicant-proposed measures (see Section 5.2.2.3.1 for additional details) soil erosion likely would be temporary to short-term, localized, and minor.

Soil Compaction

Heavy equipment passage, grading of the right-of-way, and transport of pipe sections may compact soils. Compacted soils impede penetration of plant roots, which affects reestablishment of plant communities after construction activities are completed. Soil compaction also reduces pore space and infiltration within the soil, leading to increased runoff that can further promote erosion. Hydric soils and compaction-prone soils, particularly when wet, would be most susceptible to these impacts.

Hydric soils occur across 134 total miles of the Applicant's preferred route through Minnesota, with 68 of those miles between Clearbrook and Carlton. Other compaction-prone soils occur along only 7 percent of the route, with none present between Clearbrook and Carlton. If the Applicant-proposed measures are implemented, such as deep tillage and use of timber mats and/or low-ground-pressure equipment (Appendix E), soil compaction from proposed Project construction likely would be temporary, localized, and negligible to minor.

Soil Mixing

Topsoil and subsoil removal and segregation during excavation may allow some mixing of these soils. If soil is mixed during backfilling, some biological and chemical properties of the soil may be altered, which may affect reestablishment of plant communities in the short-term (several years) after reclamation. In addition, rocks from the subsoil or from potential blasting operations may become mixed into the

topsoil, further reducing its productivity. The Applicant has proposed measures to reduce the potential for soil mixing, particularly removal, segregation, and replacement of soils (Appendix E). With implementation of Applicant-proposed measures, soil mixing during construction of the Applicant's preferred route likely would result in short-term and negligible to minor impacts.

Soil Contamination

Soils may become contaminated from minor spills of industrial chemicals or hazardous materials (e.g., lubricants, gasoline, oil, other fuels, coolants, and transmission fluid) during construction activities such as fuel storage, equipment refueling, and equipment maintenance. Applicant-proposed measures to reduce the potential for minor spills include training employees in proper storage and dispensing of fuels and other hazardous materials, and use of spill kits and designated Spill Coordinators to minimize impacts in the event of a spill. With implementation of such measures, potential impacts likely would be localized, temporary, and negligible to minor.

Presence of Shallow Bedrock

The Applicant has identified one 0.3-mile segment on the Applicant's preferred route in eastern Carlton County where bedrock outcrops at the surface for approximately 1,500 feet. Blasting of the bedrock with explosives would be required to break up and remove the bedrock in order to install the pipeline in this segment. The Applicant anticipates that four blasting events would be required, each event breaking up approximately 400 feet of the rock outcrop (Enbridge 2016b).

The Applicant would develop a Blasting Plan prior to construction, which would comply with all federal, state, and local regulations, including those related to the safety, use, storage, and transportation of explosives (Enbridge 2016b). Blasting debris would be used as trench backfill material, and large fragments of rock (larger than those in surrounding undisturbed areas) would be removed from the construction work area. Removal of bedrock by blasting is a permanent impact; however, unless the rock is a source of rare or unique fossils or mineral resources, the impact on geology and soils is considered minor.

Impacts on Paleontological Resources

Potential impacts on paleontological resources during construction include damage to or destruction of fossils from excavation and blasting operations, if conducted; erosion of fossil beds from grading; and unauthorized collection of fossils by construction personnel or the public. Where blasting is required, it likely would disturb and fracture any fossils potentially found in shallow bedrock. Fossils most likely to be present in shallow bedrock are common marine invertebrate fossils that are globally abundant and not considered scientifically significant. Damage to or destruction of common marine invertebrate fossils from blasting or ripping of bedrock would be a permanent minor impact.

Pleistocene-age mammal fossils are rare but may be unearthed in the glacial sediments overlying bedrock during excavation activities for the proposed Project; these fossils would be considered scientifically important. The Applicant developed a state-specific Unanticipated Discovery Plan (Appendix O) that requires work to stop in the event that important paleontological resources are discovered during construction activities. With adherence to the Unanticipated Discovery Plan, impacts on rare or unique paleontological resource would likely be negligible to minor. However, if a rare or unique paleontological resource was damaged or destroyed prior to being discovered, the impact would be permanent and major to the individual resource. The likelihood of such an occurrence, however, is low.

Changes to Topography

Modifications to topography from pipeline installation would be temporary, localized and minor. At the close of construction, the Applicant would restore the natural contour of any slopes and drainage patterns. After pipe installation is complete, backfilling and regrading of the right-of-way would return the disturbed surface to pre-Project conditions.

Minor, localized, and temporary modifications to topography may take place during construction of temporary material storage yards, contractor yards, and temporary access roads. Disturbed areas would be re-graded at the close of construction, and surfaces would be returned to their pre-Project elevations, in accordance with BMPs. Differential settling of the land surface may occur in the months following regrading, but impacts would be negligible.

Minor permanent modifications to topography (e.g., excavations for foundations, permanent road grading) may be required for some aboveground facilities (e.g., pump stations, MLVs, cathodic protection systems, and permanent access roads).

Subsidence and Sinkhole Hazards

Subsidence or sinkhole formation is not anticipated within the Applicant's preferred route, as no known shallow carbonate rocks intersect the route.

Operations Impacts

During standard operations, impacts on geologic and soil resources would be limited to permanent loss of soil cover where surface sediments would be converted to impervious surfaces on new roads and aboveground facilities; and potential erosion and compaction during permanent right-of-way maintenance and use of permanent unpaved access roads. Furthermore, along the Applicant's preferred route, there is a low potential for landslide hazards in isolated sections across the route, and no known potential for subsidence and sinkhole hazards, as detailed below.

Permanent Loss of Soil Cover

Construction of permanent access roads and associated facilities would require permanent removal or conversion of surface soil, to be replaced with materials such as cement and gravel. Loss of soil cover would total 278 acres for access roads and 67 acres for other permanent facilities along the Applicant's preferred route in Minnesota. Between Clearbrook and Carlton, loss of soil cover would total 240 acres for access roads and 42 acres for other permanent facilities. This would result in permanent minor impacts on soil. In addition, replacement of natural soil cover with less permeable cement and other materials could increase runoff and potential erosion and sedimentation outside of the construction area. See Section 5.2.1.2 for a discussion of runoff and sedimentation.

Soil Erosion and Compaction

Approximately 2,057 acres that encompass the permanent right-of-way would be subject to permanent, minor soil compaction from maintenance operations (i.e., heavy vehicles traversing the area). New permanent access roads that are unpaved would be subject to minor, localized, permanent erosion and

sedimentation (sedimentation is addressed in Section 5.2.1.2). The locations of new permanent access roads also would experience negligible to minor, localized, and permanent soil compaction.

Landslide Hazards

Landslide potential is low across most of the Applicant's preferred route. There is increased potential for landslide activity in isolated sections of the Applicant's preferred route, mostly at stream crossings between Carlton and the Minnesota-Wisconsin border. Areas along the Applicant's preferred route known to have high susceptibility to landslides are limited to 0.4 mile between Clearbrook and Carlton, and 8 miles between Carlton and the Minnesota-Wisconsin border. The proposed Project also would follow existing design and engineering specifications (in accordance with 49 CFR Parts 192 and 193) to ensure that pipeline facilities are protected from potential landslides. The likelihood of a landslide affecting the pipeline or associated facilities would be low. The severity of impact on pipeline facilities for an individual landslide event depends on the nature of the slope, the geologic materials present, and the design of the facilities; such a determination is beyond the scope of this analysis. It should be noted that, although the potential is low, a landslide could occur at any time throughout the life of the Project.

Subsidence and Sinkhole Hazards

Subsidence or sinkhole formation is not anticipated within the Applicant's preferred route because no known shallow carbonate rocks intersect the route.

6.3.2.3.2 Route Alternatives (between Clearbrook and Carlton)

During construction and operations, the types of soil and geology impacts for the route alternatives between Clearbrook and Carlton would be similar to those described for the Applicant's preferred route. If any of the route alternatives are constructed, it was assumed that Enbridge would implement the same Applicant-proposed measures that were identified for the Applicant's preferred route to reduce impacts on geologic resources along the route alternatives.

The extent of soil disturbance from construction varies among the route alternatives based on the pipeline length and width of the construction work area. The length of the various routes between Clearbrook and Carlton ranges from 165 miles (RA-08) to 275 miles (RA-03AM); this represents a 40-percent difference in the extent of surface disturbance based on pipeline length (Table 6.3.2-1). The width of the construction work area varies among the routes from a standard of 120 feet (for all but RA-07) to an estimated 205 feet (for RA-07), representing almost a 60-percent difference in the extent of surface disturbance based on the width of the construction work area.

Similarly, the extent of impacts on soils during operations is influenced by the length of the route alternative. The large majority of the affected acreage would be associated with periodic mowing of the permanent right-of-way. Although the specific locations of aboveground facilities have not been identified for the route alternatives, the approximate acreage associated with permanent access roads and aboveground facilities across route alternatives is expected to be comparable to the acreage associated with the Applicant's preferred route between Clearbrook and Carlton (approximately 283 acres), except as discussed below.

Route Alternative RA-03AM

Construction Impacts

Approximately 4,000 acres of soil would be disturbed during construction of RA-03AM between Clearbrook and Carlton. Approximately 95 percent of the RA-03AM route would be co-located with existing infrastructure, where prior disturbance to soils likely has occurred.

As noted in Table 6.3.2-1, soils that are highly erodible by water are not encountered on the RA-03AM route, although some sections contain soils that are highly erodible by wind. As a result, a minor, localized, and temporary to short-term increase in soil erosion likely would result from construction and restoration activities. Hydric soils are present along only 19 percent of RA-03AM, while routes farther to the north pass through slightly more hydric soils, as wetlands and lakes are more abundant. No soils considered highly susceptible to compaction are present along the RA-03AM route between Clearbrook and Carlton. With implementation of Applicant-proposed measures, soil compaction from construction disturbance along RA-03AM likely would be temporary and negligible.

Bedrock is likely present at or near the surface along some eastern segments of RA-03AM, most likely in Todd, Pine, and Carlton counties. Shallow bedrock likely would require blasting with explosives for installation of buried pipeline in some segments of the route, but the specific need for blasting cannot be determined without field-based geotechnical studies.

Known karst conditions, with potential for solution cavities at depth, are present along approximately 12 miles of the RA-03AM route where the pipeline would cross through Pine County. Subsidence or sinkhole formation from cavity collapse would be a potential impact on pipeline installation in this segment of the route. Karst topography can pose increased risks to the successful installation of pipelines by HDD techniques, in particular, due to loose unstable soils and open voids along the drill path. Potential impacts include loss of drilling fluid into open conduits and inadvertent drilling fluid returns, leading to potential contamination and turbidity in nearby wells, springs, and rivers (addressed in Section 5.2.1.1); and ground subsidence and possible sinkhole formation due to excavating zones of loose unstable soils. The probability and severity of the potential impact of subsidence or sinkhole formation on pipeline construction depend on the nature of the bedrock, the groundwater, the timing of the occurrence, and the design of the facilities. Such a determination is beyond the scope of this analysis.

Operations Impacts

Most impacts on geology and soil resources during operations for the RA-03AM route would be similar to those for the Applicant's preferred route. Route alternative RA-03AM would be significantly longer than the other routes, however, resulting in a longer permanent right-of-way, additional pump stations, and additional MLVs.

Of the acreage disturbed during construction, approximately 1,667 acres would be maintained as permanent right-of-way during operations for RA-03AM. Within the permanent right-of-way, installation of permanent access roads and facilities would cause a localized, minor, permanent loss of soil cover. In addition, replacement of natural soil cover with less permeable cement and other materials could increase runoff and associated erosion and sedimentation (addressed in Section 5.2.1.2).

Vehicle traffic associated with right-of-way maintenance would cause permanent, minor soil compaction. The locations of new permanent unpaved access roads also would experience negligible to minor, localized, and permanent soil compaction and erosion.

One key difference in potential impacts between RA-03AM and the other routes is the potential for subsidence or sinkhole formation from the presence of karst conditions along the RA-03AM route. As previously stated, the probability and severity of the potential impact of subsidence or sinkhole formation on the integrity of the pipeline or associated facilities depend on the nature of the bedrock, the groundwater, the timing of the occurrence, and the specific engineering design of the facilities. Such a determination is beyond the scope of this analysis.

Route Alternative RA-06

Construction Impacts

Soil disturbance along RA-06 would total approximately 2,862 acres during construction. Approximately 20 percent of the RA-06 route would be co-located with existing infrastructure, where prior disturbance to soils likely has occurred. Co-location of the route is discussed in Section 6.7.

As noted in Table 6.3.2-2, soils that are highly erodible by water are encountered on only 0.2 mile of the RA-06 route between Carlton and Clearbrook, while approximately 51 miles contain soils that are highly erodible by wind. A localized, minor, and temporary to short-term increase in soil erosion potential likely would result from construction and restoration activities across all route options. RA-06, being the farthest north of the routes analyzed, passes through the highest percentage of hydric soils (44 percent). Other soils prone to compaction are present along only about 7 miles of this route. With implementation of the Applicant-proposed measures, impacts from soil compaction likely would be temporary and negligible to minor.

Bedrock is present at or near the surface in substantial portions of RA-06 where it passes through Itasca County and possibly in shorter segments in Carlton County. Bedrock blasting likely would be necessary in some of these segments of RA-06, but the specific need for blasting cannot be determined without field-based geotechnical studies. Because no known karst conditions are present along the RA-06 route, no impacts from subsidence or sinkhole formation are anticipated.

Operations Impacts

Impacts on geology and soil resources for operations of the RA-06 route would be similar to those for the Applicant's preferred route. Of the amount disturbed during construction, 1,192 acres would be maintained as permanent right-of-way during operations. Within the permanent right-of-way, installation of permanent access roads and facilities would cause a localized, minor, permanent loss of soil cover. In addition, replacement of natural soil cover with less permeable cement and other materials could increase runoff and associated erosion and sedimentation.

Vehicle traffic associated with right-of-way maintenance would cause permanent minor soil compaction. The locations of new permanent unpaved access roads also would experience negligible to minor, localized, and permanent soil compaction and erosion.

Route Alternative RA-07

Construction Impacts

Because of a wider construction work area, soil disturbance along RA-07 would total approximately 4,156 acres during construction. The entire RA-07 route would be co-located along Enbridge's Mainline corridor, where prior disturbance to soils likely has occurred.

As noted in Table 6.3.2-2, soils that are highly erodible by water are not encountered on the RA-07 route, while approximately 84 miles of the route contain soils that are highly erodible by wind. If Applicant-proposed measures are implemented, soil erosion from construction activities likely would be localized, temporary to short-term, and minor. Hydric soils are present along 37 percent of this route between Clearbrook and Carlton, and other soils susceptible to compaction are present along only approximately 2 miles of the route. With implementation of the Applicant-proposed measures, impacts from soil compaction likely would be localized, temporary, and negligible to minor.

Bedrock may be present at or near the surface in isolated segments of RA-07 where it crosses Itasca and Carlton counties. It is possible that bedrock blasting with explosives would be required for installation of buried pipeline in these segments of the route, but the specific need for blasting cannot be determined without field-based geotechnical studies. Because no known karst conditions are present along the RA-07 route, no impacts from subsidence or sinkhole formation are anticipated.

Operations Impacts

Impacts on geology and soil resources for operation of the RA-07 route would be similar to those for the Applicant's preferred route. Of the acreage disturbed during construction, 1,017 acres would be maintained as permanent right-of-way during operations. Within the permanent right-of-way, installation of permanent access roads and facilities would cause a localized, minor, permanent loss of soil cover. In addition, replacement of natural soil cover with less permeable cement and other materials could increase runoff and associated erosion and sedimentation (addressed in Section 5.2.1.2).

Vehicle traffic associated with right-of-way maintenance would cause permanent, minor soil compaction. The locations of new permanent unpaved access roads also would experience negligible to minor, localized, and permanent soil compaction and erosion.

Route Alternative RA-08

Construction Impacts

Soil disturbance along RA-08 would total approximately 2,398 acres during construction. The entire RA-08 route would be co-located with existing infrastructure, where prior disturbance to soils likely has occurred.

As noted in Table 6.3.2-1, soils that are highly erodible by water are not present on the RA-08 route; however, approximately 64 miles of the route contain soils that are highly erodible by wind. With implementation of Applicant-proposed measures to control soil erosion, soil erosion from construction likely would be temporary to short-term and minor. Hydric soils are present along 42 percent of the RA-08 route, while other soils susceptible to compaction are present along less than 3 miles of the route. With implementation of the Applicant-proposed measures, impacts from compaction of soils along RA-08 during construction likely would be localized, temporary and negligible to minor.

Bedrock may be present at or near the surface in isolated segments of RA-08 where it crosses Itasca and Carlton counties. It is possible that bedrock blasting would be necessary in these segments, but the specific need for blasting cannot be determined without field-based geotechnical studies.

Because no known karst conditions are present along route RA-08, no impacts from subsidence or sinkhole formation are anticipated.

Operations Impacts

Impacts on geology and soil resources for operation of the RA-08 route would be similar to those for the Applicant's preferred route. Of the acreage disturbed during construction, 999 acres would be maintained as permanent right-of-way during operations. Within the permanent right-of-way, installation of permanent access roads and facilities would cause a localized, minor, permanent loss of soil cover. In addition, replacement of natural soil cover with less permeable cement and other materials could increase runoff and associated erosion and sedimentation (addressed in Section 5.2.1.2).

Vehicle traffic associated with right-of-way maintenance would cause permanent minor soil compaction. The locations of new permanent unpaved access roads also would experience negligible to minor, localized, and permanent soil compaction and erosion.

6.3.2.4 Summary and Mitigation

6.3.2.4.1 Summary

Construction and operation of the Applicant's preferred route and all route alternatives would affect geologic and soil resources. Table 6.3.2-3 provides a summary of the occurrence and extent of potential impacts on geology and soils associated with the Applicant's preferred route and route alternatives. If the protective measures outlined in the Applicant's Environmental Protection Plan (Appendix E) are implemented, most construction impacts on geology and soils would be negligible to minor and temporary to short-term.

In general, the primary differences in the extent of impacts among the routes are associated with the pipeline length and the width of the construction work area—in terms of both general surface disturbance and sensitive geologic and soils characteristics. The length of the various routes between Clearbrook and Carlton ranges from 165 miles (RA-08) to 275 miles (RA-03AM); this represents a 40-percent difference in the extent of surface disturbance based on pipeline length (Table 6.3.2-3). Similarly, the width of the construction work area varies among the routes from a standard width of 120 feet (for all but RA-07) to an estimated width of 205 feet (for RA-07), representing almost a 60-percent difference in surface disturbance based on the width of the construction work area. Despite these differences, implementation of the Applicant-proposed measures to limit impacts on geology and soils would minimize the duration and magnitude of construction and operations impacts. Overall, both temporary and long-term effects on geology and soils are expected to be minor.

The Applicant's preferred route and all of the route alternatives cross through rich agricultural areas, with soils designated as prime farmland. The types of soil impacts along the Applicant's preferred route and the route alternatives would be similar, as all routes share similar overall soil conditions. Soils prone to erosion by water are rare across all route options, while soils prone to erosion by wind are present to similar extents across the routes. The susceptibility to soil compaction is similar for all route options, as the occurrence of hydric soils is somewhat similar among the four route alternatives and the Applicant's preferred route. The presence of other compaction-prone soils is not common (Table 6.3.2-3). The

potential for soil mixing from soil removal and soil contamination from minor spills during construction would be the same for all route options.

The need for bedrock removal from blasting is likely similar across the Applicant's preferred route and the route alternatives. One minor segment of shallow bedrock along the Applicant's preferred route has been documented to require blasting. Shallow bedrock likely would require blasting in some isolated eastern segments of all four route alternatives, but the specific need for blasting along the route alternatives cannot be determined without field-specific geotechnical studies. The potential for encountering scientifically significant fossil-bearing layers is low across all routes. For the most part, the terrain is flat through all route options, and any impacts on topography would be negligible to minor for all route options.

Landslide potential is similarly low for all the route options, with an elevated hazard in only isolated minor areas for all route options. Known karst conditions are present along approximately 12 miles of RA-03AM where the pipeline would cross through Pine County, with a potential for subsidence and sinkhole formation. No known karst features are present along the Applicant's preferred route or the other three route alternatives.

The greatest impact on soils during operations would be the loss of soil cover associated with aboveground facilities; these losses would be permanent and minor for the Applicant's preferred route and all route alternatives. The extent of permanent soil conversion to an impervious surface for all route alternatives would be expected to comparable to the Applicant's preferred route (283 acres), although the permanent conversion of soil to an impervious surface would be slightly higher for RA-03AM because it would require additional pump stations.

6.3.2.4.2 Mitigation

Beyond the potential for an unanticipated discovery of and damage to a rare paleontological resource, no major impacts are expected on geologic and soil resources associated with the Applicant's preferred route or any route alternative. Beyond the Applicant-proposed measures described for the Applicant's preferred route, no mitigation measures have been identified to further avoid and minimize impacts on geology and soils.

Table 6.3.2-3. Summary of Potential Impacts on Geology and Soils for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Prone to soil erosion by wind or water	Temporary to short-term/ minor localized impacts • 86.0 miles	Temporary to short-term/ minor localized impacts • 74.0 miles	Temporary to short-term/ minor localized impacts • 50.8 miles	Temporary to short-term/ minor localized impacts • 84.4 miles	Temporary to short-term/ minor localized impacts • 64.2 miles
Prone to soil compaction, hydric, or other sensitive soils	Temporary/negligible to minor localized impacts • 68.4 miles	Temporary/negligible localized impacts • 53.3 miles	Temporary/negligible to minor localized impacts • 93.6 miles	Temporary/negligible to minor localized impacts • 64.4 miles	Temporary/negligible to minor localized impacts • 72.0 miles
Increase in soil mixing	Short-term/negligible to minor impacts	Short-term/negligible to minor impacts	Short-term/negligible to minor impacts	Short-term/negligible to minor impacts	Short-term/negligible to minor impacts
Potential for soil contamination from minor spills	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts
Potential for shallow bedrock blasting[a]	Permanent/minor impacts • 0.3 mile	Permanent/minor impacts • *The extent of blasting required is unknown.*			
Potential paleontological disturbance from excavation or blasting[a]	Permanent/negligible to major impacts	Permanent/negligible to major impacts	Permanent/negligible to major impacts	Permanent/negligible to major impacts	Permanent/negligible to major impacts
Potential for modifications to topography	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts	Temporary/negligible to minor localized impacts
	Permanent/minor modifications to topography (e.g., excavations for foundations, permanent road grading) for some aboveground facilities (e.g., pump stations, mainline valves, cathodic protection systems, and permanent access roads); locations of these facilities have not been determined for the route alternatives.				

Table 6.3.2-3. Summary of Potential Impacts on Geology and Soils for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Operations Impacts					
Permanent loss of soil cover	Permanent/minor impacts • 282.6 acres	Permanent/minor impacts[b]	Permanent/minor impacts[b]	Permanent/minor impacts[b]	Permanent/minor impacts[b]
Potential for soil erosion and compaction	Permanent/negligible to minor localized impacts	Permanent/negligible to minor localized impacts	Permanent/negligible to minor localized impacts	Permanent/negligible to minor localized impacts	Permanent/negligible to minor localized impacts
Landslide hazard?	Yes	Yes	Yes	Yes	Yes
Subsidence or sinkhole hazard?	No	Yes	No	No	No

[a] Shallow bedrock likely would require blasting in some isolated eastern segments of all four route alternatives, but the specific need for blasting along the route alternatives cannot be determined without field-specific geotechnical studies.

[b] Permanent loss of soil cover is not quantifiable for the route alternatives because the specific locations of activities and facilities are not known.

6.3.2.5 References

Enbridge Energy, Limited Partnership (Enbridge). 2016a. Environmental Assessment Worksheet (EAW). November. Response to Data Request 01 to provide additional details for the EAW filed by Enbridge in April 2015.

_____. 2016b. Response to Data Request 2 (submitted on November 18, 2016) for more information on blasting techniques. Received on December 1.

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_____. 2016b. Karst Feature Inventory Points. https://gisdata.mn.gov/dataset/geos-karst-feature-inventory-pts. Accessed on November 15, 2016.

Minnesota Geological Survey (MGS). 2016. Geologic Map of Minnesota – Bedrock Geology. https://gisdata.mn.gov/dataset/geos-bedrock-geology-mn. Accessed on November 15, 2016.National Elevation Dataset Digital Elevation Models (NED DEM). 2016. http://viewer.nationalmap.gov/basic/. Accessed on December 15, 2016.

National Pipeline Mapping System Landslide Hazard Rank (NPMS LSHR). 2016. https://www.npms.phmsa.dot.gov/DisasterData.aspx. Accessed on December 15, 2016.

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Paleontology Portal. 2016. http://paleoportal.org/. Accessed on November 14, 2016.

U.S. Geological Survey (USGS). 2016. Quaternary Fault and Fold Database. http://earthquake.usgs.gov/hazards/qfaults/. Accessed on December 15, 2016.

6.3.3 Vegetation

Vegetation is a critical component of ecosystem sustainability, as it regulates biological and biochemical cycles, influences water quality, replenishes and stabilizes soils, provides habitat for wildlife, and contributes directly and indirectly to socioeconomic benefits.

Vegetation is represented by land cover types (assemblages of plants that grow in similar habitat). The evaluation considered the existing land cover types and site-specific impacts to identify and quantify potential changes to vegetation cover, native plant communities, Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites), old-growth forests, high conservation value forests (HCVFs), and noxious weed and invasive plant distributions affected by the Applicant's preferred route and the route alternatives. The analysis of impacts on vegetation during construction and operation of the Applicant's preferred route and route alternatives considered the following:

- Loss or alteration of existing vegetation cover;
- Loss or alteration of native plant communities, including MBS Sites, old-growth forests, and HCVFs; and
- Spread of noxious weeds and invasive plants.

After providing information on applicable regulations and the methodology for review, this section describes the existing conditions within an area along the Applicant's preferred route and each of the route alternatives (RA-03AM, RA-06, RA-07, and RA-08) where vegetation could be affected by construction and operation of the Project. Next, the potential Project-related impacts of construction and operation on vegetation are discussed for the five route options (the Applicant's preferred route and the four route alternatives). The impact analysis focuses on the segments of the route alternatives between Clearbrook and Carlton, as described below. A summary and comparison of the impacts are included at the end of the section. Chapter 10 addresses the potential impacts on vegetation from an unanticipated crude oil release.

6.3.3.1 Regulatory Context and Methodology

6.3.3.1.1 Regulatory Context

Regulations pertaining to the conservation, protection, and management of vegetation are established at various levels of federal, state, and local government. Conservation and protection activities regarding sensitive plant resources are managed by federal and state agencies. State regulatory protection for calcareous fens and other wetlands are addressed in Section 6.3.1. Other regulatory measures protect federally and state-listed endangered or threatened plants, as discussed in the Section 6.3.5.

Native plant communities (defined under Methodology) are naturally occurring vegetation with considerable resource value. In Minnesota, conservation and protection activities are managed by Minnesota DNR. Data collected are used to identify native plant community types, evaluate quality and quantity, assign rarity, and provide recommendations for land management practices to avoid and minimize disturbance of rare resources. Few regulations provide protection for native plant communities, although resource agencies devote considerable expense to their conservation for ecological and public values.

A "noxious weed" is "any plant or plant product that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture, irrigation, navigation, natural resources of the United States, public health, or the environment" as defined in the U.S. Plant Protection Act of 2000 (7 U.S. Code 7701–7772). "Invasive plants" are non-native plants also identified as potential threats to the natural environment because of their ability to dominate and exclude other vegetation. Weed and invasive plant classifications and rules vary between regulating agencies.

In Minnesota, the Department of Natural Resources is responsible for state-prohibited and state-regulated invasive aquatic plants, and the Department of Agriculture is responsible for state-prohibited and state-regulated terrestrial plants classified as noxious weeds under the Minnesota Noxious Weed Law (Minn. Stat. § 18.75 to 18.91).

6.3.3.1.2 Methodology

Existing vegetation resources were identified and analyzed using multiple information sources, starting at a broad scale and narrowing to a more localized scale. These data provided consistent classification and nomenclature of vegetation that allowed comparison of the impacts of the Applicant's preferred route and the route alternatives on specific vegetation resources at different levels

The vegetation evaluation considered impacts on Minnesota Ecological Classification System (ECS) units, NLCD landcover types, MBS Sites and native plant communities, old-growth forests, HCVFs, and noxious weeds and invasive plants that may occur from construction and operation of the Project.

Minnesota's ECS is used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. Like EPA's ecoregions used in the Chapter 5 analysis, the ECS integrates biotic and environmental factors (e.g., climate, geology, topography, soils, hydrology, and vegetation) in a hierarchical framework to identify increasingly fine gradations of landscape characteristics. A full description of this system is available on Minnesota DNR's website (http://www.dnr.state.mn.us/ecs/index.html) (Minnesota DNR 2016a). The following levels of the ECS framework are referenced.

Provinces: units of land defined using major climate zones, native vegetation, and biomes such as prairies, deciduous forests, or boreal forests. There are 4 Provinces in Minnesota.

Sections: units within provinces that are defined by origin of glacial deposits, regional elevation, distribution of plants, and regional climate. Minnesota has 10 sections.

Subsections: units within sections that are defined using glacial deposition processes, surface bedrock formations, local climate, topographic relief, and the distribution of plants, especially trees. Minnesota has 26 subsections.

The NLCD (Homer et al. 2015) was used to analyze construction and operations impacts on 10 broad-scale land classes of vegetation cover. The NLCD uses a combination of satellite imagery, national vegetation survey data, and local vegetation survey data to provide a spatial reference and descriptive data for characteristics of the land surface by grouping similar types of land cover into a variety of classifications (e.g., developed, forested, and cultivated).

Not all of the NLCD cover classifications are used in this analysis. For example, because the category of developed lands (residential, commercial, and industrial lands) primarily include artificially created

landscapes with minimal naturally occurring vegetation, these lands were not included in the vegetation impact summaries.

The NLCD vegetation cover classes that are within the ROI for the Applicant's preferred route and route alternatives are defined in Table 6. 3.3-1 below and illustrated in Figure 6.3.3-1 under Existing Conditions.

Table 6.3.3-1. National Land Cover Database Land Cover Classifications

Classification	Definition
Barren land (rock/sand/clay)	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.
Deciduous forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
Shrub/scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes true shrubs, young trees in an early successional stage, and trees stunted from environmental conditions.
Grassland/herbaceous	Areas dominated by graminoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing.
Pasture/hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Cultivated crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Woody wetlands	Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Emergent herbaceous wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

MBS Sites are extensive landscape areas mapped by Minnesota DNR staff that communicate the native biological diversity significance of each site to natural resource professionals, state and local government officials, and the public. Mapping is still being conducted for portions of the northern-most counties crossed by all routes. MBS Sites are rated for a suite of biodiversity values and are assigned a rank from "outstanding" to "below." The biodiversity ranks help to guide conservation and management. (Refer to the ranking criteria in Section 6.3.5, "Minnesota Biological Survey Sites of

Biodiversity Significance.") Outstanding and high-ranked sites are of most concern for conservation, as they contain rare species, native plant communities, and intact landscapes (Figure 5.2.3-2).

Minnesota native plant communities are groups of native plants that associate with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable plant communities that re-occur in similar ecological conditions. Native plant community mapping continues across the state; all completed MBS Sites have native plant community mapping done only within outstanding and high ranked units. Native plant communities are also mapped outside of MBS Sites. Native plant communities are ranked by state conservation status, which reflects the level of rarity across the state. The conservation status ranks range from S1 – critically imperiled to S5 – secure, common, widespread, and abundant; native plant communities ranked as S1 – critically imperiled, S2 – imperiled, and S3 – vulnerable to extirpation or extinction are considered to be "rare."

Old-growth forests, identified in Minnesota DNR's Forest Stand Inventory, are designated forests in Minnesota that have not experienced severe, stand-replacing disturbance over the last 120 years. Old-growth forests are recognized as valuable resources in Minnesota and are protected from harvesting operations. They provide unique wildlife habitat, rare plant refugia, genetic reservoirs, and research opportunities.

Minnesota DNR requires designation of HCVFs as part of the Forest Stewardship Council's forest certification (Minnesota DNR 2016f). HCVFs are forest areas that contain concentrations of rare, threatened, or endangered species; natural communities; and other biodiversity values that occur in numbers, frequency, quality, and/or density that are sufficiently outstanding to be considered unique or highly important in comparison with other forest areas within the ecoregion. HCVF lands are managed for a broad set of objectives and forest resources in a manner that will maintain or enhance these values across the landscape.

Impacts related to vegetation were evaluated by overlaying construction work areas of the Applicant's preferred route and route alternatives with:

- Minnesota DNR ECS maps (Minnesota DNR 2016a) to identify and quantify broad-scale patterns of existing vegetation within the pipeline corridors;
- NLCD (Homer et al. 2015) to quantify site-specific construction and operations impacts;
- MBS Sites (Minnesota DNR 2016e) to identify areas of biological integrity and quantify construction and operations impacts;
- Locations of Minnesota native plant communities, including rare native plant communities (Minnesota DNR 2016c) to quantify site-specific construction and operations impacts;
- Minnesota DNR Forest Stand Inventory (Minnesota DNR 2016c) old-growth forest stand data to quantify site-specific construction and operations impacts;
- HCVF maps (Minnesota DNR 2016f) to identify forests of outstanding biological or cultural significance in order to quantify site-specific construction and operations impacts; and
- Minnesota noxious weed and invasive plant data layers (University of Georgia 2016; Minnesota DA 2016; Minnesota DNR 2016d) to identify infestations that could be spread by construction activities.

The ROI for this evaluation generally encompasses the area that could be directly or indirectly affected by pipeline construction within 0.5 mile of the centerline of the pipeline routes. To assess and quantify the magnitude of impacts, the analysis drew on the land cover and vegetation datasets referenced above to identify the number of acres of each vegetation type or native plant resource that could be affected.

Vegetation impacts for the Applicant's preferred route were based on refined footprints provided by the Applicant that identify the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations. Dimensions for these footprints are included in the Project description.

Construction impacts for route alternatives RA-03AM, RA-06, and RA-08 were estimated by overlaying a 120-foot-wide construction work area centered on the pipeline route alternative onto available vegetation maps. Construction impacts for route alternative RA-07 were estimated by overlaying a 205-foot-wide construction work area (this width extended 10 feet on the north side of the existing Line 3 pipeline permanent right-of-way and 195 feet on the south side of the existing Line 3 pipeline permanent right-of-way). Operations impacts for all route options were estimated by overlaying a 50-foot-wide operations right-of-way onto available vegetation maps.

Impacts associated with construction activities would be common regardless of pipeline route and were identified based on construction methods described in Enbridge's November 2016 EAW (Enbridge 2016).

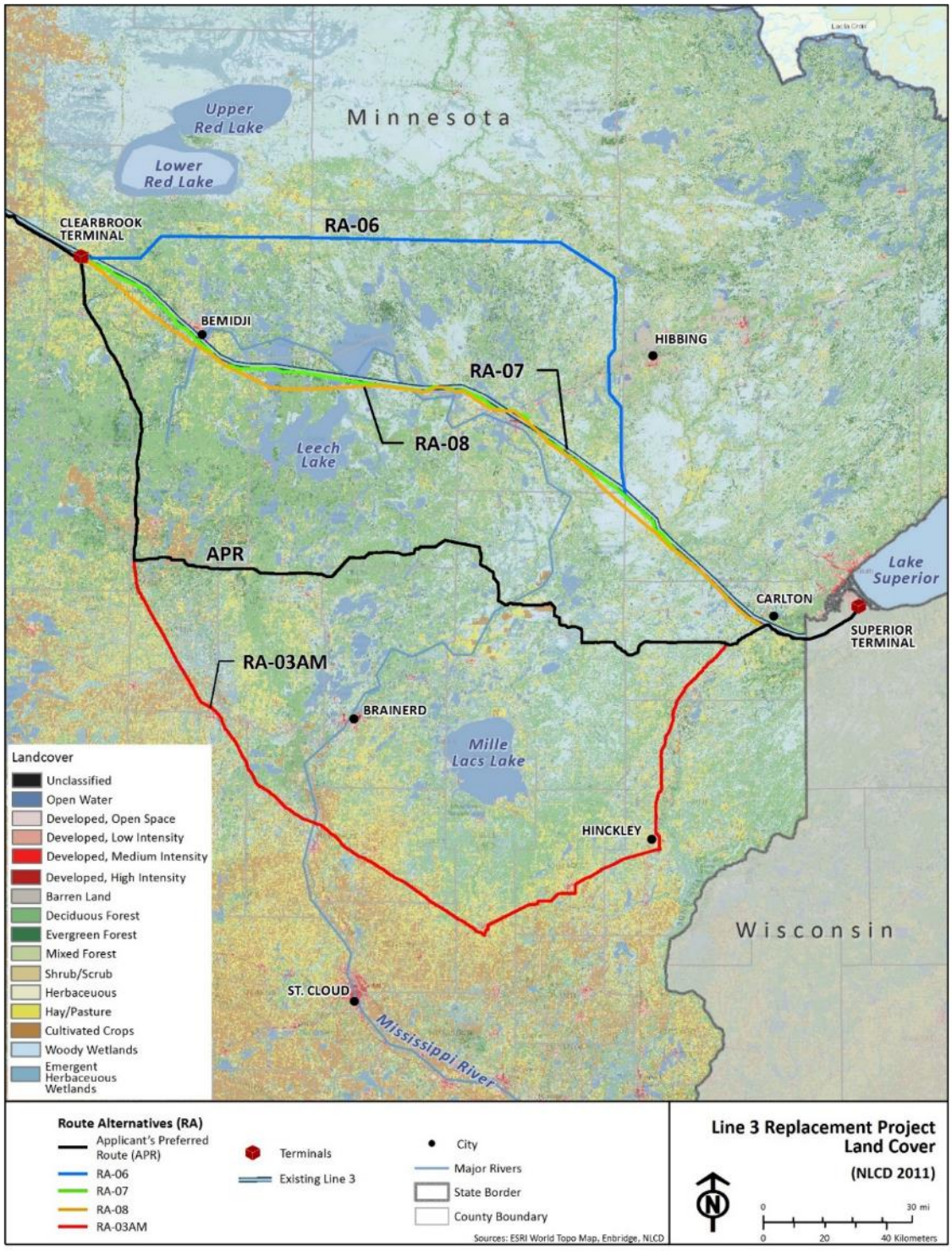
All of the route alternatives have the same route between the North Dakota border and Clearbrook, and from Carlton to the Wisconsin border. Therefore, the comparison of impacts among the route alternatives focuses on the segments of the routes between Clearbrook and Carlton.

6.3.3.2 Existing Conditions

Every ECS province (the largest land classification areas) is crossed by one or more of the Applicant's preferred route and pipeline route alternatives. The route alternatives largely occur within the Laurentian Mixed Forest province. Between Clearbrook and Carlton, the ECS provinces transition (west to east) from grasslands and parklands to uplands and peatlands dominated by forests. The next classification level is the ECS section. Eight ECS sections occur within the ROI for one or more of the route options (the Applicant's preferred route and the route alternatives) addressed in this chapter.

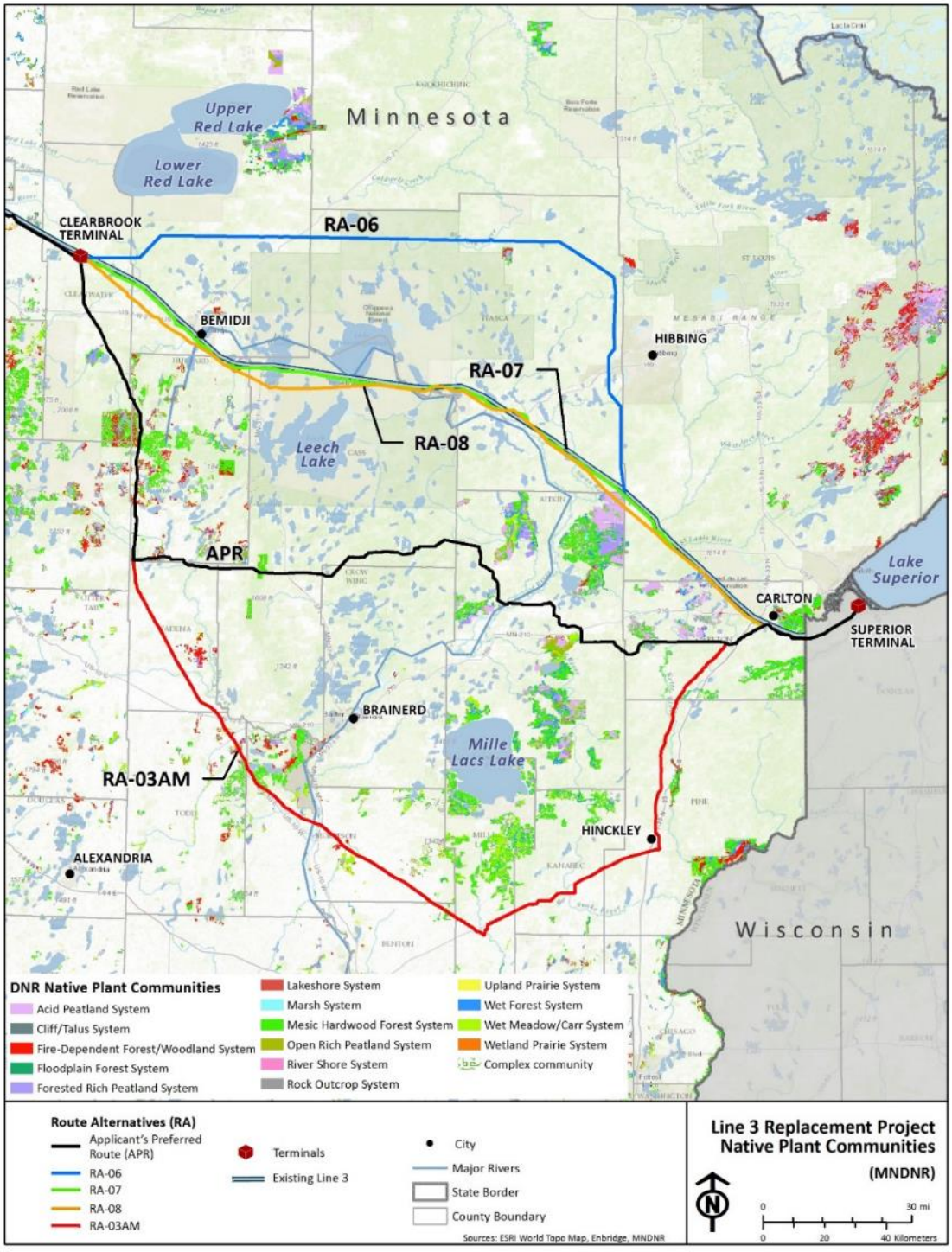
Figure 6.3.3-1 shows the distribution of NLCD vegetation in Minnesota (broad-scale vegetation cover classes, as described in the NLCD, Homer et al. 2015) along the route alternatives. Color gradations from yellow to green show landscape level changes from prairie and farmland to forest cover types.

Figure 6.3.3-2 illustrates the MBS Sites crossed by the Applicant's preferred route and route alternatives.



Source: Homer et al. 2015.

Figure 6.3.3-1. NLCD Vegetation Cover Crossed by the Applicant's Preferred Route and Route Alternatives in Minnesota



Source: Minnesota DNR 2016c.

Figure 6.3.3-2. Native Plant Community Systems Crossed by the Applicant's Preferred Route and Route Alternatives in Minnesota

6.3.3.2.1 Applicant's Preferred Route

Ecological Classifications and Vegetation Cover

The Applicant's preferred route crosses all four ECS provinces within Minnesota and two ECS provinces between Clearbrook and Carlton. The Applicant's preferred route would cross through three ECS sections before Clearbrook. From Clearbrook to Carlton, the Applicant's preferred route is almost entirely within one section; close to Carlton, the Applicant's preferred route crosses through two sections before the Wisconsin border (Table 6.3.3-2.).

Table 6.3.3-2. Minnesota Ecological Sections Crossed by the Applicant's Preferred Route

Province	Section	Subsection	Total Distance Crossed within Minnesota (miles)	Distance Crossed between Clearbrook and Carlton (miles)
Prairie Parklands	Red River Valley	Red River Prairie	35.1	--
Prairie Parklands subtotal			***35.1***	***--***
Tallgrass Aspen Parklands	Lake Agassiz, Aspen Parklands	Aspen Parklands	61.6	--
Tallgrass Aspen Parklands subtotal			***61.6***	***--***
Eastern Broadleaf Forest	Minnesota & NE Iowa Morainal	Hardwood Hills	20.9	8.5
Eastern Broadleaf Forest subtotal			***20.9***	***8.5***
Laurentian Mixed Forest	N. Minnesota Drift & Lake Plains	Chippewa Plains	31.5	31.5
		Pine Moraines & Outwash Plains	94.7	94.7
		St. Louis Moraines	36.6	36.6
		Tamarack Lowlands	31.3	31.3
	Southern Superior Uplands	Glacial Lake Superior Plain	7.1	--
	Western Superior Uplands	Mille Lacs Uplands	20.8	18.2
Laurentian Mixed Forest subtotal			***222.1***	***212.4***
TOTAL			**339.6**	**220.9**

Source: Minnesota DNR 2016a.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

See Appendix K, Table K-1 for additional detail.

"--" = no occurrence

Review of the NLCD land cover patterns demonstrates that the Applicant's preferred route primarily occurs within areas dominated by forests (e.g., deciduous forest, woody wetland), shorter canopied scrub/shrub, and agricultural (e.g., hay/pasture, cultivated crops) cover classes (Figure 6.3.3-1).

MBS Sites and Native Plant Communities

Native plant community systems that occur within 0.5 mile of the Applicant's preferred route include 11 sensitive prairie, wetland, and forest systems. These primarily consist of forested and wetland forested systems, including acid peatland system, complex community, fire-dependent forest/woodland system, floodplain forest system, forested rich peatland system, marsh system, mesic hardwood forest system, open rich peatland system, upland prairie system, wet forest system, and wet meadow/Carr system (Aaseng et al. 2011). These occur within MBS Sites that are ranked as moderate to outstanding under the MBS Sites of Biodiversity significance ranking (Figure 6.2.3-2). Specific locations for moderate- to outstanding-ranked MBS Sites and the imbedded native plant communities relative to the location of the Applicant's preferred route are shown in detail in Appendix A.

Nineteen rare native plant community types (with S1, S2, or S3 conservation rank) were documented within 0.5 mile of the Applicant's preferred route. Three old-growth forest stands were identified within 0.5 mile of the Applicant's preferred route: two ash and one Norway pine. In addition, one HCVF was identified within 0.5 mile of the Applicant's preferred route (Kettle Lake Peatlands HCVF).

Noxious Weeds and Invasive Plants

A total of 18 noxious weed and invasive plant species have been reported near the Applicant's preferred route, totaling 413 occurrences in Minnesota and 401 occurrences between Clearbrook and Carlton (Table 6.3.3-3). Noxious and invasive weeds occurring near the Project include commonly occurring Midwest weeds such as reed canary grass, common tansy, spotted knapweed, and thistle.

Table 6.3.3-3. Noxious Weeds and Invasive Plants within 0.5 Mile of the Applicant's Preferred Route

Common Name	Scientific Name	Minnesota Status[a]	Occurrences within Minnesota[b]	Occurrences between Clearbrook and Carlton[c]
Alyssum, hoary	*Berteroa incana*	NR	1	1
Daisy, oxeye	*Leucanthemum vulgare*	NR	5	5
Grass, reed canary	*Phalaris arundinacea*	NR	66	65
Grass, smooth brome	*Bromus inermis*	NR	14	14
Hawkweed, orange	*Hieracium aurantiacum*	NR	3	3
Honeysuckle, exotic	*Lonicera* spp.	NR	1	1
Knapweed, spotted	*Centaurea stoebe*	PNW	48	47
Peashrub, Siberian	*Caragana arborescens*	NR	1	1
Spurge, leafy	*Euphorbia esula*	PNW	1	0
Sweetclover, white	*Melilotus alba*	NR	7	7
Sweetclover, yellow	*Melilotus officinalis*	NR	5	5
Tansy	*Tanacetum vulgare*	PNW	115	107
Thistle	*Various*	NR	92	92
Thistle, bull	*Cirsium vulgare*	NR	14	14
Thistle, Canada	*Cirsium arvense*	PNW	18	18
Thistle, plumeless	*Carduus acanthoides*	PNW	1	1
Thistle, sow	*Sonchus arvensis*	NR	9	9
Trefoil, birdsfoot	*Lotus corniculatus*	NR	12	11
Number of Taxa			***18***	***17***
Total Number of Occurrences			**413**	**401**

Sources: Minnesota DNR 2016d; Minnesota DA 2016.

Notes:

See Appendix K, Table K-2 for additional detail.

[a] PNW – prohibited noxious weed, RNW – regulated noxious weed, SRP – specially regulated plants, NR – not regulated

[b] Number of occurrences of infestations within 0.5 mile of the centerline of the Applicant's preferred route in Minnesota.

[c] Number of occurrences of infestations within 0.5 mile of the centerline of the Applicant's preferred route between Clearbrook and Carlton, Minnesota.

6.3.3.2.2 Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to vegetation for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Ecological Classifications and Vegetation Cover

Two ECS provinces would be crossed by route alternative RA-03AM: Eastern Broadleaf Forest and Laurentian Mixed Forest (Table 6.3.3-4). RA-03AM largely occurs within the Laurentian Mixed Forest province. Three ECS sections would be crossed by RA-03AM. RA-03AM crosses 10 broad-scale vegetation cover classes as described in the NLCD: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Homer et al. 2015). Figure 6.3.3-1 shows the distribution of vegetation cover along the route alternatives. Review of these broad-scale vegetation cover patterns demonstrates that RA-03AM is primarily located within areas dominated by agricultural (e.g., hay/pasture and cultivated crops) and deciduous forest cover classes.

Table 6.3.3-4. Minnesota Ecological Sections Crossed by Route Alternative RA-03AM

Province	Section	Subsection	Distance Crossed (miles)
Eastern Broadleaf Forest	Minnesota & NE Iowa Morainal	Anoka Sand Plain	10.7
		Hardwood Hills	24.0
Eastern Broadleaf Forest subtotal			***34.7***
Laurentian Mixed Forest	N. Minnesota Drift & Lake Plains	Chippewa Plains	31.5
		Pine Moraines & Outwash Plains	78.3
	Western Superior Uplands	Mille Lacs Uplands	130.2
Laurentian Mixed Forest subtotal			***240.0***
TOTAL			**274.7**

Source: Minnesota DNR 2016a.

Note:

See Appendix K, Table K-1 for additional detail.

Native Plant Communities

Between Clearbrook and Carlton, 87 acres of native plant communities have been documented within the construction work area for RA-03AM, 36 acres have been documented within the operations right-of-way, and 7,732 acres have been documented within 0.5 mile of the pipeline centerline (Minnesota DNR 2016b, 2016e). Minnesota native plant community systems that occur within 0.5 mile from RA-03AM are primarily mesic hardwood forest and fire dependent forest/ woodland. Native plant community systems crossed by RA-03AM are shown in Figure 6.3.3-2 (Minnesota DNR 2016c). Specific locations for moderate- to outstanding-ranked MBS Sites and imbedded native plant communities relative to the location of RA-03AM are shown in greater detail in Appendix A. Rare native plant community types (with S1, S2, or S3 conservation rank) also occur within the construction work area and

permanent right-of-way for RA-03AM, including oak-aspen forest and black ash – (red maple) seepage swamp. One old-growth forest stand type (Norway pine) was identified within 0.5 mile of RA-03AM. No HCVFs occur within or near the route.

Noxious Weeds and Invasive Plants

A total of 23 noxious weed and invasive plant species have been reported within 0.5 mile of RA-03AM, totaling 314 occurrences between Clearbrook and Carlton (Table 6.3.3-5). Noxious and invasive weeds occurring near the route include commonly occurring Midwest weeds, such as reed canary grass, common tansy, and thistle.

Table 6.3.3-5. Noxious Weeds and Invasive Plants within 0.5 Mile of Route Alternative RA-03AM

Common Name	Scientific Name	Minnesota Status[a]	Occurrences[b]
Alyssum, hoary	*Berteroa incana*	NR	1
Buckthorn, common	*Rhamnus cathartica*	RNW	18
Creeping Charlie	*Glechoma hederacea*	NR	1
Daisy, oxeye	*Leucanthemum vulgare*	NR	5
Elm, Siberian	*Ulmus pumila*	NR	1
Grass, reed canary	*Phalaris arundinacea*	NR	14
Grass, smooth brome	*Bromus inermis*	NR	14
Hawkweed, orange	*Hieracium aurantiacum*	NR	7
Honeysuckle, exotic	*Lonicera* spp.	NR	2
Knapweed, spotted	*Centaurea stoebe*	PNW	53
Maple, amur	*Acer ginnala*	NR	1
Mullein, common	*Verbascum thapsus*	NR	1
Peashrub, Siberian	*Caragana arborescens*	NR	4
Sweetclover, white	*Melilotus alba*	NR	9
Sweetclover, yellow	*Melilotus officinalis*	NR	5
Tansy	*Tanacetum vulgare*	PNW	76
Thistle	*Various*	NR	34
Thistle, bull	*Cirsium vulgare*	NR	23
Thistle, Canada	*Cirsium arvense*	PNW	29
Thistle, sow	*Sonchus arvensis*	NR	1
Trefoil, birdsfoot	*Lotus corniculatus*	NR	11
Vetch, cow	*Vicia cracca*	NR	1
Vetch, crown	*Coronilla varia*	NR	3
Number of Taxa			***23***
TOTAL NUMBER OF OCCURRENCES			**314**

Sources: Minnesota DNR 2016d; Minnesota DA 2016.

Notes:

See Appendix K, Table K-2 for additional detail.

[a] PNW – prohibited noxious weed, RNW – regulated noxious weed, SRP – specially regulated plants, NR – not regulated

[b] Number of occurrences of infestations within 0.5 mile of the centerline of the RA-03AM route between Clearbrook and Carlton, Minnesota.

Route Alternative RA-06

Ecological Classifications and Vegetation Cover

Two ECS provinces would be crossed by route alternative RA-06: Eastern Broadleaf Forest and Laurentian Mixed Forest (Table 6.3.3-6). RA-06 is largely located within the Laurentian Mixed Forest province. Five ECS sections would be crossed by RA-06. RA-06 crosses 10 broad-scale vegetation cover classes, as described in the NLCD: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Homer et al. 2015). Figure 6.3.3-1 shows the distribution of vegetation cover along the route alternative. Review of these broad-scale vegetation cover patterns demonstrates that RA-06 is primarily located within areas dominated deciduous forest, and woody wetland cover classes.

Table 6.3.3-6. Minnesota Ecological Sections Crossed by Route Alternative RA-06

Province	Section	Subsection	Distance Crossed (Miles)
Eastern Broadleaf Forest	Minnesota & NE Iowa Morainal	Hardwood Hills	9.6
Eastern Broadleaf Forest subtotal			***9.6***
Laurentian Mixed Forest	N. Minnesota & Ontario Peatlands	Littlefork-Vermillion Uplands	21.2
	N. Minnesota Drift & Lake Plains	Chippewa Plains	54.9
		St. Louis Moraines	29.2
		Tamarack Lowlands	29.4
	Northern Superior Uplands	Nashwauk Uplands	30.9
		North Shore Highlands	17.0
	Western Superior Uplands	Mille Lacs Uplands	3.7
Laurentian Mixed Forest subtotal			***186.3***
TOTAL			**195.9**

Source: Minnesota DNR 2016a.

Note:

See Appendix K, Table K-1 for additional detail.

Native Plant Communities

Native plant community systems that occur within the construction work area and permanent right-of-way for RA-06 include acid peatland system, forested rich peatland system and small portions of mesic hardwood forest system and wet forest system. No rare native plant community types are documented within or near (within 0.5 mile) the construction work area or permanent right-of-way. Native plant community systems crossed by RA-06 are shown in Figure 6.3.3-2 (Minnesota DNR 2016c). Specific locations for moderate- to outstanding-ranked MBS Sites and imbedded native plant communities relative to the location of RA-06 are show in greater detail in Appendix A. Three old-growth forest stand types were identified within 0.5 mile of RA-06, including aspen, birch, and Norway pine. No HCVFs occur within 0.5 mile of the route.

Noxious Weeds and Invasive Plants

A total of 13 noxious weed and invasive plant species have been reported within 0.5 mile of RA-06, totaling 408 occurrences between Clearbrook and Carlton (Table 6.3.3-7). Noxious and invasive weeds occurring near the route include commonly occurring Midwest weeds, such as reed canary grass, common tansy, and thistle.

Table 6.3.3-7. Noxious Weeds and Invasive Plants within 0.5 Mile of Route Alternative RA-06

Common Name	Scientific Name	Minnesota Status[a]	Occurrences[b]
Daisy, oxeye	*Leucanthemum vulgare*	NR	5
Grass, reed canary	*Phalaris arundinacea*	NR	106
Grass, smooth brome	*Bromus inermis*	NR	1
Knapweed, spotted	*Centaurea stoebe*	PNW	21
Parsnip, wild	*Pastinaca sativa*	PNW	6
Peashrub, Siberian	*Caragana arborescens*	NR	2
Sweetclover, white	*Melilotus alba*	NR	12
Sweetclover, yellow	*Melilotus officinalis*	NR	2
Tansy	*Tanacetum vulgare*	PNW	108
Thistle	*Various*	NR	117
Thistle, bull	*Cirsium vulgare*	NR	1
Thistle, Canada	*Cirsium arvense*	PNW	17
Trefoil, birdsfoot	*Lotus corniculatus*	NR	10
Number of Taxa			***13***
TOTAL NUMBER OF OCCURRENCES			**408**

Sources: Minnesota DNR 2016d; Minnesota DA 2016.

Notes:

See Appendix K, Table K-2 for additional detail.

[a] PNW – prohibited noxious weed, RNW – regulated noxious weed, SRP – specially regulated plants, NR – not regulated

[b] Number of occurrences of infestations within 0.5 mile of the RA-06 route between Clearbrook and Carlton, Minnesota.

Route Alternative RA-07

Ecological Classifications and Vegetation Cover

Two ECS provinces would be crossed by route alternative RA-07: Eastern Broadleaf Forest and Laurentian Mixed Forest provinces (Table 6.3.3-8). RA-07 is largely located within the Laurentian Mixed Forest province. Four ECS sections would be crossed by RA-07. RA-07 crosses 10 broad-scale vegetation cover classes as described in the NLCD: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Homer et al. 2015). Figure 6.3.3-1 shows the distribution of vegetation cover along the route alternative. Review of these broad-scale vegetation cover patterns demonstrates that RA-07 is primarily located within areas dominated by woody wetland, deciduous forest, and emergent herbaceous wetlands cover classes.

Table 6.3.3-8. Minnesota Ecological Sections Crossed by Route Alternative RA-07

Province	Section	Subsection	Distance Crossed (Miles)
Eastern Broadleaf Forest	Minnesota & NE Iowa Morainal	Hardwood Hills	6.2
Eastern Broadleaf Forest subtotal			***6.2***
Laurentian Mixed Forest	N. Minnesota Drift & Lake Plains	Chippewa Plains	87.3
		St. Louis Moraines	16.0
		Tamarack Lowlands	37.6
	Northern Superior Uplands	North Shore Highlands	17.0
	Western Superior Uplands	Mille Lacs Uplands	3.7
Laurentian Mixed Forest subtotal			***161.6***
TOTAL			**167.7**

Source: Minnesota DNR 2016a.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

See Appendix K, Table K-1 for additional detail.

Native Plant Communities

Between Clearbrook and Carlton, 65 acres of native plant communities have been documented within the construction work area for RA-07, 4 acres have been documented within the operations permanent right-of-way, and 1,807 acres have been documented within 0.5 mile of the route. Minnesota native plant community systems that occur within the construction work area for RA-07 are primarily forested and wetland forested systems, including acid peatland system, fire-dependent forest/woodland system, forested rich peatland system, mesic hardwood forest system, open rich peatland system, wet forest system, and wet meadow/Carr system (Aaseng et al. 2011). Native plant community systems crossed by RA-07 are shown in Figure 6.3.3-2 (Minnesota DNR 2016c). Specific locations for moderate- to outstanding- ranked MBS Sites and imbedded native plant communities relative to the location of RA-07 are shown in greater detail in Appendix A. Rare native plant communities, including Jack pine – (yarrow) woodland and oak – aspen forest also occur within the construction work area and permanent right-of-way. Three old-growth forest stand types (aspen, Norway pine, and white cedar) were identified within 0.5 mile of RA-07. No HCVFs occur within 0.5 mile of the route.

Noxious Weeds and Invasive Plants

A total of 20 noxious weed and invasive plant species have been reported within 0.5 mile of RA-07, totaling 1,002 occurrences between Clearbrook and Carlton (Table 6.3.3-9). Noxious and invasive weeds occurring near the route include commonly occurring Midwest weeds, such as reed canary grass, common tansy, spotted knapweed, and thistle.

Table 6.3.3-9. Noxious Weeds and Invasive Plants within 0.5 Mile of Route Alternative RA-07

Common	Scientific Name	Minnesota Status[a]	Occurrences[b]
Daisy, oxeye	*Leucanthemum vulgare*	NR	26
Grass, amur silver	*Miscanthus sacchariflorus*	NR	1
Grass, reed canary	*Phalaris arundinacea*	NR	316
Hawkweed, orange	*Hieracium aurantiacum*	NR	1
Honeysuckle, exotic	*Lonicera* spp.	NR	1
Knapweed, spotted	*Centaurea stoebe*	PNW	110
Locust, black	*Robinia pseudoacacia*	NR	4
Loosestrife, purple	*Lythrum salicaria*	PNW	4
Maple, amur	*Acer ginnala*	NR	4
Parsnip, wild	*Pastinaca sativa*	PNW	128
Peashrub, Siberian	*Caragana arborescens*	NR	5
Rose, multi-flora	*Rosa multiflora*	RNW	2
Spurge, leafy	*Euphorbia esula*	PNW	4
Sweetclover, white	*Melilotus alba*	NR	43
Tansy	*Tanacetum vulgare*	PNW	150
Thistle	*Various*	NR	117
Thistle, bull	*Cirsium vulgare*	NR	1
Thistle, Canada	*Cirsium arvense*	PNW	34
Trefoil, birdsfoot	*Lotus corniculatus*	NR	50
Vetch, crown	*Coronilla varia*	NR	1
Number of Taxa			**20**
TOTAL NUMBER OF OCCURRENCES			**1,002**

Sources: Minnesota DNR 2016d; Minnesota DA 2016.

Notes:

See Appendix K, Table K-2 for additional detail.

[a] PNW – prohibited noxious weed, RNW – regulated noxious weed, SRP – specially regulated plants, NR – not regulated

[b] Number of occurrences of infestations within 0.5 mile of the RA-07 route between Clearbrook and Carlton, Minnesota.

Route Alternative RA-08

Ecological Classifications and Vegetation Cover

Two ECS provinces would be crossed by route alternative RA-08: Eastern Broadleaf Forest and Laurentian Mixed Forest provinces (Table 6.3.3-10). RA-08 is largely located within the Laurentian Mixed Forest province. Five ECS sections would be crossed by RA-08. RA-08 crosses 10 broad-scale vegetation cover classes as described in the NLCD: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Homer et al. 2015). Figure 6.3.3-1 shows the distribution of vegetation cover along the

route alternative. Review of these broad-scale vegetation cover patterns demonstrates that RA-08 is primarily located within areas dominated by woody wetland and deciduous forest cover classes.

Table 6.3.3-10. Minnesota Ecological Sections Crossed by Route Alternative RA-08

Province	Section	Subsection	Total Miles
Eastern Broadleaf Forest	Minnesota & NE Iowa Morainal	Hardwood Hills	6.4
Eastern Broadleaf Forest subtotal			***6.4***
Laurentian Mixed Forest	N. Minnesota & Ontario Peatlands	Chippewa Plains	87.9
	N. Minnesota Drift & Lake Plains		
		St. Louis Moraines	13.2
		Tamarack Lowlands	37.0
	Northern Superior Uplands	North Shore Highlands	16.9
	Western Superior Uplands	Mille Lacs Uplands	3.6
Laurentian Mixed Forest subtotal			***158.5***
TOTAL			**164.8**

Source: Minnesota DNR 2016a.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

See Appendix K, Table K-1 for additional detail.

Native Plant Communities

Between Clearbrook and Carlton, 50 acres of native plant communities have been documented within the construction work area for RA-08, 21 acres have been documented within the operations permanent right-of-way, and 4,234 acres have been documented within 0.5 mile of the route. Minnesota native plant community systems that occur within the construction work area for RA-08 are primarily forested and wetland forested systems, including acid peatland system, fire-dependent forest/woodland system, forested rich peatland system, mesic hardwood forest system, open rich peatland system, wet forest system, and wet meadow/Carr system (Aaseng et al. 2011). Native plant community systems crossed by RA-08 are shown in Figure 6.3.3-2 (Minnesota DNR 2016c). Specific locations for moderate- to outstanding- ranked MBS Sites and imbedded native plant communities relative to the location of RA-08 are shown in greater detail in Appendix A. Rare native plant communities (aspen – birch – fir forest, Jack pine – (yarrow) woodland, and oak – aspen forest) also occur within 0.5 mile of the route, but none occur within the construction work area or permanent right-of-way. Five old-growth forest stand types were identified within 0.5 mile of RA-08, including aspen, birch, northern hardwood, white pine, and white cedar. One HCVF (Floodwood Bog) is intersected by RA-08.

Noxious Weeds and Invasive Plants

A total of 19 noxious weed and invasive plant species have been reported within 0.5 mile of the RA-08 route, totaling 665 occurrences between Clearbrook and Carlton (Table 6.3.3-11). Noxious and invasive weeds occurring near the route include commonly occurring Midwest weeds, such as reed canary grass, common tansy, spotted knapweed, and thistle.

Table 6.3.3-11. Noxious Weeds and Invasive Plants within 0.5 Mile of Route Alternative RA-08

Common Name	Scientific Name	Minnesota Status[a]	Occurrences[b]
Alyssum, hoary	*Berteroa incana*	NR	7
Daisy, oxeye	*Leucanthemum vulgare*	NR	12
Elm, Siberian	*Ulmus pumila*	NR	4
Grass, reed canary	*Phalaris arundinacea*	NR	208
Grass, smooth brome	*Bromus inermis*	NR	9
Knapweed, spotted	*Centaurea stoebe*	PNW	56
Knotweed, giant	*Polygonum sachalinense*	SRP	1
Loosestrife, purple	*Lythrum salicaria*	PNW	2
Maple, amur	*Acer ginnala*	NR	1
Parsnip, wild	*Pastinaca sativa*	PNW	50
Peashrub, Siberian	*Caragana arborescens*	NR	4
Rose, multi-flora	*Rosa multiflora*	RNW	2
Sweetclover, white	*Melilotus alba*	NR	37
Sweetclover, yellow	*Melilotus officinalis*	NR	2
Tansy	*Tanacetum vulgare*	PNW	152
Thistle	*Various*	NR	60
Thistle, bull	*Cirsium vulgare*	NR	2
Thistle, Canada	*Cirsium arvense*	PNW	29
Trefoil, birdsfoot	*Lotus corniculatus*	NR	27
Number of Taxa			**19**
TOTAL NUMBER OF OCCURRENCES			**665**

Sources: Minnesota DNR 2016d; Minnesota DA 2016.

Notes:

See Appendix K, Table K-2 for additional detail.

[a] PNW – prohibited noxious weed, RNW – regulated noxious weed, SRP – specially regulated plants, NR – not regulated

[b] Number of occurrences of infestations within 0.5 mile of the RA-08 route between Clearbrook and Carlton, Minnesota.

6.3.3.3 Impact Assessment

This section describes the potential impacts on existing vegetation cover, rare native plant communities, and old-growth forests, and the potential spread of noxious and invasive plants. Vegetation cover would be temporarily or permanently altered by construction and operations within the affected ecoregions and rare plant communities, as discussed.

The effects of construction and operation of the Applicant's preferred route and route alternatives are described below within the following three categories:

- Loss or alteration of vegetation cover,

- Loss or alteration of native plant communities, and
- Spread of noxious weeds and invasive plants.

6.3.3.3.1 Applicant's Preferred Route (in Minnesota)

Most of the Applicant's preferred route in Minnesota (65 percent) is within the Laurentian Mixed Forest Ecological province (Table 6.3.3-2). Approximately 18 percent of the Applicant's preferred route is within the Tallgrass Aspen Parklands province.

Construction Impacts

Loss or Alteration of Vegetation Cover

As shown in Table 6.3.3-12, land cover in the construction work area of the Applicant's preferred route is comprised primarily of deciduous forest (29 percent), cultivated crops (33 percent), and hay/pasture (13.8 percent). The Clearbrook-to-Carlton segment is predominately deciduous forest (45 percent) followed by hay/pasture (14 percent), and woody wetlands (11 percent). Most (75 percent) of the Clearbrook-to-Carlton segment would be adjacent to pipeline, transmission line, or road corridors that previously have been disturbed by construction. From the North Dakota border to Clearbrook, the Minnesota segment of the route is predominately cultivated cropland (approximately 1,154 acres, or 80 percent), all of which would be co-located with the existing pipeline corridor. Over 70 percent of the Carlton, Minnesota to Wisconsin border segment consists of a combination of hay/pasture (58 acres) and deciduous forest (38 acres) vegetation cover types, all of which would be co-located along the existing pipeline corridor.

The Applicant's preferred route would result in short-term to permanent and minor to major impacts on up to approximately 5,081 acres of existing vegetation in Minnesota (Table 6.3.3-12). Permanent major impacts on up to 291 acres of vegetation would occur as a result of permanent conversion to aboveground facilities and access roads. Short-term minor impacts are expected as a result of clearing and grading of up to 3,031 acres of non-forested vegetation communities, which would be reclaimed and would return to a similar vegetation type over time following construction. Long-term major impacts on 134 acres of forested upland and wetland vegetation would occur from additional temporary workspaces and pipe yards, all of which would be reclaimed and allowed to return to forested vegetation type over time (up to 50 years for full recovery) following construction. Long-term or permanent major construction impacts would occur on 2,050 acres of forested upland and wetland vegetation, about 45 percent of which would be maintained as herbaceous vegetation within the permanent right-of-way for the life of the Project.

Additional vegetation cover impacts would occur from construction of ATWS and pipe storage yards, which would affect an additional 656 acres. Vegetation cover within these areas includes cultivated croplands (327 acres), hay/pasture (121 acres), and deciduous forest (97 acres) (Table 5.2.3-7). Cumulatively, this accounts for over 80 percent of the additional construction areas and aboveground facilities proposed for the Project.

Table 6.3.3-12. Potential Impacts on Vegetation for the Applicant's Preferred Route in Minnesota

Vegetation Cover Class	Construction Work Area[a]		Permanent Right-of-Way[b]	
	Acres	Percent	Acres	Percent
Minnesota				
Evergreen forest	198	4%	86	4%
Deciduous forest	1477	29%	670	30%
Mixed forest	20	0%	10	0%
Scrub/shrub	243	5%	125	6%
Grassland/herbaceous	164	3%	73	3%
Hay/pasture	699	14%	320	14%
Cultivated crops	1665	33%	617	28%
Woody wetlands	355	7%	185	8%
Emergent herbaceous wetlands	249	5%	132	6%
Barren land	12	0%	2	0%
MINNESOTA TOTAL	**5,081**	100%	**2,220**	100%
Clearbrook to Carlton				
Evergreen forest	173	6%	70	5%
Deciduous forest	1256	45%	554	43%
Mixed forest	18	1%	7	1%
Scrub/shrub	211	8%	104	8%
Grassland/herbaceous	94	3%	45	3%
Hay/pasture	388	14%	175	14%
Cultivated crops	173	6%	76	6%
Woody wetlands	317	11%	159	12%
Emergent herbaceous wetlands	174	6%	95	7%
Barren land	4	0%	2	0%
Clearbrook to Carlton subtotal	***2,806***	100%	***1,288***	100%

Source: Homer et al. 2015.

Notes:

See Appendix K, Table K-3 for additional detail.

[a] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[b] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

Clearing of trees within forested communities, including evergreen forest, deciduous forest, mixed forest, and woody wetland cover types, would result in long-term minor impacts totaling approximately 2,050 acres (Applicant's preferred route plus construction work areas and aboveground facilities) within the construction work areas, as these vegetation cover classes generally are considered late-succession vegetation communities and generally regenerate over longer periods of time.

Loss or Alteration of Native Plant Communities

Construction of the Applicant's preferred route would disturb a total of approximately 164 acres within 152 individual native plant communities that are associated with MBS Sites with biodiversity ranks of moderate or above (Table 6.3.3-13). Approximately 80 percent of these native plant community systems are forested uplands and wetlands; construction and operation would result in the loss of those native plant communities and habitat. Some local native plant communities may reestablish over time; however, it is expected that the quality and diversity of these communities would be lowered. Therefore, the resulting impact on the forested uplands and wetlands would be long term to permanent and major.

Most of the native plant communities that would be affected by construction are ranked moderate for biodiversity. Construction would affect approximately 4 acres of outstanding biodiversity forested rich peatlands (Table 6.3.3-13). Totals for the Clearbrook-to-Carlton segment are provided in Table 6.3.3-14. Specific locations for moderate- to outstanding-ranked MBS Site native plant communities relative to the location of the alternatives are shown in greater detail in Appendix A.

A total of 46 acres that include 39 rare plant communities would be affected by the Applicant's preferred route during construction (Table 6.3.3-15). These rare plant communities include calcareous fen and prairie wetlands located along the route from the North Dakota border to Clearbrook, Minnesota. Impacts on calcareous fens and other wetlands are further addressed in Section 6.3.1. Construction impacts on native prairies include the potential for alteration of prairie soils, loss of sensitive plant communities, and introduction of invasive plants. Direct impacts on previously untilled prairie soils and vegetation during construction are expected to be long term and could require a significant amount of time to achieve full recovery. Prior to construction, the lead and assisting agencies would be consulted on identification of avoidance and mitigation measures for rare plant communities that are located within the Applicant's preferred route and could be affected by construction or operation. Avoidance measures could include rerouting the pipeline, use of directional drilling, or preparation of and adherence to an agency-approved site-specific prairie crossing plan. Impacts on these rare native plant communities would be permanent and major. These communities are not expected to fully recover following restoration; however, in some circumstances, these communities may make a full recovery over time. Totals for the Clearbrook-to-Carlton segment are provided in Table 6.3.3-16.

Construction-related impacts on old-growth forest include potential indirect effects on one Norway pine and two ash old-growth forest stands that occur within 0.5 mile of the Applicant's preferred route; no old-growth forest stands occur within the construction work area or permanent right-of-way. Potential Indirect impacts include the spread of noxious weeds and invasive plants, and potential removal of contiguous forest areas that serve as protective buffers. No direct construction or operations impacts are expected to occur on old-growth forests from construction of the Applicant's preferred route. One HCVF (Kettle Lake Peatlands) occurs within 0.5 mile of the Applicant's preferred route; no direct construction or operations impacts on the HCVF are expected to occur.

Table 6.3.3-13 Estimated Impacts on Minnesota Native Plant Community Systems for the Applicant's Preferred Route in Minnesota

Native Plant Community System	MBS Site Biodiversity Significance Rank[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	2.4	3	1.2	3	339.5	23
Complex community	High	--	--	--	--	135.2	7
	Moderate	5.8	2	3.1	2	288.4	5
Fire-dependent forest/woodland system	Outstanding	--	--	1.5	2	267.3	32
	High	0.3	1	--	--	276.5	24
	Moderate	32.2	28	17.2	15	1,817.4	59
Forested rich peatland system	Outstanding	3.5	2	1.8	2	27.0	1
	High	17.6	6	9.7	8	650.1	32
	Moderate	5.0	6	4.6	5	442.1	19
Marsh system	Outstanding	--	--	--	--	197.2	29
	Moderate	--	--	--	--	<0.1	1
Mesic hardwood forest system	Outstanding	--	--	--	--	128.9	30
	High	9.2	9	4.0	7	565.7	30
	Moderate	54.7	44	21.1	12	1,393.5	28
Open rich peatland system	Outstanding	--	--	--	--	49.5	3
	High	--	--	--	--	7.1	1
	Moderate	5.5	10	4.3	7	514.5	16
Upland prairie system	Outstanding	--	--	--	--	37.1	6
	High	--	--	--	--	92.5	3
	Moderate	2.0	2	0.7	1	43.9	1

Table 6.3.3-13 Estimated Impacts on Minnesota Native Plant Community Systems for the Applicant's Preferred Route in Minnesota

Native Plant Community System	MBS Site Biodiversity Significance Rank[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Wet forest system	Outstanding	--	--	--	--	51.6	11
	High	6.8	7	2.8	4	206.2	18
	Moderate	2.9	4	1.9	3	207.2	8
Wet meadow/Carr system	Outstanding	--	--	<0.1	1	35.4	35
	High	11.0	12	0.3	1	177.3	19
	Moderate	4.7	16	4.1	11	765.2	106
Wetland prairie system	High	--	--	--	--	164.5	8
TOTAL		**163.6**	**152**	**78.4**	**84**	**8,880.9**	**555**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

See Appendix K, Table K-4 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[c] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[d] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route

"--" = no occurrence

Table 6.3.3-14. Estimated Impacts on Native Plant Community Systems for the Applicant's Preferred Route between Clearbrook and Carlton

Native Plant Community System	MBS Site Biodiversity Significance Rating[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	2.4	3	1.2	3	339.5	23
Complex community	High	--	--	--	--	24.1	3
Fire-dependent forest/ woodland system	Outstanding	--	--	--	--	133.2	16
	High	--	--	--	--	269.3	23
	Moderate	26.7	8	12.6	8	1,785.6	58
Forested rich peatland system	High	17.6	6	9.1	6	650.1	32
	Moderate	4.9	5	4.6	5	432.0	18
Marsh system	Outstanding	--	--	--	--	12.5	23
	Moderate	--	--	--	--	<0.1	1
Mesic hardwood forest system	Outstanding	--	--	--	--	128.9	30
	High	9.0	7	4.0	7	565.7	30
	Moderate	42.7	7	19.0	7	1,393.5	28
Open rich peatland system	Outstanding	--	--	--	--	1.3	1
	Moderate	5.5	7	4.3	7	514.5	16
Wet forest system	Outstanding	--	--	--	--	4.6	10
	High	6.2	4	2.8	4	190.9	17
	Moderate	2.8	3	1.9	3	164.7	7
Wet meadow/Carr system	Outstanding	--	--	--	--	35.4	35
	High	0.5	1	0.3	1	177.3	19
	Moderate	4.7	16	4.1	11	765.2	106
TOTAL		**122.9**	**67**	**63.8**	**62**	**7,588.4**	**496**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

See Appendix K, Table K-4 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities), and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[c] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[d] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-15. Estimated Impacts on Rare Native Plant Communities for the Applicant's Preferred Route in Minnesota

Native Plant Community	MBS Site Biodiversity Significance Rank[a]	Conservation Rank[b]	Construction Work Area[c]		Permanent Right-of-Way[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Alder – (red currant – meadow-rue) swamp	Outstanding	S3	--	--	--	--	1.9	2
	Not ranked	S3	--	--	--	--	<0.1	1
Black ash – (red maple) seepage swamp	High	S1/S2	5.7	5	2.4	2	65.5	5
Calcareous fen (northwestern)	High	S2	--	--	--	--	7.1	1
Graminoid poor fen (basin)	High	S3	--	--	--	--	11.5	3
Jack pine – (bush honeysuckle) woodland	Moderate	S1/S2/S3	11.7	10	7.7	9	714.5	22
Jack pine – (bush honeysuckle) woodland, bracken subtype	High	S1	0.3	1	--	--	68.2	2
Jack pine – (yarrow) woodland	High	S1/S2	--	--	--	--	30.4	1
Mesic brush-prairie (northern)	High	S2	--	--	--	--	92.5	3
	Outstanding	S2	--	--	--	--	33.1	4
Mesic prairie (northern)	Outstanding	S2	--	--	--	--	4.1	2
	Moderate	S2	2.0	2	0.7	1	43.9	1
Oak – aspen forest	Outstanding	S3	--	--	0.8	1	128.1	15
	High	S3	--	--	--	--	87.8	2
	Moderate	S3	18.0	12	8.4	5	1,024.4	34
	Below	S3	7.2	5	2.6	2	60.2	1
	Not ranked	S3	--	--	--	--	0.1	2
Red pine – white pine forest	Outstanding	S2	--	--	0.7	1	5.1	1
	High	S2	--	--	--	--	49.8	13
	Moderate	S2	--	--	--	--	43.9	1
Red pine – white pine woodland, balsam fir subtype	High	S3	--	--	--	--	22.9	3
Red pine – white pine woodland, mountain maple subtype	High	S3	--	--	--	--	10.2	2
Spikerush – bur reed marsh (northern)	Outstanding	S2	--	--	--	--	12.5	23
	Moderate	S2	--	--	--	--	<0.1	1
	Not ranked	S2	--	--	--	--	0.4	7

Table 6.3.3-15. Estimated Impacts on Rare Native Plant Communities for the Applicant's Preferred Route in Minnesota

Native Plant Community	MBS Site Biodiversity Significance Rank[a]	Conservation Rank[b]	Construction Work Area[c]		Permanent Right-of-Way[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Sugar maple – basswood – (bluebead lily) forest	High	S3	--	--	--	--	97.9	2
Tamarack seepage swamp (aspen parkland)	Outstanding	S3	--	--	--	--	27.0	1
	Moderate	S3	--	--	--	--	10.1	1
Wet brush-prairie (northern)	High	S3	--	--	--	--	64.5	5
Wet prairie (northern)	High	S3	--	--	--	--	100.0	3
White pine – white spruce – paper birch forest	High	S2	0.6	4	0.3	3	59.9	9
TOTAL			**45.5**	**39**	**23.6**	**24**	**2,877.6**	**173**

Sources: Minnesota DNR 2016b, 2016e, 2016d.

Notes:

See Appendix K, Table K-5 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation.

[c] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[d] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[e] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-16. Estimated Impacts on Rare Native Plant Communities for the Applicant's Preferred Route between Clearbrook and Carlton

Native Plant Communities	MBS Site Biodiversity Significance Rating[a]	Conservation Rank[b]	Construction[c]		Operations[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Alder – (red currant – meadow-rue) swamp	Outstanding	S3	--	--	--	--	1.9	2
	Not ranked	S3	--	--	--	--	<0.1	1
Black ash – (red maple) seepage swamp	High	S1S2	5.1	2	2.4	2	65.5	5
Graminoid poor fen (basin)	High	S3	--	--	--	--	11.5	3
Jack pine – (bush honeysuckle) woodland	Moderate	S1 or S3	10.3	5	5.4	5	714.5	22
Jack pine – (bush honeysuckle) woodland, bracken subtype	High	S1	--	--	--	--	68.2	2
Jack pine – (yarrow) woodland	High	S1S2	--	--	--	--	30.4	1
Oak – aspen forest	Outstanding	S3	--	--	--	--	128.1	15
	High	S3	--	--	--	--	87.8	2
	Moderate	S3	16.4	3	7.2	3	1,024.4	34
	Below	S3	6.3	1	2.6	1	60.2	1
	Not ranked	S3	--	--	--	--	0.1	2
Red pine – white pine forest	Outstanding	S2	--	--	--	--	5.1	1
	High	S2	--	--	--	--	49.8	13
	Moderate	S2	--	--	--	--	43.9	1
Red pine – white pine woodland, balsam fir subtype	High	S3	--	--	--	--	22.9	3
Red pine – white pine woodland, mountain maple subtype	High	S3	--	--	--	--	10.2	2
Spikerush – bur reed marsh (northern)	Outstanding	S2	--	--	--	--	12.5	23
	Moderate	S2	--	--	--	--	<0.1	1
	Not ranked	S2	--	--	--	--	0.4	7
Sugar maple – basswood – (bluebeard lily) forest	High	S3	--	--	--	--	97.9	2

Table 6.3.3-16. Estimated Impacts on Rare Native Plant Communities for the Applicant's Preferred Route between Clearbrook and Carlton

Native Plant Communities	MBS Site Biodiversity Significance Rating[a]	Conservation Rank[b]	Construction[c]		Operations[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
White pine – white spruce – paper birch forest	High	S2	0.6	3	0.3	3	59.9	9
TOTAL			**38.7**	**14**	**17.9**	**14**	**2,495.3**	**152**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

See Appendix K, Table K-5 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation.

[c] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[d] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[e] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Spread of Noxious Weeds and Invasive Plants

Eighteen noxious weeds and invasive plants have been documented within the Applicant's preferred route, and 17 noxious weed and invasive plants were documented within 0.5 mile of the Applicant's preferred route between Clearbrook and Carlton (Table 6.3.3-3). Most disturbance to vegetation cover would occur during construction from clearing and grading within the construction work area. Barren soil in cleared work areas is susceptible to invasion by noxious weeds and invasive plants, which may inhibit regeneration of native plants. Impacts associated with invasion of noxious weeds are difficult to quantify. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. As a result, impacts would be short term and minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Right-of-way maintenance in both upland and wetland areas would include mechanical removal of woody vegetation, typically by a rubber-tracked skid-steer vehicle with specialized cutting equipment. The 766 acres of forested communities and 185 acres of woody wetlands that would be removed during construction would be subject to periodic mowing and brush clearing during operation (Table 6.3.3-12). This would result in a permanent major impact on forested vegetation. For areas of previously disturbed non-forested vegetation communities within the permanent right-of-way, routine vegetation management would result in short-term minor impacts.

Construction of aboveground facilities, including pump stations, permanent access roads, and MLVs, would result in the loss of approximately 291 acres of vegetation. Vegetation removed includes deciduous forest (107 acres), hay/pasture (62 acres), and cultivated crops (44 acres), which cumulatively account for over 70 percent of the vegetation for the additional construction areas and aboveground facilities. The loss of this cover would result in a permanent minor impact.

Loss or Alteration of Native Plant Communities

Operations impacts on native plant community classes could include periodic maintenance of the permanent right-of-way to prevent re-growth of woody vegetation in approximately 78 acres of previous native plant communities. In addition, pipeline maintenance occasionally would require excavation within the permanent right-of-way to repair or replace pipe segments, which also could affect native plant communities depending on the location of the integrity dig. Native plant communities likely would have been subjected to impacts during construction such that they are not likely to persist or reestablish within the permanent right-of-way. If they did persist, these operations activities could periodically result in short-term minor impacts on previously disturbed native plant communities for the life of the Project.

Operations impacts on 24 acres of 24 rare native plant communities could include continued maintenance of the permanent right-of-way to prevent large woody growth and, on rare occasions, pipeline maintenance that could require excavation (Table 6.3.3-15). With the exception of red pine-white pine forest, which does not occur in the permanent right-of-way, all other vegetation communities are non-forested and would be maintained free of large woody vegetation. This has the potential to benefit the herbaceous native plant community. General impacts on rare native plant communities and mitigation are addressed in Section 5.2.3.3. These communities would have been subject to impacts during construction and are not expected to persist or reestablish within the permanent right-of-way during operations. If they did persist, short-term minor impacts could periodically occur during pipeline operation, as maintenance work may occur in previously disturbed rare native plant communities.

Spread of Noxious Weeds and Invasive Plants

The opportunity for the spread of noxious weeds and invasive plants would continue for the life of the Project during operation. As noted above, to minimize the spread of noxious weeds and invasive plants, the Applicant would implement a Noxious Weeds and Invasive Species Control Plan that would detail control measures to be implemented during operation. Vegetation within the permanent right-of-way and around facilities would be managed to identify and prevent the establishment or further spread of noxious weeds. Permanent minor impacts are expected to occur as a result of noxious weed and invasive plant infestations during operation.

6.3.3.3.2 Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

Loss or Alteration of Vegetation Cover

Construction of RA-03AM would affect 3,578 acres of vegetation. Most (95 percent) of the Clearbrook-to-Carlton segment would be adjacent to pipeline, transmission line, or road corridors that previously have been disturbed by construction. Consequently, the area of undisturbed vegetation that potentially affected by construction would be minimized. Hay/pasture (28.2 percent), deciduous forest (27.2 percent), and cultivated crops (15.8 percent) vegetation cover classes dominate the route of this alternative. Clearing trees within evergreen forest, deciduous forest, mixed forest, and woody wetlands would result in long-term to permanent major impacts on approximately 1,329 acres of forest vegetation cover within the construction work areas (Table 6.3.3-17).

Loss or Alteration of Native Plant Communities

Construction of RA-03AM would result in long-term to permanent major impacts on 87 acres of forested and wet meadow/peatland/fen native plant community systems (Table 6.3.3-17) and 20 acres within four conservation-ranked rare native plant communities, including both wetland and upland forest communities (Table 6.3.3-18). No old-growth forest or HCVFs would be affected during construction of RA-03AM.

Spread of Noxious Weeds and Invasive Plants

Twenty-three noxious weed species, totaling 314 occurrences, have been documented within 0.5 mile of RA-03AM (Table 6.3.3-5). The types of potential impacts would be the same as those described for the Applicant's preferred route, and the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. As a result, impacts due to the spread of noxious weeds and invasive plants during construction of RA-03AM would be short term and minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Maintenance activities would be the same as those described for the Applicant's preferred route. These activities for RA-03AM would affect 1,494 acres of vegetation, primarily the hay/pasture, deciduous forest, and cultivated crops vegetation cover. Approximately 547 acres of the affected area would be forested uplands and wetlands, which would be permanently maintained as scrub/shrub, grassland, or emergent herbaceous wetlands vegetation during operation. This would result in permanent major impacts on forested vegetation (Table 6.3.3-17). For areas of previously disturbed non-forested vegetation communities within the permanent right-of-way, routine vegetation management would result in temporary to short-term minor impacts.

Loss or Alteration of Native Plant Communities

Operations impacts associated with RA-03AM would affect 36 acres of native plant community systems (Table 6.3.3-18) and 20 acres of an S2 conservation-ranked rare native plant communities (Table 6.3.3-19). No old-growth forest would be affected by operation of RA-03AM. The affected native plant

communities would have been subject to permanent major impacts associated with construction and are not expected to fully recover during operations.

If they did persist, short-term minor impacts on previously disturbed rare plant communities would occur as a result of maintenance activities during operation but would occur periodically for the life of the Project.

Spread of Noxious Weeds and Invasive Plants

Twenty-three noxious weed species, totaling 314 occurrences, have been documented within 0.5 mile of RA-03AM (Table 6.3.3-5). Operations-related impacts associated with noxious weeds would be identical to those identified for the Applicant's preferred route (i.e., permanent and minor).

Table 6.3.3-17. Estimated Impacts on Vegetation Cover for Route Alternative RA-03AM between Clearbrook and Carlton

Vegetation Cover	Construction Work Area[a]		Permanent Right-of-Way[b]	
	Acres	Percent	Acres	Percent
Evergreen forest	145	4%	60	4%
Deciduous forest	975	27%	403	27%
Mixed forest	14	0%	6	0%
Scrub/shrub	191	5%	80	5%
Grassland/herbaceous	143	4%	61	4%
Hay/pasture	1,031	29%	433	29%
Cultivated crops	565	16%	238	16%
Woody wetlands	195	5%	78	5%
Emergent herbaceous wetlands	315	9%	134	9%
Barren land	5	0%	2	0%
TOTAL	**3,578**	100%	**1,494**	100%

Source: Homer et al. 2015.

Notes:

See Appendix K, Table K-6 for additional detail.

[a] Estimated 120-foot-wide construction work area centered on pipeline route, includes the 50-foot-wide permanent right-of-way.

[b] Estimated operations area based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Table 6.3.3-18. Estimated Impacts on Native Plant Communities for Route Alternative RA-03AM between Clearbrook and Carlton

Native Plant Community System	MBS Site Biodiversity Significance Rating[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	--	--	--	--	1.1	1
	Moderate	--	--	--	--	76.6	15
Complex community	Moderate	<0.1	1	--	--	68.5	12
Fire-dependent forest/ woodland system	Outstanding	--	--	--	--	133.3	17
	High	--	--	--	--	255.9	22
	Moderate	20.2	14	8.1	10	1,777.7	66
Floodplain forest system	High	--	--	--	--	0.1	1
Forested rich peatland system	High	2.5	2	1.0	1	33.1	5
	Moderate	2.2	8	0.6	4	531.9	36
Marsh system	Outstanding	--	--	--	--	12.5	23
	High	--	--	--	--	3.2	1
	Moderate	--	--	--	--	40.7	3
Mesic hardwood forest system	Outstanding	--	--	--	--	128.9	30
	High	0.9	4	0.3	3	403.2	20
	Moderate	32.7	7	15.7	5	2,331.9	34
Open rich peatland system	Outstanding	--	--	--	--	1.3	1
	Moderate	8.4	10	3.3	7	648.5	27
Upland prairie system	High	--	--	--	--	3.7	1
Wet forest system	Outstanding	--	--	--	--	4.6	10
	High	5.6	2	2.4	2	128.4	8
	Moderate	5.3	5	2.2	5	199.7	14

Table 6.3.3-18. Estimated Impacts on Native Plant Communities for Route Alternative RA-03AM between Clearbrook and Carlton

Native Plant Community System	MBS Site Biodiversity Significance Rating[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Wet meadow/Carr system	Outstanding	--	--	--	--	35.5	37
	High	2.6	2	1.1	2	247.1	21
	Moderate	6.1	11	1.8	9	664.4	109
TOTAL		**86.5**	**66**	**36.4**	**48**	**7,732.1**	**514**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

See Appendix K, Table K-7 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[c] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[d] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-19. Estimated Impacts on Rare Native Plant Communities for Route Alternative RA-03AM between Clearbrook and Carlton

Native Plant Communities	MBS Site Biodiversity Significance Rating[a]	Conservation Rank[b]	Construction Work Area[c]		Permanent Right-of-Way[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Alder – (red currant – meadow-rue) swamp	Outstanding	S3	--	--	--	--	1.9	2
	Not ranked	S3	--	--	--	--	<0.1	1
Basswood – black ash forest	High	S3	--	--	--	--	41.8	1
	Moderate	S3	--	--	--	--	85.2	2
Black ash – (red maple) seepage swamp	High	S1S2	5.6	2	2.4	2	65.5	5
Black ash – silver maple terrace forest	High	S3	--	--	--	--	0.1	1
Black ash – yellow birch – red maple – basswood swamp (eastcentral)	Moderate	S3	0.2	1	<0.1	1	65.4	6
Dry sand – gravel oak savanna (southern)	High	S1S2	--	--	--	--	3.7	1
Jack pine – (bush honeysuckle) woodland	Moderate	S1 or S3	--	--	--	--	48.6	3
Jack pine – (bush honeysuckle) woodland, bracken subtype	High	S1	--	--	--	--	68.2	2
Jack pine – (yarrow) woodland	High	S1S2	--	--	--	--	30.4	1
Oak – aspen forest	Outstanding	S3	--	--	--	--	128.2	16
	High	S3	--	--	--	--	70.3	1
	Moderate	S3	13.7	3	7.2	3	1,019.6	33
	Not ranked	S3	--	--	--	--	0.1	2
Pin oak – bur oak woodland	High	S3	--	--	--	--	14.0	1
	Moderate	S3	--	--	--	--	40.3	1
Red pine – white pine forest	Outstanding	S2	--	--	--	--	5.1	1
	High	S2	--	--	--	--	49.8	13
	Moderate	S2	--	--	--	--	43.9	1
Red pine – white pine woodland, balsam fir subtype	High	S3	--	--	--	--	22.9	3

Table 6.3.3-19. Estimated Impacts on Rare Native Plant Communities for Route Alternative RA-03AM between Clearbrook and Carlton

Native Plant Communities	MBS Site Biodiversity Significance Rating[a]	Conservation Rank[b]	Construction Work Area[c]		Permanent Right-of-Way[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Red pine – white pine woodland, mountain maple subtype	High	S3	--	--	--	--	0.3	1
Spikerush – bur reed marsh (northern)	Outstanding	S2	--	--	--	--	12.5	23
	Moderate	S2	--	--	--	--	<0.1	1
	Not ranked	S2	--	--	--	--	0.4	7
White pine – white spruce – paper birch forest	High	S2	0.7	3	0.3	3	59.9	9
TOTAL			**20.3**	**9**	**9.9**	**9**	**1,878.3**	**138**

Sources: Minnesota DNR 2016b, 2016e, 2016d.

Notes:

See Appendix K, Table K-8 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation.

[c] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[d] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[e] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Route Alternative RA-06

Construction Impacts

Loss or Alteration of Vegetation Cover

Construction of RA-06 would affect 2,674 acres of vegetation. This route is dominated by deciduous forest (30 percent), woody wetlands (27 percent), and scrub/shrub vegetation (9 percent). Clearing trees within forested communities would result in long-term to permanent major impacts on approximately 1,798 acres of forested areas within the construction work area (Table 6.3.3-20). All of the Clearbrook-to-Carlton segment would be within a new pipeline corridor, much of it crossing through areas with no previous ground disturbance.

Loss or Alteration of Native Plant Communities

Construction of RA-06 would result in long-term to permanent major impacts on 20 acres of forested and peatland/fen native plant community systems Table 6.3.3-21. No rare native plant communities, old-growth forest, or HCVFs would be affected by construction of RA-06.

Table 6.3.3-20. Estimated Impacts on Vegetation Cover for Route Alternative RA-06 between Clearbrook and Carlton

Vegetation Cover	Construction Work Area[a]		Permanent Right-of-Way[b]	
	Acres	Percent	Acres	Percent
Evergreen forest	103	4%	43	4%
Deciduous forest	798	30%	333	30%
Mixed forest	164	6%	68	6%
Scrub/shrub	251	9%	104	9%
Grassland/herbaceous	116	4%	49	4%
Hay/pasture	213	8%	89	8%
Cultivated crops	43	2%	18	2%
Woody wetlands	732	27%	304	27%
Emergent herbaceous wetlands	223	8%	94	8%
Barren land	31	1%	13	1%
TOTAL	**2,674**	**100%**	**1,115**	**100%**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to totals due to rounding.

See Appendix K, Table K-6 for additional detail.

[a] Estimated 120-foot-wide construction work area centered on pipeline route, includes the 50-foot-wide permanent right-of-way.

[b] Estimated operations area based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Table 6.3.3-21. Estimated Impacts on Native Plant Community Systems for Route Alternative RA-06 between Clearbrook and Carlton

Native Plant Community System	MBS Site Biodiversity Significance Rating[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	8.6	2	3.7	2	290.1	8
Fire-dependent forest/ woodland system	High	--	--	--	--	9.5	1
Forested rich peatland system	High	9.9	4	3.5	3	429.0	19
Mesic hardwood forest system	High	0.4	2	<0.1	1	62.9	9
Wet forest system	High	0.6	2	--	--	233.0	10
Wet meadow/Carr system	High	--	--	--	--	3.3	1
TOTAL		**19.5**	**10**	**7.3**	**6**	**1,027.7**	**48**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

Values in table may not sum to totals due to rounding.

See Appendix K, Table K-7 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[c] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[d] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-22. Estimated Impacts on Old-Growth Forest Communities for Route Alternative RA-06 between Clearbrook and Carlton

Main Cover Type	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
	Acres	Number of Stands	Acres	Number of Stands	Acres	Number of Stands
Aspen	--	--	--	--	24.7	1
Birch	--	--	--	--	23.1	1
Norway pine	--	--	--	--	34.3	2
TOTAL	--	--	--	--	**82.1**	**4**

Sources: Minnesota DNR 2016c.

Notes:

Values in table may not sum to totals due to rounding.

Old-growth forest as identified by Timber Status = 5 (designated old-growth) and 7 (potential or future old-growth)

See Appendix K, Table K-9 for additional detail.

[a] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[b] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[c] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Spread of Noxious Weeds and Invasive Plants

Thirteen noxious weed species, totaling 408 occurrences, have been documented within 0.5 mile of RA-06 (Table 6.3.3-7). The types of potential impacts would be the same as those described for the Applicant's preferred route, and the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Consequently, impacts from the spread of noxious weeds and invasive plants during construction of RA-06 would be short term and minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Operation of Alternative RA-06 would affect approximately 1,115 acres of vegetation. This route is dominated by deciduous forest, woody wetlands, and scrub/shrub vegetation cover. Approximately 748 acres of forested uplands and wetlands would be permanently maintained as scrub/shrub, grassland, or emergent herbaceous wetlands vegetation during operation of the pipeline, resulting in permanent major impacts on forested vegetation (Table 6.3.3-19).

Loss or Alteration of Native Plant Communities

RA-06 would affect 7 acres of native plant community systems during operations (Table 6.3.3-21). No rare native plant communities, old-growth forest, or HCVFs would be affected during operation.

Spread of Noxious Weeds and Invasive Plants

Thirteen noxious weed species, totaling 408 occurrences, have been documented within 0.5 mile of RA-06 (Table 6.3.3-7). Operations-related impacts associated with noxious weeds would be identical to those identified for the Applicant's preferred route (i.e., permanent and minor).

Route Alternative RA-07

Construction Impacts

Loss or Alteration of Vegetation Cover

Construction of RA-07 would affect approximately 3,832 acres of vegetation. This alternative is dominated by woody wetlands (28 percent), deciduous forest (20 percent), and emergent herbaceous wetlands vegetation (14 percent) landcover classes. Because RA-07 would be constructed within the existing Line 3 pipeline right-of-way, much of this vegetation would have been previously disturbed. Some new forest clearing for the expanded work area would be required; and some forested areas, especially near stream crossings, may be avoided by HDD. Clearing the construction work area would affect about 1,147 acres of forested communities and 1,056 acres of woody wetlands. Because most of the permanent right-of-way within the construction work area is already cleared of trees, this would result in long-term major impacts on forested communities within the construction work area but primarily outside of the permanent right-of-way (Table 6.3.3-23).

Table 6.3.3-23. Estimated Impacts on Vegetation Cover for Route Alternative RA-07 between Clearbrook and Carlton

Vegetation Cover	Construction Work Area[a]		Permanent Right-of-Way[b]	
	Acres	Percent	Acres	Percent
Evergreen forest	235	6%	37	4%
Deciduous forest	773	20%	177	19%
Mixed forest	139	4%	28	3%
Scrub/shrub	277	7%	83	9%
Grassland/herbaceous	405	11%	107	11%
Hay/pasture	326	8%	88	9%
Cultivated crops	76	2%	23	2%
Woody wetlands	1,056	28%	236	25%
Emergent herbaceous wetlands	536	14%	154	16%
Barren land	10	0%	3	0%
TOTAL	**3,832**	**100%**	**937**	**100%**

Source: Homer et al. 2015.

Notes:

RA-07 involves removing the existing Line 3 and placing the new Line 3 in the same trench. RA-07 would be centered in the existing Enbridge Mainline, which is largely cleared of trees. However, the resolution of the GIS landcover data does not provide accurate representation of land-cover/land use the scale of the mainline corridor right-of-way. This limitation in the data creates some uncertainty about accuracy of the landcover within the anticipated construction workzone. The numbers shown should be considered a very conservative estimate of forest impacts; the actual numbers are likely to be much lower.

See Appendix K, Table K-6 for additional detail.

[a] Estimated 205-foot-wide construction work area, with 10-feet-wide on the north side of Line 3 and 195-feet-wide on the south side of Line 3, includes the 50-foot-wide permanent right-of-way.

[b] Estimated operations area based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Loss or Alteration of Native Plant Communities

Construction of RA-07 would result in long-term to permanent major impacts on 65 acres of forested and wet meadow/peatland/fen native plant community systems (Table 6.3.3-24), one conservation-

ranked rare native plant community (Jack pine woodland) (Table 6.3.3-25), and one Norway pine old-growth forest (Table 6.3.3-26). No HCVFs would be affected.

Table 6.3.3-24. Estimated Impacts on Native Plant Community Systems for Route Alternative RA-07 between Clearbrook and Carlton

Native Plant Community System	MBS Site Biodiversity Significance Rating[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	27.3	2	3.4	1	493.7	14
Fire-dependent forest/ woodland system	High	--	--	--	--	9.5	1
	Moderate	2.7	1	--	--	217.0	4
Forested rich peatland system	High	14.3	3	0.3	1	436.1	18
	Moderate	8.4	1	--	--	264.2	4
Mesic hardwood forest system	High	2.5	3	<0.1	1	62.9	9
Open rich peatland system	Moderate	--	--	--	--	48.4	2
Wet forest system	High	9.0	3	--	--	233.0	11
Wet meadow/Carr system	High	--	--	--	--	3.3	1
	Moderate	0.7	1	--	--	39.2	3
TOTAL		**64.9**	**14**	**3.8**	**3**	**1,807.2**	**67**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

See Appendix K, Table K-7 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[c] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[d] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-25. Estimated Impacts on Rare Native Plant Communities for Route Alternative RA-07 between Clearbrook and Carlton

Native Plant Communities	MBS Site Biodiversity Significance Rating[a]	Conservation Rank[b]	Construction Work Area[c]		Permanent Right-of-Way[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Jack pine – (yarrow) woodland	Moderate	S1/S2	2.7	1	--	--	160.7	2
Oak – aspen forest	Moderate	S3	--	--	--	--	56.3	2
TOTAL			**2.7**	**1**	**--**	**--**	**--**	**--**

Sources: Minnesota DNR 2016b, 2016e, 2016d.

Notes:

See Appendix K, Table K-8 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation.

[c] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[d] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[e] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-26. Estimated Impacts on Old-Growth Forest Communities for Route Alternative RA-07 between Clearbrook and Carlton

Main Cover Type	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
	Acres	Number of Stands	Acres	Number of Stands	Acres	Number of Stands
Aspen	--	--	--	--	16.8	1
Norway pine	0.1	1	--	--	43.5	3
White cedar	--	--	--	--	28.3	1
TOTAL	**0.1**	**1**	--	--	**88.5**	**5**

Source: Minnesota DNR 2016c.

Notes:

Old-growth forest as identified by Timber Status = 5 (designated old-growth) and 7 (potential or future old-growth)

See Appendix K, Table K-9 for additional detail.

[a] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[b] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[c] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Spread of Noxious Weeds and Invasive Plants

Twenty noxious weed species, totaling 1,002 occurrences, have been documented within 0.5 mile of RA-07 (Table 6.3.3-9). Of all route options between Clearbrook and Carlton, RA-07 has the greatest number of potential noxious weed occurrences and would disturb the largest area of vegetation during construction activities. The types of potential impacts would be the same as those described for the Applicant's preferred route, and the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Consequently, impacts from the spread of noxious weeds and invasive plants during construction of RA-07 would be short term and minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Operation of RA-07 would affect 937 acres of vegetation (Table 6.3.3-23). This alternative is dominated by woody wetlands, deciduous forest, and emergent herbaceous wetlands vegetation cover. Approximately 478 acres of forested uplands and wetlands would be permanently maintained as scrub/shrub, grassland, or emergent herbaceous wetland vegetation during operation, resulting in permanent major impacts on forested vegetation.

Loss or Alteration of Native Plant Communities

Operations associated with RA-07 would affect 4 acres of native plant community systems (Table 6.3.3-24), two conservation-ranked rare native plant communities (Table 6.3.3-25), and no old-growth forest (Table 6.3.3-26). These communities would have been subjected to construction impacts and are not expected to persist or reestablish within the permanent right-of-way. If they did persist, short-term minor impacts could periodically occur during pipeline operation, as maintenance work may occur in previously disturbed rare native plant communities for the life of the Project.

Spread of Noxious Weeds and Invasive Plants

Twenty noxious weed species, totaling 1,002 occurrences, have been documented within 0.5 mile of RA-07 (Table 6.3.3-9). Operations-related impacts associated with noxious weeds for the route would be identical to those identified for the Applicant's preferred route (i.e., permanent and minor).

Route Alternative RA-08

Construction Impacts

Loss or Alteration of Vegetation Cover

All of the Clearbrook-to-Carlton segment would be co-located next to the existing pipeline corridor that has been exposed to previous pipeline construction and operation disturbances. Construction of RA-08 would affect 2,286 acres of vegetation (Table 6.3.3-26). This alternative is dominated by woody wetlands (28 percent), deciduous forest (26 percent), emergent herbaceous wetlands (14 percent), and hay/pasture (13) landcover classes. Clearing the construction work area would affect approximately 1,424 acres of forested communities, resulting in long-term to permanent major impacts on those communities.

Table 6.3.3-27. Estimated Impacts on Vegetation Cover for Route Alternative RA-08 between Clearbrook and Carlton

Vegetation Cover	Construction Work Area[a]		Permanent Right-of-Way[b]	
	Acres	Percent	Acres	Percent
Evergreen forest	106	5%	44	5%
Deciduous forest	592	26%	246	26%
Mixed forest	75	3%	31	3%
Scrub/shrub	124	5%	52	5%
Grassland/herbaceous	81	4%	35	4%
Hay/pasture	304	13%	128	13%
Cultivated crops	32	1%	13	1%
Woody wetlands	651	28%	270	28%
Emergent herbaceous wetlands	319	14%	135	14%
Barren land	3	0%	1	0%
TOTAL	**2,286**	100%	**954**	100%

Source: Homer et al. 2015.

Notes:

See Appendix K, Table K-6 for additional detail.

[a] Estimated 120-foot-wide construction work area centered on pipeline route, includes the 50-foot-wide permanent right-of-way.

[b] Estimated operations area based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Loss or Alteration of Native Plant Communities

Construction of RA-08 would result in long-term to permanent major impacts on 50 acres of forested and wet meadow/peatland/fen native plant community systems (Table 6.3.3-28), one white cedar old-

growth forest (Table 6.3.3-30), and one HCVF (Floodwood Bog). No conservation-ranked rare native plant communities would be affected.

Table 6.3.3-28. Estimated Impacts on Native Plant Community Systems for Route Alternative RA-08 between Clearbrook and Carlton

Native Plant Community System	MBS Site Biodiversity Significance Rating[a]	Construction Work Area[b]		Permanent Right-of-Way[c]		Within 0.5 Mile[d]	
		Acres	No.	Acres	No.	Acres	No.
Acid peatland system	High	37.2	9	15.9	8	2,580.0	42
Fire-dependent forest/woodland system	High	--	--	--	--	9.5	1
	Moderate	--	--	--	--	148.2	4
Forested rich peatland system	High	2.0	2	0.6	1	330.4	14
	Moderate	2.3	1	0.4	1	412.9	9
Mesic hardwood forest system	High	3.9	3	1.6	2	229.1	26
	Moderate	--	--	--	--	3.5	1
Open rich peatland system	Moderate	2.9	2	1.2	2	168.2	4
Wet forest system	High	1.3	1	0.6	1	301.2	10
Wet meadow/Carr system	High	0.4	1	0.2	1	11.7	2
	Moderate	--	--	--	--	39.2	3
TOTAL		**50.1**	**19**	**20.6**	**16**	**4,233.9**	**116**

Sources: Minnesota DNR 2016b, 2016e.

Notes:

See Appendix K, Table K-7 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[c] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[d] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-29. Estimated Impacts on Rare Native Plant Communities for Route Alternative RA-08 between Clearbrook and Carlton

Native Plant Communities	MBS Site Biodiversity Significance Rating[a]	Conservation Rank[b]	Construction Work Area[c]		Permanent Right-of-Way[d]		Within 0.5 Mile[e]	
			Acres	No.	Acres	No.	Acres	No.
Aspen – birch – fir forest	Moderate	S3	--	--	--	--	3.5	1
Jack pine – (yarrow) woodland	Moderate	S1 or S2	--	--	--	--	100.7	2
Oak – aspen forest	Moderate	S3	--	--	--	--	47.5	2
TOTAL			--	--	--	--	**151.8**	**5**

Sources: Minnesota DNR 2016b, 2016e, 2016d.

Notes:

See Appendix K, Table K-8 for additional detail.

[a] Systems occurring within Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites) are given these ranks (Minnesota only):
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for outstanding, high, or moderate rank.
(blank) = no corresponding Biodiversity Significance Rank

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation.

[c] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[d] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[e] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Table 6.3.3-30. Estimated Impacts on Old-Growth Forest Communities for Route Alternative RA-08 between Clearbrook and Carlton

Main Cover Type	Construction Work Area[a]		Permanent Right-of-Way[b]		Within 0.5 Mile[c]	
	Acres	Number of Stands	Acres	Number of Stands	Acres	Number of Stands
Aspen	--	--	--	--	23.3	2
Birch	--	--	--	--	3.1	1
Northern hardwoods	--	--	--	--	11.5	2
White pine	--	--	--	--	22.0	3
White cedar	2.1	1	0.9	1	28.6	2
TOTAL	**2.1**	**1**	**0.9**	**1**	**88.4**	**10**

Sources: Minnesota DNR 2016c.

Notes:

Old-growth forest as identified by Timber Status = 5 (designated old-growth) and 7 (potential or future old-growth

See Appendix K, Table K-9 for additional detail.

[a] Sum of Enbridge-provided construction work area, additional temporary workspace (including pipe yards), and temporary access roads.

[b] Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (including valve pads and driveways).

[c] Minnesota native plant community systems within 0.5 mile of the centerline of the pipeline route.

"--" = no occurrence

Spread of Noxious Weeds and Invasive Plants

Nineteen noxious weeds, totaling 665 occurrences, have been documented within 0.5 mile of RA-08 (Table 6.3.3-11). The types of potential impacts would be the same as those described for the Applicant's preferred route, and the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Consequently, impacts from the spread of noxious weeds and invasive plants during construction of RA-08 would be short term and minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Operation of RA-08 would affect 954 acres of vegetation (Table 6.3.3-27). This route is dominated by woody wetlands, deciduous forest, and emergent herbaceous wetlands vegetation cover. Approximately 590 acres of forested uplands and wetlands would be permanently maintained as scrub/shrub, grassland, or emergent wetland vegetation during operation of the pipeline, resulting in permanent major impacts on forested vegetation.

Loss of Alteration of Native Plant Communities

Operation of RA-08 would affect 21 acres of native plant community systems (Table 6.3.3-28), two conservation-ranked rare native plant communities (Table 6.3.3-29), one stand of old-growth white cedar forest, and one HCVF (Table 6.3.3-30). These communities would have been subject to construction impacts and are not expected to persist or to reestablish within the permanent right-of-

way. If they did persist, short-term minor impacts could periodically occur during pipeline operation, as maintenance work may occur in previously disturbed rare native plant communities for the life of the Project.

Spread of Noxious Weeds and Invasive Plants

Nineteen noxious weeds, totaling 665 occurrences, have been documented within 0.5 mile of RA-08 (Table 6.3.3-11). Operations-related impacts associated with noxious weeds would be identical to those identified for the Applicant's preferred route (i.e., permanent and minor).

6.3.3.4 Summary and Mitigation

6.3.3.4.1 Summary

The potential impacts on all vegetation types for the Applicant's preferred route and route alternatives between Clearbrook and Carlton are summarized in Table 6.3.3-31. This includes a summary of construction- and operations-related impacts on existing landcover, Minnesota MBS Sites and native plant communities, as well as potential impact from the spread of noxious weeds and invasive plants. The area from Clearbrook to Carlton was evaluated because all route options follow the same route from Neche, North Dakota, to Clearbrook and from Carlton to Superior, Wisconsin.

Avoidance and minimization measures considered in the assessment of impacts included rerouting the pipeline, use of HDD and preparation of and adherence to an agency-approved site-specific crossing plan. The impact assessment also considered the effects of implementation of BMPs during construction and operation as well as revegetation and reclamation commitments for the pipeline rights-of-way, which would be similar for all route options.

The BMPs that the Applicant would incorporate into the Project to minimize impacts on vegetation are presented in the revegetation and monitoring guidance portion of the Applicant's Environmental Protection Plan (Appendix E). Following construction, the entire pipeline right-of-way would be reclaimed following the guidance presented in this document, including implementation of compaction prevention measures, seeding, plantings, application of soil amendments, and a period of monitoring to document stabilization of the right-of-way. In areas where soil quality is a concern for revegetation, applicable agencies would be consulted to develop seed mixes and seeding dates adapted to the immediate areas of concern.

In addition, the Applicant committed to preparation and implementation of the following plans, procedures, and general vegetation protection measures during construction:

- Co-locate construction within and near existing utility corridors to minimize environmental impacts;
- Develop and adhere to Project-specific construction methods and procedures for vegetation clearing methods, including treatment of existing vegetation, topsoil segregation, storage, and reapplication;
- Restore preconstruction contours and use slope breakers, sediment barriers, mulch, geotextile fabric, and other erosion control devices to stabilize the disturbed areas during the vegetation re-growth phase and reduce runoff into the adjacent environment;
- Co-locate the Project with existing rights-of-way where feasible;

- Design and plan pipeline construction (including parking, access, and temporary work areas) to reduce environmental impacts on sensitive plant communities, such as rare native plant communities, calcareous fens, wetland vegetation, old-growth forests, and prairie vegetation;
- Inspect and clean all equipment prior to bringing it to the site to prevent the introduction and spread of invasive species; and
- Use certified weed-free mulch, topsoil, and seed mix.

Impacts on rare plant communities that cannot be avoided would be addressed through implementation of the Project's approved revegetation and monitoring measures, and invasive and noxious weed control measures outlined in the Environmental Protection Plan (Appendix E). Measures that would be implemented to prevent the spread of noxious and invasive weeds during construction include minimizing the time between ground-disturbing work and site reclamation and reseeding, staking avoidance areas at known weed locations, and implementing other BMPs.

Prior to construction, the lead and assisting agencies would be consulted on identification of any additional avoidance and mitigation measures for rare plant communities, old-growth forests, and HCVFs that are within the selected route and could be affected by construction or operation. Avoidance measures could include minor pipeline route adjustments, use of directional drilling, or preparation of and adherence to an agency-approved site-specific crossing plan.

Construction Impacts

General types of construction impacts would be the same for all route options. Many impacts on vegetation would be short term and minor, while other impacts would be permanent and major within the footprint of the aboveground facilities and the permanent right-of-way. Individual impacts at specific locations along all the alternatives where the existing vegetation can recover is anticipated to be minor, with appropriate use of BMP construction and operation practices. However, others will need to be maintained in a way that prohibits return to its existing state, and will be permanently altered or removed. Due to the great lengths of all alternatives, the total impact would be additive and distributed along the routes. The importance of these impacts is determined by the distance of the alternative, number of vegetation communities affected, and the quality of vegetation resources affected.

Loss or Alteration of Vegetation Cover

The total acreage of vegetation affected during construction would range from 2,286 acres for RA-08 to 3,832 acres for RA-07 in the portions of the routes from Clearbrook to Carlton. The potential impacts on forested land would be long term to permanent and major for all route options due to the long period of time required for forest regeneration. The Applicant's preferred route would affect the most forest land, RA-08 would affect the least, with RA-03AM, RA-06, and RA-07 each affecting about the same amount.

Areas cleared of other vegetation types during pipeline construction, including grassland/herbaceous, hay/pasture, cultivated crops, and emergent wetlands vegetation cover class types, would be reclaimed after construction to the specifications or conditions of the authorizing/permitting agency. The recovery period for these areas would range from a single growing season to several years. As a result, the impacts would be short term and minor. RA-03AM would affect substantially more grasslands and croplands than the other route alternatives.

All of the route options except RA-06 would be co-located to varying extents with existing pipelines, electrical transmission lines, or roads, which would reduce the effects of clearing and grading since some

of those areas were previously disturbed. RA-06 would be constructed within a new pipeline corridor, in many areas across previously undisturbed vegetation communities.

Loss or Alteration of Rare Native Plant Communities

Rare native plant communities would be affected due to construction of each route alternative. These impacts typically would be long term to permanent and major because these communities generally would be lost or degraded. The Applicant's preferred route would affect the largest area of rare native plant communities during construction and RA-06 would affect the smallest area of such communities. This estimated effect may be underestimated, however, because the native plant communities crossed by RA-06 may not be as completely surveyed and mapped as elsewhere. Only RA-07 and RA-08 would affect old-growth forest, with RA-08 affecting the most, along with one HCVF. The impact would be long term to permanent and major.

Spread of Noxious Weeds and Invasive Plants

Noxious weed and invasive plant management and control would be implemented during construction to minimize the effect of noxious weeds. The potential for impacts due to the spread of noxious weeds and invasive plants during construction would be about the same for all route options, although RA-07 and RA-08 support substantially more infestations than the other route alternatives. For all route options, the impact of noxious weeds and invasive species during construction would be short term and minor.

Operations Impacts

Loss or Alteration of Vegetation Cover

Vegetation management activities during pipeline operation would prevent trees and large shrubs from reestablishing within the pipeline permanent right-of-way. The greatest effect would be on 631 acres of previously forested areas within the permanent right-of-way for the Applicant's preferred route, and the least effect would be about 242 acres of previously forested area for RA-07. The impact for all route options would be permanent and major. The forested and scrub/shrub areas cleared from the construction work area and outside of the permanent right-of-way would be allowed to regenerate, but the process would take decades to reach full recovery.

The Applicant's Integrity Management Program would require periodic excavation to repair or replace sections of pipe segments, which would affect the vegetative cover of the permanent right-of-way. Because the Applicant's preferred route and all of the route alternatives would be new pipelines and there would not be a difference in age of the pipe, and the lengths of the routes area similar, there would not be a substantial difference anticipated in the number of integrity digs. Therefore, there would not be a substantial difference in the impacts on vegetation due to this activity.

Loss or Alteration of Rare Native Plant Communities

Potential operations impacts on rare native plant communities would be expected to be minor because these communities are unlikely to persist within the permanent right-of-way after construction. Vegetation management and integrity digs could result in recurring impacts on previously disturbed rare native plant communities if these communities continued to persist within the permanent right-of-way, but there likely would not be a difference in impacts among the route options due to these activities. If rare native plants persist in the permanent right-of-way after construction, the Applicant's preferred route could support the largest number of rare native plant communities within the permanent right-of-way, followed by RA-03AM. Maintenance activities for the other route alternatives would not affect rare

native plant communities. RA-08 is the only route alternative for which maintenance activities during operation would affect areas of HCVF and previous old-growth forest.

Spread of Noxious Weeds and Invasive Plants

As a result of implementation of a Noxious Weed and Invasive Plant Management and Control Plan for the route options, the risk of spreading infestations of noxious weeds and invasive plants during operations would be similar for the pipeline routes. The impact would be long term and minor, although RA-03AM would have a slightly greater area potentially affected than the Applicant's preferred route and other route alternatives due to its greater length. For all routes, the potential impact of the spread of noxious weeds and invasive species would be permanent and minor.

6.3.3.4.2 Mitigation

In addition to the avoidance and minimization measures and BMPs that the Applicant has identified, Minnesota DNR identified the following mitigation measures that could reduce impacts on vegetation:

- Defining equipment cleaning methods and inspection standards to ensure that equipment is free of invasive species, and on Minnesota DNR lands following Operational Order 113, would further reduce the spread of noxious weeds and invasive plants and animals.
- Replanting appropriate tree species for restoration within cleared forested areas to reduce the recovery time, prevent changes in watershed hydrology and runoff impacts that could alter stream geomorphology.
- Woody vegetation would not typically be cleared at ATWS. If clearing of woody vegetation is necessary, potential mitigation to offset the clearing could include reestablishing or enhancing the existing cover type within up to 50 feet of surface waters, depending on topography. On state forest lands or WMAs, tree planting may be desired for all temporary workspaces within the property boundary to reduce erosion and runoff, and to reestablish trees for potential future large woody habitat recruitment to streams and rivers.
- In counties where oaks are affected by oak wilt disease caused by a non-native fungus, seasonal restrictions on tree clearing would reduce the chance of sap-sucking beetles transporting fungal spores through fresh wounds during the infection period that extends from April through July.
- Removal, debarking, or chipping of cut pines and pine slash larger than 3 inches in diameter within 3 weeks of cutting during May through mid-August would prevent pine bark beetle outbreaks in pine stands.

Table 6.3.3-31 Summary of Potential Impacts on Vegetation for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[c]	Route Alternative RA-08[b]
Construction Impacts					
Loss or alteration of vegetation cover	Long-term to permanent/ major impacts • 1,447 acres of forests • 211 acres of scrub/shrub Short-term/minor impacts • 482 acres of grasslands • 173 acres of croplands • 2,806 acres total • 72% adjacent to existing corridors	Long-term to permanent/ major impacts • 1,134 acres of forests • 191 acres of scrub/shrub Short-term/minor impacts • 1,173 acres of grasslands • 565 acres of croplands • 3,578 acres total • 95% adjacent to existing corridors	Long-term to permanent/ major impacts • 1,065 acres of forests • 251 acres of scrub/shrub Short-term/minor impacts • 329 acres of grasslands • 43 acres of croplands • 2,674 acres total • All new corridor	Long-term to permanent/ major impacts • 1,147 acres of forests • 201 acres of scrub/shrub Short-term/minor impacts • 730 acres of grasslands • 76 acres of croplands • 3,832 acres total • All within existing corridor	Long-term to permanent/ major impacts • 773 acres of forests • 124 acres of scrub/shrub Short-term/minor impacts • 385 acres of grasslands • 32 acres of croplands • 2,286 acres total • All adjacent to existing corridor
Loss or alteration of rare native plant communities	Long-term to permanent/ major impacts • 39 acres of rare native plant communities No impact • Old-growth forests or HCVFs	Long-term to permanent/ major impacts • 20 acres of rare native plant communities No impact • Old-growth forests or HCVFs	No impact on rare native plant communities, old-growth forests, or HCVFs	Long-term to permanent/ major impacts • 3 acres of rare native plant communities • 0.1 acre of old-growth forest No impact on HCVFs	Long-term to permanent/ major impacts • 2 acres of old-growth forest • 1 HCVF
Spread of noxious weeds and invasive plants	Short-term/minor impacts • 401 noxious weed occurrences • 17 species	Short-term/minor impacts • 314 noxious weed occurrences • 23 species	Short-term/minor impacts • 408 noxious weed occurrences • 13 species	Short-term/minor impacts • 1,002 noxious weed occurrences • 20 species	Short-term/minor impacts • 665 noxious weed occurrences • 19 species

Table 6.3.3-31 Summary of Potential Impacts on Vegetation for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[c]	Route Alternative RA-08[b]
Operations Impacts					
Loss or alteration of vegetation cover	Permanent/major impacts • 631 acres of forests Short-term/minor impacts • 104 acres of scrub/shrub • 220 acres of grasslands • 76 acres of croplands • 1,288 acres total	Permanent/major impacts • 469 acres of forests Short-term/minor impacts • 80 acres of scrub/shrub • 494 acres of grasslands • 238 acres of croplands • 1,494 acres total	Permanent/major impacts • 444 acres of forests Short-term/minor impacts • 104 acres of scrub/shrub • 138 acres of grasslands • 18 acres of croplands • 1,115 acres total	Permanent/major impacts • 242 acres of forests Short-term/minor impacts • 83 acres of scrub/shrub • 195 acres of grasslands • 23 acres of croplands • 937 acres total	Permanent/major impacts • 320 acres of forests Short-term/minor impacts • 52 acres of scrub/shrub • 163 acres of grasslands • 13 acres of croplands • 954 acres total
Loss or alteration of rare native plant communities	Short-term/minor impacts from maintenance • 18 acres of rare native plant communities No impact on old-growth forests or HCVFs	Short-term/minor impacts from maintenance • 10 acres of rare native plant communities No impact on old-growth forests or HCVFs	No impact on rare native plant communities, old-growth forests, or HCVFs	No impact on rare native plant communities, old-growth forests, or HCVFs	Short-term/minor impacts from maintenance • 0.9 acre of old-growth forest • 1 HCVF No impact on rare native plant communities
Spread of noxious weeds and invasive plants	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts

[a] Enbridge-provided footprint for construction work area, Enbridge-provided footprint for permanent right-of-way.

[b] Estimated 120-foot-wide construction work area centered on pipeline route, includes the 50-foot-wide permanent right-of-way; estimated operations area based on 50-foot-wide permanent right-of-way centered on pipeline route.

[c] Estimated 205-foot-wide construction work area, with 10-feet-wide on the north side of Line 3 and 195-feet-wide on the south side of Line 3, includes the permanent right-of-way; estimated operations area based on 50-foot-wide permanent right-of-way centered on pipeline route.

HCVF = high conservation value forest

6.3.3.5 References

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6.3.4 Fish and Wildlife

Fish and wildlife provide important social and cultural resources; they are managed by federal and state agencies for consumption and conservation. The general Project area supports a diversity of fish and wildlife, including coldwater, coolwater, and warmwater fisheries; mammals including big and small game animals; fur-bearing animals; and birds including waterfowl, game, nongame, resident, and migratory species. Lakes, rivers, streams, and wetlands provide habitat for fish as well as for aquatic and terrestrial wildlife. Wildlife habitats include a variety of vegetation communities that provide forage, shelter, overwintering, migration stopover, and breeding habitats for a wide variety of wildlife.

This section identifies the common and abundant fish and wildlife resources that may be affected by construction or operation of the Applicant's preferred route or the other alternative routes in Minnesota. The analysis of impacts on fish and wildlife during construction and operation of the Applicant's preferred route and route alternatives considered the potential for injury, mortality, disturbance or any other impacts of aquatic and wildlife species and habitats.

This section first describes the regulations relevant to assessing impacts on fish and wildlife resources, the methods used to conduct the impact assessment, and the existing conditions within the defined ROIs (identified below). The potential construction- and operations-related impacts for the Applicant's preferred route and the route alternatives (RA-03AM, RA-06, RA-07, and RA-08) on fish and wildlife are presented next. A summary and comparison of the impacts for the route options between Clearbrook and Carlton are included at the end of the section, along with potential mitigation measures that could minimize impacts.

Wildlife protected under state and federal endangered species regulations are addressed in Section 6.3.5. Outstanding resource value waters are addressed in Section 6.3.1.2.

Potential impacts on fish and wildlife resources from an unanticipated crude oil release are addressed in Chapter 10.

6.3.4.1 Regulatory Context and Methodology

6.3.4.1.1 Regulatory Context

Regulations pertaining to fish and wildlife are managed by federal (e.g., USFWS) and state (e.g., Minnesota DNR) natural resources agencies. The goal of these agencies is to conserve, protect, and enhance fish, wildlife, and other natural resources for the benefit of the public. Fish, wildlife, and their habitats that are protected under federal and state endangered species laws or other protective regulations for special or unique resources are discussed in Section 6.3.5. Other federally enacted regulations provide protection for fish and wildlife not otherwise protected under the Endangered Species Act of 1973 (ESA). These include the Migratory Bird Treaty Act of 1918 (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). USFWS has statutory authority and responsibility for enforcing the MBTA (16 U.S. Code 703–712; 40 Stat. 755 as amended), and the BGEPA (16 U.S. Code 66-8-668d).

The MBTA makes it illegal for anyone to capture, kill, or possess migratory birds, or any parts, nests, or eggs of any migratory bird except under terms of a valid permit issued pursuant to federal regulations. In addition to the MBTA, Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," further directs executive departments and agencies to promote migratory bird conservation conventions to protect migratory birds and their habitats, including migratory waterfowl

and game birds. The MBTA prohibits the take of any migratory bird without authorization from USFWS. "Migratory birds" are all species native to the United States or its territories. Non-native birds are not protected under the MBTA (USFWS 2016a).

Bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are protected under the BGEPA. This act prohibits anyone from taking (i.e., pursuing, shooting or shooting at, poisoning, wounding, killing, capturing, trapping, molesting, or disturbing) eagles, including their parts (e.g., feathers), nests, or eggs (USFWS 2016b). This definition also covers impacts from human-induced alterations at nest sites when eagles are not present; therefore, if removal of an eagle nest is necessary and unavoidable, a permit and consultation with USFWS would be required. Minnesota also issues permits for removal or disturbance of active and inactive bald eagle and osprey (*Pandion haliaetus*) nests per its statutory authority as provided by Chapter 97A (Game and Fish), Part 97A.045 (Commissioner, General Powers and Duties), Subdivision 2 (Power to Protect Wild Animals).

The National Invasive Species Act (16 U.S. Code 4701) is a federal law that requires state management plans along with regional panels to actively fight the spread of aquatic invasive species in U.S. waterways. Minnesota DNR regulates the state's invasive species laws (Minn. Stat. § 84D and Minn. R. 6216).

Minnesota DNR regulates potential effects on Minnesota's public lands and waters; crossing these areas requires a license, which could in turn require mitigation measures. Minnesota DNR has jurisdiction over wildlife in Minnesota and administers the Minnesota outdoor recreation system, including WMAs, Scientific Natural Areas, state parks, and state forests. As with USFWS, Minnesota DNR encourages project applicants to consult with them to ascertain a project's potential to affect state-listed threatened and endangered species and to identify possible mitigation measures. Minnesota DNR also regulates water withdrawals from both groundwater and surface water sources, and requires a permit for withdrawals in excess of 10,000 gpm or 1 million gallons per year. A detailed discussion of the regulatory framework for all aspects of the Project is provided in Chapter 3.

6.3.4.1.2 Methodology

Potential impacts on fish and wildlife resources and their habitats from construction and operation of the Applicant's preferred route and route alternatives were assessed as described in this section. The ROI for this evaluation encompassed the area that could be affected, including indirectly, by pipeline construction and operation within 0.5 mile of the route centerlines. As described below, the assessment of potential direct impacts focused on the areas directly affected by construction and operation activities. Where appropriate, a larger region was considered to describe existing resources and evaluate activities that would occur more than 0.5 mile from the route. Invasive species locations were identified within 1 mile from the route centerlines. Additional information specific to the Applicant's preferred route in Minnesota and the route alternatives between Clearbrook and Carlton are provided below.

The impact analysis identified changes to fish and wildlife resources and their habitats, including consideration of the following:

- Fish and aquatic habitats
  - Fish distribution and habitat use, muskellunge waters (*Esox masquinongy)*, designated trout streams and lakes, and mussel concentration areas; and

  - Lakes, rivers, and streams, Aquatic Management Areas (AMAs), Fish Index of Biotic Integrity (Fish IBI) Lakes, waters infested with aquatic invasive spcies, Lakes of Biological Significance, and Sentinel Lakes.

- Wildlife and wildlife habitats
  - Wildlife distribution and habitat use, raptor nests and colonial waterbird colonies; and
  - Vegetated land cover, designated wildlife conservation areas (e.g., WMAs, waterfowl production areas, wetland management districts, U.S. Bureau of Land Management (BLM) land, federal and state forests, state parks, recreation areas, natural areas, nature preserves, scenic trails, and private conservation areas), and Audubon Important Bird Areas (IBAs).

The methods used to evaluate potential impacts on fisheries and aquatic habitats, and on wildlife and wildlife habitats are described below.

Fisheries and Aquatic Habitat

Descriptions of fish, fisheries, aquatic habitats, and aquatic invasive species were obtained from publicly available sources published by federal and state agencies, including data from USFWS, USGS, and Minnesota DNR.

Minnesota has several methods of classification used to identify, manage, or rate waterbodies in relation to water quality or habitat. The analysis of Project impacts considered the proximity of the Applicant's preferred route and the route alternatives to classified waterbodies or areas, including AMAs, Sentinel Lakes, Lakes of Biological Significance, designated wildlife lakes, and waterbodies assigned an IBI. These management units are described below. Additional waterbody classifications specific to individual species (e.g., trout streams and muskellunge lakes) also were included in the analysis.

Management Units Considered

Aquatic Management Areas were established by the State of Minnesota to "protect, develop and manage lakes, rivers, streams, and adjacent wetlands and lands that are critical for fish and other aquatic life for water quality, and for their intrinsic biological value, public fishing, or other compatible outdoor recreational uses" (Minn. Stat. 86A, Subd. 14). In Minnesota, the demand for shoreline property is high, and such areas are rapidly being developed. Minnesota DNR acquires riparian shoreline parcels to designate as AMAs in order to (1) establish protections for critical fish and wildlife habitat; (2) ensure that non-boat public access to water resources will always be available; and (3) ensure that habitat can be developed in previously disturbed areas (Minnesota DNR 2016a). North Dakota and Wisconsin do not specifically designate AMAs but manage more general wildlife areas for hunting, fishing, trapping, and other recreational activities (see Section 5.2.4.2.3).

Sentinel Lakes were designated to model and monitor Minnesota Lake ecosystems for detection and better understanding of environmental stressors in order to guide management that sustains fisheries and water resources for future generations (Minnesota DNR 2016b).

Lakes of Biological Significance were identified and classified by Minnesota DNR subject matter experts based on objective criteria for four community types (aquatic plants, fish, amphibians, and birds). Unique plant or animal presence is the primary measure of a lake's biological significance. Lakes are assigned one of three biological significance classes:

- Outstanding – Plants: high aquatic plant richness, high floristic quality, and a population of an endangered or threatened plant; important wild rice lakes. Fish: exceptional fishery for selected game fish or an outstanding nongame fish community. Birds: endangered or threatened colonial waterbird nesting area; presence of several endangered, threatened or special concern lake bird species; or six or more lake bird Species of Greatest Conservation Need (SGCN).[14]
- High – Plants: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. Fish: populations of more than one fish of special concern or SGCN. Birds: colonial waterbird nesting area; history of endangered or threatened colonial waterbird nesting; presence of endangered, threatened, or special concern lake bird species or five lake bird Species of Greatest Conservation Need. Amphibians – mudpuppy presence.
- Moderate – Plants: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. Fish: populations of one fish species of special concern or fish SGCN. Birds: history of colonial waterbird nesting; presence of an endangered, threatened or special concern lake bird species; or several lake bird SGCN (Minnesota DNR 2015a).

Index of Biotic Integrity is a biologically based method for measuring the integrity of aquatic systems that incorporates fish data on species richness, community assemblage, and trophic composition. Each metric represents an aspect of the biological assemblage structure, function, or other measurable characteristic that changes in some predictable way with increased human-induced stress. Fish IBI scores respond to differences in land use patterns, trophic state, and aquatic vegetation.

Other waterbodies evaluated include DNR fish hatcheries, muskellunge waters, and designated trout streams and lakes. In Minnesota, trout streams and lakes are designated to protect and foster the propagation of trout and provide fishing opportunities and angler access. Further detail for these waterbody classification systems is included in the discussions of existing conditions below.

Data Sources and Potential Impact Areas

Specific geospatial data sources evaluated for impacts on fish and aquatic habitats included:

- USGS National Hydrography Dataset;
- Minnesota DNR and Minnesota PCA geospatial data for:
  - AMAs (Minnesota DNR 2016a),
  - Sentinel Lakes (Minnesota PCA 2016),
  - Lakes with Fish IBI scores (Minnesota DNR 2014a),
  - Lakes of Biological Significance (Minnesota DNR 2015b),

[14] Animals whose populations are rare, declining, or vulnerable to decline and are below levels desirable to ensure their long-term health and stability (Minnesota DNR 2006).

  - Trout lakes and streams (Minnesota DNR 2015c),
  - Muskie lakes (Minnesota DNR 2008),
  - Infested Waters List (Minnesota DNR 2016d), and
  - Minnesota Natural Heritage Information System (NHIS) mussel concentration areas (Minnesota DNR 2016e); and
- USGS nonindigenous aquatic species (USGS NAS 2016).

Impacts on fish and aquatic habitats from construction of the Applicant's preferred route were evaluated within the Project footprints provided by the Applicant for the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations. Using GIS, these footprints were overlain on the resource maps to identify the resources potentially affected. The potentially affected areas during operation of the Applicant's preferred route were identified in a similar manner, using a 50-foot-wide permanent right-of-way.

The resources potentially affected by route alternatives RA-03AM, RA-06, and RA-08 were estimated using a 120-foot-wide construction work area centered on the route alternative. For RA-07, a 205-foot-wide construction work area was used, with 10 feet on the north side of the existing Line 3 pipeline permanent right-of-way and 195 feet on the south side of the existing Line 3 pipeline permanent right-of-way. Operations comparisons for all route alternatives used a 50-foot-wide permanent right-of-way overlain on the available resource maps.

Additional analyses were performed to compare the aquatic habitat value of waters along the route alternatives between Clearbrook and Carlton. These comparisons were developed using Minnesota PCA's Watershed Health Assessment parameters for species richness, stream species quality, and habitat quality and connectivity (Minnesota DNR 2016f). Values for each of these parameters were compared for the Applicant's preferred route and route alternatives by calculating the mean weighted average for the index of interest of the watersheds crossed by each alternative. Results are presented below in Section 6.3.4.3.

The ROI for the fisheries and aquatic habitat evaluation encompasses the area that could be directly or indirectly affected by pipeline construction within 0.5 mile from the route centerlines because some construction activities and indirect effects may occur within areas beyond the construction work areas.

Wildlife and Wildlife Habitat

Descriptions of common wildlife (e.g., abundance, distribution, and seasonal sensitivity) and wildlife habitats were obtained from publicly available information published by Minnesota DNR, USFWS, USGS, and the National Audubon Society. Information on raptor nest locations was obtained from reports on raptor nest surveys completed for the Project (Merjent 2015a, 2015b). Colonial waterbird nesting locations were evaluated based on NHIS data (Minnesota DNR 2016e).

Designated Management Units

The impacts analysis considered the proximity of the Applicant's preferred route and route alternatives to areas considered significant for conservation of wildlife or for preservation of wildlife habitat.

Wildlife conservation lands are presented under various naming conventions, including but not limited to, WMAs, waterfowl production areas, wetland management districts, BLM land, federal and state

forests, state parks, recreation areas, natural areas, nature preserves, scenic trails, and private conservation areas. USGS Gap Analysis Program (GAP) data provide a compilation of these conservation areas. Each area is assigned status codes (1, 2, and 3) to indicate the level of protection and management objectives. All three of these GAP status codes include permanent protection from conversion of natural land cover over all or most of their area (USGS GAP 2013). GAP status 1 and 2 lands are managed for biodiversity, while GAP status 3 lands include areas managed for multiple uses. Minnesota's WMAs were established to protect lands and waters with productive habitat for fish and wildlife, as well as fish- and wildlife-oriented recreation (e.g., hunting, fishing, and bird watching) (Minnesota DNR 2016f).

IBAs established by the National Audubon Society (rather than by state or federal agencies) are a useful management tool to identify and protect habitats on which birds depend. Audubon IBAs include both public and private lands and lack formal protections. IBAs are identified through a rigorous process by bird experts. Each IBA represents a place that supports species of conservation concern (e.g., threatened and endangered species), range-restricted species (e.g., those species limited spatially), species that occur in only one habitat type or biome, or species or groups of species (e.g., waterfowl or shorebirds) that are vulnerable because they congregate in large numbers.

In addition to these wildlife areas, general vegetation land cover including large blocks (greater than 100 acres) of forested and wetland habitats provides important information about available habitats and the wildlife that likely use them. Further details for each of these land classification systems are provided in the existing conditions section.

Data Sources and Potential Impact Areas

Specific geospatial data sources evaluated for impacts on wildlife and wildlife habitats included:

- NLCD (Homer et al. 2015) for land cover information, including aquatic and terrestrial (vegetation) habitats;
- Federal, state, and local wildlife conservation areas and easements (USGS-GAP 2016);
- Minnesota wildlife refuge inventory (Minnesota DNR 2016g);
- Audubon IBAs (Audubon 2016);
- Minnesota NHIS colonial waterbird nesting aggregations (Minnesota DNR 2016e); and
- Raptor nest surveys for the Applicant's preferred route (Merjent 2015a, 2015b).

Areas of potential impacts on wildlife and wildlife habitat due to construction of the Applicant's preferred route were evaluated within the Project footprints provided by the Applicant for the construction work area, ATWS, access roads, pipe yards, permanent right-of-way, MLVs and driveways, and pump stations. Using GIS, these footprints were overlain on the resource maps to identify the resources potentially affected. The potentially affected areas during operation of the Applicant's preferred route were identified in a similar manner, using a 50-foot-wide permanent right-of-way.

The resources potentially affected by route alternatives RA-03AM, RA-06, and RA-08 were similarly estimated using a 120-foot-wide construction work area centered on the route alternative. For alternative RA-07, a 205-foot-wide construction work area was used, with 10 feet on the north side of the existing Line 3 pipeline permanent right-of-way and 195 feet on the south side of the existing Line 3 pipeline

permanent right-of-way. Operations comparisons used a 50-foot-wide permanent right-of-way overlain on the wildlife distribution and wildlife habitat resource maps.

The ROI for the wildlife and wildlife habitat evaluation encompasses the area that could be directly or indirectly affected by pipeline construction within 0.5 mile of the route centerlines because some construction activities and indirect effects may occur in areas beyond the construction work areas.

Typical terrestrial wildlife habitat impacts from pipeline construction and operational maintenance were qualitatively evaluated, including the alteration of vegetation cover. Permanent loss of wildlife habitat was quantified as the area required for maintenance of permanent facilities. Temporary loss and permanent alteration of wildlife habitats were quantified as the size and quality of the area disturbed by the construction work areas and permanent right-of-way by providing the total acres disturbed within wildlife conservation areas and by vegetation cover class. Habitats susceptible to fragmentation were identified by locating large blocks (greater than 100 acres) (Homer et al. 2015) of continuous upland forest and woody wetland cover that would be crossed by the alternative routes where those routes are not co-located with other linear infrastructure. Particular attention was given to large, mature core or interior forested areas that serve as habitat for protected migratory birds and other wildlife.

The potential for wildlife mortality impacts were qualitatively evaluated based on occurrence, the animal's ability to move away from construction activities, and the animal's susceptibility to being run over or hit by equipment or crew vehicles. The potential for wildlife disturbance, displacement, or blockage of movements also were qualitatively evaluated based on occurrence, locations of migration corridors, locations of sensitive breeding or migration staging areas, and differential sensitivity to human activities.

6.3.4.2 Existing Conditions

The following summary provides information on existing conditions specific to Minnesota. See Section 5.2.4.2 for additional detail on aquatic environments and their relationship to fisheries and aquatic species.

6.3.4.2.1 Fisheries and Aquatic Habitat

The Applicant's preferred route and all route alternatives would cross surface waters, including large rivers; perennial (permanent) streams, intermittent (wet during part of the year) streams, and ephemeral (wet only after precipitation) streams; and large lakes, shallow lakes, and wetlands. See Sections 6.3.1.1, 6.3.1.2, and 6.3.1.3 for a discussion of potential impacts on ground water, surface water, and wetland resources, respectively.

Aquatic Habitat in the Project Area

Waterbodies of all sizes provide habitat for fish and other wildlife. Typically, large rivers are quite wide; flow more slowly than smaller rivers; and have numerous meanders and oxbows, islands, and backwaters. The backwater areas of these rivers are biologically productive and provide important spawning areas for several species of fish, as well as refuge habitat for many other animal species. Connectivity of these rivers is an important feature and influences the distribution of fish populations and other species. Smaller rivers, streams, and wetlands provide foraging areas, nesting areas, and refuge for myriad species of fish and wildlife, including SGCN birds such as yellow rails (*Coturnicops noveboracensis*) and sedge wrens (*Cistothorus platensis*) (see Section 6.3.5 for more information about SGCN). The Mississippi River, which would be crossed by the Applicant's preferred route and all route

alternatives (except for RA-06), has a naturally reproducing population of muskellunge that since 2006 also has been stocked with fingerlings or adults.

Lakes are important to Minnesota's environment and economy (e.g., hunting and fishing, many forms of lake recreation, and the tourism industry). Good-quality lake habitat is largely the result of healthy, intact watersheds and shorelines. Watersheds influence water quality, where more intact watersheds tend to result in lakes with better water quality. Shoreline habitat provides bottom substrates, structure, and vegetation that fish and other aquatic animals need for foraging, spawning substrate, and cover from predation.

Shallow lakes provide habitat for many species. They are permanent or semi-permanent waterbodies that are less than 15 feet deep and typified by abundant aquatic plant growth that results from generally high levels of nutrients (e.g., phosphorus, nitrogen, and minerals) and abundant sunlight availability in shallow water. Wetlands and vegetated fringes form along the edges of lakes and include stands of emergent and floating-leaved aquatic plants such as cattails (*Typha* spp.), bulrush (several genera), water lily (*Nymphaea* spp.) and reeds (several genera), as well as submerged plants (e.g., coontail [*Ceratophyllum demersum*]), creating an extended littoral zone. These plants provide excellent food and habitat for zooplankton, insects, fish, waterfowl, and other wildlife. Abundant aquatic vegetation also helps to maintain water clarity by anchoring sediments. Shallow lakes are important breeding, nesting, and foraging areas for waterfowl and waterbirds such as ducks, geese, herons, rails, and many more (Minnesota DNR 2016h).

Aquatic Management Areas

All of the route options would traverse areas with abundant freshwater lakes that provide habitat for many species. There are 19 AMAs within 0.5 mile of the Applicant's preferred route and route alternatives (Figure 6.3.4-1).

Other Management Units

Minnesota has identified a number of lakes and streams as having excellent quality or high biological significance. These datasets include Fish IBI lakes, Lakes of Biological Significance, Sentinel Lakes, and designated wildlife lakes. A total of 35 Lakes of Biological Significance, including 25 lakes rated outstanding, 4 lakes rated high, and 6 lakes rated moderate, occur within 0.5 mile of the Applicant's preferred route and route alternatives (Appendix L, Fish and Wildlife, Table L-2). Six of these lakes would be crossed by the Applicant's preferred route and route alternatives (Table 6.3.4-1), including Portage Lake, which is a Sentinel Lake.

Minnesota DNR-designated trout streams occur primarily in southeastern Minnesota and along the north shore of Lake Superior, although trout streams occur throughout the state.

Based on strong public interest in large muskellunge angling, Minnesota DNR maintains a set of specific management goals and strategies to maintain trophy muskellunge populations (including tiger muskellunge) in select waterbodies. Muskellunge waters must meet one of three criteria: (1) they are stocked; (2) a viable population exists; or (3) they represent an important component of the lake's fishery (either biologically or in terms of angler experience). Muskellunge are actively managed in 99 waters covering a total of 480,153 surface acres, including 8 rivers (Minnesota DNR 2016i).



Source: Minnesota DNR 2016h.

Figure 6.3.4-1. Aquatic Management Areas near the Applicant's Preferred Route and Route Alternatives

Table 6.3.4-1. Lakes of Biological Significance Crossed by the Applicant's Preferred Route and Route Alternatives

Route	Watershed	Area (acres)	Shoreline (miles)	LBS Class[a]	Ranking Category[b]		
					Plant Rank	Fish Rank	Bird Rank
Applicant's preferred route	Unnamed (Wetland)	209	7.3	Moderate	--	--	3
Route alternative RA-06	Long	132	4.1	High	--	2	--
Route alternative RA-07	West Four-Legged	432	8.0	Outstanding	1	--	--
Route alternative RA-07	East Four-Legged	357	6.4	Outstanding	1	--	--
Route alternative RA-07	Pike Bay	4,751	10.7	Outstanding	--	1	--
Route alternative RA-08	Shallow	539	5.1	Outstanding	--	1	--

Sources: Minnesota DNR 2015b, 2016b.

Notes:

[a] Lake of Biological Significance (LBS) class definitions:

Outstanding – *Plants*: high aquatic plant richness, high floristic quality, and a population of an endangered or threatened plant; important wild rice lakes. *Fish*: exceptional fishery for selected game fish or an outstanding nongame fish community. *Birds*: endangered or threatened colonial waterbird nesting area; presence of several endangered, threatened, or special concern lake bird species; or six or more lake bird Species of Greatest Conservation Need (SGCN).

High – *Plants*: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. *Fish*: populations of more than one fish of special concern and/or SGCN. *Birds*: colonial waterbird nesting area; history of endangered or threatened colonial waterbird nesting; presence of endangered, threatened, or special concern lake bird species; or five lake bird SGCN.

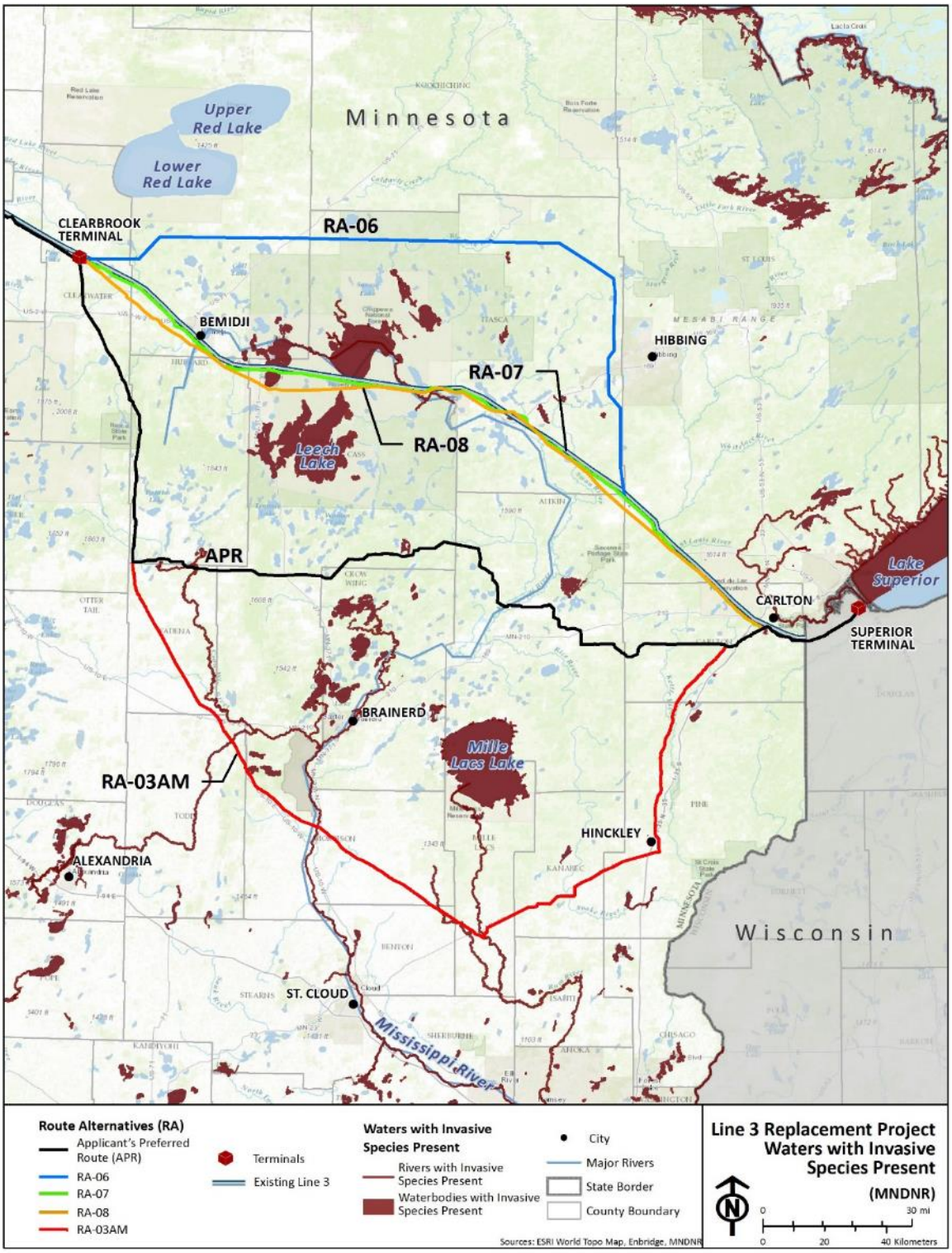
Moderate – *Plants*: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. *Fish*: populations of one fish species of special concern and/or fish SGCN. *Birds*: history of colonial waterbird nesting; presence of an endangered, threatened, or special concern lake bird species; or several lake bird SGCN.

[b] Number of lakes with ranks crossed

"--" = no crossing

Aquatic Invasive Species and Infested Waters

Minnesota DNR maintains an Infested Waters List of waters containing high-priority aquatic invasive species. A lake, river, pond, or wetland is included in the infested waters list if it contains an aquatic invasive species that could spread to other waters (Minnesota DNR 2017a). The Applicant's preferred route segment from Clearbrook to Carlton and all route alternatives except for RA-06 would cross or pass near rivers and lakes containing aquatic invasive species (Figure 6.3.4-2) (Table 6.3.4-2). A permit to appropriate, divert, or transport infested waters may be required from Minnesota DNR if a selected alternative would cross an infested waterway.



Source: Minnesota DNR 2016d.

Figure 6.3.4-2. Documented Aquatic Invasive Species Occurrences in Relation to the Applicant's Preferred Route and Route Alternatives

Table 6.3.4-2. Aquatic Invasive Species Infestations within 1 Mile of the Applicant's Preferred Route and Route Alternatives in Minnesota

Drainage (HUC-8) Location	Common Name	Scientific Name	Status	Applicant's Preferred Route		Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
				Minnesota Total	Clearbrook to Carlton				
Clearwater									
Clearwater County	Narrow-leaved cattail	*Typha angustifolia*	Collected	1	1	1	--	--	--
	Northern bur-reed	*Sparganium glomeratum*	Collected	1	1	1	--	--	--
Crow Wing									
Crow Wing River (south-central part of county)	Rusty crayfish	*Orconectes rusticus*	Collected	1	1	--	--	--	--
Upper Twin Lake	Mud bithynia, faucet snail	*Bithynia tentaculata*	Established	1	1	--	--	--	--
Kettle									
Moose Horn River, County Road 46 bridge	Chinese mysterysnail	*Cipangopaludina chinensis*	Established	--	--	1	--	--	--
Pine									
Margaret Lake west of Crooked Lake Township	Curly-leaf pondweed	*Potamogeton crispus*	Established	1	1	--	--	--	--
Platte-Spunk									
[No locality description provided by MARIS]	Common carp	*Cyprinus carpio*	Established	--	--	8	--	--	--
Prairie-Willow									
Ice (Crystal) Lake	Eurasian watermilfoil	*Myriophyllum spicatum*	Established	--	--	--	--	2	2
McKinney Lake	Eurasian watermilfoil	*Myriophyllum spicatum*	Established	--	--	--	--	2	2

Table 6.3.4-2. Aquatic Invasive Species Infestations within 1 Mile of the Applicant's Preferred Route and Route Alternatives in Minnesota

Drainage (HUC-8) Location	Common Name	Scientific Name	Status	Applicant's Preferred Route		Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
				Minnesota Total	Clearbrook to Carlton				
Snake									
Middle River	Common carp	*Cyprinus carpio*	Established	1	--	--	--	--	--
St. Louis									
Beauty Lake (~10 miles northeast of Warba, MN)	Rusty crayfish	*Orconectes rusticus*	Collected	--	--	--	1	--	--
Chub Lake	Eurasian watermilfoil	*Myriophyllum spicatum*	Established	1	--	--	--	--	--
TOTAL				**7**	**5**	**11**	**1**	**4**	**4**

Source: USGS NAS 2016.

Notes:

Numbers represent number of reported occurrences (infestations) within 1 mile of route centerlines as recorded in the USGS Aquatic Invasive Species database.

"--"= no occurrence

HUC-8 = 8-digit hydrologic unit code that delineates watershed boundaries, defined by USGS NHD 2016

Fisheries in the Project Area

Fish species present are similar along the Applicant's preferred route and the route alternatives. Federal, state, and tribal agencies have identified substantial fisheries with recreational or commercial value that occur in waterbodies (e.g., streams, rivers, lakes, and ponds) at or immediately downstream of proposed pipeline crossings. Maintaining abundant populations of fish requires high-quality aquatic habitat and healthy ecosystems. Minnesota DNR has 28 fisheries managers who work with local fishing clubs, lake associations, individuals, and conservation groups to manage the state's lakes and streams. Fisheries management includes protecting and restoring habitats and water quality, regulating the harvest, stocking, and public education.

Minnesota DNR has many fish hatcheries to meet stocking and other needs (Figure 6.3.4-3). Some hatcheries raise trout or northern pike and muskellunge, and white suckers may be raised as food for pike and muskellunge. Minnesota's coolwater hatcheries produce from 2 to 5 million walleye fingerlings and millions of fry each year. Minnesota has more walleye, walleye lakes, and walleye anglers than any other state; and most hatcheries are dedicated to producing walleye. While substantial numbers of walleye are produced at state hatcheries, the majority of walleye result from natural reproduction that occurs in the state, including within the areas crossed by the Applicant's preferred route and route alternatives. Stocking can provide walleye fishing in lakes that lack successful or consistent reproduction but can otherwise support walleye. Stocking also is effective for lakes that have been "rehabilitated" or those that occasionally winterkill. Because many hatcheries use natural water sources as part of their operation, the analysis of potential impacts identified hatcheries downstream of the route options; however, there are no hatcheries within 1 mile of the surface water crossings of the Applicant's preferred route or the route alternatives.

The Applicant's preferred route and route alternatives would cross surface waters with fisheries in the Red River, Rainy River, Upper Mississippi River, Lake Superior, and St. Croix River drainages (Table 6.3.4-3). Common Minnesota game fish and their habitats and distributions in those drainages are listed in Table 6.3.4-4.

Fisheries can be defined as coldwater, coolwater, or warmwater; they are associated with particular fish assemblages. These fisheries can include both game and nongame species. All three types are present in the region. Protected and rare species are discussed in Section 6.3.5, including species designated by Minnesota DNR or USFWS as threatened and endangered.

Coldwater Fisheries

Coldwater fisheries support trout and salmon (Salmonidae), which are important commercial and sport fishes that require cold, clean water for survival and reproduction. Three species of Pacific salmon have been introduced to Lake Superior and now spawn in its tributaries (Minnesota DNR 2016i). Lake trout (*Salvelinus namaycush*) are naturally reproducing in cold lakes throughout the region. The native brook trout (*Salvelinus fontinalis*) and the introduced brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) also are present in rivers and streams in the region.



Source: Minnesota DNR 2016m

Figure 6.3.4-3. Minnesota Fisheries Management Districts and Hatcheries near the Applicant's Preferred Route and Route Alternatives

Table 6.3.4-3. River Drainages Crossed by the Applicant's Preferred Route and Route Alternatives

Route	River Drainage				
	Red River	Rainy River	Upper Mississippi River	Lake Superior	St. Croix River
Applicant's preferred route	X	--	X	X	X
Route alternative RA-03AM	X	--	X	X	X
Route alternative RA-06	X	X	X	X	--
Route alternative RA-07	X	--	X	X	--
Route alternative RA-08	X	--	X	X	--

Notes:

Drainages with an "X" indicate drainages crossed.

[a] See Table 6.3.4-4 for common Minnesota game fish in these drainages.

"--" = no crossing

Table 6.3.4-4. Common Minnesota Game Fish in Major River Drainages Crossed by the Applicant's Preferred Route and Route Alternatives

Common Name	Scientific Name	Habitat	River Drainage[a]				
			Red River	Rainy River	Upper Mississippi River	Lake Superior	St. Croix River
Coldwater – Salmon and Trout							
Brook trout	*Salvelinus fontinalis*	Cool and clear water with sandy and gravelly bottoms and moderate vegetation	i	i	i	x	x
Brown trout	*Salmo trutta*	Coolwater lakes and streams; Lake Superior	i	i	i	i	i
Atlantic salmon	*Salmo salar*	Lake Superior and tributaries	--	--	--	i	--
Chinook salmon	*Oncorhynchus tshawytscha*	Lake Superior and tributaries	--	--	--	i	--
Coho salmon	*Oncorhynchus kisutch*	Lake Superior and tributaries	--	--	--	i	--
Pink salmon	*Oncorhynchus gorbuscha*	Lake Superior and tributaries	--	--	--	i	--
Cisco (tullibee or lake herring)	*Coregonus artedi*	Lakes, large rivers	x	x	x	x	u

Table 6.3.4-4. Common Minnesota Game Fish in Major River Drainages Crossed by the Applicant's Preferred Route and Route Alternatives

Common Name	Scientific Name	Habitat	River Drainage[a]				
			Red River	Rainy River	Upper Mississippi River	Lake Superior	St. Croix River
Lake whitefish	*Coregonus clupeaformis*	Lake Superior and deep, coolwater lakes in northern Minnesota	x	x	x	x	L#
Lake trout	*Salvelinus namaycush*	Coldwater lakes	--	x	i	x	i
Rainbow trout	*Oncorhynchus mykiss*	Cold streams and lakes	i	i	i	i	i
Coolwater – Pike and Perch							
Muskellunge (muskie)	*Esox masquinongy*	Clear, clean lakes	i	x	x	x	i
Northern pike	*Esox lucius*	Vegetated areas of quiet, slow-moving waters in lakes, ponds, and rivers	x	x	x	x	x
Sauger	*Sander canadense*	Large rivers with deep pools	--	x	--	--	L
Walleye	*Sander vitreus*	Large, shallow lakes with gravel shoals	x	x	x	x	x
Yellow perch	*Perca flavescens*	Lakes and backwaters of large rivers; pools and runs of small streams	x	x	x	x	x
Warmwater – Bass, Sunfish, and Catfish							
Largemouth bass	*Micropterus salmoides*	Shallow, fertile, lakes and river backwaters with ample aquatic vegetation as well as vegetated bays of larger lakes	x	x	x	x	x
Smallmouth bass	*Micropterus dolomieu*	Streams, rivers with clear water	i	i	x	x	x
White bass	*Morone chrysops*	Shallow rivers, creeks, and streams	i	--	--	--	L
Yellow bass	*Morone mississippiensis*	Slow-moving rivers, lakes, and ponds	--	--	--	--	--
Black crappie	*Pomoxis nigromaculatus*	Deep, cool, clear lakes	x	x	x	x	x
White crappie	*Pomoxis annularis*	Deep, cool, clear lakes	i	--	--	--	x
Bluegill	*Lepomis macrochirus*	Ponds, lakes, and slow-moving rivers	x	x	x	x	x

Table 6.3.4-4. Common Minnesota Game Fish in Major River Drainages Crossed by the Applicant's Preferred Route and Route Alternatives

Common Name	Scientific Name	Habitat	River Drainage[a]				
			Red River	Rainy River	Upper Mississippi River	Lake Superior	St. Croix River
Pumpkinseed	*Lepomis gibbosus*	Ponds, lakes, and slow-moving rivers	x	x	x	x	x
Green sunfish	*Lepomis cyanellus*	Ponds, lakes, and slow-moving rivers	x	x	x	x	x
Orangespotted sunfish	*Lepomis humilis*	Ponds, lakes, and slow-moving rivers	x	--	x	--	--
Longear sunfish	*Lepomis megalotis*	Shallow ponds, lakes, and slow-moving rivers	--	x	x	--	U W I IA
Warmouth	*Lepomis gulosus*	Shallow ponds, lakes, and slow-moving rivers	--	i	--	--	L W I IA
Rock bass	*Ambloplites rupestris*	Well-oxygenated lakes and streams with boulder and sand bottoms	x	x	x	x	x
Channel catfish	*Ictalurus punctatus*	Large and small rivers, lakes, and ponds	x	--	i	x	x
Flathead catfish	*Pylodictis olivaris*	Turbid, slow-moving streams	--	--	i	--	x
Black bullhead	Ameiurus melas	Slow-moving, quiet waters with soft bottoms made up of mud, sand, and gravel	x	x	x	x	x
Brown bullhead	Ameiurus nebulosus	Slow-moving, quiet waters with soft bottoms made up of mud, sand, and gravel	x	x	x	x	x
Yellow bullhead	Ameiurus natalis	Slow-moving, quiet waters with soft bottoms made up of mud, sand, and gravel	x	--	x	x	x
Miscellaneous							
Rainbow smelt	*Osmerus mordax*	Rivers, coastal areas, and ponds	--	i	i	i	i
Lake sturgeon	*Acipenser fulvescens*	Lakes and rivers with sandy, gravelly, and muddy bottoms	R	x	--	x	x
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	Large rivers	--	--	--	--	L

Table 6.3.4-4. Common Minnesota Game Fish in Major River Drainages Crossed by the Applicant's Preferred Route and Route Alternatives

Common Name	Scientific Name	Habitat	River Drainage[a]				
			Red River	Rainy River	Upper Mississippi River	Lake Superior	St. Croix River
Paddlefish	*Polyodon spathula*	Large rivers and river lakes (e.g., Lake Pepin), oxbow lakes, and backwaters	--	--	--	--	L
Bowfin	*Amia calva*	Clear lakes and slow streams	x	--	x	--	x
Burbot	*Lota*	Cool waters of northern lakes and rivers; Lake Superior	x	x	x	x	x

Sources: Minnesota DNR 2016k; Hatch and Schmidt 2004.

[a] River drainage explanations:
"--" = not listed as present in the drainage
i = introduced to the drainage,
IA = Iowa portion of drainage,
L = below Taylor's Falls
U = above Taylor's Falls
R = native and reintroduced
x = native to and present today in drainage
WI = Wisconsin portion of drainage
# = present prior to 1975

Coolwater Fisheries

Coolwater fisheries support gamefish such as northern pike (*Esox lucius*) and muskellunge or muskie, walleye (*Sander vitreus*), and yellow perch (*Perca flavescens*). Northern pike generally inhabit clear, shallow, warm waters near shore but move to deeper water midsummer using coolwater areas (Michigan DNR 2016a). Muskellunge survive in a wide range of temperatures and prefer clear water (ADW 2016). They move from shallow, weedy water to deeper water as they grow larger (ADW 2016). Walleye are found in submerged bars and rocky areas of shallow bay lake waters in spring and fall but also move to cooler, deeper water (i.e., less than 50 feet) in summer (Michigan DNR 2016b). Yellow perch generally prefer relatively shallow water (i.e., less than 30 feet deep) near shore (Michigan DNR 2016c).

Warmwater Fisheries

Warmwater fisheries support catfish and bullheads (Ictaluridae), sunfish and bass (Centrarchidae), carp and minnows (Cyprinidae), and temperate bass (Moronidae). Catfish and bullheads are found throughout the region, but are most common in warm, fertile rivers and lakes (Minnesota DNR 2016j). Sunfish, including the bluegill (*Lepomis macrochirus*)—which is the most popular sunfish—prefer lakes and slow streams (Minnesota DNR 2016k). Bass, both largemouth (*Micropterus salmoides*) and smallmouth (*Micropterus dolomieu*), are becoming increasingly popular with anglers. Largemouth bass tend to favor clear lakes with abundant aquatic vegetation, and they can tolerate quite warm water temperatures. Smallmouth bass often are found in rivers with suitable gravel or rubble for spawning that are warmer than those that support trout (Minnesota DNR 2016l). Carp and minnows occupy a variety of habitats,

including coldwater and warmwater environments (Cornell 2016), and several are listed as SGCN. The common carp (*Cyprinus carpio*) and a number of Asian carp species are invasive fish. The white bass (*Morone chrysops*), important for sport fishing due to its size and abundance, occurs in rivers, tributaries, and reservoirs, as well as in several lakes (Minnesota DNR 2016m). The yellow bass (*Morone mississippiensis*) is found in the Mississippi River backwaters below Lake Pepin (Minnesota DNR 2016m).

6.3.4.2.2 Wildlife and Wildlife Habitat

Wildlife Habitat in the Project Area

Northern Minnesota is relatively undeveloped, with large expanses of protected lands that are home to many species of wildlife. The Applicant's preferred route and route alternatives would cross 10 broad-scale vegetation cover classes: evergreen forest, deciduous forest, mixed forest, scrub/shrub, grassland/herbaceous, hay/pasture, cultivated crops, woody wetlands, emergent herbaceous wetlands, and barren land (Homer et al. 2015). Developed lands (residential, commercial, and industrial lands) primarily include artificially created landscapes with minimal naturally occurring vegetation. Broadly, the Applicant's preferred route and the route alternatives occur within ecoregions with forested uplands, forested wetlands, non-forested wetlands, prairie/grasslands, and agricultural areas.

Forested uplands typically exhibit closed canopies, dense understories, large trees, and downed trees. These areas are important habitat components for a variety of birds, salamanders, deer, and large carnivores such as timber wolves (*Canis lupus*) and black bears (*Ursus americanus*). Grasslands and prairies are typified by large open areas with grasses and flowering plants dominating, which provide habitat for many species of pollinators, songbirds, small mammals, snakes, and grazing animals such as deer. Non-forested wetlands and wooded wetlands, such as marshes, are permanently or periodically inundated with water and provide habitat for amphibians and reptiles, aquatic insects, aquatic mammals such as muskrats, and many species of birds. Calcareous fens are a type of wetland that support unique plant and animal species (see Section 6.3.1.3). Lakes and rivers with wild rice (discussed in Section 6.3.1.2) support wildlife, particularly waterfowl and rails. Agricultural lands attract white-tailed deer (*Odocoileus virginianus*), elk (*Cervus canadensis*), sandhill cranes (*Grus canadensis*), trumpeter swans (*Cygnus buccinator*), and wild turkeys (*Meleagris gallopavo*) that come to feed on crops.

Management Units

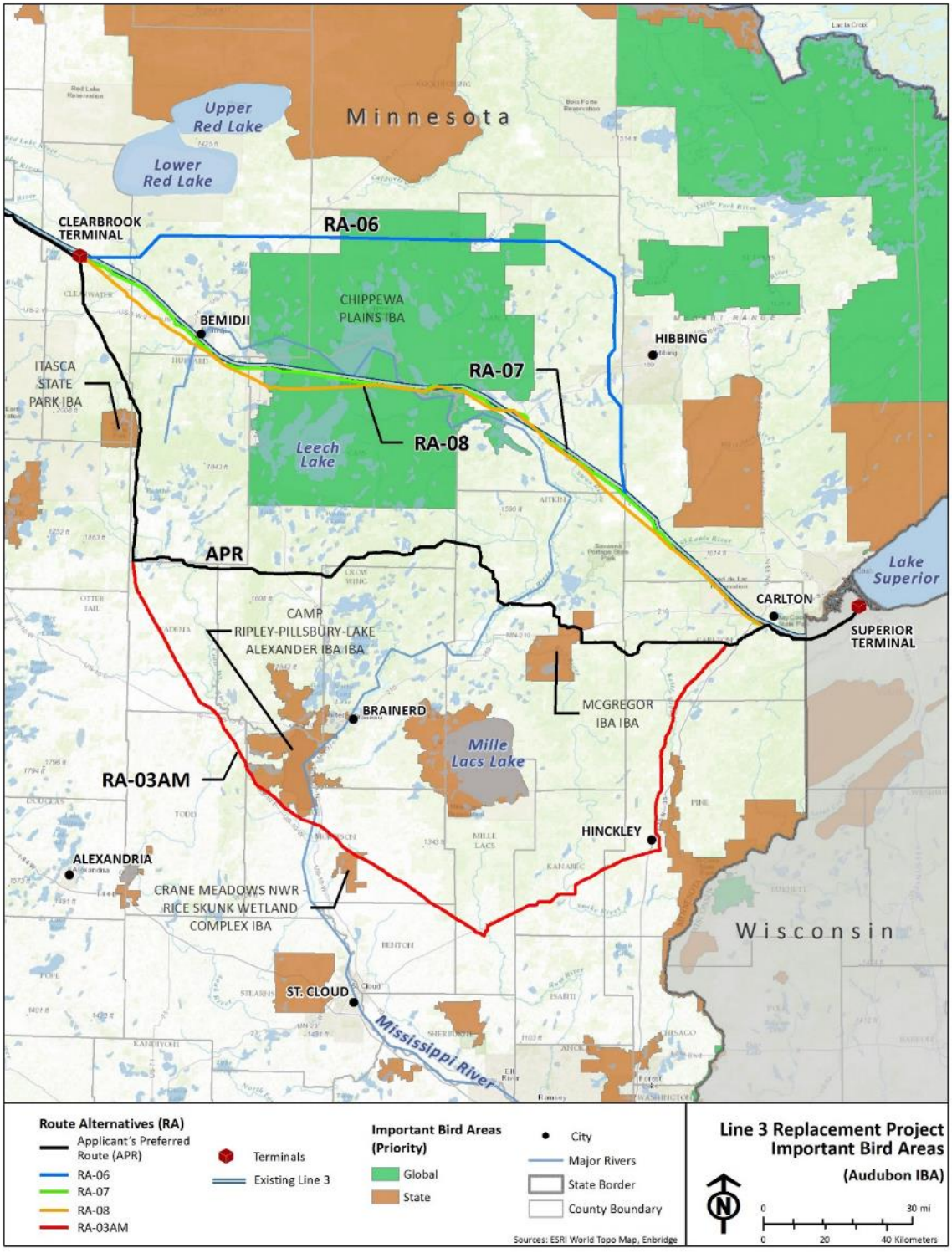
Wildlife conservation lands (described in Section 6.3.4.1.2) that occur along or near the Applicant's preferred route are listed in Table 5.2.4-4. The Applicant's preferred route and route alternatives cross a variety of Minnesota DNR wildlife management and conservation areas, including WMAs, wildlife refuges, state forests, and recreation areas. Minnesota's WMAs are established to protect lands and waters that have productive habitat for fish and wildlife, as well as fish- and wildlife-oriented recreation (e.g., hunting, fishing, and bird watching). WMA managers actively plant food plots, restore native plants and wetlands, conduct prescribed burns, and manipulate water levels to provide habitat for game species such as deer, bear, small game, forest upland birds, and waterfowl.

Audubon Important Bird Areas

IBAs established by the National Audubon Society (rather than by state or federal agencies) are a useful management tool to identify and protect habitats that birds depend on. Audubon IBAs include both public and private lands and lack formal protections. IBAs are identified through a rigorous process by bird experts. Each IBA represents a place that supports species of conservation concern (e.g., threatened and endangered species), range-restricted species (e.g., those species limited spatially), species that occur in only one habitat type or biome, or species or groups of species (e.g., waterfowl or shorebirds)

that are vulnerable because they congregate in large numbers. IBAs in the vicinity of the Applicant's preferred route and route alternatives are shown in Figure 6.3.4-4 and include the following:

- Itasca State Park IBA – This state priority IBA supports 222 species of birds. Itasca's extensive stands of boreal forests with mixed hardwoods provide excellent habitat for many northern birds such as crossbills (*Loxia* spp.), gray jays (*Perisoreus canadensis)*, finches (Fringillidae), thrushes (Turdidae), black-backed woodpeckers (*Picoides arcticus*), and warblers (Parulidae). Over 20 species of warblers nest within the park.
- McGregor IBA – This state priority IBA has important habitat for many birds that includes wetlands, lowland forests, upland deciduous forests, open brushlands, and open grasslands. McGregor IBA is probably best known for the fall ring-necked duck (*Aythya collaris*) migration but also has a variety of nesting birds such as American bittern (*Botaurus lentiginosus*), yellow rail (*Coturnicops noveboracensis*), sora (*Porzana carolina*), black tern (*Chlidonias niger*), sandhill crane; 12 species of nesting warblers; trumpeter swan; bald eagle; American woodcock (*Scolopax minor*); wood thrush (*Hylocichla mustelina*); black-billed cuckoo (*Coccyzus erythropthalmus*); LeConte's sparrow (*Ammodramus leconteii*); and bobolink (*Dolichonyx oryzivorus*).
- Camp Ripley-Pillsbury-Lake Alexander IBA – This IBA supports the greatest known concentration of nesting red-shouldered hawks (*Buteo lineatus*, a state listed Special Concern Species) in the state. Habitat consists of relatively large blocks of upland deciduous and riparian forests. In addition, 228 species of birds have been documented here since monitoring started in 1991, including 28 species of warblers (and one of the most northerly reports of the hooded warbler [*Setophaga citrina*]). Other listed species that occur in this IBA include bald eagle, trumpeter swan, yellow rail, and Louisiana waterthrush (*Parkesia motacilla*). Other important features within this IBA are the 21 miles of the Mississippi River and 27 miles of major tributaries (Crow Wing and Gull Rivers), that provide important riparian corridors and migration pathways.
- Chippewa Plains IBA – This IBA is a vast area of large lakes (Winnibigoshish, Leech, Cass, and Pokegama), rivers, and streams, as well as large tracts of upland and lowland forests. The Mississippi River, which flows through the IBA, provides a large river ecosystem complemented by smaller river systems throughout the IBA. Chippewa Plains is important for migrating waterfowl, with 160,000 ring-necked ducks and 30,000 lesser scaup (*Aythya affinis*) recorded in 2011. Nesting waterbirds include ring-billed (*Larus delawarensis*) and herring gulls (*Larus argentatus*), American white pelicans (*Pelecanus erythrorhynchos*), common terns (*Sterna hirundo*), and Minnesota's only site for Caspian terns (*Hydroprogne caspia*).
- Crane Meadows NWR-Rice Skunk Wetland Complex IBA – Crane Meadows WMA consists mostly of lowland grass and brush, with limited upland wooded areas of aspen and oak. Rice-Skunk WMA is characterized by oak woods, lowland aspen, and brush emergent wetlands, and lowland grasses. This IBA is important for migrating waterfowl, nesting waterbirds (great blue herons [*Ardea herodias*], American bitterns, and least bitterns [*Ixobrychus exilis*]), and both breeding and migrating populations of sandhill cranes.



Source: Audubon 2016.

Figure 6.3.4-4. Audubon Important Bird Areas near the Applicant's Preferred Route and Route Alternatives

Wildlife in the Project Area

Wildlife species present would be similar along the Applicant's preferred route and the route alternatives. The species that could be present are described below. The Project region supports a diversity of wildlife, including mammals, birds, amphibians, reptiles, and invertebrates. Mammals include both game species (species that are hunted or trapped such as big and small game animals and fur-bearing animals) and nongame species (small mammals and non-hunted species). Birds present are both resident and migratory, and include game species (waterfowl and upland birds) and nongame species (see Section 5.2.4, Table 5.2.4-5). Amphibians and reptiles include frogs, toads, salamanders, snakes, lizards, and turtles. Invertebrates include a wide variety of insects as well as mollusks.

Mammals

Large Mammals and Big Game

White-tailed deer is the most common big game animal along the pipeline routes. Deer occur throughout the Project region and are an ecologically, socially, and economically important species. White-tailed deer inhabit a wide variety of habitats and are highly adaptable. Croplands, grasslands, shrublands, orchards, woodlands, and even residential areas provide foraging and resting areas for deer. White-tailed deer eat a varied diet that may include acorns, corn, soybeans, mushrooms, grasses, tree leaves, buds, twigs and bark, wild grapes, apples, and assorted shrubs. During winter, deer often aggregate or "yard" in forested stream bottoms and other areas protected from heavy snows. Wolves, coyotes (*Canis latrans*), bears, and bobcats (*Lynx rufus*) are natural predators of deer. White-tailed deer are hunted for sport and meat, and permits are available to hunt using regular firearms (e.g., shotgun, rifle), muzzleloaders, or archery (e.g., bow and arrow).

Black bears are another big game mammal that occurs in the Project region. Black bears occur mainly in the northern third of Minnesota but range as far south as the interface between the forested and agricultural areas (Minnesota DNR 2016i). There are roughly 20,000 black bears in Minnesota (Minnesota DNR 2016n). Black bears live in forests, swamps, and other areas with dense cover, but they also venture into clearings to feed. Black bears feed primarily on new plant growth in spring, switching to ants and ant pupae and a variety of berries in summer, and nuts (acorns and hazelnuts) in autumn. Black bears supplement their diets with corn and other crops, bird eggs, honey, and deer fawns opportunistically. Black bears are hunted for their meat and fur, and most bears are harvested in coniferous areas of northeast Minnesota. Sport hunting is their main source of mortality. Minnesota hunters harvest an average of about 3,000 black bears annually (Minnesota DNR 2016n).

While elk are managed as a game species in many states; only two small remnant populations are present in Minnesota, and elk are listed as a Species of Concern in the state. Elk once were distributed throughout Minnesota, but the native woodland (*Cervus elaphus anadensis*) and prairie subspecies (*C. e. manitobensis*) were nearly extirpated from the state by the early 1900s because of excessive hunting during the 1800s. In the early 1930s, captive-bred elk were used to reestablish a population in northwest Beltrami County. Since that time, a second elk herd has become established in Kittson and Roseau counties near the Manitoba border. This northern herd is believed to include individuals that have naturally emigrated from Canada, North Dakota, and the original Beltrami County reintroduced herd (Minnesota DNR 2016o). Elk prefer a diet of grasses and forbs, but their diet varies by season. Elk will browse on willow (*Salix* spp.), aspen (*Populus* spp.), and other woody vegetation, and will consume many agricultural crops. Wolves, coyotes, black bears, and cougars (*Puma concolor*) are natural predators of elk. Elk hunting is conservatively managed in Minnesota. Each year, a limited number of licenses are offered to Minnesota residents to hunt elk. Hunters are selected using a lottery system. In

2014, 1,167 hunters applied for a license, but only nine permits were issued and six elk ultimately were harvested (Minnesota DNR 2014b).

Moose (*Alces alces*) occur in the Project region in the northwestern and northeastern portions of Minnesota. Moose hunting was allowed in Minnesota in both these regions until 1997 when it was prohibited in the northwest corner. Hunting continued in the northeast of the state until a 2013 aerial survey of moose revealed that the moose population had declined in this area by 52 percent since 2010, after which Minnesota DNR suspended moose hunting indefinitely (Minnesota DNR 2013, 2016p). Moose eat aspen, maple (*Acer* spp.), and cherry (*Prunus* spp.) trees and many kinds of water plants (Minnesota DNR 2016q). Wolves and bears are natural predators of moose.

Cougars, also known as mountain lions or pumas, are rare but could occur within the region. Cougars occurred throughout most of Minnesota prior to European settlement (Minnesota DNR 2016i). Today, they are occasionally observed in Minnesota. Because there is no evidence of a viable breeding population in Minnesota, cougars are not currently tracked in the Minnesota DNR's Rare Features Database. Cougars are not considered a game animal in Minnesota.

Mid-Sized Mammals, Small Game, and Furbearers

The Project region is home to a number of mid-sized mammals, many of which are classified as "small game" in hunting regulations or as furbearers in trapping regulations. Common small game and furbearers that are hunted or trapped in the Project area include badger (*Taxidea taxus*), beaver (*Castor canadensis*), bobcat, coyote, fisher (*Martes pennant*), pine marten (*Martes martes*), red and gray foxes (*Vulpes vulpes* and *Urocyon cinereoargenteus*), mink (*Neovison vison*), muskrat, Virginia opossum (*Didelphis virginiana*), river otter (*Lontra canadensis*), rabbits and hares (Leporidae), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), squirrels (Sciuridae), and weasels (Mustelidae). Many furbearers are associated with water and wetlands (e.g., muskrats, mink, otters, and beavers). Rabbits, raccoons, opossums, and coyotes are present in a wide variety of habitats, including croplands, residential areas, hedgerows, and forests. Squirrels require forested habitats with abundant acorn or hickory trees. Mid-sized mammals not traditionally hunted or trapped include porcupine (*Erethizon dorsatum*) and groundhog or woodchuck (*Marmota monax*).

Small Mammals

Small mammals, including mice, moles, voles, and shrews, are important members of ecosystems. Herbivorous small mammals shape vegetative communities by spreading seeds and grazing. Their burrowing activities and the addition of feces and urine to the soil influence soil chemistry through changes in nutrient and mineral cycling rates and pathways (Hull Sieg 1987). Small mammals such as shrews and bats also function as secondary consumers by preying on invertebrates and other mammals. Small mammals serve as food supply for a large number of predators and can influence predator population cycles. Predators such as foxes and barred owls (*Strix varia*) rely heavily on rodents and other small mammals for food.

Some representative species of small mammals that are likely to occur in the Project area include southern bog lemming (*Synaptomys cooperi*), meadow vole (*Microtus pennsylvanicus*), red-backed vole (*Myodes gapperi*), meadow jumping mouse (*Zapus hudsonius*), woodland jumping mouse (*Napaeozapus insignis*), western harvest mouse (*Reithrodontomys megalotis*), white-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus maniculatus*), house mouse (*Mus musculus*), star-nosed mole (*Condylura cristata*), and Norway rat (*Rattus norvegicus*) (Minnesota DNR 2016r). Shrews are the smallest mammals in the Project area. Shrews that could occur in the Project region include the pygmy shrew (*Sorex minutus*), short-tail

shrew (*Blarina brevicauda*), and masked shrew (*Sorex cinereus*). Northern water shrews (*Sorex palustris*) and arctic shrews (*Sorex arcticus*) also could occur (Minnesota DNR 2016s).

Bats are important to ecosystems in part because they consume vast numbers of insects, including agricultural pests. The bats in the Project region are primarily forest dwelling or associated with riparian areas and are insectivorous. In summer, the bats roost in forests or in buildings; in winter, most migrate to caves to hibernate. Little brown bats (*Myotis lucifugus*) and big brown bats (*Eptesicus fuscus*) are the most common species in Minnesota. Other species in the Project region include northern myotis (*Myotis septentrionalis*), hoary bat (*Lasiurus cinereus*), eastern red bat (*Lasiurus borealis*), and silver-haired bat (*Lasionycteris noctivagans*). Northern myotis recently was listed as threatened by USFWS (see Section 5.2.5).

Birds

Waterfowl and Gamebirds

All waterfowl and some gamebirds occurring in the Project region are considered migratory birds and are protected under the MBTA (which prohibits the take of any migratory birds without authorization from USFWS). Hunting regulations are developed and authorized by USFWS and state game and fish departments. Waterfowl are harvested primarily in autumn, with some goose seasons occurring in spring. Many waterfowl species breed in or migrate through areas that would be crossed by the Applicant's preferred route and route alternatives. Important recreational waterfowl include Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), blue-winged teal (*Anas discors*), and ring-necked duck. Waterfowl habitats include wooded river bottoms, flooded forests, lakes (particularly those with wild rice), rivers, marshes, and flooded grain fields.

Other gamebird species include American woodcock (*Scolopax minor*), Wilson's snipe (*Gallinago delicate*), mourning dove (*Zenaida macroura*), wild turkey, sandhill crane, greater prairie chicken (*Tympanuchus cupido*), sharp-tailed grouse, and introduced gamebirds such as ring-necked pheasant (*Phasianus colchicus*) and gray partridge (*Perdix perdix*).These species occur in areas crossed by the Applicant's preferred route and route alternatives.

Nongame Birds

The upper Midwest is home to many nongame bird species. Birds are an important part of healthy functioning ecosystems, including forests and prairies, and developed areas such as agricultural, urban, and suburban areas. While a number of bird species are resident or migrate only short distances, many species perform long annual migrations in spring and fall. Minnesota and adjacent states are on the Mississippi Flyway, a key migration flyway that roughly follows the Mississippi River for millions of birds and hundreds of species. Nongame birds occur in all habitat types in the ROI, including coniferous, deciduous, and mixed forests; riparian areas and forested and non-forested wetlands; lakes, rivers, and streams; grasslands, prairies, and pastures; and shelterbelts and agricultural lands.

Bald eagles (*Haliaeetus leucocephalus*) once were protected by the ESA. Through the federal government's banning of Dichlorodiphenyltrichloroethane (DDT) and various conservation actions taken across the United States, populations recovered sufficiently, and bald eagles were removed from the endangered species list (delisted) in 2007. However, bald eagles are still protected under the MBTA and the BGEPA. This legislation also protects their nesting structures, which tend to be used for a number of years. Bald eagles nest near lakes and rivers in forested areas where tall, large-diameter trees are available for nesting.

Ospreys also were affected by DDT and suffered population declines in the 1960 and 1970s. Their populations have since recovered, and they occur throughout much of the upper Midwest. While ospreys used to rely entirely on dead trees for nests, they now also use man-made structures such as powerlines and communication towers. Raptor stick nest surveys were conducted within 0.5 mile along the Applicant's preferred route to locate and identify bald eagle and osprey nests between 2014 and 2016. Raptor nest surveys were only conducted along the Applicant's preferred route; six active bald eagle nests and one osprey nest were observed during the most recent survey in 2016 (see Section 5.2.4, Table 5.2.4-6).

Reptiles and Amphibians

Amphibians are four-legged, cold-blooded (meaning they get their warmth from the environment), and typically start out as larvae living in water. The young generally undergo metamorphosis from larva with gills to an adult air-breathing form with lungs. Amphibians use their skin as a secondary respiratory surface; some small terrestrial salamanders and frogs lack lungs and rely entirely on their skin for respiration. Reptiles are cold-blooded and can be four-legged, like turtles and lizards, or may have descended from four-legged ancestors, like snakes. Unlike amphibians, reptiles do not have an aquatic larval stage. Many amphibians and reptiles move between aquatic and terrestrial habitats; consequently, they are major links in the flow of energy between these habitats.

Amphibians and reptiles commonly occurring in and around wetlands, lakes, ponds, and rivers include turtles such as the snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys picta*), map turtles (*Graptemys* spp.), and spiny softshell turtle (*Apalone spinifer*a); frogs that are highly aquatic as adults such as green frog (*Lithobates clamitans*) and mink frog (*Lithobates septentrionalis*); some aquatic salamander species such as eastern newt (*Notophthalmus viridescens*) and common mudpuppy (*Necturus maculosus*); and snakes, including the brown snake (*Storeria dekayi*) and northern watersnake (*Nerodia sipedon*). Amphibians and reptiles that are more likely to be associated with grasslands, prairies, and agricultural areas include hognose snakes (*Heterodon* spp.), garter snakes (*Thamnophis* spp.), the smooth green snake (*Opheodrys vernalis*), the prairie skink (*Plestiodon septentrionalis*), and the Great Plains toad (*Anaxyrus cognatus*). Amphibians and reptiles associated with forested habitats include treefrogs (*Hyla* spp.), spring peeper (*Pseudacris crucifer*), American toad (*Anaxyrus americanus*), and salamanders (*Ambystoma* spp.). Many of these common species of reptiles and amphibians occur in the vicinity of the Applicant's preferred route and route alternatives.

Invertebrates

Invertebrates are an essential component of the food chain in many ecosystems. Many hundreds of species of invertebrates occur within the aquatic, wetland, and upland areas that would be crossed by the Applicant's preferred route and route alternatives. Notable groups of aquatic insects include mayflies (Ephemeroptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata), and midges and mosquitoes (Diptera). Other aquatic invertebrates include mollusks such as native mussels (Palaeoheterodonta), snails (Gastropoda), and crayfish (Astacidea). Commonly seen upland invertebrates include bees, ants, and wasps (Hymenoptera); ladybugs and other beetles (Coleoptera); butterflies and moths (Lepidoptera); grasshoppers, katydids, and crickets (Orthoptera); cicadas, leafhoppers and other true bugs (Hemiptera); and ticks, spiders, and mites (Arachnida).

6.3.4.3 Impact Assessment

6.3.4.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Clearing and grading would be required for construction of the pipeline, MLVs, new and expanded pump stations, and cathodic protection sites—as well as for access roads and ATWS, including six pipe yards in Minnesota. Construction activities that may affect fish, wildlife, and their habitats could include clearing, grading, dewatering, trenching, blasting, access road construction, waterbody crossings, surface water withdrawals and discharges (e.g., for hydrostatic testing), fueling and use of hazardous materials, facilities construction, and restoration or reclamation of construction areas.

Fisheries and Aquatic Habitat

Construction of the Applicant's preferred route in Minnesota would require 192 stream crossings, with 111 of those crossings occurring between Clearbrook and Carlton (see Table 6.3.1.2-2). The Applicant's preferred route also crosses streams in North Dakota and Wisconsin; streams outside of Minnesota are discussed in Section 5.2.4. The surface waters crossed support warmwater, coolwater, and coldwater trout fisheries.

Surface Water Crossing Methods and Measures Proposed as Part of the Project

Surface water crossings would be designed as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow to create the shortest possible crossing length. The Applicant would determine and obtain approval for specific crossing methods based on factors such as waterbody size, sensitivity, water levels, soil/sediment stability installation, and anticipated season of installation (Appendix E). The Applicant would cross waterbodies using the most environmentally appropriate and feasible method based on consultation among the Applicant, appropriate regulatory agencies and engineering personnel. Methods that may be used include the wet open-cut method, dry open-cut methods (dam-and-pump and flume), guided bore method, or HDD method. These methods are summarized below:

- The wet open-cut method involves trenching through the waterbody while the water continues to flow through the construction work area. The wet trench method has the greatest potential for impacts on fisheries and aquatic habitat.
- The dam-and-pump method is used to cross sensitive waterbodies with low gradients and low flow or meandering channels. It involves installing temporary dams across the waterbody both upstream and downstream of the crossing location, with pumps and piping used to carry streamflow around the construction area. This method results in less sedimentation and turbidity than the wet open-cut method.
- The flume method can be used on relatively shallow and narrow waterbodies that do not have large rocks or bedrock at the trench line and have a relatively straight channel. Similar to the dam-and-pump method, two dams are used to dry the work area. One or more pipes (flumes) extend the course of the waterbody through both dams, carrying streamflow through the construction area. This method results in less sedimentation and turbidity than the wet open-cut method.
- A guided bore could be used to cross ditches adjacent to roads or railroads. The guided bore method involves digging a pit on each side of the waterbody, boring a tunnel from one pit to

the other, and installing the pipe in the tunnel. Dewatering and sheet-piling are needed to maintain the integrity of the excavated pits. This method typically results in no sediment release to surface water.

- HDD involves drilling under the surface water and installing the pipeline without physical disturbance of the surface water. HDD crossings are advantageous because they do not disturb streambeds or streambanks and they maintain stream flow and fish passage. However, they require ATWS on both sides of the crossing, which involves vegetative clearing, soil disturbance, and subsequent restoration activities. This method would be used to cross the most environmentally sensitive areas such as sensitive fishery resources and impaired waters. Unless a release of drilling fluid occurs (see Section 6.3.1.2.3), use of this crossing method would not alter or remove aquatic habitat and would not affect fisheries.

As currently planned, the methods used to cross surface waters for the Applicant's preferred route are listed in Table 6.3.4-5.

Table 6.3.4-5. Number of Stream Crossings by Crossing Type for the Applicant's Preferred Route in Minnesota

Water Type	HDD	Guided Bore	Dry Open Cut	Wet Open Cut	Undetermined	Total
Stream/river – perennial	6	--	23	1	4	34
Stream/river – intermittent	--	1	34	7	30	72
Artificial path	11	--	2	--	2	15
Connector	--	--	1	--	3	4
Canal ditch	2	7	24	8	8	49
Lake/pond – perennial	--	--	--	--	18	18
TOTAL CROSSINGS	**19**	**8**	**84**	**16**	**65**	**192**

Source: Water types from USGS NHD 2016. Also see maps in Appendix A.

Notes:

Stream/river, artificial path, and connector types are the crossing types that are most likely to provide fish habitat.

"--" = no crossing

HDD = horizontal directional drill

To avoid or reduce impacts on fisheries and aquatic habitat during construction, the Applicant would implement the measures described in the Environmental Protection Plan (Appendix E), including the following:

- Prepare a list of waterbodies to be crossed and the type of crossing method to be used for each crossing, as a part of obtaining Section 401/404 permits from USACE for all surface water crossings.
- Comply with the seasonal restrictions and other requirements in the Section 401/404 permits to limit impacts on aquatic resources.
- Complete the crossings as quickly as possible to allow suspended sediment levels to return to preconstruction levels after instream work is completed.

- Cross waterbodies using the most environmentally appropriate and feasible method based on consultation among the Applicant, appropriate regulatory agencies, and engineering personnel. Methods that may be used include the wet open-cut method, dry open-cut methods (dam-and-pump and flume), guided bore method, or HDD method.
- Develop and implement BMPs in collaboration with state and federal agencies to avoid and minimize potential impacts associated with water crossing methods (e.g., use of silt or straw as sediment runoff barriers and use of construction mats to minimize ground pressure and soil compaction).
- Implement erosion and sediment control measures and limit the duration of construction in waterbodies, including the measures listed in Section 1.9 of the Applicant's Environmental Protection Plan (Appendix E) (e.g., temporary stabilization, erosion control blankets, mulch, cat tracking, and temporary slope breakers).
- Comply with Minnesota DNR guidance on water crossing by avoiding in-water work during the exclusion periods: from September 1 through April 15 or September 15 through April 30 for coldwater fisheries (trout) stream crossings, and from March 15 to June 15 or April 1 to June 30 for coolwater and warmwater fisheries stream crossings, depending on the Minnesota DNR region in which the work occurs.
- Suspend temporary water intake hoses or structures above the stream or lake bottom and equip the intakes with screens or equivalent devices to prevent fish uptake.
- Install trench breakers at all waterbody crossings, as appropriate, to prevent diversion of water into upland portions of the pipeline trench and to keep accumulated trench water out of the waterbody.
- Wash and dry equipment designated for use within waterbodies prior to use; purge and clean all pumps before proceeding from one crossing location to the next if designated noxious weeds or invasive aquatic species (e.g., zebra mussels and Eurasian milfoil) are known to be present in the area. Follow all permit requirements to prevent the spread of invasive species.
- Maintain a 20-foot-wide buffer of undisturbed herbaceous vegetation at all streambanks during the initial clearing and complete any instream trenching within 24 hours of initiation at minor waterbodies and within 48 hours at intermediate or major waterbodies (not including HDD crossings).
- Comply with the measures in the Environmental Protection Plan (Appendix E) to avoid or minimize impacts due to the unanticipated release of drilling fluids used in HDD crossings. These measures include (1) planned response actions if releases of drilling mud were to occur in waterbodies or upland areas; (2) containment, clean-up, and notification procedures; and (3) steps to be taken to restore affected areas.
- Discharge hydrostatic waters in a manner that avoids discharge into surface waters with commercially or recreationally important species, and in compliance with the stipulations of permits required for both intake and discharge. This would include seasonal restrictions and limitations associated with infested waters.

General Potential Impacts on Fisheries and Aquatic Habitat due to Surface Water Crossings

Increased Sedimentation. Construction of the Applicant's preferred route would require clearing of vegetation from the construction work area (more information below about impacts of structure removal). Removal of large trees and other woody vegetation near waterbodies would result in loss of shading, nutrients, and habitat features for fish at waterbody crossings. In addition, this change in streambank features would alter aquatic habitats used by fish for cover, spawning, and foraging. Loss of riparian cover can result in increased water temperatures, which can be detrimental to coldwater species such as trout or salmon. The amount of vegetation that would be permanently removed adjacent to surface waters would be restricted to the permanent right-of-way at waterbody crossings, and streambanks would be restored with vegetation. Revegetation would take longer for forested areas in the construction work areas adjacent to the permanent right-of-way as compared to prairie or agricultural areas. Therefore, vegetation clearing for construction of the Applicant's preferred route in grassy or agricultural streambank areas would result in indirect, short-term, negligible to minor impacts on fisheries and aquatic habitats; impacts in forested or other woody streambank areas would be long term and minor to major, depending on existing surface water conditions. Removal of vegetation along waterbodies also can create conditions for bank destabilization and further erosion, which would result in direct temporary to short-term minor impacts on species residing in the immediate vicinity while the Applicant undertakes measures to stabilize the banks. For example, erosion can suffocate eggs and other aquatic species.

As a part of the crossing construction process, riverbeds and streambeds would be restored to preconstruction condition, with no impediments to water flow anticipated, and streambanks would be restored to preconstruction grades when practicable. If the slope of the bank is determined to be unstable, it would be reshaped to prevent slumping. The use of open-cut crossings during pipeline construction would result in short- to long-term minor impacts on channel morphology and stability (see Section 6.3.1.2), which in turn would result in short-to long-term minor impacts on fisheries and aquatic habitats.

The wet open-cut crossing method would result in greater amounts of sedimentation than the other methods. As currently planned, only 16 of the surface water crossings would be accomplished using the wet open-cut method. Crossings using the dam-and-pump and flume methods would increase sedimentation, but less than if using the wet open-cut method. The guided bore and HDD methods would not result in increased sedimentation if conducted successfully. However, if a frac-out were to occur, the consequences can be major because of the release of materials into already sensitive or impaired waters (more information about frac-outs below).

Increased sedimentation and turbidity can degrade aquatic habitat by filling in inter-gravel spaces and pool habitats, which reduces spawning habitat, rearing habitat, and benthic invertebrate production. Reduced productivity of aquatic invertebrates can result in reduced food available for insectivorous fish. Mussels are particularly vulnerable to suffocation from instream construction activities. Fine sediments introduced by these processes can suffocate fish eggs and newly hatched larvae living in gravel, resulting in reduced survival. In addition, sediments can abrade the sensitive gill membranes of young and adult fish, resulting in injury or death; and can reduce the ability of fish to locate prey or escape predation, leading to increased energy expenditure for foraging and increased mortality. Large concentrated sediment plumes can cause sediment accumulation within the gills of young and adult fish, which can lead to suffocation and increased mortality of fish that are not able to move away from sediment plumes fast enough to find refuge.

Disturbed areas at crossings would be restored and stabilized as soon as practical after pipeline installation. (Section 6.3.1.2.3 identifies erosion and sedimentation control measures that would be implemented during and after open-cut crossings and describes the potential impacts on surface water quality and sedimentation that could result from each crossing method.) The increase in sedimentation is expected to be minor, and the impact on fisheries and aquatic habitat from increases in sedimentation associated with surface water crossings would be temporary to short term and minor. With successful use of the guided bore or HDD crossing methods, sedimentation would not increase and fisheries and aquatic habitats would not be affected. If a frac-out were to occur, the impacts would be short term to long term and major.

Removal of Large Instream Structures. At some surface water crossings, large in-water structures (e.g., large woody debris and boulders) may need to be removed during construction of the crossing. These structures would be replaced after completion of the crossing, and stream hydrodynamics would transport sediments from upstream to the disturbed area until equilibrium is reestablished. This construction activity would result in a temporary to short-term, negligible to minor impact on aquatic habitat.

Direct Impacts on Fisheries. Trenching and backfilling, damming, and other instream construction activities could result in direct or indirect injury or mortality of fish. Mussels are particularly vulnerable to crushing from instream construction activities. However, fish likely would respond to the increased instream activities by leaving the construction area and avoiding direct impacts. Small fish species and juvenile individuals of larger fish species may be injured or killed by entrainment, which results when a fish gets trapped within hoses or pipes being used to dewater construction areas or divert surface waters around construction areas. Fish entrainment can be reduced by screening the ends of pipes and pump hoses, smaller fish may still be injured or killed by being impinged, trapped against, the screening due to suction and water pressure. The potential direct impacts of instream construction on aquatic species would be temporary and minor.

Leaks or Small Spills. Spills and leaks of fuel or other hazardous liquids could occur during vehicle and equipment operation, during refueling and lubricating of construction equipment, and from leaks from storage containers or equipment working in or near streams. To protect surface water resources, NPDES permits would require secondary containment of hazardous materials, prohibition of engine degreasing at work sites, containment and collection of liquid and solid wastes, and a spill prevention and response plan for fueling and maintenance of vehicles. The Applicant would store petroleum products, hazardous chemicals, and lubricating oils; conduct refueling, maintenance, and lubricating operations; and perform concrete coating activities in upland areas more than 100 feet from surface waters (Appendix E). Although these and other similar measures would be implemented (see Section 6.3.1.2 for additional details), small leaks or spills could reach surface waters and would alter water quality in the area of the release and for short distances downstream. Because such releases would likely be small and rapidly dispersed, the impacts on fisheries and aquatic habitats are expected to be temporary to short term and minor.

Potential impacts on fisheries and aquatic habitats from an unanticipated release of crude oil are discussed in Chapter 10.

Unanticipated Release of Drilling Fluids. For HDD crossings, there is a risk of escape of drilling fluids (frac-out) into rivers at crossings. During drilling, fluid (water, bentonite clay, and possible additives) is circulated through the drilling pipe to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. The potential exists for an inadvertent release or “frac-out” of this drilling fluid to occur when

pressurization of the drill hole is beyond the containment capability of the overburden soil material, which would allow the drilling fluid to flow to the ground or riverbed surface. Although bentonite clay is non-toxic, drilling mud can smother aquatic wildlife and increase turbidity in affected surface waters. The consequences of a frac-out are amplified in waters where this technique is used, because these waters are already identified as sensitive or impaired. Additives may be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only non-hazardous additives approved by Minnesota PCA under permit conditions would be used, and a Material Safety Data Sheet for the drilling fluid would be maintained onsite. If a frac-out occurred near the streambank, bank stability may be compromised. Construction personnel would monitor the crossing to detect releases of drilling mud.

The HDD operator would constantly monitor drilling fluid pressures during pilot hole operations and, if a loss in fluid pressure or circulation was identified, the operator would notify onsite construction observers who would visually monitor the portion of the drill path where the drill tool is located to determine whether a drilling mud release occurred. If a release occurred, the Applicant would implement containment, response, and clean-up procedures as outlined in the Environmental Protection Plan (Appendix E) to limit the potential for drilling mud to reach surface water. These procedures include containment using straw bales, sandbags, pumps, and hoses, vacuum trucks; response activities, including adjusting drill rates and pump volumes or stopping drilling, removal of mud with pumps and appropriate storage away from the waterbody prior to disposal; and coordination with appropriate agencies to discuss additional containment or clean-up requirements. If a frac-out occurred and went undetected or was not quickly contained, impacts on surface water quality as well as on fisheries and aquatic habitat could be long term and major. However, with implementation of the Applicant-proposed measures to respond to a drilling mud release during HDD construction, the impact of a release could be short term to long term and major, depending on the nature of the release and resources near the location of the crossing.

Hydrostatic Test Water Withdrawal and Discharge. The Applicant would withdraw water for hydrostatic testing, dust control, trench dewatering, and HDD installation. Hydrostatic testing would require approximately 11 to 17 million gallons of water for each construction spread that would be obtained from lakes, streams, or groundwater wells. The Applicant is currently evaluating transferring water from one test section to another in order to minimize the total quantity of water needed to complete the hydrostatic test. The volume of water appropriation needed for dust control, trench dewatering, and HDD installation has not been determined. Prior to construction, the Applicant would obtain a water appropriation permit from Minnesota DNR.

Withdrawals from surface waters for construction could result in entrainment of small fish, eggs, and macroinvertebrates during extraction; however, intakes would be equipped with a screen or equivalent device to prevent uptake of aquatic species. Smaller fish and invertebrates may still be injured or killed by being impinged, trapped against, the screening due to suction and water pressure. Spawning fish could be displaced through decreased water levels, fish eggs could desiccate if water levels drop too low, or eggs may experience delayed development due to impaired water quality. Larval and juvenile fish could be affected through entrainment during water withdrawal, decreased survival under conditions of poor water quality, and reduced prey availability.

As stipulated in permit requirements, the Applicant would select appropriation sites that would meet Minnesota DNR's criteria of "doing no harm," and all appropriation sites would be reviewed by Minnesota DNR prior to issuance of a water appropriation permit. The permit requires that water withdrawals have a minimal potential for impacts on groundwater resources and must not adversely

affect trout streams, calcareous fens, or other significant environmental resources. If water is withdrawn from surface water, hose intakes would be equipped with screens to prevent entrainment of aquatic species, and adequate waterbody flow rates and volumes would be maintained to protect aquatic life and allow for downstream uses as required by the water use permit (Appendix E).

Hydrostatic test water would be discharged from a test section in one of two ways: (1) into well-vegetated upland areas using controlled-flow velocity with a dewatering structure such as a silt fence and straw bales or into geotextile filter bags that are used to avoid soil erosion, sediment transport, and bottom scouring; or (2) into the waterbody from which it was withdrawn to prevent the spread of invasive species or degradation in water quality; the discharge rate would not exceed the permitted applicable discharge rate (Appendix E). Water would be treated as specified in the NPDES permit prior to discharge; and the Applicant would monitor pH, dissolved oxygen levels, and any other parameters required by the permit, as described in Appendix D of the Environmental Protection Plan (Appendix E). Discharges would adhere to all conditions set forth in NPDES and water appropriation permits, including discharge over approved energy dissipation measures (e.g., sand bags, plastic sheeting, or natural rock riprap) and the sedimentation control measures as described above. If inter-basin transfers of water occur, there is also the potential to introduce and spread aquatic nuisance species; however, hydrostatic waters would be discharged through a filtering device to the source waterbody and following all requirements of acquired permits. With adherence to water appropriation and NPDES permit conditions, and implementation of the Applicant-proposed measure described above, impacts on fisheries and aquatic habitats from water appropriation and discharge during construction would be temporary and minor

Impacts on Management Units and Managed Species

Aquatic Management Areas. LaSalle Creek would be crossed using the HDD method; this would affect 0.4 acre of the LaSalle Creek AMA. The LaSalle Creek AMA is 28 acres and provides angling opportunities (as described below, LaSalle Creek also is a designated trout stream). This would be the second pipeline to cross this AMA; an existing pipeline crossing is at the southern extent of the AMA. Woody vegetation would be removed from the construction work area during construction and, depending on the crossing method used, the habitat quality of LaSalle Creek adjacent to the crossing location may be reduced. The crossing of LaSalle Creek has the potential to introduce invasive species and result in the loss of habitat and reduction of habitat quality. These impacts are expected to be short term, and negligible to minor as little habitat would be lost in the construction work area and BMPs would be in place to prevent the spread of invasive species.

The Applicant's preferred route would come within 0.5 mile of three other AMAs (Figure 6.3.4-1) but would not directly disturb these areas (Table 6.3.4-6). AMAs represent good-quality aquatic habitats with functional adjacent uplands.

Table 6.3.4-6. Aquatic Management Areas Crossed by or near the Applicant's Preferred Route in Minnesota (acres)

Aquatic Management Area	Construction Work Area[a]	Permanent Right-of-Way[b]	Within 0.5 Mile of Centerline[c]
Blackhoof River AMA	<0.1	<0.1	44.4
LaSalle Creek AMA	0.4	0.2	27.4
Spire Valley AMA	<0.1	<0.1	56.2
Straight River AMA	<0.1	<0.1	16.6
TOTAL	**0.4**	**0.2**	**144.6**

Source: Minnesota DNR 2016h.

[a] Enbridge-provided footprint for construction work area, including additional temporary workspaces and access roads.

[b] Enbridge-provided footprint for permanent right-of-way, including primary access roads, pump stations, and mainline valves.

[c] Acres of Aquatic Management Area (AMA) within 0.5 mile of the centerline of the Applicant's preferred route.

Other Management Units. Thirty-nine sensitive aquatic resources are present within 0.5 mile of the Applicant's preferred route, including 5 lakes rated for Fish IBI, 10 Lakes of Biological Significance, 1 Sentinel Lake, 21 trout streams, 1 trout lake, and 1 lake managed for muskellunge.

The Applicant's preferred route would not cross any of the five lakes rated for Fish IBI that occur within 0.5 mile (Table 6.3.4-7); therefore, no impacts are anticipated. One of the lakes, Portage Lake, also is a designated Sentinel Lake; the construction work area for the Applicant's preferred route would be on the edge of the basin of Portage Lake. BMPs would be in place to prevent erosion or other impacts on this lake during construction. The disturbance area would be restored to preconstruction conditions once the crossing is complete (see Section 6.3.1.2). Little habitat would be lost due to construction, and BMPs would be in place to reduce impacts on aquatic habitats, as described above so the resultant impact is expected to be short term and negligible to minor.

Table 6.3.4-7. Lakes with Fish Index of Biotic Integrity Ranking within 0.5 Mile of the Applicant's Preferred Route in Minnesota

Watershed	DNR Identifier No.	Fish Index of Biological integrity Status
Roosevelt	14175	Exceptional
Island	14798	Exceptional
Waukenabo	13413	Below impairment threshold
Big LaSalle	14298	Exceptional
Portage	15124	Exceptional

Source: Minnesota DNR 2014a.

Occurrences are within 0.5 mile centered on the Applicant's preferred route (none would be crossed by the route).

Of the 10 Lakes of Biological Significance within 0.5 mile of the Applicant's preferred route (Appendix L, Fish and Wildlife Table L-2), 8 are classified as outstanding. Construction of the Applicant's preferred route could result in the introduction of invasive species, loss of high-quality habitat, and reduction of habitat suitability for special-status species. However, the impacts would be indirect and short term and negligible to minor, because little habitat would be removed and BMPs would be in place to prevent the spread of invasive species.

No hatcheries are within 0.5 mile of the Applicant's preferred route, and none are immediately downstream of a water crossing for the Applicant's preferred route. The nearest hatchery is the Spire Valley trout hatchery which is located about 0.65 mile upstream of a crossing; the hatchery's water supply is dependent on artesian groundwater quantity and quality. Consequently, construction of the Applicant's preferred route would not affect the hatchery. A discussion of crossings where artesian conditions exist and associated BMPs is provided in Section 6.3.1.1.

Twenty-one trout streams are within 0.5 mile of the Applicant's preferred route; the Applicant's preferred route crosses six of those trout streams (Table 6.3.4-8). One trout lake (Marion Lake in Cass County) is within 0.5 mile of the Applicant's preferred route but is not within the construction work area.

Trout streams are sensitive to erosion, sedimentation, and changes to riparian vegetation in areas adjacent to the streams because those habitats provide shade and cooling. Pipeline construction could alter groundwater connectivity or flow, resulting in warming of the stream and reduced habitat suitability for trout and their invertebrate prey. Trout streams may have groundwater discharge zones or wetland seepage areas on hillsides or slopes with deep organic soils that could be disrupted during construction. Destabilization of these soils could result in long-term increases to nutrients and sediments in the streams. Removal of vegetation along small trout streams could result in less large woody vegetation in the stream. However, riparian vegetation would be removed only from the construction work area adjacent to the trout stream and only if either wet or dry open-cut crossing methods are used. If HDD methods are used for crossing clearing of vegetation could be limited to the 50-foot permanent right-of-way. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way, which could lead to permanent major thermal effects on trout streams. If tributaries to trout streams are crossed, some downstream impacts from sedimentation could occur, depending on the distance to the trout stream. The Applicant's preferred route would cross the Moose Horn River downstream of a protected trout stream and upstream of a tributary (King Creek) to a protected trout stream. As noted in Section 6.3.1.1, the impacts of sedimentation on surface water crossings and the impact of pipeline crossings on water quality along the Applicant's preferred route would be temporary to short term and minor. As a result of these considerations, and with selection of the most appropriate crossing method and implementation of appropriate BMPs, the impacts on trout streams from construction of the Applicant's preferred route would be permanent to short term and minor to major, depending on the crossing.

Table 6.3.4-8. Number of Trout Streams Crossed by or near the Applicant's Preferred Route in Minnesota

Trout Streams – Kittle Name (Kittle Number)	Milepost	Construction Work Area[a]	Permanent Right-of-Way[b]	Within 0.5 Mile of Centerline[c]
Blackhoof River (S-001-003)	MN 408.1	1	1	1
King Creek (M-050-046-029-023)	MN 344.2	1	1	1
LaSalle Creek (M-163)	MN 171.4	--	--	1
LaSalle Creek (M-163)	MN 171.7	1	1	1
Pine River, South Fork (M-106-013)	MN 232.7	--	--	1
Spring Brook (M-106-004-002-001)	MN 265.3	1	1	2
Straight River (M-096-035-002-002)	MN 198.3	1	1	1
Unnamed stream (M-050-046-029-023-002)	MN 344.8	--	--	1
Unnamed stream (M-050-046-029-029)	MN 406.3	--	--	1
Unnamed stream (M-106-013-008)	MN 232.4	--	--	1
Unnamed stream (S-001.9-009)	MN 313.4	--	--	1
Unnamed stream (S-001.9-011)	MN 364.2	--	--	1
Unnamed stream (S-001-003-027.8)	MN 408.1	--	--	1
Unnamed stream (S-001-003-028)	MN 352.1	--	--	1
Unnamed stream (S-001-003-029)	MN 352.3	1	1	1
Unnamed stream (S-001-003-030)	MN 352.7	--	--	1
Unnamed stream (S-001-003-030-001)	MN 408.7	--	--	1
Unnamed stream (S-001-003-030-001-B001)	MN 408.8	--	--	1
Unnamed stream (S-002-008-001)	MN 339.9	--	--	1
Unnamed stream (S-002-008-001-005)	MN 361.8	--	--	1
TOTAL		**6**	**6**	**21**

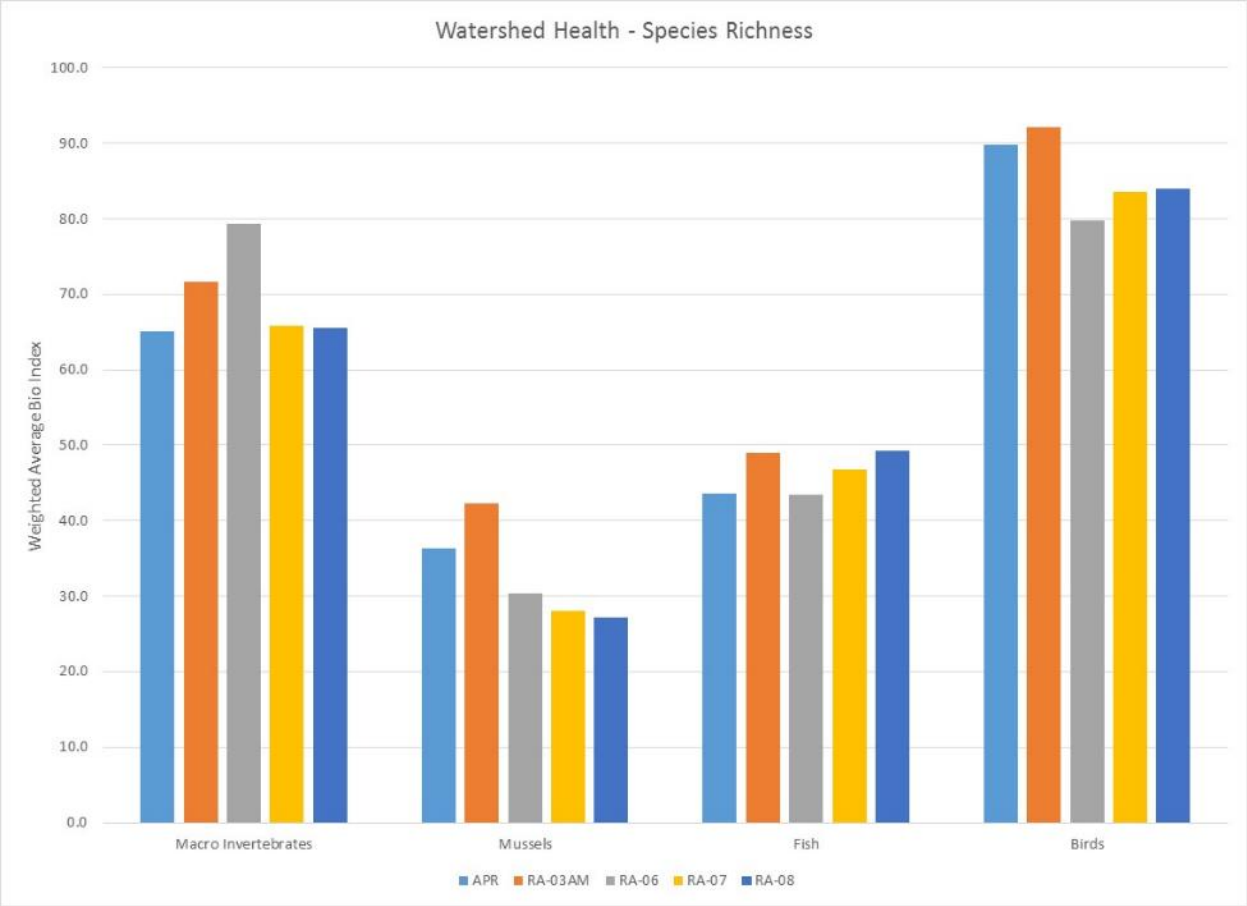
Source: Minnesota DNR 2015a.

[a] Enbridge-provided footprint for construction work area.

[b] Enbridge-provided footprint for permanent right-of-way.

[c] Number of trout streams within 0.5 mile of the centerline of the Applicant's preferred route.

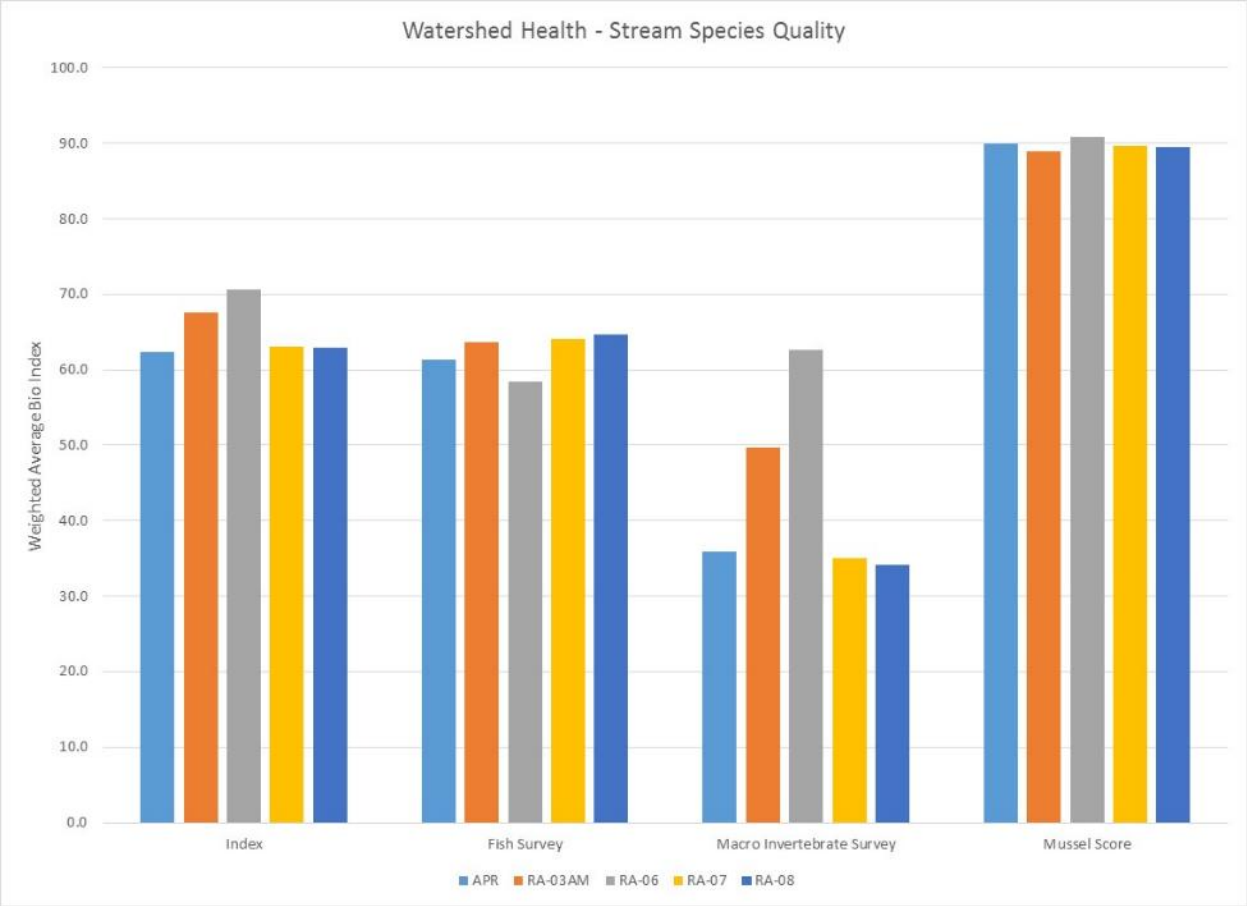
Minnesota PCA's Watershed Health Assessment parameters for species richness, stream species quality, and habitat quality and connectivity were compared for the Applicant's preferred route and RA-03AM, RA-06, RA-07, and RA-08 between Clearbrook and Carlton using the data in Figures 6.3.4-5, 6.3.4-6, and 6.3.4-7. No clear consistent trends distinguished among the potential routes, although in some instances, one alternative scored higher than the others for some individual indices.



Source: Minnesota DNR 2016f.

APR = Applicant's preferred route, RA = route alternative

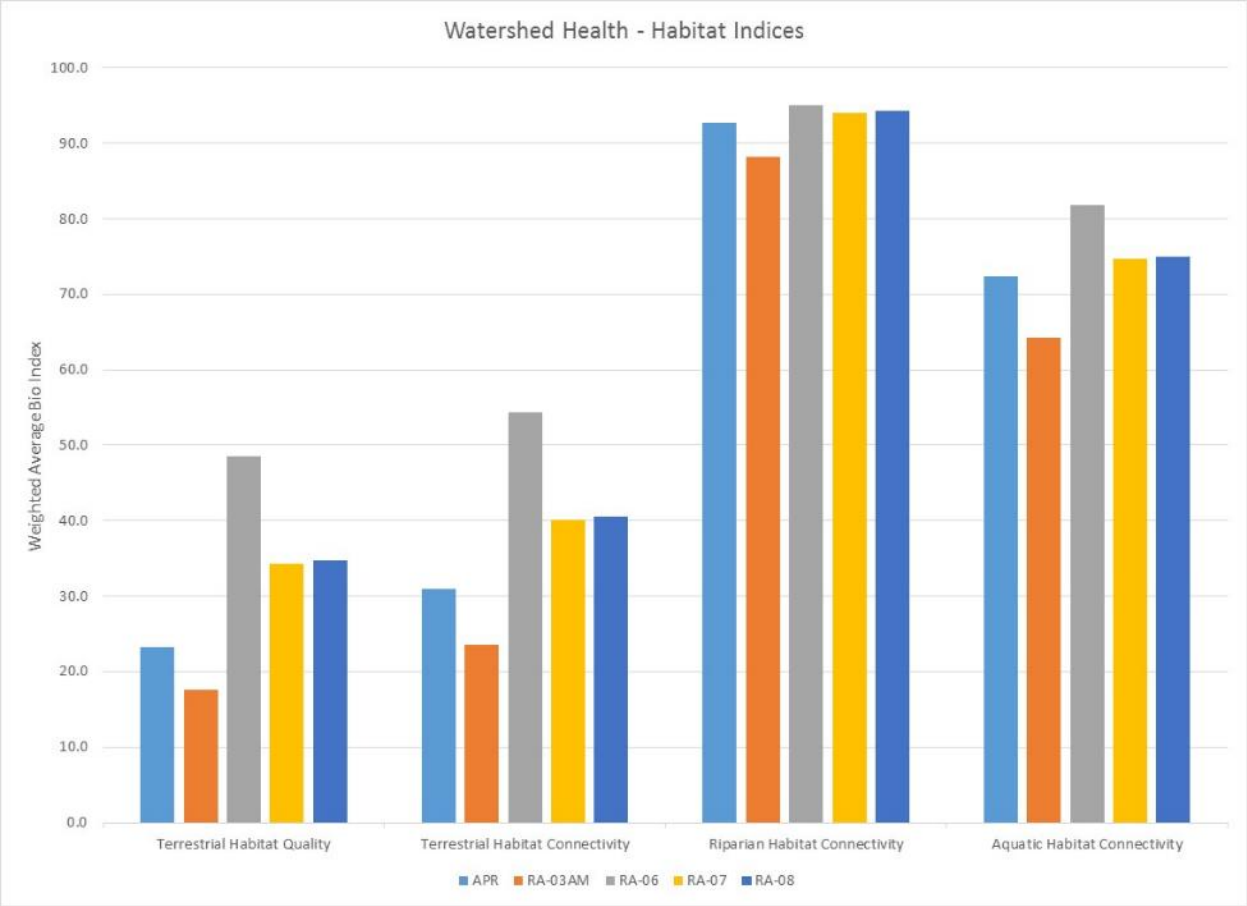
Figure 6.3.4-5. Weighted Average Species Richness Indices for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton



Source: Minnesota DNR 2016f.

APR = Applicant's preferred route, RA = route alternative

Figure 6.3.4-6. Weighted Average Stream Species Quality Indices for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton



Source: Minnesota DNR 2016f.

APR = Applicant's preferred route, RA = route alternative

Figure 6.3.4-7. Weighted Average Habitat Quality and Connectivity Indices for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Wildlife and Wildlife Habitat

General Potential Impacts

Construction would include clearing and grading of the construction work area, ATWS, temporary and permanent access roads, and the sites of MLVs, new and expanded pump stations, and cathodic protection sites. Other construction activities that could affect wildlife and wildlife habitats include trenching, dewatering, blasting, waterbody crossings, surface water withdrawals and discharges (e.g., for hydrostatic testing), fueling and use of hazardous materials, facility construction, and restoration or reclamation of temporary construction areas. Wildlife may be affected directly by construction activities or indirectly from disturbances caused by human activity and noise associated with construction activities. Although only a narrow band of habitat would be directly altered by construction, indirect effects would occur over a wider area

As noted above, the Applicant would incorporate measures into the Project to avoid or minimize construction impacts on fisheries and fisheries habitat, and many of those measures would help to avoid or minimize impacts on wildlife and wildlife habitats. In addition to the fishery-related measures, the

Applicant would implement the following measures to avoid or reduce impacts on wildlife and wildlife habitats:

- Confine clearing activities to the approved construction work areas and adhere to erosion control specifications to minimize impacts on vegetation, aquatic resources and wildlife.
- Fell trees toward previously cleared construction areas to prevent damage to adjacent trees.
- Upon completion of pipeline installation and backfilling and construction of facilities, revegetate disturbed areas in accordance with the Environmental Protection Plan (Appendix E) unless otherwise directed by landowners or land management agencies.
- Restore cleared areas and reseed with an appropriate seed mix (e.g., Minnesota BWSR-approved mixes) to minimize the duration of vegetative disturbance. Where appropriate, this seed mix could be used to provide a food source for wildlife.
- Slope the ends of open trenches to provide ramps for wildlife that fall into the trench (e.g., small animals such as rodents, amphibians, and snakes) to be able to escape.
- Handle, store, and dispose of food and general waste generated during construction to reduce attraction for opportunistic scavengers such as raccoons, crows, and gulls that could prey on other wildlife in the area.
- Handle, store, and dispose of all solid waste and hazardous materials in accordance with stipulations of permits and as presented in the Environmental Protection Plan.

Construction of the Applicant's preferred route would result in clearing of 1,695 acres of evergreen, deciduous and mixed forested habitats as well as 1,665 acres of cultivated crops (Table 6.3.4-9). Forest and cultivated crops represent approximately 66 percent of the total vegetation affected by construction of the Applicant's preferred route. Additionally, 604 acres of woody and emergent herbaceous wetlands would be disturbed by construction.

The areas cleared would remain clear of brush, trees, and vegetation until restoration is completed. This would result in the loss of habitat for some species, including those species that use tree and shrub habitats for cover, forage, and nesting. The effects on wildlife habitat generally would be short term and minor, except in areas where woody vegetation is removed or wetlands affected. In those areas, the impact would be long term to permanent and minor to major, because of the long recovery period for forested areas and the sensitivity of wetlands to disturbance. Woody vegetation would be permanently excluded from the permanent right-of-way of the pipeline but would be allowed to recover in the construction work area outside of the permanent right-of-way. This loss of habitat would affect small mammals, amphibians, reptiles, and other small animals to a greater extent than large animals (e.g., deer and large birds), which have larger territories and can avoid the active construction areas. Therefore, the impact on wildlife from the loss of habitat would range from temporary to permanent and minor to major for small wildlife species, and short term and minor for larger species.

Table 6.3.4-9. Vegetation Cover Removed for the Applicant's Preferred Route in Minnesota (acres)

Vegetation Cover Class	Con[a]	Op[b]	ATWS[c]	Access Roads	Pump Stations	MLVs[d]	Total[e]	
							Con	Op
Evergreen forest	175.8	70.7	18.2	18.6	0.5	0.5	197.9	86.4
Deciduous forest	1,349.2	594.0	96.8	102.6	2.4	2.1	1,477.1	670.0
Mixed forest	18.2	7.8	1.4	2.3	--	--	19.7	10.0
Scrub/Shrub	225.8	111.5	15.2	13.1	2.1	--	242.5	125.3
Grassland/herbaceous	129.8	62.1	32.4	8.7	3.5	0.2	164.1	72.5
Hay/pasture	577.2	258.7	120.7	45.4	15.7	1.2	698.7	320.2
Cultivated crops	1,335.5	574.6	326.9	22.3	20.1	1.8	1,664.5	616.8
Woody wetlands	336.0	169.6	17.7	13.0	3.0	0.5	355.3	184.6
Emergent herbaceous wetlands	229.2	122.4	18.9	7.1	3.0	0.1	249.2	131.5
Barren land	3.6	1.7	8.1	0.6	--	--	11.7	2.4
TOTAL	**4,380.3**	**1,973.2**	**656.2**	**233.8**	**50.2**	**6.6**	**5,080.8**	**2,219.5**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area.

[b] Op = Enbridge-provided footprint for permanent right-of-way.

[c] ATWS = additional temporary workspace (also pipe yards).

[d] MLVs = mainline valves, including valve pad and driveways.

[e] Con = Sum of Enbridge-provided construction work area, ATWS including pipe yards, and temporary access roads; Op = Sum of Enbridge-provided pipeline permanent right-of-way, primary access roads, pump stations, and MLVs (including valve pads and driveways).

"--" = no occurrence

Clearing, grading, trenching, and the use of construction vehicles and equipment would result in direct impacts on some animals, particularly small and mid-sized mammals, reptiles, amphibians, and invertebrates. Members of these species would be affected more than large wildlife because of their relative lack of mobility compared to that of larger animals (e.g., deer and coyotes). Burrows and dens could be destroyed or abandoned during clearing and excavation, resulting in displacement or loss of young, and loss of foraging or cover habitat during rearing seasons. Burrowing animals would be expected to return and recolonize the right-of-way after construction; however, compacted areas, such as temporary work areas, may become less suitable habitat because they would no longer be conducive to burrowing (Lauzon et al. 2002). In addition, nests could be destroyed or abandoned, resulting in loss of eggs and young, and loss of foraging or cover habitat during nesting seasons. Although open trenches would be sloped at the ends, some small animals may become trapped in open trenches and may not survive. As a result of these considerations, it anticipated that the direct impact of these activities on wildlife would be temporary to short term and minor.

Many animals would be temporarily displaced from the active construction areas and adjacent areas because of clearing activities, noise, and human disturbance. Human disturbance could influence wildlife

behavior or cause displacement of species that are less tolerant of human intrusion or more sensitive to noise, and intraspecific competition could increase stress among some individuals. Noise disturbance from construction activities also could lead to nest abandonment and subsequent depredation of eggs or young. The indirect effects of construction disturbance may include reduced foraging time and increased alerting behaviors, which could result in increased energy expenditure and potentially lower survival or reproduction. These indirect impacts would be reduced with implementation of the BMPs incorporated into the Project as described above. In addition, nearby habitat could provide cover and suitable escape habitat for many of the common wildlife species that would be displaced, and mobile animals could return to the area after completion of construction and restoration activities, if appropriate habitats are available. Consequently, the impact of these displacements during construction would be temporary to short term and minor.

The Applicant may be required to trap beavers or alter or remove beaver dams to lower water elevations within the construction corridor prior to construction. Because beavers would likely move back to the area once construction is complete (Wisconsin DNR 2005), these activities would result in a temporary to short term and negligible to minor impact on beavers and on the altered waterbodies. Removal of a beaver dam may require a separate Public Waters Work Permit and, depending on the location, may not be permitted where beaver dams maintain control of basin water levels.

Disturbed areas would be susceptible to invasion by noxious and invasive species; if that occurred, the wildlife habitats would be degraded. However, implementation of BMPs to address invasive species would reduce the potential establishment and spread of noxious weeds, resulting in short-term and negligible to minor impacts.

During construction and clearing of the right-of-way, vehicle emission by-products (e.g., polycyclic aromatic hydrocarbons, aldehydes, carbon monoxide, nitrogen oxides, ozone, and sulfur oxides) could contaminate soil and vegetation in the areas immediately adjacent to the construction vehicles and equipment. The construction period at any location would be relatively short-and would occur only during daytime hours—except for HDD crossings of surface waters, which would occur for 24 hours per day, and the level of contamination in vegetation is not expected to be substantial. Although it is possible that species such as pollinators and herbivores that inhabit the areas where vegetation is exposed to these contaminants could be affected, the impact would be short term and negligible.

Impacts on Management Units and Managed Species

Construction of the Applicant's preferred route would result in habitat loss or alteration of 439 acres within WMAs and state forests (Table 6.3.4-10), including approximately 15 acres of the Grayling Marsh WMA and approximately 3 acres of the Lawler WMA. Loss or alteration of habitats could adversely affect both game and nongame wildlife that use these WMAs until vegetation has recovered. The resultant impact on the WMAs would be short term to long term, depending on the existing habitat types, and minor to major, depending on the landscape context of these public areas to the areas around them (see Table 6.3.4-10).

Construction would occur on land within eight state forests (Table 6.3.4-10), resulting in loss and alteration of forest habitat as well as fragmentation of forest. Because the recovery of forested areas in the temporary construction work area (i.e., the disturbed areas outside of the permanent right-of-way) would take decades, the impact would be long term to permanent but minor to major because of the relatively small area affected compared to the amount of nearby forested areas and habitat fragmentation (see Table 6.3.4-10).

Table 6.3.4-10. Wildlife Conservation Lands Potentially Affected by Construction and Operation of the Applicant's Preferred Route in Minnesota

Designation Type	Con[a] (acres)	Op[b] (acres)	Facilities[c]		Total[d]		Within 0.5 Mile of Centerline	
			Con[a] (acres)	Op[b] (acres)	Con (acres)	Op (acres)	Acres	No.
Habitat or Species Management Area								
Grayling Marsh Wildlife Management Area	14.1	6.4	0.6	--	14.8	6.4	820.1	1
Lawler Wildlife Management Area	2.9	1.5	--	--	2.9	1.5	197.8	2
Lowe Wildlife Management Area	--	--	--	--	--	--	57.9	1
McGregor Wildlife Management Area	--	--	--	--	--	--	152.1	1
Mud Lake Wildlife Management Area	--	--	--	--	--	--	3.6	1
Salo Marsh Wildlife Management Area	--	--	--	--	--	--	201.6	1
Resource Management Area								
BLM land	--	--	--	--	--	--	60.8	1
State Forest								
Badoura	--	--	--	0.4	--	0.4	--	--
Fond du Lac	--	--	--	--	--	--	987.8	2
Foothills	42.3	18.6	11.8	1.1	54.1	19.7	1,811.4	1
Hill River	102.9	48.3	5.0	6.0	107.9	54.2	5,056.0	1
Huntersville	96.9	42.9	11.9	7.4	108.9	50.3	4,504.0	2
Land O'Lakes	130.2	58.1	25.9	5.2	156.2	63.4	5,913.6	5
Mississippi Headwaters	25.1	10.7	3.8	6.7	28.9	17.4	1,335.2	2
Paul Bunyan	--	--	--	--	--	--	264.9	1
Savanna	8.7	4.6	0.2	0.1	9.0	4.6	579.6	6
Waukenabo	15.8	8.3	0.5	0.7	16.2	8.9	545.5	4
White Earth	--	--	--	1.5	--	1.5	207.6	1
Private Conservation Land								
Marginal cropland – Limited	--	--	--	--	--	--	22.3	4
TOTAL[d]	**439.1**	**199.4**	**59.7**	**29.1**	**498.9**	**228.5**	**22,721.8**	**37**

Source: USGS-GAP 2016

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = estimated construction work area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Enbridge-provided footprint for permanent right-of-way.

[b] Op = estimated permanent right-of-way in acres based on a 50-foot-wide right-of-way centered on the route; Enbridge-provided footprint for permanent right-of-way in Minnesota.

[c] Facilities for construction include additional temporary work spaces (ATWS), including pipe yards, and temporary access roads; facilities for operation include primary access roads; pump stations; and mainline valves (MLVs), including valve pads and driveways.

[d] Con = sum of pipeline construction work area, ATWS (including pipe yards), and temporary access roads; Op = sum of pipeline permanent right-of-way, primary access roads, pump stations, and MLVs, including valve pads and driveways.

"--" = no crossing

The Applicant's preferred route would cross the McGregor IBA, affecting about 48 acres during construction (Table 6.3.4-11). Construction during the nesting season (beginning May 1 for most birds of conservation concern) could result in the loss of bird eggs and young. The Applicant would work with USFWS and Minnesota DNR to develop measures that would avoid and minimize disturbance or destruction of migratory birds. The impact on the IBA and breeding birds within the IBA from removal of vegetation would be short term to long term and minor based on to the relatively small area affected compared to the acreage of the unaffected portion of the IBA (see Table 6.3.4-11).

Table 6.3.4-11. Audubon Important Bird Areas and Colonial Waterbird Nesting Sites Potentially Affected by the Applicant's Preferred Route in Minnesota

Resource	Con[a]	Op[b]	ATWS	Access Roads	Pump Stations and MLVs	Total[c]		Within 0.5 Mile of Centerline
						Con	Op	
Audubon Important Bird Areas (acres)								
McGregor IBA	47.5	24.5	3.1	2.2	0.1	50.6	26.8	3,023.3
Itasca State Park IBA	--	--	--	1.5	--	--	1.5	384.7
TOTAL	**47.5**	**24.5**	**3.1**	**3.7**	**0.1**	**50.6**	**28.3**	**3,408.1**
Colonial Waterbird Nesting Sites (number)								
Mahtowa – great blue heron	--	--	--	--	--	--	--	1
Shell River – great blue heron	--	--	--	--	--	--	--	1
TOTAL	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**

Sources: Audubon 2016; Minnesota DNR 2016e.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = estimated construction work area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Enbridge-provided footprint for permanent right-of-way.

[b] Op = estimated permanent right-of-way in acres based on a 50-foot-wide right-of-way centered on the route; Enbridge-provided footprint for permanent right-of-way in Minnesota.

[c] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), including pipe yards, and temporary access roads; Op = sum of pipeline permanent right-of-way, primary access roads, pump stations, and mainline valves (MLVs), including valve pads and driveways

"--" = no crossing

IBA = Important Bird Area

An access road would cross the Itasca State Park IBA; however, the pipeline corridor would not cross the IBA and would be co-located with an existing pipeline for most of the length near this IBA. As a result, no impacts are expected on this IBA; if noise and disturbance affected some species within the IBA, the impact would be temporary and negligible.

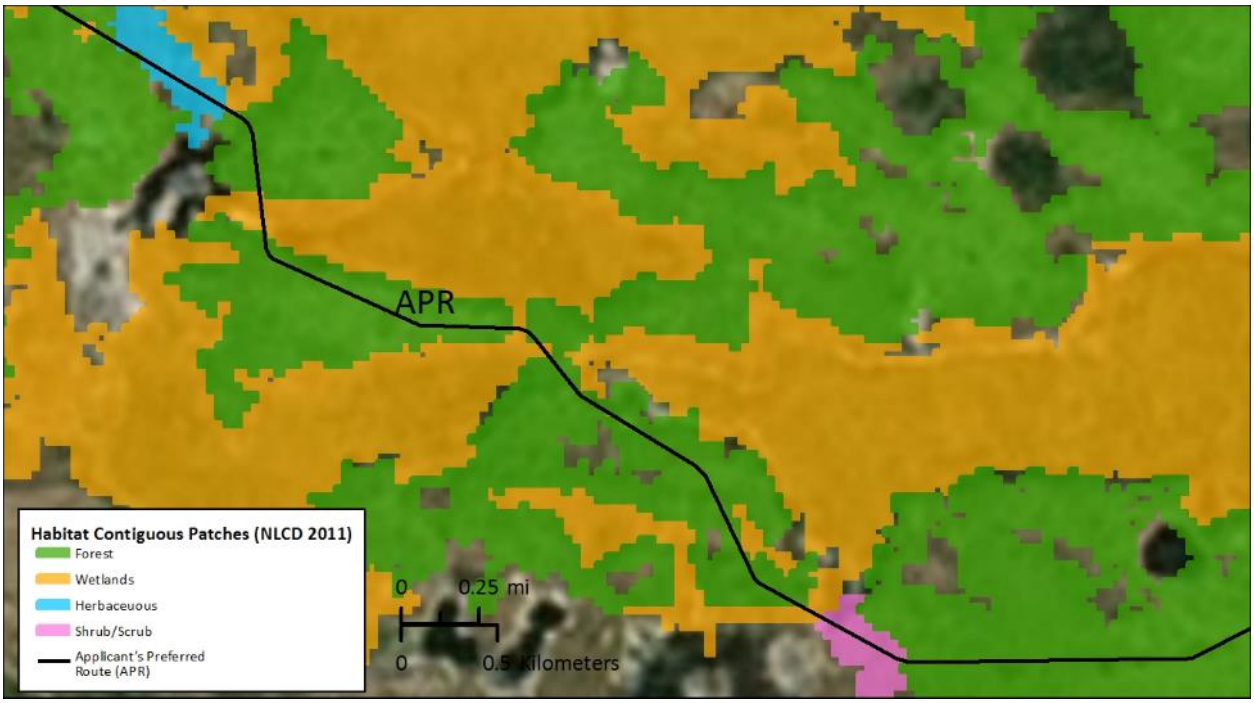
Raptor habitat could be compromised by removal of trees from the construction work area and extra workspaces in adjacent areas. Many of these species require large, unfragmented habitats. In addition, because most raptors reuse nest structures for many years, loss of nest structures would require a pair to find a new nest tree and build a new nest. If suitable new nest trees are not available within established

territories, new territories would need to be established. These processes would lead to increased energy demands during nesting and could lead to reduced or lost reproduction in subsequent years. Most migratory birds begin nesting from mid-April through late July; however, bald eagles may nest as early as January (Minnesota DNR 2017b). Construction during the nesting season (beginning May 1 for most birds of conservation concern) could result in loss of bird eggs and young. The Applicant would work with USFWS to develop measures to avoid and minimize destruction of migratory birds. Raptor nests identified during 2014 to 2016 surveys would be avoided when possible. If removal of one of these nests is unavoidable, a permit and consultation with USFWS and Minnesota DNR would be required.

Two colonial waterbird nesting sites (rookeries) occur within 0.5 mile of the Applicant's preferred route (Table 6.3.4-11). Waterbirds can be vulnerable to development, particularly when appropriate replacement habitat is not available and disturbance, even though a number of the species are not rare. Direct impacts may occur from the loss of nesting habitat; indirect impacts could occur from disturbance to adults, nests, young due to construction. Wildlife agencies often recommend a buffer of no impact around the colony and/or season restrictions on construction. The Shell River great blue heron rookery is about 1,220 feet from the closest construction work area; the impact on this rookery is expected to be indirect, temporary, and negligible to minor, depending on the time of year construction takes place. The Mahtowa great blue heron rookery is about 340 feet from the closest construction work area. Because construction activities would occur within a distance that would affect the Mahtowa colony, the Applicant would be required to consult with USFWS and Minnesota DNR, and a permit may be required. The impact of construction within this buffer zone would be temporary to long term and could be minor to major, depending on the construction activities conducted.

Impacts from Habitat Fragmentation

Habitat fragmentation is caused when contiguous habitats are divided into separate fragments. Large-block habitats (habitats larger than 100 acres) are susceptible to impacts from fragmentation—particularly large, mature-core or interior forested areas that serve as habitat for migratory birds and other wildlife (see Figure 6.3.4-8). Construction of linear projects such as pipelines can cause habitat fragmentation as well as changes in vegetation cover. Potential fragmentation effects on wildlife habitat include a decrease in total habitat area, amount of interior habitat, biodiversity (richness), and connectivity. Fragmentation also may cause an increase in amount of edge habitat, increase the risk of invasive species spread, and isolate some habitat types. The reduction in habitat connectivity can disrupt behavior and movement of species, alter population dynamics, reduce the chance of recolonization in extirpated island habitats, and decrease genetic diversity. Forest-nesting birds are particularly vulnerable to habitat fragmentation effects resulting from linear construction projects. Habitat fragmentation leads to increased predation, increased competition by generalist species, and changes in microclimate and vegetation that may result in extirpation and reduced reproductive success for area-sensitive species.



Source: Analysis based on Homer et al. 2015.

Figure 6.3.4-8. Example of Potential Fragmentation of Large-Block Habitats by the Applicant's Preferred Route

The Applicant's preferred route is co-located with other pipelines, utilities, or roads along most of its length. However, between Clearbrook and Carlton, nine segments (between approximately MPs 215.0 and 352.0 [Table 6.3.4-12]) are not co-located with other infrastructure. Within this span, 21 large-block forested and wetland habitats would be crossed and fragmented by construction of the Applicant's preferred route. This would occur along approximately 38 miles of the Applicant's preferred route, or approximately 11 percent of the route in Minnesota and 17 percent of the route between Clearbrook and Carlton. These habitat "patches" that would be crossed include primarily forested and woody wetland habitats. The largest patch crossed is approximately 4,500 acres over approximately 7 miles, and the smallest patch crossed is about 130 acres over less than 1 mile (Table 6.3.4-12). Impacts on wildlife from habitat fragmentation would be permanent and major, depending on the habitat type and species present. These impacts would be greatest in the least disturbed areas.

Table 6.3.4-12. Large-Block Habitat Patches Crossed by the Applicant's Preferred Route in Minnesota

Beginning Milepost	Ending Milepost	Crossing Length (miles)	Patch Type	Patch Size (acres)
214.7	221.9	7.2	Forest/wetlands/herbaceous	4,513
223.1	224.3	1.2	Forest	1,208
265.2	266.1	0.9	Forest/ scrub/shrub	561
279.8	283.4	3.6	Forest/wetlands	2,558
283.8	284.7	0.9	Wetlands	738
286.8	289.8	3.0	Forest/wetlands	549
291.5	292.9	1.4	Forest/wetlands	587
294.1	296.5	2.4	Wetlands	678
297.3	299.1	1.8	Wetlands	2,629
302.0	302.6	0.6	Forest/wetlands	156
302.9	303.6	0.7	Forest/wetlands	149
307.1	307.8	0.7	Forest/wetlands	133
308.1	308.7	0.6	Forest/wetlands	222
308.9	310.1	1.2	Forest/wetlands	1,200
311.1	312.1	1.0	Forest/wetlands	654
322.1	328.8	6.7	Forest/wetlands	8,951
329.7	330.8	1.1	Forest/wetlands	556
348.0	348.1	0.1	Forest	135
349.3	350.9	1.6	Forest/wetlands	332
351.5	352.0	0.5	Wetlands	408
352.1	352.5	0.4	Forest/wetlands	187
TOTAL		**37.6**		**27,101**

Source: Fragmentation analysis based on Homer et al. 2015.

Operations Impacts

The following sections describe the potential impacts of normal operation of the Applicant's preferred route. Potential impacts from an accidental release of crude oil during operation are addressed in Chapter 10.

Fisheries and Aquatic Habitat

General Potential Impacts

The pipeline right-of-way in upland areas would be maintained in an herbaceous vegetative state during operation to allow access along the right-of-way for inspection, monitoring, and maintenance. Permanent removal of riparian vegetation within the permanent right-of-way in areas adjacent to waterbody crossings would result in localized alterations in habitat, streambank stability loss and erosion, and the potential for increased sedimentation. The Applicant would conduct regular monitoring of the right-of-way and would be able to identify streambank areas where changes may occur to the topography or vegetation. If any such changes are identified, the Applicant would consult Minnesota DNR and Minnesota PCA and make repairs and improvements following recommendations of these agencies. With implementation of these measures, localized changes to topography or vegetation would result in short-term minor impacts in the vicinity of the alteration.

Permanent removal of riparian vegetation in areas adjacent to some waterbody crossings would allow more light to enter the waterbody and could cause long-term to permanent, negligible to minor increases in temperature at these locations. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way. This could lead to permanent thermal effects on trout streams. During normal operation, no other measurable changes to water quality in surface waters would be expected, with no impacts on most fisheries or aquatic habitats.

Minor accidental fuel and lubricant leaks and spills could be released from maintenance and inspection vehicles using the permanent right-of-way and nearby areas. Any refueling, fuel storage, or vehicle maintenance would follow the Applicant-proposed measures set forth in the Environmental Protection Plan (Appendix E). If minor leaks or spills during operations reach surface waters, negligible to minor changes to surface water quality would result, and the subsequent temporary impacts on fisheries and aquatic habitats would be negligible to minor.

Chemical methods (i.e., herbicides) to control invasive vegetation species during operations could be used near waterbodies. The Applicant would implement its noxious weed plans that include methods to prevent and reduce the introduction and spread of noxious weeds and invasive species, and would implement BMPs for herbicide applications. Only herbicides and surfactants labeled for aquatic use would be used within 50 feet of any waterbody (Appendix E). In addition, herbicide use would be based on the invasive species present from monitoring, and the minimum herbicide would be used to treat the species present. These actions would reduce potential impacts on aquatic species from herbicides reaching surface waters with runoff. As a result, the use of herbicides would result in temporary and negligible impacts on fisheries and aquatic habitats.

Impacts from Integrity Management Digs

During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. In upland areas, these integrity digs would result in loss of vegetation in localized areas for relatively short periods of time. The Applicant would implement measures to minimize runoff to surface water during and after

these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing, as described above. Impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be short term to long term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During repair or replacement of pipe as part of the Integrity Management Program, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. The frequency with which hydrostatic testing would occur, locations of testing, and amount of water needed for testing and dust control are not defined. As described for pipeline construction, the Applicant would be required to obtain water appropriation and NPDES permits for testing procedures, and the volume of water would be substantially less than for construction. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, potential impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts

During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody vegetation from re-growing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be permanent in the area of the temporary construction work area that is outside of the permanent right-of-way because of the long period of time required for forest habitat to regenerate. Within the permanent right-of-way, the impact of this loss would be permanent and minor to major.

Differences in vegetation cover between the permanent right-of-way and the surrounding landscape can act as a barrier for some species, such as squirrels and small mammals, while acting as a travel corridor for others, such as raccoons and coyotes. Small mammals that do attempt to cross the cleared right-of-way in previously forested areas could be exposed to increased predation by coyotes, foxes, or birds. Trees and shrubs along rivers and creeks provide high-value wildlife habitat. Furbearers such as muskrats, mink, otter, weasels, and beaver use river edge habitats; and permanent removal of trees and large shrubs along the 50-foot-wide permanent right-of-way would create a break in cover that could increase exposure to terrestrial predators like foxes and coyotes, as well as predatory birds. Losses of tree and shrub habitats used by small mammals and birds for cover, forage, and nesting would be a permanent and minor impact because the permanent right-of-way would be maintained free of trees and large shrubs.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on common wildlife for each occurrence; but the mowing would be repeated periodically over the life of the Project.

The maintained permanent right-of-way may be used as travel corridors by some big game animals and humans. Increased human use could lead to disturbance and hunting pressure on game animals, resulting in minor permanent effects on wildlife (Hinkle et al. 2002).

The permanent right-of-way may become attractive to some small species as well. For example, during operations, there may be some warming of the soil above the pipeline, which may attract rabbits, badgers, and other burrowing rodents, especially during winter months. Small mammals attracted to the permanent right-of-way could be exposed to increased predation by coyotes, foxes, or birds. The pipeline right-of-way also could attract migratory waterfowl during early spring if it becomes snow free before surrounding habitats. This has been demonstrated during the early spring melt, when early vegetation emergence near roadways and the buried portion of the Trans Alaska Pipeline in Northern Alaska attracts waterfowl, shorebirds, and ptarmigan (Trans Alaska Pipeline System Owners 2001). Migratory birds attracted to the permanent right-of-way could be exposed to increased predation by coyotes, foxes, or other predators. These effects would be permanent but minor.

Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. The use of chemical controls can adversely affect wildlife species, particularly amphibians because of their sensitivity to chemical exposure. However, implementation of BMPs for use of herbicides that include measures such as only using herbicides when necessary and using aquatic formulations within 50 feet of water, and prevention of the spread of noxious species would minimize the potential for impacts; and the impact on wildlife and wildlife habitats is expected to be temporary to short term and minor.

Impacts on Management Units and Managed Species

The Applicant's preferred route would cross the McGregor IBA, permanently affecting about 25 acres. IBAs represent relatively intact areas that are important to birds. Maintenance of the permanent right-of-way could reduce populations of species sensitive to habitat disturbance and could indirectly result in a permanent and minor effect on breeding birds within the McGregor IBA.

Impacts from Habitat Fragmentation

During operation, the habitat fragmentation along the permanent right-of-way would continue, as described for construction impacts, and could reduce populations of some forest interior species (e.g., birds, mammals, and amphibians). Forest-nesting birds are particularly vulnerable to habitat fragmentation effects of linear construction projects. Forest-nesting songbird abundance, diversity, and reproduction rates have been shown to become depressed from the fragmentation associated with linear developments (Jalkotzy et al. 1997). Linear corridors also increase songbird nest predation and parasitism (e.g., by brown-headed cowbirds), by fragmenting forest habitats and increasing access to nests. As a result, habitat fragmentation during operation of the Applicant's preferred route would cause permanent minor to major impacts on wildlife, depending on the location and species.

Impacts from Integrity Management Digs

The integrity management digs described above (see operations impacts for fisheries and aquatic habitat) would result in changes to the permanent right-of-way that would be similar to those during construction.

During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. In upland areas, these integrity digs would result in loss of vegetation in localized areas for relatively short periods of time. The Applicant would restore the affected areas to conditions present prior to initiating the integrity dig. The impacts would be similar to those during construction of the pipeline, but over a substantially smaller area and without impacts on forested areas because the areas affected by integrity digs essentially would be limited to the permanent right-of-way. Consequently, impacts on wildlife and wildlife habitat would be short term and negligible to minor but would occur periodically over the life of the Project.

6.3.4.3.2 Route Alternatives (from Clearbrook to Carlton)

The types of potential impacts on fisheries and aquatic resources and wildlife and wildlife habitat that would result from construction and operation of route alternatives RA-03AM, RA-06, RA-07, and RA-08 would be the same as those described for the Applicant's preferred route. The species present would be similar for the Applicant's preferred route and all route alternatives. The duration and magnitude of impacts would be similar among all of the alternatives, with relatively minor differences resulting from different locations and increased or decreased occurrences of the impacts along the routes. As a result, this section refers to the impact analysis presented above for the Applicant's preferred route for most anticipated impacts.

Route Alternative RA-03AM

Construction Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. Construction of RA-03AM would require crossing 167 streams, including 8 trout streams (Tables 6.3.4-13 and 6.4.3-14). These crossings would be constructed using the methods described in Section 6.3.4.3.1 for construction of surface water crossings of the Applicant's preferred route, including incorporation of the BMPs described in that section. The impacts of surface water crossings for RA-03AM would be the same as those for the Applicant's preferred route. Most crossing impacts would be temporary to short term and negligible to minor, although the use of wet open-cut crossings could result in a short- to long-term, minor impact at each crossing. Where streambanks are cleared of forested or other woody vegetation, the potential impacts on fisheries and aquatic habitats would be permanent and minor to major, depending on existing surface water conditions. Crossing methods have not been established for RA-03AM.

Table 6.3.4-13. Number of Stream Crossings for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Water Type	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Stream/river – perennial	25	41	57	28	31
Stream/river – intermittent	42	62	29	20	27
Artificial path	11	13	18	5	6
Connector	3	6	5	2	4
Canal ditch	15	31	12	19	27
Lake/pond – perennial	15	14	16	6	11
Swamp/marsh – intermittent	--	--	--	1	--
TOTAL CROSSINGS	**111**	**167**	**137**	**81**	**106**

Source: USGS NHD 2016.

Note:

The surface water types most likely to provide fish habitat are stream/river, artificial path, and connector.

Table 6.3.4-14. Number of Sensitive Aquatic Resources Crossed by and near the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Sensitive Aquatic Resource	Applicant's Preferred Route[a]			Route Alternative RA-03AM[b]			Route Alternative RA-06[b]			Route Alternative RA-07[c]			Route Alternative RA-08[b]		
	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]
Fish IBI Lake	--	--	5	--	--	6	--	--	--	--	--	3	--	--	1
Sentinel Lake	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--
Lake of Biological Significance	--	--	10	--	--	6	1	1	4	3	2	16	1	1	16
Trout stream	6	6	17	8	8	19	7	6	28	8	6	7	7	4	18
Trout lake	--	--	1	--	--	--	1	1	--	--	--	--	--	--	--
Muskie lake	--	--	1	--	--	--	--	--	--	--	--	4	--	--	2
TOTAL	**6**	**6**	**35**	**8**	**8**	**32**	**9**	**8**	**32**	**11**	**8**	**30**	**8**	**5**	**37**

Sources: Minnesota DNR 2015b; 2015c; 2016b.

Notes:

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route.

[d] 0.5 mile = within 0.5 mile of the centerline of the route.

"—" = no crossing

Fish IBI Lake = Fish Index of Biotic Integrity Lake

Potential Impacts on Management Units and Managed Species. RA-03AM would result in 0.5 acre of disturbance to the LaSalle Creek AMA and would pass within 0.5 mile of seven other AMAs (Table 6.3.4-15). AMAs represent good-quality habitats with functional adjacent upland wildlife habitat areas. Impacts on AMAs from construction would depend on the type of waterbody crossing method used. As for the Applicant's preferred route, the Applicant would incorporate BMPs into construction to avoid or minimize impacts. Consequently; the impacts of construction of RA-03AM related to loss of habitat and reduction of habitat quality would be short term and negligible to minor. RA-03AM also would pass within 0.5 mile of six lakes with Fish IBI ratings (Table 6.3.4-16). The Applicant would implement BMPs to prevent the spread of invasive species, with the resultant impacts expected to be at most short term and negligible to minor. RA-03 would not cross any Lakes of Biological Significance (Table 6.3.4-17) or any waters managed for muskellunge (Table 6.3.4-18).

Table 6.3.4-15. Aquatic Management Areas Crossed by or near the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton (acres)

Aquatic Management Area	Applicant's Preferred Route[a]			Route Alternative RA-03AM[b]			Route Alternative RA-06[b]			Route Alternative RA-07[c]			Route Alternative RA-08[b]		
	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]
Blackhoof River AMA	--	--	44.4	--	--	44.4	--	--	--	--	--	--	--	--	--
Bruce Creek AMA	--	--	--	--	--	--	--	--	--	--	--	0.2	0.3	0.1	3.8
Cat Creek AMA	--	--	--	--	--	14.9	--	--	--	--	--	--	--	--	--
Clearwater River AMA	--	--	--	--	--	--	0.2	0.1	17.3	0.3	0.1	15.4	--	--	4.9
Fish Lake AMA	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--
Fish Trap Lake #1 FMA	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--
LaSalle Creek AMA	0.4	0.2	27.4	0.5	0.2	27.4	--	--	--	--	--	--	--	--	--
Little Otter Creek AMA	--	--	--	--	--	--	4.6	1.9	92.9	7.8	1.9	92.9	4.4	1.8	82.2
Midge-Little Midge FMA	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--	--
Mississippi River AMA	--	--	--	--	--	12.8	--	--	--	--	--	--	--	--	--
Necktie River AMA	--	--	--	--	--	--	--	--	--	--	--	41.9	--	--	41.9
Otter Creek AMA	--	--	--	--	--	--	--	--	67.2	--	--	67.2	--	--	66.6
Pierz Fish Lake AMA	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--
Popple River AMA	--	--	--	--	--	--	--	--	3.1	--	--	--	--	--	--
Prairie River AMA	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--
Spire Valley AMA	--	--	56.2	--	--	--	--	--	--	--	--	--	--	--	--
St. Louis River II AMA	--	--	--	--	--	--	--	--	25.1	--	--	25.1	--	--	--
Straight River AMA	--	--	16.6	--	--	16.6	--	--	--	--	--	--	--	--	--

Table 6.3.4-15. Aquatic Management Areas Crossed by or near the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton (acres)

Aquatic Management Area	Applicant's Preferred Route[a]			Route Alternative RA-03AM[b]			Route Alternative RA-06[b]			Route Alternative RA-07[c]			Route Alternative RA-08[b]		
	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]	Con	Op	0.5 Mile[d]
Venning Creek AMA	--	--	--	--	--	--	0.3	0.1	12.5	--	--	--	--	--	--
TOTAL	**0.4**	**0.2**	**144.6**	**0.5**	**0.2**	**117.2**	**5.0**	**2.1**	**218.2**	**8.2**	**2.0**	**243.2**	**4.7**	**2.0**	**199.5**

Source: Minnesota DNR 2016h.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide right-of-way centered on the route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the route.

[d] 0.5 mile = within 0.5 mile of the centerline of the route.

"—" = no crossing

AMA = Aquatic Management Area, FMA = Fisheries Management Area

Table 6.3.4-16. Number of Lakes with Fish IBI Ranking within 0.5 Mile of the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Lake Name	Fish IBI Status	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Big LaSalle	Exceptional	1	1	--	--	--
Fish	Meeting standard	--	1	--	--	--
Fish Trap	Exceptional	--	1	--	--	--
Green Prairie Fish	Mixed results – below/meeting	--	1	--	--	--
Irving	Exceptional	--	--	--	1	--
Island	Exceptional	1	1	--	-	--
Little Wolf	Exceptional	--	--	--	1	
Lower Sucker	Meeting standard	--	--	--	--	1
Midge	Meeting standard	--	--	--	1	--
Portage	Exceptional	1	1	--	--	--
Roosevelt	Exceptional	1	--	--	--	--
Waukenabo	Below impairment threshold	1	--	--	--	--
TOTAL		**5**	**6**	**0**	**3**	**1**

Source: Minnesota DNR 2014a.

Notes:

Number of occurrences within 0.5 mile centered on route (none would be crossed by route construction work area).

Fish IBI = Index of Biotic Integrity thresholds were developed to classify lakes based on their fish communities as exceptional, meeting standards, vulnerable to impairment, and impaired.

"--" no occurrence

Table 6.3.4-17. Lakes of Biological Significance Crossed by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton (acres)

Class	Watershed, Minnesota DNR Identifier	Applicant's Preferred Route[a]		Route Alternative RA-03AM[b]		Route Alternative RA-06[b]		Route Alternative RA-07[c]		Route Alternative RA-08[b]	
		Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Outstanding	13543	--	--	--	--	--	--	--	--	6.0	2.5
	Pike Bay, 14487	--	--	--	--	--	--	1.5	--	--	--
	West Four-Legged, 21300	--	--	--	--	--	--	7.0	1.5	--	--
	East Four-Legged, 23949	--	--	--	--	--	--	2.0	0.6	--	--
High	12005	--	--	--	--	3.4	1.4	--	--	--	--
TOTAL		**--**	**--**	**--**	**--**	**3.4**	**1.4**	**10.9**	**2.1**	**6.0**	**2.5**

Source: Minnesota DNR 2016b.

Notes:

Includes lakes and ponds.

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide right-of-way centered on the route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline.

"--" no crossing

Table 6.3.4-18. Number of Lakes Managed for Muskellunge Fisheries within 0.5 Mile of the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Watershed	Minnesota DNR Identifier	Muskie Population[a]	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Cass	14870	N	--	--	--	1	--
Leech	21722	N	--	--	--	--	1
Little Wolf	14970	I	--	--	--	1	--
Pike Bay	14487	N	--	--	--	1	1
Roosevelt	14175	I	1	--	--	--	--
Winnibigoshish	12798	N	--	--	--	1	--
TOTAL			**1**	**--**	**--**	**4**	**2**

Source: Minnesota DNR 2008 – Muskellunge Waters.

Notes:

Occurrences within 0.5 mile centered on route (none would be crossed by a construction work area).

[a] Muskie (Muskellunge) population: N = native, I = introduced

"--" = no occurrence

Minnesota PCA's Watershed Health Assessment parameters for species richness, stream species quality, and habitat quality and connectivity were compared for the Applicant's preferred route and RA-03AM, RA-06, RA-07, and RA-08 between Clearbrook and Carlton using the data in Figures 6.3.4-5, 6.3.4-6, and 6.3.4-7. No clear consistent trends distinguished between the potential routes, although in some instances, one alternative scored higher than the others for some individual indices.

Wildlife and Wildlife Habitat

General Potential Impacts. The types of construction-related impacts on wildlife and wildlife habitats for RA-03AM and the measures to be implemented to avoid or reduce impacts associated with pipeline construction would be the same as those described in Section 6.3.4.3.1 for the Applicant's preferred route. Construction of RA-03AM would disturb 3,578 acres of wildlife habitat, primarily consisting of forest, hay, and pasture land (Table 6.3.4-19). Impacts on these areas would be similar to those described above, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Forests provide complex and valuable habitat for many species of wildlife and would require decades to recover to maturity. Compared to the Applicant's preferred route, RA-06, RA-07, and RA-08, construction of RA-03AM would disturb the smallest acreage of wetlands (Table 6.3.4-19). The potential impact on wildlife and wildlife habitat from construction of RA-03AM would be long term to permanent and minor to major.

Table 6.3.4-19. Vegetation Cover Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Vegetation Cover Class	Applicant's Preferred Route[a]		Route Alternative RA-03AM[b]		Route Alternative RA-06[b]		Route Alternative RA-07[c]		Route Alternative RA-08[b]	
	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Evergreen forest	173.4	69.6	145.4	60.1	102.6	42.6	234.5	37.0	106.4	43.7
Deciduous forest	1,255.5	554.0	975.1	403.1	797.7	332.9	772.6	177.1	591.8	245.5
Mixed forest	17.5	7.4	13.5	5.7	164.2	68.3	139.4	27.9	74.6	30.5
Scrub/shrub	210.6	104.3	190.5	80.2	251.4	104.2	276.9	83.4	123.8	51.8
Grassland/herbaceous	93.5	45.0	142.8	60.6	115.5	49.2	404.8	107.0	81.3	34.5
Hay/pasture	388.1	175.2	1,030.6	432.9	213.2	89.2	325.5	88.4	303.9	128.2
Cultivated crops	173.4	76.4	565.2	237.7	43.0	18.0	76.3	23.1	31.7	13.2
Woody wetlands	316.6	158.8	194.7	78.1	732.2	304.2	1,055.9	236.1	651.1	270.2
Emergent herbaceous wetlands	174.0	95.3	315.1	133.5	223.3	94.0	536.1	154.2	318.6	134.7
Barren land	3.6	1.7	5.1	2.2	30.5	12.8	10.4	3.2	2.8	1.1
TOTAL	**2,806.4**	**1,287.8**	**3,578.0**	**1,494.1**	**2,673.6**	**1,115.4**	**3,832.3**	**937.4**	**2,286.0**	**953.5**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the pipeline route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

Potential Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from construction of RA-03AM would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Construction of RA-03AM would have short-term minor impacts on 44.1 acres of wildlife conservation areas, including one waterfowl refuge, one WMA, one state forest and one land classified as "other forest land" (Table 6.3.4-20). RA-03AM also would cross two IBAs, resulting in approximately 70 acres of short-term minor disturbance during construction as this pipeline would be co-located with existing corridors (Table 6.3.4-21). RA-03AM would not pass near any colonial nesting waterbird sites (Table 6.3.4-22).

Table 6.3.4-20. Wildlife Management Areas and Forests Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton (acres)

Unit Type and Name	Applicant's Preferred Route[a]		Route Alternative RA-03AM[b]		Route Alternative RA-06[b]		Route Alternative RA-07[c]		Route Alternative RA-08[b]	
	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Wildlife Refuge										
Bemidji Game Refuge	--	--	--	--	--	--	142.1	35.1	62.8	26.2
Staples Waterfowl Refuge	--	--	4.9	2.0	--	--	--	--	--	--
Wildlife refuge subtotal	***--***	***--***	***4.9***	***2.0***	***--***	***--***	***142.1***	***35.1***	***62.8***	***26.2***
Wildlife Management Area										
Bemidji Slough WMA	--	--	--	--	--	--	--	--	4.1	1.7
Grayling Marsh WMA	15.5	6.5	--	--	--	--	--	--	--	--
Lawler WMA	4.0	1.5	--	--	--	--	--	--	--	--
Neitermeier WMA	--	--	5.4	2.2	--	--	--	--	--	--
Swan River Deer Yard WMA	--	--	--	--	--	--	--	--	7.4	3.1
Wildlife management area subtotal	***19.5***	***8.0***	***5.4***	***2.2***	***--***	***--***	***142.1***	***35.1***	***11.6***	***4.8***
State Forest										
Big Fork	--	--	--	--	69.6	29.0	--	--	--	--
Bowstring	--	--	--	--	--	--	217.9	55.4	96.8	40.4
Fond du Lac	--	--	--	--	15.4	6.4	26.2	6.4	15.3	6.4
Foot Hills	30.2	12.6	--	--	--	--	--	--	--	--
George Washington	--	--	--	--	106.5	44.4	--	--	--	--
Hill River	67.5	27.9	--	--	--	--	--	--	--	--
Huntersville	45.5	19.0	--	--	--	--	--	--	--	--
Land O'Lakes	101.0	42.1	--	--	--	--	--	--	--	--
Mississippi Headwaters	8.5	3.5	8.5	3.5	--	--	2.9	0.7	7.7	3.2
Savanna	11.0	4.6	--	--	--	--	--	--	38.1	15.9

Table 6.3.4-20. Wildlife Management Areas and Forests Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton (acres)

Unit Type and Name	Applicant's Preferred Route[a]		Route Alternative RA-03AM[b]		Route Alternative RA-06[b]		Route Alternative RA-07[c]		Route Alternative RA-08[b]	
	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Waukenabo	19.8	8.3	--	--	--	--	--	--	--	--
State forest subtotal	***283.6***	***118.0***	***8.5***	***3.5***	***191.5***	***79.8***	***247.1***	***62.6***	***158.0***	***65.9***
Other Forest Land										
Miscellaneous	77.6	32.5	30.3	12.8	133.9	55.5	97.1	23.6	67.6	28.2
Other forest land subtotal	***77.6***	***32.5***	***30.3***	***12.8***	***133.9***	***55.5***	***97.1***	***23.6***	***67.6***	***28.2***
TOTAL	**380.7**	**158.5**	**44.1**	**18.5**	**325.3**	**135.2**	**486.3**	**86.1**	**237.1**	**98.9**

Sources: Minnesota DNR 2016n, Minnesota DNR 2016g = wildlife refuge inventory.

Notes:

All impacts on Minnesota wildlife management areas (WMAs) and state forests would occur between Clearbrook and Carlton, Minnesota.

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the pipeline route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on pipeline route.

"--" = no occurrence

Table 6.3.4-21. Estimated Impacts on Important Bird Areas for the Applicant's Preferred Route and Route Alternatives Between Clearbrook and Carlton (acres)

Audubon Important Bird Area	Applicant's Preferred Route[a]			Route Alternative RA-03AM[b]			Route Alternative RA-06[b]			Route Alternative RA-07[c]			Route Alternative RA-08[b]		
	Con	Op	0.5 Mile	Con	Op	0.5 Mile	Con	Op	0.5 Mile	Con	Op	0.5 Mile	Con	Op	0.5 Mile
Camp Ripley-Pillsbury-Lake Alexander IBA	--	--	--	42.3	17.2	2,758.2	--	--	--	--	--	--	--	--	--
Chippewa Plains IBA	--	--	--	--	--	--	512.1	213.3	22,651.0	1,016.1	247.8	26,492.8	594.2	247.6	26,137.6
Crane Meadows NWR – Rice Skunk Wetland Complex IBA	--	--	--	27.6	11.5	1,233.9	--	--	--	--	--	--	--	--	--
Itasca State Park IBA	--	--	384.7	--	--	384.9	--	--	--	--	--	--	--	--	--
McGregor IBA	47.5	24.5	3,023.4	--	--		--	--	--	--	--	--	--	--	--
TOTAL	**47.5**	**24.5**	**3,408.1**	**69.8**	**28.7**	**4,377.1**	**512.1**	**213.3**	**22,651.0**	**1,016.1**	**247.8**	**26,492.8**	**594.2**	**247.6**	**26,137.6**

Source: Audubon 2016.

Notes:

Values in table may not sum to subtotals and totals due to rounding.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide right-of-way centered on the pipeline route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

"--" = no occurrence

IBA = Important Bird Area, NWR = National Wildlife Refuge

Table 6.3.4-22. Number of Colonial Waterbird Nesting Sites Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Description	Applicant's Preferred Route[a]			Route Alternative RA-06[b]			Route Alternative RA-07[c]			Route Alternative RA-08[b]		
	Con	Op	0.5 Mile	Con	Op	0.5 Mile	Con	Op	0.5 Mile	Con	Op	0.5 Mile
Big Fork River – great blue heron	--	--	--	--	--	1	--	--	--	--	--	--
Boulder Hill – great blue heron	--	--	--	--	--	--	--	--	1	--	--	1
Grass Lake – red-necked grebe	--	--	--	--	--	--	--	--	1	--	--	--
Larson Lake – great blue heron	--	--	--	1	1	1	--	--	--	--	--	--
Mahtowa – great blue heron	--	--	1	--	--	--	--	--	--	--	--	--
Portage Creek – great blue heron	--	--	--	--	--	--	--	--	--	1	1	1
Red Lake Trail – great blue heron	--	--	--	--	--	1	--	--	--	--	--	--
Sherry Lake – great blue heron	--	--	-	1	1	1	--	--	--	--	--	--
Wagner Creek #2 – great blue heron	--	--	--	--	--	1	--	--	--	--	--	--
Shell River – great blue heron	--	--	1	--	--	--	--	--	--	--	--	--
TOTAL	**--**	**--**	**2**	**2**	**2**	**5**	**--**	**--**	**2**	**1**	**1**	**3**

Source: Minnesota DNR 2016e.

Notes:

No colonial waterbird nests occur within 0.5 mile of RA-03AM.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the pipeline route.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on the pipeline route.

0.5 mile = 0.5 mile from centerline of pipeline route

"--" = no occurrence

Impacts from Habitat Fragmentation. RA-03AM is co-located with existing pipelines, transmission lines, and roads across all of its length. No large-block habitats would be fragmented by RA-03AM; however, widening corridors in this area could contribute to habitat loss and conversion, decreased habitat quality, and increased risk of the introduction of invasive species. Impacts on wildlife habitat and wildlife from fragmentation are expected to be temporary to short term and negligible.

Operations Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. General impacts from operation of a pipeline along the RA-03AM route would be similar to those described for the Applicant's preferred route above. Operation of RA-03AM

would affect 167 stream crossings, including 9 trout streams within the permanent right-of-way. Impacts could result from maintenance activities, including vegetation management at stream edges that would occur for the life of the Project. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way, which could lead to permanent major thermal effects on trout streams. Additional impacts could occur from the use of herbicides and accidental fuel and lubricant leaks and spills from maintenance and inspection vehicles. With implementation of the proposed BMPs, these impacts would be short- to long-term and minor to major, depending on the nature of the vegetation permanently removed. RA-03AM would result in 0.2 acre of disturbance to the LaSalle Creek AMA.

Impacts from Integrity Management Digs. Impacts from integrity management digs for RA-03AM would be similar to those described for the Applicant's preferred route. During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. The Applicant would implement measures to minimize runoff to surface water during and after these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing, as described above. The impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be short term to long term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During repair or replacement of pipe as part of the Applicant's Integrity Management Program, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, the impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts. General impacts from operation of a pipeline along the RA-03AM route would be similar to those described for the Applicant's preferred route. Operation of RA-03AM would affect 1,494 acres of wildlife habitat, primarily consisting of deciduous forest, hay, and pasture land. During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody vegetation from re-growing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be long term to permanent in the area of the construction work area that is outside of the permanent right-of-way because of the long period of time that forest requires to regenerate. Within the permanent right-of-way, the impact would be permanent and minor to major.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on common wildlife for each occurrence; but the mowing would be repeated periodically over the life of the Project. The permanent right-of-way also could create a travel corridor for some species. Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. The use of chemical controls can adversely affect wildlife species, particularly amphibians because of their sensitivity to chemical exposure. However, implementation of BMPs for use of herbicides that include measures such as only using herbicides when necessary and using aquatic formulations within 50 feet of

water, and prevention of the spread of noxious species would minimize the potential for impacts; and the impact on wildlife and wildlife habitats is expected to be temporary to short term and minor.

Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from operation of RA-03AM would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Construction of RA-03AM would permanently disturb 19 acres of wildlife conservation areas, including one waterfowl refuge, one WMA, one state forest, and one land classified as "other forest land" (Table 6.3.4-20). RA-03AM also would cross two IBAs, resulting in approximately 29 acres of permanent minor to major disturbance during operation (Table 6.3.4-21).

Impacts from Habitat Fragmentation. RA-03AM is co-located with existing pipelines, transmission lines, and roads across all of its length. No large-block habitats would be fragmented by RA-03AM; however, widening corridors in this area could contribute to permanent habitat loss and conversion, decreased habitat quality, and increased risk of invasive species introduction. The impacts on wildlife habitat and wildlife from fragmentation are expected to be temporary to short term and negligible.

Impacts from Integrity Management Digs. Integrity management digs would result in disturbance to wildlife and wildlife habitat as described above for construction impacts; however, the area affected would be substantially smaller and would occur entirely within the established right-of-way. As a result, impacts on wildlife and wildlife habitat from integrity digs would be short term and negligible to minor but would occur periodically over the life of the Project.

Route Alternative RA-06

Construction Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. Construction of RA-06 would require crossing 137 streams, including seven trout streams and one trout lake (Tables 6.3.4-13 and 6.4.3-15). These crossings would be constructed using the methods described in Section 6.3.4.3.1 for construction of surface water crossings for the Applicant's preferred route, including incorporation of the BMPs described in that section. The impacts of surface water crossings for RA-06 would be the same as those for the Applicant's preferred route. Most crossing impacts would be temporary to short term and negligible to minor; although the use of wet open-cut crossings could result in a short- to long-term, minor impact at each crossing. Where streambanks are cleared of forested or other woody vegetation, the potential impacts on fisheries and aquatic habitats would be permanent and minor to major, depending on existing surface water conditions. Crossing methods have not been established for RA-06.

Potential Impacts on Management Units and Managed Species. RA-06 would cumulatively result in 5 acres of disturbance to three AMAs (Clearwater, Little Otter Creek, and Venning Creek) and would pass within 0.5 mile of three other AMAs (Table 6.3.4-14). AMAs represent good-quality habitats with functional adjacent upland wildlife habitat areas. Impacts on AMAs from construction would depend on the type of waterbody crossing method used. Construction of RA-06 would disturb 3.4 acres of one Minnesota Lake of Biological Significance with a rating of high (Table 6.3.4-18).

As for the Applicant's preferred route, the Applicant would incorporate BMPs into construction to avoid or minimize impacts; consequently, impacts from loss of habitat and reduction of habitat quality would be

short term and negligible to minor. The Applicant would implement BMPs to prevent the spread of invasive species, with the resultant impact expected to be at most short term and negligible to minor.

Minnesota PCA's Watershed Health Assessment parameters for species richness, stream species quality, and habitat quality and connectivity were compared for the Applicant's preferred route and RA-03AM, RA-06, RA-07, and RA-08 between Clearbrook and Carlton using the data in Figures 6.3.4-5, 6.3.4-6, and 6.3.4-7. No clear consistent trends distinguished between the potential routes, although in some instances, one alternative scored higher than the others for some individual indices (e.g., RA-06 scored highest for macroinvertebrate species richness, terrestrial habitat quality, terrestrial habitat connectivity, and aquatic habitat connectivity).

Wildlife and Wildlife Habitat

General Potential Impacts. The types of impacts on wildlife and wildlife habitats from construction of RA-06 and the measures to be implemented to avoid or reduce construction-related impacts would be the same as those described in Section 6.3.4.3.1 for the Applicant's preferred route. Construction of RA-06 would disturb 2,674 acres of wildlife habitat, primarily consisting of forest and woody wetlands (Table 6.3.4-19). Impacts on these areas would be similar to those described above, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Forests provide complex and valuable habitat for many species of wildlife and would take decades to recover to maturity. The potential impact on wildlife and wildlife habitat from construction of RA-06 would be long term to permanent and minor to major.

Potential Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from construction of RA-06 would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Construction of RA-06 would have short- to long-term minor impacts on 325 acres of wildlife conservation areas, including three state forests (Table 6.3.4-20). RA-06 also would cross the Chippewa Plains IBA, resulting in approximately 512 acres of permanent minor disturbance during construction from clearing of the right-of-way (Table 6.3.4-21). RA-06 would also disturb the Larson Lake and Sherry Lake great blue heron rookeries (Table 6.3.4-22). Research has shown that construction activities within 300 meters (984 feet) of nesting great blue herons can cause nest abandonment and reproductive failure (VFWD 2002; MNFI 2016). RA-06 could result in removal of great blue heron rookery trees within construction work areas, which would result in permanent major impacts on heron nesting habitat and short-term and minor impacts on individual birds as they would be forced to find new nest sites. Permits would be needed from USFWS and Minnesota DNR if tree removal would occur during the nesting season.

Impacts from Habitat Fragmentation. RA-06 is not co-located with other pipelines, utilities, or roads across much of its length and would affect a greater number of large-block habitats than any other potential route. Sixty large-block habitats (more than 100 acres) would be crossed and fragmented by construction of RA-06 between approximately MP 140.0 and 295.0 (Table 6.3.4-23). The large-block habitats that would be crossed by RA-06 primarily include forested and woody wetland habitats, with the largest patch size (about 9,100 acres) crossed by approximately 7 miles of pipeline and the smallest patch size (about 110 acres) crossed by approximately 0.4 mile of pipeline (Table 6.3.4-23). Habitats along RA-06 would be fragmented across a total of approximately 114 miles (about 58 percent of the route) between Clearbrook and Carlton. The construction of RA-06 would result in a total of 83,996 acres fragmented. Habitat fragmentation resulting from construction of RA-06 would create more edge habitats, may result in decreased populations of forest interior species, and could facilitate

spread of invasive species. Impacts from habitat fragmentation by construction of RA-06 would be long term and major.

Table 6.3.4-23. Large-Block Habitat Patches Crossed by Route Alternative RA-06 in Minnesota

Beginning Milepost	Ending Milepost	Crossing Length (miles)	Patch Type	Patch Size (acres)
140.1	140.8	0.7	Forest	349
142.7	143.8	1.1	Forest, wetlands	1,729
144.0	144.4	0.4	Forest, wetlands	109
146.4	151.5	5.1	Forest, wetlands, scrub/shrub	6,589
151.6	153.3	1.7	Forest	1,233
153.4	153.7	0.3	Forest, wetlands, scrub/shrub	533
155.2	155.5	0.3	Forest	1,960
155.5	155.5	0.0	Wetlands	465
155.5	157.8	2.3	Forest, wetlands	1,867
158.0	159.0	1.0	Forest, wetlands	466
160.3	160.9	0.6	Forest, wetlands	395
161.4	162.7	1.3	Forest, wetlands	333
163.5	165.0	1.5	Forest, scrub/shrub	689
166.6	167.6	1.0	Forest, wetlands	413
168.1	169.0	0.9	Forest, wetlands	166
170.7	171.0	0.3	Forest	173
180.7	182.3	1.6	Forest, wetlands	784
182.4	183.6	1.2	Forest, wetlands	315
183.8	193.3	9.5	Forest, wetlands, scrub/shrub	8,539
193.4	196.7	3.3	Forest, wetlands	2,607
196.8	202.1	5.3	Forest, wetlands	467
204.4	205.4	1.0	Forest, wetlands	324
205.5	207.0	1.5	Forest, wetlands	2,882
207.3	208.3	1.0	Forest, wetlands, scrub/shrub	121
208.4	210.0	1.6	Forest, wetlands, scrub/shrub, herbaceous	968
210.2	212.1	1.9	Forest, wetlands	508
214.4	215.2	0.8	Forest, wetlands	1,870
215.3	215.9	0.6	Forest, wetlands	235
215.6	216.2	0.6	Forest	237
218.5	221.1	2.6	Forest, wetlands, scrub/shrub, herbaceous	3,260
222.6	223.4	0.8	Forest	138

Table 6.3.4-23. Large-Block Habitat Patches Crossed by Route Alternative RA-06 in Minnesota

Beginning Milepost	Ending Milepost	Crossing Length (miles)	Patch Type	Patch Size (acres)
223.7	230.3	6.6	Forest, scrub/shrub	9,135
230.4	233.1	2.7	Forest, scrub/shrub	909
234.4	236.2	1.8	Forest, scrub/shrub, herbaceous	945
236.3	237.1	0.8	Scrub/shrub	1,266
237.3	239.5	2.2	Scrub/shrub	1,128
239.5	242.4	2.9	Forest, wetlands, scrub/shrub, herbaceous	1,280
242.5	243.6	1.1	Forest, wetlands, scrub/shrub, herbaceous	248
244.2	244.7	0.5	Forest	116
244.8	246.5	1.7	Forest, wetlands, scrub/shrub	706
246.6	249.3	2.7	Forest, wetlands, scrub/shrub, herbaceous	586
249.6	252.7	3.1	Wetlands	3,251
252.8	254.5	1.7	Forest, wetlands	367
254.9	255.8	0.9	Forest, wetlands, scrub/shrub	524
255.9	257.3	1.4	Forest, wetlands	295
257.4	257.9	0.5	Forest	133
257.9	261.4	3.5	Forest, wetlands	783
261.5	262.3	0.8	Forest	143
262.4	264.0	1.6	Scrub/shrub, wetlands	723
264.1	265.3	1.2	Forest	274
265.4	266.7	1.3	Forest, wetlands, scrub/shrub	184
266.9	268.3	1.4	Forest	790
269.3	272.2	2.9	Forest	886
272.8	273.5	0.7	Forest	145
274.2	276.4	2.2	Forest, wetlands	821
276.5	277.8	1.3	Forest, wetlands, scrub/shrub	1,570
279.2	280.3	1.1	Forest, wetlands	467
281.1	284.1	3.0	Forest	3,339
284.4	290.8	6.4	Forest, wetlands	5,451
290.7	295.2	4.5	Wetlands	6,804
TOTAL		**114.3**		**83,996**

Source: Fragmentation analysis based on Homer et al. 2015 – NLCD 2011.

Operations Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. General impacts from operation of a pipeline along system RA-06 would be similar to those described for the Applicant's preferred route above. Operation of RA-06 would affect 137 stream crossings (Table 6.3.4-13), including seven trout streams and one trout lake within the permanent right-of-way (Table 6.3.4-15). Operations of RA-06 would impact 2.1 acres of AMA and 1.4 acres of Lakes of Biological Significance (Table 6.3.4-15). Impacts could result from maintenance activities, including vegetation management at stream edges that would occur for the life of the Project. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way, which could lead to permanent major thermal effects on trout streams and permanent minor changes at other waterbody crossings. Additional impacts could occur from the use of herbicides and accidental fuel and lubricant leaks and spills from maintenance and inspection vehicles. With implementation of the proposed BMPs, these impacts would be short term and negligible to minor.

Impacts due to Integrity Management Digs. Impacts from integrity management digs of a pipeline along system alternative RA-06 would be similar to those described for the Applicant's preferred route above. During operation, the Applicant would implement its Integrity Management Program, which has the potential to require excavation and repair or replacement of sections of the pipeline. The Applicant would implement measures to minimize runoff to surface water during and after these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, either the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing as described above. The impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be short term to long term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During the repair or replacement of pipe as part of the Applicant's Integrity Management Program described above, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, the impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts. General impacts from operation of a pipeline along system RA-06 would be similar to those described for the Applicant's preferred route above. Operation of RA-06 would affect 1,115 acres of wildlife habitat, primarily consisting of deciduous forest and woody wetlands. During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody vegetation from regrowing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be long term to permanent in the area of the construction work area that is outside of the permanent right-of-way due to the long period of time for forest to regenerate. Within the permanent right-of-way, this impact would be permanent and minor to major.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on

common wildlife for each occurrence, but the mowing would be repeated periodically over the life of the Project. The permanent right-of-way also could create a travel corridor for some species. Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. Use of chemical weed controls can adversely affect wildlife species, particularly amphibians because of their sensitivity to chemical exposure. However, implementation of BMPs for use of herbicides that include measures such as only using herbicides when necessary and using aquatic formulations within 50 feet of water, and prevention of the spread of noxious species would minimize the potential for impacts; and the impact on wildlife and wildlife habitats is expected to be temporary to short term and minor.

Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from operation of RA-06 would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Construction of RA-06 would permanently disturb 135 acres of wildlife conservation areas, including three state forests (Table 6.3.4-20). RA-06 also would cross the Chippewa Plains IBA, resulting in approximately 213 acres of permanent disturbance during operation (Table 6.3.4-21).

Impacts from Habitat Fragmentation. RA-06 is not co-located with other pipelines, utilities, or roads across much of its length and would affect a greater number of large-block habitats than any other potential route. Sixty large-block habitats (more than 100 acres) would be crossed and fragmented by construction of RA-06 between approximately MP 140.0 and 295.0 (Table 6.3.4-23). The large-block habitats that would be crossed by RA-06 primarily include forested and woody wetland habitats. The largest patch size (about 9,100 acres) would be crossed by approximately 7 miles of pipeline, and the smallest patch size (about 110 acres) would be crossed by approximately 0.4 mile of pipeline (Table 6.3.4-23). Habitats along RA-06 would be fragmented across a total of approximately 114 miles (about 58 percent of the route) between Clearbrook and Carlton. Habitat fragmentation resulting from construction of RA-06 would create more edge habitats, may result in decreased populations of forest interior species, and could facilitate the spread of invasive species. Impacts from habitat fragmentation by operations of RA-06 would be permanent and major.

Impacts from Integrity Management Digs. Integrity management digs would disturb wildlife and wildlife habitat as described above for construction impacts; however, the area affected would be substantially smaller and would occur entirely within the established right-of-way. Consequently, impacts on wildlife and wildlife habitat would be short term and negligible to minor but would occur periodically over the life of the Project.

Route Alternative RA-07

Construction Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. Construction of RA-07 would require crossing 81 streams, including 6 trout streams (Tables 6.3.4-13 and 6.4.3-15). These crossings would be constructed using the methods described in Section 6.3.4.3.1 for construction of surface water crossings of the Applicant's preferred route, including incorporation of the BMPs described in that section. The impacts of surface water crossings for RA-07 would be the same as those for the Applicant's preferred route. Most crossing impacts would be temporary to short term and negligible to minor; although the use of wet open-cut

crossings could result in a short- to long-term, minor impact at each crossing. Where streambanks are cleared of forested or other woody vegetation, the potential impacts on fisheries and aquatic habitats would be permanent and minor to major, depending on existing surface water conditions. Crossing methods have not been established for RA-07.

Potential Impacts on Management Units and Managed Species. RA-07 would cumulatively result in 8.2 acres of disturbance to two AMAs (Clearwater and Little Otter Creek) and would pass within 0.5 mile of six other AMAs (Table 6.3.4-14). AMAs represent good-quality habitats with functional adjacent upland wildlife habitat areas. Impacts on AMAs from construction would depend on the type of waterbody crossing method used. RA-07 also would pass within 0.5 mile of three lakes with Fish IBI ratings (Table 6.3.4-16). Construction of RA-07 would disturb 10.9 acres within three Minnesota Lakes of Biological Significance rated as outstanding (Table 6.3.4-17) as well as pass within 0.5 mile of four lakes managed for muskellunge (Table 6.3.4-18).The Applicant would incorporate BMPs into construction to avoid or minimize impacts; as a result, construction-related impacts from loss of habitat and reduction of habitat quality would be short term and negligible to minor. The Applicant also would implement BMPs to prevent the spread of invasive species, with the resultant impact expected to be at most short term and negligible to minor. Minnesota PCA's Watershed Health Assessment parameters for species richness, stream species quality, and habitat quality and connectivity were compared for the Applicant's preferred route and RA-03AM, RA-06, RA-07, and RA-08 between Clearbrook and Carlton using the data in Figures 6.3.4-5, 6.3.4-6, and 6.3.4-7. No clear consistent trends distinguished between the route options.

Wildlife and Wildlife Habitat

General Potential Impacts. The types of impacts on wildlife and wildlife habitats from construction of RA-07 and the measures to be implemented to avoid or reduce construction-related impacts would be the same as those described in Section 6.3.4.3.1 for the Applicant's preferred route. Construction of RA-07 would disturb 3,832 acres of wildlife habitat primarily consisting of forest and wetlands (Table 6.3.4-19). Impacts on these areas would be similar to those described above including the potential of introduction of invasive species, loss of habitat, and reduction of habitat quality. Forests provide complex and valuable habitat for many species of wildlife and would take decades to recover to maturity. The potential impact on wildlife and wildlife habitat from construction of RA-07 would be long term to permanent and minor to major.

Potential Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from construction of RA-07 would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Construction of RA-07 would have short-term minor impacts on 486 acres of wildlife conservation areas, including one wildlife refuge and three state forests (Table 6.3.4-20). RA-07 also would cross the Chippewa Plains IBA, resulting in approximately 1,016 acres of disturbance during construction (Table 6.3.4-21); however, RA-07 is within or adjacent to existing pipelines and corridors with high levels of disturbance and therefore its impact on IBAs would be less than routes traversing undisturbed areas. These impacts would be short term and minor.

Red-necked grebes occupy the Grass Lake rookery, which is nearly 2,000 feet from the proposed route of RA-07. At this distance, construction activities would not be expected to disturb nesting red-necked grebes and any impacts would be temporary and negligible, regardless of the construction season.

Impacts from Habitat Fragmentation. RA-07 is co-located with existing pipelines, transmission lines, and roads across all of its length. No large-block habitats would be fragmented by RA-07; however, widening corridors in this area could contribute to habitat loss and conversion, decreased habitat quality, and increased risk of the introduction of invasive species. Potential impacts on wildlife habitat and wildlife from fragmentation are expected to be temporary to short term and negligible.

Operations Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. General impacts from operation of a pipeline along the RA-07 route would be similar to those described for the Applicant's preferred route. Operation of RA-07 would affect 81 stream crossings, including 6 trout streams within the permanent right-of-way. Impacts could result from maintenance activities, including vegetation management at stream edges that would occur for the life of the Project. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way, which could lead to permanent major thermal effects on trout streams and permanent minor effects at other water crossings. Additional impacts could occur from the use of herbicides and accidental fuel and lubricant leaks and spills from maintenance and inspection vehicles. With implementation of the proposed BMPs, these impacts would be temporary and negligible to minor. RA-07 would disturb 2 acres within AMAs. Operation of RA-07 also would disturb 2.1 acres of Minnesota Lakes of Biological Significance. Permanent and minor impacts would be expected for these resources.

Impacts from Integrity Management Digs. Impacts from integrity management digs along the RA-07 route would be similar to those described for the Applicant's preferred route. During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. The Applicant would implement measures to minimize runoff to surface water during and after these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing, as described above. Potential impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be short term to long term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During repair or replacement of pipe as part of the Integrity Management Program, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts. General impacts from operation of a pipeline along the RA-07 route would be similar to those described for the Applicant's preferred route. Operation of RA-07 would affect 937 acres of wildlife habitat, primarily consisting of deciduous forest and woody wetlands. During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody vegetation from re-growing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be long term to permanent in the area of the construction work area that is outside of the

permanent right-of-way because of the long period of time required for forest to regenerate. Within the permanent right-of-way, the impact would be permanent and minor to major.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on common wildlife for each occurrence; but the mowing would be repeated periodically over the life of the Project. The permanent right-of-way also could create a travel corridor for some species. Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. The use of chemical controls can adversely affect wildlife species, particularly amphibians because of their sensitivity to chemical exposure. However, implementation of BMPs for use of herbicides that include measures such as only using herbicides when necessary and using aquatic formulations within 50 feet of water, and prevention of the spread of noxious species would minimize the potential for impacts; and the impact on wildlife and wildlife habitats is expected to be short term and minor.

Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from operation of RA-07 would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Operation of RA-07 would permanently disturb 86 acres of wildlife conservation areas (Table 6.3.4-20). RA-07 also would cross the Chippewa Plains IBA, resulting in approximately 248 acres of permanent disturbance during operation (Table 6.3.4-21). Impacts on these resources would be long term to permanent and minor.

Impacts from Habitat Fragmentation. RA-07 is co-located with existing pipelines, transmission lines, and roads across all of its length. No large-block habitats would be fragmented by RA-07; however, widening corridors in this area could contribute to habitat loss and conversion, decreased habitat quality, and increased risk of the introduction of invasive species. Impacts on wildlife habitat and wildlife from fragmentation are expected to be temporary to short term and negligible.

Impacts from Integrity Management Digs. Integrity management digs would disturb wildlife and wildlife habitat as described above for construction impacts; however, the area affected would be substantially smaller and would occur entirely within the established right-of-way. Consequently, impacts on wildlife and wildlife habitat from integrity digs would be short term and negligible to minor but would occur periodically over the life of the Project.

Route Alternative RA-08

Construction Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. Construction of RA-08 would require crossing 106 streams, including 7 trout streams (Tables 6.3.4-13 and 6.4.3-15). These crossings would be constructed using the methods described in Section 6.3.4.3.1 for construction of surface water crossings of the Applicant's preferred route, including incorporation of the BMPs described in that section. The impacts of surface water crossings for RA-08 would be the same as those described for the Applicant's preferred route. Most crossing impacts would be temporary to short term and negligible to minor; although the use of wet open-cut crossings could result in a short- to long-term, minor impact at each crossing. Where streambanks are cleared of forested or other woody vegetation, the potential impacts on fisheries and

aquatic habitats would be permanent and minor to major, depending on existing surface water conditions. Crossing methods have not been established for RA-08.

Potential Impacts on Management Units and Managed Species. RA-08 would cumulatively result in 4.7 acres of disturbance to two AMAs (Bruce Creek and Little Otter Creek) and would pass within 0.5 mile of three other AMAs (Table 6.3.4-14). AMAs represent good-quality habitats with functional adjacent upland wildlife habitat areas. Impacts on AMAs from construction would depend on the type of waterbody crossing method used. RA-08 also would pass within 0.5 mile of one lake with a Fish IBI rating (Table 6.3.4-16). Construction of RA-08 would disturb 6 acres of one Minnesota Lake of Biological Significance with a rating of outstanding (Table 6.3.4-17) as well as pass within 0.5 mile of two lakes managed for muskellunge (Table 6.3.4-18). As for the Applicant's preferred route, the Applicant would incorporate BMPs into construction to avoid or minimize impacts; as a result, the impacts of construction of RA-08 from loss of habitat and reduction of habitat quality would be short term and negligible to minor. The Applicant would implement BMPs to prevent the spread of invasive species, with the resultant impact expected to be at most short term and negligible to minor. Minnesota PCA's Watershed Health Assessment parameters for species richness, stream species quality, and habitat quality and connectivity were compared for the Applicant's preferred route and RA-03AM, RA-06, RA-07, and RA-08 between Clearbrook and Carlton using the data in Figures 6.3.4-5, 6.3.4-6, and 6.3.4-7. No clear consistent trends distinguished between the potential routes.

Wildlife and Wildlife Habitat

General Potential Impacts. The types of impacts on wildlife and wildlife habitats that would occur for construction of RA-08 and the measures to be implemented to avoid or reduce impacts associated with pipeline construction would be the same as those described in Section 6.3.4.3.1 for the Applicant's preferred route. Construction of RA-08 would disturb 2,286 acres of wildlife habitat, primarily consisting of forest and wetlands (Table 6.3.4-19). Impacts on these areas would be similar to those described above, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Forests provide complex and valuable habitat for many species of wildlife and would require decades to recover to maturity. Potential impacts on wildlife and wildlife habitat from construction of RA-08 would be long term to permanent and minor to major.

Potential Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from construction of RA-08 would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Construction of RA-08 would have short-term minor impacts on 237 acres of wildlife conservation areas, including one wildlife refuge, two WMAs, and four state forests (Table 6.3.4-20). RA-08 also would cross the Chippewa Plains IBA, resulting in approximately 594 acres of long-term to permanent and minor to major disturbance during construction (Table 6.3.4-21). Because RA-08 is within or adjacent to existing pipelines and corridors with high levels of disturbance, impacts on IBAs would be somewhat less than for routes traversing undisturbed areas.

A great blue heron colony falls within the construction and operation area of RA-08. Construction of RA-08 would result in disturbance to the Portage Creek great blue heron rookery (Table 6.3.4-22). Research has shown that construction activities within 300 meters (984 feet) of nesting great blue herons can cause nest abandonment and reproductive failure (VFWD 2002; MNFI 2016). RA-08 could result in removal of great blue heron rookery trees within construction work areas, which would cause permanent major impacts on Portage Creek heron nesting habitat and short-term and minor impacts on

individual birds, as they would be forced to find new nest sites. Permits would be needed from USFWS and Minnesota DNR if tree removal would occur during the nesting season.

Impacts from Habitat Fragmentation. RA-08 is co-located with existing pipelines, transmission lines, and roads across all of its length. No large-block habitats would be fragmented by RA-08; however, widening corridors in this area could contribute to habitat loss and conversion, decreased habitat quality, and increased risk of invasive species introduction. Potential impacts on wildlife habitat and wildlife from fragmentation are expected to be temporary to short term and negligible.

Operations Impacts

Fisheries and Aquatic Habitat

General Potential Impacts. General impacts from operation of a pipeline along the RA-08 route would be similar to those described for the Applicant's preferred route above. Operation of RA-08 would affect 106 stream crossings, including 4 trout streams within the permanent right-of-way. Operation of RA-08 would disturb 2 acres of AMAs and 2.5 acres of Minnesota Lakes of Biological Significance. Impacts could result from maintenance activities, including vegetation management at stream edges that would occur for the life of the Project. Trees and shrubs would not be allowed to reestablish within the permanent right-of-way, which could lead to permanent major thermal effects on trout streams and permanent but minor impacts at other water crossings. Additional impacts could occur from the use of herbicides and accidental fuel and lubricant leaks and spills from maintenance and inspection vehicles. With implementation of the proposed BMPs, these impacts would be short term and negligible to minor.

Impacts from Integrity Management Digs. Impacts from integrity management digs along the RA-08 route would be similar to those described for the Applicant's preferred route above. During operation, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline. The Applicant would implement measures to minimize runoff to surface water during and after these activities, similar to the measures incorporated into the Project during construction. If pipe segments need to be repaired or replaced along surface water crossings, the wet open-cut or dry open-cut method would be used to access the pipe. These methods would be the same as those used for construction of the crossing, as described above. Potential impacts on fisheries and aquatic habitat would be similar to those experienced during construction; for each integrity dig, the impacts would be short term to long term and minor, depending on the location, habitats affected, and whether repair or replacement are needed. These impacts would occur periodically over the life of the Project.

During repair or replacement of pipe as part of the Integrity Management Program, it may be necessary to withdraw and discharge water to hydrostatically test sections of pipe and for dust control during the integrity digs and backfilling activities. With adherence to permits and implementation of BMPs to avoid the intake or entrainment of fish, the impacts associated with minor alterations in stream flows from water appropriation and discharge for each integrity dig would be temporary and negligible.

Wildlife and Wildlife Habitat

General Potential Impacts. The types of impacts on wildlife and wildlife habitats from construction of RA-08 and the measures to be implemented to avoid or reduce construction-related impacts would be the same as those described in Section 6.3.4.3.1 for the Applicant's preferred route. Operation of RA-08 would affect 954 acres of wildlife habitat, primarily consisting of deciduous forest and wetlands. During operation of the pipeline, the permanent right-of-way would be maintained to prevent woody

vegetation from re-growing. Losses of tree and shrub habitats used by birds for cover, forage, and nesting would be long term to permanent in the area of the construction work area that is outside of the permanent right-of-way because of the long period of time required for forest to regenerate. Within the permanent right-of-way, the impact would be permanent and minor to major.

Mowing and vegetation removal can result in injury or direct mortality of smaller species such as turtles, small mammals, and bird eggs and young. This recurring impact would be localized to the permanent right-of-way and the areas around aboveground facilities, resulting in short-term minor impacts on common wildlife for each occurrence; but the mowing would be repeated periodically over the life of the Project. The permanent right-of-way also could create a travel corridor for some species. Habitat in the permanent right-of-way could be degraded if native vegetation is replaced by noxious and invasive species. The use of chemical controls can adversely affect wildlife species, particularly birds, from accidental ingestion. However, implementation of BMPs for use of herbicides and prevention of the spread of noxious species would minimize the potential for impacts. Therefore, the potential impact on wildlife and wildlife habitats is expected to be short term and minor.

Impacts on Management Units and Managed Species. Potential impacts on WMAs, state forests, and other conservation lands from operation of RA-08 would be similar to those described for the Applicant's preferred route, including the potential for introduction of invasive species, loss of habitat, and reduction of habitat quality. Operation of RA-08 would permanently disturb 237 acres of wildlife conservation areas (Table 6.3.4-20). RA-08 also would cross the Chippewa Plains IBA, resulting in approximately 248 acres of permanent disturbance during operation (Table 6.3.4-21). Operation of RA-08 would result in permanent removal of the Portage Creek great blue heron rookery (Table 6.3.4-22) resulting in permanent major impacts on the colony but short-term and minor impacts on the individuals.

Impacts from Habitat Fragmentation. RA-08 is co-located with existing pipelines, transmission lines, and roads across all of its length. No large-block habitats would be fragmented by RA-08; however, widening corridors in this area could contribute to habitat loss and conversion, decreased habitat quality, and increased risk of the introduction of invasive species. The impacts on wildlife habitat and wildlife due to fragmentation are expected to be temporary to short term and negligible.

Impacts from Integrity Management Digs. Integrity management digs would disturb wildlife and wildlife habitat as described above for construction impacts; however, the area affected would be substantially smaller and would occur entirely within the established right-of-way. As a result, impacts on wildlife and wildlife habitat would be short term and negligible to minor but would occur periodically over the life of the Project.

6.3.4.4 Summary and Mitigation

6.3.4.4.1 Summary

Construction and operation of the Applicant's preferred route or any of route alternatives could result in impacts on aquatic habitat, fish, wildlife habitat, and wildlife, ranging from no impact to permanent major impacts. Impacts would likely occur in forested areas and wetlands where habitat fragmentation would be most noticeable as well as in areas where large trees are permanently removed along stream banks. Impacts would also occur where colonial waterbird nesting trees are removed. Table 6.3.4-24 presents a summary of construction- and operations-related impacts on aquatic habitat, fish, wildlife habitat, and wildlife for the Applicant's preferred route and route alternatives.

Avoidance and impact minimization measures that would influence the duration and magnitude of impacts include Applicant-proposed measures, measures proposed by Minnesota DNR, and measures that would be included in state and federal permits. All stream crossings and measureable disturbance to wildlife (e.g., beaver dams, colonial nesting waterbirds, raptor nests) or aquatic species (e.g., fish, mussels) would be reviewed and approved by the authorizing agency prior to construction and may include requirements for further surveys or additional mitigation. The avoidance and mitigation measures and the standard BMPs described for the Applicant's preferred route would be applicable to the route alternatives.

Fisheries and Aquatic Habitat

Construction Impacts

The largest potential impacts on aquatic habitat due to construction would result from clearing vegetation along stream banks, in-water disturbance from construction of the Applicant's preferred route or route alternative pipelines across surface water where the wet or dry open-cut crossing methods are used, and if a frac-out occurred during the HDD method in sensitive or impaired waters.

The Applicant's preferred route would cross 192 surface waters along its total length and 111 waterbodies between Clearbrook and Carlton. For two route alternatives, the number of surface water crossings between Clearbrook and Carlton is greater (167 crossings for RA-03AM and 137 crossings for RA-06); and for two route alternatives, the number is less (81 crossings for RA-07 and 106 crossings for RA-08). All of the potential routes would cross AMAs and sensitive aquatic resources within the ROIs of the pipeline routes between Clearbrook and Carlton, including Fish IBI Lakes, Lakes of Biological Significance (including many ranked as outstanding), one Sentinel Lake (along RA-03M), seven trout streams, one trout lake, and lakes managed for muskellunge. No hatcheries are within the ROIs of the potential routes. Although there are hatcheries farther downstream, construction is not expected to affect those hatcheries.

The Applicant's preferred route and the route alternatives pass through forested areas and would involve the removal of woody vegetation that provides shade and stability along some streams. This could result in long-term major impacts on trout streams due to the potential for thermal changes. However, impacts on aquatic habitat, including trout streams and other sensitive aquatic resources, could be temporary to long-term and minor if the crossing method with least disturbance is used and BMPs are in place to reduce impacts. Proper restoration of stream banks after construction of stream crossings would prevent additional sedimentation as well as changes to the width, depth, and temperature of all streams, including trout streams.

The waters within the ROIs of the Applicant's preferred route and route alternatives provide habitat for similar species of fish, including important managed recreational species such as muskellunge and trout. Fish in the vicinity of surface water crossings along all routes likely would respond to the increased instream activities by leaving the construction area and avoiding direct impacts; however, injuries or mortality could occur resulting in temporary and minor impacts for common species in the area. Aquatic habitat connectivity and species richness of macroinvertebrates, mussels, and fish do not differ among pipeline routes.

With adherence to water appropriation and NPDES permit conditions and implementation of Applicant-proposed measures, impacts on fisheries and aquatic habitats from water appropriation and discharge during pipeline construction would be temporary and minor for the Applicant's preferred route and route alternatives.

Operations Impacts

Vegetation maintenance during operations would require the removal of riparian vegetation from the permanent right-of-way of each of the pipeline alternatives, including areas adjacent to waterbody crossings. The resultant impacts on aquatic habitat would be similar for the Applicant's preferred route and route alternatives with RA-03AM and RA-06 requiring the greatest number of stream crossings. The impacts for the new pipeline would be long term and minor to major at heavily wooded crossing locations, and short term to long term and minor to major at crossings within grasslands or croplands. That Applicant's preferred route and all route alternatives would cross trout streams where the impact during operation would be permanent and major due to possible increases in temperature.

If minor leaks or spills occurred during normal operations for the Applicant's preferred route and route alternatives there would be negligible to minor changes to surface water quality and the resultant impacts on fisheries and aquatic habitats would be temporary and negligible to minor.

For all alternatives, the Applicant would implement its noxious weed plans that include methods to prevent and reduce the introduction and spread of noxious weeds and invasive species, and would implement BMPs for herbicide applications to minimize impacts on aquatic and terrestrial resources. As a result, the use of herbicides would result in temporary negligible impacts on fisheries and aquatic habitats.

During operation of the pipeline route options, the Applicant would implement its Integrity Management Program, which could require excavation and repair or replacement of sections of the pipeline at surface water crossings using the wet or dry open-cut method to access the pipe. For each integrity dig, impacts would be short term and minor, and would occur periodically over the life of the Project. Impacts from integrity digs would be similar for all routes.

Wildlife and Wildlife Habitat

Construction Impacts

Impacts on wildlife habitat would vary slightly among the Applicant's preferred route and route alternatives. The acreage of wildlife habitat affected by construction of the pipeline route options ranges from 2,286 acres (RA-08) to 3,578 acres (RA-03AM). All of the routes would cross WMAs. The Applicant's preferred route, RA-06 and RA-07 would permanently convert the greatest number of acres to maintained pipeline right-of-way. Audubon IBAs would be crossed by all routes. Route alternatives RA-06, RA-07, and RA-08 would result in greater permanent habitat removal than RA-03AM or the Applicant's preferred route.

Overall, wildlife habitat quality is similar for all routes based on vegetation cover class. Some routes would have greater impacts on high-value habitat such as wetlands (i.e., RA-07) or deciduous forest (i.e., Applicant's preferred route) than others. RA-03AM would mostly affect hay and pasture land. RA-07 and RA-08 would be co-located with existing pipelines for their entire lengths; RA-03AM would be co-located with existing pipelines, electrical transmission lines, and roads (Section 6.7). RA-06 would not be co-located with other pipelines, utilities, or roads across much of its length. Alternatives co-located

would occupy areas that are already somewhat degraded, resulting in less impact on wildlife and habitat than routes or portions of routes that are not within or adjacent to utility corridors. Habitat fragmentation would be greatest for the Applicant's preferred route (36.7 miles and 27,101 acres) and RA-06 (114.3 miles 83,996 acres). Route alternatives RA-03AM, RA-07, and RA-08 would be co-located with existing pipelines, transmission lines, and roads across most of their lengths such that these route alternatives would not contribute to wildlife habitat fragmentation.

For the Applicant's preferred route and all route alternatives, clearing, grading, trenching, and the use of construction vehicles and equipment would result in direct impacts on some animals, particularly small and mid-sized mammals, reptiles, amphibians and invertebrates. Members of these species would be affected more than large wildlife because of their relative lack of mobility compared to that of larger animals (e.g., deer and coyotes). The impact of these activities on wildlife would be temporary to short term and minor for all route options. Both RA-06 and RA-08 could result in permanent removal of heron nesting trees.

Many animals would be temporarily displaced from the active construction areas and adjacent areas. Nearby habitat could provide cover and suitable escape habitat for many of the displaced species, and the more mobile animals could return to the area after completion of construction and restoration activities, if appropriate habitats are available. As a result, the impact of these displacements during construction would be temporary to short term and minor.

Operations Impacts

The types of impacts associated with operations would be similar for the Applicant's preferred route and the route alternatives and would occur for the life of the Project. The general impacts of right-of-way maintenance would be temporary to short term and minor for each occurrence for all potential pipeline routes. Impacts of right-of-way maintenance within general wildlife habitat, conservation lands, and IBAs would be short term to permanent and minor to major, depending on the type of habitat present. Maintenance activities could reduce populations of species sensitive to habitat disturbance and could result in permanent minor effects on breeding birds. Maintenance of the right-of-way would also include mowing of vegetation, which could disturb wildlife or result in mortality of common small species. These impacts would be short term and minor.

The maintained permanent rights-of-way may be used as travel corridors by some big game animals and humans and may become attractive to some small species. This could result in permanent and minor effects on common wildlife. Implementation of BMPs to prevent the spread of noxious species would minimize impacts from herbicide applications and from colonization of the rights-of-way with invasive plants.

During operation, the Applicant's Integrity Management Program would periodically require excavation and repair or replacement of sections of the pipeline. The impacts would be similar to those occurring during construction of the pipeline; but they would occur over a substantially smaller area. For all routes, these impacts would be short term and negligible to minor for each occurrence but would occur periodically over the life of the Project.

6.3.4.4.2 Mitigation

In addition to the measures the Applicant would incorporate into the Project to avoid or minimize impacts, including stipulations in the permits required for the Project, Minnesota DNR has identified the following measures to reduce impacts on fisheries and wildlife:

- Use the HDD crossing method at all crossings of tributaries that are upstream of trout streams.
- Cover open-vent pipe ends with screens at cathodic protection systems to prevent birds and small mammals from becoming trapped in the pipe.
- During maintenance mowing of the permanent right-of-way, set the mower blade height at 6 to 8 inches above the ground to reduce injury and mortality impacts on small animals, and to prevent erosion.
- If construction activities occur within the recommended buffer distance of 984 feet from the Mahtowa or other heron rookeries during the nesting season (from April through August), the Applicant must consult with USFWS and Minnesota DNR and obtain any permits that may be required.
- Use wider vegetated buffers during construction near trout streams (100 feet vs the standard 50 feet).
- Reduce the construction work area width.

Table 6.3.4-24. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[C]	Route Alternative RA-08[b]
Construction Impacts					
Aquatic habitat loss or reduction of aquatic habitat quality from construction activities, including hydrostatic testing	Generally temporary to long-term/negligible to minor impacts Long-term to permanent/minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 111 stream crossings	Generally temporary to long-term/negligible to minor impacts Long-term to permanent /minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 167 stream crossings	Generally temporary to long-term/negligible to minor impacts Long-term to permanent /minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 137 stream crossings	Generally temporary to long-term/negligible to minor impacts Long-term to permanent /minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 81 stream crossings	Generally temporary to long-term/negligible to minor impacts Long-term to permanent /minor to major impacts *(where streambanks are cleared of forested or woody vegetation)* • 106 stream crossings
Trout stream habitat loss or reduction of aquatic habitat quality from surface water crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 6 trout stream crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 8 trout stream crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 7 trout stream and 1 trout lake crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 8 trout stream crossings	Short-term/minor impacts Permanent/major potential thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 7 trout stream crossings
Loss of habitat and reduction of habitat quality in Aquatic Management Areas (AMAs)	Short-term/negligible to minor impacts • 0.4 acre of AMA disturbance	Short-term/negligible to minor impacts • 0.5 acre of AMA disturbance	Short-term/negligible to minor impacts • 5.0 acres of AMA disturbance	Short-term/negligible to minor impacts • 8.2 acres of AMA disturbance	Short-term/negligible to minor impacts • 4.7 acres of AMA disturbance

Table 6.3.4-24. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[C]	Route Alternative RA-08[b]
Loss of habitat and reduction of habitat quality in Minnesota Lakes of Biological Significance (LBS) and other sensitive aquatic resources such as fish IBI Lakes, mussel beds, and muskie lakes	No impact on LBS, but 1 sentinel lake may have short-tern/negligible to minor impacts	No impact	Short-term/negligible to minor impacts • 3.4 acres of LBS disturbance	Short-term/negligible to minor impacts • 10.9 acres of LBS disturbance	Short-term/negligible to minor impacts • 6 acres of LBS disturbance
Potential for injury, mortality, or disturbance of aquatic species affecting fisheries	Temporary/minor to major impacts	Temporary/minor to major impacts	Temporary/minor to major impacts	Temporary/minor to major impacts	Temporary/minor to major impacts
Loss of habitat or reduction of wildlife habitat quality from construction activities and vegetation clearing[d]	Temporary to permanent/minor to major impacts from clearing of the right-of-way; pipeline would be co-located with existing corridors • 2,806 acres of habitat, primarily deciduous forest and crop land	Temporary to permanent/minor impacts; pipeline would be co-located with existing corridors the entire length • 3,578 acres of habitat, primarily deciduous forest, hay, and pasture land	Long-term to permanent/minor to major impacts from clearing of the right-of-way • 2,674 acres of habitat, primarily forest and woody wetlands	Long-term/minor to major impacts; pipeline would be co-located with existing corridors the entire length • 3,832 acres of habitat, primarily wetlands and forest	Long-term to permanent to /minor to major impacts; pipeline would be co-located with existing corridors the entire length • 2,286 acres of habitat, primarily wetlands and forest
Loss of habitat or reduction of wildlife habitat quality in wildlife conservation areas from vegetation clearing	Short-term to permanent/minor to major impacts from clearing of the right-of-way • 381 acres of wildlife conservation areas	Short-term/minor impacts; pipeline would be co-located with existing corridors • 44 acres of wildlife conservation areas	Short-term/minor impacts from clearing of the right-of-way • 325 acres of wildlife conservation areas	Short-term/minor impacts; pipeline would be co-located with existing corridors • 486 acres of wildlife conservation areas	Short-term/minor; pipeline would be co-located with existing corridors • 237 acres of wildlife conservation areas

Table 6.3.4-24. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[C]	Route Alternative RA-08[b]
Loss of habitat or reduction of wildlife habitat quality in Audubon Important Bird Areas (IBAs) from vegetation clearing	Short- to long-term/minor impacts from clearing of the right-of-way • 48 acres of IBAs	Short-term/minor impacts because pipeline would be co-located with existing corridors • 70 acres of IBAs	Permanent/minor to major impacts from clearing of the right-of-way • 512 acres of IBAs	Short-term/minor impacts because pipeline would be co-located with existing corridors • 1,016 acres of IBAs	Short-term/minor impacts because pipeline would be co-located with existing corridors • 594 acres of IBAs
Disturbance or loss of colonial waterbird nesting sites	Temporary/minor to major impacts on the Mahtowa rookery depending on season	No impact	Permanent/major impacts from removal of colonial waterbird nesting tree(s) at the Larson Lake and Sherry Lake great blue heron rookeries	Temporary/negligible impacts on Grass Lake red-necked grebe rookery	Permanent/major impacts from removal of colonial waterbird nesting tree(s) at the Portage Creek great blue heron rookery
Loss of habitat or reduction of wildlife habitat quality from habitat fragmentation	Permanent/minor to major impacts on primarily forested and woody wetlands • 37.6 miles of habitat fragmented • 21 large-block habitats (>100 acres) crossed • 27,101 acres total habitat fragmented	No impact because pipeline would be co-located with existing corridors	Permanent/major impacts on primarily forested and woody wetlands • 114.3 miles of habitat fragmented • 60 large-block habitats (>100 acres) crossed • 83,996 acres total habitat fragmented	No impact because pipeline would be co-located with existing corridors	No impact because pipeline would be co-located with existing corridors
Potential for injury, mortality, or disturbance of wildlife species	Temporary/minor to major impacts	Temporary/minor to major impacts	Temporary/minor to major impacts	Temporary/minor to major impacts	Temporary/minor to major impacts

Table 6.3.4-24. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[C]	Route Alternative RA-08[b]
Operations Impacts					
Aquatic habitat loss or reduction of aquatic habitat quality from maintenance activities, integrity digs, or small leaks and spills	Short-term to long-term/ minor to major impacts Permanent/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 111 stream crossings	Short-term to long-term/ minor to major impacts Permanent/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 167 stream crossings	Short-term to long-term/ minor to major impacts Permanent/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 137 stream crossings	Short-term to long-term/ minor to major impacts Permanent/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 81 stream crossings	Short-term to long-term/ minor to major impacts Permanent/major thermal effects (*where streambanks are cleared of forested or woody vegetation*) • 106 stream crossings
Trout stream habitat loss or reduction of aquatic habitat quality from right-of-way maintenance at surface water crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 6 trout stream crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 8 trout stream crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 6 trout stream and 1 lake crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 6 trout stream crossings	Short-term/minor impacts Permanent/major thermal effects *(where streambanks are cleared of forested or woody vegetation)* • 4 trout stream crossings
Loss of habitat and reduction of habitat quality in Aquatic Management Areas (AMAs)	Short-term/negligible to minor impacts *This would be the second pipeline to cross LaSalle Creek AMA* • 0.2 acre of AMA disturbance	Short-term/negligible to minor impacts *This would be the second pipeline to cross LaSalle Creek AMA* • 0.2 acre of AMA disturbance	Short-term/negligible to minor impacts • 2.1 acres of AMA disturbance	Short-term/negligible to minor impacts • 2 acres of AMA disturbance	Short-term/negligible to minor impacts • 2 acres of AMA disturbance
Loss of habitat and reduction of habitat quality in Minnesota LBS; no other sensitive aquatic resources were affected	No impact	No impact	Short-term/negligible to minor impacts • 1.4 acres of LBS disturbance	Short-term/negligible to minor impacts • 2.1 acres of LBS disturbance	Short-term/negligible to minor impacts • 2.5 acres of LBS disturbance

Table 6.3.4-24. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[C]	Route Alternative RA-08[b]
Potential for injury, mortality, or disturbance of aquatic species impacting fisheries from leaks, spills, or herbicide applications	Temporary to long-term/ minor impacts	Temporary to long-term/ minor impacts	Temporary to long-term/ minor impacts	Temporary to long-term/ minor impacts	Temporary to long-term/ minor impacts
Loss of habitat or reduction of wildlife habitat quality from maintenance activities and vegetation clearing	Permanent/minor to major impacts from maintenance of the right-of-way • 1,288 acres of habitat, primarily forest	Permanent/minor to major impacts from maintenance of the right-of-way • 1,494 acres of habitat, primarily deciduous forest, hay, and pasture land	Permanent/minor to major impacts from maintenance of the right-of-way • 1,115 acres of habitat, primarily forest and woody wetland	Permanent/minor to major impacts from maintenance of the right-of-way • 937 acres of habitat, primarily wetlands and deciduous forest	Permanent/minor to major impacts from maintenance of the right-of-way • 954 acres of habitat, primarily wetlands and deciduous forest
Loss of habitat or reduction of wildlife habitat quality in wildlife conservation areas from maintenance and vegetation clearing	Permanent/minor to major impacts from maintenance of the right-of-way • 159 acres of wildlife conservation areas	Permanent/minor to major impacts from maintenance of the right-of-way • 19 acres of wildlife conservation areas	Permanent/minor to major impacts from maintenance of the right-of-way • 135 acres of wildlife conservation areas	Permanent/minor to major impacts from maintenance of the right-of-way • 86 acres of wildlife conservation areas	Permanent/minor to major impacts from maintenance of the right-of-way • 99 acres of wildlife conservation areas
Loss of habitat or reduction of wildlife habitat quality in Audubon IBAs from maintenance and vegetation clearing	Permanent/minor to major impacts from maintenance of the right-of-way • 25 acres of IBA	Permanent/minor to major impacts from maintenance of the right-of-way • 29 acres of IBA	Permanent/minor to major impacts from maintenance of the right-of-way • 213 acres of IBA	Permanent/minor to major impacts from maintenance of the right-of-way • 248 acres of IBA	Permanent/minor to major impacts from maintenance of the right-of-way • 248 acres of IBA

Table 6.3.4-24. Summary of Potential Impacts on Fish and Wildlife for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[C]	Route Alternative RA-08[b]
Loss of habitat or reduction of wildlife habitat quality from habitat fragmentation	Permanent/major impacts on primarily forested and woody wetlands • 21 large-block habitats (>100 acres) • 27,101 acres total habitat fragmented	Temporary to short-term/negligible impacts from widening existing corridor	Permanent/major impacts on primarily forested and woody wetlands • 60 large-block habitats (>100 acres) crossed • 83,996 acres total habitat fragmented	Temporary to short-term/negligible impacts from widening existing corridor	Temporary to short-term/negligible impacts from widening existing corridor
Potential for injury, mortality, or disturbance of wildlife species	Short-term minor to major impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities; maintenance may also disturb the Mahtowa heron colony.	Short-term minor to major impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities	Short-term minor to major impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities	Short-term minor to major impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities	Short-term minor to major impacts from habitat loss or fragmentation and mortality of common species during mowing and other maintenance activities

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way.

[b] Con = estimated 120-foot-wide construction work area centered on route, Op = estimated 50-foot-wide permanent right-of-way.

[c] Con = estimated 205-foot-wide construction work area (with 10 feet wide on the north side of the existing Line 3 and 95 feet wide on the south side of the existing Line 3); Op = estimated 50-foot-wide permanent right-of-way.

[d] Permanent loss in forested areas that are newly developed. The impacs would be less along co-located lines (e.g., RA-07).

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6.3.5 Unique Natural Resources

This section describes protected, rare, and sensitive plants and animals (termed "unique natural resources") that could be affected by construction and operation associated with the Minnesota portion of the Applicant's preferred route and route alternatives. The effects could result from loss or disturbance of a resource or from habitat loss and degradation. The analysis of impacts on unique natural resources from construction and operation of the Applicant's preferred route and route alternatives considered the potential for injury, mortality, or disturbance of the following:

- Federally listed endangered and threatened species;
- State-listed threatened, endangered, and special concern species;
- Minnesota SGCN;
- MBS Sites; and
- Minnesota Scientific and Natural Areas (SNAs).

This section first describes the existing conditions for unique natural resources that may be affected by construction and operation of the Applicant's preferred route and the route alternatives. The potential Project-related impacts on these resources from construction and operation of the Applicant's preferred route are then described, along with measures the Applicant would implement to minimize impacts. Next, the potential Project-related impacts on unique natural resources from construction and operation are addressed for each route alternative (RA-03AM, RA-06, RA-07, and RA-08) and compared to each other and to the Applicant's preferred route between Clearbrook and Carlton. The comparison focuses on the area between Clearbrook and Carlton because the Applicant's preferred route and the route alternatives all have identical routes from Neche, North Dakota, to Clearbrook and from Carlton to Superior, Wisconsin. A summary and comparison of the impacts are included at the end of the section, along with potential mitigation measures to be considered. Potential impacts on unique natural resources from an unanticipated crude oil release are addressed in Chapter 10.

6.3.5.1 Regulatory Context and Methodology

6.3.5.1.1 Regulatory Context

The regulatory context for evaluating impacts on unique natural resources is described in Section 5.2.5.1, including the federal ESA and Minnesota's Endangered Species Statute (Minn. R. Ch. 6134) and associated rules. This section provides information for regulatory agencies to assess potential impacts on unique natural resources. The Applicant would be required to comply with appropriate species-specific conservation measures identified by state and federal natural resource agencies.

6.3.5.1.2 Methodology

The methodology for evaluating impacts on unique natural resources is described in Section 5.2.5.1. For federally listed species, the ROI for this evaluation encompassed the area within a distance of 1 mile from the centerlines of the pipeline routes. For the state-listed species and related concerns, the ROI for the evaluation encompassed the area within a distance of 0.5 mile from the centerlines of the pipeline routes. This is the area that could be directly or indirectly affected by pipeline construction. The area within 0.5 mile of the route centerlines was used as the ROI for non-federal data instead of 1 mile because the available non-federal data have more specific locations associated with known occurrences.

Impacts were evaluated by considering the area directly and indirectly affected by the Applicant's preferred route and the route alternatives between Clearbrook and Carlton, Minnesota.

Direct impacts for the Applicant's preferred route were evaluated based on construction footprints provided by the Applicant. The areas identified consist of the construction work area, ATWS, access roads, pipe yards, pipeline permanent right-of-way, valve pads and driveways, and pump stations within Minnesota. Comparisons of construction impacts for route alternatives were based on the Applicant-provided construction work area for the Applicant's preferred route; a 120-foot-wide construction work area for RA-03AM, RA-06, and RA-08; and a 205-foot-wide construction work area for RA-07. Comparisons of operations impacts were based on the Applicant's footprint for the pipeline permanent right-of-way (a 50-foot-wide area centered on the pipeline route) and a 50-foot-wide permanent pipeline rights-of-way centered on the routes of RA-03AM, RA-06, RA-07, and RA-08. Animals were considered affected when they occurred within 0.5 mile of the route centerlines; plants were considered affected when they occurred within construction work areas and permanent rights-of-way.

The regulatory drivers for unique natural resources and the geospatial data sources evaluated were as follows:

- Federally listed animals and plants were evaluated using the USFWS Information for Planning and Conservation (IPaC) online system for the area within a 2-mile-wide ROI (i.e., 1 mile from the centerline of each pipeline). While impacts were assessed for this entire area, direct impacts primarily would occur within construction work areas and the pipeline permanent rights-of-way. These data were used to determine the presence of federally listed animals and plants for the evaluation.
- Minnesota-listed animals and plants were evaluated using NHIS data for endangered, threatened, and special concern species within the ROI (0.5 mile from route centerlines). These data were used to determine the presence of Minnesota-listed animals and plants.
- Minnesota SGCN were evaluated using Minnesota's Wildlife Action Network (WAN) within the ROI for 0.5 mile from the route centerlines. Impacts on WAN habitats were evaluated for areas of direct construction and operations impacts by overlaying the WAN map on maps of the construction areas described above. The impact areas were quantified, and the proportion of WAN areas affected by the route alternatives were compared based on the proportion of WAN habitat available within the ROI.
- MBS Sites were evaluated within the ROI for 0.5 mile from the route centerlines. Impacts on MBS Site habitats were evaluated for areas of direct construction and operations impacts by overlaying the MBS Sites map on maps of the construction areas described above. The impact areas were quantified, and the proportion of MBS Site areas affected by the route alternatives were compared based on the proportion of MBS Sites available within the ROI.
- Minnesota SNAs were identified within the ROI for 0.5 mile from the route centerlines. Impacts on SNA habitats were evaluated for areas of direct construction and operations impacts by overlaying the SNA map on maps of the construction areas described above.

6.3.5.2 Existing Conditions

The discussion of existing conditions includes information presented in Section 5.2.5.2 but focuses on conditions in Minnesota.

6.3.5.2.1 Applicant's Preferred Route

Federally Listed Species

The Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), northern long-eared bat (*Myotis septentrionalis*), Dakota skipper (*Hesperia dacotae*), Poweshiek skipperling (*Oarisma poweshiek*), rusty patched bumble bee (*Bombus affinis*), and western prairie fringe orchid (*Platanthera praeclara*) have the potential to occur within the ROI for the Applicant's preferred route (Table 6.3.5-1). While there are no documented IPaC occurrences of mussels within the ROI, Merjent (2014a) determined that 33 waterbody crossings in Minnesota have potentially suitable habitat for protected mussels and recommended field surveys. The Applicant completed mussel field surveys at 16 sites along the Applicant's preferred route in Minnesota, and no federally listed mussels were found (Merjent 2015a).

Table 6.3.5-1. Potential Occurrences of Federally Protected Species within the Region of Interest for the Applicant's Preferred Route

Species	Preferred Habitat	Status[a]	Potential Occurrence[b]	
			In Minnesota	Clearbrook to Carlton
ANIMALS				
Mammals				
Canada lynx *(Lynx canadensis)*	Boreal regions dominated by coniferous or mixed forests. Dens in mature or old-growth forests with high density of logs. Breeds late winter to early spring.	T	Yes	Yes
Gray wolf (*Canis lupus*) Great Lakes Distinct Population Segment	Suitable habitats in the ROI include hardwood forest, mixed forest, and grasslands. Digs dens in suitable soils or uses dens initiated by other animals. Breeds February to late June.	T	Yes	Yes
Gray wolf (*Canis lupus*)	Same as above.	E	Yes	No
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	T	Yes	Yes
Birds				
Whooping crane (*Grus americana*)	Summers in muskeg, prairie pools, and marshes. Eggs are laid in late April to mid-May, and hatch 1 month later. Winters in coastal marsh.	E	Yes	No

Table 6.3.5-1. Potential Occurrences of Federally Protected Species within the Region of Interest for the Applicant's Preferred Route

Species	Preferred Habitat	Status[a]	Potential Occurrence[b]	
			In Minnesota	Clearbrook to Carlton
Insects				
Dakota skipper (*Hesperia dacotae*)	Prefers native prairies (lowland and upland prairies) containing a high diversity of wildflowers and grasses. Eggs are laid in June and July and hatch after 10 days. Larvae are dormant in fall, and pupation usually occurs in June.	T	Yes	No
Poweshiek skipperling (*Oarisma poweshiek*)	Prefers native prairies (and in some cases, fens) containing a high diversity of wildflowers and grasses. Eggs are laid mid-June to mid-July, and hatch 9 days later.	E	Yes	No
Rusty patched bumble bee (*Bombus affinis*)	Grasslands and tallgrass prairies with areas that provide flowers, nesting sites such as abandoned rodent cavities or grass clumps, and overwintering sites in undisturbed soil for hibernating queens. Eggs are laid in spring.	E	Yes	Yes
PLANTS				
Vascular Plants				
Western prairie fringed orchid (*Platanthera praeclara*)	Occurs in mesic-wet tallgrass native prairie, herbaceous wetlands, and dune complexes. Emerges in May and flowers in early to mid-July.	T	Yes	No

Source: USFWS 2016.

Notes:

[a] E = Endangered, T = Threatened

[b] IPaC search = area within 1 mile of route centerline

ROI = region of interest

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened animals and plants that are within the ROI, including those that are also federally listed, are presented in Table 6.3.5-2. Presence or absence of state-listed species was determined based on Minnesota NHIS element occurrence records or site-specific survey results where applicable. As described in Section 5.2.5, the Applicant performed surveys along the Applicant's preferred route. Results of these surveys are included in the impact discussion. Merjent (2014a) determined that 33 waterbody crossings have potentially suitable habitat for protected mussels and recommended field surveys. The Applicant completed mussel field surveys at 16 sites along the Applicant's preferred route in Minnesota, and no state-listed mussels were found (Merjent 2015a).

Table 6.3.5-2. Known Occurrences of State-Protected Animals and Plants within the Region of Interest for the Applicant's Preferred Route

Species	Preferred Habitat	Status[a]	Occurrences[b]	
			In Minnesota	Clearbrook to Carlton
ANIMALS				
Fish				
Pugnose shiner (*Notropis anogenus*)	Found in glacial lakes and streams with an abundance of submerged vegetation. Prefers low-velocity waters with a substrate of sand, mud, or gravel. Shallow waters in warm months and deeper waters in cold months.	T	Yes	Yes
Mollusks				
Fluted-shell (*Lasmigona costata*)	Found in streams or river beds. Likely spawns from June to July.	T	Yes	No
PLANTS				
Nonvascular Plants				
A species of liverwort [Woolywort] (*Trichocolea tomentella*)	Damp, shaded rocks in forested rich peatland and wet forest.	T	Yes	Yes
Vascular Plants				
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes, and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	T	Yes	Yes
Bog bluegrass (*Poa paludigena*)	Perched upon wet substrates (e.g., moss, fallen trees) in spring-fed swamps. Specifically, occurs within *Fraxinus nigra-Betula lutea* swamps along the base of steep bluffs and at the head of the spring that feeds into the swamp. Blooms in late May to early June.	T	Yes	Yes
Bristle-berry (*Rubus fulleri*)	Swamp and marsh edges, wet and sedge meadows, and uplands mainly in central Minnesota. Flowers mid- to late June.	T	Yes	Yes
Butternut (*Juglans cinerea*)	Full sunlight on well-drained soils of bottomlands and floodplains. Flowers appear in mid-spring, and fruits develop throughout the summer.	E	Yes	Yes
Clinton's bulrush (*Trichophorum clintonii*)	Rocky river ledges, argillaceous soils, clearings of fir forests, and prairie and open woods. Reproductive structures are present from early May through the end of June in southern Minnesota, and late May through June in northern Minnesota.	T	Yes	No
Gray ragwort (*Packera cana*)	Northern plains, including the upper slopes of dry prairie remnant hills in sandy or gravelly soil. Flowers from May to June.	E	Yes	No

Table 6.3.5-2. Known Occurrences of State-Protected Animals and Plants within the Region of Interest for the Applicant's Preferred Route

Species	Preferred Habitat	Status[a]	Occurrences[b]	
			In Minnesota	Clearbrook to Carlton
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring and flowers mid-summer.	T	Yes	No
Handsome sedge (*Carex formosa*)	Typically occurs in or at the edge of limey swamps, seeps, or bottomland forests, but known to occur in moist, rich upland forests. Also can occur in disturbed habitats such as road edges and disturbed prairies. Blooms throughout June and fruits throughout July.	E	Yes	No
Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	In woods and on hummocks in swamps, and in cool to warm, mostly rich, sub-acid soils. May be found in open fields at the northern end of its range. Site elevations range from near sea level to 3,600 feet. Leaves emerge in spring and spores mature through summer.	T	Yes	Yes
Purple-flowered bladderwort (*Utricularia purpurea*)	Adjacent to boggy shorelines in small to medium size lakes with high water quality. Flowers from mid-July to September.	E	Yes	Yes
Red saltwort (*Salicornia rubra*)	Salt flats, saline swales, alkaline depressions, and exposed shores of alkaline lakes. Flowers from late July into August.	T	Yes	No
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	T	Yes	Yes
Whorled nutrush (*Scleria verticillata*)	Restricted to the least disturbed calcareous fens in the prairie region. Blooms late June through late July.	T	Yes	No

Sources: Minnesota DNR 2016a, 2017a; Merjent 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

[a] E = Endangered, T = Threatened

[b] Database search = within 0.5 mile of route centerline.

Special Concern Species

State-listed special concern species that occur within the ROI for the Applicant's preferred route include 12 vertebrates, 3 invertebrates, and 11 plants (Tables 6.3.5-3 and 6.3.5-4).

Table 6.3.5-3. Known Occurrences of Special Concern Animals within the Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name
Mammals	
Big brown bat	*Eptesicus fuscus*
Little brown myotis	*Myotis lucifugus*
Northern long-eared bat	*Myotis septentrionalis*
Prairie vole	*Microtus ochrogaster*
Birds	
Greater prairie-chicken	*Tympanuchus cupido*
Nelson's sparrow	*Ammodramus nelsoni*
Northern goshawk	*Accipiter gentilis*
Red-shouldered hawk	*Buteo lineatus*
Short-eared owl	*Asio flammeus*
Trumpeter swan	*Cygnus buccinator*
Amphibians	
Four-toed salamander	*Hemidactylium scutatum*
Fish	
Least darter	*Etheostoma microperca*
Insects and Spiders	
A caddisfly	*Anabolia ozburni*
Mollusks	
Black sandshell	*Ligumia recta*
Creek heelsplitter	*Lasmigona compressa*

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Table 6.3.5-4. Known Occurrences of Special Concern Plants within the Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name
Forests	
Least moonwort	*Botrychium simplex*
Peatlands	
Few-flowered spikerush	*Eleocharis quinqueflora*
Twig rush	*Cladium mariscoides*
White adder's mouth	*Malaxis monophyllos* var. *brachypoda*
Prairies	
Blunt sedge	*Carex obtusata*
Northern single-spike sedge	*Carex scirpoidea*
Small white lady's-slipper	*Cypripedium candidum*
Wetlands/Water	
False mountain willow	*Salix pseudomonticola*
McCalla's willow	*Salix maccalliana*
Slender naiad	*Najas gracillima*
Torrey's mannagrass	*Torreyochloa pallida*

Sources: Minnesota DNR 2016a, 2017c.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

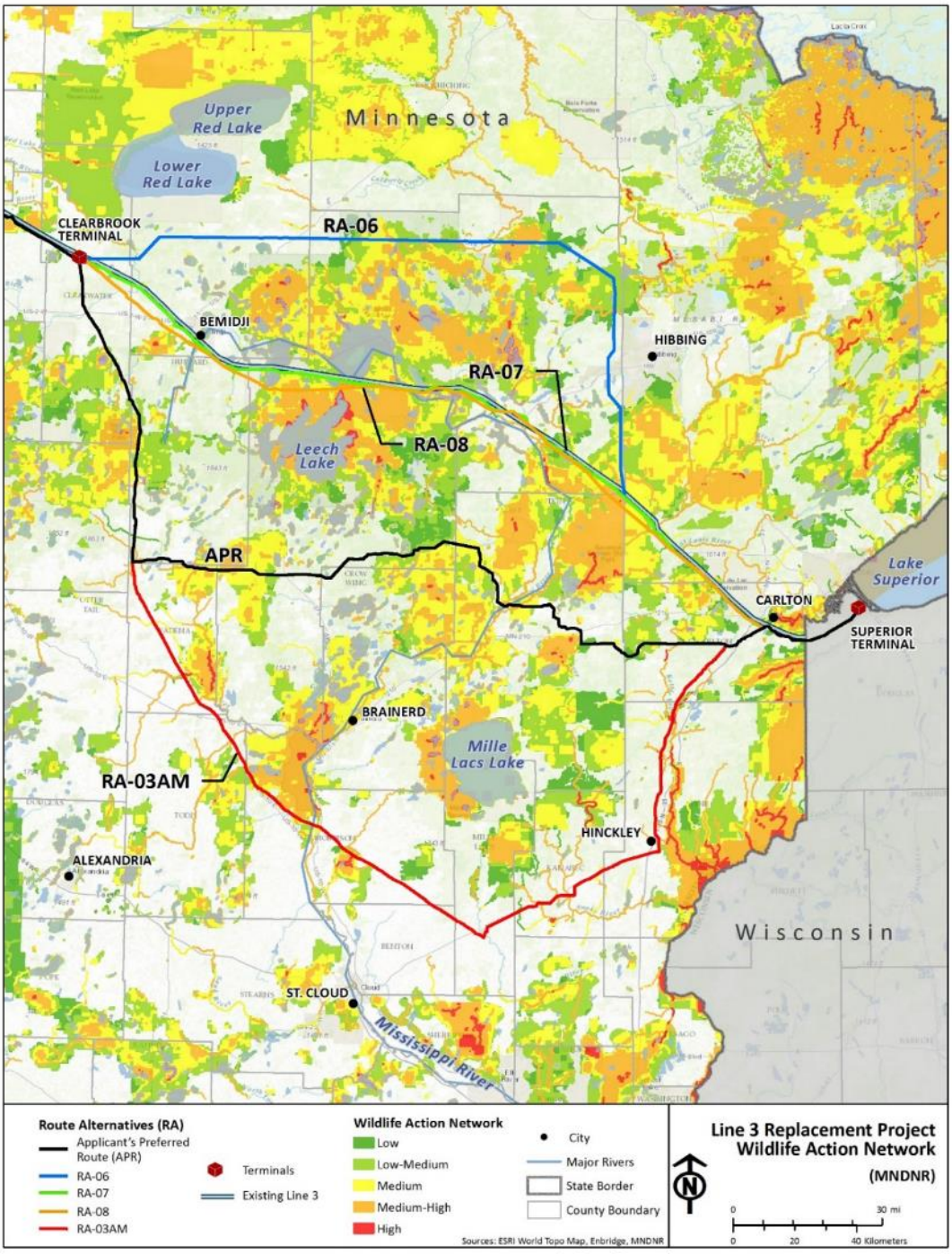
Database search = within 0.5 mile of route centerline.

Minnesota Species of Greatest Conservation Need

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota crossed by the Applicant's preferred route (Minnesota DNR 2016f). As shown in Figure 6.3.5-1, the Applicant's preferred route would cross habitats within the WAN that could be used by multiple SGCNs. Approximately 30 percent of the area within the ROI is within the WAN.

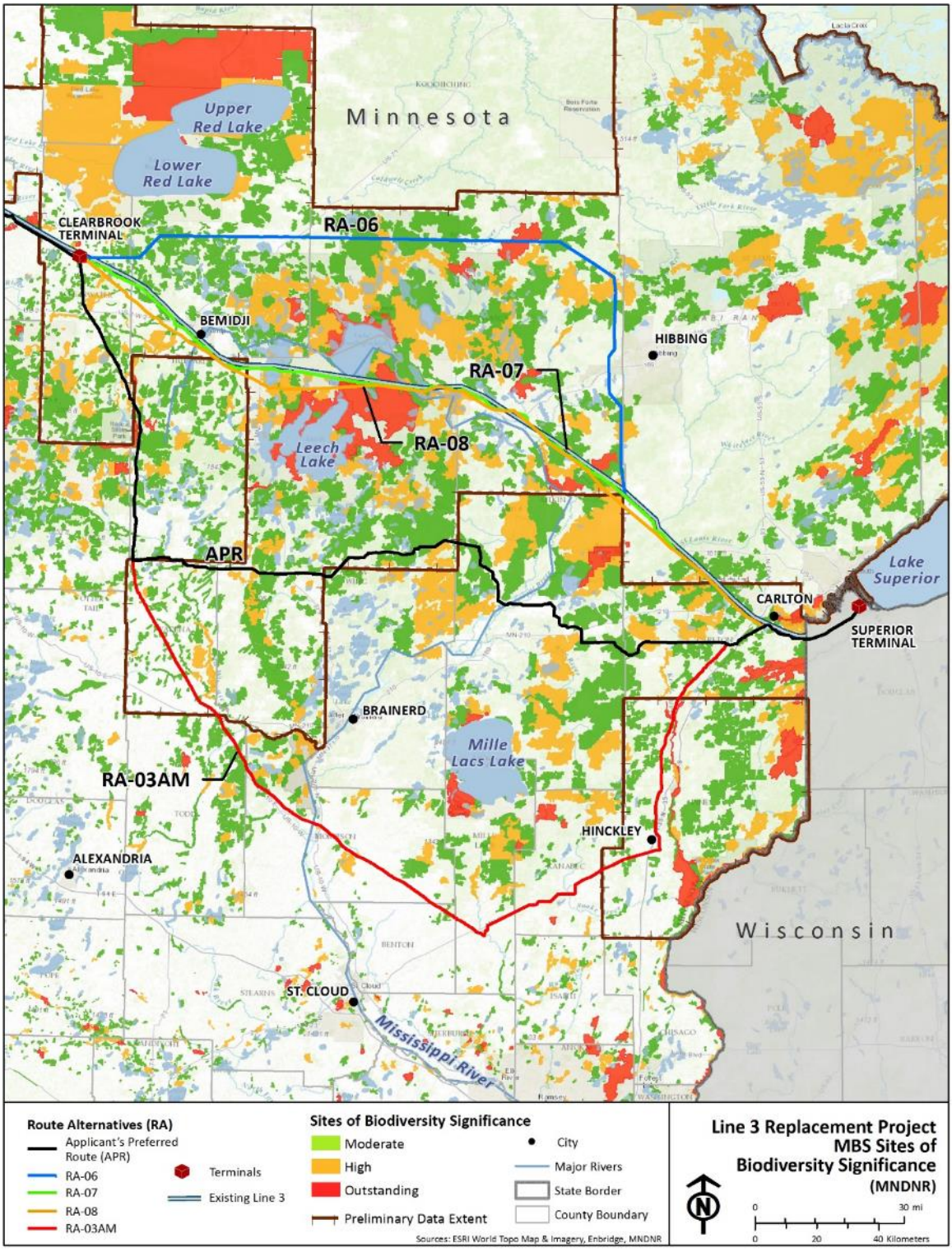
Minnesota Biological Survey Sites of Biodiversity Significance

As shown in Figure 6.3.5-2, the Applicant's preferred route would cross t areas with MBS Sites. Areas crossed that score outstanding, high, and moderate have an increased potential of containing habitats used by rare animals and plants that potentially would be affected, as discussed below in the impact assessment. Approximately 21 percent of the area within the ROI is rated as an outstanding (less than 1 percent), high (3 percent), or moderate (17 percent) MBS Site.



Source: Minnesota DNR 2016b.

Figure 6.3.5-1. Wildlife Action Network Crossed by the Applicant's Preferred Route and Route Alternatives



Source: Minnesota DNR 2016h.

Figure 6.3.5-2. Minnesota Biological Survey Sites of Biodiversity Significance Crossed by the Applicant's Preferred Route and Route Alternatives

Minnesota Scientific and Natural Areas

Minnesota's SNAs are state lands that preserve ecological and geological diversity, including rare species, native plants, and significant geological features (Minnesota DNR 2016c). Multiple sites in each landscape region are protected in order to capture genetic diversity and prevent the loss of important species, communities, and features (Minnesota DNR 2016c). Natural areas are distinguished by undisturbed plant communities, rare or endangered species habitat, seasonal habitat, natural geologic formations and features, and plant communities undergoing natural succession (Minnesota DNR 2016c). No SNAs would be crossed by or be within the ROI for the Applicant's preferred route.

6.3.5.2.2 Route Alternatives

The only segment in Minnesota where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton. The existing conditions relevant to unique natural resources for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, and rusty patched bumble bee have the potential to occur within or near RA-03AM (Table 6.3.5-5).

Table 6.3.5-5. Potential Occurrences of Federally Protected Species within the Region of Interest for Route Alternative RA-03AM

Species	Preferred Habitat	Status[a]
Mammals		
Canada lynx *(Lynx canadensis)*	Boreal regions dominated by coniferous or mixed forests. Dens in mature or old-growth forests with high density of logs. Breeds late winter to early spring.	T
Gray wolf (*Canis lupus*) Great Lakes Distinct Population Segment	Suitable habitats in the ROI include hardwood forest, mixed forest, and grasslands. Digs dens in suitable soils or uses dens initiated by other animals. Breeds February to late June.	T
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	T
Insects		
Rusty patched bumble bee (*Bombus affinis*)	Grasslands and tallgrass prairies with areas that provide flowers, nesting sites such as abandoned rodent cavities or grass clumps, and overwintering sites in undisturbed soil for hibernating queens. Eggs are laid in spring.	E

Source: USFWS 2016.

Notes:

IPaC search = within 1 mile of route centerline.

[a] E = Endangered, T = Threatened

ROI = region of interest

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened animals and plants likely to occur within the ROI for RA-03AM, including those that are also federally listed, are presented in Table 6.3.5-6. Presence or absence of state-listed species was determined based on Minnesota NHIS element occurrence records.

Table 6.3.5-6. Known Occurrences of State-Protected Animals and Plants within the Region of Interest for Route Alternative RA-03AM

Species	Preferred Habitat	Status[a]
ANIMALS		
Amphibians and Reptiles		
Blanding's turtle (*Emydoidea blandingii*)	Found in productive, clean, shallow waters with abundant aquatic vegetation and soft, muddy bottoms over firm substrates—in ponds, marshes, swamps, bogs, wet prairies, river backwaters, sloughs, slow-moving rivers, protected coves, and lake shallows and inlets. Extensive marshes bordering rivers provide excellent habitat. Nests in grasses and sedge close to water.	T
Wood turtle (*Glyptemys insculpta*)	Found in moderate- to fast-flowing clear streams or rivers associated with forested riparian corridors, which provide primary overwintering, courtship, basking, and foraging habitat. Typically inhabited waterways possess a sand, gravel, or cobble substrate with limited silt or muck. Nesting occurs in well-drained open or sparsely vegetated sandy soils, typically within 200 feet of suitable aquatic habitat. Nesting habitat includes native dry prairies, moderately sloughing sand banks, sandbars, agricultural fields, or areas of disturbed sandy soils that support no or sparse ground layer vegetation.	T
Mollusks		
Elktoe (*Alasmidonta marginata*)	Found in medium to large rivers with moderate to fast velocities and sand and gravel substrates.	T
Fluted-shell (*Lasmigona costata*)	Found in streams or river beds. Likely spawns from June to July.	T
Mucket (*Actinonaias ligamentina*)	Found in medium to large rivers with coarse sand and gravel substrates.	T
Spike (*Elliptio dilatata*)	Found in small to large rivers, reservoirs, and lakes with sand and gravel substrates. Usually associated with outlet habitats dominated by swift currents when found in lakes. Spawns in early to mid-May.	T
PLANTS		
Vascular Plants		
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes, and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	T
Bog bluegrass (*Poa paludigena*)	Perched upon wet substrates such as moss, fallen trees, etc. in spring-fed swamps. Specifically, occurs within *Fraxinus nigra-Betula lutea* swamps along the base of steep bluffs and at the head of the spring that feeds into the swamp. Blooms in late May to early June.	T

Table 6.3.5-6. Known Occurrences of State-Protected Animals and Plants within the Region of Interest for Route Alternative RA-03AM

Species	Preferred Habitat	Status[a]
Bristle-berry (*Rubus fulleri*)	Swamp and marsh edges, wet and sedge meadows, and uplands mainly in central Minnesota. Flowers mid- to late June.	T
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring, and flowers mid-summer.	T
Kitten-tails (*Besseya bullii*)	Savannas of the Midwest. This plant is more common in the oak openings than in the prairies. Kitten tails have been observed in grazed pastures, in mesic forests, in open woods, and on flat, grassy slopes. Blooms April through June.	T
Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	In woods and on hummocks in swamps, and in cool to warm, mostly rich, subacid soils. May be found in open fields at the northern end of its range. Site elevations range from near sea level to 3,600 feet. Leaves emerge in spring and spores mature through summer.	T
Snailseed pondweed (*Potamogeton bicupulatus*)	Soft water lakes (i.e., low dissolved mineral levels) with clear water. Fruits during July and August.	E
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	T

Sources: Minnesota DNR 2016a, 2017a; Merjent 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

[a] E = Endangered, T = Threatened

Special Concern Species

Occurrences of Minnesota special concern animals and plants, including federally listed species, within the ROI for RA-03AM are listed in Tables 6.3.5-7 and 6.3.5-8.

Table 6.3.5-7. Known Occurrences of Special Concern Animals within the Region of Interest for Route Alternative RA-03AM

Common Name	Scientific Name
Mammals	
Big brown bat	*Eptesicus fuscus*
Little brown myotis	*Myotis lucifugus*
Northern long-eared bat	*Myotis septentrionalis*
Birds	
Greater prairie-chicken	*Tympanuchus cupido*
Nelson's sparrow	*Ammodramus nelsoni*
Northern goshawk	*Accipiter gentilis*
Red-shouldered hawk	*Buteo lineatus*
Short-eared owl	*Asio flammeus*
Trumpeter swan	*Cygnus buccinator*
Fish	
Gilt darter	*Percina evides*
Lake sturgeon	*Acipenser fulvescens*
Least darter	*Etheostoma microperca*
Southern brook lamprey	*Ichthyomyzon gagei*
Insects	
A caddisfly	*Anabolia ozburni*
Mollusks	
Black sandshell	*Ligumia recta*
Creek heelsplitter	*Lasmigona compressa*
Round pigtoe	*Pleurobema sintoxia*

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Table 6.3.5-8. Known Occurrences of Special Concern Plants within the Region of Interest for Route Alternative RA-03AM

Common Name	Scientific Name
Forests	
Least moonwort	*Botrychium simplex*
Peatlands	
English sundew	*Drosera anglica*
Few-flowered spikerush	*Eleocharis quinqueflora*
Twig rush	*Cladium mariscoides*
White adder's mouth	*Malaxis monophyllos* var. *brachypoda*
Prairies	
Blunt sedge	*Carex obtusata*
Hill's thistle	*Cirsium pumilum* var. *hillii*
Northern single-spike sedge	*Carex scirpoidea*
Small white lady's-slipper	*Cypripedium candidum*
Wetlands/Water	
Autumn fimbry	*Fimbristylis autumnalis*
False mountain willow	*Salix pseudomonticola*
McCalla's willow	*Salix maccalliana*
Slender naiad	*Najas gracillima*

Sources: Minnesota DNR 2016a; 2017a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = 0.5 mile from route centerline.

Species of Greatest Conservation Need

The WAN shows viable or persistent populations and richness hotspots for regions in Minnesota (Minnesota DNR 2016f). As shown in Figure 6.3.5-1, RA-03AM would cross habitats within the WAN that could be used by multiple SGCNs.

Minnesota Biological Survey Sites of Biodiversity Significance

As shown in Figure 6.3.5-2, RA-03AM would cross areas with MBS Sites. Areas scoring outstanding, high, and moderate that are crossed by a route have an increased potential of containing habitats used by rare animals and plants that potentially would be affected, as discussed below in the impact assessment.

Minnesota Scientific and Natural Areas

RA-03AM would cross the Lake Alexander Woods SNA (Figure 6.5.3-3). The topography of the Lake Alexander SNA consists of hummocky mounds alternating with depressions (also known as knob and kettle), and the vegetation includes undisturbed mesic oak and aspen-birch forests interspersed with

wetlands. A variety of wildlife use this area, including bald eagles, red-shouldered hawks (*Buteo lineatus*), and the threatened bog bluegrass (*Poa paludigena*) (Minnesota DNR 2016e).

Route Alternative RA-06

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, rufa red knot (*Calidris canutus rufa*), and rusty patched bumble bee have the potential to occur within the ROI for RA-06 (Table 6.3.5-9).

Table 6.3.5-9. Potential Occurrences of Federally Protected Species within the Region of Interest for Route Alternative RA-06

Species	Preferred Habitat	Status[a]
Mammals		
Canada lynx *(Lynx canadensis)*	Boreal regions dominated by coniferous or mixed forests. Dens in mature or old-growth forests with high density of logs. Breeds late winter to early spring.	T
Gray wolf (*Canis lupus*) Great Lakes Distinct Population Segment	Suitable habitats in the ROI include hardwood forest, mixed forest, and grasslands. Digs dens in suitable soils or uses dens initiated by other animals. Breeds February to late June.	T
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	T
Birds		
Red knot (*Calidris canutus rufa*)	Shorelines, tidal zones, sandy beaches. Nests in Arctic tundra, usually near water. Breeds late May to early June.	T
Insects		
Rusty patched bumble bee (*Bombus affinis*)	Grasslands and tallgrass prairies with areas that provide flowers, nesting sites such as abandoned rodent cavities or grass clumps, and overwintering sites in undisturbed soil for hibernating queens. Eggs are laid in spring.	E

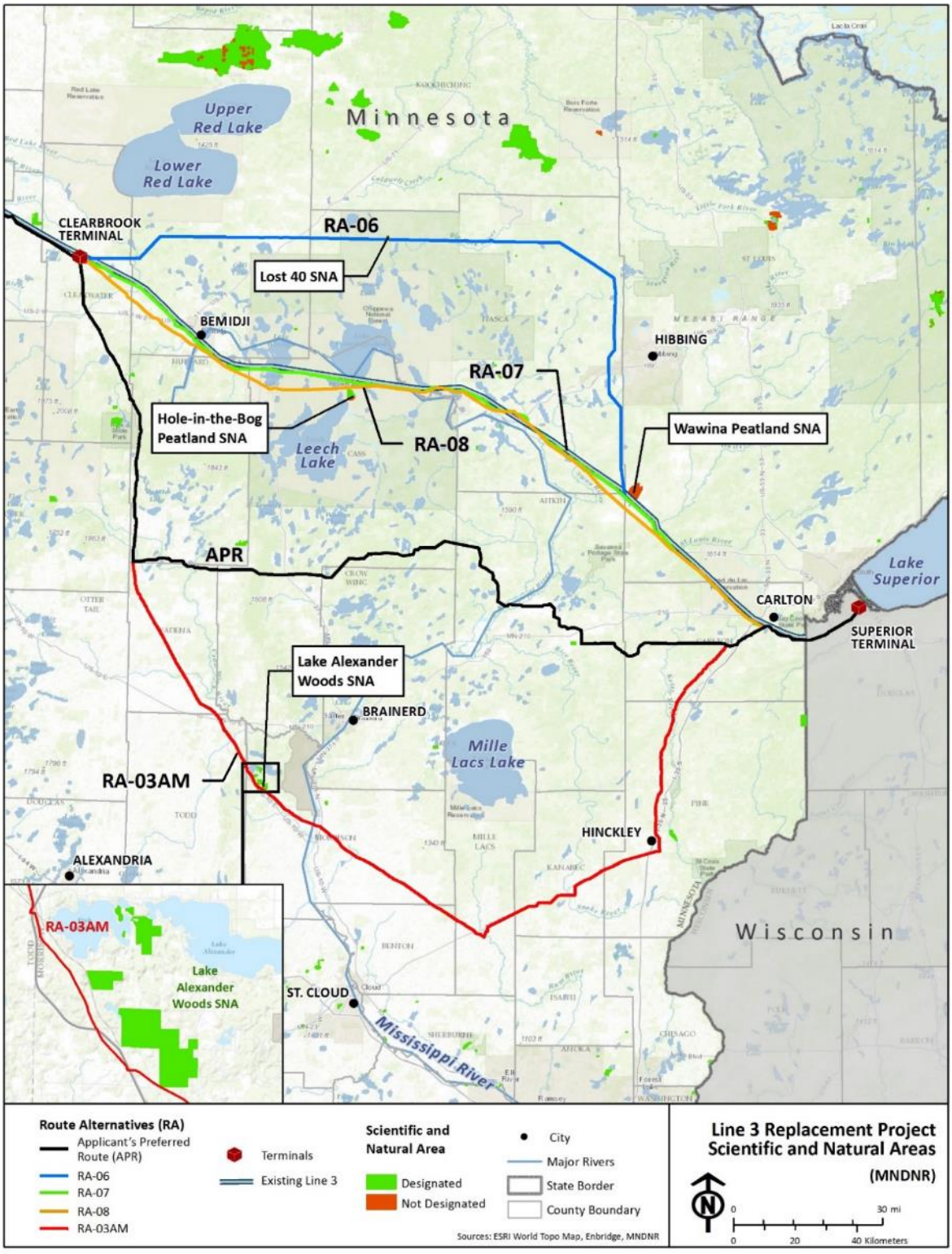
Sources: USFWS 2016.

Notes:

IPaC search = within 1 mile of route centerline

[a] E = Endangered, T = Threatened

ROI = region of interest



Source: Minnesota DNR 2016i.

Figure 6.3.5-3. Scientific and Natural Areas Crossed by the Route Alternatives

State-Listed Species

Endangered and Threatened Species

State-listed endangered and threatened animals and plants likely to occur within the ROI for RA-06 are presented in Table 6.3.5-10. Presence or absence of state-listed species was determined based on Minnesota NHIS element occurrence records.

Table 6.3.5-10. Known Occurrences of State-Protected Animals and Plants within the Region of Interest for Route Alternative RA-06

Species	Preferred Habitat	Status[a]
Fish		
Pugnose shiner (*Notropis anogenus*)	Found in glacial lakes and streams with an abundance of submerged vegetation. Prefers low-velocity waters with a substrate of sand, mud, or gravel. Shallow waters in warm months and deeper waters in cold months.	T
Vascular Plants		
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes, and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	T
Blunt-lobed grapefern (*Botrychium oneidense*)	Second-growth forests in shallow depressions and ephemeral pools. A new leaf emerges in the summer (i.e., late June).	T
Goblin fern (*Botrychium mormo*)	Rich leaf mold on shaded forest floors in mature maple-basswood and maple-basswood-beech forests. Plants emerge from the ground in June, and sporangia open in late September.	T
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring, and flowers mid-summer.	T
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	T

Sources: Minnesota DNR 2016a, 2017a; Merjent 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

[a] E = Endangered, T = Threatened

Special Concern Species

Occurrences of Minnesota special concern animals and plants, including federally listed species, within the ROI for RA-06 are listed in Tables 6.3.5-11 and 6.3.5-12.

Table 6.3.5-11. Known Occurrences of Special Concern Animals within the Region of Interest for Route Alternative RA-06

Common Name	Scientific Name
Mammals	
Big brown bat	*Eptesicus fuscus*
Little brown myotis	*Myotis lucifugus*
Northern long-eared bat	*Myotis septentrionalis*
Birds	
Nelson's sparrow	*Ammodramus nelsoni*
Northern goshawk	*Accipiter gentilis*
Short-eared owl	*Asio flammeus*
Trumpeter swan	*Cygnus buccinator*
Amphibians	
Four-toed salamander	*Hemidactylium scutatum*
Fish	
Least darter	*Etheostoma microperca*
Mollusks	
Black sandshell	*Ligumia recta*
Creek heelsplitter	*Lasmigona compressa*

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Table 6.3.5-12. Known Occurrences of Special Concern Plants within the Region of Interest for Route Alternative RA-06

Common Name	Scientific Name
Forests	
Least moonwort	*Botrychium simplex*
Peatlands	
Bog rush	*Juncus stygius* var. *americanus*
English sundew	*Drosera anglica*
Few-flowered spikerush	*Eleocharis quinqueflora*
Small green wood orchid	*Platanthera clavellata*
Twig rush	*Cladium mariscoides*
White adder's mouth	*Malaxis monophyllos* var. *brachypoda*
Prairies	
Blunt sedge	*Carex obtusata*
Northern single-spike sedge	*Carex scirpoidea*
Small white lady's-slipper	*Cypripedium candidum*
Wetlands/Water	
Discoid beggarticks	*Bidens discoidea*
False mountain willow	*Salix pseudomonticola*
McCalla's willow	*Salix maccalliana*

Sources: Minnesota DNR 2016a; 2017a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Minnesota Species of Greatest Conservation Need

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota (Minnesota DNR 2016f). As shown in Figure 6.3.5-1, RA-06 would cross habitats within the WAN that could be used by multiple SGCNs.

Minnesota Biological Survey Sites of Biodiversity Significance

As shown in Figure 6.3.5-2, RA-06 would cross areas with MBS Sites. Areas scoring outstanding, high, and moderate that are crossed by this route alternative have an increased potential of containing habitats used by rare animals and plants that potentially would be affected, as discussed below in the impact assessment.

Minnesota Scientific and Natural Areas

As depicted in Figure 6.3.5-3, RA-06 would come within 0.5 mile of the Lost 40 and Wawina Peatland SNAs (Minnesota DNR 2016i). The Lost 40 SNA has virgin old-growth white pine-red pine forest that is considered to be the most significant stand outside of the Boundary Waters and Itasca State Park

(Minnesota DNR 2016f). The Wawina Peatland SNA is a large-patterned peatland complex with ovoid island patterns, a featureless water track, raised bog, and crested raised bog (Minnesota DNR 2016g).

Route Alternative RA-07

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, rufa red knot, and rusty patched bumble bee have the potential to occur within the ROI for RA-07 (Table 6.3.5-13).

Table 6.3.5-13. Potential Occurrences of Federally Protected Species within the Region of Interest for Route Alternative RA-07

Species	Preferred Habitat	Status[a]
Mammals		
Canada lynx *(Lynx canadensis)*	Boreal regions dominated by coniferous or mixed forests. Dens in mature or old-growth forests with high density of logs. Breeds late winter to early spring.	T
Gray wolf (*Canis lupus*) Great Lakes Distinct Population Segment	Suitable habitats in the ROI include hardwood forest, mixed forest, and grasslands. Digs dens in suitable soils or uses dens initiated by other animals. Breeds February to late June.	T
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	T
Birds		
Red knot (*Calidris canutus rufa*)	Shorelines, tidal zones, sandy beaches. Nests in Arctic tundra, usually near water. Breeds late May to early June.	T
Insects		
Rusty patched bumble bee (*Bombus affinis*)	Grasslands and tallgrass prairies with areas that provide flowers, nesting sites such as abandoned rodent cavities or grass clumps, and overwintering sites in undisturbed soil for hibernating queens. Eggs are laid in spring.	E

Source: USFWS 2016.

Notes:

IPaC search = within 1 mile of route centerline.

[a] E = Endangered, T = Threatened

ROI = region of interest

State-Listed Species

Endangered and Threatened Species

No state-protected animals are reported to occur along the RA-07 route. State-listed endangered and threatened plants likely to occur along RA-07 are presented in Table 6.3.5-14. Presence or absence of state-listed species was determined based on Minnesota NHIS element occurrence records.

Table 6.3.5-14. Known Occurrences of State-Protected Plants within the Region of Interest for Route Alternative RA-07

Species	Preferred Habitat	Status[a]
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes, and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	T
Goblin fern (*Botrychium mormo*)	Rich leaf mold on shaded forest floors in mature maple-basswood and maple-basswood-beech forests. Plants emerge from the ground in June, and sporangia open in late September.	T
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring, and flowers mid-summer.	T
Hidden-fruited bladderwort (*Utricularia geminiscapa*)	Wetlands, including bogs, fens, lakes, ponds, and river or lake shores. Blooms July through August.	T
Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	In woods and on hummocks in swamps, and in cool to warm, mostly rich, subacid soils. May be found in open fields at the northern end of its range. Site elevations range from near sea level to 3,600 feet. Leaves emerge in spring and spores mature through summer.	T
Ram's head orchid (*Cypripedium arietinum*)	Cool, dense white cedar, balsam, and spruce swamps; nearly pure sand over limestone beach cobble or bedrock, mulched with conifer needles; and in mesic soil of sandy loam or clay under the partial shade of conifer or mixed forest. Prefers cool, sub-acid or neutral soil, loam, or sand in upland sites and nutrient-poor peat in lowland sites. Flowers from late May through mid-June.	T
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	T

Sources: Minnesota DNR 2016a, 2017a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline; no occurrence of state-protected animals.

[a] E = Endangered, T = Threatened

Special Concern Species

Occurrences of Minnesota special concern animals and plants, including federally listed species, within the ROI for RA-07 are listed in Tables 6.3.5-15 and 6.3.5-16.

Table 6.3.5-15. Known Occurrences of Special Concern Species within the Region of Interest for Route Alternative RA-07

Common Name	Scientific Name
Mammals	
Big brown bat	*Eptesicus fuscus*
Little brown myotis	*Myotis lucifugus*
Northern long-eared bat	*Myotis septentrionalis*
Birds	
Nelson's sparrow	*Ammodramus nelsoni*
Trumpeter swan	*Cygnus buccinator*
Yellow rail	*Coturnicops noveboracensis*
Mollusks	
Black sandshell	*Ligumia recta*
Creek heelsplitter	*Lasmigona compressa*

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Table 6.3.5-16. Known Occurrences of Special Concern Plants within the Region of Interest for Route Alternative RA-07

Common Name	Scientific Name
Forests	
Barren strawberry	*Waldsteinia fragarioides* var. *fragarioides*
Least moonwort	*Botrychium simplex*
Mingan moonwort	*Botrychium minganense*
Pale moonwort	*Botrychium pallidum*
St. Lawrence grapefern	*Botrychium rugulosum*
Peatlands	
English sundew	*Drosera anglica*
Few-flowered spikerush	*Eleocharis quinqueflora*
Lapland buttercup	*Ranunculus lapponicus*
Twig rush	*Cladium mariscoides*
Prairies	
Blunt sedge	*Carex obtusata*
Northern single-spike sedge	*Carex scirpoidea*
Small white lady's-slipper	*Cypripedium candidum*
Wetlands/Water	
False mountain willow	*Salix pseudomonticola*
McCalla's willow	*Salix maccalliana*

Sources: Minnesota DNR 2016a, 2017a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Species of Greatest Conservation Need

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota (Minnesota DNR 2016f). As shown in Figure 6.3.5-1, RA-07 would cross habitats within the WAN that could be used by multiple SGCNs.

Minnesota Biological Survey Sites of Biodiversity Significance

As shown in Figure 6.3.5-2, RA-07 would cross areas with MBS Sites. Areas scoring outstanding, high, and moderate that are crossed have an increased potential of containing habitats used by rare animals and plants that potentially would be affected, as discussed below in the impact assessment.

Minnesota Scientific and Natural Areas

As depicted in Figure 6.3.5-3, RA-07 would come within 0.5 mile of the Wawina Peatland SNA, which is a large-patterned peatland complex with ovoid island patterns, a featureless water track, raised bog, and crested raised bog (Minnesota DNR 2016g).

Route Alternative RA-08

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, rufa red knot, and rusty patched bumble bee have the potential to occur within or near RA-08 (Table 6.3.5-17).

Table 6.3.5-17. Potential Occurrences of Federally Protected Species within the Region of Interest for Route Alternative RA-08

Species	Preferred Habitat	Status[a]
Mammals		
Canada lynx *(Lynx canadensis)*	Boreal regions dominated by coniferous or mixed forests. Dens in mature or old-growth forests with high density of logs. Breeds late winter to early spring.	T
Gray wolf (*Canis lupus*) Great Lakes Distinct Population Segment	Suitable habitats in the ROI include hardwood forest, mixed forest, and grasslands. Digs dens in suitable soils or uses dens initiated by other animals. Breeds February to late June.	T
Northern long-eared bat (*Myotis septentrionalis*)	Suitable habitat occurs in the ROI. In summer, bats roost underneath bark, in cavities, or in crevices of both live trees and snags. Mates in fall and gives birth in summer (May to July). Caves and mines are winter hibernacula (October to April).	T
Birds		
Red knot (*Calidris canutus rufa*)	Shorelines, tidal zones, sandy beaches. Nests in Arctic tundra, usually near water. Breeds late May to early June.	T
Insects		
Rusty patched bumble bee (*Bombus affinis*)	Grasslands and tallgrass prairies with areas that provide flowers, nesting sites such as abandoned rodent cavities or grass clumps, and overwintering sites in undisturbed soil for hibernating queens. Eggs are laid in spring.	E

Source: USFWS 2016.

Notes:

IPaC search = within 1 mile of route centerline.

[a] E = Endangered, T = Threatened

ROI = region of interest

State-Listed Species

Endangered and Threatened Species

No state-protected animals are likely to occur along the RA-08 route. State-listed endangered and threatened plants likely to occur within the ROI for RA-08, including those that are also federally listed, are presented in Table 6.3.5-18. Presence or absence of state-listed species was determined based on Minnesota NHIS element occurrence records.

Table 6.3.5-18. Known Occurrences of State-Protected Plants within the Region of Interest for Route Alternative RA-08

Species	Preferred Habitat	Status[a]
Beaked spikerush (*Eleocharis rostellata*)	Coastal salt marshes, and inland in saline, alkaline, or strongly calcareous habitats (e.g., around hot springs). Fruits during summer to fall in the north.	T
Bog adder's mouth (*Malaxis paludosa*)	Open, acidic, sphagnum bogs; very wet forests; and occasionally along stream edges on peaty mud and among grasses. In the southern part of its range, it often occurs in deep shade, possibly because it requires cool temperatures. Flowers and fruits from mid-July to late August.	E
Clinton's bulrush (*Trichophorum clintonii*)	Rocky river ledges, argillaceous soils, clearings of fir forests, and prairie and open woods. Reproductive structures are present from early May through the end of June in southern Minnesota, and late May through June in northern Minnesota.	T
Goblin fern (*Botrychium mormo*)	Rich leaf mold on shaded forest floors in mature maple-basswood and maple-basswood-beech forests. Plants emerge from the ground in June, and sporangia open in late September.	T
Hair-like beak rush (*Rhynchospora capillacea*)	Calcareous fens, especially along the margins, and spring fens. Germinates in the spring, and flowers mid-summer.	T
Hidden-fruited bladderwort (*Utricularia geminiscapa*)	Wetlands, including bogs, fens, lakes, ponds, and river or lake shores. Blooms July through August.	T
Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	In woods and on hummocks in swamps, and in cool to warm, mostly rich, subacid soils. May be found in open fields at the northern end of its range. Site elevations range from near sea level to 3,600 feet. Leaves emerge in spring and spores mature through summer.	T
Oakes' pondweed (*Potamogeton oakesianus*)	Wetlands, including lakes, ponds, rivers, and streams. Blooms summer through fall (i.e., June to October).	E
One-flowered broomrape (*Orobanche uniflora*)	Woodland and bluff prairies with a variety of soil and light conditions. Blooms from late spring to early summer.	T
Sterile sedge (*Carex sterilis*)	Mineral-rich calcareous fens of the prairie region. Mature perigynia are present from early June to late July.	T

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline; no occurrences of state-protected animals.

[a] E = Endangered, T = Threatened

Special Concern Species

Occurrences of Minnesota special concern animals and plants, including federally listed species, within the ROI for RA-08 are listed in Tables 6.3.5-19 and 6.3.5-20.

Table 6.3.5-19. Known Occurrences of Special Concern Animals within the Region of Interest for Route Alternative RA-08

Common Name	Scientific Name
Mammals	
Big brown bat	*Eptesicus fuscus*
Little brown myotis	*Myotis lucifugus*
Northern long-eared bat	*Myotis septentrionalis*
Birds	
Nelson's sparrow	*Ammodramus nelsoni*
Northern goshawk	*Accipiter gentilis*
Red-shouldered hawk	*Buteo lineatus*
Short-eared owl	*Asio flammeus*
Trumpeter swan	*Cygnus buccinator*
Insects and Spiders	
A Caddisfly	*Anabolia ozburni*
Mollusks	
Black sandshell	*Ligumia recta*
Creek heelsplitter	*Lasmigona compressa*

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Table 6.3.5-20. Known Occurrences of Special Concern Plants within the Region of Interest for Route Alternative RA-08

Common Name	Scientific Name
Forests	
Least moonwort	*Botrychium simplex*
Mingan moonwort	*Botrychium minganense*
Pale moonwort	*Botrychium pallidum*
St. Lawrence grapefern	*Botrychium rugulosum*
Peatlands	
English sundew	*Drosera anglica*
Few-flowered spikerush	*Eleocharis quinqueflora*
Twig rush	*Cladium mariscoides*
White adder's mouth	*Malaxis monophyllos* var. *brachypoda*
Prairies	
Blunt sedge	*Carex obtusata*
Northern single-spike sedge	*Carex scirpoidea*
Small white lady's-slipper	*Cypripedium candidum*
Wetlands/Water	
False mountain willow	*Salix pseudomonticola*
McCalla's willow	*Salix maccalliana*
Slender naiad	*Najas gracillima*

Sources: Minnesota DNR 2016a; 2017a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Database search = within 0.5 mile of route centerline.

Species of Greatest Conservation Need

The WAN shows viable or persistent populations and richness hotspots for the regions in Minnesota (Minnesota DNR 2016f). As shown in Figure 6.3.5-1, RA-08 would cross habitats within the WAN that could be used by multiple SGCNs.

Minnesota Biological Survey Sites of Biodiversity Significance

As shown in Figure 6.3.5-2, RA-08 would cross areas with MBS Sites. Areas rated outstanding, high, and moderate that are crossed by the alternative have an increased potential of containing habitats used by rare animals and plants that potentially would be affected, as discussed below in the impact assessment.

Minnesota Scientific and Natural Areas

RA-08 would come within 0.5 mile of the Hole-in-the-Bog Peatland SNA (Figure 6.3.5-3), which is a minimally disturbed, well-defined, crested raised bog and peatland lake (Minnesota DNR 2016d). As the

only protected peatland of this type, it is Minnesota's best example of a basin-filled raised bog and is one of few outside a major glacial lake plain (Minnesota DNR 2016d).

6.3.5.3 Impact Assessment

Potential impacts on unique natural resources from construction of the Applicant's preferred route and route alternatives include the following:

- Injury or loss of aquatic invertebrates, fish, and reptiles from waterbody crossing construction;
- Injury or loss of terrestrial invertebrates, small mammals, reptiles, bird eggs and young, and plants from vegetation clearing, trench excavation, and vehicle operations;
- Loss or alteration of forage and cover habitats from vegetation clearing, site grading, and trenching;
- Disturbance from construction noise and activity; and
- Exposure to small leaks and drips from construction equipment and vehicles.

Operations impacts on unique natural resources could include:

- Continued habitat loss or alteration from pipeline right-of-way vegetation management,
- Continued habitat loss or alteration from excavation for pipeline inspection and repair, and
- Continued disturbance from noise and activity at facilities.

The potential for effects on unique natural resources depends on whether the protected unique natural resources occur near the facilities, infrastructure, activities, and habitat changes associated with construction and operation of the route alternatives, and whether these conditions may result in injury, harm, or disturbance. Impact assessments specific to route alternatives in Minnesota are presented below.

6.3.5.3.1 Applicant's Preferred Route (in Minnesota)

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, whooping crane (*Grus americana*), Dakota skipper, Poweshiek skipperling, rusty patched bumble bee, and western prairie fringe orchid have the potential to occur within the ROI for the Applicant's preferred route (Table 6.3.5-1). Of these species, the Canada lynx, gray wolf, northern long-eared bat, and rusty patched bumble bee potentially occur between Clearbrook and Carlton (Table 6.3.5-1).

Construction Impacts

If present, the Canada lynx could be disturbed by construction noise and activity that likely would cause lynx to move to other areas, possibly returning after construction activities stop. Disturbance effects likely would be minor and temporary unless den sites are disturbed. Most den sites, which are used from April to June, would not be present within the cleared work area because den sites usually are located around downed logs and windfall trees in the forest interior. Most tree clearing for pipeline construction, ATWS, access roads, and facility sites would occur next to previously cleared utility corridors that are not likely to support den sites. Most (approximately 75 percent) of the Clearbrook-to-Carlton segment would be

adjacent to pipeline, transmission line, or road corridors that previously have been disturbed by construction. The habitat fragmentation analysis in Section 6.3.4 identifies 17 forested large-block habitats between MPs 215.0 and 352.0 that could support Canada lynx and den sites.

Foraging and reproductive activities for gray wolves could be affected by exposure to Project-related noise and increased human activity. Construction of a pipeline likely would displace a few gray wolves and alter used habitats, especially if packs currently use existing rights-of-way as a travel corridor. If dens are present in the vicinity, construction-related disturbance could reduce pup survival. In addition, wolf-vehicle collisions continue to be a major contributor to wolf mortality. Typical conservation measures to reduce impacts on the gray wolf include:

- Stop construction activities if the contractor or Environmental Inspector observes a gray wolf or possible den site within the construction corridor, or if USFWS notifies the Applicant of a gray wolf sighting within 1 mile of the construction work area; the stop work order for that area of construction should continue until the wolves leave the area.
- Report any wolf sightings immediately to USFWS, USACE, and state resource agencies (e.g., Minnesota DNR).

Current use of the Applicant's preferred route by northern long-eared bats was confirmed by surveys performed by Merjent from 2014 to 2016 (Merjent 2015b, 2015c, 2016b). The Applicant conducted acoustic and telemetry surveys within suitable habitats during 2014 and 2015 to determine the summer presence or absence of and the locations of maternity or roost trees used by northern long-eared bats. Northern long-eared bats were confirmed at acoustic survey sites in Aitkin, Carlton, Cass, Crow Wing, Hubbard, and Wadena counties (Merjent 2014b, 2015b). In 2015, mist-net and telemetry surveys were completed at 13 sites along the Applicant's preferred route. Northern long-eared bats were captured at nine sites in Aitkin, Carlton, Cass, and Wadena counties. A total of 14 roosts, including 9 maternity roost trees were identified (2 trees in Carlton County and 7 in Cass County) (Merjent 2015c). In 2016, acoustic surveys were conducted at six sites along the Applicant's preferred route in Aitkin, Clearwater, Polk, and Red Lake counties, to determine probable absence or presence. No acoustic positives were detected, and northern long-eared bats are considered absent from all six survey sites (Merjent 2016b).

If northern long-eared bats occur in the construction area, individuals or colonies of bats could be affected if clearing or construction occurs when bats are using summer roosts. Northern long-eared bats could be disturbed by noise or human presence, causing them to abandon occupied tree cavities. Bats could be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. Because the population of northern long-eared bats is declining from white-nose syndrome and destruction of habitat among other factors, the protection of these bats—and particularly of groups of bats in maternity colonies—is of critical importance.

Conservation measures were included in the ESA 4(d) rule[15] to reduce potential impacts on northern long-eared bats. Under the Final 4(d) rule, incidental take involving tree removal in the white nose syndrome zone is not prohibited if the following two conservation measures are followed:

[15] Regulations identified by USFWS that are deemed "necessary and advisable" for protection and conservation of a threatened species.

- Maintain a year-round 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known northern long-eared bat hibernacula.
- Protect known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree, equivalent to 1.6 acres, during the pup season from June 1 to July 31.

Whooping cranes could occur near the Applicant's preferred route during spring and fall migrations. Noise and activity during construction can displace whooping cranes from stopover habitats during foraging or from wetlands or riverine habitats during roosting. Whooping cranes generally depart from wintering grounds during late March to mid-April and return from breeding grounds beginning in mid-September, arriving between late October and mid-November. The Aransas-Wood Buffalo Park whooping crane population migrates between wintering grounds in the Aransas NWR to breeding grounds in Wood Buffalo National Park in northern Alberta. The migration corridor for this population crosses through central Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota and is located generally west of the Applicant's preferred route in western Minnesota. Potential impacts could include disturbance to foraging or roosting birds from pipeline construction during migration periods (USFWS 2009).

If present, the Dakota skipper, Poweshiek skipperling, and rusty patched bumble bee could be affected by construction activities that disturb native vegetation. These activities would disrupt egg laying and foraging during spring and summer, and could crush dormant larvae during fall and winter. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these butterflies and bees, and could remove forage plants.

The Applicant completed a desktop and field assessment of potentially suitable native prairie habitat for the Dakota skipper and Poweshiek skipperling along the Applicant's preferred route. Potentially suitable Dakota skipper and Poweshiek skipperling habitat was documented at one location along the survey corridor in Polk County, and potentially suitable habitat for Poweshiek skipperling was documented at two locations in Pennington County. Suitable habitats were found in small, isolated pockets that ranged in size from 0.4 to 1.8 acres. Presence/absence surveys were conducted in 2015 at a subset of USFWS selected locations identified in the 2013/2014 habitat assessment. Sites were selected based on habitat quality and size (Merjent 2015d). Surveys did not identify the presence of Dakota skippers or Poweshiek skipperling at the three suitable habitat locations in Pennington and Polk counties in Minnesota (Merjent 2015d). Presence/absence surveys have not been performed based on the revised 2016 habitat assessment (Merjent 2016c). While it is possible that these species could occur, based on the results of the habitat survey and earlier presence/absence survey, it is unlikely that the Dakota skipper or Poweshiek skipperling would be affected by construction activities.

The Applicant's preferred route would not cross any current high use areas for rusty patched bumble bees, and construction is not likely to directly or indirectly affect any individuals or current high use areas. The Applicant's preferred route crosses through current potential low use areas where rusty patched bumble bees may disperse from current high use areas or where their occurrence is uncertain. Construction could render some potentially used habitat as unusable, such that the rusty patched bumble bee could experience short-term, minor impacts. The rusty patched bumble bee may benefit from opportunities to conserve the species within the dispersal area, and USFWS may recommend surveys. Applicable conservation measures that would benefit the rusty patched bumble bee within this

dispersal area include restoration and maintenance of high-quality habitat through control of invasive species and restoration that includes a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Western prairie fringed orchids have the potential to occur within 1 mile of the Applicant's preferred route; however, there are no known occurrences of this plant within the construction work area for the Applicant's preferred route in Minnesota. If these plants were to occur, direct impacts could include trampling and destruction during construction from grubbing, grading, and trenching. Indirect effects from construction could include conversion of already fragmented prairie habitat into other habitat types and the spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction.

Impacts on prairie soils from construction would be long term and could require a substantial amount of recovery time, which could affect any western prairie fringed orchids present. The Applicant completed habitat analyses and field surveys of potentially suitable western prairie fringed orchid habitat from 2013 to 2016, and no orchids were located during these surveys (Merjent 2015e, 2016a). Potentially suitable habitat was identified at one location, but no western prairie fringed orchids were found. Therefore, it is unlikely that western prairie fringed orchids would be affected by construction of the Applicant's preferred route.

Summary

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf would experience temporary minor effects associated with construction activities. While habitat fragmentation represents a permanent impact on all species, the impact would be minor due to the limited extent of the fragmentation. Northern long-eared bats and occupied maternity roots are known to occur along the Applicant's preferred route. With implementation of conservation measures, they would experience temporary minor effects from construction. Given the limited distribution within the ROI for whooping cranes, construction impacts likely would be temporary to short term and negligible. Effects on the Dakota skipper and Poweshiek skipperling are not expected. Effects on potential rusty patched bumble bee habitat could be short term and minor. With implementation of BMPs and general conservation measures, impacts from construction would be temporary and minor. Impacts specific to Minnesota key habitats with the potential to affect federally listed species are described below for WAN and MBS Sites. Effects on the federally listed western prairie fringed orchid would be negligible based on the lack of presence and the scarcity of suitable habitat.

Operations Impacts

Project-related noise and increased human activity during operations and maintenance activities could interrupt foraging and reproductive activities for the gray wolf and Canada lynx. Fragmentation of the 17 forested large-block habitats could reduce habitat suitability of these forests for Canada lynx. Post-construction disturbances, such as public and private use of all-terrain vehicles and snow machines along the right-of-way, could increase human interactions, resulting in permanent minor impacts on Canada lynx and gray wolf.

Operations impacts on the northern long-eared bat could include continued habitat loss or alteration and disturbance from noise and activity at aboveground facilities and from right-of-way inspection overflights or ground surveillance. Human activities during operation typically would occur during daylight hours; therefore, operations activities would not interrupt foraging activities, and impacts would be permanent and negligible. Operation of pipeline pump stations could increase nearby noise levels over existing ambient levels; however, as described in Section 6.2.2, noise would be compliant with Minnesota Noise Standards and would decrease over distance. Pump station footprints would be devoid of trees. Although bats could forage in the vicinity, they would not roost at the pump station. Unless a roost site is near a pump station, the effects from operation of pump stations would be permanent and negligible.

As described for construction, Dakota skipper and Poweshiek skipperling are unlikely to occur along the Applicant's preferred route. Operation activities, especially periodic mowing to prevent growth of trees and shrubs, have the potential to affect insect adults, eggs, caterpillars, or larvae directly if the species come in contact with equipment, personnel, or chemicals. Effects could include death, reduced reproduction, or displacement. While it is possible that Dakota skipper or Poweshiek skipperling could occur, based on the results of the habitat surveys and previous presence/absence surveys conducted by the Applicant, it is unlikely that these insects would occur in the study area; therefore, operations impacts would not be expected to occur.

The Applicant's preferred route would not cross any current high use areas for rusty patched bumble bees, and operation is not likely to directly or indirectly affect any individuals or current high use areas. The Applicant's preferred route crosses current potential low use areas where rusty patched bumble bees may disperse from current high use areas or where their occurrence is uncertain, resulting in minor, but permanent habitat impacts. Opportunities to conserve the rusty patched bumble bee may benefit the species within the dispersal area, and USFWS may recommend surveys. Applicable conservation measures that would benefit the rusty patched bumble bee within this dispersal area during operations may include:

- Limiting vegetation management in high-quality habitat during the active season (March through September);
- Leaving one or more areas unmowed for the entire year in vegetation management areas;
- Using a minimum of 8 to 10 inches cutting height to prevent disturbance of overwintering queens or nesting sites; and
- Careful and targeted pesticide use to control pests and invasive species:
  - Use least toxic options, follow label directions to ensure proper use,
  - Apply as locally and directly as possible, avoid broadcast application that may be harmful to the rusty patched bumble bee or their nectar plants in areas where the species is likely to be found, and
  - Ensure that field crews recognize target weeds to avoid adverse effects on important native plants (USFWS 2017).

If the federally listed western prairie fringed orchid occurred or persisted within the permanent right-of-way, these plants could be permanently affected by vegetation management activities. Given the lack of appropriate habitat and known presence, impacts would be expected to be negligible.

Summary

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf would experience permanent minor effects associated with operation activities. Northern long-eared bats would experience some potential habitat loss and noise from operations that would result in permanent, negligible effects. Impacts on the Dakota skipper and Poweshiek skipperling are unlikely to occur, and impacts would be negligible. Vegetation management could potentially affect grassland habitats that could be used by dispersing rusty patched bumble bees, resulting in minor, permanent effects. Effects on the western prairie fringed orchid would be negligible based on the lack of presence and the scarcity of appropriate habitat. Impacts specific to Minnesota key habitats with the potential to affect federally listed species are described below under WAN and MBS Sites.

State-Listed Species

Endangered and Threatened Species

Two Minnesota-listed aquatic animals, the pugnose shiner (*Notropis anogenus*) and fluted-shell mussel (*Lasmigona costata*), and 14 Minnesota-listed plants could occur within the construction work area for the Applicant's preferred route and could be affected during construction and operation (Tables 6.3.5-23 and 6.3.5-24). The pugnose shiner and eight Minnesota-listed plants occur between Clearbrook and Carlton. Potential impacts and conservation measures applicable for Minnesota-protected species are summarized below for construction and operation.

Construction Impacts

The pugnose shiner and fluted shell mussel have been documented in the ROI for the Applicant's preferred route. The Applicant surveyed for mussels at sixteen sites along the Applicant's preferred route, and no state-protected mussels were found (Merjent 2015b).

If present at the time of construction, the pugnose shiner and fluted-shell mussel could be affected by instream construction or construction activities that take place in the adjacent uplands. Both species are vulnerable to any deterioration in water quality, especially increased siltation. Disturbance to the stream bottom could crush or suffocate the fluted-shell mussel and would temporarily increase turbidity that could reduce feeding efficiency and damage these sensitive aquatic animals. HDD is proposed for both of the stream crossings where these two species have been documented, so any impacts due to instream construction would be avoided. Increased turbidity and siltation could still occur due to surface runoff from construction work areas. Stringent erosion and sediment control practices will minimize these potential effects. Contaminated construction equipment and water used for hydrostatic testing could introduce invasive aquatic animals such as zebra and quagga mussels that could displace and reduce habitat quality for aquatic animals. To minimize the potential for introduction of invasive species, the Applicant would implement an invasive species minimization plan. In addition, environmental inspectors would monitor construction activities to ensure compliance with permit conditions and the invasive species plan, reducing the potential for introduction of invasive species during construction.

Based on the surface water crossing method that would be used and the BMPs that would be implemented for water withdrawals and discharge, construction impacts on the pugnose shiner and fluted-shell mussel would be temporary to short term and negligible.

Minnesota-listed plants were documented at 19 survey sites along the Applicant's preferred route. The Applicant would avoid all state-listed plants at 12 of these sites (Table 6.3.5-21). Avoidance strategies include, but are not limited to, workspace area reductions or modifications, exclusion fencing, and minor route centerline adjustments.

The Applicant would not avoid populations of six Minnesota-listed plants at seven survey sites and would consult with Minnesota DNR to complete the Endangered Species permit process for takings (Table 6.3.5-22). Takings include picking, digging, or destroying. If there are no feasible alternatives to takings, the Applicant would propose compensatory mitigation to reduce the impact to an acceptable level. The magnitude of the compensation required would be related to the degree of impact on each plant species (e.g., loss of the whole population at a site versus the loss of just a few individuals), and the statewide significance of the population at the site that would be affected. Types of acceptable compensatory mitigation for taking endangered or threatened plants in Minnesota could include:

- Funding state acquisition and protection of another site where the species occurs that is currently unprotected and vulnerable to destruction,
- Funding additional survey work to locate other sites, and
- Funding research to improve Minnesota DNR's understanding of the habitat requirements or protection needs of the species.

Summary

Measures to avoid or reduce construction impacts on Minnesota-protected animals and plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state protected species. No unavoidable impact on Minnesota-listed animals are expected. Minnesota-listed plants are known to occur within the construction work area. Therefore, effects on Minnesota-protected plants are expected to be permanent and major. All species could be indirectly affected by habitat loss and alteration.

Operations Impacts

Operation and maintenance activities include mowing, equipment maintenance, and invasive species control. Vegetation maintenance that removes riparian trees and large shrubs could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. State-protected plants that persist within the permanent right-of-way after construction could be permanently affected by vegetation maintenance activities; however, given the few occurrences and potential for avoidance within this area, overall impacts would be permanent but minor.

Table 6.3.5-21. Minnesota Endangered and Threatened Plant Populations Avoided by the Applicant's Preferred Route

Survey Site	County	Common and Scientific Name	Status[a]	How Avoided
North Dakota Border to Clearbrook				
L3R_03	Kittson	Red saltwort (*Salicornia rubra*)	Threatened	Enbridge modified workspace to avoid all 91 individuals of red saltwort. [a]
L3R_04	Kittson/Marshall	Red saltwort (*Salicornia rubra*)	Threatened	All 14,949 individuals of red saltwort are outside of workspace. [a]
L3R_08	Pennington	Sterile sedge (*Carex sterilis*)	Threatened	All individuals of sterile sedge are outside of workspace.
L3R_11	Red Lake	Clinton's bulrush (*Trichophorum clintonii*)	Threatened	All individuals of Clinton's bulrush are outside of workspace.
L3R_12	Polk	Whorled nutrush (*Scleria verticillata*)	Threatened	All 787 individuals of whorled nutrush are outside of workspace. [b]
L3R_14a	Clearwater	Handsome sedge (*Carex formosa*)	Endangered	Enbridge modified workspace to avoid 11 individuals of handsome sedge. Enbridge would use exclusion fencing to avoid one individual of handsome sedge within workspace. [b]
Clearbrook to Carlton				
L3X_22/23/58	Cass	Butternut (*Juglans cinerea*)	Endangered	Enbridge developed and adopted a route deviation to avoid all 24 individual butternut trees. [c]
		Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	There are 19 individuals of narrow triangle moonwort outside of the workspace. [d, e] Other individuals of this species will be affected.
L3X_25	Cass	Purple-flowered bladderwort (*Utricularia purpurea*)	Endangered	All individuals of purple flowered bladderwort are outside of workspace.
L3X_105	Cass	A bristle-berry (*Rubus fuller*)	Threatened	All individuals of a bristle-berry[f] are outside of workspace.
L3X_81a	Aitkin	Narrow triangle moonwort *(Botrychium lanceolatum* ssp. *angustisegmentum)*	Threatened	All individuals of narrow triangle moonwort are outside of workspace.

Table 6.3.5-21. Minnesota Endangered and Threatened Plant Populations Avoided by the Applicant's Preferred Route

Survey Site	County	Common and Scientific Name	Status[a]	How Avoided
		Bog bluegrass (*Poa paludigena*)	Threatened	Large numbers of bog bluegrass are outside of workspace. Other individuals of this species would be affected.
L3X_29	Carlton	A liverwort (*Trichocolea tomentella*)	Threatened	All individuals of *T. tomentella* are outside of workspace.
L3X_64	Carlton	Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	All individuals of narrow triangle moonwort are outside of workspace. [g]

Source: Minnesota DNR 2017c.

Notes:

No endangered or threatened plant populations were identified in the Carlton-to-Wisconsin border segment for the Applicant's preferred route.

[a] Number of individuals avoided is based on 2015 population count data. At survey site L3R_03, no individuals were observed during 2016 population counts.

[b] Number of individuals avoided is based on 2016 population count data.

[c] The avoidance of all butternut trees at survey site L3X_22/23/58 is based on 2013 survey data. Enbridge would install exclusion fencing at a 25-foot radius around one individual to avoid impacts on the root zone. This tree, approximately 25 feet tall with a 7-inch diameter at breast height, is within 7 feet of construction workspace and within 12 feet of additional temporary workspace. The tree size was measured on August 23, 2016. On the same site visit, there was no evidence of butternut canker (a lethal fungal disease) for this tree.

[d] Number of individuals avoided is based on a combination of 2015 and 2016 population count data.

[e] Enbridge would fence individuals that are outside of the workspace but within 5 feet of the workspace edge to facilitate avoidance during construction.

[f] This species was tentatively identified on June 20, 2016. Upon revisit on August 23, 2016, to confirm the species identification based on characteristics of mature primocanes, the individuals were no longer present due to logging of the area.

[g] No individuals were observed within workspace or within 5 feet of the edge of workspace during 2016 population counts.

Table 6.3.5-22. Minnesota Endangered and Threatened Plant Populations Potentially Affected by Construction and Operation of the Applicant's Preferred Route

Survey Site	County	Common and Scientific Name	Status[a]	Number of Avoided Individuals	Number of Affected Individuals
North Dakota Border to Clearbrook					
L3R_07	Marshall	Sterile sedge (*Carex sterilis*)	Threatened	268 [b]	47 [c]
L3R_12	Polk	Sterile sedge (*Carex sterilis*)	Threatened	657 [d]	292
		Beaked spikerush (*Eleocharis rostellata*)	Threatened	14,665 [d]	5,036
		Hair-like beak rush (*Rhynchospora capillacea*)	Threatened	18	106
L3R_14	Clearwater	Handsome sedge (*Carex formosa*)	Endangered	62 [c, d]	3 [c]
Clearbrook to Carlton					
L3X_99	Cass	Bog bluegrass (*Poa paludigena*)	Threatened	10 (3,500) [c, e]	4 [c]
L3X _22/23/58	Cass	Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	19 [b]	1 + 40 [f, g]
L3X _C1	Cass	Narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*)	Threatened	--	20 [f]
L3X _81a	Aitkin	Bog bluegrass (*Poa paludigena*)	Threatened	45 (7,000) [e]	242 [c]
		Bog bluegrass (*Poa paludigena*)	Threatened	257 (8,000) [e]	961 [c]
		Bog bluegrass (*Poa paludigena*)	Threatened	1,173 (5,000) [e]	744 [c]

Sources: Minnesota DNR 2017c.

Notes:

No Minnesota endangered or threatened plant populations were identified in the Carlton-to-Wisconsin border segment for the Applicant's preferred route.

[a] Status refers to Minnesota listing (E = endangered, T = threatened).

[b] Number of individuals is based on a combination of 2015 and 2016 population counts.

[c] Number of individuals is based on 2016 population count data.

[d] Enbridge would fence individuals that are outside of the workspace but within 5 feet of the workspace edge to facilitate avoidance during construction.

[e] First number is based on number of individuals avoided within site boundary used for 2016 population count. Second number (in parentheses) is based on estimated size of population beyond site boundary during 2016 occurrence surveys.

[f] Number of individuals is based on 2015 population count data.

[g] Enbridge would avoid all individual butternut trees at this site with the understanding that some individuals of narrow triangle moonwort (which have a shorter time to maturity and are less imperiled) would be affected as a result.

"--" = no occurrence

Table 6.3.5-23. Known Occurrences of Minnesota-Protected Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name	State Status[a]	Federal Status[b]	North Dakota Border to Clearbrook			Clearbrook to Carlton			Carlton to Wisconsin Border			Total		
				Con[c]	Op[c]	Within 0.5 Mile	Con[c]	Op[c]	Within 0.5 Mile	Con[c]	Op[c]	Within 0.5 Mile	Con[c]	Op[c]	Within 0.5 Mile
Fish															
Pugnose shiner	*Notropis anogenus*	THR	NA	--	--	--	1	1	1	--	--	--	1	1	1
Mollusks															
Fluted-shell mussel	*Lasmigona costata*	THR	NA	1	1	1	--	--	--	--	--	--	1	1	1

Source: Minnesota DNR 2016a.

Notes:

[a] THR = Threatened

[b] NA = not applicable

[c] Results for Applicant's preferred route within Minnesota based on Enbridge-provided footprints. Con = sum of pipeline construction work area, additional temporary workspaces, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves.

"--" = no occurrence

Table 6.3.5-24. Known Occurrences of Minnesota-Protected Plants within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name	State Status[a]	Federal Status[b]	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Total	
				Con	Op	Con	Op	Con	Op	Con	Op
Vascular Plants											
Beaked spikerush	*Eleocharis rostellata*	THR	NA	1	1	--	--	--	--	1	1
Bog bluegrass	*Poa paludigena*	THR	NA	--	--	--	--	1	1	--	--
Butternut	*Juglans cinerea*	END	NA	--	--	1	1	--	--	1	1
Hair-like beak rush	*Rhynchospora capillacea*	THR	NA	1	1	--	--	--	--	1	1
Narrow triangle moonwort	*Botrychium lanceolatum* ssp. *angustisegmentum*	THR	NA	--	--	3	2	--	--	3	2
Red saltwort	*Salicornia rubra*	THR	NA	1	--	--	--	--	--	1	--
Sterile sedge	*Carex sterilis*	THR	NA	2	2	--	--	--	--	2	2

Sources: Minnesota DNR 2016a; Merjent 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Results for Applicant's preferred route within Minnesota based on Enbridge-provided footprints. Con = sum of pipeline construction work area, additional temporary workspaces, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves

[a] END = Endangered, THR = Threatened

[b] NA = not applicable

"--" = no occurrence

Special Concern Species

Minnesota-listed special concern species that could be affected by construction and operation of the Applicant's preferred route include mollusks, mammals, birds, fish, and plants (Tables 6.3.5-25 and 6.3.5-26).

Construction Impacts

The greatest impacts on special concern species based on known occurrence would be to mammals, birds, amphibians, and fish that occur within the Clearbrook-to-Carlton segment, while plants would experience the greatest impact in the segment from the North Dakota border to Clearbrook (Tables 6.3.5-25 and 6.3.5-26).

Given the Applicant's surveys for bats, there are several known occurrences of bats along the Applicant's preferred route. Impacts on individuals or colonies of bats may occur if clearing or construction occurs when bats are using summer roosts. Bats could be disturbed by noise or human presence, causing them to abandon occupied roosts. Bats could also be injured or killed if occupied trees are cut down. Impacts could be substantial if trees with maternity colonies are destroyed or abandoned. Implementation of the conservation measure that protect the northern long-eared bat would protect these bats as well.

Potential impacts on the prairie vole include disturbance due to construction noise and activity and fatalities due to heavy equipment use and earth movement within the construction work area. Prairie voles are mainly restricted to relatively undisturbed dry grasslands and would not be present throughout the entire route. Effects on mammal populations likely would be temporary and minor with implementation of BMPs.

Of the six species of birds with the potential to occur, construction impacts likely would be the greatest for the prairie-chicken (*Tympanuchus cupido*), which is a ground-nesting grassland bird that is an uncommon year-round resident of Minnesota. If construction activities occur in grassland habitat during spring and summer when the birds are breeding and fledging, activities could disrupt breeding and destroy eggs, while construction post-hatch could kill or disrupt young within nests. The remainder of the special concern birds could also be disturbed by construction activities during the breeding season. Potential impacts include nest abandonment due to disturbance, and nest/egg destruction or bird fatalities due to tree removal or earth movement. Outside of the breeding season, special concern birds could be disturbed by noise or human presence. While construction activities would be temporary, impacts associated with reduced fecundity could be longer lasting for populations. Avoiding tree removal and impacts on grasslands during the breeding season will help to minimize impacts. Four-toed salamanders occur in isolated colonies in mature upland forests interspersed with sphagnum seepages, vernal ponds, or other fish-free habitats. Upland forests provide cover, foraging, and overwintering habitat, while egg deposition and larval development occur in wetlands. Potential impacts would be limited to areas with suitable habitat, and include fatalities due to construction activities and habitat destruction, degradation, and fragmentation due to tree clearing and earth movement. Measures to minimize disturbance include minimizing wetland impacts, herbicide application, and surface runoff.

Table 6.3.5-25. Known Occurrences of Special Concern Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name	Federal Status[a]	North Dakota Border to Clearbrook			Clearbrook to Carlton			Carlton to Wisconsin Border			Total		
			Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile
Mammals														
Big brown bat	*Eptesicus fuscus*	NA	--	--	--	4	3	7	--	--	--	4	3	7
Little brown myotis	*Myotis lucifugus*	NA	--	--	--	8	6	11	--	--	--	8	6	11
Northern long-eared bat	*Myotis septentrionalis*	THR	--	--	--	16	15	26	1	1	2	16	15	27
Prairie vole	*Microtus ochrogaster*	NA	--	--	--	--	--	1	--	--	--	--	--	1
Birds														
Greater prairie-chicken	*Tympanuchus cupido*	NA	--	--	--	9	8	11	--	--	--	9	8	11
Nelson's sparrow	*Ammodramus nelsoni*	BCC	2	2	2	--	--	-	--	--	--	2	2	2
Northern goshawk	*Accipiter gentilis*	NA	--	--	--	--	--	1	--	--	--	--	--	1
Red-shouldered hawk	*Buteo lineatus*	NA	--	--	--	--	--	1	--	--	--	--	--	1
Short-eared owl	*Asio flammeus*	BCC	1	1	1	--	--	--	--	--	--	1	1	1
Trumpeter swan	*Cygnus buccinators*	NA	--	--	--	--	--	2	--	--	--	-	-	2
Reptiles and Amphibians														
Four-toed salamander	*Hemidactylium scutatum*	NA	--	--	--	--	--	1	--	--	--	--	--	1
Fish														
Least darter	*Etheostoma microperca*	NA	--	--	--	1	1	2	--	--	--	--	--	2

Table 6.3.5-25. Known Occurrences of Special Concern Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name	Federal Status[a]	North Dakota Border to Clearbrook			Clearbrook to Carlton			Carlton to Wisconsin Border			Total		
			Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile
Insects														
A caddisfly	*Anabolia ozburni*	NA	--	--	--	1	--	1	--	--	--	--	--	1
Mollusks														
Black sandshell	*Ligumia recta*	NA	1	1	1	1	1	1	--	--	--	2	2	2
Creek heelsplitter	*Lasmigona compressa*	NA	2	2	2	1	1	2	--	--	--	3	3	4

Source: Minnesota DNR 2016a.

Notes:

Results for Applicant's preferred route within Minnesota based on Enbridge-provided footprints: Con = sum of pipeline construction work area, ATWS, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves.

[a] NA = not applicable

"--" = no occurrence

Table 6.3.5-26. Known Occurrences of Special Concern Plants within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route

Common Name	Scientific Name	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Total	
		Con	Op	Con	Op	Con	Op	Con	Op
Blunt sedge	*Carex obtusata*	1	1	--	--	--	--	1	1
False mountain willow	*Salix pseudomonticola*	2	1	--	--	--	--	2	1
Few-flowered spikerush	*Eleocharis quinqueflora*	2	2	--	--	--	--	2	2
McCalla's willow	*Salix maccalliana*	1	--	--	--	--	--	1	--
Least moonwort	*Botrychium simplex*	--	--	3	1	--	--	3	1
Northern single-spike sedge	*Carex scirpoidea*	2	2	--	--	--	--	2	2
Slender naiad	*Najas gracillima*	--	--	1	1	--	--	1	1
Small white lady's-slipper	*Cypripedium candidum*	1	1	--	--	--	--	1	1
Torrey's mannagrass	*Torreyochloa pallida*	--	--	2	2	--	--	2	2

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Results for Applicant's preferred route within Minnesota based on Enbridge-provided footprints: Con = sum of pipeline construction work area, additional temporary workspaces, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves.

"--" = no occurrence

General construction impacts and measures to avoid or reduce impacts on rare and protected species would be the same as those described for vegetation and fish and wildlife in Sections 5.2.3 and 5.3.3, respectively. Construction impacts on fish, aquatic insects, and mussels would be short term and negligible to minor during construction of the stream crossings.

Impacts on special concern plants would be the same as described above for federally and state-protected species; the impacts would be long term and minor.

Operations Impacts

Pipeline operation would include vegetation management and pipeline inspections that could include excavation and repair or replacement of sections of the pipeline. Vegetation management would be conducted to prevent trees and large shrubs from growing over the pipeline. Mammals, birds, and amphibians that depend on closed canopies may avoid the permanent right-of-way, which may act as a barrier to travel for some species, fragmenting SGCN habitat. General effects of fragmentation, including habitat loss and alteration, would be permanent and minor; these types of impacts are further described in Section 5.2.4. Impacts on greater prairie-chickens from habitat fragmentation would also be permanent, although clearing and maintenance of herbaceous cover may benefit this bird.

Species of Greatest Conservation Need

Approximately 30 percent of the segments from the North Dakota border to Clearbrook and from Clearbrook to Carlton contain areas within the WAN (Table 6.3.5-27). Most of the WAN habitats, 78 percent, that would be affected by construction and operation of the Applicant's preferred route are rated low-medium and medium, and no WAN habitats that would be affected by the route were rated high (Table 6.3.5-27). The lack of high-quality WAN habitats indicates that the habitat affected would not be likely to be a SCGN richness hotspot. Most of the 97 miles (about 77 percent) of the Applicant's preferred route that crosses through WAN habitats in Minnesota would occur within existing utility or transportation corridors; although 23 miles (23 percent) would cross a new right-of-way, potentially contributing to fragmentation of these WAN habitats. Most of the new corridor that crosses WAN habitats is between Clearbrook and Carlton. Overall impacts on WAN habitats, and the SGCN that they support, from construction and operation would be permanent and minor and caused by habitat loss and alteration, which is described in more detail in Section 5.2.4.

Table 6.3.5-27. Estimated Impacts on Wildlife Action Network Habitat from Construction and Operation of the Applicant's Preferred Route in Minnesota (acres)

Wildlife Action Network Rating	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Total	
	Con	Op	Con	Op	Con	Op	Con	Op
Low	121.4	42.8	141.7	61.3	9.8	3.5	272.9	107.6
Low-medium	302.6	116.9	424.6	182.4	--	--	727.2	299.4
Medium	47.3	20.4	440.5	205.0	--	--	487.8	225.4
Medium-high	38.8	17.6	34.1	18.7	--	--	72.9	36.3
High	--	--	--	--	--	--	--	--
WAN TOTAL	**510.2**	**197.8**	**1,040.9**	**467.4**	**9.8**	**3.5**	**1,560.9**	**665.1**
Segment total	***1,587.3***	***661.4***	***3,207.0***	***1,337.4***	***139.8***	***58.3***	***4,934.1***	***2,057.1***
Proportion in WAN	***32.1%***	***29.9%***	***32.5%***	***35.0%***	***7.0%***	***6.0%***	***31.6%***	***32.3%***

Source: Minnesota DNR 2016b.

Notes:

Enbridge-provided footprints: Con = sum of pipeline construction work area, ATWS, pipe yards, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves.

WAN = Wildlife Action Network

"--"= no occurrence

Minnesota Biological Survey Sites of Biodiversity Significance

The proportion of the Applicant's preferred route that occurs in an MBS Site within the ROI, the construction work area, and the permanent right-of-way are similar; therefore, the overall route would not disproportionately affect MBS Sites. Most of this area is rated as moderate. Construction would affect an estimated 877 acres of MBS Sites, and operations would affect an estimated 403 acres of these designated lands (Table 6.3.5-28). Potential impacts and conservation measures applicable for MBS Sites are described in Section 5.2.5.3 and summarized below for construction and operations.

Construction Impacts

Construction of the Applicant's preferred route would affect an estimated 877 acres of MBS Sites (Table 6.3.5-28). Outstanding MBS Sites (7 acres) within the construction work areas are primarily within the segment from the North Dakota border to Clearbrook in Pennington County. Within the construction work areas that overlap this MBS Site, MBS has documented a northern mixed cattail marsh, a rare type of wetland that is considered imperiled in Minnesota. However, this is in an existing utility corridor that has already been affected by previous construction activities.

All impacts on MBS Sites ranked high (78 acres) within the construction work areas would occur within the Clearbrook-to-Carlton segment of the Applicant's preferred route. This section crosses two MBS Sites ranked high: the LaSalle Creek MBS Site in Hubbard County and the Automba 1 MBS Site in Carlton County. Although an existing utility corridor crosses the LaSalle Creek MBS Site, the centerline of the Applicant's preferred route does not follow the existing corridor. Instead, the centerline creates a new crossing of LaSalle Creek, which would result in new impacts on high-quality rare native plant

communities, including habitat destruction and fragmentation. The Automba 1 MBS Site also contains an existing utility corridor, and the centerline of the Applicant's preferred route mostly follows this corridor. However, the construction work area would widen the existing corridor and result in habitat destruction.

Construction activities would result in destruction of native plant communities (and rare plants) within the construction work area and in the footprints of aboveground facilities. In turn, this would decrease the habitat available for rare animals that depend on the MBS Site. Depending on whether the corridor goes through the edge or the interior of the MBS Site and whether there is an existing utility corridor, construction activities would decrease the size of the MBS Site, fragment the MBS Site, or widen an existing corridor. Utility corridors can be effective barriers to animal movements, especially small mammals, amphibians, and reptiles. The wider the corridor, the more animals likely to be affected. Construction activities also may temporarily affect the hydrology of wetlands within the construction work area. Approximately 61 miles of the Applicant's preferred route would be constructed within new rights-of-way, creating a new corridor. Of this new corridor, 17 miles (28 percent) would cross moderate, high, and outstanding ranked MBS Sites, potentially fragmenting habitats within 14 MBS Sites—most of which (16 miles) is between Clearbrook and Carlton.

Construction activities also would affect the portions of MBS Sites that are adjacent to the construction work area. Potential impacts caused by surface runoff from the construction work area include increased sedimentation and the introduction or spread of invasive species. Sedimentation can affect surrounding uplands or wetlands, as well as waterways in the vicinity of the construction.

The Applicant has committed to preparation of the following plans, procedures, and general vegetation protection measures during construction:

- Co-locate the construction within and near existing utility corridors to minimize environmental impacts;
- Co-locate the Project with existing rights-of-way where feasible;
- Minimize and confine all construction equipment and vehicles to the approved designated construction work area and ATWS;
- Develop and adhere to Project-specific construction methods and procedures for vegetation clearing methods, including treatment of existing vegetation, topsoil segregation, storage, and reapplication;
- Restore preconstruction contours and use slope breakers, sediment barriers, mulch, geotextile fabric, and other erosion control devices to stabilize the disturbed areas during the vegetative regrowth phase and reduce runoff into the adjacent environment;
- Design and plan Project pipeline construction areas (parking, access, and temporary work areas) to reduce environmental impacts on sensitive plant communities;
- Inspect and clean all equipment prior to bringing it to the site to prevent the introduction and spread of invasive species; and
- Use weed-free mulch, topsoil, and seed mix.

Impacts on MBS Sites from construction activities would be short term (i.e., until vegetation cover is reestablished) and major given their occurrence along the Applicant's preferred route.

Table 6.3.5-28. Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity Significance within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for the Applicant's Preferred Route in Minnesota (acres)

MBS Sites Rating	North Dakota Border to Clearbrook			Clearbrook to Carlton			Carlton to Wisconsin Border			Applicant's Preferred Route Total		
	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile
Outstanding	5.8	3.0	664.1	1.6	1.6	381.2	0	0	0	7.4	4.6	1,045.4
High	0	0	461.1	77.6	39.7	5,731.2	0	0	0	77.6	39.7	6,192.3
Moderate	19.7	9.6	722.3	749.1	340.7	35,549.2	23.2	8.6	788.7	791.9	358.8	37,060.1
MBS SITES TOTAL	**25.4**	**12.6**	**1,847.5**	**828.3**	**381.9**	**46,244.9**	**23.2**	**8.6**	**788.7**	**876.9**	**403.2**	**44,297.8**
Segment total	***1,587.3***	***661.4***	***69,683.4***	***3,207.0***	***1,337.4***	***140,068.0***	***139.8***	***58.3***	***6,130.9***	***4,934.1***	***2,057.1***	***215,882.3***
Proportion in MBS Sites	***1.6%***	***1.9%***	***2.7%***	***25.8%***	***28.6%***	***33.0%***	***16.6%***	***14.8%***	***12.9%***	***17.8%***	***19.6%***	***20.5%***

Source: Minnesota DNR 2016h.

Notes:

Enbridge-provided footprints: Con = sum of pipeline construction work area, additional temporary workspaces, pipe yards, and temporary access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, pump stations, and valves.

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance

Operations Impacts

Operations would continue to affect an estimated 403 acres of MBS Sites (Table 6.3.5-11). Vegetation maintenance to remove trees and large shrubs within the pipeline permanent right-of-way would reduce the habitat availability for rare animals. The utility corridor would be a permanent habitat loss and would continue to be a barrier or impediment to travel for some animals.

Conversely, the pipeline corridor can provide easy access to more remote MBS Sites and may result in increased human use of the corridor and the MBS Sites. This can negatively affect the ecological integrity of these MBS Sites by causing habitat degradation (e.g., operation of off-road vehicles in native plant communities) or by increasing the spread of invasive species.

Long-term vegetation management during operation would result in a major permanent change to MBS Sites.

Minnesota Scientific and Natural Areas

No impact on SNAs would occur from construction or operations of the Applicant's preferred route.

6.3.5.3.2 Route Alternatives (from Clearbrook to Carlton)

The only segment in Minnesota where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton. The impacts relevant to unique natural resources for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, and rusty patched bumble bee have the potential to occur within or near RA-03AM (Table 6.3.5-5). The types of impacts on all of these species from construction and operation of RA-03AM would be the same as those described above for the Applicant's preferred route. An evaluation of potential effects for each species is provided below.

Construction Impacts

The Canada lynx and gray wolf would experience temporary minor effects from disturbance by construction noise and activity associated with construction of RA-03AM. Most of the route (95 percent) would be co-located with existing pipeline, electrical transmission line, or road corridors that previously have been disturbed by construction. No large-block forested habitats occur within the non-co-located sections, and none would be fragmented by construction of the RA-03AM route. Typical conservation measures to reduce construction disturbance to gray wolves include stopping construction if a gray wolf or possible den site is observed until the wolf leaves the area, and reporting any wolf sighting to USFWS, USACE, and Minnesota DNR.

Current use of portions of RA-03AM by northern long-eared bats was confirmed by surveys performed by Merjent from 2014 to 2016 (Merjent 2015b, 2015c, 2016b). Northern long-eared bats were confirmed at acoustic survey sites in Carlton and Hubbard counties, where the RA-03AM route would be the same as the Applicant's preferred route (Merjent 2014b, 2015b). In 2015, mist-net and telemetry surveys were completed at 13 sites along the Applicant's preferred route. Northern long-eared bats were captured for telemetry surveys at sites in Carlton County. If northern long-eared bats occur in the construction area, temporary minor impacts could occur if individuals or colonies of bats are disturbed

by noise or human presence, causing them to abandon occupied tree cavities. If bats are injured or killed, or if occupied trees or maternity roosts are destroyed or abandoned, the impacts would be short term and major. Conservation measures to reduce potential impacts on northern long-eared bats include protecting known, occupied maternity roost trees and other trees within a 150-foot radius around maternity roost trees during the pup season from June 1 to July 31.

The rusty patched bumble bee could experience temporary minor effects associated with vegetation clearing and the use of construction equipment and vehicles. Vegetation clearing and replacement with non-native ground covers could injure or kill these butterflies and bees, and could remove forage plants. The RA-03AM route would not cross any current high use areas for rusty patched bumble bees, and construction is not likely to directly or indirectly affect any individuals or current high use areas. The RA-03AM route would cross current potential low use areas where rusty patched bumble bees may disperse from adjacent high use areas or where their occurrence is uncertain. Construction could render some potentially used habitat in the dispersal area as unusable, and the rusty patched bumble bee could experience short-term minor impacts. The rusty patched bumble bee may benefit from measures designed to conserve the species within the dispersal area and USFWS may recommend surveys. Although habitat surveys have not been completed for RA-03AM, no native prairie habitats appear to occur within the area that would be crossed by RA-03AM based on Minnesota DNR mapped native plant communities (Minnesota DNR 2017b). Conservation measures that would benefit the rusty patched bumble bee within these potential dispersal areas during construction include restoration and maintenance of high-quality habitat through control of invasive species, and restoration that includes a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Summary. Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf would experience temporary minor effects associated with noise and human activities during construction. While habitat fragmentation represents a permanent impact on all species, the impact would be minor based on the limited extent of the fragmentation. Northern long-eared bats are known to occur along RA-03AM; with implementation of conservation measures, they would experience temporary minor effects from construction. Effects on potential habitat for rusty patched bumble bees could be short term and minor. Impacts specific to Minnesota key habitats with the potential to affect federally listed species are described below under WAN and MBS Sites.

Operations Impacts

Project-related noise and increased human activity during operations and maintenance activities could interrupt foraging and reproductive activities for the gray wolf and Canada lynx. Post-construction disturbances, such as public and private use of all-terrain vehicles and snow machines along the right-of-way, could increase human interactions, resulting in permanent minor impacts on Canada lynx and gray wolf.

Operations impacts on the northern long-eared bat could include continued habitat loss or alteration and disturbance from noise and activity at aboveground facilities and from right-of-way inspection overflights or ground surveillance. Human activities during operations typically would occur during daylight hours; therefore, operations activities would not interrupt foraging activities, and impacts would be permanent and negligible.

The rusty patched bumblebee could experience permanent, negligible effects associated with ongoing vegetation clearing and integrity digs. The Applicant's preferred route would not cross any current high use areas for rusty patched bumble bees, and operations are not likely to directly or indirectly affect any individuals or current high use areas. The Applicant's preferred route crosses through current potential low use areas where rusty patched bumble bees may disperse from current high use areas or where their occurrence is uncertain. Vegetation management could affect grassland habitats that could be used by dispersing rusty patched bumble bees, resulting in permanent minor effects. Conservation measures for the rusty patched bumble bee may benefit the species within the dispersal area, and USFWS may recommend surveys. Conservation measures that would benefit the rusty patched bumble bee within these potential dispersal areas during operations include limiting vegetation management in high-quality habitat during the active season (March through September), using a minimum of 8 to 10 inches cutting height for mowers, and careful and targeted pesticide use as described above (USFWS 2017).

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA.

State-Listed Species

Endangered and Threatened Species

Minnesota-protected animals occurring within the ROI for RA-03AM include two reptiles, four mollusks, and eight plants (Tables 6.3.6-6 and 6.3.5-29).

Table 6.3.5-29. Known Occurrences of Minnesota-Protected Species within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-03AM

Common Name	Scientific Name	State Status[a]	Federal Status[b]	Con[c]	Op[d]	Within 0.5 Mile
ANIMALS						
Amphibians and Reptiles						
Blanding's turtle	*Emydoidea blandingii*	THR	NA	5	5	8
Wood turtle	*Glyptemys insculpta*	THR	NA	--	--	1
Mollusks						
Elktoe	*Alasmidonta marginata*	THR	NA	--	--	2
Fluted-shell	*Lasmigona costata*	THR	NA	1	1	5
Mucket	*Actinonaias ligamentina*	THR	NA	1	1	5
Spike	*Elliptio dilatata*	THR	NA	--	--	1
PLANTS						
Beaked spikerush	*Eleocharis rostellata*	THR	NA	--	--	1
Bog bluegrass	*Poa paludigena*	THR	NA	1	1	1
Bristle-berry	*Rubus fulleri*	THR	NA	--	--	1
Hair-like beak rush	*Rhynchospora capillacea*	THR	NA	--	--	1
Kitten-tails	*Besseya bullii*	THR	NA	--	--	1
Narrow triangle moonwort	*Botrychium lanceolatum* ssp. *angustisegmentum*	THR	NA	--	--	1
Snailseed pondweed	*Potamogeton bicupulatus*	END	NA	--	--	1
Sterile sedge	*Carex sterilis*	THR	NA	--	--	1

Sources: Minnesota DNR 2016a; Merjent 2016a.

Notes:

[a] THR = Threatened

[b] NA = not applicable

[c] Con = estimated construction impact area in acres based on 120-foot-wide construction work area.

[d] Op = estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Construction Impacts. The Blanding's turtle (*Emydoidea blandingii*) and wood turtle (*Glyptemys insculpta*) inhabit aquatic habitats and adjacent uplands. If they are present, construction activities could result in direct mortality to turtles or nests, which could be crushed by machinery, buried under excavated soil, or trapped in trenches. Surface water disturbances during construction also would affect aquatic habitats potentially used by turtles. Applicable conservation measures that would avoid and minimize potential impacts on Blanding's turtles and wood turtles include:

- Turtles in imminent danger should be moved, by hand, out of harm's way;

- Silt fencing should be set up to keep turtles out of construction areas;
- If erosion control mesh will be used, limit the mesh to wildlife-friendly materials; Minimize access and maintenance roads to a minimum to reduce road kill (tunnels should be considered in areas with concentrations of turtle crossings);
- Roads should be ditched, not curbed or below grade;
- Culverts between wetland areas, or between wetland areas and nesting areas, should be 36 inches or greater in diameter, and elliptical or flat-bottomed;
- Roads crossing streams should be bridged, or use oversized culverts (at least twice as wide as the normal width of open water) and flat-bottomed or elliptical;
- Check trenches prior to backfilling to avoid burying trapped turtles, and return the site to the original grade; and
- Revegetate with native grasses and forbs (Minnesota DNR 2008).

Impacts on turtles during construction likely would be short-term and minor. Measures to avoid or reduce construction impacts on Minnesota-listed animals and plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species.

Mussel surveys were not completed for the route alternatives. Effects on mollusks from construction would depend on whether live mussels are present at the crossing locations and the method used to construct the crossing. Four state-listed threatened mussels have been documented within 0.5 mile of RA-03AM and may occur at stream crossings if suitable habitat is present. If stream crossings are constructed using the HDD method and standard BMPs are implemented for surface runoff and water withdrawals and discharges, construction impacts would be temporary and negligible for state-listed mollusks. If the wet or dry open-cut crossing methods are used, mussel beds could be destroyed; and temporary increases in turbidity could cause damage to gills, cover mussels with sediment, and decrease habitat suitability.

Botanical surveys were not conducted along RA-03AM, except for where it overlaps with the Applicant's preferred route. Minnesota-listed plants were documented during surveys at one site for RA-03AM where it overlaps with the Applicant's preferred route. Direct impacts on the occurrence of narrow triangle moonwort (*Botrychium lanceolatum* ssp. *angustisegmentum*) at the site in Carlton County would be avoided because the plants are outside of the construction work area (Table 5.2.5-16). The Minnesota DNR NHIS data also contain a known occurrence from 1991 of bog bluegrass potentially within the construction work area in a northern wet ash swamp in a moderate rated MBS Site in Morrison County. The current size and extent of this population are unknown. If construction proceeds in this area, botanical surveys likely would be needed to inform the takings permit process. If the bog bluegrass occurs within the construction work area, it could be destroyed during grubbing, grading, and trenching; and habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction. Nevertheless, impacts on bog bluegrass could be permanent and major.

Other state-protected plants have been documented within the ROI and these species may occur within the construction work area if suitable habitat is present. Given that there are 368 acres of MBS Sites (a measure of rare species habitat) within the construction area of RA-03AM, it is likely that additional state-protected plants would be discovered if surveys were conducted along this route. If state-protected plants are present, the plants have the potential to be directly affected by construction. Some construction impacts may be avoidable through survey and flagging and through refinement of the construction work areas. BMPs to minimize overall impacts on vegetation and prevent the spread of noxious weeds and invasive plants would be implemented as noted above. For state-protected plants within the construction work area, impacts could range from short term to permanent and minor to major.

Measures to avoid or reduce construction impacts on state-protected animals and plants would be developed in consultation with the appropriate state agencies, if required, to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species.

Summary. Measures to avoid or reduce construction impacts on Minnesota-protected animals and plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state protected species. Impacts on turtles would be minor and short-term. Construction impacts on mussels would depend on the location and crossing method employed and would range from no impact to temporary and negligible impacts when HDD is used, to short term and minor if mussels occur at a location crossed using the open-cut method. No impact would occur on the narrow triangle moonwort in Carlton County, as it is outside of the construction work area. Impacts on bog bluegrass could be permanent and major. Impacts on any other state-protected plants that may occur in the construction work area could range from short term to permanent and minor to major depending on the implementation of BMPs to minimize overall impacts and to prevent the spread of noxious weeds and invasive plants.

Operations Impacts. Operations and maintenance activities that could result in impacts include mowing, equipment maintenance, inspection of the permanent right-of-way, integrity digs to repair or replace segments of pipe, and invasive species control.

Operation of RA-03AM has the potential to impact state-listed threatened turtles. Vegetation management that prevents trees and large shrubs from reestablishing in riparian habitats could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. Vegetation management and integrity digs could crush turtle adults, nests, and eggs. Mowing can kill turtles and make it easier for predators to locate turtles.

Conservation measures related to vegetation management in infrequently mowed areas along access roads and the permanent pipeline right-of-way include:

- Use of mechanical methods (chemicals should not be used), and
- Limit maintenance periods to the fall through spring (i.e., after October 1 and before June 1) (Minnesota DNR 2008).

Potential impacts on the Blanding's turtle and the wood turtle during operations could be minor and permanent. If bog bluegrass continues to persist within the permanent right-of-way, these plants would be permanently affected by vegetation management. All state-listed species could be indirectly affected by habitat loss and alteration resulting from maintenance of the permanent right-of-way. Measures to avoid or reduce construction impacts on Minnesota-listed animals and plants would be developed in

consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state protected species. Overall impacts would be permanent and minor.

Special Concern Species

Minnesota special concern animals and plants within the ROI for RA-03AM are listed in Tables 6.3.5-7 and 6.3.5-8. NHIS occurrences for Minnesota-listed special concern species that could be affected by construction and operation of RA-03AM are listed in (Tables 6.3.5-30 and 6.3.5-31).

Table 6.3.5-30. Known Occurrences of Special Concern Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-03AM

Common Name	Scientific Name	Federal Status[a]	Con[b]	Op[c]	Within 0.5 Mile
Mammals					
Big brown bat	*Eptesicus fuscus*	NA	2	1	3
Little brown myotis	*Myotis lucifugus*	NA	2	1	3
Northern long-eared bat	*Myotis septentrionalis*	THR	2	2	3
Birds					
Greater prairie-chicken	*Tympanuchus cupido*	NA	1	1	3
Northern goshawk	*Accipiter gentilis*	NA	--	--	1
Red-shouldered hawk	*Buteo lineatus*	NA	--	--	3
Trumpeter swan	*Cygnus buccinator*	NA	--	--	1
Fish					
Gilt darter	*Percina evides*	NA	--	--	2
Lake sturgeon	*Acipenser fulvescens*	NA	--	--	1
Least darter	*Etheostoma microperca*	NA	--	--	1
Southern brook lamprey	*Ichthyomyzon gagei*	NA	--	--	2
Insects					
A caddisfly	*Anabolia ozburni*	NA	--	--	1
Mollusks					
Black sandshell	*Ligumia recta*	NA	3	3	7
Creek heelsplitter	*Lasmigona compressa*	NA	6	6	13
Round pigtoe	*Pleurobema sintoxia*	NA	1	1	4

Source: Minnesota DNR 2016a.

Notes:

[a] NA = not applicable, THR = Threatened

[b] Con = estimated construction impact area in acres based on 120-foot-wide construction work area.

[c] Op = estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Table 6.3.5-31 Known Occurrences of Special Concern Plants within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-03AM

Common Name	Scientific Name	Federal Status[a]	Construction[b]	Operations[c]
Autumn fimbry	*Fimbristylis autumnalis*	NA	1	1
Least moonwort	*Botrychium simplex*	NA	1	--
Twig rush	*Cladium mariscoides*	NA	1	1

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Protected plant surveys have not been conducted for the route.

[a] NA = not applicable

[b] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[c] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

Construction Impacts. Construction impacts on bats, birds, fish, insects, and mollusks would generally be the same as described above for the Applicant's preferred route. There are three additional fish species and one additional mussel species that are known to occur in the ROI of RA-03AM, but impacts would be the same as discussed for the Applicant's preferred route. There are no known occurrences of the prairie vole or four-toed salamander in the ROI of RA-03AM, so impacts on these species would not be anticipated.

There are known occurrences of 13 Minnesota special concern plants within the ROI for RA-03AM and these species may occur within the construction work area if suitable habitat is present. Three of the species have been documented within the construction work area and could be destroyed by construction activities. These three plants occur in forests – least moonwort (*Botrychium simplex*), peatlands – twig rush (*Cladium mariscoides*), and wetlands – autumn fimbry (*Fimbristylis autumnalis*). Given the 368 acres of MBS Sites (habitat for rare species) within the construction work area of RA-03AM and that botanical surveys were not conducted along the entire route, it is likely that additional special concern plants would be documented within the construction work area if surveys were conducted. The list of special concern species known to occur in the ROI for RA-03AM is very similar to the list for the ROI of the Applicant's preferred route. Potential Impacts on special concern plants would be the same as described above for the Applicant's preferred route.

Operations Impacts. Pipeline operation would require ongoing vegetation management to prevent trees and large shrubs from growing over the pipeline. Mammals and birds that depend on closed canopies may avoid the permanent right-of-way, which may act as a barrier to travel for some species, and fragment the habitats of the area. In addition, vegetation management that prevents trees and large shrubs from reestablishing in riparian habitats could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. Plants that persist within the permanent right-of-way after construction could be permanently affected by vegetation management activities. Overall, impacts on special concern species from operations activities would be permanent and minor.

Species of Greatest Conservation Need

Compared to the other route alternatives, the lowest proportion (12 percent) of WAN occurs in the construction work area and permanent right-of-way for RA-03AM (Table 6.3.5-32). The majority of WAN habitats that would be affected by construction and operations are rated low-medium and medium. The scarcity of high-quality WAN lands indicates that the habitat affected probably would not be SCGN richness hotspots. Although RA-03AM is the only alternative that could affect high-rated WAN habitats that may provide SCGN richness hotspots, the area affected would be less than 1 acre. All of the WAN habitats crossed by RA-03AM occur within existing pipeline corridors and therefore have experienced previous disturbances. Overall impacts on WAN land, and the SGCN that they support, from construction and operations would be permanent and minor based on habitat loss and alteration.

Table 6.3.5-32 Estimated Impacts on Wildlife Action Network Habitat within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-03AM (acres)

Wildlife Action Network Ratings	Construction[a]	Operations[b]
Low	1.1	0.4
Low-medium	257.4	107.1
Medium	194.0	80.7
Medium-high	29.3	12.2
High	0.7	0.3
WAN TOTAL	**482.6**	**200.7**
RA-03AM total	***4,000.4***	***1,666.9***
Proportion in WAN	***12.1%***	***12.0%***

Source: Minnesota DNR 2016b.

Notes:

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

WAN = Wildlife Action Network

Minnesota Biological Survey Sites of Biodiversity Significance

The proportion of the RA-03AM route between Clearbrook and Carlton that passes through the MBS Sites within the ROI, the construction work area, and the permanent right-of-way are roughly similar (Table 6.3.5-33); therefore, the overall route would not disproportionately affect MBS Sites. The majority of the affected area is rated as moderate. Potential impacts and conservation measures applicable for MBS Sites are described in Section 5.2.5 and summarized below for construction and operation.

Table 6.3.5-33 Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity Significance within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-03AM (acres)

MBS Site Rating	Construction[a]	Operations[b]	Within 0.5 Mile
Outstanding	0.6	0.3	595.3
High	38.0	15.9	3,132.4
Moderate	329.2	139.5	20,478.7
MBS SITES TOTAL	**367.8**	**155.6**	**24,206.3**
RA-03AM total	***4,000.4***	***1,666.9***	***175,189.0***
Proportion in MBS Sites	***9.2%***	***9.3%***	***13.8%***

Source: Minnesota DNR 2016h.

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance

Construction Impacts

Construction would affect 368 acres of MBS Sites in the construction work area (Table 6.3.5-33). Construction activities in the construction work area likely would reduce the overall diversity of the MBS Site and create a barrier to animal movements, as described above for the Applicant's preferred route. MBS Sites provide habitat for rare species and may contain additional occurrences of state-protected species.

Of the 26 miles of the RA-03AM route that crosses through moderate to outstanding rated MBS Sites, all but 1 mile would be within an existing pipeline, electrical transmission line, or road corridor. Construction impacts on MBS Sites would be short term and minor given their persistent occurrence along the route.

Operations Impacts

Operations would continue to affect an estimated 207 acres of MBS Sites previously affected during construction. Operations vegetation maintenance to remove trees and large shrubs within the pipeline permanent right-of-way would reduce the capacity for these sites to provide diverse habitats for wildlife, including habitats for protected, conservation concern, and rare animals. The permanent right-of-way would represent a permanent habitat loss and would continue to be a barrier or impediment to travel for some animals. Increased human access, as described above for the Applicant preferred route, could negatively affect the ecological integrity of these MBS Sites by causing habitat degradation or increasing the spread of invasive species.

Long-term vegetation management would result in a minor permanent change to MBS Sites.

Minnesota Scientific and Natural Areas

RA-03AM is the only route alternative that would cross an SNA, potentially affecting 0.4 acre of the Lake Alexander Woods SNA during construction and 0.2 acre during operations. Minnesota DNR would not grant a license or easement to cross any SNA; therefore, the RA-03AM route would need to be modified to avoid this crossing.

Route Alternative RA-06

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, rufa red knot, and rusty patched bumble bee have the potential to occur within the ROI for RA-06 (Table 6.3.5-9). The types of impacts on Canada lynx, gray wolf, northern long-eared bat, and rusty patched bumble bee from construction and operation of RA-06 would be the same as those described for the Applicant's preferred route. All of the Clearbrook-to-Carlton segment would be within a new pipeline corridor, much of it crossing through areas with no previous ground disturbance. In addition, construction of RA-06 would fragment forested large-block habitats, which could reduce habitat suitability for Canada lynx. Impacts on these species are summarized below, along with a discussion of impacts specific to the rufa red knot.

Construction Impacts

The Canada lynx and gray wolf would experience temporary minor effects associated with construction of RA-06. RA-06 is not co-located with other pipelines, utilities, or roads along much of its length and would cross 60 large-block habitats that would be fragmented by construction. This would affect more than 100 acres along approximately 114 miles (or about 58 percent of the route) between approximately MPs 140.0 and 295.0. Habitat fragmentation could reduce habitat suitability for the Canada lynx.

As described above for the Applicant's preferred route, typical conservation measures to reduce construction disturbance to gray wolves include stopping construction if a gray wolf or possible den site is observed within 1 mile of the construction area; enforcing the stop work order until the wolf leaves the area; and reporting any wolf sighting to USFWS, USACE, and Minnesota DNR.

NHIS data document one occurrence of the northern long-eared bat within the construction work area for RA-06. If northern long-eared bats occur in the construction area during the construction period, temporary minor impacts could occur if individuals or colonies of bats are disturbed by noise or human presence and abandon occupied tree cavities. Short-term major impacts could result if bats are injured or killed, or if occupied trees or maternity roosts are destroyed or abandoned. Conservation measures to reduce potential impacts on northern long-eared bats include protecting known, occupied maternity roost trees and other trees within a 150-foot radius around maternity roost trees during the pup season from June 1 to July 31.

The rusty patched bumble bee could experience temporary minor effects associated with vegetation clearing and the presence of construction equipment and vehicles. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these bumble bees, and remove forage plants. Although habitat surveys have not be completed for RA-06, no native prairie habitats appear to be crossed (Minnesota DNR 2017b). The route would cross within about 180 feet of a current high use area in Clearwater County within the bee dispersal area. Construction could render some potentially used habitat in the dispersal area as unusable, resulting in short-term minor impacts on the rusty patched bumble bee. Conservation measures may benefit the species within the dispersal area, and USFWS may recommend surveys. Conservation measures that would benefit the rusty patched bumble bee within this dispersal area during construction include limiting vegetation management in high-quality habitat during the active season (March through September); using a minimum of 8 to 10 inches cutting height for mowers; and careful and targeted pesticide use, as described above (USFWS 2017).

The rufa red knot may use wetlands, cultivated fields, or waterbodies in the vicinity of the RA-06 as migratory stopover habitat. Construction activities have the potential to disturb rufa red knots, especially if disturbance coincides with important migration stopover locations. Noise or presence of humans and equipment during construction could cause rufa red knots to startle and flush from wetlands or fields or to avoid the area entirely. Short-term impacts on wetlands and cultivated fields from clearing during construction could affect the availability of foraging and sheltering habitats. However, wetlands in the vicinity of the RA-06 are predominantly forested, which is not the preferred habitat of the rufa red knot; therefore, construction would be unlikely to affect overall availability of stopover habitat for rufa red knots, and the impacts on an individual bird's survival or reproductive capacity would be short term and negligible.

Summary. Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf would experience temporary minor effects associated with construction activities. Northern long-eared bats are known to occur in the ROI for RA-06; with implementation of conservation measures, the species would experience temporary minor effects from construction. Potential effects on rusty patched bumble bee habitat could be short term and minor. Potential impacts on the rufa red knot would be short term and negligible based on a lack of preferred habitat. Potential impacts specific to Minnesota key habitats that may affect federally listed species are described below under WAN and MBS Sites.

Operations Impacts

The gray wolf, northern long-eared bat, and rufa red knot would experience permanent minor effects associated with disturbance from Project-related noise and increased human activity during operations. Post-construction disturbances, such as public and private use of all-terrain vehicles and snow machines along the permanent right-of-way, could increase human interaction with Canada lynx and wolf, resulting in permanent minor impacts on the Canada lynx and gray wolf. Habitat fragmentation from the pipeline corridor would represent a permanent minor to major impact that may result in major impacts on the Canada lynx, especially if the permanent right-of-way facilitates human access and recreational use.

The rusty patched bumblebee could experience permanent minor effects associated with ongoing vegetation clearing activities. The Applicant's preferred route would not cross any current high use areas for rusty patched bumble bees, and operations are not likely to directly or indirectly affect any individuals or current high use areas. The Applicant's preferred route crosses current potential low use areas where rusty patched bumble bees may disperse from current high use areas or where their occurrence is uncertain. Vegetation management could affect grassland habitats that could be used by dispersing rusty patched bumble bees, resulting in permanent minor effects. Conservation measures may benefit the species within the dispersal areas, and USFWS may recommend surveys. Conservation measures that would benefit the rusty patched bumble bee within these potential dispersal areas during operations include limiting vegetation management in high-quality habitat during the active season (March through September); using a minimum of 8 to 10 inches cutting height for mowers; and careful and targeted pesticide use, as described above (USFWS 2017).

Summary. Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. Operations impacts specific to

Minnesota key habitats with the potential to affect federally listed species, including the Canada lynx and rusty patched bumble bee, are described below.

State-Listed Species

Endangered and Threatened Species

Minnesota-protected animals that occur within the ROI for RA-06 include the pugnose shiner and five protected plant species[16] (Table 6.3.6-10). Impacts on these species from construction and operation of RA-06 would be the same as described for the Applicant's preferred route; a conclusion of effects is summarized below.

Construction Impacts. Effects on the pugnose shiner from construction would be the same as described for the Applicant's preferred route. If surface waters are crossed by the HDD method and BMPs are in place for water withdrawals and discharge, construction impacts on the pugnose shiner would be temporary and negligible.

Based on the Minnesota DNR NHIS data, there are no known occurrences of state-protected plants within the RA-06 construction work area between Clearbrook and Carlton. However, given that there are 1,160 acres of MBS Sites (habitat for rare species) within the construction work area for RA-06, it is likely that additional state-protected plants would be found within the construction work area if botanical surveys were conducted. If state-listed plants are present within the construction zone, they could be destroyed during grubbing, grading, and trenching activities. In addition, their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants. Noxious weed and invasive plant management measures would be in place during and after construction. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include measures to control noxious weeds and invasive plants during construction. Some construction impacts may be avoidable through surveys, flagging areas of concern, and refinement of the construction work areas. Potential impacts on state-protected plants would be short term and minor.

Measures to avoid or reduce construction impacts on Minnesota-listed animals and plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species.

Operations Impacts. Vegetation maintenance that removes riparian trees and large shrubs could increase stream temperatures by removing shade, which would reduce habitat suitability for the pugnose shiner. If listed plants persist within the permanent right-of-way, they would be permanently affected by vegetation maintenance activities; however, given their expected limited distribution within this area, overall impacts would be minor. All state-listed species could be indirectly affected by habitat loss and alteration resulting from maintenance of the permanent right-of-way and periodic integrity digs. Measures to avoid or reduce construction impacts on Minnesota-listed animals and plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state protected species.

[16] Protected plant surveys have not been completed for the route alternatives.

Special Concern Species

Minnesota special concern animals and plants within the ROI for RA-06 are listed in Tables 6.3.5-11 and 6.3.5-12. NHIS occurrences for Minnesota-listed special concern animals that could be affected by construction and operation of RA-06 are listed in Table 6.3.5-34. There are no known occurrences of special concern plants in the construction work area or permanent right-of-way for RA-06; however, protected plant surveys have not been completed for the route.

Table 6.3.5-34. Known Occurrences of Special Concern Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-06

Common Name	Scientific Name	Federal Status[a]	Construction[b]	Operations[c]	Within 0.5 Mile
Mammals					
Big brown bat	*Eptesicus fuscus*	NA	--	--	1
Little brown myotis	*Myotis lucifugus*	NA	--	--	1
Northern long-eared bat	*Myotis septentrionalis*	THR	1	1	2
Birds					
Northern goshawk	*Accipiter gentilis*	NA	--	--	1
Trumpeter swan	*Cygnus buccinator*	NA	--	--	1
Amphibians and Reptiles					
Four-toed salamander	*Hemidactylium scutatum*	NA	--	--	1
Fish					
Least darter	*Etheostoma microperca*	NA	1	1	1
Mollusks					
Black sandshell	*Ligumia recta*	NA	1	1	1

Source: Minnesota DNR 2016a.

Notes:

Protected plant surveys have not been conducted for the route.

[a] NA = not applicable, THR = Threatened

[b] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[c] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Construction Impacts. Construction impacts on state-listed special concern animals would be the same as described above for the Applicant's preferred route. Impacts on state-listed special concern plants would be similar to those for the Applicant's preferred route, although there is some difference in the species that would be potentially affected.

Operations Impacts. Mammals and birds that depend on closed canopies may avoid the maintained permanent right-of-way, which may act as a barrier to travel for some species and may fragment habitats. In addition, vegetation management that prevents riparian trees and large shrubs from reestablishing could increase stream temperatures by removing shade, which would reduce habitat

suitability for aquatic animals. Habitat would be permanently altered by vegetation management, resulting in long-term minor impacts on special concern animals and plants that occur in the permanent right-of-way. Overall, impacts on special concern species from operations activities would be permanent and minor.

Species of Greatest Conservation Need

Approximately 41 percent of the route for RA-06 occurs within WAN areas (Table 6.3.5-35). The majority of WAN habitats that would be affected by construction and operations are rated low-medium and medium; no high-rated WAN lands would be affected by the RA-06 route. The lack of high-quality WAN lands indicates that the habitat affected would not likely be SCGN richness hotspots. About 66 miles (or 81 percent) of the approximately 81 miles of WAN habitats that would be crossed by RA-06 would be within a new pipeline corridor. Therefore, overall construction- and operations-related impacts on WAN land, and the SGCN that they support, would be permanent and major, and caused by habitat loss and alteration.

Table 6.3.5-35. Estimated Impacts on Wildlife Action Network Habitat within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-06 (acres)

Wildlife Action Network Ratings	Construction[a]	Operations[b]
Low	201.3	83.4
Low-medium	442.5	183.9
Medium	395.2	164.5
Medium-high	135.8	56.7
High	--	--
WAN TOTAL	**1,174.8**	**488.5**
RA-06 total	***2,861.8***	***1,192.4***
Proportion in WAN	***41.1%***	***41.0%***

Source: Minnesota DNR 2016b.

Notes:

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

WAN = Wildlife Action Network

"--" = no occurrence

Minnesota Biological Survey Sites of Biodiversity Significance

A high proportion (40 percent) of the RA-06 construction and operations impact area is within MBS Sites, similar to the proportion within the ROI (Table 6.3.5-36). The majority of the MBS Sites are rated moderate, but approximately 10 percent of the construction work area is within outstanding and high rated MBS Sites. All of the Clearbrook-to-Carlton segment would be within a new pipeline corridor, much of it crossing through areas with no previous ground disturbance.

Table 6.3.5-36. Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity Significance within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-06 (acres)

MBS Site Rating	Construction[a]	Operations[b]	Within 0.5 Mile
Outstanding	58.7	24.4	2,979.3
High	225.6	93.1	9,311.2
Moderate	875.4	363.2	39,878.0
MBS SITE TOTAL	**1,159.6**	**480.7**	**52,168.5**
RA-06 total	***2,861.8***	***1,192.4***	***125,825.0***
Proportion in MBS Sites	***40.5%***	***40.3%***	***41.5%***

Source: Minnesota DNR 2016h.

Notes:

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance

Construction Impacts

About 1,160 acres of MBS Sites would be affected by construction of RA-06 (Table 6.3.5-36). Construction and post-construction reclamation through these sites likely would alter vegetation structure and reduce their overall diversity. Of the 79 miles of the RA-06 route that crosses moderate to outstanding rated MBS Sites, 68 miles would be new pipeline corridor. Of those 68 miles, 4 miles would extend through outstanding rated MBS Sites, 15 miles through high rated MBS Sites, and 49 miles through moderate rated MBS Sites.

Construction impacts on MBS Sites would be short term and major given the abundance of outstanding and high rated sites that have not been previously fragmented by a pipeline corridor, and the time required for reestablishment of vegetation. However, changes to the native plant communities would be permanent.

Operations Impacts

Operations would affect 481 acres of MBS Sites. Vegetation maintenance during operations to remove trees and large shrubs within the pipeline permanent right-of-way would reduce the capacity for these sites to provide these diverse habitats for wildlife, including habitats for protected, conservation concern, and rare animals. Long-term vegetation management would result in a permanent major impact on MBS Sites.

Minnesota Scientific and Natural Areas

RA-06 would not cross any SNA, and no impact on SNAs would result from construction or operation of the route alternative.

Route Alternative RA-07

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, rufa red knot, and rusty patched bumble bee have the potential to occur within the ROI for RA-07. The types of impacts on Canada lynx, gray wolf, and northern long-eared bat from construction and operation of RA-07 would be the same as described for the Applicant's preferred route, and the types of impacts on the rufa red knot would be similar to those described for RA-06. The effects on each of these species are summarized below.

Construction Impacts

The Canada lynx and gray wolf would experience temporary minor effects from construction of RA-07. This route alternative would be constructed within the existing Line 3 pipeline corridor and would not contribute to additional habitat fragmentation. Typical conservation measures to reduce construction disturbance to gray wolves include stopping construction if a gray wolf or possible den site is observed within 1 mile of the construction area; enforcing the stop work order until the wolf leaves the area; and reporting any wolf sighting to USFWS, USACE, and Minnesota DNR.

NHIS data document one occurrence of the northern long-eared bat within the construction work area for RA-07. If northern long-eared bats occur in the construction area, temporary minor impacts could occur if individuals or colonies of bats are disturbed by noise or human presence and they abandon occupied tree cavities. Short term major impacts could result if bats are injured or killed, or if occupied trees or maternity roosts are destroyed or abandoned. Conservation measures to reduce potential impacts on northern long-eared bats include protecting known, occupied maternity roost trees and other trees within a 150-foot radius around maternity roost trees during the pup season from June 1 to July 31.

The rusty patched bumble bee could experience temporary major effects associated with vegetation clearing and the presence of construction vehicles. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these bumble bees and could remove forage plants. The RA-07 route would cross a current high use area and dispersal area in Clearwater County, where bumble bees could experience short-term major impacts related to construction. Conservation measures may benefit the species within the dispersal area, and USFWS may recommend surveys. Conservation measures that would minimize construction impacts and benefit the rusty patched bumble bee within the high use and dispersal area during construction include restoration and maintenance of high-quality habitat through control of invasive species and restoration that includes a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Construction activities have the potential to disturb rufa red knots, especially if disturbance coincides with important migration stopover locations. Emergent wetlands in the vicinity of the RA-07 route could provide stopover habitat. Noise or the presence of humans and construction equipment could cause rufa red knots to startle and flush from wetlands or fields, or to avoid the area entirely. Short-term impacts on wetlands and cultivated fields from clearing during construction could affect the availability of foraging and sheltering habitats. Construction would be unlikely to affect the overall availability of stopover habitat for rufa red knots, and impacts on an individual bird's survival or reproductive capacity would be short term and negligible.

Construction impacts specific to Minnesota key habitats with the potential to affect federally listed species are described below under WAN and MBS Sites.

Summary. Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf would experience temporary minor effects associated with construction of RA-07. With implementation of conservation measures, northern long-eared bats in the construction area could experience temporary minor impacts. The rufa red knot could be affected by construction activities that occur in the vicinity of stopover habitats; however, disturbances to emergent wetlands in the vicinity of the RA-07 route are unlikely to affect the overall availability of stopover habitat for rufa red knots. Thus, impacts on an individual bird's survival or reproductive capacity would be short term and negligible. The RA-07 route would cross a current high use area and dispersal area in Clearwater County for rusty patched bumble bees. The bees could experience short-term major construction-related impacts.

Operations Impacts

The Canada lynx, gray wolf, northern long-eared bat, and rufa red knot would experience permanent minor effects associated with disturbance from Project-related noise and increased human activity within the permanent right-of-way during operations. Post-construction disturbances, such as public and private use of all-terrain vehicles and snow machines along the right-of-way, could increase lynx- and wolf-human interactions, resulting in permanent minor impacts on the Canada lynx and gray wolf. Operations for RA-07 would not contribute to habitat fragmentation because the route would be constructed entirely within an existing pipeline corridor.

The rusty patched bumblebee could experience permanent, major effects associated with ongoing vegetation management activities, particularly caused by mowing and integrity digs. Conservation measures may benefit the species within the high use and dispersal areas, and USFWS may recommend surveys. Conservation measures that would benefit the rusty patched bumble bee within this dispersal area during operations include limiting vegetation management in high-quality habitat during the active season (March through September); using a minimum of 8 to 10 inches cutting height for mowers; and careful and targeted pesticide use, as described above (USFWS 2017).

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. Operations impacts specific to Minnesota key habitats with the potential to affect federally listed species, including the rusty patched bumble bee, are described below.

State-Listed Species

Endangered and Threatened Species

No Minnesota protected animals occur within the ROI for RA-07, although seven protected plants could occur[17] (Table 6.3.6-14). RA-07 would be constructed within the existing Line 3 pipeline corridor. If state-protected plants persist along the existing pipeline corridor, impacts from construction and operation of RA-07 would be the same as described for the Applicant's preferred route. Effects on these species are discussed below.

Construction Impacts. Botanical surveys were not conducted from Clearbrook to Carlton on route alternative RA-07. Where RA-07 overlaps with the Applicant's preferred route, the potential impacts would be the same as described for the Applicant's preferred route. In addition, the Minnesota DNR NHIS contains a known occurrence of state-listed threatened species within the construction work area. This record was documented within a moderate rated MBS Site in Cass County in 2010 and consisted of two plants. The current size and extent of this population is unknown. If construction proceeds in this area, botanical surveys likely would be needed to inform the takings permit process.

The other state-protected plants documented within the ROI have the potential to occur within the construction work area if suitable habitat is present. Given that the portion of the RA-07 route from Clearbrook to Carlton contains 1,279 acres of MBS Sites that provide habitat for rare plants, it is likely that additional occurrences of state-protected species would be identified if botanical surveys were conducted along this segment.

Plants within the construction area could be destroyed during vegetation clearing and grading, and potential habitat could be degraded by the introduction or spread of noxious weeds and invasive plants. Some construction impacts may be avoidable through survey, flagging areas to avoid, and refinement of the construction work areas. BMPs to minimize overall vegetation impacts and prevent the spread of noxious weeds and invasive plants would be implemented. Noxious weed and invasive plant management measures would be in place during and after construction. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include measures to control noxious weeds and invasive plants during construction. If this population is unavoidable, the resultant impacts would be permanent and potentially major. Impacts on other state-protected plants, should they be present in construction zones, would be short term and minor.

Measures to avoid or reduce construction impacts on Minnesota-listed animals and plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species.

Operations Impacts. Operations and maintenance activities include mowing, equipment maintenance, invasive species control, integrity digs, and aerial surveillance of the permanent right-of-way. If listed plants occur within the permanent right-of-way, they would be permanently affected by maintenance activities. The goblin fern population is located outside of the RA-07 permanent right-of-way. If this population persists during operation, potential impacts could include indirect effects due to decreased shade cause by the reduced canopy cover along the margin of the maintained permanent right-of-way.

[17] Protected plant surveys have not been completed for the route alternatives.

These indirect habitat impacts may be sufficient to prevent the population from persisting, which would result in a permanent, major impact on the population.

All state-listed plant species that persist in areas within or adjacent to the permanent right-of-way could be indirectly affected by habitat loss and alteration resulting from maintenance of the permanent right-of-way. Measures to avoid or reduce impacts on Minnesota-listed plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state-protected species.

Special Concern Species

Minnesota special concern animals and plants within the ROI for RA-07 are listed in Tables 6.3.5-15 and 6.3.5-16. NHIS occurrences of Minnesota-listed special concern animals and plants that could be affected by construction and operation of RA-06 are listed in Tables 6.3.5-37 and 6.3.5-38.

Table 6.3.5-37. Known Occurrences of Special Concern Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-07

Common Name	Scientific Name	Federal Status[a]	Construction[b]	Operations[c]	Within 0.5 Mile
Mammals					
Big brown bat	*Eptesicus fuscus*	NA	--	--	1
Little brown myotis	*Myotis lucifugus*	NA	--	--	1
Northern long-eared bat	*Myotis septentrionalis*	THR	1	1	2
Birds					
Nelson's sparrow	*Ammodramus nelsoni*	BCC	1	1	1
Trumpeter swan	*Cygnus buccinator*	NA	1	1	1
Yellow rail	*Coturnicops noveboracensis*	BCC	1	1	1
Mollusks					
Black sandshell	*Ligumia recta*	NA	2	1	3
Creek heelsplitter	*Lasmigona compressa*	NA	1	1	2

Source: Minnesota DNR 2016a.

Notes:

[a] BCC = Birds of Conservation Concern, NA = not applicable, THR = Threatened

[b] Estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3).

[c] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Table 6.3.5-38. Known Occurrences of Special Concern Plants within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-07

Common Name	Scientific Name	Federal Status[a]	Construction[b]	Operations[c]
Barren strawberry	*Waldsteinia fragarioides* var. *fragarioides*	NA	1	1
Few-flowered spikerush	*Eleocharis quinqueflora*	NA	1	1
Lapland buttercup	*Ranunculus lapponicus*	NA	1	--
Least moonwort	*Botrychium simplex*	NA	5	5
Mingan moonwort	*Botrychium minganense*	NA	4	4
Pale moonwort	*Botrychium pallidum*	NA	4	4
St. Lawrence grapefern	*Botrychium rugulosum*	NA	4	4

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Protected plant surveys have not been conducted for the route.

[a] NA = not applicable

[b] Estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3).

[c] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Construction Impacts. Construction impacts on bats, birds, mollusks, and plants would be the same as described for the Applicant's preferred route. Construction impacts on bats and birds primarily would result from these species moving away from the area because of increased human activity and noise. Impacts would be temporary and minor, as the species likely would return after construction is completed. Construction impacts on mollusks would be short term and negligible to minor during construction of surface water crossings. Impacts on special concern plants would be long term and minor.

Operations Impacts. Pipeline operation would require ongoing vegetation management to prevent trees and large shrubs from reestablishing within the permanent right-of-way. Mammals and birds that depend on closed canopies may avoid the permanent right-of-way, which may act as a barrier to travel for some species. In addition, vegetation management that prevents riparian trees and large shrubs from reestablishing could increase stream temperatures by removing shade, which could reduce habitat suitability for aquatic animals. Habitat within the permanent right-of-way would be permanently altered by periodic vegetation management activities, resulting in permanent minor impacts on special concern animals and plants—especially bats and forest plants, including barren strawberry, least moonwort, mingan moonwort, pale moonwort, and St. Lawrence grapefern that occur in the permanent right-of-way. Overall, impacts on special concern species from operations activities would be permanent and minor.

Species of Greatest Conservation Need

Approximately 41 percent of the route for RA-07 occurs within WAN areas (Table 6.3.5-39). The majority of WAN habitats that would be affected by construction and operation are rated low-medium and medium, there are no high-rated WAN lands that would be affected by the RA-06. The lack of high-quality WAN lands indicates that the habitat affected would not likely be SCGN richness hotspots. All of the 68.5 miles of WAN habitats crossed by RA-07 would be within an existing pipeline corridor. Therefore, overall construction- and operations-related impacts on WAN land, and the SGCN that they support, would be permanent and minor due to habitat loss and alteration, which is described in more detail in Section 5.2.4.

Table 6.3.5-39. Estimated Impacts on the Wildlife Action Network Habitat within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-07 (acres)

Wildlife Action Network Ratings	Construction[a]	Operations[b]
Low	151.5	35.2
Low-medium	954.9	235.0
Medium	370.9	87.3
Medium-high	249.9	57.9
High	--	--
WAN TOTAL	**1,727.2**	**415.5**
RA-07 total	***4,139.7***	***1,016.5***
Proportion in WAN	***41.7%***	***40.9%***

Source: Minnesota DNR 2016b.

[a] Estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3).

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

WAN = Wildlife Action Network

"--" = no occurrence

Minnesota Biological Survey Sites of Biodiversity Significance

The proportion of MBS Sites that would be affected by the RA-07 route between Clearbrook and Carlton would be similar for the ROI, construction work area, and permanent right-of-way (Table 6.3.5-40). Therefore, the overall route would not disproportionately affect MBS Sites. RA-07 would be constructed within the existing pipeline corridor, and the majority of the affected area is rated as moderate.

Table 6.3.5-40 Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity Significance within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-07 (acres)

MBS Site Rating	Construction[a]	Operations[b]	Within 0.5 Mile
Outstanding	126.5	21.9	3,532.6
High	238.1	46.9	8,742.0
Moderate	914.2	214.9	25,340.0
MBS SITE TOTAL	**1,278.7**	**283.7**	**37,614.6**
RA-07 total	***4,139.7***	***1,016.5***	***107,004.0***
Proportion in MBS Sites	***30.9%***	***27.9%***	***35.1%***

Source: Minnesota DNR 2016h.

Notes:

[a] Estimated construction impact area in acres based on 205-foot-wide construction work area (10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3).

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

MBS Site = Minnesota Biological Survey Site of Biodiversity Significance

Construction Impacts

Construction would affect 1,279 acres (RA-07) of MBS Sites. Construction and post-construction reclamation through these MBS Sites likely would change the vegetation structure and reduce the overall diversity. Construction impacts on MBS Sites would be short term, lasting until vegetation cover is reestablished, and minor, given their persistent occurrence along the route.

Operations Impacts

Operations would affect 334 acres of MBS Sites. Vegetation management activities that prevent the reestablishment of trees and large shrubs within the pipeline permanent right-of-way would reduce the capacity for these sites to provide diverse habitats for wildlife, including habitats for protected, special concern, and rare animals. The Applicant's long-term vegetation management program would result in a permanent change to a minor portion of the overall available MBS Sites; however, this would not differ from current conditions within the permanent right-of-way for the existing Line 3 pipeline.

Minnesota Scientific and Natural Areas

No impact on SNAs would occur from construction or operations for RA-07.

Route Alternative RA-08

Federally Listed Species

The Canada lynx, gray wolf, northern long-eared bat, rufa red knot, and rusty patched bumble bee have the potential to occur within the ROI for RA-08. The types of impacts on Canada lynx, gray wolf, northern long-eared bat, and rusty patched bumble bee from construction and operation of RA-08 would be the same as those described for the Applicant's preferred route, and impacts on the rufa red knot would be the similar to those described for RA-06. Effects on these species are discussed below.

Construction Impacts

The Canada lynx and gray wolf would experience temporary minor effects associated with construction of RA-08. The route would be constructed within an existing pipeline corridor, and the addition of this pipeline would increase the width of the existing corridor; however, it would not result in additional habitat fragmentation. Typical conservation measures to reduce construction disturbance to gray wolves include stopping construction if a gray wolf or possible den site is observed within 1 mile of the construction area; enforcing the stop work order until the wolf leaves the area; and reporting any wolf sighting to USFWS, USACE, and Minnesota DNR.

NHIS data document one occurrence of the northern long-eared bat within the construction work area for RA-08. If northern long-eared bats are present in the construction area, temporary and minor impacts could occur if individuals or colonies of bats are disturbed by noise or human presence, causing them to abandon occupied tree cavities. Short-term major impacts could result if bats are injured or killed, or if occupied trees or maternity roosts are destroyed or abandoned. Conservation measures to reduce potential impacts on northern long-eared bats include protecting known occupied maternity roost trees and other trees within a 150-foot radius from maternity roost trees during the pup season from June 1 to July 31.

The rusty patched bumble bee could experience temporary major effects associated with vegetation clearing and the presence of construction equipment and vehicles. These prairie-dependent insects depend on high-quality native grasslands and tallgrass prairies to provide food from flower pollen and nectar. Vegetation clearing and replacement with non-native ground covers could injure or kill these bumble bees, and could remove forage plants. The RA-08 route would cross a current high use area and dispersal area in Clearwater County, where bumble bees could experience short-term major construction impacts. Conservation measures may benefit the species within the dispersal area, and USFWS may recommend surveys. Conservation measures that would minimize the impacts of construction and benefit the rusty patched bumble bee within this dispersal area include restoration and maintenance of high-quality habitat through control of invasive species and restoration that includes a high diversity and abundance of wildflowers appropriate for the region and local characteristics (USFWS 2017).

Construction activities have the potential to disturb rufa red knots, especially if disturbance coincides with important migration stopover locations. Noise or presence of humans and construction equipment could cause rufa red knots to startle and flush from wetlands or fields, or to avoid the area entirely. Emergent wetlands in the vicinity of the RA-08 route could provide stopover habitat, and short-term impacts on wetlands and cultivated fields from clearing during construction could affect the availability of foraging and sheltering habitats. However, construction would be unlikely to affect the overall availability of stopover habitat for rufa red knots, and the potential impacts on an individual bird's survival or reproductive capacity would be short term and negligible.

Summary. Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA. The Canada lynx and gray wolf would experience temporary minor effects associated with construction of RA-08. Northern long-eared bats are present in the construction area. With implementation of conservation measures, the species would experience temporary minor effects from construction, if individuals or colonies of bats are disturbed by noise or human presence and they abandon occupied tree cavities. The rufa red knot could be affected by construction activities occurring in the vicinity of their stopover habitat. However,

disturbances to emergent wetlands used for stopover habitat in the vicinity of the route are unlikely to affect the overall availability of stopover habitat for rufa red knots. Therefore, the potential impact on an individual bird's survival or reproductive capacity would be short term and negligible. The RA-08 route would cross a current high use area and dispersal area for rusty patched bumblebees in Clearwater County; construction through that area would result in short-term major impacts.

Impacts specific to Minnesota key habitats with the potential to affect federally listed species are described below under WAN and MBS Sites.

Operations Impacts

The Canada lynx, gray wolf, northern long-eared bat, and rufa red knot would experience permanent minor effects associated with disturbance from Project-related noise and increased human activity during operation. Post-construction disturbances, such as public and private use of all-terrain vehicles and snow machines along the permanent right-of-way, could increase lynx- and wolf-human interactions, resulting in permanent minor impacts on Canada lynx and gray wolf. Operations for RA-08 would not contribute to habitat fragmentation because the route would be constructed entirely within an existing pipeline corridor.

The rusty patched bumblebee could experience permanent major effects associated with vegetation management activities that include mowing. Conservation measures may benefit the species within the high use and dispersal areas, and USFWS may recommend surveys. Conservation measures that would benefit the rusty patched bumble bee within this dispersal area during operations include limiting vegetation management in high-quality habitat during the active season (March through September); using a minimum of 8 to 10 inches cutting height for mowers; and careful and targeted pesticide use, as described above (USFWS 2017).

Measures to avoid or reduce construction impacts on federally listed animals and plants would be developed in consultation with USFWS to ensure that any unavoidable impacts would not jeopardize the continued existence of species protected by the ESA.

State-Listed Species

Endangered and Threatened Species

No state-listed animals are likely to occur within the ROI for RA-08; 10 protected plants could occur[18] (Table 6.3.5-18). Of the 10 Minnesota-listed plants within the ROI, four potentially occur within the construction work area—Clinton's bulrush (*Trichophorum clintonii*), goblin fern, hidden-fruited bladderwort (*Utricularia geminiscapa*), and one-flowered broomrape (*Orobanche uniflora*). Impacts on these species from construction and operation of RA-08 would be the same as described for the Applicant's preferred route.

Construction Impacts. Minnesota DNR NHIS data contain four known occurrences of state-protected plants within the construction work area. Goblin fern was documented within a high rated MBS Site in Cass County in 1992 and 1996. Approximately 665 flowering stems of one-flowered broomrape were documented in 2009 along the edge of a pipeline corridor in Cass County. Three plants of Clinton's bulrush were documented in 2011 in Beltrami County. A minimum of 20 individual plants of hidden-fruit bladderwort were observed in 2009 growing in a northern spruce bog in Cass County. The current size

[18] Protected plant surveys have not been completed for the route alternatives.

and extent of these populations are unknown. If construction proceeds in this area, botanical surveys likely would be needed to inform the takings permit process.

As there are 889 acres of MBS Sites within the construction work area of the Clearbrook-to-Carlton segment of RA-08, it is likely that additional occurrences of state-protected species would be identified if botanical surveys were conducted along this segment.

Minnesota-protected plants within the construction work area could be destroyed during clearing, grading, and trenching. Their habitats could be degraded by the introduction or spread of noxious weeds and invasive plants, which would result in permanent major impacts. To minimize the spread of noxious weeds and invasive plants, the Applicant would implement measures in a Noxious Weeds and Invasive Species Control Plan. This plan would include control measures for management of noxious weeds and invasive plants during construction.

Other state listed plants could experience short-term minor impacts. Some construction impacts may be avoidable through survey, flagging to identify and avoid plants, and refinement of the construction work areas. BMPs to minimize overall vegetation impacts and prevent the spread of noxious weeds and invasive plants would be implemented as noted above. If it is not possible to avoid these populations, impacts would be permanent and potentially major. Measures to avoid or reduce construction impacts on Minnesota-listed plants would be developed in consultation with Minnesota DNR to ensure that any unavoidable impacts would not jeopardize the continued existence of state protected species.

Operations Impacts. If state-protected plants persist within the permanent right-of-way, they would be permanently affected by vegetation management activities and integrity digs. Given their expected limited distribution within the permanent right-of-way, the overall impact on listed plants would be short term and minor.

Special Concern Species

Minnesota-listed special concern animals and plants that could be affected by construction and operation of the route alternative are listed in Tables 6.3.5-41 and 6.3.5-42.

Construction Impacts. Construction impacts on Minnesota-listed special concern mammals, birds, mollusks, and plants would be the same as described for the Applicant's preferred route. Construction impacts on mammals and birds primarily would result from these species moving away from the area because of increased human activity and noise. Impacts would be temporary and minor, as the species likely would return after construction is complete. Construction impacts on mollusks would be short term and negligible to minor during construction of the surface water crossings. Construction impacts on special concern plants would be long term and minor.

Operations Impacts. Pipeline operation would require ongoing vegetation management to prevent trees and large shrubs from growing over the pipeline. Mammals and birds that depend on closed canopies may avoid the permanent right-of-way, which may act as a barrier to travel for some species, fragmenting habitat. The RA-08 route would be co-located with an existing pipeline corridor and would widen the corridor but would not contribute to new fragmentation. In addition, vegetation management that prevents the reestablishment of riparian trees and large shrubs could increase stream temperatures by removing shade, which could reduce habitat suitability for mollusks. If special concern plants were to persist within the permanent right-of-way, they would be permanently affected by vegetation

management activities. Given the lack of occurrence, the impact would be minor. Overall, impacts on special concern species from operations activities would be permanent and minor.

Table 6.3.5-41. Known Occurrences of Special Concern Animals within the Construction Work Area, Permanent Right-of-Way, and Region of Interest for Route Alternative RA-08

Common Name	Scientific Name	Federal Status[a]	Construction[b]	Operations[c]	Within 0.5 Mile
Mammals					
Big brown bat	*Eptesicus fuscus*	NA	--	--	1
Little brown myotis	*Myotis lucifugus*	NA	--	--	1
Northern long-eared bat	*Myotis septentrionalis*	THR	1	1	2
Birds					
Northern goshawk	*Accipiter gentilis*	NA	--	--	2
Red-shouldered hawk	*Buteo lineatus*	NA	1	1	6
Trumpeter swan	*Cygnus buccinator*	NA	1	1	1
Mollusks					
Black sandshell	*Ligumia recta*	NA	--	--	3
Creek heelsplitter	*Lasmigona compressa*	NA	--	--	3

Source: Minnesota DNR 2016a.

Notes:

[a] NA = not applicable, THR = Threatened

[b] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[c] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Table 6.3.5-42. Known Occurrences of Special Concern Plants within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-08

Common Name	Scientific Name	Federal Status	Construction[a]	Operations[b]
Few-flowered spikerush	*Eleocharis quinqueflora*	None	1	--
Least moonwort	*Botrychium simplex*	None	3	2
Mingan moonwort	*Botrychium minganense*	None	4	4
Slender naiad	*Najas gracillima*	None	1	1
White adder's mouth	*Malaxis monophyllos* var. *brachypoda*	None	1	1

Source: Minnesota DNR 2016a.

Notes:

An occurrence can consist of one or more observations of one or more individuals temporally and spatially.

Protected plant surveys have not been conducted for the route.

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

"--" = no occurrence

Species of Greatest Conservation Need

Approximately 45 percent of the RA-08 route occurs within WAN areas (Table 6.3.5-43). The majority of WAN habitats that would be affected by construction and operation are rated low-medium and medium. No high rated WAN lands would be affected by the RA-08 route. The lack of high-quality WAN lands indicates that the habitat affected would not likely be SCGN richness hotspots. All of the 74.2 miles of WAN habitats crossed by RA-08 would be within an existing pipeline corridor. Therefore, overall construction- and operations-related impacts on WAN land, and the SGCN that they support, would be permanent and minor, and would be caused by habitat loss and alteration.

Table 6.3.5-43. Estimated Impacts on Wildlife Action Network Habitat within the Construction Work Area and Permanent Right-of-Way for Route Alternative RA-08 (acres)

Wildlife Action Network Ratings	Construction[a]	Operations[b]
Low	104.7	43.7
Low-medium	372.9	155.1
Medium	388.0	161.7
Medium-high	213.9	89.2
High	--	--
WAN TOTAL	**1,079.5**	**449.7**
RA-08 total	***2,397.7***	***999.0***
Proportion in WAN	***45.0%***	***45.0%***

Source: Minnesota DNR 2016b.

Notes:

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

WAN = Wildlife Action Network

"--"= no occurrence

Minnesota Biological Survey Sites of Biodiversity Significance

The proportion of MBS Sites that would be affected by the RA-08 route between Clearbrook and Carlton would be similar for the ROI, construction work area, and permanent right-of-way (Table 6.3.5-44). Therefore, the overall route would not disproportionately affect MBS Sites. In addition, the route of RA-08 would be entirely within an existing pipeline corridor.

Construction Impacts

Construction would affect 889 acres of MBS Sites in the construction work area between Clearbrook and Carlton. Construction and post-construction reclamation through these sites likely would reduce their overall diversities. Construction impacts on MBS Sites would be short term (lasting until vegetation cover is reestablished) and minor given their persistent occurrence along the route, which is located within an existing pipeline corridor.

Table 6.3.5-44. Estimated Impacts on Minnesota Biological Survey Sites of Biodiversity in the Construction Work Area, Permanent Right-of-Way and Region of Interest for Route Alternative RA-08 (acres)

MBS Sites Rating	Construction[a]	Operations[b]	Within 0.5 Mile
Outstanding	124.0	51.7	5,958.8
High	271.6	112.7	12,931.6
Moderate	493.3	205.2	22,777.1
MBS SITE TOTAL	**888.8**	**369.6**	**41,667.6**
RA-08 total	***2,397.7***	***999.0***	***105,470.0***
Proportion in MBS Sites	***37.1%***	***37.0%***	***39.5%***

Source: Minnesota DNR 2016h.

Notes:

[a] Estimated construction impact area in acres based on 120-foot-wide construction work area.

[b] Estimated operations impact area in acres based on 50-foot-wide right-of-way centered on the pipeline route.

MBS Site = Minnesota Biological Survey Site of Biodiversity Significance

Operations Impacts

Operations would affect 370 acres of MBS Sites. Vegetation management during operations to prevent the reestablishment of trees and large shrubs within the permanent right-of-way would reduce the capacity for these sites to provide diverse habitats for wildlife, including habitats for protected, conservation concern, and rare animals. Long-term vegetation management would result in a permanent change to a minor portion of the overall available MBS Sites.

Minnesota Scientific and Natural Areas

No impacts on SNAs would occur from construction and operation of RA-08.

6.3.5.4 Summary and Mitigation

6.3.5.4.1 Summary

Potential effects on protected and rare species were directly assessed by quantifying occurrences based on IPaC searches and NHIS data, and indirectly through evaluation of habitat-based measures in Minnesota, including the WAN, MBS Sites, and SNAs. Potential effects on federally and state-protected and rare animals and plants depend on whether they occur near the route options (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08) and whether they are present when activities are occurring that may result in injury, harm, or disturbance. Table 6.3.5-45 presents a summary of construction- and operations-related impacts on unique resources for the Applicant's preferred route and the route alternatives.

The data and analyses regarding unique natural resources presented in this EIS can be used by the regulatory agencies to assess potential impacts on unique natural resources. In addition, USACE is preparing a Biological Assessment for the Project that would be used by USFWS as part of its determination on whether the Project would jeopardize the continued existence of any federally listed species or would result in destruction or adverse modification of their critical habitat. Potential effects on

protected species would require avoidance and conservation measures, and formal ESA consultation and federal and state incidental take permits may be required where unavoidable impacts are likely to occur.

Construction impacts could include (1) injury or loss of aquatic and terrestrial invertebrates; amphibians reptiles, and small mammals; bird eggs and young; and plants; (2) loss or alteration of forage and cover habitats; and (3) disturbance from noise and activity. Operations effects could include permanent habitat loss or alteration and continued disturbance from noise and activity at aboveground facilities and from pipeline inspection overflights, ground surveillance, and pipeline integrity excavation. Creation of new pipeline rights-of-way may contribute to fragmentation of habitats, creating barriers to movements for amphibians, reptiles, and small mammals; facilitated movements for some predators; new edge habitats; and potential reduction in the abundance and diversity of forest-nesting birds. Potential direct injury or mortality of protected animals may be avoided or minimized through typically required conservation measures, although reduction in habitat quality resulting from facility and pipeline construction may indirectly affect protected animals because of a permanent reduction in the habitat's ability to support some protected species.

Construction Impacts

Construction activities have the potential to disturb special-status animals, plants, and habitats because of increased noise and human activity, use of construction equipment, and vegetation removal. Injury, mortality, or disturbance of special-status species and alteration of habitat types also could occur as a result of these activities.

Construction noise and increased human activity likely would cause more mobile species (e.g., larger mammals, bats, and birds) to move to other areas; they would possibly return after construction activities stop. If these disturbances occurred during sensitive reproductive periods, animals could abandon their young or nesting/denning area, resulting in a decrease in survival and possible reproductive failure of individual mating pairs. Less mobile species that occur within the construction work area would not be able to avoid construction activities and could be crushed and killed.

Surface water crossings could affect aquatic species that are present. Disturbance to the stream bottom during the use of dry or wet open-cut crossing methods could crush or suffocate aquatic species and their nests. The temporarily increased turbidity could reduce feeding efficiency and damage these sensitive aquatic animals in the vicinity. Contaminated construction equipment and water used for hydrostatic testing could introduce invasive aquatic animals such as zebra and quagga mussels that could displace and reduce habitat quality for aquatic animals. Use of HDD to cross waterbodies would avoid mortality and injury of special-status aquatic species, and impacts on their habitat.

Vegetation removal could injure or kill special-status species if they are present when clearing or construction activities occur. Mobile special-status animals would be likely to move to other areas, while less-mobile species could be crushed and killed. Protected plants may be lost during construction, and changes to soils and surrounding vegetation communities may leave habitats unsuitable after construction. Avoidance may be possible, once precise locations are determined through surveys such as those completed for the Applicant's preferred route. Some protected and special concern plants may be preserved and continue to persist within pipeline rights-of-way. In general, construction of aboveground facility sites and establishment of the pipeline rights-of-way would alter existing habitat types (including WAN and MBS Sites) and increase fragmentation.

Construction of the Applicant's preferred route or any of the route alternatives has the potential to affect special-status species and habitats. All route options could affect four or five federally protected species. Of the federally listed species, four occur within the construction work areas for the Applicant's preferred route and RA-03AM; and five occur within the construction work areas for RA-06, RA-07, and RA-08. Based on the potential for species to occur and total known occurrences, effects on state-listed species would be the greatest for RA-03AM and the Applicant's preferred route. Construction of RA-06, RA-07, and RA-08 would affect fewer species, and construction of RA-07 and RA-08 would affect only plants because no state-protected animals are known to occur within the ROIs for these route alternatives. In general, direct impacts on federally and state-listed and special concern vertebrate and invertebrate animals would be temporary and minor with implementation of BMPs and conservation measures; potential impacts on listed plants would be permanent and minor.

All routes would pass though WAN areas and MBS Sites. The percent of the route distance that would affect WAN habitat would be the greatest for RA-08, RA-07, and RA-06 (41 to 45 percent); 30 percent of the Applicant's preferred route would affect WAN acreage, and 12 percent of RA-03AM would affect WAN habitat. The majority of WAN areas crossed by the Applicant's preferred route, RA-03AM, RA-07, and RA-08 would be in existing corridors, limiting the impacts. WAN acreage crossed by RA-06 would be in a new pipeline corridor, resulting in habitat loss and alteration, with potential reduced use by SGCNs. There is no high ranked WAN habitat along the RA-06 route, indicating that the WAN habitat is unlikely to provide SGCN richness hotspots. Overall, the lack of high-quality WAN lands across all alternatives indicates that the habitat affected would not likely be SCGN richness hotspots. Impacts on WAN habitats, and the associated SGCNs they support, crossed by the Applicant's preferred route, RA-03AM, RA-07, and RA-08 would be minor and permanent based on the extent of and ratings for WAN habitats affected and the proximity of routes to existing pipeline and utility corridors. Construction of RA-06 would result in permanent major impacts on WAN habitat because a new pipeline corridor would be created.

The percent of MBS Sites affected would be the greatest for RA-06 and RA-08 and the least for RA-03AM. Areas where routes cross MBS Sites would experience long-term impacts. Because these areas, for all route options, represent a small proportion of available MBS Sites in Minnesota, the overall impact would be minor. Minnesota SNAs would be unaffected by all routes except RA-03AM, where less than an acre would be affected by construction. Minnesota DNR would not grant a license or easement to cross any SNA; therefore, this route would need to be altered slightly if it is selected.

Operations Impacts

Pipeline right-of-way maintenance activities during operations would include mowing, equipment maintenance, invasive species control, right-of-way monitoring, and integrity digs to repair or replace pipe segments. Vegetation maintenance that removes riparian trees and large shrubs could increase stream temperatures by removing shade, which would reduce habitat suitability for aquatic animals. Activities in and around water, as well as upland vegetation maintenance could result in direct mortality of less mobile species through crushing, if species are present while the activity is occurring. State-listed plants that persist within the permanent right-of-way after construction could be permanently affected by vegetation maintenance activities.

All special-status species within the ROIs for the route options could be indirectly affected by habitat loss and alteration. The maintained permanent right-of-way of each route option could act as a barrier to travel for some animals such as amphibians, reptiles, and small mammals, and could fragment SGCN habitat. Habitat fragmentation can increase edge habitats favored by some animals and avoided by

others; and can create a barrier to movements for some animals while facilitating movements of others, especially predators.

With implementation of BMPs and appropriate species-specific conservation measures for pipeline operations, most impacts during operations would be caused by temporary disturbance and permanent habitat alteration, resulting in overall minor impacts for all route options for the life of the Project.

6.3.5.4.2 Mitigation

In addition to the Applicant-proposed measures described above, which would be incorporated into the Project, the Applicant would comply with conditions specified in permits required by agencies with jurisdiction. Typical conservation measures to reduce impacts on unique resources are identified in the discussions above for specific species. These measures likely would be required by the applicable agencies, and additional mitigation for potential impacts could be required.

Actions identified by Minnesota DNR to further minimize disturbance to MBS Sites include, but are not limited to:

- Do not park equipment or stockpile supplies within MBS Sites,
- Do not place spoil within MBS Sites,
- Limit construction activities to frozen ground conditions, and
- Revegetate disturbed soil with native species suitable to the local habitat as soon after construction as possible.

Table 6.3.5-45. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Federally Protected Species					
Construction Impacts					
Potential for injury, mortality, or disturbance of federally listed ESA species	Minor/temporary impacts • 3 mammals Minor/short-term impacts • 1 insect	Minor/temporary impacts • 3 mammals Minor/short-term impacts • 1 insect	Minor/temporary impacts • 3 mammals Minor/short-term impacts • 1 insect Negligible/short-term impacts • 1 bird	Major/short-term impacts • 1 insect Minor/temporary impacts • 3 mammals Negligible/short-term impacts • 1 bird	Major/short-term impacts • 1 insect Minor/temporary impacts • 3 mammals Negligible/short-term impacts • 1 bird
Operations Impacts					
Potential for injury, mortality, or disturbance of federally listed ESA species	Minor/permanent impacts • 2 mammals • 1 insect Negligible/permanent impacts • 1 mammal	Minor/permanent impacts • 2 mammals • 1 insect Negligible/permanent impacts • 1 mammal	Major/permanent impacts • 1 mammal Minor/permanent impacts • 2 mammals • 1 bird • 1 insect	Major/permanent impacts • 1 insect Minor/permanent impacts • 3 mammals • 1 bird	Major/permanent impacts • 1 insect Minor/permanent impacts • 3 mammals • 1 bird
State-Listed Endangered or Threatened Species					
Construction Impacts					
Impacts on herptiles	No impact	Minor/short-term impacts • 2 species	No impact	No impact	No impact
Impacts on fish	Negligible/temporary impacts • 1 species	No impact	Negligible/temporary impacts • 1 species	No impact	No impact

Table 6.3.5-45. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Impacts on mussels	No impact	Negligible to minor/ temporary to short-term • 4 species	No impact	No impact	No impact
Impacts on plants	Major/permanent impacts • 6 species No Impact • 2 species	Minor to major/ short-term to permanent impacts • 8 species	Minor/permanent impacts • 5 species	Major/permanent impacts • 1 species Minor/short-term impacts • 6 species	Major/permanent impacts • 4 species Minor/short-term impacts • 6 species
Operations Impacts					
Impacts on herptiles	No impact	Minor/short-term impacts • 2 species	No impact	No impact	No impact
Impacts on fish	No impact • 1 species	No impact	Negligible/temporary impacts • 1 species	No impact	No impact
Impacts on mussels	No impact	Negligible to minor/ temporary to short-term impacts • 4 species	No impact	No impact	No impact
Impacts on plants	Minor/short-term to permanent impacts • 8 species	Minor/short-term to permanent impacts • 8 species	Minor/short-term to permanent impacts • 5 species	Minor/short-term to permanent impacts • 7 species	Minor/short-term to permanent impacts • 10 species
Species of Special Concern					
Construction Impacts					
Impacts on mammals	Minor to major/ temporary to permanent impacts • 4 species	Minor to major/ temporary to permanent impacts • 3 species	Minor to major/ temporary to permanent impacts • 3 species	Minor to major/ temporary to permanent impacts • 3 species	Minor to major/ temporary to permanent impacts • 3 species

Table 6.3.5-45. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Impacts on birds	Major/short-term impacts • 6 species	Major/short-term impacts • 4 species	Major/short-term impacts • 2 species	Major/short-term impacts • 3 species	Major/short-term impacts • 2 species
Impacts on herptiles	Negligible to major/short-term impacts • 1 species	No impact	Negligible to major/short-term impacts • 1 species	No impact	No impact
Impacts on fish	Negligible to major/short-term impacts • 1 species	Negligible to major/short-term impacts • 4 species	Negligible to major/short-term impacts • 1 species	No impact	No impact
Impacts on mussels	Negligible to major/short-term impacts • 3 species	Negligible to major/short-term impacts • 3 species	Negligible to major/short-term impacts • 1 species	Negligible to major/short-term impacts • 2 species	Negligible to major/short-term impacts • 2 species
Impacts on aquatic insects	Negligible/short-term impacts • 1 species	Negligible/short-term impacts • 1 species	No impact	No impact	No impact
Impacts on plants	Major/permanent impacts • 9 species	Major/permanent impacts • 3 species	No impact	No impact	Major/permanent impacts • 5 species
Operations Impacts					
Impacts on mammals	Minor/permanent impacts • 4 species	Minor/permanent impacts • 3 species	Minor to major/ temporary to permanent impacts • 3 species	Minor to major/ temporary to permanent impacts • 3 species	Minor to major/ temporary to permanent impacts • 3 species
Impacts on birds	Major/permanent impacts • 6 species	Major/permanent impacts • 4 species	Minor/short-term impacts • 2 species	Minor/short-term impacts • 3 species	Minor/short-term impacts • 2 species
Impacts on herptiles	Minor/permanent impacts • 1 species	No impact	Minor/permanent impacts • 1 species	No impact	No impact

Table 6.3.5-45. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Impacts on fish	Minor/permanent impacts • 1 species	Minor/permanent impacts • 4 species	Minor/permanent impacts • 1 species	No impact	No impact
Impacts on mussels	Negligible to major permanent/minor short-term impacts • 3 species	Negligible to major permanent/minor short-term impacts • 3 species	Negligible to major permanent/minor short-term impacts • 1 species	Negligible to major permanent/minor short-term impacts • 2 species	Negligible to major permanent/minor short-term impacts • 2 species
Impacts on insects	Negligible/short-term impacts • 1 species	Negligible/short-term impacts • 1 species	No impact	No impact	No impact
Impacts on plants	Minor/permanent impacts • 9 species	Minor/permanent impacts • 3 species	No impact	No impact	Minor/permanent impacts • 5 species
Species of Greatest Conservation Need					
Construction Impacts					
Impacts on habitat for Species of Greatest Conservation Need	Minor/permanent impacts • 22.4 miles of new corridor • 1,041 acres	Minor/permanent impacts • 0 mile of new corridor • 483 acres	Major/permanent impacts • 0 mile of new corridor • 1,175 acres	Minor/permanent impacts • 0 mile of new corridor • 1,727 acres	Minor/permanent impacts • 0 mile of new corridor • 1,080 acres
Operations Impacts					
Impacts on habitat for Species of Greatest Conservation Need	Minor/permanent impacts • 467 acres	Minor/permanent impacts • 201 acres	Minor/permanent impacts • 489 acres	Minor/permanent impacts • 416 acres	Minor/permanent impacts • 450 acres

Table 6.3.5-45. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Minnesota Biological Survey Sites of Biodiversity Significance					
Construction Impacts					
Impacts on outstanding-ranked MBS Sites (acres)	Major/short-term impacts • 16 miles in new corridor • 2 acres	Minor/short-term impacts • 1 mile in new corridor • 1 acres	Major/short-term impacts • 68 miles in new corridor • 59 acres	Minor/short-term impacts • 0 mile in new corridor • 127 acres	Minor/short-term impacts • 0 mile in new corridor • 124 acres
Impacts on high-ranked MBS Sites (acres)	Major/short-term impacts • 16 miles in new corridor • 78 acres	Minor/short-term impacts • 1 mile in new corridor • 38 acres	Major/short-term impacts • 68 miles in new corridor • 226 acres	Minor/short-term impacts • 0 mile in new corridor • 238 acres	Minor/short-term impacts • 0 mile in new corridor • 272 acres
Total affected acres	• 828 acres	• 368 acres	• 1,160 acres	• 1,279 acres	• 889 acres
Operations Impacts					
Impacts on outstanding-ranked MBS Sites (acres)	Major/permanent impacts • 2 acres	Minor/permanent impacts • <1 acre	Major/permanent impacts • 24 acres	Minor/permanent impacts • 22 acres	Minor/permanent impacts • 52 acres
Impacts on high-ranked MBS Sites (acres)	Major/permanent impacts • 40 acres	Minor/permanent impacts • 16 acres	Major/permanent impacts • 93 acres	Minor/short-term impacts • 47 acres	Minor/short-term impacts • 113 acres
Total affected acres	• 382 acres	• 156 acres	• 481 acres	• 284 acres	• 370 acres
Minnesota Scientific and Natural Areas					
Construction Impacts					
Impacts on Scientific and Natural Areas (SNAs)	No impact	No impact Avoidance required for Lake Alexander Woods SNA	No impact	No impact	No impact

Table 6.3.5-45. Summary of Potential Impacts on Unique Natural Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Operations Impacts					
Impacts on Scientific and Natural Areas (SNAs)	No impact	No impact Avoidance required for Lake Alexander Woods SNA	No impact	No impact	No impact

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance

6.3.5.5 References

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6.3.6 Public Lands

Public lands are lands managed or held by federal, state, and county governments for a variety of public benefits—including preservation of natural areas, wildlife habitat, timber, mineral resources, water resources and other natural resources, recreation areas, and other public interests. Because construction and operation of the Applicant's preferred route and the route alternatives may affect the future use of federal, state, and county land, the public lands analysis assessed:

- Potential impacts on public lands, including compatibility of the Project with designated uses of specific public lands.

In addition to the analysis of compatibility with the designated use of public lands in this section, impacts on the public resources contained within public lands are generally described (e.g., vegetation, wildlife, and recreation) although not correlated to specific public lands, and the measures that would be implemented to minimize potential impacts on those resources can be found in several other sections within Chapter 6, including Sections 6.3.1, 6.3.3, 6.3.4, and 6.5.2.

This section first describes the existing amounts of federal, state, and county land within an area along the Applicant's preferred route and each of the route alternatives where these lands could be affected by construction and operation of the Project. Potential Project-related impacts of construction and operation then are discussed and compared across each of the five routing options (the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08). A summary and comparison of the impacts for the Applicant's preferred route and the route alternatives are included at the end of the section.

Potential impacts on public lands from a release of crude oil are addressed in Chapter 10.

6.3.6.1 Regulatory Context and Methodology

6.3.6.1.1 Regulatory Context

Regulations that govern public lands vary significantly depending on the government entity that manages the land and the specific purpose for which the land was obtained. Therefore, identification of the authorizing agency and the relevant regulatory provisions are provided for each land type (federal, state, and county) within each routing option. The Applicant's preferred route and all of the route alternatives cross varying amounts of federal, state, and county land.

6.3.6.1.2 Methodology

The ROI for the analysis of impacts on public lands was focused on Minnesota only and included the construction and operations footprints for the Applicant's preferred route and the route alternatives. All federal, state, and county land in Minnesota directly crossed by construction and operations areas within the ROI was assessed for the Applicant's preferred route and route alternatives. See Section 6.3.1 for discussion of public waters that would be crossed by the Applicant's preferred route and the route alternatives. The analysis was undertaken by first identifying and inventorying in GIS all public lands in the counties crossed by the Applicant's preferred route and the route alternative. The following construction and operations footprints were overlaid to quantify resources affected by construction and operation:

- The route and estimated footprints for the pipeline and associated facilities for the Applicant's preferred route;

- The 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for route alternatives (except portions of RA-07 where a 205-foot-wide construction work area was overlaid; see Chapter 4);

Public lands within the ROI for the Applicant's preferred route and route alternatives were identified using GIS datasets and layers in the following data source:

- Protected Areas Database of the United States (PAD-US).

Where data were available, ownership and identification of the authorizing agency for each land type are provided, along with a discussion of compatibility with relevant regulatory provisions.

6.3.6.2 Existing Conditions

This section identifies public lands that could be affected by the Applicant's preferred route and the route alternatives. Appendix A includes maps of the federal and state lands within the ROI.

Federal Land

Federal lands are lands in the United States for which ownership is claimed by the U.S. federal government. The primary purpose of federal land is to benefit the people of the United States, with conservation of the natural resources as a priority; most federally owned lands are open to the public for recreational use. Primary federal landholders of the land that would be crossed by the Applicant's preferred route and route alternatives include the Department of the Interior (DOI), which includes agencies such as BLM, USFWS, NPS, and the Department of Agriculture—which includes USFS. The types of land in federal ownership in this analysis include forests that are managed by USFS, refuge land managed by USFWS, National Heritage Parks managed by NPS, and other land managed by BLM. Compatibility of the Project with designated uses varies by authorizing agencies; therefore, a general discussion of the responsible agency based on land ownership and any associated regulatory provisions is provided. When multiple federal properties that are operated by more than one federal agency or bureau would be crossed by a project, an application would be filed with BLM.

State Land

State lands are lands that are held under state management. State lands that would be crossed by the Applicant's preferred route and route alternatives include state WMAs, AMAs, and state forests. These lands are administered by each state's respective DNR. Compatibility of the Project with designated uses varies by authorizing agencies; therefore, a general discussion of the responsible agency based on land ownership and any associated regulatory provisions is provided.

In certain instances, more than one government agency may have an interest in a specific piece of land; thus, additional regulatory authorizations would be needed. For example, if the State of Minnesota purchased and designated land as a WMA but used federal grant money as part of that purchase, the federal government has different and additional regulatory processes for considering proposed encroachments such as pipelines.

County Land

County lands are lands that are held in trust for the public, for which ownership is claimed by county governments. As with federal and state land, their primary purpose is to benefit the public. These lands typically include county parks, forests, and other special management areas. Compatibility of the Project with designated uses varies by authorizing agencies; therefore, a general discussion of the responsible agency based on land ownership and any associated regulatory provisions is provided

Counties in Minnesota may acquire land through tax forfeiture. Some of this land is then sold or exchanged; if the lands are classified as conservation lands, they may be retained and managed for designated conservation purposes or as forestry land. Some lands bordering lakes and streams cannot be sold by the counties.

6.3.6.2.1 Applicant's Preferred Route

The following section describes existing conditions in Minnesota for public lands. Information enabling comparison of the route alternatives to the Applicant's preferred route is provided below

Federal Land

The only federal land that would be crossed by the Applicant's preferred route would be:

- North Country National Scenic Trail – The North Country National Scenic Trail stretches across seven states from New York to North Dakota (North Country Trail Association 2016). The National Scenic Trail program is administered through NPS. It includes trails that are 100 miles or longer and provides non-motorized recreational opportunities. At the location of the proposed crossing, the trail is administered by Hubbard County. However, compatibility of the Project with designated uses would be determined by the authorizing agency, which is NPS, and ultimately DOI. In 2015, the House Committee on Natural Resources passed a bill granting the Secretary of DOI the power to negotiate rights-of-way for gas pipelines through national park lands.

State Land

In total, the amount of state land in the ROI for the Applicant's preferred route, including access roads, ATWS, and MLVs, is 526 acres (Table 6.3.6-1). This includes about 17 acres between two WMAs: the Grayling Marsh WMA (14 acres) and Lawler WMA (3 acres), and approximately 0.4 acre of the LaSalle Creek AMA.

The Applicant's preferred route would cross approximately 422 acres in eight state forests:

- Foothills State Forest (42 acres),
- Hill River State Forest (103 acres),
- Huntersville State Forest (97 acres),
- Land O'Lakes State Forest (130 acres),
- Mississippi Headwaters State Forest (25 acres),
- Paul Bunyan State Forest (less than 0.1 acre),

- Savanna State Forest (9 acres), and
- Waukenabo State Forest (16 acres).

Table 6.3.6-1. State Lands Crossed by the Applicant's Preferred Route (acres)

Segment	State Land							
	Construction Work Area	Permanent Right-of-Way	ATWS	Temp Access Road	Perm Access Road	Valves[a]	Con Total[b]	Op Total[b]
North Dakota border to Clearbrook	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clearbrook to Carlton	439.6	199.4	32.1	27.6	27.0	0.2	525.5	226.6
Carlton to Wisconsin border	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**439.6**	**199.4**	**32.1**	**27.6**	**27.0**	**0.2**	**525.5**	**226.6**

Source: PAD-US – USGS 2016.

Notes:

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route.

[a] Includes valve sites and valve driveways. Because valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated from double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations.

Perm = permanent, Temp = temporary

These forests, WMAs, and AMA are managed by Minnesota DNR as multiple-use areas. They are primarily used for fish and wildlife resource protection, forestry, and recreation. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR.

Although not directly affected by pipeline construction or standard operations, the Applicant's preferred route would pass directly east of Itasca State Park, and an existing road that passes through the park would be used as an access road. This state park is one of Minnesota's flagship state parks, with over 500,000 annual visits. The park was established in 1891 to preserve remnant stands of virgin pine and to protect the basin that is the source of the Mississippi River.

County Land

In total, approximately 548 acres of county land would be within the ROI for construction work area of the Applicant's preferred route with an additional 102 acres disturbed for ATWS, access roads and valves. Counties with lands crossed would be Cass (274 acres), Carlton (128 acres), Hubbard (119 acres), and Clearwater (27 acres). During operation about 228 acres would be affected by the permanent right-of-way, including 114 acres in Cass County, 53 acres in Carlton County, 50 acres in Hubbard County, and 11 acres in Clearwater County. While the exact designated use of this land is unknown, it is likely to be

land in county parks and/or forests; therefore, compatibility with designated uses would be determined by the relevant county governments

Table 6.3.6-2. County Lands Crossed by the Applicant's Preferred Route (acres)

Segment	State Land							
	Construction Work Area	Permanent Right-of-Way	ATWS	Temp Access Road	Perm Access Road	Valves[a]	Con Total[b]	Op Total[b]
North Dakota border to Clearbrook	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clearbrook to Carlton	547.7	228.1	36.3	29.1	36.5	0.1	649.7	264.7
Carlton to Wisconsin border	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**547.7**	**228.1**	**36.3**	**29.1**	**36.5**	**0.1**	**649.7**	**264.7**

Source: County-owned parcels were identified using the "owner" name within each county's GIS parcel data. Because parcel data and "owner" naming conventions vary from county to county, DOC-EERA identified county-owned parcels as best as possible. Note that Red Lake County had no GIS parcel data, and Aitkin County had no ownership information on their parcel data; therefore, these counties were not included in the analysis

Notes:

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route.

[a] Includes valve sites and valve driveways. Because valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated from double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations

Perm = permanent; Temp = temporary

6.3.6.2.2 Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to public lands for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Table 6.3.6-3 lists the acreage of federal, state, and county lands crossed by RA-03AM during construction and operation.

Table 6.3.6-3. Public Lands Crossed by Route Alternative RA-03AM (acres)

Segment	Federal Lands[a,b]		State Lands[a,b]		County Lands[b,c]	
	Con	Op	Con	Op	Con	Op
Clearbrook to Carlton	25.4	10.6	32.5	13.5	261.7	119.2

[a] Source: PAD-US – USGS 2016.

[b] Con = 120-foot-wide construction footprint, Op = 50-foot-wide permanent right-of-way.

[c] Source: County-owned parcels were identified using the "owner" name within each county's GIS parcel data. Because parcel data and owner naming conventions vary from county to county, DOC-EERA identified county-owned parcels as best as possible. Note that Red Lake County had no GIS parcel data, and Aitkin County had no ownership information on their parcel data; therefore, these counties were not included in the analysis.

Federal Land

Approximately 25 acres of the ROI for RA-03AM are within the Crane Meadows NWR, which is managed by USFWS. The land is primarily used for bird and wildlife resource management; and is open for public access and general wildlife-dependent recreation such as hunting, wildlife watching, and photography. Therefore, the Applicant would be required to comply with the designated uses and regulatory provisions established through USFWS as the authorizing agency. Non-federal oil and gas operations on NWRs and the associated regulatory provisions are contained within 50 CFR, Part 29, Subparts C and D. Specifically, Section 29.32(a)(2) of Subpart C states that, "Persons conducting mineral operations on Service-administered lands and waters must comply with all applicable Federal and State laws and regulations for the protection of wildlife and the administration of the area."

State Land

The state land consists of 26 acres within the Mississippi Headwaters State Forest, 5 acres within the Neitermeier WMA, and 0.2 acre within the LaSalle Creek AMA. This forest, WMA, and AMA are managed by Minnesota DNR as multiple-use areas. They are primarily used for fish and wildlife resource protection, forestry, and recreation. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR.

Although not directly affected by pipeline construction or standard operations, RA-03AM would pass directly east of Itasca State Park, and an existing road that passes through the park would be used as an access road.

County Land

Construction work areas for RA-03AM includes land in seven counties during construction: 108 acres in Hubbard County, 69 acres in Mille Lacs County, 31 acres in Carlton County, 27 acres in Clearwater County, 25 acres in Pine County, 2 acres in Kenabec County, and 0.3 acre in Morrison County. The operational right-of-way includes 45 acres in Hubbard County, 36 acres in Mille Lacs County, 14 acres in Pine County, 13 acres in Carlton County, 11 acres in Clearwater County, 0.5 acre in Kenabec County, and 0.1 acre in Morrison County. While the exact designated use of this land is unknown, it is likely to be land in county parks or forests; therefore, compatibility with designated uses would be determined by the relevant county governments.

Route Alternative RA-06

Table 6.3.6-4 lists the acreage of federal, state, and county lands crossed by RA-06 during construction and operation.

Table 6.3.6-4. Public Lands Crossed by Route Alternative RA-06 (acres)

Segment	Federal Lands[a,b]		State Lands[a,b]		County Lands[b,c]	
	Con	Op	Con	Op	Con	Op
Clearbrook to Carlton	90.5	37.7	794.0	330.8	10.8	4.5

[a] Source: PAD-US – USGS 2016.

[b] Con = 120-foot-wide construction footprint, Op = 50-foot-wide permanent right-of-way.

[c] Source: County-owned parcels were identified using the "owner" name within each county's GIS parcel data. Because parcel data and owner naming conventions vary from county to county, DOC-EERA identified county-owned parcels as best as possible. Note that Red Lake County had no GIS parcel data, and Aitkin County had no ownership information on their parcel data; therefore, these counties were not included in the analysis.

Federal Land

RA-06 would cross approximately 86 acres of Chippewa National Forest, which is managed by USFS, and 4 acres of BLM-owned land. The forest is managed to protect forest and water resources and provides a variety of recreational opportunities; therefore, the Applicant would be required to comply with the designated uses as established by USFS as the authorizing agency. Grants for pipeline rights-of-way through BLM land are administered under the Mineral Leasing Act of 1920. Specifically, 43 CFR 2880 states, "As authorized by MLA [Mineral Leasing Act], the BLM will issue ROW grants for oil and natural gas gathering, and distribution pipelines and related facilities (not authorized by appropriate leases), and oil and natural gas transmission pipelines and related facilities." Therefore, the Applicant would need to apply for a right-of-way grant.

State Land

Construction of RA-06 would cross 794 acres of state lands, including 294 acres of Big Fork State Forest, 37 acres of Fond du Lac State Forest, 458 acres of George Washington State Forest, 0.2 acre of Clearwater River AMA, 5 acres of Little Otter Creek AMA, and 0.3 acre of Venning Creek AMA. These forests and AMAs are managed by Minnesota DNR as multiple-use areas. They are primarily used for fish and wildlife resource protection, forestry, and recreation. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR.

County Land

RA-06 would cross county land in two counties: 10 acres in Carlton County and 0.7 acre in St. Louis County. During operation, RA-06 would affect 4 acres in Carlton County and 0.3 acre in St. Louis County. While the exact designated use of this land is unknown, it is likely to be land in county parks or forests; therefore, compatibility with designated uses would be determined by the relevant county governments.

Route Alternative RA-07

Table 6.3.6-5 lists the acreage of federal, state, and county lands crossed by RA-07 during construction and operation.

Table 6.3.6-5. Public Lands Crossed by Route Alternative RA-07 (acres)

Segment	Federal Lands[a,b]		State Lands[a,b]		County Lands[b,c]	
	Con	Op	Con	Op	Con	Op
Clearbrook to Carlton	157.1	36.5	900.1	219.6	82.7	34.6

[a] Source: PAD-US – USGS 2016.

[b] Con = 205-foot-wide construction footprint, Op = 50-foot-wide permanent right-of-way.

[c] Source: County-owned parcels were identified using the "owner" name within each county's GIS parcel data. Because parcel data and owner naming conventions vary from county to county, DOC-EERA identified county-owned parcels as best as possible. Note that Red Lake County had no GIS parcel data, and Aitkin County had no ownership information on their parcel data; therefore, these counties were not included in the analysis.

Federal Land

RA-07 would cross 157 acres of Chippewa National Forest, which is managed by USFS. The forest is managed to protect forest and water resources, and provides a variety of recreational opportunities. Therefore, the Applicant would be required to comply with the designated uses as established by USFS as the authorizing agency.

State Land

Construction of RA-07 would cross approximately 900 acres of state lands, including three state forests (Bowstring State Forest [698 acres], Fond du Lac State Forest [63 acres], Mississippi Headwaters State Forest [131 acres]) and two AMAs (Clearwater River AMA [0.3 acre] and Little Otter Creek AMA [8 acres]). These forests and AMAs are managed by Minnesota DNR as multiple-use areas. They are primarily used for fish and wildlife resource protection, forestry, and recreation. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR.

County Land

Construction of RA-07 would affect county land in seven counties: 61 acres in Hubbard County, 10 acres in Carlton County, 5.5 acres in Clearwater County, 3 acres in Cass County, 2 acres in Beltrami County, and 0.5 acre in Itasca County. The operational right-of-way would include 26 acres in Hubbard County, 4 acres in Carlton County, 2 acres in Clearwater County, 1 acre in Cass County, 0.7 acre in Beltrami County, 0.3 acre in St. Louis County, and 0.2 acre in Itasca County. While the exact designated use of this land is unknown, it is likely to be land in county parks or forests. Therefore, compatibility with designated uses would be determined by the relevant county governments.

Route Alternative RA-08

Table 6.3.6-6 lists the acreage of federal, state, and county lands crossed by RA-08 during construction and operation.

Table 6.3.6-6. Public Lands Crossed by Route Alternative RA-08 (acres)

Segment	Federal Lands[a,b]		State Lands[a,b]		County Lands[b,c]	
	Con	Op	Con	Op	Con	Op
Clearbrook to Carlton	84.4	35.2	583.7	243.2	47.9	19.9

[a] Source: PAD-US – USGS 2016.

[b] Con = 120-foot-wide construction footprint, Op = 50-foot-wide permanent right-of-way.

[c] Source: County-owned parcels were identified using the "owner" name within each county's GIS parcel data. Because parcel data and owner naming conventions vary from county to county, DOC-EERA identified county-owned parcels as best as possible. Note that Red Lake County had no GIS parcel data, and Aitkin County had no ownership information on their parcel data; therefore, these counties were not included in the analysis.

Federal Land

RA-08 would cross 84 acres of Chippewa National Forest, which is managed by USFS. The forest is managed to protect forest and water resources, and provides a variety of recreational opportunities. Therefore, the Applicant would be required to comply with the designated uses as established by USFS as the authorizing agency.

State Land

Construction of RA-08 would cross 584 acres of state lands, including two AMAs (Bruce Creek AMA [0.3 acre] and Little Otter Creek AMA [4 acres]), five state forests (Bowstring State Forest [410 acres], Fond du Lac State Forest [36 acres], Mississippi Headwaters State Forest [68 acres], Savanna State Forest [38 acres], and Welsh Lake State Forest]15 acres]), and two WMAs (Bemidji Slough WMA [4 acres] and Swan River Deer Yard WMA [7 acres]). These forests, WMAs, and AMAs are managed by Minnesota DNR as multiple-use areas. They are primarily used for fish and wildlife resource protection, forestry, and recreation. Compatibility of the Project with designated uses would be determined during easement negotiations with the authorizing agency, which is Minnesota DNR.

County Land

RA-08 would cross county-owned land in six counties: 24 acres of county land in Hubbard County, 10.6 acres in Carlton County, 6 acres in Clearwater County, 5 acres in Itasca County, 2 acres in St. Louis County, and 0.2 acre in Beltrami County. During operation, the RA-08 route would include 10 acres in Hubbard County, 4 acres in Carlton County, 2 acres in Clearwater County, 2 acres in Itasca County, 1 acre in St. Louis County, and 0.1 acre in Beltrami County. While the exact designated use of this land is unknown, it is likely to be land in county parks or forests. Therefore, compatibility with designated uses would be determined by the relevant county governments.

6.3.6.3 Impact Assessment

The impact assessment focuses on compatibility of construction and operation of the Applicant's preferred route and route alternatives with designated uses of specific federal, state, and county public lands. In addition to the analysis of compatibility with the designated use of public lands in this section, impacts on the public resources contained within public lands (e.g., vegetation, wildlife, and recreation) and the measures that would be implemented to minimize potential impacts on those resources can be found in several other sections within Chapter 6, including Sections 6.3.1, 6.3.3, 6.3.4, 6.2.3, and 6.5.2.

6.3.6.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

In Minnesota, the Applicant's preferred route would cross 0.4 mile of federal land associated with the North County Scenic Trail federal land. It would cross approximately 440 acres of state land, including AMAs, WMAs, and state forests, and 548 acres of county land.

Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a variety of factors such as land use type, topography, weather, and other environmental conditions. Limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. However, the affected area would represent a relatively small area in proportion to the total amount of public land within the specific forest or resource management area that remains undisturbed or unaffected. Given that construction impacts would be limited to small areas within the overall forest and resource management area, and that the original use of these larger areas would be maintained during construction, it is likely that construction of the pipeline would result in a temporary to long-term and minor to negligible impact related to compatibility with the designated uses of these public lands. Removal of forested habitat would be a long-term impact; depending on the route and the forest, the magnitude could be major.

There would be no direct impacts on Itasca State Park; during construction of the Applicant's preferred route, however, access to the park and visitor experience could be indirectly affected.

Operations Impacts

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation along public lands. During operation, the permanent right-of-way for the Applicant's preferred route includes 2 acres of federal land, 199 acres of state land, and 228 acres of county land. The permanent right-of-way would be periodically cleared of vegetation, and no trees would be permitted to grow. With the exception of the 37 acres of county land and 27 acres of state lands that would be permanently converted to permanent access roads and valve sites (see Tables 6.3.6-1 and 6.3.6-2), the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. Therefore, the public land could continue to be managed for its designated uses, and impacts associated with operation would likely be long-term but negligible to minor. The exception to this would be on forested land where the management objective is timber production, and no trees would be permitted to grow within the permanent right-of-wayof the pipeline corridor. Given the amount of affected land in state forests compared to the overall forested land that remains available for timber production, it is likely that operation of the pipeline would result in a permanent but minor impact related to compatibility with the designated use of forested land for timber production.

6.3.6.3.2 Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

During construction, federal, state, and county lands affected by RA-03AM would total approximately 320 acres (Table 6.3.6-3). The largest portion of this land would be county land (262 acres); followed by 33 acres of state forests, WMAs, and AMAs; and 25 acres of federal land within the Crane Meadows NWR, which is managed by USFWS.

Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. However, the affected area would represent a relatively small area in proportion to the total amount of public land within the specific forest or resource management area that remains undisturbed or unaffected. Given that construction impacts are limited to small areas within the overall forest and resource management area, and that the original use of these larger areas would be maintained during construction, it is likely that construction of the pipeline would result in a temporary to long-term and minor to negligible impact related to compatibility with the designated uses of these public lands. Removal of forested habitat would be a long-term impact; depending on the route and the forest, the magnitude could be major.

There would be no direct impacts on Itasca State Park; during construction of RA-03AM, however, access to the park and visitor experience would be indirectly affected.

Operations Impacts

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation along public lands. During operation, the permanent right-of-way for the RA-03AM route would include 143 acres of public lands, most of which would be county-owned lands (Table 6.3.6-3).

With the exception of public lands that would be permanently converted to permanent access roads and valve sites, the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. The public land could continue to be managed for its designated uses; therefore, impacts associated with operation are likely to be long term but negligible to minor. The exception to this would be on forested land where the management objective is timber production, and no trees would be permitted to grow within the permanent right-of-way of the pipeline corridor. However, given the amount of affected land in state forests compared to the overall forested land that remains available for timber production, it is likely that operation of the pipeline would result in a permanent but minor impact related to compatibility with the designated use of forested land for timber production.

Route Alternative RA-06

Construction Impacts

During construction, the federal, state, and county lands affected by RA-06 would total approximately 895 acres (Table 6.3.6-4). The largest portion of this land would be state land (794 acres), followed by approximately 90 acres of federal land (86 acres of the Chippewa National Forest, which is managed by USFS, and 4 acres of BLM-owned land).

Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. However, the affected area would represent a relatively small area in proportion to the total amount of public land within the specific forest or resource management area that remains undisturbed or unaffected. Given that construction impacts are limited to small areas within the overall forest and resource management area and that the original use of these larger areas would be maintained during construction, it is likely that construction of the pipeline would result in a temporary to long-term and minor to negligible impact related to compatibility with the designated uses of these public lands. Removal of forested habitat would be a long-term impact; depending on the route and the forest, the magnitude could be major.

Operations Impacts

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation along public lands. During operation, the permanent right-of-way for RA-06 includes 38 acres of federal land, 331 acres of state land, and 5 acres of county land.

With the exception of public lands that would be permanently converted to permanent access roads and valve sites, the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. The public land could continue to be managed for its designated uses; therefore, impacts associated with operation are likely to be long term but negligible to minor. The exception to this would be on forested land where the management objective is timber production, and no trees would be permitted to grow within the permanent right-of-way of the pipeline corridor. However, given the amount of affected land in state forests compared to the overall forested land that remains available for timber production, it is likely that operation of the pipeline would result in a permanent but minor impact related to compatibility with the designated use of forested land for timber production.

Route Alternative RA-07

Construction Impacts

During construction, the federal, state, and county lands affected by RA-07 would total approximately 1,140 acres (Table 6.3.6-5). The largest portion of this land would be state land (900 acres), followed by 157 acres of federal land through the Chippewa National Forest, which is managed by USFS.

Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a

variety of factors such as land use type, topography, weather, and other environmental conditions; limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. However, the affected area would represent a relatively small area in proportion to the total amount of public land within the specific forest or resource management area that remains undisturbed or unaffected. Given that construction impacts are limited to small areas within the overall forest and resource management area and that the original use of these larger areas would be maintained during construction, it is likely that construction of the pipeline would result in a temporary to long-term and minor to negligible impact related to compatibility with the designated uses of these public lands. Removal of forested habitat would be a long-term impact; depending on the route and the forest, the magnitude could be major.

Operations Impacts

With the exception of public lands that would be permanently converted to permanent access roads and valve sites, the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. The public land could continue to be managed for its designated uses; therefore, impacts associated with operation are likely to be long term but negligible to minor. The exception to this would be on forested land where the management objective is timber production, and no trees would be permitted to grow within the permanent right-of-way of the pipeline corridor. However, given the amount of affected land in state forests compared to the overall forested land that remains available for timber production, it is likely that operation of the pipeline would result in a permanent but minor impact related to compatibility with the designated use of forested land for timber production.

Route Alternative RA-08

Construction Impacts

During construction, the federal, state, and county lands affected by RA-08 would total approximately 716 acres (Table 6.3.6-6). The largest portion of this land would be state land (584 acres), followed by 84 acres of federal land through the Chippewa National Forest, which is managed by USFS.

Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. However, the affected area would represent a relatively small area in proportion to the total amount of public land within the specific forest or resource management area that remains undisturbed or unaffected. Given that construction impacts are limited to small areas within the overall forest and resource management area and that the original use of these larger areas would be maintained during construction, it is likely that construction of the pipeline would result in a temporary to long-term and minor to negligible impact related to compatibility with the designated uses of these public lands. Removal of forested habitat would be a long-term impact; depending on the route and the forest, the magnitude could be major.

Operations Impacts

Operation of the pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation along public lands. During operation, the permanent right-of-way for RA-08 includes 35 acres of federal land, 243 acres of state land, and 20 acres of county land.

With the exception of public lands that would be permanently converted to permanent access roads and valve sites, the pipeline itself would be buried so there would be no ongoing restriction to surface use, except at valve locations. The public land could continue to be managed for its designated uses; therefore, impacts associated with operation are likely to be long term but negligible to minor. The exception to this would be on forested land where the management objective is timber production, and no trees would be permitted to grow within the permanent right-of-way of the pipeline corridor. However, given the amount of affected land in state forests compared to the overall forested land that remains available for timber production, it is likely that operation of the pipeline would result in a permanent but minor impact related to compatibility with the designated use of forested land for timber production.

6.3.6.4 Summary and Mitigation

6.3.6.4.1 Summary

Table 6.3.6-7 presents the results of the analysis of potential compatibility impacts on public lands from construction and operation of the Applicant's preferred route and the route alternatives. Depending on the specific resource or feature being affected, impacts on public lands from construction would vary. The use of public lands would be temporarily restricted during the period of active construction. Construction in any location would last for several days to several weeks, depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; limited use, access restrictions, and noise and visual disturbance could occur during this timeframe.

The duration and magnitude of the construction impacts related to the compatibility of the Applicant's preferred route and route alternatives with the designated uses of public land would range from negligible to minor and temporary to long-term impacts. The low level of impact occurs for two reasons. The limitation represents a small portion of the overall land designated for public use in most affected areas, and any impacts on this land would be restored following construction. Therefore, any impacts related to the compatibility of the pipeline with the designated uses of the land would be limited to the duration of construction and site restoration. Construction of the Applicant's preferred route would have the largest effect in terms of total land area on county-owned land (548 acres), whereas the RA-07 route would have the largest total impact on federally and state-owned land (157 acres and 900 acres, respectively).

During operations, impacts on public lands related to compatibility of a pipeline (for any route option) with their designated uses would be long term to permanent and negligible to major. With the exception of public lands that would be permanently converted to permanent access roads and valve sites, the pipeline itself would be buried so there would be limited restriction to surface use, except at valve locations. Therefore, the public land could continue to be managed for its designated uses, and impacts associated with operation are likely to be long term but negligible to minor. The exception to this would be on forested land within the permanent right-of-way of the pipeline corridor where there would be permanent minor impacts on forest production, recreation and habitat. Given the area of the affected land relative to the public land that remains available for timber production, it is likely that continued operation of the pipeline (for any route option) would result in a permanent but minor impact related to compatibility of a pipeline with the designated use of the affected land.

6.3.6.4.2 Mitigation

As previously noted, crossing through public lands would prompt authorizing agencies to ensure that the Applicant's preferred route or a route alternative complies with the designated uses of the land; therefore, the various agencies would require mitigation and the Applicant would need to coordinate with the authorizing agency.

With implementation of Applicant-proposed measures and compliance with conditions specified in required permits by the authorizing agencies, no mitigation has been identified to further minimize impacts on federal, state, and county lands—with the exception of forested land within the permanent right-of-way, which would not be allowed to re-establish. A potential mitigation would be to purchase and dedicate private forest land to timber production as an offset; or to compensate the state, federal, or county government for any merchantable timber lost.

Table 6.3.6-7. Summary of Potential Impacts Related to Compatibility of the Applicant's Preferred Route and Route Alternatives with Designated Uses of Public Land

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Federal land	Temporary/negligible to minor impacts • 5 acres	Temporary/negligible to minor impacts • 25 acres	Temporary/negligible to minor impacts • 91 acres	Temporary/negligible to minor impacts • 157 acres	Temporary/negligible to minor impacts • 84 acres
State land	Temporary to long-term/negligible to minor impacts • 440 acres	Temporary to long-term/negligible to minor impacts • 33 acres	Temporary to long-term/negligible to minor impacts • 794 acres	Temporary to long-term/negligible to minor impacts • 900 acres	Temporary to long-term/negligible to minor impacts • 584 acres
County land	Temporary/negligible to minor impacts • 548 acres	Temporary/negligible to minor impacts • 262 acres	Temporary/negligible to minor impacts • 11 acres	Temporary/negligible to minor impacts • 83 acres	Temporary/negligible to minor impacts • 48 acres
Operations Impacts					
ederal land	Long-term to permanent/ negligible to minor impacts • 2 acres	Long-term to permanent/ negligible to minor impacts • 11 acres	Long-term to permanent/ negligible to minor impacts • 38 acres	Long-term to permanent/negligible to minor impacts • 37 acres	Long-term to permanent/negligible to minor impacts • 35 acres
Impacts on state land	Long-term to permanent/ negligible to minor impacts • 199 acres	Long-term to permanent/ negligible to minor impacts • 14 acres	Long-term to permanent/ negligible to minor impacts • 331 acres	Long-term to permanent/negligible to minor impacts • 220 acres	Long-term to permanent/negligible to minor impacts • 243 acres
Impacts on county land	Long-term to permanent/ negligible to minor impacts • 228 acres	Long-term to permanent/ negligible to minor impacts • 119 acres	Long-term to permanent/ negligible to minor impacts • 5 acres	Long-term to permanent/negligible to minor impacts • 35 acres	Long-term to permanent/negligible to minor impacts • 20 acres

6.3.6.5 References

Minnesota Department of Natural Resources (Minnesota DNR). 2016. Wildlife Management Areas. http://dnr.state.mn.us/wmas/description.html. Accessed on December 9, 2016.

North Country Trail Association. 2016. Trail association website. https://northcountrytrail.org/trail/. Accessed on December 11, 2016.

U.S. Geological Survey (USGS). 2016. Gap Analysis Program. May 2016. Protected Areas Database of the United States (PAD-US), Version 1.4 Combined Feature Class.

6.3.7 Air Quality

Construction and operation of the Applicant's preferred route and route alternatives may affect air quality in Minnesota through the emission of air pollutants that, directly or indirectly, enter the atmosphere and contribute to increased air pollution. Air quality is defined by the ambient concentration of certain pollutants (i.e., criteria pollutants) in the atmosphere determined by EPA to be of concern to the health and welfare of the general public and the environment.

Pipeline construction causes air pollution primarily through emissions from construction equipment (i.e., non-road engines), mobile sources (i.e., vehicles), and construction-related activities (i.e., burning, blasting, and road travel). This analysis evaluates air quality impacts from construction of the Applicant's preferred route and route alternatives by assessing:

- Air pollutants, including greenhouse gas GHG emissions, generated by construction; and
- Stored carbon releases from tree removal within the construction work areas.

Under normal operations, oil pipelines emit small amounts of fugitive emissions. More significant emissions may result from storage tanks at terminals and pump stations that use internal combustion engines. The pump stations for the Applicant's preferred route would use electric-drive motors that do not emit air pollutants but do create air emissions indirectly from the electricity generation required to operate them. Furthermore, an underlying issue associated with oil pipelines has been their potential to affect climate change through increased concentrations of GHGs in the atmosphere. This analysis evaluates air impacts from operations for the Applicant's preferred route and route alternatives by assessing:

- Air pollutants, including GHG emissions, from pipeline operations; and
- Loss of carbon storage capability (i.e., carbon sequestration) from tree removal within the pipeline rights-of-way.

This section first describes the existing condition for air quality within an area along the Applicant's preferred route and route alternatives where air quality could be affected by construction and operation. Next, the section evaluates the potential impacts of construction and operation on the existing conditions and compares these impacts for the five route options (i.e., the Applicant's preferred route, RA-03AM, RA-06, RA-07, and RA-08).

Chapter 10 addresses the impacts on air quality resulting from a crude oil release.

6.3.7.1 Regulatory Context and Methodology

6.3.7.1.1 Regulatory Context

Air Quality Standards

Criteria pollutants and federal air quality standards are defined in Section 5.2.7.1 and Table 5.2.7-1. Minnesota has adopted ambient air quality standards that are the same as or more stringent than the National Ambient Air Quality Standards (NAAQS); these are referred to as "Minnesota Ambient Air Quality Standards" (MAAQS). Minnesota also has established state standards for hydrogen sulfide (H_2S) and particulate matter (PM) (EPA 2016a; Minnesota PCA 2000).

Attainment of Air Quality Standards

Neither the Applicant's preferred route nor any route alternative would pass through an air quality maintenance or nonattainment area within Minnesota (EPA 2016b). Refer to Section 5.2.7.2 for general information on air quality attainment status.

Air Quality Control Regions

Air quality control regions are categorized as Class I, Class II, or Class III. Class I areas (commonly called "pristine areas") were established primarily as national parks and wilderness areas above a certain size and receive special protections under the Clean Air Act to help maintain pristine air quality. Minnesota contains two Class I areas: Voyageurs National Park (in Koochiching and St. Louis counties) and the Boundary Waters Canoe Area (in St. Louis, Lake, and Cook counties). In addition, the Fond du Lac Band of Lake Superior Chippewa is currently seeking re-designation of the Fond du Lac Reservation from a Class II to a Class I area. The closest distances to Class I and pending Class I areas are listed in Table 6.3.7-1. Neither the Applicant's preferred route nor any route alternative would pass through a Class I area within Minnesota; however, route alternatives RA-06, RA-07, and RA-08 would pass through the Fond du Lac Reservation.

Table 6.3.7-1. Closest Distance to Class I Areas in Minnesota for the Applicant's Preferred Route and Route Alternatives (miles)

Route	Distance to Boundary Waters Canoe Area Wilderness Area	Distance to Voyageurs National Park	Distance to Fond du Lac Reservation (pending re-designation)
Applicant's preferred route	87.6	110.8	2.0
Route alternative RA-03AM	87.6	112.9	2.0
Route alternative RA-06	38.6	47.4	0.0
Route alternative RA-07	69.1	82.4	0.0
Route alternative RA-08	69.5	82.6	0.0

Source: Minnesota PCA 2016a.

Air Quality Permitting Requirements

Air permits may be required for a project, depending on the quantity of specific project emissions. In general, federal permits are required for larger emitters and are implemented nationwide under a consistently applied permitting program. Minnesota has been delegated authority to implement the federal permits program. State permits are those air permits required by state rule and statutes. In Minnesota, these permits are the result of state-specific strategies approved by the federal government to regulate minor sources of air emissions and to attain compliance with broader air quality federal laws and regulations (e.g., registration permits, capped emission permits).

Generally, no significant air emissions are associated with operation of a pipeline itself. While there may be what are termed "fugitive emissions" from a pipeline, such emissions are generally very minor and typically are not subject to the requirement to obtain a permit. The pipeline-associated facilities that most commonly trigger the requirement to obtain a permit for operations are storage tanks at terminals and pump stations that use internal combustion engines to power pipeline pumps. All the pump stations

proposed for the Applicant's preferred route and route alternatives use electric-drive motors and do not emit air pollutants. However, they do create air emissions indirectly from the additional electricity generation required to operate them. Note that, although pipeline construction causes air pollution through emissions from non-road engines and mobile sources, these emissions do not count toward permitting triggers and therefore do not require air permits.

6.3.7.1.2 Methodology

Construction and operation of the Applicant's preferred route and route alternatives would result in emissions that may affect local air quality. The ROI consisted of the designated airsheds (geographical regions that share the same air supply and are subject to the same air pollutants) through which the pipeline routes pass. Because of the large regional nature of airsheds, the Applicant's preferred route and the route alternatives generally would occur within the same airsheds.

Potential impacts on air quality within the ROI from construction and operation of the Applicant's preferred route and route alternatives were assessed as follows:

- Direct construction emissions data were obtained from the Applicant for one pipeline construction spread. Each construction emission source group from the Applicant's data was divided by an average of 54.8 miles per spread to obtain emissions per mile. Emissions per mile then were multiplied by the corresponding pipeline segment length to determine the emissions for each source group for each route segment. This allowed a comparable assessment of the construction emissions from the Clearbrook-to-Carlton segment for the Applicant's preferred route and route alternatives.
- Direct operations emissions data were obtained from the Applicant for the Applicant's preferred route and route alternatives based on the number of electric pump stations and MLV sites. Operational emissions for the Applicant's preferred route and route alternatives were presented for the entire routes within Minnesota, not just the Clearbrook-to-Carlton segment.
- Indirect GHG emissions for the Applicant's preferred route and route alternatives from generation of electricity by the existing local utilities for electric pump station operations were calculated using pump station electricity consumption data supplied by the Applicant and GHG emission factors from EPA's Emissions and Generation Resource Integrated Database (eGRID).
- The amounts of carbon that potentially would be released back into the atmosphere during tree removal within the construction work areas were estimated using the average carbon density of trees within the Northern Lake States developed by USFS.
- The loss of carbon sequestration for areas along the permanent right-of-way that would remain cleared was estimated using the average annual carbon accumulation associated with trees within the Northern Lake States developed by the Chicago Climate Exchange.

6.3.7.2 Existing Conditions

6.3.7.2.1 Applicant's Preferred Route and Route Alternatives

Climate/Meteorology

Air quality is substantially influenced by climate and meteorological conditions. Minnesota has a continental climate with cold, often frigid winters and hot summers. Refer to Table 5.2.7-3 for representative climate data.

Existing Air Quality

To characterize the background air quality for northern Minnesota when no site-specific monitoring data were available, data were obtained from air quality monitoring stations located within the counties that would be crossed by the Applicant's preferred route and route alternatives. To obtain representative background air quality for nitrogen dioxide (NO_2) and sulfur dioxide (SO_2), data from a monitoring station in Anoka County were used. This monitoring station is the closest station to counties in the ROI that monitors for NO_2 and SO_2 emissions. A summary of the available background air quality concentrations for 2015 is presented in Table 6.3.7-2. The table shows that ambient air quality for all criteria pollutants are below the NAAQS for all areas that would be crossed by the Applicant's preferred route and route alternatives.

EPA developed the Air Quality Index to provide a simple, uniform way to report daily air quality conditions taking into account all of the criteria air pollutants measured within a geographic area. Minnesota reports the Air Quality Index in 10 reporting areas across the state. According to the Air Quality Index report for 2015, all of the routes are in areas that are in-attainment for air quality standards, and none are located near any of the areas noted for unhealthy air quality (Minnesota PCA 2016b).

Greenhouse Gases

GHGs occur in the atmosphere both naturally and as a result of human activities, such as burning fossil fuels. Based on overwhelming scientific evidence, EPA found that GHGs constitute a threat to public health and welfare (Center for Climate and Energy Solutions 2016). Refer to Section 5.2.7.2.1 for a general discussion of federal actions designed to reduce overall GHG emissions in 2025 by 26 to 28 percent over 2005 emission levels.

Minnesota has implemented various programs and legislation to reduce GHG emissions. Since the 1990s, the state has provided tax exemptions for renewable and alternative energy sources (Minn. Stat. § 272.02 and 297A.68). The Next Generation Energy Act of 2007 established state GHG reduction goals of 15 percent by 2015, 30 percent by 2025, and 80 percent by 2050. Recent data indicate that Minnesota missed the 2015 target and is not on track to meet the other goals (MNDOT 2017; MPR News 2016).

Table 6.3.7-2. Representative Background Air Quality Data in the Vicinity of the Applicant's Preferred Route and Route Alternatives in Minnesota (2015)

Pollutant (Averaging Time)	Monitoring Station Location				
	Beltrami County	Carlton County	Crow Wing County	St. Louis County	Anoka County[a]
PM-10 (24-hour, 2nd max)	--	--	--	67 µg/m³ (45% of NAAQS)	--
PM-2.5 (Annual, mean)	5.0 µg/m³ (42% of NAAQS)	6.8[b] µg/m³ (57% of NAAQS)	6.2 µg/m³ (52% of NAAQS)	5.6 µg/m³ (47% of NAAQS)	6.6 µg/m³ (55% of NAAQS)
PM-2.5 (24-hour, 98%)	14 µg/m³ (40% of NAAQS)	23 µg/m³ (66% of NAAQS)	16 µg/m³ (46% of NAAQS)	16 µg/m³ (46% of NAAQS)	15 µg/m³ (43% of NAAQS)
SO_2 (1-hour, 99%)	--	--	--	--	4 ppb (5% of NAAQS)
NO_2 (Annual, mean)	--	--	--	--	6.55 ppb (12% of NAAQS)
NO_2 (1-hour, 98%)	--	--	--	--	44 ppb (44% of NAAQS)
Ozone (8-hour, 4th max)	--	0.06 ppm (86% of NAAQS)	0.06 ppm (86% of NAAQS)	0.056 ppm (80% of NAAQS)	0.064 ppm (91% of NAAQS)
CO (8-hour, 2nd max)	--	--	--	--	0.9 ppm (10% of NAAQS)
CO (1-hour, 2nd max)	--	--	--	--	1.2 ppm (4% of MAAQS)
Lead (Max 3-month average)	--	--	--	0 µg/m³ (0% of NAAQS)	0.01 µg/m³ (7% of NAAQS)

Source: EPA 2016c.

Notes:

Table results depict the data from the monitoring site within the county with the highest pollutant level, including exceptional events data.

Air pollution levels measured at a particular monitoring site are not necessarily representative of the air quality for an entire county or urban area.

Air quality standards for some pollutants (PM-2.5, lead) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standards. In those cases, the site-level statistics may differ from the monitor–level statistics.

[a] Although the region of interest (ROI) is not within Anoka County, this monitoring station is the closest station to counties in the ROI that monitors for NO_2 and SO_2 emissions.

[b] The mean value does not satisfy minimum data completeness criteria.

CO = carbon monoxide, MAAQS = Minnesota Ambient Air Quality Standards, NAAQS = National Ambient Air Quality Standards, NO_2 = nitrogen dioxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, ppb = parts per billion, ppm = parts per million, SO_2 = sulfur dioxide, µg/m³ = micrograms per cubic meter

"--" = no available data

Total GHG emissions in Minnesota in 2012 were approximately 154 million tons of carbon dioxide equivalents (CO_2e). Between 2005 and 2012, GHG emissions from Minnesota declined by 11 million tons of CO_2e, or about 7 percent, with the most significant reductions coming from electric power utilities and transportation energy use. In 2012, about 31 percent of the GHG emissions were from consumption of electricity, and about 25 percent of emissions were from transportation, as identified in Table 6.3.7-3 (Minnesota PCA 2015).

Table 6.3.7-3. Minnesota Greenhouse Gases by Sector (2012)

Economic Sector	Percent of 2012 Total	Sector Description
Electric utility	31%	Combustion of fuel for generation of electricity; all emissions from electricity consumption in Minnesota, including electricity imported from other states
Transportation	25%	Fuel combustion, air conditioning leakage, and natural gas pipelines
Agriculture	19%	Ruminant digestion, animal feedlots and manure management, fertilizer use, crop cultivation, and fuel combustion
Industrial	14%	Fuel combustion; taconite processing; petroleum refining; magnesium casting; lead recycling; and manufacturing steel, glass, insulating foam, and semiconductors
Residential	6%	Fuel combustion (space and water heating, dryers), fertilizer and product use, housing material carbon sequestration, and air conditioner and refrigerator leakage
Commercial	4%	Fuel combustion, solvent use, medical N_2O; includes institutional sources
Waste	1%	Waste processing and incineration, methane from landfill gas and wastewater, and carbon sequestered in demolition landfills

Source: Minnesota PCA 2015.

6.3.7.3 Impact Assessment

This section of the analysis assesses the temporary air quality effects associated with construction of the pipeline and associated facilities, and the permanent air quality effects resulting from facility operations for the Applicant's preferred route and each of the route alternatives. See Section 5.2.7.3 for a general discussion of potential air quality effects related to pipeline construction and operation.

6.3.7.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

The total estimated construction emissions for the Applicant's preferred route in Minnesota are shown in Table 6.3.7-4. Because the pipeline would be constructed in seven spreads (seven separate sections), total emissions would not be concentrated in any one location but would occur incrementally along the pipeline route. Further, each spread of pipeline activity moves along the route daily during construction; therefore, emissions would be minimal at any specific location, and typical meteorological conditions likely would cause rapid dispersal. The Applicant would minimize dust generated from construction activities by wetting soils on the right-of-way and limiting working hours in residential areas as needed (Enbridge 2016a). As a result, air emissions from construction would result in only localized minor, intermittent and temporary impacts. Because air permitting is not triggered by temporary construction phase emissions, dispersion modeling to ensure compliance with ambient air quality standards would not be required.

Table 6.3.7-4. Estimated Construction Emissions for the Applicant's Preferred Route in Minnesota

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
North Dakota Border to Clearbrook								
On- and off-road diesel equipment combustion emissions	17.1	245.8	241.0	0.4	10.6	9.9	47,162.5	1.1
On- and off-road gasoline equipment combustion emissions	2.2	4.7	30.4	2.4	0.5	0.4	4,190.7	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	117.7	28.9	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	16.7	1.7	0.0	0.0
Open burning of wood debris emissions	0.0	0.0	542.9	0.0	52.9	52.9	280.7	0.0
Subtotal	***19.3***	***250.4***	***814.2***	***2.8***	***198.3***	***93.7***	***51,633.9***	***1.1***
Clearbrook to Carlton								
On- and off-road diesel equipment combustion emissions	34.5	497.6	487.8	0.9	21.4	20.0	95,473.4	2.1
On- and off-road gasoline equipment combustion emissions	4.4	9.4	61.5	4.8	0.9	0.9	8,483.5	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	238.3	58.5	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	33.8	3.4	0.0	0.0
Open burning of wood debris emissions	0.0	0.0	1,099.0	0.0	107.0	107.0	568.3	0.0
Blasting emissions[a]	0.0	0.2	0.3	0.003	0.0005	0.00003	0.0	0.0
Subtotal	***39.0***	***507.1***	***1,648.6***	***5.6***	***401.5***	***189.8***	***104,525.1***	***2.1***
Carlton to Wisconsin Border								
On- and off-road diesel equipment combustion emissions	1.5	21.6	21.2	0.04	0.9	0.9	4.2	0.1
On- and off-road gasoline equipment combustion emissions	0.2	0.4	2.7	0.2	0.04	0.04	369.0	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	10.4	2.6	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	1.5	0.2	0.0	0.0

Table 6.3.7-4. Estimated Construction Emissions for the Applicant's Preferred Route in Minnesota

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
Open burning of wood debris emissions	0.0	0.0	47.8	0.0	4.7	4.7	24.7	0.0
Subtotal	***1.7***	***22.1***	***71.7***	***0.2***	***17.5***	***8.3***	***4,546.9***	***0.1***
TOTAL MINNESOTA EMISSIONS	**59.9**	**779.6**	**2,534.6**	**8.7**	**617.3**	**291.8**	**160,705.8**	**3.3**

Source: Enbridge 2017.

Notes:

Calculations are based on the emissions per spread presented in Table 5.2.7-6 (absent blasting), and an average of 54.8 miles per spread was used to determine emissions per mile. Emissions per mile then were multiplied by the corresponding pipeline length to determine the emissions for each source group for each route segment.

[a] Blasting would be required only for one 1,500-foot section in Spread 7.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

Stored Carbon Releases

Construction along the Applicant's preferred route could require removal of trees from up to 1,543 acres of forested land within the construction work area in Minnesota (i.e., 1,447 acres between Clearbrook and Carlton). Of this, 673 acres are to remain permanently without trees, while the forest would be allowed to regrow on the other 871 acres. When a tree is harvested and converted into forest products, the CO_2 it has stored or sequestered over a lifetime is retained within its cellular structure. When trees die and decompose or are burned, some of the sequestered carbon remains as forest litter and soils, but much of the rest is released back into the atmosphere as CO_2. Within the Northern Lake States, USFS estimated the carbon density of forested lands for six forest types: aspen-birch, elm-ash-cottonwood, maple-beech-birch, oak-hickory, spruce-fir, and white-red-jack pine (Smith et al. 2006). The average for the six forest types is 30.2 metric-tons of carbon per acre. Consequently, the amount of carbon that potentially would be released back into the atmosphere as a result of tree removal over 1,543 acres is estimated at 188,523 tons of CO_2e, with approximately 176,710 tons of CO_2e occurring between Clearbrook and Carlton. Regrowth of the forest on the 871 acres outside of the pipeline right-of-way eventually would more than halve this loss, in the long-run, after forest regrowth, bringing net CO_2 emissions from forest clearance to a level of about 82,095 tons. Note that the annual loss of carbon sequestration is quantified below as an operations impact.

Operations Impacts

Total annual emissions during operations are shown in Table 6.3.7-5. These emissions would result from 8 pipeline pump stations operated with electric motors and 27 MLV sites (Enbridge 2017). Indirect GHG emissions resulting from power generation to supply electrical energy to the pump stations is considered in the following section.

Table 6.3.7-5. Estimated Operations Emissions for the Applicant's Preferred Route in Minnesota

Emission Source Description	Direct Emissions (tons per year)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	2.9	0.0	0.0	0.0	0.0	0.0	0.04	0.09
Mainline valve fugitive emissions from piping components	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.004
Clearbrook terminal fugitive emissions from pumps, piping components, sump tanks, and pig traps	0.5	0.0	0.0	0.0	0.0	0.0	0.006	0.02
Additional Clearbrook terminal storage tank withdrawal losses from pipeline throughput[a]	17.5	0.0	0.0	0.0	0.0	0.0	372.2	1.2
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	0.1	0.01	0.0	0.0
Vehicle combustion emissions	0.002	0.004	0.03	0.002	0.0004	0.0004	4.1	0.0
TOTAL MINNESOTA EMISSIONS	**21.0**	**0.004**	**0.03**	**0.002**	**0.1**	**0.01**	**375.9**	**1.3**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 8 pump stations and 27 mainline valve sites.

[a] Only those emissions associated with the proposed increase in throughput of the Clearbrook terminal are included as part of the Project's operations emissions (i.e., existing operations emissions are equivalent to the existing environment).

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

As discussed in Section 5.2.7.3, the external floating roof storage tanks at the existing Clearbrook terminal are subject to New Source Performance Standards (NSPS) in 40 CFR 60 Subpart Kb, "Standards of Performance for Volatile Organic Liquid Storage Vessels." Subpart Kb regulates VOC emissions and establishes controls based on the vapor pressure of the stored liquid. The Clearbrook terminal currently operates under a minor source Option A Registration Permit, which is a State of Minnesota permit, solely because an NSPS applies and no federal or state permitting thresholds are exceeded (i.e., applicability to NSPS Subpart Kb requires a state air permit under Minnesota Administrative Rules Part 7007.0250). The increased throughput associated with the Applicant's preferred route would cause potential emissions of VOCs at the Clearbrook terminal that exceed the 100 tons-per-year major source threshold, triggering a Title V operating permit. The Applicant would obtain a synthetic-minor individual state permit to limit VOC emissions in order to retain status as a minor source (Enbridge 2016a).

Overall, operations would be expected to result in permanent, minor, localized air quality impacts; and GHG emissions could contribute to global climate change. Dispersion modeling to ensure compliance with ambient air quality standards has not been completed and would likely not be triggered by the

synthetic-minor individual state permit. Furthermore, operations emissions would consist primarily of VOCs, which are a precursor to the criteria pollutant ozone. VOC emissions cannot practically be modeled to show a source's ozone formation given the regional transport nature of the pollutant.

Indirect Greenhouse Gases

In addition to the direct operations emissions presented in Table 6.3.7-5 (376 tons of CO_2e per year), the pump stations would be powered by electricity from existing local electric utilities, which would produce indirect air emissions (i.e., emissions not from the Project itself but from power plant emissions that generate the electricity used by the Project). The projected power consumption from operations of all pump stations is 533,249 megawatt-hours (MWh) per year (Enbridge 2016b). This estimate includes the power consumption for the existing Line 3 pump stations.

GHG emissions for electricity use for the power control area for each of the proposed pump stations were calculated using EPA's eGRID emission factors:

- 1,894 pounds of CO_2e per MWh for the Otter Tail Power Company for the Donaldson, Viking, Plummer, and Clearbrook terminal pump stations; and
- 1,836 pounds of CO_2e per MWh for the Great River Energy for the Two Inlets, Backus, Palisade, and Cromwell pump stations.

Based on these data, the maximum indirect GHG emissions from pump station operations would be 497,112 tons of CO_2e per year (EPA 2015). The maximum indirect GHG emissions from pump station operations associated only with the increased throughput would be 452,497 tons of CO_2e per year, after removing 44,615 tons of CO_2e per year that is associated with existing Line 3 and considered part of the existing environment (Enbridge 2017). The criteria pollutant emissions associated with the electric generating facilities would be authorized by applicable air quality operating permits that ensure compliance with ambient air quality standards.

Loss of Carbon Sequestration

Following construction, 871 acres of previously cleared forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 673 acres along the permanent right-of-way within Minnesota would remain cleared (i.e., 631 acres between Clearbrook and Carlton). The nature of the proposed tree removal is to permanently convert forested land within the permanent right-of-way and aboveground facility sites to a non-forested land use, which would result in a permanent loss of carbon sequestration. The mechanism for carbon sequestration is discussed in Section 5.2. 7.3.

Within the Northern Lake States, the Chicago Climate Exchange (2009) estimated the annual carbon accumulation on forested lands for six forest types: aspen-birch, elm-ash-cottonwood, maple-beech-birch, oak-hickory, spruce-fir, and white-red-jack pine. For these forest types, 1.6 metric tons of CO_2 is annually sequestered in the non-soil components of the forest. Thus, the carbon sequestration foregone annually on the 631 acres that are permanently deforested would be 1,210 tons. Between Clearbrook and Carlton, 631 acres would sequester approximately 1,135 tons of CO_2e per year.

6.3.7.3.2 Route Alternatives (from Clearbrook to Carlton)

In general, the air quality impacts associated with construction and operation of the route alternatives would be similar to those described above for the Applicant's preferred route.

Route Alternative RA-03AM

Construction Impacts

Table 6.3.7-6 shows the estimated construction emissions for RA-03AM between Clearbrook and Carlton. The Applicant-proposed measures to minimize air impacts for the Applicant's preferred route also would be implemented for the route alternative; consequently, the air quality impacts during construction would be minor and temporary.

Table 6.3.7-6. Estimated Construction Emissions for Route Alternative RA-03AM between Clearbrook and Carlton

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
On- and off-road diesel equipment combustion emissions	43.0	619.5	607.4	1.1	26.6	24.9	118,873.2	2.7
On- and off-road gasoline equipment combustion emissions	5.5	11.7	76.6	5.9	1.2	1.1	10,562.6	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	296.8	72.9	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	42.1	4.2	0.0	0.0
Open burning of wood debris emissions	0.0	0.0	1,368.4	0.0	133.2	133.2	707.5	0.0
Blasting emissions[a]	--	--	--	--	--	--	--	--
TOTAL EMISSIONS	**48.5**	**631.2**	**2,052.3**	**7.0**	**499.9**	**236.3**	**130,143.3**	**2.7**

Source: Enbridge 2017.

Notes:

Calculations are based on the emissions per spread presented in Table 5.2.7-6 (absent blasting), and an average of 54.8 miles per spread was used to determine emissions per mile. Emissions per mile then were multiplied by the corresponding pipeline length to determine the emissions for each emission source group for the route alternative.

[a] Blasting emissions have not been quantified.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Stored Carbon Releases

During construction, RA-03AM could require removal of trees from the construction work area between Clearbrook and Carlton that, when removed, would release GHGs. Using the same emissions factor of 30.2 metric-tons of carbon per acre as noted for the Applicant's preferred route, the amount of carbon that potentially would be released back into the atmosphere during construction tree removal of 1,138 acres is estimated at 138,986 tons of CO_2e. Regrowth of the forest on the 667 acres outside of the pipeline right-of-way eventually would more than halve this loss, in the long-run, after forest regrowth, bringing net CO_2 emissions from forest clearance to a level of about 57,455 tons.

Operations Impacts

Table 6.3.7-7 shows the estimated operations emissions for RA-03AM in Minnesota based on 9 pump stations and 29 MLV sites (Enbridge 2017). The table includes indirect GHG emissions from the purchase of electricity for pump station operations determined as a function of the pipeline length. Although the route alternative varies only in the Clearbrook-to-Carlton segment, the operations emissions presented in the table are for the entire pipeline route within Minnesota. Similar to the Applicant's preferred route, operations of RA-03AM would result in minor permanent impacts on air quality, and GHG emissions could contribute to global climate change. Note that emissions from vehicle combustion and unpaved roads have not been quantified.

Table 6.3.7-7. Estimated Operations Emissions for Route Alternative RA-03AM in Minnesota

Emission Source Description	Direct Emissions (tons per year)[a]								Indirect Emissions (tons per year)[b]
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs	GHGs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	3.7	0.0	0.0	0.0	0.0	0.0	0.05	0.1	N/A
Mainline valve fugitive emissions from piping components	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.004	N/A
Clearbrook terminal fugitive emissions from pumps, piping components, sump tanks, and pig traps	0.5	0.0	0.0	0.0	0.0	0.0	0.006	0.02	N/A
Additional Clearbrook terminal storage tank withdrawal losses from pipeline throughput	17.5	0.0	0.0	0.0	0.0	0.0	372.2	1.2	N/A
Unpaved roads fugitive emissions[c]	--	--	--	--	--	--	--	--	N/A
Vehicle combustion emissions[c]	--	--	--	--	--	--	--	--	N/A
Pump stations indirect emissions from being powered by electricity from existing local electric utilities	--	--	--	--	--	--	--	--	518,668.3
TOTAL EMISSIONS	**21.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**372.2**	**1.3**	**518,668.3**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 9 pump stations and 29 mainline valve sites.

[a] Only those emissions associated with the proposed increase in throughput of the Clearbrook terminal are included as part of the operations emissions (i.e., existing operations emissions are equivalent to the existing environment).

[b] Because the projected power consumption from the pump stations is unknown, indirect GHG emissions for the route alternatives were calculated based on 452,497 tons of CO_2e per year for the Applicant's preferred route over 380 total miles (i.e., 1,191 tons of CO_2e per year per mile).

[c] Air emissions from vehicles and unpaved roads have not been quantified for operations for RA-03AM.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, N/A = not applicable, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Loss of Carbon Sequestration

Following construction of RA-03AM, 667 acres of previously cleared forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 471 acres along the permanent right-

of-way between Clearbrook and Carlton would remain cleared and would not provide any future carbon sequestration. Using the same emission factor of 1.6 metric-tons of CO_2 per acre per year as noted for the Applicant's preferred route, the amount of carbon that would have been sequestered by 471 acres is estimated at 846 tons of CO_2e per year.

Route Alternative RA-06

Construction Impacts

Table 6.3.7-8 shows the estimated construction emissions for RA-06 between Clearbrook and Carlton. The Applicant-proposed measures to minimize air impacts for the Applicant's preferred route also would be implemented for the route alternative; consequently, air quality impacts during construction would be minor and temporary.

Table 6.3.7-8. Estimated Construction Emissions for Route Alternative RA-06 between Clearbrook and Carlton

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
On- and off-road diesel equipment combustion emissions	30.8	443.1	434.5	0.8	19.1	17.8	85,031.4	1.9
On- and off-road gasoline equipment combustion emissions	3.9	8.4	54.8	4.2	0.8	0.8	7,555.6	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	212.3	52.1	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	30.1	3.0	0.0	0.0
Open burning of wood debris emissions	0.0	0.0	978.8	0.0	95.3	95.3	506.1	0.0
Blasting emissions[a]	--	--	--	--	--	--	--	--
TOTAL EMISSIONS	**34.7**	**451.5**	**1,468.0**	**5.0**	**357.6**	**169.0**	**93,093.0**	**1.9**

Source: Enbridge 2017.

Notes:

Calculations are based on the emissions per spread presented in Table 5.2.7-6 (absent blasting), and an average of 54.8 miles per spread was used to determine emissions per mile. Emissions per mile then were multiplied by the corresponding pipeline length to determine the emissions for each emission source group for the route alternative.

[a] Blasting emissions have not been quantified.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Stored Carbon Releases

During construction, RA-06 could require removal of trees from the construction work area between Clearbrook and Carlton that, when removed, would release GHGs. Using the same emission factor of 30.2 metric-tons of carbon per acre as noted for the Applicant's preferred route, the amount of carbon that potentially would be released back into the atmosphere during construction tree removal of

1,107 acres is estimated at 135,272 tons of CO_2e. Regrowth on the forest on the 646 acres outside of the pipeline right-of-way eventually would more than halve this loss, in the long-run, after forest regrowth, bringing net CO_2 emissions from forest clearance to a level of about 56,245 tons.

Operations Impacts

Table 6.3.7-9 shows the estimated operations emissions for RA-06 in Minnesota based on 7 pump stations and 24 MLV sites (Enbridge 2017). The table includes indirect GHG emissions from the purchase of electricity for pump station operations determined as a function of the pipeline length. Although the route alternative varies only in the Clearbrook-to-Carlton segment, the operations emissions presented in the table are for the entire pipeline route within Minnesota. Similar to the Applicant's preferred route, operations of RA-06 would result in minor permanent impacts on air quality, and GHG emissions could contribute to global climate change. Note that emissions from vehicle combustion and unpaved roads have not been quantified.

Table 6.3.7-9. Estimated Operations Emissions for Route Alternative RA-06 in Minnesota

Emission Source Description	Direct Emissions (tons per year)[a]								Indirect Emissions (tons per year)[b]
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs	GHGs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	2.9	0.0	0.0	0.0	0.0	0.0	0.04	0.09	N/A
Mainline valve fugitive emissions from piping components	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.003	N/A
Clearbrook terminal fugitive emissions from pumps, piping components, sump tanks, and pig traps	0.5	0.0	0.0	0.0	0.0	0.0	0.006	0.02	N/A
Additional Clearbrook terminal storage tank withdrawal losses from pipeline throughput	17.5	0.0	0.0	0.0	0.0	0.0	372.2	1.2	N/A
Unpaved roads fugitive emissions[c]	--	--	--	--	--	--	--	--	N/A
Vehicle combustion emissions[c]	--	--	--	--	--	--	--	--	N/A
Pump stations indirect emissions from being powered by electricity from existing local electric utilities	--	--	--	--	--	--	--	--	425,442.1
TOTAL EMISSIONS	**21.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**372.2**	**1.3**	**425,442.1**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 7 pump stations and 24 mainline valve sites.

[a] Only those emissions associated with the proposed increase in throughput of the Clearbrook terminal are included as part of the operations emissions (i.e., existing operations emissions are equivalent to the existing environment).

[b] Because the projected power consumption from the pump stations are unknown, indirect GHG emissions for the route alternatives were calculated based on 452,497 tons of CO_2e per year for the Applicant's preferred route over 380 total miles (i.e., 1,308 tons of CO_2e per year per mile).

[c] Air emissions from vehicles and unpaved roads have not been quantified for operations for RA-06.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, N/A = not applicable, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Loss of Carbon Sequestration

Following construction of RA-06, 646 acres of previously forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 461 acres along the permanent right-of-way between Clearbrook and Carlton would remain cleared and would not provide any future carbon sequestration. Using the same emission factor of 1.6 metric-tons of CO_2 per acre per year as noted for the Applicant's preferred route, the amount of carbon that would have been sequestered for 461 acres is estimated at 829 tons of CO_2e per year.

Route Alternative RA-07

Construction Impacts

Table 6.3.7-10 shows the estimated construction emissions for RA-07 between Clearbrook and Carlton. The Applicant-proposed measures to minimize air impacts for the Applicant's preferred route also would be implemented for the route alternative; consequently, air quality impacts during construction would be minor and temporary.

Table 6.3.7-10. Estimated Construction Emissions for Route Alternative RA-07 between Clearbrook and Carlton

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
On- and off-road diesel equipment combustion emissions	26.2	377.8	370.4	0.7	16.2	15.2	72,487.5	1.6
On- and off-road gasoline equipment combustion emissions	3.4	7.2	46.7	3.6	0.7	0.6	6,441.0	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	181.0	44.4	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	25.7	2.6	0.0	0.0
Open burning of wood debris emissions	0.0	0.0	834.4	0.0	81.2	81.2	431.4	0.0
Blasting emissions[a]	--	--	--	--	--	--	--	--
TOTAL EMISSIONS	**29.6**	**384.9**	**1,251.5**	**4.3**	**304.8**	**144.1**	**79,359.9**	**1.6**

Source: Enbridge 2017.

Notes:

Calculations are based on the emissions per spread presented in Table 5.2.7-6 (absent blasting), and an average of 54.8 miles per spread was used to determine emissions per mile. Emissions per mile then were multiplied by the corresponding pipeline length to determine the emissions for each emission source group for the route alternative.

[a] Blasting emissions have not been quantified.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Stored Carbon Releases

During construction, RA-07 could require removal of trees from the construction work area between Clearbrook and Carlton that, when removed, would release GHGs. Using the same emission factor of 30.2 metric-tons of carbon per acre as noted for the Applicant's preferred route, the amount of carbon that would potentially be released back into the atmosphere during construction tree removal of 1,146 acres is estimated at 140,048 tons of CO_2e. Regrowth of the forest on the 904 acres outside of the pipeline right-of-way eventually would more than halve this loss, in the long-run, after forest regrowth, bringing net CO_2 emissions from forest clearance to a level of about 29,520 tons.

Operations Impacts

Table 6.3.7-11 shows the estimated operations emissions for RA-07 in Minnesota based on 7 pump stations and 22 MLV sites for RA-07 (Enbridge 2017). The table includes indirect GHG emissions from the purchase of electricity for pump station operations determined as a function of the pipeline length. Although the route alternative varies only in the Clearbrook-to-Carlton segment, the operations emissions presented in the table are for the entire pipeline route within Minnesota. Similar to the Applicant's preferred route, operations of RA-07 would result in minor permanent impacts on air quality, and GHG emissions could contribute to global climate change. Note that emissions from vehicle combustion and unpaved roads have not been quantified.

Loss of Carbon Sequestration

Following construction of RA-07, 904 acres of previously forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 242 acres along the permanent right-of-way between Clearbrook and Carlton would remain cleared and would not provide any future carbon sequestration. Using the same emission factor of 1.6 metric-tons of CO_2 per acre per year as used for the Applicant's preferred route, the amount of carbon that would have been sequestered for 242 acres is estimated at 435 tons of CO_2e per year.

Table 6.3.7-11. Estimated Operations Emissions for Route Alternative RA-07 in Minnesota

Emission Source Description	Direct Emissions (tons per year)[a]								Indirect Emissions (tons per year)[b]
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs	GHGs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	2.9	0.0	0.0	0.0	0.0	0.0	0.04	0.09	N/A
Mainline valve fugitive emissions from piping components	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.003	N/A
Clearbrook terminal fugitive emissions from pumps, piping components, sump tanks, and pig traps	0.5	0.0	0.0	0.0	0.0	0.0	0.006	0.02	N/A
Additional Clearbrook terminal storage tank withdrawal losses from pipeline throughput	17.5	0.0	0.0	0.0	0.0	0.0	372.2	1.2	N/A
Unpaved roads fugitive emissions[c]	--	--	--	--	--	--	--	--	N/A
Vehicle combustion emissions[c]	--	--	--	--	--	--	--	--	N/A
Pump stations indirect emissions from being powered by electricity from existing local electric utilities	--	--	--	--	--	--	--	--	390,873.7
TOTAL EMISSIONS	**21.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**372.2**	**1.3**	**390,873.7**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 7 pump stations and 22 mainline valve sites.

[a] Only those emissions associated with the proposed increase in throughput of the Clearbrook terminal are included as part of the operations emissions (i.e., existing operations emissions are equivalent to the existing environment).

[b] Because the projected power consumption from the pump stations are unknown, indirect GHG emissions for the route alternatives were calculated based on 452,497 tons of CO_2e per year for the Applicant's preferred route over 380 total miles (i.e., 1,308 tons of CO_2e per year per mile).

[c] Air emissions from vehicles and unpaved roads have not been quantified for operations for RA-07.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, N/A = not applicable, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Route Alternative RA-08

Construction Impacts

Table 6.3.7-12 shows the estimated construction emissions for RA-08 between Clearbrook and Carlton. The Applicant-proposed measures to minimize air impacts for the Applicant's preferred route also would be implemented for the route alternative; consequently, air quality impacts during construction would be minor and temporary.

Table 6.3.7-12. Estimated Construction Emissions for Route Alternative RA-08 between Clearbrook and Carlton

Emission Source Description	Direct Emissions (tons)							
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs
On- and off-road diesel equipment combustion emissions	25.8	371.3	364.0	0.7	16.0	14.9	71,238.6	1.9
On- and off-road gasoline equipment combustion emissions	3.3	7.0	45.9	3.5	0.7	0.6	6,330.0	0.0
Paved roads fugitive emissions	0.0	0.0	0.0	0.0	177.8	43.7	0.0	0.0
Unpaved roads fugitive emissions	0.0	0.0	0.0	0.0	25.2	2.5	0.0	0.0
Open burning of wood debris emissions	0.0	0.0	820.0	0.0	79.8	79.8	424.0	0.0
Blasting emissions[a]	--	--	--	--	--	--	--	--
TOTAL EMISSIONS	**29.1**	**378.3**	**1,229.9**	**4.2**	**299.6**	**141.6**	**77,992.0**	**1.6**

Source: Enbridge 2017.

Notes:

Calculations are based on the emissions per spread presented in Table 5.2.7-6 (absent blasting), and an average of 54.8 miles per spread was used to determine emissions per mile. Emissions per mile then were multiplied by the corresponding pipeline length to determine the emissions for each emission source group for the route alternative.

[a] Blasting emissions have not been quantified.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

Stored Carbon Releases

During construction, RA-08 could require removal of trees from the construction work area between Clearbrook and Carlton that, when removed, would release GHGs. Using the same emission factor of 30.2 metric-tons of carbon per acre as used for the Applicant's preferred route, the amount of carbon that would potentially be released back into the atmosphere during construction tree removal of 773 acres is estimated at 944,408 tons of CO_2e. Regrowth of the forest on the 453 acres outside of the pipeline right-of-way eventually would more than halve this loss, in the long-run, after forest regrowth, bringing net CO_2 emissions from forest clearance to a level of about 39,035 tons.

Operations Impacts

Table 6.3.7-13 shows the estimated operations emissions for RA-08 in Minnesota based on 6 pump stations and 22 MLV sites (Enbridge 2017). The table includes indirect GHG emissions from the purchase of electricity for pump station operations determined as a function of the pipeline length. Although the route alternative varies only in the Clearbrook-to-Carlton segment, the operations emissions presented in the table are for the entire pipeline route within Minnesota. Similar to the Applicant's preferred route, operations of RA-08 would result in minor permanent impacts on air quality, and GHG emissions could contribute to global climate change. Note that emissions from vehicle combustion and unpaved roads have not been quantified.

Loss of Carbon Sequestration

Following construction of RA-08, 453 acres of previously forested land could be reforested to provide a carbon sequestration (storage) reservoir. The remaining 320 acres along the permanent right-of-way between Clearbrook and Carlton would remain cleared and would not provide any future carbon sequestration. Using the same emission factor of 1.6 metric-tons of CO_2 per acre per year as used for the Applicant's preferred route, the amount of carbon that would have been sequestered for 320 acres is estimated at 575 tons of CO_2e per year.

Table 6.3.7-13. Estimated Operations Emissions for Route Alternative RA-08 in Minnesota

Emission Source Description	Direct Emissions (tons per year)[a]								Indirect Emissions (tons per year)[b]
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs	GHGs
Pump station fugitive emissions from pumps, piping components, sump tanks, and pig traps	2.5	0.0	0.0	0.0	0.0	0.0	0.03	0.08	N/A
Mainline valve fugitive emissions from piping components	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.003	N/A
Clearbrook terminal fugitive emissions from pumps, piping components, sump tanks, and pig traps	0.5	0.0	0.0	0.0	0.0	0.0	0.006	0.02	N/A
Additional Clearbrook terminal storage tank withdrawal losses from pipeline throughput	17.5	0.0	0.0	0.0	0.0	0.0	372.2	1.2	N/A
Unpaved roads fugitive emissions[c]	--	--	--	--	--	--	--	--	N/A
Vehicle combustion emissions[c]	--	--	--	--	--	--	--	--	N/A

Table 6.3.7-13. Estimated Operations Emissions for Route Alternative RA-08 in Minnesota

Emission Source Description	Direct Emissions (tons per year)[a]								Indirect Emissions (tons per year)[b]
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	HAPs	GHGs
Pump stations indirect emissions from being powered by electricity from existing local electric utilities	--	--	--	--	--	--	--	--	387,450.4
TOTAL EMISSIONS	**20.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**372.2**	**1.3**	**387,450.4**

Source: Enbridge 2017.

Notes:

Operations emissions are based on 6 pump stations and 22 mainline valve sites.

[a] Only those emissions associated with the proposed increase in throughput of the Clearbrook terminal are included as part of the operations emissions (i.e., existing operations emissions are equivalent to the existing environment).

[b] Because the projected power consumption from the pump stations are unknown, indirect GHG emissions for the route alternatives were calculated based on 452,497 tons of CO_2e per year for the Applicant's preferred route over 380 total miles (i.e., 1,308 tons of CO_2e per year per mile).

[c] Air emissions from vehicles and unpaved roads have not been quantified for operations for RA-08.

CO = carbon monoxide, GHGs = greenhouse gases, HAPs = hazardous air pollutants, N/A = not applicable, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

"--" = Emissions not estimated.

6.3.7.4 Summary and Mitigation

6.3.7.4.1 Summary

Overall, construction impacts on air quality would be minor, localized, and intermittent and temporary along the construction work areas for the Applicant's preferred route and each of the route alternatives. This is primarily due to the nature of pipeline construction, where the construction activity moves along the pipeline route, thus limiting the exposure of residents and resources in any one area. Air quality impacts during operations for any of the route options would be minor but permanent. Because the Applicant plans to use electric power pumps for pipeline operation, no significant new point source emissions would be created. Instead, generation of electrical power to operate the pumps would be spread through the state's existing electrical generation system. Other emissions during operations would be limited to small, limited sources. No effects on achievement of either NAAQS or MAAQS would be expected to occur from construction or operation of any of the route options, although air dispersion modeling has not been completed. GHG emissions from construction, operations, and changes in the carbon sequestration of forested lands would occur for all the route options. These GHG emissions could contribute to climate change.

The estimated construction emissions for the Applicant's preferred route and route alternatives between Clearbrook and Carlton are shown in Table 6.3.7-14. Comparing the route options, RA-03AM would have the highest emissions, followed by the Applicant's preferred route, and then RA-06, RA-07,

and RA-08, in that order. The length of each alternative between Clearbrook and Carlton determines this ranking, as the longer the route distance, the higher the total construction-related emissions.

Table 6.3.7-14. Estimated Total Construction Emissions for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Route	Direct Emissions (tons)						
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs
Applicant's preferred route	39.0	507.0	1,648.3	5.6	401.5	189.8	104,525.1
Route alternative RA-03AM	48.5	631.2	2,052.3	7.0	499.9	236.3	130,143.3
Route alternative RA-06	34.7	451.5	1,468.0	5.0	357.6	169.0	93,093.0
Route alternative RA-07	29.6	384.9	1,251.5	4.3	304.8	144.1	79,359.9
Route alternative RA-08	29.1	378.3	1,229.9	4.2	299.6	141.6	77,992.0

Notes:

The estimates for GHGs do not include emissions from forest clearance.

Blasting emissions have not been quantified for the route alternatives.

CO = carbon monoxide, GHGs = greenhouse gases, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

During construction, all of the route options would require tree removal from construction work areas between Clearbrook and Carlton; when removed, the trees would release GHGs. The Applicant's preferred route would affect more forested lands than the route alternatives, and thus would release more GHGs. The RA-08 route would affect less forested lands than the other route options and thus would release less GHGs.

Table 6.3.7-15 presents the operations emissions (for those that can be quantified) for the Applicant's preferred route and route alternatives in Minnesota. Although the route alternatives vary only in the Clearbrook-to-Carlton segment, the operations emissions presented in the table are for the entire pipeline route within Minnesota. The table includes indirect GHG emissions from electricity purchased for operation of the pump stations. Similar to construction impacts, because the Applicant's preferred route has a shorter pipeline length than the RA-03AM route, the resulting air emissions and associated impacts from operations would be lower. Conversely, because the Applicant's preferred route has a longer pipeline length than the RA-06, RA-07, and RA-08 routes, the resulting air emissions and associated impacts from operations would be greater.

During operations, all route options would require that previously forested land within the permanent rights-of-way between Clearbrook and Carlton remain cleared. If not removed, the trees would sequester GHGs. The Applicant's preferred route would affect more forested lands than the route alternatives and thus would remove more sequestration potential. The RA-07 route would affect less forested lands than the other route options and thus would remove less sequestration potential.

Table 6.3.7-15. Estimated Operations Emissions for the Applicant's Preferred Route and Route Alternatives in Minnesota

Route	Direct Emissions (tons per year)							Indirect Emissions (tons per year)
	VOCs	NOx	CO	SO_2	PM-10	PM-2.5	GHGs	GHGs
Applicant's preferred route	21.0	0.004	0.03	0.002	0.1	0.01	375.9	452,497.6
Route alternative RA-03AM	21.8	0.0	0.0	0.0	0.0	0.0	372.2	518,668.3
Route alternative RA-06	21.0	0.0	0.0	0.0	0.0	0.0	372.2	425,442.1
Route alternative RA-07	21.0	0.0	0.0	0.0	0.0	0.0	372.2	390,873.7
Route alternative RA-08	20.6	0.0	0.0	0.0	0.0	0.0	372.2	387,420.4

Notes:

The estimates for GHGs do not include emissions for lost sequestration potential.

Air emissions from vehicles and unpaved roads have not been quantified for the route alternatives.

CO = carbon monoxide, GHGs = greenhouse gases, NOx = nitrogen oxide, PM-10 = suspended particulate matter less than or equal to 10 microns in diameter, PM-2.5 = fine PM less than or equal to 2.5 microns in diameter, SO_2 = sulfur dioxide, VOCs = volatile organic compounds

In summary, construction- and operations-related impacts on air quality would be expected to be minor for all routes, as detailed in Table 6.3.7-16. Construction and operation of the Applicant's preferred route and route alternatives would directly contribute to global GHG emissions and associated climate change, which collectively could lead to a threat to public health and welfare. For further information about the impacts of climate change, refer to Chapter 12.

6.3.7.4.2 Mitigation

Beyond the Applicant-proposed measures described above for the Applicant's preferred route, air impacts could be reduced further by:

- Burning small and dry brush piles only;
- Operating construction equipment as far as possible from sensitive receptors (e.g., residences, schools, and hospitals);
- Limiting construction equipment idling to the extent practical when not in use; and
- Following equipment manufacturer-recommended operations and good combustion practices, including not tampering with engines to increase horsepower and using ultra-low sulfur diesel.

Table 6.3.7-16. Summary of Potential Impacts on Air Quality for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Direct and indirect emissions	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts	Temporary/minor impacts
Greenhouse gases (GHG)	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change
Operations Impacts					
Direct and indirect emissions	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts	Permanent/minor impacts
Greenhouse gases	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change	GHG emissions contribute to overall global climate change

6.3.7.5 References

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6.4 CULTURAL RESOURCES

Cultural resources include the locations of human activity, occupation, or usage that contain materials, structures, or landscapes that were used, built, or modified by people. They also include the institutions that form and maintain communities and link them to their surroundings. Cultural resources consist of archaeological resources (e.g., sites and isolated finds), historic resources (e.g., buildings and structures), and sacred places (including traditional cultural properties and traditional cultural landscapes). Cultural resources also include tribal, usufructuary rights resources both within reservation boundaries and ceded lands by treaty (e.g., traditional hunting and fishing areas) and treaty areas, which are discussed in detail in Chapter 9. For the purposes of this discussion, these resources are referred to collectively as cultural resources.

The cultural resources addressed in this section are limited to direct and indirect impacts on archaeological and historic resources. This section first describes the existing conditions for the cultural resources within an area along the Applicant's preferred route and each of the route alternatives where cultural resources could be affected by construction and operation of the Project. Potential impacts on cultural resources are discussed and compared for the Applicant's preferred route and route alternatives (RA-03AM, RA-06, RA-07, and RA-08). None of the impacts or mitigation measures described in this chapter reflect how American Indians describe impacts on the landscape and tribal resources within reservation boundaries and ceded lands (see Chapter 9). Potential impacts on cultural resources from an accidental release of crude oil are discussed in Chapter 10.

6.4.1 Regulatory Context and Methodology

6.4.1.1 Regulatory Context

Minnesota Field Archaeology Act of 1963

The Minnesota Field Archaeology Act of 1963 (Minn. Stat. 138.31-42) allows the State of Minnesota to reserve the exclusive right of field archaeology on state sites in order to protect and preserve archaeological sites on state lands. It prohibits unlicensed field archaeology on state sites and discourages unlicensed field archaeology on privately owned lands. Based on the Field Archaeology Act, it is a gross misdemeanor for a person to willfully conduct unlicensed archaeology on state sites; willfully deface, injure, destroy, displace, or remove any object or data belonging to the State; or willfully interfere with evidence or work on any state site or other site for which a license has been issued. Persons having knowledge of the location of archaeological sites are encouraged to communicate such information to the State Archaeologist.

The Field Archaeology Act also outlines the duties of the Office of the State Archaeologist (Minnesota OSA), which include consultation with the Minnesota Indian Affairs Council (MIAC). The MIAC shares legal responsibility for monitoring and enforcing laws that protect Indian human remains and associated burial items. The MIAC reviews archaeological license applications to conduct fieldwork to determine if a burial or cemetery are within the project area. The authority for the MIAC is contained in Minnesota Statutes § 138.31.

Under the Field Archaeology Act, the Minnesota OSA shares some duties with the Minnesota Historical Society (MHS), but the Minnesota OSA is not affiliated with the MHS or the State Historic Preservation Officer (SHPO). The Minnesota OSA and the MHS/SHPO operate independently but cooperatively with regard to their shared duties.

Minnesota DNR, MNDOT, and all other state agencies whose activities may be affected are required to cooperate with MHS and the State Archaeologist to carry out the provisions of the Field Archaeology Act. Under the Field Archaeology Act, state agencies must supply MHS and the State Archaeologist with a development plan when known or suspected sites on lands under their jurisdiction may be affected by implementation of the plan. The Minnesota Environmental Quality Board submits copies of Environmental Assessment Worksheets to the MHS/SHPO for comment on potential effects of privately funded developments, such as the Project, on historic properties in Minnesota (Minnesota SHPO 2005).

Minnesota Historic Sites Act

The Minnesota Historic Sites Act (Minn. Stat. § 138.661–669) established the Minnesota Historic Sites Network. The sites are significant state resources that MHS is preserving, developing, interpreting, and maintaining for public use, benefit, and access.

The Minnesota Historic Sites Act also created the State Register of Historic Places, which is an inventory of outstanding properties possessing historical, architectural, archaeological, and aesthetic values that are of paramount importance in the development of the state. These historic properties represent and reflect elements of the state's cultural, social, economic, religious, political, architectural, and aesthetic heritage. These properties are separate from the Minnesota Historic Sites Network and are not operated by MHS for historical interpretive or public use and access purposes.

Historic properties are selected for inclusion in the State Register of Historic Places based on any of the following criteria:

1. The quality of significance in American history, architecture, archaeology, engineering, and culture that is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association;
2. Association with events that have made a significant contribution to the broad patterns of our history;
3. Association with the lives of persons significant in our past;
4. Embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
5. The yielding or likelihood of yielding information pertinent in prehistory or history.

The Minnesota Historic Sites Act outlines the responsibility of the State in protecting the physical features and historic character of properties designated in the Minnesota Historic Sites Network, State Register of Historic Places, or National Register of Historic Places (NRHP). Before carrying out any undertaking that would affect designated or listed properties, or funding or licensing an undertaking by other parties, the state department or agency must consult with the MHS to determine appropriate treatments and to seek ways to avoid and mitigate any adverse effects on designated or listed properties.

Minnesota Private Cemeteries Act

Minnesota's "Private Cemeteries Act" (Minn. Stat. § 307.08) protects all human remains and burials older than 50 years, and located outside of platted, recorded or identified cemeteries, protection from unauthorized disturbance; whether on either public or private lands or waters. In the event that a burial

is either known or suspected to be associated with American Indian peoples, Minnesota OSA works together with the MIAC to ensure the integrity of these sites. The Minnesota OSA maintains a database of identified burial sites in the state.

When a known or suspected burial is involved with a development project under review by the SHPO, the SHPO copies Minnesota OSA with appropriate correspondence. MHS has no role in the authentication process.

Minnesota State Historic Preservation Office

The Minnesota SHPO is a department of MHS. While the SHPO's principal responsibilities are defined in the National Historic Preservation Act (NHPA) Section 110, the SHPO also has historic preservation duties under Minnesota state law. The SHPO acts for MHS in the review of state agency projects that may affect state archaeological sites. The proposed Project is a private project and is not a state project. Therefore, the Applicant has the responsibility of consulting with the SHPO.

The SHPO is responsible for maintaining an inventory of historic properties; identifying and nominating properties to the NRHP; implementing a statewide historic preservation plan; administering a federal grants program; assisting federal, state, and local governments with historic preservation duties; and working with state and federal agencies to ensure that historic properties are considered by planning and development.

As defined in 36 CFR 800, the SHPO plays a central role in the Section 106 process and "advises and assists federal agencies in carrying out their 106 responsibilities." The SHPO ensures that agencies make "a reasonable and good faith effort" to consider the effects of their undertakings on historic properties. "Historic properties" for the purposes of Section 106 are defined as sites, districts, buildings, structures, or objects that are included in or are eligible for listing in the NRHP. Historic properties also can be defined as any locations that are part of the historic fabric of the state; this includes unevaluated properties and, under state law, even properties that may not be eligible for listing in the NRHP.

Minnesota archaeological laws do not set standards for site significance and do not discuss integrity, but the SHPO evaluates affected sites using NRHP criteria and suggests treatments of significant state sites that are consistent with Section 106.

Minnesota Governor's Executive Order 13-10

The Minnesota Governor's Executive Order 13-10 directs state government agencies to implement new re consultation policies aimed at improving relationships and collaboration with Minnesota's 11 tribal governments. It provides for consultation, coordination, and cooperation between the State and the 11 Indian tribes.

6.4.1.2 Methodology

The ROI for this impact analysis encompasses the areas in the estimated footprints of the Applicant's preferred route and route alternatives where archaeological or historic resources could be directly or indirectly disturbed during Project-related construction or operations. The ROI for the Applicant's preferred route includes the construction work area, permanent right-of-way, ATWS, access roads, and aboveground facilities, including 0.5 mile on either side of the pipeline centerline for archaeological resources, and 1 mile on either side of the pipeline centerline for historic resources. The ROI also includes 0.5 mile on either side of the pipeline centerline for archaeological resources and 1 mile on

either side of the pipeline centerline for historic resources for the route alternatives. For route alternatives, no locations for ATWS, access roads or aboveground facilities have been identified; however, the ROI would generally encompass the likely extent of the features.

Existing data were obtained from MHS on November 16, 2017, for historic and archaeological resources within the ROI for Minnesota. Cultural resources were identified that are eligible for listing, listed, or nominated but currently unevaluated for listing in the Minnesota State Historic Sites Network and the Minnesota State Register of Historic Places.

The data collected included site number, site/property type, site location, date of recordation, historic context, and associated reports. The types of cultural resources were input into GIS and overlaid with the Applicant's preferred route and route alternatives. Potential impacts on archaeological and historic resources for the Applicant's preferred route and route alternatives were considered where construction or operation of the routes could cause disturbance, loss, or modification of the resource.

Additionally, surveys were completed for archaeological resources by the Applicant for the Applicant's preferred route in Minnesota, the information from which is included in this analysis. Surveys were not completed for historic resources in Minnesota. DOC-EERA's consultation with SHPO is ongoing, and the results of the consultation concerning determinations of eligibility, Project effects, and any necessary treatment for impacts are not currently available.

6.4.2 Existing Conditions

6.4.2.1 Applicant's Preferred Route

6.4.2.1.1 Archaeological Resources

For the Applicant's preferred route in Minnesota, the Applicant conducted eight archaeological surveys (Phase I) and site evaluations (Phase II) between May 2013 and 2016 (Table 6.4.2-1). Three of the eight reports were available at MHS at the time of this study. As part of the Applicant's surveys, a total of 89 sites were recorded, of which 63 sites were documented in the Applicant's survey area for the Applicant's preferred route. Of the 63 sites, 59 sites were newly identified and four sites were revisited. The 63 sites recorded by the surveys conducted by the Applicant include 46 pre-contact archaeological sites, 16 historic archaeological sites, and 1 site that includes artifacts from both a historic period and a pre-contact period.

Based on data obtained from MHS on November 17, 2016, 53 previously recorded archaeological resources are located within the archaeological resources ROI for the Applicant's preferred route in Minnesota (Table 6.4.2-2). Of these 53 archaeological resources in the ROI, 9 would be located within the construction work area, four of which are in the permanent right-of-way (Table 6.4.2-2). Additionally, three archaeological sites would be located within the ATWS for the Applicant's preferred route.

Table 6.4.2-1. Archaeological Investigations Conducted by the Applicant in the Region of Interest for the Applicant's Preferred Route in Minnesota

Survey Date	Survey Type	Reference	Archaeological Resources Recorded	Counties	Miles Surveyed	Acres Surveyed
May – November 2013	Phase I	Mueller et al. January 2015	48	Aitkin, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Polk, and Red Lake	358	20,845
April – October 2014	Phase I and Phase II	Watson et al. 2014 Addendum	9	Polk, Crow Wing, Clearwater, Red Lake, Cass, Hubbard, Wadena, Aitkin, and Carlton	Unknown	3,800
May – November 2014	Phase I	Mueller and Terry March 2015	18	Kittson, Marshall, Pennington, Red Lake, Polk, and Clearwater	119	8,263
June – August 2015 [a]	Phase I	Mueller and Terry October 2015	2	Aitkin, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Polk, and Red Lake	Unknown	1,617
August – November 2015 [a]	Phase I	Mueller et al. 2016 Addendum	4	Aitkin, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Polk, and Red Lake	Unknown	1,347
June – July 2015[a]	Phase II	Watson et al. September 2015	5	Polk, Clearwater, Hubbard, and Carlton	N/A	N/A
June – August 2015 [a]	Phase I	Mueller and Terry October 2015	2	Kittson, Marshall, Pennington, Red Lake, Polk, and Clearwater	119	8,409
August – November 2015 [a]	Phase I	Mueller et al. February 2016 Addendum	1	Polk	Unknown	69

[a] Report not available at Minnesota Historical Society.

Table 6.4.2-2. Previously Recorded Archaeological Resources in the Region of Interest for the Applicant's Preferred Route

Route Segment	Number of Archaeological Resources in Region of Interest	Number of Archaeological Resources in Construction Work Area	Number of Archaeological Resources in Permanent Right-of-Way
North Dakota border to Clearbrook	27	1	0
Clearbrook to Carlton	24	8	4
Carlton to Wisconsin border	2	0	0

Source: MHS 2016.

6.4.2.1.2 Historic Resources

The Applicant did not conduct surveys for historic resources. Based on data obtained from MHS on November 17, 2016, 80 previously recorded historic resources are located within the ROI for the Applicant's preferred route (Table 6.4.2-3). These historic resources include structures, buildings, NPS buildings, and bridges. None of these would be located within the construction work area or the permanent right-of-way of the Applicant's preferred route.

Table 6.4.2-3. Previously Recorded Historic Resources in the Region of Interest for the Applicant's Preferred Route and Route Alternatives

Route Segment	Number of Historic Resources in Region of Interest	Number of Historic Resources in Construction Work Area	Number of Historic Resources in Permanent Right-of-Way
North Dakota border to Clearbrook	34	0	0
Clearbrook to Carlton	40	0	0
Carlton to Wisconsin border	6	0	0

Source: MHS 2016.

6.4.2.2 Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to archaeological and historic resources for the route alternatives between Clearbrook and Carlton are described below. No Project-specific surveys were conducted for archaeological or historic resources; the following summary is based on available data obtained from MHS on November 17, 2016.

6.4.2.2.1 Route Alternative RA-03AM

Archaeological Resources

Based on data obtained from MHS, 47 previously recorded archaeological sites are located within the ROI for RA-03AM. Of these, six would be in the construction work area, one of which would also be in the permanent right-of-way.

Historic Resources

There are 141 previously recorded historic resources located in the ROI for RA-03AM; 7 of these would be within the construction work area, and 2 would be in the permanent right-of-way.

6.4.2.2.2 Route Alternative RA-06

Archaeological Resources

Based on data obtained from MHS, eight previously recorded archaeological sites were identified within the ROI for RA-06, none of which would be in the construction work area or in the permanent right-of-way.

Historic Resources

There are 27 previously recorded historic resources located in the ROI for RA-06, 1 of which would be in the construction work area (none would be in the permanent right-of-way).

6.4.2.2.3 Route Alternative RA-07

Archaeological Resources

Based on data obtained from MHS, 107 previously recorded archaeological sites were identified within the ROI for RA-07. Of these, seven would be in the construction work area, five of which would be in the permanent right-of-way.

Historic Resources

There are 166 previously recorded historic resources located in the ROI for RA-07; 3 of these would be in the construction work area, and 1 would be in the permanent right-of-way.

6.4.2.2.4 Route Alternative RA-08

Archaeological Resources

Based on data obtained from MHS, 119 previously recorded archaeological sites were identified within the ROI for RA-08. Of these, 12 would be in the construction work area, and 10 would be in the permanent right-of-way.

Historic Resources

There are 74 previously recorded historic resources located in the ROI for RA-08; 3 of these would be in the construction work area, 1 of which would also be in the permanent right-of-way.

6.4.3 Impact Assessment

The Project would cause potential direct and indirect impacts on archaeological and historic resources during construction and operations. These impacts affect the ability of a cultural resource to convey its significance and may affect its integrity, visibility, accessibility, and research potential. The duration of impact could range from temporary to permanent, depending on the type of impact and type of cultural resource. The magnitude of impact could range from negligible to major, depending on the type of cultural resource that would be affected and its location relative to the construction work area or permanent right-of-way. Additional information on general direct and indirect impacts on cultural resources is described in Section 5.4.2.

The level of impact on archaeological resource would depend on the type of resource and its eligibility for listing in the State Register of Historic Places or the State Historic Site Network, as well as its significance to affected Indian tribes (e.g., a sacred place). For example, a lithic scatter may be more likely to be vandalized than a railroad spur, which would cause a higher magnitude of impacts on the vandalized archaeological site. A site that is eligible for listing in the State Register of Historic Places would have a higher magnitude of impacts than a site that is not eligible for the same register based on the site's importance to the affiliated culture or the State of Minnesota. Single artifacts and surface site expressions may have a lower potential to yield information important to prehistory than a deeply stratified site containing faunal remains, hearths, and charcoal. As such, impacts on the former would be

less than on the site with high research potential. If an archaeological site is physically affected, the impact would be permanent and would range in magnitude from minor to major.

The level of impact would also vary depending on the location of the construction-related activity and the type of soil, bedrock, and vegetation. For example, vegetation removal may cause damage to surface sites more than deeply buried sites. Compaction may affect shallow sites and not affect deeply buried sites.

It is possible that currently unknown archaeological resources located within the construction work area could be discovered during ground-disturbing activities. To reduce impacts on currently unknown archaeological resources, an Unanticipated Discovery Plan would be implemented during construction (Appendix O). Impacts on inadvertently discovered archaeological resources would be similar to those described for previously recorded resources.

Contamination of archaeological resources could occur from small spills or leaks of lubricants, gasoline, oil, other fuels, coolants, transmission fluid, or other hazardous chemicals during construction activities for the Applicant's preferred route or route alternatives. These spills would be managed according to pending SPCC Plans. Direct impacts on archaeological resources due to contamination and disturbance from cleanup activities would be permanent, depending on the type and location of resource and would range in magnitude from minor to major. Direct impacts on historic resources would range from temporary to permanent and negligible to major, depending on the type and location of resource.

Since only the Applicant's preferred route was surveyed for archaeological resources, the analyses for the remaining alternatives are based on the archival review of existing site data. Additionally, no surveys were conducted for historic resources; thus, only archival data were used in these analyses. As such, it is likely that unidentified archaeological resources are present within the ROI, construction work area, and permanent right-of-way for the route alternatives that have not yet been documented.

6.4.3.1 Applicant's Preferred Route (in Minnesota)

6.4.3.1.1 Construction Impacts

Archaeological Resources

Construction-related activities would directly impact the nine previously recorded archaeological resources within the construction work area (see Table 6.4.2-2). Construction-related activities such as excavation, grading, rutting, compaction, and removing vegetation would directly impact these archaeological resources. Damage to an archaeological resource could occur from clearing and grading of the pipeline alignment, construction work area, ATWS, access roads, pump stations, and materials staging areas. There could be an increased risk that erosion, vandalism, looting, and compaction of archaeological resources could occur from movement of heavy machinery and transport of pipe sections, which may alter site stratigraphy and artifact morphology. In addition, impacts could be associated with minor Project-related spills or leaks such as contamination or disturbance during cleanup activities, or encountering existing contamination.

Direct impacts on sites during construction would be permanent and minor to major depending on the type of resource. American Indians would consider any impact on archaeological resources to be permanent and irreversible. Such impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and the affected public (see Section 6.4.4).

Indirect impacts during construction would be temporary, localized, and negligible to minor. These impacts include vibration, changes in noise and air quality, dust, and visual intrusions.

Historic Resources

No previously recorded historic resources would be within the construction work area (Table 6.4.2-3). As such, construction-related direct impacts on historic resources are unlikely to occur. However, indirect impacts may occur on the 80 historic resources within the ROI during construction. These indirect impacts include dust, vibration, and intrusion related to construction equipment, as well as construction-related noise. These impacts would be temporary and negligible to minor. Spill response activities and personnel would also cause temporary negligible to minor indirect impacts. Indirect visual intrusions due to vegetation clearing would be long-term and negligible to minor. Indirect impacts from the construction of aboveground facilities would be permanent and negligible to major. Most of the viewshed along the Applicant's preferred route contains existing pipelines and transmission lines and the changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

6.4.3.1.2 Operations Impacts

Archaeological Resources

Disturbed areas would be restored and stabilized to the extent practicable after pipeline installation. Such restoration is unlikely to cause damage to archaeological resources beyond what may occur during construction. Inspection, monitoring, and maintenance activities are unlikely to affect the four archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction, and as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur; however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 6.4.4).

If new ground disturbance occurs during the lifespan of the project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction; thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts of new ground disturbance during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Historic Resources

Operations impacts are unlikely to directly impact historic resources, as no known historic resources are located within the permanent right-of-way. Indirect temporary impacts may occur on historic resources within the ROI during pipeline operations. These indirect impacts would primarily consist of the presence of MLVs, pump stations, and maintenance crews and equipment, resulting in dust, vibration, and visual and auditory intrusion. These indirect impacts would be temporary to permanent and negligible to minor. Spill response activities and personnel would also cause temporary negligible to minor indirect impacts.

Indirect visual intrusions from the new pipeline would be permanent and negligible to minor as almost all of the viewshed contains existing pipelines and transmission lines and the changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

6.4.3.2 Route Alternatives (from Clearbrook to Carlton)

Archaeological and historic resources information along the route alternatives is limited to archival information along the pipeline corridor. No field surveys have been completed for the route alternatives. Archaeological and historic resource types are similar between the route alternatives and the Applicant's preferred route. Archaeological resources include historic scatters, pre-contact artifacts, pre-contact surface features, railroads, and agricultural developments. Historic resources include bridges, farmhouses and associated outbuildings, and other buildings and structures.

6.4.3.2.1 Route Alternative RA-03AM

Construction Impacts

Archaeological Resources

Based on MHS data, six previously recorded archaeological resources would be within the construction work area. Construction-related impacts would be similar to those described in Section 6.4.3.1 for the Applicant's preferred route. Direct impacts could result from ground excavation with machinery and hand tools, grading, vegetation removal, leak containment, and any inadvertent exposure of contaminated sediments. Construction activity may expose archaeological resources to looting and vandalism. Archaeological resources within the RA-03AM construction work area primarily include artifact scatters, which would be permanently affected by ground disturbance related to construction if not avoided. Direct impacts would be permanent and minor to major, depending on the types of affected sites and their significance. In addition, impacts could be associated with minor Project-related spills and leaks such as contamination or disturbance during cleanup activities, or encountering existing contamination (see Section 6.2.2). American Indians would consider any impact on archaeological resources to be permanent and irreversible. These direct impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and the affected public (see Section 6.4.4).

Indirect impacts during construction would be temporary, localized, and negligible to minor. These impacts include vibration, changes in noise and air quality, dust, and visual intrusions.

Historic Resources

Based on MHS data, seven previously recorded historic resources would be within the construction work area, including railroads, structural ruins, and farm buildings. Construction along RA-03AM would directly impact more known historic resources than the other route alternatives. Construction-related direct impacts on historic resources may include physical destruction, alteration, or damage caused by equipment and excavation, which would cause permanent minor to major impacts.

Indirect impacts may occur on the 141 historic resources within the ROI during construction. These indirect impacts include dust, vibration, and intrusion related to construction equipment, as well as construction-related noise. These impacts would be temporary and negligible to minor. Indirect visual intrusions due to vegetation clearing would be long-term and negligible to minor. Indirect impacts from the construction of aboveground facilities would be permanent and negligible to major. Almost all of the viewshed contains existing pipelines and transmission lines and the changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

Minor spills have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. These impacts would be temporary to permanent and negligible to major.

Operations Impacts

Archaeological Resources

Based on MHS data, one previously recorded archaeological resource would be within the permanent right-of-way. Disturbed areas would be restored and stabilized to the extent practicable after pipeline installation. Such restoration is unlikely to cause damage to archaeological resources beyond what may occur during construction. Inspection, monitoring, and maintenance activities are unlikely to affect the one archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction, and as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur; however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 6.4.4).

If new ground disturbance occurs during the lifespan of the project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction; thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts of new ground disturbance during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Historic Resources

Based on MHS data, two previously recorded historic resources are within the permanent right-of-way for RA-03AM, including a historic farmstead. No ground disturbance would occur during operations; therefore, direct impacts are not anticipated beyond those that occurred during construction. Inspection, monitoring, and maintenance activities are unlikely to affect historic resources because they would be undertaken using established access routes. Impacts could be associated with Project-related spills or encountering existing contamination, which may cause temporary to permanent and negligible to major impacts.

Indirect impacts may occur on the 141 historic resources within the ROI during pipeline operations. These indirect impacts would primarily consist of the presence of MLVs, pump stations, and maintenance crews and equipment, resulting in dust, vibration, and visual and auditory intrusion. These indirect impacts would be temporary to permanent and negligible to minor. Spill response activities and personnel would also cause temporary negligible to minor indirect impacts. Indirect visual intrusions from the new pipeline would be permanent and negligible to minor as almost all of the viewshed contains existing pipelines and transmission lines. The changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

6.4.3.2.2 Route Alternative RA-06

Construction Impacts

Archaeological Resources

Based on MHS data, no previously recorded archaeological resources would be within the construction work area. As such, this route alternative would not directly or indirectly impact known archaeological sites. It is possible that currently unknown archaeological resources are located within the construction work area that could be discovered and affected during ground-disturbing activities. To reduce impacts on currently unknown cultural resources, an Unanticipated Discovery Plan would be implemented during construction (Appendix O). American Indians would consider any impact on archaeological resources to be permanent and irreversible.

Historic Resources

Based on MHS data, one previously recorded historic resource would be within the construction work area. RA-06 would affect fewer known historic resources than the other route alternatives. Construction-related direct impacts on historic resources may include physical destruction, alteration, or damage caused by equipment and excavation, which would cause permanent minor to major impacts.

Indirect impacts may occur on the 27 historic resources within the ROI during construction. These indirect impacts include dust, vibration, and intrusion related to construction equipment, as well as construction-related noise. These impacts would be temporary and negligible to minor. Indirect visual intrusions due to vegetation clearing would be long-term and negligible to minor. The changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way. Indirect impacts from the construction of aboveground

facilities would be permanent and negligible to major given that relatively little of the viewshed contains existing pipelines, transmission lines, and associated facilities.

Minor spills have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. These impacts would be temporary to permanent and negligible to major.

Operations Impacts

Archaeological Resources

Based on MHS data, no previously recorded archaeological resources would be within the permanent right-of-way. Therefore, no direct or indirect impacts on known archaeological resources are expected during operation of RA-06.

Historic Resources

Based on MHS data, no previously recorded historic resources would be within the permanent right-of-way. Therefore, no direct impacts on historic resources are expected during operation of RA-06. Inspection, monitoring, and maintenance activities are unlikely to affect historic resources because there are no historic resources in the permanent right-of-way. Similarly, no impacts caused by Project-related spills or encountering existing contamination are expected as no historic resources are within the permanent right-of-way.

Indirect impacts may occur on the 27 historic resources within the ROI during pipeline operations. These indirect impacts would primarily consist of the presence of MLVs, pump stations, and maintenance crews and equipment, resulting in dust, vibration, and visual and auditory intrusion. These indirect impacts would be temporary to permanent and negligible to minor. Spill response activities and personnel would also cause temporary negligible to minor indirect impacts. Indirect visual intrusions from the new pipeline would be permanent and negligible to major as relatively little of the viewshed contains existing pipelines and transmission lines. The changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

6.4.3.2.3 Route Alternative RA-07

Construction Impacts

Archaeological Resources

Based on MHS data, seven previously recorded archaeological resources would be within the construction work area. The types of construction-related impacts would be similar to those described in Section 6.4.3.1 for the Applicant's preferred route; however, the extent would differ as the construction work area would be larger (205 feet wide), and the activities would be more intensive and last longer to allow removal and replacement of the pipeline. Direct impacts could result from ground excavation with machinery and hand tools, grading, vegetation management, leak containment, and any inadvertent exposure of contaminated sediments. Construction activity may expose archaeological resources to looting and vandalism. Archaeological resources within the RA-07 construction work area primarily include artifact scatters, which would be permanently affected by ground disturbance related to construction, if not avoided. Direct impacts would be permanent and minor to major, depending on the types of affected sites and their significance. In addition, impacts could be associated with Project-

related spills including contamination or disturbance during cleanup activities, or encountering existing contamination (see Section 6.2.2). American Indians would consider any impact on archaeological resources to be permanent and irreversible. These direct impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and the affected public (see Section 6.4.4).

Indirect impacts during construction would be temporary, localized, and negligible to minor. These impacts include vibration, changes in noise and air quality, dust, and visual intrusions.

Historic Resources

Based on MHS data, three previously recorded historic resources would be within the construction work area for RA-07. Construction-related direct impacts on historic resources may include physical destruction, alteration, or damage caused by equipment and excavation, which would cause permanent minor to major impacts.

Indirect impacts on the 166 historic resources in the ROI. These indirect impacts include dust, vibration, and intrusion related to construction equipment, as well as construction-related noise. These impacts would be temporary and negligible to minor. Indirect visual intrusions due to vegetation clearing would be long-term and negligible to minor. Indirect impacts from the construction of aboveground facilities would be permanent and negligible to major. The entire viewshed contains existing pipelines and transmission lines along the Mainline corridor and the changes in viewshed would decrease over time from revegetation of temporary construction work areas.

Minor spills have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. These impacts would be temporary to permanent and negligible to major.

Operations Impacts

Archaeological Resources

Based on MHS data, five previously recorded archaeological resources would be within the permanent right-of-way. Disturbed areas would be restored and stabilized to the extent practicable after pipeline installation. Such restoration is unlikely to cause damage to archaeological resources beyond what may occur during construction. Inspection, monitoring, and maintenance activities are unlikely to affect the five archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction, and as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur; however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 6.4.4).

If new ground disturbance occurs during the lifespan of the project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction; thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts of new ground disturbance during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Historic Resources

Based on MHS data, one previously recorded historic resource would be within the permanent right-of-way. No ground disturbance would occur during operations; therefore, direct impacts are not anticipated during operations beyond those that occurred during construction. Inspection, monitoring, and maintenance activities are unlikely to affect historic resources because they would be undertaken using established access routes. Impacts could be associated with minor Project-related spills and leaks or encountering existing contamination, which may cause temporary to permanent and negligible to major impacts.

Indirect impacts may occur on the 166 historic resources within the ROI during pipeline operations. These indirect impacts would primarily consist of the presence of MLVs, pump stations, and maintenance crews and equipment, resulting in dust, vibration, and visual and auditory intrusion. These indirect impacts would be temporary to permanent and negligible to minor. Spill response activities and personnel would also cause temporary negligible to minor indirect impacts. Indirect visual intrusions from the new pipeline would be permanent and negligible to minor as the viewshed along the Mainline corridor contains existing pipelines and transmission lines. The changes in viewshed would decrease over time from revegetation of temporary construction work areas.

6.4.3.2.4 Route Alternative RA-08

Construction Impacts

Archaeological Resources

Based on MHS data, 12 previously recorded archaeological resources would be within the construction work area. Construction related impacts would be similar to those described in Section 6.4.3.1 for the Applicant's preferred route. Direct impacts could result from ground excavation with machinery and hand tools, grading, vegetation management, leak containment, and any inadvertent exposure of contaminated sediments. Construction activity may expose archaeological resources to looting and vandalism. Archaeological resources within the RA-08 construction work area primarily include artifact scatters, which would be permanently affected by ground disturbance related to construction, if not avoided. Direct impacts would be permanent and minor to major, depending on the types of affected sites and their significance. In addition, impacts could be associated with Project-related spills including contamination or disturbance during cleanup activities, or encountering existing contamination (see Section 6.2.2). American Indians would consider any impact on archaeological resources to be permanent and irreversible. These direct impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and the affected public (see Section 6.4.4).

Indirect impacts during construction would be temporary, localized, and negligible to minor. These impacts include vibration, changes in noise and air quality, dust, and visual intrusions.

Historic Resources

Based on MHS data, three previously recorded historic resources would be located within the construction work area (Table 6.4.2-3). Construction-related direct impacts on historic resources may include physical destruction or damage caused by equipment, which would cause long-term to permanent minor to major impacts.

Indirect impacts on the 74 historic resources within the ROI during construction. These indirect impacts include dust, vibration, and intrusion related to construction equipment, as well as construction-related noise. These impacts would be temporary and negligible to minor. Indirect visual intrusions due to vegetation clearing would be long-term and negligible to minor. Indirect impacts from the construction of aboveground facilities would be permanent and negligible to major. The entire viewshed contains existing pipelines and transmission lines and the changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

Minor spills have the potential to directly and indirectly affect historic resources through contamination, changes in access and setting, and response activities. These impacts would be temporary to permanent and negligible to major.

Operations Impacts

Archaeological Resources

Based on MHS data, 10 previously recorded archaeological resources would be within the permanent right-of-way. Disturbed areas would be restored and stabilized to the extent practicable after pipeline installation. Such restoration is unlikely to cause damage to archaeological resources beyond what may occur during construction. Inspection, monitoring, and maintenance activities are unlikely to affect the four archaeological resources within the permanent right-of-way because these activities would be undertaken using established access routes. The archaeological resources present within the permanent right-of-way would have been directly affected during construction; as such, additional impacts from these activities would not be expected. Direct impacts associated with Project-related spills or encountering existing contamination could occur; however, no additional impacts would be expected as the archaeological resources would have already been disturbed during construction.

If operations-related activities result in direct impacts on archaeological resources that were not previously disturbed during construction (i.e., avoided) or to those resources that are adjacent to the construction work area, then the impacts would be permanent and minor to major. Such impacts would require mitigation that would be determined in consultation with the SHPO, affected Indian tribes, and affected public (see Section 6.4.4).

If new ground disturbance occurs during the lifespan of the project, it would occur within the already disturbed permanent right-of-way or construction work area. As such, direct impacts on archaeological resources would have already occurred during construction; thus, any new ground disturbance is unlikely to cause additional impacts on these resources. However, if archaeological resources had been avoided during construction, or if they are adjacent to the construction work area, new ground disturbance may cause new impacts on these resources, which would be permanent and minor to major.

Indirect impacts of new ground disturbance during operations would be temporary, localized, and negligible to minor. Temporary impacts would include vibration, changes in noise and air quality, and visual intrusions.

Historic Resources

Based on MHS data, one previously recorded historic resource would be located within the permanent right-of-way. No new ground disturbance would be expected to occur during operations; therefore, direct impacts are not anticipated during operations beyond those that occurred during construction. Inspection, monitoring, and maintenance activities are unlikely to affect historic resources because they would be undertaken using established access routes. Impacts could be associated with minor Project-related spills and leaks or encountering existing contamination, which may cause temporary to permanent and negligible to major impacts.

Indirect impacts may occur on the 74 historic resources within the ROI during pipeline operations. These indirect impacts would primarily consist of the presence of MLVs, pump stations, and maintenance crews and equipment, resulting in dust, vibration, and visual and auditory intrusion. These indirect impacts would be temporary to permanent and negligible to minor. Spill response activities and personnel would also cause temporary negligible to minor indirect impacts. Indirect visual intrusions from the new pipeline would be permanent and negligible to minor as the entire viewshed contains existing pipelines and transmission lines. The changes in viewshed would decrease over time from revegetation of temporary construction work areas and to a lesser degree the permanent right-of-way.

6.4.4 Summary and Mitigation

6.4.4.1 Summary

Construction and operation of the Applicant's preferred route and route alternatives could impact archaeological and historic resources. Based on the current information, impacts on archaeological and historic resources could range from negligible to major during construction and operations (Table 6.4.4-1). DOC-EERA's consultation with the SHPO is ongoing, and the results of the consultation concerning determinations of eligibility, Project effects, and any necessary treatment for impacts, are not yet available.

During construction, direct impacts on archaeological resources would be permanent and could range from minor to major for the Applicant's preferred route and each route alternative. American Indians would consider any impact on archaeological resources to be permanent and irreversible. The types of archaeological resources across the ROI for the Applicant's preferred route and route alternatives primarily consist of individual lithic artifacts or lithic scatter. As a result, the primary difference in potential impacts on archaeological resources among route options is associated with the number of resources present in the ROI and construction footprint between Clearbrook and Carlton. The number of previously recorded archaeological resources that could be directly affected ranges from none for RA-06 up to 12 resources for RA-08 (Table 6.4.4-1). Direct impacts on historic resources would be permanent and minor to major if there was physical disturbance of these resources during construction or operation. Historic resources within the construction footprints of the route options ranges from none for the Applicant's preferred route to seven historic resources for RA-03AM. Indirect impacts on historic resources within the ROI for a route option could occur (e.g., dust, noise, visibility of new features) during construction and operation. Most construction impacts would be temporary and negligible to minor. However, construction of new features on the landscape could result in permanent and minor to

major impacts. Historic resources along the ROI for the route options range from 27 historic resources for RA-06 to up to 166 resources for RA-07 (Table 6.4.4-1).

During operations, direct and indirect impacts on archaeological resources could continue with the operational footprint of the Project. The number of archaeological resources within the permanent right-of-way would range from no resources for RA-07 to up to 10 resources for RA-08 (Table 6.4.4-1). As potential impacts on historic structures across the ROI during construction could be permanent, the same number of historic structures within the ROI for each route option could continue to be affected during operations if no minimization measures were implemented.

6.4.4.2 Mitigation

It may be possible to avoid known archaeological resources in the construction work area, which would include fencing around the site boundary or designated buffer and incorporation of an archaeological monitor during ground-disturbing activities. To reduce impacts on currently unknown archaeological resources, an Unanticipated Discovery Plan would be implemented during construction (Appendix O). Archaeological and/or tribal monitoring could be implemented in sensitive areas during construction to further minimize impacts.

The need for minimization and mitigation measures for impacts on cultural resources would be discussed with MHS, the SHPO, State Archaeologist, and affected Indian tribes. Minimization measures may include avoidance, site staking, and archaeological and tribal monitoring during construction. Mitigation measures may include data recovery excavations of significance archaeological sites, intensive recordation of historic resources, ethnographic studies, and guaranteed access, among others.

Table 6.4.4-1. Summary of Potential Impacts on Archaeological and Historic Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Previously recorded archaeological resources	Direct: Permanent/minor to major impacts • 9 resources Indirect: Temporary/ negligible to minor impacts • 9 resources	Direct: Permanent/minor to major impacts • 6 resources Indirect: Temporary/negligible to minor impacts • 6 resources	Direct: No impact • 0 resources Indirect: No impact • 0 resources	Direct: Permanent/minor to major impacts • 7 resources Indirect: Temporary/negligible to minor impacts • 7 resources	Direct: Permanent/minor to major impacts • 12 resources Indirect: Temporary/negligible to minor impacts • 12 resources
Previously recorded historic resources	Direct: No impacts • 0 resources Indirect: Temporary to permanent/ negligible to major impacts • 40 resources	Direct: Permanent/minor to major impacts • 7 resources Indirect: Temporary to permanent/ negligible to major impacts • 141 resources	Direct: Permanent/minor to major impacts • 1 resource Indirect: Temporary to permanent/ negligible to major impacts • 27 resources	Direct: Permanent/minor to major impacts • 3 resources Indirect: Temporary to permanent/ negligible to major impacts • 166 resources	Direct: Permanent/minor to major impacts • 3 resources Indirect: Temporary to permanent/ negligible to major impacts • 74 resources
Operations Impacts					
Previously recorded archaeological resources	Direct: Permanent/minor to major impacts • 4 resources Indirect: Temporary/ negligible to minor impacts • 4 resources	Direct: Permanent/minor to major impacts • 1 resources Indirect: Temporary/negligible to minor impacts • 1 resources	Direct: No impact • 0 resources Indirect: No impact • 0 resources	Direct: Permanent/minor to major impacts • 5 resources Indirect: Temporary/negligible to minor impacts • 5 resources	Direct: Permanent/minor to major impacts • 10 resources Indirect: Temporary/negligible to minor impacts • 10 resources

Table 6.4.4-1. Summary of Potential Impacts on Archaeological and Historic Resources for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Previously recorded historic resources	Direct: No impacts • 0 resources Indirect: Temporary to permanent/ negligible to minor impacts • 40 resources	Direct: Temporary to permanent/negligible to major impacts • 2 resources Indirect: Temporary to permanent/ negligible to minor impacts • 141 resources	Direct: No impact • 0 resources Indirect: Temporary to permanent/ negligible to minor impacts • 27 resources	Direct: Temporary to permanent/negligible to major impacts • 1 resource Indirect: Temporary to permanent/ negligible to minor impacts • 166 resources	Direct: Temporary to permanent/ negligible to major impacts • 1 resource Indirect: Temporary to permanent/ negligible to minor impacts • 74 resources

6.4.5 References

Minnesota Historical Society (MHS). 2016. Minnesota State Historic Preservation Office data, on file at the Minnesota Historical Society, file search completed November 17, 2016.

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6.5 SOCIOECONOMICS

The 20 counties in Minnesota that could be crossed by the Applicant's preferred route and route alternatives contribute to regional and statewide economies through the production of a variety of goods and services. Project actions have the potential to affect these economies (both positively and negatively). This section discusses the existing conditions and assesses potential Project-related impacts with respect to commodity production; recreation and tourism; and employment, income, and tax revenues.

6.5.1 Commodity Production

The primary commodities produced along the Applicant's preferred route and the route alternatives that would be affected by construction or operations of the Project include agricultural commodities, forestry products, and mining production. Construction of Project facilities and permanent maintenance of a cleared right-of-way during operations may displace some capacity for production of these commodities. The analysis of impacts on commodity production during construction and operations for the Applicant's preferred route and route alternatives considered the following issues:

- Disturbance and loss of agricultural land and lost yields,
- Disturbance and loss of forested land and timber resources, and
- Disturbance and loss of land used for mining.

This section first describes the existing conditions within an area along the Applicant's preferred route and each of the route alternatives where commodity production could be affected by construction and operation of the Project. The potential impacts on commodity production of Project-related construction and operation in these areas are considered next. Potential impacts for each route alternative (RA-03AM, RA-06, RA-07, and RA-08) also are assessed and then compared to each other and to the Applicant's preferred route between Clearbrook and Carlton. A summary and comparison of the impacts for all route options are included at the end of the section. Chapter 10 addresses the impacts on commodity production resulting from an unanticipated crude oil release.

6.5.1.1 Regulatory Context and Methodology

6.5.1.1.1 Regulatory Context

Several Minnesota statutes provide for the protection and management of land used to produce commodities. Minnesota Statutes § 17.80 – 17.84 set the state policy on agricultural land preservation and conservation. One of the main goals is "[…] to minimize the disruption of agricultural production in accordance with local social, economic and environmental considerations of the agricultural community." Minnesota Statutes § 89.002 establishes the policies for managing forest resources of state forest lands, providing for the responsible and sustainable use of forest products. The provision for leasing state-owned lands and mineral rights for nonferrous metallic minerals and other minerals, other than iron ore, is found in Minnesota Statutes § 93.25. Furthermore, state-owned lands and mineral rights administered by the Commissioner of Natural Resources may be leased for peat, sand, gravel, stone, clay, and rock under Minnesota Statutes § 92.50.

6.5.1.1.2 Methodology

The ROI for the analysis of impacts on commodities consists of all land currently used in the production of agricultural, timber, or mineral products—or land with the potential to be used for these purposes—that could be disturbed or removed from production along the Applicant's preferred route or the route alternatives. This includes the permanent right-of-way and the broader construction work area. Impacts on commodity production were evaluated by:

- Using GIS data resources to identify and inventory all land in the ROI currently being used, or with the potential to be used, in the production of agricultural, timber, or mineral production in the counties crossed by the Applicant's preferred route and route alternatives.
- Overlaying the construction and operations footprints for the Applicant's preferred route and the route alternatives on these areas. The footprint for the Applicant's preferred route is based on specific geo-referenced information provided by Enbridge; the construction footprint for the route alternatives is based on a standard 120-foot-wide construction footprint (except for RA-07, which would have a 205-foot-wide construction footprint; see Chapter 4) and a 50-foot-wide permanent right-of-way.
- Determining the geographic extent of impacts on all land currently being used for commodity production or land that could be used for commodity production from the construction work area, the permanent right-of-way, and the associated aboveground facilities.
- Providing a range of estimates of lost yield and market value of the affected commodities (where applicable).
- Providing a qualitative statement of the duration and magnitude of impacts on the productivity of commodity lands.

Various state and federal database layers were obtained for agricultural land, forested land, and mineral resources. Acreages of agricultural and forested lands were obtained using the NLCD 2011 Classification System (Homer et al. 2015). Acreages of farmland soils were obtained using the NRCS database to identify prime farmland and farmlands of statewide importance (NRCS 2011). For mining, acreages of active lease land and acreages of land with potential sand and gravel deposits were obtained from Minnesota DNR and USGS. Based on the geographic extent of impacts on the land used in the production of each commodity, a qualitative assessment is provided of the relative magnitude (i.e., negligible, minor, or major) and duration (i.e., temporary, short-term, long-term, or permanent) of the impacts in terms of lost production, access, and disruption.

6.5.1.2 Existing Conditions

Existing conditions are described for the entire length of the Applicant's preferred route in Minnesota. Route alternatives RA-03AM, RA-06, RA-07, and RA-08 represent alternative routes to the Applicant's preferred route between Clearbrook and Carlton. A subset of data for the segment from Clearbrook to Carlton is included in the description of existing conditions for the Applicant's preferred route to enable direct comparison of the route alternatives to the Applicant's preferred route.

The following discussion of existing conditions describes agricultural land, forested land, and mineral resource lands. These land types are defined as follows:

- Agricultural lands – Cultivated cropland and grassland that includes activities such as crop harvesting, livestock grazing, dairy production, and organic farming. It also includes land with areas of soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops (i.e., prime farmland); or areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods (i.e., farmland of statewide importance). Collectively, these soils are referred to as "farmland soils." Farmland soils can include agricultural land as defined above or land that is not currently being used for agricultural production but has high potential for future productivity.
- Forested lands – Commercially productive land that is actively managed for the sustainable harvest of timber and includes the following land cover types: deciduous, evergreen, and mixed forest. This land currently is being used in the production of timber or has timber resources that could be harvested in the future. The timber industry is an important part of Minnesota's economy.
- Mineral resource lands – lands where non-metallic (e.g., sand, gravel, and crushed stone) and metallic (e.g., iron ore, nickel, and titanium) minerals are produced.

6.5.1.2.1 Applicant's Preferred Route

Agricultural Lands

Table 6.5.1-1 presents the agricultural land located within the ROI for the Applicant's preferred route. Within the construction work area 1,913 acres are classified as agricultural land; 562 of these acres occur in the segment between Clearbrook and Carlton. The construction work area includes 1,907 acres of farmland soils (classified as prime farmland or farmland of statewide importance). Of this total, approximately 1,278 acres are located between Clearbrook and Carlton.

An additional approximately 487 acres of farmland soils and 554 acres of agricultural land are within the footprint of ATWS, access roads, valve sites, and pump stations. Some of the farmland soils may be in active production, while some may not be actively farmed as the designation is based on soil characteristics, not land use. In total, approximately 2,394 acres of farmland soils and 2,467 acres of agricultural land are located within the ROI for the Applicant's preferred route (Table 5.3.1-1).

The market value of crops (as reported by the U.S. Department of Agriculture in 2016) within the area disturbed by the Applicant's preferred route for construction and operation is shown in Table 6.5.1-2 (i.e., the average yield per acre multiplied by the acres crossed) by crop type. In total, the market value of the crops grown on lands crossed by the Applicant's preferred route is approximately $817,000 within the construction work area and approximately $333,000 within the permanent right-of-way.

Table 6.5.1-1. Agricultural Land and Farmland Soils Crossed by the Applicant's Preferred Route (acres)

Agricultural Land Type	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Construction Work Area Subtotal		ATWS	Temp Access Roads	Perm Access Roads	Pump Stations	Valves[a]	Total[b]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Agricultural Land															
Cultivated crops	1,154	495	173	76	8	4	1,336	575	327	2	20	21	2	1,707	617
Grass/pastureland	131	58	388	175	58	25	577	259	121	1	45	16	2	760	320
Agricultural land subtotal	***1,285***	***553***	***562***	***252***	***66***	***29***	***1,913***	***832***	***448***	***3***	***65***	***36***	***3***	***2,467***	***937***
Farmland															
Prime farmland	337	146	514	227	11	4	862	371	182	8	60	4	1	1,116	444
Farmland of statewide importance	206	90	763	332	76	33	1,046	459	134	12	67	17	3	1,278	542
Farmland soils subtotal	***541***	***236***	***1,278***	***559***	***84***	***38***	***1,907***	***833***	***315***	***19***	***127***	***21***	***5***	***2,394***	***986***

Sources: Homer et al. 2015 for agricultural lands; NRCS 2011 for prime farmland and farmland of statewide importance.

Notes:

Values in the table may not sum to subtotals and totals due to rounding.

Enbridge-provided footprints: Con = construction work area, Op = operations permanent right-of-way.

[a] Includes valve sites and valve driveways. Since valve sites are within the permanent right-of-way, total project impacts may be slightly overestimated due to double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations.

Table 6.5.1-2. Market Value of Crops Crossed by the Applicant's Preferred Route ($2016 thousands)

Crop Type	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Construction Work Area Subtotal		ATWS	Temp Access Roads	Perm Access Roads	Pump Station	Valves[a]	Total[b]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Alfalfa	$21.7	$9.7	$25.3	$11.3	$2.1	$0.9	$49.1	$21.9	$6.3	$0.1	$2.7	$2.6	$0.3	$61.1	$27.5
Barley	$6.6	$2.7	$0.0	$0.0	$0.0	$0.0	$6.7	$2.7	$1.5	$0.0	$0.0	$1.6	$0.2	$10.0	$4.5
Buckwheat	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Corn	$44.3	$18.7	$13.3	$5.6	$2.1	$1.0	$59.7	$25.3	$10.9	$0.1	$0.6	$0.2	$3.0	$74.5	$29.1
Dry beans	$8.9	$4.1	$24.7	$10.1	$0.0	$0.0	$33.6	$14.3	$2.9	$0.2	$2.0	$0.2	$1.2	$40.1	$17.7
Oats	$0.7	$0.3	$0.9	$0.4	$0.0	$0.0	$1.6	$0.7	$0.1	$0.0	$0.2	$0.2	$0.1	$2.2	$1.1
Other hay/ non alfalfa	$1.2	$0.6	$5.6	$2.5	$0.4	$0.2	$7.3	$3.2	$0.7	$0.0	$0.4	$0.1	$2.3	$10.8	$6.0
Potatoes	$0.0	$0.0	$31.0	$11.5	$0.0	$0.0	$31.0	$11.5	$7.7	$0.0	$1.2	$0.0	$0.0	$39.9	$12.7
Rye	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Soybeans	$246.0	$105.0	$7.8	$3.7	$0.0	$0.0	$253.8	$108.7	$37.3	$0.0	$3.2	$2.4	$32.8	$329.5	$147.0
Spring wheat	$93.9	$40.0	$2.8	$1.1	$0.0	$0.0	$96.6	$41.1	$20.9	$0.0	$1.1	$0.4	$1.2	$120.3	$43.9
Sugarbeets	$92.6	$37.3	$0.0	$0.0	$0.0	$0.0	$92.6	$37.3	$22.3	$0.0	$0.2	$0.3	$0.6	$116.0	$38.3
Sunflower	$4.7	$1.9	$0.0	$0.0	$0.0	$0.0	$4.7	$1.9	$1.1	$0.0	$0.0	$0.0	$0.1	$6.0	$2.1
Winter wheat	$6.2	$2.7	$0.0	$0.0	$0.0	$0.0	$6.3	$2.8	$0.8	$0.0	$0.1	$0.0	$0.0	$7.2	$2.9
TOTAL	**$526.9**	**$223.0**	**$111.4**	**$46.3**	**$4.6**	**$2.1**	**$642.9**	**$271.4**	**$112.6**	**$0.5**	**$11.6**	**$8.1**	**$41.7**	**$817.4**	**$332.7**

Source: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

Notes:

Values in the table may not sum to subtotals and totals due to rounding.

Enbridge-provided footprints: Con = construction work area, Op = operations permanent right-of-way.

[a] Includes valve sites and valve driveways. Since valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated due to double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations.

Forested Land

Forested land in the State of Minnesota represents 17.4 million acres of land (all ownerships). Of this total area, 15.7 million acres is considered to be commercially productive. This is forested land that is actively managed for sustainable harvest of timber and includes the following land cover types: deciduous, evergreen, and mixed forest. This land currently is being used for production of timber or has timber resources that could be harvested in the future.

Table 6.5.1-3 presents the total acres of forested land that would be crossed by the Applicant's preferred route. In total, approximately 1,790 acres of forested land is present within the ROI for the Applicant's preferred route (including footprints for the ATWS, pump stations, valve sites, and temporary access roads). The majority of forested land that would be crossed by the proposed pipeline is within the Clearbrook-to-Carlton segment (approximately 1,447 acres) and currently is owned by private landowners. These lands are used primarily as residential property, as recreational property, or for harvesting wood products.

Table 6.5.1-4 presents the current market value of the timber within the ROI for the Applicant's preferred route, which is approximately $337,000, based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008).

Mineral Lands

In Minnesota, mineral resource commodity areas host occurrences, deposits, or mine operations, or are sites of active or recurrent exploration.

Table 6.5.1-5 presents the total acres of active mineral exploration areas that would be crossed by the Applicant's preferred route and the route alternatives. The Applicant's preferred route crosses approximately 0.5 acre of land within active county metallic areas for a temporary access road in Carlton County.

Table 6.5.1-6 presents the acres of land within the ROI for the Applicant's preferred route that contain undeveloped sand, gravel, and mineral resources. These include glacial lake sediments with potential commercially important deposits of sand and gravel. Glacial deposits in the area of the proposed pipeline range from 5 to 450 feet in depth. In total, including the ATWS and access roads (Table 6.5.1-6), the construction work area of the Applicant's preferred route would cross approximately 513 acres of land with glacial deposits containing potentially valuable sand and gravel resources. MLVs and permanent access roads would permanently convert approximately 8 acres of land with potential sand and gravel resources, whereas 191 acres would remain within the permanent right-of-way.

Table 6.5.1-3. Forested Land Crossed by the Applicant's Preferred Route (acres)

Forested Land Type	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Construction Work Area Subtotal[a]		ATWS	Temp Access Roads	Perm Access Roads	Pump Stations	Valves[a]	Total[b]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Deciduous forest	56	26	1,256	554.0	38	14	1,349	594	97	31	73	2	2	1,554	671
Evergreen forest	1	1	173	70	1	1	176	71	18	4	15	1	1	214	86
Mixed forest	-	-	18	7	1	0	18	8	1	0	2	0	0	22	10
TOTAL	**57**	**27**	**1,446**	**631**	**40**	**15**	**1,543**	**673**	**116**	**35**	**90**	**3**	**3**	**1,790**	**767**

Source: Homer et al. 2015.

Notes:

Enbridge-provided footprints: Con = construction work area; Op = operations permanent right-of-way.

[a] Includes valve sites and valve driveways. Since valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated due to double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations.

Table 6.5.1-4. Estimated Market Value of Forested Land Crossed by the Applicant's Preferred Route ($2016 thousands)

Forested Land Type	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Construction Work Area Subtotal		ATWS	Temp Access Roads	Perm Access Roads	Pump Stations	Valves[a]	Total[b]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Deciduous forest	$10.6	$5.0	$239.3	$105.6	$7.2	$2.7	$257.2	$113.2	$18.4	$5.9	$13.8	$0.5	$0.4	$296.2	$127.9
Evergreen forest	$0.2	$0.1	$33.0	$13.3	$0.2	$0.1	$33.5	$13.5	$3.5	$0.7	$2.8	$0.1	$0.1	$40.7	$16.5
Mixed forest	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
TOTAL	**$10.9**	**$5.1**	**$272.3**	**$118.9**	**$7.4**	**$2.8**	**$290.6**	**$126.7**	**$21.9**	**$6.7**	**$16.6**	**$0.6**	**$0.5**	**$336.9**	**$144.4**

Source: USFS 2008.

Notes:

Values in the table may not sum to subtotals and totals due to rounding.

Enbridge-provided footprints: Con = construction work area, Op = operations permanent right-of-way.

Assumes that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40.

[a] Includes valve sites and valve driveways. Since valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated due to double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations.

Table 6.5.1-5. Active Mineral Areas Crossed by the Applicant's Preferred Route and Route Alternatives (acres)

Project Phase	North Dakota Border to Clearbrook[a]	Clearbrook to Carlton					Carlton to Wisconsin Border[a]
		Applicant's Preferred Route[b]	Route Alternative RA-03AM[a]	Route Alternative RA-06[a]	Route Alternative RA-07[c]	Route Alternative RA-08[a]	
Construction	0.0	0.51	0.0	2.7	0.0	0.0	0.0
Operations	0.0	<0.1	0.0	1.1	0.0	0.0	0.0

Source: Minnesota DNR 2016.

Note:

[a] Con = estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way; Op = estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

[b] Enbridge-provided footprints: Con = construction work area, Op = operations permanent right-of-way.

[c] Con = estimated construction impact area in acres based on 205-foot-wide construction area, 10 feet wide on the north side of the existing Line 3 and 195 feet wide on the south side of the existing Line 3; Op = estimated operations impact area in acres based on 50-foot-wide operations permanent right-of-way centered on the route.

Table 6.5.1-6. Land with Potential Sand and Gravel Resources Crossed by the Applicant's Preferred Route (acres)

Resource	North Dakota Border to Clearbrook		Clearbrook to Carlton		Carlton to Wisconsin Border		Applicant's Preferred Route Total		ATWS	Temp Access Roads	Perm Access Roads	Pump Stations	Valves[a]	Total[b]	
	Con	Op	Con	Op	Con	Op	Con	Op						Con	Op
Land with glacial deposits	395.2	170.9	14.1	6.8	32.1	13.5	441.4	191.2	62.7	0.0	7.1	0.0	1.2	513.2	199.5

Source: USGS 2006.

Notes:

Enbridge-provided footprints: Con = construction work area, Op = operations permanent right-of-way.

[a] Includes valve sites and valve driveways. Since valve sites are within the permanent right-of-way, total Project impacts may be slightly overestimated due to double counting.

[b] Con = sum of pipeline construction work area, additional temporary workspaces (ATWS), pump stations, valves, and temporary and permanent access roads; Op = sum of pipeline permanent right-of-way, permanent access roads, valves, and pump stations.

6.5.1.2.2 Route Alternatives

As previously noted, the only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to commodity production for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Agricultural Land

Table 6.5.1-7 presents the agricultural commodity land located within the ROI for RA-03AM. In total, the construction work area of the route would include approximately 1,681 acres of agricultural land between Clearbrook and Carlton. It also would cross approximately 1,608 acres of farmland soils that may or may not currently be in active production. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified.

Table 6.5.1-7. Agricultural Commodity Land Crossed by Route Alternative RA-03AM (acres)

Agricultural Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Agricultural Land		
Cultivated crops	585	246
Grass/pastureland	1,096	460
Agricultural land subtotal	***1,681***	***706***
Farmland		
Prime farmland	493	206
Farmland of statewide importance	1,115	465
Farmland soils subtotal	***1,608***	***671***

Sources: Homer et al. 2015 for agricultural lands; NRCS 2011 for prime farmland and farmland of statewide importance.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

To illustrate the impact in terms of market value, Table 6.5.1-8 presents the total dollar value of the yield (i.e., the average yield per acre multiplied by the acres crossed) by crop type. In total, the market value of the crops grown on lands crossed by RA-03AM is approximately $482,000 within the construction work area and approximately $201,000 within the permanent right-of-way.

Table 6.5.1-8. Market Value of Crops for Route Alternative RA-03AM[a] ($2016)

Crop Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Alfalfa	$78,401	$33,058
Barley	$224	$81
Corn	$155,598	$64,904
Dry beans	$38,175	$16,020
Oats	$3,173	$1,369
Other hay/non alfalfa	$9,289	$3,735
Potatoes	$147,638	$61,571
Soybeans	$46,114	$18,954
Spring wheat	$2,735	$1,095
Sugarbeets	$134	$27
Sunflower	$167	$78
Winter wheat	$39	$23
TOTAL	**$481,687**	**$200,914**

Source: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Forested Land

Table 6.5.1-9 presents the total acres of forested land that would be crossed by RA-03AM during construction and operation of the pipeline. In total, the construction work area of the route would include approximately 1,175 acres of forested land between Clearbrook and Carlton; and the permanent right-of-way would include 486 acres of forested land. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified. Table 6.5.1-10 presents the current market value of timber within the ROI for RA-03AM, which is $193,000 within the construction work area and approximately $80,000 within the permanent right-of-way for operation. This is based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008).

Table 6.5.1-9. Forested Land Crossed by Route Alternative RA-03AM (acres)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	1,013	419
Evergreen forest	147	61
Mixed forest	15	6
TOTAL	**1,175**	**486**

Source: Homer et al. 2015.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Table 6.5.1-10. Market Value of Forested Land Crossed by Route Alternative RA-03 AM ($2016 thousands)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	$193.0	$79.8
Evergreen forest	$27.9	$11.6
Mixed forest	$2.8	$1.2
TOTAL	**$193.0**	**$79.8**

Sources: Minnesota DNR 2016; U.S. Forest Service 2008.

Notes:

Assumes that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Mineral Lands

No active mineral mining areas would be crossed by RA-03AM during construction or operations. Glacial lake sediments have potential commercially important deposits of sand and gravel. The construction work area would cross approximately 442 acres of land with potential sand and gravel resources, and the permanent right-of-way would cross approximately 184 acres.

Route Alternative RA-06

Agricultural Land

Table 6.5.1-11 presents the agricultural commodity land located within the ROI for RA-06. In total, the construction work area would include approximately 326 acres of agricultural land between Clearbrook and Carlton. The route also would cross approximately 1,241 acres of farmland soils that may or may not currently be in active production. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified.

Table 6.5.1-11. Agricultural Commodity Land Crossed by Route Alternative RA-06 (acres)

Agricultural Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Agricultural Land		
Cultivated crops	51	22
Grass/pastureland	275	115
Agricultural land subtotal	***326***	***137***
Farmland		
Prime farmland	770	321
Farmland of statewide importance	471	197
Farmland soils subtotal	***1,241***	***518***

Sources: Homer et al. 2015 for agricultural lands; NRCS 2011 for prime farmland and farmland of statewide importance.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Table 6.5.1-12 presents the total dollar value of the yield (i.e., the average yield per acre multiplied by the acres crossed) by crop type. In total, the recent market value of the crops grown on lands crossed by RA-06 is approximately $52,000 within the construction work area and approximately $22,000 within the permanent right-of-way.

Table 6.5.1-12. Market Value of Crops for Route Alternative RA-06 ($2016)

Crop Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Alfalfa	$27,538	$11,613
Corn	$12,071	$5,210
Oats	$1,737	$713
Other hay/non alfalfa	$1,763	$706
Soybeans	$8,214	$3,392
Spring wheat	$932	$393
TOTAL	**$52,255**	**$22,026**

Source: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Forested Land

Table 6.5.1-13 presents the total acres of forested land that would be crossed by RA-06 during construction and operation of the pipeline. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified. Table 6.5.1-14 presents the current market value of timber within the ROI for RA-06, which is approximately $165,000 within the construction work area and approximately $69,000 within the permanent right-of-way. This is based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008).

Table 6.5.1-13. Forested Land Crossed by Route Alternative RA-06 (acres)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	865	360
Evergreen forest	105	44
Mixed forest	174	72
TOTAL	**1,143**	**476**

Sources: Homer et al. 2015.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Table 6.5.1-14. Market Value of Forested Land for Route Alternative RA-06 ($2016 thousands)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	$164.8	$68.6
Evergreen forest	$20.0	$8.3
Mixed forest	$33.1	$13.8
TOTAL	**$164.8**	**$68.6**

Sources: USFS 2008.

Notes:

Assumes that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Mineral Lands

The 120-foot construction footprint for RA-06 would cross the highest amount of land with active county metallic areas (approximately 3 acres), and approximately 1 acre would be crossed during operations (Table 6.5.1-15). Glacial lake sediments have potential commercially important deposits of sand and gravel. The construction work area would cross approximately 571 acres of land with potential sand and gravel resources, and the permanent right-of-way would cross approximately 238 acres.

Table 6.5.1-15. Mining Areas Crossed by Route Alternative RA-06 (acres)

Project Phase	Active Mineral Areas	Land with Potential Sand and Gravel Resources
Construction[a]	2.7	570.7
Operations[b]	1.1	237.8

Source: Minnesota DNR 2016.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Route Alternative RA-07

Agricultural Land

Table 6.5.1-16 presents the agricultural commodity land located within the ROI for RA-07. In total, the construction work area for the route would include approximately 402 acres of agricultural land between Clearbrook and Carlton. It also would cross approximately 1,082 acres of farmland soils that may or may not currently be in active production. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified.

Table 6.5.1-16. Agricultural Commodity Land Crossed by Route Alternative RA-07 (acres)

Agricultural Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Agricultural Land		
Cultivated crops	76	57
Grass/pastureland	326	114
Agricultural land subtotal	***402***	***170***
Farmland		
Prime farmland	422	113
Farmland of statewide importance	660	189
Farmland soils subtotal	***1,082***	***302***

Sources: Homer et al. 2015 for agricultural lands; NRCS 2011 for prime farmland and farmland of statewide importance.

[a] Estimated construction impact area in acres based on 205-foot-wide construction work area, 10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3.

[b] Estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route.

To illustrate the impact in terms of market value, Table 6.5.1-17 presents the total dollar value of the yield (i.e., the. average yield per acre multiplied by the acres crossed) by crop type. In total, the market value of the crops grown on lands crossed by RA-07 is approximately $39,000 within the construction work area and approximately $15,000 within the permanent right-of-way.

Table 6.5.1-17. Market Value of Crops for Route Alternative RA-07 ($2016)

Crop Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Alfalfa	$18,717	$7,918
Corn	$4,433	$1,936
Oats	$207	$90
Other hay/non alfalfa	$2,522	$1,035
Soybeans	$5,300	$2,293
Spring wheat	$3,040	$1,276
Sunflower	$36	$16
TOTAL	**$39,153**	**$14,564**

Sources: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

[a] Estimated construction impact area in acres based on 205-foot-wide construction work area, 10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3.

[b] Estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route.

Forested Land

Table 6.5.1-18 presents a conservative estimate of the total acres of forested land that would be crossed by RA-07 during construction and operation of the pipeline. RA-07 involves removing the existing Line 3 and placing the new Line 3 in the same trench. RA-07 would be centered in the existing Enbridge Mainline, which is largely cleared of trees. However, the resolution of the GIS land cover data does not provide accurate representation of land cover/land use at the scale of the Mainline corridor right-of-way. This limitation in the data creates some uncertainty about the accuracy of the land cover data within the anticipated construction work area. The numbers shown should be considered a very conservative estimate of impacts on forested land; the actual numbers are likely to be much lower.

Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified. Table 6.5.1-19 presents the current market value of timber within the ROI for RA-07, which is approximately $147,000 within the construction work area and approximately $36,000 within the permanent right-of-way. This is based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008).

Table 6.5.1-18. Forested Land Crossed by Route Alternative RA-07 (acres)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	773	192
Evergreen forest	235	38
Mixed forest	139	28
TOTAL	**1,147**	**258**

Sources: Homer et al. 2015.

[a] Estimated construction impact area in acres based on 205-foot-wide construction work area, 10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3.

[b] Estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route.

Table 6.5.1-19. Market Value of Forested Land for Route Alternative RA-07 ($2016 thousands)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	$147.3	$36.4
Evergreen forest	$44.7	$7.1
Mixed forest	$26.6	$5.4
TOTAL	**$147.3**	**$36.4**

Sources: USFS 2008.

Notes:

Assumes that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40.

[a] Estimated construction impact area in acres based on 205-foot-wide construction work area, 10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3.

[b] Estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route.

Mineral Lands

No active mineral areas would be crossed by RA-07 during construction or operations. Glacial lake sediments have potential commercially important deposits of sand and gravel. The construction work area would cross approximately 562 acres of land with potential sand and gravel resources, and the permanent right-of-way would cross approximately 234 acres.

Route Alternative RA-08

Agricultural Land

Table 6.5.1-20 presents the agricultural commodity land located within the ROI for RA-08. In total, the construction work area for the route would include approximately 405 acres of agricultural land between Clearbrook and Carlton. It also would cross approximately 944 acres of farmland soils that may or may not currently be in active production. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified.

To illustrate the impact in terms of market value, Table 6.5.1-21 presents the total dollar value of the yield (i.e., the average yield per acre multiplied by the acres crossed) by crop type. In total, the market value of the crops grown on lands crossed by RA-08 is approximately $41,000 within the construction work area and approximately $17,000 within the permanent right-of-way.

Table 6.5.1-20. Agricultural Commodity Land Crossed by Route Alternative RA-08 (acres)

Agricultural Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Agricultural Land		
Cultivated crops	41	17
Grass/pastureland	364	153
Agricultural land subtotal	***405***	***170***
Farmland		
Prime farmland	387	162
Farmland of statewide importance	556	232
Farmland soils subtotal	***944***	***394***

Sources: Homer et al. 2015 for agricultural lands; NRCS 2011 for prime farmland and farmland of statewide importance.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Table 6.5.1-21. Market Value of Crops for Route Alternative RA-08 ($2016)

Crop Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Alfalfa	$22,604	$9,596
Corn	$8,678	$3,690
Oats	$690	$293
Other hay/non alfalfa	$1,381	$560
Soybeans	$6,918	$2,957
Spring wheat	$373	$146
TOTAL	**$40,645**	**$17,242**

Sources: U.S. Department of Agriculture, National Agricultural Statistical Service 2016.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Forested Land

Table 6.5.1-22 presents the total acres of forested land that would be crossed by RA-08 during construction and operation of the pipeline. Temporary and permanent access roads, pump stations, and valve sites have not been determined for the route alternatives; therefore, the additional affected acreage from these footprints cannot be quantified. Table 6.5.1-23 presents the current market value of the timber within the ROI for RA-08, which is approximately $119,000 within the construction work area and approximately $50,000 within the permanent right-of-way easement. This is based on the assumption that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40 (USFS 2008).

Table 6.5.1-22. Forested Land Crossed by Route Alternative RA-08 (acres)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	626	260
Evergreen forest	108	44
Mixed forest	76	31
TOTAL	**810**	**335**

Sources: Homer et al. 2015.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Table 6.5.1-23. Market Value of Forested Land for Route Alternative RA-08 ($2016 thousands)

Forest Land Type	Construction Work Area[a]	Permanent Right-of-Way[b]
Deciduous forest	$119.3	$49.5
Evergreen forest	$20.5	$8.4
Mixed forest	$14.4	$5.9
TOTAL	**$119.3**	**$49.5**

Sources: USFS 2008.

Notes:

Assumes that an acre of forested land produces 7.8 cords of wood and the average value per cord across all species is $24.40.

[a] Estimated construction impact area in acres based on a 120-foot-wide construction work area centered on the route, including the 50-foot-wide permanent right-of-way.

[b] Estimated operations impact area in acres based on a 50-foot-wide permanent right-of-way centered on the route.

Mineral Lands

No active mineral areas would be crossed by RA-08 during construction or operations. Glacial lake sediments have potential commercially important deposits of sand and gravel. The construction work area would cross approximately 555 acres of land with glacial deposits, and the permanent right-of-way would cross approximately 231 acres.

6.5.1.3 Impact Assessment

Potential impacts on land used in the production of commodities from construction and operation of the Applicant's preferred route and route alternatives include impacts on agricultural productivity and commercial forestry through the loss of both current and future productivity from removal of crops, disruption of farmland soils, and clearing of trees. This also could affect the corresponding economies, depending on the total market value of the commodities lost and the overall size of the relevant commodity market in the counties crossed. Land that is currently being mined for mineral resources could temporarily be disrupted during construction, and land containing undeveloped potential mineral resources would not be accessible within the permanent right-of-way. The extent and magnitude of these impacts are influenced by the overall geographic scope of the impact and whether the land would recover or be available for future production.

The duration of potential Project impacts on commodity production along the pipeline right-of-way could range from temporary during active construction to permanent (e.g., aboveground facilities, a new corridor through forested areas). During construction, the greatest impacts on commodity production would be caused by clearing of vegetation. Operations impacts would be limited to the addition of aboveground facilities and reduced production from the permanent removal of trees on cleared forested land. In general, agricultural areas would return to their preconstruction condition relatively quickly, whereas forested lands would not be permitted to regrow within the permanent right-of-way.

6.5.1.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Construction activities would affect agricultural land (i.e., cropland and hay/pastures). Impacts could include soil erosion, interference with and damage to agricultural surface and subsurface drainage and irrigation systems, mixing or loss of fertile topsoil and subsoil, and soil compaction. During construction, the production of crops on agricultural land typically would need to be deferred for one growing season, resulting in short-term minor impacts on land currently in production. The Applicant would compensate all landowners for lost crops and any documented damage that may be caused by construction activities.

To prevent soil compaction, drainage alteration, and damage to crops, operation of equipment on agricultural lands would be limited to the access routes to the construction footprint agreed upon with landowners. The Applicant would implement measures to avoid or minimize potential impacts on soil productivity in accordance with their Agricultural Protection Plan (Appendix F). These measures include erosion control, topsoil segregation, rock removal, and measures to avoid compaction or loosen compacted soils. In temporary construction work areas and along the permanent right-of-way, agricultural activity typically would be prevented for one growing season, resulting in short-term minor losses to agricultural productivity.

The Agricultural Protection Plan provides additional measures that would be applied specifically to organic agricultural lands, such as organic-certified farms or farms that are in active transition to organic-certified status, in order to address the unique management and certification requirements of these operations. The Applicant has identified two organic farms that would be crossed by the Applicant's preferred route. Both organic farms are located east of Clearbrook, and both landowners have signed easement agreements (Enbridge 2016). The Applicant would continue to work with affected landowners to identify organic farms that have not been identified to date and would implement measures in the Agricultural Protection Plan accordingly. As part of this plan, The Applicant has developed specific measures, outlined in an appendix to the plan, to minimize impacts on organic farms.

Construction activities also could affect farmland soils. Impacts on prime farmland and farmland of statewide importance from construction of the Applicant's preferred route could include interference with agricultural drainage (if present), mixing of topsoil and subsoil, and compaction and rutting of soil. These impacts could result from clearing, trench excavation and backfilling, and vehicular traffic within the construction work area. Potential impacts include temporary and short-term minor soil erosion, short-term minor soil compaction, permanent increases in the proportion of large rocks in the topsoil, and short-term to long-term minor soil contamination. Overall, these impacts could result in short-term to long-term minor impacts on the current and future productivity of the soil in terms of agricultural production.

The current market value of crops within the construction work area is approximately $643,000 and the total value is approximately $817,000 including the value of crops within the footprint of ATWS, access roads, valve sites and pump stations (Table 6.5.1-2). Within the Clearbrook-to-Carlton segment, this amount is approximately $111,000. This amount represents less than one-half of a percent of the total market value of agricultural products in the counties that would be crossed by the Applicant's preferred route; therefore, it is likely that construction of the Project would result in a temporary negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Lands and Timber Resources

During construction, trees from forested areas would be cleared within the construction work area, which would result in loss of timber production. However, the Applicant would compensate Minnesota DNR for any merchantable timber loss on state-managed forested lands, and compensation on private lands would be agreed upon by the Applicant and the landowner during easement acquisition. For any merchantable timber on state lands, disposal/sale must be handled with the division of forestry. Any merchantable timber within the ROI belongs to the State and must follow its procedures. For forested land in WMAs, any revenue for merchantable timber that is harvested would be deposited into the WMA revenue account.

Following construction activities, trees would be allowed to regenerate naturally within the construction work areas, temporary access roads, and ATWS; however, the area within the construction work area could take up to 50 years to regenerate harvestable timber. Construction activities likely would result in long-term to permanent, minor impacts on land used for timber production. Based on the value of the annual lost growth, the present value of the future growth foregone is approximately $2.3 million, with the majority of the impact occurring in Minnesota. When compared to the present value of the timber harvest market over the same time period (50 years, $662 million), the impact of construction is likely to cause a long-term to permanent, minor impact on the associated local timber industry.

Disturbance and Loss of Land Used for Mining

Because the pipeline for Applicant's preferred route would be installed mainly within and adjacent to an existing right-of-way, no additional restrictions on the current use of land for mining mineral resources would be expected from construction. Approximately 0.5 acre of land in active mineral areas would be crossed by the route for a temporary access road; however, impacts on productivity are expected to be temporary and negligible. Given the temporary nature of construction coupled with the relatively undeveloped state of the resources and the average depth of their location below the surface (from 5 to 450 feet), impacts from construction on future exploration or mining of lands with potential sand and gravel resources are likely to be temporary and negligible. If future discovery of metallic mineral resources occurs where the pipeline crosses state lands, realignment of the pipeline would be handled under standard licensing clauses.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Impacts on agricultural lands during operation would be minimal, as most of these areas would recover following construction and typically would not require maintenance mowing. During operation, the easement for the permanent right-of-way would include 833 acres of agricultural land (cropland and grass/pastureland), the majority of which would be located along the existing pipeline corridor. Following final restoration, agricultural activities would be able to resume across the construction work area and the permanent right-of-way, resulting in no additional impacts during continued operation of

the pipeline. Operation of the pipeline would not affect land currently being used for agricultural production, except for land within the permanent footprint of pump stations, MLVs, and permanent access roads that would be converted to industrial/developed land uses. Approximately 104 acres of agricultural land in the Clearbrook-to-Carlton segment would be converted to industrial/developed land associated with aboveground facilities and associated access. As with construction of the pipeline, the Applicant would compensate all landowners for lost crops and any documented damage that may be caused by maintenance activities.

The current market value of crops on agricultural land that would be converted to other land uses is approximately $61,400 (value of the land converted to pump stations, valve sites, and permanent access roads from Table 6.5.1-2). The value of this annual loss into perpetuity would equal approximately $2.1 million. The annual loss of commodities from agricultural land removed from agricultural use relative to the overall value of agricultural products sold in the affected counties would be small; therefore, the impact on the local agricultural economy would be permanent and negligible.

The easement for the Applicant's preferred route also would include farmland soils (i.e., 378 acres of prime farmland and 455 acres of farmland of statewide importance). Following final restoration, agricultural activities would be able to resume across this land, resulting in no additional impacts during the continued operation of the pipeline. Impacts on farmland soils from operation of the pipeline therefore would be short term and minor. The exception would be about 153 acres that would be permanently converted to industrial use for the pump stations, permanent access roads, and MLVs, and would no longer be available for future production. Conversion of this land would result in a permanent negligible impact.

Disturbance and Loss of Forested Lands and Timber Resources

Forested lands would not be allowed to reestablish within the permanent right-of-way because it would be maintained clear of trees for operational purposes, such as facilitating aerial inspections, preserving pipeline integrity, and providing access for maintenance or emergency work. The permanent right-of-way for the Applicant's preferred route would include approximately 673 acres of forested land, of which the majority (88 percent) is deciduous forest. This land would permanently be removed from the ability to commercially produce timber for use in the wood product industries. Given the available timber resources in the area, as well as compensation that would be received by landowners, impacts on land that could be used in the production of timber products from operation of the pipeline are considered permanent and minor.

The current market value of the timber that would be removed is approximately $144,000 (Table 6.5.1-4). Assuming that this annual loss is continued into perpetuity, the present value of the foregone annual harvest is $4.8 million; the present value of annual timber harvest in Minnesota into perpetuity is $1.6 billion. Permanent conversion of 673 acres of forested land during operation of the Applicant's preferred route therefore would result in a permanent minor impact on the local timber economy.

The Applicant would continue to work with potentially affected landowners to determine whether any impacts would occur as a result of operations activities and would compensate them accordingly.

Disturbance and Loss of Land Used for Mining

Operation of the pipeline is not expected to affect land in active mineral areas. In terms of land with potential sand and gravel resources, 191 acres would be within the permanent right-of-way for the entire route, while approximately 7 acres would be within the permanent easement in the Clearbrook-to-Carlton segment. Impacts could involve permanently removing this land from current and future mining activities. Impacts on future mineral development would not constitute a significant loss of mineral resources or mineral availability because the resource potential is unknown. In addition, the width of the right-of-way is narrow relative to the expanse of areas with mineral resource potential. Operations-related impacts on land with potential mineral resources are likely to be permanent and negligible.

6.5.1.3.2 Route Alternatives (from Clearbrook to Carlton)

Route alternatives consist of temporary construction work areas and permanent pipeline rights-of-way along a specific alignment. The route alternatives would require pump stations and MLVs, but specific locations and designs of any aboveground facilities have not been identified. As such, the analysis of impacts focuses on the proximity of sensitive receptors to the identified pipeline corridor and recognizes that land used in the production of commodities could experience additional permanent impacts from the presence of aboveground facilities if a route alternative is selected and locations for these facilities have been identified.

Although impacts differ in location and quantity, the types of impacts would be similar between the Applicant's preferred route and the route alternatives. Impacts from construction on land used in the production of agricultural products would decrease productivity in the short term from removal of existing vegetation within the construction work area, whereas impacts from construction on forested land would be long term based on the time until trees within the temporary construction work area would regenerate. Impacts from operations primarily would be associated with the permanent clearing of trees and vegetation along the right-of-way and access roads, as well as with permanent aboveground facilities.

Route Alternative RA-03AM

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Construction of the RA-03AM route would affect 1,680 acres of agricultural land (cropland and grass/pasture) and 1,608 acres of farmland soils. During construction, production of crops on agricultural land typically would be prevented for one growing season, resulting in short-term minor losses to land currently being used for agricultural production. The estimated market value of crops lost during construction is approximately $482,000 annually. This amount represents less than one-half of a percent of the total market value of agricultural products in the counties that would be crossed by the route; therefore, it is likely that construction of RA-03AM would result in a temporary negligible impact on the local agricultural economy. In terms of agricultural production on farmland soils, short-term to long-term minor impacts on the current and future productivity of farmland soils could occur.

Disturbance and Loss of Forested Lands and Timber Resources

RA-03AM also would affect 1,174 acres of forested land. The duration and magnitude of impacts during construction would be the same as those described for the Applicant's preferred route (minor long-term

to permanent impacts). The estimated dollar value of harvestable timber that would be lost within the construction work area until the trees would be harvestable would be approximately $1.9 million.

Disturbance and Loss of Land Used for Mining

Construction of the RA-03AM route would not affect any land in active mine areas and would traverse the smallest amount of land area (442 acres) between Clearbrook and Carlton that contains potential sand and gravel resources. Given the temporary nature of construction coupled with the relatively undeveloped state of the resources and the average depth of their location below the surface (from 5 to 450 feet), impacts from construction on the future exploration or mining of these resources are likely to be temporary and negligible. If future discovery of metallic mineral resources occurs where the pipeline crosses state lands, realignment of the pipeline would be handled under standard licensing clauses.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Following final restoration, agricultural activities would be able to resume across the construction work area and the permanent right-of-way, resulting in no additional impacts during continued operation of the pipeline. Operation of the pipeline would not affect land currently being used for agricultural production, except for land within the permanent footprint of pump stations, MLVs, and permanent access roads that would be converted to industrial/developed land uses. Because the location of permanent facilities and access roads have not been determined for the route alternatives, the amount of agricultural land permanently converted to industrial uses cannot be quantified; however, given that it is likely to be similar to the Applicant's preferred route, it is likely that operation along RA-03AM would result in a permanent but negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Lands and Timber Resources

Forested lands would not be allowed to reestablish within the permanent right-of-way to allow ongoing inspection and maintenance. The permanent easement for the RA-03AM route would include approximately 485 acres of forested land within the Clearbrook-to-Carlton segment, of which the majority (88 percent) is deciduous forest. This land would be permanently restricted from commercial timber production. Assuming that the current annual value of this timber would be lost into perpetuity, the present value of the timber removed from annual harvest is approximately $3.1 million, compared to the present value of the annual timber harvest in Minnesota over the same time period (perpetuity), which is $1.6 billion. Permanent conversion of 485 acres of forested land during operation of RA-03AM would result in a permanent minor impact on the local timber economy.

Disturbance and Loss of Land Used for Mining

Operation of the pipeline is not expected to affect land in active mineral areas. Operations could involve permanently removing land with potential sand and gravel resources from both current and future mining activities. Impacts on future mineral development would not constitute a significant loss of mineral resources or mineral availability because the resource potential is unknown. In addition, the width of the right-of-way is narrow relative to the expanse of areas with mineral resource potential. Impacts on land with potential mineral resources from operation are likely to be permanent and negligible.

Route Alternative RA-06

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Construction of RA-06 would affect 326 acres of agricultural land (cropland and grass/pasture) and 1,241 acres of farmland soils. During construction, production of crops on agricultural land would typically be prevented for one growing season, resulting in short-term minor losses to land currently being used for agricultural production. The estimated market value of crops lost during construction is approximately $52,000. This amount represents less than one-half of a percent of the total market value of agricultural products in the counties that would be crossed by the route; therefore, it is likely that construction of RA-06 would result in a temporary negligible impact on the local agricultural economy. The impacts on farmland soils would be the same as those described for the Applicant's preferred route (short term to long term and minor).

Disturbance and Loss of Forested Lands and Timber Resources

The RA-06 route would cross 1,143 acres of forested land, which would result in impacts similar to those described for the Applicant's preferred route (minor long-term to permanent impacts). The estimated dollar value of harvestable timber that would be lost within the construction work area until the trees would be harvestable would be approximately $1.8 million.

Disturbance and Loss of Land Used for Mining

Unlike the other route alternatives, RA-06 route would cross 0.2 mile of land in active mine areas and would traverse a larger amount of land areas that contain potential sand and gravel resources (570 acres). Therefore, it is likely that construction of RA-06 could cause a temporary minor impact on current mining activities.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Following final restoration, agricultural activities would be able to resume across the temporary construction work area and the permanent right-of-way, resulting in no additional impacts during continued operation of the pipeline. Operation of the pipeline would result in short-term minor losses to land currently being used for agricultural production. Because the location of permanent facilities and access roads have not been determined for the route alternatives, the amount of agricultural land permanently converted to industrial uses cannot be quantified; however, given that it is likely to be similar to the Applicant's preferred route, it is likely that operation along RA-06 would result in a permanent but negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Lands and Timber Resources

To allow for visual inspection and maintenance of the pipeline, forested lands would not be allowed to reestablish within the permanent right-of-way. The easement for RA-06 route would include approximately 476 acres of forested land within the Clearbrook-to-Carlton segment, of which the majority is deciduous forest. This land would permanently be removed from the ability to commercially produce timber for use in the wood product industries. Assuming that the current annual value of this timber is lost into perpetuity, the present value of the timber removed from annual harvest is approximately $3.0 million, compared to the present value of the annual timber harvest in Minnesota over the same time period (perpetuity), which is $1.6 billion. Permanent conversion of 476 acres of

forested land during operation of the RA-06 route would result in a permanent minor impact on the local timber economy.

Disturbance and Loss of Land Used for Mining

Operation of the pipeline is not expected to affect land in active mineral areas. Operations could involve permanently removing land with potential sand and gravel resources from both current and future mining activities. Impacts on future mineral development would not constitute a significant loss of mineral resources or mineral availability because the resource potential is unknown. In addition, the width of the right-of-way is narrow relative to the expanse of areas with mineral resource potential. Operations impacts on land with potential mineral resources are likely to be permanent and negligible.

Route Alternative RA-07

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Construction of the RA-07 route would result in the second lowest total impacts on agricultural land (402 acres of agricultural land and 1,082 acres of farmland soils). During construction, production of crops on agricultural land typically would be prevented for one growing season, resulting in temporary minor losses to land currently being used for agricultural production. The estimated market value of crops lost during construction is approximately $39,000. This amount represents less than one-half of a percent of the total market value of agricultural products in the counties that would be crossed by the route; therefore, it is likely that construction of RA-07 would result in a temporary negligible impact on the local agricultural economy. The impacts on farmland soils would be the same as those described for the Applicant's preferred route (short term to long term and minor).

Disturbance and Loss of Forested Lands and Timber Resources

The RA-07 route would cross 1,147 acres of forested land. Because RA-07 involves replacement of the existing Line 3, most impacts would be within the existing permanent right-of-way. The remainder of the construction footprint for RA-07 would be within the former construction footprint for Line 67, limiting the severity of impacts. Impacts on timber production would be long term but negligible because there should be little harvestable timber within the existing permanent right-of-way.

Disturbance and Loss of Land Used for Mining

The RA-07 route also would not cross any land in active mine areas but would traverse the largest amount of land areas with potential sand and gravel resources relative to the Applicant's preferred route (562 acres), resulting in a temporary minor impact during construction.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Following final restoration, agricultural activities would be able to resume across the construction work area and the permanent right-of-way, resulting in no additional impacts during continued operation of the pipeline. Operations for the RA-07 pipeline would not affect land currently being used for agricultural production, except for land within the permanent footprint of pump stations, MLVs, and permanent access roads that would be converted to industrial/developed land uses. Because the location of permanent facilities and access roads have not been determined for the route alternatives, the amount of agricultural land permanently converted to industrial uses cannot be quantified; however, given that it is

likely to be similar to the Applicant's preferred route, it is likely that operation along RA-07 would result in a permanent but negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Land and Timber Resources

To allow for visual inspection and maintenance of the pipeline, forested lands would not be allowed to reestablish within the permanent right-of-way. The easement for the RA-07 route would include approximately 257 acres of forested land within the Clearbrook-to-Carlton segment, of which the majority is deciduous forest. Given that the majority of this forested land already has been cleared within the permanent right-of-way of the existing Line 3 and in the construction of Line 67, little to no harvestable timber likely is present on the existing land, thereby resulting in a long-term negligible impact on the local timber industry.

Disturbance and Loss of Land Used for Mining

Operations for the RA-07 pipeline are not expected to affect land in active mineral areas. Operations could involve permanently removing land with potential sand and gravel resources from both current and future mining activities. Impacts on future mineral development would not constitute a significant loss of mineral resources or mineral availability because the resource potential is unknown. In addition, the width of the right-of-way is narrow relative to the expanse of areas with mineral resource potential. Impacts on land with potential mineral resources from operation are likely to be permanent and negligible.

Route Alternative RA-08

Construction Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Construction of the RA-08 route would affect 405 acres of agricultural land and 944 acres of farmland soils. During construction, production of crops on agricultural land typically would be prevented for one growing season, resulting in short-term minor losses to land currently being used for agricultural production. The estimated market value of crops lost during construction is approximately $41,000. This amount represents less than one-half of a percent of the total market value of agricultural products in the counties that would be crossed by the route; therefore, it is likely that construction of RA-08 would result in a temporary negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Land and Timber Resources

Construction of the RA-08 route would result in the lowest impact on total forested land (809 acres), resulting in a minor long-term impact on timber production. The estimated dollar value of harvestable timber that would be lost within the construction work area until the trees would be harvestable again would be approximately $1.3 million.

Disturbance and Loss of Land Used for Mining

The RA-08 route would not cross any land in active mine areas but would traverse a larger amount of land areas with potential sand and gravel resources relative to the Applicant's preferred route (555 acres). The impact on mining would be temporary and minor during construction.

Operations Impacts

Disturbance and Loss of Agricultural Land and Lost Yields

Following final restoration, agricultural activities would be able to resume across the construction work area and the permanent right-of-way, resulting in no additional impacts during continued operation of the pipeline. Operation of the pipeline would not affect land currently being used for agricultural production, except for land within the permanent footprint of pump stations, MLVs, and permanent access roads that would be converted to industrial/developed land uses. Because the location of permanent facilities and access road have not been determined for the route alternatives, the amount of agricultural land permanently converted to industrial uses cannot be quantified; however, given that it is likely to be similar to the Applicant's preferred route, it is likely that operation along RA-08 would result in a permanent but negligible impact on the local agricultural economy.

Disturbance and Loss of Forested Land and Timber Resources

To allow for visual inspection and maintenance of the pipeline, forested lands would not be allowed to reestablish within the permanent right-of-way. The permanent easement for RA-08 route would include approximately 335 acres of forested land within the Clearbrook-to-Carlton segment, of which the majority is deciduous forest. This land would permanently be removed from the ability to commercially produce timber for use in the wood product industries. Assuming that the current annual value of this timber would be lost into perpetuity, the present value of the timber removed from annual harvest is approximately $2.1 million, compared to present value of annual timber harvest in Minnesota over the same time period (perpetuity), which is $1.6 billion. The permanent conversion of 335 acres of forested land during operations for the RA-08 route therefore would cause a permanent minor impact on the local timber economy.

Disturbance and Loss of Land Used for Mining

Operation of the pipeline is not expected to affect land in active mineral areas. Operations could involve permanently removing land with potential sand and gravel resources from both current and future mining activities. Impacts on future mineral development would not constitute a significant loss of mineral resources or mineral availability because the resource potential is unknown. In addition, the width of the right-of-way is narrow relative to the expanse of areas with mineral resource potential. Impacts on land with potential mineral resources from operation are likely to be permanent and negligible.

6.5.1.4 Summary and Mitigation

6.5.1.4.1 Summary

Table 6.5.1-24 summarizes the potential impacts on commodity production in counties along the Applicant's preferred route and each of the route alternatives. Overall, the impact analysis found the following potential effects on agricultural land for the Applicant's preferred route and all of the route alternatives:

- Minor and short-term impacts during construction; and
- No additional impacts during continued operations, except for the land within the footprints of the pump stations, MLVs, and permanent access roads.

These impacts on agricultural land would lead to the following potential effects on the agricultural economies of the counties that would be crossed:

- Negligible temporary impacts during construction, and
- Negligible permanent impacts during operations.

These results are based on several factors. The aggregate value of the crop production foregone during construction is relatively low when compared to the overall aggregate value of those crops produced in the counties through which the pipeline routes pass. In addition, the Applicant would compensate for deferred crop production in the construction work area.

Removal of timber resources from the construction work area represents a permanent impact but, as with crop production, the economic impact would be partially offset by the sale of merchantable timber. For forested land and timber resources, the potential impact on timber production during construction of the pipelines would be long term and minor. It would take up to 50 years for the land cleared for construction to produce harvestable timber; however, the value of the timber lost is low relative to the value of the timber that remains available for harvest in the counties that would be crossed. Continued operation of the pipelines is expected to result in permanent negligible impacts on the agricultural economy, permanent minor impacts on the timber economy, and permanent negligible impacts on land with potential mineral resources.

No land in active mining areas would be affected by construction or operations of any route option, except for a temporary facility access road for the Applicant's preferred route that would affect 0.5 acre in Carlton County (access roads would be required for all route alternatives, but none have been identified) and approximately 1 acre of the permanent right-of-way along RA-06. Although the potential for future mining based on mineral resources beneath the surface is unknown, it is expected that construction of the Applicant's preferred route and route alternatives would result in a temporary negligible impact on this land, while operations would result in a permanent negligible impact.

Beyond the finding that impacts on commodity production would be negligible to minor and temporary to permanent, the Applicant's preferred route and the route alternatives can be compared to each other based on projected impact values and differences identified among them.

When considering disturbance or loss of agricultural land from construction, the Applicant's preferred route and RA-06, RA-07, and RA-08 are in a similar lower range of acreage affected, while RA-03AM would result in a much higher value. Lost agricultural yields has a similar result; RA-03AM has a much higher yield loss, more than four times as much as any of the other routes. In this case, however, the Applicant's preferred route has a loss of yield that, while relatively small, is greater than RA-06, RA-07, and RA-08.

On the basis of disturbance and loss of forested land and associated economic yields during construction, the Applicant's preferred route affects the greatest amount of acreage and yield. All of the route alternatives were found to be in a similar range of impacts and loss of economic yield.

The comparative results for operations were similar to those for construction. For agricultural production and forestry, lower effects were predicted for RA-06, RA-07, and RA-08; and the Applicant's preferred route was at the high end of the range. The effects of RA-03AM were measurably higher.

For mining resources, the impacts for the Applicant's preferred route were significantly less than for all of the route alternatives.

6.5.1.4.2 Mitigation

The Applicant proposes several measures to minimize or avoid impacts that are discussed in the Agricultural Protection Plan (Appendix F). Beyond the Applicant-proposed measures to avoid and minimize impacts on commodity production, no mitigation has been identified.

Table 6.5.1-24. Summary of Potential Impacts on Commodity Production for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[b]	Route Alternative RA-08[b]
Construction Impacts					
Disturbance and loss of agricultural land	Short-term/minor impacts • 562 acres of agricultural land Short- to long-term/minor impacts • 1,278 acres of farmland soils	Short-term/minor impacts • 1,680 acres of agricultural land Short- to long-term/minor impacts • 1,608 acres of farmland soils	Short-term/minor impacts • 326 acres of agricultural land Short- to long-term/minor impacts • 1,241 acres of farmland soils	Short-term/minor impacts • 402 acres of agricultural land Short- to long-term/minor impacts • 1,082 acres of farmland soils	Short-term/minor impacts • 405 acres of agricultural land Short- to long-term/minor impacts • 944 acres of farmland soils
Lost agricultural land yields	Temporary/negligible impacts • $111,000 market value of crops	Temporary/negligible impacts • $481,000 market value of crops	Temporary/negligible impacts • $52,000 market value of crops	Temporary/negligible impacts • $39,000 market value of crops	Temporary/negligible impacts • $41,000 market value of crops
Disturbance and loss of forested land and timber resources	Long-term to permanent/ minor impacts • 1,446 acres of forested areas • $2.3 million market value of timber	Long-term to permanent/ minor impacts • 1,174 acres of forested areas • $1.9 million market value of timber	Long-term to permanent/ minor impacts • 1,143 acres of forested areas • $1.8 million market value of timber	Long-term/negligible impacts • 1,145 acres of forested areas • Negligible – occurs within existing right-of-way, which is cleared of trees	Long-term to permanent/ minor impacts • 809 acres of forested areas • $1.3 million market value of timber
Disturbance and loss of land used for mining	Temporary/negligible impacts • 14 acres of land with potential sand and gravel resources No impact on active mines	Temporary/negligible impacts • 444 acres of land with potential sand and gravel resources No impact on active mines	Temporary/negligible impacts • 571 acres of land with potential sand and gravel resources Temporary/minor impact • 3 acres of active mines	Temporary/negligible impacts • 562 acres of land with potential sand and gravel resources No impact on active mines	Temporary/negligible impacts • 555 acres of land with potential sand and gravel resources No impact on active mines

Table 6.5.1-24. Summary of Potential Impacts on Commodity Production for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[b]	Route Alternative RA-08[b]
Operations Impacts					
Disturbance and loss of agricultural land	Permanent/negligible impacts • 104 acres of agricultural land • 153 acres of farmland soils No additional impact on land within the permanent easement: • 252 acres of agricultural land • 559 acres of farmland soils	Permanent/negligible impacts on land within the footprint of the pump stations, MLVs, and permanent access roads. No additional impact land within the permanent easement: • 706 acres of agricultural land • 670 acres of farmland soils	Permanent/negligible impacts on land within the footprint of the pump stations, MLVs, and permanent access roads. No additional impact land within the permanent easement: • 136 acres of agricultural land • 518 acres of farmland soils	Permanent/negligible impacts on land within the footprint of the pump stations, MLVs, and permanent access roads. No additional impact land within the permanent easement: • 170 acres of agricultural land • 302 acres of farmland soils	Permanent/negligible impacts on land within the footprint of the pump stations, MLVs, and permanent access roads. No additional impact on land within the permanent easement: • 170 acres of agricultural land • 394 acres of farmland soils
Lost agricultural land yields	Permanent/negligible impacts • $64,000 market value of crops No additional lost yield on land within the permanent easement	Permanent/negligible impacts within facilities footprint No additional lost yield on land within the permanent easement	Permanent/negligible impacts within facilities footprint No additional lost yield on land within the permanent easement	Permanent/negligible impacts within facilities footprint No additional lost yield on land within the permanent easement	Permanent/negligible impacts within facilities footprint No additional lost yield on land within the permanent easement
Disturbance and loss of forested land and timber resources	Permanent/minor impacts • 631 acres of forested areas • $4.8 million market value of timber	Permanent/minor impacts • 485 acres of forested areas • $3.1 million market value of timber	Permanent/minor impacts • 476 acres of forested areas • $3.0 million market value of timber	Long-term/negligible impacts • 257 acres of forested areas • Negligible – occurs within existing right-of-way which is cleared of trees	Permanent/minor impacts • 335 acres of forested areas • $2.1 million market value of timber

Table 6.5.1-24. Summary of Potential Impacts on Commodity Production for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route[a]	Route Alternative RA-03AM[b]	Route Alternative RA-06[b]	Route Alternative RA-07[b]	Route Alternative RA-08[b]
Disturbance and loss of land used for mining	Permanent/negligible impacts • 7 acres of land with sand and gravel resources No impact on active mines	Permanent/negligible impacts • 184 acres of land with sand and gravel resources No impact on active mines	Permanent/negligible impacts • 238 acres of land with sand and gravel resources • 1 acre of active mines	Permanent/negligible impacts • 234 acres of land with sand and gravel resources No impact on active mines	Permanent/negligible impacts • 231 acres of land with sand and gravel resources No impact on active mines

[a] Enbridge-provided footprints: Construction = construction work area, Operations = operations permanent right-of-way.

[b] Construction = 120-foot-wide construction footprint (except RA-07 would be 205 feet wide), Operations = 50-foot-wide permanent right-of-way.

6.5.1.5 References

Enbridge Energy, Limited Partnership (Enbridge). 2016. Environmental Assessment Worksheet (EAW). November. Response to Data Request 01 to provide additional details for the EAW filed by Enbridge in April 2015.

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6.5.2 Recreation and Tourism

Recreational tourism dollars contribute to recreational economies. They are based on spending associated with participation in outdoor activities that take place on public lands and waters, such as parks, forests, and special management areas; state-designated land based trails; state-designated water trails and trout streams; and state- and federally designated scenic byways. Recreational activities contribute to the local economy through the influx of tourists, purchases of gear and related equipment, and trip-related spending (e.g., gas, lodging, and food).

The issues of concern related to recreation and tourism are the loss of recreation-based spending and the associated effects on the recreational economies in the counties that would be crossed. This potential loss would come from a measurable decrease in recreation-based visitation because of trail closings and access limitations during construction and operation of the Project. This section assesses the potential for construction and operation of the Applicant's preferred route and route alternatives to affect the recreation economy. Impacts on recreation and tourism that could occur during construction and operation include:

- Limitations to recreation access, and
- Changes to the recreational economy.

This section first describes the existing conditions within an area along the Applicant's preferred route and each of the route alternatives where recreation and tourism could be affected by construction or operation of the Project. The potential impacts of Project-related construction and operation on recreation and tourism are considered next. Potential impacts for each route alternative (RA-03AM, RA-06, RA-07, and RA-08) are assessed and compared to each other and to the Applicant's preferred route between Clearbrook and Carlton. A summary and comparison of the impacts are included at the end of the section. Chapter 10 addresses the potential impacts on recreation and tourism resulting an unanticipated release of crude oil.

6.5.2.1 Regulatory Context and Methodology

6.5.2.1.1 Regulatory Context

Minnesota Administrative Rules Part 7852.0700, Subpart (3) provides the criteria the Commission must consider in determining the route of a pipeline. This includes, among other things, the potential impacts of, and the methods to minimize or mitigate the potential impacts of, all proposed routes on, "the natural environment, public and designated lands, including but not limited to natural areas, wildlife habitat, water, and *recreational lands*," (emphasis added) and "economies within the route, including agricultural, commercial or industrial, forestry, *recreational*, and mining operations" (emphasis added).

6.5.2.1.2 Methodology

The ROI for the analysis of recreation and tourism impacts is twofold. It narrowly focuses on the public recreational lands and recreational waterbodies directly crossed by construction and operational areas the Applicant's preferred route and the route alternatives in order to qualitatively assess how Project-related changes would affect recreation-based visitation. It broadly includes the counties through which the Applicant's preferred route and the route alternatives pass to assess whether the Project-related changes would affect recreation-based visitation at the county-level and subsequently the local

recreation-based economy. The counties where Project related impacts would occur represent the relevant local recreational economies that are likely to be the most sensitive to Project-related actions.

The analysis was undertaken by first identifying and inventorying in GIS all public recreational lands, trails, and waterbodies in the counties crossed by the Applicant's preferred route and the route alternatives. The following construction and operations footprints were overlaid to quantify resources affected by construction and operation:

- The route and estimated footprints for the pipeline and associated facilities for the Applicant's preferred route;
- The 120-foot-wide construction footprint for RA-03AM, RA-06, and RA-08; 205-foot-wide construction footprint for RA-07; and 50-foot-wide permanent right-of-way for all route alternatives.

The geographic extent (acres) of restricted access to recreational land from the construction work areas, permanent rights-of-way, and associated aboveground facilities—in addition to the geographic extent of restricted access to recreational waterbodies, land-based trails, and scenic byways—was determined by analyzing the number of crossings and crossing methods described by the Applicant. The analysis assumed that access would be restricted to the affected resource over the entire construction work area for the duration of construction. During operations the analysis assumed that access would be restricted during operations along the permanent right-of-way for pipelines and at any associated above ground facilities.

The geographical extent of restricted access was assessed to determine potential impacts on localized recreational use and recreational economies at the county level. Current statistics on visitation to the specific recreation areas identified in this analysis and any associated recreational spending were not available; consequently, quantitative estimates of economic impacts could not be developed. However, a qualitative assessment was developed to assess the overall potential for disruption of these activities and the magnitude of the associated loss of tourism. A qualitative discussion of impacts on recreation-based tourism characterizes the direction and magnitude of potential impacts on the regional recreation/tourism economy at the county level.

Recreational land and waterbodies within the ROI for the Applicant's preferred route and route alternatives were identified using GIS datasets and layers in the following federal- and state-level data sources:

- Protected Areas Database of the United States (PAD-US),
- Minnesota DNR water trails,
- Minnesota DNR snowmobile trails,
- Minnesota DNR state-designated trails,
- Minnesota DNR hunter walking trails, and
- Minnesota state-designated trout streams.

A more detailed discussion of the methodology may be found in Section 5.3.2.1.2.

6.5.2.2 Existing Conditions

This section identifies recreational resources that could be affected by the Applicant's preferred route and route alternatives (see Section 5.3.2.2 for a full description of each resource). As previously described, changes to these resources could reduce or restrict recreational use, which could affect recreational spending at the county level. This section does not discuss current recreational use or spending at the county level because publicly available, accurate, and consistent data were not available for each of the resources discussed. For context, an estimate of the approximate acreages or total size of the resources are provided where appropriate for the Applicant's preferred route and each route alternative.

6.5.2.1.3 Applicant's Preferred Route

Section 5.3.2 describes existing conditions in Minnesota for recreational use of parks, forests, and special management areas; state-designated land-based trails; state-designated water trails and trout streams; and scenic byways. Information enabling comparison of the route alternatives to the Applicant's preferred route is provided below.

Parks, Forests, and Special Management Areas

Table 6.5.2-1 lists by county the miles and acres of parks, forests, and special management areas that would be crossed by the Applicant's preferred route. No federal or state parks in Minnesota would be crossed by the Applicant's preferred route. The Applicant's preferred route would not cross any federally owned forests but would cross approximately 32 miles of state forested land (all within the Clearbrook-to-Carlton segment) and approximately 1 mile of special management areas, which includes two WMAs (both in Aitkin County). The total amount of land used for recreational purposes in the ROI for the Applicant's preferred route (and all is within the Clearbrook-to-Carlton segment) is approximately 526 acres (including access roads, ATWS, and MLVs), compared to the total land available for recreation in the forests and WMAs that would be crossed (714,633 acres) (Table 6.5.2-1).

State-Designated Land-Based Trails

State-designated land-based trails include multi-use trails, hunter walking trails, and state-managed snowmobile trails. Minnesota has 25 state trails that were developed for multi-use purposes such as hiking, biking, horseback riding, and more. In addition, dozens of hunter walking trails are located within WMAs, and over 22,000 miles of groomed snowmobile trails are managed by Minnesota DNR.

The Applicant's preferred route would cross three state-designated multi-use trails, each located in the Clearbrook-to-Carlton segment. Two of the trails would be crossed once (Paul Bunyan State Trail in Cass County and Willard Munger State Trail in Carlton County), and a hunter walking trail in the Hill River State Forest would be crossed twice. The route would cross 0.8 mile of snowmobile/all-terrain vehicle (ATV) trails.

No state-designated multi-use trails would be crossed in the Carlton-to-Wisconsin border segment or in the North Dakota border-to-Clearbrook segment.

Table 6.5.2-1. Parks, Forests, and Special Management Areas Crossed by the Applicant's Preferred Route (Clearbrook to Carlton)

County	Name	Total Size (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)	Access Roads	ATWS	Valves	Con Total[a]	Op Total[b]
Aitkin County	Grayling Marsh WMA	9,627	1.1	14	6	--	1	--	15	6
Aitkin County	Lawler WMA	235	0.3	3	2	--	--	--	3	2
Cass County	Foot Hills State Forest	46,896	3.1	42	19	8	5	--	55	19
Aitkin County	Hill River State Forest	124,204	8.0	103	48	6	5	--	114	48
Wadena County	Huntersville State Forest	33,963	7.1	97	43	11	8	--	116	43
Cass County	Land O'Lakes State Forest	49,890	9.6	130	58	22	9	--	161	58
Hubbard County	Mississippi Headwaters State Forest	45,290	1.8	25	11	7	4	0.2	35	11
Hubbard County	Paul Bunyan State Forest	150,113	--	<0.1	<0.1	--	--	--	0	0
Aitkin County	Savanna State Forest	238,954	0.8	9	5	0	0	--	9	5
Aitkin County	Waukenabo State Forest	15,461	1.4	16	8	1	1	--	17	8
TOTAL		**714,633**	**33.2**	**439**	**199.4**	**54.6**	**32.1**	**0.2**	**526**	**200**

Source: USGS GAP 2016.

Notes:

The Applicant's preferred route would not cross parks, forests, or special management areas from the North Dakota border to Clearbrook or from Carlton to the Wisconsin border.

Acres for the construction work area and the permanent right-of-way are based on Enbridge-provided footprints for the Applicant's preferred route and a 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way used for the route alternatives.

[a] Con Total = For the Applicant's preferred route, the construction total is the sum of the Applicant-provided footprints, additional temporary workspaces (ATWS) that include pipe yards, and temporary access roads.

[b] Op Total = For the Applicant's preferred route, the operations total is the sum of the Applicant-provided pipeline permanent right-of-way, primary access roads, pump stations, and valves (where valves include valve pad and driveway).

"--" = no occurrence

WMA = Wildlife Management Area

In total, the Applicant's preferred route would cross 19 snowmobile trails within Minnesota, of which 12 trails are in the Clearbrook-to-Carlton segment. In Clearwater County, the Clearwater Blazer Trail would be crossed once; in Hubbard County, the North Country Trail and the Wadena Trail would be crossed once, and the Forest Rider Trail would be crossed six times; in Wadena County, the Wadena Trail would be crossed twice, and the Nevis Wilder Trail would be crossed once; in Cass County, the Cass County Trail would be crossed four times, and the Emily-Outing Snowbird Trail would be crossed twice; in Aitkin County, the Haypoint Trail would be crossed once, the Palisade Trail would be crossed three times, and the Tamarack Trail would be crossed four times; and in Carlton County, the Kettle Trail would be crossed once. No snowmobile trails would be crossed from Carlton to the Wisconsin border.

State-Designated Water Trails and Trout Streams

Water trails are marked routes on navigable waterways (e.g., rivers, lakes, canals, and coastlines) for people using small, non-motorized boats (e.g., kayaks, canoes, rafts, and rowboats). Minnesota has 35 state-designated canoe and boating routes totaling over 4,500 miles.

The Applicant's preferred route would cross five state-designated canoe and boating trails in Minnesota, three of which are between Clearbrook and Carlton. Two of the rivers (Crow Wing River in Wadena County and Pine River in Cass County) would be crossed once; while the Mississippi River would be crossed two times, once in Clearwater County and again in Aitkin County (see Figure 6.5.2-1). Each of the rivers that would be crossed range in length from 60 miles (Pine River) to over 500 miles (Red River of the North).

State-designated trout streams provide an important source of recreational activity to local anglers. For context, Minnesota has 687 designated trout streams, totaling 3,782 miles. In total, the Applicant's preferred route would require crossing six state-designated trout streams, all located in the Clearbrook-to-Carlton segment (King Creek and an unnamed stream in Carlton County, Straight River in Hubbard County, Spring Brook in Cass County, Blackhoof River in Carlton County, and LaSalle Creek in Hubbard County). No trout streams would be crossed outside of the Clearbrook-to-Carlton segment.

Scenic Byways

In Minnesota, 21 scenic byways (8 of which are national byways) cross several of Minnesota's finest cultural, historic, recreational, and scenic locations. In total, the Applicant's preferred route would cross one national byway (the Great River Road) twice, once in Clearwater County and again in Aitkin County; and three state-designated byways, one of which is located in the Clearwater-to-Carlton segment (Lake Country in Hubbard County) (Figure 6.5.2-2).

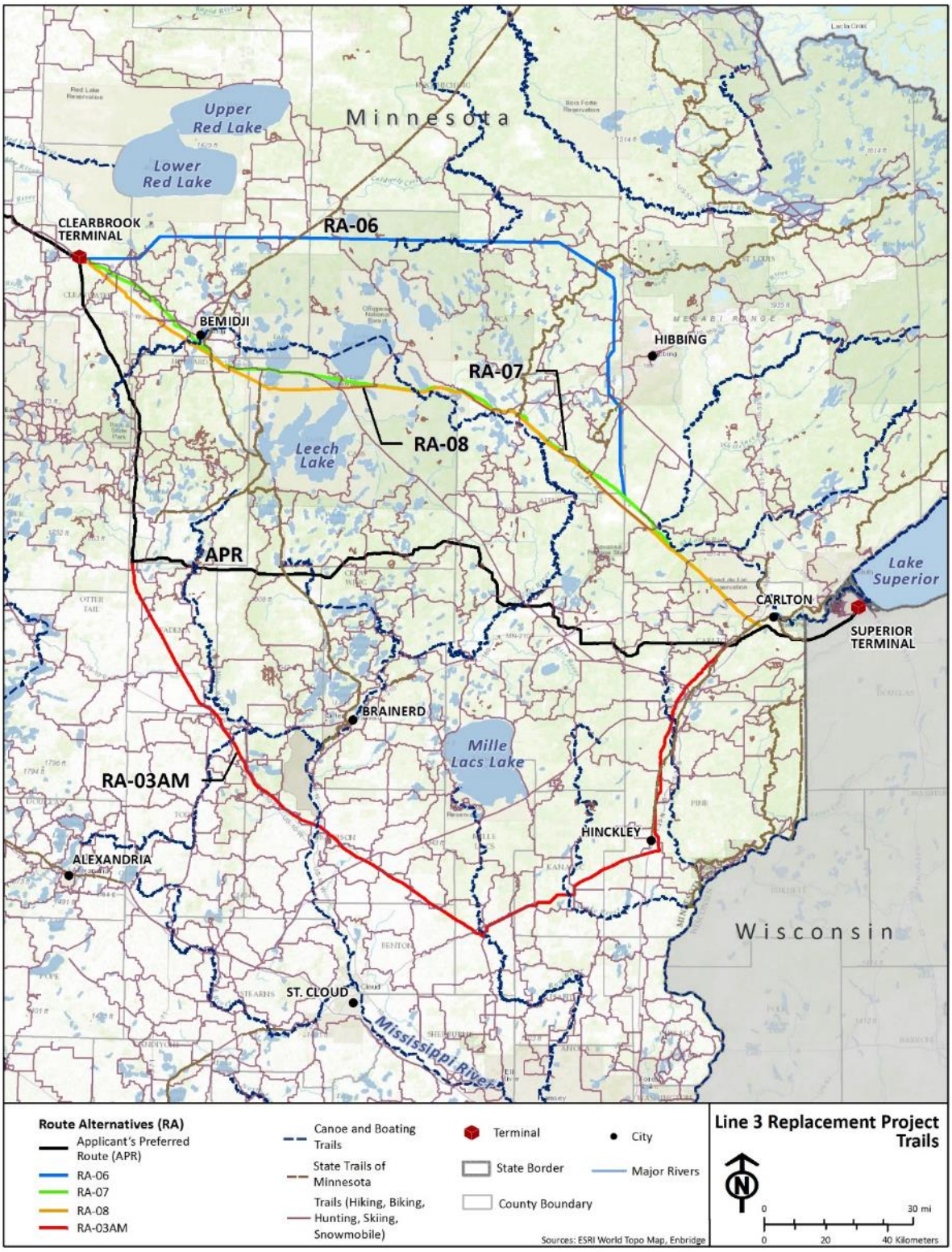

Figure 6.5.2-1. State Designated Multi-Use, Canoe, and Boating Trails Crossed by the Applicant's Preferred Route and Route Alternatives

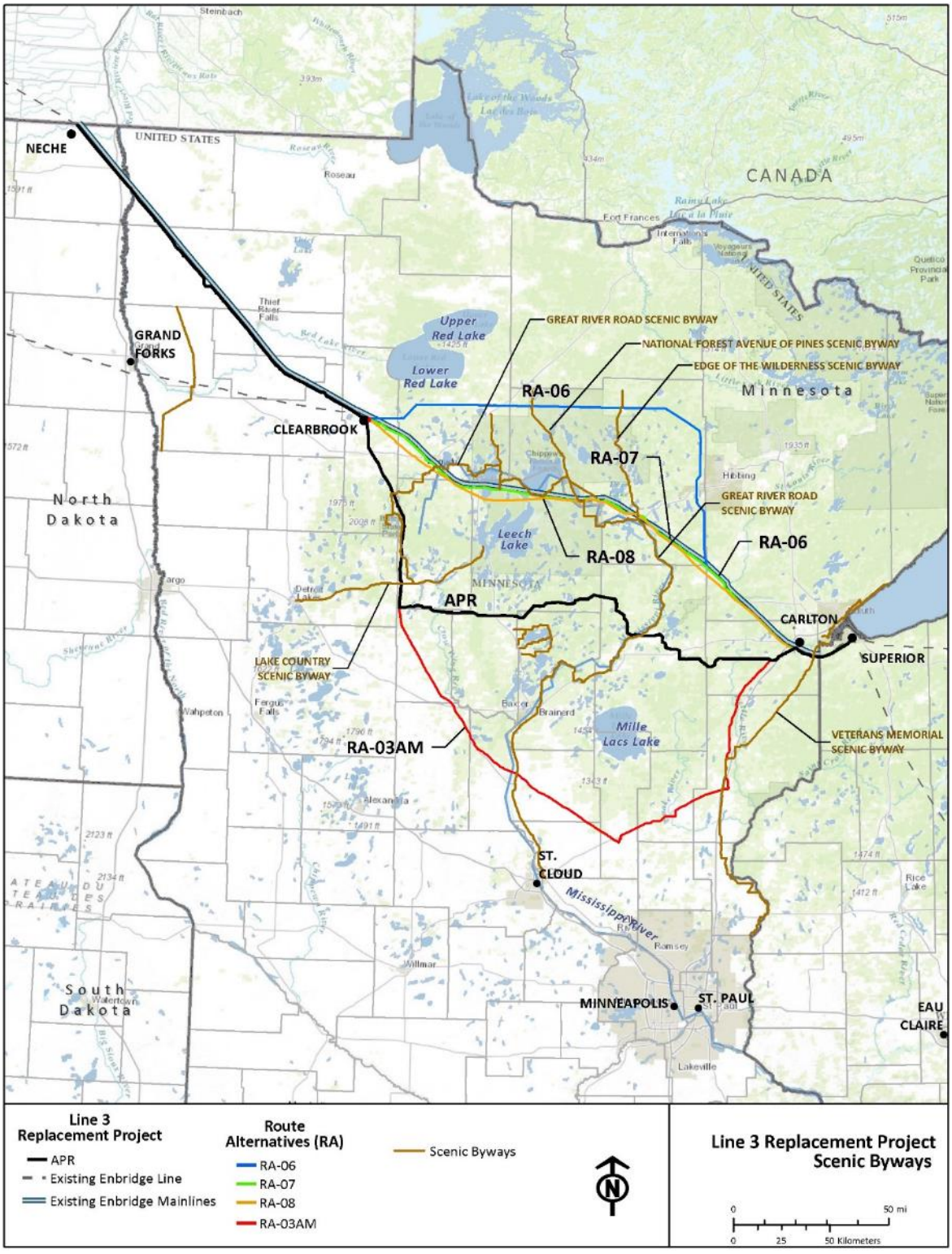

Figure 6.5.2-2. Scenic Byways Crossed by the Applicant's Preferred Route and Route Alternatives

6.5.2.1.4 Route Alternatives

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to recreation and tourism for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Parks, Forests, and Special Management Areas

No federal or state parks would be crossed by RA-03AM (Table 6.5.2-2). The route would cross approximately 5 acres of WMAs, 25 acres of NWRs, and 26 acres of state forest—all within the Mississippi Headwaters State Forest. The total amount of land used for recreational purposes in the ROI for RA-03AM within the Clearbrook-to-Carlton segment is 57 acres, compared to the total land available for recreation in the forests and WMAs that would be crossed (59,071 acres) (Table 6.5.2-2).

Table 6.5.2-2. Parks, Forests, and Special Management Areas Crossed by Route Alternative RA-03AM

County	Name	Total Area (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)
Hubbard County	Mississippi Headwaters State Forest	45,290	1.8	26	11
Morrison County	Crane Meadows National Wildlife Refuge	13,504	1.8	25	11
Morrison County	Neitermeier WMA	277	0.4	5	2
TOTAL		**59,071**	**4.0**	**57**	**24**

Source: USGS GAP 2016.

Notes:

Acres for the construction work area and the permanent right-of-way are based on a 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for RA-03AM. The specific locations of activities and facilities are not known for the route alternatives.

WMA = Wildlife Management Area

State-Designated Land-Based Trails

No hunter walking trails would be crossed by RA-03AM; however, it would cross one state-designated trail (Willard Munger State Trail) two times in Pine County and once in Carlton County (Figure 6.5.2-1). RA-03AM would cross the most snowmobile trails (16 trails/5.6 miles within the Clearbrook-to-Carlton segment).

State-Designated Water Trails and Trout Streams

RA-03AM would cross the highest number of state-designated canoe and boating trails (Kettle River in Pine County, Long Prairie River in Todd County, Mississippi River [two crossings] once in Clearwater County and again in Morrison County, Rum River in Mille Lacs County, and Snake River in Kanabec County) (Figure 6.5.2-1). RA-03AM would require the most trout stream crossings (nine crossings).

Scenic Byways

RA-03AM would require three crossings of scenic byways (Great River Road once in Clearwater County and again in Morison County, Lake Country in Hubbard County, and St. Croix in Pine County) (Figure 6.5.2-2).

Route Alternative RA-06

Parks, Forests, and Special Management Areas

No federal or state parks would be crossed by RA-06; however, it would cross through the Chippewa National Forest (Table 6.5.2-3). Furthermore, RA-06 would cross the highest amount of forest (over 59 miles), of which 54 miles, or 91 percent, is within state forests. RA-06 has the second largest land area of state forests and special management areas crossed by the route (approximately 875 acres), and the highest acreage of parks, forests, and special management areas remaining in the permanent right-of-way (approximately 365 acres). The total amount of land used for recreational purposes in the ROI for the RA-06 route within the Clearbrook-to-Carlton segment is 875 acres, compared to the total land available for recreation in the forests and WMAs that would be crossed (2,113,000 acres) (Table 6.5.2-3).

Table 6.5.2-3. Parks, Forests, and Special Management Areas Crossed by Route Alternative RA-06

County	Name	Total Land Area (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)
Cass County	Chippewa National Forest	1,600,000	5.9	86	36
Itasca County	George Washington State Forest	320,534	31.5	458	191
Itasca County	Big Fork State Forest	127,929	20.2	294	123
Carlton County	Fond du Lac State Forest	64,505	2.5	37	15
TOTAL		**2,112,968**	**60.1**	**875**	**365**

Source: USGS GAP 2016.

Notes:

Acres for the construction work area and the permanent right-of-way are based on a 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for RA-06. The specific locations of activities and facilities are not known for the route alternatives.

WMA = Wildlife Management Area

State-Designated Land-Based Trails

No hunter walking trails would be crossed by RA-06; however, it would cross the Blue Ox State Trail in Beltrami County, the Willard Munger State Trail in Carlton County, and the Taconite State Trail and Pengilly to Goodland State Trail—both located in Itasca County (Figure 6.5.2-1). The route would cross 0.7 mile of snowmobile/ATV trails.

State-Designated Water Trails and Trout Streams

RA-06 would cross one state-designated canoe and boating trail three times; would cross the Big Fork River in Itasca County (see Figure 6.5.2-1); and would require eight trout stream crossings (an unnamed creek, Clearwater River, Spring Creek, and O'Brien Creek in Beltrami County; two unnamed streams in Itasca County; and Otter Creek and an unnamed stream in Carlton County).

Scenic Byways

RA-06 would cross two byways: the National Forest Avenue of Pines Byway and the Edge of the Wilderness Byway, both in Itasca County (Figure 6.5.2-2).

Route Alternative RA-07

Parks, Forests, and Special Management Areas

No federal or state parks would be crossed by RA-07; however, it would cross through the Chippewa National Forest (Table 6.5.2-4). RA-07 would cross the greatest amount of land available for recreation (approximately 1,049 acres), primarily in the Bowstring State Forest (698 acres) in both Cass and Itasca counties. The total amount of land used for recreational purposes in the ROI for the RA-07 route within the Clearbrook-to-Carlton segment is approximately 1,049 acres, compared to the total land available for recreation in the forests and WMAs that would be crossed (2,236,364 acres) (Table 6.5.2-4).

Table 6.5.2-4. Parks, Forests, and Special Management Areas Crossed by Route Alternative RA-07

County	Name	Total Land Area (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)
Cass County	Bowstring State Forest	526,569	28.1	698	170
Carlton County	Fond du Lac State Forest	64,505	2.5	63	15
Beltrami County	Mississippi Headwaters State Forest	45,290	5.3	131	32
Cass County	Chippewa National Forest	1.6 million	6.0	157	36
TOTAL		**2,236,364**	**41.9**	**1,049**	**254**

Source: USGS GAP 2016.

Notes:

Acres for the construction work area and the permanent right-of-way are based on a 205-foot-wide construction footprint, 10 feet wide on the north side of existing Line 3 and 195 feet wide on the south side of existing Line 3and 50-foot-wide permanent right-of-way for RA-07. The specific locations of activities and facilities are not known for the route alternatives.

WMA = Wildlife Management Area

State-Designated Land-Based Trails

No hunter walking trails would be crossed by RA-07; however, RA-07 would cross the Paul Bunyan State Trail in Beltrami County, the Heartland State Trail in Cass County, and the Taconite State Trail in Itasca County (Figure 6.5.2-1). The route would cross 2.6 miles of snowmobile/ATV trails.

State-Designated Water Trails and Trout Streams

RA-07 would cross two state-designated canoe and boating trails (the Mississippi River) two times (once in Beltrami County, and again in Itasca County) and the St. Louis River in St. Louis County (Figure 6.5.2-1). The route would require six trout stream crossings (an unnamed creek and the Clearwater River in Beltrami County; the Necktie River in Hubbard County; and Otter Creek, Little Otter Creek, and an unnamed stream in Carlton County).

Scenic Byways

RA-07 would cross two byways: the Great River Road four times (once in Beltrami County and three times in Cass County) and the Edge of the Wilderness Byway in Itasca County (Figure 6.5.2-2).

Route Alternative RA-08

Parks, Forests, and Special Management Areas

No federal or state parks would be crossed by RA-08; however, it would cross through the Chippewa National Forest (Table 6.5.2-5). The total amount of land used for recreational purposes in the ROI for the RA-08 route within the Clearbrook-to-Carlton segment is approximately 663 acres, compared to the total land available for recreation in the forests and WMAs that would be crossed (2,496,073 acres) (Table 6.5.2-5).

Table 6.5.2-5. Parks, Forests, and Special Management Areas Crossed by Route Alternative RA-08

Route/ County	Name	Total Land Area (acres)	Centerline (miles)	Construction Work Area (acres)	Permanent Right-of-Way (acres)
Cass County	Chippewa National Forest	1,600,000	5.8	84	35
Beltrami County	Bemidji Slough WMA	49	0.3	4	2
Itasca County	Swan River Deer Yard WMA	909	0.5	7	3
Cass County	Bowstring State Forest	526,569	28.2	410	171
Carlton County	Fond du Lac State Forest	64,505	2.4	36	15
Beltrami County	Mississippi Headwaters State Forest	45,290	4.7	68	28
Cass Count	Welsh Lake State Forest	19,797	1.1	15	6
Aitkin County	Savanna State Forest	238,954	2.6	38	16
TOTAL		**2,496,073**	**45.6**	**663**	**276**

Source: USGS GAP 2016.

Acres for the construction work area and the permanent right-of-way are based on a 120-foot-wide construction footprint and 50-foot-wide permanent right-of-way for RA-08. The specific locations of activities and facilities are not known for the route alternatives.

WMA = Wildlife Management Area

State-Designated Land-Based Trails

No hunter walking trails would be crossed by RA-08; however, it would cross the Paul Bunyan State Trail in Beltrami County, the Heartland State Trail in Cass County, and the Taconite State Trail in Itasca County (Figure 6.5.2-1). The route would cross 2.9 miles of snowmobile/ATV trails.

State-Designated Water Trails and Trout Streams

RA-08 would cross only one state-designated canoe and boating trail (the Mississippi River) three times: once in Beltrami County, once in Cass County, and again in Itasca County (see Figure 6.5.2-1). RA-08 would require the fewest number of state-designated trout stream crossings (four crossings): the Necktie River in Beltrami County and the Little Otter Creek, Otter Creek, and an unnamed stream in Carlton County.

Scenic Byways

RA-08 would cross two byways: the Great River Road Byway twice (once in Beltrami and again in Itasca County) and the Edge of the Wilderness Byway, also in Itasca County (Figure 6.5.2-2).

6.5.2.3 Impact Assessment

6.5.2.1.5 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas

Based on a review of relevant maps and satellite imagery, most land within the construction work areas does not include developed recreational areas (i.e., areas with facilities such as parking, campsites, boat launches, and hiking trails). This is also true for the two WMAs in Aitkin County because they are primarily designated for undeveloped recreational use. Generally, the land affected by construction of the pipeline consists of open public land available for informal recreation and does not include any developed areas, with the exception of off-road trails, all-terrain vehicles trails, and snowmobile trails.

During construction, impacts on eight state forests, and two special management areas within the construction work area include removal of existing vegetation, grading, excavation, pipeline installation, and reconstruction (for trails). Access to the affected land would be limited or restricted during this time. The Applicant may need to temporarily close or restrict access to trails within state forests (both non-motorized and off road) during construction of the pipeline across any trails. Enbridge would cross trails using the bore or open-cut method. If a bore is used, no impacts on the trail would be expected. If the open-cut method is used, Enbridge would complete pipeline installation activities across trails within 48 hours.

Construction in any location would last for several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; therefore, limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. After this time period, recreational activities on the affected acres could resume as normal. Additional detail on noise and visual disturbance is provided in Sections 6.2.2 and 6.2.3, respectively.

At the county level, the majority of the land disturbed during construction (156 acres) would occur in state forests and WMAs within Aitkin County (Table 6.5.2-1). A review of forest and WMA maps revealed that the disturbed land represents a very small portion (less than 1 percent) of the total amount of land that remains available in each forest and WMA that would be crossed by the pipeline. In total, over 388,000 acres of land in the same forests and WMAs in Aitkin County would remain unaffected and available during construction. This is also true in Cass County (217 acres of 96,876 total), Wadena County (116 acres of 33,963 total) and Hubbard County (36 acres of 45,290 total). Impacts on forests and special management areas are anticipated to be temporary and minor because impacts would be confined to small portions of the total land available for recreation and any closures of these areas would be limited to during and immediately following construction.

State-Designated Land-Based Trails

Construction-related activities would temporarily affect public access and use of land-based trails where the pipeline crosses the trail for a short time during pipeline installation. The Applicant proposes to use

the bore or open-cut method at trail crossings. If the latter is used, trail use would be suspended for 48 hours during construction. After completion of pipeline installation, the Applicant would restore the trail surface to allow passage.

Based on a review of the trail route map for the Paul Bunyan and the Willard Munger state trails, the pipeline crossing would occur in areas with no designated public access or facilities. The Paul Bunyan State Trail is over 120 miles long, and the intersection would occur near the middle of the trail just south of Backus, which does not include any public access points or recreational facilities. The pipeline also crosses the Willard Munger State Trail, which is over 90 miles long. The intersection occurs just north of Mahtowa and does not include any public access points or recreational facilities. Construction-related impacts on these trails likely would result in a temporary restriction on recreational access where the pipeline crosses over during pipeline installation. Based on the overall length of the trails and alternative locations to access it, a temporary negligible impact on the recreational access of state trails is expected.

For the hunter walking trail in the Hill River State Forest, the Applicant would maintain access during the hunting season. Noise and visual disturbance may continue to affect the recreational experience in the disturbed areas during construction; however, restrictions in use would no longer be necessary. Overall, impacts on the recreational access to state-designated land-based trails are anticipated to be temporary and negligible. Impacts would be confined to the area where the pipeline crosses the trail, and any restrictions to access at these intersections would be limited to during and immediately following construction.

State-Designated Water Trails and Trout Streams

The Applicant's preferred route would cross three state-designated canoe and boating trails and six state-designated trout streams between Clearbrook and Carlton. Except for the Pine River, the canoe and boating trails would be crossed using HDD, resulting in no impacts on recreation or tourism. Public use and access to the Pine River would be interrupted temporarily at the intersection of the river and the pipeline during installation of the pipeline. After the pipeline is installed, river users would be allowed to cross the construction area. Based on a review of the trail route map, the pipeline crossing would occur near the end of the trail (on or around River Mile 45 of 59 miles), which does not include any public access points or recreational facilities. Construction-related impacts on the Pine River likely would result in a temporary restriction on recreational access where the pipeline crosses the river during pipeline installation. Based on the overall length of the Pine River (59 miles) and alternative sites to access the river, a temporary negligible impact on the overall recreational access of the Pine River is expected. Potential impacts associated with trout stream waterbody crossings are discussed in Section 5.3.2. Because impacts on these streams would be temporary and would not occur during designated trout fishing seasons, temporary negligible impacts on the recreational use of trout streams are anticipated.

Scenic Byways

The Applicant's preferred route would cross scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction of the proposed Project would not disrupt use of the byways and therefore would not limit recreational access. Impacts associated with aesthetic changes along scenic byways are discussed in Section 6.2.3.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas

Construction could disrupt the activities or alter the recreational experience of people who regularly use the affected areas for specific recreational purposes. However, these impacts would be temporary, minor, and localized and would be limited to small portions of the overall recreational site (i.e., the forest or WMA). Because the majority of the land crossed by the Applicant's preferred route does not include developed recreational areas (e.g., facilities and trails) that are more likely to attract visitors from outside of the area, it is likely that impacts would be limited to local people who live in and around the immediate area.

During construction, local recreational users could re-locate to undisturbed areas throughout each of the state forests and WMAs, given the overall size of these areas relative to the area affected by the construction footprint (439 acres of land disturbed for construction of 714,633 acres of total land available). Construction-related impacts likely would result in a temporary, negligible impact on the number of recreation-based trips people take to state forests and WMAs. Construction impacts would be temporary (several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions) and limited to areas with very little opportunities for developed recreation. In addition, recreational users have a variety of substitute or alternative sites both within the affected forest or WMA and in the county as a whole. Construction activities may limit access to the affected areas or reduce the quality of the experience. However, given the temporary nature of the activity and the opportunity to recreate in a variety of other places in the county, the loss of recreation-based visitation is not expected to be large enough to measure in terms of recreational spending at the county level. Consequently, impacts on the recreational economies in each of the counties that would be crossed would be temporary and negligible.

State-Designated Land-Based Trails

Because construction-related impacts are likely to be confined to a very short segment of the trail (on the order of 170 feet) and general access to the trail would not be restricted, the change in overall recreation-based visitation to trails at the county level would not be large enough to measurably affect the amount of recreation-based spending in the county. Subsequently, this would result in a temporary and negligible impact on the recreational economy at the county level.

State-Designated Water Trails and Trout Streams

Since only the Pine River would be affected temporarily by construction of the Applicant's preferred route where the pipeline crosses the waterbody, it is likely that construction-related impacts on the recreational use of state-designated water trails would not be large enough to measurably affect the amount of recreation-based spending at the county level. This would likely cause a temporary, negligible impact on the recreational economy.

Impacts on trout streams would not occur during designated trout fishing seasons; therefore, impacts on the recreational use of trout streams are likely to be temporary and negligible. Subsequently, temporary negligible impacts on the recreational economy at the county level could be expected.

Scenic Byways

The Applicant's preferred route would cross scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. Therefore, there would be no impacts on the recreational economy.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas

Operation of the pipeline for the Applicant's preferred route would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access to parks, forests, and special management areas; trails; and scenic byways would not be restricted or limited as a result of maintenance mowing or inspection operation. Aboveground facilities, MLVs, and permanent access roads would also not limit recreational access to parks, forests, or special management areas. Therefore, no impacts on recreational use of parks, forests, or special management areas are expected during operation of the pipeline.

State-Designated Land-Based Trails

Access and use of state-designated trails that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection activities during operation. Aboveground facilities, MLVs, and permanent access roads would not limit recreational access to state-designated land-based trails. Therefore, no impacts on recreational use of land-based trails during operation of the pipeline are expected.

State-Designated Water Trails and Trout Streams

Access and use of state-designated canoe routes and other waterbodies that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection activities during operation. Aboveground facilities, MLVs, and permanent access roads would not affect recreation use of water trails or trout streams. Therefore, no impacts on recreational use of state-designated water trails or trout streams are expected during operation of the pipeline.

Scenic Byways

Access and use of federally and state-designated scenic highways that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection activities during operation. Aboveground facilities, MLVs, and permanent access roads would not affect recreational use. Therefore, no impacts on recreational use of scenic byways are expected during operation of the pipeline.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas

Because recreational use of forests and special management areas would not be affected by the Applicant's preferred route during operations, the recreational economy in each of the counties crossed would not be affected.

State-Designated Land-Based Trails

Because recreational use of state-designated land-based trails would not be affected by the Applicant's preferred route during operations, the recreational economy in each of the counties crossed would not be affected.

State-Designated Water Trails and Trout Streams

Because recreational use of state-designated water trails and trout streams would not be affected by the Applicant's preferred route during operations, the recreational economy in each of the counties crossed would not be affected.

Scenic Byways

Because recreational use scenic byways would not be affected by the Applicant's preferred route during operations, the recreational economy in each of the counties crossed would not be affected.

6.5.2.1.6 Route Alternatives (from Clearbrook to Carlton)

The only segment where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The potential construction and operations impacts on recreational access and recreational economies for the route alternatives between Clearbrook and Carlton are described below.

Route Alternative RA-03AM

Construction Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. No federal or state parks would be crossed by RA-03AM between Clearbrook and Carlton. Unlike the other route alternatives, RA-03AM would not cross through the Chippewa National Forest. RA-03AM follows the same route as the Applicant's preferred route through the Mississippi Headwaters; therefore, the impacts on recreational access would be the same (i.e., temporary and minor). Similar to the Applicant's preferred route, the land affected by construction of the pipeline primarily consists of open public land that is available for informal recreation and does not include any developed recreational areas except for off-road trails, all-terrain vehicle trails, and snowmobile trails.

Construction in any location would last for several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; therefore, limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. After this time period, recreational activities on the affected acres could resume as normal. Details on noise and visual disturbance are provided in Sections 6.2.2 and 6.2.3, respectively.

At the county level, the majority of the land disturbed during construction (approximately 31 acres) would occur in a national wildlife refuge and WMA within Morrison County (Table 6.5.2-2). A review of maps revealed that the disturbed land represents a very small portion (less than one-half of a percent) of the total amount of land that remains available in the refuge and WMA that would be crossed by the pipeline. In total, over 13,781 acres of land within the same refuge and WMA in Morrison County would remain unaffected and available during construction. This is also true in Hubbard County (26 acres of 45,290 total). Therefore, impacts on access to forests, WMAs, and special management areas are anticipated to be temporary and minor. Impacts would be confined to small portions of the total land available for recreation, and any closures of these areas would be limited to during and immediately following construction.

State-Designated Land-Based Trails. RA-03AM would cross the most snowmobile trails (16 trails within the Clearbrook-to-Carlton segment). It also would cross the Willard Munger State Trail two times. In

total, approximately 9 miles of the trail would be temporarily affected during construction, of 90 total miles of the trail. If bore or HDD crossing methods are used for crossings, no impacts on trails are expected. If the open-cut method is used, Enbridge would complete pipeline installation activities across trails within 48 hours and then would restore the trail surface to allow passage. Noise and visual disturbance may continue to affect the recreational trail experience in disturbed areas during construction; however, restrictions to access would no longer be necessary. Overall, impacts on state-designated land-based trails are anticipated to be temporary and negligible. Impacts would be confined to the area where the pipeline crosses the trail, and any restrictions to access at these intersections would be limited to during and immediately following construction.

State-Designated Water Trails and Trout Streams. RA-03AM would cross the highest number of state-designated canoe and boating trails (Kettle River in Pine County; Long Prairie River in Todd County; Mississippi River [two crossings], once in Clearwater County and again in Morrison County; Rum River in Mille Lacs County; and Snake River in Kanabec County). Canoe and boating trails crossed using HDD would not affect recreational access. Public use and access to the state water trails would be interrupted temporarily where the pipeline intersects the river during installation of the pipeline, resulting in a temporary negligible impact on the overall recreational use of the water trails.

Depending on the crossing method, impacts on trout streams are likely to be the same as those described for the Applicant's preferred route. The Applicant has proposed no in-channel work during peak trout season in each waterbody. Because impacts on these streams would be temporary, and assuming that construction would not occur during designated trout fishing seasons, temporary negligible impacts on the recreational use of trout streams are anticipated during construction of RA-03AM.

Scenic Byways. Three scenic byways crossings would be required during construction of RA-03AM. Assuming that bore or HDD is used for these three crossings to avoid road closures and any direct impacts on the roads, construction activities would not affect the recreational access of the byways. Impacts associated with aesthetic changes along scenic byways are discussed in Section 6.2.3.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. During construction for RA-03AM, local recreational users could re-locate to undisturbed areas throughout each of the affected resources, given the overall size of these areas relative to the area affected by the construction footprint (57 acres of land disturbed for construction of 59,071 acres of total land available) (Table 6.5.2-2). Given the temporary nature of the construction activity and the opportunity to recreate in a variety of other places in the county, a loss of recreation-based visitation is not expected to be large enough to measure in terms of recreation spending at the county level. Little to no net change in recreation-based trips would be expected at the county level, resulting in a temporary negligible impact on the recreational economies in each of the counties that would be crossed.

State-Designated Land-Based Trails. Since construction-related impacts for RA-03AM would be confined to specific segments of trails and general access to trails would not be limited, the change in overall recreation-based visitation to trails level would not be large enough to measurably affect the amount of recreation-based spending in the counties crossed. Subsequently, this would result in a temporary and negligible impact on the recreational economy at the county level.

State-Designated Water Trails and Trout Streams. Because of the limited number of crossings with associated impacts for RA-03AM and the temporary nature of the impacts, it is likely that construction-related impacts on the recreational use of state-designated water trails would not be large enough to measurably affect the amount of recreation-based spending at the county level, resulting in a temporary negligible impact on the recreational economy.

Impacts on trout streams would not occur during designated trout fishing seasons; therefore, temporary negligible impacts on the recreational use of trout streams are expected. Subsequently, temporary negligible impacts on the recreational economy at the county level could be expected.

Scenic Byways. The Applicant would cross each of the scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction for RA-03AM would not affect the recreational economy of the counties crossed.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. Operation of the RA-03AM pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access to parks, forests, and special management areas would not be restricted or limited as a result of maintenance mowing and inspection operation. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of parks, forests, or special management areas during operation of the pipeline are expected.

State-Designated Land-Based Trails. Access and use of state-designated trails that would be crossed by RA-03AM would not be affected during maintenance mowing and inspection operation activities. Aboveground facilities, MLVs, and permanent access roads would not affect recreation use. Therefore, no impacts on recreational use of land-based trails are expected.

State-Designated Water Trails and Trout Streams. Access and use of state-designated canoe routes and other waterbodies that would be crossed by RA-03AM would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of state designated water trails or trout streams are expected.

Scenic Byways. Access and use of federally and state-designated scenic highways that would be crossed by RA-03AM would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of scenic byways are expected.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. Because recreational use of forests and special management areas would not be affected during operations for RA-03AM, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Land-Based Trails. Because recreational use of land-based trails would not be affected during operations for RA-03AM, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Water Trails and Trout Streams. Because recreational use of state-designated water trails and trout streams would not be affected during operations for RA-03AM, the recreational economy in each of the affected counties crossed would not be affected by pipeline operations.

Scenic Byways. Because recreational use of scenic byways would not be affected during operation of RA-03AM, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

Route Alternative RA-06

Construction Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. RA-06 would cross the Chippewa National Forest, George Washington State Forest, Big Fork State Forest, and Fond du Lac State Forest. RA-06 also crosses two lakes, one of which has a public campground. Therefore, it is likely that construction-related impacts could cause a temporary, minor impact on the recreational use of these areas near the route.

Construction in any location would last for several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; therefore, limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. After this time period, recreational activities on the affected acres could resume as normal. Details on noise and visual disturbance are provided in Sections 6.2.2 and 6.2.3, respectively.

At the county level, the majority of the land disturbed during construction (753 acres) would occur in state forests within Itasca County (Table 6.5.2-3). Based on a review of forest and WMA maps, the disturbed land represents a very small portion (less than one-half of a percent) of the total amount of land that remains available in each forest that would be crossed by the pipeline. In total, approximately 447,000 acres of land within the same forests in Itasca County would remain unaffected and available during construction. This is also true in Cass County (86 acres of 1.6 million total), and Carlton County (37 acres of 64,505 total). Impacts on access to forests are anticipated to be temporary and minor because impacts would be confined to small portions of the total land available for recreation, and any closures of these areas would be limited to during and immediately following construction.

State-Designated Land-Based Trails. RA-06 would cross the Blue Ox State Trail in Beltrami County; the Willard Munger State Trail in Carlton County; and the Taconite State Trail and Pengilly to Goodland State Trail, both located in Itasca County. RA-06 would cross the Willard Munger State Trail two times in Pine County and once in Carlton County. Construction-related activities would temporarily affect public access and use of the trail where it intersects the pipeline for a short time during pipeline installation. The Applicant has proposed to use the bore or open-cut method at trail crossings. If the latter is used, trail use would be suspended for 48 hours during construction and then the trail surface would be restored to allow passage. Noise and visual disturbance may continue to affect the recreational experience in the affected areas during construction; however, restrictions in use would no longer be necessary. Overall, impacts on recreational access to state-designated land-based trails are anticipated

to be temporary and negligible because impacts would be confined to the area where the pipeline crosses the trail, and any restricted access at these intersections would be limited to during and immediately following construction.

State-Designated Water Trails and Trout Streams. RA-06 would cross one state-designated canoe and boating trail, the Big Fork River in Itasca County, three times. Canoe and boating trails crossed using HDD would not affect recreation or tourism. Public use and access to the state water trail would be interrupted where the pipeline intersects the river temporarily during installation of the pipeline, resulting in a temporary negligible impact on the overall recreational use of the trail.

Depending on the crossing method, impacts on trout streams are likely to be the same as those described for the Applicant's preferred route. The Applicant has proposed no in-channel work during peak trout season in each waterbody. Because impacts on these streams would be temporary, and assuming that construction would not occur during designated trout fishing seasons, temporary negligible impacts on the recreational use of trout streams are anticipated during construction of RA-06.

Scenic Byways. Three scenic byways crossings would be required during construction of RA-06. Assuming that bore or HDD is used for these three crossings to avoid road closures and any direct impacts on the roads, construction activities would not affect recreational access to the byways. Impacts associated with aesthetic changes along scenic byways are discussed in Section 6.2.3.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. During construction for RA-06, local recreational users could re-locate to undisturbed areas throughout each of the affected resources, given the overall size of these areas relative to the area affected by the construction footprint (60 acres of land disturbed for construction of approximately 2.1 million acres of total land available) (Table 6.5.2-3). Given the temporary nature of the construction activity and the opportunity to recreate in a variety of other places with the county, the loss of recreation-based visitation at the county level is not expected to be large enough to measure in terms of recreation-based spending at the county level. Therefore, a temporary negligible impact on the recreational economies in each of the counties crossed would result.

State-Designated Land-Based Trails. Because construction-related impacts for RA-06 would be confined to specific segments of trails and general access to trails would not be limited, the change in overall recreation-based visitation to trails at the county level would not be large enough to measurably affect the amount of recreation-based spending at the county level. Subsequently, this would result in a temporary and negligible impact on the recreational economy at the county level.

State-Designated Water Trails and Trout Streams. Because of the limited number of crossings with associated impacts and the temporary nature of the impacts for RA-06, it is likely that construction-related impacts on the recreational use of state-designated water trails would not be large enough to measurably affect the amount of recreation-based spending at the county level, resulting in a temporary negligible impact on the recreational economy.

Impacts on trout streams would not occur during designated trout fishing seasons; therefore, temporary negligible impacts on the recreational use of trout streams are likely. Subsequently, temporary negligible impacts on the recreational economy at the county level could be expected.

Scenic Byways. The Applicant would cross each of the scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction would not affect the recreational economy of the affected counties.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. Operation of the RA-06 pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access to parks, forests, and special management areas would not be restricted or limited as a result of maintenance mowing and inspection operation. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of parks, forests, or special management areas during operation of the pipeline are expected.

State-Designated Land-Based Trails. Access and use of state-designated trails that would be crossed by RA-06 would not be affected during maintenance mowing and inspection operation activities. Aboveground facilities, MLVs, and permanent access roads would not affect recreation use. Therefore, no impacts on recreational use of land-based trails are expected.

State-Designated Water Trails and Trout Streams. Access and use of state-designated canoe routes and other waterbodies that would be crossed by RA-06 would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of state-designated water trails or trout streams are expected.

Scenic Byways. Access and use of federally and state-designated scenic highways that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of scenic byways are expected.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. Because recreational use of forests and special management areas would not be affected during operations for RA-06, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Land-Based Trails. Because recreational use of land-based trails would not be affected during operations for RA-06, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Water Trails and Trout Streams. Because recreational use of state-designated water trails and trout streams would not be affected during operations for RA-06, the recreational economy in each of the affected counties crossed would not be affected by pipeline operations.

Scenic Byways. Because recreational use of scenic byways would not be affected during operation of RA-06, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

Route Alternative RA-07

Construction Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. RA-07 would require the largest acreage for construction work area in state and national forests (1,049 acres), and could temporarily affect the recreational use of two lakes, as well as general recreation that occurs on less developed land in the Bowstring State Forest.

Construction in any location would last for several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; therefore, limited use, access restrictions, and noise and visual disturbance could occur during this timeframe. After this time period, recreational activities on the affected acres could resume as normal. Details on noise and visual disturbance are provided in Sections 6.2.2 and 6.2.3, respectively.

At the county level, the majority of the land disturbed during construction (855 acres) would occur in forests within Cass County (Table 6.5.2-4). However, a review of forest and WMA maps revealed that the disturbed land represents a very small portion (less than one half of a percent) of the total amount of land that remains available in each forest that would be crossed by the pipeline. In total, there are over 2.1 million acres of land within the same forests in Cass County that would remain unaffected and available during construction. This is also true in Beltrami County (131 acres out of 45,290 total), and Carlton County (63 acres out of 64,505 total). Impacts on access to forests are anticipated to be temporary and minor because impacts would be confined to small portions of the total land available for recreation, and any closures of these areas would be limited to during and immediately following construction.

State-Designated Land-Based Trails. RA-07 would cross the Paul Bunyan State Trail in Beltrami County, the Heartland State Trail in Cass County, and the Taconite State Trail in Itasca County. Construction-related activities would temporarily affect public access and use of the trail where the trail intersects the pipeline for a short time during pipeline installation. The Applicant has proposed to use the bore or open-cut method at trail crossings. If the latter is used, trail use would be suspended for 48 hours during construction and then the trail surface would be restored to allow passage. Noise and visual disturbance may continue to affect the recreational experience in the affected areas during construction; however, restrictions in use would no longer be necessary. Overall, impacts on recreational access to state-designated land-based trails are anticipated to be temporary and negligible because impacts would be confined to the area where the pipeline crosses the trail, and any restricted access at these intersections would be limited to during and immediately following construction.

State-Designated Water Trails and Trout Streams. RA-07 would cross one state-designated canoe and boating trail (the Mississippi River) two times. Canoe and boating trails crossed using HDD would not affect recreational access. Public use and access to the state water trail would be interrupted temporarily where the pipeline crosses the river during installation of the pipeline, resulting in a temporary negligible impact on the overall recreational use of the trail.

Depending on the crossing method, impacts on trout streams are likely to be the same as those described for the Applicant's preferred route. The Applicant has proposed no in-channel work during peak trout season in each waterbody. Because impacts on these streams would be temporary, and

assuming that construction would not occur during designated trout fishing seasons, temporary negligible impacts on the recreational use of trout streams are anticipated during construction of RA-07.

Scenic Byways. Three scenic byways crossings would be required during construction of RA-07. Assuming that bore or HDD is used for these three crossings to avoid road closures and any direct impacts on the roads, construction activities would not affect recreational access to the byways. Impacts associated with aesthetic changes along scenic byways are discussed in Section 6.2.3.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. During construction, local recreational users could re-locate to undisturbed areas throughout each of the affected resources, given the overall size of these areas relative to the area affected by the construction footprint (1,049 acres of land disturbed for construction of approximately 2.2 million acres of total land available) (Table 6.5.2-4). Because of the temporary nature of the construction activity and the opportunity to recreate in a variety of other places in the county, the loss of recreation-based visitation would not be large enough to measure in terms of recreation-based spending at the county level. Therefore, construction of RA-07 would result in a temporary negligible impact on the recreational economy in each of the counties crossed.

State-Designated Land-Based Trails. Because construction-related impacts would be confined to specific segments of trails and general access to trails would not be limited, the change in overall recreation-based visitation to trails at the county level would not be large enough to measurably affect the amount of recreation-based spending at the county level. Subsequently, this would result in a temporary negligible impact on the recreational economy at the county level.

State-Designated Water Trails and Trout Streams. Because of the limited number of crossings with associated impacts for RA-07 and the temporary nature of the impacts, it is likely that construction-related impacts on the recreational use of state-designated water trails would not be large enough to measurably affect the amount of recreation-based spending at the county level, resulting in a temporary negligible impact on the recreational economy.

Impacts on trout streams would not occur during designated trout fishing seasons; therefore, temporary negligible impacts on the recreational use of trout streams are expected. Subsequently, temporary negligible impacts on the recreational economy at the county level could be expected.

Scenic Byways. The Applicant would cross each of the scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction would not affect the recreational economy of the counties crossed.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. Operation of the RA-07 pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access to parks, forests, and special management areas would not be restricted or limited as a result of maintenance mowing and inspection operation. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of parks, forests, or special management areas during operation of the pipeline are expected.

State-Designated Land-Based Trails. Access and use of state-designated trails that would be crossed by RA-07 would not be affected during maintenance mowing and inspection operation activities. Aboveground facilities, MLVs, and permanent access roads would not affect recreation use. Therefore, no impacts on recreational use of land-based trails are expected.

State-Designated Water Trails and Trout Streams. Access and use of state-designated canoe routes and other waterbodies that would be crossed by RA-07 would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of state designated water trails and trout streams are expected.

Scenic Byways. Access and use of federally and state-designated scenic highways that would be crossed by the Applicant's preferred route would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of scenic byways are expected.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. Because recreational use of forests and special management areas would not be affected during operations for RA-07, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Land-Based Trails. Because recreational use of land-based trails would not be affected during operations for RA-07, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Water Trails and Trout Streams. Because recreational use of state-designated water trails and trout streams would not be affected during operations for RA-07, the recreational economy in each of the affected counties crossed would not be affected by pipeline operations.

Scenic Byways. Because recreational use of scenic byways would not be affected during operation of RA-07, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

Route Alternative RA-08

Construction Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. RA-08 could temporarily affect the recreational use of two lakes, as well as general recreation that occurs on less developed land in the Bowstring State Forest. The route also crosses through the Chippewa National Forest, as well as six other state forests. It is likely that construction-related impacts could cause a temporary minor impact on the recreational use of these areas along RA-08.

Construction in any location would last for several days to several weeks depending on a variety of factors such as land use type, topography, weather, and other environmental conditions; therefore, limited use, access restrictions, and noise and visual disturbance could occur during this timeframe.

After this time period, recreational activities on the affected acres could resume as normal. Details on noise and visual disturbance are provided in Sections 6.2.2 and 6.2.3, respectively.

At the county level, the majority of the land disturbed during construction (510 acres) would occur in forests within Cass County (Table 6.5.2-5). A review of forest and WMA maps revealed that the disturbed land represents a very small portion (less than one-half of a percent) of the total amount of land that remains available in each forest that would be crossed by the pipeline. In total, over 2.1 million acres of land within the same forests in Cass County would remain unaffected and available during construction. This is also true in Beltrami County (72 acres of 45,339 total), Aitkin County (38 acres of 238,954 total), Itasca County (7 acres of 909 total) and Carlton County (36 acres of 64,505 total). Impacts on access to forests are anticipated to be temporary and minor because impacts would be confined to small portions of the total land available for recreation, and any closures of these areas would be limited to during and immediately following construction.

State-Designated Land-Based Trails. RA-08 would cross the Paul Bunyan State Trail in Beltrami County, the Heartland State Trail in Cass County, and the Taconite State Trail in Itasca County. Construction-related activities would temporarily affect public access and use of the trail for a short time during pipeline installation. The Applicant has proposed to use the bore or open-cut method at trail crossings. If the latter is used, trail use would be suspended for 48 hours during construction and then the trail surface would be restored to allow passage. Noise and visual disturbance may continue to affect the recreational experience in the affected areas during construction; however, restrictions in use would no longer be necessary. Overall, impacts on recreational access to state-designated land-based trails are anticipated to be temporary and negligible because impacts would be confined to the area where the pipeline crosses the trail, and any restricted access at these intersections would be limited to during and immediately following construction.

State-Designated Water Trails and Trout Streams. RA-08 would cross one state-designated canoe and boating trail (the Mississippi River) three times. Canoe and boating trails crossed using HDD would not affect recreational access. Public use and access to the state water trail would be interrupted temporarily where the pipeline intersects the trail during installation of the pipeline, resulting in a temporary negligible impact on the overall recreational use of the trail.

Depending on the crossing method, impacts on trout streams are likely to be the same as those described for the Applicant's preferred route. The Applicant has proposed no in-channel work during peak trout season in each waterbody. Because impacts on these streams would be temporary, and assuming that construction would not occur during designated trout fishing seasons, temporary negligible impacts on the recreational use of trout streams are anticipated during construction of RA-08.

Scenic Byways. Three scenic byways crossings would be required during construction of RA-08. Assuming that bore or HDD is used for these three crossings to avoid road closures and any direct impacts on the roads, construction activities would not disrupt use of the byways. Impacts associated with aesthetic changes along scenic byways are discussed in Section 6.2.3.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. During construction of RA-08, local recreational users could re-locate to undisturbed areas throughout each of the affected resources, given the overall size of these areas relative to the area affected by the construction footprint (663 acres of land disturbed for construction of approximately 2.5 million acres of total land available) (Table 6.5.2-5). Given the

temporary nature of the construction activity and the opportunity to recreate in a variety of other places with the county, the loss of recreation-based visitation at the county level is not expected to be large enough to measure in terms of tourism dollars. There would likely be little to no net change in recreation-based trips at the county level, which would result in a temporary negligible impact on the recreational economy in each of the counties crossed.

State-Designated Land-Based Trails. Because construction-related impacts for RA-08 would be confined to specific segments of trails and general access to trails would not be limited, the change in overall recreation-based visitation to trails at the county level would not be large enough to measurably affect the amount of recreation-based spending at the county level. Subsequently, this would result in a temporary negligible impact on the recreational economy at the county level.

State-Designated Water Trails and Trout Streams. Because of the limited number of crossings with associated impacts for RA-08 and the temporary nature of the impacts, it is likely that construction-related impacts on the recreational use of state-designated water trails would not be large enough to measurably affect the amount of recreation-based spending at the county level, resulting in a temporary negligible impact on the recreational economy.

Impacts on trout streams would not occur during designated trout fishing seasons; therefore, temporary negligible impacts on the recreational use of trout streams are expected. Subsequently, temporary negligible impacts on the recreational economy at the county level could be expected.

Scenic Byways. The Applicant would cross each of the scenic byways using a bore or HDD, which would avoid road closures and any direct impacts on the roads. As a result, construction would not affect the recreational economy of the counties crossed.

Operations Impacts

Limitations to Recreation Access

Parks, Forests, and Special Management Areas. Operation of the RA-08 pipeline would involve periodic inspection, pipeline maintenance activities, and mowing to maintain appropriate vegetation. Access to parks, forests, and special management areas would not be restricted or limited as a result of maintenance mowing and inspection operation. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of parks, forests, or special management areas during operation of the pipeline are expected.

State-Designated Land-Based Trails. Access and use of state-designated trails that would be crossed by RA-08 would not be affected during maintenance mowing and inspection operation activities. Aboveground facilities, MLVs, and permanent access roads would not affect recreation use. Therefore, no impacts on recreational use of land-based trails are expected.

State-Designated Water Trails and Trout Streams. Access and use of state-designated canoe routes and other waterbodies that would be crossed by RA-08 would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of state designated water trails and trout streams are expected.

Scenic Byways. Access and use of federally and state-designated scenic highways that would be crossed by RA-08 would not be affected during maintenance mowing and inspection operation activities. Although the exact location of aboveground facilities, MLVs, and permanent access roads is unknown, it is unlikely that they would limit recreational access. Therefore, no impacts on recreational use of scenic byways are expected.

Changes to the Recreational Economy

Parks, Forests, and Special Management Areas. Because recreational use of forests and special management areas would not be affected during operations for RA-08, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Land-Based Trails. Because recreational use of land-based trails would not be affected during operations for RA-08, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

State-Designated Water Trails and Trout Streams. Because recreational use of state-designated water trails and trout streams would not be affected during operations for RA-08, the recreational economy in each of the affected counties crossed would not be affected by pipeline operations.

Scenic Byways. Because recreational use of scenic byways would not be affected during operation of RA-08, the recreational economy in each of the counties crossed would not be affected by pipeline operations.

6.5.2.4 Summary and Mitigation

6.5.2.4.1 Summary

Table 6.5.2-6 presents the potential impacts from construction and operation of the Applicant's preferred route and the route alternatives on access to recreational resources and subsequent impacts on recreational economies at the county level. The results show that impacts on access to recreational resources for the Applicant's preferred route and all of the route alternatives would range from no impact to negligible or minor temporary impacts for construction and no impacts during operations. Similarly, potential effects on recreational spending and the regional economies of the counties through which the routes pass were found to be temporary and negligible or no impact during construction and nonexistent during operations.

The low level of impact occurs primarily for two reasons. The routes through forests and special management areas do not intersect any developed recreational sites; therefore, the only limited access to the forest or managed area would be at the actual construction work site. This limitation represents a small portion (less than one-half of a percent) of the overall land designated for recreational use in most affected areas. At linear recreation resources (e.g., waterways and trails), only a short portion of the waterway or trail would be restricted from temporary use where the pipeline crosses the trail, and the restriction would be limited to the short construction period.

Although the Applicant's preferred route and all of the route alternatives would experience negligible or no impacts, the geographic extent of the affected area within recreational lands differs among the route options. RA-07 would affect the greatest amount of land available for recreation in forests or special management areas (1,049 acres), while RA-03AM would affect the least (57 acres). The Applicant's preferred route would affect 439 acres.

Except for RA-03AM, all proposed routes each would cross three state-designated multi-use trails; RA-03AM would cross only one (three times). None of the route alternatives would cross hunter walking trails, but the Applicant's preferred route would cross one trail two times. RA-03AM would cross the most amount of snowmobile trails (16), whereas the Applicant's preferred route would cross the least (12). RA-03AM would cross the most amount of state-designated water trails (six). RA-06, RA-07, and RA-08 each would cross one water trail multiple times. RA-03AM would cross the most trout streams (nine), whereas RA-08 would cross the fewest (four); and the Applicant's preferred route would cross six. Based on the crossing methods proposed by the Applicant and the limited number of crossings, impacts on the recreational use of these trails and waterbodies are likely to be temporary and negligible. Although the crossing methods have not been identified for the route alternatives, construction impacts in recreation areas would be similar to those described for the Applicant's preferred route (negligible), with a corresponding negligible impact on the recreational economies of the counties crossed. Construction-related impacts are not expected to result in a measurable impact on overall visitation to trails and waterbodies at the county level, thereby resulting in a negligible impact on the amount of recreation-based spending at the county level.

Construction methods proposed by the Applicant for the Applicant's preferred route and route alternatives would not disrupt use of scenic byways and therefore would not affect their users or the recreational economies of the counties crossed. Operation of the pipeline would not cause additional impacts on land-based trails, water trails, trout streams, or byways and consequently would not affect the recreational economies in the counties crossed. For all alternatives, no impacts on recreational use or the recreational economy in the counties crossed would occur during operations.

6.5.2.4.2 Mitigation

Based on the limited impacts and implementation of Applicant-proposed measures to reduce impacts on recreation use, no mitigation measures have been identified to further reduce potential impacts on recreational access or economies.

Table 6.5.2-6. Summary of Potential Impacts on Recreation and Tourism for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Limited recreation access to parks, forests and special management areas during construction	Temporary/minor impacts • 439 acres	Temporary/minor impacts • 57 acres	Temporary/minor impacts • 875 acres	Temporary/minor impacts • 1,049 acres	Temporary/minor impacts • 663 acres
Limited recreation access to state-designated trails and trout streams during construction	Temporary/negligible impacts • 0.8 mile of snowmobile/ATV trail crossings • 4 land trail crossings • 1 water trail crossing • 6 trout stream crossings No impact due to crossing methods • 4 water trails	Temporary/negligible impacts • 5.6 miles of snowmobile/ATV trail crossings • 3 land trail crossings • 6 water trail crossings • 9 trout stream crossings	Temporary/negligible impacts • 0.7 mile of snowmobile/ATV trail crossings • 4 land trail crossings • 1 water trail crossing • 8 trout stream crossings	Temporary/negligible impacts • 2.6 miles of snowmobile/ATV trail crossings • 3 land trail crossings • 3 water trail crossings • 6 trout stream crossings	Temporary/negligible impacts • 2.9 miles of snowmobile/ATV trail crossings • 3 land trail crossings • 3 water trail crossings • 4 trout stream crossings
Limited recreation access to scenic byways	No impact	No impact *(assuming bore or HDD crossing method used)*	No impact *(assuming bore or HDD crossing method used)*	No impact *(assuming bore or HDD crossing method used)*	No impact *(assuming bore or HDD crossing method used)*
Changes to the recreational economy during construction	Temporary/no impact to negligible impacts	Temporary/ no impact to negligible impacts	Temporary/ no impact to negligible impacts	Temporary/ no impact to negligible impacts	Temporary/ no impact to negligible impacts
Operations Impacts					
Limitations to recreation access and changes to the recreational economy during operations	No impact	No impact	No impact	No impact	No impact

6.5.2.5 References

U.S. Geological Survey, Gap Analysis Program (USGS GAP). 2016. Protected Areas Database of the United States (PAD-US). Version 1.4 Combined Feature Class. May.

6.5.3 Population

Population in the vicinity of the Applicant's preferred route and route alternatives may be affected by construction and operation of new facilities. The population analysis focuses on how populations may be affected by the direct increase in Project-related workers. It does not consider indirect population changes from increased local economic activities. Such indirect changes in growth are expected to be limited because the Project-related workforce is transitory. The analysis of effects on local populations includes changes in local workforces and disruption to local populations by the following potential impacts:

- Increases in local workforces from the influx of non-local workers temporarily or permanently moving to an area to support construction or operations. Changes in workforce population may affect demand on emergency services, increase traffic congestion from commuting, and the availability of housing.
- Disruptions to high-population areas and other populated areas in proximity to construction work areas from noise, dust, and vibrations from construction and operations equipment; disruptions to traffic and services such as water and gas during construction, and permanent displacement of residences and structures during operations.

Potential impacts on populations from pipeline crude oil releases are discussed in Chapter 10.

This section first describes the existing populations along the Applicant's preferred route and the route alternatives within an area where populations would be most directly affected by construction and operation of the pipeline (the ROI). The potential Project-related impacts of construction and operation on those populations are considered next. Potential impacts for each route alternative (RA-03AM, RA-06, RA-07, and RA-08) also are assessed and then compared to each other and to the Applicant's preferred route between Clearbrook and Carlton. A summary and comparison of the impacts are included at the end of the section.

6.5.3.1 Regulatory Context and Methodology

6.5.3.1.1 Regulatory Context

In Minnesota, the Commission must consider the existence and density of populated areas when routing a crude oil pipeline in the state (Minn. R. 7852.1900, Subp. 3[a]). No specific standards related to the proximity of populated areas to pipeline facilities were identified other than compliance with local planning and zoning ordinances. See Section 6.2.1 for a discussion of planning and zoning.

6.5.3.1.2 Methodology

The analysis for impacts on population is broken into two components: impacts associated with the non-local workforce re-locating to communities near the Project, and impacts associated with construction and operation of the pipeline near densely populated areas.

The additional pipeline workforce may affect communities during construction or operation if existing infrastructure and services are not adequate. Additionally, routing a pipeline through population centers or areas of higher population density is difficult because these areas have more infrastructure in place such as roads, structures, and utilities. A greater number of people potentially would be affected by noise, dust, population increase, and traffic during construction in these areas, which may increase the

magnitude and duration of impacts compared to less populated areas. Associated impacts related to planning and zoning, noise, housing, transportation, and air quality are evaluated in Sections 6.2.1, 6.2.2, 6.2.4, 6.2.5, and 6.3.7, respectively.

Non-Local Workforce

Net change to local populations from worker influx were assessed by:

- Gathering current population statistics from the U.S. Census Bureau for the counties that would be crossed by the Applicant's preferred route and the route alternatives;
- Estimating the total population increase that could result from workers moving to the counties with their families;
- Identifying the areas where the total population increase in a county could be 10 percent or more, and the expected impacts of the increase; and
- Qualitatively assessing impacts related to population increases based on the percent and duration of the change.

The ROI for assessment of non-local workforce effects is the counties that are crossed by the Applicant's preferred route and the route alternatives. County-level data provide a summary of populations potentially affected by the influx of the construction workforce. Workers re-locating to the area would commute to work from various communities near, but not necessarily along, the pipeline route. The counties crossed by the pipeline reflect a reasonable estimate for where the workers are likely to re-locate and the level of current population that would be affected.

Populated Areas

Impacts on high-population areas and other populated areas that may occur from construction and operation of the Project were assessed by:

- Overlaying the Applicant's preferred route and the route alternatives onto a map of high consequence areas that includes highly populated areas and other populated areas;
- Recording the total miles of populated areas crossed by the centerlines of each route and the total area of populated areas that would fall within 1,250 feet of the construction work area;
- Identifying all populated areas within the ROI; and
- Assessing the nature, extent, duration, and magnitude of impacts on populated areas and any measures to minimize potential impacts.

The ROI for the review of populated areas consists of the area within 1,250 feet of the construction footprint for the Applicant's preferred route and the route alternatives. For this analysis, "populated areas, as defined by the U.S. Census Bureau, consist of incorporated areas or legal entities, and census-designated places, which are statistical entities."

Data for populated areas within 1,250 feet of the routes were derived from the U.S. Census Bureau's Master Address File / Topologically Integrated Geographic Encoding and Referencing Database (U.S. Census Bureau 2016). Impacts on these areas were quantified in terms of the number of populated areas crossed, the extent of the pipeline crossing in these populated areas (i.e., miles crossed by the

centerline), and the populated area (acreage) within 1,250 feet of construction. These metrics are intended to capture the number of communities most affected and the degree to which each community would be affected. The miles of an area crossed by the centerline quantifies the relative extent of impact but does not reflect impacts on locations adjacent to the pipeline. Using a 1,250-foot buffer accounts for areas that may be affected by noise, dust, vibration, and increased traffic from construction (typical construction noise would most likely be within acceptable levels at a distance of 1,250 feet, as discussed in Section 6.2.2).

6.5.3.2 Existing Conditions

Existing conditions are described for the entire length of the Applicant's preferred route in Minnesota. RA-03AM, RA-06, RA-07 and RA-08 represent alternative routes to the Applicant's preferred route between Clearbrook and Carlton. Included in the description of existing conditions for the Applicant's preferred route is a subset of data for the segment from Clearbrook to Carlton to allow for direct comparison of the route alternatives to the Applicant's preferred route.

Populated areas and population density within those areas for the counties crossed by the Applicant's preferred route and route alternatives are shown in Figure 6.5.3-1.

6.5.3.2.1 Applicant's Preferred Route

The Applicant's preferred route would cross 12 counties in Minnesota. County population estimates for 2010 and 2015, the percentage population change, and the population density are presented in Appendix N. As described in Section 5.3.3.2.1, the population density along the Applicant's preferred route is low and generally similar to the statewide average.

Non-Local Workforce

The Applicant's preferred route would cross 12 counties in Minnesota. Of these, 7 counties (Kittson, Marshall, Pennington, Red Lake, Polk, Clearwater, and Carlton) would be crossed by all 5 route options (Figure 6.5.3-1). Between Clearbrook and Carlton, the Applicant's preferred route would cross seven counties (Clearwater, Hubbard, Wadena, Cass, Crow Wing, Aitkin, and Carlton). County population estimates for 2010 and 2015, the percentage population change, and the population density for all counties crossed by the Applicant's preferred route or the route alternatives are presented in Appendix N.

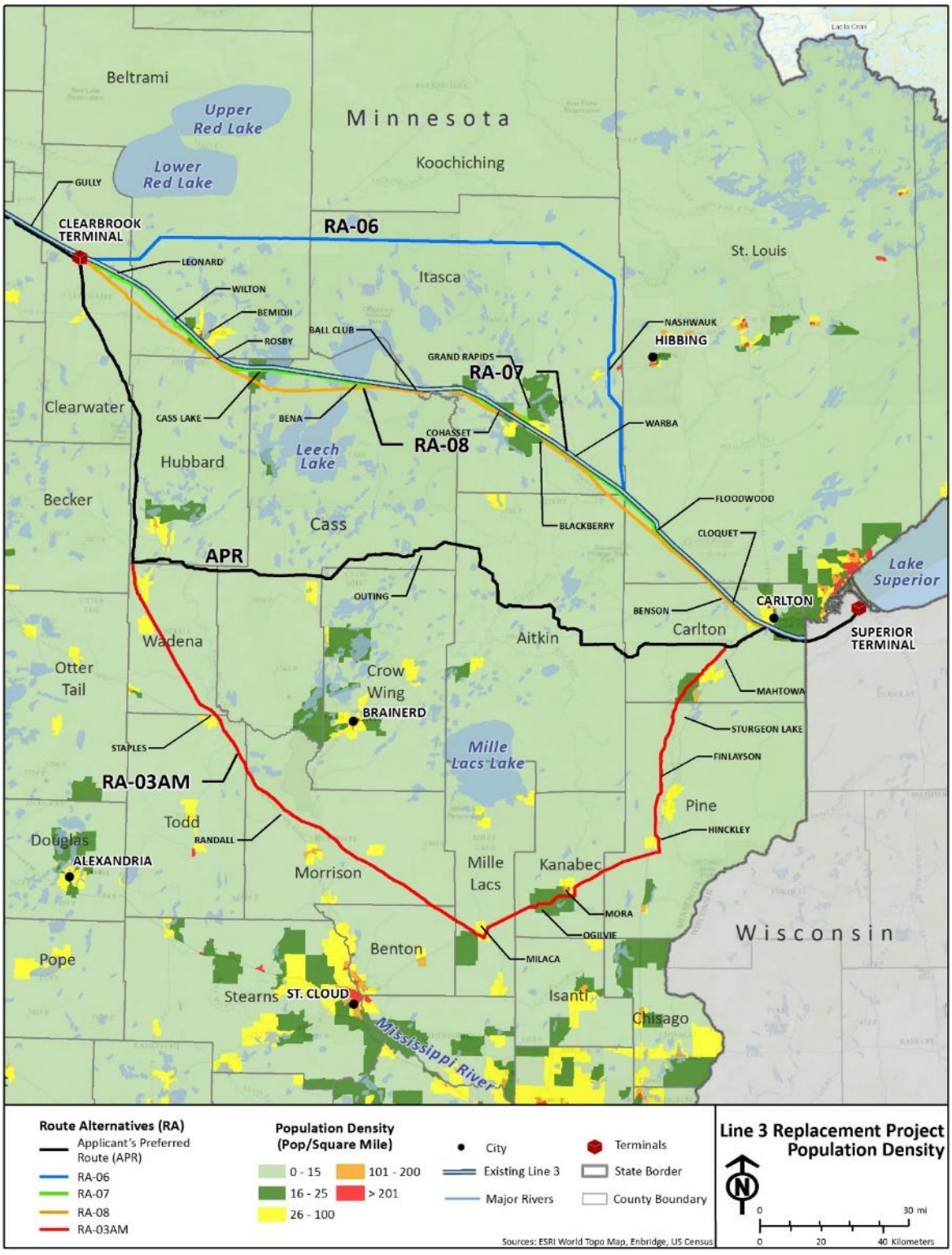

Figure 6.5.3-1. Population Density for the Counties Crossed by the Applicant's Preferred Route and the Route Alternatives

Populated Areas

Table 6.5.3-1 lists the populated areas that occur along the Applicant's preferred route (divided into three segments to isolate the Clearbrook-to-Carlton segment). For each populated area, the table also gives the population of the local populated area, the length of the route centerline that passes through the populated area, and the total acreage of populated areas that would be located within 1,250 feet of the construction footprint. These populated areas also are labeled in Figure 6.5.3-1. Across the entire route, 14 populated areas are located along the Applicant's preferred route; within these 13 populated areas 4,104 people are living within 1,250 feet of the construction work area. In the section of the Applicant's preferred route from Clearbrook to Carlton, five populated areas with 1,204 people are within 1,250 feet of the construction work area.

Table 6.5.3-1. Populated Areas near the Applicant's Preferred Route

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
North Dakota Border to Clearbrook			
Clearbrook	518	0.0	33
Gonvick	282	0.0	0
Gully	66	0.0	12
Oklee	435	0.8	215
Plummer	292	2.0	605
Trail	46	0.7	217
Subtotal	***1,639***	***3.5***	***1,082***
Clearbrook to Carlton			
Clearbrook	518	0.0	38
Mahtowa	370	2.9	792
Mule Lake	--	0.0	3
Outing	--	0.0	41
Waukenabo	316	0.0	2
Subtotal	***1,204***	***2.9***	***876***
Carlton to Wisconsin Border			
Carlton	862	0.0	84
Chub Lake	--	0.0	6
Wrenshall	399	0.1	79
Subtotal	***1,261***	***0.1***	***170***
TOTAL	**4,104**	**6.5**	**2,127**

[a] Source: U.S. Census Bureau 2010.

"--" = These areas are not census-designated areas; therefore, population information is not available.

6.5.3.2.2 Route Alternatives

Route Alternative RA-03AM

Non-Local Workforce

Of the 10 counties (Clearwater, Hubbard, Wadena, Todd, Morrison, Benton, Mille Lacs, Kanabec, Pine, and Carlton) through which RA-03AM passes, Benton County has the highest population density, at 97 people per square mile. The lowest population density is 9 people per square mile in Clearwater County. For context, the overall population density of the State of Minnesota is 69 people per square mile.

Population growth between 2010 and 2015 in the affected Minnesota counties was highest in Benton County, which grew 3 percent. Todd County's population decreased 3 percent in the same timeframe, which was the largest decrease of the affected counties. All of the counties saw a lower percentage population change than the 4-percent increase in population for the State of Minnesota.

Populated Areas

Table 6.5.3-2 presents the population of populated areas near RA-03AM, the miles of populated areas that would be crossed by the pipeline centerline, and the total acreage of populated areas that would be located within 1,250 feet of the construction footprint. These populated areas also are labeled in Figure 6.5.3-1.

Table 6.5.3-2. Populated Areas near Route Alternative RA-03AM

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
Bock	106	0.0	59
Brook Park	522	1.1	315
Finlayson	456	0.5	192
Hinckley	1,800	2.0	526
Mahtowa	370	6.5	1,716
Milaca	2,946	0.5	199
Mora	3,571	0.7	284
Ogilvie	369	1.3	341
Quamba	123	0.9	280
Randall	650	0.0	7
Staples	2,981	1.4	476
Sturgeon Lake	439	0.0	35
TOTAL	**14,333**	**14.9**	**4,429**

[a] Source: U.S. Census Bureau 2010.

Route Alternative RA-06

Non-Local Workforce

RA-06 would pass through six counties (Clearwater, Beltrami, Itasca, Aitkin, St. Louis, and Carlton). Of these, the county with the greatest existing population density is Carlton County, at 41 people per square mile. The lowest population density is 9 people per square mile in Aitkin County. This compares to a statewide population density of 69 people per square mile.

Population growth between 2010 and 2015 in the affected Minnesota counties was highest in Beltrami County, which grew 3 percent. Aitkin County experienced a decline in population of 3 percent in the same timeframe, which was the lowest. The population of the State of Minnesota as a whole increased by 4 percent for the same time period.

Populated Areas

Table 6.5.3-3 presents the population of populated areas near RA-06, the miles of populated areas that would be crossed by the pipeline centerline, and the total acreage of populated areas that would be located within 1,250 feet of the construction footprint.

Table 6.5.3-3. Populated Areas near Route Alternative RA-06

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
Big Lake	10,060	0.9	284
Bigfork	446	0.0	16
Cloquet	12,124	0.1	42
Floodwood	528	0.4	167
Nashwauk	938	2.0	619
TOTAL	**24,096**	**3.4**	**1,127**

[a] Source: U.S. Census Bureau 2010.

Route Alternative RA-07

Non-Local Workforce

RA-07 would pass through eight counties (Clearwater, Beltrami, Hubbard, Cass, Itasca, Aitkin, St. Louis, and Carlton). The county with the greatest existing population density is Carlton County, at 41 people per square mile. The lowest population density is 9 people per square mile in Aitkin County. This compares to a statewide population density of 69 people per square mile.

Population growth between 2010 and 2015 in the affected Minnesota counties was highest in Beltrami County, which grew 3 percent. Aitkin County experienced a decline in population of 3 percent in the same timeframe, which was the lowest of the counties. The overall population of the State of Minnesota increased by 4 percent for the same time period.

Populated Areas

Table 6.5.3-4 presents the population of populated areas near RA-07, the miles of populated areas that would be crossed by the pipeline centerline, and the total acreage of populated areas that would be located within 1,250 feet of the construction footprint.

Table 6.5.3-4. Populated Areas near Route Alternative RA-07

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
Ball Club	342	1.8	492
Bemidji	13,431	4.7	1,749
Bena	116	0.8	250
Big Lake	10,060	0.9	304
Blackberry	--	1.6	402
Cass Lake	770	1.6	566
Chub Lake	--	0.0	2
Cloquet	12,124	0.1	41
Cohasset	2,698	3.4	1,126
Coleraine	1,970	3.3	1,051
Deer River	930	0.0	9
Floodwood	528	0.4	173
Grand Rapids	10,869	4.6	1,509
Grant Creek	--	0.0	18
La Prairie	665	0.0	17
Leonard	41	0.2	54
Midge Lake	--	0.0	15
Pinewood	--	0.0	39
Portage Lake	--	0.0	18
Rosby	--	0.6	155
Warba	181	1.0	344
Wilton	204	1.6	561
Zemple	93	1.1	311
TOTAL	**55,022**	**27.7**	**9,205**

[a] Source: U.S. Census Bureau 2010.

"--" = These areas are not census-designated areas; therefore, population information is not available.

Route Alternative RA-08

Non-Local Workforce

RA-08 would pass through eight counties (Clearwater, Beltrami, Hubbard, Cass, Itasca, Aitkin, St. Louis, and Carlton). The county with the greatest existing population density is Carlton County, at 41 people per square mile. The lowest population density is 9 people per square mile in Aitkin County. This compares to a statewide population density of 69 people per square mile.

Population growth between 2010 and 2015 in the affected Minnesota counties was highest in Beltrami County, which grew 3 percent. Aitkin County experienced the lowest population growth and declined 3 percent in the same timeframe. These growth rates compare to an overall 4-percent increase in population for the State of Minnesota for the same time period.

Populated Areas

Table 6.5.3-5 presents the population of populated areas near RA-08, the miles of populated areas that would be crossed by the pipeline centerline, and the total acreage of populated areas that would be located within 1,250 feet of the construction footprint.

Table 6.5.3-5. Populated Areas near Route Alternative RA-08

Populated Area	Population[a]	Miles of Populated Areas Crossed by Pipeline Centerline	Populated Areas within 1,250 Feet of Construction Work Area (acres)
Ball Club	342	1.6	456
Bemidji	13,431	4.4	1,453
Bena	116	0.0	37
Big Lake	10,060	1.0	299
Blackberry	--	0.4	165
Cloquet	12,124	0.1	37
Cohasset	2,698	4.3	1,370
Coleraine	1,970	2.0	626
Floodwood	528	0.3	132
Grand Rapids	10,869	4.5	1,431
La Prairie	665	0.7	224
Rosby	--	0.5	159
Warba	181	0.8	249
Zemple	93	1.3	370
TOTAL	**53,077**	**21.9**	**7,008**

[a] Source: U.S. Census Bureau 2010.

"--" = These areas are not census-designated areas; therefore, population information is not available.

6.5.3.3 Impact Assessment

Impacts on populations may result from an influx of workers from outside the ROI for construction or operation. The additional population may increase the demand for local amenities, services, infrastructure, and temporary housing and hospitality (e.g., restaurants). Areas with greater populations and amenities are able to absorb the influx of temporary workers more readily than areas with lower populations and fewer amenities (e.g., hotels, restaurants).

Conversely, the more populated the area, the more people who may be disrupted by construction and the greater the potential impact (e.g., greater density of roads, residents, and businesses). Services may be disrupted when pipeline construction crosses underground utilities or roads. Noise, dust, and vibrations caused by construction equipment may disturb more people in nearby homes and businesses. Following construction land within the permanent right-of-way easement would be restricted from further development for certain uses.

6.5.3.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Non-Local Workforce

The Applicant provided an estimate that construction would occur simultaneously over seven separate construction spreads for the portion of the overall Line 3 Replacement Project located in Minnesota. Each construction spread would require approximately 600 workers, resulting in a total maximum workforce of 4,200 workers to construct the entire Project. Based on the length of the Applicant's preferred route, each spread would cover approximately 49 miles. While it is likely that Enbridge would use some local workers, as a worst case, it was assumed that all workers would be non-local and would need to temporarily re-locate to the area during construction. Additionally, some workers could be accompanied by their families. According to the U.S. Census Bureau (2014), the average number of persons per household in the United States is approximately 3. If each of the non-local workers brought their families, the increase in local population could be approximately 12,600 people. This represents a 5-percent increase to the current population of all counties that would be crossed by the Applicant's preferred route. Given the transitory nature of the Project and the limited time period of construction, however, it is unlikely that all workers would re-locate with their families so the total temporary change in population would be less than 5 percent.

In the event that two construction spreads are adjacent to each other during construction, a maximum of 1,200 workers could be present in a county at a given time. In the largest county crossed by the Applicant's preferred route (Crow Wing County), it would represent a 2-percent increase in population. In the smallest county crossed by the route (Red Lake County), this would represent 30 percent of the county's total population. Additionally, Kittson County (27 percent), Marshall County (13 percent), and Clearwater County (14 percent) all would experience population increases over 10 percent of their current population. For these counties, additional strain may be expected in a worst-case scenario. Added population would create more traffic on roadways and emergency services, as discussed in Section 6.2.5. As discussed in Section 6.2.4, the total housing available is expected to be adequate. While adequate housing may be available across the ROI and the potential population increase would be less than 10 percent for most counties, 4 of the 12 counties (Red Lake, Kittson, Marshall, and Clearwater) could experience more than a 10-percent increase in population if all workers from two construction spreads were present in the county at the same time. This could result in congestion on the roads and within the service industry area (e.g., restaurants, gas stations). However, the worst-case

scenario of two construction spreads operating close to each other would be temporary as pipeline construction moves along the route, and any local impacts would diminish. Overall, impacts related to the influx of non-local workforce are expected to be minor and temporary, but could be major and temporary for those counties with low population density if a large number of workers bring their families and if construction spreads operate in proximity to each other.

Populated Areas

A total of 13 populated areas would be proximal to the Applicant's preferred route. These areas have a total population of 3,586 people. A total of approximately 6 miles of populated areas would be crossed by the Applicant's preferred route, and a total of 2,127 acres of populated areas would be within the ROI in Minnesota.

For the segment of the Applicant's preferred route between Clearbrook and Carlton, five populated areas would be proximal to the construction area, with a total population of 1,204 people. A total of 3 miles of populated areas would be crossed by the centerline in this segment, and 876 acres of populated areas would be within the ROI.

Impacts on the populated areas within the ROI during construction would be caused by noise, dust, and vibrations from equipment; displaced residences and structures; the potential for traffic disruptions; and the potential for disrupted services such as water, electricity, or gas during construction. Populated areas are more likely to be affected by these impacts due to the higher density of people, structures, and infrastructure.

As described in Section 6.2.2, calculations show that typical construction noise attenuates to compliance levels with the daytime noise standards at 1,250 feet from the noise source. If a large portion of land that falls within a populated area is within this distance, there is a greater likelihood of impacts, including the number of people who would experience noise at levels that exceed the daytime standard. Applicant-proposed measures to limit noise during construction include limiting construction to daylight hours, maintaining equipment in good working order, limiting transportation to areas of active construction, and using manufacturer-supplied silencers when available. Detailed noise and vibration analyses are given in Section 6.2.2, as are additional recommendations that should be implemented to further reduce noise or vibration impacts.

During construction, increased dust can be harmful or bothersome to people located near work areas. Dust from construction is discussed in Section 6.3.7. Enbridge would wet construction areas and roadways as necessary to minimize dust.

The potential for displaced structures is increased when the pipeline is routed through populated areas. Structures in the permanent right-of-way would be removed or re-located during construction. No structures would be permitted in the permanent right-of-way during operation. Section 6.2.4 further discusses displacement of residences. Enbridge has reached agreements with landowners for all structures identified within the permanent right-of-way.

Populated areas have a higher density of roads and driveways than more rural areas. Additionally, the roadways generally have more traffic on them, and more people would be affected by traffic congestion created by the movement of construction workers and equipment or road closures. To minimize traffic impacts, Enbridge has proposed to cross all paved roads using the bore technique or HDD. These

methods would prevent road closures by tunneling underneath the road surface. Impacts on roads are further discussed in Section 6.2.5.

Enbridge would consult with all utility companies prior to construction and utilize the Minnesota GSOC system prior to excavation to ensure that all adjacent pipelines and underground utilities are properly marked prior to construction. This would minimize the potential for service interruptions from construction. Nevertheless, interruptions would be more likely in areas of dense population due to the amount of infrastructure, with potential effects on more people. Utilities are further discussed in Section 6.2.5.

Overall, relatively few populated areas are crossed by the Applicant's preferred route, and the areas that are crossed have relatively small populations. With implementation of Applicant-proposed measures, impacts on populated areas during construction would be temporary and minor.

Operations Impacts

Non-Local Workforce

Enbridge estimates that operation of the pipeline would require few workers along the pipeline route; therefore, populations of local communities would not be affected.

Populated Areas

During operations, populated areas may be affected through restrictions placed on land within the permanent right-of-way or pipeline leaks or spills. The presence of a pipeline easement would prevent further development within the easement. Populated areas with more miles crossed by the pipeline centerline would have more land with this restriction. For the Applicant's preferred route, approximately 6 miles of populated areas would be crossed, with 3 miles of that occurring between Clearbrook and Carlton. While the restrictions would be placed on structures along the right-of-way, the existence of the permanent right-of-way would not restrict access across the easement. Typically, the pipeline would be buried at least 48 inches underground. Potential impacts associated with an accidental release of crude oil and associated emergency response procedures are discussed in Chapter 10.

Standard maintenance of the permanent right-of-way would include periodic mowing to prevent woody vegetation from interfering with inspection of the right-of-way or encroaching on the pipeline itself. In populated areas, mowing activity may be noticed by more people, but it would be infrequent and transitory.

Overall, operational impacts on populated areas would be negligible but permanent.

6.5.3.3.2 Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

Non-Local Workforce

For RA-03AM, the route from Clearbrook to Carlton would be 275 miles long, about 54 miles longer than the Applicant's preferred route. Based on the length of the route, it could require five construction spreads, resulting in the need for 3,000 workers. Assuming that each worker would be accompanied by

their family, the population increase within the RA-03AM ROI would be 1 percent. Given the transitory nature of the Project and the limited time period for construction, it is unlikely that all workers would re-locate with their families.

In the event that two construction spreads are adjacent to each other during construction, a maximum of 1,200 workers could be present in a county at a given time. In the largest county crossed by RA-03AM (Benton County), this would represent a 3-percent increase in population. In the smallest county crossed by the route (Clearwater County), this would represent 14 percent of the county's total population. Added population would create more traffic on roadways and emergency services, as discussed in Section 6.2.5. As discussed in Section 6.2.4, the total housing available is expected to be adequate. Overall, impacts related to the non-local workforce are expected to be minor and temporary but could be major and temporary in areas with low population density.

Populated Areas

Impacts on populated areas would be similar to those described for the Applicant's preferred route. Differences between the Applicant's preferred route and the route alternatives would be due to the number and size of populated areas crossed and the extent to which they would be crossed. RA-03AM would affect 12 populated areas with a total population of 14,333. The largest populated area within the ROI would be Mora with 3,571 people. A total of 14.9 miles of populated areas would be crossed by the pipeline centerline, and 4,429.1 acres would be within the ROI. Impacts on populated areas would be minor because of the relatively low population affected and the temporary construction duration.

Operations Impacts

Non-Local Workforce

Enbridge estimates that operation of the route alternatives would not require significant numbers of workers along the pipeline route; therefore, populations would not be affected by a non-local workforce.

Populated Areas

Operations impacts on populated areas along the route alternatives would be similar to those presented for the Applicant's preferred route, constituting a negligible but permanent impact.

Route Alternative RA-06

Construction Impacts

Non-Local Workforce

The length of the RA-06 route is to the Applicant's preferred route and would require approximately four construction spreads. The four construction spreads would total roughly 2,400 workers, which would represent about 1 percent of the population in the counties crossed by RA-06. If two construction spreads were in the same county at the same time, impacts could be magnified and up to 1,200 workers could be located in one county. The largest county crossed by RA-06 (St. Louis County) has a population of 200,431 people; two spreads would represent 1 percent of that population. The smallest county crossed would be Clearwater County, with 8,803 people; two construction spreads would represent 14 percent of that population. Impacts related to the non-local workforce would be minor and temporary but could be major and temporary in the instance of multiple construction spreads working at the same time in the smaller counties with low populations.

Populated Areas

RA-06 would affect five populated areas, with a total population of 24,096. The largest populated area within the ROI would be Cloquet, with 12,124 people. A total of 3.4 miles of populated areas would be crossed by the pipeline centerline, and 1,127 acres would be within the ROI. Impacts on populated areas would be minor and temporary because of the relatively low population affected and the transitory nature of construction.

Operations Impacts

Non-Local Workforce

Enbridge estimates that operation of the route alternatives would not require significant numbers of workers along the pipeline route; therefore, populations would not be affected by a non-local workforce.

Populated Areas

Operations impacts on populated areas along the route alternatives would be similar to those presented for the Applicant's preferred route, constituting a negligible but permanent impact.

Route Alternative RA-07

Construction Impacts

Non-Local Workforce

The length of the RA-07 route is similar to the Applicant's preferred route and would require approximately four construction spreads. The four construction spreads would total roughly 2,400 workers, representing about 1 percent of the population in the counties crossed by RA-07. If two construction spreads were in the same county at the same time, impacts could be magnified and up to 1,200 workers could be located in one county. The largest county crossed by RA-07 (St. Louis County) has a population of 200,431 people; two spreads would represent 1 percent of the population. The smallest county crossed would be Clearwater County, with 8,803 people; two construction spreads would represent 14 percent of the population. Impacts related to the non-local workforce would be minor and temporary but could be major and temporary in the instance of multiple construction spreads working at the same time in the smaller counties with low populations.

Populated Areas

RA-07 would affect 23 populated areas, with a total population of 55,022. The largest populated area within the ROI would be Bemidji, with 13,431 people. A total of 27.7 miles of populated areas would be crossed by the pipeline centerline and 9,205 acres of populated areas would be within the ROI. Impacts on populated areas would be minor because of the relatively low population of the areas affected. As noted for the Applicant's preferred route, populated areas are more likely to be affected by construction impacts because of the higher density of people, structures, and infrastructure. Impacts would be temporary during construction.

Operations Impacts

Non-Local Workforce

Enbridge estimates that operation of the route alternatives would not require significant numbers of workers along the pipeline route; therefore, populations would not be affected by a non-local workforce.

Populated Areas

Operations impacts on populated areas along the route alternatives would be similar to those presented for the Applicant's preferred route, constituting a negligible but permanent impact.

Route Alternative RA-08

Construction Impacts

Non-Local Workforce

The length of the RA-08 route is similar to the Applicant's preferred route and would require approximately four construction spreads. The four construction spreads would total roughly 2,400 workers, representing about 1 percent of the population in the counties crossed by RA-08. If two construction spreads were in the same county at the same time, impacts could be magnified and up to 1,200 workers could be located in one county. The largest county crossed by RA-07 (St. Louis County) has a population of 200,431 people; two spreads would represent 1 percent of that population. The smallest county crossed would be Clearwater County, with 8,803 people; two construction spreads would represent 14 percent of the population. Impacts related to the non-local workforce would be minor and temporary, but could be major and temporary in the instance of multiple construction spreads working at the same time in the smaller counties with low populations.

Populated Areas

RA-08 would affect 14 populated areas, with a total population of 53,077. The largest populated area within the ROI would be Bemidji, with 13,431 people. A total of 21.9 miles of populated areas would be crossed by the pipeline centerline, and 7,008 acres of populated areas would be within the ROI. Impacts on populated areas would be minor because of the relatively low population levels in the areas affected and would be temporary during construction.

Operations Impacts

Non-Local Workforce

Enbridge estimates that operation of the route alternatives would not require significant numbers of workers along the pipeline route; therefore, populations would not be affected by a non-local workforce.

Populated Areas

Operations impacts on populated areas along the route alternatives would be similar to those presented for the Applicant's preferred route, constituting a negligible but permanent impact.

6.5.3.4 Summary and Mitigation

6.5.3.4.1 Summary

Impacts on population for the Applicant's preferred route and the route alternatives are summarized in Table 6.5.3-6. Overall, the influx of construction workers to build and operate the Applicant's preferred route or any of the route alternatives would result in negligible to minor impacts except in those few counties with the lowest populations. The influx of non-local workers is not expected to affect the local populations unless two construction spreads are working in proximity to each other within a single low-population county. The nature of the construction work requires the workers to move through each area after a short time, and the existing services and housing in the areas on a county-wide basis are adequate to support the worker influx. In the circumstance where two construction spreads are active in the same low-population county, temporary but major impacts could occur.

Potential impacts from operations would be permanent but negligible for the Applicant's preferred route and all of the route alternatives. Pipeline operations would require relatively few additional employees and thus would not affect the local workforce, need for housing, or local services.

When comparing the Applicant's preferred route and the route alternatives to each other, the Applicant's preferred route would be expected to have the lowest impact on populated areas. It has the lowest number of populated areas within the ROI and the lowest total population within those populated areas. It also has the least acreage along of permanent right-of-way that crosses populated areas and would restrict surface land use within populated areas.

The next highest population exposure would occur from RA-03AM, where approximately ten times as many people are in populated areas proximal to the pipeline route. The permanent right-of-way acreage that would need to remain cleared in the populated areas would be five times greater for RA-03AM than for the Applicant's preferred route.

RA-06, RA-08, and RA-07, in that order, would increase the exposed population within populated areas; and the amount of exposed population increases significantly. However, at all levels of population exposure, impacts are expected to be negligible to minor as shown in Table 6.5.3-6.

The amount of acreage restricted for surface land use also is higher for RA-06, RA-07, and RA-08, as shown in Table 6.5.3-6.

6.5.3.4.2 Mitigation

Beyond the Applicant-proposed measures described for the Applicant's preferred route, mitigation measures to address potential major impacts of traffic congestion for the rail and truck alternatives could include:

- Freeways – Construct additional freeway lanes, off ramps and other traffic flow features in congested areas to reduce traffic density.
- Highways – Upgrade (widening) or add lanes to existing state and county highways to increase traffic flow and reduce traffic density. Construction of additional lane capacity or dedicated truck-only lanes on State Highway 92 near Clearbrook may be required.
- Populated areas – Construct dedicated access roads to the Clearbrook terminal.

Given the temporary nature of the construction activity (the construction spread moves along the construction route), potential impacts are expected to be minor to negligible and temporary. Likewise, pipeline operations would require relatively few additional employees and thus would not affect the local workforce, need for housing, or local services. No additional mitigation has been identified associated with employment.

Table 6.5.3-6. Summary of Potential Impacts on Population for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Changes in Population from Non-Local Workforce					
Percentage increase in local population across all counties	Temporary/minor impacts • 6.7 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*	Temporary/minor impacts • 5.1 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*	Temporary/minor impacts • 3.6 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*	Temporary/minor impacts • 3.1 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*	Temporary/minor impacts • 3.1 percent increase Temporary/major impacts *(in counties where population increase would be greater than 10 percent)*
Disruptions to Populated Areas					
Number of populated areas crossed or within 1,250 feet of construction work area	Temporary/minor impacts • 5 populated areas	Temporary/minor impacts • 12 populated areas	Temporary/minor impacts • 5 populated areas	Temporary/minor impacts • 23 populated areas	Temporary/minor impacts • 14 populated areas
Total population of populated areas crossed	Temporary/minor impacts • 1,204	Temporary/minor impacts • 14,333	Temporary/minor impacts • 24,096	Temporary/minor impacts • 55,022	Temporary/minor impacts • 53,077
Total area of populated areas crossed or within 1,250 feet of construction work area (acres)	Temporary/minor impacts • 875.7 acres	Temporary/minor impacts • 4,429.1 acres	Temporary/minor impacts • 1,127.0 acres	Temporary/minor impacts • 9,205.1 acres	Temporary/minor impacts • 7,008.4 acres

Table 6.5.3-6. Summary of Potential Impacts on Population for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Operations Impacts					
Changes in Population from Non-Local Workforce					
Increase in local population across all counties	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts
Disruptions to Populated Areas					
Miles of populated areas crossed by pipeline centerline	Permanent/negligible impacts • 2.9 miles	Permanent/negligible impacts • 14.9 miles	Permanent/negligible impacts • 3.4 miles	Permanent/negligible impacts • 27.7 miles	Permanent/negligible impacts • 21.9 miles

6.5.3.5 References

U.S. Census Bureau. 2010. 2010 Census. QuickFacts. https://www.census.gov/quickfacts/table/PST045215/00. Accessed on January 23, 2017.

_____. 2014. 2010 – 2014 American Community Survey. American Fact Finder. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed on January 23, 2017.

_____. 2016. 2016 TIGER Geodatabases. https://www.census.gov/geo/maps-data/data/tiger-geodatabases.html.

6.5.4 Employment, Income, and Tax Revenues

Employment and income statistics provide insight into local economic conditions. Changes in employment and income influence the level of tax revenues received by local and state governments, making tax revenues another important indicator of how well an economy is doing. The issues addressed in this section related to employment, income, and tax revenue associated with construction and operation of the Applicant's preferred route and route alternatives are:

- Construction-related employment, payroll spending, and expenditures on materials, supplies and equipment;
- Operation-related employment and payroll spending;
- Income tax revenue from workers during construction and operation; and
- Property taxes paid by the Applicant during operation.

This section first describes the regulatory context and methods used in the assessment of impacts (Section 6.5.4.1), followed by a description of relevant economic conditions within the counties along the Applicant's preferred route and each of the route alternatives (Section 6.5.4.2); these counties could experience changes in employment, income, and tax revenue as a result of construction and operation of the Project. Section 6.5.4.3 addresses the potential impacts on employment, income, and tax revenue from construction and operation of the Project. That section identifies the potential impacts for all the route options (the Applicant's preferred route and route alternatives RA-03AM, RA-06, RA-07, and RA-08). A summary and comparison of the impacts are presented in Section 6.5.4.4.

6.5.4.1 Regulatory Context and Methodology

6.5.4.1.1 Regulatory Context

Minnesota Administrative Rules Part 7852.1900, Subpart (3) describes what the Commission must consider in determining the route of a pipeline. Among other things, the Commission must consider the potential impacts, and methods to minimize or mitigate the potential impacts, of all proposed routes on "economies within the route." A "local economy" is defined as the activities that take place within a designated geographic area.

6.5.4.1.2 Methodology

The assessment addressed the impacts on employment, income, and tax revenue from construction and operation of the Applicant's preferred route and route alternatives. This assessment consisted of the following:

- Describing the existing economic conditions in the counties that would be crossed by the Applicant's preferred route and route alternatives using county-level employment, income, and tax revenues (where available); and
- Determining potential impacts on the economic baseline by using employment numbers and construction related expenditures provided by the Applicant to provide a qualitative discussion of the relative magnitude (i.e., negligible, minor, or major) of Project-related changes to county-level employment and income levels, and to quantitatively estimate the potential increase in income tax revenue by county.

For this analysis, the ROI encompasses the counties crossed by the Applicant's preferred route and route alternatives. County-level data provide a reasonable base for defining a local economy and determining Project-related impacts in each county crossed by each route. The comparison of impacts on most of the other resources in this EIS consider the alternative routes between the Enbridge terminals at Clearbrook and Carlton since the routes of those alternatives are the same between the North Dakota border and Clearbrook and between Carlton and the Wisconsin border. However, because the impact analysis for this section is based on county data, the comparisons were made using (1) data for existing conditions in all of Clearwater County, in which Clearbrook is located, and all of Carlton County, in which Carlton is located; and (2) construction employment for the four construction spreads between the Enbridge terminals at Clearbrook and Carlton.

The employment and income statistics used to describe the economic baseline (or existing conditions) include median household income from the U.S. Census Bureau, and per capita income, total labor force numbers, and unemployment rates from the U.S. Bureau of Labor Statistics. Median household income is commonly used to describe a household's economic status or to track economic trends, whereas per capita household income often is used to measure the standard of living within a geographic area. Labor force numbers represent the total number of people (15 years and older) who are currently employed or unemployed but looking for work, while the unemployment rate represents the percentage of the labor force that is currently unemployed. All data are from the most recent survey years available when this EIS was prepared, unless otherwise noted.

Existing conditions for tax revenues were based on available data from the Minnesota Department of Revenue for the ROI except for Benton and Pine counties. These data include total government revenue and the portion of revenue from property taxes. Construction of a pipeline and associated facilities would generate tax revenues in the form of property taxes paid by the Applicant for the life of the Project. Property tax revenue used in the impact assessment was based on the appraised value of the pipeline easement and the state and local tax rates. Enbridge has appealed the amount of property taxes it paid between 2012 and 2016, alleging that the Minnesota Department of Revenue overvalued the value of the pipeline property, resulting in overpayment of taxes to counties and Minnesota. The appeal has not been settled at the time this document was prepared. This revenue would be in addition to the amount that the current landowner pays and represents additional revenue to the county and the state.

County governments receive income tax appropriations from the state of Minnesota. The state determines the amount each county receives. Output from a national IMPLAN model (an economic input-output model) and the number of miles of pipeline per county were used to allocate the potential change in income taxes appropriated from the State of Minnesota to each county in the ROI for the Applicant's preferred route and route alternatives. The total estimated labor income to Minnesota was generated using the IMPLAN output along with each county's share of the total pipeline (in miles). The total estimated income tax to the state was generated using the IMPLAN output and Minnesota's current income tax rate of 7.08 percent. The resultant estimated state income tax was allocated to each county in the ROI based on the number of miles of pipeline in the county.

It is likely that the Applicant would hire local residents during construction of any of the alternative routes for a portion of its workforce. However, in this EIS, the impacts on population and housing are based on the assumption that all of the workers would be from outside of the counties crossed by the routes and they would therefore re-locate to the area during construction (see Section 6.2.4.3). These

workers may reside in Minnesota or may be out-of-state workers, which is a common situation in pipeline construction projects.

6.5.4.2 Existing Conditions

6.5.4.2.1 Applicant's Preferred Route

Employment and Income

Summary statistics of employment, per capita income, and median household income for the counties that would be crossed by the Applicant's preferred route are listed in Table 6.5.4-1. In all of the counties, the median household income is below the state average of $60,828, and only one county (Kittson) is above the state average for per capita personal income of $50,541; however, Kittson County also had the highest unemployment rate (7 percent).

Table 6.5.4-1. Employment and Income Conditions in Counties Crossed by the Applicant's Preferred Route in Minnesota

County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015 – September 2016)[a]	Unemployment Rate (August 2015 – September 2016)[a]
North Dakota Border to Clearbrook				
Kittson	$52,326	$48,950	2,543	7.0%
Marshall	$47,271	$53,373	5,574	4.9%
Pennington	$48,980	$47,436	8,933	3.4%
Red Lake	$45,722	$47,253	2,259	3.9%
Polk	$42,157	$51,085	16,795	3.8%
Clearwater	$36,512	$45,158	4,493	6.7%
Subtotal/Average	***Average = $45,495***	***Average = $48,876***	***Subtotal = 40,957***	***Average = 4.6%***
Clearbrook to Carlton[c]				
Hubbard	$36,338	$46,466	9,847	4.5%
Wadena	$32,836	$38,706	6,236	4.6%
Cass	$42,349	$45,620	14,690	5.1%
Crow Wing	$37,863	$49,244	32,402	3.9%
Aitkin	$36,363	$42,085	6,757	4.4%
Carlton	$36,801	$53,492	17,328	4.2%
Subtotal/average	***Average = $37,092***	***Average = $45,936***	***Subtotal = 87,260***	***Average = 4.5%***
TOTAL/AVERAGE	**AVERAGE = $41,616**	**AVERAGE = $47,519**	**TOTAL = 127,857**	**AVERAGE = 4.7%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

[c] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

Tax Revenues

Table 6.5.4-2 lists the current total government revenue and the portion of revenue from property taxes for each county that would be crossed by the Applicant's preferred route. For many of these counties, property taxes are an important source of income. Pennington and Red Lake counties have the highest share of their total revenues from property taxes (86 and 74 percent, respectively). Crow Wing County has the highest total government revenue at $77 million. In 2015, income taxes received by the State of Minnesota were approximately $11 billion (U.S. Census 2015).

Table 6.5.4-2. Government Revenue in Counties Crossed by the Applicant's Preferred Route in Minnesota

County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
North Dakota Border to Clearbrook				
Kittson	5%	$12,209	$3,346	27%
Marshall	11%	$17,237	$5,463	32%
Pennington	6%	$8,289	$7,153	86%
Red Lake	5%	$2,977	$2,198	74%
Polk	4%	$55,276	$20,562	37%
Clearwater[b]	12%	$12,209	$3,346	27%
Subtotal/average	***Subtotal = 43%***	***Subtotal = $108,197***	***Subtotal = $42,068***	***Average = 47%***
Clearbrook to Carlton[c]				
Hubbard	13%	$18,828	$6,142	33%
Wadena	2%	$31,732	$12,200	38%
Cass	14%	$21,289	$7,675	36%
Crow Wing	1%	$50,103	$20,332	41%
Aitkin	15%	$71,060	$35,583	50%
Carlton	11%	$35,408	$11,457	32%
Subtotal/average	***Subtotal = 57%***	***Subtotal = $228,420***	***Subtotal = $93,389***	***Average = 38%***
TOTAL/AVERAGE	**TOTAL = 100%**	**TOTAL = $336,617**	**TOTAL = $135,457**	**AVERAGE = 43%**

[a] Source: Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary.

[b] Includes data for all of Clearwater County.

[c] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

6.5.4.2.2 Route Alternatives

The only area where the route alternatives would vary from the alignment of the Applicant's preferred route is between Clearbrook and Carlton in Minnesota. The existing conditions relevant to employment, income, and tax revenue for the route alternatives between Clearbrook and Carlton are described below. However, because this assessment incorporates county data, the information associated with routes in Carlton County includes data for the entire county, although the differences in the alignments of the route alternatives extend only between the Enbridge terminals at Clearbrook and Carlton.

Route Alternative RA-03AM

Employment and Income

Summary statistics of employment, per capita income, and median household income for the counties that would be crossed by RA-03AM between Clearbrook and Carlton are listed in Table 6.5.4-3. Kanabec and Pine counties have the highest unemployment rates (5 percent), and the median household income averaged $47,475 for all the counties crossed.

Table 6.5.4-3. Employment and Income Conditions in Counties Crossed by Route Alternative RA-03AM between Clearbrook and Carlton

County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015 – September 2016)[a]	Unemployment Rate (August 2015 – September 2016)[a]
Hubbard	$36,338	$46,466	9,847	4.5%
Wadena	$32,836	$38,706	6,236	4.6%
Todd	$38,082	$45,432	12,822	3.4%
Morrison	$37,448	$40,080	17,717	3.9%
Benton	$41,101	$60,589	21,694	3.6%
Mille Lacs	$34,168	$48,763	12,761	4.4%
Kanabec	$35,290	$46,872	8,860	5%
Pine	$35,290	$46,872	8,860	5%
Carlton[c]	$36,801	$53,492	17,328	4.2%
TOTAL/AVERAGE	**AVERAGE = $36,373**	**AVERAGE = $47,475**	**TOTAL = 116,125**	**AVERAGE = 4.29%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

[c] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

Tax Revenues

Table 6.5.4-4 lists the current total government revenue and the portion of revenue from property taxes for each county crossed by RA-03AM between Clearbrook and Carlton. For many of these counties, property taxes are an important source of income, averaging 40 percent. No data were available for Todd, Benton, or Pine counties.

Table 6.5.4-4. Government Revenue in Counties Crossed by Route Alternative RA-03AM between Clearbrook and Carlton

County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Hubbard	9%	$18,828	$6,142	33%
Wadena	9%	$31,732	$12,200	38%
Todd	3%	NA	NA	--
Morrison	12%	41,762	16,964	41%
Benton	1%	NA	NA	--
Mille Lacs	4%	$34,234	15,052	44%
Kanabec	6%	$26,625	$11,094	42%
Pine	11%	NA	NA	--
Carlton[b]	6%	$35,408	$11,457	32%
TOTAL/AVERAGE	**61% (of total route)[c]**	**$138,029**	**$54,567**	**40%**

Notes:

[a] Source: Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary.

[b] Includes data for all of Carlton County.

[c] Does not sum to 100% since this represents only the portion of the pipeline from Clearbrook to Carlton.

NA = Data were not readily available or available publicly via the Internet.

"--" = Could not calculate because no data were available.

Route Alternative RA-06

Employment and Income

Summary statistics of employment, per capita income, and median household income for the counties that would be crossed by RA-06 between Clearbrook and Carlton are listed in Table 6.5.4-5. Itasca County has the highest unemployment rates (5.8 percent), and the median household income averaged $46,765 for all the counties crossed.

Table 6.5.4-5. Employment and Income Conditions in Counties Crossed by Route Alternative RA-06 between Clearbrook and Carlton

County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015 – September 2016)[a]	Unemployment Rate (August 2015 – September 2016)[a]
Beltrami	$35,078	$43,990	23,451	4.1%
Itasca	$36,367	$47,122	22,967	5.8%
Aikin	$36,363	$42,085	6,757	4.4%
St. Louis	$39,861	$47,138	8,569	3.4%
Carlton[c]	$36,801	$53,492	17,328	4.2%
TOTAL/AVERAGE	**AVERAGE = $36,894**	**AVERAGE = $46,765**	**TOTAL = 79,072**	**AVERAGE = 4.4%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

[c] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

Tax Revenues

Table 6.5.4-6 summarizes the current total government revenue and the portion of revenue from property taxes for each county between Clearbrook and Carlton that would be crossed by RA-06. For many of these counties, property taxes are an important source of income, averaging 38 percent.

Table 6.5.4-6. Government Revenue in Counties Crossed by Route Alternative RA-06 between Clearbrook and Carlton

County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Beltrami	12%	$72,476	$26,651	37%
Itasca	34%	$94,707	$28,855	30%
Aitkin	0.2%	$71,060	$35,583	50%
St. Louis	8%	$278,021	$111,234	40%
Carlton[b]	5%	$35,408	$11,457	32%
TOTAL/AVERAGE	**62% (of total route)[c]**	**TOTAL = $551,672**	**TOTAL = $213,780**	**AVERAGE = 38%**

[a] Source: Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary.

[b] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

[c] Does not sum to 100% since this represents only the portion of the pipeline from Clearbrook to Carlton.

Route Alternative RA-07

Employment and Income

Summary statistics of employment, per capita income, and median household income for the counties that would be crossed by RA-07 between Clearbrook and Carlton are listed in Table 6.5.4-7. Itasca County has the highest unemployment rates (5.8 percent), and the median household income averaged $46,559 for all the counties crossed.

Table 6.5.4-7. Employment and Income Conditions in Counties Crossed by Route Alternative RA-07 between Clearbrook and Carlton

County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015 – September 2016)[a]	Unemployment Rate (August 2015 – September 2016)[a]
Beltrami	$35,078	$43,990	23,451	4.1%
Hubbard	$36,338	$46,466	9,847	4.5%
Cass	$42,349	$45,620	14,690	5.1%
Itasca	$36,367	$47,122	22,967	5.8%
Aitkin	$36,363	$42,085	6,757	4.4%
St. Louis	$39,861	$47,138	8,569	3.4%
Carlton[c]	$36,801	$53,492	17,328	4.2%
TOTAL/AVERAGE	**AVERAGE = $37,594**	**AVERAGE = $46,559**	**TOTAL = 103,609**	**AVERAGE = 4.5%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

[c] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

Tax Revenues

Table 6.5.4-8 lists the current total government revenue and the portion of revenue from property taxes for each county crossed by RA-07 between Clearbrook and Carlton. For many of these counties, property taxes are an important source of income, averaging 37 percent.

Table 6.5.4-8. Government Revenue in Counties Crossed by Route Alternative RA-07 between Clearbrook and Carlton

County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Beltrami	8%	$72,476	$26,651	37%
Hubbard	3%	$18,828	$6,142	33%
Cass	12%	$21,289	$7,675	36%
Itasca	17%	$94,707	$28,855	30%
Aitkin	0.4%	$71,060	$35,583	50%
St. Louis	9%	$278,021	$111,234	40%
Carlton[b]	5%	$35,408	$11,457	32%
TOTAL/AVERAGE	**54% (of total route)[c]**	**TOTAL = $519,313**	**TOTAL = $200,946**	**AVERAGE = 37%**

[a] Source: Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary.

[b] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

[c] Does not sum to 100% since this represents only the portion of the pipeline from Clearbrook to Carlton.

Route Alternative RA-08

Employment and Income

Summary statistics of employment, per capita income, and median household income for the counties that would be crossed by RA-08 between Clearbrook and Carlton are listed in Table 6.5.4-9. Itasca County has the highest unemployment rates (5.8 percent), and the median household income averaged $46,559 for all the counties crossed.

Table 6.5.4-9. Employment and Income Conditions in Counties Crossed by Route Alternative RA-08 between Clearbrook and Carlton

County	Per Capita Personal Income 2014[a] ($2015)	Median Household Income 2010–2014[b] ($2015)	Labor Force (August 2015 – September 2016)[a]	Unemployment Rate (August 2015 – September 2016)[a]
Beltrami	$35,078	$43,990	23,451	4.1%
Hubbard	$36,338	$46,466	9,847	4.5%
Cass	$42,349	$45,620	14,690	5.1%
Itasca	$36,367	$47,122	22,967	5.8%
Aitkin	$36,363	$42,085	6,757	4.4%
St. Louis	$39,861	$47,138	8,569	3.4%
Carlton[c]	$36,801	$53,492	17,328	4.2%
TOTAL/AVERAGE	**AVERAGE = $37,594**	**AVERAGE = $46,559**	**TOTAL = 103,609**	**AVERAGE = 4.5%**

[a] Source: U.S. Bureau of Economic Analysis 2015.

[b] Source: U.S. Census Bureau 2014.

[c] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

Tax Revenues

Table 6.5.4-10 lists the current total government revenue and the portion of revenue from property taxes for each county crossed by RA-08 between Clearbrook and Carlton. For many of these counties, property taxes are an important source of income, averaging 37 percent.

Table 6.5.4-10. Government Revenue in Counties Crossed by Route Alternative RA-08 between Clearbrook and Carlton

County	Portion of Pipeline through County	Government Revenue ($2015 thousands)[a]	County Property Tax Revenue ($2015 thousands)[a]	Share of Government Revenue from Property Taxes
Beltrami	7%	$72,476	$26,651	37%
Hubbard	3%	$18,828	$6,142	33%
Cass	12%	$21,289	$7,675	36%
Itasca	16%	$94,707	$28,855	30%
Aitkin	2%	$71,060	$35,583	50%
St. Louis	8%	$278,021	$111,234	40%
Carlton[b]	5%	$35,408	$11,457	32%
TOTAL/AVERAGE	**53% (of total route)[c]**	**TOTAL = $519,313**	**TOTAL = $200,946**	**AVERAGE = 37%**

[a] Source: Minnesota Office of the State Auditor 2015, adjusted to $2015 based on the consumer price index where necessary.

[b] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

[c] Does not sum to 100% since this represents only the portion of the pipeline from Clearbrook to Carlton.

6.5.4.3 Impact Assessment

Construction and operation of the Applicant's preferred route or an alternative route would increase employment, income, and tax revenue. Direct impacts on employment would be driven by the large number of construction personnel. Although it is expected that the workers would not live in the counties where construction would occur, they may temporarily re-locate to these counties during construction or spend money locally, which could result in temporary county-level income changes in supporting industries. Tax revenues would increase due to the increase in labor income (i.e., taxable income), sales tax on the purchase of goods locally, and property taxes. Construction would also have a temporary indirect influence on economic conditions due to employment and income for service industries supporting construction activities (e.g., the hotel industry, fueling services, and the food service industry).

6.5.4.3.1 Applicant's Preferred Route (in Minnesota)

Construction Impacts

Employment and Income

Construction of the Applicant's preferred route across Minnesota is expected to require up to a maximum of 4,200 workers across 7 different construction spreads over an 8-month period. The portion of the route between Clearbrook and Carlton would require up to 2,400 workers across 4 construction spreads. As noted above, this impact assessment is based on the assumption that all workers would re-locate to the area during construction. Based on this assumption, it is likely that direct construction-

related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

In addition to direct Project-related employment and payroll spending, a large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. The Applicant estimated the material costs for construction of its preferred route in Minnesota to be $438.9 million. According to the IMPLAN model results, the top industries (as defined in the model) that would be positively affected by construction-related spending are construction services for new, non-residential structures; food services and drinking places; real estate businesses; wholesale trade business (businesses engaged in wholesaling merchandise such as agriculture and mining); architectural and engineering services; offices of health practitioners; private hospitals; employment services; and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

If the Applicant employs some local residents during construction, there would be a greater influence on employment, unemployment, and per capita income at the county level along the route; and the temporary, positive impact would be greater.

Tax Revenues

Construction of the Applicant's preferred route would generate state and local taxes from a variety of sources. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., wages paid to construction workers). In other words, regardless of where a construction worker lives, a portion of their wages would be subject to Minnesota state income taxes since the construction occurs in Minnesota over an extended period of time. In addition, if the industries indirectly affected by construction hire additional staff to accommodate the increased business as described above, wages paid to those workers would also increase state and county tax revenues. In terms of property taxes, as previously stated, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments as determined by the state. Table 6.5.4-11 presents the estimated increase in the state income tax that would be appropriated to each county in the ROI based on the portion of total length of the pipeline through each county. Based on these estimates, Aitkin County would receive the highest increase in income tax revenue at $15.2 million. The counties along the Clearbrook-to-Carlton segment would receive approximately $55.9 million in income tax revenue from construction of the Project. This positive impact on income tax revenues to the counties would be temporary and minor to major (i.e., depending on the allocation to each individual county).

Table 6.5.4-11. Estimated Income Tax Generated from Construction-Related Income for the Applicant's Preferred Route

County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income ($2016 millions)[a]
North Dakota Border to Clearbrook		
Kittson	15.4	$4.5
Marshall	36.3	$10.7
Pennington	19.7	$5.8
Red Lake	15.7	$4.6
Polk	14.0	$4.1
Clearwater	42.2	$12.4
Subtotal	***143.3***	***$42.1***
Clearbrook to Carlton		
Hubbard	44.6	$13.1
Wadena	7.1	$2.1
Cass	47.4	$12.0
Crow Wing	4.8	$1.4
Aitkin	51.6	$15.2
Carlton[b]	41.0	$12.1
Subtotal	***196.5***	***$55.9***
TOTAL	**339.8**	**$98.0**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

[b] Carlton County extends to the Wisconsin border; because this is a county-level analysis, it includes data for all of Carlton County.

Operations Impacts

Employment and Income

The Applicant stated that the existing operations staff would be able to operate the Project and that few additional employees would be hired to assist the staff. As a result, operation of the pipeline would have no measureable impact on local employment, per capita household income, median household income, or unemployment in the ROI.

Tax Revenues

Since there would be few additional staff members hired for operation of the Project, there would be very little change in income tax or sales tax revenues due to increased spending by permanent operational staff. Therefore, the impact on income tax and sales tax revenues would be permanent, but at most negligible.

Property tax revenues would be the largest source of ongoing revenue to the counties along the route. Local and state governments would continue to collect annual property taxes from the Applicant based on the assessed value of the pipeline easements for the life of the Project. This would result in permanent, major positive impacts on property tax revenues for the counties along the route.

6.5.4.3.2 Route Alternatives (from Clearbrook to Carlton)

Route Alternative RA-03AM

Construction Impacts

Employment and Income

RA-03AM is between 55 miles longer than the other routes between the Clearbrook and Carlton terminals, and construction between Clearbrook to Carlton and may require five spreads and an additional 600 workers (up to 3,000 total) during construction. Based on the assumptions that the additional workers would not be local, as described above, direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. Construction of RA-03AM would have the largest increase of local spending on goods and services of all alternatives due to the additional 600 workers. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

A large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. According to the IMPLAN model results, the top industries (as defined in the model) that would be positively affected by

construction-related spending are construction services for new, non-residential structures; food services and drinking places; real estate businesses; wholesale trade business (i.e., businesses engaged in wholesaling merchandise like agriculture, and mining); architectural and engineering services; offices of health practitioners; private hospitals; employment services; and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

Tax Revenues

Construction of RA-03AM would generate state and local taxes from a variety of sources. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., wages paid to construction workers). This increase in income tax revenues would be highest for RA-03AM compared to the other alternatives as a result of the increase in workers for the route. If the industries indirectly affected by construction hire additional staff to accommodate the increased business as described above, wages paid to those workers would also increase state and county tax revenues. As noted above, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments as determined by the state. Table 6.5.4-12 presents the estimated increase in the state income tax that would be appropriated to each county in the ROI based on the portion of total length of the pipeline through each county. Based on the IMPLAN output in Table 6.5.4-12, counties crossed by RA-03AM would receive the highest total amount of income taxes ($73 million) as compared to that of the other alternatives. This positive impact on income tax revenues to the counties would be temporary and minor to major (i.e., depending on the allocation to each individual county).

Table 6.5.4-12. Estimated Income Tax Generated from Construction-Related Income for Route Alternative RA-03AM

County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
Hubbard	33.7	$9.7
Wadena	35.9	$10.4
Todd	12.6	$3.7
Morrison	47.8	$13.9
Benton	5.5	$1.6
Mille Lacs	15.6	$4.5
Kanabec	22.0	$6.4
Pine	43.6	$12.6
Carlton[b]	34.1	$9.9
TOTAL	**250.8**	**$72.7**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

[b] Carlton County extends to the Wisconsin border; since this is a county-level analysis, this includes data for all of Carlton County.

Operations Impacts

Employment and Income

As for the Applicant's preferred route, the existing operations staff would be able to operate RA-03AM and few additional employees would be hired to assist the staff. As a result, operation of the pipeline would have no measureable impact on local employment, per capita household income, median household income, or unemployment in the ROI.

Tax Revenues

Since there would be few additional staff members hired for operation of the Project, there would be very little change in income tax or sales tax revenues due to increased spending by permanent operational staff. Therefore, the impact on income tax and sales tax revenues would be permanent, but at most negligible.

Property tax revenues would be the largest source of ongoing revenue to the counties along the route. Local and state governments would continue to collect annual property taxes from the Applicant based on the assessed value of the pipeline easements for the life of the Project. This would result in permanent, major positive impacts on property tax revenues for the counties along the route.

Route Alternative RA-06

Construction Impacts

Employment and Income

The portion of the RA-06 between Clearbrook and Carlton would require up to 2,400 workers across 4 construction spreads. As noted in Section 6.5.4.1, this impact assessment is based on the assumption that all workers would re-locate to the area during construction. Based on this assumption, it is likely that direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

A large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. According to the IMPLAN model results, the top industries (as defined in the model) that would be positively affected by construction-related spending are construction services for new, non-residential structures; food services and drinking places; real estate businesses; wholesale trade business (i.e., businesses engaged in wholesaling merchandise like agriculture, and mining); architectural and engineering services; offices of health practitioners; private hospitals; employment services; and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

Tax Revenues

Construction of RA-06 would generate state and local taxes from a variety of sources. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., wages paid to construction workers). If the industries indirectly affect by construction hire additional staff to accommodate the increased business as described above, wages paid to those workers would also increase state and county tax revenues. In terms of property taxes, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would have no impact on property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments as determined by the state. Table 6.5.4-13 presents the estimated increase in the state income tax that would be appropriated to each county in the ROI based on the portion of total length of the pipeline through each county. Based on the IMPLAN output in Table 6.5.4-13, counties crossed by RA-06 would receive $58.2 million in taxes, and Itasca County would experience the greatest revenue increase from income taxes ($32.1 million). This positive impact on income tax revenues to the counties would be temporary and minor to major (i.e., depending on the allocation to each individual county).

Table 6.5.4-13. Estimated Income Tax Generated from Construction-Related Income for Route Alternative RA-06

County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
Beltrami	38.4	$11.4
Itasca	108.2	$32.1
Aitkin	0.8	$0.2
St. Louis	24.7	$7.3
Carlton[b]	24.2	$7.2
TOTAL	**196.3**	**$58.2**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

[b] Carlton County extends to the Wisconsin border; since this is a county-level analysis, it includes data for all of Carlton County.

Operations Impacts

Employment and Income

The existing operations staff would be able to operate SA-06 and few additional employees would be hired to assist the staff. As a result, operation of the pipeline would have no measureable impact on local employment, per capita household income, median household income, or unemployment in the ROI.

Tax Revenue

Since there would be few additional staff members hired for operation of the Project, there would be very little change in income tax or sales tax revenues due to increased spending by permanent operational staff. Therefore, the impact on income tax and sales tax revenues would be permanent, but at most negligible.

Property tax revenues would be the largest source of ongoing revenue to the counties along the route. Local and state governments would continue to collect annual property taxes from the Applicant based on the assessed value of the pipeline easements for the life of the Project. This would result in permanent, major positive impacts on property tax revenues for the counties along the route.

Route Alternative RA-07

Construction Impacts

Employment and Income

The portion of the RA-07 between Clearbrook and Carlton would require up to 2,400 workers across 4 construction spreads. As noted in Section 6.5.4.1, this impact assessment is based on the assumption that all workers would re-locate to the area during construction. Based on this assumption, it is likely that direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

A large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. According to the IMPLAN model results, the top industries (as defined in the model) that would be positively affected by construction-related spending are construction services for new, non-residential structures; food services and drinking places; real estate businesses; wholesale trade business (i.e., businesses engaged in wholesaling merchandise like agriculture, and mining); architectural and engineering services; offices of health practitioners; private hospitals; employment services; and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

Tax Revenues

Construction of RA-07 would generate state and local taxes from a variety of sources. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., wages paid to construction workers). If the industries indirectly affect by construction hire additional staff to accommodate the increased business as described above, wages paid to those workers would also increase state and county tax revenues. As previously noted, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments as determined by the state. Table 6.5.4-14 presents the estimated increase in the state income tax that would be appropriated to each county in the ROI based on the portion of total length of the pipeline through each county. Based on the IMPLAN output in Table 6.5.4-14, counties crossed by RA-07 would receive $49.6 million in taxes, and Itasca County would receive the greatest portion of revenue increases from income taxes ($15.1 million). This positive impact on income tax revenues to the counties would be temporary and minor to major (i.e., depending on the allocation to each individual county).

Operations Impacts

Employment and Income

The existing operations staff would be able to operate SA-07 and few additional employees would be hired to assist the staff. As a result, operation of the pipeline would have no measureable impact on local employment, per capita household income, median household income, or unemployment in the ROI.

Tax Revenues

Since there would be few additional staff members hired for operation of the Project, there would be very little change in income tax or sales tax revenues due to increased spending by permanent operational staff. Therefore, the impact on income tax and sales tax revenues would be permanent, but at most negligible.

Property tax revenues would be the largest source of ongoing revenue to the counties along the route. Local and state governments would continue to collect annual property taxes from the Applicant based on the assessed value of the pipeline easements for the life of the Project. This would result in permanent, major positive impacts on property tax revenues for the counties along the route.

Table 6.5.4-14. Estimated Income Tax Generated from Construction-Related Income for Route Alternative RA-07

County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
Beltrami	22.9	$6.9
Hubbard	7.9	$2.4
Cass	34.2	$10.2
Itasca	50.3	$15.1
Aitkin	1.1	$0.3
St. Louis	24.7	$7.4
Carlton[b]	24.2	$7.3
TOTAL	**165.3**	**$49.6**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

[b] Carlton County extends to the Wisconsin border; since this is a county-level analysis, it includes data for all of Carlton County.

Route Alternative RA-08

Construction Impacts

Employment and Income

The portion of the RA-08 between Clearbrook and Carlton would require up to 2,400 workers across 4 construction spreads. As noted in Section 6.5.4.1, this impact assessment is based on the assumption that all workers would re-locate to the area during construction. Based on this assumption, it is likely that direct construction-related employment would not affect county-level unemployment or per capita and/or median household income levels. However, it is likely that some of the non-technical work could be accomplished by local residents (e.g., clearing and trenching); hiring of local residents for those positions would have a temporary and negligible impact on county-level unemployment or per capita and/or median household income levels.

Construction workers who re-locate to the Project area would spend a portion of their income on local goods and services such as food, gas, and lodging. These expenditures would increase revenues to those secondary or supporting industries (i.e., industries that indirectly support the construction industry) for the duration of the construction period in the area of the construction spread. This would result in a temporary, minor positive impact on the secondary industries. If businesses in the secondary industries hire additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment and unemployment within each county along the route.

A large portion of the construction-related expenses would be for construction materials, supplies, equipment, parts, and other goods and services such as fuel and hardware. According to the IMPLAN model results, the top industries (as defined in the model) that would be positively affected by construction-related spending are construction services for new, non-residential structures; food services and drinking places; real estate businesses; wholesale trade business (i.e., businesses engaged in wholesaling merchandise like agriculture, and mining); architectural and engineering services; offices of health practitioners; private hospitals; employment services; and financial services. These expenditures during construction would result in temporary and negligible to minor indirect, positive impacts on those industries, particularly within the counties along the route. The magnitude of the impact on the industries would depend on the size of the industries and the portion of the expenditures that would be spent locally in each county crossed by the route.

If businesses in these industries hire local additional staff to accommodate increased business, there would be a temporary, positive but negligible indirect impact on employment, unemployment, and per capita income at the county level along the route.

Tax Revenues

Construction of RA-08 would generate state and local taxes from a variety of sources. State and county tax revenues would increase due to increased employment payrolls directly associated with construction (i.e., wages paid to construction workers). If the industries indirectly affected by construction hire additional staff to accommodate the increased business as described above, wages paid to those workers would also increase state and county tax revenues. As noted, it was assumed that property taxes would not begin to accrue until the operations phase of the Project; therefore, construction of the pipeline would not affect property taxes at the county level.

As previously discussed, income taxes are generated at the state level and reapportioned to county governments as determined by the state. Table 6.5.4-15 presents the estimated increase in the state income tax that would be appropriated to each county in the ROI based on the portion of total length of the pipeline through each county. Based on the IMPLAN output in Table 6.5.4-15, counties crossed by RA-08 would receive $48.2 million in taxes, and Itasca County would receive the greatest portion of revenue increases from income taxes ($13.9 million). This positive impact on income tax revenues to the counties would be temporary and minor to major (i.e., depending on the allocation to each individual county).

Operations Impacts

Employment and Income

The existing operations staff would be able to operate SA-08 and few additional employees would be hired to assist the staff. As a result, operation of the pipeline would have no measureable impact on local employment, per capita household income, median household income, or unemployment in the ROI.

Tax Revenues

Since there would be few additional staff members hired for operation of the Project, there would be very little change in income tax or sales tax revenues due to increased spending by permanent operational staff. Therefore, the impact on income tax and sales tax revenues would be permanent, but at most negligible.

Property tax revenues would be the largest source of ongoing revenue to the counties along the route. Local and state governments would continue to collect annual property taxes from the Applicant based on the assessed value of the pipeline easements for the life of the Project. This would result in permanent, major positive impacts on property tax revenues for the counties along the route.

Table 6.5.4-15. Estimated Income Tax Generated from Construction-Related Income for Route Alternative RA-08

County	Miles of Pipeline through County	Estimated Income Tax Generated from Direct and Indirect Construction-Related Income[a] ($2016 millions)
Beltrami	20.4	$6.1
Hubbard	8.3	$2.5
Cass	34.3	$10.3
Itasca	46.3	$13.9
Aitkin	4.7	$1.4
St. Louis	22.6	$6.8
Carlton[b]	23.9	$7.2
TOTAL	**160.5**	**$48.2**

[a] The estimates represent a conservative upper bound on the actual values. The underlying data are based on results from an IMPLAN model that uses national data, rather than data at the state level. The national data inflate the results at a more localized level, compared to a state-level model.

[b] Carlton County extends to the Wisconsin border; since this is a county-level analysis, it includes data for all of Carlton County.

6.5.4.4 Summary and Mitigation

6.5.4.4.1 Summary

Potential impacts on employment, income, and tax revenue were assessed for construction and operation of the Applicant's preferred route and route alternatives. These evaluations considered construction-related employment, payroll spending, and expenditures on materials, supplies and equipment; operation-related employment and payroll spending, income tax revenue from workers during construction and operation, and property taxes paid by the Applicant during operation. The ROI for this analysis consists of the counties in Minnesota crossed by the Applicant's preferred route and route alternatives. Table 6.5.4-16 provides a summary list of the potential impacts of construction and operation of the Applicant's preferred route and route alternatives, including the anticipated duration and magnitude of the impacts.

Construction Impacts

Pipeline construction would require a substantial workforce. To develop a conservative estimate of the positive economic impacts, it was assumed that the construction workforce would not be hired locally. Based on that assumption, the construction workforce would not affect employment and income at the county level. If the Applicant employs some local residents during construction, there would be a greater influence on employment, unemployment, and per capita income at the county level that would result in a temporary positive but negligible impact.

During construction, there could be an increase in hiring in secondary industries (i.e., the industries that support the construction industry). The impact of that increase in employment would have temporary, negligible impacts on employment and income at the county level. If the Applicant employs some local residents during construction, there would be a greater influence on employment, unemployment, and per capita income at the county level and the temporary, positive impact would be somewhat greater.

Construction-related tax revenues would be largely due to income taxes paid at the state level and apportioned to the counties crossed by the pipeline, as well as sales and use taxes on construction-related goods and services. Tax revenues generated during construction are likely to be temporary and minor to major for all alternatives.

Employment and income effects as well as the impacts on tax revenues during construction would be substantially the same for all of the routes. Differences in impacts would be due to the differences in length of the route options. RA-03AM would have the largest positive impact on the tax revenues during construction, with an estimated $73 million in income tax revenue, because it has the longest route. The Applicant's preferred route and RA-06 are the next longest, followed by RA-07 and RA-08.

Operations Impacts

Operation of the Applicant's preferred route and each of the route alternatives would require a small number of new hires since the new pipeline would be operated primarily by the existing operations staff for the Enbridge Mainline. Therefore, operation would not result in a measureable effect on county-level income and employment levels. In addition, the small number of permanent staff required to operate each pipeline would not be substantial enough to change tax revenues at the county-level. However, property taxes would be substantial and would result in a permanent, major impact on county-level tax revenues. As noted above, the impact on property taxes would differ slightly, with the longest route (RA-03AM) generating higher taxes than the shorter routes.

6.5.4.4.2 Mitigation

The only major impacts of the Applicant's preferred route or route alternatives on employment, income, and tax revenue would be associated with beneficial increases in tax revenue for all route options, including temporary increases in local tax during construction and permanent increases in property tax revenue during operation. No mitigation measures have been identified to address impacts on employment, income, or tax revenues.

Table 6.5.4-16. Summary of Potential County-Level Impacts on Employment, Income, and Tax Revenues for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Impact	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Construction Impacts					
Employment, unemployment, per capita income, median household income	Temporary/negligible to minor impacts • 2,400 workers (*all workers assumed non-local*) • Increase in income/jobs in secondary industries that support construction	Temporary/negligible to minor impacts • 3,000 workers (*all workers assumed non-local*) • Increase in income/jobs in secondary industries that support construction	Temporary/negligible to minor impacts • 2,400 workers (*all workers assumed non-local*) • Increase in income/jobs in secondary industries that support construction	Temporary/negligible to minor impacts • 2,400 workers (*all workers assumed non-local*) • Increase in income/jobs in secondary industries that support construction	Temporary/negligible to minor impacts • 2,400 workers (*all workers assumed non-local*) • Increase in income/jobs in secondary industries that support construction
Property tax revenue during construction	No impact	No impact	No impact	No impact	No impact
Income tax revenue during construction	Temporary/minor to major impacts (*depending on the allocation to each individual county*) • $56 million in income tax revenue	Temporary/minor to major impacts (*depending on the allocation to each individual county*) • $73 million in income tax revenue	Temporary/minor to major impacts (*depending on the allocation to each individual county*) • $58 million in income tax revenue	Temporary/minor to major impacts (*depending on the allocation to each individual county*) • $49 million in income tax revenue	Temporary/minor to major impacts (*depending on the allocation to each individual county*) • $48 million in income tax revenue
Operations Impacts					
Employment, unemployment, per capita income, median household income	No impact • Few new staff needed	No impact • Few new staff needed	No impact • Few new staff needed	No impact • Few new staff needed	No impact • Few new staff needed
Property tax revenue during operations	Permanent/major impacts	Permanent/major impacts • Longest route, greatest property tax revenue	Permanent/major impacts	Permanent/major impacts	Permanent/major impacts • Shortest route, least property tax revenue
Income tax revenue during operations	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts	Permanent/negligible impacts

6.5.4.5 References

Minnesota Office of the State Auditor. 2015. http://www.osa.state.mn.us/list.aspx?get=8 Accessed on November 16, 2016.

U.S. Census Bureau. 2014. 2010–2014 American Community Survey. American Fact Finder. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed on November 11, 2016.

U.S. Bureau of Economic Analysis. 2015. Local Personal Income 2015. http://www.bea.gov/newsreleases/regional/lapi/lapi_newsrelease.htm. Accessed on November 11, 2016.

6.6 COST COMPARISON

Project costs is one of the factors to be considered by the Commission for approval of a pipeline (Minn. R. 7850.4100, Subp. L). Two major categories of cost were considered: construction costs and operations costs; these costs were considered on a comparative basis.

6.6.1 Methodology

To estimate costs, information supplied by Enbridge for the cost of the Applicant's preferred route was used to determine a per-mile cost for the pipeline. The per-mile cost then was applied to the length of each route alternative to derive comparative costs. Cost estimates were prepared for the entire length of each route alternative in Minnesota. Costs also were broken out for the Clearbrook-to-Carlton segment of each route where the route alternative varies from the Applicant's preferred route.

6.6.2 Construction Costs

Construction costs include the costs for acquiring right-of-way easements or land purchase, construction equipment, pipe and associated equipment, pump station equipment, expendable supplies, and labor. Enbridge has reported that construction of the Applicant's preferred route across Minnesota would cost approximately $2.1 billion, or an average of $6.2 million per mile. After subtracting the cost of pump stations, the cost of a pipeline project of a given pipe diameter is highly correlated to the length of the project. Nevertheless, site-specific conditions, such as acquisition of easements, obtaining access, and special construction methods influence actual costs.

The average cost per mile for the Applicant's preferred route was applied to the length of each route alternative to obtain a cost for comparison (see Table 6.6-1). Total costs were calculated for each route alternative over the entire route in Minnesota and for the portion of the route between Clearbrook and Carlton that varied from the Applicant's preferred route. Overall construction costs across Minnesota ranged from $1.8 billion dollars (RA-07 and RA-08) to $2.4 billion dollars (RA-03AM). The significant portion of the cost would be for construction of the route segment between Clearbrook and Carlton, which would total between $1.0 billion (RA-08) and $1.7 billion (RA-03AM).

Table 6.6-1. Estimated Construction Costs for the Applicant's Preferred Route and Route Alternatives

Route	Minnesota Total		Clearbrook-to-Carlton Segment	
	Miles	Cost ($ billions)	Miles	Cost ($ billions)
Applicant's preferred route	339.7	$2.1	220.9	$1.4
Route alternative RA-03AM	394.9	$2.4	275.1	$1.7
Route alternative RA-06	316.6	$2.0	196.7	$1.2
Route alternative RA-07	287.5	$1.8	167.7	$1.0
Route alternative RA-08	284.6	$1.8	164.8	$1.0

Source: Average cost per mile for the Applicant's preferred route (Enbridge 2016).

6.6.3 Operations Costs

An estimate of operations costs was not available for the Minnesota portion of the proposed Project, as Enbridge would operate the Line 3 Replacement Project as part of its proprietary Mainline system. However, pumping costs (energy) is a major factor in the cost of operating the proposed Project in Minnesota. Like construction costs, pumping costs are related to pipeline length. Other length-related costs are surveillance and maintenance of the permanent right-of-way. Enbridge has indicated that energy use for the Applicant's preferred route would total over 533 million kilowatt-hours per year. Based on the average energy use per mile and the estimated cost of energy per kilowatt, the energy cost of operation was estimated for each route alternative (see Table 6.6-2). The annual energy costs for RA-03AM would be approximately 116 percent higher than for the Applicant's preferred route for the entire route in Minnesota. Energy costs for RA-06, RA-07, and RA-08 would be from 84 to 93 percent of the energy costs for the Applicant's preferred route in Minnesota. For the portion of the route between Clearbrook and Carlton that contains the route alternatives, energy costs for RA-03AM would be approximately 124 percent of the costs for the Applicant's preferred route; costs for RA-06, RA-07, and RA-08 would range from 75 to 88 percent of the costs for the Applicant's preferred route (Table 6.6-2).

Table 6.6-2. Estimated Annual Energy Costs during Operation for the Applicant's Preferred Route and Route Alternatives

Route	Minnesota Total		Clearbrook-to-Carlton Segment	
	Miles	Cost ($ millions)	Miles	Cost ($ millions)
Applicant's preferred route	339.7	$47.1	220.9	$30.7
Route alternative RA-03AM	394.9	$54.8	275.1	$38.2
Route alternative RA-06	316.6	$43.9	196.7	$27.3
Route alternative RA-07	287.5	$39.9	167.7	$23.3
Route alternative RA-08	284.6	$39.5	164.8	$22.9

Sources: Average cost per mile for Applicant's preferred route based on energy use provided by Enbridge (2016) and the average commercial energy cost in Minnesota in 2016 of 8.84 cents per kilowatt-hour (Electricity Local 2016).

6.6.4 References

Electricity Local. 2016. Minnesota Electricity Rates & Consumption. Electricitylocal.com/states/Minnesota. Accessed on December 19, 2016.

Enbridge Energy, Limited Partnership (Enbridge). 2016. Environmental Assessment Worksheet (EAW). November. Response to Data Request 01 to provide additional details for the EAW filed by Enbridge in April 2015.

6.7 RIGHT-OF-WAY SHARING OR PARALLELING

The Commission considers the extent of right-of-way sharing or right-of-way paralleling in its review of pipeline routes (Minn. R. 7850.4200, Subp. H and J). Right-of-way sharing or paralleling is a desirable land use policy because it concentrates the effects of linear infrastructure within corridors. Both right-of-way sharing and right-of-way paralleling avoid creating new corridors and habitat fragmentation, and can reduce the extent of new disturbance of vegetation and surface soils during construction compared to the creation of new corridors. Right-of-way sharing typically further reduces the extent of disturbance to vegetation and surface soils because of the overlap of the two standard rights-of-way widths.

The types of existing linear infrastructure in the shared or paralleled corridor also can influence the allowable proximity of adjacent infrastructure. For example, new oil pipelines may be co-located closer to an existing crude oil or refined products pipeline than to a highway or high-voltage transmission line, especially when the pipelines are owned by the same company, out of consideration for constructability, safety, and easement rights.

6.7.1 Regulatory Context and Methodology

6.7.1.1 Regulatory Context

Right-of-way sharing occurs when the permanent right-of-way of new linear infrastructure overlaps with the permanent right-of-way of existing infrastructure. For example, Enbridge's existing Mainline system in Minnesota contains six adjacent pipelines spaced approximately 10 to 15 feet from each other within a permanent right-of-way. Right-of-way paralleling occurs when the right-of-way of a new linear infrastructure is located adjacent to the permanent right-of-way of another linear infrastructure system but does not overlap. For example, two pipelines with 50-foot permanent rights-of-way (25 feet on either side of each pipe) would result in the two pipelines being 50 feet apart. Although no state-level regulations currently require right-of-way sharing or paralleling, the practice of resource management agencies is to encourage right-of-way sharing or paralleling.

6.7.1.2 Methodology

To assess right-of-way sharing or paralleling, the permanent rights-of-way for the Applicant's preferred route and each of the route alternatives were overlain on maps of existing infrastructure corridors using GIS to determine the portions of each route that would share, parallel, or be located independently of existing oil and gas pipelines, electric transmission lines, railroads, and highways.

6.7.2 Co-Location of Applicant's Preferred Route and Route Alternatives

Between Clearbrook and Carlton, the Applicant's preferred route and most of the route alternatives would share or parallel existing rights-of-way for the majority of their length (see Table 6.7-1). RA-07 would parallel the right-of-way with the Enbridge Mainline system from the North Dakota border to the Wisconsin border and share the right-of-way from Clearbrook to Carlton. RA-08 would share or parallel rights-of-way with existing pipelines for its entire length. The Applicant's preferred route would share or parallel existing rights-of-way along 73 percent of its length between Clearbrook and Carlton. RA-06 has the lowest proportion of its route co-located with existing rights-of-way between Clearbrook and Carlton (20 percent).

Table 6.7-1. Extent of Co-Location for the Applicant's Preferred Route and Route Alternatives

Segment	Total Length (miles)	New Right-of-Way (miles)	Type of Existing Infrastructure (miles)[a]			Percent of Co-Location
			Oil and gas pipeline	Transmission /utility lines	Road	
North Dakota Border to Clearbrook						
Applicant's preferred route	109.3	0	109.3	0	0	100
Clearbrook to Carlton						
Applicant's preferred route	220.9	59.8	66.2	92.0	2.9	73
Route alternative RA-03AM	275.1	12.9	223.6	13.8	24.8	95
Route alternative RA-06	196.7	156.5	40.3	0	0	20
Route alternative RA-07	167.7	0	167.7	0	0	100
Route alternative RA-08	164.8	0	164.8	0	0	100
Carlton to Wisconsin Border						
Applicant's preferred route	9.6	0	9.6	0	0	100

[a] Total miles co-located may be greater than total length due to areas where segment is shared with multiple types of existing infrastructure.

6.8 REGULATORY CONTROL

A wide variety of state and federal permits and approvals are required initially for approval of the Project and subsequently for various elements of Project construction and operation. The primary state regulations and associated major permits are described in Chapter 3. Resource-specific regulations and permits are discussed in the "Regulatory Context and Methodology" sub-sections found for each of the resources in Chapters 5 and 6.

Not all regulations require a permit or jurisdictional approval. Those that do are listed in Table 6.8-1, along with the government agency that issues approval, the type of application, the application status, and the general purpose for the permit.

Minnesota Statutes § 216G.02 Subdivision 3, Subpart (b)(4) states that the Commission must give "consideration of local government land use laws," including pipeline setback ordinances. Subdivision 4 also states that, while the statute requires consideration of the local laws, the pipeline permit supersedes those laws. Subdivision 4 stipulates that issuance of a pipeline routing permit "is the only site approval required" and that "the pipeline routing permit supersedes and preempts all zoning, building, or land use rules, regulations, or ordinances promulgated by regional, county, local, and special purpose governments." Because of this pre-emption, all local permits—and in particular, local land use/zoning permits—are not included in Table 6.8-1.

Table 6.8-1. Status of Required Permits and Approvals

Unit of Government	Type of Application	Status		Reason Required
		Applicant's Preferred Route	Route Alternatives	
U.S. Army Corps of Engineers – St. Paul District and Minnesota Pollution Control Agency (Minnesota PCA)	Section 10/404 Individual Permit and associated state 401 Individual Water Quality Certification	Application submitted and determined complete (January 28, 2016)	Not initiated	Authorizes discharge of dredged and fill material into waters of the United States, including wetlands, and crossing of navigable waters of the United States
U.S. Fish & Wildlife Service	Section 7 Endangered Species Act (ESA) consultation (federally endangered species)	Consultation ongoing	Not initiated	Establishes conservation measures and authorizes, as needed, take of federally protected species
	Bald Eagle Nest Removal Permit	Pending submittal	Not initiated	Allows for removal of a known bald eagle nest in proximity to construction activities
U.S. Department of the Interior, Bureau of Indian Affairs	25 Code of Federal Regulations (CFR) Section 169	Not applicable	Applicable, but not initiated	Considers issuing a right-of-way grant (easement) across tribal land.

Table 6.8-1. Status of Required Permits and Approvals

Unit of Government	Type of Application	Status		Reason Required
		Applicant's Preferred Route	Route Alternatives	
U.S. Department of Agriculture, U.S. Forest Service, Chippewa National Forest (CNF)	39 CFR Section 219; 16 U.S. Code 1601–1604	Not applicable	Applicable, but not initiated	Reviews the Project for consistency with CNF Land and Resource Management Plan; considers issuance of special use permit; Section 7 ESA and Section 106 National Historic Preservation Act (NHPA) consultations
Advisory Council on Historic Preservation	Section 106 of the NHPA	Not applicable	Applicable, but not initiated	Reviews and comments on the effects of the Project on historic properties
Leech Lake Band of Ojibwe Indians	Section 7 of the ESA	Not applicable	Applicable, but not initiated	Coordinates in preparation of Biological Assessment /Biological Evaluation
	Section 106 of the NHPA	Not applicable	Applicable, but not initiated	Reviews and comments on the effects of the Project on historic properties and properties of religious and cultural importance
	Leech Lake Land Use Plan	Not applicable	Applicable, but not initiated	Considers issuance of land use permit
	Leech Lake Open Burning, Burn Barrel, and Fire Prevention Ordinance	Not applicable	Applicable, but not initiated	Considers need for burning permit
Fond du Lac Band of Lake Superior Chippewa (FDL)	Section 106 of the NHPA	Not applicable	Applicable, but not initiated	Reviews and comments on the effects of the Project on historic properties and properties of religious and cultural importance
	FDL Wetlands Protection and Management Ordinance 03/06	Not applicable	Applicable, but not initiated	Reviews and considers applications for Wetland Activity Permits
	Section 401 of the Clean Water Act, FDL Water Quality Certification Standards, Ordinance 01/06	Not applicable	Applicable, but not initiated	Considers issuing 401 Water Quality Certificate and Tribal Water Quality Certification for areas within the FDL Reservation
	Special Use and Shoreland Use under FDL Land Use Ordinance 02/07	Not applicable	Applicable, but not initiated	Reviews and considers applications for Conditional Use Permits

Table 6.8-1. Status of Required Permits and Approvals

Unit of Government	Type of Application	Status		Reason Required
		Applicant's Preferred Route	Route Alternatives	
	FDL Open Burning Restrictions and Permitting Requirements Ordinance 5/93	Not applicable	Applicable, but not initiated	Reviews and considers applications for burning permits, if appropriate
	FDL Ordinance 5/84 and Secretarial Order 3215.	Not applicable	Applicable, but not initiated	Considers issuance of a Timber Cutting Permit based on results of timber surveys
Minnesota Public Utilities Commission	Certificate of Need	Application submitted	Not initiated	Determines the need for the pipeline, including questions of size, type, and timing
	Route permit	Application submitted	Not initiated	Authorizes construction of the pipeline along a specific route, subject to certain conditions
Minnesota Department of Natural Resources (Minnesota DNR)	License to Cross Public Waters	Application submitted	Not initiated	50-year license that allows a proposed utility to cross public waters
	License to Cross Public Lands	Application submitted	Not initiated	50-year license that allows a proposed utility to cross public lands
	Long-term Lease – Access Roads	Pending submittal	Not initiated	Authorizes use of access roads managed by Minnesota DNR during construction and operation
	Water Appropriation Permit – Pipeline and Facilities	Pending submittal	Not initiated	Authorizes withdrawal and use of water from surface water or groundwater sources
	State Endangered Species Permit and Avoidance Plan	Pending submittal	Not initiated	Outlines plans for avoidance, minimization, and mitigation of take of state-listed species
	Osprey Nest Disturbance Authorization	Pending submittal	Not initiated	Allows removal of a known osprey nest
	Eagle Nest Removal Permit	Pending submittal	Not initiated	Allows removal of a known eagle nest
	Gully 30 Fen Management Plan	Pending submittal	Not initiated	Authorizes construction across the Gully 30 fen
Minnesota PCA	Clearbrook Terminal Air Quality Permit – Synthetic –Minor Individual State Operating Permit	Pending submittal	Not initiated	Authorizes construction and operation at the modified Clearbrook terminal

Table 6.8-1. Status of Required Permits and Approvals

Unit of Government	Type of Application	Status		Reason Required
		Applicant's Preferred Route	Route Alternatives	
	Any aboveground overpressure relief storage tanks (ASTs) (usually 100,000- to 200,00-gallon capacity) will need to meet applicable standards	Pending submittal	Not initiated	All ASTs must meet American Petroleum Institute Standards 620, 650, 651, and 653.
	Clean Water Act Section 401 Certification	Pending submittal	Not initiated	Section 401 of the Clean Water Act requires this certification for a federal license or permit (in this case, a Section 404 wetland permit) to conduct an activity that may result in a discharge of a pollutant into waters of the United States.
	National Pollutant Discharge Elimination System (NPDES) Individual Construction Stormwater, Hydrostatic Test, and Trench Dewatering Permit – Pipeline Construction	Pending submittal	Not initiated	Authorizes ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on a construction site, discharge of water from hydrotesting activities, and removal of water that may accumulate in the pipeline trench
	NPDES General Construction Stormwater Coverage – Facilities	Pending submittal	Not initiated	Authorizes ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on a construction site
	NPDES General Construction Stormwater Coverage – Pipeyards and Contractor Yards	Pipe yard permits received and stormwater monitoring ongoing	Not initiated	Authorizes ground disturbance with approved protection measures to manage soil erosion and stormwater discharge on a construction site
Minnesota State Historic Preservation Office	Cultural Resources consultation, NHPA Section 106 clearance	Consultation ongoing	Not initiated	Ensures adequate consideration of impacts on significant cultural resources
Minnesota Department of Agriculture	Agricultural Protection Plan	Consultation initiated	Not initiated	Establishes measures for agricultural protection
Minnesota Department of Transportation	Road crossing permits	Pending submittal	Not initiated	Authorizes crossings of state jurisdictional roadways
	Temporary access/entrance permits	Pending submittal	Not initiated	Authorizes access to private lands during construction from state highway right-of-way

Table 6.8-1. Status of Required Permits and Approvals

Unit of Government	Type of Application	Status		Reason Required
		Applicant's Preferred Route	Route Alternatives	
Minnesota Department of Health and Wrenshall and Sundsrud Court drinking water supply management areas	Drinking Water Supply Management Area/Wellhead Protection Area consultation	Consultation only (in progress)	Not initiated	Ensures that pipeline construction and operation are compatible with goals of relevant plans
Mississippi Headwaters Board	Local land use review	Consultation only (in progress)	Not initiated	Ensures compatibility with land use plan
Red Lake, Wild Rice, Two Rivers, and Middle-Snake watershed districts	Watershed District Permit	Pending submittal	Not initiated	Authorizes crossing of legal drains and ditches within watershed
Minnesota Board of Water and Soil Resources/ Wetland Conservation Act Local Governmental Units	Notice of Intent to Utilize Federal Approvals for Utilities Project Exemption	Notice submitted	Not initiated	Notice of use of exemption required
Local/County	Permits pertaining to off-right-of-way yard use	Pending submittal	Not initiated	Ensures compatibility with relevant land use plans
	Road crossing permits	Pending submittal	Not initiated	Authorizes crossing of local and county jurisdictional roadways
	Construction haul road agreements	Pending submittal	Not initiated	Authorizes use of local and county roads to haul oversized loads
	Temporary access/entrance permits	Pending submittal	Not initiated	Authorizes access to private lands from local and county road rights-of-way
	Short- to long-term leases – access roads	Pending submittal	Not initiated	Authorizes use of temporary roads on locally and county-owned lands

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Chapter 7
Route Segment Alternatives

Chapter 7 compares individual route segment alternatives (RSAs) with the segment of the Applicant's preferred route they would replace. Commenters proposed RSAs during the scoping process to mitigate impacts on localized resources. Most are relatively short deviations; however, two are over 50 miles long. This chapter also describes RSA-53, a stand-alone RSA that connects to RSA-21, making it possible for RA-06, RA-07, or RA-08 to avoid the Fond du Lac Indian Reservation. Table 4.3-5 describes the location of each RSA, as well as its intended purpose. Figure 7-1 shows the location of the RSAs.

7.1 BACKGROUND

The discussion that follows identifies differences between individual RSAs and the segment of the Applicant's preferred route they replace by comparing common resources and factors. Each RSA is briefly described and discussed; meaningful variations between the RSA and the segment of the Applicant's preferred route it replaces are highlighted; affected resources are shown in a table; and the RSA is identified on a map. Note that the purpose of this chapter is to identify differences between the routing options—that is, the variation between the RSA and the segment of the Applicant's preferred route it replaces. As such, this chapter does not discuss impacts that are similar regardless of their intensity level.

The analysis used geographic information system (GIS) software to identify resources affected by the pipeline based upon the commenter's proposed alignment. In certain instances, re-aligning the pipeline within the route width might avoid specific resources. A centerline modification within a non-homogenous route segment might change the resources affected. This analysis does not account for these changes because without detailed engineering surveys and consideration of design constraints or restrictions associated with other resources within the route segment, it is difficult to accurately determine if re-alignment is possible and, if it is possible, where the pipeline would ultimately be located. Instead, in these instances the analysis relies on generic assessments, for example: "Re-aligning the pipeline within the route width would avoid this structure; re-alignment would likely increase the number of forested acres within the construction work area."

7.2 ASSUMPTIONS

Existing conditions along individual RSAs at the landscape scale are similar to those described in Chapter 6. Construction and operation practices are identical to those described in Chapter 2, including Applicant-proposed measures to avoid and minimize environmental impacts. Mitigation measures discussed throughout Chapters 2, 5, and 6 apply to any RSA selected. This analysis assumes coordination with local, state, federal, and tribal agencies would occur to determine appropriate design, construction, and operation techniques.

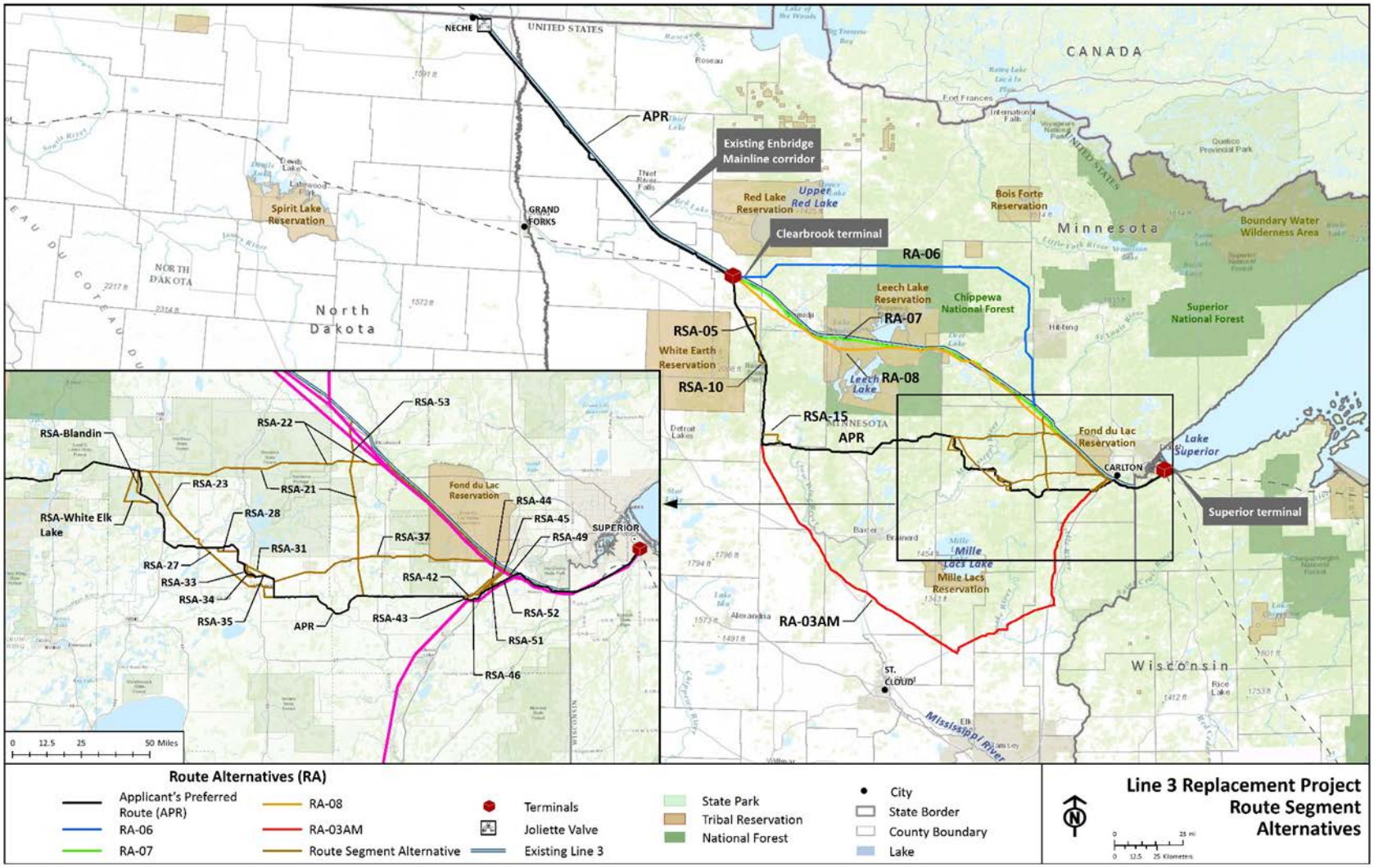

Figure 7-1. Location of Route Segment Alternatives

If the Minnesota Public Utilities Commission (Commission) selects RSA-21, RSA-22, RSA-23, or RSA-37, a new pump station might be required. A pump station would require approximately 8 acres of land. Additional mainline valves (MLV) could be required for RSA-05, RSA-21, RSA-22, RSA-23, RSA-27, and RSA-37 because of their length or proximity to sensitive resources. Specific footprints of these facilities are not evaluated in this analysis because pump station or MLV locations have not been identified. Facilities would be sited as part of final design if a given RSA is selected by the Commission for the permitted route.

The analysis in Section 7.3 highlights meaningful variations between routing options. To reduce redundancy, potential impacts are described once below. Impacts are organized by routing factor. The analysis of meaningful variations between routing options in Section 7.3 pulls from these descriptions.

(A) Human Settlement

Aesthetics: Aesthetic impacts are subjective and relate to an individual's perceived sense of beauty. They are influenced by many factors. Commonly, people consider a harmonious viewshed to be aesthetically pleasing.

In general, the duration of visual impacts during construction in all but areas of woody vegetation, including forested wetlands, would persist until vegetation has reestablished in the construction work area. Operational impacts would be associated mainly with aboveground facilities and permanent clearing of woody vegetation within the 50-foot-wide permanent right-of-way. These impacts would be strongest where they are in the immediate foreground of sensitive observation points.

Noise: Project-related noise impacts generally fall into two categories: temporary impacts resulting from the use of construction equipment and activities, and permanent impacts resulting from pump station facility operations. Because Chapter 7 does not discuss facilities, permanent noise impacts are not discussed.

Construction-related noise associated with heavy equipment can range from 80 to 90 decibels (specifically A-weighted decibels or dBa) at full power. Heavy equipment usually runs at full power 50 percent of the time. Point source sounds decrease 6 dBa per doubling of distance. This means an 80 dBa sound at 50 feet is perceived as a 56 dBa sound at 800 feet. A 90 dBa sound is perceived as 66 dBa. As such, construction-related noises are anticipated to be greatest within 1,250 feet of the centerline of the pipeline permanent right-of-way.

Transportation: Pipeline companies cross roads and other features by a variety of methods: open trench, bore, or directional drill. These methods affect traffic patterns differently. For example, the open trench method will result in road closures, whereas a bore or directional drill method might occur while traffic utilizes the road. The Applicant is proposing to cross paved roads and railroads by boring or horizontal directional drill (HDD), which would prevent road closures.

Displacement: Displacement is the forced removal of a residence or business to accommodate the routing of the pipeline. Often displacement can be avoided by re-aligning the pipeline within the route width.

Environmental Justice: Environmental justice refers to the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income. In general, environmental justice is

addressed to ensure equal protection from environmental and health hazards, as well as equal access to the environmental decision-making process.

Minority or low-income communities are often concentrated in small geographical areas within the larger area of study. Identifying these areas enables an analysis of whether these communities might experience disproportionate impacts from a project. This allows analysts and decision makers to identify and understand what portion of the total impacts may be borne by minority or low-income communities, to assess whether they are disproportionately high and adverse and to develop alternatives and mitigation measures if necessary.

(B) Natural Environment

Vegetation: Vegetation is an assemblage of plants with similar structure that are categorized into types of ground cover. This analysis is based on existing cover types and site-specific impacts.

Vegetation would be removed or disturbed during construction. Short-term impacts are the result of grading and other physical disturbances. Woody species are not permitted to regenerate in the permanent right-of-way. This alters the composition and structure of the vegetation by converting it to herbaceous cover types. These impacts are permanent. Clearing vegetation increases potential for the introduction of invasive species; however, for the purposes of Chapter 7, potential impacts from invasive species are assumed to be similar for all routing options.

Native plant communities are a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. Impacts on these communities are considered greater than impacts on other areas (e.g., non-native plant communities, heavily disturbed areas).

Wildlife Habitat: As a result of vegetation clearing, the underlying wildlife habitat would be altered—in some instances, permanently. Habitat loss has a consistent negative effect on biodiversity and can adversely affect species richness and population growth rates, among other measures. Habitat loss results from the creation of new corridors (called greenfield crossings) or the expansion of an existing corridor. Greenfield crossings create new habitat fragmentation, or the breaking apart of habitat, and new “edge” effects, or the creation of an artificial habitat boundary. While expansion of existing corridors further emphasizes existing habitat fragmentation and edge effects on one side of the right-of-way, potential impacts are less than those created by greenfield crossings.

Designated trout stream corridors are permanent easements that encompass 66 feet of land and water on either side of the centerline of the stream. Easements permit angler access, provide corridor protection, and allow the Minnesota DNR to conduct habitat improvement activities if needed. Impacts on these areas are considered greater due to the public investment of funds to secure the easement and the habitat they protect.

Wildlife: Wildlife that inhabit the route are anticipated to relocate during Project construction. The majority would return; however, some might be permanently displaced—especially species that rely upon woody vegetation or unfragmented habitats. Some individuals might be struck or killed, but population-level impacts are not anticipated.

Public Lands: Potential impacts on public lands—lands identified and protected because of their value to the state—would affect all Minnesotans. Given the importance of state lands to wildlife, recreation, and

tourism, potential impacts would be regional. Impacts on private lands generally only affect those specific landowners and communities, and remain local. While both impacts may be significant, this analysis assumes, that on whole, potential impacts on public lands are greater.

(G) Natural Resources

Water Resources: Pipelines can affect surface waters, generally through indirect impacts from vegetation removal during right-of-way clearing. These impacts can include changes in water flow patterns or increased sedimentation. The potential for surface water impacts increases at stream/river crossings and in proximity to surface waters, such as rivers, lakes, and ponds. Direct impacts on groundwater can occur when a pipeline trench affects shallow water tables or underground pathways to aquifers. Potential for impacts is assumed to correlate with vulnerable water table distance crossed. Indirect impacts on groundwater can result from direct impacts on surface water.

Wetlands: Potential impacts on wetlands generally occur during construction; however, unlike most construction impacts, impacts on wetlands are usually long term or permanent because of the soil types associated with them. Impacts on the hydrology of a wetland can significantly impair its function. Conversion of forested or woody wetlands will not reduce the overall wetland acreage, but will permanently convert the wetland to a different vegetation community and wetland type. Like surface waters, wetlands are affected in large part from changes in water flow patterns or increased sedimentation. The potential for impacts increases in proximity to the wetland.

(D) Economics

Agriculture: Impacts on agriculture occur during pipeline construction. Impacts can include soil erosion, interference with and damage to agricultural surface and subsurface drainage and irrigation systems, mixing or loss of fertile topsoil and subsoil, and soil compaction. During construction, the production of crops on agricultural land would typically be prevented for one growing season, resulting in temporary minor losses to land currently being used for agricultural production. For the purposes of this analysis, impacts on peat lands are assumed to be permanent.

Recreation and Tourism: Impacts on recreation can be positive or negative. Potential impacts might be negative if they change the aesthetics of a recreational destination. Conversely, right-of-way clearing might increase opportunities for wildlife viewing or hunting. Impacts on recreation affect tourism if the impact increases or decreases visitor use. Since the majority of the land crossed by the route does not include developed recreational areas such as facilities and trails, potential impacts are likely to be temporary and localized, and limited to recreational users who live in and around the area.

7.3 ANALYSIS

Section 7.3 analyses 24 RSAs.

7.3.1 Route Segment Alternative RSA-05

RSA-05 is located in Clearwater County. It is 13.0 miles long and replaces a 9.8-mile segment of the Applicant's preferred route between Milepost (MP) 154.1 and MP 164.0 (Figure 7.3-1). RSA-05 traverses an area of mixed active farmland and forested land. It departs from the Minnesota Pipeline Company, LLC (MPL) pipeline corridor along which the Applicant's preferred route is co-located, creating a new greenfield corridor. The purpose of RSA-05 is to avoid the Eastern Wild Rice watershed and a possible hydrological connection to Lower Rice Lake. Table 7.3-1 highlights the differences between RSA-05 and the Applicant's preferred route.

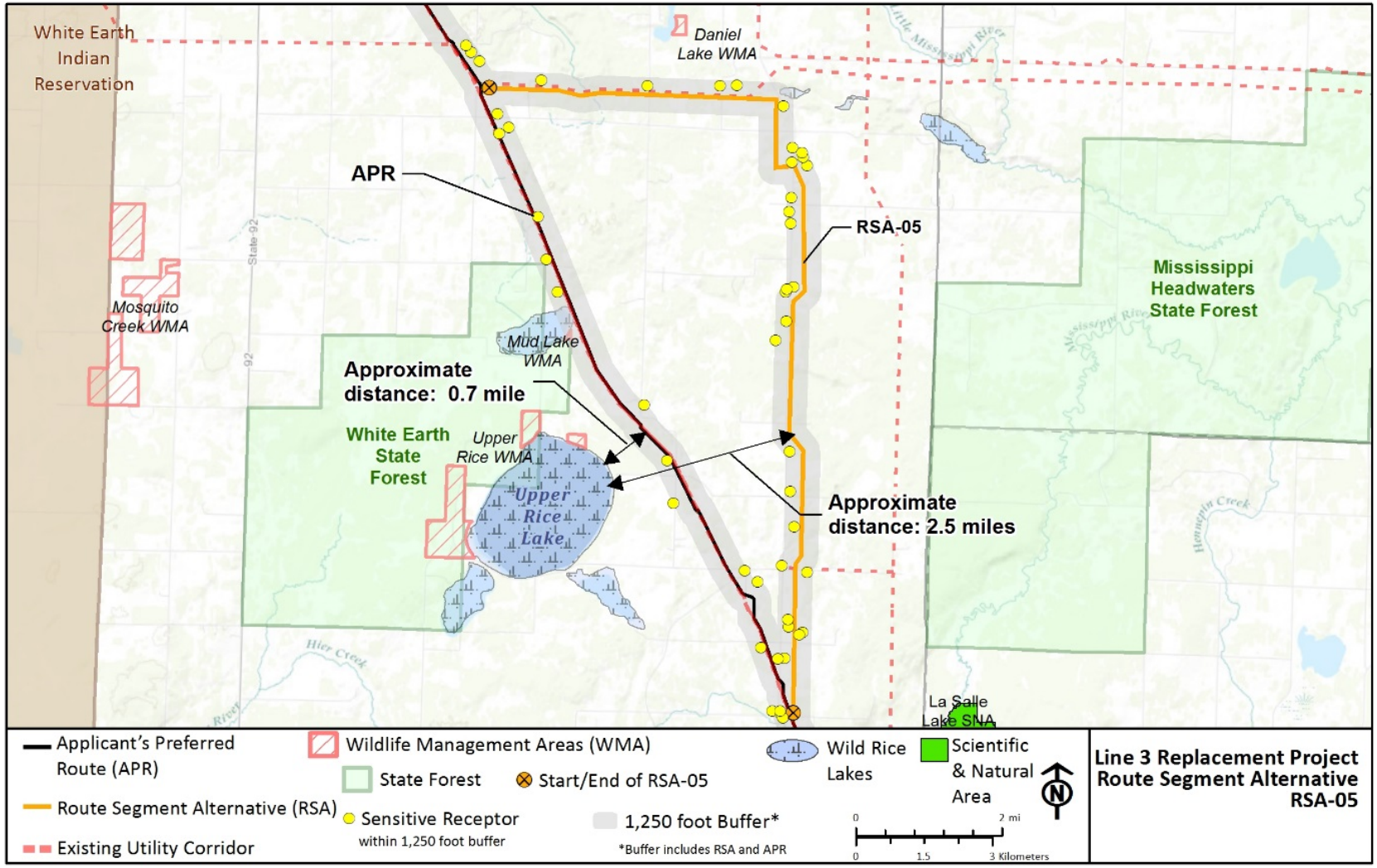

Figure 7.3-1. Route Segment Alternative RSA-05

Table 7.3-1. Localized Differences between Route Segment Alternative RSA-05 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	189.20	128.79	**+ 60.41**
Percentage co-located with existing corridors[a]	28.4%	100%	**– 71.6%**
Number of sensitive noise receptors[b]	32	18	**+ 14**
Number of stream/river crossings	7	2	**+ 5**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	89.15	59.80	**+ 29.35**
Acres of wetland crossings (construction work area)	16.91	22.81	**– 5.9**
Miles of vulnerable water table crossings[c]	2.3	1.5	**+ 0.8**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	41%	2%	48%	4%	6%
Replaced segment	32%	3%	45%	8%	11%
Change	**+ 9%**	**– 1%**	**+ 3%**	**– 4%**	**– 5%**

Wetlands – Permanent Right-of Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	3.42	3.71	--	--	--
Replaced segment	4.76	6.82	0.23	--	--
Change	**– 1.34**	**– 3.11**	**– 0.23**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-05 would consist of transmission line and road rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative, "--" = Not applicable

RSA-05 moves the pipeline out of the Eastern Wild Rice watershed. However, it shifts the resources at risk from an accidental release of oil to the Clearwater River watershed and Mississippi River – Headwaters watershed. These two watersheds are otherwise affected by the Applicant's preferred route in the immediate area; the Eastern Wild Rice watershed is not.

The Wild Rice River flows from Upper Rice Lake and meanders through Lower Rice Lake and the Eastern Wild Rice watershed until it reaches the Red River. The Applicant's preferred route is 0.7 mile from Upper Rice Lake at its closest point. Due to this distance, impacts on this waterbody from construction

and normal operation are not anticipated. Mud Lake is approximately 1.3 miles north of Upper Rice Lake. Satellite imagery and topographic maps suggest that Mud Lake also drains to the Wild Rice River. The Applicant's preferred route passes approximately 500 feet northeast of this waterbody through a freshwater emergent wetland. It appears that, should this wetland be saturated, a hydrological connection between the Applicant's preferred route and the Wild Rice River might exist.

RSA-05 increases the minimum separation between these lakes and the pipeline to approximately 2.5 miles and moves the pipeline out of the Eastern Wild Rice watershed. However, RSA-05 crosses Walter Brook, which is a tributary to the Clearwater River. In addition, RSA-05 crosses an unnamed, intermittent stream at three locations. This stream flows through Duncan, Berg, and Moose lakes prior to joining the Little Mississippi River. The Little Mississippi is a tributary to the Mississippi River.

Meaningful Variation Exists Between Routing Options

RSA-05 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: Both routing options expand or create new openings on the landscape; however, RSA-05 requires greenfield crossings, while the Applicant's preferred route does not. Therefore, RSA-05 is anticipated to increase aesthetic impacts.

Noise: The centerline of RSA-05 is within 1,250 feet of 14 additional sensitive noise receptors. This increases potential construction-related noise impacts.

Transportation: RSA-05 crosses approximately twice as many roadways. This may or may not affect traffic patterns during Project construction depending upon the construction method used to cross the roadway.

(B) Natural Environment

Vegetation: RSA-05 clears an additional 29 acres of forested cover types.

Wildlife Habitat: RSA-05 would affect 29 additional acres of woodland habitat, but 5 fewer acres of wetland habitat.

RSA-05 requires greenfield crossings; the Applicant's preferred route does not. Because of this, impacts from habitat fragmentation and edge effects would be greater along RSA-05.

(F) Co-Location

RSA-05 is co-located with existing corridors for approximately 71 percent less of its length than the Applicant's preferred route.

(G) Natural Resources

Water Resources: RSA-05 increases potential for surface water and groundwater impacts because it requires five additional stream crossings and crosses an additional 0.8 mile of vulnerable water table aquifers compared with the Applicant's preferred route.

Wetlands: RSA-05 would affect half as many wetland acres and reduce conversion of forested wetlands, reducing potential impacts on wetlands overall.

7.3.2 Route Segment Alternative RSA-10

RSA-10 is located in Clearwater and Hubbard counties. It is approximately 6.8 miles long and replaces a 5.6-mile segment of the Applicant's preferred route between MP 167.4 and MP 173.1 (Figure 7.3-2). RSA-10 is located adjacent to road rights-of-way and crosses forested areas intermixed with farmland. The purpose of RSA-10 is to move the crossing at LaSalle Creek to a more accessible location for emergency response. LaSalle Creek is a tributary to the Mississippi River. It flows south-to-north through various wetland types and Big LaSalle Lake, Middle LaSalle Lake, and LaSalle Lake before joining the Mississippi River. Table 7.3-2 highlights the differences between RSA-10 and the Applicant's preferred route.

RSA-10 locates the LaSalle Creek crossing in a more accessible location. The Applicant's preferred route positions the LaSalle Creek crossing approximately 0.5 mile upstream from Big LaSalle Lake, about 0.8 miles from Itasca Township Road 187, and 1.6 miles from 105th Avenue. The Applicant's preferred route crossing would be accessible via maintenance roads along new or existing oil pipelines. RSA-10 increases the distance of the crossing from Big LaSalle Lake to approximately 3.0 miles. It crosses LaSalle Creek along County Road 96, effectively eliminating separation from road access.

Cumulative Impacts Influence Route Segment Alternative RSA-10

Minnkota Power Cooperative proposes to construct a 115-kilovolt (kV) high-voltage transmission line to serve the industrial load for a new pumping station to be constructed and operated by MPL. The project is referred to as the Minnesota Pipeline – Laporte 115-kV Transmission Line Project (MPL-Laporte Project). RSA-10 follows the preferred transmission line route. Should the Commission ultimately select the preferred transmission line route, it would necessitate shifting the RSA-10 centerline for a portion of its length to provide adequate spacing between it and the transmission line.

The Environmental Assessment (EA) for the MPL-Laporte Project included an alternative that co-located the transmission line along the existing MPL pipeline corridor (Collocate Alternative Route). During development of the Collocate Alternative Route, MPL requested that a separation distance of 100 feet be maintained between the existing pipeline corridor and the new 115-kV transmission line, resulting in a 25-foot gap between the existing pipeline right-of-way and the transmission line right-of-way.

In the Relative Merits analysis contained in the EA, staff determined the Collocate Alternative Route had greater potential for negative impacts than the preferred route because of the separation between rights-of-way. This separation would create a new corridor, causing greater aesthetic impacts and increased habitat fragmentation and edge effects.

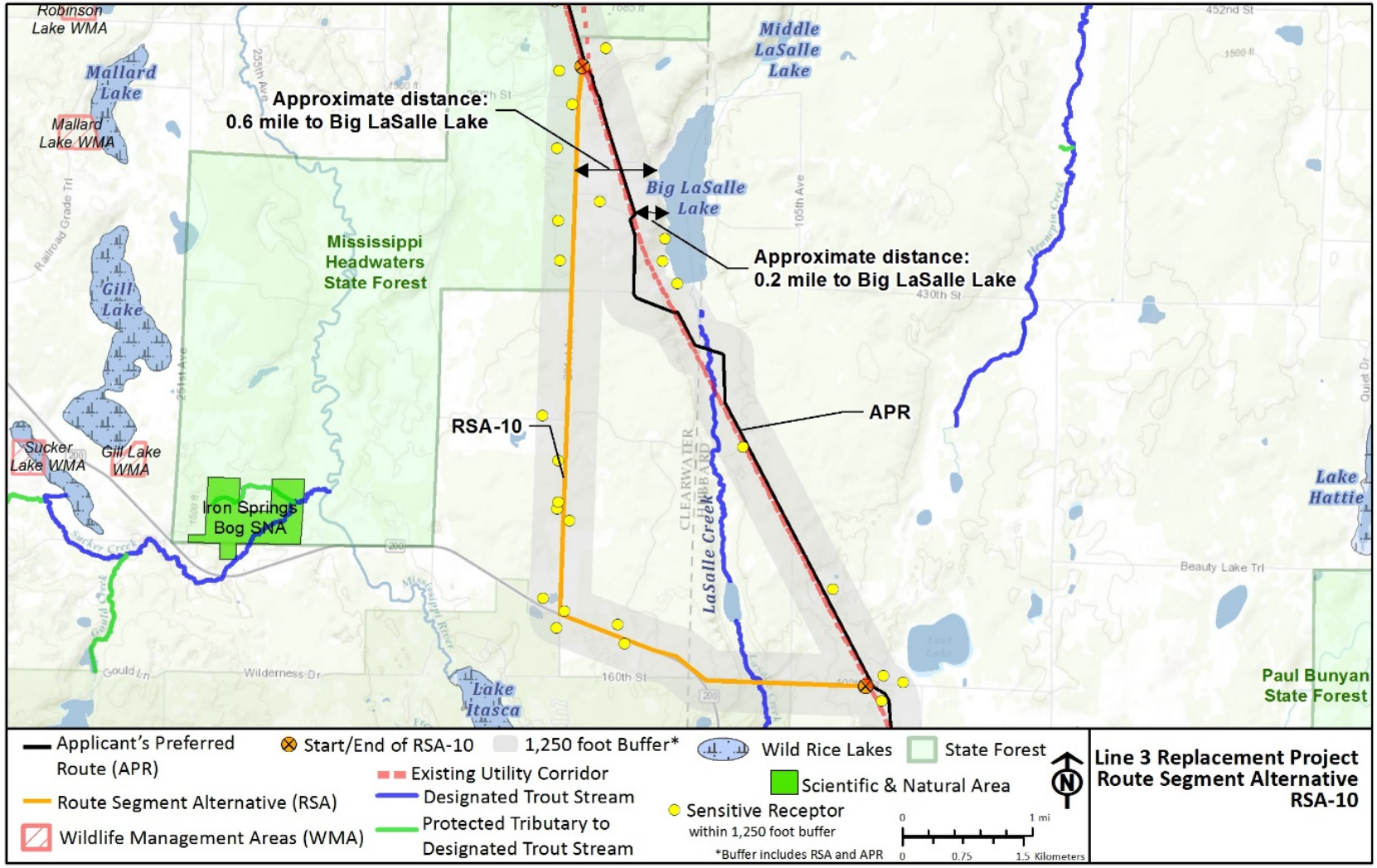

Figure 7.3-2. Route Segment Alternative RSA-10

Table 7.3-2. Localized Differences between Route Segment Alternative RSA-10 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of permanent right-of-way	99.25	78.12	**+ 21.13**
Percentage co-located with existing corridors[a]	99%	70%	**+ 29%**
Number of sensitive noise receptors[b]	16	9	**+ 7**
Number of river crossings	2	2	**No change**
Number of designated trout stream crossings	1	1	**No change**
Acres of native plant community crossings (construction work area)	4.73	8.19	**– 3.46**
Acres of forested land crossings (construction work area)	44.97	69.01	**– 24.04**
Acres of wetland crossings (construction work area)	5.70	1.82	**+ 3.88**
Miles of vulnerable water table crossings[c]	0.2	0.9	**– 0.7**

Land Cover[d]

Route Segment	*Agricultural*	*Developed*	*Forest*	*Water/Wetlands*	*Other*
RSA	14%	33%	45%	2%	7%
Replaced segment	6%	2%	87%	1%	5%
Change	**+ 8%**	**+ 31%**	**– 42%**	**+ 1%**	**– 2%**

Wetlands[e]

Route Segment	*Emergent*	*Forested/Shrub*	*Freshwater Pond*	*Lake*	*Riverine*
RSA	0.20	2.40	--	--	--
Replaced segment	0.76	0.08	--	--	--
Change	**– 0.56**	**+ 2.32**	**No change**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-10 would consist of road right-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n.d.). Permanent right-of-way in acres.

RSA = route segment alternative

In the MPL-Laporte Project EA, staff indicated that the preferred transmission line route has the least potential for negative impacts. Should the Commission ultimately select this route, it would likely necessitate shifting the RSA-10 centerline 150 feet farther from 281st Avenue to provide adequate spacing between it and the transmission line—much like the Collocate Alternative Route discussed above—leaving a 75-foot gap between the pipeline and transmission line rights-of-way. This area may or may not be cleared of vegetation. This spacing is not necessary between pipelines. Therefore, should the Applicant's preferred route be selected instead of RSA-10, a separation distance would not be

necessary, and the impacts discussed above (greater aesthetic impacts, increased habitat fragmentation, and new edge effects) would not occur.

Meaningful Variation Exists Between Routing Options

RSA-10 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: RSA-10 follows roadways for its entire length. This would result in greater visual disturbance during construction than the Applicant's preferred route. Long-term aesthetic impacts may or may not be noticeable to the casual observer.

Noise: The centerline of RSA-10 is within 1,250 feet of six additional sensitive noise receptors, increasing potential noise impacts related to construction.

Transportation: RSA-10 would cross more roads; this may affect traffic patterns during Project construction.

(B) Natural Environment

Vegetation: As currently routed, RSA-10 would affect approximately 25 forested acres; however, should the preferred route of the MPL-Laporte Project be selected, this would necessitate the pipeline being shifted from its current location. This would likely increase impacts on forested lands along the RSA and, as a result, would make impacts on forested cover types similar between routing options.

RSA-10 would affect approximately half as many acres within a native plant community compared with the Applicant's preferred route.

Wildlife Habitat: The Applicant's preferred route would create a habitat patch within a native plant community and an overlapping Minnesota Biological Survey Site of Biodiversity Significance (MBS Site). This habitat patch would be approximately 25 square acres in size. It is not so isolated or small that impacts beyond those generally associated with habitat loss are expected.

Similar to vegetation impacts, should the preferred transmission line route be selected, impacts on woodland habitats would likely be similar between routing options.

RSA-10 would cross a designated trout stream (LaSalle Creek) in a less sensitive location (existing road crossing), reducing impacts on this resource.

Public Lands: RSA-10 borders Itasca State Park for a portion of its length; the Applicant's preferred route does not.

(F) Co-Location

RSA-10 is co-located with existing corridors for approximately 29 percent more of its length than the Applicant's preferred route.

(G) Natural Resources

Water Resources: The LaSalle Creek crossing along RSA-10 is approximately 3.0 miles from Big LaSalle Lake—a 2.5-mile increase over the Applicant's preferred route—potentially reducing impacts on Big LaSalle Lake from an accidental release of oil.

Wetlands: RSA-10 would convert approximately 2.5 acres of forested wetlands; the Applicant's preferred route would convert less than 0.1 acre. Overall, RSA-10 crosses more acres of wetlands, increasing potential impacts.

7.3.3 Route Segment Alternative RSA-15

RSA-15 is located in Hubbard County. It is approximately 9.5 miles long and replaces a 10.4-mile segment of the Applicant's preferred route between MP 199.7 and MP 210.1 (Figure 7.3-3). RSA-15 is co-located with existing corridors for its entire length, and passes through farmland, forest, and wetland areas. The purpose of RSA-15 is to provide better access near Twin Lakes and Shell River for emergency response. Table 7.3-3 highlights the differences between RSA-15 and the Applicant's preferred route.

RSA-15 does not cross the Shell River, but rather the Fishhook River about 1,300 feet upstream of the Shell River and 1.7 miles from Upper Twin Lake. The crossing is approximately 900 feet from Arbor Road. The Applicant's preferred route crosses the Shell River at three locations, one of which is approximately 0.5 mile from Upper Twin Lake. The crossing is 0.6 mile from County Road 6. There is no road access between the Applicant's preferred route and Upper Twin Lake, whereas along RSA-15 the Shell River passes beneath Arbor Road approximately 1.4 miles upstream of Upper Twin Lake.

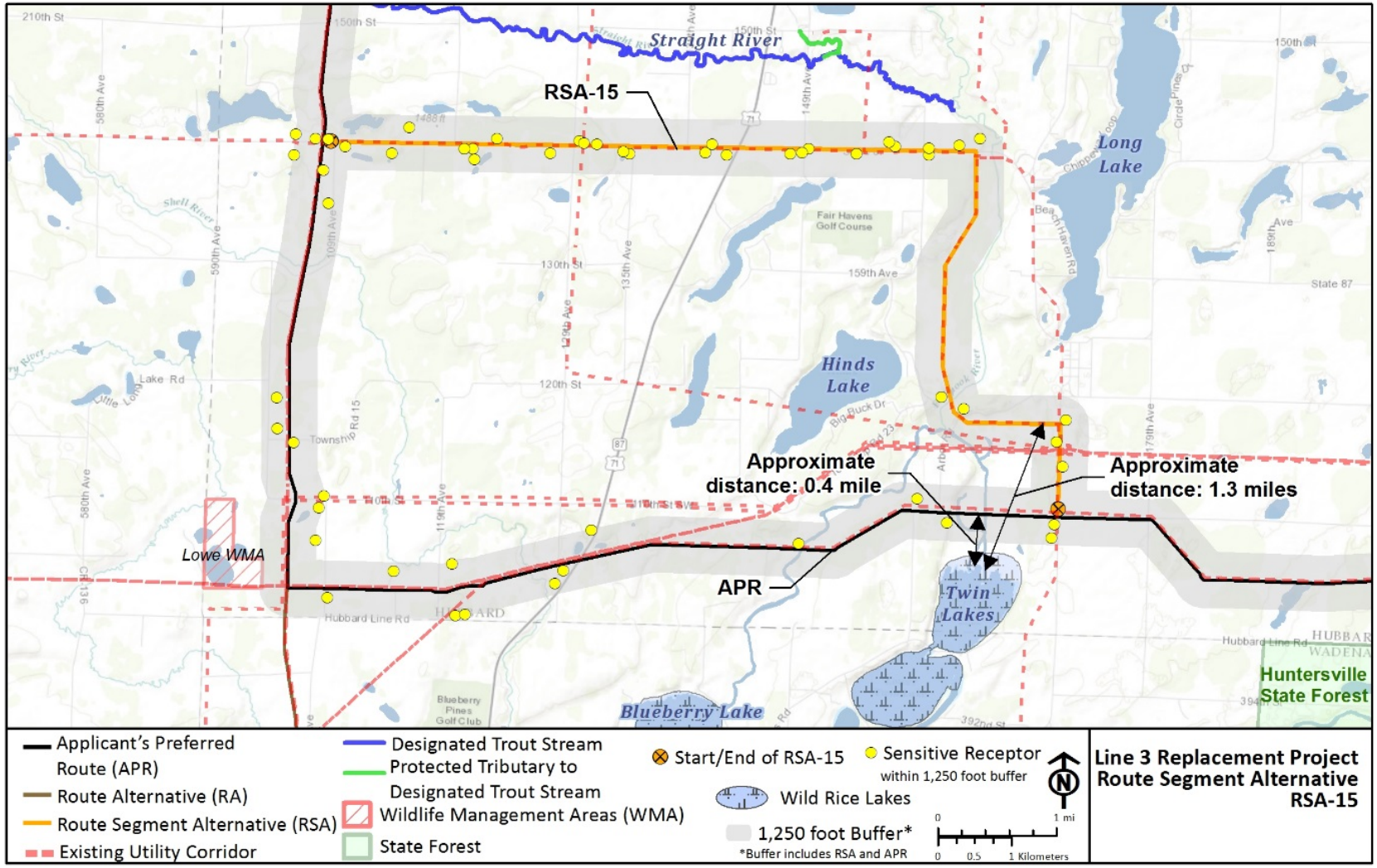

Figure 7.3-3. Route Segment Alternative RSA-15

Table 7.3-3. Localized Differences between Route Segment Alternative RSA-15 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	137.77	133.30	**+ 4.47**
Percentage co-located with existing corridors[a]	100%	100%	**No change**
Number of sensitive noise receptors[b]	32	23	**+ 9**
Number of river crossings	1	3	**– 2**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	30.01	16.70	**+ 13.31**
Acres of forested land crossings (construction work area)	52.38	80.02	**– 27.64**
Acres of wetland crossings (construction work area)	30.38	11.93	**+ 18.45**
Miles of vulnerable water table crossings[c]	6.9	9.7	**– 2.8**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	26%	26%	36%	6%	5%
Replaced segment	20%	3%	57%	13%	7%
Change	**+ 6%**	**+ 23%**	**– 21%**	**– 7%**	**– 2%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	4.24	8.25	--	--	--
Replaced segment	3.62	5.80	0.15	--	0.26
Change	**+ 0.62**	**+ 2.45**	**– 0.15**	**No change**	**– 0.26**

Notes:

[a] Existing corridors used by RSA-15 would consist of transmission line rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

Meaningful Variation Exists Between Routing Options

RSA-15 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; and (G) Natural Resources.

(A) Human Settlement

Noise: The centerline of RSA-15 is within 1,250 feet of twice as many sensitive noise receptors, thereby increasing potential noise impacts related to construction.

Displacement: As currently proposed, RSA-15 displaces several residences. The homes could be avoided by re-aligning the pipeline within the route width. This would likely increase impacts on agricultural and forested cover types.

(B) Natural Environment

Vegetation: RSA-15 would affect approximately twice as many acres of native plant communities, but 30 fewer acres of forested cover types.

(G) Natural Resources

Water Resources: RSA-15 reduces the number of stream crossings. Moreover, these crossing are closer to roads than the crossings along the Applicant's preferred route.

Wetlands: RSA-15 would increase potential impacts on wetlands.

7.3.4 Route Segment Alternative RSA-Blandin

RSA-Blandin is located in Aitkin County. It is approximately 3.9 miles in length and replaces a 3.9-mile segment of the Applicant's preferred route between MP 278.3 and MP 282.2 (Figure 7.3-4). RSA-Blandin is a greenfield route that crosses mainly forested areas and some wetlands. Its purpose is to avoid a Minnesota DNR Forest Legacy Easement, which contains a provision restricting disturbance from a pipeline. RSA-Blandin avoids the Forest Legacy Easement. Minnesota DNR commented that uncertainty associated with these restrictions necessitates additional routing options in this area. Table 7.3-4 highlights the differences between RSA-Blandin and the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-Blandin and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: Both routing options create new openings within Hill River State Forest that would create visual impacts; however, 15 percent of the Applicant's preferred route is co-located with existing road corridor, reducing this effect.

(B) Natural Environment

Vegetation: RSA-Blandin would affect 20 additional forested acres than the Applicant's preferred route.

Wildlife Habitat: Both routing options reduce wildlife habitat in an MBS site, specifically forest and wetland habitats; however, the Applicant's preferred route would have less habitat fragmentation and lower edge effects because a greater percentage is co-located with existing infrastructure.

(F) Co-Location

The Applicant's preferred route is co-located for 15 percent of its length. RSA-Blandin is a greenfield route.

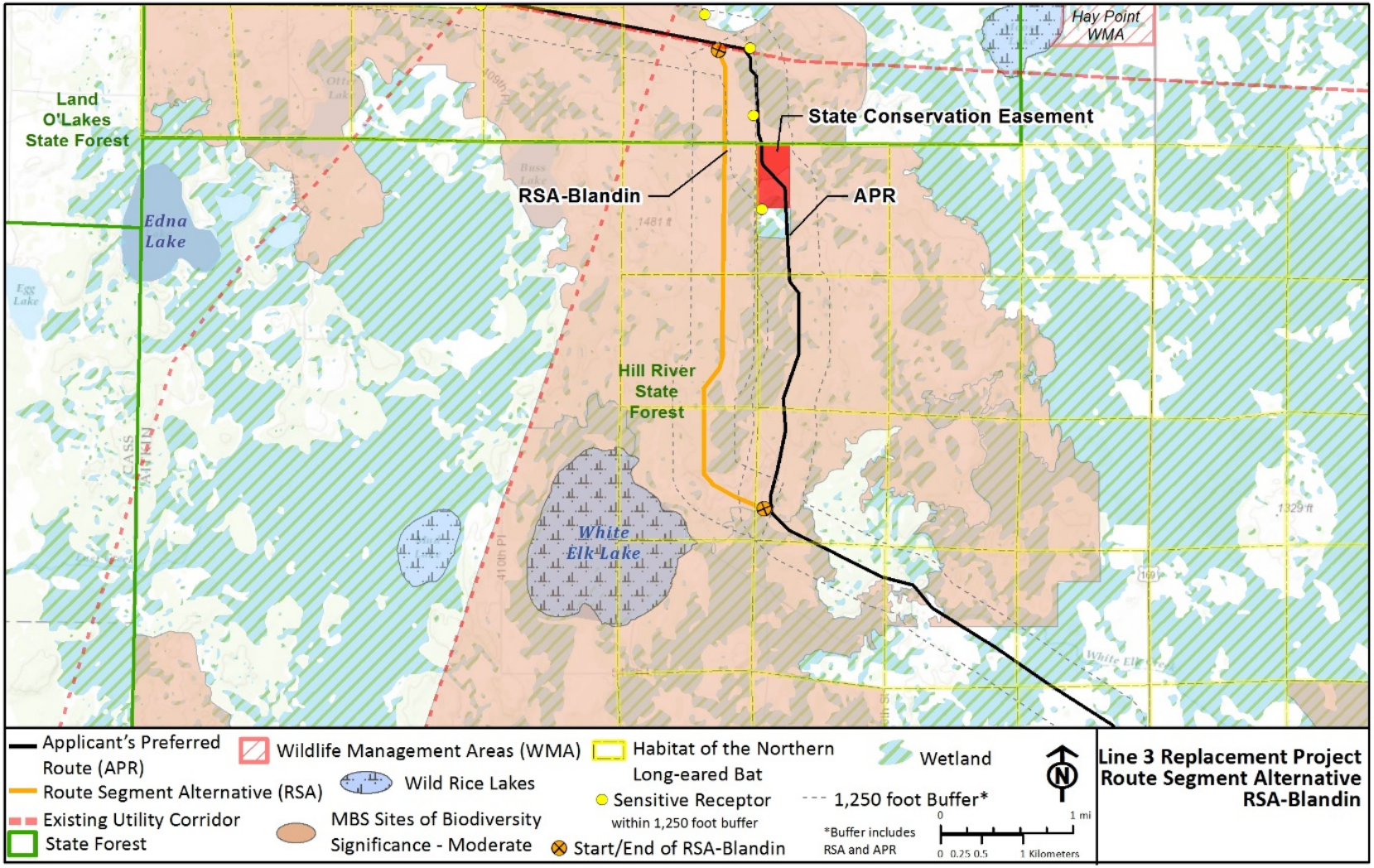

Figure 7.3-4. Route Segment Alternative RSA-Blandin

Table 7.3-4. Localized Differences between Route Segment Alternative RSA-Blandin and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	56.84	50.67	**+ 6.17**
Percentage co-located with existing corridors[a]	0%	15.8%	**– 15.8%**
Number of sensitive noise receptors[b]	2	3	**– 1**
Number of river crossings	0	1	**– 1**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	48.52	28.50	**+ 20.02**
Acres of wetland crossings (construction work area)	3.34	9.40	**– 6.06**
Miles of vulnerable water table crossings[c]	--	0.5	**– 0.5**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	--	2%	86%	7%	5%
Replaced segment	--	16%	55%	20%	9%
Change	**No change**	**– 14%**	**+ 31%**	**– 13%**	**– 4%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	0.29	1.17	--	--	--
Replaced segment	0.96	3.85	--	--	--
Change	**– 0.67**	**– 2.68**	**No change**	**No change**	**No change**

Notes:

[a] RSA-Blandin would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

(G) Natural Resources

Water Resources: RSA-Blandin requires neither river crossings nor vulnerable water table crossings.

Wetlands: RSA-Blandin would affect 6 fewer acres of wetlands and about half as many forested wetlands as the Applicant's preferred route.

7.3.5 Route Segment Alternative RSA-White Elk Lake

RSA-White Elk Lake is located in Aitkin County. It is approximately 9.7 miles long and would replace a 6.8-mile segment of the Applicant's preferred route between MP 277.9 and MP 284.7 (Figure 7.3-5). RSA-White Elk is co-located with existing infrastructure, and runs through primarily forest and wetlands areas. The purposes of RSA-White Elk Lake are to avoid a Minnesota DNR Forest Legacy Easement and fragmentation of an MBS Site. Minnesota DNR commented that uncertainty associated with Forest Legacy Easement necessitates additional routing options in this area. Table 7.3-5 highlights the differences between RSA-White Elk Lake and the Applicant's preferred route.

RSA-White Elk Lake avoids the Forest Legacy Easement. This is the same easement avoided by RSA-Blandin, and contains a provision restricting disturbance from a pipeline. RSA-White Elk Lake is co-located with existing roadway and transmission line corridors for its entire length; therefore, while it crosses an MBS Site, it does not create new habitat fragmentation, specifically new edge effects.

Meaningful Variation Exists Between Routing Options

RSA-White Elk Lake and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: RSA-White Elk Lake follows existing infrastructure for the greater portion of its length, reducing potential for visual impacts.

Noise: The centerline of RSA-White Elk Lake is within 1,250 feet of twice as many sensitive noise receptors as the Applicant's preferred route, thereby increasing potential noise impacts related to construction.

(B) Natural Environment

Wildlife: RSA-White Elk Lake avoids documented maternity roost tree or hibernacula entrance locations for the northern long-eared bat along the Applicant's preferred route; however, considering the proximity of the two routing options, the species likely uses portions of the RSA as well.

Wildlife Habitat: Both routing options would have reduced wildlife habitat in an MBS Site, specifically forest and wetland habitats; however, RSA-White Elk Lake would have reduced habitat fragmentation and edge effects because a greater percentage is co-located with existing infrastructure—that is, the MBS Site is already fragmented along RSA-White Elk Lake.

(F) Co-Location

RSA-White Elk Lake is co-located for 68 percent of its length with existing corridors; the Applicant's preferred route is co-located for 15 percent of its length.

(G) Natural Resources

Wetlands: RSA-White Elk Lake is significantly longer than the Applicant's preferred route. For this reason, it doubles potential impacts on wetlands. The RSA passes through a wetland that might hydrologically connect two wild rice lakes.

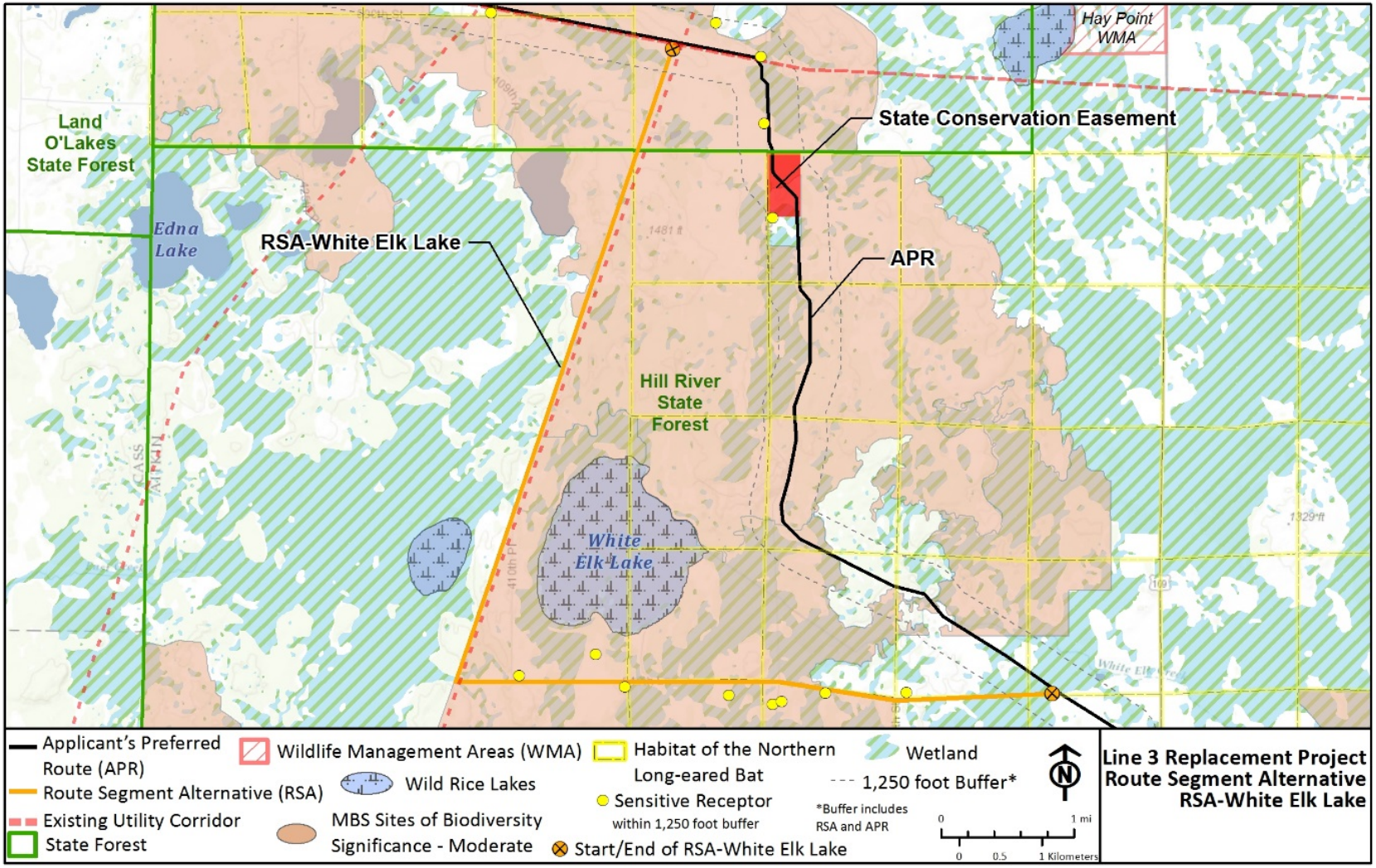

Figure 7.3-5. Route Segment Alternative RSA-White Elk Lake

Table 7.3-5. Localized Differences between Route Segment Alternative RSA-White Elk Lake and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	140.79	86.95	**+ 53.84**
Percentage co-located with existing corridors[a]	68.0%	8.8%	**+ 60.0%**
Number of sensitive noise receptors[b]	8	4	**+ 4**
Number of river crossings	2	2	**No change**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	42.92	47.59	**– 4.67**
Acres of wetland crossings (construction work area)	36.54	18.23	**+ 18.31**
Miles of vulnerable water table crossings[c]	--	0.5	**– 0.5**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	10%	5%	30%	30%	25%
Replaced segment	1%	9%	53%	28%	9%
Change	**+ 9%**	**– 4%**	**– 23%**	**+ 2%**	**+ 14%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	7.84	7.34	--	--	--
Replaced segment	4.95	4.45	--	--	--
Change	**+ 2.89**	**+ 2.89**	**No change**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-White Elk Lake would consist of transmission line and road rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.6 Route Segment Alternative RSA-21

RSA-21 is located in Aitkin County. It is approximately 53.9 miles long and would replace a 53.5-mile segment of the Applicant's preferred route between MP 278.5 and MP 331.9 (Figure 7.3-6). RSA-21 crosses primarily wetland cover types, but forested cover types are also crossed. The purpose of RSA-21 is to avoid impacts on the Sandy River, an ecologically and economically significant fisheries resource, especially downstream resources, such as wild rice and trout streams in the Big Sandy Lake watershed. Table 7.3-6 highlights differences between RSA-21 and the Applicant's preferred route.

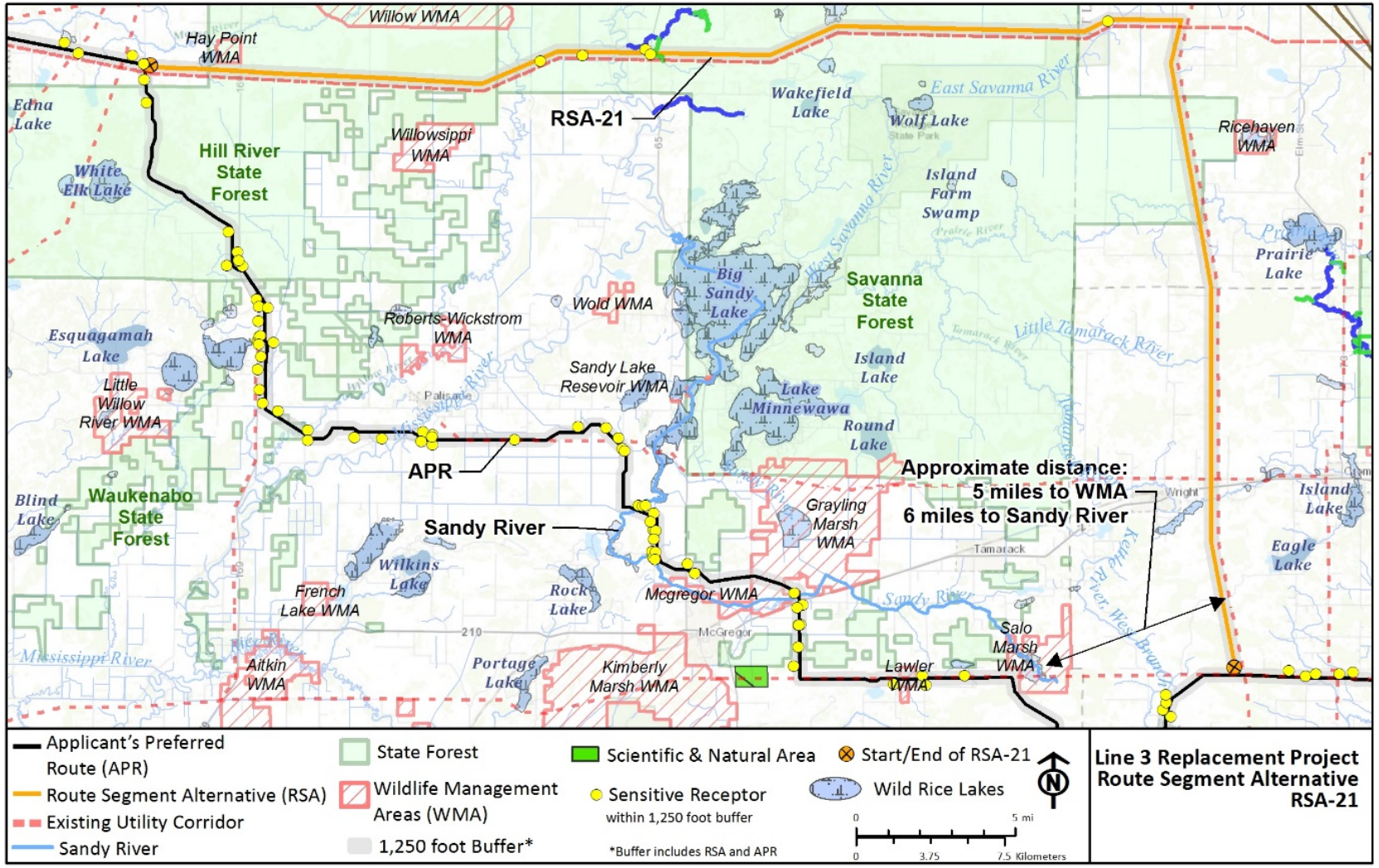

Figure 7.3-6. Route Segment Alternative RSA-21

Table 7.3-6. Localized Differences between Route Segment Alternative RSA-21 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	784.49	667.86	**+ 116.63**
Percentage co-located with existing corridors[a]	100%	26.3%	**+ 73.7%**
Number of sensitive noise receptors[b]	6	63	**– 57**
Number of river crossings	11	14	**– 3**
Number of designated trout stream crossings	1	--	**+ 1**
Acres of native plant community crossings (construction work area)	76.12	9.70	**+ 66.42**
Acres of forested land crossings (construction work area)	169.37	232.65	**– 63.28**
Acres of wetland crossings (construction work area)	403.25	164.83	**+ 238.42**
Miles of vulnerable water table crossings[c]	6.0	1.9	**+ 4.1**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	--	1%	21%	61%	16%
Replaced segment	20%	5%	33%	36%	5%
Change	**– 20%**	**– 4%**	**– 12%**	**+ 25%**	**+ 11%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	12.70	154.27	0.97	0.13	0.24
Replaced segment	20.37	65.19	0.48	--	0.50
Change	**– 7.67**	**+ 89.08**	**+ 0.49**	**+ 0.13**	**– 0.26**

Notes:

[a] Existing corridors used by RSA-21 would consist of transmission line rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

RSA-21 eliminates crossings of, and increases separation between, the pipeline and the Sandy River. It does not eliminate impacts on wild rice waters, and it crosses an additional designated trout stream.

RSA-21 avoids crossing the Sandy River; however, it crosses the West Savanna River, Prairie River, and Tamarack River, all of which flow to Big Sandy Lake. The RSA also crosses a wetland that, based on desktop analysis, is hydrologically connected to the Little Tamarack River, which flows to the Tamarack River and into Big Sandy Lake. Therefore, while RSA-21 might eliminate potential impacts on

the Sandy River from an accidental release of oil, it does not necessary avoid potential impacts on Big Sandy Lake.

RSA-21 avoids impacts on wild rice waters along the Sandy River, specifically, Davis Lake, Steamboat Lake, Flowage Lake, Sandy River Lake, and Big Sandy Lake. However, it does not eliminate impacts on wild rice waters. RSA-21 passes adjacent to Moose Lake, an identified wild rice water. It crosses the Tamarack River approximately 0.5 mile upstream of Tamarack Lake, a wild rice water. Additionally, the RSA crosses West Savanna River, Prairie River, and Tamarack River, all of which flow to Big Sandy Lake.

Meaningful Variation Exists Between Routing Options

RSA-21 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (D) Economics; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: The RSA would have reduced visual impacts compared with the Applicant's preferred route due to its distance from population centers and co-location with existing corridors.

Noise: The centerline of RSA-21 is within 1,250 feet of 57 fewer sensitive noise receptors, thereby decreasing potential noise impacts related to construction.

(B) Natural Environment

Vegetation: RSA-21 would reduce impacts on forested areas by approximately 60 acres. It would increase impacts on native plant communities by approximately the same acreage, including two high conservation value forests—Savanna Hardwoods and Floodwood Bog—within the Savanna State Forest. These forest types are managed in accordance with Forest Stewardship Council forest certification for high biodiversity value.

Public Lands: RSA-21 would increase separation or avoid several Wildlife Management Areas (WMAs)—Grayling Marsh and Lawler—near the Applicant's preferred route. It approaches Hay Point WMA to the north. Overall, RSA-21 increases separation between the pipeline and WMAs. A greater portion of RSA-21 crosses state forests. RSA-21 borders the Savanna Portage State Park for a portion of its length.

(D) Economics

Agriculture: RSA-21 would reduce temporary and permanent impacts on agricultural land.

(F) Co-Location

RSA-21 is co-located with existing transmission line rights-of-way for its entire length; the Applicant's preferred route is co-located for approximately one-quarter of its length.

(G) Natural Resources

Water Resources: RSA-21 has three fewer river crossings compared with the Applicant's preferred route, but it has an additional crossing of a designated trout stream tributary. The Applicant's preferred route does not cross a trout stream.

Wetlands: RSA-21 crosses approximately two-thirds more wetland acres: 403 acres compared to 164 acres. It would convert twice as many forested wetlands (154 acres) to a different wetland type.

7.3.7 Route Segment Alternative RSA-22

RSA-22 is located in Aitkin, St. Louis, and Carlton counties. It is approximately 64.7 miles long and replaces a 73.8-mile segment of the Applicant's preferred route between MP 278.5 and MP 356.7 (Figure 7.3-7). RSA-22 is predominately wetland and forested cover types; however, some farming does occur in this area. The purpose of this RSA is to avoid important habitat in the Big Sandy Lake watershed as well as Grayling Marsh WMA, McGregor WMA, Lawler WMA, and Salo Marsh WMA. Table 7.3-7 highlights the differences between RSA-22 and the Applicant's preferred route.

RSA-22 avoids crossing the Sandy River; however, it crosses the West Savanna River, which flows to Big Sandy Lake. Therefore, it would have reduced potential impacts on the Sandy River from an accidental release of oil, but does not necessarily avoid potential impacts on the Big Sandy Lake watershed.

RSA-22 increases separation or avoids several WMAs—Grayling Marsh and Lawler—near the Applicant's preferred route. It approaches Hay Point WMA to the north. Overall, this RSA increases separation between the pipeline and WMAs.

Meaningful Variation Exists Between Routing Options

RSA-22 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: The RSA would reduce visual impacts due to its distance from population centers and co-location with existing corridors.

Noise: The centerline of RSA-22 is within 1,250 feet of 47 fewer sensitive noise receptors, thereby decreasing potential noise impacts related to construction.

Environmental Justice: RSA-22 passes through the Fond du Lac Indian Reservation, whereas the Applicant's preferred route does not.

(F) Co-Location

RSA-22 is co-located with existing transmission line, refined product pipeline, oil pipeline, or natural gas pipeline rights-of-way for its entire length; the Applicant's preferred route is co-located for 44 percent of its length.

(B) Natural Environment

Vegetation: RSA-22 crosses 130 fewer forested acres, but an additional 40 acres of native plant communities, including two high conservation value forests—Savanna Hardwoods and Floodwood Bog—within the Savanna State Forest. These forest types are managed in accordance with Forest Stewardship Council forest certification for high biodiversity value. RSA-22 increases separation or avoids several WMAs, including Grayling Marsh and Lawler WMAs, near the Applicant's preferred route.

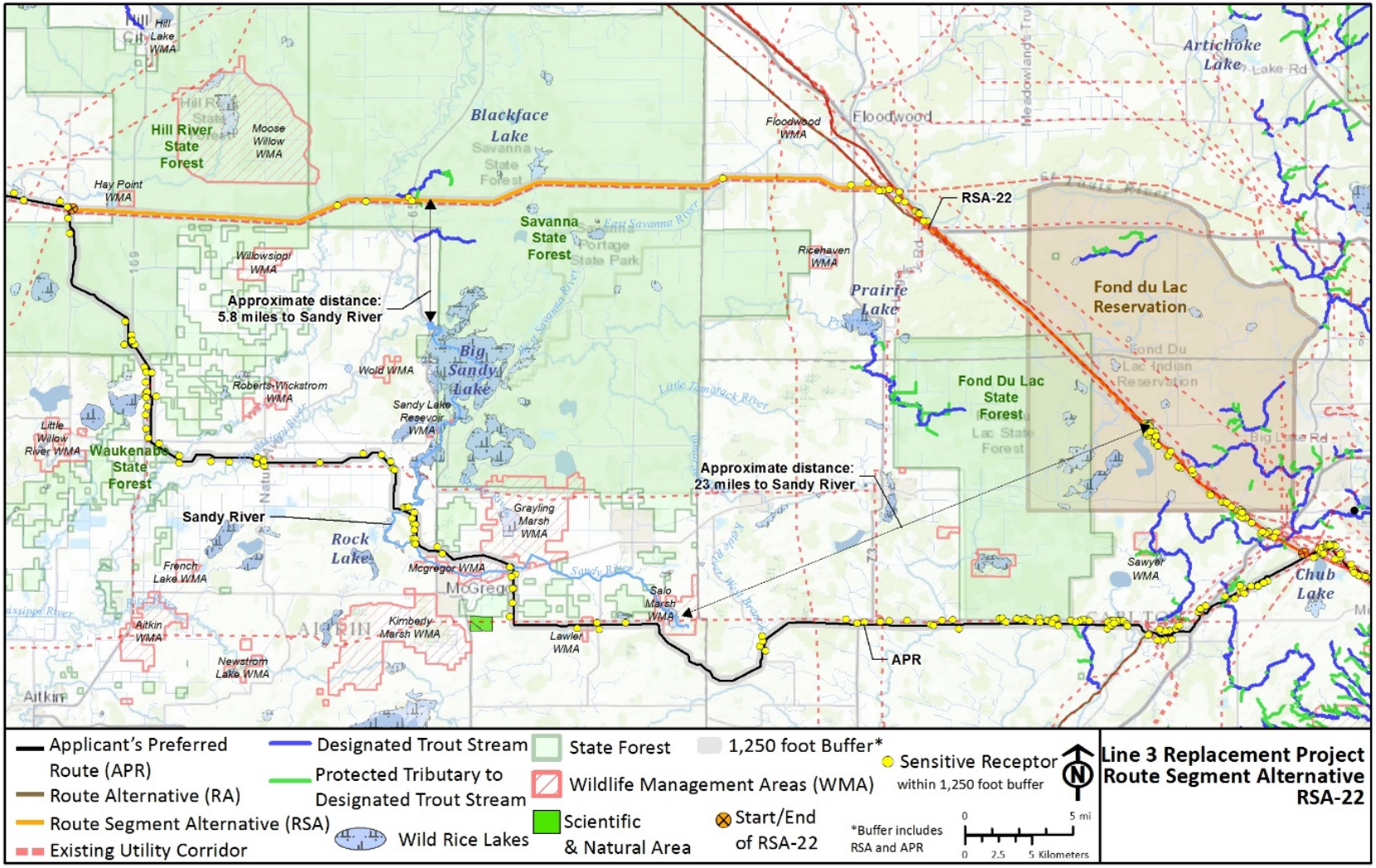

Figure 7.3-7. Route Segment Alternative RSA-22

Table 7.3-7. Localized Differences between Route Segment Alternative RSA-22 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	940.81	985.84	**– 45.03**
Percentage co-located with existing corridors[a]	100%	44.3%	**+ 55.7%**
Number of sensitive noise receptors[b]	75	122	**– 47**
Number of river crossings	17	29	**– 12**
Number of designated trout stream crossings	2	3	**– 1**
Acres of native plant community crossings (construction work area)	68.99	27.49	**+ 41.50**
Acres of forested land crossings (construction work area)	217.38	348.96	**– 131.58**
Acres of wetland crossings (construction work area)	418.44	273.07	**+ 145.37**
Miles of vulnerable water table crossings[c]	12.0	6.2	**+ 5.8**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	4%	2%	23%	52%	20%
Replaced segment	16%	4%	33%	39%	7%
Change	**– 12%**	**– 2%**	**– 10%**	**+ 13%**	**+ 13%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	19.51	152.79	2.11	0.13	0.23
Replaced segment	32.79	106.84	0.83	--	0.50
Change	**– 13.28**	**+ 45.95**	**+ 1.28**	**+ 0.13**	**– 0.27**

Notes:

[a] Existing corridors used by RSA-22 would consist of transmission line, refined product pipeline, oil pipeline, and natural gas pipeline rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

Public Lands: RSA-22 approaches Hay Point WMA to the north. Overall, RSA-22 increases separation between WMAs; however, the RSA is routed through significantly more State Forest—Savanna and Fond du Lac State Forests—and borders Savanna Portage State Park for a portion of its length.

(G) Natural Resources

Water Resources: The RSA crosses about half as many streams and rivers, one additional designated trout stream tributary, and a wild rice lake compared with Applicant's preferred route.

Wetlands: RSA-22 crosses twice as many acres of wetland habitat, including an additional 90 acres of forested wetlands, as the Applicant's preferred route. It crosses twice as many miles of vulnerable water tables.

7.3.8 Route Segment Alternative RSA-23

RSA-23 is located in Aitkin County. It is approximately 31.2 miles long and replaces a 37.0-mile segment of the Applicant's preferred route between MP 278.5 and MP 315.5 (Figure 7.3-8). RSA-23 co-locates the pipeline route with the Soo Line North Trail, a recreational off-highway vehicle trail, for the majority of its length. Wetlands dominate RSA-23; forested areas also exist. The Applicant had originally considered this routing option, but ultimately did not include it in their preferred route. Though no specific environmental reasons were given, multiple commenters requested the RSA be assessed in the Environmental Impact Statement (EIS). Table 7.3-8 highlights the differences between RSA-23 and the Applicant's preferred route.

Route Segment Alternative Crosses a Prohibited Area

RSA-23 crosses the McGregor Marsh Scientific and Natural Area (SNA) following an existing corridor. McGregor SNA is a sensitive area. It is an extensive marsh in the bed of Glacial Lake Aitkin that contains very specific habitat requirements for two rare birds.

Minnesota Statutes 86A.05, Subdivision 5(c), states that "[*p*]*hysical development shall be limited to the facilities absolutely necessary for protection, research, and educational projects, and, where appropriate, for interpretive services*." Minnesota Rule 6135.1100 [Utility Crossings], Subpart 5, indicates that unless no feasible alternative exists, Minnesota DNR must avoid permitting utility crossings across SNAs. Minnesota DNR has indicated it will not permit this crossing.

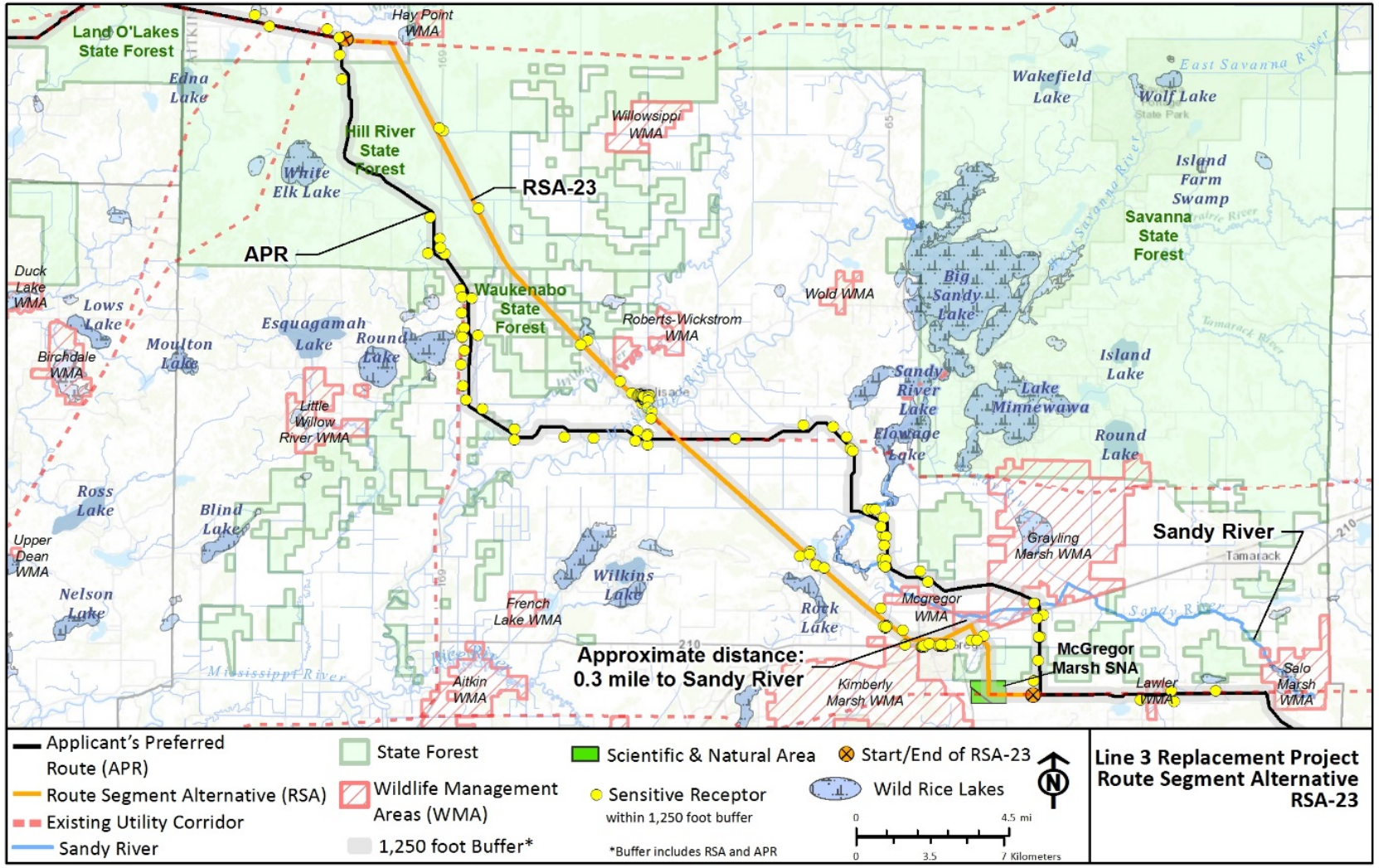

Figure 7.3-8. Route Segment Alternative RSA-23

Table 7.3-8. Localized Differences between Route Segment Alternative RSA-23 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	453.24	449.61	**+ 3.63**
Percentage co-located with existing corridors[a]	15.8%	7.3%	**+ 8.5%**
Number of sensitive noise receptors[b]	96	54	**+ 42**
Number of river crossings	8	11	**– 3**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	28.22	--	**+ 28.22**
Acres of forested land crossings (construction work area)	83.86	118.83	**– 34.97**
Acres of wetland crossings (construction work area)	283.70	129.28	**+ 154.42**
Miles of vulnerable water table crossings[c]	6.2	1.9	**+ 4.3**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	4%	3%	18%	69%	5%
Replaced segment	22%	7%	26%	41%	4%
Change	**– 18%**	**– 4%**	**– 8%**	**+ 28%**	**+ 1%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	34.28	85.02	--	--	0.22
Replaced segment	15.68	51.51	0.48	--	0.50
Change	**+ 18.60**	**+ 33.51**	**– 0.48**	**No change**	**– 0.23**

Notes:

[a] Existing corridors used by RSA-23 would consist of transmission line, road, and railroad rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.9 Route Segment Alternative RSA-27

RSA-27 is located Aitkin, St. Louis, and Carlton counties. It is approximately 13.2 miles long and replaces a 16.0-mile segment of the Applicant's preferred route between MP 298.1 and MP 314.0 (Figure 7.3-9). It follows the Soo Line North Trail, a recreational off-highway vehicle trail, for a significant portion of its length. RSA-27 is primarily dominated by wetlands, and crosses forested cover types to a lesser extent. Its purpose is to avoid the McGregor Marsh SNA and the Sandy River watershed. Table 7.3-9 highlights the differences between RSA-27 and the Applicant's preferred route.

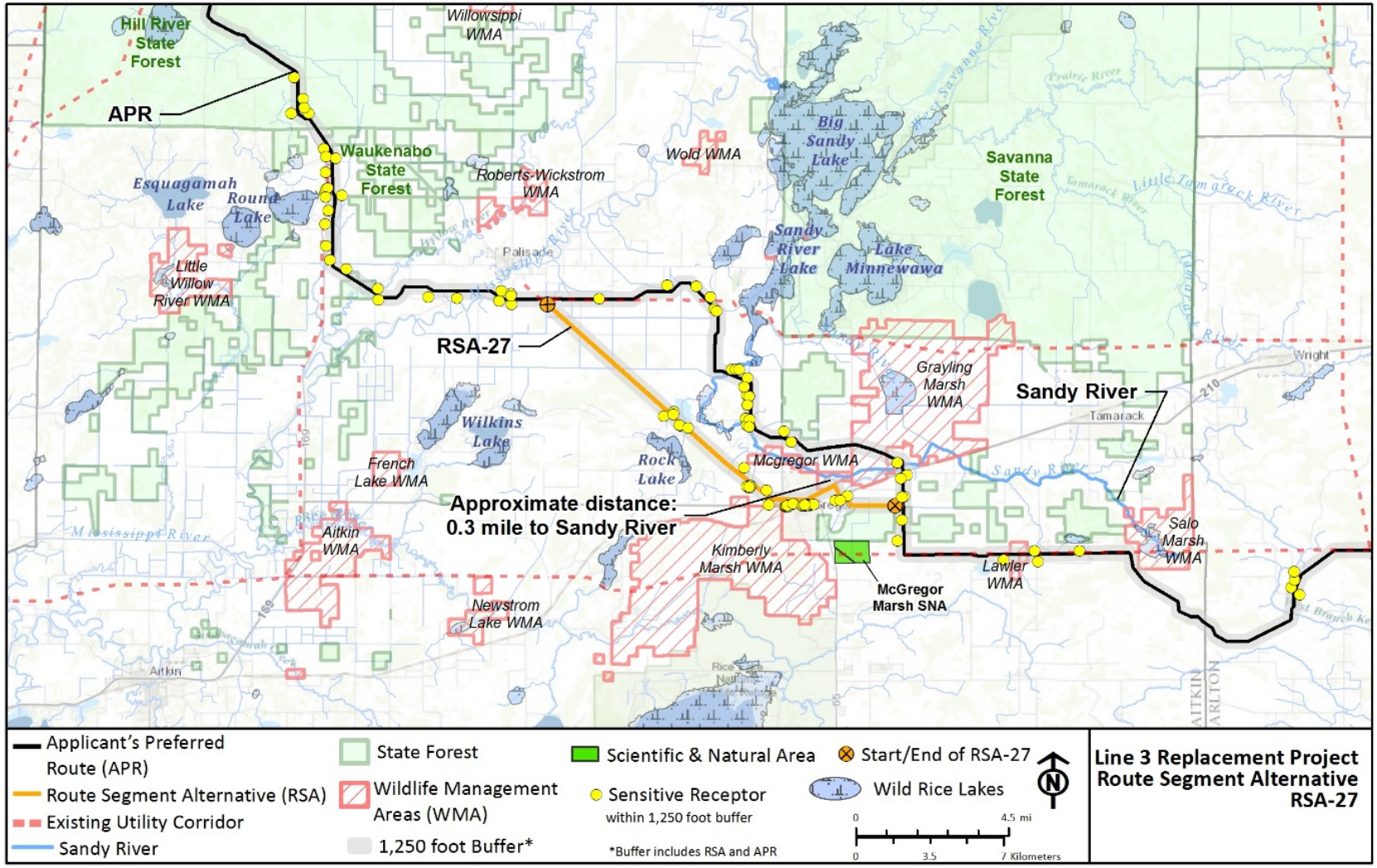

Figure 7.3-9. Route Segment Alternative RSA-27

Table 7.3-9. Localized Differences between Route Segment Alternative RSA-27 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	192.50	190.34	**+ 2.16**
Percentage co-located with existing corridors[a]	15.8%	7.3%	**+ 8.5%**
Number of sensitive noise receptors[b]	35	25	**+ 10**
Number of river crossings	3	4	**– 1**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	16.49	--	**+ 16.49**
Acres of forested land crossings (construction work area)	32.03	40.60	**– 8.57**
Acres of wetland crossings (construction work area)	139.07	40.88	**+ 98.19**
Miles of vulnerable water table crossings[c]	3.8	1.1	**+ 2.7**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	1%	2%	17%	79%	1%
Replaced segment	33%	9%	21%	34%	3%
Change	**– 32%**	**– 7%**	**– 4%**	**+ 45%**	**– 2%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	15.18	42.85	--	--	--
Replaced segment	8.58	13.11	0.48	--	0.24
Change	**+ 6.60**	**+ 29.74**	**– 0.48**	**No change**	**– 0.24**

Notes:

[a] Existing corridors used by RSA-27 would consist of road and railroad rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

RSA-27 avoids the McGregor Marsh SNA. The Applicant's preferred route also avoids the SNA. RSA-27 avoids crossing the Sandy River, but does not eliminate potential impacts on the Sandy River watershed. RSA-27 crosses an unnamed stream that connects Rock Lake to Round Lake to Davis Lake. As currently routed, the proposed pipeline would run adjacent to Round Lake. The Sandy River flows through Davis Lake. Overall, the RSA decreases the number of Sandy River crossings, reducing potential impacts on the Sandy River watershed.

Meaningful Variation Exists Between Routing Options

RSA-27 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (D) Economics; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: The RSA would increase visual impacts due to its proximity to the city of McGregor and the Soo Line North Trail.

Noise: The centerline of RSA-27 is within 1,250 feet of 10 additional sensitive noise receptors, thereby increasing potential noise impacts related to construction.

(B) Natural Environment

Vegetation: RSA-27 crosses 16 acres of native plant communities; the replaced segment of the Applicant's preferred route does not.

Public Lands: RSA-27 avoids crossing the Grayling Marsh WMA. It crosses the McGregor WMA, but the pipeline alignment could avoid this WMA through re-alignment of the centerline within the route width. RSA-27 approaches Kimberly Marsh WMA. Overall, the RSA reduces impacts on WMAs.

(D) Economics

Recreation and Tourism: RSA-27 parallels the Soo Line North Trail for a portion of its length. Construction of the pipeline would affect recreational users. Permanent impacts would result from the conversion of forest and forested wetland cover types near the trail. These impacts (cleared right-of-way) would be perceptible to trail users after restoration of the pipeline in select locations; however, the trail parallels or crosses existing utility corridors and roadways in different locations along its length. Once constructed, impacts on recreation or tourism are not expected.

Agriculture: RSA-27 crosses less agricultural land as a percentage of its length than the Applicant's preferred route, decreasing short-term agricultural impacts.

(G) Natural Resources

Wetlands: RSA-27 crosses an additional 100 acres of wetlands than the Applicant's preferred route, including 30 acres of forested wetlands.

Water Resources: The RSA crosses 2 additional miles of vulnerable water tables.

7.3.10 Route Segment Alternative RSA-28

RSA-28 is located in Aitkin County. It is approximately 3.6 miles long and replaces a 3.8-mile segment of the Applicant's preferred route from MP 300.2 to MP 303.9 (Figure 7.3-10). RSA-28 is located primarily in an agricultural area. It was submitted as a map with no comment attached; therefore, its purpose is unknown. The RSA avoids multiple diagonal crossings of rural properties. It passes through land previously proposed by U.S. Steel (Keetac) as a compensatory wetland mitigation site; however, geospatial data from Minnesota DNR do not identify a mitigation bank easement in this location. Table 7.3-10 highlights the differences between RSA-28 and the Applicant's preferred route.

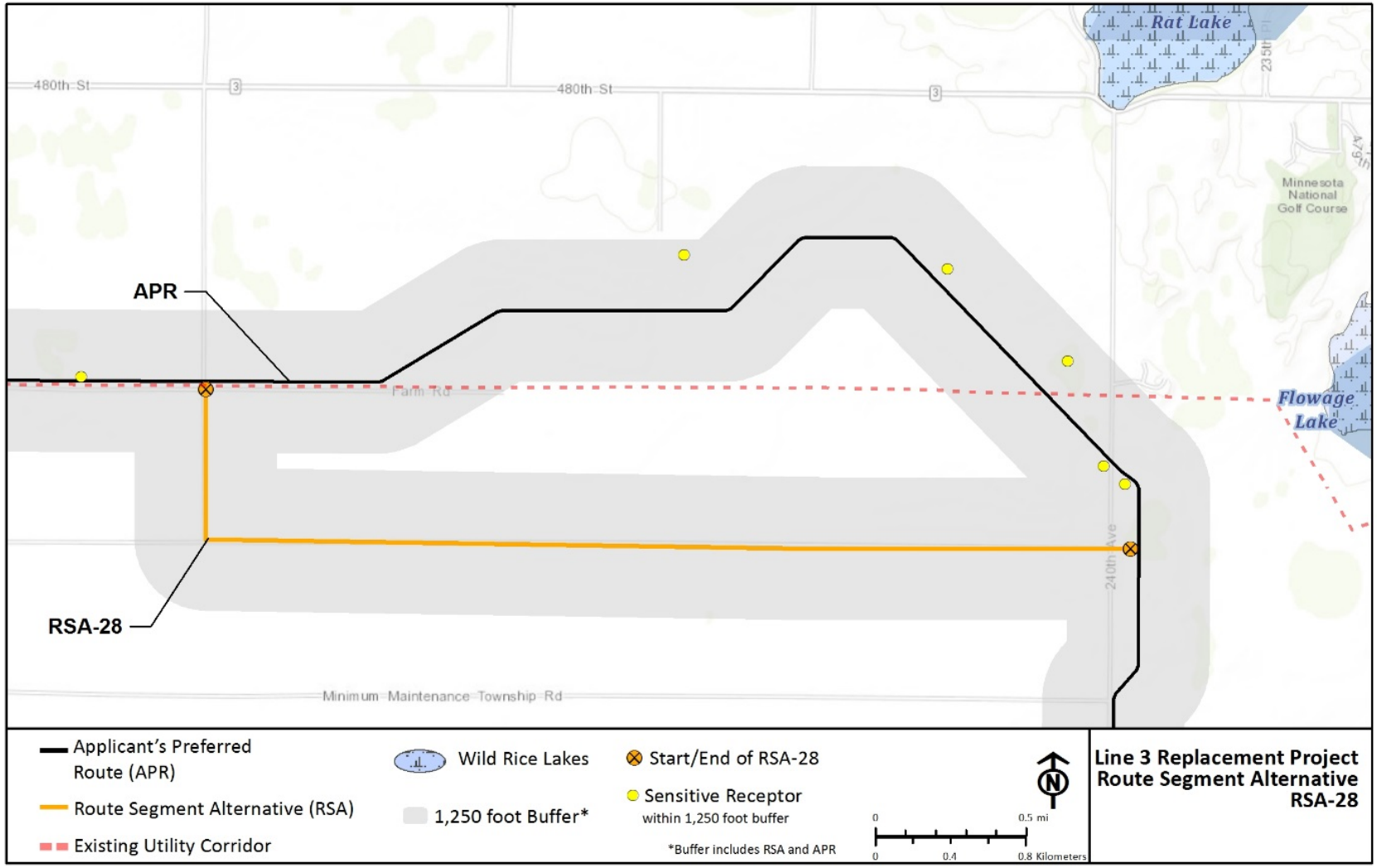

Figure 7.3-10. Route Segment Alternative RSA-28

Table 7.3-10. Localized Differences between Route Segment Alternative RSA-28 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	52.57	45.86	**– 6.71**
Percentage co-located with existing corridors[a]	41.6%	15.7%	**+ 25.9%**
Number of sensitive noise receptors[b]	1	5	**– 4**
Number of river crossings	--	--	**No change**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	0.73	9.04	**– 8.31**
Acres of wetland crossings (construction work area)	15.64	14.11	**+ 1.53**
Miles of vulnerable water table crossings[c]	--	--	**No change**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	84%	5%	2%	5%	4%
Replaced segment	53%	1%	21%	25%	--
Change	**+ 31%**	**+ 4%**	**– 19%**	**– 20%**	**+ 4%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	6.43	--	--	--	--
Replaced segment	5.11	1.88	--	--	--
Change	**+ 1.32**	**– 1.88**	**No change**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-28 would consist of road rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

Meaningful Variation Exists Between Routing Options

RSA-28 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (D) Economics; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Noise: The centerline of RSA-28 is within 1,250 feet of one sensitive noise receptor, reducing potential noise impacts.

Aesthetics: The RSA would reduce visual impacts due to co-location with existing road rights-of-way and farm roads.

(B) Natural Environment

Vegetation: RSA-28 would affect less than 1 acre of forested cover types. The Applicant's preferred route would affect 8 acres.

(F) Co-Location

RSA-28 is co-located with existing road rights-of-way for approximately 40 percent of its length; however, it follows linear infrastructure for its entire length. The Applicant's preferred route follows road rights-of-way for 15 percent of its length.

(D) Economics

Agriculture: RSA-28 would affect peat lands for the majority of its length. These impacts would be permanent.

(G) Natural Resources

Wetlands: RSA-28 would reduce potential conversion of forested wetlands.

7.3.11 Route Segment Alternative RSA-31

RSA-31 is located in Aitkin County. It is approximately 6.1 miles long and replaces a 7.2-mile segment of the Applicant's preferred route from MP 305.5 to MP 312.7 (Figure 7.3-11). RSA-31 is a greenfield crossing across developed farmland, wetlands, and forests. Its purpose is to straighten and shorten the pipeline route. RSA-31 was proposed to reduce the distance between the pipeline and a specific residence. Table 7.3-11 highlights the differences between RSA-31 and the Applicant's preferred route.

RSA-31 shortens and straightens the pipeline route. It increases the distance between the pipeline and many of the receptors along the replaced segment of the Applicant's preferred route; however, it decreases the distance between the pipeline and two receptors.

Meaningful Variation Exists Between Routing Options

RSA-31 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (D) Economics; and (G) Natural Resources.

(A) Human Settlement

Noise: RSA-31 decreases the number of sensitive noise receptors within 1,250 feet of the pipeline centerline by 11, reducing construction-related noise impacts.

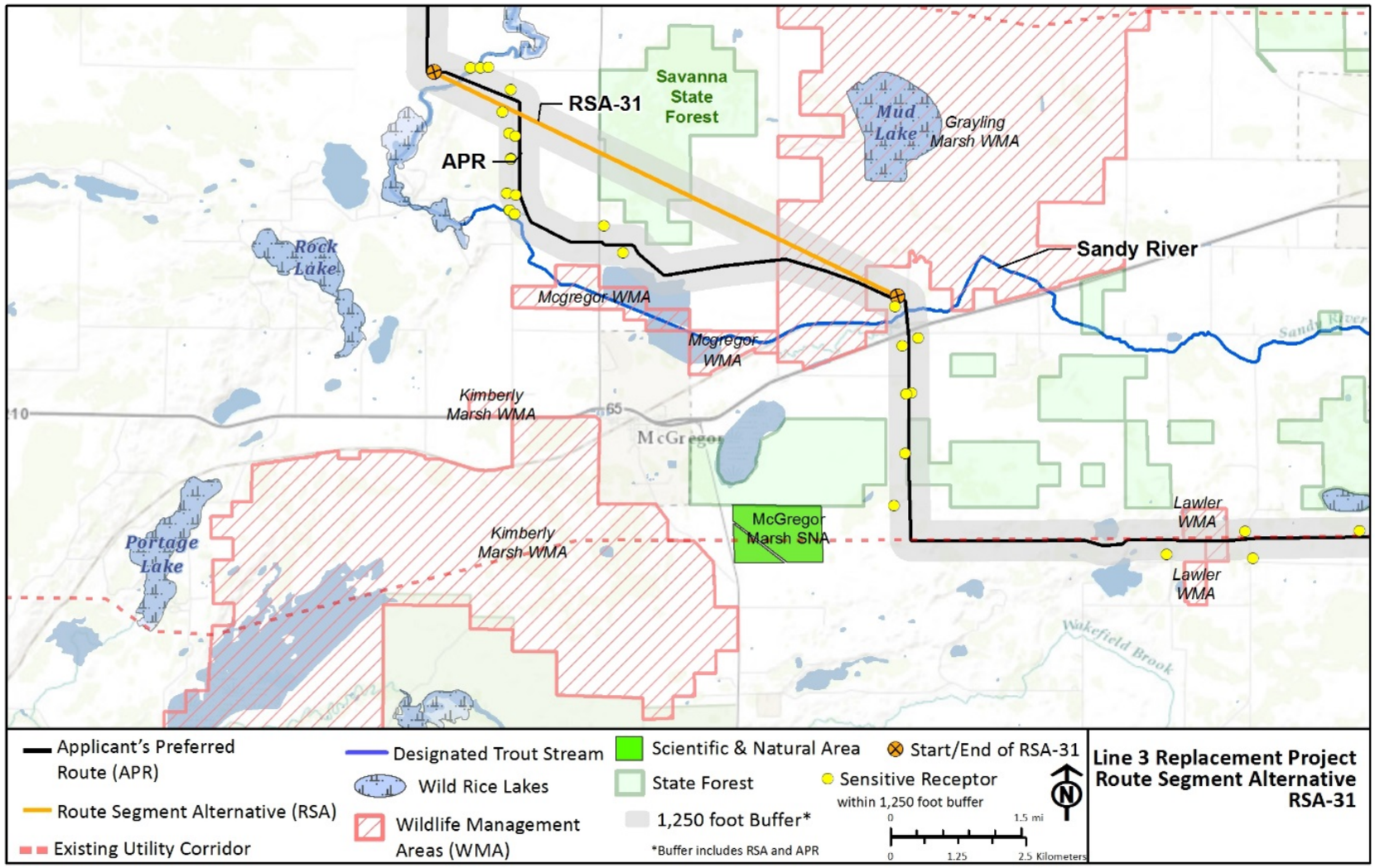

Figure 7.3-11. Route Segment Alternative RSA-31

Table 7.3-11. Localized Differences between Route Segment Alternative RSA-31 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	88.68	87.03	**+ 1.65**
Percentage co-located with existing corridors[a]	--	--	**No change**
Number of sensitive noise receptors[b]	4	15	**– 11**
Number of river crossings	2	4	**– 2**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	16.97	28.99	**– 12.02**
Acres of wetland crossings (construction work area)	36.89	14.31	**+ 22.58**
Miles of vulnerable water table crossings[c]	0.1	1.1	**– 1.0**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	25%	1%	20%	47%	7%
Replaced segment	28%	1%	33%	33%	4%
Change	**– 3%**	**No change**	**– 13%**	**+ 14%**	**+ 3%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	1.81	13.11	--	--	0.47
Replaced segment	1.13	6.46	--	--	0.24
Change	**+ 0.68**	**+ 6.65**	**No change**	**No change**	**+ 0.23**

Notes:

[a] RSA-31 would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

(B) Natural Environment

Vegetation: RSA-31 crosses approximately 12 fewer forested acres than the Applicant's preferred route.

Public Lands: The RSA crosses Savanna State Forest; the replaced segment of the Applicant's preferred route does not.

(D) Economics

Agriculture: The RSA bisects an active peat farm near Savanna State Forest.

(G) Natural Resources

Wetlands: RSA-31 would affect approximately 22 additional acres of wetlands, and would convert twice as many acres of forested wetlands to a different wetland type.

Water Resources: RSA-31 crosses 1 less mile of vulnerable water tables, and would require half as many river crossings.

7.3.12 Route Segment Alternative RSA-33

RSA-33 is located in Aitkin County. It is approximately 1.8 miles long and replaces a 1.7-mile segment of the Applicant's preferred route between MP 306.7 and MP 308.4 (Figure 7.3-12). RSA-33 is located on primarily forest and wetland cover types. This RSA moves the pipeline to a different portion of the commenter's property, where it is adjacent to a peat plant. It relocates the pipeline further from residences, and does not shift these impacts to other residences. Table 7.3-12 highlights the differences between RSA-33 and the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-33 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement and (G) Natural Resources.

(A) Human Settlement

Noise: RSA-33 eliminates sensitive noise receptors within 1,250 feet of the pipeline centerline, avoiding construction-related noise impacts.

(G) Natural Resources

Wetlands: RSA-33 would affect approximately 8 acres of wetlands, half of which are forested wetlands, increasing conversion of forested wetlands to another wetland type by 3 acres.

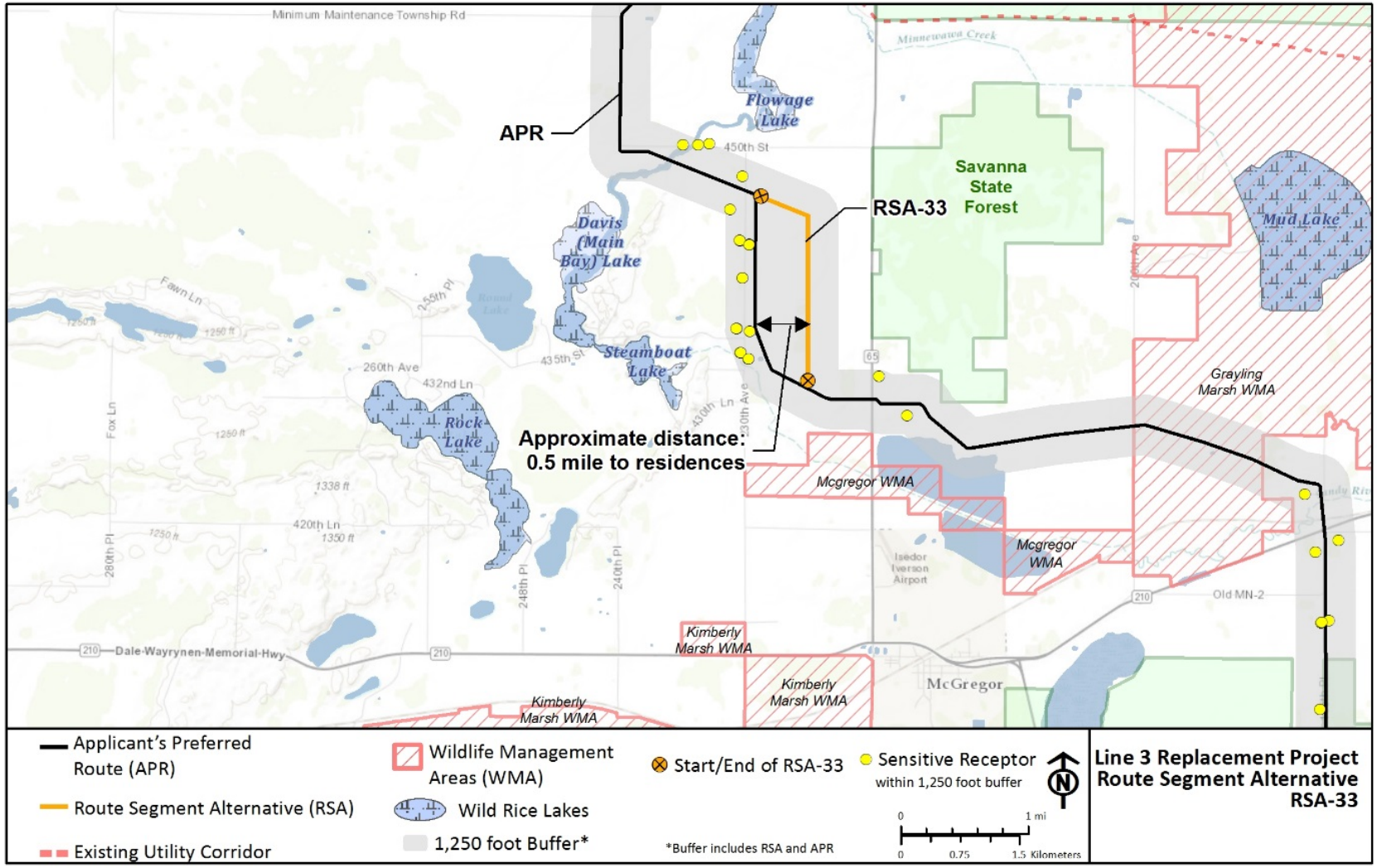

Figure 7.3-12. Route Segment Alternative RSA-33

Table 7.3-12. Localized Differences between Route Segment Alternative RSA-33 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	26.47	20.99	**+ 5.48**
Percentage co-located with existing corridors[a]	--	--	**No change**
Number of sensitive noise receptors[b]	--	8	**– 8**
Number of river crossings	3	2	**+ 1**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	8.66	5.93	**+ 2.73**
Acres of wetland crossings (construction work area)	11.20	2.57	**+ 8.63**
Miles of vulnerable water table crossings[c]	0.5	0.4	**+ 0.1**

Land Cover – Permanent Right-of-Way[d]

Route Segment	*Agricultural*	*Developed*	*Forest*	*Water/Wetlands*	*Other*
RSA	11%	--	33%	46%	9%
Replaced segment	22%	--	29%	47%	2%
Change	**– 11%**	**No change**	**+ 4%**	**– 1%**	**+ 7%**

Wetlands – Permanent Right-of-Way[e]

Route Segment	*Emergent*	*Forested/Shrub*	*Freshwater Pond*	*Lake*	*Riverine*
RSA	--	4.64	--	--	--
Replaced segment	--	1.35	--	--	--
Change	**No change**	**+ 3.29**	**No change**	**No change**	**No change**

Notes:

[a] RSA-33 would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.13 Route Segment Alternative RSA-34

RSA-34 is located in Aitkin County. It is approximately 2.2 miles long and replaces a 2.5-mile segment of the Applicant's preferred route between MP 307.6 and MP 310.1 (Figure 7.3-13). It is primarily wetland, forest, and agricultural cover types. RSA-34 was proposed to increase the distance from a specific residence. It reduces the number of sensitive noise receptors within 1,250 feet of the pipeline centerline; however, it shifts impacts to an active peat mining facility, crossing its storage and processing facility. Table 7.3-13 highlights the differences between RSA-34 and the replaced segment of the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-34 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (D) Economics; and (G) Natural Resources.

(A) Human Settlement

Noise: RSA-34 reduces the number of sensitive noise receptors within 1,250 feet of the pipeline centerline by half, avoiding construction-related noise impacts.

(B) Natural Environment

Vegetation: The RSA passes through approximately half as many acres of forested cover types as the Applicant's preferred route.

(D) Economics

Agriculture: The RSA crosses through an active peat processing and storage facility. Based on satellite imagery, should RSA-34 be selected it would likely necessitate re-routing the pipeline route to avoid this business. This would increase impacts on forested cover types. Re-routing within the route width may or may not be possible within the route width.

(G) Natural Resources

Wetlands: RSA-34 would affect approximately 10 additional wetland acres, increasing conversion of forested wetlands to another wetland type by approximately 5 acres.

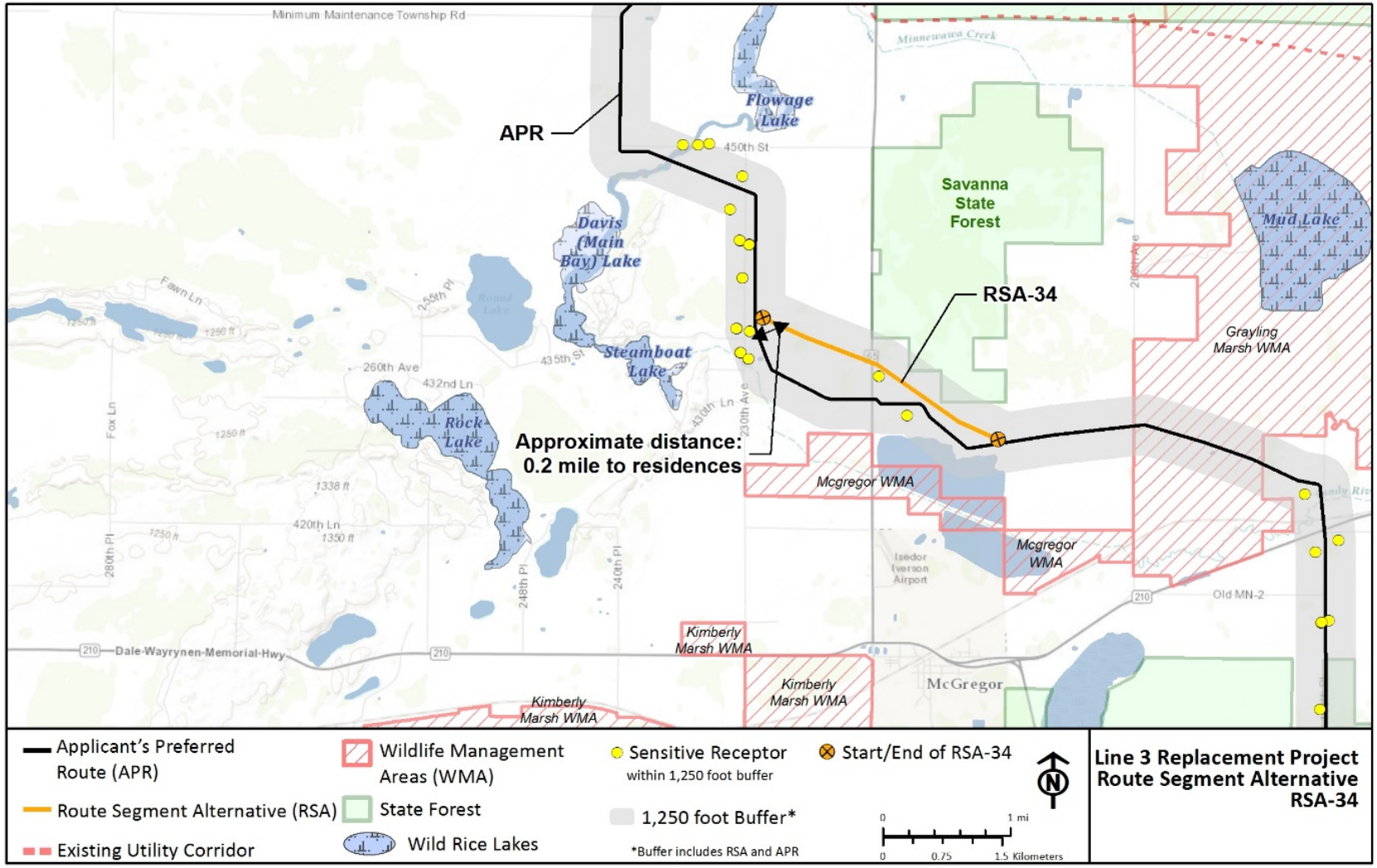

Figure 7.3-13. Route Segment Alternative RSA-34

Table 7.3-13. Localized Differences between Route Segment Alternative RSA-34 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	32.23	31.37	**+ 0.86**
Percentage co-located with existing corridors[a]	--	--	**No change**
Number of sensitive noise receptors[b]	3	6	**– 3**
Number of river crossings	3	3	**No change**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	11.65	19.39	**– 7.74**
Acres of wetland crossings (construction work area)	14.93	4.77	**+ 10.16**
Miles of vulnerable water table crossings[c]	1.0	1.1	**– 0.1**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	16%	2%	37%	45%	1%
Replaced segment	5%	1%	62%	30%	1%
Change	**+ 11%**	**+ 1%**	**– 25%**	**+ 15%**	**No change**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	0.35	5.87	--	--	--
Replaced segment	0.57	1.92	--	--	--
Change	**– 0.22**	**+ 3.95**	**No change**	**No change**	**No change**

Notes:

[a] RSA-34 would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.14 Route Segment Alternative RSA-35

RSA-35 is located in Aitkin County. It is approximately 1.6 miles long and replaces a 1.4-mile segment of the Applicant's preferred route from MP 308.4 to MP 309.8 (Figure 7.3-14). The RSA crosses primarily forested and wetland cover types. These National Land Cover Database (Homer et al. 2015) identified wetlands are likely peat fields that may or may not be active. The RSA was proposed to increase the distance between the pipeline and a specific residence. RSA-35 does not change the number of sensitive noise receptors within 1,250 feet of the pipeline centerline. It simply shift impacts from one residence to another. Table 7.3-14 highlights the differences between RSA-35 and the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-35 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (D) Economics; and (G) Natural Resources.

(A) Human Settlement

Displacement: The current alignment of RSA-35 would displace a residence; as such, it would need to be re-routed within the route width. This would likely increase impacts on wetland cover types.

(B) Natural Environment

Vegetation: The RSA passes through approximately half as many acres of forested cover types as the Applicant's preferred route.

Public Lands: RSA-35 crosses the McGregor WMA for approximately 0.5 mile of its length.

(D) Economics

Agriculture: While both RSA-35 and the Applicant's preferred route cross peat lands, the RSA is located within peat lands for a greater portion of its length.

(G) Natural Resources

Wetlands: RSA-35 would affect approximately 10 additional wetland acres. The majority of these wetlands appear to be active peat mining lands.

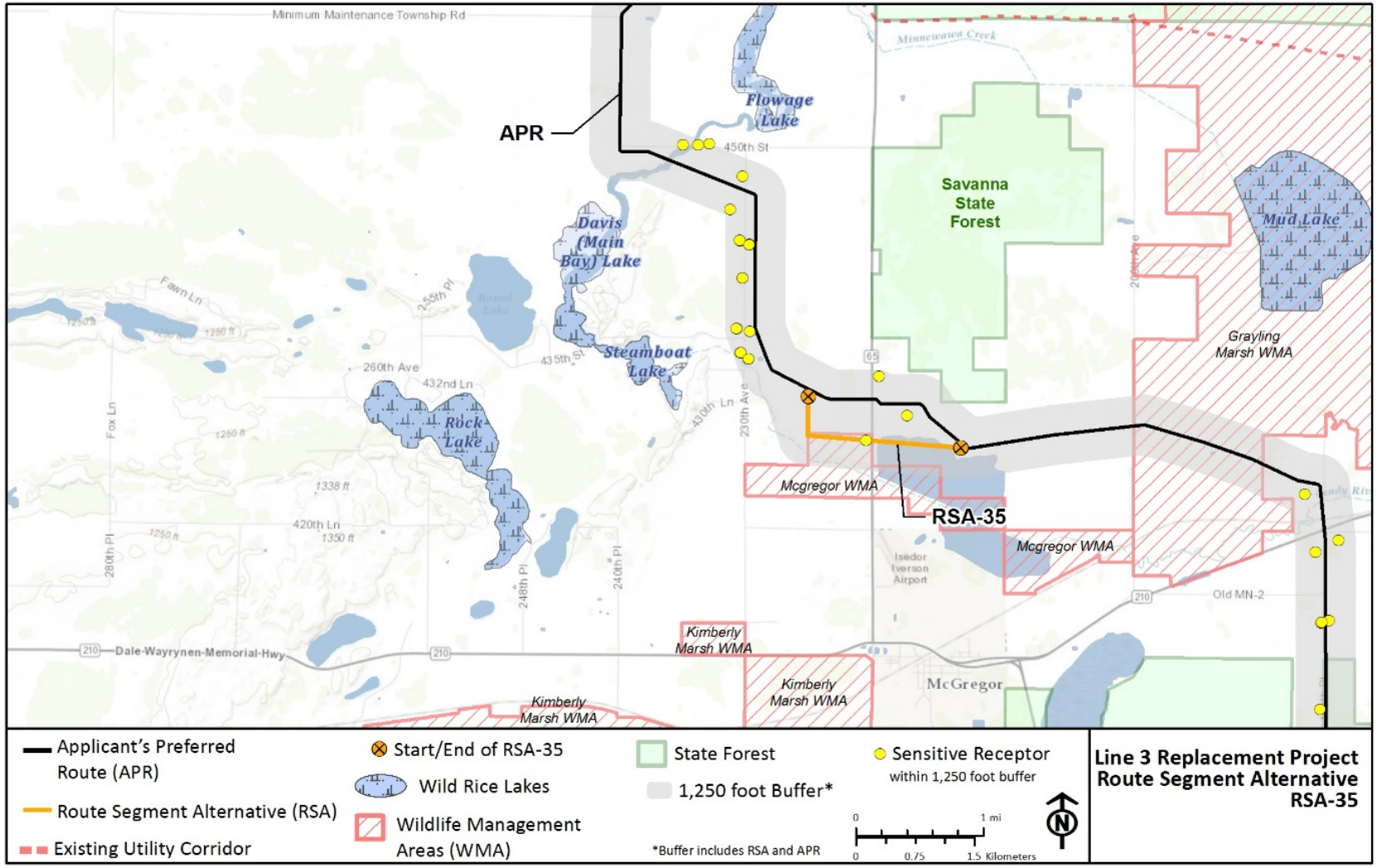

Figure 7.3-14. Route Segment Alternative RSA-35

Table 7.3-14. Localized Differences between Route Segment Alternative RSA-35 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	23.68	17.93	**+ 5.75**
Percentage co-located with existing corridors[a]	--	--	**No change**
Number of sensitive noise receptors[b]	2	2	**No change**
Number of river crossings	1	1	**No change**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	7.73	12.21	**– 4.48**
Acres of wetland crossings (construction work area)	14.53	2.93	**+ 11.60**
Miles of vulnerable water table crossings[c]	0.5	0.7	**– 0.2**

Land Cover – Permanent Right-of-Way[d]

Route Segment	*Agricultural*	*Developed*	*Forest*	*Water/Wetlands*	*Other*
RSA	--	2%	34%	64%	--
Replaced segment	--	3%	66%	28%	3%
Change	**No change**	**– 1%**	**– 32%**	**+ 36%**	**– 3%**

Wetlands – Permanent Right-of-Way[e]

Route Segment	*Emergent*	*Forested/Shrub*	*Freshwater Pond*	*Lake*	*Riverine*
RSA	5.42	0.66	--	--	--
Replaced segment	0.29	1.23	--	--	--
Change	**+ 5.13**	**– 0.57**	**No change**	**No change**	**No change**

Notes:

[a] RSA-35 would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.15 Route Segment Alternative RSA-37

RSA-37 is located in Aitkin and Carlton counties. It is approximately 38.7 miles long and replaces a 43.7-mile segment of the Applicant's preferred route between MP 313.1 and MP 356.8 (Figure 7.3-15). The RSA was proposed to avoid Salo Marsh WMA and Lawler WMA.

RSA-37 is not a viable routing option; therefore, no further analysis is provided. As proposed, this RSA is unworkable. It passes beneath multiple structures, most notably beneath Cromwell High School. The school and its grounds cannot be avoided within the route width. Table 7.3-15 nonetheless highlights the differences between RSA-37 and the Applicant's preferred route.

Table 7.3-15. Localized Differences between Route Segment Alternative RSA-37 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	562.17	564.91	**– 2.74**
Percentage co-located with existing corridors[a]	11.4%	68.9%	**– 57.5%**
Number of sensitive noise receptors[b]	190	97	**+ 93**
Number of river crossings	14	18	**– 4**
Number of designated trout stream crossings	2	3	**– 1**
Acres of native plant community crossings (construction work area)	21.82	27.49	**– 5.67**
Acres of forested land crossings (construction work area)	94.92	236.31	**– 141.39**
Acres of wetland crossings (construction work area)	235.96	154.98	**+ 80.98**
Miles of vulnerable water table crossings[c]	6.6	4.4	**+ 2.2**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	17%	4%	17%	52%	10%
Replaced segment	10%	4%	39%	39%	9%
Change	**+ 7%**	**No change**	**– 22%**	**+ 13%**	**+ 1%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	28.63	67.02	1.49	1.76	--
Replaced segment	18.17	60.14	0.35	--	--
Change	**+ 10.46**	**+ 6.88**	**+ 1.14**	**+ 1.76**	**No change**

Notes:

[a] Existing corridors used by RSA-37 would consist of road, railroad, oil pipeline, and refined product pipeline rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

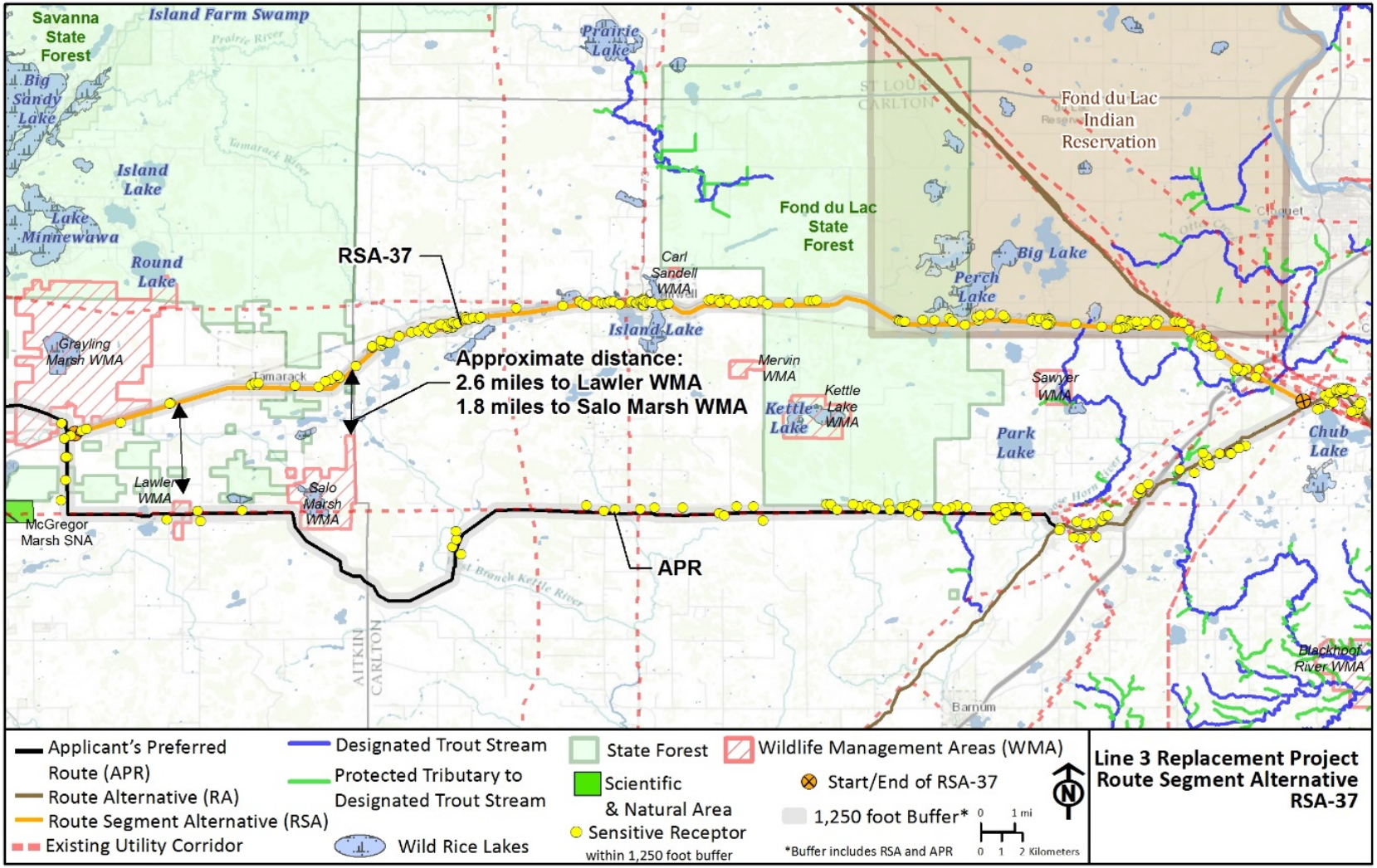

Figure 7.3-15. Route Segment Alternative RSA-37

7.3.16 Route Segment Alternative RSA-42

RSA-42 is located in Carlton County. It is approximately 3.5 miles long and replaces a 4.3-mile segment of the Applicant's preferred route between MP 347.1 and MP 351.4 (Figure 7.3-16). The RSA crosses primarily wetland cover types. Forested and agricultural cover types are also crossed. The purpose of the RSA is to co-locate the pipeline with an existing transmission line corridor. Table 7.3-16 highlights the differences between RSA-42 and the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-42 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Aesthetics: RSA-42 reduces aesthetic impacts because it is co-located with existing corridors for its entire length.

(B) Natural Environment

Wildlife Habitat: RSA-42 crosses two designated trout streams; the Applicant's preferred route does not. RSA-42 would affect more acres of wetland habitat.

(F) Co-Location

RSA-42 is co-located for its entire length; the Applicant's preferred route is not co-located with existing corridors.

(G) Natural Resources

Water Resources: The RSA is routed within 500 feet of several designated trout waters for approximately 10,000 feet of its length, which increases potential impacts on floodplain hydrology and water quality for these streams as much of the pipeline crosses the floodplain wetlands immediately adjacent to these streams.

Wetlands: RSA-42 would affect approximately twice as many wetland acres compared with the Applicant's preferred route.

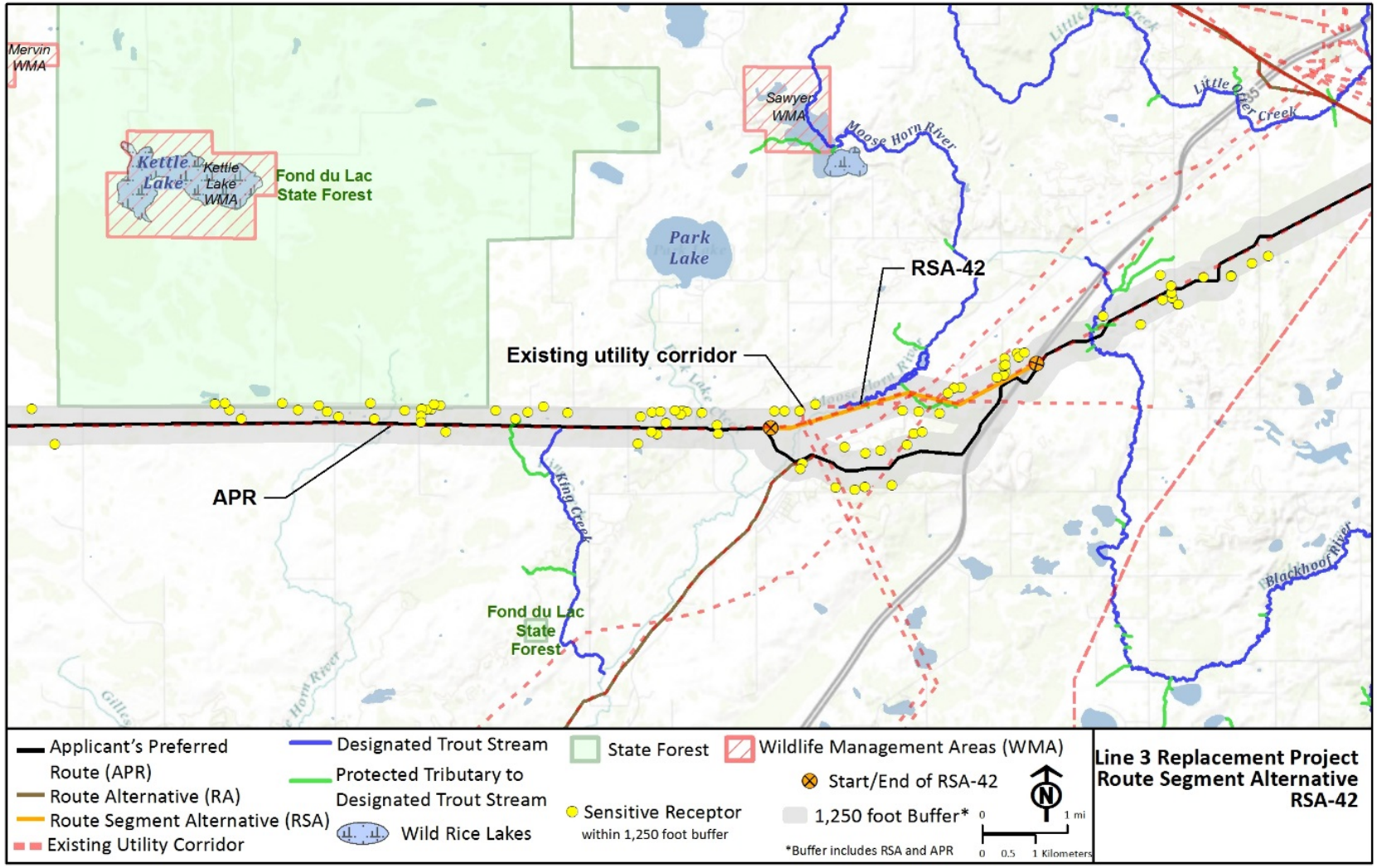

Figure 7.3-16. Route Segment Alternative RSA-42

Table 7.3-16. Localized Differences between Route Segment Alternative RSA-42 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	50.91	56.59	**– 5.68**
Percentage co-located with existing corridors[a]	100%	-	**+ 100%**
Number of sensitive noise receptors[b]	19	18	**+ 1**
Number of river crossings	1	2	**– 1**
Number of designated trout stream crossings	2	0	**+ 2**
Acres of native plant community crossings (construction work area)	-	-	**No change**
Acres of forested land crossings (construction work area)	8.49	25.14	**– 16.65**
Acres of wetland crossings (construction work area)	32.71	16.29	**+ 16.42**
Miles of vulnerable water table crossings[c]	-	-	**No change**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	10%	8%	17%	66%	1%
Replaced Segment	14%	4%	44%	31%	7%
Change	**– 4%**	**+ 4%**	**– 27%**	**+ 35%**	**– 6%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	4.23	9.36	-	-	-
Replaced Segment	-	7.66	-	-	-
Change	**+ 4.23**	**+ 1.70**	**No change**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-42 would consist of transmission line rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.17 Route Segment Alternative RSA-43

RSA-43 is located in Carlton County. It is approximately 3.1 miles long and replaces a 3.5-mile segment of the Applicant's preferred route between MP 347.9 and 351.4 (Figure 7.3-17). RSA-43 crosses primarily forested and wetland cover types. Its purpose is to co-locate the pipeline with existing corridors. The RSA is co-located for its entire length. Table 7.3-17 highlights the differences between RSA-43 and the Applicant's preferred route.

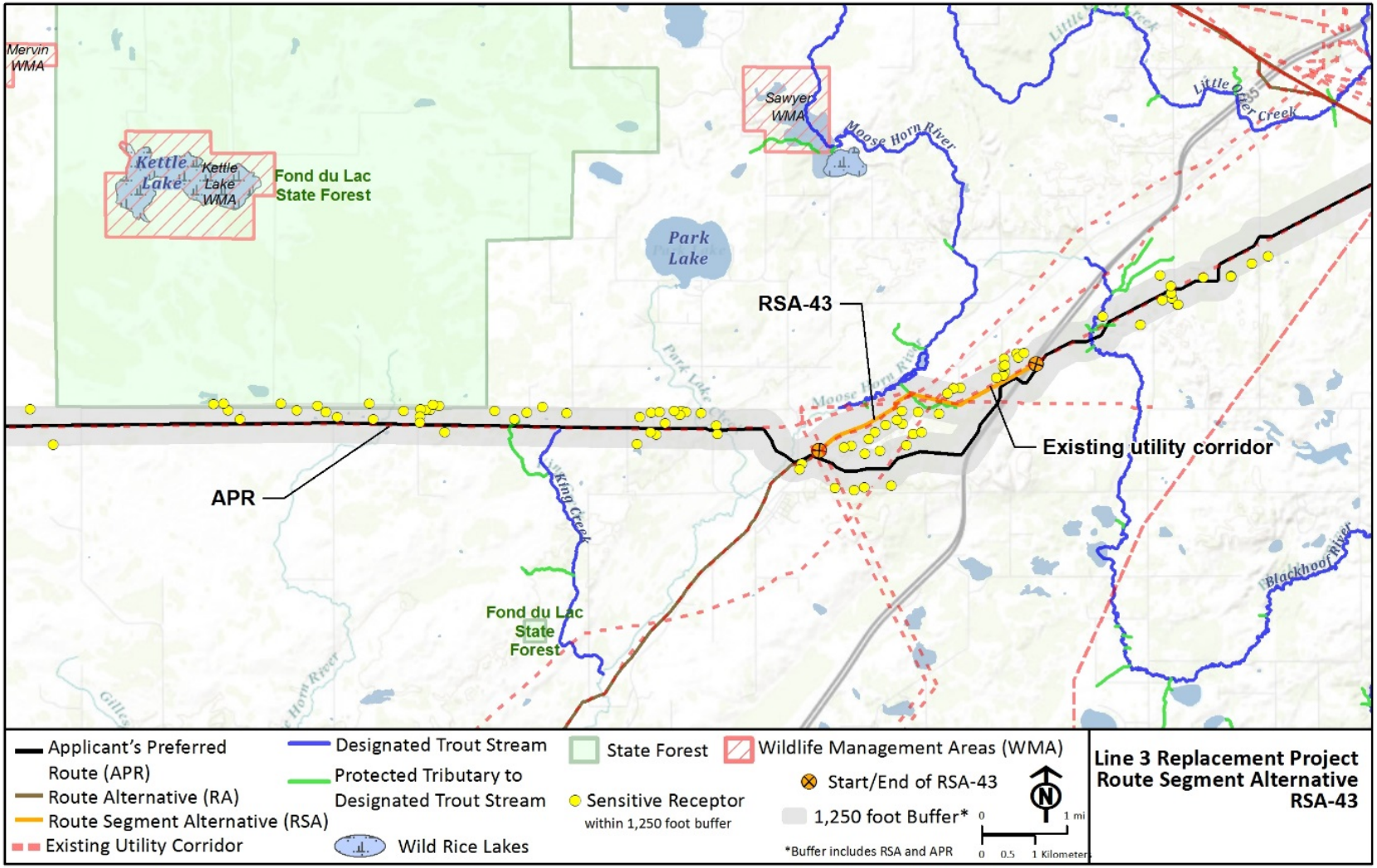

Figure 7.3-17. Route Segment Alternative RSA-43

Table 7.3-17. Localized Differences between Route Segment Alternative RSA-43 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	44.85	46.84	**– 1.99**
Percentage co-located with existing corridors[a]	100%	--	**+ 100%**
Number of sensitive noise receptors[b]	22	16	**+ 6**
Number of river crossings	1	1	**No change**
Number of designated trout stream crossings	1	0	**+ 1**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	17.70	21.45	**– 3.75**
Acres of wetland crossings (construction work area)	13.59	11.71	**+ 1.88**
Miles of vulnerable water table crossings[c]	--	--	**No change**

Land Cover[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	11%	8%	41%	37%	3%
Replaced segment	17%	4%	45%	25%	8%
Change	**– 6%**	**+ 4%**	**– 4%**	**+ 12%**	**– 5%**

Wetlands[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	--	5.71	--	--	--
Replaced segment	--	5.43	--	--	--
Change	**No change**	**+ 0.28**	**No change**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-43 would consist of transmission line and refined product pipeline rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

Meaningful Variation Exists Between Routing Options

RSA-43 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; and (F) Co-Location.

(A) Human Settlement

Aesthetics: RSA-43 reduces aesthetic impacts because it is co-located with existing corridors for its entire length.

(B) Natural Environment

Wildlife Habitat: RSA-43 crosses a designated trout stream; the Applicant's preferred route does not.

(F) Co-Location

RSA-43 is co-located with existing corridors for its entire length; the Applicant's preferred route is not.

7.3.18 Route Segment Alternative RSA-44

RSA-44 is located in Carlton County. It is approximately 9.1 miles long and replaces an 8.9-mile segment of the Applicant's preferred route between MP 347.9 and MP 356.8 (Figure 7.3-18). The RSA was proposed to avoid the Blackhoof River watershed and potential impacts from groundwater flow around the watershed.

RSA-44 is not a viable routing option; therefore, no further analysis is provided. As proposed, this RSA is unworkable. The RSA passes beneath multiple structures, most notably the cluster of structures south of Omar's Sand & Gravel. These buildings cannot be avoided within the route width. Table 7.3-18 nonetheless highlights the differences between RSA-44 and the Applicant's preferred route.

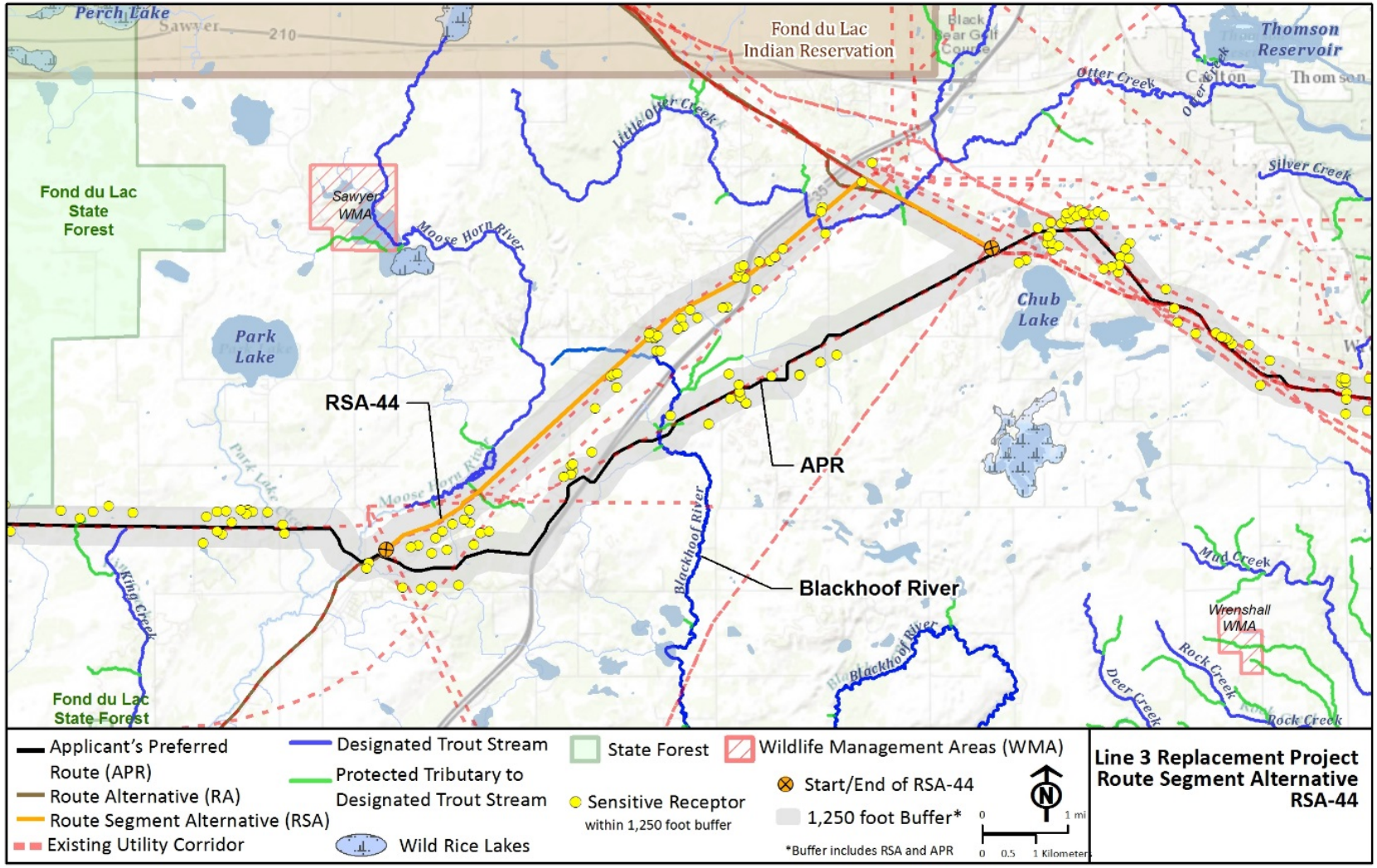

Figure 7.3-18. Route Segment Alternative RSA-44

Table 7.3-18. Localized Differences between Route Segment Alternative RSA-44 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	131.60	116.85	**+ 14.75**
Percentage co-located with existing corridors[a]	19.9%	60.2%	**– 57.5%**
Number of sensitive noise receptors[b]	42	28	**+ 14**
Number of river crossings	6	4	**+ 2**
Number of designated trout stream crossings	3	2	**+ 1**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	39.88	45.56	**– 5.68**
Acres of wetland crossings (construction work area)	51.42	35.33	**+ 16.09**
Miles of vulnerable water table crossings[c]	--	--	**No change**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	13%	3%	31%	41%	12%
Replaced segment	10%	5%	37%	39%	9%
Change	**+ 3%**	**– 2%**	**– 6%**	**+ 2%**	**+ 3%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	0.34	21.12	--	--	--
Replaced segment	--	17.28	0.35	--	--
Change	**+ 0.34**	**+ 3.84**	**– 0.35**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-44 would consist of oil pipeline and refined product pipeline rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.19 Route Segment Alternative RSA-45

RSA-45 is located in Carlton County. It is approximately 9.1 miles long and replaces an 8.8-mile segment of the Applicant's preferred route between MP 347.9 and 356.8 (Figure 7.3-19). The RSA crosses primarily forest and wetland cover types. It makes new greenfield crossings in an area heavily affected by habitat fragmentation. A commenter suggested following an existing utility corridor on the north side of State Highway 61 to avoid the Blackhoof River watershed and potential impacts from groundwater flow around the watershed. RSA-45 crosses the Blackhoof River. The Blackhoof River meets with the Nemadji River and eventually flows to Lake Superior. Table 7.3-19 highlights the differences between RSA-45 and the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-45 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Noise: RSA-45 increases the number of sensitive noise receptors within 1,250 feet of the pipeline centerline by 13, increasing potential noise impacts.

(B) Natural Environment

Wildlife Habitat: RSA-45 would further fragment an area already heavily affected by habitat fragmentation. It would affect approximately 14 additional acres of wetland habitat. RSA-45 would require two additional designated trout stream crossings (Little Otter Creek).

(F) Co-Location

RSA-45 is co-located with existing infrastructure for 16 percent of its length; the Applicant's preferred route is co-located for 60 percent of its length.

(G) Natural Resources

Water Resources: RSA-45 crosses 1.2 fewer miles of vulnerable water tables compared with the Applicant's preferred route. It makes two additional river crossings.

Wetlands: RSA-45 would affect approximately 14 additional acres of wetlands.

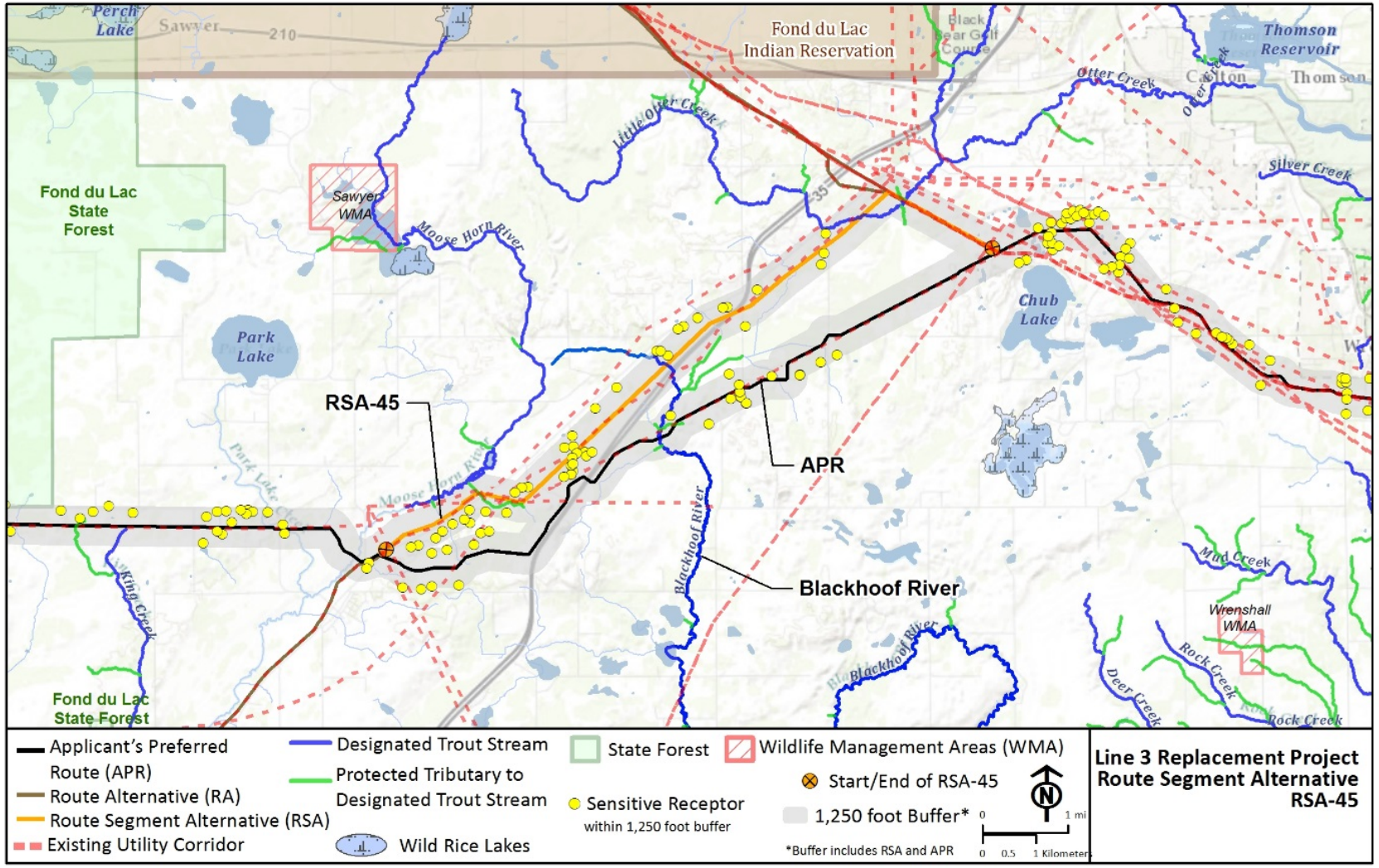

Figure 7.3-19. Route Segment Alternative RSA-45

Table 7.3-19. Localized Differences between Route Segment Alternative RSA-45 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	131.53	116.85	**+ 14.68**
Percentage co-located with existing corridors[a]	16.60	60.20	**– 43.6%**
Number of sensitive noise receptors[b]	41	28	**+ 13**
Number of river crossings	6	4	**+ 2**
Number of designated trout stream crossings	4	2	**+ 2**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	42.91	45.56	**– 2.65**
Acres of wetland crossings (construction work area)	49.03	35.33	**+ 13.70**
Miles of vulnerable water table crossings[c]	0.5	1.7	**– 1.2**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	6%	5%	33%	46%	9%
Replaced Segment	10%	5%	37%	39%	9%
Change	**– 4%**	**No change**	**– 4%**	**+ 7%**	**No change**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	1.96	18.50	--	--	--
Replaced Segment	--	17.28	0.35	--	--
Change	**+ 1.96**	**+ 1.22**	**– 0.35**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-45 would consist of oil pipeline and refined product pipeline rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.20 Route Segment Alternative RSA-46

RSA-46 is located in Carlton County. It is approximately 1.0 mile long and replaces a 0.9-mile segment of the Applicant's preferred route between MP 348.9 and MP 349.8 (Figure 7.3-20). RSA-46 is located primarily through wetland and forest cover types. It avoids an area of active farmland. Table 7.3-20 highlights the differences between RSA-46 and the Applicant's preferred route.

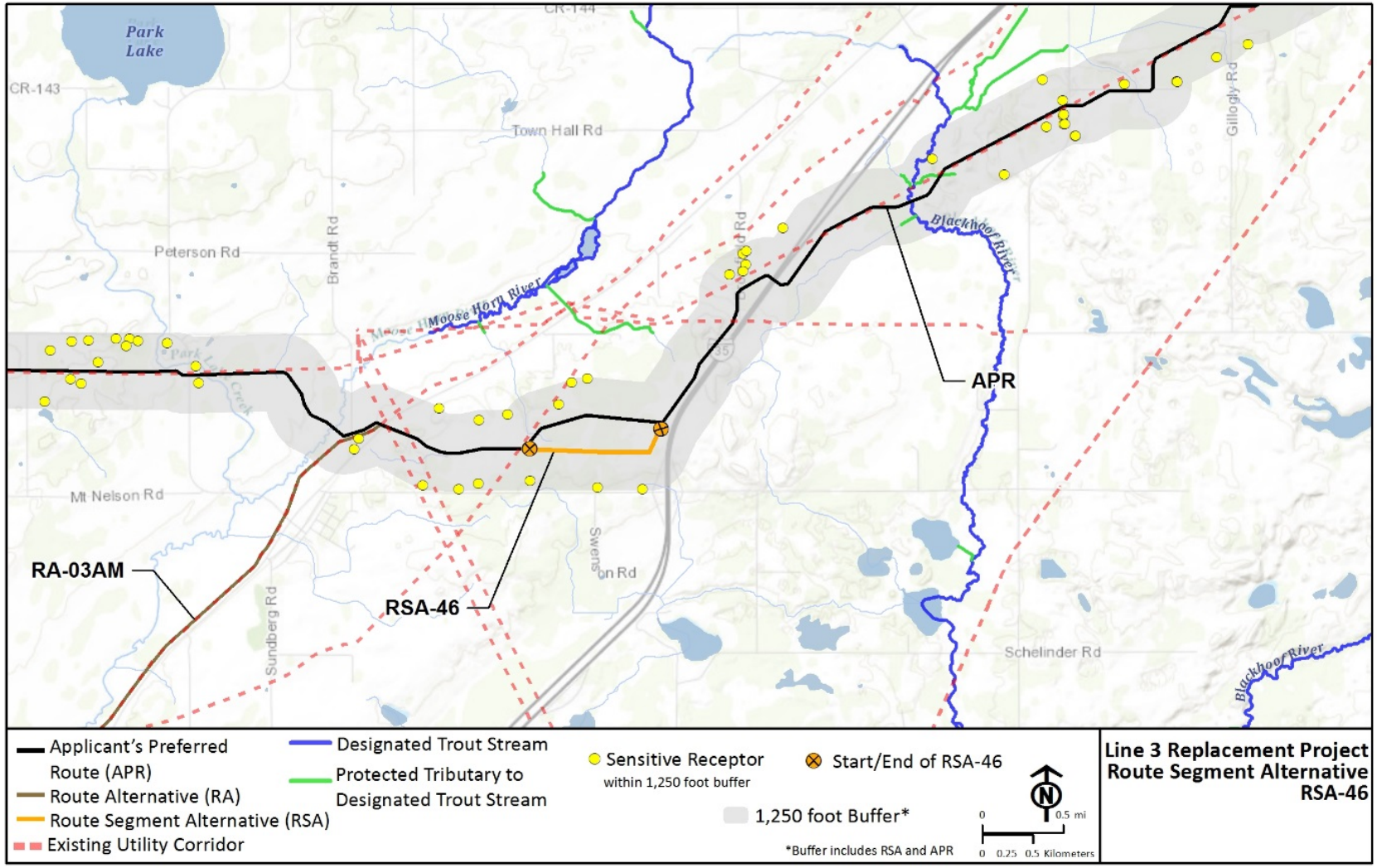

Figure 7.3-20. Route Segment Alternative RSA-46

Table 7.3-20. Localized Differences between Route Segment Alternative RSA-46 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	14.47	13.01	**+ 1.46**
Percentage co-located with existing corridors[a]	--	--	**No change**
Number of sensitive noise receptors[b]	3	5	**– 2**
Number of river crossings	0	1	**– 1**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	6.91	4.16	**+ 2.75**
Acres of wetland crossings (construction work area)	5.47	3.02	**+ 2.45**
Miles of vulnerable water table crossings[c]	--	--	**No change**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	--	--	46%	46%	7%
Replaced segment	36%	--	31%	26%	6%
Change	**– 36%**	**No change**	**+ 15%**	**+ 20%**	**+ 1%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	--	2.30	--	--	--
Replaced segment	--	1.44	--	--	--
Change	**No change**	**+ 0.86**	**No change**	**No change**	**No change**

Notes:

[a] RSA-46 would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

Meaningful Variation Exists Between Routing Options

RSA-46 and the Applicant's preferred route are different in the following criteria: (B) Natural Environment; (D) Economics; and (G) Natural Resources.

(B) Natural Environment

Vegetation: RSA-46 crosses an additional 2.75 acres of forested cover types compared with the Applicant's preferred route.

(D) Economics

Agriculture: The RSA avoids a 0.3-mile diagonal crossing across active farmland.

(G) Natural Resources

Wetlands: The RSA would affect approximately 2.5 additional wetland acres and approximately twice as many forested wetlands as the Applicant's preferred route.

7.3.21 Route Segment Alternative RSA-49

RSA-49 is located in Carlton County. It is approximately 6.0 miles long and replaces a 5.4-mile segment between MP 351.4 and 356.8 (Figure 7.3-21). RSA-49 is dominated by wetland and forested cover types. A commenter requested following the south sides of Interstate 35 and State Highway 61 to distance the pipeline from multiple properties. The RSA accomplishes this purpose. Table 7.3-21 highlights the differences between RSA-49 and the Applicant's preferred route.

Meaningful Variation Exists Between Routing Options

RSA-49 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement; (B) Natural Environment; and (F) Co-Location; and (G) Natural Resources.

(A) Human Settlement

Noise: RSA-49 reduces the number of sensitive noise receptors within 1,250 feet of the pipeline centerline by four, decreasing potential noise impacts.

(B) Natural Environment

Wildlife Habitat: RSA-49 would further fragment an area already heavily affected by habitat fragmentation. It would affect approximately 30 additional acres of wetland habitat. RSA-49 would cross two additional designated trout streams, and be routed adjacent to tributary S-001-003-030-001 for approximately 3,000 feet, increasing potential for impacts on riparian vegetation and shading. These impacts might be avoidable by re-aligning the pipeline within the route width. Re-alignment would likely result in impacts on similar cover types.

(F) Co-Location

RSA-49 is co-located with existing infrastructure for 25 percent of its length; the Applicant's preferred route is co-located for 80 percent of its length.

(G) Natural Resources

Water Resources: RSA-49 crosses 1.2 fewer miles of vulnerable water tables. It makes four additional river crossings.

Wetlands: RSA-49 would affect approximately 30 additional acres of wetlands, and convert twice as many acres of forested wetlands to a different wetland type.

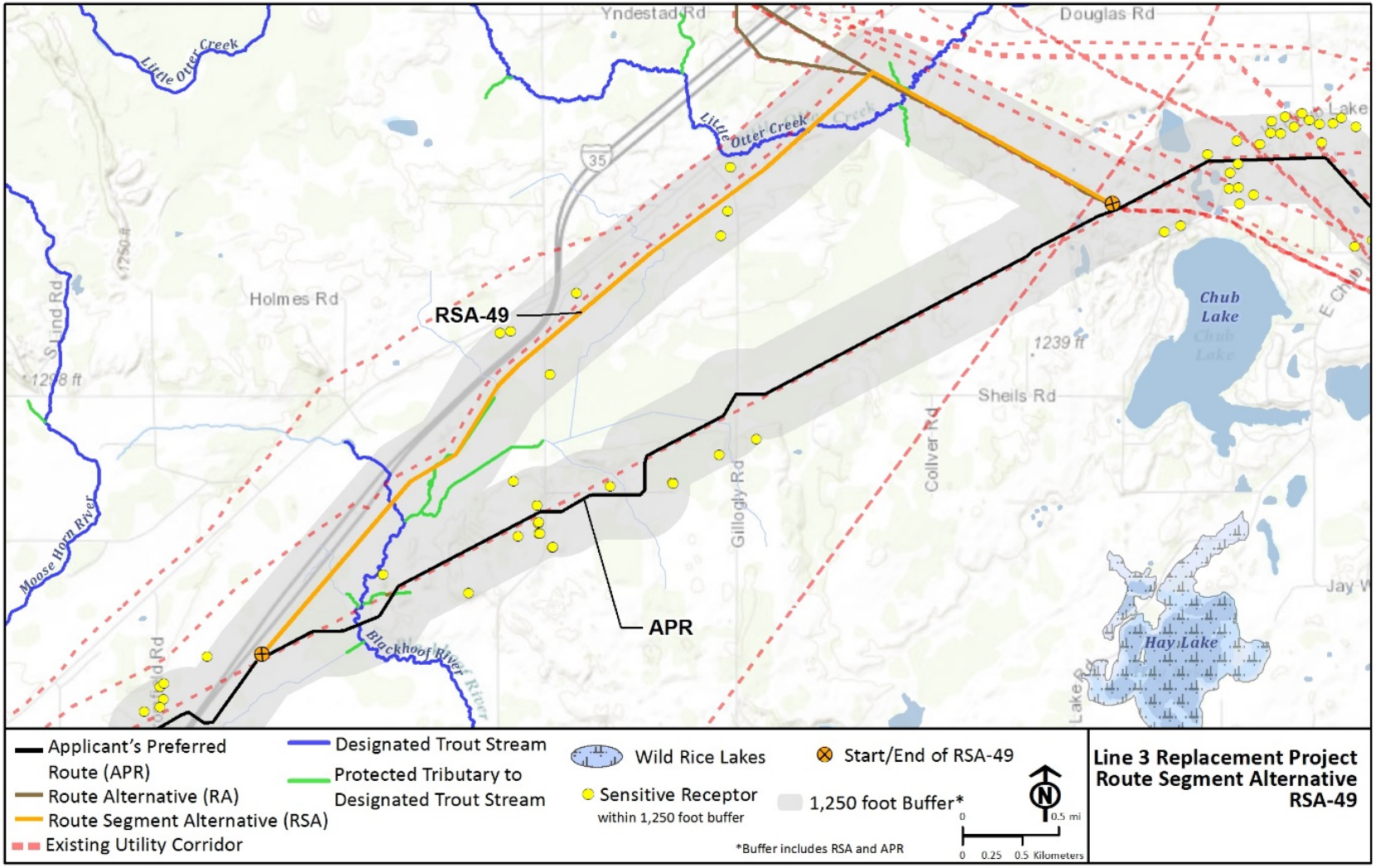

Figure 7.3-21. Route Segment Alternative RSA-49

Table 7.3-21. Localized Differences between Route Segment Alternative RSA-49 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	86.53	69.11	**+ 17.42**
Percentage co-located with existing corridors[a]	25.4%	80.7%	**– 55.3%**
Number of sensitive noise receptors[b]	8	12	**– 4**
Number of river crossings	7	3	**+ 4**
Number of designated trout stream crossings	4	2	**+ 2**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	15.38	24.11	**– 8.73**
Acres of wetland crossings (construction work area)	53.84	22.93	**+ 30.91**
Miles of vulnerable water table crossings[c]	0.5	1.7	**– 1.2**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	1%	1%	19%	68%	11%
Replaced segment	6%	6%	31%	46%	10%
Change	**– 5%**	**– 5%**	**– 12%**	**+ 22%**	**+ 1%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	0.88	21.48	--	--	--
Replaced segment	--	11.51	0.35	--	--
Change	**+ 0.88**	**+ 9.97**	**– 0.35**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-49 would consist of oil pipeline, refined product pipeline, and natural gas pipeline rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.22 Route Segment Alternative RSA-51

RSA-51 is located in Carlton County. It is approximately 1.4 miles long and replaces a 1.3-mile segment of the Applicant's preferred route between MP 352.8 and MP 354.1 (Figure 7.3-22). Forest and wetland cover types dominate this RSA. A commenter proposed shifting the pipeline north to follow the tree line and distance the pipeline from homesteads. Table 7.3-22 highlights the differences between RSA-51 and the Applicant's preferred route.

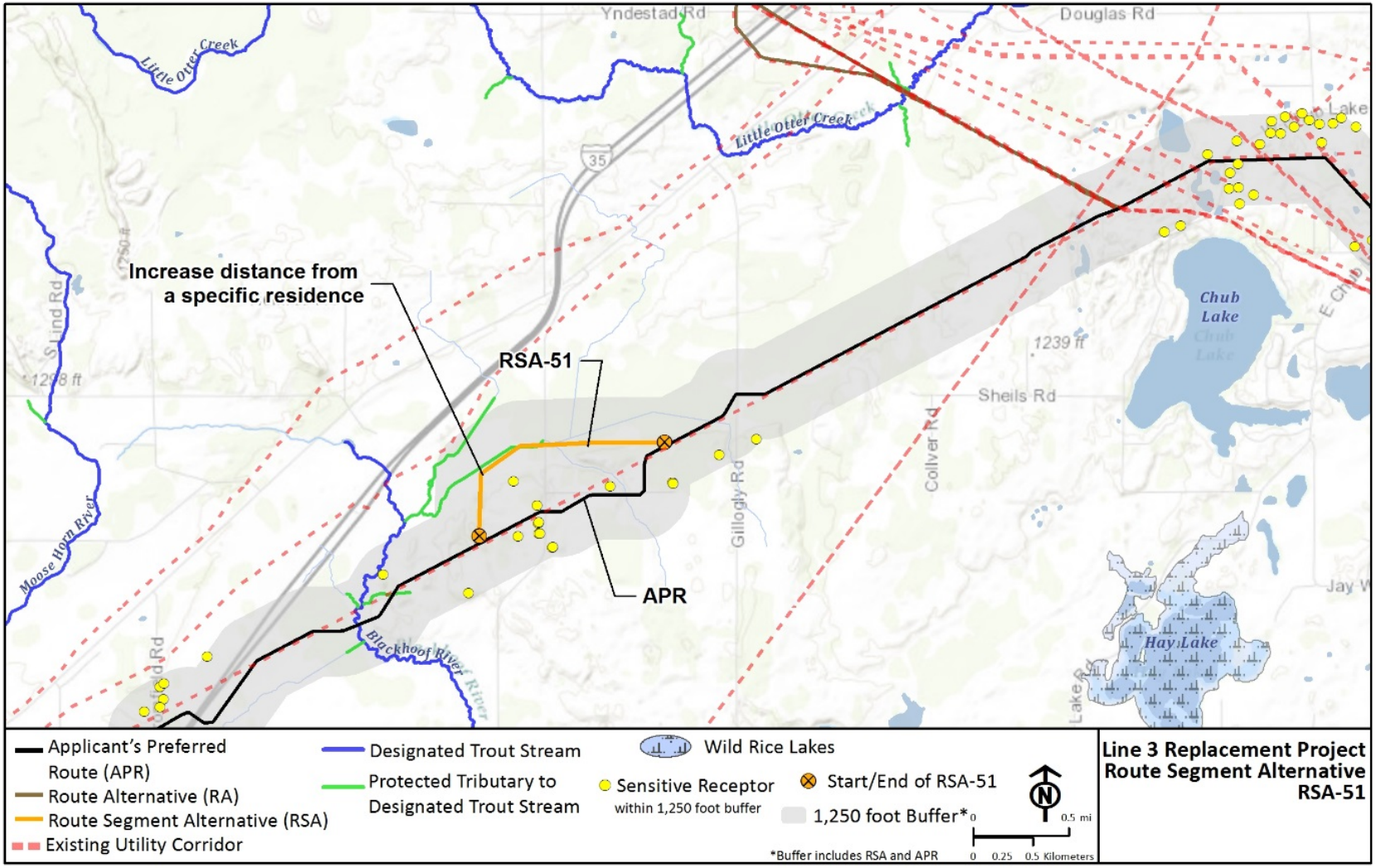

Figure 7.3-22. Route Segment Alternative RSA-51

Table 7.3-22. Localized Differences between Route Segment Alternative RSA-51 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	20.56	18.62	**+ 1.94**
Percentage co-located with existing corridors[a]	--	43.3%	**– 43.3%**
Number of sensitive noise receptors[b]	4	8	**– 4**
Number of river crossings	3	1	**+ 2**
Number of designated trout stream crossings	1	--	**+ 1**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	9.39	8.14	**+ 1.25**
Acres of wetland crossings (construction work area)	9.26	--	**+ 9.26**
Miles of vulnerable water table crossings[c]	0.5	1.3	**– 0.8**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	--	1%	45%	50%	3%
Replaced segment	16%	24%	43%	8%	10%
Change	**– 16%**	**– 23%**	**+ 2%**	**+ 42%**	**– 7%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	--	3.97	--	--	--
Replaced segment	--	--	--	--	--
Change	**No change**	**+ 3.97**	**No change**	**No change**	**No change**

Notes:

[a] RSA-51 would not be co-located with any existing corridors.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

RSA-51 reduces the number of sensitive noise receptors within 1,250 feet of the pipeline centerline; it does not shift impacts to other residences.

Meaningful Variation Exists Between Routing Options

RSA-51 and the Applicant's preferred route are different in the following criteria: (A) Human Settlement (F) Co-location; and (G) Natural Resources.

(A) Human Settlement

Noise: RSA-51 reduces the number of sensitive noise receptors within 1,250 feet of the pipeline centerline by half.

(F) Co-Location

RSA-51 is not co-located with existing infrastructure; the Applicant's preferred route is co-located for 43 percent of its length.

(G) Natural Resources

Wetlands: RSA-51 crosses 9 acres of wetlands and 4 acres of forested wetlands. The Applicant's preferred route does not cross wetlands.

Water Resources: The RSA makes two additional river crossings of a tributary to the Blackhoof River.

7.3.23 Route Segment Alternative RSA-52

RSA-52 is located in Carlton County. It is approximately 1.0 mile long and replaces a 0.9-mile segment of the Applicant's preferred route between MP 353.2 and MP 354.1 (Figure 7.3-23). Forest and wetland cover types dominate this RSA. A commenter proposed shifting the pipeline north to follow the tree line to increase separation between the pipeline and homesteads. Table 7.3-23 highlights the differences between RSA-52 and the Applicant's preferred route.

RSA-52 reduces the number of sensitive noise receptors within 1,250 feet of the pipeline centerline by one. It borders one homestead on two sides.

Meaningful Variation Exists Between Routing Options

RSA-52 and the Applicant's preferred route are different in the following criteria: (B) Natural Environment; (F) Co-location; and (G) Natural Resources.

(B) Natural Environment

Vegetation: The RSA doubles the number of forested acres crossed.

(F) Co-Location

RSA-52 is co-located with existing road right-of-way for approximately 25 percent of its length; the Applicant's preferred route is co-located for 43 percent of its length.

(G) Natural Resources

Wetlands: The RSA would affect approximately 2.5 additional wetland acres, of which 2 acres are forested wetlands. The Applicant's preferred route would not affect wetlands.

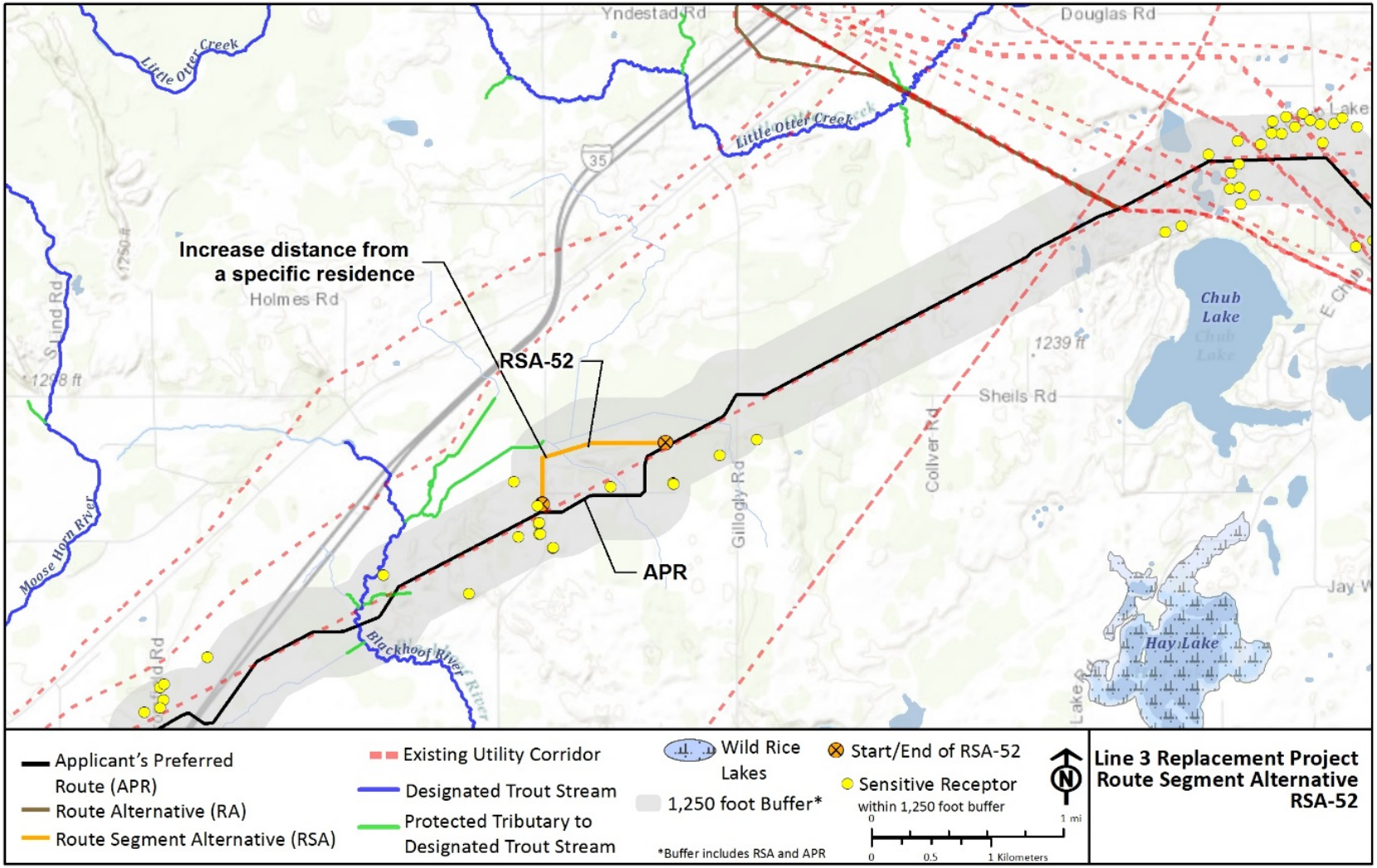

Figure 7.3-23. Route Segment Alternative RSA-52

Table 7.3-23. Localized Differences between Route Segment Alternative RSA-52 and the Applicant's Preferred Route

Resource or Factor	Route Segment Alternative	Replaced Segment of Route	Change
Acres of construction work area	14.20	13.22	**+ 0.98**
Percentage co-located with existing corridors[a]	~25%	43.3%	**– ~18.3%**
Number of sensitive noise receptors[b]	4	5	**– 1**
Number of river crossings	1	1	**No change**
Number of designated trout stream crossings	--	--	**No change**
Acres of native plant community crossings (construction work area)	--	--	**No change**
Acres of forested land crossings (construction work area)	8.51	3.53	**+ 4.98**
Acres of wetland crossings (construction work area)	4.07	--	**+ 4.07**
Miles of vulnerable water table crossings[c]	0.7	1.1	**– 0.4**

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	--	2%	60%	35%	2%
Replaced segment	22%	34%	23%	11%	10%
Change	**– 22%**	**– 32%**	**+ 37%**	**+ 24%**	**– 8%**

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	--	1.76	--	--	--
Replaced segment	--	--	--	--	--
Change	**No change**	**+ 1.76**	**No change**	**No change**	**No change**

Notes:

[a] Existing corridors used by RSA-52 would consist of road right-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n. d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.3.24 Route Segment Alternative RSA-53

RSA-53 is in St. Louis County. It is approximately 6.15 miles long and begins at MP 270.4 along RA-07 (Figure 7.3-24). It is dominated by wetland cover types and is co-located with existing transmission infrastructure for its entire length. RSA-53 would convert approximately 30 acres of forested wetlands to a different wetland type. The RSA was proposed to connect RA-07 with RSA-21, allowing a connection between the northern route alternatives (RA-06, RA-07, and RA-08) and the Applicant's preferred route to avoid crossing the Fond du Lac Indian Reservation. Table 7.3-24 highlights the differences between RSA-53 and the Applicant's preferred route.

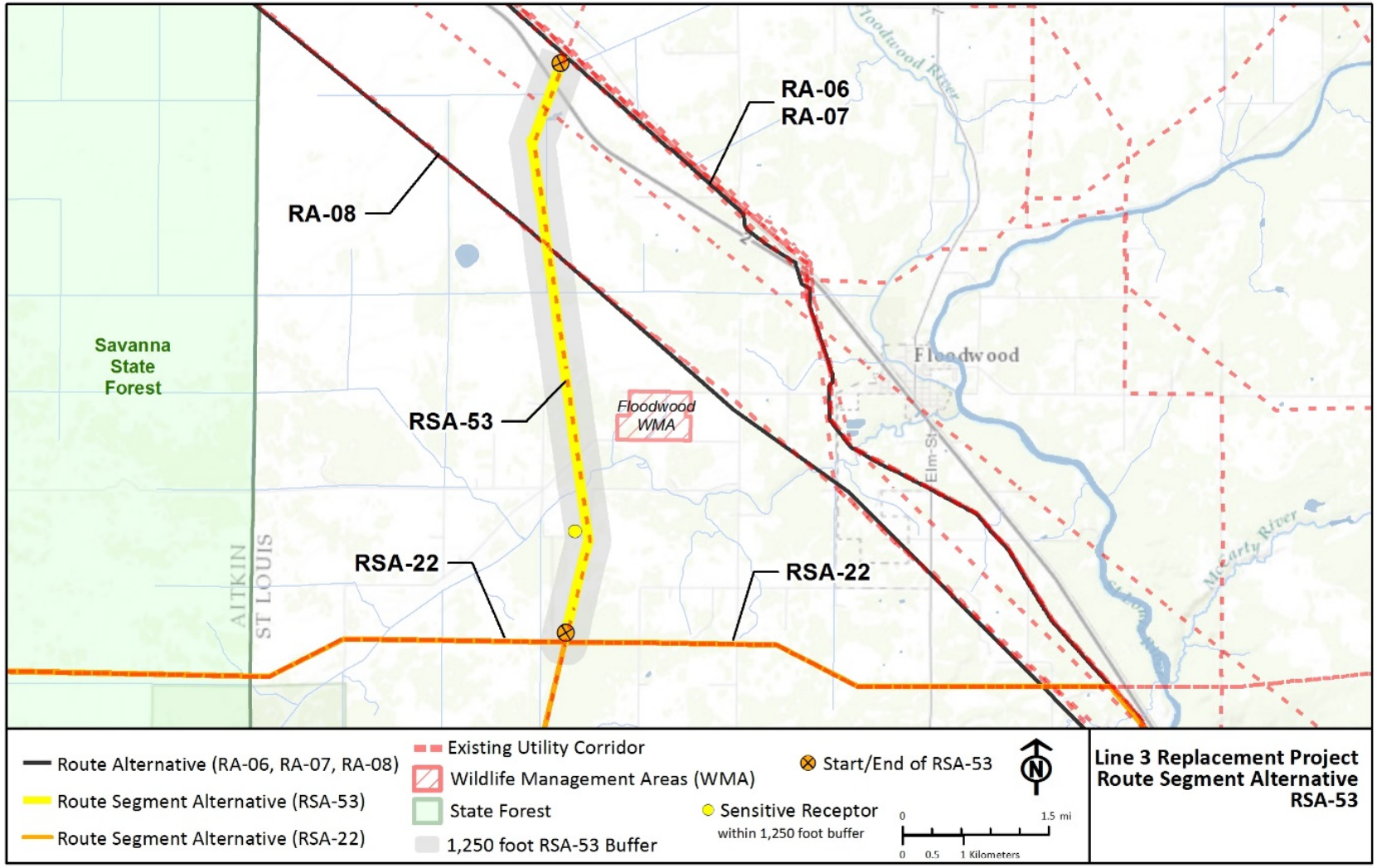

Figure 7.3-24. Route Segment Alternative RSA-53

Table 7.3-24. Route Segment Alternative RSA-53 Resources and Factors

Resource or Factor	Route Segment Alternative
Acres of construction work area	89.5
Percentage co-located with existing corridors[a]	100%
Number of sensitive noise receptors[b]	1
Number of river crossings	1
Number of designated trout stream crossings	--
Acres of native plant community crossings (construction work area)	--
Acres of forested land crossings (construction work area)	3.75
Acres of wetland crossings (construction work area)	76.68
Miles of vulnerable water table crossings[c]	--

Land Cover – Permanent Right-of-Way[d]					
Route Segment	***Agricultural***	***Developed***	***Forest***	***Water/Wetlands***	***Other***
RSA	3%	2%	4%	88%	3%

Wetlands – Permanent Right-of-Way[e]					
Route Segment	***Emergent***	***Forested/Shrub***	***Freshwater Pond***	***Lake***	***Riverine***
RSA	0.60	30.75	0.18	-	-

Notes:

[a] Existing corridors used by RSA-53 would consist of transmission line rights-of-way.

[b] Sensitive noise receptors within 1,250 feet of the centerline of the pipeline permanent right-of-way.

[c] Provided by Minnesota Department of Natural Resources.

[d] National Land Cover Database (Homer et al. 2015). Percentage of permanent right-of-way in acres.

[e] National Wetlands Inventory (USFWS n.d.). Permanent right-of-way in acres.

RSA = route segment alternative

7.4 REFERENCES

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354.

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Chapter 8
Existing Line 3 Abandonment and Removal

8.1 INTRODUCTION

Options for Existing Line 3 Include Abandonment, Removal, and Removal with Replacement in the Same Trench

As part of the Project, Enbridge proposes to abandon the existing Line 3, permanently removing it from service, following state[1] and federal[2] regulations, which outline the process and requirements for pipeline abandonment. As an alternative to abandonment, this Environmental Impact Statement (EIS) considers the possibility of excavating and removing the existing Line 3.

Four of the five routes considered in this EIS (the Applicant's preferred route and route alternatives RA-03AM, RA-06, and RA-08) could be coupled with either abandonment of the existing Line 3 or removal of the existing Line 3. As discussed in Chapter 4, RA-07 specifically contemplates removal of the existing Line 3 with the new line placed in the existing trench.

Options for Existing Line 3 Provide Benefits but Also Raise Challenges

This chapter discusses the benefits and drawbacks of each of the options for the existing Line 3. Additionally, this chapter discusses the potential impacts and identifies possible mitigation measures.

Major issues considered in the assessment of abandonment of the existing Line 3 include:

- Potential environmental benefits of avoiding disturbance to active pipelines located on either side of the existing Line 3;
- Potential environmental risks and impacts of any existing contamination surrounding the pipe that would never be discovered and remediated if the line was abandoned; and
- Potential environmental risks and impacts associated with ongoing deterioration of abandoned pipeline.

Major issues considered in the assessment of removal of the existing Line 3 include:

- Potential risk that pipeline removal activities could damage an active pipeline located on either side of the existing Line 3, causing an oil leak;
- Potential impacts associated with disturbances at waterbody and roadway crossings;

[1] Minnesota Statutes § 216D.04, Subd. 3(f) and Minnesota Administrative Rules Part 7560.0125 (known collectively as "Gopher State One Call," or call before you dig) require specific document retention for all abandoned underground utilities in Minnesota (after December 31, 1998) and require providing specific information to excavators.

[2] 49 Code of Federal Regulations (CFR) 195.402(10) "Abandoning Pipeline Facilities"; 49 CFR 195.59 abandonment reporting requirements.

- Potential environmental benefits associated with discovery and remediation of existing contamination surrounding the pipe during removal; and
- Avoidance of potential environmental risks and impacts associated with ongoing deterioration of abandoned pipeline.

The option of removing the existing Line 3 and placing the new Line 3 in the existing trench (RA-07) would raise similar issues to those listed above related to simply removing the existing Line 3. Replacement in the same trench, however, would require Line 3 to be out of service for the period during removal of the existing Line 3 and construction of the new Line 3. Issues, impacts, and mitigation associated with the option of removal and replacement within the same trench are addressed in detail in the evaluation of RA-07 in Chapter 6.

8.2 REGULATORY FRAMEWORK AND METHODOLOGY

Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations govern the abandonment of pipelines. These regulations prescribe certain steps for formal abandonment of oil pipelines, including the disconnection, purging, and sealing of abandoned pipelines left in place,[3] but require that the pipeline owner prepare a plan that details how the basic requirements of the regulation will be met. In addition, federal regulations require operators to file an abandonment report for each abandoned facility that crosses a navigable waterway. This abandonment report includes certification that the facility was abandoned in accordance with all applicable laws.[4] Minnesota's regulations require specific document retention for all abandoned underground utilities in Minnesota to prevent unexpected discovery during excavation activities.[5] State and federal pipeline regulations do not specifically regulate the removal of pipelines.

Abandonment and removal activities that involve clearing and ground disturbance would require authorizations, permits, and approvals similar to any other construction activity including, for example, construction stormwater permits, permits for construction in public waters, and permitting for impacts on wetlands. The regulations that govern these programs are discussed in detail in Chapters 5 and 6.

Impacts of abandonment have been characterized based on:

- A review of the nature and extent of the on-the-ground activities that are involved in each of the steps of abandonment (e.g., disconnection, purging, sealing, and long-term monitoring); and
- A review of literature and studies that characterize potential long-term interactions between the abandoned pipe and the surrounding resources as the pipeline degrades.

[3] 49 CFR 192.3; 195.2.

[4] 49 CFR 192.727(g); 195.59.

[5] Minnesota Statutes § 216D.04, Subd. 3(f) and Minnesota Administrative Rules Part 7560.0125 (known collectively as "Gopher State One Call," or call before you dig).

Impacts of removal have been characterized based on:

- A review of the nature and extent of the on-the-ground activities that are involved in each of the steps involved in removal (e.g., excavation, removal/haul-away, and remediation of contaminated soil).

8.3 ABANDONMENT

Enbridge Has Filed a Proposed Abandonment Plan per PHMSA Regulations

In its Certificate of Need and route permit applications, Enbridge proposed to abandon the existing Line 3 following the PHMSA requirements for abandonment and generally described how they would do it. Subsequently, Enbridge filed with the Minnesota Public Utilities Commission (Commission) a draft of the required plan that details how the basic requirements of the PHMSA abandonment regulations will be met (Appendix B). Enbridge's abandonment plan for the portion of existing Line 3 in Canada is discussed in the Canadian National Energy Board's (CNEB's) Report regarding Line 3. The discussion here draws upon Enbridge's abandonment plan filed with the Commission and the CNEB report.

Enbridge proposes abandonment in place of the existing Line 3 that includes:

- **Removing the Oil** – Oil within existing Line 3 would be purged from the pipeline using cylindrical plug-like devices known as "pigs." The pigs would be propelled by nitrogen gas. Oil removed from the line would be moved to tanks at the Clearbrook terminal and the Superior terminal.
- **Cleaning the Pipeline** – Following removal of the oil, the pipeline would undergo a multi-step cleaning process. The process involves sending a variety of cleaning solutions and specialized pigs through the pipeline to remove any remaining oil or associated hydrocarbons. Enbridge has indicated that all solid waste materials generated as a result of cleaning activities will be handled and disposed of in accordance with applicable federal and state requirements. All of the cleaning solution used during this process will be appropriated and disposed of in accordance with permit requirements.
- **Disconnecting the Pipeline** – The existing pipeline would be physically disconnected from pump station terminals. The pipeline's mainline valves would be closed and electrically disconnected so that they could not be operated.
- **Segmenting the Pipeline** – In addition to disconnecting the pipeline and closing mainline valves, engineers for Enbridge would evaluate the existing line to determine whether additional segmentation of the pipeline would be needed to prevent the pipeline from acting as a water conduit. At any such locations, the pipeline would be accessed and cut, and a cap welded onto the pipeline.
- **Monitoring and Maintaining the Pipeline** – Enbridge would continue to monitor and maintain the abandoned Line 3 right-of-way in accordance with PHMSA regulations indefinitely. Enbridge notes that this monitoring would enable them to identify and assess any risks to the public or the environment caused by the abandoned Line 3. Enbridge would take measures to mitigate identified potential risks, and cathodic protection would be maintained for the abandoned pipeline to prevent corrosion.

8.3.1 Potential Impacts and Mitigation Measures

Disconnecting and Segmenting Existing Line 3 Would Require Some Ground Disturbance

Clearing and ground disturbance required for cleaning, disconnecting, segmenting, and any on-the-ground activities associated with long-term monitoring of the abandoned pipeline would occur within the Mainline corridor. With clearing and excavation activities limited to the Mainline corridor, the potential impacts associated with abandonment activities are anticipated to be minimal. As noted above, impacts from clearing and ground disturbance would be managed through permitting similar to any other construction activity including, for example, construction stormwater permits, permits for construction in public waters, and permitting for impacts on wetlands. Many of the same construction techniques and environmental protection measures described in Chapters 5 and 6 would be required for pipeline abandonment activities, including the use of work windows to avoid sensitive species' lifecycles (like breeding or nesting), vehicle and equipment crossing methods, sediment control measures, and bank restoration.

Abandonment Would Minimize Risks to Other Pipelines

The existing Line 3 is situated between other active oil pipelines within Enbridge's Mainline corridor (see Figure 4.3-2). The distance between pipelines within this corridor varies, but they are generally 10 to 15 feet apart. Enbridge has indicated that abandonment would minimize risk to other pipelines in the Mainline corridor by limiting the extent of disturbance and thereby reducing the chances of striking the adjacent pipelines with equipment or stressing the adjacent pipelines with the weight of heavy equipment.

Leaving Existing Line 3 in Place Could Have Potentially Significant Effects

There are, however, some potentially significant impacts associated with abandoning the existing Line 3. These longer term impacts are caused by the continued presence of undiscovered legacy contamination that may exist surrounding the existing pipeline, as well as the potential hazards associated with the aging of the abandoned pipe. These impacts include soil and water contamination, the ability of the pipeline to serve as a water conduit, subsidence due to the failure over time of the pipeline, and loss of buoyancy control[6] for the pipeline. These impacts are discussed further here. A summary of potential impacts of abandonment of the existing Line 3 is provided in Table 8.3-1.

[6] Buoyancy controls prevent the pipeline from becoming buoyant and, eventually, becoming exposed at the surface. The buoyancy of a pipeline depends on the weight of the pipe, the weight of the volume of water displaced by the pipe, the weight of the liquid load carried by the pipe, and the weight of the backfill. When a pipe is empty, the weight of the liquid load that once contributed to buoyancy control is lost. As a result, the pipe could become buoyant and begin rising toward the surface at watercourse crossings, in wetlands, and in locations where soil density is low and the water table is high.

Table 8.3-1. Potential Impacts of Line 3 Abandonment

Resource	Impact
Human Settlements	In the near term, impacts on human settlements are anticipated to be minimal. Work to clean, disconnect, segment, and monitor the pipeline would occur within the Mainline corridor. Some segmentation activities could require site-specific excavation. It is anticipated that this work, and all work within the Mainline corridor, would comply with all applicable permits and approvals, thus minimizing and mitigating potential impacts. In the longer term, impacts on transportation and public services could be significant due to potential subsidence. These impacts could be avoided and mitigated through long-term monitoring, adaptive management, and site-specific mitigation measures.
Natural Resources	In the near term, impacts on natural resources are anticipated to be minimal. Enbridge proposes to protect these resources by clearing the pipe of potential pollutants and segmenting the pipe to prevent it from acting as a water conduit. The effectiveness of Enbridge's cleaning protocol and proposed segmentation of Line 3 could require further review and alteration as appropriate. In the longer term, impacts on natural resources could be significant due to subsidence and exposed segments of pipeline (buoyancy). These potential impacts could be mitigated by monitoring, adaptive management, and site-specific mitigation measures.
Cultural Resources	No impacts on cultural resources are anticipated. Abandonment activities would take place within the Mainline corridor and along the existing Line 3.
Socioeconomics	In the near term, impacts on socioeconomics are anticipated to be minimal. Abandonment could decrease tax revenues or shift them to other taxing authorities. In the longer term, impacts on socioeconomics, particularly agricultural production, could be significant due to subsidence and exposure of pipeline. These potential impacts could be mitigated by monitoring, adaptive management, and site-specific mitigation measures.
Cost	Enbridge estimates the short-term cost of deactivating Line 3 in place to be approximately $85 million.[7] Enbridge estimates annual monitoring costs for Line 3 to be about $100,000.[8] Costs for future site-specific mitigation measures (e.g., to mitigate subsidence or loss of buoyancy control) are uncertain and would depend on the nature of the mitigation measures.
Environmental Justice	Communities with potential environmental justice impacts related to the Line 3 Project are discussed in Chapter 11. The abandonment of existing Line 3 could negatively affect these communities due to ongoing stress or anxiety related to the presence of the pipeline and ongoing risks related to water flow, soil and water contamination, and subsidence.

7 Communication with Enbridge, March 10, 2017.

8 Id.

8.3.1.1 Soil and Water Contamination

Remaining Oils and Solvents Could Potentially Cause Future Damage

Oil or solvents that remain in the pipeline after cleaning have the potential, at some time in the future, to leak and contaminate soils and waters near the pipeline. Corrosion of the pipeline would be slowed by cathodic protection. Over a long enough period of time, however, the pipeline will corrode and begin to fail (discussed further below). Thus, ensuring that the pipeline contains as few oils or solvents as possible is key to minimizing potential future impacts on nearby soils and waters.

Enbridge Has Developed a Cleaning Protocol to Comply with PHMSA Regulations

Enbridge's proposed abandonment plan includes removing the oil from the existing Line 3, cleaning the line of remaining oil and associated hydrocarbons, and using a variety of pigs and solvents to clean the pipeline. The pigs would have a variety of smooth and scraping surfaces to remove oils, hydrocarbons, and any other materials on the pipeline walls. The pigs would be propelled through the pipeline by nitrogen gas, and the solvents would consist of water and biodegradable cleaning agents.

Enbridge has developed and tested a cleaning protocol using a 12-mile abandoned section of Line 3 in Manitoba. Enbridge indicates that its proposed cleaning protocol removes over 99.99 percent of the remaining oil and hydrocarbons from a pipeline. All solid waste materials generated as a result of cleaning activities will be handled and disposed of in accordance with applicable federal and state requirements. All of the cleaning solution used during this process will be appropriated and disposed of in accordance with permit requirements.

Laboratory analysis conducted by Enbridge indicates that its proposed cleaning protocol is effective at minimizing impacts on soils and waters (Appendix B). Thus, potential impacts on soil and water resources near the existing Line 3 due to oils or other hydrocarbons from the abandoned Line 3 are anticipated to be minimal.

If Effective on Long Pipelines, Enbridge's Protocol Could Minimize Effects on Soils and Waters

However, the testing done by Enbridge of its cleaning protocol was conducted on a 12-mile length of pipe, and the existing Line 3 in Minnesota is approximately 282 miles long. It is currently unknown whether Enbridge's protocol works on a longer length of pipeline. Potential future impacts on soils and waters along the existing Line 3 could be minimized by ensuring that Enbridge's protocol works on the longer length of pipeline in Minnesota as well as it did in testing of the protocol. Coordination with resource agencies and authorities would ensure the efficacy of the cleaning protocol and proper handling of all waste materials.

8.3.1.1.1 Contamination Outside of the Pipeline

Past and Present Contaminants Outside Existing Line 3 Could Cause Impacts

Soils and waters near the abandoned Line 3 could also be adversely affected where undiscovered contamination along the existing pipeline (from lubricants, process chemicals, and oil spills) are left behind. Potential impacts on soil and water resources are highly uncertain, however, as they depend on the extent of the existing undiscovered contamination.

Enbridge has indicated that it would develop a contaminated sites management plan to identify, manage, and mitigate historically contaminated soils and waters. Such a plan would require them to identify potential contamination sources along abandoned Line 3 and coordinate with resource agencies and authorities to determine appropriate mitigation measures (see Sections 5.2.1.1, 5.2.2, 6.3.1.1, and 6.3.2).

8.3.1.2 Existing Line 3 as a Water Conduit

If It Were to Act as a Water Conduit, Existing Line 3 Could Affect Water Resources

Over time, despite cathodic protection, the abandoned Line 3 would corrode and lose structural integrity such that water could enter the pipeline. This water could flow through the pipeline by gravity and exit the pipeline at another location. Thus, the abandoned pipeline could serve as a conduit for water to move from one water resource to another, creating hydrological connections that might not otherwise occur. These connections could make water relatively more scarce or more abundant in specific locations, leading to potential impacts on wetlands, watercourses, and lakes and on human uses of water such as drinking water or for agricultural irrigation.

Cathodic Protection and Segmenting the Pipeline Would Minimize Effects on Water Resources

Enbridge's proposed abandonment plan includes maintaining cathodic protection of the pipeline to minimize corrosion, segmenting the pipeline to prevent the pipeline from acting as a water conduit, and monitoring the pipeline. Enbridge's abandonment plan proposes to segment Line 3 at 47 locations, with three other locations requiring further study (for a possible total of 50 locations; see Appendix B).

The 47 locations consist of 40 mainline valves, six pump stations, and one pump station/terminal. Enbridge selected the segmentation locations based on topographical data, GIS analysis, and computer modeling. Enbridge notes that water resources are generally located at lower elevations within a landscape. Because the pipeline elevation on either side of a waterbody is higher than the elevation of the segment of pipe that passes beneath the waterbody, gravity will tend to keep any water that might enter the pipe from flowing uphill and passing beyond the limited segment of pipe that runs beneath the water body. These conditions imposed by elevation and gravity typically effectively limit water movement beyond the limited segment of pipe that passes below a particular water resource.

Work at Pump Stations and Mainline Valves Would Take Place within Their Fenced Boundaries

At pump stations and terminals, the abandoned Line 3 would be disconnected and segmented by excavating down to the pipeline, cutting the pipeline, and welding a cap onto the pipe. Enbridge anticipates that this work would occur within the fenced boundaries of the pump stations and terminals. Mainline valves that serve as segmentation locations would be closed and electrically disconnected so that they could not be operated. For all other segmentation locations, Enbridge proposes to excavate to the pipeline, cut the pipeline, and weld a cap onto the pipe or close the pipe with grout.

Additional Segmentation Locations Still Need to Be Studied

If Enbridge's proposed abandonment plan is effectively implemented, including segmentation of the existing Line 3, the potential impacts on water resources resulting from a potential flow of water through existing Line 3 are anticipated to be minimal. As Enbridge acknowledges in its plan, however, additional segmentation locations require further study. Additionally, water resources may be identified

by state, federal, and tribal resource agencies that these agencies believe are not adequately protected by Enbridge's proposed plan and that, as a result, require additional segmentation of an abandoned Line 3.

8.3.1.3 Subsidence

Failure of Existing Line 3 Depends on Structural Integrity and Applied Loads

In addition to potentially serving as a water conduit, as the abandoned Line 3 corrodes and loses its structural integrity, soil could enter the pipeline, causing a subsidence of the ground. This would likely occur over time with soil slowly filling the pipe, but the pipeline could also collapse quickly, before it has much soil in it. Subsidence could affect public safety, particularly if it occurred at highways, railroads, or other utility crossings. It could also affect agricultural production and could lead to water channeling and erosion with concomitant adverse impacts on water resources.

Underground Loads Are Typically Less Than Surface Loads

Whether subsidence occurs, and the extent to which it occurs, depends on the structural integrity of the pipe and on the loads applied to the pipe that could cause it to deform and fail. In general, loads at the pipe level (underground) are less than live loads at the surface (like those from a heavy truck), because part of the load is shared with the surrounding soil. If there is a dearth of surrounding soil, or if the cover for the pipeline is relatively shallow, the pipeline bears more of the load and, all things being equal, is more likely to fail.

The Longer the Pipe Is in the Ground, the More Likely It Is to Fail

Enbridge has analyzed and modeled potential subsidence of the abandoned Line 3 in its proposed abandonment plan (see Appendix B). This analysis includes projecting loss of pipeline wall thickness due to corrosion over time, possible failure modes for the pipeline, and estimated subsidence levels should the pipeline fail. In general, subsidence is a time-dependent risk. The longer the pipe is in the ground, the greater the advancement of corrosions such that the pipe may fail.

Subsidence Is Inversely Proportional to the Amount of Soil That Has Entered the Pipeline

Enbridge's analysis indicates that it would take a minimum of 506 years for the abandoned Line 3 to fail under typical highway loads and 87 years to fail under typical railway loads. How much subsidence occurs as a result of these failures depends on whether or not soil has been slowly filling the pipe over these time periods. The greatest subsidence would occur when no soil has entered the pipe. Enbridge estimates that subsidence with no soil having entered the pipeline prior to loss of structural integrity would range from about 3 to 7 inches, depending on the pipeline's depth of cover.

Few Near-Term Effects on Natural Resources, Land-Based Economies, and Public Safety

In light of Enbridge's analysis, impacts on natural resources and land-based economies such as agriculture are anticipated to be minimal in the near term (i.e., the next 40 years) but could be significant longer term. For many areas and land-uses along the route of the existing Line 3, mitigation of subsidence can be corrected, to some extent, by fill with soil. In some areas, however, a fill would not be possible (e.g., in each incident where the pipeline passes underneath a watercourse). Due to the

length of the existing Line 3 and the variety of resources along it, the primary mitigation strategy would be effective monitoring and adaptive management.

Enbridge's analysis also indicates that impacts on public safety are anticipated to be minimal in the near term, but that the potential exists for significant impacts on highway, railways, and other utilities, absent monitoring, adaptive management, and effective mitigation measures. Subsidence of highways and railways could result in significant adverse impacts, and avoiding and mitigating these impacts is a site-specific and authority-specific endeavor. Initial analysis by Enbridge indicates that the existing Line 3 crosses under 297 roads and 17 railways.

Enbridge notes that tolerable subsidence levels for roads, railways, and utilities have not been established with respect to pipelines. Each pipeline crossing scenario is evaluated independently to determine potential risks and mitigation measures. In some instances, the preferable approach for road or railway crossings could be to fill the abandoned pipe with an engineered fill material that would provide structural integrity over the longer term.

Long-Term Effects Could Be Significant and Would Require Site-Specific Mitigation Measures

In sum, impacts on human and natural resources due to potential subsidence of the ground above the abandoned Line 3 are anticipated to be minimal in the near term but could be significant in the longer term, absent effective monitoring, adaptive management, and the timely introduction of mitigation measures. Because of the length of Line 3 and the variety of resources crossed, mitigation measures would be site specific and would need to be designed in collaboration with those agencies and authorities responsible for the resources in question.

8.3.1.4 Loss of Buoyancy Control

Loss of Buoyancy Control Could Cause Pipe to Become Exposed

Once existing Line 3 is emptied of oil, the pipeline could become buoyant at watercourse crossings. That is, once the pipeline is no longer burdened by the weight of the transported oil, the depth of cover and other buoyancy control measures might no longer be adequate to prevent the pipeline from becoming buoyant and, eventually, becoming exposed at the surface. Enbridge has indicated that loss of buoyancy control could occur at watercourse crossings, in wetlands, and in locations where soil density is low and the water table is high.

Exposed Pipe Could Affect Streambeds and Cause Erosion, but Locations Are Difficult to Predict

If the abandoned Line 3 became buoyant, the exposed pipeline could adversely affect natural resources, including soil erosion and impacts on streambeds. Because of the length of Line 3, the variety of resources crossed, and the number of variables that determine whether a specific segment of pipe will become buoyant, it is difficult to predict where buoyancy and exposed pipe will occur. Accordingly, the primary mitigation measures are monitoring and adaptive management.

In the CNEB report, Enbridge indicated that it would conduct a preliminary buoyancy analysis of Line 3 in Canada to determine areas where there might be pipeline buoyancy issues. Buoyancy analysis may also be required by PHMSA. Enbridge noted that it would use a variety of mitigation measures to address exposed pipeline, including weights or engineered fill, placing additional cover over the pipeline and, in some circumstances, removing segments of the pipeline.

Complexity and Variety of Affected Resources Would Require Site-Specific Mitigation Measures

Enbridge's proposed abandonment plan for Line 3 in Minnesota does not explicitly discuss buoyancy. The plan does, however, discuss the possibility of exposed pipe and potential mitigation measures. Enbridge indicates in its proposed plan that it would monitor for exposed pipeline and, if found, would work with relevant agencies and authorities to develop site-specific mitigation measures, which could include removing a segment of pipeline, grouting, and continued monitoring.

Because of the length of Line 3 and the variety of resources crossed, mitigation measures for buoyancy and exposed segments of the abandoned Line 3 would be site specific and would need to be designed in collaboration with the responsible agencies. In Minnesota, the Department of Natural Resources is responsible for issues that involve crossing the state's waters. Buoyancy is a phenomenon that occurs near and within water resources, making it more likely that mitigation measures designed for specific exposed segments of pipeline would involve working with the Department of Natural Resources.

8.3.1.5 Cost

Short-Term Cost of Abandonment Estimated at $85 Million

Enbridge estimates the short-term cost of abandoning Line 3 in place to be approximately $85 million.[9] For context, Enbridge estimates annual monitoring costs for Line 3 to be about $100,000.[10] Costs for future site-specific mitigation measures (e.g., to mitigate subsidence or loss of buoyancy control) are uncertain and would depend on the nature of the mitigation measures.

8.4 REMOVAL

Removing a Pipeline Requires Much the Same Process as Constructing a Pipeline

An alternative to deactivating Line 3 in place is to remove the pipeline. A description of the removal process is included in the discussion of RA-07 (see Section 4.3.4). Removing an existing pipeline is essentially the reverse of constructing a pipeline and involves topsoil removal, excavation, pipe removal, backfilling and compaction of the trench, replacement of the topsoil, and revegetation measures.

With clearing and excavation activities occurring within and immediately adjacent to the Mainline corridor, potential impacts related to construction disturbance are anticipated to be minimal. As noted above, impacts from clearing and ground disturbance would be managed through permitting similar to any other construction activity including, for example, construction stormwater permits, permits for construction in public waters, and permitting for impacts on wetlands. Many of the same construction techniques and environmental protection measures would apply to pipeline removal in order to reduce impacts, including the use of work windows to avoid sensitive species' lifecycles (like breeding or nesting), vehicle and equipment crossing methods, sediment control measures, and bank restoration.

9 Communication with Enbridge, March 10, 2017.

10 Id.

Soil materials required to fill the trench after pipe removal could be recovered from areas immediately adjacent to the pipeline right-of-way, although additional topsoil may need to be obtained from local borrow sources.

Pipe cleaning would be required if the pipe were to be removed to avoid contamination of soil and groundwater during the removal process. Cleaning would need to be conducted using a process similar to the process used for pipeline abandonment to minimize risks to humans and the environment from residual oil.

8.4.1 Potential Impacts and Mitigation Measures

The potential impacts of removing the existing Line 3 are anticipated to be similar to those for removing and replacing Line 3 in the same trench (route alternative RA-07). Potential impacts of RA-07 are discussed in Chapter 6. Impacts are also summarized here in Table 8.4-1.

Table 8.4-1. Potential Impacts of Line 3 Removal

Resource	Impacts
Human Settlements	Impacts on human settlements are anticipated to be similar to those for route alternative RA-07, as discussed in Section 6.2, and include temporary noise and aesthetic impacts and impacts due to the heavy use of local roads. There is a significant risk of damage to existing pipelines and the risk of an oil leak that could significantly affect human settlements. Impacts on roads, railways, and utilities could be significant if subsidence occurs with removal of Line 3.
Natural Resources	Impacts on natural resources are anticipated to be similar to those for RA-07, as discussed in Section 6.3, and include minor vegetation clearing, air emissions, and construction stormwater impacts. There is a significant risk of damage to existing pipelines and the risk of an oil leak that could significantly affect natural resources. In wetland areas, it might not be possible to remove Line 3 without damaging existing pipelines.
Cultural Resources	Impacts on cultural resources are anticipated to be similar to those for RA-07, as discussed in Section 6.4, and are anticipated to be negligible, with ground-disturbing activities limited to the Mainline corridor and immediately adjacent areas.
Socioeconomics	Impacts on socioeconomic resources are anticipated to be similar to those for RA-07, as discussed in Section 6.5, and include minor impacts associated with disturbance to recreation and tourism as well as minor impacts on local economies. There is a significant risk of damage to existing pipelines and the risk of an oil leak that could significantly affect socioeconomic resources. In wet soils, it might not be possible to remove Line 3 without damaging existing pipelines. Tax revenues could decrease or shift to other taxing authorities.
Cost	Enbridge estimates the cost of removing Line 3 at approximately $1.28 billion. Enbridge estimates the cost per-foot for removal at about $855.a
Environmental Justice	Communities with potential environmental justice impacts related to the Line 3 Project are discussed in Chapter 11. Removal of the existing Line 3 could positively affect these communities by removing stress or anxiety related to the presence of the abandoned pipeline and ongoing risks related to water flow, soil and water contamination, and subsidence.

[a] Communication with Enbridge, March 10, 2017.

Primary Challenge Is Proximity of Other Pipelines, but Mitigation Measures Would Be Used

The primary challenge in removing Line 3 is that it is situated between other active oil pipelines within Enbridge's Mainline corridor (see Figure 4.3-2). The distance between pipelines within this corridor varies, but they are generally 10 to 15 feet apart. Enbridge has indicated that there is a significant risk that pipeline removal activities could damage an active pipeline and cause an accidental release. Damage could be caused by striking a pipeline with equipment or by the weight of the equipment as it works above operating pipelines. This damage would be immediately apparent if equipment struck a pipeline, or observable later if the pipeline was damaged and only leaked in the future.

Enbridge's assessment of the risks and benefits of removal included in their abandonment plan contemplated the use of timber mats over operating pipelines to create a work and travel surface for equipment. These mats would help disperse the weight of the equipment and minimize potential impacts on these pipelines. Enbridge also indicates that sheet piling would likely be required to isolate specific segments of existing Line 3, particularly in wet soils and wetlands. Enbridge notes that it might not be possible to use typical excavation equipment to excavate Line 3, due to the weight of the equipment and the proximity to operating pipelines. Enbridge notes that it would likely use a hydraulic vacuum or hand dig to minimize potential impacts on existing pipelines.

As discussed above, certain segments of the existing Line 3 could not be removed using existing technology like timber mats or sheet piling, without significant risk of damaging operating pipelines. If the existing Line 3 was removed in these areas and operating pipelines were damaged, these pipelines would need to be excavated and repaired, with considerable risk of further damage and leakage.

Special Mitigation Measures Would Be Needed at Watercourses and Where Line 3 Removal Would Create Unacceptable Risks

Where Line 3 crosses underneath watercourses, roads, and railways, excavation and removal could temporarily but significantly affect waters and fisheries or access to roads and railways.

There may also be areas where local geology would cause removal to create a high risk of erosion or subsidence. In these areas, mitigation measures would be site specific and would need to be designed in collaboration with the responsible agencies and authorities.

Where existing Line 3 cannot be safely removed, the appropriate mitigation measure could be segmenting and deactivating the pipeline or using an engineered fill until the pipeline could be reached without damaging existing pipelines. Similarly, where Line 3 crosses under watercourses, roads, and railways, the appropriate mitigation measure might be to deactivate and segment the pipeline and use an engineered fill to prevent subsidence.

Contaminated Soil Could Be Remediated

Enbridge has indicated that it would develop a contaminated sites management plan to identify, manage, and mitigate historically contaminated soils and waters. Any existing contamination discovered during excavation of the existing Line 3 could be remediated in accordance with this plan, avoiding the potential for long-term adverse impacts on soil and water quality caused by undiscovered contamination along the existing pipeline (from lubricants, process chemicals, and oil spills) as discussed in Sections 5.2.1.1, 5.2.2, 6.3.1.1, and 6.3.2.

Proper Handling of Waste Materials Would Be Critical to Minimize Impacts

Enbridge indicates that, if the existing Line 3 was removed with a hydraulic vacuum process, the removal would generate approximately 1.7 million gallons of slurry waste that would need to be properly handled to minimize potential impacts. In addition, the pipe would need to be recycled or disposed of. Pipe that would be used for another purpose after removal would also be cleaned of hazardous materials while in place and can include supplementary cleaning techniques after the pipe has been removed from the ground. For pipe that is targeted for disposal, existing disposal or landfilling guidelines would determine the required cleanliness of the pipe.

Cost of Removal Estimated at Approximately $1.28 Billion

Enbridge estimates the cost of removing Line 3 at approximately $1.28 billion.[11] This estimate is based on a per-foot cost for removal at about $855.[12]

8.5 REFERENCES

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11 Communication with Enbridge, March 10, 2017.

12 Id.

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Chapter 9
Tribal Resources

9.1 INTRODUCTION

Impacts analyzed within an Environmental Impact Statement (EIS) generally rely heavily on quantitative data and a western worldview of science and its applications (Dongoske et al. 2015). Using western scientific methods to evaluate environmental impacts "fails to consider and incorporate Native American perspectives of, values about, and relationships with the environment." The goal of this chapter is to provide an alternative, qualitative measure of the impact of Enbridge's proposed Line 3 Replacement Project (Project) on American Indians. This chapter employs a methodology that frames the discussion to reflect American Indian perceptions of the environment and the impacts associated with constructing a pipeline through an area of traditional, cultural, spiritual, and natural resource significance.

Impacts are discussed in the preceding chapters of the EIS, including impacts on reservation lands, treaty lands, resources that hold tribal significance such as wild rice and water resources, and climate change. To fully understand and appreciate the impacts of the proposed Project and its alternatives on American Indian communities and cultures, qualitative *and* quantitative discussions are necessary. The differences between these approaches highlights the unique impacts on tribal communities and tribal members.

American Indian traditions are interwoven into the ecosystems in which they live, from subsistence gathering to sacred sites—all places that have spiritual and artistic meaning. For example, wild rice has important cultural ties to local traditions, spiritual fulfillment, and more. "Culturally important ecosystem services often cannot be measured in pounds, gallons, acres, or kilowatts" (Fletcher and Christin 2015). This chapter identifies tribal resources and details their importance to the survival of tribal traditional ways. The intent is to provide a more complete analysis of long-term consequences of any alteration, modification, or rerouting of Line 3, all which would have impacts on the watershed's natural assets (Fletcher and Christin 2015).

9.2 HISTORICAL AND LEGAL FRAMEWORK

There are 11 federally recognized Indian reservations in Minnesota, including the Minnesota Chippewa Tribe, consisting of six member tribes: Grand Portage, Boise Fort, Fond du Lac, Mille Lacs, White Earth, and Leech Lake. The main groups of Indians in Minnesota are the Dakota and the Chippewa, also referred to as Ojibwe or Anishinaabe. The Dakota tribes in Minnesota call themselves communities, which stems from the original Dakota Community, established in 1851. The current reservation locations were established by federal Congressional action in 1886 by treaty (Fletcher and Christin 2015). All seven Ojibwe reservations in Minnesota were originally established by treaty, and the United States government accordingly considers them as unique sovereign nations (Figure 9-1).

The Ojibwe (Chippewa) tribes in Minnesota are: Bois Forte (Nett Lake), Fond du Lac, Grand Portage, Leech Lake, Mille Lacs, Red Lake, and White Earth. The Dakota Communities (Sioux) in the state are: Lower Sioux, Prairie Island, Shakopee-Mdewakanton, and Upper Sioux. The members of the Minnesota Chippewa Tribe include: Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs, and White

Earth. The six Wisconsin Ojibwe Bands—St. Croix, Lac Courte Oreilles, Sakoagan (Mole Lake), Bad River, Red Cliff, and Lac du Flambeau—also have treaty rights within the portion of the 1837 ceded territory that lies within the state of Minnesota. The Ho-Chunk Nation of Wisconsin also has trust lands within Minnesota. Many other tribal groups currently residing in the western United States have historical and ancestral ties to what is now Minnesota.

The Lakota and Dakota people of Minnesota have fished, hunted, and gathered within the state borders of the land now known as Minnesota and neighboring states for thousands of years. As sovereign nations, tribes manage natural resources accordingly. In association with the multiple treaties signed between tribes and the United States government, numerous tribes in the region retain the right to fish, hunt, and gather on their ceded lands, which extend outside of reservation boundaries. Tribal members continue to exercise these rights by fishing, hunting, and gathering on traditional lands for a variety of plants, animals, fish, and materials traditionally and currently used in or as medicines, foods, tools, textiles, building materials, carvings, and sacred objects.

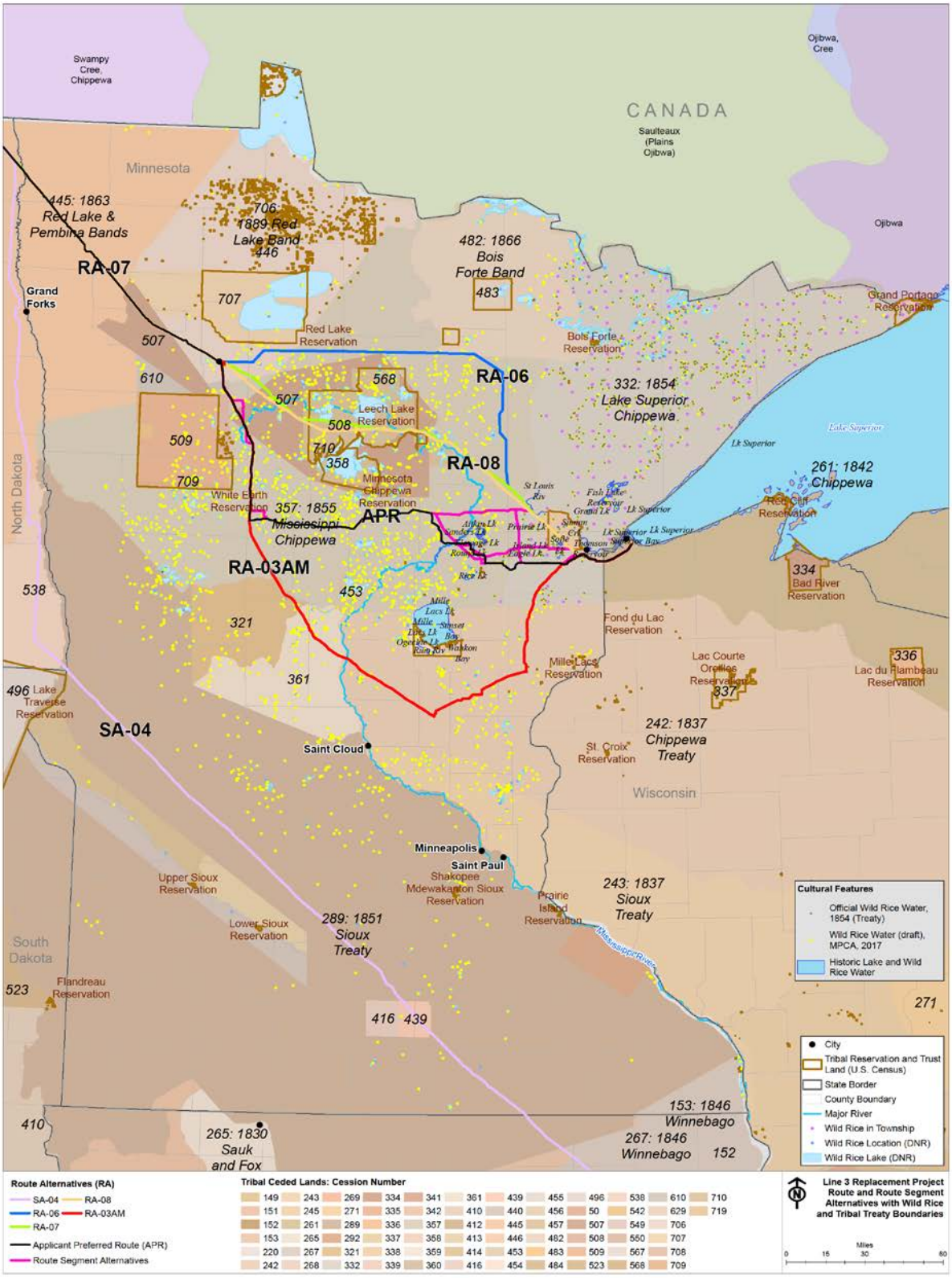

Figure 9-1. Route and Route Segment Alternatives with Tribal Treaty Boundaries

9.2.1 Federal Indian Law and Policy

American Indian law and public policy have evolved significantly since the founding of the United States. The Indian Commerce Clause of the U.S. Constitution recognizes tribes as distinct political entities by authorizing Congress "to regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." In addition, the Treaty Clause, while not explicitly referencing Indian tribes, played a major role in structuring a government-to-government relationship between tribes and the United States. The Indian Commerce Clause and the Treaty Clause are most often cited as the constitutional bases for legislation regarding Indian tribes. In 2004, the Supreme Court reaffirmed that the federal power to regulate Indian affairs is derived from the structure and text of the Constitution (Cohen 1982: §5.01).[1]

The courts have recognized that Congress has broad or "plenary" power to legislate in the area of Indian affairs, and Congressional power to set policy in Indian affairs supersedes conflicting state laws or state constitutional provisions. Congress may constitutionally enact legislation, execute provisions of a treaty, or ratify agreements with a tribe, even if doing so affects state interests (Cohen 1982: §5.02). This power includes the power to recognize and to terminate tribal relations with the United States and to impose federal laws limiting tribal authority without tribal consent.

In 1871, Congress discontinued the practice of treaty making with Indian tribes, while expressly continuing existing treaties in force. Subsequently, the executive branch negotiated agreements with tribes, which were then enacted into positive law by Congress. These agreements are accorded the same legal standing as treaties; they are the supreme law of the land. In recent years, tribes have entered into a number of agreements with the executive branch, implemented by legislation, dealing with a variety of subjects including settlement of land and water rights claims.

Treaties, agreements, and federal laws implementing them preempt state laws and state constitutional provisions. Treaties and treaty substitutes, such as agreements and compacts, remain in force absent later Congressional action abrogating particular provisions and serve as the source of judicially enforceable property rights and personal rights (Cohen 1982: §5.01).

Federally recognized tribes are sovereigns that retain the power of self-governance over their lands and members. The U.S. Supreme Court has characterized tribal governments as "domestic dependent nations" to whom the federal government has essentially a fiduciary relationship. One element of this fiduciary relationship has been to preserve tribes' status as self-governing entities within their territories, including protection from state interference without their prior, informed consent absent an act of Congress. Tribal sovereignty and the right to self-govern is the central tenet of federal Indian policy.

9.2.2 Indian Country and Indian Lands

"Indian country" is land that falls under the primary jurisdiction of the tribe inhabiting it and the federal government. State jurisdiction over Indian country is limited. Once established, Indian country can only

[1] See *United States v. Lara*, 541 U.S. 193, 200 (2004) (Commerce and Treaty clauses and structure of Constitution are basis for "plenary and exclusive" power of Congress); *McClanahan v. Ariz. State Tax Comm'n*, 411 U.S. 164, 172, n.7 (1973) ("[t]he source of federal authority over Indian matters has been the subject of some confusion, but it is now generally recognized that the power derives from federal responsibility for regulating commerce with Indian tribes and for treaty making"); see also *Morton v. Mancari*, 417 U.S. 535, 551–552 (1974) ("[t]he plenary power of Congress to deal with the special problems of Indians is drawn both explicitly and implicitly from the Constitution itself.").

be diminished or terminated by Congress, and its intent to do so must be clearly expressed. Indian country includes all land within the limits of any Indian reservation, including fee lands and rights-of-way, dependent Indian communities, and lands allotted to Indian individuals.

Indian reservations are areas of land set aside under federal protection for the residence or use of tribal Indians. Reservations include areas reserved from cession by treaties; areas set aside for tribes by executive order or Congressional act; and lands held in trust for Indians by the United States. Lands held in simple fee title by both non-Indians and tribal members and non-Indian government land also exist within the exterior boundaries of reservations due to massive land losses suffered by the tribes in the "Allotment Era." The Fond du Lac Band has expended large amounts of revenue to regain its land base within its own reservation, a common story for tribes. In 1934, Congress delegated to the Secretary of the Interior the authority to take land in trust for Indians, establish new reservations, or add area to existing reservations.

Indian trust land is land owned in fee by the United States but administered for the benefit of the tribes and individuals who are the equitable owners of the land. Land may be held in trust for tribes or individual Indians. The federal government, as the trustee of the lands, has a fiduciary duty to administer the land for the benefit of the Indian owners. Trust land cannot be sold or conveyed by its tribal or individual Indian owners without federal consent.

Tribal trust lands are held in trust by the federal government for a tribe's use. Tribal trust land is held in common for the benefit of all members of the tribe. Although most tribal property is trust land, not all tribal property is held in trust. Congress or the Secretary of the Interior can accept fee land into trust for individual Indians or tribes. Trust land is exempt from state and local property taxes.

Allotted trust lands are held in trust for the use of an individual Indian (or his or her heirs). The federal government holds the legal title and the individual (or his or her heirs) holds the beneficial interest. It is important to distinguish an Indian reservation from tribal property. An Indian reservation is a place within which a tribe may exercise tribal powers, but not all land within a reservation may belong to the tribe. In addition, tribes may own land, including trust land, outside the limits of a reservation, or tribes may claim rights in land now occupied by others by virtue of original possession and exercise of sovereignty, or rights reserved by treaty (Cohen 1982: §15.02). State power over tribal property is limited to those powers that Congress has delegated to it or those that have not been preempted by federal or tribal law.

Despite near-complete cession and colonization of their lands, American Indians continue to successfully negotiate challenges to their identities (Cohen 1982: §5.01).[2] The land, watershed, and air are not only part of the landscapes they call home but integral to who they are and to their sense of self and community (Cohen 1982: §5.02). For many tribes, self-governance centers on the management of tribally important natural resources. A fundamental difference between natural resource management by American Indian tribes and non-tribal governments is the "cultural significance of being indigenous to the United States with cultural roots to the land" (Cohen 1982: §5.02). In many cases, the natural

[2] See *United States v. Lara*, 541 U.S. 193, 200 (2004) (Commerce and Treaty clauses and structure of Constitution are basis for "plenary and exclusive" power of Congress); *McClanahan v. Ariz. State Tax Comm'n*, 411 U.S. 164, 172, n.7 (1973) ("[t]he source of federal authority over Indian matters has been the subject of some confusion, but it is now generally recognized that the power derives from federal responsibility for regulating commerce with Indian tribes and for treaty making"); see also *Morton v. Mancari*, 417 U.S. 535, 551–552 (1974) ("[t]he plenary power of Congress to deal with the special problems of Indians is drawn both explicitly and implicitly from the Constitution itself.").

resources on which tribes and their members depend are managed not by the tribes themselves, but by other governmental entities. Tribes have regulatory authority over lands and resources within the boundaries of their respective reservations, but have limited authority outside reservation boundaries. Tribally important resources off-reservation are sometimes ‘‘co-managed’’ with federal or state governments (Cohen 1982: §5.01).

In addition to lands within reservation boundaries, this chapter takes into account the ceded lands affected by Enbridge’s proposed Project due to the tribal resources, benefits, and conditions retained by the tribes.

9.2.3 Treaties and Reserved Rights

Treaties are contracts that were signed between Indian tribes and the U.S. government prior to 1871 that recognize and establish sets of rights, benefits, and conditions for the tribes who agreed to cede millions of acres of their homelands to the United States and accept the protection of the United States in return (BIA 2017).

Since well before Europeans arrived in North America, many tribes have relied on hunting, fishing, trapping, and gathering to provide food, clothing, and shelter. As the Supreme Court stated in *United States v. Winans*, these activities “were not much less necessary to the existence of the Indians than the atmosphere they breathed.” Aboriginal, or original Indian, title over land includes the right to engage in hunting, fishing, and gathering activities. Aboriginal title, along with its component hunting, fishing, and gathering rights, remains in the tribe that originally possessed it unless it has been granted to the United States by treaty or extinguished by statute. If aboriginal title to land is extinguished, the hunting, fishing, and gathering rights on the land are extinguished as well, unless those rights are expressly or implicitly reserved by treaty, statute, or executive order (Cohen 1982: §18.01).

Some tribes entered into treaties that expressly reserved hunting, fishing, and gathering rights on specified lands outside reservation borders. Treaties reserving hunting, fishing, and gathering rights over previously owned tribal lands do not constitute a “grant of rights to the Indians, but a grant of rights from them—a reservation of those not granted.” Treaty-reserved hunting, fishing, and gathering rights on off-reservation lands are akin to easements running with the burdened lands, and include easements to access hunting, fishing, and gathering sites. Thus, reserved rights on off-reservation lands do not require the tribe to have title to the underlying land (Cohen 1982: §18.02).

Tribal resources include collective rights reserved by tribes for tribal members to hunt, fish, and gather natural resources. These resources may be used for commercial, subsistence, or ceremonial purposes. Tribes regulate fishing, hunting, and gathering on their reservations. Congress may abrogate treaty rights, but it must clearly express its intent to do so.

The United States has a trust responsibility under which the United States has both moral and legally enforceable fiduciary obligations to protect tribal resources, lands, assets, and resources (BIA 2017). Therefore, when a project such as Enbridge’s proposed Line 3 Replacement Project is under consideration, tribes must be consulted; they have legally protected standing because of the unique impacts on tribal rights and resources. However, tribes with co-management authority over natural resources would assert that along with the co-management of the land, the same consultation as the federal government is required as to the managed resources.

9.2.3.1 Ceded Lands in Minnesota

Ceded lands are those lands that the Indian tribes relinquished to the U.S. government as part of a treaty (Figure 9-1). Treaties were written in the English language, the language of the people seeking to appropriate the lands from the Dakota and Ojibwe people in Minnesota. The treaty negotiations were conducted under the implicit threat of an armed military invasion as had been done against tribes farther to the east. Tribes may retain treaty rights over ceded lands if such rights are reserved within the treaty. Tribal members still rely on natural and cultural resources located within ceded lands. Within the state of Minnesota's boundaries, all of the Applicant's preferred route and its alternatives traverse ceded lands.

The 1837 and 1854 treaties with the Ojibwe provide for the "usufructuary right to hunt, fish, and gather the wild rice, upon the lands, the rivers, and the lakes included in the territory ceded" outside the reservation boundaries (TASC 2016). For many decades the State of Minnesota actively interfered with treaty rights held by the Ojibwe bands of Minnesota and Wisconsin. Many Anishinaabeg people were subject to fines, jail, harassment, and even imprisonment by the state and by non-Indian citizens simply for exercising the rights their ancestors had preserved in the treaties. As a result, the Ojibwe were forced to pursue litigation in federal courts to protect the free exercise of their treaty rights within the ceded territories. Treaty rights to the ceded territory were found to remain in force by the Federal District Court, the Eighth Circuit Court of Appeals, and finally the Supreme Court in *Minnesota v. Mille Lacs* in the 1990s. The Mille Lacs Band, the Fond du Lac Band, and several Wisconsin Ojibwe bands retain the right to hunt, fish, and gather on the Treaty of 1837 ceded lands, which extend from northeast Minnesota to Canada. The bands developed a conservation code with the State of Minnesota for the 1837 ceded territory, which requires licenses for public lands in the ceded territory, limits hunting on private land in the ceded territory, and requires daily permits for spearing and netting (Mille Lacs Band of Ojibwe 2014).

The 1854 treaty established permanent reservations for the Fond du Lac, Grand Portage, and Bois Forte bands. Article 11 of the 1854 treaty retains the three bands' right to hunt and fish within the ceded territory (Kappler 1904). The Minnesota Legislature approved an agreement with the three bands in 1988 by which the bands agreed to restrict hunting, fishing, and wild rice gathering off-reservation in exchange for an annual payment from the state. The Fond du Lac Band withdrew from the agreement in 1989 (Minnesota DNR 2016).

The 1855 treaty established the Mille Lacs and Leech Lake reservations, among others. The 1863 treaty included the Red Lake and Pembina bands. The treaty ceded 11,000,000 acres in present-day Minnesota and North Dakota to the United States. The 1863 treaty was changed before being ratified, and several Ojibwe bands did not sign it. The next year, a new version was negotiated, which increased the annual payments.

9.2.3.2 Reservation Land

Within the context of this EIS, a federal Indian reservation is an area of land that is reserved for an Indian tribe or tribes, under treaty or other agreement with the United States, executive order, or federal statute or administrative action, as permanent tribal homelands (BIA 2017).

9.2.3.3 Government Lands

Reservation lands may include other land holdings, including those of state and federal agencies. Government-owned lands within the context of this EIS refers to all lands owned by a government, either state or federal, and subject to sale or disposal under the homestead laws.

9.2.3.3.1 Ojibwe Tribes

The seven Minnesota Ojibwe reservations are located across central and northern Minnesota, in the following areas: Grand Portage is located in the northeast corner of the state; Bois Forte is located in northern Minnesota; Red Lake is located in northern Minnesota west of Bois Forte; White Earth is located in northwestern Minnesota; Leech Lake is located in the north-central portion of the state; Fond du Lac is located in northeast Minnesota west of the city of Duluth; and Mille Lacs is located in the central part of the state, south and east of Brainerd.

Six of the seven reservations were allotted to individual Indians during the late 1800s or otherwise subjected to federal action that resulted in reservation lands passing out of tribal ownership. The Red Lake Indian Reservation is the only reservation in Minnesota that was never allotted; all of the reservation land continues to be held in common by all tribal members. The other six Minnesota Ojibwe reservations are a mix of tribal trust land, tribal fee land, and land not owned by the governing tribe.

In the Old Crossing Treaty of 1863, the Red Lake Nation ceded more than 11 million acres of the richest agricultural land in Minnesota in exchange for monetary compensation and a stipulation that the "President of the United States direct a certain sum of money to be applied to agricultural education and to such other beneficial purposes calculated to promote the prosperity and happiness of the Red Lake Indian." In 1889 and 1904, Red Lake Nation ceded another 2,256,152 acres but received guarantees that all benefits under existing treaties would not change.

According to the 1837 and 1842 treaties, the Ojibwe were to receive annuities for 25 years as payment for relinquished land (GLIFWC n.d.). The annuities were made to the people in the fall months on Madeline Island in Lake Superior. In 1850, President Zachary Taylor ordered the Ojibwe people living east of the Mississippi River to move to unceded land. The order failed, so Ramsey (Territorial Governor and Superintendent of Indian Affairs in Minnesota) informed the Ojibwe that in order to receive their annuities, they would have to travel from Madeline Island to Sandy Lake, 285 miles by canoe to the west. The intent was to trap the Ojibwe at Sandy Lake over the winter. More than 5,500 Ojibwe set out for Sandy Lake. They arrived exhausted. There was no food. Living conditions deteriorated. A harsh winter and disease took hold; more than 150 Ojibwe people died. The government sent a 3-day food supply early in December. In response, many people headed home on foot. An additional 250 Ojibwe died on the reverse trail; those who reached their homelands vowed that they would never leave again. There is a present-day memorial located on a glacial mound overlooking Sandy Lake called the Mikwendaagoziwag Memorial (GLIFWC n.d.).

9.2.3.3.2 Dakota Communities

The four Dakota Communities in Minnesota are primarily in the southern and western areas of the state. Shakopee Mdewakanton is located south of the Twin Cities near Prior Lake; Prairie Island is located near Red Wing; Lower Sioux is located near Redwood Falls; and Upper Sioux is near the city of Granite Falls.

The original Dakota Community was established by treaty in 1851. The treaty established a 10-mile-wide strip of land on both sides of the Minnesota River as the permanent home of the Dakota. However, after

the U.S.-Dakota Conflict of 1862, Congress severed all treaties with the Dakota and forced them from their homes in the state. The four communities were reestablished in their current localities by acts of Congress in 1886. The four Dakota Community land bases today represent a small fraction of the original reservations and were restored to the Dakota by acts of Congress or Proclamations of the Secretary of Interior.

9.2.3.3.3 Formal Tribal Government Actions on Line 3 Replacement Project

The Minnesota Chippewa, the Minnesota Indian Affairs Council (MIAC), the National Congress of American Indians, Leech Lake Band, and Red Lake Nation have passed formal resolutions (Resolutions) in opposition to the proposed Project. The Resolutions are included in Appendix P.

Memoranda of understanding between the tribes and the U.S. Forest Service (Chippewa National Forest) for co-management of forest lands are also included in the appendix (Leech Lake Reservation Tribal Council and Chippewa National Forest 1993; U.S. Department of Agriculture – Forest Service and Tribes 2012).

9.3 METHODOLOGY

The unique sovereign status of each tribe and their tribal resources are critical to understanding the impacts on natural, cultural, and spiritual resources. Tribal resources rights include access to fishing, hunting, wild rice, and medicinal and traditional plants and foods, which are the foundation of the physical and mental well-being of the tribal community. An evaluation of this Project's potential impacts on tribal resources can only be made within the cultural context from which those values are derived (Bureau of Land Management 2015).

The information presented in this chapter is informed by the following methods:

1. Tribal consultation with the sovereign nations affected by the proposed Project,
2. Coordination with tribal natural resource departments and technical experts and Tribal Historic Preservation Offices,
3. Community meetings,
4. Interviews with tribal elders and historians,
5. Comments submitted during comment periods in 2015 and 2016, and
6. Literature reviews.

9.3.1 Tribal Consultation

Tribal consultation with the sovereign nations affected by the proposed Project began in 2015 with a request from the Mille Lacs Band of Ojibwe for formal government-to-government consultation with the Minnesota Department of Commerce (Commerce Department) on Enbridge's Sandpiper pipeline proposal (now withdrawn). The Commerce Department identified the need to develop a formal consultation policy and asked the MIAC to accept an interim policy for use in March 2016. The Commerce Department developed and began tribal consultation even though it was not required under Governor Dayton's Executive Order 13-10 to establish a formal government-to-government tribal consultation policy or a tribal liaison. Once accepted by MIAC, the Commissioner of Commerce held formal government-to-government consultations with the Fond du Lac, Leech Lake, Mille Lacs, Red Lake,

and White Earth. In addition, the commissioner consulted with the Leech Lake, Mille Lacs, Red Lake, and White Earth specifically on the EIS in early 2017.

Through consultation with MIAC and the sovereign nations directly affected by the proposed Project, the Commerce Department was made aware of bands with land holdings and ceded territories that could also be affected by the proposed Project. Commerce sent letters to Bois Forte, Grand Portage, Lower Sioux, Upper Sioux, Prairie Island, Shakopee Mdewakanton, Ho-Chunk (Wisconsin), Bad River Band of the Lake Superior Tribe of Chippewa (Wisconsin), Lac Courte Oreilles Band of Lake Superior Chippewa (Wisconsin), Lac du Flambeau Band of Lake Superior Chippewa (Wisconsin), Red Cliff Band of Lake Superior Chippewa (Wisconsin), Sokaogon Chippewa Community (Wisconsin), and the St. Croix Chippewa Indians of Wisconsin for formal consultation (see Appendix P). Commerce is in the process of beginning consultation with the six federally recognized Wisconsin Ojibwe bands that are also signatories to the 1837 treaty and thus exercise harvesting rights and governmental co-regulatory authority with the Minnesota bands and the State of Minnesota in that portion of the 1837 ceded territory within Minnesota.

9.3.2 Coordination

The Commerce Department began technical coordination meetings between tribal technical staff and Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) technical staff in 2015. These meetings included tribal natural resource departments (wildlife, fisheries, biology, air quality, and many other tribal technical staff). The meetings provided an opportunity for tribal technical staff to share information on natural resources and culturally important or sensitive areas. In addition to sovereignty and treaty rights, the tribal resource concerns and interests currently identified through coordination are spill analysis, groundwater impacts, surface water impacts, wild rice impacts, tribal resources, climate change, and the impact of abandoning the existing Line 3 (see Appendix P).

9.3.3 Community Meetings

The Commerce Department invited all of the Ojibwe tribes in the Project vicinity to co-host a community meeting for tribal members. The purpose of the meeting was to provide an informal question-and-answer session on the development of the Draft EIS and the environmental review process. Community meetings were held with the Mille Lacs and Fond du Lac bands in March 2017.

9.3.4 Interviews with Tribal Elders and Historians

To gain information for this chapter, Commerce Department staff interviewed tribal elders and historians. Staff from the Mille Lacs Tribal Historic Preservation Office and the MIAC provided oral information on the cultural, spiritual, and historical Ojibwe culture in Minnesota. The Commerce Department asked the following questions for gathering insight and input for this chapter:

- Describe the interconnectedness of land, identity, and spirituality. Can they be separated from one another and if not why?
- What obligations do the Anishinaabe have to Mother Earth and how can they be met today?
- There are many projects that affect tribal interests such energy transmission, rights-of-way, etc. Is there something specific about pipelines that threatens the Anishinaabe way of life and relationship to place?

- What are sacred places? How is this different from sacred sites? What are culturally significant sites or cultural sites?
- What do you see as the biggest difference between the Anishinaabe communal, traditional use of land and the Anglo-Saxon concept of private land ownership and land use?
- How could state agencies more effectively understand or respect the inherent right to self-govern and sovereignty when coordinating special projects that affect tribal interests?
- What cultural resources are most threatened by pipeline projects? Please describe.
- We have heard of the water protectors—please explain their role within the community.

During the coordination meetings and the meetings with tribal elders and historians, Commerce Department staff collected information about significant cultural and spiritual sites across northern Minnesota to develop a map for use in this chapter, which illustrates the rich history and value the land holds for American Indians in Minnesota (see Appendix P).

9.3.5 Scoping Comments

Scoping meetings for the Project were held in 2015 and 2016. Fifteen scoping meetings were held in the Project vicinity in 2015, with meetings held on the White Earth and Mille Lacs reservations. Twelve scoping meetings were held in 2016, including meetings held on the White Earth and Mille Lacs reservations. Written and oral comments from the scoping meetings were cataloged and used to develop the scope of the EIS and develop route alternatives (DOC-EERA 2016).

9.3.6 Guiding Principles

The preparation of this chapter is guided by the following principles:

- Recognition of the privilege and importance of the information shared and presented;
- Respect for, and protection of, the rights, interests, and sensitivities of sovereign tribal governments in Minnesota;
- Accountability through face-to-face interviews and opportunity for review and feedback; and
- Intentionality to accurately reflect the information gathered.

For the purposes of this chapter, the concept of region of interest does not apply. To use an artificial distance from the center of a pipeline route alternative is antithetical to understanding tribal concepts of resource importance and use

Cultural differences and different worldviews between tribal and non-tribal governments creates a cultural dilemma. For example, it is common within the framework of the National Environmental Policy Act or the Minnesota Environmental Policy Act to view tribal governments as simply another partner in the federal or state process. This construct forces tribal governments to “participate” in processes that are not reflective of their governments or cultural belief systems. For environmental justice to have any meaning, it is important not to place traditional tribal spiritual beliefs and practices below those of more commonly understood Western religions. The constitutional system of government has too often robustly defended western religious practices while simultaneously allowing myriad assaults against the integrity of Native religions because they are categorized as something less than or too abstract to the

non-Indian understanding to be given parity with Western faith practices. A different model of government-to-government relations would be to accept tribal cultural differences and recognize "tribal governments can form the basis for a different civic community with a different sense of the public good" (Ranco et al. 2011).

Members of all 11 federally recognized sovereign nations in Minnesota maintain longstanding ancestral and traditional-use practices, which connect them to the natural and spiritual worlds. Tribal connections are maintained by protecting these resources and retaining the ability to manage them. Management of, and access to, tribal resources provides opportunities to pass traditional ecological knowledge to younger generations and to cement social bonds and shared cultural values (Ranco et al. 2011).

The well-being of tribal members depends on the health of tribal cultural and traditional resources (Ranco et al. 2011). When tribes are deprived of access to, and management of, natural and cultural resources, their cultural identity suffers. This has led to the historical trauma that tribal members experience today. The traditional tribal worldview may consider the cultural and spiritual value of the resource and not the total number of affected resources. For example, some tribes consider an adverse impact on a single natural resource as harmful as an impact on multiple resources.

9.4 TRIBAL RESOURCES

This section describes resources important to American Indians. These resources have natural, spiritual, and cultural values associated with them.

9.4.1 Cultural Properties

A Traditional Cultural Property (TCP) is defined in the National Register Bulletin 38 as a property that is "eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (in this context Manoomin, rice beds, and their natural environments encompass traditional and cultural properties).

Tribal resources refer to the collective rights and resources associated with a tribe's sovereignty or formal treaty rights, or their interest in and use of these resources. Therefore, a natural resource is also one of cultural and spiritual value. Traditional Indian cultural belief considers all elements of an ecosystem to be interconnected, and that certain species of wildlife and plants are relatives and spiritual messengers. For example, the White Earth Nation defines cultural resources as prehistoric and historic archaeological or anthropological sites, objects, historic standing structures, sacred and burial locations, and areas where traditional practices, resources, or cultural properties are used, located or collected (see Appendix P). The Mille Lacs band defines its cultural resources as the ceremonial areas, cemeteries, archeological sites and artifacts, bodies of water, wild rice lakes and rivers, wildlife, and medicinal plants within the historical Ojibwe native region. Cultural resources also include the language, customs, beliefs, and significant items of the Ojibwe people.

Many tribal members respect the natural world by paying reverence to wildlife phenomena as divine inspiration and prefer to eat wild, traditional foods from their ancestral homelands. Any diminishment of natural resources or access to those resources amounts to a diminishment of treaty-protected rights, which are also tribal property rights. Traditional cultural resources associated with cultural practices and beliefs of a living community are rooted in its history and are important in maintaining the continuing cultural identity of the community; such properties are not quantifiable nor alienable.

Preservation of cultural resources is governed by the following laws: Antiquities Act of 1906; Historic Sites Act of 1935; Executive Order 13007; the National Historic Preservation Act of 1966, as amended; the Archaeological and Historic Preservation Act of 1974; the Native American Graves Protection and Repatriation Act of 1990; and the Archaeological Resources Protection Act of 1979. Executive Order 11593 also provides necessary guidance on protection and enhancement of cultural resources.

Minnesota Statutes 138.31-138.42 require licensure for field archaeology undertaken on all lands or waters owned, leased by, or subject to the paramount right of the state or its subdivisions, as well as on lands affected by publicly funded development projects. Proposed projects are reviewed to assess the appropriateness of research methodology and to assist in identifying strategies for mitigating potential adverse effects on known cultural resources. Only professional archaeologists meeting the Secretary of the Interior's Standards for Archaeology (36 Code of Federal Regulations Part 61) may be licensed to conduct such investigations in the state of Minnesota.

Minnesota's Private Cemeteries Act (Minnesota Statutes 307.08) protects all human remains and burials older than 50 years and located outside of platted, recorded, or identified cemeteries from unauthorized disturbance, whether on public or private lands or waters. In the event that a burial is either known or suspected to be associated with American Indian peoples, the Office of the State Archeologist work together with the MIAC to ensure the integrity of these sites. The Office of the State Archaeologist maintains a database of identified burial sites in the state.

The MIAC shares legal responsibility for monitoring and enforcing laws that protect Indian human remains and associated burial items. The MIAC reviews archaeological license applications to conduct fieldwork to determine if a burial or cemetery is within a project area. The authority for the MIAC is contained in Minnesota Statute 138.31, Field Archaeology Act.[3] The Applicant's preferred route as well as any proposed alternative would result in a diminishment of Indian interests.

9.4.2 Cultural Corridors

Cultural corridors are geographic areas that served as conduits for trade or travel of American Indians. In Minnesota, many of these corridors are along rivers and streams, where Native American cultures lived and traveled. Jim Jones, the cultural historian for MIAC, describes cultural corridors in the Project vicinity as areas that were important in the development of tribal communities today. Many of these corridors are historic routes that go back thousands of years and are based on historic trade routes that indigenous people have had with one another for centuries. Tribes retain the inherent rights to fish, travel, hunt, and gather along these routes and watersheds. The crossing of the proposed route north of Outing, Minnesota, and north of Roosevelt Lake is another example of this type of corridor.

MIAC recommends a complete survey of the entire proposed route; this survey should occur prior to the start of any construction as it will involve gaining input from a number of tribal communities and gathering their oral histories to assist with the identification of these places. Figure 9-2 identifies some of the cultural corridors and features described during tribal consultation, coordination, and community meetings.

There are both applicable state and federal laws that govern to cultural resource management and the different cultural areas of the state. Any survey work will have to meet certain federal requirements

[3] Minn Stat. 138.32-138.42; 307.08

while concurrently coordinating with the different tribal nations, multiple agencies, and the different landowners potentially affected by this Project (see Appendix P).

The Applicant's preferred route as well as any proposed alternative would result in a diminishment of Indian interests.

Potential impacts could occur on the following tribal resources:

- Water – Spirituality and loss of connection to Mother Earth;
- Hunting – restricted access to hunting areas due to construction; loss of resources from fragmented forests, contamination, and habitat destruction;
- Fishing – restricted access to fishing areas due to construction; loss of resources from contamination and habitat destruction;
- Wild rice – restricted access to wild rice lakes due to construction; loss of resources from contamination and habitat destruction;
- Spiritual practices;
- Medicinal and traditional plants and foods – restricted access to resource gathering areas due to construction; loss of resources from contamination and habitat destruction; and
- Health – loss of tribal connections and educational opportunities due to restricted access to tribal resources, and contaminated or destroyed tribal resources.

American Indian communities depend on traditional land use activities and related natural resources that exist along the Applicant's preferred route and route alternatives, such as wild rice gathering locations, hunting and fishing habitats, hunting trails, and areas for harvesting plant foods and medicinal plants. The Project also proposes leaving the existing Line 3 pipeline in its current location through abandonment. The abandonment of Line 3 directly crosses the tribal boundaries of the Leech Lake and Fond du Lac, and potential impacts of abandonment could also affect the environment, thus affecting tribal resources.

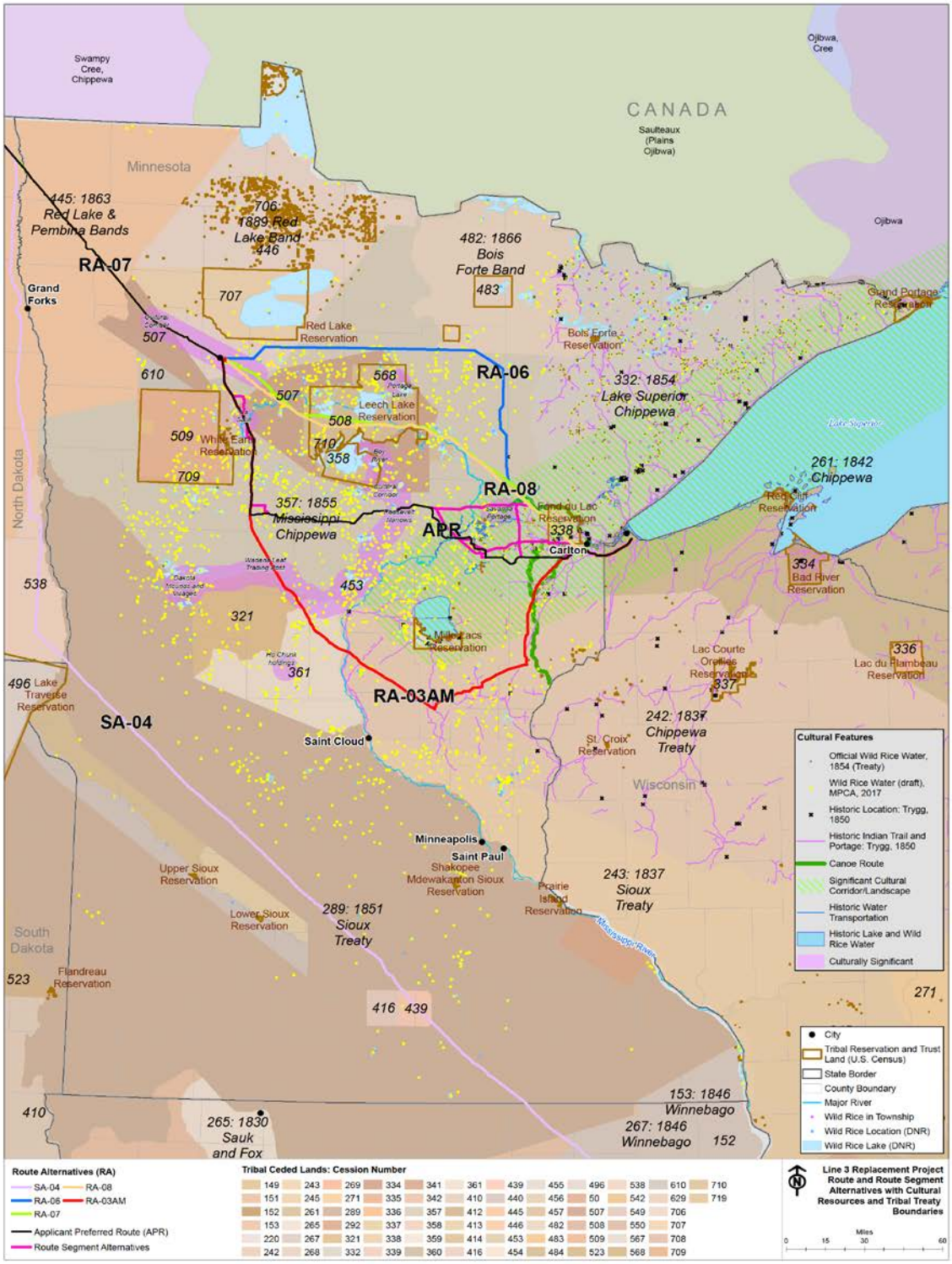

Figure 9-2. Culturally Significant Corridors and Other Features

9.4.3 Traditional Uses

Tribal resources reinforce traditional practices, beliefs, and tribal values. Such resources are interconnected with and inseparable from the health and well-being of the tribal communities. For example, Manoomin (wild rice) is the very identity of the Ojibwe nations—it is the reason for migration from the east, "to find and settle where food grows on water" (Erlinder 2011). According to tradition, the five original clans emerged from an ocean that could have been the Atlantic Ocean. Sometime prior to 1500, the Anishinaabe began a migration through the Great Lakes watershed to find a place where food grows on water (wild rice), guided by a vision of a miigis shell (Baca 2005; Benton-Banai 1979; Meyer 1994). Anishinaabe oral tradition relates a 500-year journey, with some groups settling along the way (Minnesota Department of Commerce and U.S. Department of Agriculture Rural Development 2010: 30). Ojibwae tradition teaches them that Manoomin is a gift that should not be altered by man and is not intended for profit making; rather, it is given by the Creator to them for spiritual and material sustenance (Dussias 2010; Harris 2008). Near the end of this journey, the fifth of the seven stopping places was at Sault Ste. Marie, where a group stayed because of the rich fisheries. From Sault Ste. Marie, the Ojibwe split into two groups. One traveled north around Lake Superior and the other south around the lake. They met at Spirit Island in the St. Louis River estuary, the sixth stopping place and where they found wild rice. From Spirit Island, some moved east along the south shore of Lake Superior to find the seventh stopping place, which was at Madeline Island, the last point on the migration. During consultation, members stated that "Manoomin, the food that grows on the water, not the oil that is underneath, is the source of all the life they were given and this is why we're here." It is these traditional uses that provide for spiritual, cultural, and subsistence activities. Traditional resources are essential to the maintenance and realization of tribal lifeways, and their destruction or damage can have profound cultural consequences affecting quality of life. Resources are not just shared within tribal communities, but also given to surrounding non-Indian communities and shared with other tribes.

9.4.4 Spiritual Connection to the Land

Tribal communities are concerned that traditional tribal lifeways and sites of spiritual and cultural significance are at risk of harm. In the distant and recent past, Minnesota tribes have survived relocation, termination, assimilation, and other historically traumatic events against overwhelming odds. As presented during consultation, they now see Enbridge's Line 3 Replacement Project as one more threat to their culture and future generations. It is a harmful threat to the rich watershed that is communally enjoyed and protected by the tribes in Minnesota, and because any threat to water is a threat to life.

The effects of land dispossession, culture destruction, and loss of sovereignty rights have cumulatively subjected American Indians in Minnesota to poverty, economic vulnerability, and limited political capacity. Some tribal advocates have referred to the Applicant's preferred route and its alternatives as environmental racism due to its disproportionate impact on Native resources and rights, which is discussed in Chapter 11.

One of the primary values expressed by tribal members is the quiet solitude of the reservation, which reduces stress, enhances peace of mind and mental health, and enriches the spirit. Many elders teach that the practice of Indian spirituality requires undisturbed access to culturally significant places and their resources. These specific places derive their power and sacredness from their natural state that was provided by the Creator. The Lakota and Dakota hold the earth sacred, and its places and associated ceremonies are a necessary expression of Indian spirituality and often are a key to wellness and public health. Tribal communities explained that the proposed Project would have an additional cumulative

impact on historical trauma as the affected tribes continue to face the loss of tribal resources and ongoing degradation to the natural environment because of the impacts of the Applicant's preferred route on tribal resources. At community meetings, members described detrimental mental health effects due to the presence of pipe yards and storage, which are identified as the trigger for the beginning of adverse land use changes and increased risks to the quality of water and land, which the bands depend upon for sustenance. Protection of riparian corridors is also a very high priority, both to protect the streams, but also because riparian corridors have a high biodiversity. Riparian corridors and viewsheds are culturally and aesthetically important as well (AESE, Inc. 2008).

Based on the sovereign, inherent right to self-determination, tribes collectively oversee sacred responsibilities to the land, waters, and people. Tribal members maintain a cultural responsibility to safeguard a future for all people to protect their land, water, air, and climate from harm, which comes from a legal and cultural responsibility to protect their land, water, air, and climate. Tribes are entrusted to protect the sacred resource of water. Water sustains all life and because all water is interconnected, it is therefore a tribal resource with federal protection. Traditional uses of plants and animals drive the need to protect vegetation and wildlife diversity. Appreciation of the water, the air, and the soils goes far beyond scientific or measurable descriptions normally contained in an EIS.

Tribal member identities are rooted in their relationship and responsibility to the land and all of its inhabitants. Traditionally, the Ojibway clan system was created to provide leadership and to care for these needs. There are seven original clans and each clan is known by its animal emblem, or totem. The animal totem symbolized the strength and duties of the clan. The seven original clans are given a function to serve for their people (Benton-Banai 1979).

- The Crane and the Loon clans are given the power of Chieftainship. By working together, these two clans give the people a balanced government with each serving as a check on the other. Between the two chief clans is the Fish Clan.
- The people of the Fish Clan are the teachers and scholars. They help children develop skills and healthy spirits. They also draw on their knowledge to solve disputes between the leaders of the Crane and Loon clans.
- The Bear Clan members are the strong and steady police and legal guardians. Bear Clan members spend a lot of time patrolling the land surrounding the village, and in so doing, they learn which roots, bark, and plants can be used for medicines to treat the ailments of their people.
- The people of the Hoof Clan are gentle, like the deer and moose or caribou for whom the clan is named. They care for others by making sure the community has proper housing and recreation. The Hoof Clan people are the poets and pacifists avoiding all harsh words.
- The people of the Martin Clan are hunters, food gatherers, and warriors of the Ojibway. Long ago, warriors fought to defend their village or hunting territory. They became known as master strategists in planning the defense of their people.
- The Bird Clan represents the spiritual leaders of the people and give the nation its vision of well-being and its highest development of the spirit. The people of the Bird Clan are said to possess the characteristics of the eagle, the head of their clan, in that they pursued the highest elevations of the mind just as the eagle pursues the highest elevations of the sky.

To meet all the needs of the nation, the clans work together and cooperate to achieve their goals. The clan system has built in equal justice, voice, and law and order, and it reinforces the teachings and principles of a sacred way of life.

The Ojibwe believe that any time something is taken from the land, a spirit is being removed from its natural state and environment. This could range from the smallest rock to the biggest animal. Because the spirit is being displaced, the Ojibwe people will offer tobacco to that spirit as a gift for the energy that that spirit will now share with them. The spirit will accept the gift and use it to communicate with the spirits around to relay the purpose and need of that spirit to the Ojibwe people.

Intimate familial ties to specific places in the natural world create a spiritual relationship to the land for Ojibwe and Dakota people. One result is a value placed on sustainability; Indian tribal cultures are built for the long-haul, and have endured for centuries. By contrast, the American economic and political system values material progress over sustainability, and the foundation of this system is land as real estate (MIAC n.d.; MIAC and National Museum of the American Indian n.d.).

9.4.4.1 Tribal Lands

Every mile of the Applicant's preferred route crosses ceded lands (1854, 1855, and 1863 treaties). The Applicant's preferred route also crosses through the Treaty of 1842 ceded lands near Duluth. From the Minnesota border to Superior, Wisconsin, the Applicant's preferred route would traverse through 1842 ceded territory, which the Fond du Lac are a signatory to.

The Applicant's preferred route and route alternative RA-03AM would not cross any Indian reservation land; however, these routes would cross near the White Earth Reservation and Fond du Lac Reservation on ceded land. Route alternative RA-06 would cross the Fond du Lac Reservation and ceded land. Route alternatives RA-07 and RA-08 would cross both the Fond du Lac and Leech Lake reservations and ceded land.

Fond du Lac Reservation:

- RA-06 crosses eight rivers or streams and one waterbody
- RA-07 crosses eight rivers or streams and one waterbody
- RA-08 crosses six rivers or streams and one waterbody

Leech Lake Reservation:

- RA-07 would cross 16 rivers or streams and 4 waterbodies
- RA-08 would cross 22 rivers or streams and 5 waterbodies. (For RA-08, one of these waterbodies includes Nushka Lake, which is identified as a wild rice lake. RA-08 would directly affect less than 0.1 acre of the wild rice lake.)

Chapter 11 provides information on the census tracts that are crossed by the Applicant's preferred route and route alternatives. The White Earth Reservation and Fond du Lac Reservation are not crossed; however, the Applicant's preferred route is located near the boundaries.

9.4.4.1.1 Natural Resources and Traditional Uses

This section references some traditional foods, plants, and medicinal plants used for various purposes by the Anishinaabe. Traditionally, every single plant was used by the Anishinaabe for some purpose. This is known through the oral tradition and is referenced in *Ethnobotany of the Ojibwe Indians* (Smith 1932). The author, Huron H. Smith, reports,

> *The writer collected every plant he could find in each region because he had been informed that the Ojibwe differ from other Wisconsin Indians in that they believe that every plant that grows is some kind of medicine or useful for something. The only plants discovered for which they had no name or use were adventive plants, and one could fairly well establish the date of their appearance in the state, because the Indians pay much more attention to our native flora than do the whites*.

The tribes use the majority of plants and foods for medicinal and traditional purposes as they have for generations. Often called "first foods," these plants and foods are important to tribal identities and cultural continuation, in addition to meeting nutritional and utilitarian needs (Vickery and Hunter 2014). Traditional foods include wild rice, cattail, mushrooms, game animals, fish (particularly walleye), mushrooms, and a variety of berries and roots (Zoll 2016).

- Traditional plants include wetland reeds, birch trees, tamarack, white cedar, red maple, and balsam fir (Zoll 2016).
- Medicinal plants include lily pad roots, sage, sweet grass, Labrador tea, cranberry, red-osier dogwood, bitterroot, iron wood, birch, cha ga (birch tree fungus), and red cedar (Zoll 2016). Additionally clams are used for ceremonial purposes (Zoll 2016).
- The traditional plant communities in the Mille Lacs band community include the following: Northern Rich Tamarack Swamp, Northern Spruce Bog, Northern Poor Conifer Swamp, Northern Open Bog (McGregor Marsh), and Northern Poor Fen. First foods, spiritual medicines, and traditional plants are all found within these areas (Zoll 2016).

Several of the Chippewa tribes, including the Minnesota Chippewa Tribe, White Earth Nation, Red Lake Nation, the National Congress of American Indians, Leech Lake, and Mille Lacs passed resolutions to assert the importance of their natural and cultural resources; urging for fiduciary and legal protection and preservation of culturally important resources; and mandating full consultation with the tribes.

Sweet Grass - Wiingash

Sweet grass is a gift from Mother Earth. It is said to be part of her hair and the use of sweet grass promotes strength and kindness. When braiding sweet grass, each strand of the braid represents mind, body, and spirit. It is also important to remember the teaching of the sweet grass braid and walk that way when wearing a braid in our own hair.

Cedar - Giizhig(aandag)

Cedar is used for purification and bringing balance into yourself. It is also known for attracting positive feelings, energy, and emotions. Cedar is often hung around the home and laid out on the floor of ceremonial lodges to offer protection from bad or harmful energy.

Each medicine is a gift from one of the four directions. Depending on the community, the medicines may differentiate from the direction and teaching that represent it. The reason for this is that each of the medicines traditionally traveled its own path to each community. Both spiritually and physically, medicine would have entered each community through different methods. For example, sweet grass could have been carried from the great lakes to a northern community through trade, or sage could have begun to grow to the south of one community and west from another. When addressing the directional representation of each medicine, the geography, agriculture, and traditions of the local communities must be considered.

During information and community meetings, tribal members expressed that if the food resources are injured, so will the people be. Water and Manoomin are not commodities, but rather a sustenance and way of life. The destruction of the ability to exercise usufructuary rights because of contamination or other human diminishment would profoundly affect tribal cultural, spiritual, and physical well-being. Traditional gathering also allows for the opportunity to experience, learn, and promote cultural activities, all treaty-protected rights. Tribal members believe all routes including but not limited to Applicant's preferred route pose irreparable harm to their landscapes, protected resources, and practices.

Natural resources within tribal boundaries are managed by the respective tribe. All of the tribes in the area of the Applicant's preferred route and route alternatives have Natural Resource Departments that manage natural resources and in some cases co-manage natural resources with state or federal agencies. Resource management includes forestry, fisheries, wildlife, wild rice, and air programs to name a few.

Members of the Mille Lacs Band explained that the entire subsistence cycle of hunting, fishing, and gathering depends upon the region's water system, which itself is intricately connected to the region's vast wetland resources. Traditional knowledge recognizes that these wetlands are not only vessels of life for a vast array of plant and animals, but are an integral part of the traditional life. They point to affected resources as:

- Disturbance to habitats and associated species
- Sherburne National Wildlife Refuge (important to migratory birds and waterfowl)
- Rice Lake National Wildlife Refuge (important to ring-necked ducks)
- Wild rice lakes and populations
- Changes in hydrology
- Wakefield Brook flows to Rice Lake
- Other National Wildlife Refuges (important to migratory birds and waterfowl)
- Fisheries concerns

Historically, birch bark was used for constructing canoes, containers, and homes. Cedar wood and bark were also used for these purposes. Sweet grass and sage were also harvested, and often burned for medicinal and spiritual purposes (McClurken and Cleland 2000).

9.4.5 Hunting

Traditional terrestrial game and waterfowl hunting grounds are habitat for a variety of subsistence resources, including deer, elk, bear, ducks, geese, and turkey (GLIFWC 2014). The Applicant's preferred route crosses highly productive wild turkey hunting grounds in Clearwater and Hubbard counties (TASC 2016). Two hunter trails are located nearby, including the White Elk Trail and the Salo Marsh Trail (TASC 2016). The White Elk Trail may be crossed by the proposed Project (TASC 2016).

9.4.6 Water

Surface water and groundwater are important to all people, "but it would be hard to imagine a group of people more dependent upon freshwater resources…than the Ojibwe, the original residents of the land of a thousand lakes."[4] Because water quality has a direct impact on fisheries and wild rice production, is a source of drinking water, and supports all life, it has spiritual significance as well as physical significance. Water is also tied to tribal ceremonies, such as spring celebrations of aquatic life (Mille Lacs Band of Ojibwe DNR n.d.).

High-quality waterbodies and rivers support wild rice, which is extremely sensitive to chemical pollutants.[5] The St. Louis River watershed is a primary source of wild rice. The river remains the primary reservation fishery for the Fond du Lac Band of Lake Superior Chippewa. The mainstem of the St. Louis River and several of its larger tributaries have been dammed for hydropower generation, disrupting connectivity and increasing mercury bioaccumulation in fish (Fletcher and Christin 2015). "Nagachiwanong" in Ojibwemowin translates to "where the water ends" and Fond du Lac in French translates to "the foot of the lake." Water is central to the existence of the band. The Fond du Lac Band of Lake Superior Chippewa formerly resided on the shores of the St. Louis River and Lake Superior in villages located in what is now Duluth, Minnesota, and Superior, Wisconsin. The current Fond du Lac Reservation includes a stretch of the St. Louis River upstream from those ancestral villages. The Applicant's preferred route is not many river miles from "Gitchee gummee," known as Lake Superior. Lake Superior is the world's largest freshwater lake by area and is of paramount importance to all of the Ojibwe bands, tribes, communities, and First Nations that reside upon its shores in what is now referred to as Minnesota, Wisconsin, Michigan, and Ontario.

Waterfowl habitat includes wild rice lakes such as Upper Rice Lake in Clearwater County (TASC 2016). Additional migratory birds and waterfowl habitat include the Sherburne National Wildlife Refuge, Rice Lake National Wildlife Refuge, and important bird areas (IBA) including McGregor IBA at Grayling Marsh Wildlife Management Area (WMA), Savanna State Forest, Kimberly March WMA, McGregor Marsh Scientific and Natural Area (SNA), Lawler WMA, and Sandy Lake Reservoir (WMA).

9.4.7 Fishing

Reserved tribal resources include access to traditional fishing areas. Tribal resources include walleye and trout fisheries, which are predominately used for subsistence. There are numerous trout streams crossed by or located near the Applicant's preferred route (Mille Lacs Band of Ojibwe DNR n.d.; TASC 2016). Additionally, there are tullibee sensitive lakes near the Applicant's preferred route including Roosevelt and Washburn lakes (Mille Lacs Band of Ojibwe DNR n.d.). Walleye (also called Ooga) is a very important species to the affected tribes. Walleye lakes include Lake Mille Lacs, Big LaSalle, Two Inlets,

4 Mille Lacs Band of Ojibwe, Hearing Examiner's Report on Enbridge Energy Sandpiper Pipeline, August 2015.

5 Ibid.

Island, Blueberry, Twin, Roosevelt, Bass, Park, Washburn, Upper Twin, Lower Twin, and First Crow Wing (Mille Lacs Band of Ojibwe DNR n.d.). Additional lakes of concern to the Mille Lacs Band near the Applicant's preferred route include Rice Lake, Rice River, and Wayfield Brook; Big Sandy Lake Reservoir; Lake Minnewawa; Sandy River; and Long Lake Creek.

9.4.8 Manoomin

Manoomin—wild rice—is not only sacred to the Anishinaabe but tribes in Minnesota and northern Wisconsin are the largest producers of it in the United States, making it an economic mainstay as well as a federally protected tribal resource. Tribal members believe that Manoomin is priceless; it nourishes the soul, community, and bodies of the Anishinaabe (Aubid, Sandy Lake Elder and District Representative, pers. comm., 2017). Manoomin is both a commercial and a subsistence resource that has been used for hundreds of years. It is cultivated in numerous lakes, some of which are named, while others remain unnamed. Wild rice lakes are often considered to be sacred landscapes with cultural connections (TASC 2016). Once such area, Lower Rice Lake on the White Earth Reservation, has been designated a TCP (TASC 2016). Lower Rice Lake is also the only certified organic rice lake in Minnesota (TASC 2016). The Leech Lake Band of Ojibwe harvest and cultivate seeds used to reestablish wild rice beds, which can be in lakes or rivers. Leech Lake has the most wild rice in North America (Leech Lake Band of Ojibwe 2015).

The regulations regarding wild rice lakes are discussed in Section 6.3.1. Tribal regulations of the harvest and protection of wild rice within reservation boundaries vary from tribe to tribe. In addition to tribal regulations, treaties and other agreements with the U.S. government have reserved off-reservation harvesting rights for some tribes.

As discussed in Section 6.3.1, a total of 43 wild rice lakes occur along the Applicant's preferred route and the three route alternatives between Clearbrook and Carlton, Minnesota. Wild rice can be susceptible to disturbance in lake, river, or wetland habitats and are sensitive to temperature changes, contaminants, and hydrology changes. These changes could affect germination and production.

9.5 IMPACTS

All of the proposed routes and route alternatives cross treaty lands. RA-06, RA-07, and RA-08 cross the reservation boundaries of Leech Lake and Fond du Lac. From a tribal perspective, cultural resources cannot be separated from natural resources; therefore, the conclusion is that any pipeline route would affect cultural and natural resources. The degree to which these resources are affected would vary; if quantitative values are assigned, the impacts are direct and localized. If a holistic tribal perspective is used to determine impacts, any pipeline would have direct and permanent impacts. This is illustrated by Mille Lacs Band member Terry Kemper:

> *So when you leave things behind like that [pipelines], it's like—or you create new avenues of putting those things in, it's like taking the love out of someplace and then how do you put that back? You know, how do you get that back into that area? So to us it's like the whole ecological system is just set upside down. It affects us mentally, spiritually, and physically. We're so interconnected to those things out there that even our Indian names are after them. Many people are named Zhingwaak for that [points] pine tree. People are named after rocks, Asin, Asiniikaa, Asiniinini. They're named after these things because that's how interconnected we are. We're interconnected so much that plants are things we're named after. The rocks, the*

> *earth, we're named after that. The universe and all the things that are there, people have names after that. So when they say that, you know, there wouldn't be damage, you know, digging eight feet in the ground and putting in a pipeline, that's not true to us. To us you're taking all of our relatives and you're turning them upside down. You're taking all of our medicines, all of our spirituality when you're turning it upside down and wasting it. And so it makes—it hurts. It hurts the whole tribe to see something. When you see something like that. And it affects a whole community because all of our community is connected to that. We're taught from a young age that these things have meaning to them, they have life. And so now you have 100 miles of trees that are cut down, or 50 or 25 miles of trees that are just—that's all death. They just took it. And then they come in and they plant the trees and they think that they're going to make up for it by creating a farm, you know, another ecological system. And that ecological system then is—is like us as a people trying to survive. That ecological system is us trying to remember a time when this world was just beautiful. When this world was producing everything that we needed as a people in order for us to survive. You can't see those sacred places. The moon, that's a site, you can see it, it's sacred to us. Something in the earth, something in the water that's a sacred place, you can't see it. Sacred places are places you take in a spiritual journey that you can't see. When we get into a ceremony, we go places in a sacred site. Sacred places, when you go to sleep at night, you wander, your spirit wanders and travels. It's a place that is a sacred place, but when you come back into this world you can't see that site. You can't remember. You remember it as a human being, but you don't remember it as the place. You bring it into this world. So there's two different things there, and the very rice beds are sacred sites to us, every river, every stream, every waterbed, every swamp that you see out there is a sacred site, you can see it people. It affects our past, it affects everything that we're about.*

At the end of the interview, Mr. Kemper struggled to the find the words. When Commerce explained the impacts of each route were being assessed, he responded that it could not be done, and the impact could not be isolated or measured—any impact is harmful and equally concerning.

Elders, during consultation and interviews, revealed that the health of the tribes and their members directly relates to the health of the ecosystem. They manage their lands within their reservation boundaries; they also watch the land and water that surrounds this boundary because their history and way of life is limited to the lines on current-day maps. What they choose to protect helps define them as a people (see Appendix P):

> *And so to us we can't separate the two and that's why this Project will have such an impact to us as human beings, as Anishinaabe people, as Native American people, when things are disrespected, moved around, cut down, hurt, trees are cut down, plants and ground is dug up, because basically you're digging up us. Our relatives, our ceremonies, our everything is interconnected to that earth, to those trees, to those plants. So you can't separate the two of those.*

The tribes look at not just the immediate impacts but what is going to affect future generations; they are taught to project to seven generations in the future. Any major changes to the environment affects not only the ceremony, but people's mental, physical, and spiritual health. Hunting, fishing, traditional use of resources, and gathering is ceremonial—they are not just for sustenance, but bring a whole community together to connect with the outside world.

Tribal values for natural and cultural resources (medicinal plants, culturally or spiritually important areas or resources) are not quantifiable. Actions such as the proposed Project that result in the loss of a resource, or access to a resource, are considered equally detrimental by the tribes and cannot be mitigated. Such impacts contribute to the continued erosion of tribal resources, which in turn, contributes to overall societal and health impacts. Incremental impacts on American Indian communities are part of a larger pattern of structural racism, or "the normalization of an array of dynamics—historical, cultural, institutional and interpersonal—that routinely advantage white people while producing cumulative and chronic adverse outcomes for people of color and American Indians" (Minnesota Department of Health [Minnesota DH] 2014). These patterns are perpetuated when "decisions are made without accounting for how they might benefit one population more than another, or when cultural knowledge, history and locally-generated approaches are excluded. When this happens, programs and policies can reinforce or compound existing race-based inequities" (Minnesota DH 2014). Chapter 11 provides an environmental justice analysis.

9.5.1 Construction Impacts

As described in Chapter 6, most construction impacts would be temporary to short term and restricted to the construction work area, temporary workspaces, access roads, pump stations, and materials staging areas. Construction-related activities would directly affect tribal resources located in the construction work area. These potential impacts may include damage and/or destruction, which may be a long-term to permanent minor to major impact.

Construction work areas may result in fragmentation of forests and changes in forest composition, resulting in impacts on wildlife populations (see Section 6.3.4). Another impact that may occur due to construction and operation is the spread of invasive species, which are often introduced by construction equipment and seed mixes used for restoration. Over time, invasive species can outcompete native vegetation and change plant composition, altering the types and quantity of medicinal and traditional plants. Some invasive species, such as wild parsnip, contain chemicals that are phototoxic and cause severe damage to the skin of anyone who comes into contact with it. When plants such as wild parsnip become established as they have along the Enbridge Mainline corridor, there is a further diminishment of medicinal plant resources and a diminishment of the right to gather them due to the phototoxicity of the surrounding vegetation. The Applicant will prepare a Noxious Weeds and Invasive Species Control Plan to prevent the spread of invasive species and noxious weeds (see Section 6.3.3).

Tribes are most concerned about accidental spills. Releases during construction may directly affect tribal resources. The impact would vary based upon the proximity of the resource and the type of resource, as well as the size and type of spill. Even if contained quickly, tribes state the resulting impact would compromise their protected landscapes. An example of this would be a spill during equipment refueling that may enter a wild rice lake if it was not contained.

Access to resources such as hunting and fishing areas may be restricted due to closed work areas. During construction, there would be prohibitions on hunting and fishing within the construction work area, which would typically be a moving area 120 feet wide and several miles long. Hunting success would be severely depressed in the larger area surrounding active construction and would likely be avoided by tribal hunters. A temporary loss of these activities during construction would result in negative impacts on tribal members. A major impact caused by hunting and fishing prohibitions may occur if the prohibition coincided with a peak hunt or harvest period or ceremonial event, which would cause economic, subsistence, and health effects.

Other indirect construction-related impacts would include but are not limited to dust, vibration, noise, and air quality changes. Enbridge has identified various measures to limit these impacts, such as dust suppression, limiting idling by construction vehicles, and covering spoil piles (see Environmental Protection Plan in Appendix E).

Impacts on air quality during construction would be short term and minor. Increased noise levels could result from normal construction activities such as clearing, grading, and trenching. The most significant noise impacts during construction would be the result of horizontal directional drilling operations or blasting, if needed. Increased noise may cause hunter prey species such as deer to leave the area, resulting in a profound impact on tribal hunting. Since construction-related noise is temporary, the deer may return later, resulting in this impact being temporary to short term and negligible to minor.

The Applicant's preferred route would result in impacts on 8 acres of wild rice lakes (Table 6.3.1.2-6). Additional information on impacts on wild rice are discussed in Section 6.3.1. Construction across waterbodies could result in increased turbidity and sedimentation (for more information see Section 6.3.1.2). Any waterbodies or streams crossed by the routes may experience increases in stormwater runoff and erosion from cleared vegetation, increases in turbidity and sedimentation, changes to stream flow due to horizontal directional drilling testing water, or degradation of aquatic habitat from instream construction. Such changes may affect wild rice habitat and production and fisheries. Enbridge has developed Applicant-proposed measures intended to minimize these types of impacts (see Environmental Protection Plan in Appendix E).

The Applicant's preferred route, RA-03AM, and RA-08 would cross ceded lands used for hunting, fishing, or gathering resources. Impacts on various tribal resources on these lands would be similar to those described above.

Route alternatives RA-06, RA-07, and RA-08 would cross reservation boundaries. Both RA-07 and RA-08 would cross the Leech Lake Reservation, and each route could result in the loss of forested land. Hunting would be prohibited in the construction work area, which could limit tribal members from hunting various wildlife (as discussed above). These impacts could be temporary to short term and minor to major depending upon the species and the location. Additionally, the loss of medicinal and traditional plants could be a short-term to permanent impact with a magnitude ranging from minor to major. If the same species were replanted during revegetation, the impact would be reduced. Although several acres of open water also would be affected by each of these routes through the reservation, Section 6.3.1.2 concludes that impacts on waterbodies during construction would likely be minor and temporary.

Route alternatives RA-06, RA-07, and RA-08 would cross the Fond du Lac Reservation. Closing of the hunting grounds near the construction work area and the loss of medicinal and traditional plants during construction would cause temporary to short-term minor to major impacts on tribal resources.

9.5.2 Operations Impacts

As described throughout Chapter 6, operations impacts would largely be associated with impacts on vegetation associated with maintenance of a permanent pipeline right-of-way and aboveground facilities, as well as air emissions from pump stations.

The largest potential impact on tribal resources would be a pipeline incident that resulted in the accidental release of oil. For a detailed discussion of accidental releases, refer to Chapter 10. In the event of an accidental release of oil, the severity of impacts would depend on the location and type of

resources within the area of the spill. Any release affecting a wild rice lake or river and a walleye or trout lake or stream would cause irreparable impact on tribal resources. Impacts on tribal resources may also affect the mental and physical health of the tribal community.

9.5.3 Abandonment

As detailed in Chapter 8, if Line 3 is replaced, Enbridge proposes to clean out the existing Line 3, fill it with an inert gas, cap it, and leave it in place (abandonment). Pipeline abandonment raises many concerns with the tribes. The first concern is associated with responsibility for the abandoned pipe. If all of the pipelines in the corridor are abandoned, there is concern that the tribes would ultimately become responsible for any costs associated with removal, contamination, and remediation. For example, without knowing if there is contamination in the existing corridor and the extent of any contamination, the costs associated with remediation could be significant. Another concern is the ability to reclaim the land currently occupied by the pipelines. Without the removal of abandoned pipelines, the ability of the tribes to reclaim the corridor is limited. Current right-of-way maintenance precludes many uses, including construction and many types of revegetation. In its current state, the corridor and recent construction areas are dominated by invasive species and have fragmented the landscape. If the existing corridor is contaminated, options for land reclamation may be further limited even if the pipelines were removed as a result of any necessary remediation.

During consultation, Mille Lacs leadership explained that mere abandonment without removal of existing pipeline would cause irreparable harm and violates their spiritual beliefs and practices (see Appendix P):

> *When we use something from nature, we thank the Creator and the plants and animals for what they provide for us. We take only what is necessary and recognize our dependence on Earth and all that is in it to sustain our life. A pipeline takes the Earth out of the condition the Creator intended. When the pipeline no longer is needed, we must remove the pipeline, restore the environment, and allow nature to heal. We cannot continue to use the Earth by taking it out of its natural state when it is no longer necessary to do so. Just as a surgeon would remove the gauze and other tools after a surgery and allow the body to heal, we must remove the pipeline from the Earth when it is no longer being used.*

9.5.4 Mitigation

Mitigation of impacts due to construction and operation are detailed in Chapter 6 and represent the measures Enbridge proposes.

The Applicant's preferred route and RA-03AM would not cross reservation lands; however, they would cross ceded lands on which tribes exercise their treaty rights to access tribal resources. The other route alternatives (RA-06, RA-07, and RA-08) cross reservations, as well as ceded lands. Overall, route alternatives RA-07 and RA-08 would have the greatest impact on tribal resources, as they cross two reservations and various ceded lands. RA-06 could also have some minor to major impacts on tribal resources within the Fond du Lac reservation.

The two routes that would have the fewest impacts on tribal resources would be RA-03AM and the Applicant's preferred route, as neither crosses reservation land. Direct impacts from construction could occur on tribal resources; however, most of these are considered temporary to short term and minor. Indirect impacts could occur on tribal members from temporary restrictions during construction of the

Applicant's preferred route on non-reservation lands used by the tribe for hunting, fishing, or farming operations.

While non-quantifiable impacts are difficult, if not impossible, to mitigate, tribes feel they should be entrusted with the inspection, monitoring, and maintenance activities in and through their lands and territories as they are most familiar with their resources. If tribes were given a more active role in the monitoring and inspection of pipelines, they would be better prepared to address leaks or spills that could occur within reservation boundaries.

9.6 UNIQUE TRIBAL IMPACTS

From a Native American perspective, any of the route, segment, and system alternatives would have a long-term detrimental effect on tribal members. The impacts cannot be categorized by duration (short term or permanent) or by extent (region of interest, construction work, or pipeline right-of-way). It is also not possible to determine which alternative is better when each alternative affects tribal resources, tribal identity, and tribal health. All tribal members who submitted comments and/or participated in drafting reported that all of the routes, including keeping the current Line 3 in place and/or abandonment, would add to the negative mental, spiritual, and physical health effects already disproportionately suffered by American Indian populations (Brave Heart 2011).[6]

In an interview, Mr. Kemper discussed the cumulative psychological impacts of having lands and resources diminished by ongoing infrastructure projects (see Appendix P):

> *You're taking all of our medicines, all of our spirituality when you're turning it upside down and wasting it. And so it makes—it hurts. It hurts the whole tribe to see something.*

Many resources or the environment that was in place prior to clear cutting and activities related to other infrastructure projects (e.g., roads, transmission lines, development) have cumulatively diminished many of the once-existing resources. John Reynolds of the Mille Lacs Band explains "that if a pipeline of this magnitude comes through, it would basically destroy, you know, what's remaining."

9.6.1 Climate Change

The Fond du Lac band elaborated on the cumulative effect of climate change from the Project, including the cost of petroleum extraction, the cost to the climate from production of the steel used to transport the oil, the cost of pumping the oil, the cost of trucking to transport the pipe and other assorted materials used in construction of the pipeline, the cost of the refining process, and the cost of using the oil once it is transported and refined. All of the tribes that participated in consultation and collaboration explained that any new oil transportation infrastructure serves to encourage the country's reliance on an energy resource that is inherently damaging to the world's climate, locking us into an uncertain future for our children, grandchildren, and all future generations. The pipeline would lead to increasing greenhouse gas emissions, reducing our chances of meeting pollution-reduction targets. Continued reliance on energy from oil is altering many resources on Earth, contributing to devastating climate change (see Appendix P).

[6] Historical trauma describes multigenerational trauma experienced by American Indians because of continuous subjection to trauma, poverty, dislocation, war, etc. It is cumulative and collective.

Climate change impacts threaten tribal lands and resources, way of life, culture, and economies. Some alternatives cross the Leech Lake and the Fond du Lac Reservations, which both contain numerous heritage resources, such as wild rice processing sites, cemeteries, and ceremonial grounds. The proposed Project and its alternatives are located within territories ceded to the United States by the Chippewa Indians under treaties. These lands and resources are important to preserving the traditional ways of life, including fishing, hunting, wild rice farming, maple sugar gathering, the collection of plants for medicines, spiritual, and ceremonial purposes, shelter, and other needs. Studies indicate rising temperatures and hotter, drier summers will decrease water quality and quantity in the Great Lakes region, endangering homes, human health and safety, economies, culturally important species, medicinal plants, cultural sites, and traditional foods, such as wild rice in tribal communities. Loss of or diminishment of heritage resources from global climate change would constitute an adverse effect on Indian tribes. For example, hotter and drier summers could adversely affect water levels and wild rice and fish harvests. These impacts could potentially be exacerbated by declining water quality as a result of increased surface runoff and sewage overflows. Climate change could also shift or reduce the habitat ranges of culturally significant plant and animal species, thereby affecting the ability of tribal communities to harvest these species (U.S. Department of State 2017).

9.6.2 Health Impacts

Ojibwe culture has a deep and longstanding connection with the natural environment. This connection is integral to their cultural identity, and the loss of tribal resources results in profound impacts on mental health including increased incidence of alcoholism, depression, and suicide. The evaluation of health impacts in the EIS must include these impacts in addition to impacts on physical health resulting from potential exposure to pollutants, contaminants, and increased noise and dust during construction.

The potential impacts are amplified by the fact that the Applicant's preferred route runs through the middle of the Mille Lacs Band's District II Community. District II's government services are located in the East Lake community south of the proposed pipeline while the Minnewawa and Sandy Lake communities are located north of the proposed pipeline. Closure of a roadway in the region as a result of a major pipeline failure would isolate the Minnewawa and Sandy Lake communities from the basic services provided through the East Lake community and would isolate family members living in different regions from each other. The effects of bisecting the community with the proposed pipeline would be particularly significant for the extremely traditional community with strong ties to time-honored culture, and the emotional toll of a spill in the area would be devastating (see Appendix P).

9.7 SUMMARY

This chapter provides an American Indian perspective on the construction and operation of a new pipeline. From this perspective, any route, route segment, or system alternative would have a long-term detrimental effect on tribal members and tribal resources. The impacts cannot be categorized by duration (short term or permanent) or by extent (region of interest, construction work area, permanent right-of way). It is also not possible to determine which alternative is better when each alternative affects tribal resources, tribal identity, and tribal health.

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Chapter 10
Accidental Crude Oil Releases

10.1 INTRODUCTION

During the transport of crude oil by pipeline and by the alternative modes of rail and truck transportation, unplanned events may occur that can result in a release of crude oil. Although the probability of a large or catastrophic oil release at any specific location is extremely low, the probability of a release of some type along the entire pipeline during its lifetime is not low. In addition, the consequences of a large release can be significant. Therefore, in addition to the analysis of potential Project impacts during construction and normal operations, the potential for unanticipated releases and the potential consequences of such releases must be considered in this Environmental Impact Statement (EIS).

Modeling, statistics, and resource mapping can help predict the probability of an accidental oil release, how crude oil behaves in the environment, and what resources could be at risk should there be an oil spill. However, it is impossible to predict where a spill would happen, the quantity of oil involved, how far the impacts would extend, or exactly what resources would be affected. In part, this is because there are so many incident-specific factors involved. The weather, time of year, water levels, human error, and even what type of wildlife is present at the time a spill occurs all affect its probability and outcome.

This chapter first describes the relevant federal and state regulations for crude oil transportation by pipeline, rail, and truck and the causes of crude oil releases and then describes the analysis methods used in this chapter (Section 10.1). Section 10.2 describes the types and probabilities of failures that could result in an unanticipated release of crude oil for the alternatives. The behavior of crude oil in the environment is addressed in Section 10.3, followed by descriptions of the potential exposure of and impacts on specific resources if a spill were to occur (Section 10.4). Sections 10.5 and 10.6 describe spill prevention and response measures and clean-up and recovery measures, respectively. Lastly, Section 10.7 compares the potential exposure of resources of concern to crude oil releases for the alternatives.

10.1.1 Regulatory Context

Crude oil transport by pipeline, rail, and tanker truck is regulated by a number of state and federal guidelines and standards, which are described below.

10.1.1.1 Pipeline Safety Regulations and Standards

The federal (U.S. Department of Transportation [USDOT]) and state (Minnesota Office of Pipeline Safety [MnOPS]) regulatory requirements for oil pipelines, as well as industry standards for oil pipelines, are discussed below. These regulations and standards apply to each of the pipeline alternatives.

10.1.1.1.1 U.S. Department of Transportation Regulations

USDOT is mandated to regulate pipeline safety under Title 49 U.S. Code Chapter 601. The Pipeline and Hazardous Materials Safety Administration (PHMSA) is the agency within USDOT that has jurisdiction and is responsible for developing and enforcing regulations for the safe, reliable, and environmentally

sound operation of interstate pipelines. PHMSA's regulations encompass design, construction, testing, operation, maintenance, and emergency response for hazardous liquid pipelines and related facilities.[1]

49 Code of Federal Regulations (CFR) 195 (Transportation of Hazardous Liquids by Pipeline) include Subparts A through H, establish reporting requirements, design requirements, construction requirements, pressure testing, operation and maintenance, integrity management, required qualifications of pipeline personnel, and corrosion control. For a new hazardous liquid pipeline, high consequence areas (HCAs)[2] must be identified prior to operation, and hazardous liquid pipeline operators are required to develop and submit to PHMSA a written Integrity Management Plan (IMP) within 1 year of the start of operation (49 CFR 195.452).

The Applicant's IMP must include identification of all pipeline segments that could affect HCAs; a baseline assessment plan to ensure integrity of these segments; a process for continual integrity assessment and evaluation; repair criteria to address issues identified by the integrity assessment method; a process to identify, evaluate, and implement preventative and mitigation measures to protect HCAs; and a description of how each element of the IMP would be implemented. Because populations can expand and environmental situations can change, HCA boundaries can change over time; therefore, new HCAs must be incorporated into baseline assessment plans within year of identification (PHMSA 2016). As a part of IMP implementation, the Applicant would also have to perform periodic integrity assessments on line segments that could affect HCAs at least once every 5 years.

If a pipeline is approved for the Project, it is anticipated that the Applicant's IMP for the new pipeline system would be in large part similar to its existing IMPs for the existing Enbridge pipeline system. The new IMP would include a new baseline assessment plan, identification of HCAs specific to the Project, and other Project-specific information.

10.1.1.1.2 State Pipeline Regulations

Although PHMSA is responsible for regulation, inspection, and enforcement of safety regulatory requirements for interstate pipelines as described above, it also permits individual states to adopt additional or more stringent safety regulations for intrastate pipelines. In states where such an agreement is in place, the state is the delegated inspection authority for compliance with federal rules while PHMSA retains enforcement authority. MnOPS, a division of the Minnesota Department of Public Safety, inspects pipelines within the state and has such an agreement with PHMSA to inspect pipelines.[3] PHMSA's Office of Pipeline Safety enforces its federal regulations based on the inspections conducted by MnOPS. PHMSA or MnOPS inspections or audits can occur at any time, but typically happen every 2

[1] Parts 190, 194, 195, 198, and 199 are relevant to hazardous liquid (including crude oil) pipelines. Parts 194 and 195 address issues that are directly related to pipeline system integrity and oil spill risk assessment and environmental consequences. The regulations at 49 CFR 194 (Response Plans for Onshore Oil Pipelines) contain requirements for onshore oil spill response plans that are intended to reduce the environmental impact of oil unintentionally discharged from onshore oil pipelines. Parts 190, 198, and 199 address issues that are tangential to pipeline system integrity, including rulemaking procedures, regulations for grants and state aid for safety programs, and required drug and alcohol testing for operators of pipeline facilities.

[2] HCAs are areas or features where a crude oil pipeline failure, such as a release of crude oil, may have long-term and/or permanent and major impacts on resources. They are defined and discussed in more detail in Section 10.4.1.

[3] The agreement is codified under Minnesota Statutes, Chapter 299J, Pipeline Safety.

years. The scope of audits and inspections conducted by these regulators are broad and can include the following (Enbridge 2015c):

- Compliance with aerial patrol requirements;
- Review of integrity dig records to determine both adequacy and accuracy;
- Inspection of cathodic protection systems;
- Review of tank inspection records;
- Review of operation, maintenance, and contingency manuals;
- Review of pipeline integrity methodology;
- Review of leak detection methodology;
- Review of system maximum operating pressures;
- Review of facility integrity manuals;
- Inspections of facilities;
- Review of operation and maintenance procedures and records;
- Review of operator qualification records; and
- Examination of public awareness materials.

If MnOPS identifies a violation of Minnesota pipeline laws, it has the authority to issue civil penalties for violations of these laws.

Of the states affected by the pipeline alternatives, only Minnesota has an agreement with PHMSA. The Iowa Utilities Board has primary jurisdiction over the routing and siting of hazardous liquids (including crude oil) pipelines in Iowa but does not have safety jurisdiction over hazardous liquids pipelines—PHMSA retains that authority (Iowa Utilities Board 2017). Similarly, North Dakota, Illinois, and Wisconsin have not entered into agreement with PHMSA to monitor the safety of their pipelines; therefore, PHMSA regulates, inspects, and enforces interstate liquid pipeline safety requirements in those states.

10.1.1.1.3 Pipeline Industry Standards

In addition to adhering to PHMSA regulatory requirements, major oil transport pipelines must also comply with pertinent industry standards. If a pipeline system is selected for approval, the design of the system would be expected to comply with the industry standards and codes listed below. These standards and codes were established to improve pipeline system integrity and safety and to reduce the potential for accidental releases.

- American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI) Code B31.4, "Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols": This standard addresses requirements for materials of construction welds, inspection, and testing for cross-country hazardous liquid pipelines, including crude oil pipelines, to ensure that pipelines are constructed using the appropriate methods and materials to prevent leaks. ASME B31.4 434.15.2 (a) requires mainline block valves on the upstream side of major river crossings and public water supply reservoirs, and either a block valve or a check valve on the downstream side. 49 CFR Part 195,

"Transportation of Hazardous Liquids by Pipelines," has incorporated ASME/ANSI B31.4 code by reference.

- ANSI Standards CSA Z662-03 and Z662.1-03: This standard covers the design, construction, operation, and maintenance of oil and gas industry pipeline systems that convey various fluids, including crude oil, to ensure that pipelines are constructed using appropriate methods and maintained to prevent leaks.
- American Petroleum Institute (API) 570, "Piping Inspection Code–Inspection, Repair, Alteration, and Re-Rating of In-Service Piping Systems": This code provides guidance on proper inspection and repair of pipelines the petroleum refining and chemical processing industries use, but it may be used for any piping system.
- API RP 1102, "Recommended Practices for Liquid Petroleum Pipelines Crossing Railroads and Highways": This recommended practice is a requirement of ASME/ANSI B31.4. This guide gives primary emphasis to provisions for public safety. It covers the design, installation, inspection, and testing required to ensure safe crossings of steel pipelines under railroads and highways. The provisions apply to the design and construction of welded steel pipelines under railroads and highways.
- API RP 1109, "Recommended Practice for Marking Liquid Petroleum Pipeline Facilities": ASME/ANSI B31.4 advises that this API RP 1109 be used as a guide. The recommended markers are signs that visually alert the public to the presence of a pipeline and the potential hazards associated with excavating near pipelines. Strategic placement of markers and signs also helps the pipeline operator to perform right-of-way surveillance, inspections, and other routine activities.
- NACE [National Association of Corrosion Engineers] RP 0169, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems": ASME/ANSI B31.4 refers to sections of this recommended practice as a guide for an adequate level of cathodic protection. This standard presents acknowledged practices for control of external corrosion on buried or submerged piping systems. It takes into consideration the material of the pipe, the environment around the pipe, and the nature of the contents of the pipe in determining what types of corrosion prevention should be applied to prevent external corrosion from compromising the integrity of the pipe and resulting in a leak.

10.1.1.2 Rail Safety Regulations

Transport of hazardous materials by rail is primarily regulated by PHMSA and the Federal Railroad Administration (FRA). The role of these agencies as well as connected advisory boards and pertinent legislation is discussed below.

10.1.1.2.1 Federal Agency Regulations and Requirements for Rail Transport

The FRA has jurisdiction over railroad safety, including the transport of hazardous materials such as crude oil. Congress passed the Rail Safety Improvement Act of 2008, which directed the FRA to regulate railroad safety so as to reduce the likelihood of train derailments and collisions.

On May 1, 2015, PHMSA and the FRA issued a final rule defining high-hazard flammable trains (i.e., rail cars carrying flammable liquids such as crude oil and ethanol) and addressing safety concerns raised in response to significant rail incidents involving crude oil and other hazardous/flammable materials. High-

hazard flammable trains are defined as having a continuous block of 20 or more tank cars loaded with a flammable liquid or 35 or more cars loaded with a flammable liquid dispersed through the train. Components of the requirements include enhanced braking; enhanced standards for new and existing tank cars; reduced operational speeds; implementation of risk assessments for rail routes; and provision of rail routing information to state, local, and tribal officials. The implementation of these preventative actions is meant to reduce the incidence of accidents involving high-hazard flammable trains.

In August 2016, PHMSA issued its final rule to codify tank car safety standards required by the Fixing America's Surface Transportation Act, signed in December 2015. Under these regulations, all DOT-111 tank cars used to transport crude oil, ethanol, and other flammable liquids must be phased out or retrofitted by 2025, and new tank cars must meet enhanced DOT-117 design or performance criteria. These new cars have increased shell thickness, thermal protection, full-height head shields, high-flow pressure-relief valves, protected top fittings, and upgraded bottom outlet valves for increased safety while transporting flammable materials (81 Federal Register 53935).

In addition to the FRA, the Surface Transportation Board (STB) is an independent adjudicatory and economic regulatory agency. The STB established the Rail Energy Transportation Advisory Committee in July 2007 to provide advice and guidance to the STB and to serve as a forum for discussion of emerging issues regarding the transportation of energy resources, including oil, by rail.

10.1.1.2.2 Minnesota Regulations and Requirements for Rail Transport

Minnesota has implemented new rail incident and response efforts. The Minnesota Department of Public Safety has completed its report outlining Minnesota's response capabilities for an oil transportation incident (Minnesota Department of Public Safety 2015). In addition, in April 2016 Governor Dayton appointed a State Rail Director to enhance railway safety, pursue needed infrastructure improvements, continue training and support for first responders, closely monitor rail movements, and work with communities and railroad companies to ensure the safe and efficient operation of rail systems across Minnesota.

10.1.1.3 Tanker Truck Regulations and Requirements

10.1.1.3.1 Federal Agency Regulations and Requirements for Truck Transport

Federal regulations and requirements for truck transport are established in 49 CFR 177, 178, 385, 107, 392, and 397 as described below.

- Federal regulations regarding the transport of hazardous materials, including crude oil, along public highways are provided in 49 CFR 177. Regulations cover vehicular tunnel sizes, driver training, emergency situation protocols, and other topics pertinent to transport of crude oil by tanker truck.
- 49 CFR 178 includes specifications required for the construction of tanker trucks, including USDOT Specification 407 (Cargo Tank Motor Vehicle). These specifications, including those pertaining to materials, structural integrity requirements, and pressure-relief devices, are meant to ensure safe transport of hazardous materials, including crude oil.
- Safety requirements under 49 CFR 385 include the requirement to obtain and maintain a safety permit to transport certain hazardous materials, including crude oil. Federal regulations

at 49 CFR 107, Subpart G, require registration with PHMSA for transportation of hazardous materials, including crude oil.

- The Federal Motor Carrier Safety Administration regulations in 49 CFR Parts 392 and 397 set additional requirements for parking, attendance of hazmat vehicles, routing of hazardous materials shipments, and railroad crossings. These safety requirements apply to tanker trucks transporting crude oil.

10.1.1.3.2 Minnesota Regulations and Requirements for Truck Transport

Minnesota has adopted the Federal Motor Carrier Safety Administration regulations governing hazardous materials transportation, including crude oil.[4] The Minnesota Department of Transportation regulates truck transportation of crude oil through its Office of Freight and Commercial Vehicle Operations (OFCVO). OFCVO focuses on at-risk carriers and shippers who pose the greatest threat to highway safety such as those transporting flammable products, including crude oil. OFCVO works closely with the Federal Motor Carrier Safety Administration in administering and enforcing motor carrier laws and regulations that were established to increase the safety of transporting materials such as crude oil and to minimize the potential for accidental release of those materials.

Under the auspices of the Federal Motor Carrier Safety Administration, OFCVO investigators conduct onsite investigations and reviews of interstate carrier and shipper records and determine whether the carrier or shipper has adequate safety controls in place. Safety controls include driver qualifications; weight limitations; vehicle inspection, repair, and maintenance; driver safety; insurance requirements; and placard and labeling requirements. If a carrier or shipper does not meet the safety standards set by OFCVO, the carrier or shipper can be considered unfit, which may lead to severe penalties up to and including a shutdown of its operations.

10.1.2 Potential Causes of Unanticipated Releases

10.1.2.1 Threats to Crude Oil Transport by Pipeline Systems

Modern crude oil pipeline systems are designed, constructed, and operated with technology to minimize the potential for integrity failures and to rapidly detect and manage unanticipated releases. However, releases do still occur, including releases from pipelines, pump stations, mainline valves (MLVs), and storage tanks. According to the ASME (2010), threats of pipeline failure fall within three categories: time-dependent, stable, and time-independent. Time-dependent threats are those that tend to increase over time. Stable threats are those that are always present but only manifest when activated by a change in operations or the surrounding environment. Time-independent threats are those that are not influenced by time (ASME 2010).

Time-dependent threats (e.g., aging infrastructure) include external corrosion, stress corrosion cracking, and internal corrosion. External corrosion occurs when the pipeline walls, seam welds, or joint welds weaken from corrosive action from outside the pipe. External corrosion can be caused by the natural conditions of the substrate surrounding the pipeline. Stress corrosion cracking occurs when the combined action of corrosion and applied stress causes cracks. Internal corrosion weakens the pipe through corrosive action on the interior surface of the pipe.

[4] Minnesota Statutes §221.033

Stable threats include manufacturing, construction, and equipment failure threats. Manufacturing threats are caused by defects in the pipeline system that originated during the manufacturing process, such as pipe seam defects and out-of-roundness. Construction threats result from defects caused during the construction, installation, or fabrication of the pipe and its components. Equipment threats result from a failure of the equipment to perform its intended design or its operational or functional purpose.

Time-independent threats include operational error, damage from weather or natural forces, and third-party damage. Operational errors are caused by human mistakes leading to the incorrect operation of the pipeline system that could ultimately lead to a release. Additionally, weather-related and other natural threats have the potential to damage the pipeline system. Natural forces that could stress or damage pipelines, pump stations, MLVs, and storage tanks include inclement weather (e.g., lightning strikes, flooding) or geological shifts (e.g., earthquakes, landslides, mudslides, ground settlement). Pipeline stress or corrosion can also occur due to the natural conditions of the substrate surrounding the pipeline. For example, many types of peat (which is common in Minnesota) exhibit negative buoyancy and place upward pressure on pipelines, causing stress on the pipe (Ryder et al. 2004). Third-party damage threats consist of potential actions by parties other than the pipeline operator that could compromise the integrity of the pipeline. Unintentional damage by third parties most often occurs when other parties are constructing in the vicinity of an installed pipeline and encounter the pipeline while excavating or conducting other ground-disturbing activities. Third-party damage could also include intentional vandalism or sabotage.

10.1.2.2 Threats to Crude Oil Transport by Rail

Crude oil releases associated with rail transport can result from a number of factors. Rail tank car loading or offloading[5] errors, hose failures, or rail tank car valve failures could lead to relatively small releases of crude oil within the loading or offloading facility.[6] Derailments or crashes could lead to larger spills that would not be within areas designed to contain releases. Derailments can be caused by collisions with other objects (e.g., vehicular traffic), operational errors (e.g., harsh handling such as hard braking or traveling at high speeds), mechanical failure of the tracks (e.g., broken rails), or mechanical failure of the wheels. According to a recent study, broken rails or broken welds were the leading cause of derailments at all speeds (Liu et al. 2012). Human factor-related causes such as improper use of switches and violation of switching rules were also prevalent, as were equipment failures (e.g., bearing failure, broken wheel, and axle defects) (Liu et al. 2012). Rail lines may also become the target of intentional sabotage or terrorism (U.S. Government Accountability Office 2012).

10.1.2.3 Threats to Crude Oil Transport by Truck

Crude oil releases associated with truck transport are typically related to the failure of equipment during loading or offloading or human error (Heavy Duty Innovations 2014). Loading crude oil to and offloading crude oil from a tanker truck involves transferring the oil through manifolds, hoses, and valves using a pump (typically mounted on the tractor or tank trailer) to move the oil in either direction. If any of the valves on the truck or the transfer pipes of the storage tank are not properly opened when the pump starts, crude oil under high pressure can blow out the hose or the fitting connecting to the truck's tank. These types of releases would be within the containment area of the loading or offloading facility. In addition, trucks traveling along highways and other roads are at risk of collisions and crashes due to the

[5] Loading refers to crude oil being transferred to a rail car or tanker truck from a storage tank; offloading refers to crude oil being transferred from a rail car or tanker truck to a storage tank.

[6] Section 10.1.3 defines the size categories of releases.

unpredictable nature of other drivers, driver fatigue, poor road conditions, and inclement weather conditions. When a truck crashes, the tank may be punctured or otherwise damaged, allowing the release of crude oil.

10.1.3 Release/Spill Volume Categories

For pipelines, the total volume of a release is influenced by several factors, including size of the breach, pipeline pressure, fluid properties (e.g., temperature and viscosity), time required to detect a release, time to isolate a leak and shut down the pipeline, distance between isolation valves, and effectiveness of the isolation (Stantec and Barr Engineering 2017). For rail, the total volume of the spill depends on the number of rail tank cars affected and the severity of the incident. A spill could be limited to the partial contents of a single tank car or the complete contents of many tank cars. Each tank car has a capacity of up to 800 barrels (33,600 gallons) of oil. Therefore, a full unit train of 110 tank cars could transport 88,000 barrels (3.7 million gallons) of oil. For tanker trucks, most spills would be limited to the contents of a single tank. Tanker trucks can carry approximately 190 barrels of oil (7,980 gallons).

The five categories of spill sizes established for the assessment of crude oil releases in the EIS for the Line 67 Expansion Project (U.S. Department of State [DOS] 2017) were determined to be useful in the assessment of potential spills in this EIS as well. These categories consist of the following:

- Incidental spills: less than 0.1 barrel (5 gallons);
- Small spills: equal to or greater than 0.1 barrel (5 gallons) and less than or equal to 50 barrels (2,100 gallons);
- Medium spills: greater than 50 barrels (2,100 gallons) and less than or equal to 1,000 barrels (42,000 gallons);
- Large spills: greater than 1,000 barrels (42,000 gallons) and less than or equal to 10,000 barrels (420,000 gallons); and
- Catastrophic spills: greater than 10,000 barrels (420,000 gallons).

Incidental spills (less than 0.1 barrel [5 gallons]) are considered minor by PHMSA and reporting is not required at that threshold (the minimum-volume reporting requirement that has been in effect since 2002); therefore, no historical data exist for incidental spills for use in the analysis described below. The behavior of small, medium, large, and catastrophic spills in the environment is discussed in Section 10.3.1.3.1.

10.1.4 Methodology for Assessing Failure Probabilities, Potential Exposure, and Resource Impacts

The methods employed in analyzing the frequency of accidental releases, the potential for resources along the alternatives to be exposed to crude oil, and range of impacts that could occur on resources, include the following:

- Failure probabilities (defined as the number of incidents per year) were estimated for the Project and its alternatives based on other spill studies (including studies conducted for the Project [Stantec and Barr Engineering 2017; Stantec et al. 2017]), published literature, and public databases (Section 10.2). In addition to the spill-size categories described above, failure

probabilities for pinhole releases[7] were also estimated for pipeline alternatives. The numbers of years between incidents, or the recurrence intervals, were also calculated.

- Geographic information system (GIS) was used to identify resources along alternatives with the potential to be exposed to crude oil if a release were to occur (Section 10.4).
- Potential impacts on resources are discussed based on published literature and historical observations regarding crude oil behavior in the environment (Section 10.3), as well as the vulnerability of potential resources (Section 10.4).

10.2 PROBABILITY OF CRUDE OIL RELEASES FOR THE PROJECT AND ITS ALTERNATIVES

This section presents the failure probability analyses conducted for this EIS. The methods used to estimate failure probabilities and recurrence intervals are described in Section 10.2.1 through 10.2.3. In Section 10.2.4, the results of the failure probability analyses are presented separately for the Applicant's preferred route, Certificate of Need (CN) Alternatives, and route alternatives. Section 10.2.5 compares the estimated failure probability results for pipelines to regional data and other relevant failure probability studies. Comparisons between the transport mode alternatives, based on the results of the failure probability analyses are presented in Section 10.7.

10.2.1 Failure Probability Analysis Methods for Pipeline Alternatives

Pipeline failure probabilities were based on annual failure frequencies (AFFs) (i.e., the number of incidents per year per mile of pipeline), which were developed for three different land-cover types (wetlands, open water, and uplands) relevant to Minnesota pipeline routing. These AFFs were derived from previous pipeline assessments developed for the Project (Stantec and Barr Engineering 2017; Stantec et al. 2017), as described below.

10.2.1.1 Information Sources

10.2.1.1.1 Previous Project-Specific Enbridge Studies

Enbridge funded two studies on failure probabilities related to potential pinhole leaks and large-volume releases (Stantec and Barr Engineering 2017; Stantec et al. 2017, respectively). Agency staff and the consultants selected seven sites for in-depth analysis based on (1) their distribution across the Applicant's preferred route and route alternatives,[8] and (2) how well they represented the diversity of characteristics that were identified as significant during public scoping (Figure 10.2-1).

[7] PHMSA defines a pinhole release as a leak that is difficult to see with the naked eye and is characterized as being a small hole as might be made by a pin. PHMSA also defines a pinhole leak in terms of a small unwelded area that extends through the entire thickness of a weld (PHMSA 2014). Thus, for the purpose of this analysis, a pinhole release is defined as a small leak of crude oil from a pipeline or its remote facilities (e.g., pump station valves or piping) that might not be immediately detected by leak detection systems.

[8] Stantec et al. only evaluated the Applicant's preferred route and route alternatives. The CN Alternatives, including system alternative SA-04, transportation by rail and truck, and continued use of existing Line 3 were not evaluated during their study (Stantec et al. 2017).

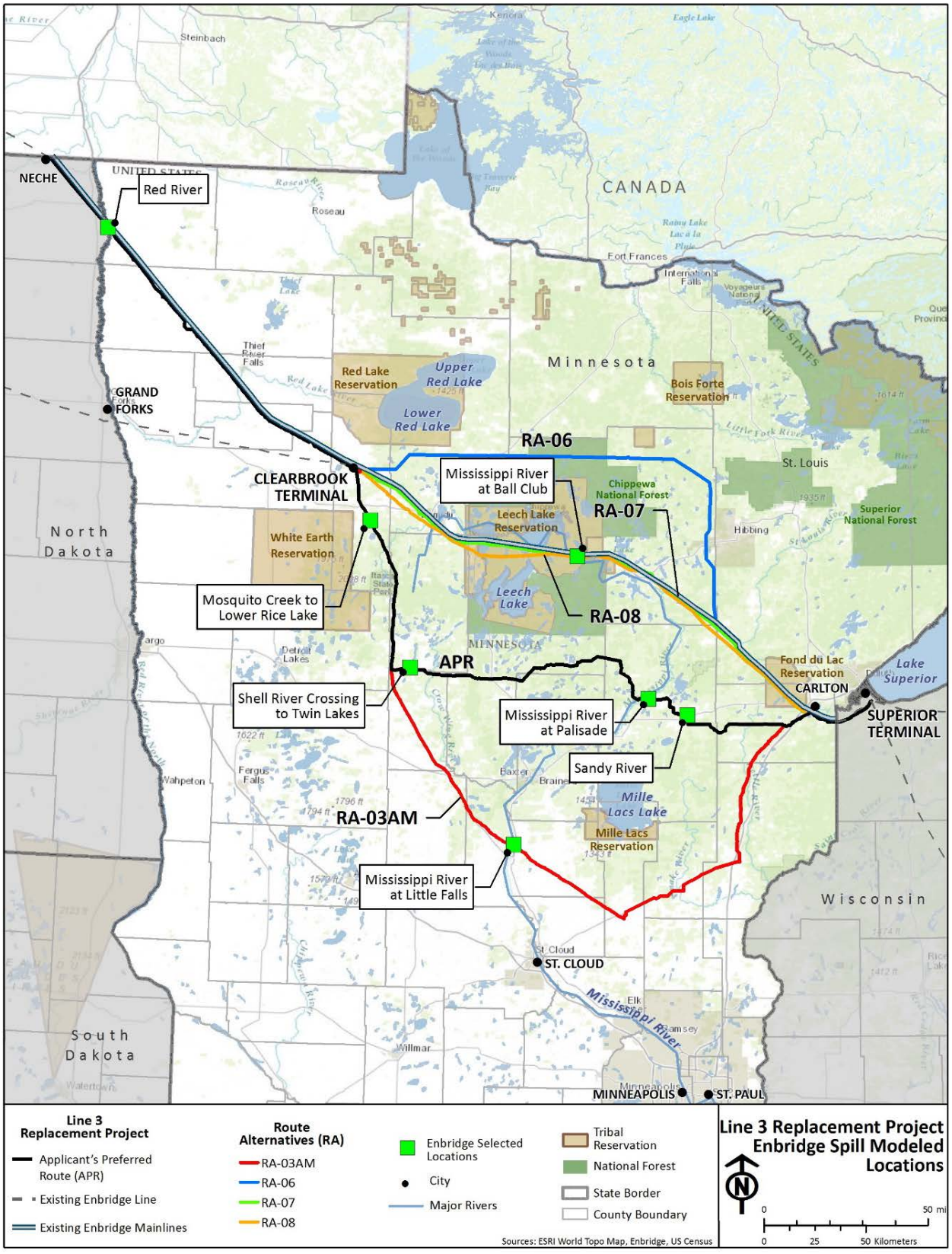

Figure 10.2-1. Seven Sites Evaluated in Stantec et al. 2017 Study

Stantec et al. conducted a failure probability analysis for these seven sites—six at pipeline water crossings and one in an upland location adjacent to a small creek (2017). As part of that analysis, they assessed potential causes of pipeline failures or threats. The threat components resulting in pipeline failure were evaluated based on current materials and technologies characteristic of a modern replacement pipeline. The results of these studies were applied to the failure probability analysis in this section, as well as the exposure assessment in Section 10.4.

The two Stantec studies (Stantec and Barr Engineering 2017; Stantec et al. 2017) are incorporated by reference in this EIS. The studies are available online on the DOC-EERA Project website (https://mn.gov/commerce/energyfacilities/line3/), on the Project eDockets site (Line 3 Route Permit PUC eDockets), and by CD included with hard copies.

10.2.1.1.2 Additional Sources

Relevant information from the Stantec studies described above was augmented by the following sources of data and information to estimate pipeline failure probabilities.

- **Keystone XL Pipeline Final Supplemental EIS (DOS 2014)**: Appendix K of the Keystone XL Pipeline Final Supplemental EIS analyzed historical PHMSA incident data to determine historical spill volumes associated with pipeline incidents and failures, identify incident causes, and characterize frequencies of pipeline spills in the United States.
- **Keystone XL Pipeline: Independent Engineering Assessment – Final Report (Battelle Memorial Institute 2013)**: Battelle Memorial Institute reviewed selected engineering components of the Keystone XL Pipeline Final Supplemental EIS to evaluate the EIS's consideration of failure frequency, risk assessment, placement of valves, fate and transport, detection and prevention of leaks, and protective and mitigating measures.
- **Alberta Energy Regulator (AER) Report (2013)**: This report represents a comprehensive analysis of Alberta, Canada, pipeline data collated from January 1, 1990, through December 31, 2012. The data describe incident statistics and incident rates (ranging from small leaks to major pipeline ruptures), which have been continually updated as Alberta pipelines have been built, discontinued, abandoned, relicensed, or returned to service. The AER (2013) data were used in the analysis for this EIS because of the similarity of land use categories between Alberta and northern Minnesota, as well as the 23-year record of reported incidents. The data provide estimates of individual threat components that contribute to overall estimates of pipeline failure probabilities.[9]

[9] The crude oil pipelines in Alberta are typically smaller (e.g., 6-inch diameter) collection systems that carry raw products from pumping sites to storage facilities. AER (2013) correspondingly caveats the extrapolation of these incident data to larger-diameter pipelines. However, the long time span of the data and the comprehensive analysis contribute to the overall importance of the Alberta statistics to derivation of AFFs for the Line 3 Replacement Project. Use of these data could result in overestimation of Line 3 Replacement pipeline failure probabilities; however, this potential bias would be consistent across all pipeline route comparisons.

- **PHMSA Incident Reports Database**: Historical pipeline incident data from the publicly available PHMSA Incident Reports Database were used.[10] PHMSA also provides a series of reports that contain statistical information on incidents by categories such as type, year, and location. The database provides key information on reported incidents, including the following:

  - Date of the incident,
  - Commodity associated with the incident (for this analysis, crude oil),
  - Volume of spill,
  - Part of pipeline from which the spill occurred,
  - Diameter of the pipe,
  - Origin/location of the spill (for this analysis, limited to onshore pipelines), and
  - Cause of spill.

  The PHMSA dataset also contains information regarding the reported causes of releases from U.S. onshore crude oil pipelines. The causes, or threats, that resulted in incidents include the following:

  - External corrosion,
  - Stress corrosion cracking,
  - Internal corrosion,
  - Manufacturing defects,
  - Construction-related error,
  - Equipment failure,
  - Operational error,
  - Damage from weather or natural forces (e.g., geotechnical and hydrological), and
  - Third-party damage.

Section 10.1.2.1 provides additional description of these threats.

10.2.1.2 Approach for Estimating Pipeline Failure Probabilities

Stantec et al. (2017) derived failure probabilities for the Applicant's preferred route and route alternatives based almost exclusively on water-crossing locations and with a focus on releases from major ruptures, while omitting analyses of failure probability for pipeline supporting infrastructure (e.g., pumping stations, storage tanks, and valves) and for integrity issues associated with these equipment components. To develop estimates of pipeline failure for non-open-water segments, which were not

[10] The PHMSA Incident Reports Database is available at https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/Welcome.aspx.

addressed by the Stantec et al. assessment, this EIS derived threat component factors specifically for upland areas including:[11]

- Third-party damages,[12]
- Geotechnical/hydrological threats,[13] and
- Equipment failure.[14]

AFFs incorporating these threat components were then derived specifically for the three different land-cover types traversed by the pipeline routes rather than exclusively for open water as in the analysis conducted by Stantec et al. (2017). The value for each land-cover type was multiplied by the miles of pipeline within that land cover for each pipeline alternative considered. This approach provided the ability to more accurately estimate the potential for a pipeline failure and release along the entire length of a pipeline as opposed to only areas of open water.

In addition to developing AFFs for three land-cover types, the failure probability analysis in this EIS adjusted Stantec et al.'s major rupture AFFs (i.e., number of major ruptures per mile per year), which only consider a large release volume, to instead derive failure probability estimates for a range of release sizes from small to catastrophic spills. Major ruptures are considered to be low-probability (although potentially high consequence) events. As reported by DOS (2017: Table 5-2), incidents resulting in catastrophic spills occur substantially less frequently than incidents resulting in large spills; similarly incidents resulting in large spills occur less frequently than medium spills, and incidents resulting in medium spills occur less often than those resulting in small spills. As a result, use of the Stantec et al. (2017) major rupture AFF values would likely underestimate the annual probability of spills. Based on the reported observation that 5 percent of overall Alberta incidents were major ruptures (AER 2013), Stantec et al.'s (2017) major rupture AFF values were scaled (divided by 5 percent [0.05]) to produce higher (more conservative) AFF values that more realistically apply across a wider range of spill sizes. The adjusted AFF values were then used to estimate annual failure probabilities.

[11] The contribution of equipment (e.g., valves, welds, pump stations) failures to overall risk was not included in the Stantec et al. (2017) study because the seven modeled water-crossing scenarios included no valves or similar infrastructure.

[12] It was assumed that the third-party damages AFF calculated by Stantec et al. (2017) for wetlands and river crossing locations could not be simply extrapolated to upland areas along the Project alternatives. The value selected for third-party damage in this EIS (0.00004983 incidents per mile per year) was adopted from the AER (2013) report, based on the general similarity of upland terrain compared with habitats in the vicinity of Project alternatives.

[13] The geotechnical/hydrological pipeline failure probability was calculated as the mean of the Stantec et al. (2017) site-specific values, which is 0.000001302 incidents/mile-year. This value was assumed to be representative of river crossings and upland segments.

[14] The equipment failure probability (0.0000500 incidents/mile-year) was based on Appendix K of the Keystone XL Pipeline Final Supplemental EIS (DOS 2014) as an estimate appropriate for the pipeline technology characteristic of the proposed Project and its alternatives. The probability estimate reported for Keystone XL compares with the value of 0.0000470 (years 2002 to 2007) provided by the USDOT (Pettitt and Morgan 2009). AER (2013) reports a higher value of 0.000577, which includes pipe failure, valves, fittings, and weld failures, and likely overestimates equipment failure as defined more narrowly by Stantec et al. (2017).

AFFs[15] calculated specifically for wetlands, open water, and upland pipeline segments are as follows:

- Wetlands: 0.0001967 incidents per mile per year
- Open water: 0.0001792 incidents per mile per year
- Upland areas: 0.0007257 incidents per mile per year

The estimated AFFs underline the increased risk of pipeline incidents in uplands compared to wetlands and river crossings. This reflects the increased contribution of third-party damages to upland areas (e.g., agricultural lands) and the inclusion of threats posed by valves and other infrastructure (e.g., pump stations) that are not present along pipeline segments that span wetlands and surface waters.

The underlying AFF values used to derive the failure estimates for the Project were based on the range of spills included in the PHMSA and supporting industry data (e.g., the Line 67 Expansion Project EIS [DOS 2017], the Keystone XL Final Supplemental EIS [DOS 2014], and AER 2013). However, to provide context concerning the likely magnitudes of spills anticipated for the Project and its alternatives, the estimates of annual incidents per 1,000 miles derived for the four spill-size categories described in Section 10.1.3 were multiplied by the total miles of pipeline for the Project and its alternatives. The estimated annual incidents are as follows:

- Small spills: 2.80 incidents per 1,000 miles
- Medium spills: 0.20 incidents per 1,000 miles
- Large spills: 0.16 incidents per 1,000 miles
- Catastrophic spills: 0.03 incidents per 1,000 miles

Recurrence intervals were calculated as the inverse of the failure probability (or 1 divided by the failure probability).

10.2.1.3 Failure Probability Analysis Method for Existing Line 3

10.2.1.3.1 Estimated Annual Failure Frequencies

The AFFs developed for analysis of the Applicant's preferred route and the pipeline CN and route alternatives reflect current pipeline technology and operations as presented in the 2010 to 2015 PHMSA data that underlie the Stantec studies. Enbridge pipelines constructed before 1980, such as the existing Line 3 employed different coating technologies which do not meet current standards for corrosion. Therefore, these AFFs are not appropriate for estimating annual failure probabilities for the existing Line 3 pipeline system. To estimate the failure probability for the existing Line 3, the AFFs were revised using historical data described and summarized in the Keystone XL Final Supplemental EIS (DOS 2014: Table 3.13.4-3). Specifically, the two threat components associated with corrosion and materials and

[15] The wetlands AFF is simply the value calculated for Mosquito Creek by Enbridge, converted to incidents per mile per year. The open water (i.e., streams, rivers, and lakes) crossing AFF value is the mean of the locations analyzed by Stantec et al. (2017). The upland areas (e.g., native plant habitat, forested lands, cultivated land) AFF combines the individual threat estimates constant across all seven Stantec et al. (2017) locations and augments them using the third-party, geotechnical/hydrological, and equipment failure rates.

construction were each increased to 0.0003 incidents per mile per year resulting in the following AFF values:

- Wetlands: 0.0007967 incidents per mile per year (0.7967 incidents/1,000 miles/year)
- Open water: 0.0007792 incidents per mile per year (0.7792 incidents/1,000 miles/year)
- Upland areas: 0.0013260 incidents per mile per year (1.3260 incidents/1,000 miles/year)

These revised AFFs were used together with the miles of land-cover types to estimate an annual failure probability and corresponding recurrence interval for the existing Line 3.

10.2.2 Failure Probability Analysis Method for Rail Transport and Existing Line 3 Supplemented by Rail Transport

The estimation of annual failure probability for rail transport was based on projecting the billion ton-miles[16] of oil transported by rail for two scenarios: transport of the entire volume of crude oil by rail and continued operation of Line 3 supplemented by rail transport. As described in Section 10.1.2.2, the primary threat components of rail transport failure are loading and offloading errors, hose or valve failures during loading or offloading, and crashes or derailments.

As described in Chapter 4, transporting the Line 3 Replacement-equivalent of 760,000 barrels per day (bpd) by rail alone would require 10 fully loaded unit trains (i.e., 10 trains, each with 110 tank cars, with up to 800 barrels in each car) traveling from Gretna to the Clearbrook and Superior terminals per day. Of those 10 trains, five trains would travel from Gretna to the Clearbrook terminal and five trains would travel from Gretna to the Superior terminal. Travel distances would be 129 miles from Gretna to Clearbrook and a mean distance of 368 miles from Gretna to Superior based on two rail alternative routes. The corresponding total annual transport by rail was calculated to be 11.99 billion ton-miles.

The alternative of existing Line 3 supplemented by rail transport would reduce the number of trains traveling from Gretna to Superior to one train per day. There would still be five trains per day traveling from Gretna to Clearbrook. The total annual transport by rail for this scenario was calculated to be 4.89 billion ton-miles.

DOS (2017) addressed the incident rates for rail travel; Table 5-4 of that report indicates that the average annual crude oil incidents per billion ton-miles is 0.8. That figure was used to estimate the annual failure probability for rail transport and existing Line 3 supplemented by rail. Recurrence intervals were calculated as the inverse of the failure probability (or 1 divided by the failure probability).

[16] The ton-mile is a unit of traffic commonly used to describe freight transport. One ton-mile is defined as 1 ton of freight transported 1 mile. One billion ton-miles is equal to 1 ton transported 1 billion miles or 1 billion tons transported 1 mile.

10.2.3 Failure Probability Analysis Method for Transportation by Truck and Existing Line 3 Supplemented by Truck Transport

The same approach used to estimate failure probabilities for rail transport was used for truck transport. For each truck transport alternative, the corresponding annual billion ton-mile equivalents were calculated and translated to the failure probability unit of incidents per year. As described in Section 10.1.2.3, the primary threat factors for truck transport failures are loading or offloading errors, hose or valve failures during loading or offloading, collisions with other vehicles, and crashes.

As described in Chapter 4, transporting the proposed Line 3 Replacement-equivalent of 760,000 bpd of oil by tanker truck alone would require 4,000 tanker trucks to travel from Gretna to the Clearbrook and Superior terminals per day. Of those 4,000 tanker trucks, 1,920 trucks would travel from Gretna to the Clearbrook terminal, and 2,080 trucks would travel from Gretna to the Superior terminal. Travel distance from Gretna to Clearbrook is 179 miles; the distance from Gretna to Superior is 360 miles. The resulting annual truck transport was calculated to be 11.55 billion ton-miles.

The alternative of existing Line 3 supplemented by truck transport would reduce the number of daily trips from Gretna to Clearbrook from 1,920 to 1,889. Trips from Gretna to Superior would be reduced from 2,080 to 58. The corresponding annual oil transport by truck was calculated to be 3.80 billion ton-miles.

DOS (2017) did not address failure incidents for transport of oil by truck. To calculate the annual probability of an incident, the failure rate of 19.95 incidents per billion ton-miles reported for industry-wide oil truck transport was used in this assessment (Furchtgott-Roth and Green 2013). Using that input, the annual number of incidents for truck transport and existing Line 3 supplemented by truck were estimated.

Recurrence intervals were calculated as the inverse of the failure probability (or 1 divided by the failure probability).

10.2.4 Results of the Failure Probability Analyses

The results of the failure probability analyses described above are provided in the two following sections:

- Failure Probabilities for the Applicant's Preferred Route and Certificate of Need Alternatives (Section 10.2.4.1), and
- Failure Probabilities for the Applicant's Preferred Route and Route Alternatives (Section 10.2.4.2).

10.2.4.1 Failure Probabilities for the Applicant's Preferred Route and Certificate of Need Alternatives

Table 10.2-1 compiles the annual failure probabilities and recurrence intervals for the Applicant's preferred route and the CN Alternatives, including existing Line 3, SA-04, transport by rail and truck, existing Line 3 supplemented by rail, and existing Line 3 supplemented by truck. The recurrence interval (sometimes called the return period) is based on the probability that the given event will be equaled or exceeded in any given year. It is an estimate of the number of years between incidences. So, for example, if the recurrence interval is 4.0 then it is estimated there will be an incidence approximately every 4 years.

Table 10.2-1. Estimated Annual Probabilities of Incidents and Recurrence Intervals for the Applicant's Proposed Project and Certificate of Need Alternatives

Probability and Recurrence	Applicant's Preferred Route	Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Annual probability of spill incident	0.249	0.404	0.568	0.960	230[a] (0.63)	0.794	76[a] (0.21)
Recurrence interval (years)	4.0	2.5	1.8	1.04	0.004 (1.59 days)	1.26	0.013 (76.9 days)

[a] Incidents per year; values in parentheses are daily probabilities.

10.2.4.1.1 Applicant's Preferred Route

Length is a key component in calculating failure probability, simply because a longer pipeline has a greater area that could be exposed to the primary pipeline threats (third-party damages, construction defects, manufacturing defects, corrosion, and equipment failure [e.g., valve failure]). The annual probability of a spill incident for the Applicant's preferred route was estimated as 0.249 incidents per year with a recurrence interval of 4.0 years, which applies to the entire 380-mile-long route. The main contributing threat components are third-party damages, construction defects, manufacturing defects, and equipment (e.g., valves) failure.

10.2.4.1.2 Continued Use of Existing Line 3

The annual failure probability of the existing Line 3 pipeline system under current pressure and volume conditions was calculated using the AFFs described in Section 10.2.1.3.1 and the miles of the three land-cover types along the 328-mile-long route of RA-07. The resultant estimate of the annual failure probability is 0.404, and the corresponding recurrence interval is 2.5 years.

The estimated Line 3 failure probability was compared to available Line 3 incident data reported to PHMSA for the period of 2002 to 2017. Seven spills were reported over this 16-year record, which corresponds to an annual failure probability of 0.438 (i.e., 7 incidents divided by 16 years) and a recurrence interval of 2.3 years. The close agreement between the estimated and data-driven values of annual failure probability for the existing Line 3 pipeline system underscore the increased risk associated with the older Line 3 technology and pipeline aging compared to the newer technology for the other pipeline alternatives. This agreement also validates the methods employed to estimate annual failure probabilities for the Project and alternatives.

Incremental Oil Volume Increase on Existing Pipelines

Most of the risks of unanticipated crude oil releases from a new crude oil pipeline are directly proportional to route length—that is, the longer the pipeline route, the higher the overall risk. However, the risk of an accidental spill on an existing pipeline in the Enbridge system in Wisconsin or elsewhere

would not be materially different whether Line 3 operates at the current capacity of 390,000 bpd, or at the proposed 760,000 bpd. The primary risks of an accidental release incident are corrosion, manufacturing defects, and damage from third-party excavation or from natural forces. The amount of oil flowing in the pipeline does not affect any of these risks.

Although the increased flow rate of oil on the existing pipeline network would not affect the risk of an oil release, it could result in an increase in release volume if a major rupture were to occur. That is, an increase in oil flow on an existing line due to the Project could increase the amount of oil that would flow out of the pipeline in the event of a major rupture before Enbridge identifies the rupture and shuts the system down by stopping the pumping and closing the valves. For a slow leak under the higher flow rate, the difference in the volume of the release would be minor.

10.2.4.1.3 System Alternative SA-04

The route of SA-04 is 795 miles long, and it is therefore the longest of the CN pipeline alternative routes. This greater length results in an estimated annual failure probability of 0.568 incidents per year and a recurrence interval of 1.8 years, both of which are greater than those of the Applicant's preferred route and the continued use of existing Line 3. Because the primary risks of an accidental release incident are corrosion, manufacturing defects, and damage from third-party excavation or from natural forces, the increased flow in the Superior to Illinois segment does not increase the risk of a spill for the other pipeline alternatives and therefore is not considered in the calculation of risk for the other pipeline alternatives

10.2.4.1.4 Transportation by Rail

The annual probability of an incident is 0.96 for the transportation by rail alternative, with a corresponding recurrence interval of 1.04 years.

10.2.4.1.5 Transportation by Truck

To calculate the annual probability of an incident, the failure rate of 19.95 incidents per billion ton-miles reported for industry-wide oil truck transport was used (Furchtgott-Roth and Green 2013). Using that input, the resulting number of expected incidents for truck transport is 230 per year. To facilitate comparison with other alternatives, the annual failure probability value was converted into a daily failure probability of 0.63 (i.e., dividing 230 annual incidents by 365 days). The corresponding recurrence interval is 0.004 years (or 1.59 days).

As for the truck transport alternative, this alternative has a higher probability of a failure than the pipeline alternatives, but it is likely that most releases would be relatively small.

10.2.4.1.6 Existing Line 3 Supplemented by Rail

As described above, this alternative would require six loaded unit trains per day to travel from Gretna to the Clearbrook and Superior terminals. This would result in a transport value of 4.89 billion ton-miles per year, with an annual probability of an incident of 0.794 and a recurrence interval of 1.26 years.

10.2.4.1.7 Existing Line 3 Supplemented by Truck

As described above, this alternative would require 1,947 loaded trucks to travel from Gretna to the Clearbrook and Superior terminals per day. To calculate the annual probability of an incident, the failure rate of 19.95 incidents per billion ton-miles reported for industry-wide oil truck transport was used (Furchtgott-Roth and Green 2013). Using that input, the resulting numbers of expected incidents from

existing Line 3 supplemented by truck each year is 76. To facilitate comparison with other alternatives, the annual failure probability value was converted into a daily failure probability of 0.21 (i.e., dividing 76 annual incidents by 365 days). The corresponding recurrence interval is 0.013 years (or 76.9 days).

10.2.4.2 Probability Based on Spill Size and Type

Spill probability was calculated for different spill sizes and for pinhole releases by Stantec and Barr Engineering (2017), Stantec et al. (2017), and DOS (2017). The probability of small, medium, large, and catastrophic spills was calculated for the Applicant's preferred route and SA-04; it was not calculated for existing Line 3 because there are historical data from Line 3 that inform the probability of different sizes of spills from it. The probability of a pinhole release was completed for the Applicant's preferred route, existing Line 3, and SA-04.

10.2.4.2.1 Spill Probability by Size for the Applicant's Preferred Route and System Alternative SA-04

Table 10.2-2 lists the estimated annual failure probabilities and recurrence intervals for small, medium, large, and catastrophic spills for the Applicant's preferred route and SA-04. Analysis of the existing Line 3 data from 2002 to 2017 indicate that spill sizes have been in the small to medium range; therefore, results for this pipeline alternative are not presented here.

In contrast to the incident data used to develop the values in Table 10.2-1, the incident data used as the basis for the values in Table 10.2-2 did not provide information on the type of land cover (i.e., wetlands, open water, and uplands) at the release location. Therefore, the values presented are the annual failure probabilities and the recurrence intervals for the entire lengths of the pipelines, and the differences in the values result from the different pipeline lengths. The results listed in Table 10.2-2 suggest that if a spill occurred, it would likely be in the small- to medium- size range.

Table 10.2-2. Annual Failure Probabilities and Recurrence Intervals for Small, Medium, Large, and Catastrophic Spills for the Applicant's Preferred Route and System Alternative SA-04

		Applicant's Preferred Route	System Alternative SA-04
	Route length (miles)	*380.4*	*795.4*
Small spills (0.1–50 barrels)	Annual probability	1.07[a] (0.003)	2.23[a] (0.007)
	Recurrence interval (years)	0.94	0.45
Medium spills (50–1,000 barrels)	Annual probability	0.076	0.159
	Recurrence interval (years)	13.1	6.3
Large spills (1,000–10,000 barrels)	Annual probability	0.061	0.127
	Recurrence interval (years)	16.4	7.9
Catastrophic spills (greater than 10,000 barrels)	Annual probability	0.011	0.024
	Recurrence interval (years)	87.6	41.9

[a] Incidents per year; values in parentheses are daily probabilities.

Calculations are based on Enbridge incident failure rates presented in DOS 2017: Table B-2.

10.2.4.2.2 Pinhole Leak Analysis for the Applicant's Preferred Route and Certificate of Need Pipeline Alternatives

Stantec and Barr Engineering (2017) estimated AFF values for pinhole leaks in regional contexts as follows:

- United States: 0.00081 incidents per year per mile;
- Upper Midwest: 0.00068 incidents per year per mile, and
- Minnesota: 0.00071 incidents per year per mile.

These estimates were based on analysis of PHMSA data for reported pinhole releases between January 2002 and December 2015 (Stantec and Barr Engineering 2017). The pinhole leak AFF for Minnesota was selected as the appropriate factor for this analysis and was multiplied by the length in miles of the Applicant's preferred route and the CN pipeline alternatives to estimate the annual probabilities of a pinhole leak. The resultant annual probabilities and recurrence intervals are presented in Table 10.2-3.

Table 10.2-3. Estimated Annual Probability of Pinhole Leaks and Recurrence Intervals for the Applicant's Preferred Route and Certificate of Need Pipeline Alternatives

Probability and Recurrence	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04
Annual probability of pinhole leak	0.270	0.233	0.568
Recurrence interval (years)	3.7	4.3	1.8

10.2.4.3 Failure Probabilities for the Applicant's Preferred Route and Route Alternatives

10.2.4.3.1 Annual Failure Probabilities and Recurrence Intervals for the Applicant's Preferred Route and Route Alternatives

Annual failure probabilities and recurrence intervals were estimated for the Applicant's preferred route and route alternatives between Clearbrook and Carlton. These results are presented in Table 10.2-4.

Table 10.2-4. Estimated Annual Probabilities of Failure and Recurrence Intervals for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Probability and Recurrence	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Annual probability of a spill incident	0.139	0.179	0.107	0.097	0.089
Recurrence interval (years)	7.2	5.6	9.4	10.3	11.2

The data in Table 10.2-4 were calculated as described in Sections 10.2.1. The minor differences in probabilities and recurrences are attributed to the differences in pipeline length of the route segments between Clearbrook and Carlton and the difference in the distance of each alternative pipeline segment through the three different land-cover types.

10.2.4.3.2 Pinhole Leak Analysis for the Applicant's Preferred Route and Route Alternatives

Table 10.2-5 presents the annual probabilities and recurrence intervals for a pinhole leak for the Applicant's preferred route and route alternatives between Clearbrook and Carlton. As for the CN Alternatives analysis described in Section 10.2.4.1, these estimates were based on analysis of PHMSA data for reported pinhole releases between January 2002 and December 2015 (Stantec and Barr Engineering 2017). The pinhole leak AFF for Minnesota was selected as the appropriate factor for this analysis and was multiplied by the length in miles of the Applicant's preferred route and the route alternatives between Clearbrook and Carlton to estimate the annual probabilities of pinhole leaks. As for the CN pipeline alternatives, the differences in probability relate to the length of the segment between Clearbrook and Carlton, with the longer distances having the greater probabilities and lower recurrence intervals.

Table 10.2-5. Estimated Annual Probabilities and Recurrence Intervals for Pinhole Leaks for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Probability and Recurrence	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Annual probability of pinhole leak	0.157	0.195	0.140	0.119	0.117
Recurrence interval (years)	6.4	5.1	7.2	8.4	8.5

10.2.4.3.3 Spill Probability by Size for Applicant's Preferred Route and Route Alternatives

Table 10.2-6 lists the annual failure probabilities and recurrence intervals for small, medium, large, and catastrophic spills. The incident data used as the basis for the calculations of the values in Table 10.2-6 did not provide information on the type of land cover (i.e., wetlands, open water, and uplands) at the release location. Therefore, the values presented are the annual failure probabilities and the recurrence intervals for the lengths of the pipelines between Clearbrook and Carlton, and the differences in the values result from the different pipeline lengths.

The incident data used in developing the probability and recurrence data listed in Table 10.2-5 are primarily associated with small and medium spills, as substantiated by the data in Table 10.2-6. Therefore, the failure probabilities in Table 10.2-5 are likely more accurate characterizations of the Applicant's preferred route and route alternatives. The results listed in Table 10.2-6 suggest that if a spill occurs, it is likely to be in the small-medium size range.

Table 10.2-6. Estimated Annual Probability and Recurrence Intervals of Spills by Range of Spill Size for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

		Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Route length (miles)		*380.38*	*435.58*	*357.28*	*328.25*	*325.35*
Small spills (0.1–50 barrels)	Annual probability	1.07 (0.003)[a]	1.22 (0.003)[a]	1.00	0.92	0.91
	Recurrence interval (years)	0.94	0.82	1.00	1.09	1.10
Medium spills (50–1,000 barrels)	Annual probability	0.076	0.087	0.071	0.066	0.065
	Recurrence interval (years)	13.1	11.5	14.0	15.2	15.4
Large spills (1,000–10,000 barrels)	Annual probability	0.061	0.070	0.057	0.053	0.052
	Recurrence interval (years)	16.4	14.3	17.5	19.0	19.2
Catastrophic spills (greater than 10,000 barrels)	Annual probability	0.011	0.013	0.011	0.010	0.010
	Recurrence interval (years)	87.6	76.5	93.3	101.5	102.5

[a] Incidents per year; daily probabilities in parentheses.

Calculations are based on Enbridge incident failure rates presented in DOS 2017: Table S-6.

10.2.5 Pipeline Failure Probability Results Compared to Regional Data and Other Studies

As described above, annual pipeline incident probabilities were estimated for the Project and its pipeline alternatives (i.e., Applicant's preferred route, continued use of existing Line 3, SA-04, and route alternatives) using AFF values (incidents per mile per year) for three general land-cover types. AFFs were derived from failure estimates from individual threat components (e.g., manufacturing defects, construction defects, equipment failure, corrosion, and third-party damage) that could contribute to a pipeline failure. To gauge the accuracy of this approach, these calculated AFF values were compared to "composite" AFF values derived from PHMSA incident data and pipeline lengths for states in the region, including Minnesota, North Dakota, and Wisconsin, as described below.

10.2.5.1 Regional Context for Existing Line 3 Failure Probability Estimates

The estimated annual failure probability and recurrence interval for the existing Line 3 pipeline was compared with the results for similar assessments of equivalent pipelines in Minnesota, North Dakota, and Wisconsin. Composite AFF values (incidents per mile per year) were derived from PHMSA data (2010 to 2015) for Minnesota, North Dakota, and Wisconsin. Multiplying the composite AFF values[17] by the existing Line 3 pipeline length of 328 miles resulted in annual incident probabilities of 0.364 (incident every 2.7 years) for Minnesota, 0.589 (incident every 1.7 years) for North Dakota, and 0.334 (incident every 3.0 years) for Wisconsin. These values are within the range (order of magnitude) of the annual incident probability of 0.404 estimated for the existing Line 3[18] using an AFF value constructed from individual threat components relevant to older pipeline technology.

The existing Line 3 results were also examined within the context defined for the Line 67 Expansion Project (DOS 2017). The routes analyzed for the Line 67 Expansion Project have similar characteristics to existing Line 3 (e.g., length, traversed geography, pipe diameter).[19] The Line 67 Expansion Project Draft Supplemental EIS (DOS 2017) reported an annual probability estimate for a catastrophic incident (i.e., a release greater than 10,000 barrels) of 0.0040 per year. DOS (2017) also used the industry-wide incident rate of 0.0030 to estimate the number of smaller spills for the 327 miles of the Line 67 Expansion for the 5 years that Line 67 was in operation between 2010 and 2015 (the EIS was in preparation in 2016); the projected spill rate was 4.9 incidents for the 5-year period, which is 0.981 incidents per year. This failure probability estimate is more than twice the number of actual incidents that occurred during that 5-year time period (two small spill incidents occurred, or a frequency of 0.4 per year).

10.2.5.2 Regional Comparisons of Failure Probabilities for SA-04

The estimated AFFs and annual probabilities for the Applicant's preferred route, SA-04, and the route alternatives were considered within the same regional context. The AFF values were identical for the route alternatives, but differences in annual incident probability estimates result from differences in the miles of wetlands, open water, and uplands traversed by each route, as well as the total distance of each route. The incident probabilities are slightly lower, but generally within the range of values developed using the data for Minnesota, North Dakota, and Wisconsin, as described above for the existing Line 3 pipeline (Section 10.2.4.1).

The route alternatives exhibit annual incident probabilities that are lower compared to those of the Line 67 Expansion (DOS 2017). The annual incident probability for SA-04 (0.568 incidents per year) is higher than other routes examined. This appears to largely result from the 795-mile length of SA-04.

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17 The AFFs calculated for these states are defined as composite values because they were obtained by dividing the reported number of incidents for each state by the corresponding number of pipeline miles. The composite AFFs do not describe the contributions of individual component threats. The resulting composite AFFs were 0.001110 (Minnesota), 0.001795 (North Dakota), and 0.001016 (Wisconsin).

18 The existing Line 3 annual failure probability value is based on land cover-specific AFF values derived from individual threat components rather than a composite AFF. This largely explains the difference between the Line 3 failure probability and the more generalized value for Minnesota pipelines of equivalent length.

19 The possible exception is SA-04, which has a higher annual incident probability, mainly because the route is 795 miles long, whereas the other pipeline alternatives range from 325 to 435 miles in length. Only the North Dakota incidents per mile value is higher than that of SA-04, mainly reflecting the relatively recent escalation of oil pipeline construction and operations associated with shale oil development in North Dakota.

10.2.5.3 Comparison of Line 3 and Line 67 Failure Probabilities

To provide further context for the failure probability analysis completed for this EIS, estimates were derived for the Applicant's preferred route and route alternatives using information from the Line 67 Expansion Draft Supplemental EIS (DOS 2017). The average incidents per mile of 0.0008 (or 0.8 incidents per 1,000 miles; DOS 2017: Table 5-3) calculated for the Line 67 Expansion for four spill categories (small to catastrophic) was applied to the route alternatives (between Clearbrook to Carlton) to derive estimates of annual failure probabilities (incidents per year) and corresponding recurrence intervals (years). These estimates were compared to the estimates calculated for this EIS (see Table 10.2-4), which are presented in parenthesis below:

- Applicant's preferred route: 0.177/5.7 (0.139/7.2)
- RA-03AM: 0.220/4.5 (0.179/5.6)
- RA-06: 0.157/6.4 (0.107/9.4)
- RA-07: 0.134/7.5 (0.097/10.3)
- RA-08: 0.132/7.6 (0.089/11.2)

The failure probabilities and recurrence intervals reported by DOS (2017) are slightly higher but certainly within the range of the estimates derived in this EIS, which provides further validation of the methods employed. Although the estimates were derived using two distinct approaches, they could be interpreted as ranges of failure probabilities and recurrence intervals. For example, the frequency of a failure occurring along the Applicant's preferred route could be interpreted as once every 5.7 to 7.2 years.

10.3 BEHAVIOR OF CRUDE OIL RELEASES

When released into the environment, each type of crude oil exhibits unique behavior that depends on many factors. The primary factors that determine the fate of crude oil released into the environment (regardless of the transport mechanism from which it is released) include the chemical and physical differences between light and heavy crude oils, weathering of the oil over time, the type of environment into which oil is released (e.g., water versus soil), and the size of the spill. These factors are addressed in Sections 10.3.1 and 10.3.2. Section 10.3.3 presents a summary of the findings of Stantec et al.'s spill trajectory and fate modeling of large-volume crude oil releases (Stantec et al. 2017), including context for the analysis of potential exposures presented in Section 10.4.

10.3.1 Factors Affecting the Behavior of Crude Oil Releases

The physical and chemical properties of the crude oil are the primary influences in determining how a spill spreads and how long it lasts in the environment. These properties are addressed in Section 10.3.1.1. When crude oil is released into the environment, it is physically and chemically altered over time through various processes collectively called "weathering." These processes and their effects on crude oil in the environment are discussed in Section 10.3.1.2. The influence of spill size on crude oil behavior in the environment is addressed in Section 10.3.1.3.

10.3.1.1 Physicochemical Characteristics of Crude Oil

Crude oil is a complex mixture of thousands of compounds. An "average" crude oil contains approximately 84 percent carbon, 14 percent hydrogen, 1 to 3 percent sulfur, 1 percent nitrogen, 1 percent oxygen, and 0.1 percent minerals and salts (API 2011). Carbon and hydrogen are present in oil as a large group of compounds called hydrocarbons, which include alkanes (also called *paraffins*); cycloalkanes (also called *naphthenes*); aromatics, including benzene, toluene, ethylbenzene, and xylenes (BTEX); polycyclic aromatic hydrocarbons (PAHs); and polar compounds, including resins and *asphaltenes* (API 1999).

The following properties of crude oil differ based on the proportions of the above compounds present and affect its behavior in the environment.

- API gravity,[20] a measure of how dense an oil is compared to water (the lower the API, the denser the oil);
- Viscosity, a measure of how readily a crude oil will flow when released;
- Flash point, the lowest temperature at which a crude oil will vaporize and ignite in air;
- Vapor pressure, a measure of how quickly a crude oil will evaporate; and
- Solubility, a measure of the propensity of a crude oil to dissolve in water.

The proposed Project would transport two types of crude oil: light and heavy crude oil, with an assumed annual proportion of 65 percent heavy crude oil, including diluted bitumen (dilbit; see Section 10.3.1.1.2), and 35 percent light crude oil (Enbridge 2016a). The physicochemical properties of light and heavy crude oils differ, and these properties influence the fate, transport, and potential impacts of crude oil in the environment and toxicity to humans and other biological receptors as described below. Crude oils are further differentiated based on their sulfur content. Crude oils that contain less than 1 percent by weight total sulfur are referred to as "sweet," and those that contain more than 1 percent by weight total sulfur are "sour" (API 2011). Both light and heavy crude oils can be sour or sweet.

10.3.1.1.1 Light Crude Oil

Light crude oils are less dense than medium and heavy crude oils due to having a higher percentage of low-molecular-weight or "light" hydrocarbon fractions (i.e., alkanes, cycloalkanes, and BTEX). They are liquids at room temperature and tend to have a lower viscosity, higher API gravity, higher vapor pressure, higher water solubility, and higher flammability than heavier oils. This means a light crude oil released into the environment would likely float on water surfaces (high API gravity), evaporate more readily (high vapor pressure), and dissolve more relatively easily in water (higher water solubility). Under certain conditions, volatile components of light crude oil can ignite explosively (high flammability).

The light crude oils that the Applicant is proposing to transport via the Project would have densities ranging from an API gravity of approximately 30 to 45 (Enbridge 2016b). The Applicant provided examples of light crude oil that could be transported by the proposed Project and these include Bakken crude oil,

[20] If a crude oil has an API gravity greater than 10, the oil is lighter than water and will float; conversely, a crude oil with an API gravity less than 10 will sink in water.

North Dakota Sweet, High Sweet Clearbrook, Mixed Sweet Blend, Pembina, Gibson Light, Pembina Sweet Blend, Rangeland Sweet, Rainbow Light, Federated, Light Smiley, and Manitoba Sweet Tundra.

10.3.1.1.2 Heavy Crude Oil

In contrast to light crude oil, heavy crude oils and dilbits exhibit higher density, lower vapor pressure, lower solubility, and higher concentrations of nitrogen, oxygen, sulfur, heavy metals, and PAHs. The specific characteristics of heavy oils are attributed to the biodegradation process in which microorganisms on a geological time scale degrade light and medium hydrocarbons, concentrating PAHs, resins, and asphaltenes in the reserves. Heavy oils can also be created via physical rather than biological means. Water washing and phase fractionation physically remove the lighter petroleum fragments (Santos et al. 2014). The result is that heavy crude oils do not flow as easily as light crude oils. In addition, refining heavy oils is more difficult and costly and produces lower proportions of high added value products such as liquefied petroleum gas, gasoline, kerosene, and diesel (Santos et al. 2014).

The most viscous heaviest and thickest of the heavy crude oils is bitumen from oil sands. Bitumen is dense and requires unique handling, which involves the addition of diluting agents (diluent) to facilitate transport. Bitumen is separated from its host rock or sand by heating, which reduces its viscosity and allows it to flow to a collection point. It is too dense and viscous for transportation by pipeline without heating or altering the material. To reduce viscosity and density, a diluent must be added to facilitate its flow. Bitumen is mostly composed of larger heavy hydrocarbons, while diluents are composed of light hydrocarbons such as natural gas condensate and naphtha. The resulting dilbit is a highly viscous oil similar in appearance to other heavy crude oils. Typically, dilbit consists of approximately 30 percent diluent and 70 percent bitumen (Crosby et al. 2013). Natural gas condensate (a byproduct of natural gas production) is currently the primary type of diluent used for Canadian heavy crude oil and is composed of hydrocarbons such as propane, butane, pentane, and hexane (Crosby et al. 2013).

When a conventional heavy crude oil reaches the aquatic environment, very little is typically lost to evaporation because of its low vapor pressure, and it is less prone to many weathering processes than light crude oil. Dilbit, however, contains light components (in the diluent) that typically volatilize when exposed to air. Once the lighter components of dilbit volatilize, the remaining heavy fraction may sink, making cleanup difficult. This is particularly true in turbulent underwater conditions. The spill of dilbit in Marshall, Michigan, involved the release of the Cold Lake Blend and Western Canadian dilbit products into a river experiencing flooding, turbidity, high velocities, and high water volumes. In that case, some of the oil floated, some submerged, and some sank. Typical dilbit has an API gravity slightly higher than 10 degrees, which means it is less dense than water and will float (Environment Canada 2013). Laboratory studies of dilbit behavior under simulated wind and wave activity failed to result in sunken oil (Witt O'Brien's et al. 2013). However, a National Academies of Sciences, Engineering, and Medicine study (2016) found that in some cases when dilbit reaches waterbodies, the weathering processes create residues that can submerge or sink to the bottom of the waterbody. In addition, the study found that the density of the residual oil does not necessarily need to reach or exceed the density of the surrounding water for the residues to sink—the dilbit may combine with particles present in the water column to submerge, and then remain in suspension or sink (National Academies of Sciences, Engineering, and Medicine 2016).

In general, the toxic properties of both bitumen and diluents are similar to those of other crude oil products, including conventional heavy crude; however, little research has been conducted on the toxicity of dilbit to organisms. The components of the diluents are commonly found in other crude oils;

however, bitumen additionally contains several potentially toxic metals, stable and persistent resins, and asphaltenes.

In the event of a land surface release, the dispersion of dilbit through soils would be slower than for other crude oils, including heavy crude oils with similar viscosities; light and medium crude oils would penetrate soils the fastest (Tsaprailis 2014). Immediately upon release, dilbit behaves much like heavy crude oil; however, weathering, temperature, and dispersion alter its properties, causing it to behave more like the original bitumen. As the diluent components volatilize, the heavier components of dilbit remain and the increasing viscosity results in slower spreading and greater adherence to soil particles. Heavy crude oils may lose up to 10 percent of their initial volume following a spill due to evaporation in the first few days (National Research Council 2003). Dilbit has been shown to lose between 11.7 and 15.9 percent of its mass within the first 6 hours of a release (Environment Canada 2013).

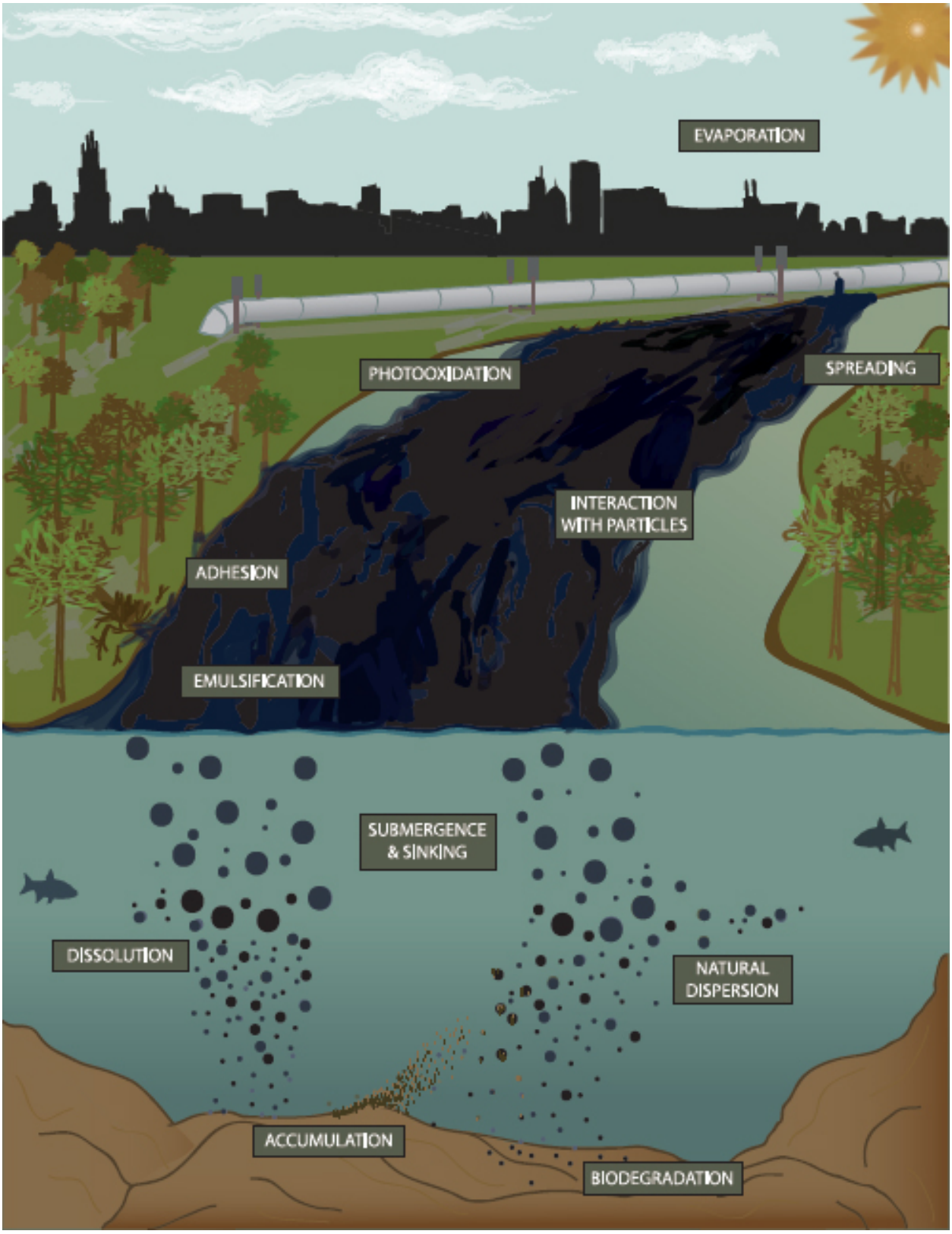
The heavy crude oils that the Applicant is proposing to transport via the Project would have API densities of approximately 21 to 25 (Enbridge 2016b). The Applicant provided examples of heavy crude oil that could be transported by the proposed Project; these include Premium Conventional Heavy, Conventional Heavy, Cold Lake Blend (dilbit blend), and Cold Lake Winter Blend (dilbit blend).

10.3.1.2 Weathering Processes

Immediately following the release of crude oil into the environment, the weathering process begins. This is a process in which the physical and chemical characteristics of the oil interact with the physical and biochemical features of the environment it has reached. This interaction determines how the oil will behave and its fate in the environment, with the rate and degree of weathering dependent on the crude oil type and environmental conditions at the spill location. The following weathering processes, which are illustrated in Figure 10.3-1, influence how crude oil behaves:

- **Spreading and thinning** of spilled oil reduces the amount of oil in one location but increases the surface area over which oil is present. This increased surface area enhances surface-dependent fate processes such as evaporation, biodegradation, photodegradation, and dissolution. Spreading from the spill source is constrained by natural conditions in the release site vicinity. For instance, oil reaching rivers and creeks would likely spread farther than in wetlands, ponds, and lakes. Lighter oils would also likely spread more quickly than heavier oils due to their lower viscosities.
- **Dispersion** is the entrainment of oil droplets in the water column (i.e., the spreading of oil vertically in water). It is enhanced by the turbulence or mixing energy of a waterbody, which is increased by rain events, wind, and tidal currents. Oil can also be dispersed through adhesion to particulate matter (e.g., organic matter, silt, and clay) suspended in the water column. Light oil tends to produce smaller oil droplets due to its lower viscosity compared to heavy oil and is more prone to dispersion.
- **Evaporation** occurs when the lighter components of crude oil volatilize. Evaporation begins as soon as oil reaches the environment, and approximately 80 percent of evaporation occurs in the first 48 hours following a release. It results in a heavier, denser, and more viscous oil remaining in the environment as compared to the released oil. Evaporation is greater and more rapid for light crude oils because they contain a greater percentage of light constituents than heavy oils, which do not evaporate as readily.

- **Dissolution** occurs as water-soluble components dissolve into the water column from a surface slick. It is estimated that only 2 to 5 percent of spilled oil in water undergoes natural dissolution following a release because the compounds that most readily dissolve (e.g., BTEX) also most readily evaporate (Neff 1990). However, these compounds are also the most toxic to aquatic life. Dissolution increases with decreasing hydrocarbon molecular weight, increasing water temperature, decreasing salinity, and increasing concentration of dissolved organic matter. Because light crude oils contain a higher proportion of BTEX compounds than heavy oils, they are more prone to dissolution.
- **Emulsification** creates mixtures of small droplets of oil and water known as emulsions. Two types of emulsions, water-in-oil (also referred to as a mousse) and oil-in-water, are formed by wave action. Emulsions are not prone to other types of weathering, leading to increased crude oil persistence in the environment. Emulsification occurs less frequently in fresh water than in saltwater, and it occurs more frequently in large waterbodies with more wave action and currents than in smaller waterbodies. Heavy crude oils that contain higher concentrations of heavy asphaltenes and resins emulsify more readily than light crude oils (API 1999).
- **Photodegradation** occurs when ultraviolet light from the sun breaks down the chemical bonds of the oil constituents. This process, which is a pronounced component of weathering on sunny days and in summer months, can be a significant factor in the degradation of lighter hydrocarbons and, therefore, lighter crude oils. Photodegraded compounds tend to be more water soluble and more prone to further degradation processes. Photodegradation has also been shown to increase the toxicity of certain PAHs (National Oceanic and Atmospheric Administration [NOAA] 2017a).
- **Adsorption** is the binding of oil to particles in soil, sediment, and water. In water, PAHs and other higher-molecular-weight hydrocarbons may bind to suspended particulates, and this process can be substantial in highly turbid or eutrophic waters (i.e., waters rich in phosphates, nitrates, and organic nutrients). Organic particles in soils or suspended in water tend to be more effective at adsorbing oils than inorganic particles (e.g., clays). Adsorption and sedimentation decrease the concentration of hydrocarbons present in the water column but also make them less susceptible to further degradation, increasing persistence in the environment.
- **Biodegradation** is the breakdown of oil compounds by naturally occurring microorganisms. This is not a substantial process in controlling the fate of crude oil released into waterbodies previously unexposed to oil. Saturated alkanes, which are more prevalent in light crude oils than in heavy crude oils, are the most readily biodegraded components of crude oil. Thus, while this process is very slow for all crude oils, heavy oils are less susceptible to biodegradation than light oils.



Source: National Academies of Sciences, Engineering, and Medicine 2016

Figure 10.3-1. Diagram of Crude Oil Weathering Processes

10.3.1.3 Influence of Spill Size on Crude Oil Behavior

Different spill sizes influence the transport, fate, and potential environmental consequences of a release. This section describes behavior of releases from small to catastrophic spills using the categories of spills defined in Section 10.1.3.

10.3.1.3.1 Small Spills

Small spills are defined as spill volumes greater than or equal to 0.1 barrel (5 gallons) and less than or equal to 50 barrels (2,100 gallons). These are the most common and most likely release volumes for the Project and its alternatives. Small spills tend to affect limited areas and dilute quickly in the environment as they spread and disperse. Despite the limited range of effects, small releases can persist in the environment for long periods of time and can cause localized contamination requiring cleanup and remediation.

10.3.1.3.2 Medium Spills

Medium spills range from greater than 50 barrels (2,100 gallons) to less than or equal to 1,000 barrels (42,000 gallons) and are less common than small-volume releases (DOS 2017). Medium spills on land or water would likely spread and disperse over a greater area than small spills. A medium spill on land could result in oil adsorbing or otherwise adhering to soil particles and being transported over extended distances by processes such as wind or water erosion. A medium spill in water could cause oil to spread over a greater area of shoreline and water surface and a higher concentration of oil to be dispersed within the water column as compared to a small spill.

Tanker trucks can carry approximately 190 barrels of oil (7,980 gallons); therefore, the majority of spills from tanker trucks would likely fall within this spill category, as it is unlikely that multiple tanker trucks would crash at the same time in the same place. Medium spills could also result from rail car accidents involving the compromise of a single tank car, which has a capacity of up to 800 barrels (33,600 gallons). Pipeline damage resulting from outside forces such as excavators and major earth movement or corrosion of the pipe could result in spills within this size class.

10.3.1.3.3 Large Spills

Large releases could result from rail car accidents involving more than one tank car. The failure of 12 tank cars in a unit train could release up to 9,600 barrels (403,200 gallons) of crude oil. Pipe damage resulting from outside forces such as excavators and major earth movement, or corrosion of the pipe, could also result in a large spill.

Large spills can result in significant volumes of crude oil on the ground surface, which could migrate over the land surface and affect vegetation, soil invertebrates, and other receptors of concern (DOS 2014). Rapid response and cleanup of these incidents would reduce the exposure and impacts on resources. Large spills along a subsurface pipeline can result in movement of oil through soils, contact with the water table, and impacts on groundwater resources adjacent to and beyond the vicinity of the release location and pipeline trench (DOS 2014). Vertical upward migration can result in substantial accumulation of crude oil on surface soil, migration along the ground surface, and potential impacts on vegetation and other receptors. Oil may pool in low-lying areas and infiltrate into the soil and contact groundwater (DOS 2014). Large spills from a rail accident would begin at the soil surface but could spread downward into the soil, depending on the properties of the oil. Even with such soil infiltration, with this volume of oil, the spill could spread overland to contaminate water sources.

10.3.1.3.4 Catastrophic Spills

Catastrophic spills are greater than 10,000 barrels (420,000 gallons). The release of this volume of crude oil could result from major pipeline ruptures or a rail incident that breaches more than 12 cars. For pipelines, very large releases are assumed to result with the release of the total volume of crude oil from the pipeline segment between the two nearest shutoff valves. Catastrophic spills from pipelines could occur as the result of a complete break in the pipeline from major earthquakes, flooding, bank erosion at horizontal directional drilling crossings, mechanical damage during third-party ground-disturbing activities, or vandalism, sabotage, or terrorist acts. Major pipeline ruptures can be defined as low-probability, high-consequence events in the context of risk assessment.

Catastrophic spills from rail transport could occur as the result of major environmental events (e.g., earthquake, flooding), rail breakage, bridge collapse, track operational malfunctions due to human error, collisions with other trains or vehicles at crossings, or mechanical damage from vandalism or sabotage of the tracks by the public or terrorists.

As with other spill sizes, the extent of oil exposure and resulting potential effects in the environment can vary based on a multitude of factors (e.g., type of crude oil, crude oil behavior, environmental conditions, and presence of resources and receptors; discussed in detail in the sections below), including spill prevention, preparedness, and response (Section 10.5). In the event of a crude oil spill, rapid and well-coordinated response actions can effectively contain and control the release, thereby reducing potential environmental impacts. The potential effects of a catastrophic spill would be similar in nature, but greater in scale (i.e., extent of exposure and adverse effects on environmental and human receptors) than large spills. A catastrophic spill would tend to migrate farther from the incident location, potentially affecting greater areas of land, water, and subsurface soil and groundwater. Oil could infiltrate deeper into soil with greater impacts on groundwater, including drinking water sources (DOS 2014).

Catastrophic spills of oil released directly into waterbodies, such as at surface water pipeline crossings or at railroad bridge crossings of rivers, would result in the majority of the oil being transported beyond the release location, especially under high-flow conditions, with substantial transport potential (DOS 2014).

10.3.1.4 Pinhole Releases

Small spills could result from pinhole releases of crude oil from subsurface pipeline segments. Subsurface pinhole releases would typically disperse to soil and more permeable trench materials immediately surrounding the pipeline (DOS 2014; Stantec et al. 2017). The released oil would generally remain in the vicinity and migrate upward, eventually reaching the surface where visual detection and response would occur (Stantec et al. 2017).

Pinhole releases can remain undetected for long periods of time, ultimately releasing volumes that would be classified as up to medium or large spills if the released oil does not reach the surface for long periods of time. Unnoticed pinhole leaks can lead to the infiltration of crude oil through unsaturated, permeable soils and result in contact with the water table and surficial groundwater aquifers (DOS 2014; Stantec et al. 2017; Exponent 2013). Surficial aquifers where overlying geologic materials are more permeable are generally most susceptible to contamination from a pinhole release of crude oil (Stantec and Barr Engineering 2017).

10.3.2 Crude Oil Behavior in the Environment

The general behavior of crude oil that is released into the terrestrial, aquatic, and human environment is described below. Section 10.4 discusses these aspects of oil behavior and the potential effects of a spill on specific resources.

10.3.2.1 Terrestrial Environment

When crude oil spills onto land or into soils beneath the ground surface, its movement will depend on the soil type, oil viscosity, and the depth to the water table (National Academies of Sciences, Engineering, and Medicine 2016). Dilbit and other heavier crude oils would disperse more slowly than lighter crude oils in terrestrial environments due to their higher viscosity. Because dilbit contains a higher concentration of higher-molecular-weight hydrocarbons compared to light oils, it is not as prone to evaporation and is, therefore, more persistent in terrestrial environments.

Spilled oil will typically spread over land until it reaches a depression, a surface waterbody, or is absorbed into the ground. In addition to topography, migration of the oil can be affected by vegetation cover and seasonal conditions.

Oil released on land is typically more easily contained than oil released into water. The rapid installation of containment features (e.g., dikes, impoundments, and physical barriers) around the spill area deters spreading and enhances clean-up activities.

10.3.2.2 Aquatic Environment

Oil spilled into surface waterbodies generally floats initially and is transported by winds and currents, depending on the waterbody type and conditions during the spill. Spills tend to spread shorter distances in standing water such as lakes and ponds with minimal currents; however, wind can increase oil dispersal in those surface waters. Currents in streams and rivers transport oil downstream, and thus impacts are likely to occur over greater areas than in lakes or ponds. However, crude oil concentrations in the water decrease as the oil thins out during spreading or adheres to shorelines and other surfaces. Both dilbit and light crude oil would be expected to initially float. Evidence from previous dilbit spills (in Marshall, Michigan, in 2010 and Burnaby, British Columbia, Canada, in 2007) has shown that dilbit floats on water until its density is altered by weathering or the entrainment of sediment, which can cause the oil to submerge and sink (Witt O'Brien's et al. 2013).

As the time after a release increases, multiple processes act to entrain oil and its constituents into the water column, which in turn affects water quality and aquatic biota. Although most of the compounds in oil are insoluble, BTEX and some of the lighter PAHs are volatile and soluble in water and can contaminate the water column. Turbulence, which is common in rivers and streams, is a key process that enhances dissolution of oil constituents, particularly BTEX. In lakes and larger rivers, wind-driven waves can also create turbulence that drives crude oil downward and facilitates dissolution of BTEX in the water column (Witt O'Brien's et al. 2013). Therefore, in larger, fast-moving rivers and creeks, oil would be quickly dispersed downstream and diluted with the flow of the river, while in smaller flowing streams and backwater eddies an oil spill could have a greater effect on the water column and surrounding habitat due to the lower relative volume and rate of water flow.

As crude oil mixes with water it forms emulsions that are thicker and stickier than the original oil. Over time, winds, waves, and currents continue to spread and disperse the emulsified oil patches into smaller pieces, or "tarballs," which are very persistent in aquatic environments and can travel hundreds of miles (NOAA 2017b). Dilbit has a similar density to water and, therefore, has greater potential for formation of tarballs and also has a greater tendency to submerge in comparison to lighter crude oils (National Academies of Sciences, Engineering, and Medicine 2016). In general, lighter crude oils are more susceptible to dissolve in water, whereas heavier crude oils have a greater tendency to form tarballs.

Wetlands, including marshes, swamps, peat bogs, and fens, are particularly sensitive to oil spills. In wetlands, small areas of shallow water, finer sediments with high organic content, greater vegetation cover, and high biochemical oxygen demand (leading to anaerobic conditions) would affect the dispersion and weathering of spilled crude oil. Oil spilled into wetlands could be widely dispersed by wind or water movement, and would typically become stranded on fine sediments or vegetation. In this case oil would not likely travel as far as it would in open water. Transport out of the wetland may occur via small stream discharge points. If the spilled oil becomes entrained within anaerobic sediments, the rate of biodegradation may be significantly reduced (Boufadel et al. 2015).

Oil released into aquatic environments is more difficult to recover in large quantities because water surface and weather conditions must be sufficiently calm to permit recovery equipment to function well and for response personnel to safely operate the equipment (International Tanker Owners Pollution Federation Limited 2016).

10.3.2.3 Human Environment

Crude oil can reach public and private lands used for commercial, agricultural, industrial, residential, and recreational purposes. Water intakes in shallow lakes and rivers can be susceptible to contamination from an oil spill, and paved surfaces and conduits such as ditches/sewers can act as preferential pathways for spills, extending the spread of oil. If a crude oil spill occurs in a developed area, oil can migrate into stormwater and sewer collection systems, particularly during rain events, and result in contamination of the infrastructure and associated treatment systems.

Spills in agricultural and other developed areas tend to pool in areas with flatter topography but can spread through ditches, small streams, and groundwater if the water table is reached. If a spill reaches groundwater, constituents in the crude oil may dissolve and migrate farther underground, forming a contaminated plume that follows the general direction of groundwater flow. The contaminated groundwater can intersect with groundwater wells or reach surface water, making water supplies potentially unsafe, depending on the degree of contamination. In karst regions, groundwater may flow more rapidly than in other areas, increasing the risk of contamination.

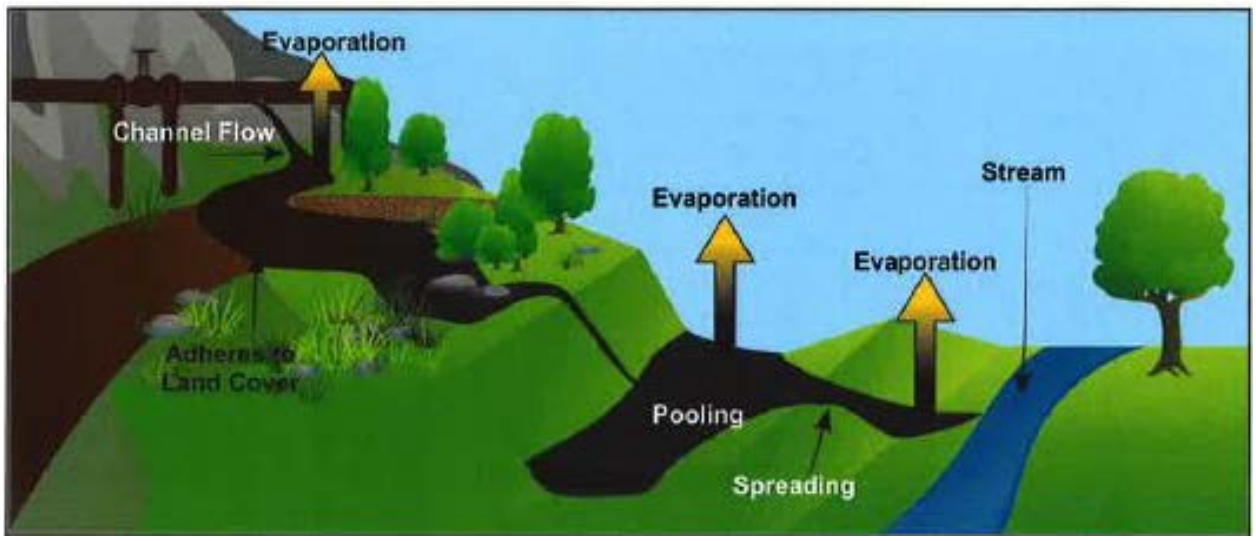
Without remediation, groundwater contamination can persist for lengthy periods of time. For example, a crude oil spill from a pipeline rupture in 1979 contaminated a shallow aquifer near Bemidji, Minnesota. Despite initial cleanup, the spill continues to be a source of contaminants to a shallow outwash aquifer. This release has been used as a research project to study the fate and transport of crude oil in groundwater. These studies to track the oil have shown that the groundwater contaminant plume has migrated a total distance of approximately 600 feet from the release point in 38 years. This is primarily because the plume is moving as dissolved petroleum constituents in groundwater and as vapors in an unsaturated zone, and that native microbes are converting the oil derivatives into carbon dioxide, methane, and other biodegradation products (U.S. Geological Survey 2017). This has resulted in a steady state system where the plume is no longer expanding appreciably.

10.3.3 Crude Oil Trajectory and Fate Modeling

Enbridge commissioned a modeling analysis for seven hypothetical crude oil releases from pipeline locations along the Applicant's preferred route and route alternatives (Stantec et al. 2017). This study is relevant to the failure probability analysis, as discussed in Section 10.2, and the exposure assessment in Section 10.4.

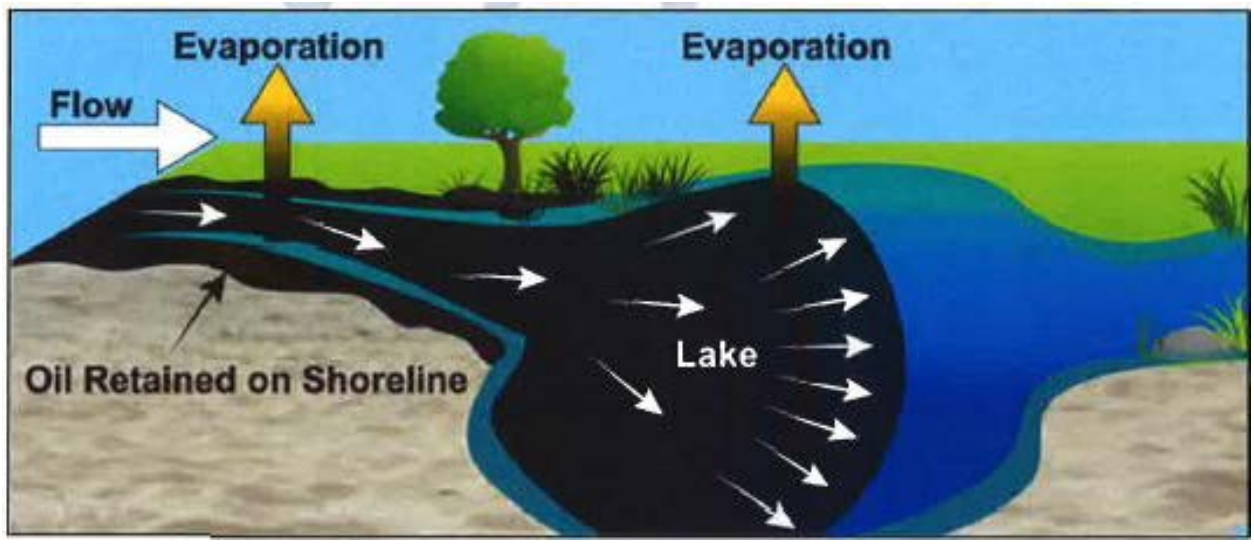
10.3.3.1 Description of the Models Used

Stantec et al. used two different models to evaluate the trajectory and fate of crude oil releases at seven study sites: OILMAP Land is a two-dimensional predictive modeling tool for predicting the trajectory and fate of released crude oil in the horizontal downslope and downstream direction (Figures 10.3-2 and 10.3-3). SIMAP is a considerably more complex model that incorporates a third dimension, vertical movement in the water column, which provides the ability to model the transport of crude oil in the water column and potential settling in river sediments (Figure 10.3-4) (Stantec et al. 2017). OILMAP Land was selected for modeling releases at less turbulent aquatic systems (Sites 1 through 5), and SIMAP was employed for higher flow, more turbulent large rivers (Sites 6 and 7) where entrainment of crude oil droplets would be more likely to occur with vertical mixing and movement within the water column and potential deposition in bottom sediments.



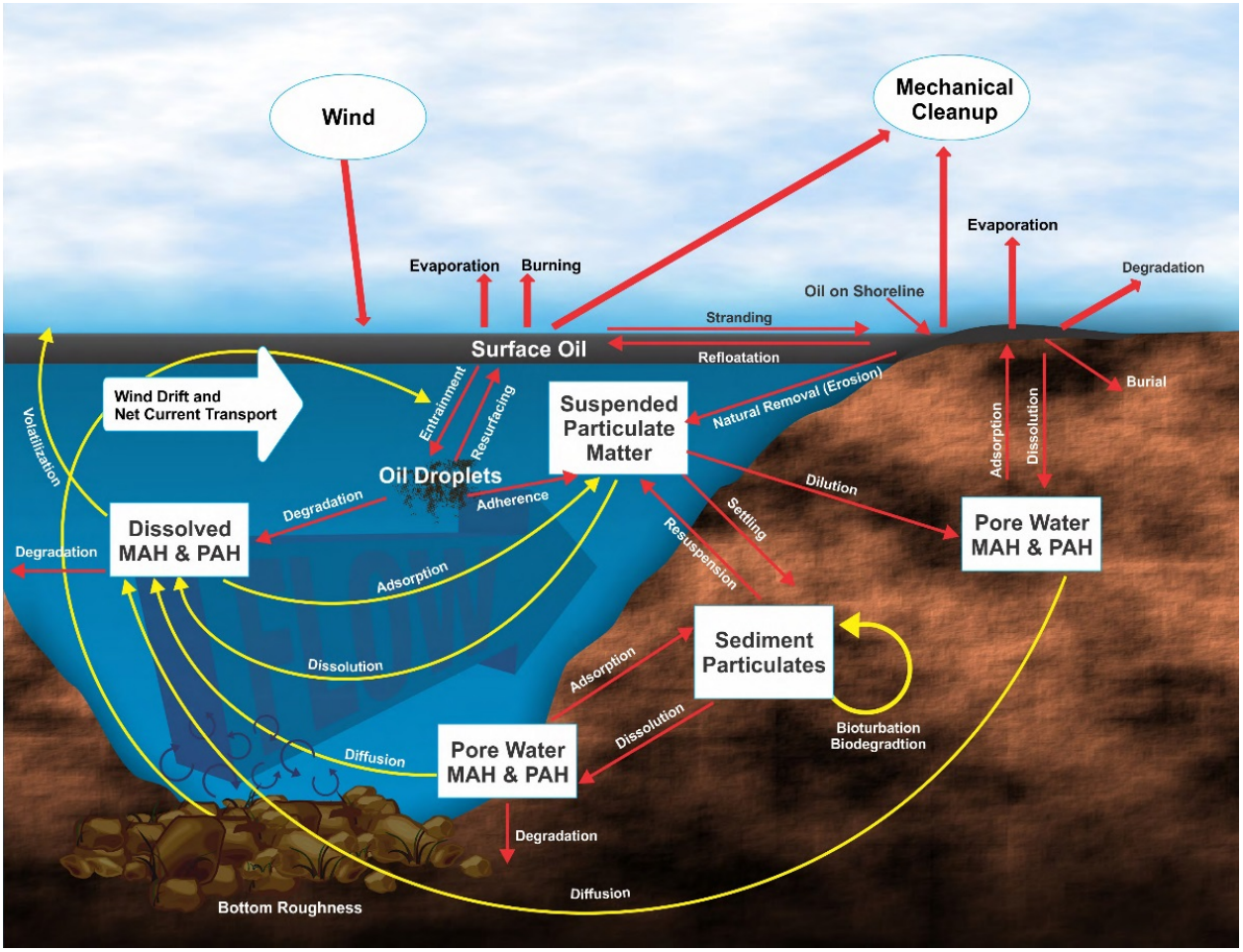
Source: Stantec et al. 2017.

Figure 10.3-2. Conceptual Diagram of Land Transport Model in OILMAP Land



Source: Stantec et al. 2017.

Figure 10.3-3. Conceptual Diagram of Downstream Transport Model in OILMAP Land



Source: Stantec et al. 2017.
MAH = monocyclic aromatic hydrocarbon, PAH = polycyclic aromatic hydrocarbon

Figure 10.3-4. Crude Oil Behavior in Aquatic Systems Simulated by SIMAP

Several release scenarios were modeled for each of the seven sites. Unmitigated releases, characterized by no emergency response for the first 24 hours, were simulated to provide a conservative, "worst-case" scenario at the hypothetical release locations[21] (Stantec et al. 2017). Two different crude oil types, a light Bakken crude oil and heavier Cold Lake Blend, were evaluated under three flow conditions (spring high flow, summer and fall average/moderate flow, and winter low flow) at the seven sites at different time intervals (6, 12, 18, and 24 hours). The spill volumes were estimated based on a 15 minute shutdown response and backflow of oil in the line based on distance between shut off valves and topography.

10.3.3.2 Summary of Results

This section summarizes some of the primary behaviors predicted by the modeling for the two crude oil types. As expected, higher river flows (during spring) resulted in greater downstream extents for both crude oil types (Table 10.3-1). Thick surface oil slicks and evaporative losses of crude oil constituents occurred in low-energy systems. Substantial shoreline oiling was also observed under these conditions, especially for the more viscous Cold Lake Blend. Dissolved hydrocarbon concentrations tended to be greater in more turbulent, high-energy systems due to dispersion.[22] Sediment oiling was also more extensive at these locations due to vertical mixing and interaction with suspended particles, which resulted in deposition on the river bottom. During low-flow conditions (winter), downstream extents were primarily dependent on river flow and oil density.[23]

Table 10.3-1. Predicted Downstream Transport Distances of Two Crude Oil Types

Study Site	Predicted Volume Out (barrels)[a]	Approximate River Width (feet)	Maximum Distance Traveled (miles)[b]	
			Bakken Crude	Cold Lake Blend
Site 1 – Mosquito Creek to Lower Rice Lake		3–35	10.4	3.5
Site 2 – Mississippi River at Ball Club		80	23.0	8.1
Site 3 – Sandy River		30	12.0	8.7
Site 4 – Shell River to Twin Lakes		95–184	21.9	3.7
Site 5 – Red River		150-400	40.3	10.5
Site 6 – Mississippi River at Palisades		250	17.5	17.5
Site 7 – Mississippi River at Little Falls		820	31.0	30.0

Source: Stantec et al. 2017.

a Enbridge has designated these predicted volume data as NONPUBLIC data.

b Predicted maximum distance traveled under high-flow conditions (during spring) following a 24-hour unmitigated release scenario. Potential further migration after 24 hours was not modeled.

21 Another conservative assumption is that crude oil would travel unimpeded during the entire 24-hour modeled run for each release scenario.

22 As described in Section 10.3, dispersion is the entrainment of oil droplets in the water column (i.e., the spreading of oil vertically in water). It is enhanced by the turbulence or mixing energy of a waterbody, which is increased by rain events, wind, and tidal currents. Oil can also be dispersed through adhesion to particulate matter (e.g., organic matter, silt, and clay) suspended in the water column. Light oil tends to produce smaller oil droplets due to its lower viscosity compared to heavy oil and is more prone to dispersion.

23 During low-flow conditions characteristic of winter, lighter Bakken crude more readily rose vertically through the water column and became trapped beneath the ice, effectively removing a portion of the oil mass from further downstream transport. In addition, shoreline oiling was limited during low-flow conditions compared to the other flow conditions when the river surface was free of ice.

These modeling results provide useful context when evaluating the potential effects of crude oil releases on the environment, and were considered during the exposure assessment in Section 10.4. For example, the predicted downstream extents of oil transport from the Stantec et al. modeling, along with the results of other relevant spill studies, were considered during the development of downstream region of interest (ROI) criteria (see Section 10.4.1).

10.4 ASSESSMENT OF POTENTIAL CRUDE OIL EXPOSURES AND IMPACTS

This section identifies the resources in the vicinity of the Applicant's preferred route and alternatives (CN Alternatives—Section 10.4.2; route alternatives—Section 10.4.3) that may be exposed to crude oil in the case of a release. The alternatives cross a wide range of habitats and conditions, including a variety of land uses, human uses, and ecosystems. Therefore, each alternative differs in terms of its potential exposure to crude oil and the resultant impacts on resources if a crude oil release were to occur. Resources within specific distances of each alternative were identified to evaluate the potential for impacts due to a spill. For this analysis, ROIs for potential releases were identified (as described in Section 10.4.1) to reflect the potential extent of a large-volume incident that could occur at any point along each route. Alternatives with a higher number of resources within the ROIs would have a greater probability of exposure and potential adverse effects following a release compared to alternatives with fewer resources within the ROIs.

10.4.1 Resources and Regions of Interest for the Comparison of Alternatives

The following three HCAs, as defined by the PHMSA criteria for hazardous liquid pipelines (PHMSA 2011), were considered in the exposure analysis (and provided directly by Enbridge):

- **Populated Areas** include both high-population areas (referred to as "urbanized areas" by the U.S. Census Bureau) and other populated areas (referred to as "designated places" by the U.S. Census Bureau).
- **Unusually Sensitive Ecological Areas** include locations of critically imperiled and imperiled species and ecological communities, federally listed threatened and endangered species, and concentrations of migratory waterbirds. Individual species and habitats are not identified for this analysis; rather it provides a general overview of potential impacts on all unusually sensitive ecological areas should a spill occur.
- **Drinking Water Sources** include those supplied by surface water or wells and where a secondary source of water supply is not available. The land area in which spilled hazardous liquid could affect the water supply is also treated as an HCA. This HCA was derived from state Wellhead Protection Area or Source Water Area.

Areas of interest (AOIs) have been identified by Minnesota Department of Natural Resources (Minnesota DNR) and Minnesota Department of Health (Minnesota DH) as sensitive areas where a crude

oil release may have long-term and/or permanent impacts on resources. The following AOI categories and subcategories were considered:

- Drinking Water AOIs
  - Drinking Water Supply Management Areas (DWSMAs) and vulnerability,
  - Wellhead protection areas (WPAs),
  - Hydrogeologic sensitivity,
  - Domestic wells and sensitivity, and
  - Public wells.
- Cultural Resources AOIs
  - Archaeological sites,
  - Historical sites, and
  - Tribal land.
- Biological AOIs
  - Aquatic Management Areas,
  - Lakes of Biological Significance,
  - Minnesota Biological Survey Sites of Biodiversity Significance (MBS Sites),
  - Native plant communities,
  - Native prairies,
  - Wetland bank easements,
  - Wild rice lakes,
  - Muskie lakes,
  - Sensitive lakeshore areas,
  - Trout streams/lakes,
  - Minnesota Board of Water and Soil Resources (Minnesota BWSR) conservation easements,
  - Calcareous fens, and
  - Scientific and Natural Areas.
- Commodity Production AOIs
  - Marginal cropland – limited,
  - Marginal cropland – perpetual,
  - National forests,

  - Other forest land, and
  - State forests.

- Recreation and Tourism AOIs
  - State plan/recreational areas,
  - State parks,
  - Wildlife Management Areas (WMAs), and
  - Waterfowl production areas.

As part of consultation with Minnesota Department of Health (and with support from Minnesota DNR and Minnesota Pollution Control Agency [Minnesota PCA]), appropriate distances for the protection of drinking water supplies, in support of a screening-level GIS approach, were determined based on a consensus of existing information and case studies.

The ROI for comparisons among alternatives encompasses a 2,500-foot-wide distance extending in each direction from the centerline of the alternative (pipeline routes and transportation mode corridor); thus, the total area assessed is a 5,000-foot-wide corridor centered on the pipeline route, rail bed, or roadway. The ROI was identified as the distance that released oil could spread on flat ground (calculated to be 1,214 feet from the centerline) plus an additional distance of 1,050 feet for estimated downgradient migration in groundwater (if groundwater were contacted); the estimated total distance of approximately 2,264 feet was rounded up to 2,500 feet.

This ROI was determined to be an appropriate distance, based on a review of existing information and relevant case studies to be applied comprehensively across the HCA and AOI resources listed above, with the exception of certain drinking water resources, which are discussed in more detail in Section 10.4.2.1.1. The numbers and/or acres of HCAs and AOIs within the ROI for each alternative were determined by overlaying GIS layers for each HCA and AOI with the ROI.

In addition to assessing exposure of resources within 2,500 feet on either side of the alternative centerlines for upland areas, a downstream exposure analysis was conducted to identify and enumerate resources that could be at risk of exposure to crude oil if a release occurred at a waterbody crossing. Based on the Stantec et al. trajectory and fate modeling analysis (2017) and available survey data, a 10-mile-long downstream ROI was applied to all waterbody crossings for this downstream exposure analysis of the Project and its alternatives (Figure 10.4-1).

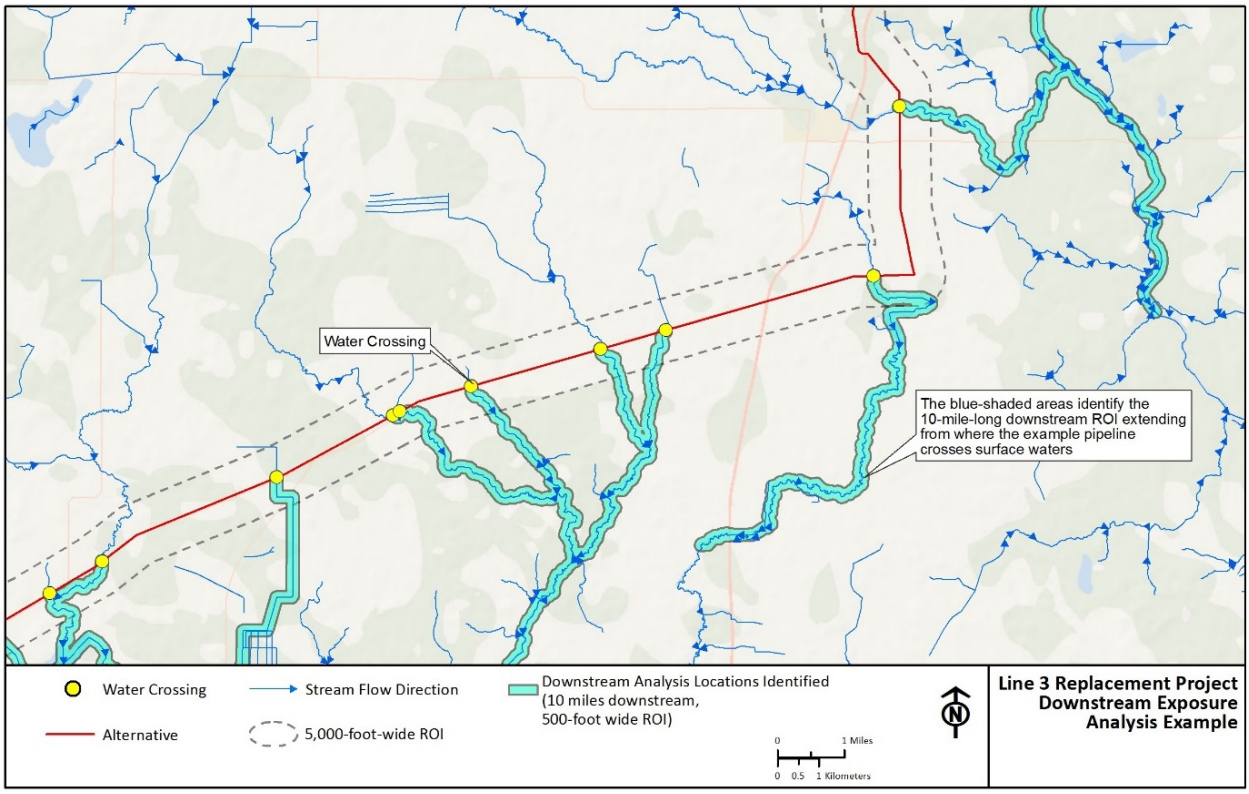


Figure 10.4-1. Example of 10-Mile-Long Downstream Region of Interest for a Pipeline Route Segment

The 10-mile-long downstream ROI was calculated in GIS starting at the point where each waterbody intersects with each alternative. Flow direction was determined using the National Hydrography Dataset flowline direction. River segments were combined and traced downstream for 10 miles. In addition, the 10-mile-long downstream ROI was extended to a width of 500 feet from the centerline of the flow to create a 1,000-foot-wide corridor of potential exposure from a spill up to 10 miles downstream of each waterbody crossing. This ROI was overlaid with HCA- and AOI-specific data layers to determine potential resources that could be exposed should a release occur.

Given the scale of the alternatives, maps of HCAs and AOIs do not include the analysis ROIs. A single map for each HCA or the AOIs is included in the 2,500-foot-wide ROI discussion and referenced in the 10-mile-long, 1,000-foot-wide downstream ROI discussion.

10.4.2 Exposure Analysis for Comparison of Certificate of Need Alternatives

Areas potentially exposed to oil spills along the CN Alternatives were identified based on the GIS methodology described above. It should be noted that the majority of system alternative SA-04 occurs outside of Minnesota, and because many of the AOIs are Minnesota-specific metrics, there are limited data available in other states, which has likely resulted in an underestimate of acreages of AOIs affected by that route.

10.4.2.1 Region of Interest Analysis

10.4.2.1.1 HCA Comparisons among Applicant's Preferred Route and Certificate of Need Alternatives

Populated Areas

Oil spills in populated areas have the potential to affect public health, public resources and infrastructure, socioeconomics, and transportation. The acreages of HCA populated areas that could be exposed to crude oil after a release along the CN Alternative routes are listed in Table 10.4-1. The CN Alternative with the greatest acreage of HCA populated area within 2,500 feet on either side of its centerline is existing Line 3 supplemented by truck, followed by existing Line 3 supplemented by rail, transportation by truck, transportation by rail, continued use of existing Line 3, and SA-04. The Applicant's preferred route has the lowest acreage of affected HCA populated area within the ROI. Potential impacts from a release of crude oil in HCA populated areas are discussed below.

Table 10.4-1. HCA Populated Areas within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
6,545.2	22,318.7	13,075.3	34,724.2	35,639.4	57,042.9	57,958.1

Source: Enbridge 2016c.

HCA = high consequence area

Public Health

Public health can be affected by oil contamination of air, water, soil, and food resources. Effects from oil exposure can be acute or chronic. Exposure may occur immediately following, or in response to, a spill through dermal contact, ingestion, or inhalation.

For most people, brief dermal contact with a small amount of oil would do no harm; however, some people are more sensitive to chemicals, including those found in crude oil (Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry 2010). Dermal contact with sticky bitumen would increase exposure, although toxicity implications are not clear given limited data (National Academies of Sciences, Engineering, and Medicine 2016). People exposed directly to oil could experience dermatitis; however, the potential for a large proportion of the population to have direct exposure to oil would be small due to restricted access to contaminated areas. Ingestion has the potential to occur through various pathways, including contaminated drinking water sources and fish tissues. In historical studies reviewed by Stantec et al. (2017), groundwater-supply wells were rarely affected, but surface water supply intakes downstream of pipeline ruptures were affected. In some cases, impacts were minimal; in others, water treatment was required. Impacts on water supplies in these case studies was short term. Long-term impacts on water supply could occur under certain

circumstances, though protective measures (i.e., using a different water supply) would reduce direct impact on human health. While the general public could be exposed to oil through contamination of aquatic food sources, fisheries are usually closed and monitored for a period after a spill to ensure food safety, reducing this mode of exposure.

People in the immediate area of a spill would experience inhalation exposure and impacts as the oil evaporates. Inhalation of petroleum-related vapors tends to include lighter weight, volatile compounds that evaporate after spills. People such as first responders and residents near an incident site could be exposed to harmful volatile compounds and would likely experience temporary health impacts such as respiratory irritation, headache, or eye irritation. Vulnerable populations, such as children, those with respiratory diseases, and the elderly, could be particularly sensitive to airborne pollutant releases following a spill and would likely experience moderate respiratory impacts depending on their proximity to the incident, current health status, and seasonal/weather conditions. Overall, air quality effects are predicted to be similar for light and heavy crude oil, as both would be similarly transported downstream during spring and summer conditions. During winter, volatilization, downstream transport, and potential human exposures to crude oil would be more limited due to lower air and water temperatures, the presence of ice on the water surface, and absorption of crude oil into the snow pack.

Longer-term health effects of oil spills are not well documented, but various components of crude oil are known or suspected carcinogens, and spills have been shown to have limited correlation to cancer (International Agency for Research on Cancer 1989).

Public Resources and Infrastructure

Oil releases have the potential to affect public resources and infrastructure that occur within the ROI as well as emergency response resources. The increased demand on emergency response resources following a large release could divert emergency response personnel from other duties, increasing delays in responding to other service calls.

Socioeconomics and Transportation

Spills can affect local economies through impacts on transportation infrastructure, business operations, property values, or natural resources. Minority and lower income populations could be affected if they are close to the site of a release and not able to easily evacuate.

Increased congestion of roadways could occur as a result of roadway closure and emergency response near the release site. Such disruption could prevent the public from reaching their workplaces. Train lines and highway shipping routes may also be disrupted, resulting in economic impacts over a broader region.

A crude oil spill could require a large response effort including the mobilization of nonlocal response workers who would temporarily relocate to the spill area. A prolonged response effort could affect population and housing. Impacts could include the provision of housing for a number of nonlocal response personnel, leading to an increase in the local population for the duration of the response effort. Potentially negative impacts could include increased traffic and demand for services.

Property value impacts could occur following a spill. The duration of property value effects resulting from contamination has been generally found to be temporary (Jackson 2001). Property values for residents within 1,000 feet of a ruptured petroleum product pipeline have decreased by 0.2 to 4.6 percent within the first 6 months following an event, and the mean sale prices within 100 feet of a

ruptured pipeline have remained between 2 and 3 percent lower approximately 5 years following the event (Hansen et al. 2006).

Unusually Sensitive Ecological Areas

HCA unusually sensitive ecological area acres that are within 2,500 feet of the alternative centerlines and would potentially be exposed to a spill are listed in Table 10.4-2 and depicted on Figure 10.4-2. Among the CN Alternatives, existing Line 3 supplemented by truck has the most acres of HCA unusually sensitive ecological areas within 2,500 feet of either side of its centerline, followed by existing Line 3 supplemented by rail, transportation by truck, continued use of existing Line 3, transportation by rail, and SA-04. The Applicant's preferred route has the least acres of HCA unusually sensitive ecological areas within 2,500 feet of either side of its centerline. General impacts on HCA unusually sensitive ecological areas that have the potential to be affected by an oil spill are discussed below.

Table 10.4-2. HCA Unusually Sensitive Ecological Areas within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
6,903.4	19,045.5	10,530.3	17,960.0	26,016.8	37,005.4	45,062.3

Source: Enbridge 2016c.

HCA = high consequence area

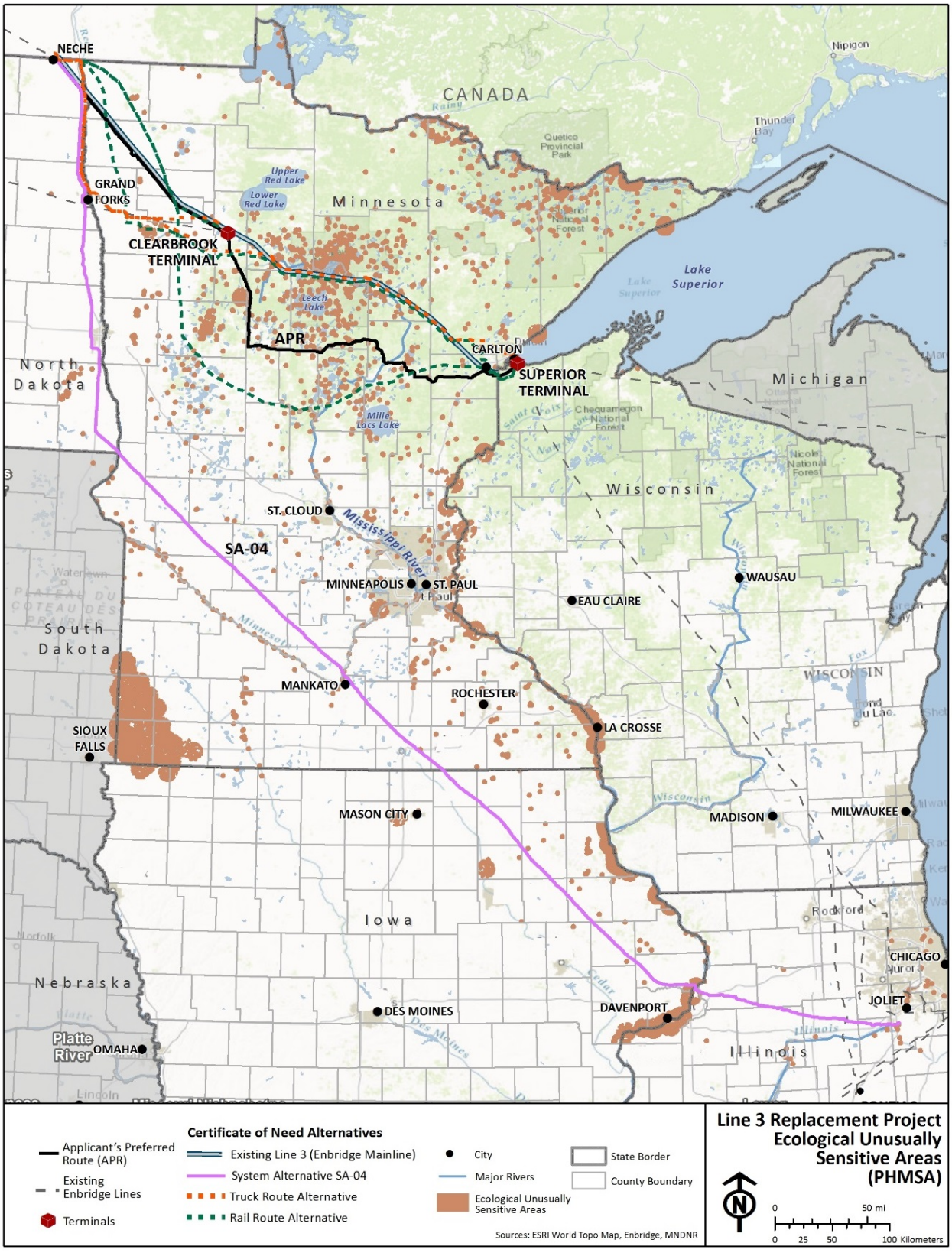


Figure 10.4-2. High Consequence Area Unusually Sensitive Ecological Areas along the Applicant's Preferred Route and Certificate of Need Alternative Routes

Terrestrial Vegetation and Habitat

Terrestrial vegetation is affected when released oil contaminates adjacent soils or comes into direct contact with plant tissues (McKendrick 1999). Petroleum released to the ground surface can have harmful effects on soil and important resident microorganisms (Stantec et al. 2017). Oil flowing over land can infiltrate into soil, and the extent to which this occurs depends on oil type and volume, topography, soil porosity and permeability, organic matter content, and seasonal conditions. Oil penetrates more readily and deeply into more porous soils like sand and gravel and to a lesser degree into silty or clayey soils. Organic matter in soils or frozen ground can impede infiltration. Though oil can become highly weathered (especially near the surface), it can remain in soil for many years (greater than 25 years; Wang et al. 1998); therefore, remediation techniques often involve excavation and removal of contaminated soil until risk of exposure is acceptably low, which would affect vegetation and availability of terrestrial habitat in the vicinity of a spill.

Plants tend to experience significant damage when oil covers leaves and other sensitive tissue. Herbaceous vegetation is particularly sensitive to oiling (Walker et al. 1978), whereas protective bark makes shrubs and trees more resistant. However, oil reaching root systems can ultimately cause mortality of shrubs and trees (Collins et al. 1994). Spills of light crude oil would be more likely to penetrate soils, spread more quickly, and exhibit higher toxicity to vegetation, especially during the growing season. Spills of heavy crude would be less likely to penetrate soils, would spread more slowly, and would cause more physical damage by coating vegetation. Numerous studies examining the impacts of crude oil on vegetation have been completed in northern latitudes that have applicability to climate and vegetation types that could be affected by this Project. An experimental application of oil onto terrestrial vegetation by Wein and Bliss (1973) in the Northwest Territories of Canada revealed that oil-contaminated deciduous plants showed effects within hours of oil application, whereas evergreen vegetation took weeks to show stress. Regrowth in oil-exposed plants was less robust than would typically occur. Plants in oil-saturated soil showed no regrowth. After a growing season, recovery varied between 20 and 55 percent, depending on the oil treatment rate.

Spills could affect special-status plants that have been documented within the ROI (see Section 5.2.5). Soil impacts that directly affect plant communities include reduced moisture and nutrient availability, impacts on essential microorganisms, and root uptake. Clean-up efforts may also result in removal of oil-saturated plants or trampling damage by workers. Response and containment activities could affect vegetation communities and terrestrial habitat through the removal of contaminated vegetation and soils. In some cases, in situ burning could be used as a response measure and could destroy or damage vegetation. Overall, cleanup activities would benefit vegetation more than no response.

Terrestrial Wildlife

Important wildlife, including amphibians, reptiles, birds, and mammals, which are present in many habitats along the ROIs (see Section 5.2.5), could ingest oil or experience external oiling as a result of a spill. The ability of birds and mammals to maintain proper body temperature can be compromised by external oiling, which can lead to hypothermia and death. Oil that is ingested during preening/grooming of residual external oiling or consumption of oil-contaminated food may result in toxicological effects. Ingestion of oil by wild birds has been associated with severe weight loss, hemolytic anemia, kidney damage, liver damage, foot problems, gut damage, and immunosuppression (Troisi et al. 2006). When oil penetrates into the feathers, it causes marked loss of insulation, waterproofing, and buoyancy in the plumage (Burger and Fry 1993). These alterations increase the risk of hypothermia and impair flight, making birds susceptible to starvation and predation. Exposure to oil could reduce reproductive success because of pathological effects on liver or endocrine systems that interfere with the reproductive

process (Tseng 1999). Stress from ingested oil can be additive to ordinary environmental stresses, such as low temperatures and metabolic costs of migration. Oil also could adversely affect food resources, which could decrease survival, future reproduction, and growth of individual receptor species.

Onsite burning to remove oil, if allowed, could create smoke plumes and particulates that could affect birds and mammals through inhalation. Clean-up activities from a spill could also result in direct disturbance and displacement of wildlife, potentially over a relatively large area. Overall, however, clean-up activities would benefit wildlife more than no response, and disturbance effects from containment and clean-up activities are usually short term.

For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time and increase the likelihood of terrestrial wildlife being exposed to the weathered oil. Clean-up success could vary, depending on the environment; but over time, remaining oil would gradually degrade. Toxic products could remain in soil, plant tissues, or prey items after cleanup and continue to bio-accumulate up the food chain.

Wetlands

Wetlands are sensitive to oil spills, with potentially immediate effects following exposure (Overstreet and Galt 1995). A crude spill could affect wetland resources directly through contamination with oil or indirectly from response vehicles, equipment, and operations that could affect wetland hydrology, vegetation, and soils. The nature and extent of impacts relates to the oil spill type and volume, surface topography, wetland type, and wetland hydrology. Unless the water is deep enough that submergence of oil poses an issue, dilbit and commonly transported crude oils pose many similar challenges following release in wetlands, but there are three factors specific to dilbit: (1) the amount of residual oil would be large compared to that produced by spills of conventional crude oils; (2) the increased level of adhesion of bitumen may complicate operations in a wetland environment; and (3) dilbit residues may persist longer in wetlands than in other environments because of their greater resistance to biodegradation (National Academies of Sciences, Engineering, and Medicine 2016).

Various wetland plant species respond differently to oil spills; plants are more sensitive to oiling during the growing season than during other periods (Zhu et al. 2004). Sediment type also plays an important role. In general, oil remains longer in soils with higher organic matter and, therefore, has greater impact on resident plants. Lin and Mendelssohn (1996) found that organic matter in soils made wetlands and plants particularly sensitive to crude oil. Some wetland sediment can act as a reservoir, absorbing oil and later releasing it into adjacent coastal habitats, causing chronic impacts on biota (Zhu et al. 2004). Hutchinson and Freedman (1978) found that intensive releases of oil were generally more damaging than spray releases, and that releases during winter months tended to be less damaging than summer releases. A study of plant recovery following a release in Alaska (Racine 1994) found that understory revegetation was nearly complete within 20 years, but areas with pooled oil had little recovery. Leck and Simpson (1992) found that contaminated soil reduced plant survival and growth from seeds, and diminished growth of plant seedlings in tidal freshwater marshes.

The type of wetland and the corresponding hydrology affect the persistence and concentration of spilled oil. Generally, marshes and swamps near larger bodies of water have water flow that helps to flush and disperse oil. Released oil also has potential to alter oxygen and microbial levels as well as overall chemistry in wetlands (Leck and Simpson 1992; Mendelssohn et al. 2012). Changes to hydrology and vegetation would likely be temporary, but soil compaction and/or contaminated soil removal could result in persistent hydrologic impacts on wetlands.

Aquatic Environment

Crude oil exposure can result in adverse effects on aquatic receptors such as benthic invertebrates, fish, and aquatic plants (emergent, floating, and submerged). Receptors present in waterbodies during and following a release would be most vulnerable to crude oil exposures and potential adverse effects.

Effects on aquatic receptors depend not only on the physical and chemical characteristics of different crude oils, but also on the site-specific environmental conditions at the time of the initial release and the spatial and temporal extent of the oiling, including lateral and downstream migration. For instance, low-energy environments promote greater concentration of oiling effects, resulting in greater toxicity within a relatively small area. Conversely, greater dispersal (e.g., from a high-energy environment or wind) would result in a broader impact, but with lower impacts on individual organisms (i.e., greater prevalence of sublethal effects). Higher, flood flows tend to disperse oil onto floodplains, where oil could become trapped in floodplain depressions and wetlands. Floods also have greater concentrations of suspended sediment, which promotes formation of tarballs. During low-flow conditions, oil tends to have greater contact with the streambed and therefore may more readily contaminate bed sediments.

The season during which the spill occurs would also affect the extent of effects on aquatic receptors. If a spill were to occur in the winter during full ice coverage, oil discharged on the surface of the ice would have a smaller impact on water, shoreline, sediments, and aquatic biota as it would not enter the aquatic system. The presence of full ice coverage could also facilitate clean-up efforts, though partial ice coverage can have the opposite effect (Miklaucic and Saseen 1989). Additionally, snow can increase oil absorption and reduce oil dispersion. If a spill were to occur when there is open water (e.g., spring, summer, and fall), oil would be more likely to enter the aquatic system. The duration of water quality and toxicity impacts on aquatic receptors within a given waterbody would depend on oil dispersal area, oil type and quantity spilled, and the degree of entrainment within bed substrates. Contaminated substrates can be scoured and mobilized well after the release to cause lingering water quality impacts and toxicity to biota.

Impacts on aquatic habitats and species would result from oil contamination within the area of surface spreading and lateral and vertical movement through the water column. Habitat degradation associated with a spill would result from the physical presence of floating and/or partially submerged (depending on its relative density) crude oil, the presence of toxic water-soluble or suspended fractions of crude oil and petroleum derivatives, and reduced dissolved oxygen concentration. The oil could come into contact with shorelines and aquatic vegetation. Lighter crudes generally have lower impacts on shorelines than heavy crudes due to differences in persistence and adhesion. Flow, scour, and depositional conditions influence effects of oils in a similar manner as discussed with respect to bed sediments. Shoreline substrates also affect the retention of oil, with impermeable materials (e.g., bedrock) absorbing less oil than sands and gravels with greater permeability. Riparian vegetation, particularly dense vegetation, tends to protect shorelines from oiling effects (Fraser et al. 1989). However, vegetation can have a trapping effect if oil initially penetrates vegetation or enters the shoreline area from land (Baca et al. 1983).

Effects on biota can be lethal or sublethal. Exposures of light crude oil can have unique effects on different categories of aquatic receptors in the freshwater environment. Light crude oil contains more soluble compounds, which can dissolve in the water column immediately following a release (and prior to significant volatilization from the water surface) and result in elevated hydrocarbon concentrations that are potentially toxic to receptors such as invertebrates and fish. Exposures and acute toxicity to fish and invertebrates can occur in high-energy aquatic systems where light crude oil can be entrained in

droplets and move throughout the water column. Sublethal and lethal effects on fish are more likely for light than heavy crude oils.

Mortality may occur as a result of direct oiling or exposure to high concentrations of oil. Sensitivity to spill effects also depends on mobility and dependence of a given species on aquatic habitats. Benthic macroinvertebrates are commonly filter feeders and immobile, meaning they can be greatly affected by oiling effects. Semi-aquatic mammals are capable of moving away from the spill site, have greater flexibility in their habitat and food sources, and would therefore generally have lower relative sensitivity to spills in aquatic environments. The magnitude of impacts also depends on the relative location of the organism within the water column. Biota dwelling at depth may be less exposed to oiling effects. Conversely, species that primarily inhabit the near-surface water column and adjacent shorelines have a greater likelihood of direct oiling effects and toxicity (Dicks 1998). Impacts on fish would depend on life stage. Some fish may not be affected at all, or, in the case of fish in larval or spawning stages, impacts may be quite detrimental (NOAA 2011) due to smothering of eggs and/or larvae. Larval/juvenile fish are generally more sensitive to toxicity than adults (Hose et al. 1996). Increased mortality of larval/juvenile fish would be expected because they are often found at the water's surface, where contact with oil is most likely, and because they are relatively immobile, whereas adult fish would be able to swim away from the spill.

Fish that have been exposed to oil may suffer from changes in heart and respiratory rate, enlarged livers, reduced growth, fin erosion, deformities, and a variety of effects at biochemical and cellular levels (USFWS 2010). Oil may also affect the reproductive capacity of fish and may result in deformed fry (United Nations Environment Programme 2011). Indirect effects on fish from an oil spill include interference with movements to feeding or spawning areas; localized reduction in food resources; and effects from consumption of contaminated prey (Brannon et al. 1986; Morrow 1974; Purdy 1989). Floating oil can contaminate plankton, which includes algae, fish eggs, and the larvae of various fish and invertebrates. Fish that feed on these organisms can subsequently become contaminated (USFWS 2010).

Floating plants are particularly vulnerable to crude oil released to the water surface, while submerged vegetation is less sensitive, especially to temporary dissolved hydrocarbon exposures. Vegetation can absorb oil and effectively protect bank sediments from oil, as was the case in the 1988 Shell oil release in Martinez, California (Fraser et al. 1989), and the 2000 M/T Westchester oil release into the Mississippi River (Michel et al. 2002). Vegetation can also absorb and hold oil on the banks, thereby increasing the length of time that oil has an effect on shorelines and banks. For example, after an oil spill in Buzzards Bay, Massachusetts, in 1969, areas with marshy vegetation retained oil residues, whereas un-vegetated areas did not (Peacock et al. 2005). Damages to aquatic plants can have impacts on the aquatic habitat in terms of both biological health and productivity as well as physical integrity (e.g., loss of plants that reduce the potential for riverbank erosion).

Immediate response would minimize a spill's spatial extent and the duration that oil would be in the water, and would thus decrease the potential for crude oil settling and adhering to streambed sediments, shoreline areas, and other aquatic habitats. However, spill response and clean-up activities could result in damage and disturbance to aquatic vegetation and habitats and displace aquatic species that are present.

Drinking Water Sources

The alternative with the greatest acreage of HCA drinking water sources within 2,500 feet of either side of its centerline is existing Line 3 supplemented by truck, followed by transportation by truck, existing Line 3 supplemented by rail, transportation by rail, system alternative SA-04, and continued use of existing Line 3. The Applicant's preferred route would have the least acres of HCA drinking water sources within the 2,500-foot-wide ROI (Table 10.4-3). Figure 10.4-3 shows HCA drinking water sources along the Applicant's preferred route and CN Alternative routes.

Table 10.4-3. HCA Drinking Water Sources within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
1,614.6	3,975.2	11,058.9	11,862.6	18,726.6	15,837.8	22,701.8

Source: Enbridge 2016c.

HCA = high consequence area

Drinking water sources can be affected when groundwater and/or surface water become contaminated. Released crude oil can enter underlying groundwater aquifers and form plumes that migrate with the natural flow of groundwater. The migration of the contaminated plumes could result in contamination of nearby drinking water supply wells and other local wells. The ultimate fate and transport of these contaminated plumes is dictated by the amount and type of oil released, groundwater flow rate, geological properties of the aquifer, chemical reactions occurring within the plume, and the presence of microbes that degrade contaminants (Stantec et al. 2017). In general, these processes tend to limit the length of groundwater plumes to 600 feet or less.



Figure 10.4-3. High Consequence Area Drinking Water Sources along the Applicant's Preferred Route and Certificate of Need Alternative Routes

A significant proportion of crude oil released in the subsurface could accumulate at the water table. A smaller portion, particularly lighter compounds with greater water solubility, would dissolve into the groundwater (O'Reilly et al. 2001). Contaminated groundwater plumes typically have a central zone of high contamination, with decreasing contamination toward the plume margins. Migration of crude oil constituents depends on groundwater flow rates, aquifer properties, and the constituent being considered. Lighter compounds (e.g., BTEX) are generally more mobile, spreading farther and faster, whereas heavier compounds (e.g., PAHs) are more likely to adhere to soils and sediments. As a contaminant plume migrates, it also is weathered and degraded by processes of evaporation volatilization, adsorption, dissolution, dispersion, and biodegradation. These processes of natural attenuation typically cause a plume to stabilize at a maximum distance in the hundreds of feet from the original spill source, and ultimately decline in size (Connor et al. 2015). If a contaminant plume intersects groundwater discharge points like surface waterbodies, or intersected groundwater extraction points, or water supply wells, contaminants can reach these receptors. Remediation techniques such as groundwater pumping and treatment, air injection to increase volatilization (evaporation), point-of-use treatment (carbon filtration), and bioremediation can be employed to mitigate the contaminant plume and reduce spreading.

Water supplies in the vicinity of an oil spill are often temporarily shut off to prevent contamination, and total petroleum hydrocarbons in drinking water are detectable by human taste and odor at concentrations below levels of concern for acute human health effects. As a result, even short-term human exposure to total petroleum hydrocarbons in drinking water is highly unlikely (World Health Organization 2004).

10.4.2.1.2 Areas of Interest Comparisons for the Applicant's Preferred Route and Certificate of Need Alternatives

Drinking Water Areas of Interest

In addition to the HCA drinking water sources, Minnesota DH identified other drinking water resources that may be susceptible to exposures of crude oil. Potential impacts on drinking water resources from a crude spill would be the same as those described above for HCA drinking water sources.

Drinking Water Supply Management Areas and Vulnerability

Data characterizing DWSMAs are not available outside of Minnesota; therefore, this metric has not been analyzed for the CN Alternatives. An analysis of DWSMA data is included in Section 10.4.3.1.2 for the route alternatives.

Wellhead Protection Areas

WPAs are Minnesota DH-approved surface and subsurface areas surrounding public water supply wells or well fields that supply a public water system and through which potential contaminants would be likely to move toward and reach the well or well field (Minnesota DH 2014). Among the alternatives, the most WPA acres are within 2,500 feet of either side of the centerline of existing Line 3 supplemented by truck, followed by existing Line 3 supplemented by rail, transportation by truck, system alternative SA-04, transportation by rail, and continued use of existing Line 3. The fewest WPA acres are within 2,500 feet of either side of the centerline for the Applicant's preferred route (Table 10.4-4).

Table 10.4-4. Wellhead Protection Areas within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
189.7	1,391.3	3,579.7	3,350.2	3,747.0	4,741.5	5,138.3

Sources: Iowa DNR 2017; Konczyk 2017, pers. comm.; Minnesota DH 2016; North Dakota Department of Health 2017.

Wisconsin well data were not available.

Domestic Wells and Associated Geological Sensitivity Ratings

Domestic (private) drinking water wells and their geological sensitivity were identified within the 2,500-foot-wide ROI for the Applicant's preferred route and the CN Alternatives. These wells are potentially at risk from released oil plumes. The alternative with the highest number of domestic drinking water wells within 2,500 feet of either side of its centerline is existing Line 3 supplemented by rail, followed by existing Line 3 supplemented by truck, system alternative SA-04, transportation by rail, the Applicant's preferred route and continued use of existing Line 3 (which have the same number of wells), and transportation by truck (Table 10.4-5).

Table 10.4-5. Numbers of Domestic Wells within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04[a]	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
618	618	920	646	564	1,264	1,182

Sources: Iowa DNR 2017; Konczyk 2017, pers. comm.; Minnesota DH 2017, pers. comm.; North Dakota Department of Health 2017.

Wisconsin well data were not available.

[a] In Illinois, 509 wells within 2,500 feet of either side of the centerline for system alternative SA-04 have not been field verified; only 16 have been field verified as non-community water supply wells. Information regarding the other 493 wells is not available; therefore, they are not included in the total for SA-04.

Public Drinking Water Supplies

Public water supply wells were identified within the 2,500-foot-wide ROI for the Applicant's preferred route and the CN Alternatives. The alternative with the highest number of public water supply wells within 2,500 feet of either side of the centerline is existing Line 3 supplemented by truck, followed by existing Line 3 supplemented by rail, continued use of existing Line 3, SA-04, the Applicant's preferred route, transportation by truck, and transportation by rail (Table 10.4-6).

Table 10.4-6. Numbers of Public Water Supply Wells within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04[a]	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
20	72	26	2	4	74	76

Sources: Minnesota DH 2017, pers. comm.; Iowa DNR 2017; Konczyk 2017, pers. comm.; North Dakota Department of Health 2017.

Wisconsin well data were not available.

[a] In Illinois, 509 wells within 2,500 feet of either side of the alternative centerline for system alternative SA-04 have not been field verified; only 1 is listed as a community water supply well. Information regarding the other 508 wells is not available; therefore, they are not included in the total for SA-04.

Cultural Resources Areas of Interest

A crude oil release along the Applicant's preferred route and the CN Alternative routes has the potential to result in exposure of tribal lands, archaeological sites, and historic sites (Table 10.4-7). Data on archaeological sites and historic resources were not available for all CN Alternatives; therefore, counts of these cultural resources were not used in this comparison.

Table 10.4-7. Tribal Lands within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
48.0	33,737.6	6,738.1	31,854.3	30,280.4	65,591.9	64,018.0

Source: ESRI 2017; Minnesota Department of Transportation 2003.

Within 2,500 feet of the centerline of the routes, existing Line 3 supplemented by rail crosses the greatest acreage of tribal lands, followed by existing Line 3 supplemented by truck, the continued use of existing Line 3, transportation by rail, transportation by truck, system alternative SA-04, and the Applicant's preferred route.

Direct impacts on tribal resources could occur by direct damage to a historic or archaeological site or secondary damage during clean-up activities. Impacts on tribal land would be similar to those described for terrestrial and aquatic habitats under HCA unusually sensitive ecological areas. Temporary access limitations are possible, especially during response efforts. In general, cultural and tribal resources related and/or in close proximity to surface waters have the most potential to be affected by oil releases. Surface water-related resources of particular concern are fisheries and wild rice harvest areas.

Biological Areas of Interest

Various biological AOIs were identified within 2,500 feet of either side of the centerlines for the Applicant's preferred route and CN Alternative routes (Table 10.4-8 and Figure 10.4-4). The most biological AOI acres are contained within the 2,500-foot-wide ROI of existing Line 3 supplemented by rail and existing Line 3 supplemented by truck, followed by the Applicant's preferred route, continued use of existing Line 3, transportation by rail, and transportation by truck. The ROI of SA-04 does not contain any of the Minnesota recorded biological AOIs; however, the biological AOIs evaluated are Minnesota-specific and comparable data were not available from other states.

Point data identifying locations of calcareous fens in Minnesota within the ROI indicate that the most calcareous fens occur along existing Line 3 supplemented by rail (average of 9), followed by continued use of existing Line 3 and the Applicant's preferred route (5 each), and SA-04 (1). Trout streams and lakes were not analyzed for the CN Alternatives as comparable data for SA-04 are not available, and therefore a comparative analysis across all routes could not be conducted.

Impacts on biological AOIs would be similar to those described above for HCA unusually sensitive ecological areas. Wild rice is considered an aquatic grass, and effects on it from a crude oil spill would be similar to those described above for wetland vegetation. Given the high organic matter found in wetland soils, plants found in this environment are particularly sensitive to crude oil (Lin and Mendelssohn 1996).

Table 10.4-8. Biological Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04[a]	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Aquatic Management Area	125.0	227.5	0	228.6	93.9	456.0	321.4
Scientific and Natural Area	0	7.5	0	186.7	0	380.8	7.5
Minnesota BWSR conservation easement	15.8	167.1	0	736.0	33.0	903.1	200.1
Lakes of Biological Significance	406.7	2,209.8	0	1,951.5	2,617.9	4,161.4	4,827.8
MBS Sites	28,046.8	12,992.6	0	18,309.7	6,285.4	31,302.3	19,278.1
Muskie lakes	41.4	976.6	0	1,060.9	1,882.1	2,037.5	2,858.8
Native plant communities	38,173.8	40,195.4	0	33,852.4	35,643.9	74,047.8	75,839.3
Sensitive lakeshore areas	300.5	1,329.8	0	743.4	1,387.9	2,073.2	2,717.7
Wetland bank easement	0	70.6	0	120.3	33.6	190.9	104.2
Wild rice lakes	675.4	1,240.4	0	1,474.1	1,661.0	1,240.4	2,901.4
TOTAL	**67,785.4**	**59,417.2**	0	**57,189.4**	**49,638.9**	**116,793.3**	**109,056.1**

Sources: Enbridge 2016c; Minnesota DNR 2016.

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance, Minnesota BWSR = Minnesota Board of Water and Soil Resources

[a] The ROI of SA-04 does not contain any of the Minnesota recorded biological areas of interest (AOIs); however, the biological AOIs evaluated are Minnesota-specific and comparable data were not available from other states.

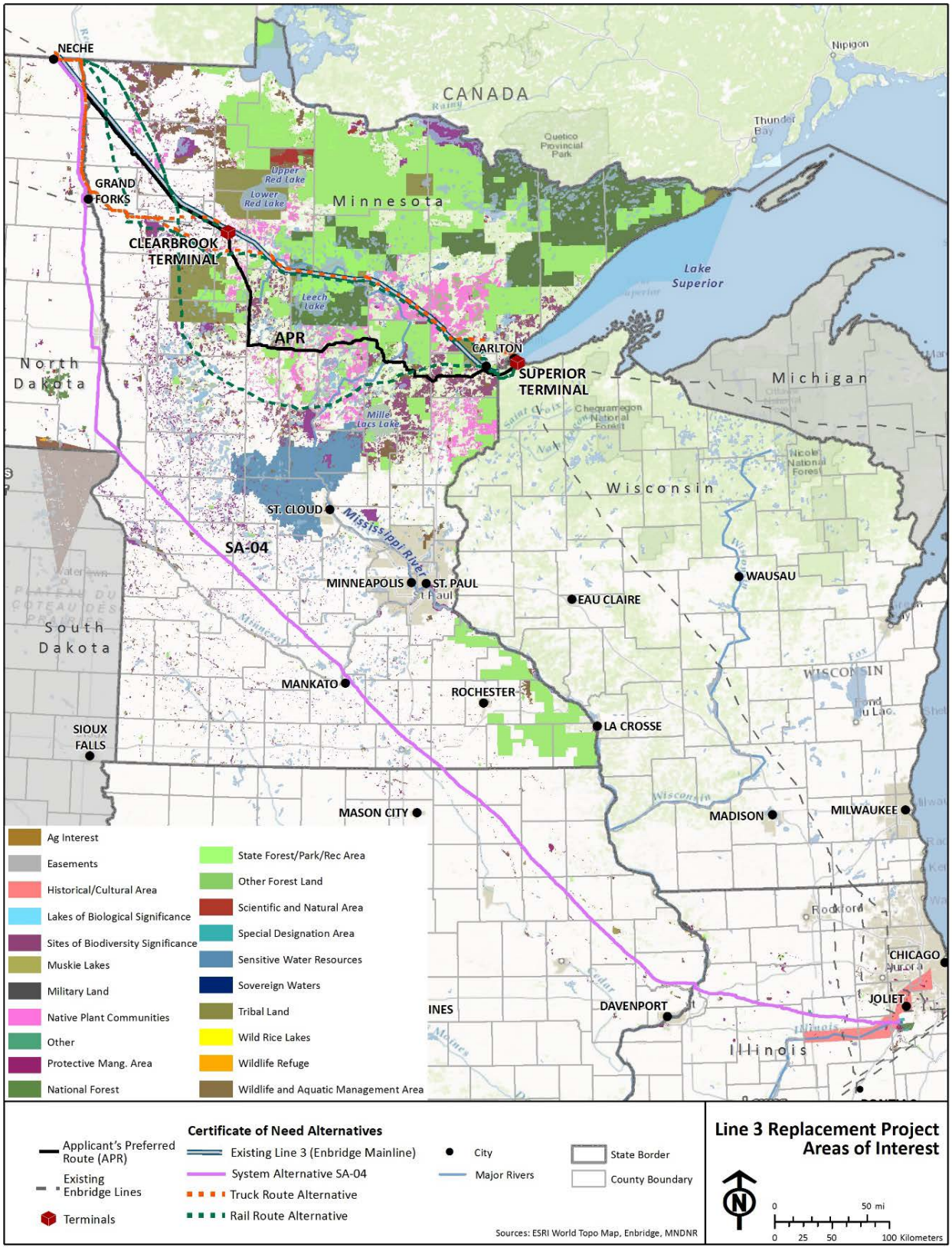


Figure 10.4-4. Areas of Interest along the Applicant's Preferred Route and Certificate of Need Alternative Routes

Contaminated soil reduces plant survival and growth from seeds and results in diminished growth of plant seedlings (Leck and Simpson 1992). A study of plant recovery following a release (Racine 1994) found that understory revegetation was nearly complete within 20 years, but areas with pooled oil had little recovery. If a spill were to occur, plants would be more sensitive to oiling during the growing season than during other periods (Zhu et al. 2004). In addition to effects from oiling, wild rice is a delicate crop that is subject to shattering, or having the seed fall to the ground in the wind, making the crop susceptible to failure if disturbed. If crude oil did reach a wild rice lake pre-harvest, not only would the plant itself be exposed to contamination, but the clean-up efforts would affect the year's harvest.

Commodity Production Areas of Interest

The 2,500-foot-wide ROI of all alternatives overlaps with various forest lands. Among the CN Alternatives, existing Line 3 supplemented by truck would affect the greatest state, national, and other forest acres, followed by existing Line 3 supplemented by rail (Table 10.4-9). In contrast, system alternative SA-04 has the lowest state, national, or other forest acreage within 2,500 feet of either side of its centerline. The Applicant's preferred route has no national forests within this ROI, but it has 31,764.3 acres of state forest and 3,349.5 acres of other forest land within the ROI. Impacts on forested land from a crude spill would be similar to those described under HCA unusually sensitive ecological areas for terrestrial vegetation and habitat.

Table 10.4-9. Commodity Production Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Marginal cropland – limited	15.6	16.1	0	73.9	5.4	90	21.5
Marginal cropland – perpetual	0	0	0	13.5	0	13.5	0
National forests	0	21,055.0	145.9	10,149.0	20,018.2	31,203.9	41,073.1
Other forest land	3,349.5	2,827.2	45.7	2,735.5	2,954.0	5,562.7	5,781.2
State forests	31,764.3	27,806.9	0	17,505.5	25,451.2	45,312.4	53,258.1
TOTAL	**35,129.4**	**51,705.1**	**191.62**	**30,477.4**	**48,428.8**	**82,182.5**	**100,133.9**

Source: Enbridge 2016c; Minnesota DNR 2016.

The alternatives also overlap with marginal cropland. Limited marginal cropland is a temporary conservation easement, while perpetual marginal cropland is a permanent easement as identified by the Minnesota Board of Water and Soil Resources. Among the CN Alternatives, existing Line 3 supplemented by rail has the greatest number of marginal cropland acres within 2,500 feet of either side of its centerline, while system alternative SA-04 has no marginal cropland within this distance (Table 10.4-9). Existing Line 3 supplemented by rail encompasses 90 acres of limited marginal cropland, and is followed by transportation by rail, existing Line 3 supplemented by truck, continued use of existing Line 3, the Applicant's preferred route, and transportation by truck. A spill in the vicinity of croplands could affect agricultural activities by smothering crops and contaminating soils. Removal of contaminated soil during cleanup could temporarily reduce the quality of affected agricultural land. A crude oil spill in 1974 in Moose Jaw, Saskatchewan, directly affected wheat crops, causing reduced yields with greater oil contamination until oil concentration in soil reached 1 percent, at which point no plant growth occurred (De Jong 1980). Over the 4 years following the release, crop yields in oil-contaminated sites improved, but not to the production level of uncontaminated areas.

Recreation and Tourism Areas of Interest

Existing Line 3 supplemented by rail and transportation by rail contain the most recreation and tourism AOI acres within 2,500 feet of either side of their centerlines. These are followed by the Applicant's preferred route, existing Line 3 supplemented by truck, transportation by truck, continued use of existing Line 3, and system alternative SA-04 (Table 10.4-10).

Table 10.4-10. Recreation and Tourism Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Certificate of Need Alternatives (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
State plan/ recreational areas	317.7	0	0	2,079.3	485.6	2,079.3	485.6
State parks	629.9	0	790.5	3,910.3	0	3,910.3	0
Wildlife Management Areas	1,299.3	16.4	105.5	3,352.1	820.55	3,368.5	836.9
Waterfowl production areas	92.0	185.80	0	632.0	485.0	817.8	670.7
TOTAL	**2,338.9**	**202.2**	**896.0**	**9,763.0**	**1,641.3**	**9,965.2**	**1,843.4**

Sources: Enbridge 2016c; Minnesota DNR 2016.

Impacts on land, water, and natural resources can, in turn, affect recreational and land use. Impacts on parks and recreation areas may be environmental, cultural, or visual in nature. Specific recreational resources of concern include trails, state parks, hunting and fishing areas, and lakes, which may be closed to the public following a spill and during response activities. Other areas affected by oil spills could include residential, commercial, industrial, agriculture, and forestry lands, and associated uses and business operations.

The tourism industry is a major source of direct and indirect employment and wages. It includes fishing, land and water touring, and retail and service firms, including lodging providers, restaurants, automobile service stations, and other businesses. A crude oil spill could lead to both temporary and long-term closures and restricted access for recreation resources including boat launch restrictions, fishing restrictions, and waterway closures. A large spill could also lead to closure or restricted access to roads, bike paths, trails, scenic overlooks, and other recreation resources. Depending on the location and extent of the spill, these resources could be inaccessible to the public for days to several weeks or longer during cleaning efforts. Longer-term impacts on fishing could result if aquatic resources were fouled or there was a reduction in the amount and/or quality of fish available for harvest. Impacts on vegetation and scenic views, both of which are draws for recreationists, could last longer. Economic damages could persist if a diminished public perception of an area occurred (Chang et al. 2014).

10.4.2.2 Downstream Exposure Analysis for Spills

10.4.2.2.1 High Consequence Area Downstream Exposure Comparisons

Populated Areas

Existing Line 3 supplemented by truck has the most HCA populated areas acres within 10 miles downstream of its waterbody crossings, followed by SA-04, existing Line 3 supplemented by rail, transportation by truck, transportation by rail, the Applicant's preferred route, and continued use of existing Line 3 (Table 10.4-11). Potential effects on HCA populated areas from a crude oil spill would be the same as described in Section 10.4.2.1.1.

Table 10.4-11. HCA Populated Areas within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
4,414.6	3,379.2	12,053.4	6,855.0	8,792.4	10,234.2	12,171.6

Source: Enbridge 2016c.

HCA = high consequence area, ROI = region of interest

Unusually Sensitive Ecological Areas

Existing Line 3 supplemented by truck has the most HCA unusually sensitive ecological area acres within 10 miles downstream of its waterbody crossings, followed by existing Line 3 supplemented by rail, transportation by truck, SA-04, transportation by rail, continued use of existing Line 3, and the Applicant's preferred route (Table 10.4-12). Potential effects on HCA unusually sensitive ecological areas from a crude oil spill would be the same as described in Section 10.4.2.1.1.

Table 10.4-12. Unusually Sensitive Ecological Area HCAs within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
5,414.6	8,482.3	9,848.1	9,618.7	11,255.2	18,101.0	19,737.5

Source: Enbridge 2016c.

HCA = high consequence area, ROI = region of interest

Drinking Water Sources

SA-04 has the greatest acreage of HCA drinking water sources within the 10-mile-long downstream ROI for its waterbody crossings, followed by existing Line 3 supplemented by truck, transportation by truck, existing Line 3 supplemented by rail, transportation by rail, the Applicant's preferred route, and continued use of existing Line 3 (Table 10.4-13). Potential effects on HCA drinking water sources from a crude oil spill would be the same as those described in Section 10.4.2.1.1.

Table 10.4-13. HCA Drinking Water Sources within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
829.3	546.7	13,409.8	2,924.6	9,215.3	3,471.3	9,762.0

Source: Enbridge 2016c.

HCA = high consequence area, ROI = region of interest

10.4.2.2.2 Areas of Interest Downstream Exposure Comparisons

Drinking Water Areas of Interest

Drinking Water Supply Management Areas and Vulnerability

Data characterizing DWSMAs are specific to Minnesota; therefore, this metric was not analyzed for the CN Alternatives. An analysis of DWSMA data is included in Section 10.4.3.1.2 for the route alternatives.

Wellhead Protection Areas

SA-04 has the greatest number of WPA acres within the 10-mile-long downstream ROI (11,906 acres), while the Applicant's preferred route has the least (approximately 130 acres). Existing Line 3 supplemented by truck would affect significantly more acres than the existing Line 3 supplemented by rail, 6,258 acres vs. 687 acres, respectively (Table 10.4-14). Potential effects on WPAs from a crude oil spill would be the same as described in Section 10.4.2.1.2.

Table 10.4-14. Wellhead Protection Areas within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
130.0	208.6	11,906.4	487.8	6,049.9	687.4	6,258.5

Sources: Iowa DNR 2017; Konczyk 2017, pers. comm.; Minnesota DH 2016; North Dakota Department of Health 2017.

Wisconsin well data were not available.

ROI = region of interest

Domestic Wells

The geographic scope of the alternatives required domestic wells data to be compiled from multiple state databases. However, the 10-mile-long downstream ROI was limited to capturing domestic wells within 1 mile of the route (or 1 mile downstream in most cases). However, because the same reduced area of analysis was applied for all alternatives, the results are considered useful for comparison purposes.

Domestic water wells within 1 mile of each alternative centerline and 500 feet from either side of the flowing waterbody were identified and are presented below in Table 10.4-15. Existing Line 3 supplemented by rail has the highest number of wells within the downstream ROI, followed by transportation by rail, SA-04, existing Line 3 supplemented by truck, transportation by truck, the Applicant's preferred route, and continued use of existing Line 3. Potential effects on domestic wells from a crude oil spill would be the same as those described in Section 10.4.2.1.2.

Table 10.4-15. Number of Domestic Wells within the 1-Mile Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
146	39	228	367	184	406	223

Sources: Iowa DNR 2017; Konczyk 2017, pers. comm.; Minnesota DH 2017, pers. comm.; North Dakota Department of Health 2017.

Wisconsin well data were not available.

ROI = region of interest

Public Water Drinking Supplies

Comparable public water wells data were not obtained for all CN Alternatives, so no meaningful analysis can be done. An analysis of public water wells is included in Section 10.4.3 for the route alternatives.

Cultural Resources Areas of Interest

Within the 10-mile-long downstream ROI, existing Line 3 supplemented by rail overlaps with the most acreage of tribal land, followed by transportation by rail, existing Line 3 supplemented by truck, continued use of existing Line 3, and SA-04 (Table 10.4-16). The Applicant's preferred route does not overlap with any tribal lands within the 10-mile-long downstream ROI. Potential effects on cultural resource AOIs from a crude oil spill would be the same as those described in Section 10.4.2.1.2.

Table 10.4-16. Cultural Resources Areas of Interest within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
0	10,400	4,868.3	23,502.5	9,956.2	33,902.0	20,356.0

Sources: Enbridge 2016c; Minnesota DNR 2016.

ROI = region of interest

Biological Areas of Interest

Biological AOIs were identified within the 10-mile-long downstream ROIs of the CN Alternatives and the Applicant's preferred route (Table 10.4-17). SA-04 overlaps the fewest AOIs (three), and all other alternatives overlap all AOIs to a varying degree. Overall, existing Line 3 supplemented by rail or truck contains the greatest acreage of AOIs within 10 miles, with the exception of Scientific and Natural Areas—the Applicant's preferred route has the greatest acreage of Scientific and Natural Areas within the 10-mile-long downstream ROI. The existing Line 3 supplemented by rail and truck alternatives both overlap approximately twice the total acreage of biological AOIs than the continued use of existing Line 3 or the Applicant's preferred route. SA-04 has significantly less acreage within the ROI than all other routes given it only crosses three AOI types (Minnesota BWSR conservation easement, MBS Sites, and native plant communities).

Point data identifying locations of calcareous fens in Minnesota within the 10-mile-long downstream ROI indicate limited fen crossings. The Applicant's preferred route would cross the most calcareous fens (two), followed by existing Line 3 supplemented by rail (one). Continued use of existing Line 3 and SA-04 would not cross any calcareous fens.

Potential effects on biological AOIs from a crude oil spill would be the same as those described in Section 10.4.2.1.2.

Table 10.4-17. Biological Areas of Interest within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Aquatic Management Area	209.8	320.0	0	196.3	183.5	516.4	503.5
Scientific and Natural Area	342.9	192.7	0	63.4	0	256.1	192.7
Minnesota BWSR conservation easement	262.0	260.7	29.8	158.2	90.9	418.8	351.5
Lakes of Biological Significance	3,608.9	3,400.1	0	3,659.1	4,559.4	7,059.2	7,959.5
MBS Sites	11,589.4	8,001.2	120.6	11,117.4	5,740.2	19,118.6	13,741.5
Muskie lakes	676.0	2,107.0	0	1,990.8	3,526.5	4,097.8	5,633.5
Native plant communities	14,015.3	22,744.8	219.0	16,735.5	19,166.4	39,480.3	41,911.3

Table 10.4-17. Biological Areas of Interest within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Sensitive lakeshore areas	441.9	513.4	0	305.3	373.6	818.7	887.0
Wetland bank easement	38.5	30.3	0	49.7	21.9	80.0	52.2
Wild rice lakes	3,396.3	2,956.4	0	3,298.6	3,899.3	6,255.0	6,855.7
TOTAL	**34,580.3**	**40,526.6**	**369.3**	**37,574.2**	**37,561.6**	**78,100.8**	**77,584.7**

Sources: Enbridge 2016c; Minnesota DNR 2016.

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance, Minnesota BWSR = Minnesota Board of Water and Soil Resources, ROI = region of interest

Commodity Production Areas of Interest

The route for the existing Line 3 supplemented by truck contains the most commodity production AOI acres within the 10-mile-long downstream ROI. It is followed by the routes of existing Line 3 supplemented by rail, continued use of existing Line 3, and the Applicant's preferred route. SA-04 would not contain commodity production AOIs within the 10-mile-long downstream ROI (Table 10.4-18).

Table 10.4-18. Commodity Production Areas of Interest within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
National/ state forests	0	8,496.3	0	14,417.2	16,965.6	22,915.5	31,384.8
Other forested land	1,910.9	2,207.8	0	1,311.3	2,451.7	3,519.1	4,659.5
Marginal cropland[a]	44.2	10.0	0	0	0	10.0	0
TOTAL	**1,955.1**	**10,714.1**	0	**15,730.5**	**19,417.3**	**26,444.6**	**36,044.3**

Sources: Enbridge 2016c; Minnesota DNR 2016.

Notes:

[a] Perpetual and limited.

ROI = region of interest

The Applicant's preferred route would cross the greatest acreage of marginal cropland among all routes (44.1 acres). The Applicant's preferred route would not cross any national forests, while continued use of existing Line 3 and existing Line 3 supplemented by rail and truck would. Existing Line 3 supplemented by truck would cross approximately 1.4 times more acreage than existing Line 3 supplemented by rail. The Applicant's preferred route and continued use of existing Line 3 would cross similar acreages of "Other forested land"; inclusion of the rail or truck supplementation would increase the acreage, with the truck route doubling the potential area exposed. Potential effects on commodity production AOIs from a crude oil spill would be the same as those described in Section 10.4.2.1.2.

Recreation and Tourism Areas of Interest

Existing Line 3 supplemented by rail and truck contain the most recreation and tourism AOI acres within the 10-mile-long downstream ROI. These are followed by continued use of existing Line 3, transportation by rail, the Applicant's preferred route, system alternative SA-04, and transportation by truck (Table 10.4-19). Potential effects on recreation and tourism AOIs from a crude oil spill would be the same as those described in Section 10.4.2.1.2.

Table 10.4-19. Recreation and Tourism Areas of Interest within the 10-Mile-Long Downstream Region of Interest for the Applicant's Preferred Route and Certificate of Need Alternative Routes (acres)

Area of Interest	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
State plan/ recreational areas	180.7	543.7	0	0	54.1	543.7	597.8
State parks	0.2	941.3	790.5	0	0	941.3	941.3
Wildlife Management Areas	1,172.7	3.0	105.5	1,562.5	699.1	1,565.5	702.1
Waterfowl production areas	11.5	182.2	0	0	0	182.2	182.2
TOTAL	**1,365.2**	**1,670.2**	**896.0**	**1,562.5**	**753.2**	**3,232.7**	**2,423.4**

Sources: Enbridge 2016c; Minnesota DNR 2016.

10.4.3 Exposure Analysis for Comparison of Applicant's Preferred Route and Route Alternatives

The comparison of the exposure due to an oil spill for the Applicant's preferred route and the route alternatives assessed the presence of HCA and AOI resources along the routes within Minnesota between the western border with North Dakota and the eastern border near Superior, Wisconsin. The analysis was completed for the entirety of the Applicant's preferred route and route alternatives within Minnesota to identify the full extent of HCA and AOI resources that could be exposed if a spill were to occur. This is a variation of the approach used for resources evaluated in Chapter 6 of the EIS, which focused on the Clearbrook to Carlton segment. As a result, data for the full length of the route alternatives is presented where available; however, much of the text focuses on the Clearbrook to Carlton section of the routes as this is where most of the HCA and AOI differences occur. In some cases, the tables present results only for the Clearbrook to Carlton segment primarily due to the absence of resources within the other two segments (the North Dakota-Minnesota border to Clearbrook and Carlton to the Minnesota-Wisconsin border). The types of impacts on the identified resources from a crude oil spill would be the same as those described in Section 10.4.2 and are not repeated here. It should be noted that differences in the exposure analysis results between the Applicant's preferred route and route alternatives presented in the tables below are due to the slight variation in where the Applicant's preferred route diverges from the other routes at the Clearbrook terminal.

10.4.3.1 Region of Interest Analysis

10.4.3.1.1 HCA Comparisons among Applicant's Preferred Route and Route Alternatives

Populated Areas

Between Clearbrook and Carlton, the RA-07 route has the greatest number of HCA populated areas acres within 2,500 feet of either side of its centerline, and the Applicant's preferred route has the least (Table 10.4-20). RA-06 has 1.3 times more HCA populated areas acres than the Applicant's preferred route, RA-03AM has 4.7 times more, RA-08 has 7.5 times more, and RA-07 has almost 10 times more.

Table 10.4-20. HCA Populated Areas within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives in Minnesota (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota-Minnesota border to Clearbrook	2,159.6	2,159.6	2,159.6	2,159.6	2,159.6
Clearbrook to Carlton	1,759.5	8,264.9	2,271.8	17,427.4	13,261.2
Carlton to Minnesota-Wisconsin border	652.3	652.3	652.3	652.3	652.3
TOTAL	**4,571.4**	**11,076.8**	**5,083.7**	**20,239.3**	**16,073.1**

Source: Enbridge 2016c.

HCA = high consequence area

Unusually Sensitive Ecological Areas

From Clearbrook to Carlton, RA-08 has the greatest number of HCA unusually sensitive ecological area acres within 2,500 feet of either side of its centerline (18,498 acres), and RA-03AM has the least (2,907 acres) (Table 10.4-21). Compared to the Applicant's preferred route, RA-03AM has half as many HCA unusually sensitive ecological area acres, RA-06 has 1.4 times more, and RA-07 and RA-08 have about three times more. Figure 10.4-5 shows HCA unusually sensitive ecological areas along all route options.

Table 10.4-21. HCA Unusually Sensitive Ecological Areas within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives in Minnesota (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota-Minnesota border to Clearbrook	673.4	673.4	673.4	673.4	673.4
Clearbrook to Carlton	6,230.0	2,906.9	8,468.7	18,372.1	18,498.1
Carlton to Minnesota-Wisconsin border	0	0	0	0	0
TOTAL	**6,903.4**	**3,580.3**	**9,142.1**	**19,045.5**	**19,171.5**

Source: Enbridge 2016c.

HCA = high consequence area

Drinking Water Sources

The RA-07 route has the greatest number of HCA drinking water sources acres within 2,500 feet of either side of its centerline from Clearbrook to Carlton, and the Applicant's preferred route has the least (Table 10.4-22). Figure 10.4-6 shows HCA drinking water sources along all route options.

Table 10.4-22. HCA Drinking Water Sources within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives in Minnesota (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota-Minnesota border to Clearbrook	1,463.8	1,512.5	1,512.5	1,512.5	1,512.5
Clearbrook to Carlton	83.4	1,322.5	168.2	2,395.3	2,105.6
Carlton to Minnesota-Wisconsin border	67.4	67.4	67.4	67.4	67.4
TOTAL	**1,614.6**	**2,902.4**	**1,748.0**	**3,975.2**	**3,685.4**

Source: Enbridge 2016c.

HCA = high consequence area

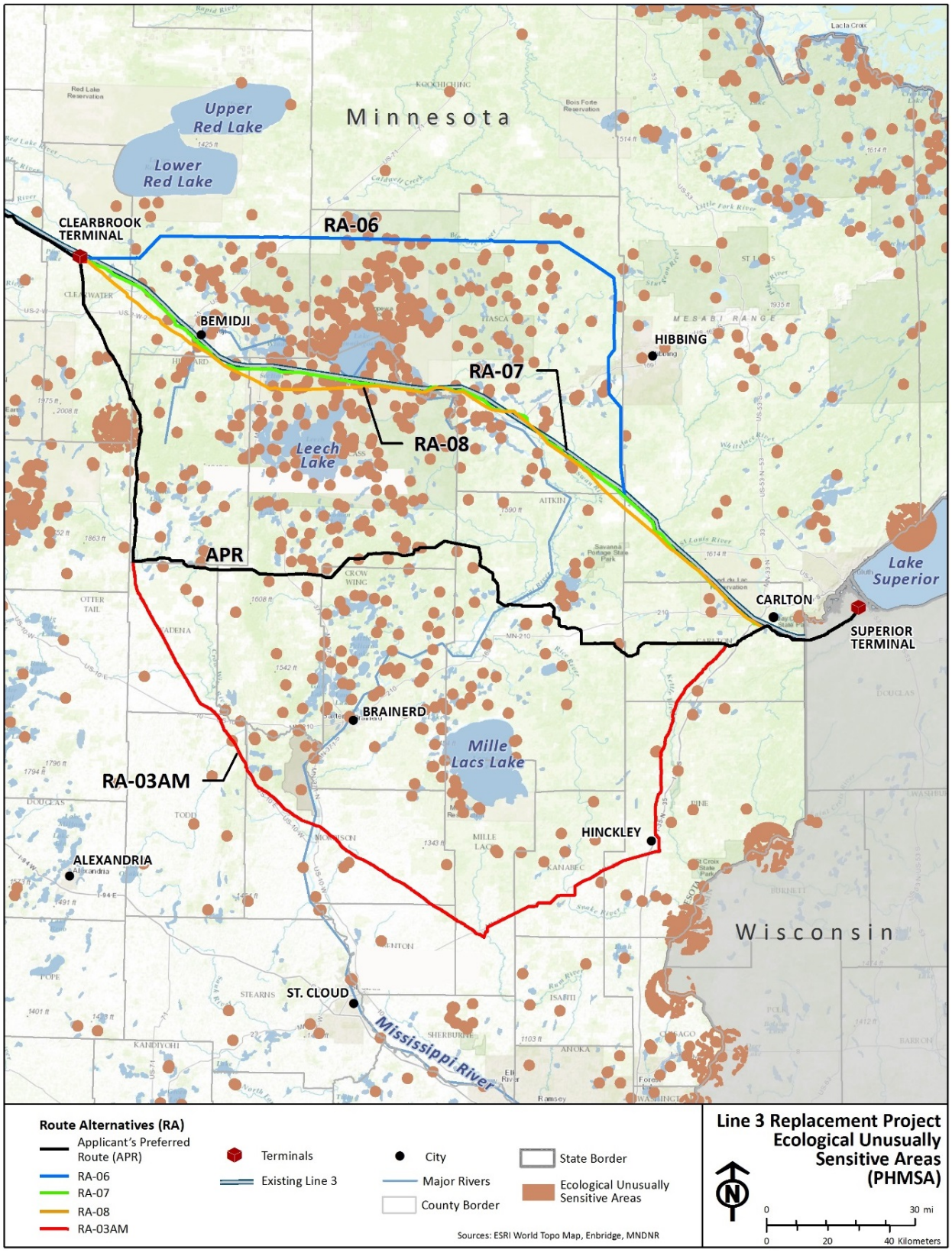


Figure 10.4-5. High Consequence Area Unusually Sensitive Ecological Areas between Clearbrook and Carlton

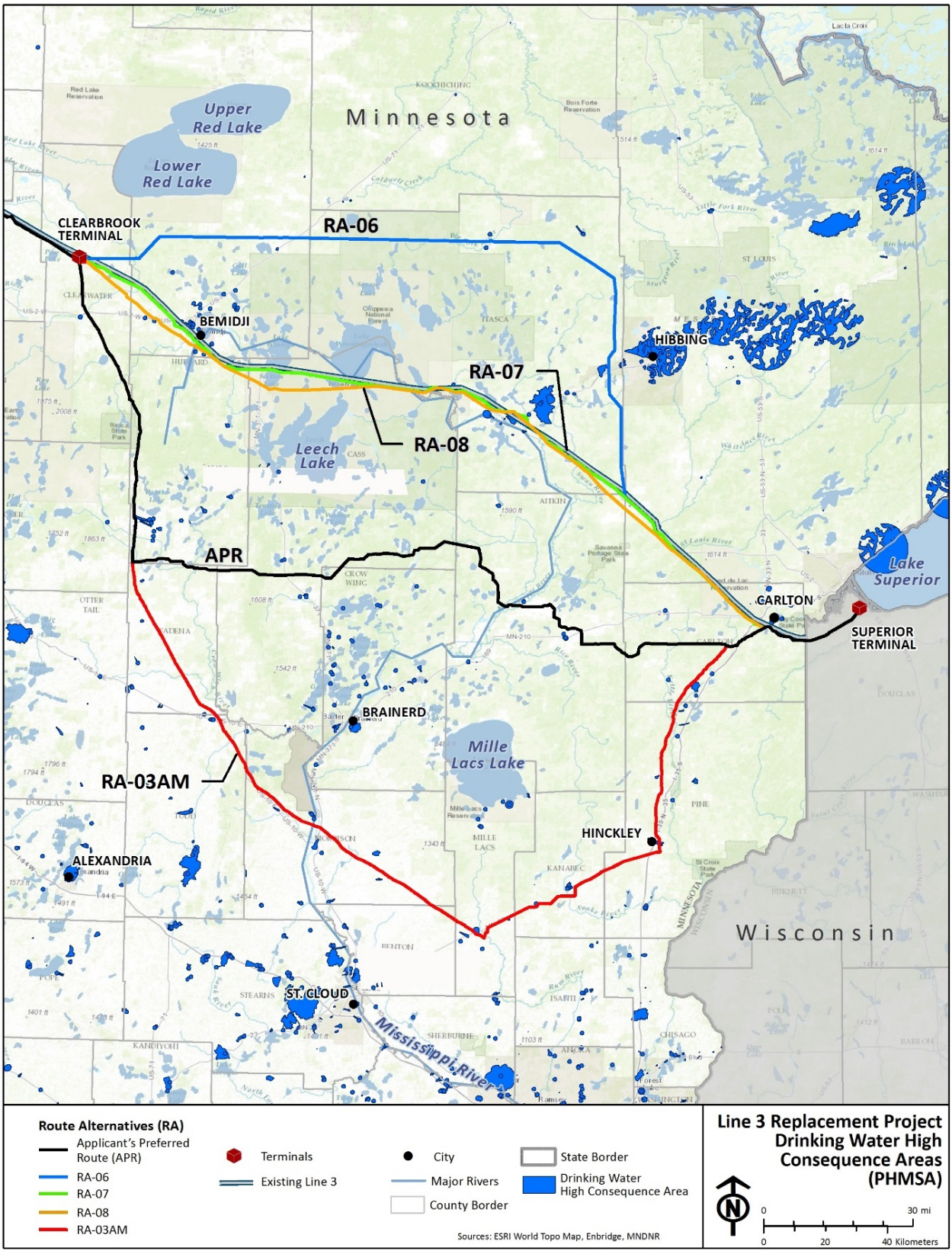


Figure 10.4-6. High Consequence Area Drinking Water Sources between Clearbrook and Carlton

10.4.3.1.2 AOI Comparisons between Applicant's Preferred Route and Route Alternatives

Drinking Water Areas of Interest

In addition to the HCA drinking water sources, Minnesota DH identified additional drinking water resources that may be susceptible to exposures of crude oil. As part of consultation with Minnesota DH (and with support from Minnesota DNR and Minnesota PCA), appropriate ROI distances for the protection of drinking water supplies were determined based on a consensus of existing information and case studies.

Drinking Water Supply Management Areas and Vulnerability

Minnesota PCA (2016) defines DWSMAs as "the surface and subsurface area surrounding a public water supply well, including the wellhead protection area that must be managed by the entity identified in a wellhead protection plan." DWSMA vulnerability is defined as "an assessment of the likelihood for a potential contaminant source within the drinking water supply management area to contaminate a public water supply well, based on geologic sensitivity and the chemical and isotopic composition of the ground water" (Minnesota DH 2015).

The numbers and acres of DWSMAs were determined, as well as the vulnerability of the DWSMAs within 1 mile of the centerline of each route. From Clearbrook to Carlton, RA-03AM has the greatest number of DWSMAs (11) within 1 mile, the most DWSMA acres, and the most acres of High and Very High vulnerability (Table 10.4-23). The Applicant's preferred route has the fewest number of DWSMAs (one) within 1 mile, fewest DWSMA acres, and fewest acres of High vulnerability; there are no Very High vulnerability areas within 1 mile of that route. Figure 10.4-7 shows the DWSMAs and their vulnerability ranking within 1 mile of the route centerlines.

Wellhead Protection Areas

A 1-mile-wide ROI was established for this drinking water resource. Minnesota WPAs are shown in Figure 10.4-8. The numbers and areas of WPAs within a 1-mile-wide ROI of each route are listed in Table 10.4-24. From Clearbrook to Carlton, RA-03AM has the greatest number of WPAs (11) and the most WPA acres. The Applicant's preferred route has the fewest number of WPAs (one) and the fewest WPA acres.

Table 10.4-23. Drinking Water Supply Management Areas with Vulnerability within 1 Mile of the Applicant's Preferred Route and Route Alternatives in Minnesota

Route	Number of DWSMAs	DWSMA Vulnerability (acres)					
		Very Low	Low	Moderate	High	Very High	Total
Applicant's preferred route	**5**	**0**	**521.3**	**734.5**	**790.6**	**0**	**2,046.4**
North Dakota-Minnesota border to Clearbrook	2	0	501.1	149.7	0	0	650.8
Clearbrook to Carlton	1	0	0	0	790.6	0	790.6
Carlton to Minnesota-Wisconsin border	2	0	20.3	584.7	0	0	605.0
Route alternative RA-03AM	**15**	**0**	**1,462.9**	**2,832.6**	**2,471.0**	**166.0**	**6,932.5**
North Dakota-Minnesota border to Clearbrook	2	0	501.1	149.7	0	0	650.8
Clearbrook to Carlton	11	0	941.6	2,098.1	2,471.0	166.0	5,676.7
Carlton to Minnesota-Wisconsin border	2	0	20.3	584.7	0	0	605.0
Route alternative RA-06	**7**	**0**	**872.2**	**1,385.6**	**0**	**109.0**	**2,366.8**
North Dakota-Minnesota border to Clearbrook	2	0	501.1	149.7	0	0	650.8
Clearbrook to Carlton	3	0	350.8	651.2	0	109.0	1,111.0
Carlton to Minnesota-Wisconsin border	2	0	20.3	584.7	0	0	605.0
Route alternative RA-07	**8**	**0**	**1,044.7**	**1,129.1**	**2,272.5**	**0**	**4,446.3**
North Dakota-Minnesota border to Clearbrook	2	0	501.1	149.7	0	0	650.8
Clearbrook to Carlton	4	0	523.4	394.6	2,272.5	0	3,190.5
Carlton to Minnesota-Wisconsin border	2	0	20.3	584.7	0	0	605.0
Route alternative RA-08	**7**	**0**	**730.3**	**1,162.9**	**2,338.0**	**0**	**4,231.2**
North Dakota-Minnesota border to Clearbrook	2	0	501.1	149.7	0	0	650.8
Clearbrook to Carlton	3	0	208.9	428.5	2,338.0	0	2,975.4
Carlton to Minnesota-Wisconsin border	2	0	20.3	584.7	0	0	605.0

Source: Minnesota DH 2016.

DWSMA = drinking water special management area

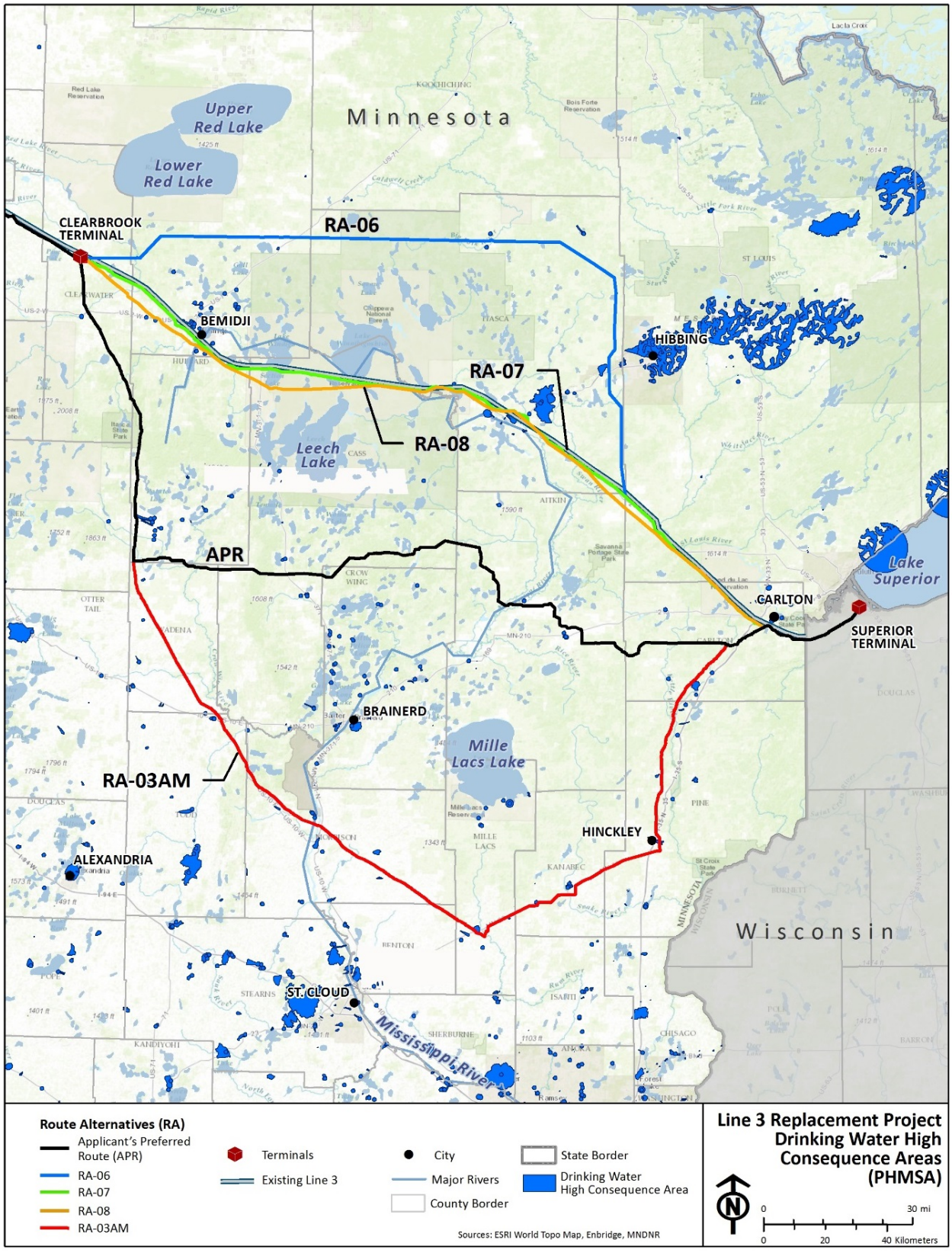


Figure 10.4-7. Drinking Water Supply Management Areas with Vulnerability between Clearbrook and Carlton

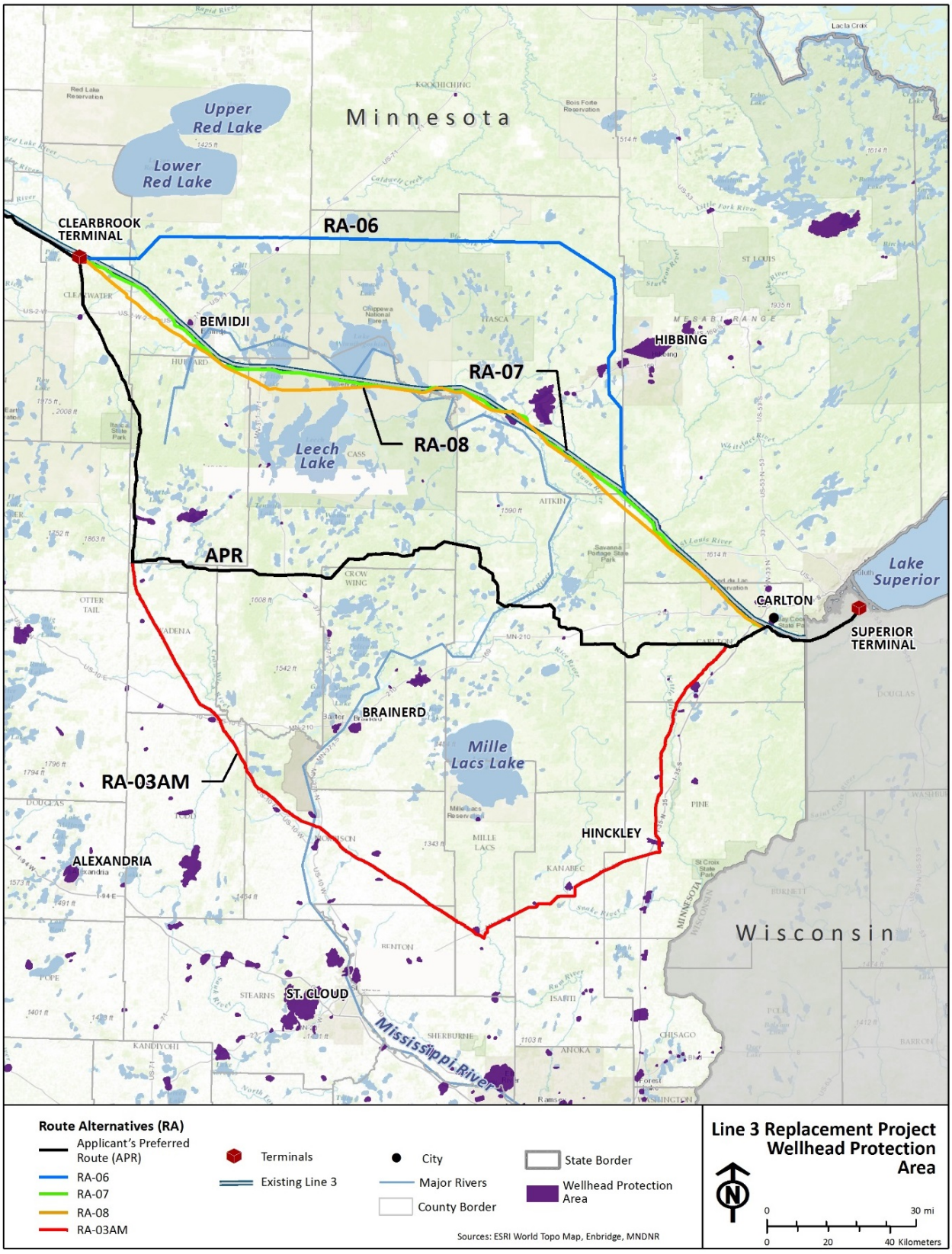


Figure 10.4-8. Wellhead Protection Areas between Clearbrook and Carlton

Table 10.4-24. Wellhead Protection Areas within 1 Mile of the Applicant's Preferred Route and Route Alternatives in Minnesota

Segment	Applicant's Preferred Route		Route Alternatives							
			RA-03AM		RA-06		RA-07		RA-08	
	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
North Dakota-Minnesota border to Clearbrook	214.3	3	214.3	3	214.3	3	214.3	3	214.3	3
Clearbrook to Carlton	219.5	1	3,159.1	11	653.6	2	2,646.5	7	2,626.8	8
Carlton to Minnesota-Wisconsin border	244.3	3	244.3	3	244.3	3	244.3	3	244.3	3
TOTAL	**678.1**	**7**	**3,617.7**	**17**	**1,112.2**	**8**	**3,105.2**	**13**	**3,085.5**	**14**

Source: Minnesota DH 2016.

Hydrogeologic Sensitivity of Near-Surface Materials

The hydrogeologic sensitivity of near-surface materials close to a pipeline is an important factor in influencing the potential migration of a plume should a crude oil release occur. Hydrogeologic sensitivity is a qualitative measure of the ability of near-surface materials to transmit contaminants vertically to the water table and is ranked as follows by Minnesota DH:

- Low: fine-grained materials such as clays and clay-silt mixtures;
- Moderate: clay-silt-sand mixtures, sandy or silty tills, and colluvium;
- High: sands and sandy mixtures; and
- Very High: gravels, or coarse sands mixed with gravel.

Areas of hydrogeologic sensitivity within 0.5 mile of each route are depicted on Figure 10.4-9 and listed in Table 10.4-25. RA-03AM has the greatest number of acres with Very High and High hydrogeologic sensitivity, followed by the Applicant's preferred route, RA-07, RA-08, and RA-06.



Figure 10.4-9. Areas of Groundwater Hydrogeologic Sensitivity within 0.5 Mile of the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Table 10.4-25. Hydrogeologic Sensitivity of Near-Surface Materials within 0.5 Mile of the Applicant's Preferred Route and Route Alternatives in Minnesota (acres)

Route	Not Evaluated	Low	Moderate	High	Very High	Total
Applicant's Preferred Route	**223.9**	**69,823.3**	**69,302.7**	**84,342.0**	**1,143.8**	**224,835.7**
North Dakota-Minnesota border to Clearbrook	0	38,022.5	36,493.4	1,509.6	0	76,025.4
Clearbrook to Carlton	223.9	29,427.9	31,222.4	80,661.7	1,143.8	142,679.7
Carlton to Minnesota-Wisconsin border	0	2,372.9	1,587.0	2,170.8	0	6,130.6
Route Alternative RA-03AM	**467.7**	**56,827.8**	**67,207.7**	**112,815.1**	**31,402.0**	**268,720.2**
North Dakota-Minnesota border to Clearbrook	0	38,023.1	37,081.0	1,509.6	0	76,613.7
Clearbrook to Carlton	467.7	16,431.8	28,539.7	109,134.8	31,402.0	185,975.9
Carlton to Minnesota-Wisconsin border	0	2,372.9	1,587.0	2,170.8	0	6,130.6
Route Alternative RA-06	**3,618.1**	**85,237.4**	**108,080.9**	**13,615.5**	**3,993.2**	**214,545.1**
North Dakota-Minnesota border to Clearbrook	0	38,023.1	37,102.2	1,509.6	0	76,634.8
Clearbrook to Carlton	3,618.1	44,841.4	69,391.8	9,935.2	3,993.2	131,779.6
Carlton to Minnesota-Wisconsin border	0	2,372.9	1,587.0	2,170.8	0	6,130.6
Route Alternative RA-07	**1,323.1**	**63,356.6**	**65,768.5**	**56,186.9**	**3,612.8**	**190,247.9**
North Dakota-Minnesota border to Clearbrook	0	38,023.1	37,098.0	1,509.6	0	76,630.7
Clearbrook to Carlton	1,323.1	22,960.6	27,083.6	52,506.8	3,612.8	107,486.8
Carlton to Minnesota-Wisconsin border	0	2,372.9	1,587.0	2,170.6	0	6,130.4
Route Alternative RA-08	**1,364.2**	**65,446.1**	**62,931.5**	**55,781.1**	**3,156.4**	**188,679.3**
North Dakota-Minnesota border to Clearbrook	0	38,023.1	37,096.1	1,509.6	0	76,628.7
Clearbrook to Carlton	1,364.2	25,050.1	24,248.5	52,100.7	3,156.4	105,919.9
Carlton to Minnesota-Wisconsin border	0	2,372.9	1,587.0	2,170.8	0	6,130.6

Source: Minnesota DH 2017, pers. comm.

Domestic Wells and Associated Geological Sensitivity Ratings

Domestic (private) drinking water wells and their sensitivity were identified within an established 1,000-foot-wide ROI of each route's centerline. The method of determining Low, Moderate, High, or Very High geologic sensitivity for a well considers the thickness of fine-grained geologic material (clay or shale) overlying an aquifer that is penetrated by a well. From Clearbrook to Carlton, RA-03AM has the greatest number of Very High and High sensitivity domestic wells, and RA-06 has the fewest number (Table 10.4-26).

Table 10.4-26. Geological Sensitivity Ratings of Domestic Wells within 1,000 Feet of the Applicant's Preferred Route and Route Alternatives in Minnesota (number of domestic wells)

	Low	Moderate	High	Very High	TOTAL
Applicant's Preferred Route	**115**	**37**	**29**	**18**	**199**
North Dakota-Minnesota border to Clearbrook	12	1	1	0	14
Clearbrook to Carlton	87	35	25	17	164
Carlton to Minnesota-Wisconsin border	16	1	3	1	21
Route Alternative RA-03AM	**270**	**101**	**28**	**32**	**431**
North Dakota-Minnesota border to Clearbrook	12	1	1	0	14
Clearbrook to Carlton	242	99	24	31	396
Carlton to Minnesota-Wisconsin border	16	1	3	1	21
Route Alternative RA-06	**61**	**5**	**5**	**4**	**75**
North Dakota-Minnesota border to Clearbrook	12	1	1	0	14
Clearbrook to Carlton	33	3	1	3	40
Carlton to Minnesota-Wisconsin border	16	1	3	1	21
Route Alternative RA-07	**146**	**48**	**14**	**10**	**218**
North Dakota-Minnesota border to Clearbrook	12	1	1	0	14
Clearbrook to Carlton	118	46	10	9	183
Carlton to Minnesota-Wisconsin border	16	1	3	1	21
Route Alternative RA-08	**133**	**48**	**9**	**7**	**197**
North Dakota-Minnesota border to Clearbrook	12	1	1	0	14
Clearbrook to Carlton	105	46	5	6	162
Carlton to Minnesota-Wisconsin border	16	1	3	1	21

Source: Minnesota DH 2017, pers. comm.

Public Drinking Water Supplies

Sources of drinking water for the Minnesota public include groundwater (public water wells) and surface water (surface water intakes). The locations of public water wells were provided by Minnesota DH. According to Minnesota DH, no surface water intakes or sources of public drinking water are within the 2,500-foot-wide ROI of any route (Table 10.4-27 and Figure 10.4-10).

Table 10.4-27. Number of Public Wells and Geologic Sensitivity within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives

	Low	Moderate	High	Very High	TOTAL
Applicant's Preferred Route	5	2	2	11	20
North Dakota-Minnesota border to Clearbrook	1	1	2	3	**7**
Clearbrook to Carlton	3	1	0	5	**9**
Carlton to Minnesota-Wisconsin border	1	0	0	3	**4**
Route Alternative RA-03AM	20	8	3	16	47
North Dakota-Minnesota border to Clearbrook	2	2	2	3	**9**
Clearbrook to Carlton	17	6	1	10	**34**
Carlton to Minnesota-Wisconsin border	1	0	0	3	**4**
Route Alternative RA-06	3	2	2	9	16
North Dakota-Minnesota border to Clearbrook	2	2	2	3	**9**
Clearbrook to Carlton	0	0	0	3	**3**
Carlton to Minnesota-Wisconsin border	1	0	0	3	**4**
Route Alternative RA-07	25	8	4	35	72
North Dakota-Minnesota border to Clearbrook	2	2	2	3	**9**
Clearbrook to Carlton	22	6	2	29	**59**
Carlton to Minnesota-Wisconsin border	1	0	0	3	**4**
Route Alternative RA-08	16	2	2	19	39
North Dakota-Minnesota border to Clearbrook	2	2	2	3	**9**
Clearbrook to Carlton	13	0	0	13	**26**
Carlton to Minnesota-Wisconsin border	1	0	0	3	**4**

Source: Minnesota DH 2017, pers. comm.



Figure 10.4-10. Public Drinking Water Wells (Groundwater) and Associated Geologic Sensitivity within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

From Clearbrook to Carlton, RA-07 has the most wells within the ROI, followed by RA-03AM, RA-08, the Applicant's preferred route, and RA-06. RA-07 also has the most wells with a Very High sensitivity rating, followed by RA-08, RA-03AM, the Applicant's preferred route, and RA-06.

Figure 10.4-11 shows sensitive drinking water resources within 2,500 feet of either side of the centerlines for all routes.

Cultural Resources Areas of Interest

A crude oil release along any of the routes has the potential to result in exposure of tribal lands, archaeological sites, and historical sites (Table 10.4-28). Between Clearbrook and Carlton, RA-07 and RA-08 ROIs overlap with the greatest amounts of tribal land, followed by RA-06 and RA-03AM ROIs. The ROI for Applicant's preferred route does not overlap with any tribal land AOIs.

Within the 2,500-foot-wide ROI, RA-07 and RA-08 contain the greatest number of archaeological sites, while RA-06 contains the least. RA-07 also has the greatest number of historic sites, and RA-06 has the least.

Biological Areas of Interest

Biological AOIs were identified within the 2,500-foot-wide ROI of the routes from Clearbrook to Carlton (Table 10.4-29 and Figure 10.4-12). The ROI of the Applicant's preferred route has the most MBS Sites acres and the fewest acres of Aquatic Management Area, Minnesota BWSR conservation easement, and Muskie lakes. It is the only route that overlaps with trout lakes (16 acres).

RA-03AM has the most Scientific and Natural Area acres and Minnesota BWSR conservation easement acres, and has the fewest native plant community and sensitive lakeshore acres. RA-06 has the fewest number of Lakes of Biological Significance and MBS Sites acres.

RA-07 has the most acreage of Aquatic Management Area, Lakes of Biological Significance, Muskie lakes, sensitive lakeshore, and wild rice lakes. It has the fewest Scientific and Natural Area acres. RA-07 and RA-08 both overlap with wetland bank easement acres (71 and 113 acres, respectively), while the other three routes do not. RA-08 has the most native plant community acres and is the only route that overlaps with native prairies (less than 2 acres).

As identified above, the Applicant's preferred route is the only route that overlaps with trout lakes within its 2,500-foot-wide ROI. All routes would overlap with trout streams. RA-06 has the greatest overlap with trout streams (20.3 miles), followed by RA-03AM (14.9 miles), RA-07 (14.7 miles), RA-08 (12.9 miles), and the Applicant's preferred route (9.4 miles). There are five calcareous fens within 2,500 feet of each side of the common alignment of the routes in the North Dakota-to-Clearbrook segment.



Figure 10.4-11. Drinking Water Sources within 2,500 Feet of the Centerlines of Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton

Table 10.4-28. Cultural Resource Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives in Minnesota

Segment	Acres of Tribal Land					Number of Archaeological Sites					Number of Historic Sites				
	APR	RA-03AM	RA-06	RA-07	RA-08	APR	RA-03AM	RA-06	RA-07	RA-08	APR	RA-03AM	RA-06	RA-07	RA-08
North Dakota-Minnesota border to Clearbrook	48.0	48.0	48.0	48.0	48.0	32	34	34	34	34	26	33	33	33	33
Clearbrook to Carlton	0	13.5	7,858.1	33,689.6	33,894.5	50	51	8	97	103	21	73	11	83	35
Carlton to Minnesota-Wisconsin border	0	0	0	0	0	3	3	3	3	3	4	4	4	4	4
TOTAL	**48.0**	**61.5**	**7,906.1**	**33,737.6**	**33,942.4**	**85**	**88**	**45**	**134**	**140**	**51**	**110**	**48**	**120**	**72**

Source: ESRI 2017; Minnesota Department of Transportation 2003.

APR = Applicant's preferred route, RA = route alternative

Table 10.4-29. Biological Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton (acres)

Area of Interest	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Aquatic Management Area	125.0	112.5	204.6	227.5	190.5
Scientific and Natural Area	0	234.5	63.7	7.5	85.2
Minnesota BWSR conservation easement	14.0	1,288.5	25.9	165.2	183.7
Lakes of Biological Significance	300.2	220.3	99.2	2,103.4	1,280.8
MBS Sites	25,016.2	16,339.8	8,952.1	9,962.2	12,257.6
Muskie lakes	41.4	0	0	976.6	55.8
Native plant communities	35,273.1	18,742.8	26,368.1	37,247.1	39,868.2
Native prairies	0	0	0	0	1.6
Sensitive lakeshore areas	300.5	178.6	0	1,329.8	1,151.6
Trout lakes[a]	16.3	0	0	0	0
Wetland bank easement	0	0	0	70.6	112.5
Wild rice lakes	675.4	708.6	92.4	1,240.4	1,119.5
TOTAL	**61,762.1**	**37,825.6**	**35,806.0**	**53,330.3**	**56,307.0**

Sources: Enbridge 2016c; Minnesota DNR 2016.

Notes:

[a] Data are for acres of trout lakes; miles of trout streams potentially affected are described in the text.

MBS = Minnesota Biological Survey Sites of Biodiversity Significance, Minnesota BWSR = Minnesota Board of Water and Soil Resources

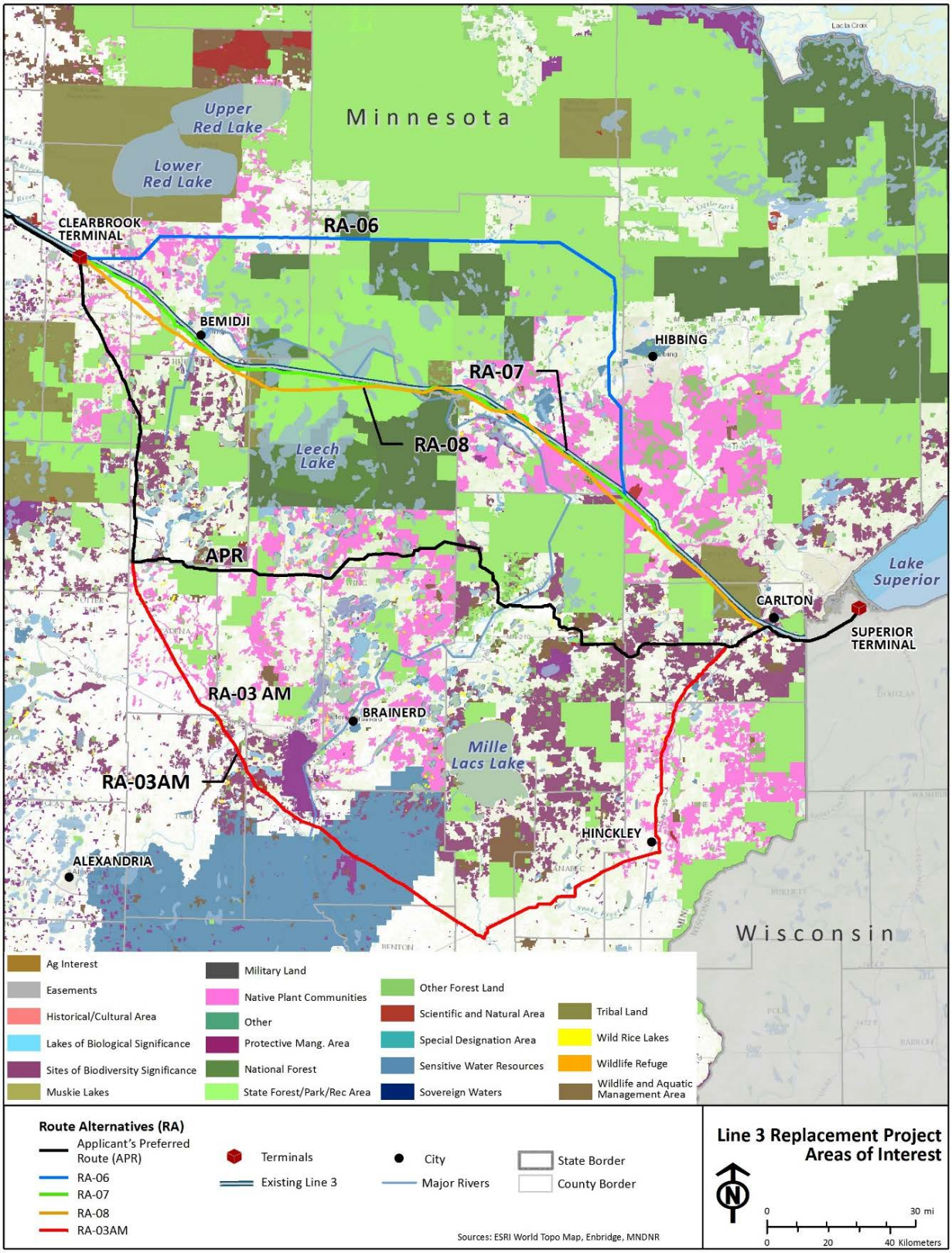


Figure 10.4-12. Areas of Interest along the Applicant's Preferred Route and Route Alternatives in Minnesota

Commodity Production Areas of Interest

The 2,500-foot-wide ROIs of all of the routes overlap with various forested lands. From Clearbrook to Carlton, RA-06 has the greatest number of national/state forest acres within its ROI, followed by RA-08, RA-07, the Applicant's preferred route, and RA-03AM (Table 10.4-30). All of the routes contain "other forested land" acres within their ROIs—RA-06 contains the most, followed by the Applicant's preferred route, RA-07, RA-08, and RA-03AM.

Table 10.4-30. Commodity Production Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton (acres)

Area of Interest	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
National/state forest	31,764.3	2,334.7	55,377.7	48,861.8	52,121.1
Other forested land	33,12.4	1,640.2	5,884.7	2,790.1	2,593.9
Marginal cropland	13.7	88.3	6.7	14.2	23.5
TOTAL	**35,090.4**	**4,063.2**	**61,269.1**	**51,666.1**	**54,738.5**

Sources: Minnesota DNR 2016; Enbridge 2016c.

The route ROIs also overlap with marginal cropland. Limited marginal cropland is a temporary conservation easement, while perpetual marginal cropland is a permanent easement as identified by the Minnesota Board of Water and Soil Resources. RA-03AM overlaps with the most acreage of marginal cropland within the 2,500-foot-wide ROI, followed by RA-08, RA-07, the Applicant's preferred route, and RA-06.

Recreation and Tourism Areas of Interest

The 2,500-foot-wide ROIs for RA-03AM and the Applicant's preferred route both overlap with approximately 318 acres of state recreation area and approximately 630 acres of state park from Clearbrook to Carlton. RA-06, RA-07, and RA-08 do not encompass any state recreation areas or state parks (Table 10.4-31).

Table 10.4-31. Recreation and Tourism Areas of Interest within 2,500 Feet of the Centerlines of the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton (acres)

Area of Interest	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
State plan/recreational areas	317.7	317.7	0	0	0
State parks	629.9	630.3	0	0	0
Wildlife Management Areas	1,299.3	477.7	294.1	16.4	439.5
Waterfowl production areas	92.0	260.8	418.0	185.8	277.2
TOTAL	**2,339.0**	**1,686.5**	**712.1**	**202.2**	**716.7**

Sources: Minnesota DNR 2016; Enbridge 2016c.

WMAs and waterfowl protection areas are present within the ROIs of all of the route alternatives. The ROI for the Applicant's preferred route has the greatest acreage of WMAs, followed by RA-03AM, RA-08, RA-06, and RA-07. RA-06 has the greatest acreage of waterfowl production areas in its ROI, followed by RA-08, RA-03AM, RA-07, and the Applicant's preferred route. The ROI for the Applicant's preferred route crosses the most total recreation and tourism AOI acres, followed by RA-03AM, RA-08, RA-06, and RA-07.

10.4.3.2 Potential Downstream Spill Exposure

10.4.3.2.1 High Consequence Area Downstream Comparisons

Populated Areas

From Clearbrook to Carlton, RA-03AM has the most HCA populated area acres within the 10-mile-long ROI downstream of its waterbody crossings, followed by RA-08, RA-07, the Applicant's preferred route, and RA-06 (Table 10.4-32).

Table 10.4-32. HCA Populated Areas within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives in Minnesota (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota-Minnesota border to Clearbrook	1,360.0	0	0	0	0
Clearbrook to Carlton	3,054.6	4,564.3	958.2	3,379.2	4,102.5
Carlton to Minnesota-Wisconsin border	0	0	0	0	0
TOTAL	**4,414.6**	**4,564.3**	**958.2**	**3,379.2**	**4,102.5**

Source: Enbridge 2016c.

HCA = high consequence area, ROI = region of interest

Unusually Sensitive Ecological Areas

From Clearbrook to Carlton, RA-08 has the most HCA unusually sensitive ecological area acres within the 10-mile-long ROI downstream of its waterbody crossings, followed by RA-07, RA-03AM, the Applicant's preferred route, and RA-06 (Table 10.4-33).

Table 10.4-33. HCA Unusually Sensitive Ecological Areas within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives In Minnesota (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota-Minnesota border to Clearbrook	666.5	666.5	666.5	666.5	666.5
Clearbrook to Carlton	4,748.1	4,845.4	4,205.7	8,482.3	9,068.8
Carlton to Minnesota-Wisconsin border	0	0	0	0	0
TOTAL	**5,414.6**	**5,511.9**	**4,872.2**	**9,148.8**	**9,735.3**

Source: Enbridge 2016c.

HCA = high consequence area, ROI = region of interest

Drinking Water Sources

From Clearbrook to Carlton, RA-03AM has the greatest number of HCA drinking water source acres within the 10-mile-long downstream ROI of its waterbody crossings, followed by RA-08, RA-06, RA-07, and the Applicant's preferred route (Table 10.4-34).

Table 10.4-34. Drinking Water Source HCAs within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives in Minnesota (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
North Dakota-Minnesota border to Clearbrook	411.6	411.6	411.6	411.6	411.6
Clearbrook to Carlton	417.7	1,076.6	549.8	546.7	892.7
Carlton to Minnesota-Wisconsin border	0	0	0	0	0

Source: Enbridge 2016c.

HCA = high consequence area, ROI = region of interest

10.4.3.2.2 Areas of Interest Downstream Comparisons

Drinking Water Areas of Interest

Drinking Water Supply Management Areas and Vulnerability

From Clearbrook to Carlton, RA-03AM has the most DWSMA acres within the 10-mile-long downstream ROI as well as the most acres of Moderate, High, and Very High vulnerability DWSMAs (Table 10.4-35). It has approximately three times as many DWSMA acres as RA-06, RA-07, and RA-08. The Applicant's preferred route has the fewest DWSMA acres. The 10-mile-long downstream ROI for RA-03AM overlaps with 11 DWSMAs; RA-06, RA-07, and RA-08 overlap with 4 DWSMAs each; and the Applicant's preferred route overlaps with 2.

Wellhead Protection Areas

From Clearbrook to Carlton, RA-03AM has the greatest number of WPA acres within the 10-mile-long downstream ROI (almost 502 acres), while the Applicant's preferred route has the least (approximately 30 acres). RA-03AM also overlaps with the most WPAs (eight), and all of the other routes overlap with two.

Domestic Wells and Associated Geological Sensitivity Ratings

Domestic water wells within 1 mile downstream of each water crossing and 500 feet from either side of the flowing waterbody were identified and are presented in Table 10.4-36. RA-03AM has the highest number of wells within the 1-mile-long downstream ROI, followed by the Applicant's preferred route, RA-08, RA-07, and RA-06. RA-03AM also has the greatest number of High and Very High sensitivity wells (40) and RA-06 and RA-07 have the least (each have 2).

Public Water Drinking Supplies

Public water well data also were available only within 1 mile of the centerline of each route. Thus, the 10-mile-long downstream ROI was limited to capturing public water wells within approximately 1 mile of the route (or 1 mile downstream in most cases).

Public water wells that fall within 1 mile of the route and 500 feet from either side of the flowing waterbody were identified. From Clearbrook to Carlton, the approximately 1-mile-long downstream ROI for the Applicant's preferred route overlaps with three public water wells, while RA-03AM and RA-08 overlap with two, RA-07 overlaps with one, and RA-06 does not overlap with any.

Cultural Resources Areas of Interest

From Clearbrook to Carlton, the 10-mile-long downstream ROI for RA-08 overlaps with the most acreage of tribal reservation boundary, followed by RA-07 and RA-06. The Applicant's preferred route and RA-03AM do not overlap with any reservation boundaries within the downstream ROI. None of the alternatives overlap with reservation boundaries in the North Dakota-Minnesota border to Clearbrook or Carlton to Minnesota-Wisconsin border segments. However, all of the route alternatives cross ceded territory. Table 10.4-37 identifies the extent of cultural resource AOIs for the Applicant's preferred route and the route alternatives. As described above, data on archaeological sites and historic resources were not available for all CN Alternatives.

Table 10.4-35. Drinking Water Special Management Areas with Vulnerability within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives in Minnesota

Route/Segment	Number of DWSMAs	Drinking Water Special Management Area Vulnerability (acres)					
		Very Low	Low	Moderate	High	Very High	Total
Applicant's Preferred Route	**4**	**175.2**	**22.0**	**45.2**	0	0	**242.3**
North Dakota-Minnesota border to Clearbrook	2	175.2	22.0	0	0	0	197.2
Clearbrook to Carlton	2	0	0	45.2	0	0	45.2
Carlton to Minnesota-Wisconsin border	0	0	0	0	0	0	0
Route Alternative RA-03AM	**11**	0	**197.5**	**334.0**	**423.6**	**41.0**	**996.0**
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0	0	0
Clearbrook to Carlton	11	0	197.5	334.0	423.6	41.0	996.0
Carlton to Minnesota-Wisconsin border	0	0	0	0	0	0	0
Route Alternative RA-06	**3**	0	**190.7**	**64.8**	**11.1**	**0.9**	**267.4**
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0	0	0
Clearbrook to Carlton	3	0	190.7	64.8	11.1	0.9	267.4
Carlton to Minnesota-Wisconsin border	0	0	0	0	0	0	0
Route Alternative RA-07	**3**	0	**312.6**	**13.1**	**11.1**	0	**336.7**
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0	0	0
Clearbrook to Carlton	3	0	312.5	13.1	11.1	0	336.7
Carlton to Minnesota-Wisconsin border	0	0	0	0	0	0	0
Route Alternative RA-08	**3**	0	**286.3**	**13.1**	**11.1**	0	**310.4**
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0	0	0
Clearbrook to Carlton	3	0	286.3	13.1	11.1	0	310.4
Carlton to Minnesota-Wisconsin border	0	0	0	0	0	0	0

Source: Minnesota DH 2016.

DWSMA = drinking water special management area, ROI = region of interest

Table 10.4-36. Domestic Wells within the Approximately 1-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives in Minnesota (number of domestic wells)

Route/Segment	Low	Moderate	High	Very High	Total
Applicant's Preferred Route	**96**	**16**	**14**	**20**	**146**
Carlton to Minnesota-Wisconsin border	4	0	0	0	4
Clearbrook to Carlton	73	16	14	19	122
North Dakota-Minnesota border to Clearbrook	19	0	0	1	20
Route Alternative RA-03AM	**101**	**36**	**20**	**20**	**177**
Carlton to Minnesota-Wisconsin border	101	36	20	20	177
Clearbrook to Carlton	101	36	20	20	177
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0
Route Alternative RA-06	**21**	**5**	0	**2**	**28**
Carlton to Minnesota-Wisconsin border	0	0	0	0	0
Clearbrook to Carlton	21	5	0	2	28
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0
Route Alternative RA-07	**29**	**8**	**1**	**1**	**39**
Carlton to Minnesota-Wisconsin border	0	0	0	0	0
Clearbrook to Carlton	29	8	1	1	39
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0
Route Alternative RA-08	**30**	**11**	**2**	**1**	**44**
Carlton to Minnesota-Wisconsin border	0	0	0	0	0
Clearbrook to Carlton	30	11	2	1	44
North Dakota-Minnesota border to Clearbrook	0	0	0	0	0

Source: Enbridge 2016c; Minnesota DH 2017, pers. comm.

ROI = region of interest

Table 10.4-37. Cultural Resources Areas of Interest within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton (acres)

Segment	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Clearbrook to Carlton	0	0	3,567.5	10,357.2	11,871.5

Source: Minnesota Department of Transportation 2003.

ROI = region of interest

Biological Areas of Interest

Biological AOIs were identified within the 10-mile-long downstream ROIs for the routes from Clearbrook to Carlton (Table 10.4-38). The ROI for the Applicant's preferred route overlaps with the most MBS Sites acres and wetland bank easement acres. It overlaps with the fewest Aquatic Management Area and native plant community acres. The Applicant's preferred route and RA-03AM are the only two routes whose ROIs overlap with Scientific and Natural Areas (approximately 150 and 238 acres, respectively).

Table 10.4-38. Biological Areas of Interest within the 10-Mile-Long Downstream ROI for the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton (acres)

Area of Interest	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
Aquatic Management Area	209.8	267.0	241.0	320.0	336.9
Scientific and Natural Areas	149.6	238.1	0	0	0
Minnesota BWSR conservation easement	37.4	385.1	0	36.1	35.9
Lakes of Biological Significance	3,608.9	1,952.6	1,222.5	3,400.1	4,286.4
MBS Sites	9,692.7	5,138.5	4,774.4	5,834.6	6,531.2
Muskie lakes	676.0	0	0	2,107.0	2,676.3
Native plant communities	14,015.3	16,937.9	15,591.9	20,211.6	21,661.8
Sensitive lakeshore areas	441.9	188. 4	158.3	513.4	713.7
Wetland bank easement	38.5	0	0	30.3	30.3
Wild rice lakes	3,396.3	2,385.1	1,021.5	2,956.4	3.902.3
TOTAL	**32,266.4**	**27,304.3**	**23,009.6**	**35,409.5**	**36,272.5**

Sources: Enbridge 2016c; Minnesota DNR 2016.

MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance, Minnesota BWSR = Minnesota Board of Water and Soil Resources, ROI = region of interest

The RA-03AM ROI overlaps with the most Minnesota BWSR conservation easement acres. It does not overlap with any Muskie lakes or wetland bank easement acres.

The RA-06 ROI overlaps with the fewest acres of Lakes of Biological Significance, MBS Sites, sensitive lakeshore area, and wild rice lakes. It also does not overlap with any Scientific and Natural Area, Minnesota BWSR conservation easement, Muskie lakes, or wetland bank easement acres. The RA-07 ROI also does not overlap with any Scientific and Natural Area acres.

The RA-08 ROI overlaps with the most Aquatic Management Area, Lakes of Biological Significance, Muskie lakes, native plant community, sensitive lakeshore, and wild rice lake acres.

All route ROIs overlap trout streams with the mileage of trout stream crossed ranging from 29.6 miles for RA-08 to 37.0 miles for RA-03AM.

Only the Applicant's preferred route ROI overlaps calcareous fens: none of the other route ROIs overlap calcareous fens.

None of the 10-mile-long downstream ROIs of any of the routes overlap with native prairies.

Commodity Production Areas of Interest

The 10-mile-long downstream ROIs of all of the routes overlap with various forested lands. From Clearbrook to Carlton, the RA-06 ROI overlaps with the greatest number of national/state forest acres, followed by RA-08, RA-07, the Applicant's preferred route, and RA-03AM. All of the route ROIs contain "other forested land" acres: RA-08 contains the most, followed by RA-07, RA-06, the Applicant's preferred route, and RA-03AM (Table 10.4-39).

Table 10.4-39. Commodity Production Areas of Interest within the 10-Mile-Long Downstream ROI of the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton (acres)

Area of Interest	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
National/state forest	12,054.9	653.9	24,550.0	17,132.8	20,897.7
Other forested land	1,904.1	838.7	2,154.5	2,207.8	2,495.8
Marginal cropland	11.3	69.3	0	10.0	10.0
TOTAL	**13,970.3**	**1,561.9**	**26,704.5**	**19,350.5**	**23,403.4**

Source: Enbridge 2016c; Minnesota DH 2017, pers. comm.

ROI = region of interest

The route ROIs also overlap with marginal cropland. The RA-03AM ROI overlaps with the most acreage of marginal cropland, followed by the Applicant's preferred route, and RA-08 and RA-07 (approximately 10 acres each). The RA-06 ROI does not overlap with any marginal cropland.

Recreation and Tourism Areas of Interest

The 10-mile-long downstream ROI of RA-03AM overlaps with the most state recreational area acres, and the Applicant's preferred route ROI overlaps with the least. RA-06, RA-07, and RA-08 ROIs all overlap with the same amount of state recreational area acres. The RA-03AM ROI also overlaps with the most state park acres, followed by RA-06, RA-07, and RA-08 (which overlap with the same amount), and the Applicant's preferred route (Table 10.4-40).

Table 10.4-40. Recreation and Tourism Areas of Interest within the 10-Mile-Long Downstream ROI of the Applicant's Preferred Route and Route Alternatives from Clearbrook to Carlton

Area of Interest	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
State plan/recreational areas	180.7	1,178.0	543.7	543.7	543.7
State parks	0.2	1,740.3	941.3	941.3	941.3
Wildlife Management Areas	1,172.7	385.6	3.0	299.5	293.1
Waterfowl production areas	11.5	11.5	182.2	0	0
TOTAL	**1,365.2**	**3,315.3**	**1,670.2**	**1,784.5**	**1,778.1**

Source: Enbridge 2016c; Minnesota DH 2017, pers. comm.

ROI = region of interest

The 10-mile-long downstream ROI of the Applicant's preferred route overlaps with the most WMA acres, followed by RA-03AM, RA-07, RA-08, and RA-06. The RA-06 ROI overlaps with the most waterfowl production acres, followed by the Applicant's preferred route and RA-03AM, and then RA-08. The RA-07 ROI does not overlap with any waterfowl production areas. The RA-03AM ROI crosses the most total recreation and tourism AOI acres, followed by RA-07, RA-08, RA-06, and the Applicant's preferred route.

10.5 SPILL PREVENTION, PREPAREDNESS, AND RESPONSE

Spill prevention is the most critical component to avoiding impacts from a crude oil release. If a release occurs, the most important actions to reduce environmental impacts are to minimize the size and spread of the release by implementing a rapid, coordinated, and effective spill response based on an established action plan. This section provides information on those activities in the following sections:

- Crude Oil Release Prevention Programs and Measures (Section 10.5.1),
- Emergency Response Planning and Preparedness (Section 10.5.2), and
- Initial Oil Spill Containment and Response Methods (Section 10.5.3).

10.5.1 Crude Oil Release Prevention Programs and Measures

The following sections address plans and programs to prevent, prepare, and respond to a crude oil release. Many of these plans are pursuant to safety standards and regulations described in Section 10.1.1.

10.5.1.1 Spill Prevention Measures

10.5.1.1.1 Pipeline Plans and Measures

The Applicant has proposed various oil spill prevention measures for the Applicant's preferred route that could also apply to operation and maintenance of system alternative SA-04 and any of the pipeline route alternatives. Enbridge's integrity management program is a key component to preventing crude oil releases. It includes highly sensitive tools that travel through and scan the internal and external conditions of the pipeline. Data collected are analyzed to identify integrity risks to the pipeline, such as corrosion or cracking, which could lead to a release of crude oil.

The proposed pipeline would have cathodic protection systems[24] to prevent corrosion of pipes. Enbridge patrols all permanent pipeline rights-of-way by air at least 26 times per year (at maximum 3-week intervals). These inspections review conditions on or adjacent to the permanent right-of-way. Line walking inspections are also used, as warranted, to supplement aerial inspections in some areas. Enbridge regularly checks operation of isolating valves (at least twice per year) and equipment used to limit, regulate, control, or relieve pipeline pressure.

In 2010 and 2014, Enbridge added the following measures and procedures into its routine operation and maintenance activities (DOS 2017):

- Augmented Control Center staff, including additional engineering and operator positions;
- Provided additional training and technical support;
- Re-organized the functional areas responsible for pipeline and facility integrity;
- Increased the number of in-line inspection programs and integrity digs (excavation, examination, maintenance, and repair);
- Revised and improved many procedures within the IMP;
- Implemented additional leak detection analysis procedures, including improvements to the leak detection escalation process, shift change transitions, alternate leak detection procedures, and analysis and communication procedures;
- Formalized a quality management system to execute more effectively the critical work activities that meet pre-defined quality objectives;
- Established a Pipeline Control Systems and Leak Detection Department, doubling the number of employees and contractors dedicated to leak detection and pipeline control;
- Implemented a Leak Detection Instrumentation Improvement Program to add and upgrade instrumentation across its system based on the assessments;

[24] Cathodic protection systems inhibit corrosion by applying a low-voltage electrical current to pipelines (see Section 2.3.2.3).

- Enhanced the Leak Detection Analyst Training Program; and
- Made changes to its pipeline remote monitoring and control systems.

A component of Enbridge's IMP is the Geohazard Management Program, which monitors for extreme weather events and for potential pipeline exposures at flowing water crossings. When an inspection is triggered by an event (such as flooding), the regional engineering group is notified and they deploy a local pipeline maintenance crew to make a visual site inspection. If the inspection finds damage within the permanent right-of-way, it is examined and repair work is completed as needed on a site-by-site basis.

Public Awareness Program

Since third-party damage is a leading cause of pipeline releases, Enbridge has a comprehensive Public Awareness Program in place. Enbridge maintains this Public Awareness Program to improve public awareness of the presence of its underground pipelines and related facilities. As a part of the program, Enbridge installs aboveground markers to identify the presence of pipelines and identifies ways to prevent damage to the pipelines from excavating equipment. The program includes communication with local, state, and national officials and agencies; emergency responders; local fire and law enforcement departments; state pipeline safety and emergency management agencies; landowners along their pipeline rights-of-way; excavators; and others. Enbridge also facilitates face-to-face communication, advertising, e-campaigns, sponsorships, events, mailings, publications in local newspapers, and grants.

10.5.1.1.2 Rail Plans and Measures

Four companies operate on major railroads in Minnesota and could transport crude oil—Burlington Northern Santa Fe, Canadian National, Canadian Pacific, and Union Pacific (Minnesota Department of Transportation 2017a). Each of these railroad companies are required to follow the national safety regulations described in Section 10.1.1.2, which are designed to prevent accidents from occurring. Railroad companies have voluntarily agreed to slow down trains carrying crude oil in 45 "high-threat urban areas," including the Twin Cities. Rail inspections to examine the tracks for flaws that could result in track failure are a key component to preventing rail accidents. The FRA specifies how many inspections should be done. Because of the risks, however, railroads have increased their own inspections well above required levels (Minnesota Department of Transportation 2017b).

10.5.1.1.3 Truck Plans and Measures

Accident prevention for transporting crude oil by truck would depend on the company hauling the crude oil. Plans would typical involve specialized employee training and safety awareness programs. Trucking companies are required to follow the national and state safety standards discussed in Section 10.1.1.3, which are designed to prevent accidents from occurring on the roads and highways. For instance the Federal Motor Carrier Safety Administration initiated the Federal Hazardous Materials Safety Permit Program for intrastate, interstate, and foreign trucks transporting certain types and amounts of hazardous materials, including crude oil. These carriers must maintain a certain level of safety in their operations and certify they have programs in place as required by regulations (Federal Motor Carrier Safety Administration 2017).

10.5.2 Emergency Response Planning and Preparedness

Spill response timing and effectiveness have a large effect on the extent, severity, and persistence of impacts from an accidental release of crude oil. A well-executed spill response that quickly stops the flow of oil and recovers the oil quickly can substantially reduce potential environmental impacts. This section addresses national oil spill response planning (Section 10.5.2.1) and regional oil spill response planning (Section 10.5.2.2) that would apply to all CN Alternatives and route alternatives. Applicant spill response planning that would apply to the Applicant's preferred route and could also apply to system alternative SA-04 and any of the route alternatives are summarized in Section 10.5.2.3.

10.5.2.1 National Spill Response Planning

Provisions of the Clean Water Act of 1972 and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) mandated development of a National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to establish standard protocol for responding to oil spills and other hazardous substance releases in the United States. The NCP, developed by the U.S. Environmental Protection Agency (EPA), established the federal National Response System (NRS), which can be activated to organize and support spill response activities. The NRS is made up of a network of cooperating response teams consisting of personnel from federal, state, and local agencies as well as organizations with specialized skills and knowledge that can be called on to respond to spill emergencies. To facilitate a rapid and effective response, NRS teams ensure that technical, financial, and operational information on responding to oil spills is available; the roles of different agencies on the NRS teams are clearly outlined; regional plans to respond to spills are maintained; oversight and consistency reviews for response plans are undertaken; and appropriate technical advice, equipment, or manpower are available to assist with a response.

10.5.2.2 Regional Spill Response Planning

The NCP also established Regional Response Teams (RRTs) with defined roles and responsibilities within the NRS. Each RRT consists of a core team (made up of federal, state, and local government representatives) that can be supplemented with appropriate incident-specific teams during a response. Minnesota is included in Region 5 of the NCP (Region 5 RRT), which also includes Illinois, Indiana, Michigan, Ohio, and Wisconsin (Region 5 RRT 2017). Since Region 5 includes areas along the U.S.-Canada border, Canadian agencies often work with members of the RRT during response plan development and may provide or request assistance in the event of a spill along the border.

The RRT acts as a regional planning and coordination body for preparedness and response actions. Preparedness activities are carried out in conjunction with appropriate state emergency response committees, area committees, local emergency planning committees, and tribal councils.

The governor of each state in Region 5 designates a lead agency that can direct state-led response operations (Region 5 RRT 2017). The primary agency representative to the Region 5 RRT for Minnesota is the Minnesota PCA. The state of Minnesota has an Emergency Response Plan as does each state agency. In case of a spill, Minnesota PCA's emergency response plan would be implemented in coordination with the regional and area plans. Minnesota PCA has staff members in eight offices throughout the state's six regions: Northwest region (Detroit Lakes Office), Northeast region (Duluth Office), North Central region (Brainerd Office), Southwest region (Willmar Office and Marshall Office), Metro region (St. Paul Office), and Southeast region (Mankato Office and Rochester Office).

10.5.2.3 Pipeline Spill Response Planning

Control of the Applicant's preferred route (or any of the pipeline alternative routes) would be incorporated into the existing Enbridge Supervisory Control and Data Acquisition system, which can automatically initiate pump station shutdowns to maintain safe operating pressures. Pipeline control operators also can manually initiate pipeline shutdown if abnormal conditions are suspected or observed. Enbridge enforces a "10-minute rule" that requires operators to shut down a pipeline within 10 minutes of observation of an abnormal condition that cannot be attributed to normal fluctuations in pressures and operating conditions.

In addition to the operations and maintenance measures described in Chapter 2 of this EIS, contingency oil spill response plans for the Project would require approval by appropriate federal agencies prior to construction and operation if a pipeline were approved. For example, PHMSA regulations require the submission of emergency response plans to PHMSA for review and approval (49 CFR 194).

Following the July 2010 rupture of Enbridge's Line 6B pipeline and subsequent catastrophic oil release into wetlands and the Kalamazoo River in Marshall, Michigan, Enbridge developed an Integrated Contingency Plan (ICP) that serves as the emergency response plan for Enbridge's pipelines for the Superior Region (from the Canadian border near Neche, North Dakota, across Minnesota, and into Wisconsin and Michigan). Input on the ICP was provided by the EPA, U.S. Coast Guard (USCG), Occupational Safety and Health Administration, and other agencies. Enbridge's ICP was approved by PHMSA on July 11, 2013, for other Enbridge pipelines, and Enbridge would require approval of the ICP from PHMSA in order for the plan to cover a Line 3 Replacement pipeline. The Applicant's preferred route and route alternatives are within the Superior Region. System alternative SA-04 is partially within the North Dakota and Mid-Continent regions.[25]

Each of the four U.S. regional annexes to the ICP contains an Emergency Response Action Plan (ERAP),[26] which is an Enbridge region-specific, concentrated version of the ICP focused on the unique features of the region. Each region-specific ERAP is designed to be used by first responders and Enbridge personnel in the field. The ERAPs provide first responders and others with important information needed to work with Enbridge spill response equipment and personnel in the event of an emergency. They contain notification lists and protocols, detailed lists of response equipment maintained by Enbridge along the pipeline routes, organization charts, decision-making flowcharts, evacuation information, mitigation and recovery efforts information, specific response and recovery techniques, Safety Data Sheets for the products transported by Enbridge, and other important forms.

Enbridge's ICP and ERAPs are prepared to fulfill the requirements of local, state, and federal regulatory agencies mandating written procedures to address planning and response to emergencies, including PHMSA's pipeline safety regulations specified in 49 CFR Parts 194 and 195 and applicable Occupational Safety and Health Administration, USCG, and API national technical standards.

At EPA's direction, Enbridge has also developed a Submerged Oil Recovery Plan to describe tactical methods that could be employed to recover spills submerged in water.[27] The plan includes methods to identify areas containing submerged oil after a spill including geomorphologic assessment, poling

[25] The Enbridge Central Region ICP is available at http://www.cnpl.enbridge.com/Projects-and-Infrastructure/Public-Awareness/Emergency-Response-Action-Plans.aspx.

[26] ERAPs are sometimes referred to as Field Emergency Response Plans in other planning documents.

[27] The Enbridge Submerged Oil Recovery Plan is available at http://dnr.wi.gov/files/PDF/pubs/ea/EA0230.pdf.

surveys, and sediment sampling and core logging. The plan also provides methods that would be used to recover submerged oil including raking, tilling, air injection, chain dragging, and other procedures.

Enbridge owns and maintains spill response equipment stored in several locations across the United States. Enbridge has established pipeline maintenance shops along the Enbridge Mainline system, including at Bemidji and Thief River Falls, Minnesota, and in Superior, Wisconsin. Equipment stored in these shops includes apparatus to contain and absorb oil released to water including various booms (e.g., river booms, sorbent booms, and containment booms), pumps and portable dam systems, skimmers, sorbent pads and rolls; boats and response vessels to handle water-based activities; and specialized equipment for land-based activities including portable tanks, generators, and trailers.

Enbridge also has portable emergency response trailers, which contain hard boom, sorbent boom, skimmers, and portable water tanks as well as various tools for initial emergency response to both land and water releases. Response equipment and supplies also include personal protective equipment for responders including respiratory equipment, hard hats, gloves, safety glasses, safety boots, and impervious clothing. The ICP contains guidance on personal protective equipment requirements, use, maintenance, storage, and disposal. Periodic inspection and maintenance is performed on each piece of equipment in accordance with recommendations from the manufacturer. After an equipment deployment exercise or actual response, each piece of deployed equipment is inspected to assess its condition and determine if any repairs or replacements need to be made. Equipment is also periodically inspected and if found to be defective, is repaired or replaced.

Enbridge employees in the United States and Canada participate in regular emergency response drills and simulations to practice and improve preparedness procedures. Employees are trained through workshops, tabletop and full-scale exercises, and procedural drills, often in partnership with local response agencies, regulators, and external observers.

The National Transportation Safety Board (NTSB) identified deficiencies in training of first responders and emergency response resources as one of the inadequacies of the response following the 2010 Line 6B rupture in Marshall, Michigan (NTSB 2012). To improve safety training, the Enbridge Enterprise Emergency Response Team was created in 2011 as a cross-company team with specialized training. The team regularly conducts major training exercises involving emergency response contractors and consultants, as well as emergency response agencies at the local, state/provincial, and federal levels. The Enbridge Enterprise Emergency Response Team is trained to respond to large-scale events in Enbridge operational locations in North America. Enbridge states that its training programs meet the National Preparedness for Response Exercise Program standards, which were developed by PHMSA, the USCG, the EPA, and the U.S. Department of the Interior to establish a minimum preparedness exercise program for federally regulated companies. Enbridge also operates Pipeline Public Awareness and Emergency Response Programs, as described in Section 2.8.1, to address the problems noted by NTSB.

10.5.3 Initial Oil Spill Containment and Response Methods

The following sections describe the response framework designed to contain a release of crude oil and minimize the potential effects on the natural and human environment due to a release:

- Notification, Mobilization, and Response (Section 10.5.3.1); and
- Potential Spill Response Challenges (Section 10.5.3.2).

10.5.3.1 Notification, Mobilization, and Response

In the event of a pipeline crude oil release, leak detection systems would be in place to alert the Control Center (see Section 2.8.1 for details on leak detection systems). The amount of time required to identify a leak depends on the nature of the release. Large ruptures result in multiple leak triggers and alarms that notify the controller almost instantaneously. Small leaks are typically detected by the computational pipeline monitoring systems and the line balance calculation process, both of which are tuned to detect large and small leaks. The smaller the leak, the more time it takes for an alarm to be triggered by these systems.

Although leak detection systems would be in place, some leaks might not be detected by the system for an extended period of time. A pinhole leak, for example, could remain undetected for a period of time if the release volume rate is below detectable levels. Detection of such leaks would likely occur through visual or olfactory identification, either by regular pipeline aerial inspections, ground patrols, or landowner or citizen observation. Pinhole leaks can also be detected by an acoustical pipeline inspection gauge (see Section 2.8.2.1).

In the event of a release of crude oil from an Enbridge pipeline during operations, the Control Center would shut down the pumps and close the MLVs in the area of the release. Following pump shutdown and valve closure, on-call operations personnel and managers would be notified internally by the Control Center. Notifications would occur for both internal and external parties, including the National Response Center, the state, and local police. Enbridge first responders would work to confirm the nature and location of the incident as notifications occur. The ERAP provides specific response steps and tactics to be used within each region, considering the unique topography and features along a pipeline route within the region. First responders would generally arrive on the scene within minutes of being alerted of an incident and work to secure the scene, undertake evacuations when necessary, and implement the ERAP procedures (Enbridge 2015a).

Enbridge's ERAP includes predetermined steps to take in the event of an incident. Maps and tables based on information in established regional response plans are included to identify HCAs along pipeline routes for each region. The maps and tables allow responders to know where to direct response resources, so that emergency responders can begin work immediately upon deployment. For example, ERAPs contain information on the location of resources of concern, such as wetland vegetation, sensitive shoreline areas, and other features. Emergency responders use the maps and tables to place booms and take other necessary response measures to protect resources and limit the scope of an oil spill incident.

In the event of an oil spill, Enbridge emergency response staff would inform the appropriate public agencies, which would determine if evacuation is necessary to safeguard human health. Evacuation parameters include consideration of the potential for fire, explosion, and presence of hazardous gases. Containment and absorbent materials would be applied to spills with the potential to reach surface waters or wetlands. If a spill did reach a waterbody, sorbent booms and pads would be applied to initiate containment and recovery of released materials in standing water. For large spills in waterbodies, Enbridge would secure emergency response contractors to further contain and clean up the spill.

Except on federal lands, response actions are generally monitored and/or implemented by the most immediate level of government with authority and capability to conduct such activities (Region 5 RRT 2017). The first level of response to a spill during Project operations would generally be onsite Enbridge personnel followed by local government agencies, or state agencies if local capabilities are exceeded (Region 5 RRT 2017). When incident response is beyond the capability of the state, the EPA is authorized

to take response measures deemed necessary to protect the public health or welfare or the environment from discharges of oil or releases of hazardous substances, pollutants, or contaminants. The EPA also has authority to respond to spills on tribal lands.

If an oil spill required additional response measures, the national and regional plans described in Section 10.5.2 could be implemented to contain and control the release. In a large response effort, a Unified Command and an Incident Management Team made up of NRS personnel would be created to address site/spill-specific concerns. In the event of a pipeline spill on land or in inland waters, the EPA would be the lead federal agency in charge of the response. In the event of a pipeline spill in coastal or international border waters, the USCG is the lead federal agency in charge of the response.

The actions that could be taken with the resources outlined in the Region 5 RRT Regional Contingency Plan/Area Contingency Plan include, but are not limited to, the following:

- Placing containment and recovery booms and pads,
- Sampling runoff and surface waters,
- Excavating soil,
- Performing hydrogeological investigations,
- Conducting wildlife rescue and rehabilitation,
- Closing drinking water intakes, and
- Providing an alternate water supply (Region 5 RRT 2017).

The Regional Contingency Plan/Area Contingency Plan identifies environmentally and economically sensitive areas in an atlas series and a set of GIS products intended to provide oil spill contingency planners and spill responders in Region 5 with the most accurate and relevant information possible for spill preparedness and response (Region 5 RRT 2017). Information mapped in GIS includes:

- Species data including federal and state-listed threatened and endangered species;
- Federal, state, regional, and privately owned and managed natural resource areas;
- Tribal lands;
- Federal, state, regional, and private designations of natural resource areas (no ownership);
- Drinking water intakes;
- Industrial water intakes;
- Locks and dams;
- Marinas and boat accesses;
- Oil storage (above 1,000 barrels [42,000 gallons]) and oil pipelines; and
- Federal, state, and tribal trustees (Region 5 RRT 2017).

The Region 5 RRT has developed an Inland Response Tactics Manual to direct responders on appropriate response methods depending on the spill location, prevailing environmental factors, and response technique considerations and limitations (Region 5 RRT 2013). For example, the manual describes and

diagrams containment methods on ice with trenches and sumps, various land barriers that can be constructed with available materials (e.g., earth, gravel, snow), and the purposes of different booming configurations in streams, rivers, and open water (Region 5 RRT 2013).

10.5.3.2 Potential Spill Response Challenges

The immediate response to a crude oil release from the Project would be by local first response agencies to secure the area, along with public and environmental health officials, local response contractors, and other parties qualified to assist with the response effort. Response times for first responders would depend on the location of the incident; crude oil releases in or near populated areas would likely result in faster response times than incidents occurring in more remote areas since there are typically more response facilities and personnel in more developed areas.

In Minnesota, the Applicant's preferred route and route alternatives generally pass through rural, sparsely populated areas. Rural communities can face challenges regarding emergency preparedness and response, such as proximity to adequate response personnel and equipment, and may lack needed space, supplies, and staff to respond quickly and effectively to emergencies (see Section 10.5.3.2.1 below). If an oil spill incident becomes too large or complex for local and onsite capabilities, the regional or national response capabilities described above would be mobilized to support the response effort.

Oil released into aquatic environments can be difficult to contain and recover in large quantities, since water surface and weather conditions must be sufficiently calm to permit the selected equipment to function well and for response personnel to safely operate equipment. In addition, spilled oil must be recoverable with available skimmers and other equipment that would be used in waterbodies. Oil spills that enter large, flowing waterbodies can spread rapidly and be difficult to completely contain and treat. Riverine currents can make spills particularly difficult to contain because oil can be rapidly carried to shorelines, wetlands, and flats. Recovery in these environments can be increased with the use of underflow dams, overflow dams, sorbent barriers, or a combination of these techniques (Crosby et al. 2013).

Spilled crude oil in waterbodies can sink, making it more difficult to detect, track, and map. In addition, submerged oil is often highly viscous, making it difficult to pump. Every submerged oil spill is a unique combination of conditions based on oil type, environmental setting, and physical processes (U.S. Department of Homeland Security 2013). Dilbit that reaches or is directly released to waterbodies may pose unique challenges because of its propensity to form dense residues during weathering and sink to the bottom, or combine with particles present in the water column (forming tarballs) to submerge and then remain in suspension or sink (National Academies of Sciences, Engineering, and Medicine 2016).

Winter oil spills may be harder to detect and more difficult to contain and recover due to the presence of snow and ice cover. An oil spill that results in oil reaching waterbodies during freeze-up[28] or breakup[29] may also be difficult to manage because ice may not be strong enough to support people or equipment. In rivers, spilled oil may be transported several miles under ice or in broken ice before it can be contained. If ice cover is not strong enough to support people and equipment, oil spilled underneath may be more difficult to detect and it may be more difficult to implement rapid containment and cleanup at and near the spill site. Major flooding or adverse weather conditions (e.g., high winds, blizzards, and extreme cold) may also hinder spill response contractors from implementing timely and

[28] The freezing over of a waterbody.

[29] The breaking, melting, and loosening of ice in the spring.

effective oil spill containment and clean-up operations. Enbridge and its response contractors have access to specialized response equipment in case of a spill during harsh winter conditions. Such response equipment includes:

- Remotely operated vehicles that can move below the surface of ice to detect oil with sensors and can transport equipment below the surface to remove oil;
- Ice drills or augers that cut holes in the ice to allow hoses and pumps to suction oil from beneath ice;
- Arctic-specific water skimming equipment that can be used in both open water and icy conditions;
- Specialized ice and fire booms that can be deployed to contain oil; and
- Vessels with water cannons that move spilled oil to containment and collection areas (Enbridge n.d.).

Training in winter conditions is undertaken by response personnel to improve readiness for such situations (Enbridge n.d.).

Five organizations are recognized in the NCP with specialized expertise that can be used to respond to difficult situations. These organizations are:

- USCG National Strike Force,
- USCG Public Information Assist Team,
- EPA Environmental Response Team,
- NOAA's Scientific Support Coordinators, and
- Natural Resource Trustees.

The lead agencies designated within the NRS are responsible for coordinating spill response efforts.

10.5.3.2.1 Remote Area Analysis

The magnitude of potential impacts on a resource may be directly related to response time and response time may be related to the accessibility of the spill. Rapid detection and response can reduce crude oil exposures and impacts on resources. Remote areas may be less accessible to spill response teams and therefore potentially more vulnerable to effects from crude oil spills. When a final route is selected, spill response strategies will be developed for areas with difficult access.

10.6 CLEANUP, RESTORATION, AND RECOVERY

After the initial spill response (focused on containment and recovery as discussed in Section 10.5.3), further cleanup would be undertaken, followed by more long-term restoration and recovery efforts. The following sections address those activities:

- Clean-Up Techniques and Equipment (Section 10.6.1),
- Restoration and Recovery Framework and Methods (Section 10.6.2), and
- Liability and Compensation (Section 10.6.3).

10.6.1 Clean-Up Techniques and Equipment

Typically implemented techniques for containment and cleanup of spilled crude oil are described in Table 10.6-1.

Table 10.6-1. Oil Spill Containment and Clean-Up Techniques and Equipment

Technique	Actions and Equipment	Additional Supporting Equipment	Locations Typically Used
Mechanical containment	Booms contain, deflect, or divert oil	Trucks or vessels to install, reposition, and maintain the booms	Open water
Removal of oil	Sorbent pads or rolls are placed in water to contain and remove floating oil	Trucks or vessels to install, reposition, and maintain the sorbent materials	Nearshore environments
	Mechanized skimmers and vacuums collect oil from the surface into containers or storage tanks	Vessels to position the skimmers Decanters to separate water collected with the oil and return the water to the environment	Open water and nearshore
	Barriers and booms prevent the entry of oil into an area of concern	Vehicles or small vessels to transport equipment/personnel	Shoreline/small waterbody
Chemical dispersion	Cleaning agents are sprayed onto the oil slick.	Boats or Airplane to spray dispersants	Open water
In situ burning	Oil is directed or corralled into a fire-resistant boom and burned	Vessel to transport boom Helicopters to ignite oil	Open water and nearshore wetlands and bogs
Cleanup	Rakes, shovels, and other tools are manually used to collect oil into bags or containers	All-terrain vehicles or vessels to transport personnel and equipment	Sheltered rocky shorelines and human-made structures; sheltered rubble slopes

Table 10.6-1. Oil Spill Containment and Clean-Up Techniques and Equipment

Technique	Actions and Equipment	Additional Supporting Equipment	Locations Typically Used
	Oil is passively collected through sorbent materials	All-terrain vehicles to transport personnel and equipment	Sand beaches, gravel beaches, sheltered rocky shores, and human-made structures; sheltered rubble slopes; sheltered vegetated low banks; and marshes
	Oil is removed by vacuum	Truck-mounted vacuums or trucks to place or remove containers and vacuums	Exposed rocky shores, sand beaches, gravel beaches, sheltered rocky shores, and human-made structures; sheltered rubble slopes; sheltered vegetated low banks; and marshes
Natural attenuation	Oil is allowed to degrade	None	Areas where removal of oil could damage resources of concern

The use of these and other clean-up techniques would be determined on a case-by-case basis, with approval from regulatory agencies and according to regional or site-specific plans. For example, EPA Region 5 does not recommend the use of dispersants or other oil emulsifiers in fresh water because of limited effectiveness, so this clean-up method would not be used within Minnesota freshwater systems (Region 5 RRT 2017). The Minnesota PCA also does not recommend the use of dispersants. In addition, the use of burning on surface waters in Region 5, particularly near wetlands or water supplies, must be approved by state and/or federal agencies (Region 5 RRT 2017).

Recovery and cleanup for sunken/submerged crude oil may require additional techniques and equipment such as diver-directed pump and vacuum systems, remotely operated vehicles in the water column, sub-bottom profiling, manned submersibles, manual removal by divers, the use of nets and trawls, and dredging. Each of these recovery and clean-up methods for sunken/submerged oil has advantages and disadvantages, and the use of these clean-up strategies would be determined on a case-by-case basis.

10.6.2 Restoration and Recovery Framework and Methods

Effective oil spill remediation, habitat restoration, and environmental recovery can influence the magnitude and duration of impacts on receptors and resources. Recovery and restoration plans are prepared by the Responsible Party[30] and submitted to the federal or state agency in charge of spill response for a particular event. After review and approval of these plans, the Responsible Party and its contractors implement these plans, with ongoing review by agencies.

If it appears that there are significant impacts on natural resources due to a spill, a Natural Resource Damage Assessment (NRDA) may be initiated. NRDA is a legal process under the Oil Pollution Act of 1990 (OPA 90) that is used by federal, state, and tribal governments (referred to as “trustees”) to seek

[30] The term “Responsible Party” has a specific meaning for different sources of oil spills. For oil pipelines, the Responsible Party is the owner or operator of the pipeline (OPA 90, Section 1001[32][E]).

compensation for natural resource damages and restore vegetation; fish, wildlife, and their habitat; recreation resources; and other affected resources to pre-spill baseline conditions. Natural resource trustees conduct NRDAs on behalf of the public. Trustees assess and collect data on spill impacts on natural resources and use these data to identify and select projects to restore affected resources. For example, NRDA trustees for the July 2010 oil spill in Marshall, Michigan, were the U.S. Fish and Wildlife Service (USFWS), NOAA, affected tribes, and Michigan state agencies. Restoration planning by these trustees consisted of two steps: (1) assessment of impacts on instream habitats including riverine and lake habitats; floodplain habitats, including wetlands; upland habitats; specific species; public recreational uses; and tribal uses; and (2) restoration project selection. The NRDA trustees for the Marshall, Michigan, spill coordinated with the larger spill response efforts via the Incident Command System and began assessment of impacts within days of the spill occurring (USFWS 2015; USFWS et al. 2015).

Studies and programs conducted in support of natural resource recovery may include:

- Submerged oil assessment and recovery;
- Overbank assessment and recovery;
- Shoreline Cleanup Assessment Technique and Shoreline and Habitat Reassessment Technique;
- Water and sediment sampling;
- Contaminant monitoring and recovery;
- Emerging oil management program;
- Geomorphic assessments;
- Rapid vegetation assessments;
- Wildlife and avian surveys and rehabilitation; and
- Fish and benthic invertebrate surveys.

The primary responsibility for conducting these surveys lies with the Responsible Party, but the surveys may be conducted by the lead federal or state agency, assisting agencies, and/or NRDA trustees, either independently or jointly with the Responsible Party. In addition, volunteers may be allowed to participate in certain aspects of these programs, such as providing support for wildlife programs.

Restoration efforts in natural environments may include the following:

- Wetlands: sediment dredging, compensatory wetland restoration and creation actions, and monitoring for wetland functions and values.
- Fresh water: improvement of fish passage, stream and floodplain connectivity, and water quality, and reduction of erosion and sedimentation. Specific actions may include replacement of inadequate or undersized culverts, monitoring fish health, removal of invasive species, restoration of wild rice beds, dam removal, and channel restoration.

- Agricultural land: restoring upland habitats, controlling invasive species, pasture enhancement, and planting cover crops.
- Forest/woodland: planting, wildlife rehabilitation and tracking/monitoring, and enhancement of wildlife habitat.

Selection of specific projects and methods for restoration of affected resources varies based on the types and extents of habitats affected and the time needed for resource recovery (which is highly variable but can require decades). The costs of recovery and restoration efforts are addressed in the following section.

10.6.3 Liability and Compensation

OPA 90 establishes a framework that addresses the liability of Responsible Parties in connection with discharge of oil into navigable waters of the United States, adjoining shorelines, or the exclusive economic zone. OPA 90 replaced the liability limitations previously established in the Clean Water Act with much higher liability limits and expanded the class of persons authorized to recover removal costs from the Responsible Party to include any person rather than only the federal government. Liability limits are set by OPA 90 and differ depending on the type of facility. The Responsible Party of an incident is the person, business, or entity that has been identified as owning the pipeline that caused the spill. The Responsible Party is liable for the removal costs and damages up to their limit of liability unless the spill was caused by an act of God, an act of war, negligence on the part of the U.S. government, and/or an act or omission of a third party.

Under the provisions of CERCLA, OPA 90, and several state statutes, cost recovery can be obtained from industry for natural resource damage caused by the release of oil or hazardous substances to the environment. Natural resources are defined as land, air, biota, groundwater, and surface water. A federal or state government entity, an Indian tribe, or other entity acting as a public trustee of a natural resource may file claims for damages to natural resources. Costs for damages that are recoverable under OPA 90 include the following:

- Natural Resources: Damages for injury to, destruction of, loss of, or loss of use of natural resources, including the reasonable costs of assessing the damage, which are recoverable by a U.S. trustee, a state trustee, an Indian tribe trustee, or a foreign trustee.
- Real or Personal Property: Damages for injury to, or economic losses resulting from destruction of, real or personal property, which are recoverable by a claimant who owns or leases that property.
- Subsistence Use: Damages for loss of subsistence use of natural resources, which are recoverable by any claimant who uses natural resources for subsistence that have been injured, destroyed, or lost, without regard to the ownership or management of the resources.
- Revenues: Damages equal to the net loss of taxes, royalties, rents, fees, or net profit shares due to the injury, destruction, or loss of real property, personal property, or natural resources, which are recoverable by the federal government, a state, or a political subdivision thereof.

- Profits and Earning Capacity: Damages equal to the loss of profits or impairment of earning capacity due to the injury, destruction, or loss of real property, personal property, or natural resources, which are recoverable by any claimant.
- Public Services: Damages for net costs of providing increased or additional public services during or after removal activities, including protection from fire, safety, or health hazards, due to a discharge of oil, which are recoverable by a state, or political subdivision of a state.

Table 10.6-2 provides descriptions of federal and state laws and regulations that establish liability for crude oil spills that may be applicable to the Project.

OPA 90 also authorized use of the Oil Spill Liability Trust Fund (OSLTF), which currently contains $1 billion. To ensure rapid, effective response to oil spills, the U.S. president has the authority to make available—without Congressional appropriation—up to $50 million each year from the OSLTF to fund removal activities and initiate NRDAs (USCG 2016). Fund uses delineated by OPA 90 include:

- Removal costs incurred by the USCG and EPA;
- State access to the OSLTF for removal activities;[31]
- Payments to federal, state, and Indian tribe trustees to conduct NRDAs and restorations;
- Payment of claims for uncompensated removal costs and damages;
- Research and development; and
- Other specific appropriations (USCG 2016).

Enbridge maintains comprehensive insurance for its subsidiaries and affiliates. Coverage includes commercial general liability insurance that applies to Enbridge's legal liability for third-party property damage and injuries arising from operational activities, including an oil spill. Since the July 2010 rupture of Enbridge's Line 6B pipeline and subsequent oil release into wetlands and the Kalamazoo River in Marshall, Michigan, Enbridge has paid over $1.2 billion in response, clean-up, and restoration costs as well as fines from state and federal agencies (U.S. Securities and Exchange Commission 2014). Enbridge currently maintains a general liability insurance program with a total limit of $860 million for the policy period. The retention (deductible) for sudden and accidental pollution events is $30 million per event, and the program is renewed annually (Enbridge 2015b).

[31] To encourage greater state participation in response to actual or threatened discharges of oil.

Table 10.6-2. Potentially Applicable Federal and State Laws and Regulations That Establish Liability for Crude Oil Spills

Statute/Regulation	Description
Oil Pollution Act of 1990 (OPA 90), 33 U.S. Code 2701 et seq.	OPA 90 established a program of prevention, response, liability, and compensation to address vessel and facility-caused oil pollution to navigable waters of the United States. Section 1002(a) provides that the Responsible Party for a pipeline from which oil is discharged, or which poses a substantial threat of a discharge, is liable for (1) certain specified damages resulting from the discharged oil; and (2) removal costs incurred in a manner consistent with the National Contingency Plan. Per Section 1018(a), OPA 90, does not preempt state law. States may impose additional liability (including unlimited liability), funding mechanisms, requirements for removal actions, and fines and penalties for Responsible Parties.
Resource Conservation and Recovery Act (RCRA), 42 U.S. Code 6973	The U.S. Environmental Agency (EPA) may issue an order or bring a suit in district court against any person who has contributed or who is contributing to the handling, treatment, storage, transportation, or disposal of solid or hazardous waste that may present an imminent and substantial endangerment to health or the environment. Persons who violate an order are subject to civil penalties of up to $7,500 per day. RCRA Section 7003(a), 42 U.S. Code 6973(a), authorizes the EPA "upon receipt of evidence that the past or present handling, storage, treatment, transportation or disposal of any solid waste or hazardous waste may present an imminent and substantial endangerment to health or the environment" to "bring suit in district court or to issue an administrative order to any person who contributed or is contributing to that handling, storage, treatment, transportation," to restrain or take any other action in response. Oil released from a pipeline would constitute solid or hazardous waste, and the authority allows the EPA to require action if the spill "may present an imminent and substantial endangerment."
Safe Drinking Water Act (SDWA), 42 U.S. Code 300f et seq.	The EPA may issue orders to any person in circumstances where a "contaminant" is present in or is likely to enter a public water system or an underground source of drinking water (defined broadly to include almost all groundwater), which may present an imminent and substantial endangerment to the health of persons and states (to whom primary responsibility is granted under the SDWA) that are not acting. The orders may require that person to take such actions as the EPA deems necessary to protect health (42 U.S. Code 300i [a]). Civil penalties are available for failure to comply with such an order. SDWA Section 1431(a), 42 U.S. Code 300i(a), authorizes the EPA "upon receipt of information that a contaminant which is present in or is likely to enter a public water system or an underground source of drinking water, which may present an imminent and substantial endangerment to the health of persons," to take "such actions as [it] deems necessary," including issuance of orders and civil judicial actions. This authority is quite broad. An underground source of drinking water is virtually any underground water that has the potential to be used for drinking water, and a "contaminant" is any biological, chemical, or physical substance in water.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S. Code 9601 et. seq.	This act is similar to OPA 90 but addresses releases of hazardous substances and specifically *excludes* oil and petroleum. CERCLA created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. It provides for liability for response costs and natural resource damages against owners or operators of a pipeline who arranged for disposal of hazardous substances. The act contains similar defenses as OPA 90, as well as contribution rights. It also provides the EPA authority to issue administrative orders requiring response actions. Local CERCLA access provides funds (limited to $25,000) in the form of reimbursements for expenses, to local, county, and tribal governments that respond to a hazardous substance release in their jurisdiction (Region 5 RRT 2017).

Table 10.6-2. Potentially Applicable Federal and State Laws and Regulations That Establish Liability for Crude Oil Spills

Statute/Regulation	Description
Environmental Response and Liability Act (MERLA) Minnesota Statutes § 115B	MERLA is the Minnesota State Superfund law. Among other things, it allows the Minnesota Pollution Control Agency and the Minnesota Department of Agriculture to clean up contaminated sites and seek recovery of their expenses from those persons who are responsible for the contamination. The law creates a Superfund account to provide funding for the cleanup and provides that any money recovered shall be deposited in the account. The law provides a statute of limitations for the state to bring a cost recovery lawsuit.
Oil and Hazardous Substance Discharge Preparedness Minnesota Statutes § 115E	Statute 115E requires persons handling oil and hazardous substances to prevent discharges that endanger the environment or public health. It also requires certain kinds of facilities to prepare spill response plans.

10.7 COMPARISONS OF ALTERNATIVES BASED ON FAILURE PROBABILITY AND POTENTIAL EXPOSURES OF RESOURCES

The following sections summarize and compare the key results of the failure probability analysis among the transport mode alternatives and an evaluation of resources of concern that could be exposed following a crude oil release:

- Comparison of Failure Probability Estimates for the Applicant's Preferred Route and Certificate of Need Alternatives (Section 10.7.1),
- Comparisons of Potential Exposure Assessment Results for the Applicant's Preferred Route and Certificate of Need Alternatives (Section 10.7.3), and
- Comparisons of Potential Exposure Assessment Results for the Applicant's Preferred Route and Route Alternatives (Section 10.7.4).

10.7.1 Comparison of Failure Probability Estimates for the Applicant's Preferred Route and Certificate of Need Alternatives

The estimated annual probabilities of an incident occurring along the Applicant's preferred route and the transport mode alternatives (i.e., CN Alternatives) and the estimated number of years between events, or recurrence intervals, are provided in Table 10.7-1.

Table 10.7-1. Estimated Annual Incident Probabilities and Recurrence Intervals for the Applicant's Preferred Route and Certificate of Need Alternatives

Probability and Recurrence	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
Annual probability of spill incident	0.249	0.404	0.568	0.960	230[a] (0.63)	0.794(days)	76[a] (0.21)
Recurrence interval (years)	4.0	2.5	1.8	1.04	0.004 (1.59 days)	1.26	0.013 (76.9 days)

[a] Incidents per year; values in parentheses are daily probabilities.

Length is a key component in calculating pipeline failure probability because a longer pipeline has a greater area that could be exposed to the primary pipeline threats (third-party damages, construction defects, manufacturing defects, corrosion, and equipment failure [e.g., valve failure]). For the pipeline alternatives, SA-04 has the longest route, the highest estimate of the annual probability of a spill, and the lowest recurrence interval (a release was estimated to occur every 1.8 years). The Applicant's preferred route has the lowest annual probability of a spill incident, with a release estimated to occur every 4.0 years.

Compared to pipelines, both truck and rail transportation alternatives have a higher likelihood of accidents and spills due to the number of transits required to transport the crude oil and the associated increase in risk due to human error. Tanker trucks use major roadways and present a greater risk of injury and fatalities to personnel and the public; this transport mode has a substantially greater annual probability of a spill incident and an estimated recurrence interval of 1.46 days (0.004 years multiplied by 365 days per year).

The very large number of trucks required for this alternative would greatly increase the risk of releases and impacts on other roadway users along the major routes between loading and offloading facilities. Similarly, the large number of unit trains required to transport 760,000 bpd of crude oil results in a relatively high estimated annual probability of a spill incident, with such an incident estimated to occur approximately once per year.

Table 10.7-2 provides additional context in the form of historical incident data for truck and rail transport of hazardous materials, a category that includes crude oil, normalized to reportable incidents per year.

Table 10.7-2. Annual Number of Incidents for Rail and Truck Transportation of Hazardous Materials

Mode	Number of Incidents per Year[a]
Rail (2007–2017)	623
Truck (2007–2017)	1,199
Pipeline (2010–2017)	391

Sources: PHMSA 2017a, 2017b.

[a] Hazardous material transport includes the transport of crude oil; hazardous materials transportation incidents required to be reported are defined in 49 CFR 171.15, 171.16 (Form F 5800.1).

10.7.2 Comparisons of Potential Exposure Assessment Results for the Applicant's Preferred Route and Certificate of Need Alternatives

The presence of HCAs and AOIs within the ROIs, as described in Section 10.4.1, was compared among the Applicant's preferred route and the CN Alternatives. These are considered the resources of concern. The two ROIs consist of a 5,000-foot-wide (2,500 feet on each side of the centerline of the pipeline or train or truck route) ROI corridor for releases on land and a 10-mile-long, 1,000-foot-wide (500 feet on each side of the centerline of the waterbody crossed) downstream ROI corridor for releases to water; these were established as areas within which oil could be present after a release. Table 10.7-3 summarizes the exposure of resources of concern in the ROIs and is presented along a color gradient (green to red). CN Alternatives are coded in a gradient from green to red based on the extent of the potential exposure of resources in their ROIs in comparison to the other alternatives.



A more detailed listing of each HCA and AOI category is provided in Table 10.7-4, and this table also codes CN Alternatives using the same gradient from red to green. The same approach to comparing the Applicant's preferred route and route alternatives is provided associated with resources of concern and HCA and AOI categories in Tables 10.9-5 and 10.5-6.

Table 10.7-3. Summary of Potentially Exposed Resources of Concern from an Unanticipated Release of Crude Oil along the Applicant's Proposed Project and Certificate of Need Alternatives (acres)

Resources of Concern	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
HCA populated area	10,959.8	25,697.9	25,128.7	41,579.2	44,431.8	67,277.1	70,129.6
HCA unusually sensitive ecological area	12,318.0	27,527.8	20,378.4	27,578.6	37,272.0	55,106.4	64,799.8
HCA drinking water source	2,443.9	4,521.9	24,468.7	14,787.2	27,941.9	19,309.1	32,463.8
Drinking water areas of interest	319.7	1,599.9	15,486.1	3,838.0	9,796.9	5,428.9	11,396.8
Cultural resources areas of interest	48.0	44,137.6	11,606.4	55,356.8	40,236.6	99,493.9	84,374.0
Biological areas of interest	102,365.7	99,943.8	369.3	94,763.6	87,200.5	194,894.1	186,640.8
Commodity production areas of interest	37,084.5	62,419.1	191.6	46,205.9	67,846.1	108,627.0	136,178.2
Recreation/tourism AOIs	3,704.1	1,872.3	1,791.9	11,325.5	2,394.5	13,197.9	4,266.8
TOTAL	**170,027.6**	**268,449.3**	**100,595.1**	**296,449.9**	**317,872.2**	**565,078.4**	**591,730.8**

Notes:

Acreages are the sum of acres within the 2,500-foot-wide and 10-mile-long downstream ROIs for each metric, with the exception of Drinking Water AOIs, which reflects Wellhead Protection Areas within a 1-mile ROI.

Drinking Water Areas of Interest include only Wellhead Protection Areas, as other resources were specific to Minnesota.

AOI = area of interest (see Section 10.4.1 for descriptions of AOIs); HCA = high consequence area (see Section 10.4.1 for descriptions of HCAs)

Table 10.7-4. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10 Miles Downstream of the Applicant's Preferred Route and Certificate of Need Alternative Routes

Resources of Concern	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
	Within 2,500 Feet of Either Side of the Centerline							Within 10 Miles Downstream						
High Consequence Areas														
HCA populated area (acres)	6,545.2	22,318.7	13,075.3	34,724.2	35,639.4	57,042.9	57,958.1	4,414.6	3,379.2	12,053.4	6,855.0	8,792.4	10,234.2	12,171.6
HCA unusually sensitive ecological area (acres)	6,903.4	19,045.5	10,530.3	17,960.0	26,016.8	37,005.4	45,062.3	5,414.6	8,482.3	9,848.1	9,618.7	11,255.2	18,101.0	19,737.5
HCA drinking water source (acres)	1,614.6	3,975.2	11,058.9	11,862.6	18,726.6	15,837.8	22,701.8	829.3	546.7	13,409.8	2,924.6	9,215.3	3,471.3	9,762.0
Drinking Water Areas of Interest														
Wellhead protection area (acres)	189.7	1,391.3	3,579.7	3,350.2	3,747.0	4,741.5	5,138.3	130.0	208.6	11,906.4	487.8	6,049.9	687.4	6,258.5
Number of domestic and public wells	638.0	690.0	946.0	648.0	568.0	1,338.0	1,258.0	146.0	39.0	228.0	367.0	184.0	406.0	223.0
Cultural Resources Areas of Interest														
Tribal land (acres)	48.0	33,737.6	6,738.1	31,854.3	30,280.4	65,591.9	64,018.0	0.0	10,400.0	4,868.3	23,502.5	9,956.2	33,902.0	20,356.0

Table 10.7-4. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10 Miles Downstream of the Applicant's Preferred Route and Certificate of Need Alternative Routes

Resources of Concern	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
	Within 2,500 Feet of Either Side of the Centerline							Within 10 Miles Downstream						
Biological Areas of Interest														
Aquatic Management Area (acres)	125.0	227.5	0.0	228.6	93.9	456.0	321.4	209.8	320.0	0.0	196.4	183.5	516.4	503.5.52
Scientific and Natural Area (acres)	0.0	7.5	0.0	186.7	0.0	380.8	7.5	342.3	192.7	0.0	63.4	0.0	256.1	192.7
Minnesota BWSR conservation easement (acres)	15.8	167.1	0.0	736.0	33.0	903.1	200.1	262.0	260.7	29.8	158.2	90.9	418.8	351.5
Lakes of Biological Significance (acres)	406.7	2,209.8	0.0	1,951.5	2,617.9	4,161.4	4,827.8	3,608.9	3,400.1	0.0	3,659.1	4,559.4	7,059.2	7,959.5
MBS Sites of Biodiversity Significance (acres)	28,046.8	12,992.7	0.0	18,309.7	6,285.4	31,302.3	19,278.1	11,589.4	8,001.2	120.6	11,117.4	5,740.2	19,118.6	13,741.5
Muskie lakes (acres)	41.4	976.6	0.0	1,060.9	1,882.1	2,037.5	2,858.8	676.0	2,107.0	0.0	1,990.8	3,526.5	4,097.8	5,633.5
Native plant communities (acres)	38,173.8	40,195.4	0.0	33,852.4	35,643.9	74,047.8	75,839.3	14,015.3	22,744.8	219.0	16,735.5	19,166.4	39,480.3	41,911.3

Table 10.7-4. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10 Miles Downstream of the Applicant's Preferred Route and Certificate of Need Alternative Routes

Resources of Concern	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
	Within 2,500 Feet of Either Side of the Centerline							Within 10 Miles Downstream						
Sensitive lakeshore areas (acres)	300.5	1,329.8	0.0	743.4	1,387.9	2,073.2	2,717.7	441.9	513.4	0.0	305.3	373.6	818.7	887.0
Wetland bank easements (acres)	0.0	70.6	0.0	120.3	33.6	190.9	104.2	38.5	30.3	0.0	49.7	21.9	80.0	52.2
Wild rice lakes (acres)	675.4	1,240.4	0.0	1,474.05	1,661.0	1,240.4	2,901.4	3,396.3	2,956.4	0.0	3,298.6	3,899.3	6,255.0	6,855.7
Commodity Production Areas of Interest														
Marginal cropland (acres)	15.6	16.1	0.0	87.4	5.4	103.5	21.5	44.2	10.0	0.0	0.0	0.0	10.0	0.0
Federal and state forests (acres)	31,764.3	48,861.8	145.9	27,654.5	45,469.4	76,516.3	94,331.2	0.0	8,496.3	0.0	14,417.2	16,965.6	22,915.5	31,384.8
Other forested land (acres)	3,349.5	2,827.2	45.7	2,735.5	2,954.0	5,562.7	5,781.2	1,910.9	2,207.8	0.0	1,311.3	2,451.7	3,519.1	4,659.5

Table 10.7-4. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10 Miles Downstream of the Applicant's Preferred Route and Certificate of Need Alternative Routes

Resources of Concern	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck	Applicant's Preferred Route	Continued Use of Existing Line 3	System Alternative SA-04	Transportation by Rail	Transportation by Truck	Existing Line 3 Supplemented by Rail	Existing Line 3 Supplemented by Truck
	Within 2,500 Feet of Either Side of the Centerline							Within 10 Miles Downstream						
Recreation/Tourism Areas of Interest														
State park and recreation areas (acres)	947.6	0.0	790.5	5,989.6	335.8	5,989.6	335.8	180.9	1,485.0	790.5	0.0	54.1	1,485.0	1,539.1
Waterfowl production areas (acres)	92.0	185.8	0.0	421.3	484.9	607.1	670.7	11.5	182.2	0.0	0.0	0.0	182.2	182.2
Wildlife Management Areas (acres)	1,299.3	16.4	105.5	3,352.1	820.6	3,368.5	836.9	1,172.7	3.0	105.5	1,562.5	699.1	1,565.5	702.1
TOTALS														
AOI Total (acres)	**121,192.6**	**192,482.7**	**47,015.8**	**197,829.1**	**214,687.2**	**390,498.5**	**407,169.9**	**48,835.0**	**75,966.6**	**53,579.3**	**98,620.8**	**103,185.0**	**174,579.9**	**184,560.9**
Combined AOI Total (acres)	**170,027.6**	**268,449.3**	**100,595.1**	**296,449.9**	**317,872.2**	**565,078.4**	**591,730.8**							

Notes:

The establishment of ROIs and GIS analysis methods are described in Section 10.4.1.

Acreages are the sum of acres within the 2,500-foot-wide and 10-mile-long downstream ROIs for each metric, with the exception of Drinking Water AOIs, which reflects Wellhead Protection Areas within a 1-mile ROI.

Minnesota BWSR = Minnesota Board of Water and Soil Resources; HCA = high sequence area (see Section 10.4.1 for descriptions of HCAs)

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Table 10.7-5. Summary of Potentially Exposed Resources of Concern from an Unanticipated Release of Crude Oil from the Applicant's Preferred Route and Route Alternatives (acres)

Resources of Concern	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
HCA populated area (acres)	4,814.1	12,829.2	3,230.0	20,806.6	17,363.7
HCA unusually sensitive ecological area (acres)	10,978.1	7,752.3	12,674.4	26,854.4	27,566.9
HCA drinking water source (acres)	501.1	2,399.1	718.0	2,942.0	2,998.3
Drinking water AOIs	83,833.7	153,971.9	16,196.0	64,785.5	63,726.0
Cultural resources AOIs	0.0	13.5	11,425.6	44,046.8	45,766.0
Biological AOIs	94,028.5	46,575.5	58,815.6	88,739.9	96,480.2
Commodity production AOIs	45,748.3	5,625.1	87,973.6	71,016.7	78,142.0
Recreation/tourism AOIs	3,704.1	4,100.9	1,838.6	1,443.0	1,924.3
TOTAL	**243,607.9**	**233,267.5**	**192,871.8**	**320,634.9**	**333,967.4**

Notes:

Acreages are the sum of acres within the 2,500-foot-wide and 10-mile-long downstream ROIs for each metric, with the exception of Drinking Water AOIs, which reflect: DWSMAs and Wellhead Protection Areas within a 1-mile ROI, and Hydrogeologic Sensitivity within a 0.5-mile ROI.

HCA = high consequence area (see Section 10.4.1 for descriptions of HCAs); AOI = area of interest (see Section 10.4.1 for descriptions of AOIs)

Table 10.7-6. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10-Mile-Long Downstream ROI of the Applicant's Preferred Route and Route Alternatives Between Clearbrook and Carlton

Resources of Concern	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
	Within 2,500 of Either Side of the Centerline					Within 10-Mile-Long Downstream ROI				
High Consequence Areas										
HCA populated area (acres)	1,759.5	8,264.9	2,271.8	17,427.4	13,261.2	3,054.6	4,564.3	958.2	3,379.2	4,102.5
HCA unusually sensitive ecological area (acres)	6,230.0	2,906.9	8,468.7	18,372.1	18,498.1	4,748.1	4,845.4	4,205.7	8,482.3	9,068.8
HCA drinking water source (acres)	83.4	1,322.5	168.2	2,395.3	2,105.6	417.7	1,076.6	549.8	546.7	892.7
Drinking Water Areas of Interest										
DWSMA (acres)	790.6	5,676.7	1,111.0	3,190.5	2,975.4	197.1	996.0	267.4	336.7	310.4
High/very high DWSMA vulnerability (acres)	790.6	2,637.0	109.0	2,272.5	2,338.0	0.0	464.5	12.0	11.1	11.1
WPAs (acres)	219.5	3,159.1	653.6	2,646.5	2,626.8	30.4	501.9	114.6	208.6	207.2
High/very high hydrogeologic sensitivity (acres)	81,805.5	140,536.7	13,928.4	56,119.6	55,257.1	N/A	N/A	N/A	N/A	N/A
Number of domestic and public wells	173.0	430.0	43.0	242.0	188.0	125.0	179.0	28.0	40.0	46.0
Cultural Resources Areas of Interest										
Tribal land (acres)	0.0	13.5	7,858.1	33,689.6	33,894.5	0.0	0.0	3,567.5	10,357.2	11,871.5
Number of archaeological and historical sites	71.0	124.0	19.0	180.0	138.0	N/A	N/A	N/A	N/A	N/A

Table 10.7-6. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10-Mile-Long Downstream ROI of the Applicant's Preferred Route and Route Alternatives Between Clearbrook and Carlton

Resources of Concern	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
	Within 2,500 of Either Side of the Centerline					Within 10-Mile-Long Downstream ROI				
Biological Areas of Interest										
Aquatic Management Areas (acres)	125.0	112.5	204.6	227.5	190.5	209.8	267.0	241.0	320.0	336.9
Scientific and Natural Areas (acres)	0.0	234.5	63.7	7.5	85.2	149.6	238.1	0.0	0.0	0.0
Minnesota BWSR conservation easement (acres)	14.0	1,288.5	25.9	165.2	183.7	37.4	385.1	0.0	36.1	35.9
Lakes of Biological Significance (acres)	300.2	220.3	99.2	2,103.4	1,280.8	3,608.9	1,952.6	1,222.5	3,400.1	4,286.4
MBS Sites of Biodiversity Significance (acres)	25,016.2	16,339.8	8,952.1	9,962.2	12,257.6	9,692.7	5,138.5	4,774.4	5,834.6	6,531.2
Muskie lakes (acres)	41.4	0.0	0.0	976.6	55.8	676.0	0.0	0.0	2,107.1	2,676.3
Native plant communities (acres)	35,273.1	18,742. 8	26,368.1	37,247.1	39,868.2	14,015.3	16,937.9	15,591.9	20,211.6	21,661.8
Sensitive lakeshore areas (acres)	300.5	178.6	0.0	1,329.8	1,151.6	441.9	188.4	158.3	513.4	713.7
Trout stream/lake (acres)	16.3	0.0	0.0	0.0	0.0	N/A	N/A	N/A	N/A	N/A
Wetland bank easements (acres)	0.0	0.0	0.0	70.6	112.5	38.5	0.0	0.0	30.3	30.3
Wild rice lakes (acres)	675.4	708.6	92.4	1,240.4	1,119.5	3,396.3	2,385.1	1,021.5	2,956.4	3,902.3

Table 10.7-6. High Consequence Areas and Areas of Interest within 2,500 Feet of Either Side of the Centerline and 10-Mile-Long Downstream ROI of the Applicant's Preferred Route and Route Alternatives Between Clearbrook and Carlton

Resources of Concern	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08	Applicant's Preferred Route	Route Alternative RA-03AM	Route Alternative RA-06	Route Alternative RA-07	Route Alternative RA-08
	Within 2,500 of Either Side of the Centerline					Within 10-Mile-Long Downstream ROI				
Commodity Production Areas of Interest										
Marginal cropland (acres)	13.7	88.3	6.7	14.2	23.5	11.3	69.3	0.0	10.0	10.0
Federal and state forests (acres)	31,764.3	2,334.7	55,377.7	48,861.8	52,121.1	12,054.9	653.9	24,550.0	17,132.8	20,897.7
Other forested land (acres)	33,12.4	1,640.2	5,884.7	2,790.1	2,593.9	1,904.1	838.7	2,154.5	2,207.8	2,495.8
Recreation/Tourism Areas of Interest										
State park and recreation areas (acres)	947.8	947.8	0.0	0.0	0.0	180.8	1,920.9	941.3	941.3	914.3
Waterfowl production areas (acres)	92.0	260.8	418.0	185.8	277.2	11.5	11.5	182.2	0.0	0.2
Wildlife Management Areas (acres)	1,299.3	477.7	294.1	16.4	439.5	1,172.7	482.2	3.0	299.5	293.1
TOTALS										
AOI Total (acres)	**187,802.3**	**189,903.6**	**132,418.0**	**241,734.1**	**243,043.3**	**56,174.6**	**44,096.9**	**60,543.8**	**79,362.8**	**91,296.1**
Combined AOI Total (acres)	**243,607.9**	**233,267.5**	**192,871.8**	**320,634.9**	**333,967.4**					

Notes:

The establishment of ROIs and GIS analysis methods are described in Section 10.4.1.

Acreages are the sum of acres within the 2,500-foot-wide and 10-mile-long downstream ROIs for each metric, with the exception of Drinking Water AOIs, which reflect: DWSMAs and Wellhead Protection Areas within a 1-mile ROI, and Hydrogeologic Sensitivity within a 0.5-mile ROI.

AOI = area of interest, MBS Sites = Minnesota Biological Survey Sites of Biodiversity Significance; Minnesota BWSR = Minnesota Board of Water and Soil Resources; HCA = high consequence area (see Section 10.4.1 for descriptions of HCAs); DWSMA = Drinking Water Supply Management Area, ROI = region of interest; WPAs = Wellhead Protection Areas

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Chapter 11
Environmental Justice

11.1 INTRODUCTION

Environmental justice (EJ) refers to the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income. In general, EJ is intended to ensure that all people benefit from equal levels of environmental protection and have the same opportunities to participate in decisions that may affect their environment or health (Minnesota Pollution Control Agency [Minnesota PCA] 2017; U.S. Environmental Protection Agency [EPA] 2017). Minority and/or low-income communities are often concentrated in small geographical areas within the larger geographically and/or economically defined population. Minority communities and low-income communities may constitute a very small percentage of the total population and/or geographical area. Therefore, the assumptions and inputs used in conjunction with traditional analytical tools for studying potential impacts and the results of the analyses may not fully reflect the impacts that may be borne by these smaller communities or populations. An analysis of disproportionate impacts provides an understanding of how the total potential impacts vary across individual communities. This allows analysts and decision-makers to identify and understand what portion of the total impacts may be borne by minority or low-income communities, to assess whether they are disproportionately high and adverse, and to develop alternatives and mitigation measures if necessary.

11.2 REGULATORY CONTEXT AND METHODOLOGY

The Council on Environmental Quality's (CEQ's) "Environmental Justice: Guidance Under the National Environmental Policy Act" (1997) and the EPA's "Promising Practices for EJ Methodologies in NEPA Reviews" (2016) were developed to provide EPA and other agencies with a process for identifying EJ communities and addressing potential impacts on them. According to these guidance documents, the basic components of an EJ assessment should include:

- A demographic assessment of the affected communities to identify minority and low-income populations that may be present;
- An integrated assessment to determine whether any adverse impacts would disproportionately affect minority or low-income populations; and
- An opportunity for the public to participate in the process, including community, minority, low-income, and tribal participation.

Minority and low-income population statistics were compiled using census tract data from the U.S. Census Bureau's American Community Survey (ACS). The ACS provides estimates based on a rolling survey conducted over 5 years. The most recent survey data are from 2011 to 2015. Census tracts are relatively permanent subdivisions of a county, created for the purpose of collecting statistical data, with boundaries confirmed or updated every 10 years. Populations in census tracts can vary from 1,200 to 8,000 people, with an optimal size of 4,000 people. To ensure census tract populations in counties are fairly equal, the geographic size of each census tract can vary widely depending on its population density.

Figure 11-1 depicts the locations of the census tracts that are areas of concern for EJ in Minnesota (with route alternatives shown). In north-central Minnesota, many census tracts are considered to be areas of concern because they meet the low income criterion.

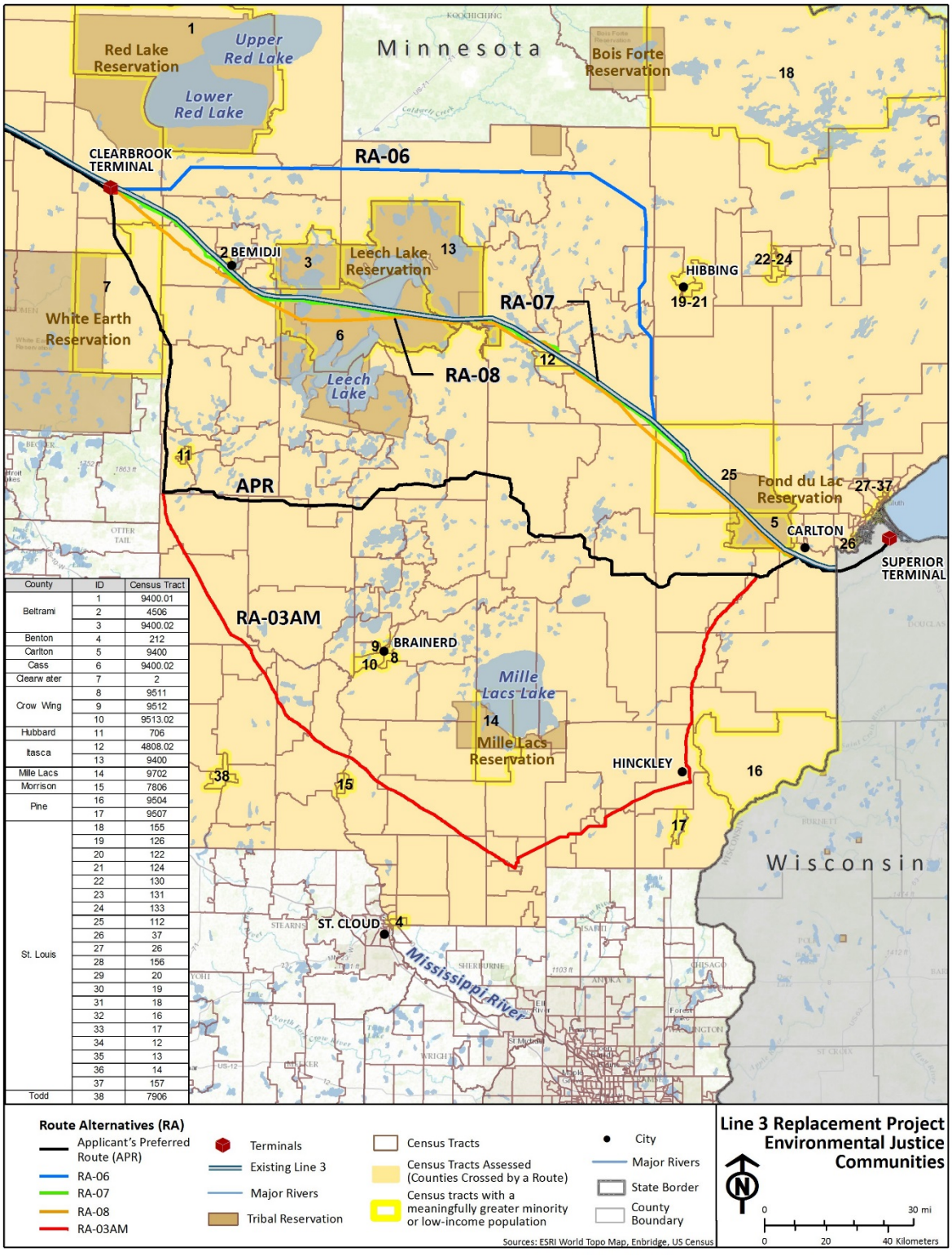
The region of interest (ROI) for this analysis includes the census tracts within the counties crossed by the Applicant's preferred route and the route alternatives. The census tracts intersected by the right-of-way for the Applicant's preferred route and route alternatives constitute the geographic area within which potential disproportionate adverse impacts from the proposed Project are likely to occur. Data for the counties and the remaining census tracts within the counties were also compiled to provide a representation of the general population in the area surrounding the proposed Project, against which demographic and poverty data can be compared. The remaining census tracts in the counties were evaluated, even if not intersected by a route, as they may potentially contain EJ areas of concern due to proximity to a route.

A comparison of census tracts within counties is included below to allow for further analysis. Statistics for census tracts were compared to their respective county statistics to determine the level of low-income and minority populations. The following guidelines were used in the comparison:

- Low-income and minority populations were determined to be present in an area when the percentage of minority group or low-income population exceeded 50 percent of the county population, or was "meaningfully greater" than the general population of the county.
- A difference of 10 percentage points or more was used to determine whether the percentage of a minority or low-income group in a census tract in the ROI was "meaningfully greater" than that group's percentage in the respective county.
- Minority populations were calculated as the populations excluding those persons who self-reported as being white (and no other race) and not Hispanic or Latino. The remainder includes persons who self-reported as Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, some other race, having two or more races, or being of Hispanic or Latino origin.

Based on recommendations from Minnesota PCA, low-income populations are those individuals with income below 185 percent of the poverty level. While Minnesota PCA generally uses a metric of 40 percent of population below 185 percent of poverty to establish EJ status, this analysis uses a difference of 10 percentage points or more to establish the "meaningfully greater" measure consistent with the comparison of minority populations.

As outlined above, the metric used to identify EJ populations in this EIS is the comparison of census tracts to the whole of a county, which allows comparison of population groups within the same general vicinity. This provides the best comparison of proportional impact. The EIS uses a comparison against county data rather than statewide data because the statewide data combine data from widely varying areas and are not representative of any particular area. Additionally, the state is a dichotomy of urban and rural communities. In general, urban areas have higher percentages of minority populations, while rural areas have lower average incomes. Combining those data does not provide a clear comparison to establish levels of economic justice at a local level.



County	ID	Census Tract
Beltrami	1	9400.01
	2	4506
	3	9400.02
Benton	4	212
Carlton	5	9400
Cass	6	9400.02
Clearw ater	7	2
Crow Wing	8	9511
	9	9512
	10	9513.02
Hubbard	11	706
Itasca	12	4808.02
	13	9400
Mille Lacs	14	9702
Morrison	15	7806
Pine	16	9504
	17	9507
St. Louis	18	155
	19	126
	20	122
	21	124
	22	130
	23	131
	24	133
	25	112
	26	37
	27	26
	28	156
	29	20
	30	19
	31	18
	32	16
	33	17
	34	12
	35	13
	36	14
	37	157
Todd	38	7906

Figure 11-1. Areas of Concern for Environmental Justice in the Region of Interest

In general, the data bear out these assumptions. The counties through which the Project and its alternatives would run are predominately rural. In 20 of those 21 counties, the percentage of the population below 185 percent of the poverty level is greater than for the state as a whole. In only one of the 21 counties is the percentage of the minority population greater than at the state level. In contrast, however, 13 of the 21 counties have a greater percentage of Native American populations than at the state level. Figure 11-1 depicts the locations of the census tracts and counties in the ROI, and indicates the census tracts with minority and low-income populations that are considered EJ communities according to the guidelines identified above.

11.3 EXISTING ENVIRONMENT

11.3.1 Minority Populations

Each of the five routes would cross one or more census tracts with a meaningfully higher minority population than the surrounding county. The Applicant's preferred route bisects and RA-03AM crosses the edge of Census Tract 002 in Clearwater County, where the minority population of 25.3 percent exceeds the county level by more than 10 percentage points (Figure 11-1; Appendix Q). This census tract includes a portion of the White Earth Reservation, and the minority population in the tract is overwhelmingly Native American (23.2 percent of the population; Appendix Q). Even though the Applicant's preferred route crosses the census tract, it does not cross the reservation.

Alternatives RA-06, RA-07 and RA-08 each cross two or more census tracts with minority populations that meaningfully exceed their county levels, and thus require consideration of EJ concerns:

- All three route alternatives cross Census Tract 9400 through the Fond du Lac Reservation in Carlton County, with a Native American population of 46.9 percent compared to the county level of 7.2 percent (Figure 11-2).

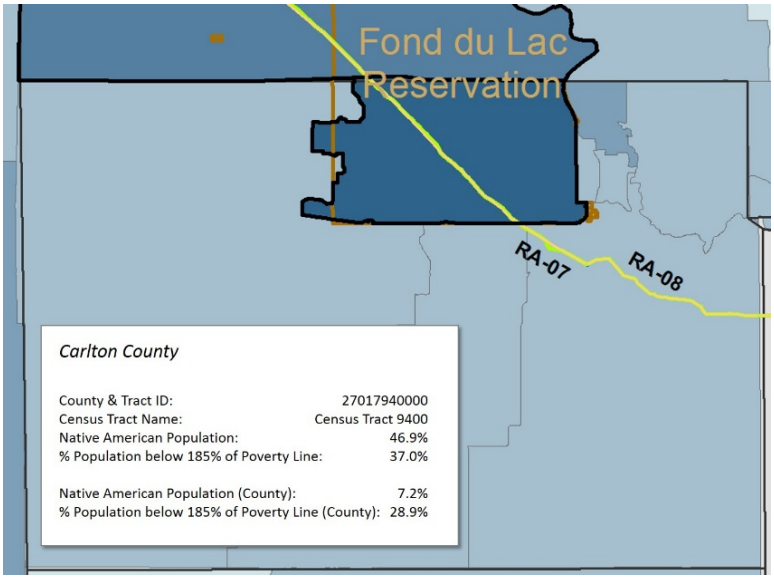


Figure 11-2. Carlton County Areas of Environmental Justice Concern

- All three routes would cross Census Tract 112 in part through the Fond du Lac Reservation in St. Louis County, with a Native American population of 17.5 percent compared to the county level of 3.4 percent (Figure 11-3).

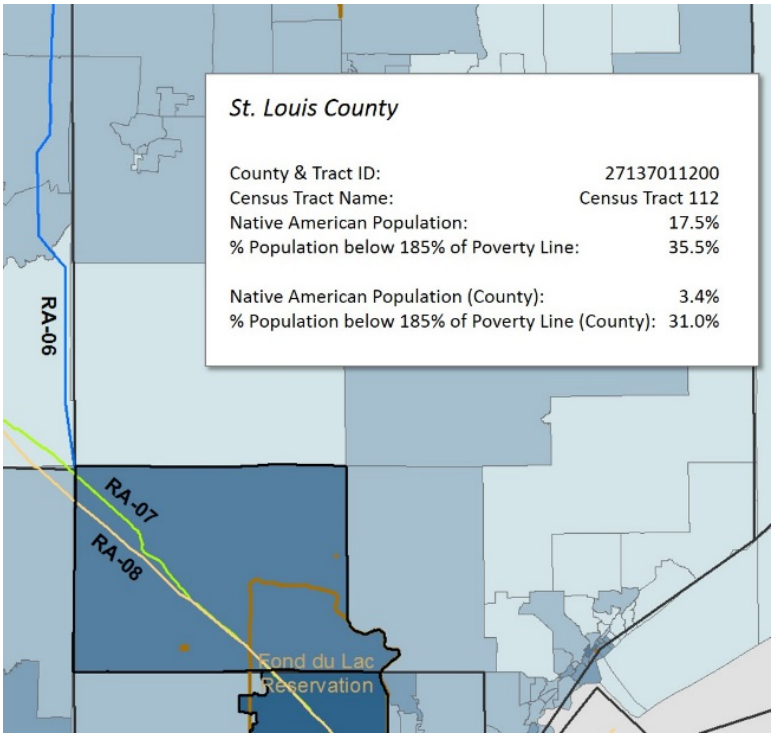


Figure 11-3. St. Louis County Areas of Environmental Justice Concern

Route alternatives RA-07 and RA-08 each create the following additional instances for consideration of EJ concerns.

- Both routes would cross Census Tract 9400 through the Leech Lake Reservation in Itasca County, with a Native American population of 29.9 percent compared to the county level of 5.0 percent (Figure 11-4).

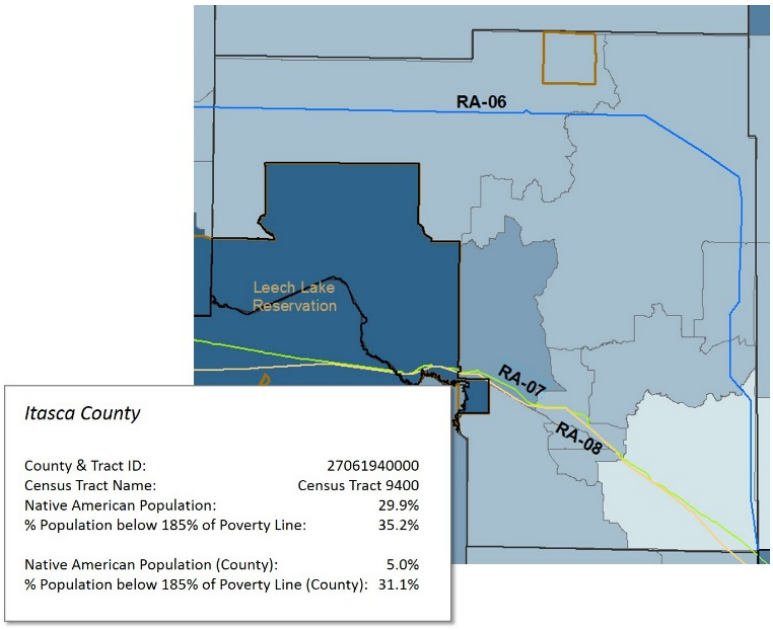


Figure 11-4. Itasca County Areas of Environmental Justice Concern

- Both routes cross Census Tract 9400.02 through Leech Lake Reservation in Cass County, with a Native American population of 69.2 percent compared to the county level of 13.2 percent. The entire census tract is located within the Leech Lake Reservation (Figure 11-5).

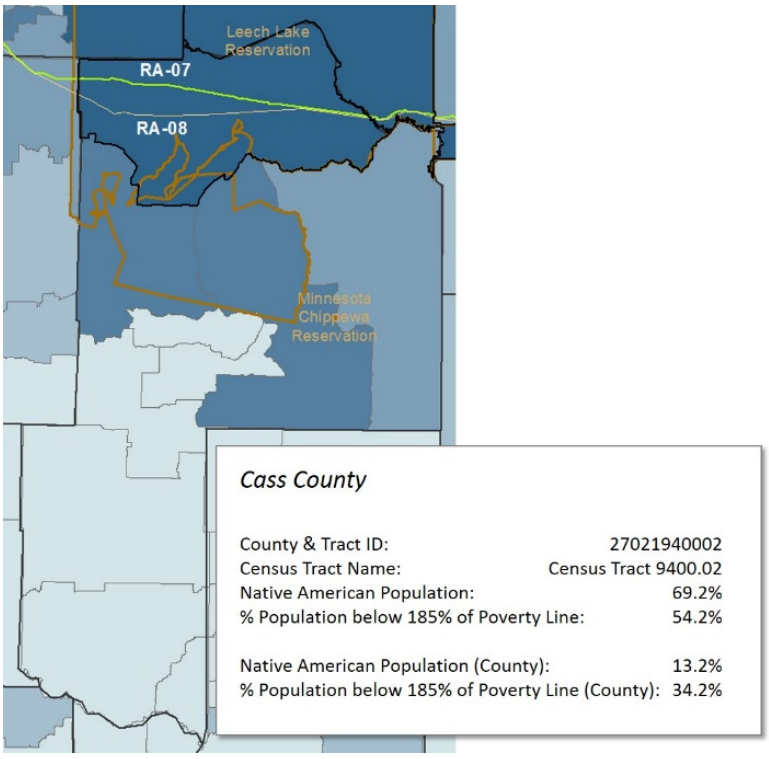


Figure 11-5. Cass County Areas of Environmental Justice Concern

11.3.2 Low-Income Populations

None of the census tracts crossed by the Applicant's preferred route has a meaningfully greater proportion of the population with income less than 185 percent of the poverty level compared to their respective county level (Appendix Q).

Route alternatives RA-07 and RA-08 each create an instance for consideration of EJ concerns. They both cross Census Tract 9400.02 (located entirely within the Leech Lake Reservation) in Cass County, where 54.2 percent of the population is below 185 percent of the poverty level, exceeding the county level of 34.2 percent. None of the other census tracts through which these two alternatives cross exceeds its respective county levels.

However, both RA-07 and RA-08 are adjacent to or near census tracts that might have the potential to create instances for consideration of EJ concerns, depending on the proximity of the pipeline or construction areas. The first is Census Tract 4506 in Beltrami County with 54.6 percent of the population below 185 percent of poverty level compared to a county level of 38.9 percent. The other is Census Tract 4808.02 in Itasca County with 42.1 percent of the population below 185 percent of the poverty level compared to a county level of 31.1 percent.

11.3.3 Tribal Lands

The Applicant's preferred route and RA-03AM do not cross any reservation lands, but would cross within miles of the White Earth Reservation and Fond du Lac Reservation. Route alternatives RA-06, RA-07, and RA-08 each cross reservation land—RA-07 and RA-08 would cross both the Leech Lake and Fond du Lac reservations, and RA-06 would cross only the Fond du Lac Reservation. All routes, including the Applicant's preferred route, would cross treaty lands that are off-reservation; these lands may be used for traditional tribal uses such as fishing, hunting and trapping, and/or agricultural activities (as described in Chapter 9). Reserved treaty rights include access to traditional fishing areas. Tribal resources include walleye and trout fisheries, which are predominately used for subsistence. Traditional terrestrial game and waterfowl hunting grounds are habitat for a variety of subsistence resources, including deer, elk, ducks, geese, and turkey. Several federal treaties have reserved wild rice lakes for use by Indian tribes, some of which are also considered Traditional Cultural Properties (Technical Assistance Services for Communities 2016). Wild rice is both a source of income and subsistence for the tribes in the area. These treaty rights and tribal resources are important to the Indian tribes as both natural and cultural resources and reinforce their cultural identity. Additionally, the mental well-being of Indian tribal members is linked to their tribal resources and access to their treaty rights.

Various land uses would be crossed by the routes within reservation boundaries (Table 11-1). In addition to the individual land use categories that would be affected by the routes, various waterbodies and streams would be crossed. On the Fond du Lac Reservation, RA-06 and RA-07 would each cross eight rivers or streams and one waterbody, and RA-08 would cross six rivers or streams and one waterbody. On the Leech Lake Reservation, RA-07 would cross 16 rivers or streams and 4 waterbodies, and RA-08 would cross 22 rivers or streams and 5 waterbodies. For RA-08, one of these waterbodies includes Nushka Lake, which is identified as a wild rice lake. RA-08 would directly affect less than 0.1 acre of the wild rice lake. No wild rice lakes would be crossed within the Fond du Lac Reservation.

Table 11.3-1. Land Uses Crossed by the Applicant's Preferred Route and Route Alternatives within Reservation Lands (acres)

Reservation Route	Agricultural		Developed		Forested		Open Land		Open Water		Wetlands		TOTAL	
	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Leech Lake Reservation														
Applicant's preferred route	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RA-03AM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RA-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RA-07	19.0	5.1	85.7	27.4	270.8	62.9	162.8	31.4	10.4	2.1	512.4	129.9	1,061.0	258.8
RA-08	42.0	18.0	17.7	7.2	255.3	105.8	25.1	10.6	6.9	2.7	278.8	116.6	625.7	260.8
Fond du Lac Reservation														
Applicant's preferred route	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RA-03AM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RA-06	4.5	1.9	6.0	2.4	9.6	3.5	43.1	18.5	8.1	3.3	117.5	49.2	188.8	78.7
RA-07	7.9	1.9	10.1	2.4	41.2	3.5	50.6	18.5	7.1	3.3	204.5	49.2	321.5	78.7
RA-08	4.9	2.0	5.6	2.4	22.4	9.1	23.1	9.4	2.7	1.1	128.8	54.1	187.5	78.1

Con = for Applicant's preferred route, construction impact area in acres based on footprint provided by Enbridge. For route alternatives, estimated construction impact area in acres based on 120-foot-wide construction work area centered on route, including the 50-foot-wide permanent right-of-way (the construction work area for RA-07 would be 205-feet-wide); Op = estimated operations impact area in acres based on 50-foot-wide permanent right-of-way centered on route; RA = route alternative

11.4 IMPACTS

11.4.1 Construction Impacts

As described throughout Chapter 6, most construction impacts are considered short term and localized primarily along the pipeline, including impacts related to noise, air quality, water resources, wildlife, and socioeconomics. During construction, impacts on air quality would include an increase in dust from construction activities and an increase in emissions from vehicles, both from construction vehicles and worker vehicles. Enbridge has identified various measures to limit these impacts, such as dust suppression, limiting idling by construction vehicles, and covering spoil piles. Impacts on air quality during construction would be temporary and minor. Increased noise levels could result from normal construction activities such as clearing, grading, and trenching. The most significant noise impacts during construction would be the result of horizontal directional drilling (HDD) operations or blasting, if needed.

During construction, there would be prohibitions on hunting, fishing, and farming within the construction work area. As discussed in Chapter 9, these activities are an essential part of the tribal community. A temporary loss of these activities during construction would result in negative economic and cultural impact on tribal members. The duration of the impacts would vary; some may be perceived as temporary and short term but would affect tribal members in different ways. For example, the introduction of invasive species following construction alters plant composition within the construction and operation area and often extends well beyond. Invasive plants diminish the overall health and well-being of the land and the enjoyment of the land by tribal members.

Construction across waterbodies could result in increased turbidity and sedimentation (for more information see Section 6.3.1.2). Any waterbodies or streams crossed by the routes may experience increases in stormwater runoff and erosion from cleared vegetation, increases in turbidity and sedimentation, changes to stream flow due to HDD testing water, or degradation of aquatic habitat from instream construction. Such impacts could alter tribal access and use of water resources. As discussed in Section 5.2.1.2, Enbridge has developed proposed measures intended to minimize these impacts; the most pertinent measures are described in the Environmental Protection Plan (Appendix E). With implementation of these measures, these impacts on water resources would be minor and temporary.

Along the Applicant's preferred route, RA-03AM, and RA-08, one census tract in Clearwater County was identified with a significantly higher minority population than the county level. This census tract includes a portion of the White Earth Reservation. None of the three routes would cross the reservation; however, they cross ceded lands used by the tribe for hunting, fishing, or farming operations. Impacts on various resources (as described above) would occur throughout the census tract.

Of the three remaining route alternatives (RA-06, RA-07, and RA-08), each would cross one or more census tracts with meaningfully greater minority populations, particularly Native American populations, and one tract with a meaningfully greater low-income population compared to the county levels. While various resources would be affected during construction, the greatest impact on the tribes would be associated with health and well-being and traditional use activities. Any Project-related activities that reduce or harm traditional uses or resources also negatively affects health and well-being. Impacts on air quality and groundwater are expected to be minor and temporary. Impacts on several land use

categories crossed by these three routes, including impacts on forested habitat, agricultural land, and water resources, indicate that the tribal communities would be disproportionately affected.

Both RA-07 and RA-08 would cross the Leech Lake Reservation, and both routes would result in the loss of hundreds of acres of forested land each. Hunting would be prohibited in these areas during construction, which could limit tribal members from hunting various wildlife that reside within forested cover. Given the importance of hunting to tribal members, both culturally and economically, this would represent a disproportionate adverse impact on the Leech Lake Reservation and its members. Additionally, the loss of plant species that are used for subsistence and medicinal purposes would cause a disproportionate impact on the Leech Lake Band of Ojibwe.

RA-06, RA-07, and RA-08 would cross the Fond du Lac Reservation. Closing of the hunting ground near the construction work area and the loss of crops during construction may result in both a cultural and economic impact on the community. Given the importance of subsistence activities, this may represent a disproportionate adverse impact on the Fond du Lac Reservation and its members.

The abandonment and removal of the existing Line 3 would also affect tribes along RA-07, RA-08, and the Applicant's preferred route. If the existing Line 3 is abandoned and the Line 3 Replacement constructed within the Mainline corridor, the Leech Lake and Fond du Lac Reservations would see disproportionate and adverse impacts as a result of construction and abandonment. If the existing Line 3 is abandoned and the Applicant's preferred route, RA-06, or RA-03AM selected for the Line 3 Replacement, not only would the Leech Lake and Fond du Lac Reservations be subjected to impacts associated with abandonment or removal, but they would also experience new impacts associated with construction and operation of the pipeline across ceded lands. Selection of any new route would increase the impacts and associated risks of a pipeline. This includes the potential development of an entirely new pipeline corridor, effectively spreading the impacts and risks over a much larger area.

Other concerns during construction are the influx of temporary workers and associated impacts, such as sex trafficking and sexual abuse in local communities. Increases in sex trafficking, particularly among Native populations, are well documented (National Congress of American Indians Policy Research Center 2016). American Indian and minority populations are often at higher risk if they are low-income, homeless, have a lack of resources, addiction, and other factors often found in tribal communities (Minnesota Department of Health [Minnesota DH] 2014). The addition of a temporary, cash-rich workforce increases the likelihood that sex trafficking or sexual abuse will occur. Additionally, rural areas often do not have the resources necessary to detect and prevent these activities.

However, Enbridge can prepare and implement an education plan or awareness campaign around this issue with the companies and subcontractors that construct, restore, and operate the pipeline, as well as by working with local communities and tribal communities to raise awareness and provide resources to address the issue.

11.4.2 Operations Impacts

As described throughout Chapter 6, operations impacts would largely be associated with impacts on vegetation associated with maintenance of a permanent pipeline right-of-way and aboveground facilities, as well as air emissions from pump stations. None of the proposed pump stations along the Applicant's preferred route are located in census tracts within significantly greater minority or low-income populations. Therefore, any operations impacts related to noise or air quality impacts from pump stations are not expected to disproportionally affect minority groups or low-income populations.

While locations for pump stations along the route alternatives have not been identified, applicants typically site these facilities in locations away from heavily populated areas and areas of cultural significance. Given the higher occurrence of EJ populations along the route alternatives, the chance of these communities being affected by aboveground facilities would be higher.

The largest potential impact on low-income and minority populations, particularly those within the reservations that would be crossed, is from a pipeline failure incident that resulted in the accidental release of oil. For a detailed discussion of accidental releases, refer to Chapter 10. In the event of an accidental release of oil, the severity of impacts would depend on the location and type of resources within the area of the release. However, an accidental release of oil within the boundary of the Leech Lake Reservation or the Fond du Lac Reservation, or a release affecting resources used by the tribes, would disproportionately adversely affect these communities and could affect culturally significant resources depending on the location and magnitude of the release.

From an Ojibwe perspective, waterbodies at risk from the proposed pipeline include any water directly downstream from a pipeline crossing. Pollution of these waters from a petroleum spill would create a significant hardship to traditional lifeways and spiritual and religious needs of the people. The risk of harm to the people who depend on these waters for sustenance of physical and spiritual needs is greatly magnified by the presence of traditional food sources such as wild rice (Manoomin) and walleyed pike (ogaa).

11.4.3 Health Impacts

As described in Chapter 9, American Indian communities and individuals have unique health issues associated with historical trauma and structural racism. Data from the Minnesota DH indicate that American Indians in Minnesota have greater health disparities and poorer health outcomes compared to other racial and ethnic groups in Minnesota (Minnesota DH 2014). In its 2014 Report to the Legislature, the Minnesota DH concludes (Minnesota DH 2014):

> *Causes of health inequities in American Indian communities are directly linked to determined and deliberate efforts of American federal, state and local governments to uproot the American Indian people from their land, eradicate their languages and destroy their way of life. First among these is the uprooting of the people from their traditional lands, a major factor that scientists recognize creates psychological and health impacts for generations. Displacement brought about a loss of traditional ways of making a living, of providing food for the table, and of being in relationship with one another. To replace these losses the American government provided "commodity" foods: bleached white flour instead of whole grain wild rice; processed pasta and cheese instead of lean protein. Diabetes rates are now endemic among American Indians throughout the U.S., including Minnesota, and the rise of these rates can be directly related to the introduction of foodstuffs with poor nutritional value. The loss of a way of life also has led to unemployment, poverty, and the high-risk behaviors that accompany the loss of hope and meaning: these are some of the systemic, socially-determined health inequities that need to be overcome to achieve health equity for American Indians in Minnesota.*

The impacts associated with the proposed Project and its alternatives would be an additional health stressor on tribal communities that already face overwhelming health disparities and inequities.

Wild parsnip (*Pastinaca sativa*) recognized by the Minnesota Department of Natural Resources to be an invasive noxious weed has been introduced to the Fond du Lac Reservation along existing pipeline

rights-of-way. Contact with this plant can lead to extremely painful rashes over the skin. This is particularly important in the context of a pipeline within reservation lands and ceded territories that are used by local indigenous groups for food gathering. The Applicant's preferred route risks introducing wild parsnip into a new area because introduction is particularly susceptible in disturbed areas. Further introduction of invasive plants such as wild parsnip in the ceded territories of northern Minnesota and Wisconsin poses a clear danger to the safe exercise of Ojibwe treaty rights.

11.4.4 Accidental Releases

A crude oil release along any of the routes has the potential to affect reservation lands, treaty lands, archaeological sites, and historical sites (see Table 10.4-28 in Chapter 10). Between Clearbrook and Carlton, RA-07 and RA-08 overlap with the greatest amounts of reservation lands, followed by RA-06 and RA-03AM. The Applicant's preferred route does not overlap with any reservation land.

Within 2,500 feet of the centerline of the pipeline alternatives, RA-07 and RA-08 contain the greatest number of recorded archaeological sites, while RA-06 contains the least. RA-07 also has the greatest number of historic sites, and RA-06 has the least. Details on resources exposed to a crude oil release are detailed in Section 10.4 of Chapter 10.

The extent of impacts from a release would vary based on the amount of oil released, the location, and existing conditions, such as time of year. Using a 10-mile downstream ROI, from Clearbrook to Carlton, RA-08 overlaps with the most acreage of reservation land, followed by RA-07 and RA-06. The Applicant's preferred route and RA-03AM do not overlap with any reservation lands within the downstream ROI. None of the alternatives overlaps with reservation land in the North Dakota-Minnesota border to Clearbrook or Carlton to Minnesota-Wisconsin border segments. Details on downstream impacts from an accidental release are discussed in Section 10.4.

11.4.4.1 Spill Prevention

Spill prevention is the most critical component to avoiding impacts from a crude oil release. If a release occurs, the most important actions to reduce environmental impacts are to minimize the size and spread of the release by implementing a rapid, coordinated, and effective spill response based on an established action plan. Section 10.5 of Chapter 10 provides information on the following:

- Crude Oil Release Prevention Programs and Measures (Section 10.5.1),
- Emergency Response Planning and Preparedness (Section 10.5.2), and
- Initial Oil Spill Containment and Response Methods (Section 10.5.3).

11.4.4.2 Cleanup, Restoration, and Recovery

Under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Oil Pollution Act (OPA 90), and several state statutes, cost recovery can be obtained from industry for natural resource damage caused by the release of oil or hazardous substances to the environment. Natural resources are defined as land, air, biota, groundwater, and surface water. A federal or state government entity, an Indian tribe, or other entity acting as a public trustee of a natural resource may file claims for damages to natural resources. Costs for damages that are recoverable under OPA 90 include the following:

- Natural Resources: Damages for injury to, destruction of, loss of, or loss of use of natural resources, including the reasonable costs of assessing the damage, which are recoverable by a U.S. trustee, a state trustee, an Indian tribe trustee, or a foreign trustee.
- Real or Personal Property: Damages for injury to, or economic losses resulting from destruction of, real or personal property, which are recoverable by a claimant who owns or leases that property.
- Subsistence Use: Damages for loss of subsistence use of natural resources, which are recoverable by any claimant who uses natural resources for subsistence that have been injured, destroyed, or lost, without regard to the ownership or management of the resources.
- Revenues: Damages equal to the net loss of taxes, royalties, rents, fees, or net profit shares due to the injury, destruction, or loss of real property, personal property, or natural resources, which are recoverable by the federal government, a state, or a political subdivision thereof.
- Profits and Earning Capacity: Damages equal to the loss of profits or impairment of earning capacity due to the injury, destruction, or loss of real property, personal property, or natural resources, which are recoverable by any claimant.
- Public Services: Damages for net costs of providing increased or additional public services during or after removal activities, including protection from fire, safety, or health hazards, due to a discharge of oil, which are recoverable by a state, or political subdivision of a state.

Details on liability and compensation in the event of a release are detailed in Section 10.6.

11.5 SUMMARY AND MITIGATION

Disproportionate and adverse impacts would occur to American Indian populations in the vicinity of the proposed Project. RA-06, RA-07, and RA-08 would have direct impacts on reservation lands (Leech Lake and Fond du Lac). Based on the discussion of tribal resources in Chapter 9, any of the routes, route segments, and system alternatives would have a long-term detrimental effect on tribal members as a result of crossing treaty lands. As summarized in Chapter 9, from a tribal perspective, the impacts cannot be categorized by duration (short term or permanent) or by extent (ROI, construction work area, permanent right-of-way). It is also not possible to determine which route alternative is better from an EJ perspective when each alternative affects tribal resources, tribal identity, and tribal health. Any of the routes selected would negatively affect tribal resources and tribal members.

The combination of tribal identity and relationship to the land and the rights tribal members have in the ceded territories complicates the traditional notion of mitigation. The ceded territories and the rights that go with them are not mobile and cannot be transferred. Tribal impacts are magnified because there would be impacts associated with abandonment and removal of the existing Line 3 and there would be additional impacts associated with the replacement of Line 3 in a new location.

A finding of “disproportionate and adverse impacts” does not preclude selection of any given alternative. This finding does, however, require detailed efforts to avoid, mitigate, minimize, rectify, reduce, or eliminate the impact associated with the construction of the Project or any alternatives. The CEQ recommends evaluating mitigation options by eliciting “the views of the affected populations on measures to mitigate a disproportionately high and adverse human health or environmental effect on a low-income population, minority population, or Indian Tribe and should carefully consider community views in developing and implementing mitigation strategies.” Furthermore, mitigation measures

identified in an EIS "should reflect the needs and preferences of affected low-income populations, minority populations, or Indian tribes to the extent practicable."

Mitigation measures beyond those already described in Chapters 5 and 6 may include a variety of approaches for addressing potential effects and balancing the needs and concerns of the affected community with the requirements of the action or activity. These measures can be evaluated in the final Certificate of Need or route permit decision. This provides an additional avenue for public notice and involvement. The types of mitigation that can be considered include the following:

- Planning for and addressing indirect impacts prior to Project construction with affected populations;
- Providing assistance to an affected community to ensure that it receives at least its fair (i.e., proportional) share of the anticipated benefits of the proposed action (e.g., through job training, community infrastructure improvements);
- Establishing a community oversight committee to monitor progress and identify potential community concerns;
- Requiring financing at the outset of the Project for both implementing the measure and monitoring its effectiveness, and ensuring clearly defined monitoring guidelines are in place;
- Requiring monitoring reporting, which should be made available to the public; and
- Identifying clear consequences and penalties for failure to implement effective mitigation measures.

11.6 REFERENCES

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Chapter 12
Cumulative Potential Effects

12.1 PURPOSE AND DESCRIPTION OF CUMULATIVE POTENTIAL EFFECTS ANALYSIS

Cumulative potential effects result when impacts associated with the proposed Line 3 Replacement Project (Project) are combined with impacts associated with past, present, or reasonably foreseeable future actions within the area affected by the proposed Project. Analysis of cumulative potential effects accounts for the possibility that, added together, the minor impacts of many separate actions could be significant. This cumulative potential effects analysis considers resources that are expected to be affected by the proposed Project or its alternatives and assesses past, present, and reasonably foreseeable future actions to identify any geographic or temporal overlap in impacts on these resources.

Although Project-Specific, This Analysis Also Considers Wider Effects on Air Resources

The environmentally relevant area for evaluating cumulative potential effects varies in size depending on the types of resources and potential impacts considered. This cumulative effects analysis provides a focused, Project-specific review of cumulative potential effects and does not address impacts outside of the environmentally relevant area at a broad regional level.[1] For example, the geographic area over which the Project and its alternatives may affect air resources (related to the airshed) is larger than the geographic area over which the Project and its alternatives may affect some habitats (the pipeline construction work area). As a result, a broader geographic region is explored in assessing the potential for past, present, and reasonably foreseeable actions to have a compounding impact on air resources while the exploration of the potential for past, present, and reasonably foreseeable actions to have a compounding impact on certain habitat types is limited to the pipeline's construction footprint.

Both Temporary and Long-Term Effects Are Considered

The time period over which cumulative potential effects are evaluated also varies depending on the types of resources and potential impacts being considered. Impacts associated with construction noise, for example, are limited to the construction period, while impacts on wooded habitat within the permanent right-of-way would persist for decades. As a result, the time window considered in the search for past, present, and reasonably foreseeable actions with noise impacts that may overlap with noise impacts from pipeline construction is limited to the construction period, while the timeframe considered in the search for past, present, and reasonably foreseeable actions with overlapping impacts on wooded habitat extends several decades.

The sections that follow identify reasonably foreseeable actions (Section 12.2) and review cumulative potential effects of these reasonably foreseeable actions in combination with Enbridge's proposed Project and the Certificate of Need (CN) Alternatives considered in Chapter 5 (Section 12.3) and with the route alternatives considered in Chapter 6 (Section 12.4). The final section of this chapter considers

[1] Card v. Kandiyohi County Board of Commissioners, 713 N.W.2d 817

more broadly the cumulative potential effects of these projects on climate change and the impacts of climate change on resources that are affected both by the proposed Project and by climate change (Section 12.5). Cumulative potential effects associated with route segment alternatives are addressed in Chapter 7. Cumulative potential effects relevant to tribal uses and environmental justice communities are discussed in Chapters 9 and 11, respectively.

12.2 PAST, PRESENT, AND REASONABLY FORESEEABLE ACTIONS

Future Actions Include Other Projects and the Possibility of Corridor Sharing

This Environmental Impact Statement (EIS) accounts for past, present, or reasonably foreseeable actions with impacts that could overlap with impacts at the same time or place as the proposed Project or its alternatives. For the purposes of this EIS, past and present actions and their associated impacts are now part of the existing environment and are included in the affected environment described in Chapters 5 and 6.[2] In determining what is "reasonably likely to occur," this cumulative potential effects assessment considers whether any applications for permits have been filed with any units of government or whether detailed plans and specifications have been prepared for a project, among other considerations. A project need not be permitted to be reasonably likely to occur.

In addition, this analysis considers potential future corridor sharing. The Minnesota Public Utilities Commission (Commission) is required to consider corridor sharing in determining which route to select and permit (Minnesota Rules 7852.1900 Subp. 2 F). This cumulative potential effects analysis acknowledges that if a new pipeline corridor is permitted for this Project outside of the existing Enbridge Mainline, the new corridor creates an opportunity for future corridor sharing that could ultimately result in accumulation of multiple pipelines within the corridor chosen for the Line 3 Replacement Project. To address potential cumulative effects, the impacts of an additional pipeline in the Line 3 Replacement Project corridor have been assessed.

The future actions considered in this cumulative potential effects analysis are summarized in Table 12.2-1 and presented in Figure 12.2-1.

[2] Minn. R. 4410.0200, Subp. 11a

Table 12.2-1. Reasonably Foreseeable Actions Considered in the Analysis

Plans, Programs, or Project	Description	Type
1. Line 67 Expansion Project *Recently constructed, environmental review for increase in throughput underway*	Line 67 began transporting 450,000 barrels per day (bpd) from Canada in 2010. It received a CN from the Commission to expand its capacity to 800,000 bpd in November 2014, but is awaiting the issuance of a Presidential Permit from the U.S. Department of State, which is required of pipeline projects that cross an international boundary. The increased capacity required construction of four new pumping stations and upgrades to three existing pump stations along the existing line. Construction of the pumping stations has been completed and increased volumes have been achieved by transferring oil to a reinforced section of existing Line 3 to cross the U.S.-Canada border and then transferring the oil back to Line 67 (U.S. Department of State 2017). Environmental Review Document: https://www.state.gov/documents/organization/267747.pdf	Crude oil pipeline
2. Minnesota Pipe Line Company, LLC (MPL) Reliability Project *Construction*	The MPL Reliability Project will add six pump stations along MPL Line 4 or the "MinnCan Pipeline" route and upgrade two existing stations in Clearbrook and Albany. MPL Line 4, constructed in 2008, is a 300-mile-long, 24-inch-diameter crude oil pipeline that runs from Clearbrook to Rosemount, Minnesota. Currently MPL Line 4 is configured to transport approximately 165,000 bpd, but after improvements will be able to transport 350,000 bpd. The work related to the new pump stations will occur on six small parcels of land located in the counties of Hubbard, Wadena, Morrison, Meeker, McLeod, and Scott, on parcels (each approximately 5–7 acres) owned or to be purchased by MPL (Department of Commerce, Energy Environmental Review and Analysis [DOC-EERA] 2015a). Environmental Review Document: http://mn.gov/commerce/energyfacilities/documents/34034/Environmental%20Review%20of%20Alternatives_Final.pdf	Pump stations
3. Koch Pipeline Company, Clearbrook Tanks Project *In permitting*	Expansion is proposed at the existing Clearbrook terminal by constructing four 300,000-barrel crude oil breakout tanks. The project will require a new 1,500-foot access road, two small buildings to house power zone centers and necessary pumps, and piping. The project footprint would affect approximately 18.0 acres of primarily agricultural land and some fragmented wooded forest land (Minnesota PCA 2015). Environmental Review Document: https://www.pca.state.mn.us/sites/default/files/p-ear2-69a.pdf	Crude oil breakout tanks
4. Menahga Area 115-kilovolt (kV) Transmission Line Project *Preconstruction*	Great River Energy's Menahga Project will construct approximately 22.5 miles of a 115-kV high-voltage transmission line (HVTL) in Hubbard, Wadena, and Becker counties to meet existing and future electric load requirements and provide electric service to a proposed Todd-Wadena distribution substation that will serve the proposed MPL Sebeka pump station. The transmission line would generally require a 500-foot right-of-way, and wider widths would be required to accommodate associated facilities (DOC-EERA 2015b). Environmental Review Document: http://mn.gov/commerce/energyfacilities//resource.html?Id=34290	Transmission line
5. MPL-Laporte 115-kV Transmission Line Project *In permitting*	Minnkota Power Cooperative proposes to build an approximately 9.4-mile 115-kV HVTL and a new 115/4.16-kV distribution substation to serve a new pumping station to be constructed and operated by MPL (DOC-EERA 2016). Environmental Review Document: http://mn.gov/commerce/energyfacilities//resource.html?Id=34630	Transmission line

Table 12.2-1. Reasonably Foreseeable Actions Considered in the Analysis

Plans, Programs, or Project	Description	Type
6. Valley Expansion Pipeline Project *In permitting*	WBI Energy has proposed to construct a 38.0-mile, 16-inch natural gas pipeline that would connect WBI Energy's existing system near Mapleton, North Dakota, with the Viking Gas Transmission Company pipeline near Felton, Minnesota. Survey work has begun on the route and construction is proposed to start in early 2018[3] Environmental Review Document: None completed for this project.	Natural gas pipeline
7. Great Northern Transmission Line *Preconstruction*	On April 8, 2016, the Commission published an order issuing a route permit to Minnesota Power to construct a 500-kV transmission line from the Minnesota-Manitoba border to the Blackberry 500-kV substation near Grand Rapids, Minnesota, as well as associated substation facilities and transmission system modifications. On November 16, 2016, Minnesota Power received a Presidential Permit from the U.S. Department of Energy for the Minnesota-Manitoba border crossing (DOC-EERA; U.S. Department of Energy 2015). Environmental Review Document: http://mn.gov/commerce/energyfacilities//resource.html?Id=34321	Transmission line
8. Fargo-Moorhead Metropolitan Area Flood Risk Management Project *Preconstruction*	The Fargo-Moorhead Metropolitan Area Flood Risk Management Project is a 30.0-mile-long, 1,500-foot-wide diversion channel including a 12.0-mile-long southern embankment, 19 highway bridges, four railroad bridges, three gated control structures, and two aqueduct structures. The project would provide flood risk reduction for more than 230,000 people and 70.0 square miles of infrastructure in the communities of Fargo, Moorhead, West Fargo, Horace, and Harwood (Minnesota Department of Natural Resources [Minnesota DNR] 2016). Environmental Review Document: http://www.dnr.state.mn.us/input/environmentalreview/fm_flood_risk/feis.html	Water diversion channel
9. Addition of pipeline in same corridor	If a new pipeline corridor is permitted for this Project, outside of the existing Enbridge Mainline, the new corridor creates an opportunity for future corridor sharing that could ultimately result in accumulation of multiple pipelines within the corridor chosen for the Line 3 Replacement Project. This analysis considers the future addition of another pipeline to a new Line 3 pipeline corridor.	Crude oil pipeline

[3] Federal Register / Vol. 82, No. 3 / Thursday, January 5, 2017

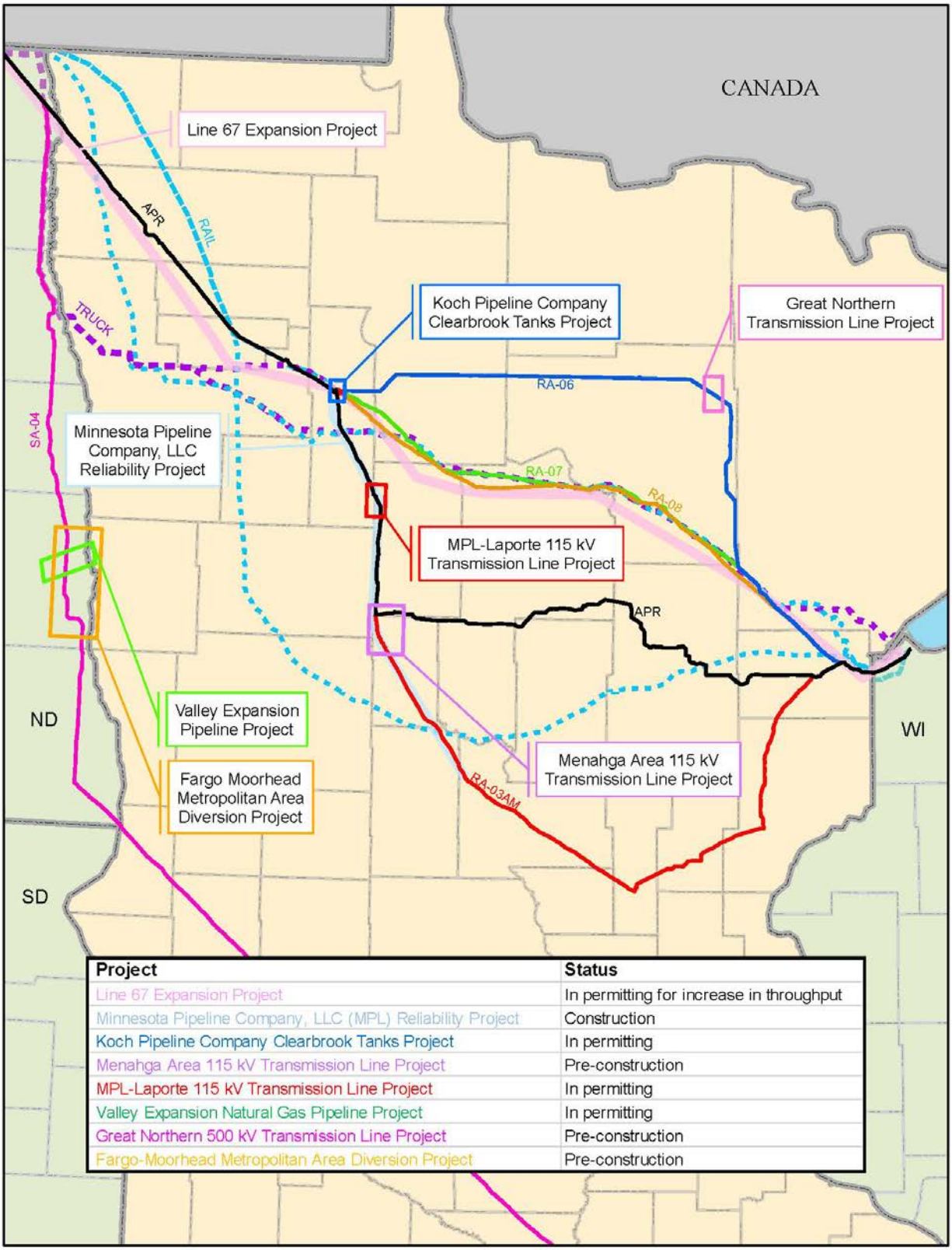

Figure 12.2-1. Reasonably Foreseeable Actions

12.3 CUMULATIVE POTENTIAL EFFECTS – CERTIFICATE OF NEED ALTERNATIVES

12.3.1 Applicant's Preferred Route

The duration and geographical extent of impacts associated with construction and operation of the Applicant's preferred route are summarized in Chapter 5. Based on the temporal and geographic extent of impacts described in Chapter 5, this analysis of cumulative potential effects for the Applicant's preferred route focuses on five reasonably foreseeable projects located within several miles of the Applicant's preferred route that are expected to be under construction or operational during or after the time the Project would be constructed (as early as spring 2018):

- Line 67 Expansion Project
- Minnesota Pipeline Company, LLC Reliability Project
- Koch Pipeline Company, Clearbrook Tanks Project
- MPL-Laporte 115-kV Transmission Line Project
- Menahga Area 115-kV Transmission Line Project

12.3.1.1 Line 67 Expansion Project

The potential cumulative effects of the Line 67 Expansion Project in combination with the Line 3 Replacement Project were evaluated in the 2017 Draft EIS prepared by the U.S. Department of State for that project. That environmental review document is incorporated here by reference (U.S. Department of State 2017).

Enbridge's Line 67 is located within the Enbridge Mainline corridor. Thus, between Neche, North Dakota, and Clearbrook, Minnesota, the Applicant's preferred route and Line 67 would run parallel to one another within the Mainline corridor (Figure 12.2-1).

Increased Throughput on Line 67 Would Not Increase Cumulative Potential Effects

Line 67 was constructed in 2009 and began transporting 450,000 barrels per day (bpd) from Canada in 2010. It received a CN from the Commission to expand its capacity to 800,000 bpd in November 2014, but is awaiting the issuance of a Presidential Permit from the U.S. Department of State, which is required of pipeline projects that cross an international boundary. Construction activities for the Line 67 upgrade are complete and the increased throughput volumes that the project was designed to handle have been achieved by transferring oil to a reinforced section of existing Line 3 to cross the U.S.-Canada border and then transferring the oil back to Line 67. As noted above, for the purposes of this EIS, past and present actions and their associated impacts are now part of the existing environment and are included in the affected environment described in Chapters 5 and 6.[4]

The issuance of a Presidential Permit will authorize the movement of the increased throughput volumes through Line 67, but will not materially change the environmental impacts already present as a result of construction and operation of the Line 67 Expansion Project. Therefore, issuance of the Presidential

[4] Minn. R. 4410.0200, Subp. 11a

Permit is not expected to cause any new cumulative potential effects with the Applicant's preferred route for the Line 3 Replacement Project.

12.3.1.2 Minnesota Pipeline Company Reliability Project

The impacts of the Minnesota Pipe Line Company (MPL) Reliability Project were evaluated in the 2015 Comparative Environmental Review completed by the Minnesota Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) for that project. That environmental review document is incorporated here by reference and its conclusions form the basis for this assessment of the potential for cumulative effects (DOC-EERA 2015a).

New and Upgraded Pump Stations Would Increase Capacity of MPL Line 4

The MPL Reliability Project would install six new pumping stations and upgrade two others in order to increase the pumping capacity of the 305-mile-long MPL Line 4. The Commission issued a route permit for MPL Line 4 ("MinnCan pipeline") on April 13, 2007, and the newly installed pipeline went into operation before the end of 2008. MPL Line 4 has a designed capacity of approximately 350,000 bpd, but is currently limited to a throughput capability of approximately 165,000 bpd.

The MPL Reliability Project would optimize the throughput capacity of MPL Line 4 without altering the actual pipeline by upgrading the existing pump stations in Clearbrook, Minnesota, and Albany, Minnesota, and installing new pump stations along the current MPL Line 4 route in rural areas of Hubbard, Wadena, Morrison, Meeker, McLeod, and Scott counties. The work related to the new pump stations will occur on six small parcels of land, each approximately 5 to 7 acres, owned or to be purchased by MPL. No new pipeline would be required and no new pipeline right-of-way would be acquired for the project.

A Portion of MPL Line 4 Shares Corridor with the Line 3 Replacement Project and One Pump Station Would Be Nearby

The Applicant's preferred route is located within the same general corridor as MPL Line 4 between Clearbrook and the southern corner of Hubbard County, where the Applicant's preferred route turns east while MPL Line 4 continues south to the Twin Cities area (Figure 12.2-1). Pump upgrades at the MPL/Koch Pipeline Company Clearbrook terminal proposed as part of the MPL Reliability Project will occur immediately south of the proposed Line 3 Replacement Project pump upgrades at Enbridge's Clearbrook terminal. One of the new MPL Line 4 pump stations, to be located near Laporte, Minnesota, would be situated adjacent to the Applicant's preferred route for the Line 3 Replacement Project. The other new pump stations and pump station upgrades proposed as part of the MPL Line 4 Reliability Project are located well south of where the Applicant's preferred route splits from the MPL Line 4 corridor and heads east.

The MPL Reliability Project is anticipated to be constructed and operational by the fourth quarter of 2017, well before construction of the Line 3 Replacement Project would be anticipated to begin (as early as spring 2018). As a result, no cumulative potential effects are anticipated from construction activities (e.g., construction stormwater, construction noise).

Cumulative potential effects that have been identified are described below, organized by potentially affected resource. Other resources, however, would not be affected and are therefore not discussed.

12.3.1.2.1 Noise and Vibration

Added Pump Stations Would Increase Noise, but Would Still Be Within Statutory Limits

Operational impacts of the MPL Reliability Project are primarily associated with pump station noise that will contribute to higher noise levels at local receptors, particularly residences. Near the MPL Clearbrook terminal, pump station upgrades at Enbridge's Clearbrook terminal will also contribute noise impacts. MPL has calculated that the closest residence to any pump station is approximately 0.1 mile (over 500 feet); at that distance, noise impacts from the MPL Reliability Project should be well within the state standard. See Section 6.2.2 for a discussion of noise associated with the proposed Project and alternatives to the proposed Project as well as state noise standards.

As discussed in Section 6.2.2, Enbridge has also modeled compliance with the state noise standard. In addition, both MPL and Enbridge have committed to post-construction monitoring and mitigation, if necessary, to maintain compliance with the state noise standard. As a result, cumulative potential effects on noise in the Clearbrook area are not anticipated to be significant. In the vicinity of the MPL Laporte terminal, no noise impacts are expected from operation of the Line 3 Replacement Project, so no cumulative potential effects are anticipated.

12.3.1.2.2 Vegetation

Need to Clear Forested Land is Mitigated by Corridor Sharing

Permanent impacts of the new MPL Laporte substation include clearing approximately 10 acres of forested land. The Applicant's preferred route for the Line 3 Replacement Project would result in further clearing within the nearby corridor, adding to the loss of forest vegetation in this area.

The clearing of vegetation and conversion from forested to open habitats could impede native vegetation by increasing potential for spread of invasive species and noxious weeds and could also increase the effects of light penetration, wind, and humidity that are more prominent on edges between different habitat types. These impacts could have significant cumulative potential effects; the use of a shared corridor, however, tends to minimize the introduction of new impacts.

12.3.1.2.3 Wildlife

Potential Cumulative Effects on Wildlife Should Not Be Significant

The new MPL pump station at Laporte is not anticipated to have a significant impact on wildlife. The forested area to be converted for the Laporte pump station is already a fragmented habitat, due to the existing MPL pipeline corridor. The pump station would be in immediate proximity to the pipeline, creating a nominal, incremental effect. The addition of the Line 3 Replacement pipeline along this corridor would further widen the cleared area, but it would be in immediate proximity to the MPL pipeline, creating a nominal, incremental effect on wildlife. Therefore, no significant cumulative potential effects are anticipated.

12.3.1.2.4 Risk of Accidental Release

Increased Capacity of MPL Line 4 Would Not Significantly Increase Spill Risk

As discussed in Chapter 10, increases in throughput do not directly translate into greater risk of accidental release. The addition of the Line 3 Replacement pipeline within the MPL corridor increases total risk of incident within the corridor by adding an entirely new pipeline. The increase in throughput on MPL Line 4 is not anticipated to significantly add to the risk profile in terms of likelihood of an event, exposure of resources, or measurable change in the ultimate size of a spill.

12.3.1.3 Koch Pipeline Company, Clearbrook Tanks Project

The potential cumulative effects of the Koch Pipeline Company's Clearbrook Tanks Project in combination with the Line 3 Replacement Project were evaluated in a 2015 Environmental Assessment Worksheet prepared by Minnesota Pollution Control Agency (Minnesota PCA) for that project (Minnesota PCA 2015). That environmental review document is incorporated here by reference, and its conclusions are summarized below.

The Clearbrook Tanks Project Would Require Four New Tanks and Other Infrastructure

The Clearbrook Tanks Project involves the addition of four field-erected 300,000-barrel (50,400,000 gallons total) external floating roof crude oil tanks at Koch Pipeline Company's existing Clearbrook terminal. The new tanks will be 196 feet in diameter and 56 feet high, and will have foundations that extend below the ground surface. In addition to the tanks and their associated containment areas, the project will require new infrastructure that would include a new 1,500-foot access road, two small buildings to house power zone centers as well as necessary pumps, and piping.

Clearbrook Tanks Project Would Have No Cumulative Short-Term Construction Effects

As noted above, the MPL/Koch Pipeline Company Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The Applicant's preferred route and proposed Line 3 Replacement Project upgrades to the Enbridge Clearbrook station would occur in the immediate vicinity of the Clearbrook Tanks Project.

Construction of the Clearbrook Tanks Project is expected to be complete well before construction of the Line 3 Replacement Project would begin. As a result, no cumulative potential effects are anticipated from construction activities (e.g., construction stormwater, construction noise).

Cumulative potential effects that have been identified are described below, organized by potentially affected resource. Other resources, however, would not be affected and are therefore not discussed.

12.3.1.3.1 Water Resources

One-Time Water Appropriations Would Not Overlap, So Would Have No Cumulative Effects

The Clearbrook Tanks Project will require a one-time water appropriation from Steenerson Lake under an existing permit for hydrostatic testing of the tanks before they are put into service. Due to the anticipated time lag between commissioning of the Clearbrook Tanks and commissioning of the Line 3 Replacement pipeline, overlap in hydrostatic test water appropriations is not expected and cumulative potential effects are therefore not anticipated. If future hydrostatic testing activities for the tanks

overlap with hydrostatic testing of the pipeline, source water for some of the hydrostatic testing activity may need to be drawn from a resource other than Steenerson Lake to avoid adverse effects on this waterbody.

12.3.1.3.2 Air Quality

Volatile Organic Compound Emissions Would Have Negligible Cumulative Potential Effect Compared to Actual Statewide Emissions

The primary cumulative potential effect of the Clearbrook Tanks Project is related to increases in air emissions in the environmentally relevant area around the Clearbrook terminal due to operation of tanks and pump stations. The Clearbrook Tanks Project's main potential environmental effects would be an increase in permitted air emissions (primarily volatile organic compounds [VOCs] and hazardous air pollutants [HAPs]). Koch Pipeline Company holds an air permit from Minnesota PCA to operate their terminal, including the new tanks, and will continue to operate within the limitations set forth in the air permit. Impacts from the Clearbrook Tanks Project air emissions would be localized and limited to the Clearbrook terminal and immediate surrounding area.

Actual VOC emissions for the Koch Pipeline Company's Clearbrook terminal were 20.91 tons. As indicated in Section 5.2.7, VOC emissions at Enbridge's Clearbrook terminal after the proposed Project are expected to be approximately 21 tons. Understanding the regional transport nature of ozone generation due to VOC emissions, the cumulative emissions from both the Koch Pipeline Company and Enbridge terminals are negligible in comparison to statewide actual VOC emissions from stationary sources.

12.3.1.4 MPL-Laporte 115-kV Transmission Line Project

The potential for cumulative effects resulting from the MPL-Laporte 115-kV Transmission Line Project in combination with the Line 3 Replacement Project was evaluated in a 2016 Environmental Assessment prepared by DOC-EERA for that project (DOC-EERA 2016a). That environmental review document is incorporated here by reference and the primary areas where cumulative potential effects were identified in that assessment are summarized below.

The MPL-Laporte 115-kV Transmission Line Project involves the construction of approximately 9.4 miles of 115-kV high-voltage transmission line (HVTL) as well as a new 115/4.16-kV distribution substation to serve the Laporte pump station proposed as part of the MPL Line 4 Reliability Project discussed above.

MPL-Laporte Transmission Line Project Would Have No Cumulative Short-Term Construction Effects

The Applicant's preferred route for the Line 3 Replacement Project overlaps the environmentally relevant area of the MPL-Laporte 115-kV transmission line, south of where the Applicant's preferred route diverts from the existing Line 3 and follows the MPL pipeline corridor south across the Clearwater-Hubbard county line.

Construction of the Laporte 115-kV HVTL is anticipated to be complete in the fourth quarter of 2017, well before construction of the Line 3 Replacement Project would be expected to begin. As a result, no cumulative potential short-term effects are anticipated from construction (e.g., construction stormwater, construction noise).

12.3.1.4.1 Aesthetics/Visual Resources

With Line 3 Replacement Project Underground, Cumulative Aesthetic Impacts Would Be Compatible with Existing Conditions

One of the route alternatives under consideration for the Laporte 115-kV HVTL ("Collocate Route Alternative") parallels the existing MPL pipeline corridor across the Clearwater-Hubbard county line and would result in a cumulative widening of this treeless linear feature. The addition of the Line 3 Replacement pipeline in this area would cumulatively create an even wider, longer area of visual disturbance. The Line 3 Replacement pipeline, however, would be located underground, so, although the addition of the pipeline would further increase the width of the cleared corridor, there would be no structures or conductors added to the viewshed. The potential cumulative aesthetic effects along the Collocate Route Alternative route are not expected to be significant as this infrastructure would not be incompatible with existing aesthetic conditions.

12.3.1.4.2 Water Resources

MPL-Laporte 115-kV Transmission Line Project Could Cumulatively Affect Wetlands and Wetland Vegetation

The MPL-Laporte 115-kV transmission line and the Applicant's preferred route for the Line 3 Replacement Project could collectively result in adverse, regional cumulative impacts on wetlands. Linear projects, such as transmission lines and pipelines, require removal of woody vegetation from the project rights-of-way for construction and operation. Should woody vegetation be removed from forested or shrub wetlands, it would convert the wetland to a different vegetation community and wetland type (see Sections 5.2.1.3 and 6.3.1.3). When considered collectively, the MPL-Laporte 115-kV transmission line in combination with the Applicant's preferred route for the Line 3 Replacement Project would be expected to cumulatively result in a conversion of wetland vegetation community and wetland type.

MPL-Laporte 115-kV Transmission Line Project Could Span Watercourses and Line 3 Replacement Project Could Be Horizontally Drilled

Regardless of the routing option selected for the MPL-Laporte 115-kV transmission line, the line would cross the LaSalle Creek watercourse; the Applicant's preferred route also crosses LaSalle Creek. Portions of LaSalle Creek are identified as a designated trout stream; clearing vegetation adjacent to trout streams can result in increased water temperature, potentially resulting in less suitable trout habitat. Additionally, portions of LaSalle Creek are also identified as Aquatic Management Areas. The MPL-Laporte 115-kV transmission line can be designed to span watercourses, floodplains, and wetlands, thereby minimizing direct impacts. While vegetation maintenance would also be required for the right-of-way for the Applicant's preferred route, placement of the pipeline is anticipated to be accomplished through horizontally drilling beneath LaSalle Creek, thereby minimizing direct impact on the creek.

12.3.1.4.3 Vegetation

Clearing of Vegetation Would Be Minimized by Using Parallel Existing Corridors

Potential cumulative effects on vegetation resources can occur if multiple projects are constructed in close proximity to each other. As noted above, the clearing of vegetation and conversion from forested to open habitats could impede native vegetation by increasing potential for spread of invasive species

and noxious weeds and could also increase the effects of light penetration, wind, and humidity that are more prominent on edges between different habitat types. Permanent removal of trees and shrubs would be required along the rights-of-way for both the Minnkota MPL-Laporte 115-kV Transmission Line Project and the Line 3 Replacement Project; these impacts could have significant cumulative potential effects. In this case, however, these impacts are minimized to the extent possible through paralleling existing corridors.

12.3.1.4.4 Wildlife

Cumulative Long-Term Effects on Wildlife Should Be Minimal

The MPL-Laporte 115-kV transmission line and Applicant's preferred route for the Line 3 Replacement Project could result in cumulative potential effects on wildlife resources; specifically, the clearing of vegetation and disturbance of wildlife habitats could physically harm or displace wildlife species. These projects could further alter the amount and quality of habitat available to wildlife in the vicinity due to tree clearing for rights-of-way. The Applicant's preferred route and the Collocate Route Alternative parallel the MPL corridor through part of their routes, so while these impacts would be long term, their localized nature and the availability of abundant forested habitat in the vicinity mean that these impacts are not expected to be significant.

12.3.1.4.5 Unique Natural Resources

The MPL-Laporte 115-kV transmission line and the Line 3 Replacement Project both involve tree removal, which could contribute to cumulative potential effects on the northern long-eared bat, which relies on forested habitat for roosting.

Field Surveys Would Be Necessary to Confirm the Presence of Rare Species or Communities

If rare species are located in disturbed areas of projects constructed in close proximity to one another, the cumulative potential effects could be detrimental to individual rare communities. Field surveys would be required, however, to confirm the presence of rare species in the respective project rights-of-way prior to construction. If species are found, the permittee would be required to coordinate with the U.S. Fish and Wildlife Service (USFWS) or Minnesota Department of Natural Resources (Minnesota DNR) regarding avoidance or mitigation.

Potentially Significant Effects on Rare Species Would Be Minimized by Using Parallel Existing Corridors

Permanent loss of forest would lead to fragmentation by reducing intact blocks of forest vegetation. Removal of vegetation and conversion to open habitats would increase the potential for spread of invasive species and would alter the structure and function of rare communities, potentially making them less suitable for the species that would typically inhabit them. Cumulative potential effects on rare communities could be significant if projects are constructed in close proximity. In this case, however, they are minimized by paralleling existing corridors.

12.3.1.4.6 Commodity Production

Project Overlap Would Minimize Cumulative Effects on Forestry and Timber Operations

Potential impacts on forestry from the MPL-Laporte 115-kV transmission line are direct and long term because, in order to operate transmission lines safely, tall growing trees are not allowed in transmission

line rights-of-way. The same requirement would apply to the Line 3 Replacement Project. No active timber management lands (state forest, private tree farms) have been identified, however, within the proposed or alternative routes for the MPL-Laporte 115-kV Transmission Line Project. Because the Collocate Route Alternative and the Applicant's preferred route for the Line 3 Replacement Project overlap for part of their routes, the cumulative potential effects on forestry and timber operations are expected to be minimal.

12.3.1.5 Menahga Area 115-kV Transmission Line Project

The potential effects of the Menahga Area 115-kV Transmission Line Project were evaluated in a 2015 Environmental Assessment prepared by DOC-EERA for that project (DOC-EERA 2015b). That environmental review document is incorporated here by reference, and its conclusions form the basis for this assessment of the potential for cumulative effects.

The Menahga Area 115-kV Transmission Line Project involves the construction of approximately 22.5 miles of new 115-kV transmission line from the existing Hubbard substation in southwestern Hubbard County westward to a new Straight River substation, and then southward to a new Blueberry substation near the city of Menahga and to a new Red Eye substation. The proposed project is expected to relieve potential overloads on the existing 34.5-kV transmission system near the city of Menahga. It will serve the Sebeka pump station proposed as part of the MPL Reliability Project discussed above.

Menahga Area Transmission Line Would Have No Cumulative Short-Term Construction Effects

The Applicant's preferred route for the Line 3 Replacement Project overlaps the environmentally relevant area of the Menahga Area 115-kV transmission line where the two would share a corridor for approximately 1 mile, following the existing MPL pipeline corridor to the southern border of Hubbard County. The Straight River substation would be located adjacent to this shared corridor.

Construction of the Menahga Area 115-kV transmission line is anticipated to be complete in 2017, well before construction of the Line 3 Replacement Project would be expected to begin. As a result, no cumulative potential short-term effects are anticipated from construction (e.g., construction stormwater, construction noise).

12.3.1.5.1 Aesthetics

With Line 3 Replacement Project Underground, Cumulative Aesthetic Impacts Would Be Compatible with Existing Conditions

The Menahga Area 115-kV transmission line would follow the existing MPL pipeline corridor near the Hubbard-Wadena county line and would result in a cumulative widening of this treeless linear feature. The addition of the Line 3 Replacement pipeline in this area would cumulatively create an even wider, longer area of visual disturbance. The Line 3 Replacement pipeline, however, would be located underground, so while the addition of the pipeline would further increase the width of the cleared corridor, there would be no structures or conductors added to the viewshed. The potential cumulative aesthetic impacts are not expected to be significant as this infrastructure would not be incompatible with existing conditions.

12.3.1.5.2 Vegetation

Clearing of Vegetation Would Be Minimized by Using Parallel Existing Corridors

As noted above, vegetation clearing would be required to maintain the right-of-way for both the Menahga Area 115-kV transmission line and the Applicant's preferred route for the Line 3 Replacement Project. Conversion from forested to open habitats could impede native vegetation by increasing potential for spread of invasive species and noxious weeds and could also increase the effects of light penetration, wind, and humidity that are more prominent on edges between different habitat types. These impacts could have significant cumulative effects; however, paralleling existing corridors tends to minimize these impacts.

12.3.1.5.3 Wildlife

Cumulative Long-Term Effects on Wildlife Should Be Minimal

The Menahga Area 115-kV transmission line and Applicant's preferred route for the Line 3 Replacement Project both pass approximately 0.5 mile from the Lowe Wildlife Management Area. The projects could result in cumulative potential effects on wildlife resources; specifically, the clearing of vegetation and disturbance of wildlife habitats could physically harm or displace wildlife species. These projects could further alter the amount and quality of habitat available to wildlife in their vicinity due to tree clearing for rights-of-way for transmission lines and a pipeline. Parts of the Applicant's preferred route and the Collocate Route Alternative parallel the MPL corridor, so while impacts on wildlife would be long term, their localized nature and the availability of abundant forested habitat in the vicinity mean that these impacts are not expected to be significant.

12.3.1.5.4 Unique Natural Resources

The Menahga Area 115-kV transmission line and the Line 3 Replacement Project both involve tree removal, which could contribute to cumulative potential effects on the northern long-eared bat, which relies on forested habitat for roosting.

Field Surveys Would Be Necessary to Confirm the Presence of Rare Species or Communities

If rare species are located in disturbed areas of projects constructed in close proximity to one another, the cumulative potential effects could be detrimental to individual rare communities. Field surveys, however, would be required to confirm the presence of rare species in the respective project rights-of-way prior to construction. If species are found, the permittee would be required to coordinate with USFWS or Minnesota DNR regarding avoidance or mitigation.

Potentially Significant Effects on Rare Species Would Be Minimized by Using Parallel Existing Corridors

Permanent loss of forest would lead to fragmentation by reducing intact blocks of forest vegetation. Removal of vegetation and conversion to open habitats would increase the potential for spread of invasive species and would alter the structure and function of rare communities, potentially making them less suitable for the species that would typically inhabit them. Cumulative potential effects on rare communities could be significant if projects are constructed in close proximity. In this case, however, they are minimized by paralleling existing corridors.

12.3.1.5.5 Commodity Production

Project Overlap Would Minimize Cumulative Potential Effects on Forestry and Timber Operations

Potential impacts on forestry from the Menahga Area 115-kV transmission line are direct and long term because, in order to operate transmission lines safely, tall growing trees are not allowed in transmission line rights-of-way. The same requirement would apply to the Line 3 Replacement Project. No active timber management lands (state forest, private tree farms) are located in or adjacent to the shared corridor. Because parts of the Menahga Area 115-kV transmission line and the Applicant's preferred route for the Line 3 Replacement Project overlap, the cumulative potential effects on forestry and timber operations are expected to be minimal.

Expanded or New Rights-of-Way Could Create New Utility Corridors

An important incremental effect associated with a new pipeline along the Applicant's preferred route in combination with past, present, and reasonably foreseeable actions is expansion of existing and creation of new rights-of-way. The amount of area necessary for new permanent rights-of-way would vary in width depending on the terms of existing easements and the current alignment of existing pipelines or utilities within existing easements.

The Applicant's preferred route for the Line 3 Replacement pipeline would create approximately 60 miles of a new right-of-way, which could potentially cause new utility corridors to be established, as the Commission considers permitting routes for future projects that co-locate within existing corridors.

New Utility Corridors Could Change Land Use, Reduce Vegetation, and Affect Wildlife Habitats

The addition of rights-of-way could cumulatively affect existing land uses. Adding pipelines in a new or expanded right-of-way could incrementally cause further reductions in forested and agricultural lands, associated reductions in commodity production, and loss of important vegetation and wildlife habitats, including unique habitats. A new utility corridor could also contribute to industrial character and new air pollutant sources from constructed facilities.

12.3.2 Continued Use of Existing Line 3

The duration and geographical extent of impacts associated with the continued use of Line 3 are summarized in Chapter 5. Based on the temporal and geographic extent of the impacts described in Chapter 5, this analysis of cumulative potential effects for the continued use of existing Line 3 focuses on two reasonably foreseeable projects located within several miles of existing Line 3:

- Line 67 Expansion Project
- Koch Pipeline Company, Clearbrook Tanks Project

12.3.2.1 Line 67 Expansion Project

As noted above, Enbridge's Line 67 is located within the Enbridge Mainline corridor. Thus, for their entire lengths the existing Line 3 and Line 67 run parallel to one another within the Mainline corridor (Figure 12.2-1).

Presidential Permit for Line 67 Expansion Project Would Not Lead to Any New Cumulative Effects

As noted above, construction activities for the Line 67 expansion are complete, and the increased throughput volumes that the project was designed to handle have been achieved by transferring oil to a reinforced section of existing Line 3 to cross the U.S.-Canada border and then transferring the oil back to Line 67. The issuance of a Presidential Permit will authorize the movement of the increased throughput volumes through Line 67, but will not materially change the environmental impacts already present as a result of construction and operation of the Line 67 Expansion Project. Therefore, the Presidential Permit is not expected to cause any new cumulative potential effects in combination with the continued use of existing Line 3.

12.3.2.2 Koch Pipeline Company, Clearbrook Tanks Project

As noted above, Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. While the continued use of existing Line 3 would not require upgrades to the Enbridge Clearbrook terminal, it is possible that integrity dig activity required for the ongoing maintenance of existing Line 3 would occur in the vicinity of the Clearbrook Tanks Project.

12.3.2.2.1 Air Quality

Line 3 Integrity Digs Would Have No Significant Cumulative Potential Effects on Air Quality

As described above, the primary long-term impact of the Clearbrook Tanks Project is increased air emissions, created by the operation of tanks and pump stations around the Clearbrook terminal. If integrity digs were to become necessary along the portion of the existing Line 3 that is within the airshed around the Clearbrook Tanks Project, operation of equipment for the dig would contribute to air emissions. Any emissions associated with integrity digs, however, would be minor and temporary, so no significant cumulative effects are anticipated.

12.3.3 System Alternative SA-04

The duration and geographical extent of impacts associated with constructing and operating system alternative SA-04 are summarized in Chapter 5. Based on the temporal and geographic extent of the impacts described in Chapter 5, this analysis of cumulative potential effects for system alternative SA-04 focuses on three reasonably foreseeable projects located within several miles of SA-04 that are expected to be under construction or operational during or after the time SA-04 would be constructed (as early as spring 2018):

- Line 67 Expansion Project
- Valley Expansion Pipeline Project
- Fargo-Moorhead Metropolitan Area Flood Risk Management Project

12.3.3.1 Line 67 Expansion Project

Presidential Permit for Line 67 Would Have No Potential Cumulative Effects

As noted above, Enbridge's Line 67 is located within the Enbridge Mainline corridor. Thus, from Neche to the point near the North Dakota-Minnesota border where system alternative SA-04 splits from

Enbridge's Mainline corridor to head south, system alternative SA-04 and Line 67 would run parallel to one another within the Mainline corridor (Figure 12.2-1).

As noted above, construction of the Line 67 expansion is complete, and the increased throughput volumes that the project was designed to handle have been achieved by transferring oil to a reinforced section of existing Line 3 to cross the U.S.-Canada border and then transferring the oil back to Line 67. The issuance of a Presidential Permit will authorize the movement of the increased throughput volumes through Line 67, but will not materially change the environmental impacts already present as a result of construction and operation of the Line 67 Expansion Project. Therefore, the Presidential Permit is not expected to cause any new cumulative potential effects in combination with system alternative SA-04.

12.3.3.2 Valley Expansion Pipeline Project

WBI Energy has proposed to construct a 38.0-mile, 16-inch natural gas pipeline that would connect WBI Energy's existing system in North Dakota, with the Viking Gas Transmission Company pipeline in Minnesota. The project would provide 40 million cubic feet per day (MMcf/d) of bidirectional capacity from an interconnection with WBI Energy's existing pipeline located near the town of Mapleton in Case County, North Dakota, to Viking Gas Transmission's existing pipeline located near the town of Felton in Clay County, Minnesota.

With Construction Starting Early in 2018, Timing of the Two Projects Could Overlap

This project would serve new and existing customers in eastern North Dakota and western Minnesota. In January 2017, the Federal Energy Regulatory Commission published *Notice of Intent to Prepare an Environmental Assessment for the Planned Valley Expansion Project and Request for Comments on Environmental Issues*.[5] Survey work has begun on the route, and construction is proposed to start in early 2018, with the pipeline becoming operational in late 2018.

System alternative SA-04 overlaps the environmentally relevant area of the Valley Expansion Pipeline Project where SA-04 crosses the proposed Valley Expansion Pipeline Project corridor just north of the Fargo-Moorhead metropolitan area. With construction of the Valley Expansion Pipeline Project proposed to begin in early 2018, it is possible that the timing of construction would overlap for the two projects.

12.3.3.2.1 Noise

If Construction Activities Overlap, Noise Effects Would Be Short Term and Therefore Not Significant

If construction of these two projects occurred simultaneously, temporary noise effects would be exacerbated during concurrent construction phases, but their short-term nature would mean these adverse impacts are not expected to be significant.

[5] Federal Register / Vol. 82, No. 3 / Thursday, January 5, 2017

12.3.3.2.2 Aesthetics/Visual Resources

Overlapping Corridors Would Not Significantly Affect Visual Aesthetics

If construction of these two projects occurred simultaneously, temporary aesthetic impacts could overlap, but their short-term nature would mean these adverse impacts are not expected to be significant.

During operation, aesthetic impacts are primarily associated with the maintenance of a cleared right-of-way. Where the two corridors cross, the cleared corridors would overlap, changing the viewshed in both directions. Both projects would, however, be located underground, and their visual impacts would overlap parallel to Interstate 29, where no notable tree or brush clearing would be required. Therefore, the cumulative potential effect of these changes is unlikely to significantly alter the existing visual character of the area.

12.3.3.2.3 Transportation and Public Services

Simultaneous Construction Would Have a Short-Term Effect on Transportation Services

If the two projects were constructed simultaneously, increased construction vehicle traffic could result in short-term, adverse traffic impacts. Both projects, however, would be required to comply with all applicable road authorities' management standards and policies during construction so cumulative potential effects are not anticipated to be significant.

12.3.3.2.4 Wildlife

Clearing Vegetation in Overlapping Area Would Not Significantly Affect Wildlife

The clearing of vegetation and disturbance of wildlife habitats for these projects could physically harm or displace wildlife species. In addition, impacts such as disturbance related to construction noise could occur. For non-listed wildlife species, these impacts are not be expected to be significant. Furthermore, in the area where the two projects overlap, they are located adjacent to Interstate 29, so nearby wildlife are likely habituated to disturbance and noise in the area.

12.3.3.2.5 Commodity Production

Simultaneous Construction Would Have Little Cumulative Effect on Agriculture

The construction of these two projects could result in short-term cumulative potential effects on agricultural operations and practices, which may need to be altered in certain areas to avoid conflicts with construction activities. Since pipeline land uses are compatible with agriculture practices, operation of these utilities should have minimal cumulative potential effects on agriculture.

12.3.3.2.6 Employment/Income/Tax Revenues

Simultaneous Construction Would Provide Jobs and Increase Tax Revenue

If the projects were constructed at the same time, there would be a cumulative socioeconomic benefit, primarily in the form of short-term construction employment and long-term revenue from taxes. Along with these construction jobs, tax revenues, gross output, and value-added spending would occur from development and construction of the proposed projects.

12.3.3.3 Fargo-Moorhead Metropolitan Area Flood Risk Management Project

The impacts of the Fargo-Moorhead Metropolitan Area Flood Risk Management Project were evaluated in the 2016 EIS completed by Minnesota DNR for that project (Minnesota DNR 2016). That environmental review document is incorporated here by reference, and its conclusions form the basis for this assessment of the potential for cumulative effects.

As indicated in Table 12.2-1, the Fargo-Moorhead Metropolitan Area Flood Risk Management Project is a 30-mile-long, 1,500-foot-wide diversion channel including a 12.0-mile-long southern embankment, 19 highway bridges, four railroad bridges, three gated control structures, and two aqueduct structures. The project would provide flood risk reduction for more than 230,000 people and 70 square miles of infrastructure in the communities of Fargo, Moorhead, West Fargo, Horace, and Harwood.

Feasibility of Co-Locating the Two Projects Has Not Yet Been Analyzed

The system alternative SA-04 corridor coincides with the proposed diversion channel west of the Fargo-Moorhead metropolitan area, from a point just south of where system alternative SA-04 splits from Interstate 29 to the point just south of the Fargo-Moorhead metropolitan area where SA-04 re-joins Interstate 29. As proposed, SA-04 would be co-located along the diversion channel and would require a number of crossings of the channel and associated facilities (e.g., staging areas). A detailed engineering analysis of the feasibility of this arrangement has not been conducted. The description of cumulative potential effects below assumes collocation in this area is a viable option and describes the general impacts that could result.

12.3.3.3.1 Displacement

Corridor Sharing Could Cause Additional Displacement of Homes

The Fargo-Moorhead Metropolitan Area Flood Risk Management Project is expected to result in some displacement of homes/residences. Depending on how system alternative SA-04 were configured in relation to the final design of the diversion project, the impact of locating these two projects in a shared corridor through a relatively restricted area could cause additional displacement of homes/residences.

12.3.3.3.2 Noise

Simultaneous Construction Would Only Have a Short-Term Effect on Noise Levels

If construction of these two projects occurred simultaneously, temporary noise effects would be exacerbated during concurrent construction phases, but their short-term nature would mean these adverse impacts are not expected to be significant.

12.3.3.3.3 Aesthetics and Visual Resources

Simultaneous Construction Would Only Have a Short-Term Effect on Aesthetics

If construction of these two projects occurred simultaneously, temporary aesthetic impacts could overlap, but their short-term nature would mean these adverse impacts are not expected to be significant.

12.3.3.3.4 Housing

Increased Demand for Housing Would Be Short Term

If construction of these two projects occurred simultaneously in this area, the influx of workers would result in a cumulative increase in demand for housing. These impacts would, however, be short term, and neither project has identified a risk of housing shortage.

12.3.3.3.5 Transportation and Public Services

Simultaneous Construction Would Have Only a Short-Term Effect on Transportation Services

If constructed simultaneously, increased construction vehicle traffic could result in short-term, adverse traffic impacts. Both projects would be required to comply with all applicable road authorities' management standards and policies during construction, however, so cumulative potential effects are not anticipated to be significant.

12.3.3.3.6 Water Resources

Potentially Significant Cumulative Effects Could Be Mitigated by Permitting, Zoning, and Use of BMPs

Together, these two projects could collectively result in adverse, regional cumulative impacts on wetlands, floodplains, and surface waters. Both projects would cause wetland impacts in this region, including construction impacts and fill or type conversion. The addition of a pipeline in the same corridor would exacerbate the impacts of both construction and operation of the Fargo-Moorhead Metropolitan Area Flood Risk Management Project, increasing potential impacts associated with construction stormwater, further altering the floodplain, and potentially causing additional impacts on local hydrology. These cumulative effects have the potential to be significant, but may be managed through compliance with wetland permitting requirements, local floodplain zoning, application of stormwater control best management practices (BMPs) during construction, and proper restoration following construction.

12.3.3.3.7 Fish and Wildlife

Potentially Significant Effects on Fish and Aquatic Habitats Could Also Be Mitigated

To the extent that these two projects could collectively result in adverse, regional cumulative potential impacts on wetlands, floodplains, and surface waters, they could also affect fish and aquatic habitat. As noted above, these cumulative effects have the potential to be significant, but may be managed through compliance with wetland permitting requirements, local floodplain zoning, application of stormwater control BMPs during construction, and proper restoration following construction.

12.3.3.3.8 Employment/Income/Tax Revenues

Simultaneous Construction Would Create Jobs and Increase Tax Revenue

If the projects were constructed at the same time, there would be a cumulative socioeconomic benefit, primarily in the form of short-term construction employment and long-term revenue from taxes. Along with these construction jobs, tax revenues, gross output, and value-added spending would occur from development and construction of the proposed projects.

12.3.4 Transportation by Rail

The duration and geographical extent of impacts associated with transportation by rail are summarized in Chapter 5. Based on the temporal and geographic extents described in Chapter 5, this analysis of cumulative potential effects for transportation by rail focuses on reasonably foreseeable projects located within several miles of the loading facilities and rail access construction and upgrades described in Chapter 4.

Because this construction is localized near Gretna, Manitoba; Clearbrook, Minnesota; and Superior, Wisconsin, the search for reasonably foreseeable projects with the potential to overlap the environmentally relevant area was focused in these three general locations. Koch Pipeline Company's Clearbrook Tanks Project was identified as having the potential to overlap with rail loading and access expansion at Clearbrook required under the transportation by rail alternative.

As noted above, Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The proposed rail upgrades would likely occur in the vicinity of the Clearbrook Tanks Project.

Construction of Rail Upgrades and Clearbrook Tank Project Would Not Overlap

Construction of the Clearbrook Tanks Project is expected to be completed well before construction of the rail loading and access facilities would begin. As a result, no cumulative potential effects are anticipated from construction activities (e.g., construction stormwater, construction noise).

12.3.4.1 Noise

Rail Facilities Would Not Have Significant Cumulative Effects on Noise Levels

Operational impacts of the MPL Reliability Project are primarily associated with pump station noise that will contribute to higher noise levels at local receptors, particularly residences. In the vicinity of the MPL Clearbrook terminal, pump station upgrades at Enbridge's Clearbrook terminal would also contribute to noise impacts. MPL has calculated that the closest residence to any pump station is approximately 0.1 mile (over 500 feet); at that distance, noise impacts from the MPL Project should be well within the state standard.

Noise from rail loading and access facilities in the Clearbrook area would further contribute to industrial noise in the area. Post-construction monitoring and mitigation might be necessary to maintain compliance with the state noise standard. If post-construction noise monitoring is conducted and mitigation is applied, cumulative potential effects on noise in the Clearbrook area are not anticipated to be significant.

12.3.4.2 Water Resources

New Rail Facilities Would Have No Significant Cumulative Effects on Water Resources

Both the Clearbrook Tanks Project and potential new rail loading and access facilities in the Clearbrook area would add new impervious surfaces and would be new sources of industrial stormwater in the area. Construction of the new tanks, secondary containment, and new internal roads will increase the impervious area of the Koch Pipeline Company's Clearbrook terminal site by approximately 18 acres and therefore requires a National Pollutant Discharge Elimination System/State Disposal System Construction Stormwater General permit.

Most of the runoff from the new impervious surfaces would be collected and retained in the secondary containment system. As a result, the new impervious surfaces would not significantly increase the rate at which water is discharged from the site to the surrounding watershed area. Accumulated stormwater would be inspected prior to discharge and would be discharged in a manner that prevents erosion or scouring in the conveyance ditch. Potential new rail loading and access facilities in the Clearbrook area would be subject to the same regulations and would not significantly increase the rate at which water is discharged from the site to the surrounding watershed area. As a result, no significant cumulative effects are anticipated.

12.3.4.3 Air Quality

New Rail Facilities Would Have No Significant Cumulative Effects on Air Quality

The primary cumulative potential effect of the Clearbrook Tanks Project would be air emissions from operating tanks and pump stations, which could potentially increase permitted air emissions (primarily VOCs and HAPs). A new rail loading facility could contribute air emissions of a similar nature during loading. Understanding the regional transport nature of ozone generation due to VOC emissions, the cumulative emissions from both the Koch Pipeline Company terminal and a new rail loading facility are negligible in comparison to regional actual VOC emissions from stationary sources.

12.3.5 Transportation by Truck

The duration and geographical extent of impacts associated with construction and operation of transportation by truck are summarized in Chapter 5. Based on the temporal and geographic extents described in Chapter 5, this analysis of cumulative potential effects for transportation by truck focuses on reasonably foreseeable projects located within several miles of the loading facilities and truck access construction and upgrades described in Chapter 4.

Because this construction would be localized near Gretna, Manitoba; Clearbrook, Minnesota; and Superior, Wisconsin, the search for reasonably foreseeable projects with the potential to overlap the environmentally relevant area was focused in these three general locations. Koch Pipeline Company's Clearbrook Tanks Project was identified as having the potential to overlap with truck loading and access expansion at Clearbrook required under the transportation by truck alternative.

As noted above, Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The proposed truck upgrades would likely occur in the vicinity of the Clearbrook Tanks Project.

Construction of Clearbrook Tanks Project and Truck Facilities Would Not Overlap

Construction of the Clearbrook Tanks Project is expected to be complete well before construction of the truck loading and access facilities for the Line 3 Replacement Project would begin. As a result, no cumulative potential short-term effects are anticipated from construction (e.g., construction stormwater, construction noise).

12.3.5.1 Noise

Truck Facilities Would Not Have Significant Cumulative Potential Effects on Noise Levels

Operational impacts of the MPL Reliability Project are primarily associated with pump station noise that would contribute to higher noise levels at local receptors, particularly residences. In the vicinity of the

MPL Clearbrook terminal, pump station upgrades at Enbridge's Clearbrook terminal would also contribute noise impacts. MPL has calculated that the closest residence to any pump station is approximately 0.1 mile (over 500 feet); at that distance, noise impacts from the MPL Reliability Project should be well within the state standard.

Noise from truck loading and access facilities in the Clearbrook area would further contribute to industrial noise in the area. Post-construction monitoring and mitigation might be necessary to maintain compliance with the state noise standard. If post-construction noise monitoring is conducted and mitigation is applied, cumulative potential effects on noise in the Clearbrook area are not anticipated to be significant.

12.3.5.2 Water Resources

New Truck Facilities Would Have No Significant Cumulative Potential Effects on Water Resources

Both the Clearbrook Tanks Project and potential new truck loading and access facilities in the Clearbrook area would add new impervious surfaces and would be new sources of industrial stormwater in the area. Construction of the new tanks, secondary containment, and new internal roads will increase the impervious area of the Koch Pipeline Company's Clearbrook terminal site by approximately 18 acres and therefore requires a National Pollutant Discharge Elimination System/State Disposal System Construction Stormwater General permit.

Most of the runoff from the new impervious surfaces would be collected and retained in the secondary containment system. As a result, the new impervious surfaces would not significantly increase the rate at which water is discharged from the site to the surrounding watershed area. Accumulated stormwater would be inspected prior to discharge and would be discharged in a manner that prevents erosion or scouring in the conveyance ditch. Potential new truck loading and access facilities in the Clearbrook area would be subject to the same regulations and would not significantly increase the rate at which water is discharged from the site to the surrounding watershed area. As a result, no significant cumulative effects are anticipated.

12.3.5.3 Air Quality

New Truck Facilities Would Have No Significant Cumulative Potential Effects on Air Quality

The primary cumulative potential effect of the Clearbrook Tanks Project would be air emissions from operating tanks and pump stations, which could potentially increase permitted air emissions (primarily VOCs and HAPs). A new truck loading facility could contribute air emissions of a similar nature during loading. Understanding the regional transport nature of ozone generation due to VOC emissions, the cumulative emissions from both the Koch Pipeline Company terminal and a new truck loading facility are negligible in comparison to actual regional VOC emissions from stationary sources.

12.3.6 Existing Line 3 Supplemented by Rail

Continuing to Use Existing Line 3 Supplemented by Rail Would Have Negligible Cumulative Potential Effects

The duration and geographical extent of impacts from continuing to use existing Line 3 supplemented by constructing and operating the transportation by rail alternative are summarized in Chapter 5. Based on these temporal and geographic extents, this analysis of cumulative potential effects for existing Line 3

supplemented by rail considers two reasonably foreseeable projects located within several miles of the both the existing Line 3 and the rail routes identified in Chapter 4:

- Line 67 Expansion Project
- Koch Pipeline Company, Clearbrook Tanks Project

As described in the preceding sections, cumulative potential effects include possible stormwater, noise, and air quality impacts. As described above, however, these cumulative potential effects are not expected to be significant.

12.3.7 Existing Line 3 Supplemented by Truck

Continuing to Use Existing Line 3 Supplemented by Truck Would Have Negligible Cumulative Potential Effects

The duration and geographical extent of impacts from continuing to use existing Line 3 supplemented by constructing and operating the transportation by truck alternative are summarized in Chapter 5. Based on these temporal and geographic extents, this analysis of cumulative potential effects for existing Line 3 supplemented by truck considers two reasonably foreseeable projects located within several miles of the both the existing Line 3 and the truck routes identified in Chapter 4:

- Line 67 Expansion Project
- Koch Pipeline Company, Clearbrook Tanks Project

As described in the preceding sections, cumulative potential effects include possible stormwater, noise, and air quality impacts. As described above, however, these cumulative potential effects are not expected to be significant.

12.4 CUMULATIVE POTENTIAL EFFECTS – ROUTE ALTERNATIVES

12.4.1 Applicant's Preferred Route

Cumulative potential effects of the Applicant's preferred route are described above in Section 12.3.1.

12.4.2 Route Alternative RA-03AM

The duration and geographical extent of impacts from constructing and operating RA-03AM are summarized in Chapter 6. Based on these temporal and geographic extents, this analysis of cumulative potential effects for RA-03AM focuses on five reasonably foreseeable projects located within several miles of RA-03AM that are expected to be under construction or operational during or after the time the Project is constructed (as early as spring 2018):

- Line 67 Expansion Project
- MPL Reliability Project
- Koch Pipeline Company, Clearbrook Tanks Project
- MPL-Laporte 115-kV Transmission Line Project

- Menahga Area 115-kV Transmission Line Project

12.4.2.1 Line 67 Expansion Project

Cumulative Effects of Line 67 Expansion Project Would Be the Same as Those for the Applicant's Preferred Route

As indicated previously, Enbridge's Line 67 is located within the Enbridge Mainline corridor. Between Neche, North Dakota, and Clearbrook, Minnesota, RA-03AM follows the same route as that proposed by the Applicant, running parallel to Line 67 within the Mainline corridor (Figure 12.2-1). The potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.1.

12.4.2.2 Minnesota Pipeline Company Reliability Project

Similar to the Applicant's preferred route, RA-03AM is located within the same general corridor as MPL Line 4 between Clearbrook and the southern corner of Hubbard County. However, where the Applicant's preferred route turns east at the southern corner of Hubbard County, RA-03AM continues to follow MPL Line 4 south before splitting from MPL Line 4 to head east as it enters Morrison County (Figure 12.2-1).

Therefore, between Clearbrook and the southern corner of Hubbard County, the potential for cumulative effects resulting from construction and operation of RA-03AM and the MPL Reliability Project is the same as described for the Applicant's preferred route in Section 12.3.1.2. Where RA-03AM follows the same general corridor as MPL Line 4 through Hubbard and Wadena counties and into Morrison County, however, the additional cumulative potential effects that may occur where the Sebeka and Fish Trap pump stations are proposed to be constructed adjacent to the shared MPL Line 4/RA-03AM corridor are described below. The other four pump stations/pump station upgrades proposed as part of the MPL Reliability Project are located well south of where the RA-03AM route splits from the MPL Line 4 corridor and heads east.

Construction of the MPL Reliability Project Would Have No Cumulative Potential Effects

The MPL Reliability Project is anticipated to be constructed and operational by the fourth quarter of 2017, well before construction of the Line 3 Replacement Project would be anticipated to begin (as early as spring 2018). As a result, no cumulative potential short-term effects are anticipated from construction (e.g., construction stormwater, construction noise).

12.4.2.2.1 Noise and Vibration

Operating the MPL Reliability Project Would Have No Cumulative Potential Effects on Noise

Operational impacts of the MPL Reliability Project are primarily associated with pump station noise that will contribute to higher noise levels at local receptors, particularly residences. In the vicinity of the MPL Sebeka and Fish Trap pump stations, no noise impacts are expected from operation of the Line 3 Replacement Project, so no cumulative potential effects are anticipated.

12.4.2.2.2 Vegetation

Corridor Sharing Would Minimize Cumulative Effects on Vegetation

Constructing the new MPL Fish Trap pump station will require clearing approximately 9 acres of forested land. Permanent impacts of the new MPL Sebeka pump station will include conversion of approximately 40 acres of land. This land, however, is predominantly agricultural. Constructing and operating RA-03AM would result in further clearing within the nearby corridor, adding to the loss of forest vegetation in this Fish Trap area.

The clearing of vegetation and conversion from forested to open habitats could impede native vegetation by increasing potential for spread of invasive species and noxious weeds and could also increase the effects of light penetration, wind, and humidity that are more prominent on edges between different habitat types. These impacts could have significant cumulative potential effects. The use of a shared corridor, however, tends to minimize the introduction of new impacts.

12.4.2.2.3 Wildlife

New MPL Pump Stations Would Have No Significant Cumulative Potential Effects on Wildlife

The new MPL pump stations at Sebeka and Fish Trap are not anticipated to have a significant impact on wildlife. The forested area to be converted for the Fish Trap station is already a fragmented habitat, due to the existing MPL pipeline corridor. The pump station would be right next to the pipeline, and would have a nominal, incremental effect. The addition of the Line 3 Replacement pipeline on the RA-03AM route along this corridor would further widen the cleared area, but it similarly would be in immediate proximity to the MPL pipeline, creating a nominal, incremental effect on wildlife. Therefore, no significant cumulative potential effects are anticipated.

12.4.2.2.4 Commodity Production

Land Conversions Would Have Only Temporary Cumulative Effects on Agriculture

As noted above, the permanent impacts of the new MPL Sebeka station will include conversion of approximately 40 acres of predominantly agricultural land to industrial use. The construction of RA-03AM could result in short-term cumulative potential effects on agricultural operations and practices, which may need to be altered in certain areas to avoid conflicts with construction activities. Since pipeline land uses are compatible with agriculture practices, cumulative potential effects on agriculture are expected to be temporary.

12.4.2.3 Koch Pipeline Company, Clearbrook Tanks Project

Potential Cumulative Effects of Clearbrook Tanks Project Are the Same as Those for the Applicant's Preferred Route

As noted above Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The Line 3 Replacement Project upgrades to the Enbridge Clearbrook station would occur in the immediate vicinity of the Clearbrook Tanks Project. The upgrades required for RA-03AM are the same as those required for the Applicant's preferred route. Therefore, the potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.3.

12.4.2.4 MPL-Laporte 115-kV Transmission Line Project

Potential Cumulative Effects of MPL-Laporte 115-kV Transmission Line Project Are the Same as Those for the Applicant's Preferred Route

The RA-03AM route and the Applicant's preferred route are the same in the environmentally relevant area for the MPL-Laporte 115-kV transmission line. Therefore, the potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.4.

12.4.2.5 Menahga Area 115-kV Transmission Line Project

Cumulative Potential Effects of Menahga Project Are the Same as Those for the Applicant's Preferred Route

The RA-03AM route and the Applicant's preferred route are the same in the environmentally relevant area for the Menahga Area 115-kV transmission line. Therefore, the potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.5.

12.4.3 Route Alternative RA-06

The duration and geographical extent of impacts associated with constructing and operating RA-06 are summarized in Chapter 6. Based on these temporal and geographic extents, this analysis of cumulative potential effects for RA-06 focuses on three reasonably foreseeable projects located within several miles of RA-06 that are expected to be under construction or operational during or after the time the Project would be constructed (as early as spring 2018):

- Line 67 Expansion Project
- Koch Pipeline Company, Clearbrook Tanks Project
- Great Northern Transmission Line (GNTL) Project

12.4.3.1 Line 67 Expansion Project

Cumulative Potential Effects of Line 67 Project Are the Same as Those for the Applicant's Preferred Route

As indicated previously, Enbridge's Line 67 is located within the Enbridge Mainline corridor. Between Neche, North Dakota, and Clearbrook, Minnesota, RA-06 follows the same route as that proposed by the Applicant, running parallel to Line 67 within the Mainline corridor (Figure 12.2-1). The potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.1.

12.4.3.2 Koch Pipeline Company, Clearbrook Tanks Project

Cumulative Potential Effects of Clearbrook Tanks Project Would Be the Same as Those for the Applicant's Preferred Route

As noted above, Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The Line 3 Replacement Project upgrades to the Enbridge Clearbrook terminal would occur in the immediate vicinity of the Clearbrook Tanks Project. The upgrades required for RA-06 are the same as

those required for the Applicant's preferred route. Therefore, the potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.3.

12.4.3.3 Great Northern Transmission Line Project

The potential for cumulative effects to result from the GNTL Project and RA-06 was evaluated in a 2015 EIS prepared by DOC-EERA and the U.S. Department of Energy for that project (DOC-EERA and U.S. Department of Energy 2015). That environmental review document is incorporated here by reference, and the areas where cumulative potential effects were identified in that assessment are summarized below.

The GNTL Project involves constructing more than 200 miles of 500-kV HVTL and a new 500-kV substation. It would run from an international border crossing in Roseau County, Minnesota, to the new Iron Range 500-kV Substation to be constructed just east of the existing Blackberry Substation near Grand Rapids, Minnesota. It would be located on a new 200-foot-wide right-of-way with a wider area required for certain spans at angle and corner structures, for guyed structures, or where special design requirements are dictated by topography.

On April 8, 2016, the Commission published an order issuing a route permit to Minnesota Power to construct a 500-kV transmission line from the Minnesota-Manitoba border to the 500-kV Blackberry Substation near Grand Rapids, as well as associated substation facilities and transmission system modifications. On November 16, 2016, Minnesota Power received a Presidential Permit from the U.S. Department of Energy for the Minnesota-Manitoba border crossing

The RA-06 route for the Line 3 Replacement Project overlaps the environmentally relevant area of the GNTL Project in northeastern Itasca County, where RA-06 would cross the permitted route for the transmission line, before turning south and paralleling the permitted route for the GNTL Project at a distance of approximately 4 miles for a short stretch northwest of Hibbing, Minnesota.

12.4.3.3.1 Aesthetics

Great Northern Transmission Line Project Would Have No Significant Effect on Aesthetics

Route alternative RA-06, if selected, would intersect the permitted GNTL route, but would be located underground where it would cross the 200-foot right-of-way of the GNTL Project. The potential cumulative aesthetic impacts in this area are not expected to be significant because they would only involve paralleling transmission lines for a short distance, and this infrastructure would not be incompatible with existing conditions.

12.4.3.3.2 Vegetation

Right-of-Way Clearing for Route Alternative RA-06 and Great Northern Transmission Line Would Have Significant Cumulative Potential Effects on Native Vegetation

Vegetation clearing would be required to maintain the right-of-way for both the GNTL and the Line 3 Replacement Project. Conversion from forested to open habitat could impede native vegetation by increasing potential for spread of invasive species and noxious weeds and could also increase the effects of light penetration, wind, and humidity that are more prominent on edges between different habitat types. These cumulative impacts could be significant, particularly where existing corridors are not used.

In the case of RA-06 and the GNTL, there is notable distance (approximately 4 miles) between the corridors that would be cleared and maintained free of woody vegetation. While the permitted route for the GNTL will parallel existing transmission infrastructure in this area, the addition of cleared right-of-way 4 miles east for RA-06 would exacerbate potential for spread of invasive species and noxious weeds and could also increase the effects of light penetration, wind, and humidity in the area.

12.4.3.3.3 Wildlife

Right-of-Way Clearing for Route Alternative RA-06 and Great Northern Transmission Line Would Further Fragment Wildlife Habitat

The GNTL Project and RA-06 could result in cumulative potential effects on wildlife resources; specifically, the clearing of vegetation and disturbance of wildlife habitats could physically harm or displace wildlife species. These projects could further alter the amount and quality of habitat available to wildlife in the vicinity due to tree clearing for rights-of-way for transmission lines and a pipeline.

As noted above, there is notable distance (approximately 4 miles) between the corridors that would be cleared. While the permitted route for the GNTL will parallel existing transmission infrastructure in this area, the addition of cleared right-of-way 4 miles east for RA-06 would contribute to a cumulative fragmentation of wildlife habitat in the area.

12.4.3.3.4 Unique Natural Resources

The GNTL Project and the Line 3 Replacement Project both involve tree removal, which could contribute to cumulative potential effects on the northern long-eared bat, which relies on forested habitat for roosting.

Field Surveys Would Be Necessary to Confirm the Presence of Rare Species or Communities

If rare species are located in disturbed areas of projects constructed in close proximity to one another, the cumulative potential effects could be detrimental to individual rare communities. Field surveys would be required, however, to confirm the presence of rare species in the respective project rights-of-way prior to construction. If species are found, the permittee would be required to coordinate with USFWS or Minnesota DNR regarding avoidance or mitigation.

Cumulative Fragmentation of Wildlife Habitat Could Potentially Affect Rare Species and Communities

Permanent loss of forest would lead to fragmentation by reducing intact blocks of forest vegetation. Removal of vegetation and conversion to open habitat would increase the potential for spread of invasive species and would alter the structure and function of rare communities, potentially making them less suitable for the species that would typically inhabit them. As noted above, the addition of cleared right-of-way for RA-06 4 miles east of the GNTL Project would contribute to a cumulative fragmentation of wildlife habitat in the area including rare species and communities.

12.4.3.3.5 Commodity Production

Route Alternative RA-06 or Great Northern Transmission Line Might Need to Be Relocated to Protect Mineral Resources

The GNTL and RA-06 would both cross areas of known mineral resources. If both projects were eventually constructed in these areas, portions of one or both of these projects may need to be relocated in the future to protect access to mineral resources.

12.4.3.3.6 Employment/Income/Tax Revenues

Route Alternative RA-06 and Great Northern Transmission Line Would Create New Jobs but not Significantly Affect Housing

The GNTL Project and RA-06 would both create new employment during construction and could contribute to a temporary housing shortage if both projects were to be constructed at the same time. Because Grand Rapids is within commuting distance of the construction area of the GNTL Project, any housing shortage would not be expected to be significant.

12.4.4 Route Alternative RA-07

The duration and geographical extent of impacts associated with constructing and operating RA-07 are summarized in Chapter 6. Based on these temporal and geographic extents, this analysis of cumulative potential effects for RA-07 focuses on two reasonably foreseeable projects located within several miles of RA-07 that are expected to be under construction or operational during or after the time the Project would be constructed (as early as spring 2018):

- Line 67 Expansion Project
- Koch Pipeline Company, Clearbrook Tanks Project

12.4.4.1 Line 67 Expansion Project

Potential Cumulative Effects of Route Alternative RA-07 and Line 67 Expansion Project Are the Same as Those for the Applicant's Preferred Route

As indicated previously, Enbridge's Line 67 is located within the Enbridge Mainline corridor. Between Neche, North Dakota, and Clearbrook, Minnesota, RA-07 follows the same route as that proposed by the Applicant, running parallel to Line 67 within the Mainline corridor (Figure 12.2-1). The potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.1.

12.4.4.2 Koch Pipeline Company, Clearbrook Tanks Project

Potential Cumulative Effects of Route Alternative RA-07 and Clearbrook Tanks Project Are the Same as Those for the Applicant's Preferred Route

As noted above, Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The Line 3 Replacement Project upgrades to the Enbridge Clearbrook terminal would occur in the immediate vicinity of the Clearbrook Tanks Project. The upgrades required for RA-07 are the same as those required for the Applicant's preferred route. Therefore, the potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.3.

12.4.5 Route Alternative RA-08

The duration and geographical extent of impacts associated with constructing and operating RA-08 are summarized in Chapter 6. Based on these temporal and geographic extents, this analysis of cumulative potential effects for RA-08 focuses on two reasonably foreseeable projects located within several miles of RA-08 that are expected to be under construction or operational during or after the time the Project would be constructed (as early as spring 2018):

- Line 67 Expansion Project
- Koch Pipeline Company, Clearbrook Tanks Project

12.4.5.1 Line 67 Expansion Project

Potential Cumulative Effects of Route Alternative RA-08 and Line 67 Expansion Project Are the Same as Those for the Applicant's Preferred Route

As indicated previously, Enbridge's Line 67 is located within the Enbridge Mainline corridor. Between Neche, North Dakota, and Clearbrook, Minnesota, RA-08 follows the same route as that proposed by the Applicant, running parallel to Line 67 within the Mainline corridor (Figure 12.2-1). The potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.1.

12.4.5.2 Koch Pipeline Company, Clearbrook Tanks Project

Potential Cumulative Effects of Route Alternative RA-08 and Clearbrook Tanks Project Are the Same as Those for the Applicant's Preferred Route

As noted above Koch Pipeline Company's Clearbrook terminal is located south of Enbridge's Clearbrook terminal. The Line 3 Replacement Project upgrades to the Enbridge Clearbrook terminal would occur in the immediate vicinity of the Clearbrook Tanks Project. The upgrades required for RA-8 are the same as those required for the Applicant's preferred route. Therefore, the potential for cumulative effects is the same as described for the Applicant's preferred route in Section 12.3.1.3.

12.4.6 Additional Pipeline in a New Route Corridor

Additional Pipeline Could Increase Spill Risk and Affect Vegetation, Wildlife, and Water Resources

If a new pipeline corridor outside of the existing Enbridge Mainline (such as the Applicant's preferred route, RA-03AM, or RA-06) were to be permitted for the proposed Project, the new corridor would create an opportunity for future corridor sharing that could ultimately result in accumulation of multiple pipelines within the corridor chosen for the Line 3 Replacement Project. To address the cumulative potential effects, the effects of an additional pipeline in a new Line 3 Replacement Project corridor generally are discussed below.

The addition of another pipeline within a new pipeline corridor would require widening of the right-of-way and would introduce additional spill risk. In general, the widening of the corridor would incrementally increase the effects on the resources described for each of the routes in Chapter 6 of this EIS. In the case of RA-06, for example, adding another pipeline in the corridor would result in additional clearing of forest in what is otherwise a densely forested, relatively undisturbed area with high-quality habitat and relatively pristine watersheds, but relatively few populated areas.

In the case of RA-03AM, adding another pipeline in the corridor would result in additional clearing in fairly forested areas with slightly more disturbed habitat and affected watersheds, but relatively more populated areas. In addition, adding an additional pipeline in any of these new corridors would increase the accidental release risk exposure of the same resources described along each of the routes in Chapter 10.

These types of general impacts are described in further detail below.

12.4.6.1 Planning and Zoning

Altering Land Use for New Pipeline Could Cumulatively Affect Planning and Zoning

Incrementally expanding right-of-way width within a new corridor could result in permanent minor cumulative potential effects on planning and zoning by alteration of existing (and in some areas protected) land uses to establish a new right-of-way.

12.4.6.2 Aesthetics

Expanding Right-of-Way for New Pipeline Could Cumulatively Affect Aesthetics

The addition of another pipeline within a new corridor would incrementally expand right-of-way width within the new corridor and could result in permanent minor cumulative potential effects on aesthetics, particularly if the new corridor passes through heavily forested and relatively undisturbed areas (e.g., RA-06).

12.4.6.3 Vegetation

Clearing Trees Now or in the Future Would Permanently Affect Forest Communities

Clearing trees within forest communities along new rights-of-way would result in long-term to permanent effects on these communities, which would be exacerbated if new pipelines were sited in new rights-of-way in the future.

12.4.6.4 Wildlife

Habitat Fragmentation Could Significantly Affect Wildlife in Some Areas

Clearing trees within forest communities along new rights-of-way would result in long-term to permanent effects on wildlife through habitat fragmentation. If new pipelines were sited within these new rights-of-way in the future, the cumulative potential effect would be minimal, because new fragmentation of habitat would not occur.

The cumulative permanent loss of wildlife habitats (including wetlands and forest lands) would affect wildlife inhabiting these areas. These cumulative potential effects could be major in areas where high-value wildlife habitat is altered.

12.4.6.5 Commodity Production

A New Corridor Could Cumulatively Affect Agriculture and Timber Production

Siting a future pipeline along a new corridor and expanding rights-of-way would incrementally affect land uses and opportunities for commodity production in agricultural and forested areas used for timber production.

12.4.6.6 Accidental Releases

Spill Risk Would Increase with Additional Pipelines but Would Still Be Low

The likelihood of multiple concurrent pipeline failures resulting in oil spills is low. However, the addition of multiple pipelines in a new corridor incrementally increases the risk of an incident occurring, so resources along the corridor are exposed to a higher probability of an incident occurring. Refer to Chapter 10 for a detailed discussion of oil spill risk and associated environmental impacts.

12.5 CUMULATIVE POTENTIAL EFFECTS – CLIMATE CHANGE

Climate Change Is Not Attributable to Any Single Action, but to a Series of Actions

As noted in the Council on Environmental Quality's 2016 Final Guidance on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change (Executive Office of the President, Council on Environmental Quality 2016), all greenhouse gas emissions contribute to cumulative climate change impacts. Recognizing that the totality of climate change is not attributable to any single action, but is exacerbated by a series of actions, this analysis does not attempt to directly link the emissions from a single action to an incremental change in climate.

This Section Considers Direct and Indirect Effects of Greenhouse Gases on the Environment in Minnesota

Instead, this section considers that collectively the proposed Project and other reasonably foreseeable actions across the world would contribute to global climate change. This section describes the cumulative potential climate change effects of greenhouse gas emissions on the environment in Minnesota and identifies resources that could experience cumulative impacts due to both the effects of climate change as well as the direct and indirect impacts of the proposed Project and its alternatives.

Chapters 5 and 6 Address Greenhouse Gas Emissions of the Proposed Project and its Alternatives

While this section focuses on the cumulative potential effects of greenhouse gas emissions on climate, the specific greenhouse gas emissions associated with the proposed Project and its alternatives are discussed in Sections 5.2.7 and 6.3.7 of this EIS. The analysis in Sections 5.2.7 and 6.3.7 accounts for greenhouse gas emissions from the proposed Project and each of the alternatives, including:

- Direct effects: greenhouse gas emissions associated with construction (e.g., fossil fuel combustion, burning) and operation (electricity consumption, lost carbon sequestration) of the Project and its alternatives.
- Indirect effects: greenhouse gas emissions associated with any changes in upstream (oil production) or downstream (oil consumption) activities that may result from the Project or its alternatives.

In Sections 5.2.7 and 6.3.7 of this EIS, the social cost of carbon is used to relate the direct and indirect greenhouse gas emissions from the proposed Project and its alternatives to the costs to society that the climate change impacts described below are creating (e.g., human health impacts, loss of tourism, agricultural losses). Please refer to Sections 5.2.7 and 6.3.7 for a comparison of the CN and route alternatives on this basis.

12.5.1 Midwest Climate Change Trends

Midwest climate change trends are discussed in detail in the National Climate Assessment (Pryor et al. 2014). That document is incorporated by reference here and key points from this assessment, as well as other regional climate assessments, are summarized below.

Warming in Minnesota Is More Pronounced in Winter and in Northern Portions of the State

Minnesota is undergoing rapid warming, especially during typically cold conditions. From 1895 to 2014, annual temperatures in Minnesota increased at an average rate of 0.2 degrees Fahrenheit (°F) per decade. Between 1895 and 1970, average Minnesota surface temperature increased at an average rate of about 0.13°F per decade. Subsequently, beginning in 1970 and extending to 2016, this accelerated to an average rate of warming of about 0.57°F per decade. Warming is occurring during all seasons, but is proceeding 10 times faster in winter than in summer: the 1970 to 2014 summer warming rate averaged 0.1°F per decade, compared to winter warming of 1.0°F per decade over the same interval (Minnesota DNR 2015).

All warming trends in all seasons are more pronounced in northern Minnesota than in southern Minnesota (Minnesota DNR 2015). Although there has been no increase in extreme heat events in Minnesota in recent decades, research summarized in the 2014 National Climate Assessment indicates that by mid-century, much of the state may see dramatic increases in the number of days reaching or exceeding 95°F (Pryor et al. 2014).

Water Temperatures Are Increasing Faster than Air Temperatures

Temperatures of surface waters in Lake Superior are increasing at a rate much greater than air temperature change, and are projected to rise by as much as 12.1°F by 2100 (Minnesota PCA 2013). An observed impact of increasing temperature is the decline in the number of days of ice cover in the Great Lakes, including Lake Superior (Minnesota PCA 2013).

Minnesota Is Becoming Wetter and the Likelihood of Extreme Rainfall Events Is Increasing

Minnesota is also becoming wetter, with increases in annual precipitation and greater rainfall extremes. From 1895 to 2014, statewide annual precipitation increased at an average rate of 0.25 inch per decade (Minnesota DNR 2015). Potentially disastrous events that produce 6 inches of rainfall or more over a 1,000-square-mile area have become more common as well, with 7 of the 10 instances documented since 1973 occurring after the year 2000 (Minnesota State Climatology Office 2016). Projections summarized in the Midwest chapter of the 2014 National Climate Assessment indicate that both annual precipitation and extreme events will continue to increase during the twenty-first century (Pryor et al. 2014). Even with these projected precipitation increases, the same models indicate more consecutive dry days between precipitation events as the twenty-first century progresses (Pryor et al. 2014).

Changes in Temperature and Precipitation Also Affect Forests, Water and Air Quality, and Agriculture

- In the next few decades, longer growing seasons and rising carbon dioxide levels will increase yields of some crops, though those benefits will be progressively offset by extreme weather events. Though adaptation options can reduce some of the detrimental effects, in the long term, the combined stresses associated with climate change are expected to decrease agricultural productivity.
- The composition of the region's forests is expected to change as rising temperatures drive suitable climates for many tree species northward. The role of the region's forests as a net absorber of carbon is at risk from disruptions to forest ecosystems, in part due to climate change.
- Increased heat wave intensity and frequency, increased humidity, degraded air quality, and reduced water quality will increase public health risks related to heat and sensitivity to poor air quality.

12.5.2 Potential Impacts of Climate Change on the Project

Main Concerns Include Severe Weather, Freeze-Thaw Cycles, and Flooding, All of Which Could Damage Project Facilities

The proposed pipeline would be buried underground at a depth of 3 feet, which would protect it from most surface impacts of climate change, including higher surface temperatures and increased precipitation. However, severe weather conditions can affect the normal operation of pipelines. For example, tornadoes can damage or disrupt communications with the monitoring systems or directly damage aboveground elements such as tanks, pumps, sensors, small pipes, and support equipment (U.S. Department of State 2017). The continued trend of greater annual average precipitation and heavy precipitation in Minnesota has the potential to increase flooding and alter hydrological patterns from increased runoff and greater volumes of water in rivers. Flooding can cause inundation of equipment and facilities by floodwaters and streambank erosion from floods and channel migration. Streams with high sediment loads and active floodplains can migrate during floods or overflow into secondary channels, increasing the potential to damage Project facilities including the pipeline. Frequent major flood events could scour the streambed and expose the buried pipeline, or changes in hydrology can cause channels to migrate over time and expose the pipeline. In addition, heavy rains, snowfall, and high winds may produce conditions that would affect the pipeline system integrity over time. Lightning and wildfires would be unlikely to damage the system integrity directly, but could cause the loss of supervisory control and data acquisition (SCADA) (U.S. Department of State 2017).

The Minnesota State Climatology Office looked at three long-term Cooperative National Weather Service temperature observation sites near the Applicant's preferred route (Crookston, Park Rapids, and Cloquet, Minnesota), each with records dating back over 100 years. In the twenty-first century (through the 2016–2017 winter), the number of days between November 1 and March 31 where the low temperature was at or above the hard freeze criterion (28°F) and the high was at or above 36°F (to indicate a strong thaw) has increased over long-term twentieth and late-nineteenth century values by 26 percent (Crookston) to 70 percent (Park Rapids). This indicates significantly more thaw days during the traditional winter period in the Project region. The Minnesota State Climatology Office did not see a significant change in the number of days with highs at or above 36°F and lows at or below 28°F, indicating no increase in same-day freeze-thaw cycles. Frost depth, and whether and for how long frost reaches the proposed Project depth of 3 feet, will be controlled heavily by the absence or presence of

snow cover, with soil frost responding much faster to warm or cold periods when no snow cover is present. Significant winter thaw periods are increasingly likely during the Project.

Climate Change Could Intensify Spill Impacts

Climate factors can impact the fate and trajectory of spilled oil and can also affect how spilled oil interacts with the environment. For example, higher ambient temperatures could increase the volatilization of air contaminants from an accidental release or flooding to cause spilled oil to be transported farther downstream. In addition, heavy rain events could potentially have an adverse effect on spill response, including containment and cleanup actions.

12.5.3 Potential Impacts of the Project in Combination with Climate Change Impacts

Operation of the proposed Project would affect resources that are experiencing or will experience impacts as a result of climate change. Figure 12.5-1 identifies areas where the Project's operational impacts would overlap with the impacts of climate change. These overlapping impacts are discussed further below.

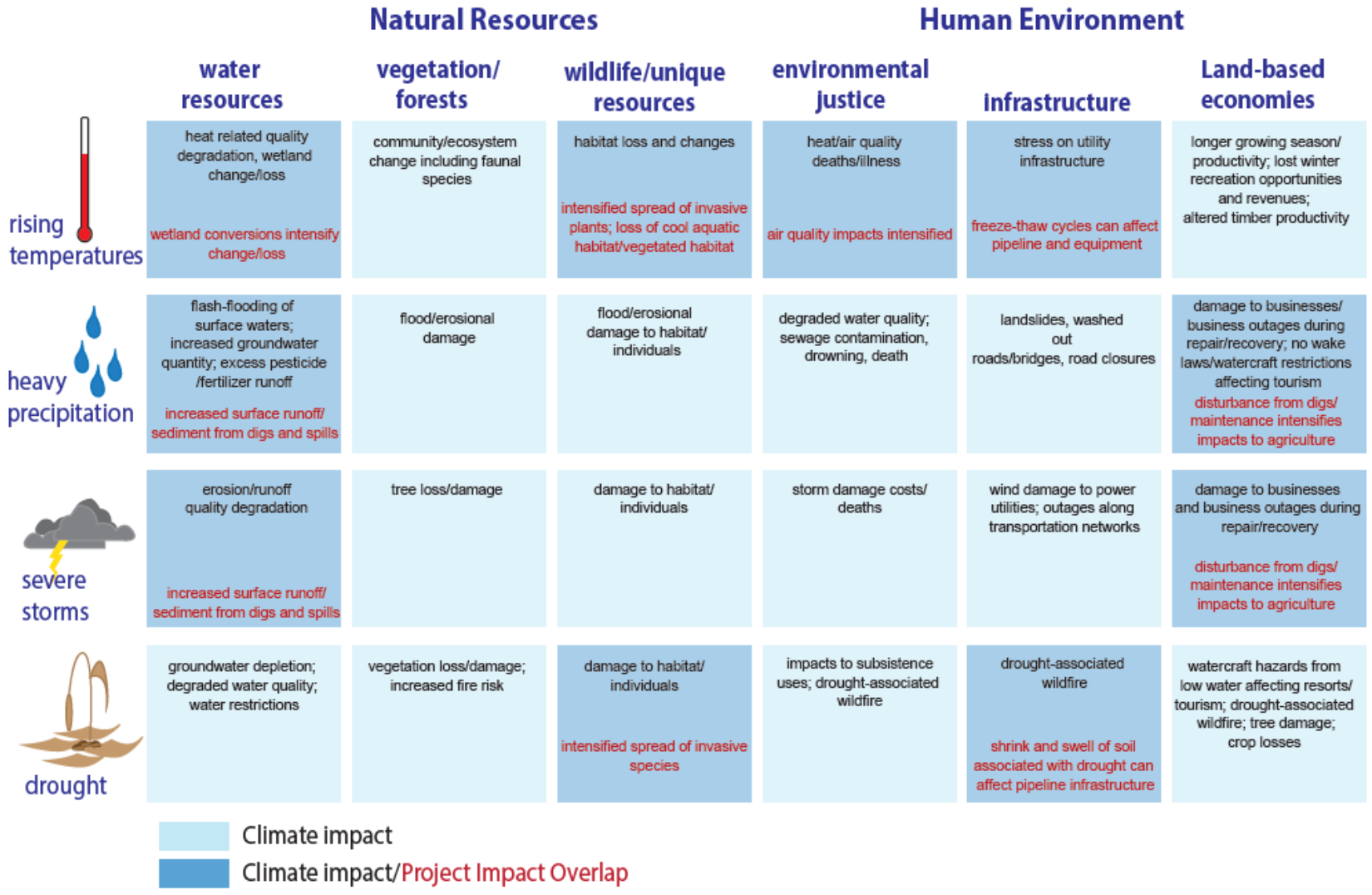

Figure 12.5-1. Potential for Overlapping Impacts from Climate Change and from Normal Operations of the Proposed Project

Warmer Water Temperatures and Loss of Shading and Habitat Features Could Affect Aquatic Species

Increased water temperatures in rivers due to climate change can have detrimental effects on aquatic species, which could be exacerbated by the permanent loss of shading, nutrients, and habitat features for fish at some waterbody crossings during pipeline operations from vegetation removal maintenance activities along the permanent right-of-way. The use of pesticides and herbicides for maintenance during pipeline operation could also add stress to aquatic species.

Higher Temperatures and Changes in Vegetation and Habitat Could Affect Wildlife

Changing composition of vegetation in the future could affect resident wildlife unable to adapt to changing conditions, which could be worsened by the permanent loss of trees and shrubs, habitat fragmentation, and changes in vegetation cover through large blocks of forest habitats within the pipeline right-of-way.

Habitat fragmentation can decrease species dispersal, increase mortality, and reduce genetic diversity, and may obstruct the free movement of species seeking new habitats in adaptation to climate change effects. The pipeline right-of-way could attract migratory waterfowl earlier in the year if it becomes snow free before surrounding habitats. Federally listed species with the potential to occur along the Applicant's preferred route include the gray wolf, northern long-eared bat, and whooping crane (see Section 6.3.5).

Gray Wolf Is Highly Adaptable but Northern Long-Eared Bat and Whooping Crane Are Less So

The gray wolf is highly adaptable to a wide variety of climates, habitats, and food sources. Prior to its near extinction in North America due to human predation, the gray wolf's territory ranged from the Pacific to Atlantic coasts and from Alaska to Mexico (USFWS 2011a). Therefore, this species is anticipated to be adaptable to the effects of climate change. A species, despite being adaptable, can face risks from human pressure on habitats and landscape-level changes from climate change.

The northern long-eared bat is particularly sensitive to changes in temperature, humidity, and precipitation and is anticipated to be much less adaptable to climate change. Further, the northern long-eared bat's winter habitat (e.g., caves, mine entrances) have specific biological and physical features that are essential to the species' survival. Climate change could lead to shifts in the long-eared bat's range, which could indirectly affect the northern long-eared bat through changes in food availability, availability of hibernacula, the timing of hibernation, and reproductive cycles (USFWS 2015).

The whooping crane is not anticipated to adapt well to climate change, although it may be slightly more adaptable than the northern long-eared bat. Their vulnerability is due to their low population numbers (about 350 individuals in the wild) and their dependence on wintering habitat along the U.S. coast of the Gulf of Mexico (Audubon 2014a). Coastal habitat is being lost primarily due to human development, but its loss is also being exacerbated by climate change. In addition, the possibility of prolonged droughts brought on by climate change could alter salinity levels in marsh habitat, making it unsuitable for whooping cranes (USFWS 2011b).

Most State-Listed Species Are Not Very Adaptable to the Effects of Climate Change

State-listed species along the Applicant's preferred route include the northern pocket gopher, Henslow's sparrow, Blanding's turtle, wood turtle, pugnose shiner fish, A caddisfly, and several mussel species

including the elktoe, fluted-shell, mucket, and spike. The northern pocket gopher's range is widespread in western to mid-North America (with northwestern Minnesota being the eastern limit of its range), and it can live in a variety of open habitats throughout its range. It has a flexible diet of both aboveground and belowground plant parts (MacMahon 1999; Verts and Carraway 1999). Since this species' life requirements are not highly specific, it is anticipated to be able to adapt to climate change.

Henslow's sparrow requires large, undisturbed grasslands in the Midwestern United States during the summer breeding season, and it spends the winters along the U.S. coast of the Gulf of Mexico (Cornell University 2015). Climate change is expected to cause a significant loss of coastal habitat in the next several decades (Audubon 2014b). Although Henslow's sparrow could expand its range to adjust to climate change, due to an already dwindling population, it is not anticipated to be highly adaptable to climate change.

North American turtles, including the Blanding's turtle and the wood turtle, can be affected by climate change, primarily through climate-induced habitat alteration (Wisconsin Department of Natural Resources 2016a, b). Historically, turtles have adapted to climate change by shifting their geographic ranges. It is more difficult for turtles to shift ranges today, however, due to managed waterways, urbanization, and agriculture (National Institute for Mathematical and Biological Synthesis 2015). Due to these limitations, the Blanding's turtle and wood turtle are not anticipated to be highly adaptable to climate change.

The pugnose shiner has strict habitat requirements, which make it less adaptable to both direct and indirect effects of climate change. One study (Doka et al. 2006) ranked the pugnose shiner as highly vulnerable (ranked sixth most vulnerable of 99 species) to climate change as a result of the loss of wetlands due to climate change (Committee on the Status of Endangered Wildlife in Canada 2013).

Caddisflies were once widely distributed across most of the western half of the United States and Canada (NatureServe 2009). Sightings today, however, are extremely rare. This is likely due to habitat loss, as species of *Limnephilus* are very sensitive to changes in the riparian corridor. Climate change effects would likely exacerbate habitat loss that is already occurring due to agriculture and urban development. A caddisfly is therefore not anticipated to be adaptable to climate change (Minnesota DNR 2012).

The elktoe, fluted-shell, mucket, and spike mussels are also not anticipated to be adaptable to climate change. Once widely distributed, elktoes, muckets, and spikes are now only found living in a small number of drainages (Minnesota DNR 2017a, b, c). The fluted-shell is more widespread than the other mussels, but its population numbers are very low (Minnesota DNR 2017d). This restricted distribution, along with specific habitat requirements (e.g., low turbidity waters, narrow thermal preference) and limited mobility, make all four species of mussels vulnerable to catastrophic events (e.g., drought, flood) (Minnesota DNR 2017a, b, c, d).

Environmental Justice Communities are Affected By Climate Change As Well As the Proposed Project and Its Alternatives

Climate change impacts threaten tribal lands and resources, way of life, culture, and economies. As discussed in Chapters 9 and 11 in greater detail and incorporated here, RA-06, RA-07, and RA-08 would have direct impacts on tribal reservations (Leech Lake and Fond du Lac). In addition, based on the discussion of tribal resources in Chapter 9, any of the routes, route segments, and system alternatives would have a long-term detrimental effect on tribal members. The lands and resources affected by the

Project are important to preserving the traditional ways of life, including fishing, hunting, wild ricing, maple sugar gathering, and collecting plants for medicines, spiritual and ceremonial purposes, shelter, and other needs. Project impacts on tribal resources would be further exacerbated by climate change impacts that affect native communities—for example, decreases in water quality and quantity in the Great Lakes region, threats to human health and safety, economic losses, and loss of culturally important species, medicinal plants, cultural sites, and traditional foods, such as wild rice.

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Chapter 13
List of Preparers

Chapter 13 provides information on primary roles in preparation of this Draft Environmental Impact Statement (EIS).

13.1 STATE AGENCIES

The Department of Commerce, Energy Environmental Review and Analysis Division (DOC-EERA) was the lead agency on behalf of the Minnesota Public Utilities Commission. The Commission is the Responsible Government Unit for the EIS. The Minnesota Department of Natural Resources and Minnesota Pollution Control Agency acted as assisting agencies throughout the process.

13.2 ENVIRONMENTAL IMPACT STATEMENT PREPARATION TEAM

DOC-EERA was supported by Cardno, Inc. in preparing the EIS. Cardno's team included project management, a range of resource specialists, technical writers, and geographic information system analysts.

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Minnesota Department of Commerce
Energy Environmental Review and Analysis

Draft Environmental Impact Statement
Line 3 Project

Mapbook
Applicant's Preferred Route

Docket Nos. PPL-15-137/CN-14-916

May 15, 2017

MINNESOTA

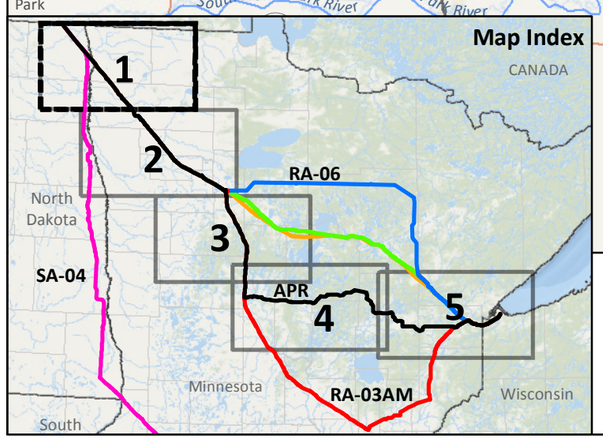
SA-04
APR
RA-03AM
RA-06
RA-07
RA-08

SA-04

APR
RA-03AM
RA-06
RA-07
RA-08

Donaldson Pump Station

Neche
Noyes
Saint Vincent
Pembina
Leroy
Humboldt
Orleans
Pinecreek
Lost River State Forest
Pine Creek
Roseau River
North Branch Two Rivers
Northcote
Lancaster
Ross
Akra
Cavalier
Hamilton
Hallock
Two Rivers
Fox
Badger
Lake Bronson
South Branch Two Rivers
Canton City
County Ditch Numbers 20 and 66
Bowesmont
State Ditch Number One
Willow Creek
Red River
Kennedy
Halma
Greenbush
Saint Thomas
Crystal
Judicial Ditch Number Ten
Robbin
Drayton
Donaldson
Karlstad
Hoople
Cart Creek
North Branch Park River
Middle Branch Park River
Nash
Cashel
Tamarac River
Strathcona
Strandquist
Thief Lake
Park
South Branch Park River
Park River
Stephen
Middle River
Thief River
Snake River
Forest River
Argyle
Newfolden



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08

Route Segment Alternatives (RSA)
Terminal
Pump Station

Interstate
Highway
Major Road
Local Road
County Boundary

White Earth Reservation - BIA
Tribal Reservation
State Park or Forest
National Forest

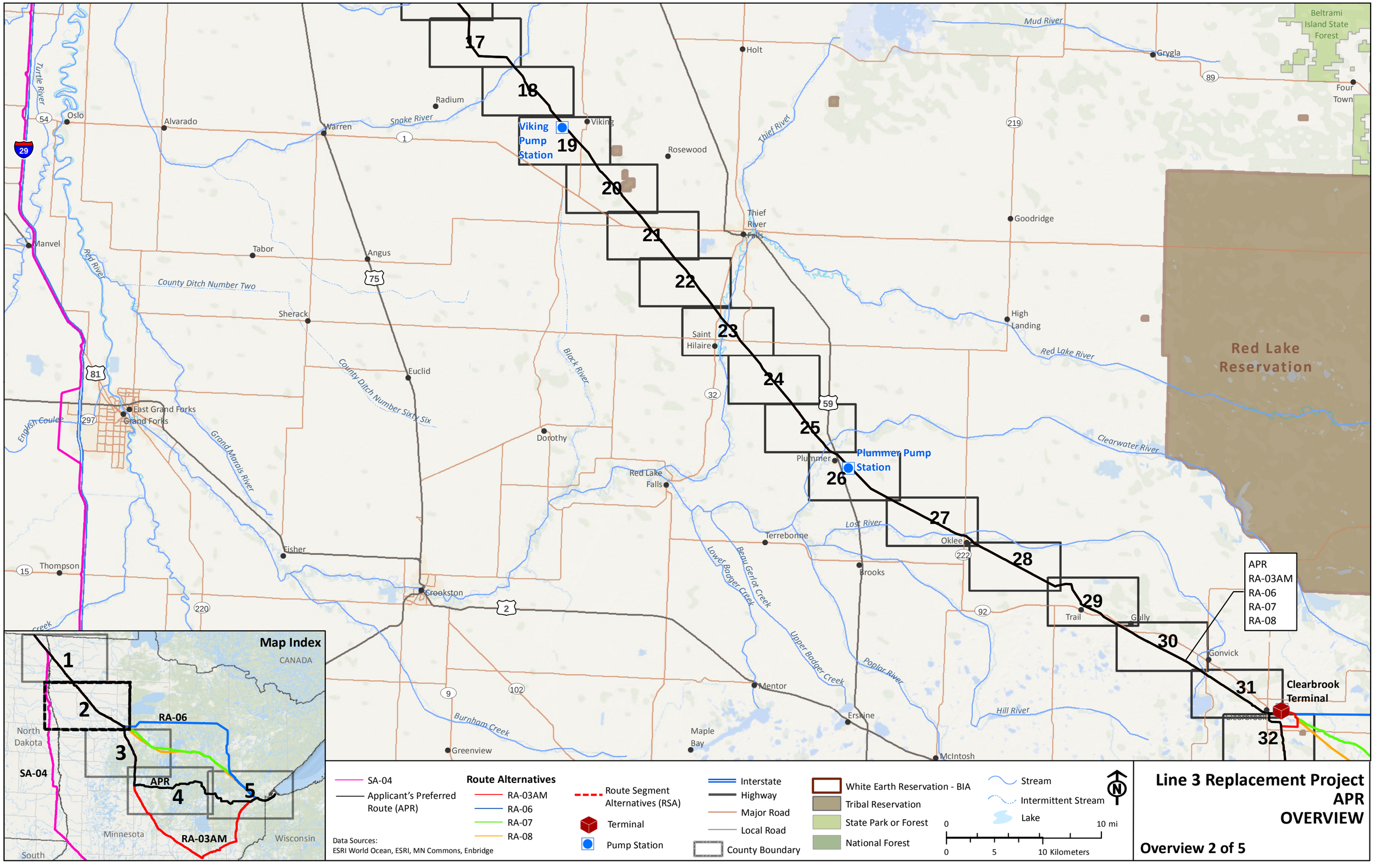
Stream
Intermittent Stream
Lake

0 10 mi
0 5 10 Kilometers

Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge

Line 3 Replacement Project
APR
OVERVIEW

Overview 1 of 5



Line 3 Replacement Project
APR
OVERVIEW

Overview 2 of 5

APR
RA-03AM

RA-08

RA-07

RA-08

33
34
35
36
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44
45
46
47
48

Two Inlets
Pump Station

White Earth Reservation - BIA

Leech Lake Reservation

Chippewa National Forest

Poplar River
Sandhill River
Clearwater River
Marsh Creek
Garden Slough
Wild Rice River
White Earth River
South Branch Wild Rice River
Mississippi River
Bungashing Creek
Schoolcraft River
Necktie River
Steamboat River
Hay Creek
Crow Wing River
Buffalo River
Shell River

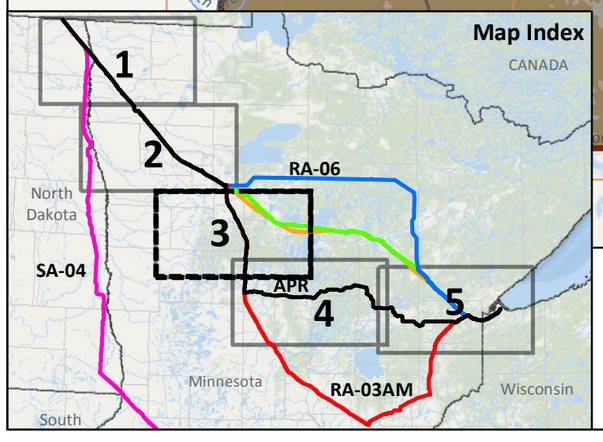
Fosston
Winger
Lengby
Bagley
Ebro
Pinewood
Shevlin
Solway
Wilton
Turtle River
Lavinia
Bemidji
Pennington
Cass Lake
Schley
Becida
Guthrie
Wilkinson
Laporte
Lake George
Benedict
Walker
Whipholt
Akeley
Nevis
Bejou
Beaulieu
Mahnomen
Naytahwaush
Fossum
Flom
Waubun
Ogema
White Earth
Lake Itasca
Foot Hills State Forest

Blackduck State Forest
Buena Vista State Forest
Mississippi Headwaters State Forest
Welsh Lake State Forest
Bowstring State Forest
Paul Bunyan State Forest
Two Inlets State Forest
Smoky Hills State Forest
White Earth State Forest

Leech Lake

2
59
200
92
113
224
225
226
197
89
71
64
371
34
290

Map Index



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08

Route Segment Alternatives (RSA)
Terminal
Pump Station

Interstate
Highway
Major Road
Local Road
County Boundary

White Earth Reservation - BIA
Tribal Reservation
State Park or Forest
National Forest

Stream
Intermittent Stream
Lake

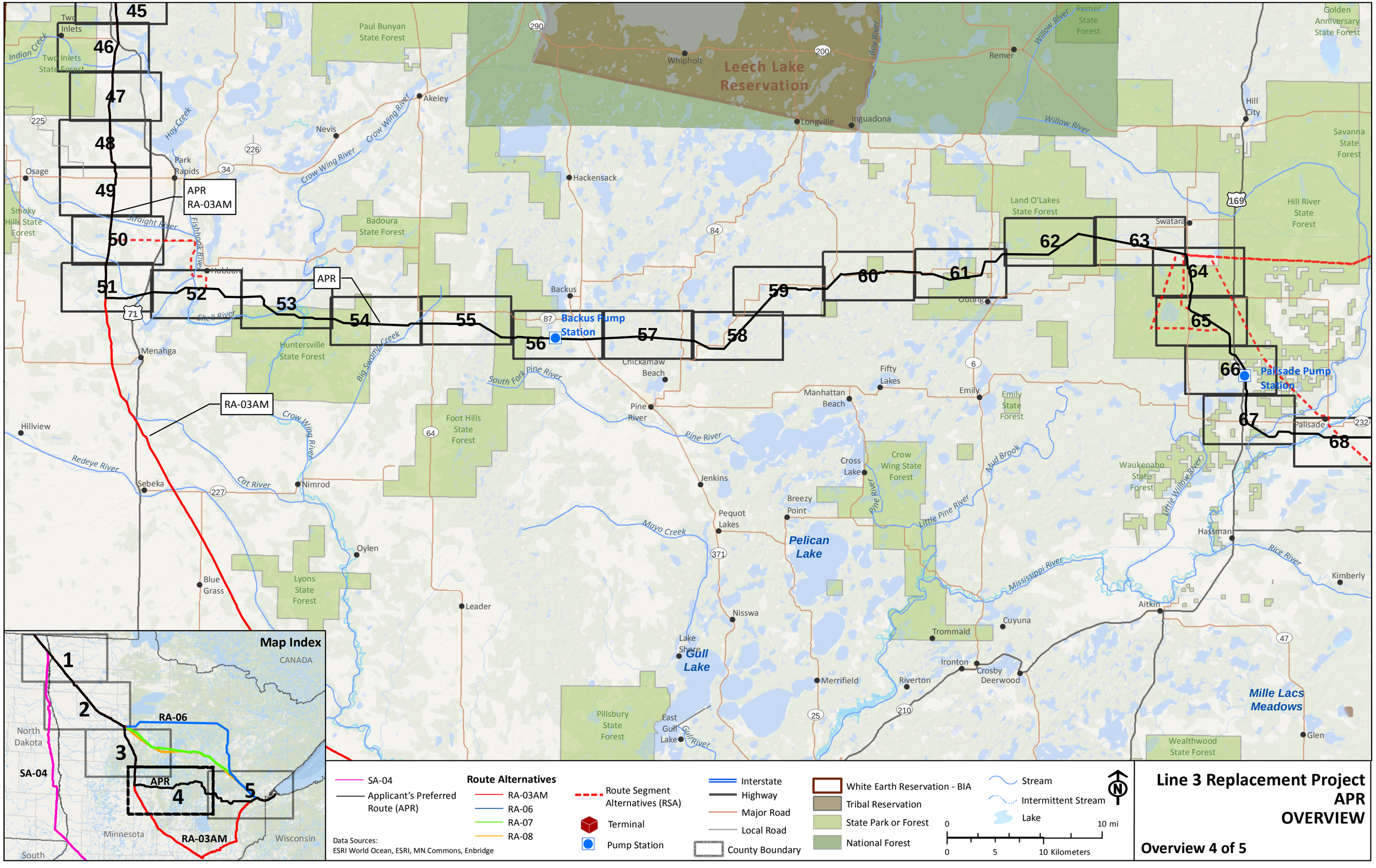
0 10 mi
0 5 10 Kilometers

N

Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge

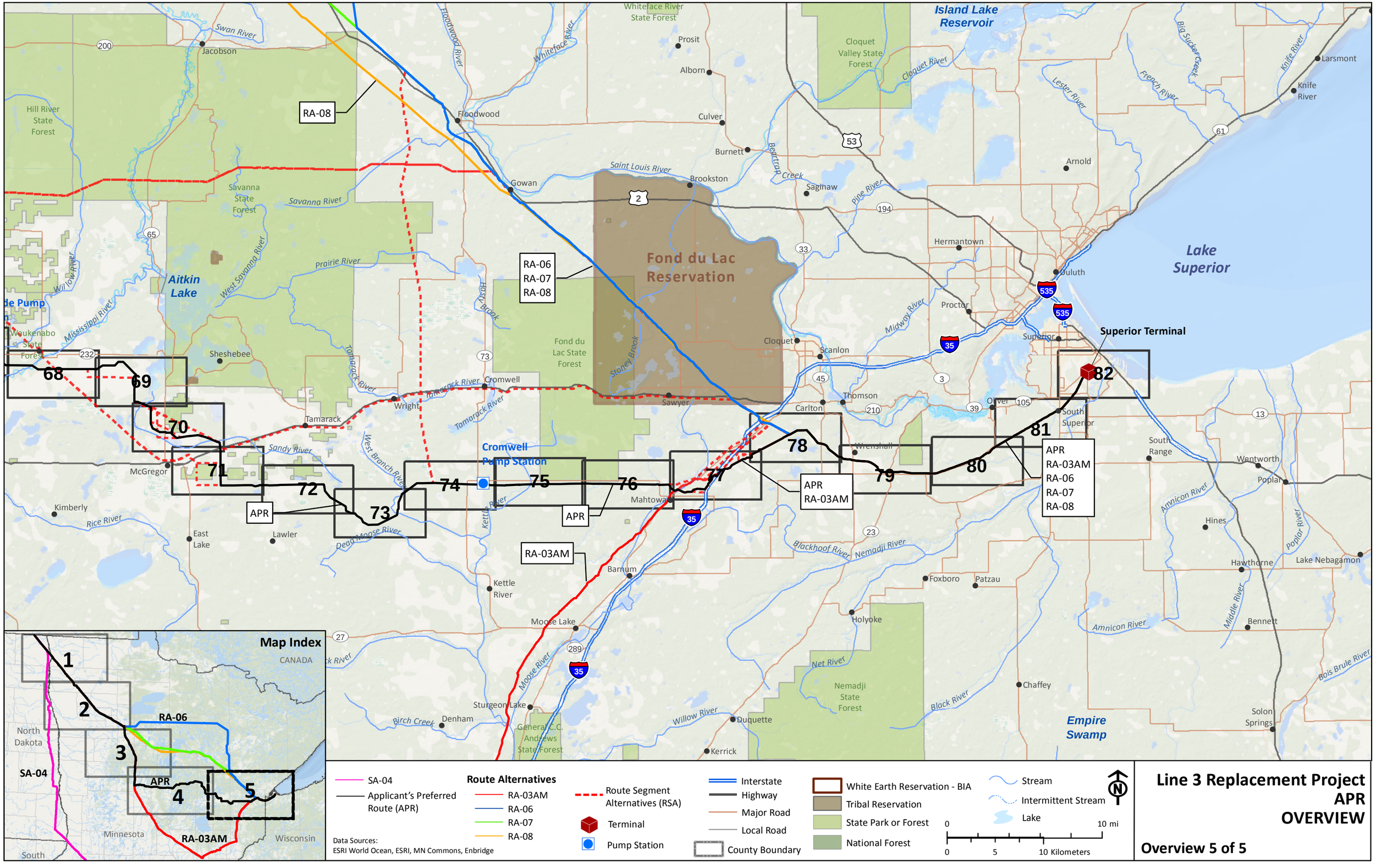
Line 3 Replacement Project
APR
OVERVIEW

Overview 3 of 5



Line 3 Replacement Project
APR
OVERVIEW

Overview 4 of 5


Swan River
Jacobson
Hill River State Forest
RA-08
Floodwood
Floodwood River
Whiteface River
Whiteface River State Forest
Prosit
Alborn
Culver
Burnett
Gowan
Saint Louis River
Brookston
Beartrap Creek
Saginaw
Pine River
Savanna State Forest
Savanna River
Aitkin Lake
West Savanna River
Prairie River
Willow River
Mississippi River
RA-06
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RA-08
Fond du Lac Reservation
Fond du Lac State Forest
Stony Brook
Rosa Brook
Waukenabo State Forest
Sheshebee
Tamarack River
Cromwell
Wright
Sawyer
Tamarack
Sandy River
McGregor
West Branch River
Cromwell Pump Station
Kettle River
Mahtowa
Kimberly
Rice River
East Lake
Lawler
Dead Moose River
APR
RA-03AM
Barnum
Kettle River
Moose Lake
Moose River
Sturgeon Lake
Birch Creek
Denham
General C.C. Andrews State Forest
Willow River
Duquette
Kerrick
Cloquet Valley State Forest
Cloquet River
Island Lake Reservoir
Big Sucker Creek
Knife River
Larsmont
Knife River
Lester River
French River
Arnold
Hermantown
Duluth
Lake Superior
Proctor
Midway River
Superior
Superior Terminal
Cloquet
Scanlon
Thomson
Carlton
Oliver
South Superior
Wrenshall
Blackhoof River
Nemadji River
Foxboro
Patzau
Holyoke
Nemadji State Forest
Net River
Black River
Chaffey
Empire Swamp
Amnicon River
Hawthorne
Lake Nebagamon
Bennett
Middle River
Poplar River
Bois Brule River
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Route Segment Alternatives (RSA)
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Pump Station
Interstate
Highway
Major Road
Local Road
County Boundary
White Earth Reservation - BIA
Tribal Reservation
State Park or Forest
National Forest
Stream
Intermittent Stream
Lake
0 10 mi
0 5 10 Kilometers
Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge
Line 3 Replacement Project
APR
OVERVIEW
Overview 5 of 5

CANADA

UNITED STATES

Neche Facility

Neche

T164N R54W S25

T164N R53W S30

T164N R53W S29

T164N R53W S28

T164N R53W S27

T164N R53W S26

T164N R53W S25

T164N R53W S31

T164N R53W S32

T164N R53W S33

T164N R53W S34

T164N R53W S35

T164N R53W S36

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08

1

2

3

T163N R53W S6

T163N R53W S5

T163N R53W S4

T163N R53W S3

T163N R53W S2

T163N R53W S1

T163N R53W S7

T163N R53W S8

T163N R53W S9

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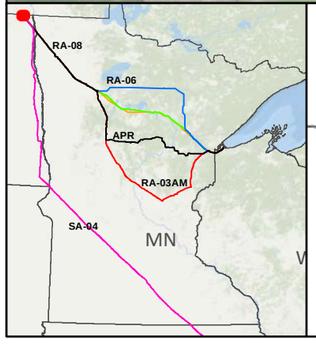
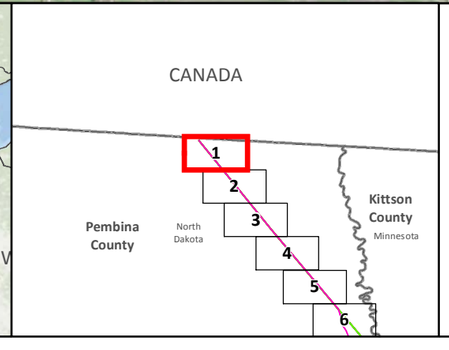
T163N R53W S11

T163N R53W S12

T163N R52W S6

T163N R52W S7





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

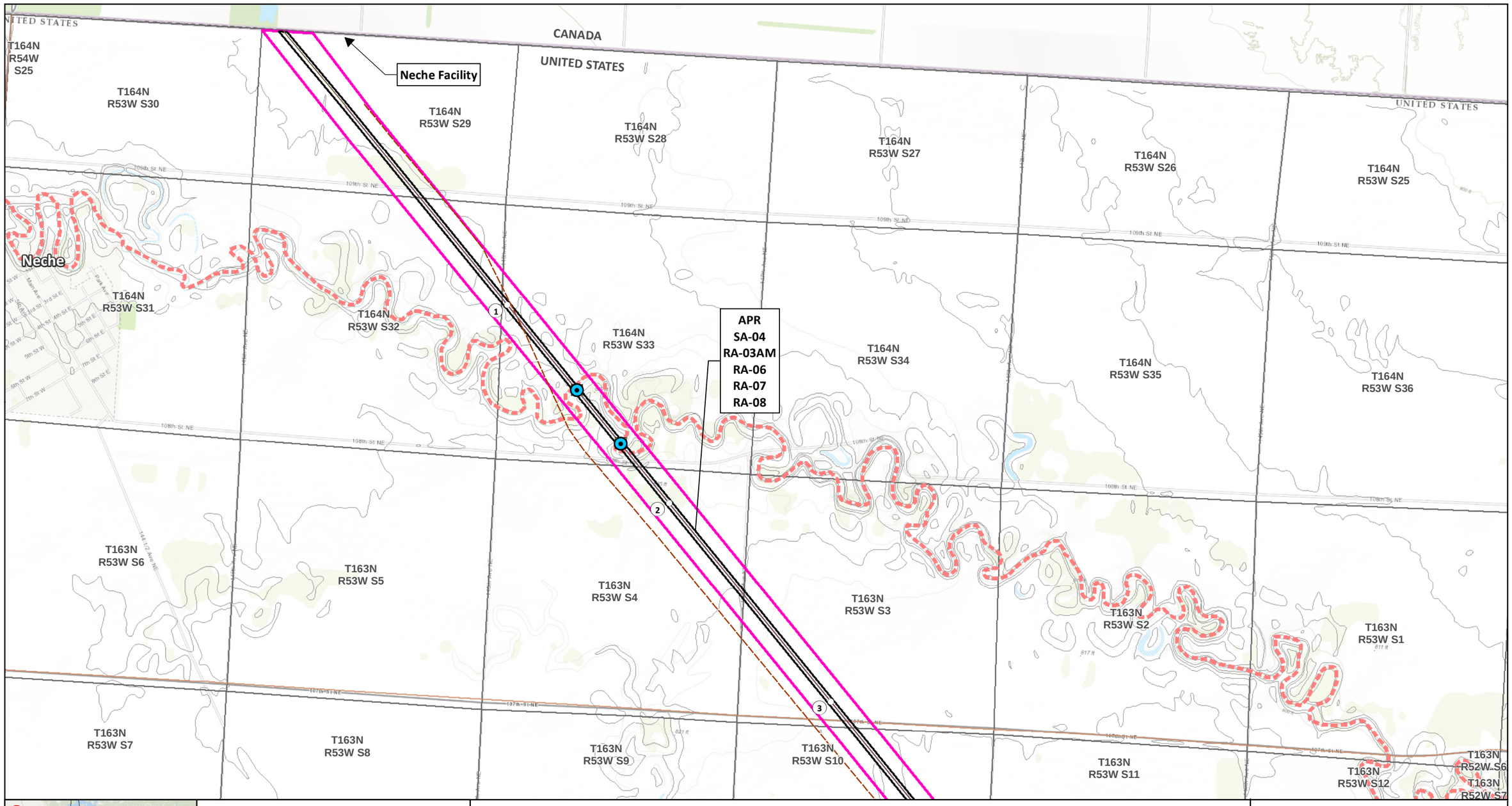
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

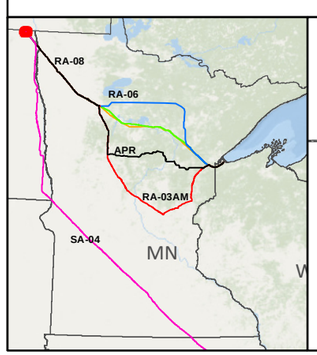
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

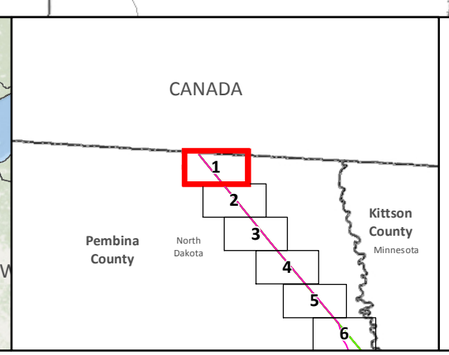
APR

Map 1A of 82

N







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 1B of 82

T163N R53W S8
T163N R53W S9
T163N R53W S10
T163N R53W S11
T163N R53W S12
T163N R52W S7
T163N R52W S8
T163N R53W S17
T163N R53W S16
T163N R53W S15
T163N R53W S14
T163N R53W S13
T163N R52W S18
T163N R52W S17
T163N R53W S20
T163N R53W S21
T163N R53W S22
T163N R53W S23
T163N R53W S24
T163N R52W S19
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T163N R53W S28
T163N R53W S27
T163N R53W S26
T163N R53W S25
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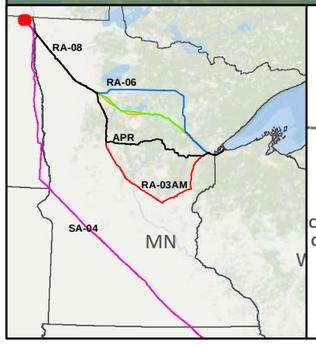
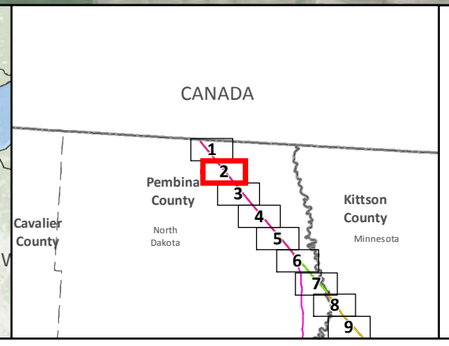
T163N R52W S29

4 5 6 7

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

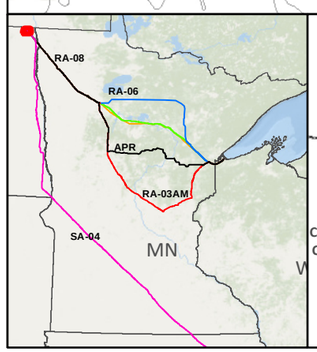
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

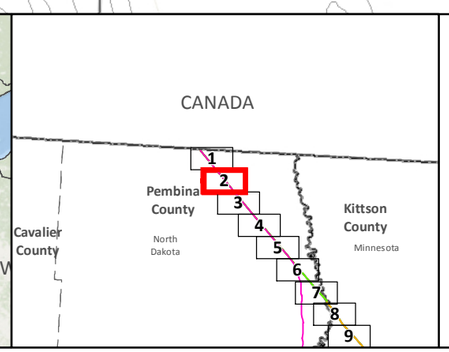
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T163N R53W S8
T163N R53W S9
T163N R53W S10
T163N R53W S11
T163N R53W S12
T163N R52W S7
T163N R52W S8
T163N R53W S17
T163N R53W S16
T163N R53W S15
T163N R53W S14
T163N R53W S13
T163N R52W S18
T163N R52W S17
T163N R53W S20
T163N R53W S21
T163N R53W S22
T163N R53W S23
T163N R53W S24
T163N R52W S19
T163N R52W S20
T163N R53W S28
T163N R53W S27
T163N R53W S26
T163N R53W S25
T163N R52W S30
T163N R52W S29

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





- SA-04
- Applicant's Preferred Route (APR)

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- RA-06
- RA-07
- RA-08
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- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 2B of 82

T163N R53W S26
T163N R53W S25
T163N R52W S30
T163N R52W S29
T163N R52W S28
T163N R52W S27
T163N R53W S35
T163N R53W S36
T163N R52W S31
T163N R52W S32
T163N R52W S33
T163N R52W S34
T163N R52W S35
T162N R53W S2
T162N R53W S1
T162N R52W S6
T162N R52W S5
T162N R52W S4
T162N R52W S3
T162N R52W S2
T162N R53W S11
T162N R53W S12
T162N R52W S7
T162N R52W S8
T162N R52W S9
T162N R52W S10
T162N R52W S11

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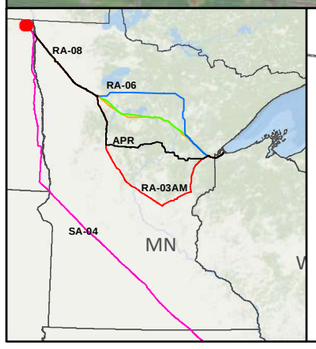
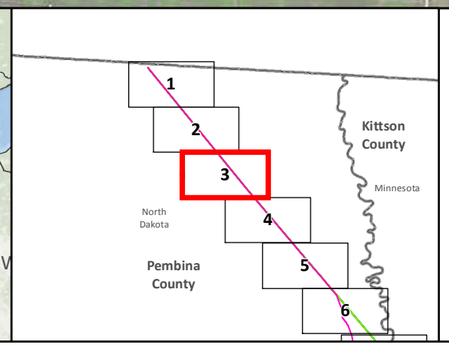
9
10
11

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

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- Route Width (750')
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- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
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- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 3A of 82

T163N R53W S26
T163N R53W S25
T163N R52W S30
T163N R52W S29
T163N R52W S28
T163N R52W S27
T163N R53W S35
T163N R53W S36
T163N R52W S31
T163N R52W S32
T163N R52W S33
T163N R52W S34
T163N R52W S35
T162N R53W S2
T162N R53W S1
T162N R52W S6
T162N R52W S5
T162N R52W S4
T162N R52W S3
T162N R52W S2
T162N R53W S11
T162N R53W S12
T162N R52W S7
T162N R52W S8
T162N R52W S9
T162N R52W S10
T162N R52W S11

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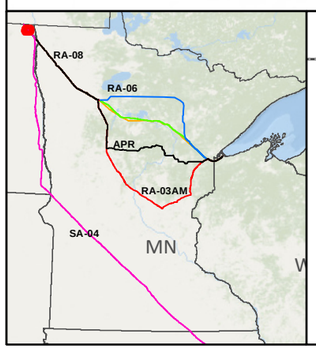
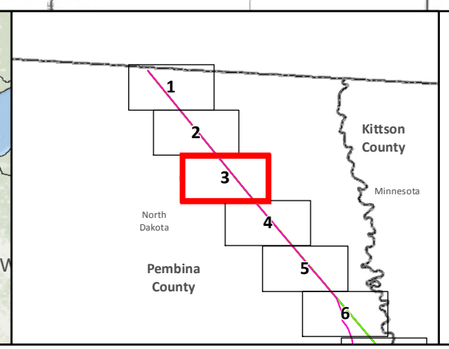
APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

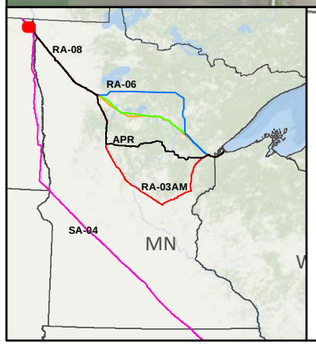
N

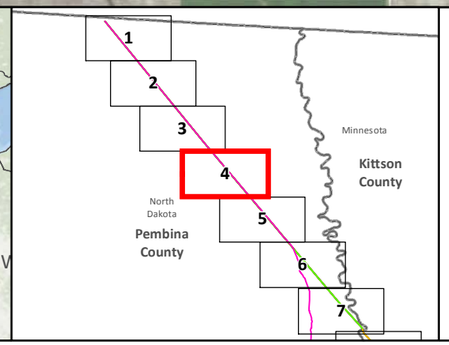
Map 3B of 82

T162N R52W S1
T162N R51W S6
T162N R52W S8
T162N R52W S9
T162N R52W S10
T162N R52W S11
T162N R52W S12
T162N R51W S7
T162N R51W S8
T162N R52W S17
T162N R52W S16
T162N R52W S15
T162N R52W S14
T162N R52W S13
T162N R51W S18
T162N R51W S17
T162N R52W S20
T162N R52W S21
T162N R52W S22
T162N R52W S23
T162N R52W S24
T162N R51W S19
T162N R51W S20
T162N R52W S29
T162N R52W S28
T162N R52W S27
T162N R52W S26
T162N R52W S25
T162N R51W S30
T162N R51W S29

12
13
14
15

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

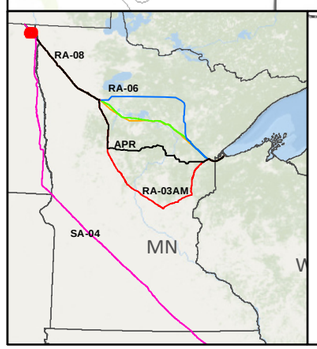
APR

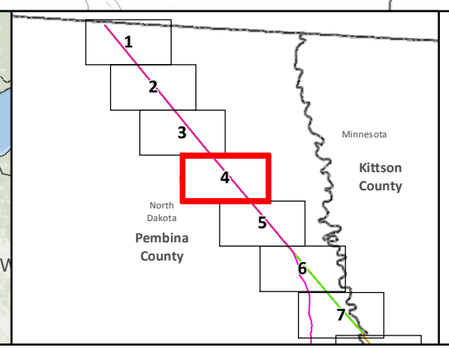
Map 4A of 82

T162N R52W S8
T162N R52W S9
T162N R52W S10
T162N R52W S11
T162N R52W S12
T162N R52W S1
T162N R51W S6
T162N R51W S7
T162N R51W S8
T162N R52W S17
T162N R52W S16
T162N R52W S15
T162N R52W S14
T162N R52W S13
T162N R51W S18
T162N R51W S17
T162N R52W S20
T162N R52W S21
T162N R52W S22
T162N R52W S23
T162N R52W S24
T162N R51W S19
T162N R51W S20
T162N R52W S29
T162N R52W S28
T162N R52W S27
T162N R52W S26
T162N R52W S25
T162N R51W S30
T162N R51W S29

12
13
14
15

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

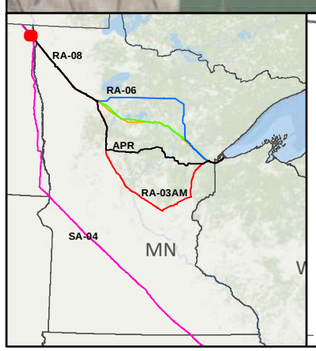
N

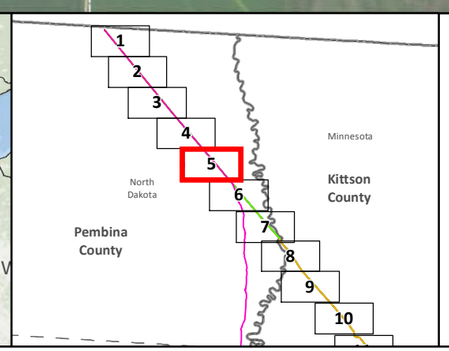
Map 4B of 82

T162N R52W S27
T162N R52W S26
T162N R52W S25
T162N R51W S30
T162N R51W S29
T162N R51W S28
T162N R51W S21
T162N R51W S22
T162N R51W S27
T162N R52W S34
T162N R52W S35
T162N R52W S36
T162N R51W S31
T162N R51W S32
T162N R51W S33
T162N R51W S34
T161N R52W S2
T161N R52W S1
T161N R51W S6
T161N R51W S5
T161N R51W S4
T161N R51W S3
T161N R52W S11
T161N R52W S12
T161N R51W S7
T161N R51W S8
T161N R51W S9
T161N R51W S10

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08

16 17 18 19 5 81 29





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
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Residences within 1/2 mile
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Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

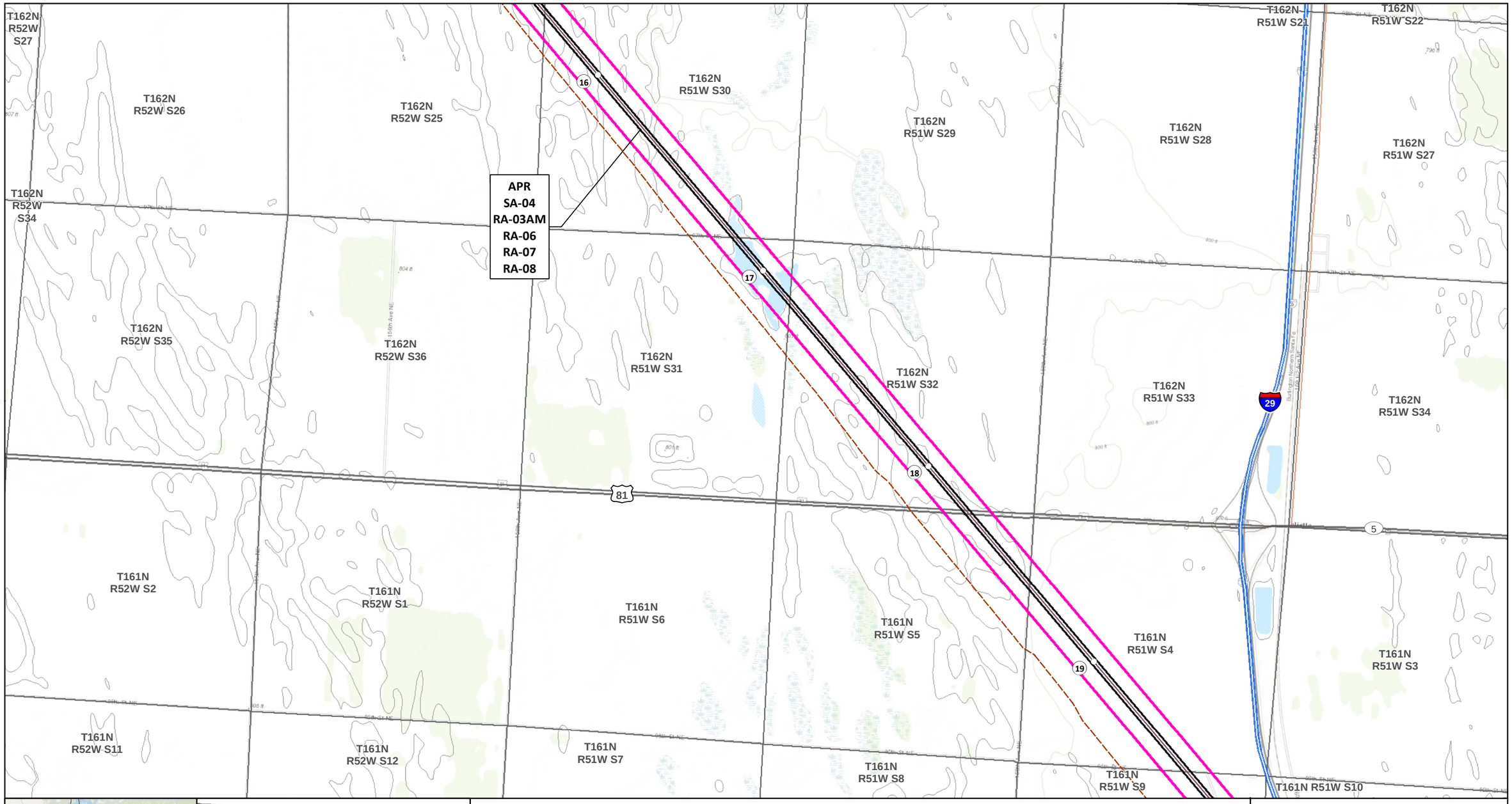
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

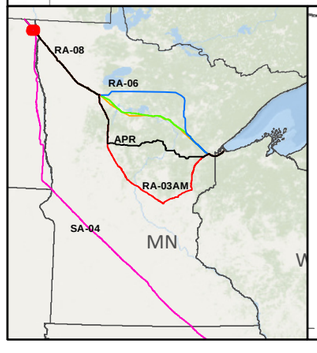
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

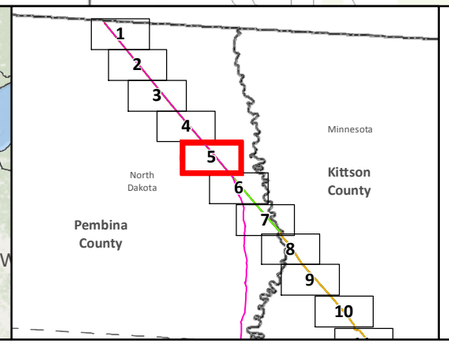
APR

Map 5A of 82

N







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
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- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 5B of 82

T161N R51W S2
T161N R51W S1
T161N R50W S6
T161 R50W S5
T161 R50W S4
North Red River Twsp Kittson Co.
T161 R50W S8
Red River
T161N R50W S7
T161 R50W S8
T161 R50W S17
T161 R50W S16
T161N R50W S18
T161 R50W S20
T161 R50W S21
T161N R50W S19
T161N R50W S30
T161N R51W S7
T161N R51W S8
T161N R51W S9
T161N R51W S10
T161N R51W S11
T161N R51W S12
T161N R51W S18
T161N R51W S17
T161N R51W S16
T161N R51W S15
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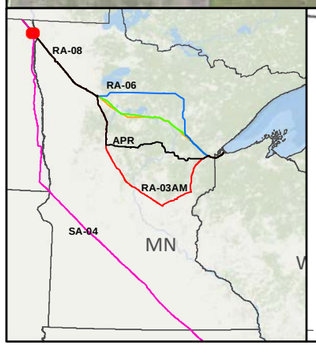
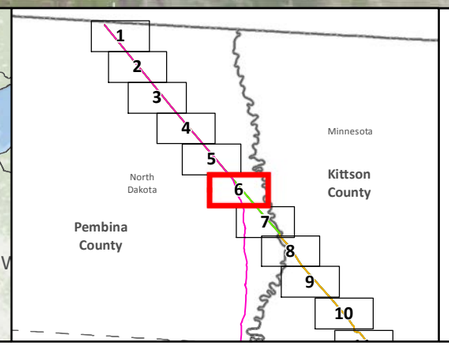
T161N R51W S19
T161N R51W S20
T161N R51W S21
T161N R51W S22
T161N R51W S23
T161N R51W S24
T161N R51W S30
T161N R51W S29
T161N R51W S28
T161N R51W S27
T161N R51W S26
T161N R51W S25
T161N R50W S30

APR
RA-03AM
RA-06
RA-07
RA-08

SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 6A of 82

T161N R51W S7
T161N R51W S8
T161N R51W S9
T161N R51W S10
T161N R51W S11
T161N R51W S12
T161N R51W S1
T161N-R51W S2
T161N R50W S6
T161 R50W S5
T161 R50W S4
North Red River Twsp Kittson Co.
T161 R50W S9
T161 R50W S8
Red River
T161N R50W S7
T161 R50W S8
T161 R50W S17
T161 R50W S16
T161N R50W S18
T161N R51W S18
T161N R51W S17
T161N R51W S16
T161N R51W S15
T161N R51W S14
T161N R51W S13
APR
RA-03AM
RA-06
RA-07
RA-08
SA-04
T161N R51W S19
T161N R51W S20
T161N R51W S21
T161N R51W S22
T161N R51W S23
T161N R51W S24
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T161 R50W S21
T161N R50W S19
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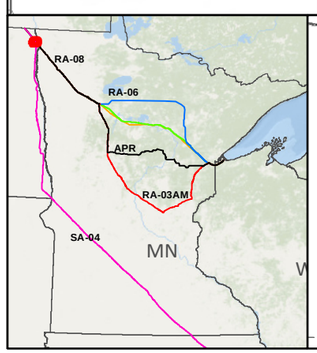
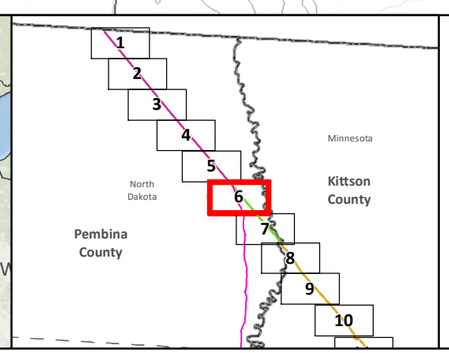
T161N R51W S28
T161N R51W S27
T161N R51W S26
T161N R51W S25
T161N R50W S30
Fleece
160 1/2 Ave NE
Bartgen Nursery Rd
20
21
22
23
29
5
18





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

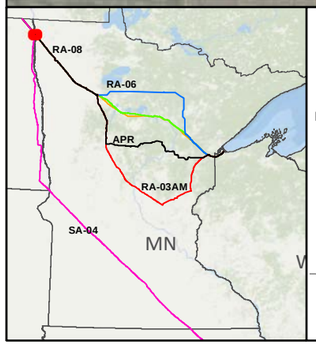
APR

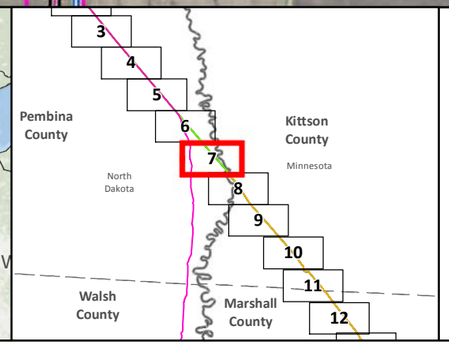
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 6B of 82

T161N R51W S27
T161N R51W S26
T161N R51W S25
T161N R50W S30
T161N R50W S29
T161 R50W S28
T161 R50W S27
T161 R50W S26
T161 R50W S22
T161 R50W S23
Red River
T161N R50W S29
North Red River Twsp Kittson Co.
T161N R51W S35
T161N R51W S34
T161N R51W S36
T161N R50W S31
T161 R50W S33
T161 R50W S34
T161 R50W S35
T161 R50W S36
T161N R50W S32
SA-04
APR
RA-03AM
RA-06
RA-07
RA-08
T160N R51W S3
T160N R51W S2
T160N R51W S1
T160N R50W S6
T160 R50W S4
T160N R50W S5
South Red River Twsp Kittson Co.
T160 R50W S3
T160 R50W S2
T160N R51W S10
T160N R51W S11
T160N R51W S12
T160N R50W S7
T160N R50W S8
T160 R50W S9
T160 R50W S10
T160 R50W S11





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

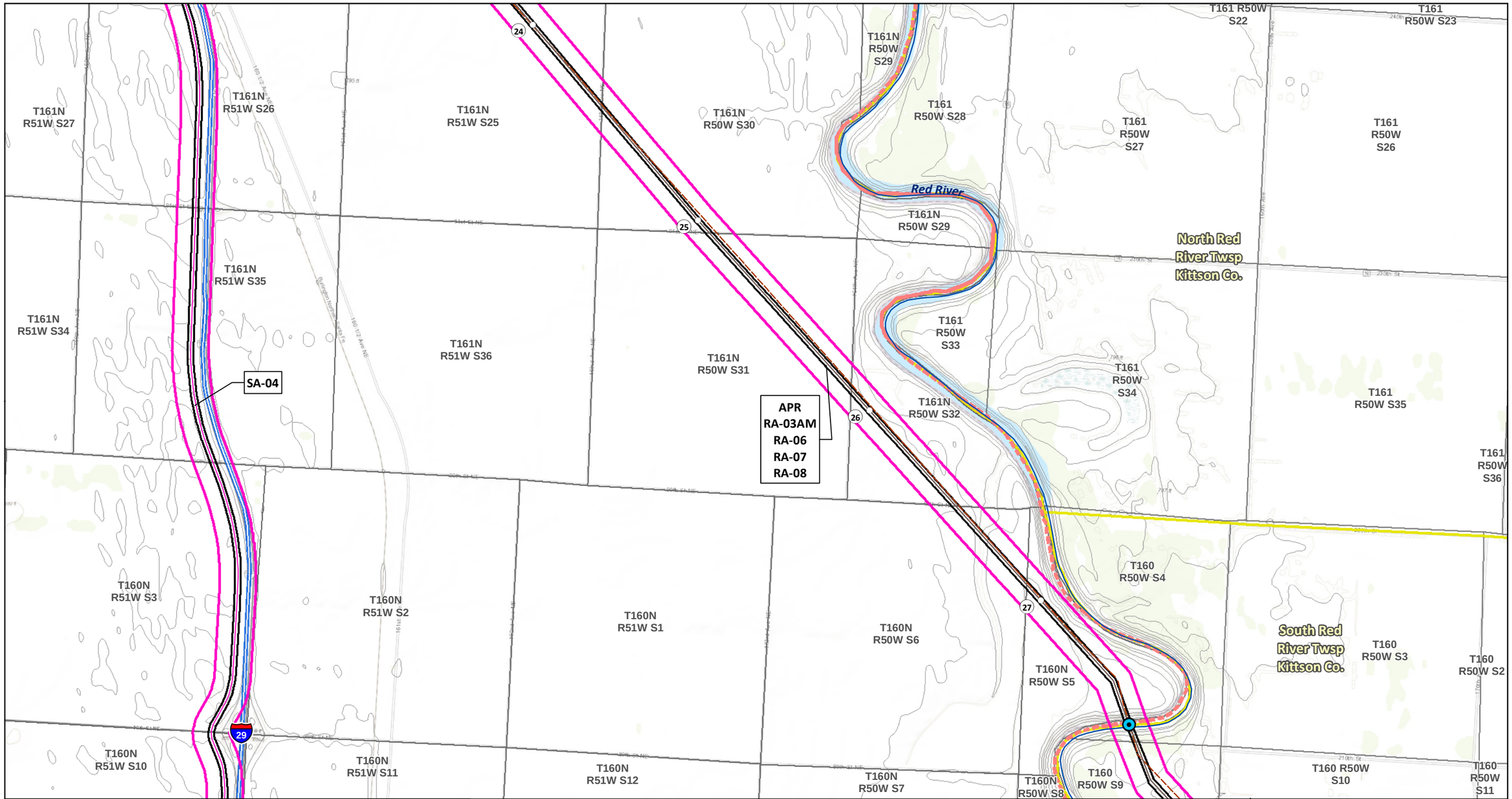
Data Sources: MNDNR, NHD, Enbridge

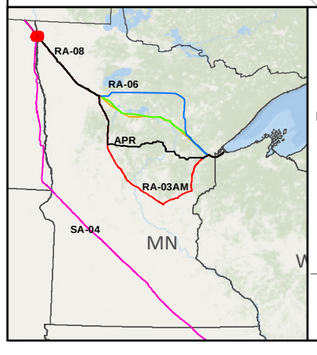
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

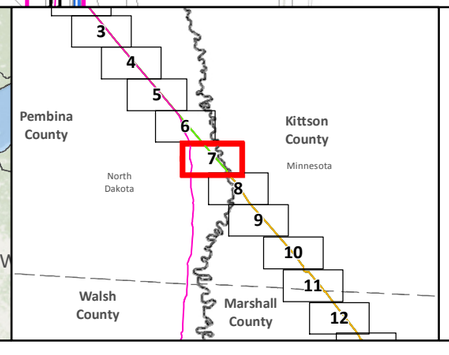
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 7A of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
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- Township Boundary

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- 303d Imparied Waters
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate
- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

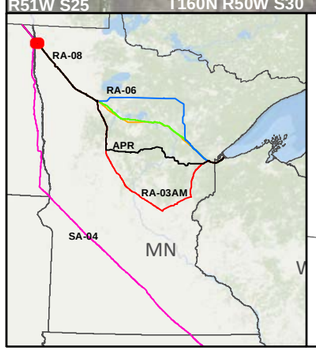
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

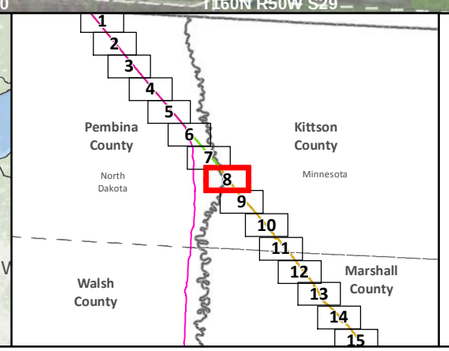
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 7B of 82

T160N R51W S1
T160N R50W S6
T160N R50W S5
T160 R50W S3
T160 R50W S2
T160 R50W S1
T160 R49W S6
T160N R51W S12
T160N R50W S7
T160 R50W S9
T160 R50W S10
T160 R50W S11
T160 R50W S12
T160 R49W S7
T160N R50W S8
APR
RA-03AM
RA-06
RA-07
RA-08
T160N R50W S9
T160N R50W S16
T160N R51W S13
T160N R50W S18
T160N R50W S17
T160 R50W S15
T160 R50W S14
T160 R50W S13
South Red River Twsp Kittson Co.
Skane Twsp Kittson Co.
T160 R49W S18
T160N R51W S24
T160N R50W S19
T160N R50W S20
T160N R50W S21
T160 R50W S22
T160 R50W S23
T160 R50W S24
T160 R49W S19
Red River
Unnamed Creek
T160N R51W S25
T160N R50W S30
T160N R50W S29
T160N R50W S21
T160 R50W S27
T160 R50W S26
T160 R50W S25





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

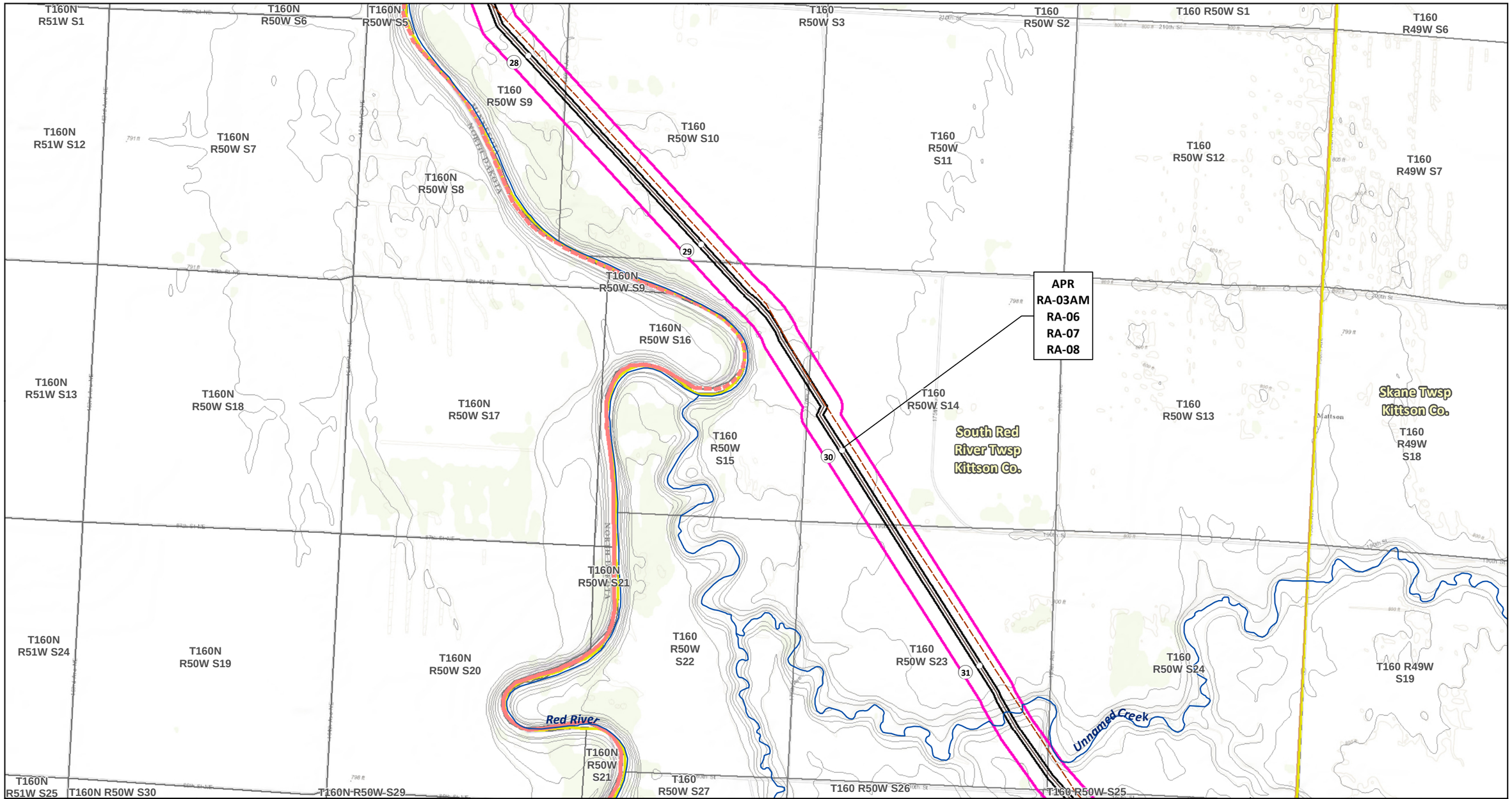
Data Sources:
MNDNR, NHD, Enbridge

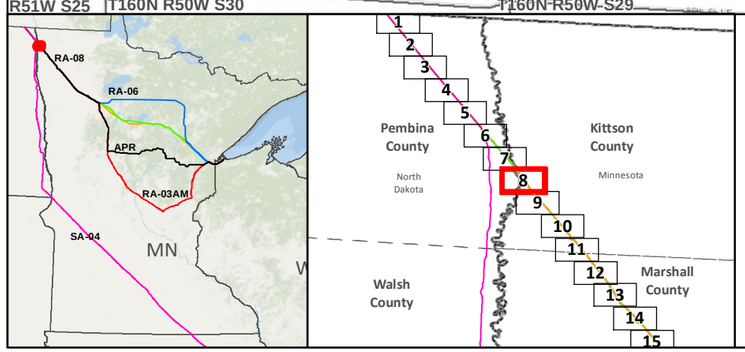
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 8A of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
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- RA-08
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Township Boundary

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Calcareous Fens
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- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

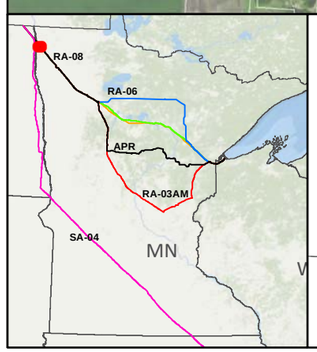
APR

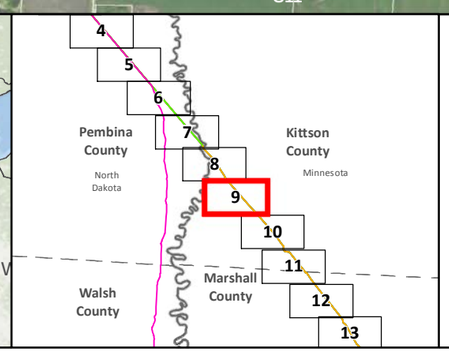
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 8B of 82

T160N R50W S29
T160N R50W S20
Red River
T160 R50W S24
T160 R49W S19
T160 R49W S20
T160 R49W S21
T160 R50W S27
T160 R50W S26
T160 R50W S28
T160 R50W S25
T160 R49W S30
T160 R49W S29
T160 R49W S28
T160 R50W S33
South Red River Twsp Kittson Co.
Skane Twsp Kittson Co.
APR
RA-03AM
RA-06
RA-07
RA-08
T160 R50W S34
T160 R50W S35
T160 R50W S36
T160 R49W S31
T160 R49W S32
T160 R49W S33
Unnamed Creek
Svea Twsp Kittson Co.
T159 R50W S2
T159 R50W S3
Teien Twsp Kittson Co.
T159 R50W S1
T159 R49W S6
T159 R49W S5
T159 R49W S4
T159 R50W S10
T159 R50W S11
T159 R50W S12
T159 R49W S7
T159 R49W S8





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
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Public Water Basin
Public Waters Watercourse
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Residences within 1/2 mile
Mile Post
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Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

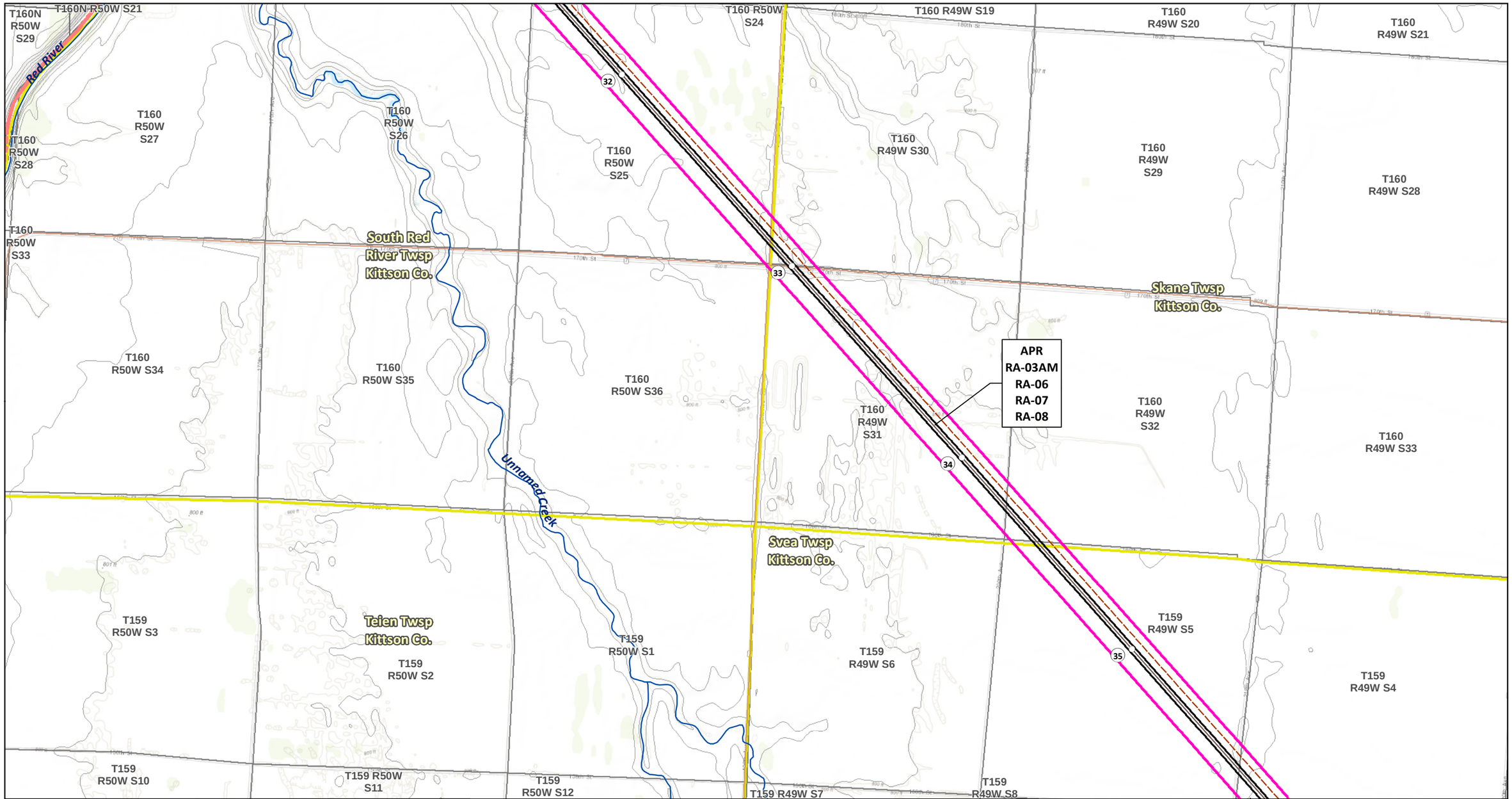
Data Sources:
MNDNR, NHD, Enbridge

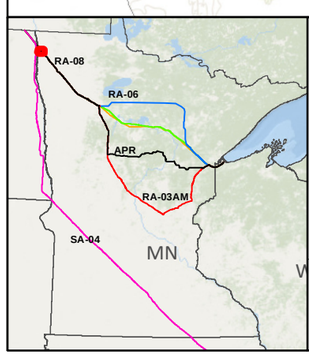
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

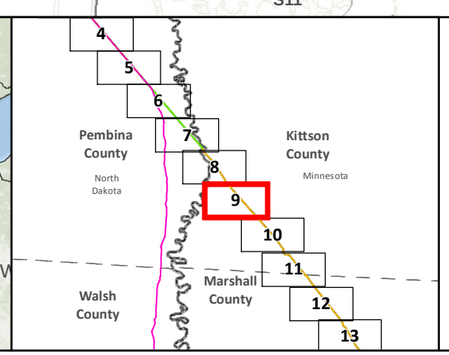
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 9A of 82







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- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-07
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- National River Inventory Crossing
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- Calcareous Fens
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- Public Waters Wetlands
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- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate
- Terminal
- Pump Station

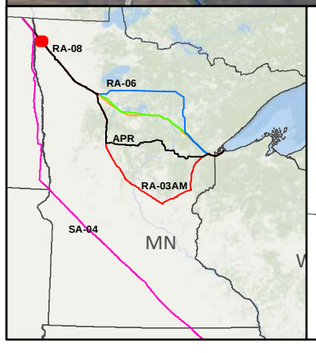
Data Sources: MNDNR, USGS, NHD, Enbridge

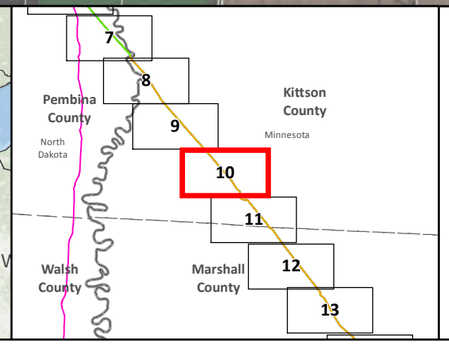
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

T159 R49W S4
T159 R49W S3
T159 R49W S2
T159 R49W S1
T159 R48W S6
Svea Twsp Kittson Co.
T159 R49W S8
T159 R49W S9
T159 R49W S10
T159 R49W S11
T159 R49W S12
T159 R48W S7
T159 R49W S7
36
37
APR
RA-03AM
RA-06
RA-07
RA-08
75
T159 R49W S18
T159 R49W S17
T159 R49W S16
38
T159 R49W S15
T159 R49W S14
T159 R49W S13
Davis Twsp Kittson Co.
T159 R48W S18
T159 R49W S19
T159 R49W S20
T159 R49W S21
T159 R49W S22
T159 R49W S23
T159 R49W S24
T159 R48W S19
Donaldson Twsp Kittson Co.
39
Unnamed Creek
T159 R49W S30
T159 R49W S29
T159 R49W S28
11
T159 R49W S27
T159 R49W S26





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

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- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
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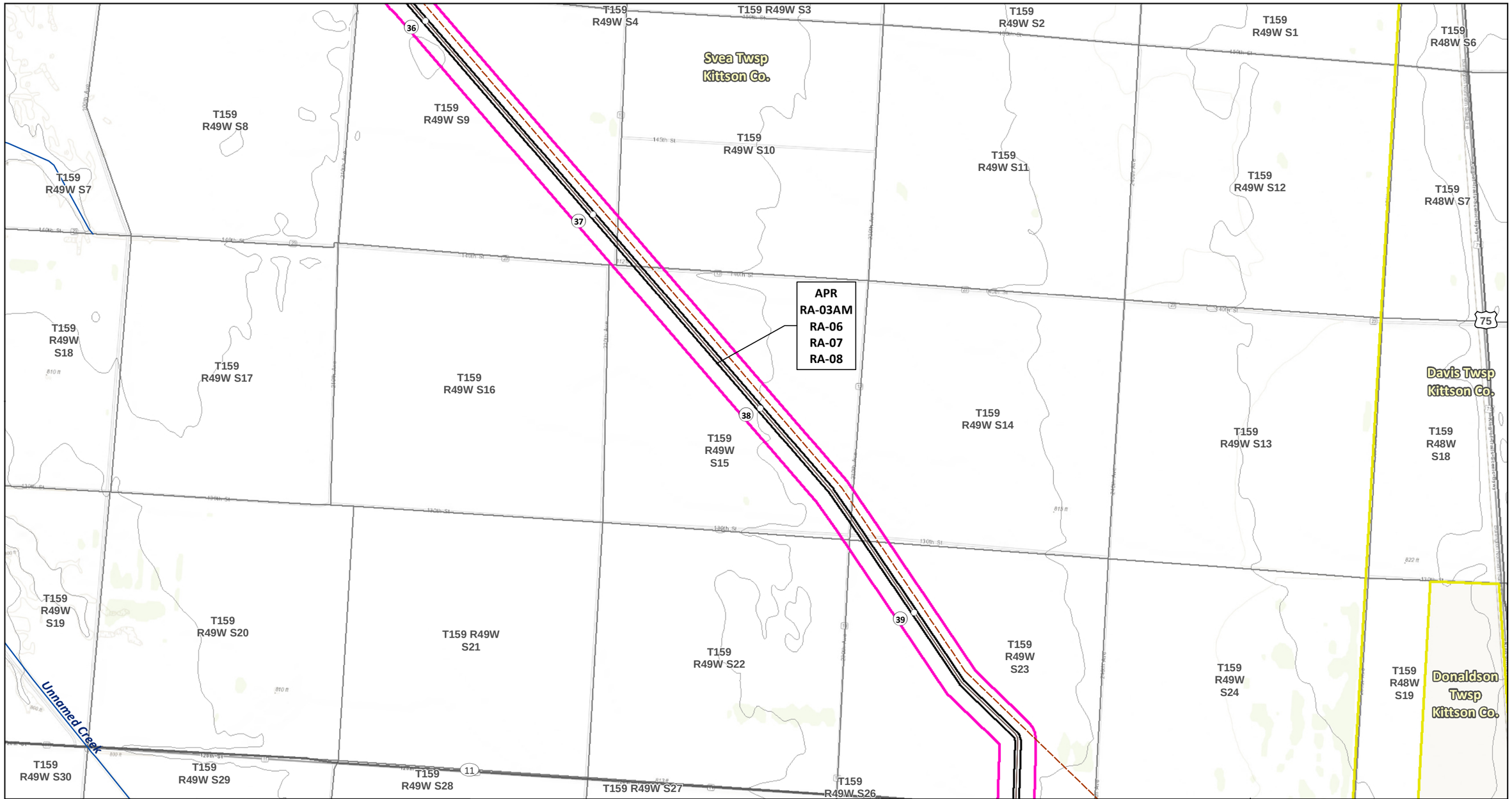
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T159 R49W S4
T159 R49W S3
T159 R49W S2
T159 R49W S1
T159 R48W S6
Svea Twsp Kittson Co.
T159 R49W S8
T159 R49W S9
T159 R49W S10
T159 R49W S11
T159 R49W S12
T159 R48W S7
T159 R49W S7
APR
RA-03AM
RA-06
RA-07
RA-08
T159 R49W S18
T159 R49W S17
T159 R49W S16
T159 R49W S15
T159 R49W S14
T159 R49W S13
T159 R48W S18
Davis Twsp Kittson Co.
T159 R49W S19
T159 R49W S20
T159 R49W S21
T159 R49W S22
T159 R49W S23
T159 R49W S24
T159 R48W S19
Donaldson Twsp Kittson Co.
Unnamed Creek
T159 R49W S30
T159 R49W S29
T159 R49W S28
T159 R49W S27
T159 R49W S26
36
37
38
39
11
75
RA-08
RA-06
APR
RA-03AM
SA-04
MN
7
8
9
10
11
12
13
Pembina County
North Dakota
Kittson County
Minnesota
Walsh County
Marshall County
SA-04
Applicant's Preferred Route (APR)
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Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
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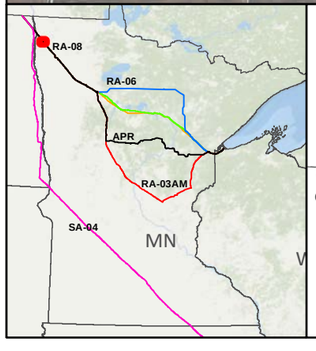
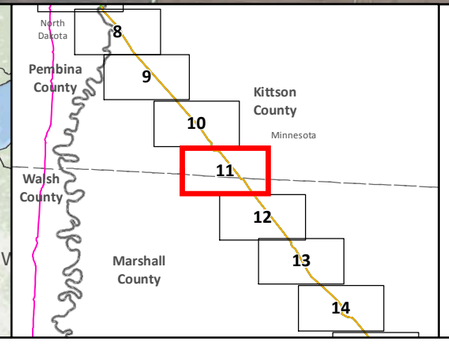
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
Map 10B of 82

T159 R49W S24
Donaldson
T159 R48W S19
T159 R48W S20
T159 R48W S21
Donaldson Twsp
Kittson Co.
T159 R49W S28
T159 R49W S27
T159 R49W S26
T159 R49W S25
T159 R48W S30
T159 R48W S29
T159 R48W S28
Svea Twsp
Kittson Co.
Unnamed Creek
Davis Twsp
Kittson Co.
APR
RA-03AM
RA-06
RA-07
RA-08
T159 R49W S33
T159 R49W S34
T159 R49W S35
T159 R49W S36
T159 R48W S31
T159 R48W S32
T159 R48W S33
T158 R49W S4
T158 R49W S2
Donnelly Twsp
Marshall Co.
T158 R49W S3
T158 R49W S1
T158 R48W S6
Sinnott Twsp
Marshall Co.
T158 R48W S4
T158 R48W S5
T158 R49W S9
T158 R49W S10
T158 R49W S11
T158 R49W S12
T158 R48W S7
T158 R48W S8
11
41
42
43
44
75





SA-04
Applicant's Preferred Route (APR)

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RA-06
RA-07
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Route Segment Alternatives (RSA)

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Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T159 R49W S24
T159 R48W S19
Donaldson
T159 R48W S20
T159 R48W S21
Donaldson Twsp
Kittson Co.
T159 R49W S28
T159 R49W S27
T159 R49W S26
T159 R49W S25
T159 R48W S30
T159 R48W S29
T159 R48W S28
Svea Twsp
Kittson Co.
Unnamed Creek
Davis Twsp
Kittson Co.
APR
RA-03AM
RA-06
RA-07
RA-08
T159 R49W S33
T159 R49W S34
T159 R49W S35
T159 R49W S36
T159 R48W S31
T159 R48W S32
T159 R48W S33
T158 R49W S4
T158 R49W S3
T158 R49W S2
Donnelly Twsp
Marshall Co.
T158 R49W S1
T158 R48W S6
T158 R48W S5
Sinnott Twsp
Marshall Co.
T158 R48W S4
T158 R49W S9
T158 R49W S10
T158 R49W S11
T158 R49W S12
T158 R48W S7
T158 R48W S8
41
42
43
44
11
75
RA-08
RA-06
APR
RA-03AM
SA-04
MN
North Dakota
Pembina County
Walsh County
Kittson County
Minnesota
Marshall County
8
9
10
11
12
13
14

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

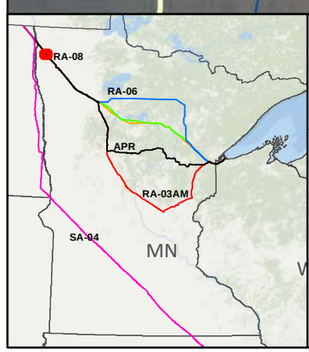
APR

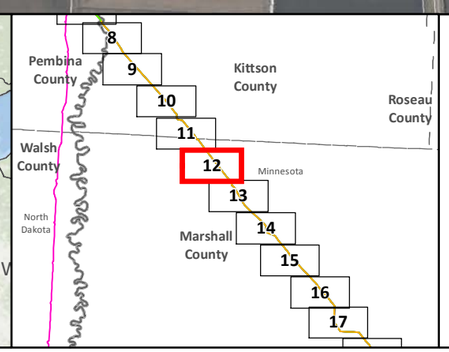
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 11B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

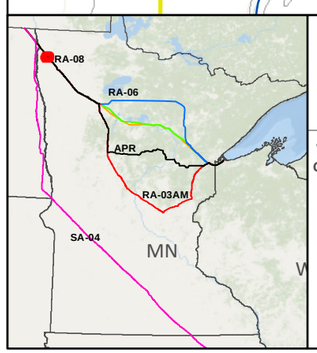
Data Sources:
MNDNR, NHD, Enbridge

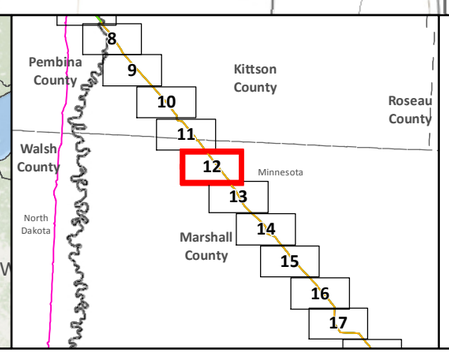
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T158 R49W S12
T158 R48W S7
T158 R48W S8
T158 R48W S9
T158 R48W S10
T158 R48W S11
T158 R48W S12
T158 R48W S1
T158 R48W S2
Donnelly Twsp Marshall Co.
T158 R49W S13
T158 R48W S18
T158 R48W S17
Sinnott Twsp Marshall Co.
T158 R48W S16
T158 R48W S15
T158 R48W S14
T158 R48W S13
APR
RA-03AM
RA-06
RA-07
RA-08
T158 R49W S24
T158 R48W S19
T158 R48W S20
T158 R48W S21
T158 R48W S22
T158 R48W S23
T158 R48W S24
Tamarac River
T158 R49W S25
T158 R48W S30
T158 R48W S29
T158 R48W S28
T158 R48W S27
T158 R48W S26
T158 R48W S25
45
46
47
48
75
440th St NW
430th St NW
420th St NW





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

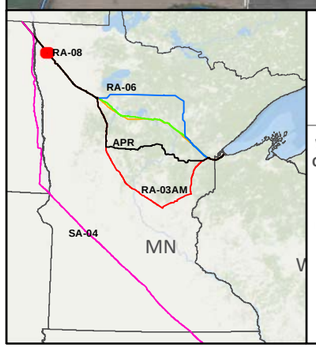
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

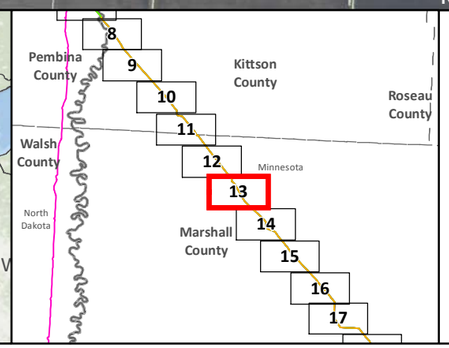
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 12B of 82

T158 R48W S23
T158 R48W S24
T158 R47W S19
T158 R47W S20
T158 R47W S21
T158 R48W S28
T158 R48W S27
T158 R48W S26
T158 R48W S25
T158 R47W S30
T158 R47W S29
T158 R47W S28
Sinnott Twsp Marshall Co.
Augsburg Twsp Marshall Co.
T158 R48W S33
T158 R48W S34
T158 R48W S35
T158 R48W S36
T158 R47W S31
T158 R47W S32
T158 R47W S33
APR
RA-03AM
RA-06
RA-07
RA-08
49
50
51
Tamarac Twsp Marshall Co.
T157 R48W S4
T157 R48W S3
T157 R48W S2
T157 R48W S1
T157 R47W S6
Wanger Twsp Marshall Co.
T157 R47W S5
T157 R47W S4
T157 R48W S9
T157 R48W S10
T157 R48W S11
T157 R48W S12
T157 R47W S7
Otter Tail River





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

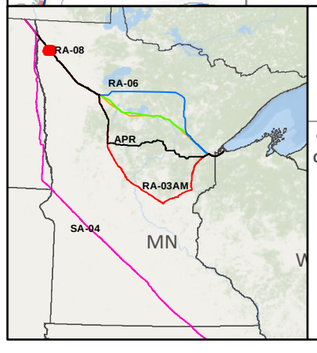
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

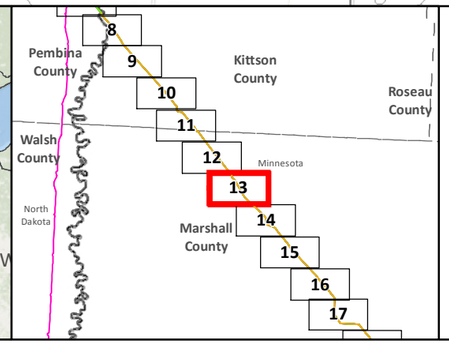
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 13A of 82

T158-R48W S23
T158 R48W S24
T158 R47W S19
T158 R47W S20
T158 R47W S21
T158 R48W S28
T158 R48W S27
T158 R48W S26
T158 R48W S25
T158 R47W S30
T158 R47W S29
T158 R47W S28
Sinnott Twsp Marshall Co.
Augsburg Twsp Marshall Co.
T158 R48W S33
T158 R48W S34
T158 R48W S35
T158 R48W S36
T158 R47W S31
T158 R47W S32
T158 R47W S33
APR
RA-03AM
RA-06
RA-07
RA-08
Tamarac Twsp Marshall Co.
T157 R48W S4
T157 R48W S3
T157 R48W S2
T157 R48W S1
T157 R47W S6
Wanger Twsp Marshall Co.
T157 R47W S5
T157 R47W S4
T157 R48W S9
T157 R48W S10
T157 R48W S11
T157 R48W S12
T157 R47W S7
Otter Tail R.
49
50
51
52





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

T157 R48W S12
T157 R47W S7
T157 R47W S8
T157 R47W S9
T157 R47W S10
T157 R47W S11
T157 R47W S12
T157 R47W S13
T157 R47W S14
T157 R47W S15
T157 R47W S16
T157 R47W S17
T157 R47W S18
T157 R48W S13
T157 R47W S19
T157 R47W S20
T157 R47W S21
T157 R47W S22
T157 R47W S23
T157 R47W S24
T157 R48W S24
T157 R47W S25
T157 R47W S26
T157 R47W S27
T157 R47W S28
T157 R47W S29
T157 R47W S30
T157 R48W S25
T157 R47W S1
T157 R47W S2
T157 R47W S3

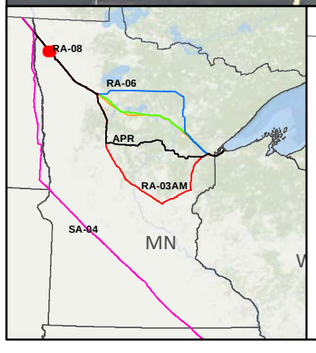
Tamarac Twsp
Marshall Co.

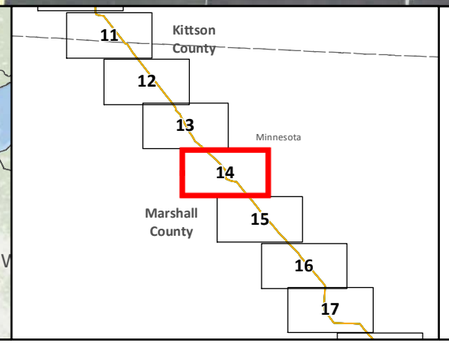
Wanger Twsp
Marshall Co.

Tamarac River

53
54
55
56

APR
RA-03AM
RA-06
RA-07
RA-08





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 14A of 82

Wanger Twsp
Marshall Co.

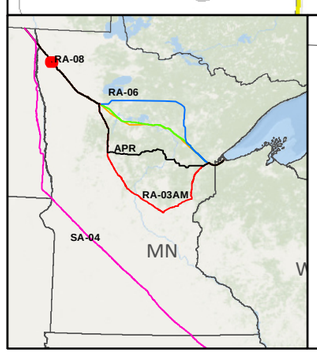
Tamarac Twsp
Marshall Co.

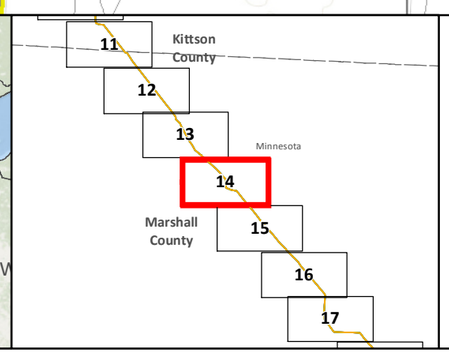
T157 R48W S12
T157 R47W S7
T157 R47W S8
T157 R47W S9
T157 R47W S10
T157 R47W S11
T157 R47W S12
T157 R47W S3
T157 R47W S2
T157 R48W S13
T157 R47W S18
T157 R47W S17
T157 R47W S16
T157 R47W S15
T157 R47W S14
T157 R48W S24
T157 R47W S19
T157 R47W S20
T157 R47W S21
T157 R47W S22
T157 R47W S23
T157 R47W S24
T157 R47W S13
T157 R48W S25
T157 R47W S30
T157 R47W S29
T157 R47W S28
T157 R47W S27
T157 R47W S26
T157 R47W S25

APR
RA-03AM
RA-06
RA-07
RA-08

Tamarac River

53 54 55 56





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
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SNA - Scientific and Natural Area

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Calcareous Fens
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Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

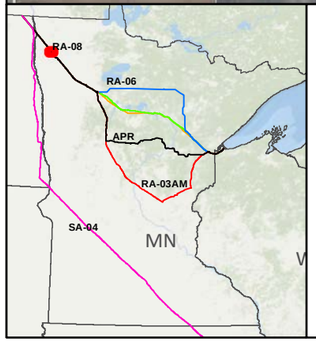
APR

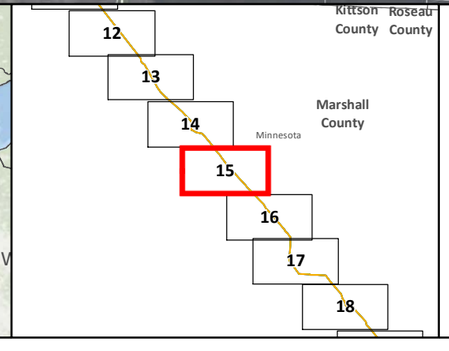
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 14B of 82

T157 R47W S29
T157 R47W S28
T157 R47W S27
T157 R47W S26
T157 R47W S25
T157 R46W S30
T157 R46W S29
T157 R47W S32
Wanger Twsp Marshall Co.
Wright Twsp Marshall Co.
T157 R47W S33
T157 R47W S34
T157 R47W S35
T157 R47W S36
T157 R46W S31
T157 R46W S32
APR
RA-03AM
RA-06
RA-07
RA-08
T156 R47W S6
Alma Twsp Marshall Co.
T156 R47W S5
T156 R47W S4
T156 R47W S3
T156 R47W S2
T156 R47W S1
T156 R46W S6
Foldahl Twsp Marshall Co.
T156 R47W S8
T156 R47W S9
T156 R47W S10
T156 R47W S11
T156 R47W S12
T156 R46W S7
57
58
59
60





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

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- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 15A of 82

T157 R47W S29
T157 R47W S28
T157 R47W S27
T157 R47W S26
T157 R47W S25
T157 R46W S30
T157 R46W S29
T157 R47W S32
T157 R47W S33
T157 R47W S34
T157 R47W S35
T157 R47W S36
T157 R46W S31
T157 R46W S32
T156 R47W S6
T156 R47W S5
T156 R47W S4
T156 R47W S3
T156 R47W S2
T156 R47W S1
T156 R46W S6
T156 R47W S8
T156 R47W S9
T156 R47W S10
T156 R47W S11
T156 R47W S12
T156 R46W S7

Wanger Twsp
Marshall Co.

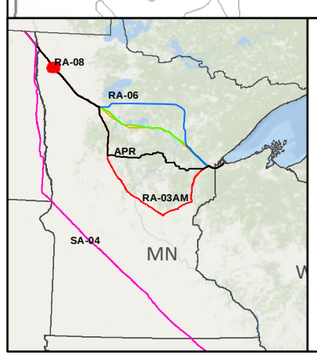
Wright Twsp
Marshall Co.

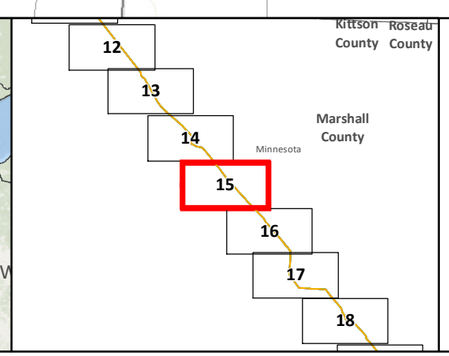
Alma Twsp
Marshall Co.

Foldahl Twsp
Marshall Co.

APR
RA-03AM
RA-06
RA-07
RA-08

57
58
59
60





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

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Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

T156 R47W S11
T156 R47W S12
T156 R46W S7
T156 R46W S8
T156 R46W S9
T156 R46W S10
T156 R47W S14
T156 R47W S13
T156 R46W S18
T156 R46W S17
T156 R46W S16
T156 R46W S15
T156 R47W S23
T156 R47W S24
T156 R46W S19
T156 R46W S20
T156 R46W S21
T156 R46W S22
T156 R47W S26
T156 R47W S25
T156 R46W S30
T156 R46W S29
T156 R46W S28
T156 R46W S27

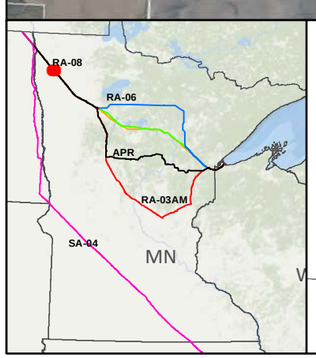
Middle River

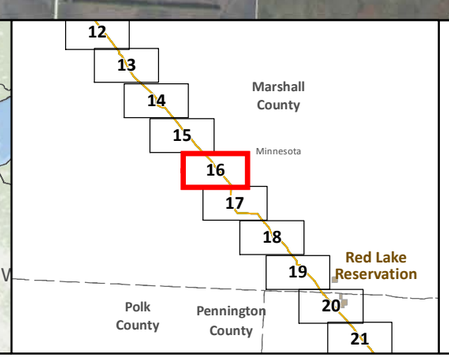
Alma Twsp
Marshall Co.

Foldahl Twsp
Marshall Co.

APR
RA-03AM
RA-06
RA-07
RA-08

62
63
64
65





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 16A of 82

T156 R47W S11
T156 R47W S12
T156 R46W S7
T156 R46W S8
T156 R46W S9
T156 R46W S10
T156 R47W S14
T156 R47W S13
T156 R46W S18
T156 R46W S17
T156 R46W S16
T156 R46W S15
T156 R47W S23
T156 R47W S24
T156 R46W S19
T156 R46W S20
T156 R46W S21
T156 R46W S22
T156 R47W S26
T156 R47W S25
T156 R46W S30
T156 R46W S29
T156 R46W S28
T156 R46W S27

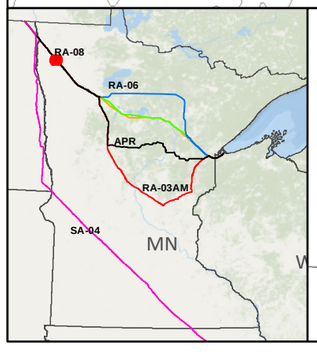
Middle River

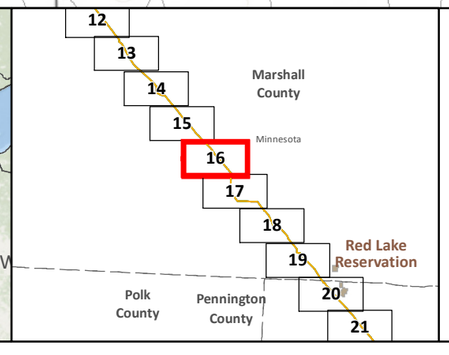
Alma Twsp
Marshall Co.

Foldahl Twsp
Marshall Co.

APR
RA-03AM
RA-06
RA-07
RA-08

62
63
64
65





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

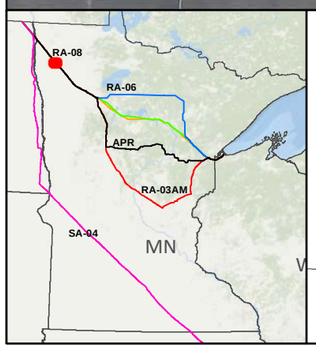
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

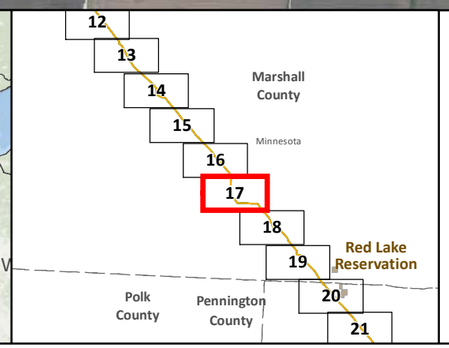
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

T156 R46W S24
T156 R46W S30
T156 R47W S25
T156 R46W S29
T156 R46W S28
T156 R46W S27
T156 R46W S26
T156 R46W S25
T156 R47W S36
66
Foldahl Twsp
Marshall Co.
T156 R46W S31
T156 R46W S32
T156 R46W S33
T156 R46W S34
T156 R46W S35
T156 R46W S36
APR
RA-03AM
RA-06
RA-07
RA-08
67
Comstock Twsp
Marshall Co.
T155 R46W S6
T155 R46W S5
T155 R46W S4
T155 R46W S3
T155 R46W S2
T155 R46W S1
68
69
70
Snake River
T155 R46W S7
T155 R46W S8
T155 R46W S9
T155 R46W S10
T155 R46W S11
T155 R46W S12





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

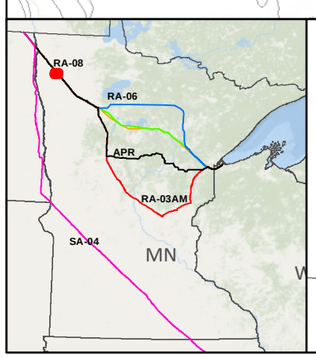
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

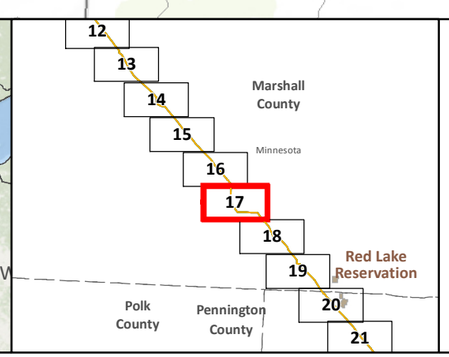
APR

Map 17A of 82

T156 R47W S25
T156 R46W S30
T156 R46W S29
T156 R46W S28
T156 R46W S27
T156 R46W S26
T156 R46W S24
T156 R46W S25
T156 R47W S36
T156 R46W S31
T156 R46W S32
T156 R46W S33
T156 R46W S34
T156 R46W S35
T156 R46W S36
Foldahl Twsp
Marshall Co.
Comstock Twsp
Marshall Co.
T155 R46W S6
T155 R46W S5
T155 R46W S4
T155 R46W S3
T155 R46W S2
T155 R46W S1
T155 R46W S7
T155 R46W S8
T155 R46W S9
T155 R46W S10
T155 R46W S11
T155 R46W S12
Snake River
66
67
68
69
70
290th St NW
270th St NW
250th St NW
Great Eastern
230th Ave NW
231st Ave NW
Roseau St NW

APR
RA-03AM
RA-06
RA-07
RA-08





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

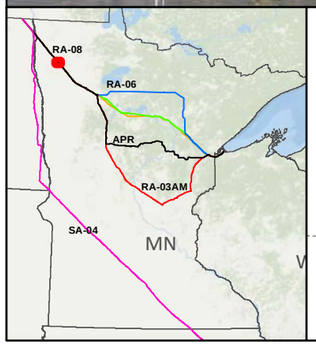
APR

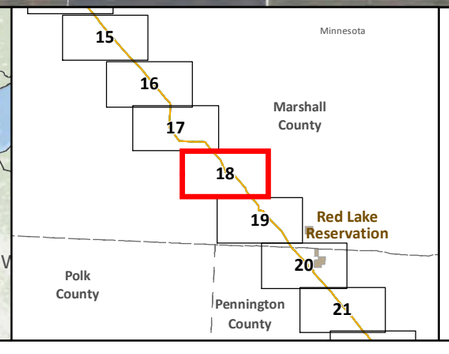
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 17B of 82

T155 R45W S4
T155 R45W S3
Unnamed Creek
T155 R46W S10
T155 R46W S11
T155 R46W S12
T155 R45W S7
T155 R45W S8
T155 R45W S9
T155 R45W S10
71
T155 R46W S15
T155 R46W S14
T155 R46W S13
Comstock Twsp Marshall Co.
72
T155 R45W S18
T155 R45W S17
Viking Twsp Marshall Co.
T155 R45W S16
T155 R45W S15
APR
RA-03AM
RA-06
RA-07
RA-08
73
Snake River
T155 R46W S22
T155 R46W S23
T155 R46W S24
T155 R45W S19
T155 R45W S20
T155 R45W S21
T155 R45W S22
74
T155 R46W S27
T155 R46W S26
T155 R46W S25
T155 R45W S30
T155 R45W S29
T155 R45W S28
T155 R45W S27





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

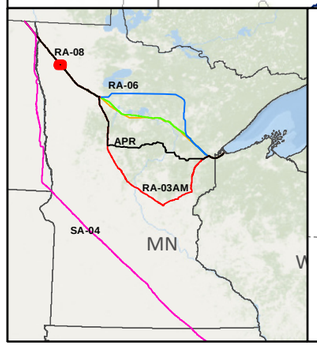
Data Sources: MNDNR, NHD, Enbridge

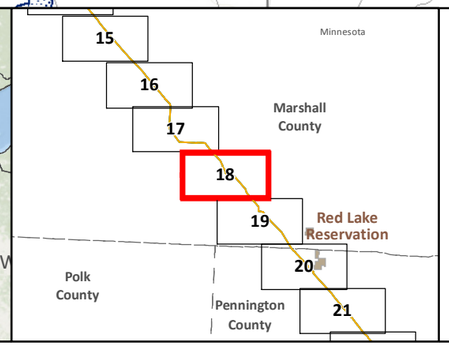
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T155 R45W S4
T155 R45W S3
Unnamed Creek
T155 R46W S10
T155 R46W S11
T155 R46W S12
T155 R45W S7
T155 R45W S8
T155 R45W S9
T155 R45W S10
Viking 18
T155 R46W S15
T155 R46W S14
T155 R46W S13
T155 R45W S18
T155 R45W S17
Comstock Twsp Marshall Co.
Viking Twsp Marshall Co.
APR
RA-03AM
RA-06
RA-07
RA-08
T155 R45W S16
T155 R45W S15
Snake River
T155 R46W S22
T155 R46W S23
T155 R46W S24
T155 R45W S19
T155 R45W S20
Viking 20
T155 R45W S21
T155 R45W S22
T155 R46W S27
T155 R46W S26
T155 R46W S25
T155 R45W S30
T155 R45W S29
T155 R45W S28
T155 R45W S27
260th St NW
240th St NW
Northern Plains Railroad
71
72
73
74





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

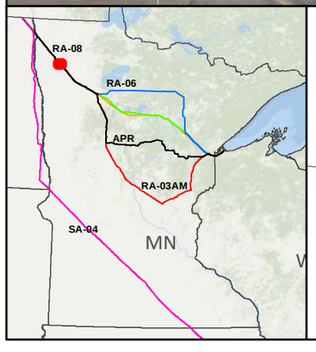
APR

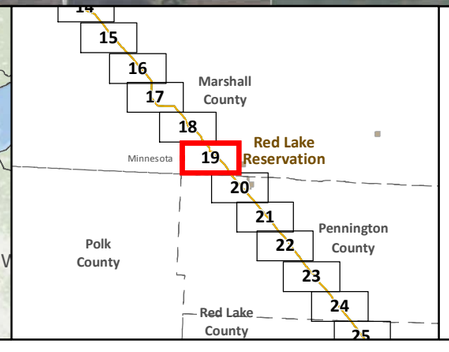
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 18B of 82

T155 R45W S30
T155 R45W S29
Unnamed Creek
T155 R45W S28
T155 R45W S27
Viking
T155 R45W S26
T155 R45W S25
75
76
APR
RA-03AM
RA-06
RA-07
RA-08
T155 R45W S34
T155 R45W S31
T155 R45W S32
T155 R45W S33
Viking Twsp
Marshall Co.
T155 R45W S35
T155 R45W S36
77
T154 R45W S6
T154 R45W S5
T154 R45W S4
T154 R45W S3
T154 R45W S2
T154 R45W S1
1
T154 R45W S7
T154 R45W S8
T154 R45W S9
T154 R45W S10
T154 R45W S11
T154 R45W S12





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

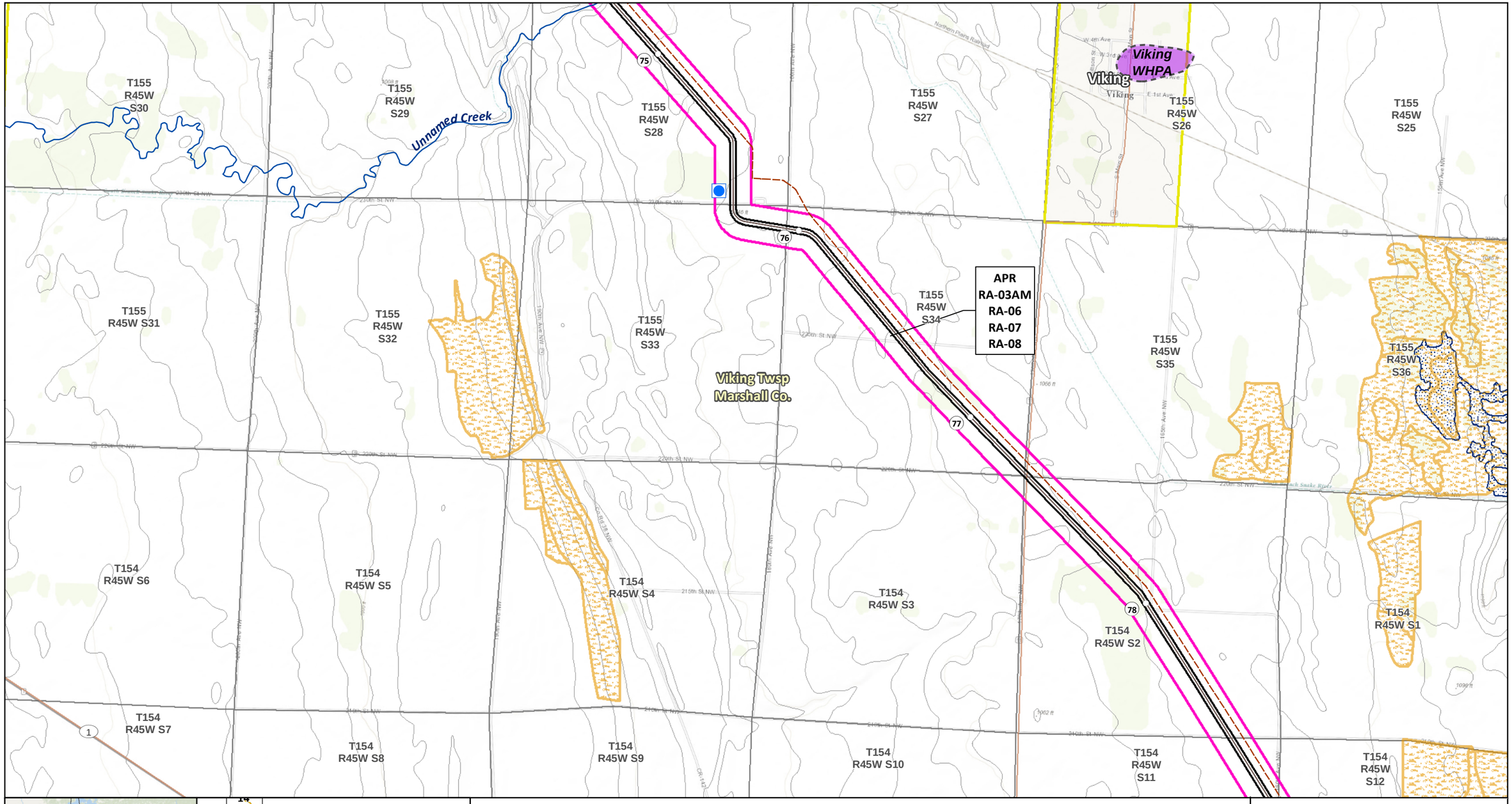
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

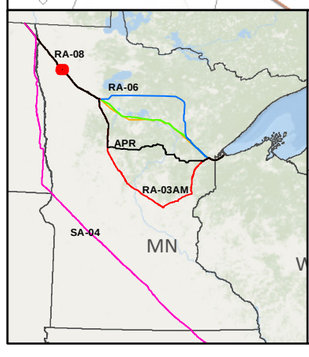
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

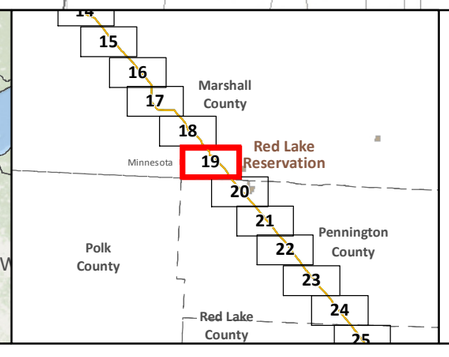
APR

N

Map 19A of 82







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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- Public Drinking Water Supply
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 19B of 82

T154 R45W S10
T154 R45W S11
Viking Twsp Marshall Co.
T154 R45W S12
T154 R44W S7
T154 R44W S8
New Solum Twsp Marshall Co.
T154 R44W S9
T154 R45W S10
T154 R45W S11
T154 R45W S12
T154 R44W S7
Red Lake Reservation
T154 R44W S8
T154 R44W S9
Unnamed Creek
T154 R45W S15
T154 R45W S14
T154 R45W S13
Red Lake Reservation
T154 R44W S18
T154 R44W S17
T154 R44W S16
APR
RA-03AM
RA-06
RA-07
RA-08
Numedal Twsp Pennington Co.
Norden Twsp Pennington Co.
T154 R45W S22
T154 R44W S15
Black River
T154 R45W S23
T154 R45W S24
T154 R44W S19
T154 R44W S20
T154 R44W S21
T154 R45W S27
T154 R45W S26
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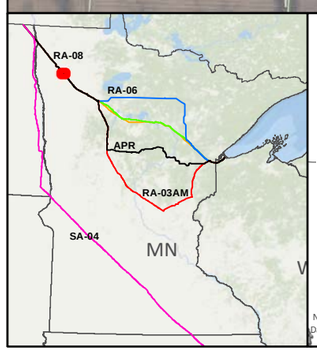
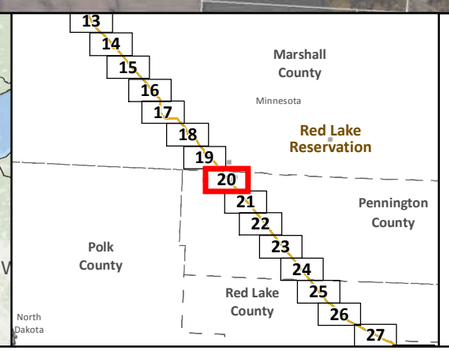
T154 R44W S29
T154 R44W S28
T154 R44W S22
T154 R44W S27





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

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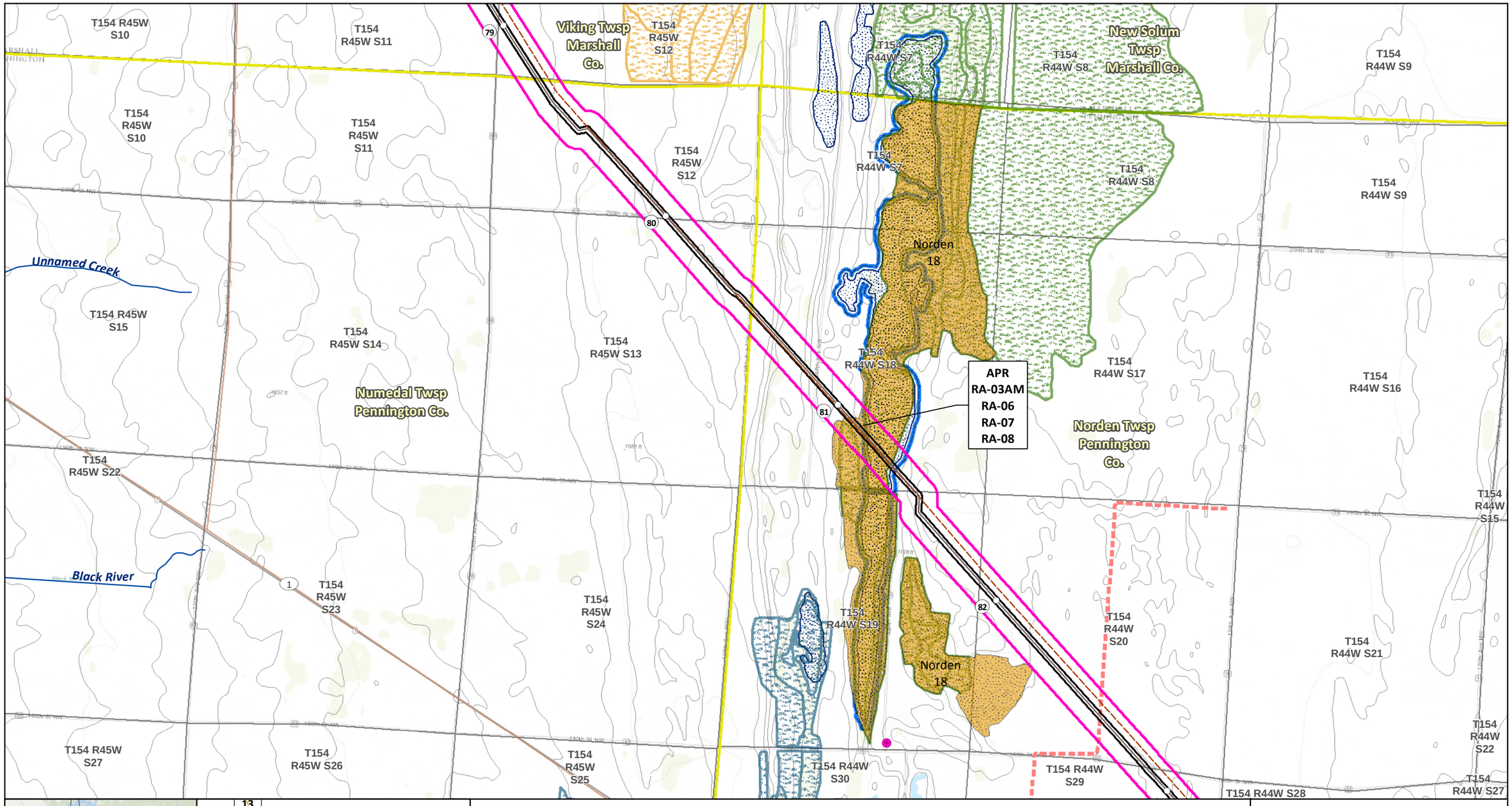
- Tribal Trust Land
- White Earth Reservation - BIA

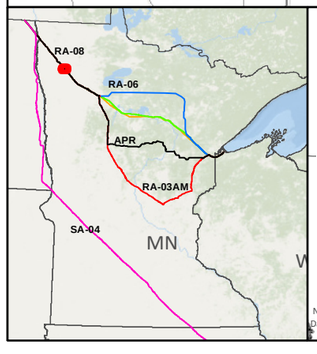
Data Sources: MNDNR, NHD, Enbridge

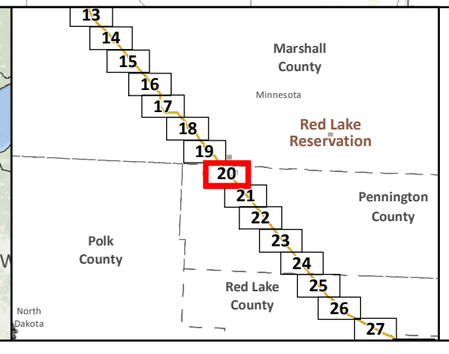
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

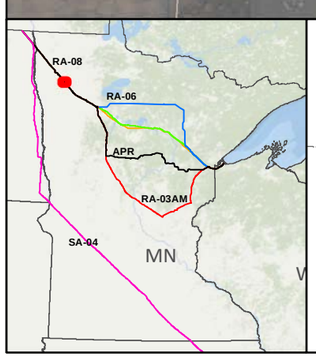
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

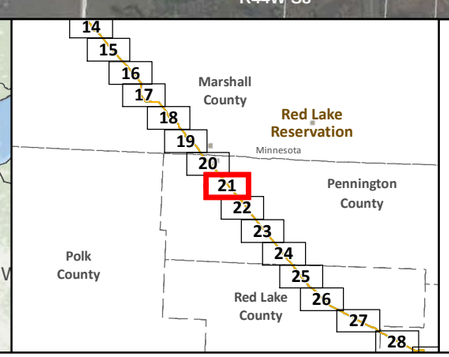
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 20B of 82

T154 R44W S21
T154 R44W S22
T154 R44W S23
T154 R44W S24
T154 R45W S25
T154 R44W S30
T154 R44W S29
T154 R44W S28
T154 R44W S27
T154 R44W S26
T154 R44W S25
Numedal Twsp Pennington Co.
T154 R45W S36
Norden Twsp Pennington Co.
T154 R44W S31
T154 R44W S32
T154 R44W S33
T154 R44W S34
T154 R44W S35
T154 R44W S36
APR
RA-03AM
RA-06
RA-07
RA-08
Unnamed Creek
T153 R44W S6
T153 R44W S5
T153 R44W S4
Sanders Twsp Pennington Co.
T153 R44W S3
T153 R44W S2
T153 R44W S1
T153 R44W S7
T153 R44W S8
T153 R44W S9
T153 R44W S10
T153 R44W S11





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 21A of 82

T154 R44W-S21

T154 R44W S22

T154 R44W S23

T154 R44W S24

T154 R45W S25

T154 R44W S30

T154 R44W S29

T154 R44W S28

T154 R44W S27

T154 R44W S26

T154 R44W S25

Numedal Twsp Pennington Co.

T154 R45W S36

Norden Twsp Pennington Co.

T154 R44W S31

T154 R44W S32

T154 R44W S33

T154 R44W S34

T154 R44W S35

T154 R44W S36

APR
RA-03AM
RA-06
RA-07
RA-08

Unnamed Creek

T153 R44W S6

T153 R44W S5

T153 R44W S4

Sanders Twsp Pennington Co.

T153 R44W S3

T153 R44W S2

T153 R44W S1

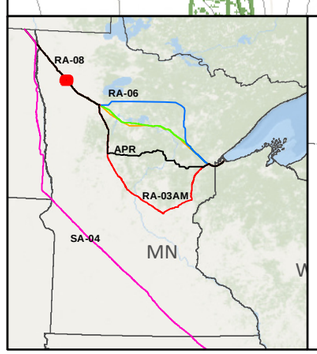
T153 R44W S7

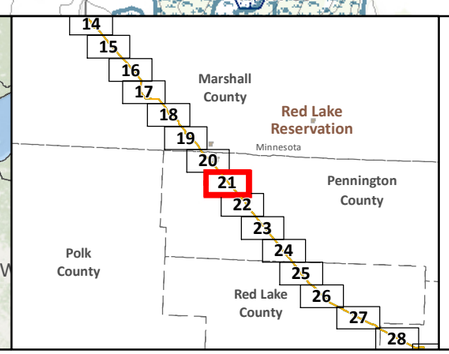
T153 R44W S8

T153 R44W S9

T153 R44W S10

T153 R44W S11





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

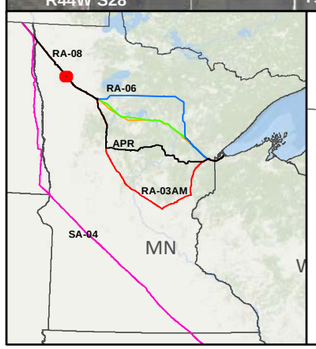
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

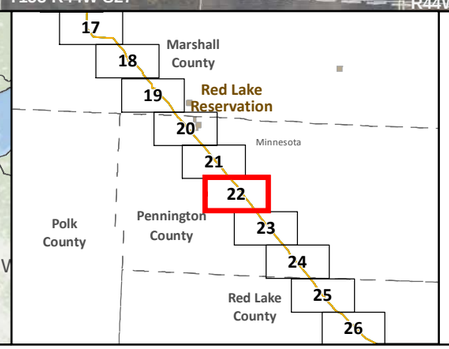
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 21B of 82

T153 R44W S4
T153 R44W S3
T153 R44W S2
T153 R44W S1
T153 R43W S6
T153 R43W S5
T153 R44W S9
T153 R44W S10
T153 R44W S11
T153 R44W S12
T153 R43W S7
T153 R43W S8
Thief River Falls Twsp Pennington Co.
T153 R43W S9
APR
RA-03AM
RA-06
RA-07
RA-08
Sanders Twsp Pennington Co.
T153 R44W S16
T153 R44W S15
T153 R44W S14
T153 R44W S13
T153 R43W S18
Rocksbury Twsp Pennington Co.
T153 R43W S17
T153 R43W S16
T153 R44W S21
T153 R44W S22
T153 R44W S23
T153 R44W S24
T153 R43W S19
T153 R43W S20
T153 R43W S21
T153 R44W S28
T153 R44W S27
T153 R44W S26
Red Lake River





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

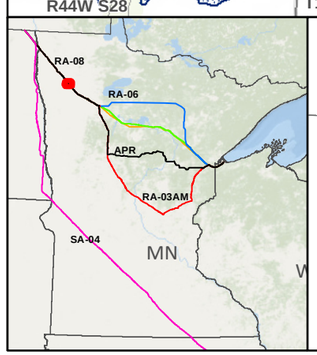
Data Sources: MNDNR, NHD, Enbridge

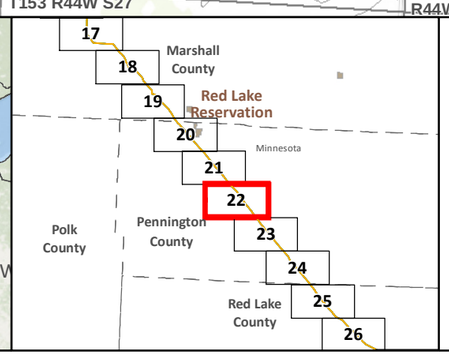
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T153 R44W S4
T153 R44W S3
T153 R44W S2
T153 R44W S1
T153 R43W S6
T153 R43W S5
T153 R44W S9
T153 R44W S10
T153 R44W S11
T153 R44W S12
T153 R43W S7
T153 R43W S8
Thief River Falls Twsp Pennington Co.
T153 R43W S9
T153 R44W S16
T153 R44W S15
Sanders Twsp Pennington Co.
T153 R44W S14
T153 R44W S13
APR
RA-03AM
RA-06
RA-07
RA-08
Rocksbury Twsp Pennington Co.
T153 R43W S18
T153 R43W S17
T153 R43W S16
T153 R44W S21
T153 R44W S22
T153 R44W S23
T153 R44W S24
T153 R43W S20
T153 R43W S19
T153 R43W S21
Red Lake River
T153 R44W S28
T153 R44W S27
T153 R44W S26





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

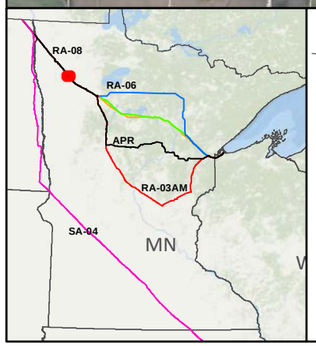
APR

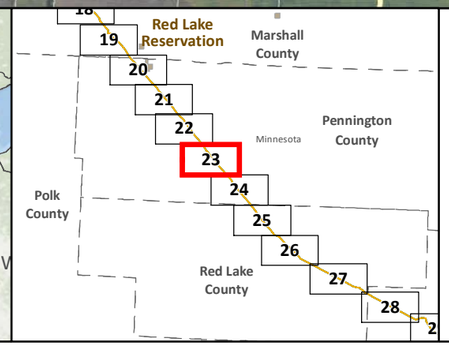
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 22B of 82

T153 R43W S19
T153 R43W S20
T153 R43W S21
T153 R43W S22
T153 R43W S23
T153 R44W S25
T153 R43W S30
T153 R43W S29
T153 R43W S28
T153 R43W S27
T153 R43W S26
Sanders Twsp
Pennington Co.
Rocksbury Twsp
Pennington Co.
T153 R44W S36
T153 R43W S31
T153 R43W S32
T153 R43W S33
T153 R43W S34
T153 R43W S35
APR
RA-03AM
RA-06
RA-07
RA-08
91
92
93
94
32
T152 R43W S6
Saint Hilaire Twsp
Pennington Co.
T152 R44W S2
Black
River Twsp
Pennington Co.
T152 R44W S1
Saint Hilaire
Red Lake River
Unnamed Creek
T152 R43W S5
River Falls Twsp
Pennington Co.
T152 R43W S4
T152 R43W S3
T152 R43W S2
T152 R44W S11
T152 R44W S12
T152 R43W S7
T152 R43W S8
T152 R43W S9
T152 R43W S10





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

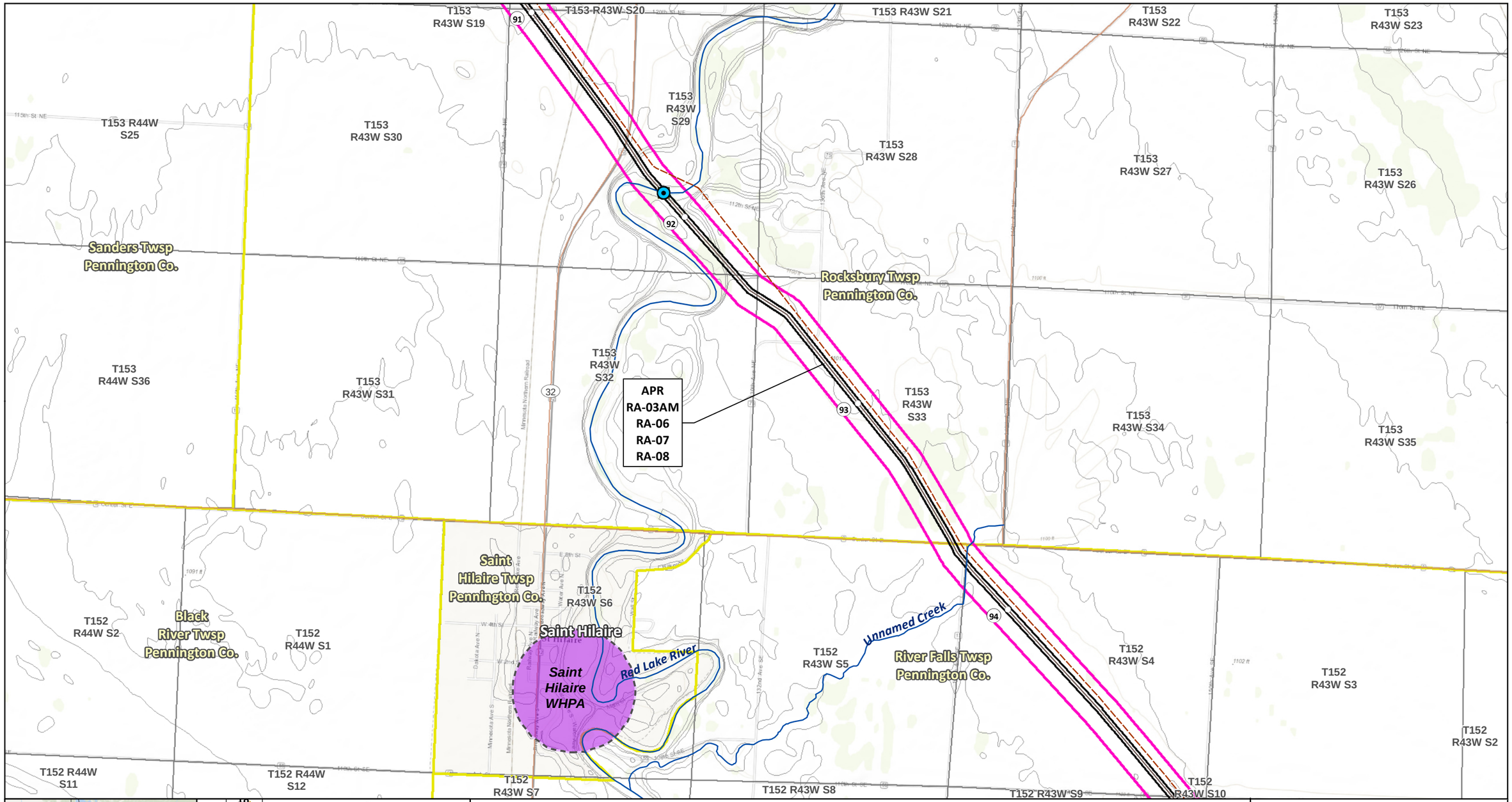
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T153 R43W S19
T153-R43W-S20
T153 R43W S21
T153 R43W S22
T153 R43W S23
T153 R44W S25
T153 R43W S30
T153 R43W S29
T153 R43W S28
T153 R43W S27
T153 R43W S26
Sanders Twsp Pennington Co.
Rocksbury Twsp Pennington Co.
T153 R44W S36
T153 R43W S31
T153 R43W S32
T153 R43W S33
T153 R43W S34
T153 R43W S35
APR
RA-03AM
RA-06
RA-07
RA-08
Saint Hilaire Twsp Pennington Co.
T152 R44W S2
Black River Twsp Pennington Co.
T152 R44W S1
T152 R43W S6
Saint Hilaire
Saint Hilaire WHPA
Red Lake River
Unnamed Creek
T152 R43W S5
River Falls Twsp Pennington Co.
T152 R43W S4
T152 R43W S3
T152 R43W S2
T152 R44W S11
T152 R44W S12
T152 R43W S7
T152 R43W S8
T152 R43W S9
T152 R43W S10
Red Lake Reservation
Marshall County
Pennington County
Polk County
Red Lake County
Minnesota
MN
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
Map 23B of 82

River Falls Twsp
Pennington Co.

T152 R43W S3

T152 R43W S2

T152 R43W S1

T152 R42W S6

T152 R42W S5

T152 R43W S8

T152 R43W S9

T152 R43W S10

T152 R43W S11

T152 R43W S12

T152 R42W S7

T152 R42W S8

95

96

97

98

APR
RA-03AM
RA-06
RA-07
RA-08

T152 R43W S17

T152 R43W S16

T152 R43W S15

T152 R43W S14

Unnamed Creek

T152 R43W S13

T152 R42W S18

T152 R42W S17

Wyandotte Twsp
Pennington Co.

T152 R43W S20

T152 R43W S21

T152 R43W S22

T152 R43W S23

T152 R43W S24

T152 R42W S19

T152 R42W S20

Red Lake River

River
Twsp Red
Lake Co.

T152 R43W S29

T152 R43W S28

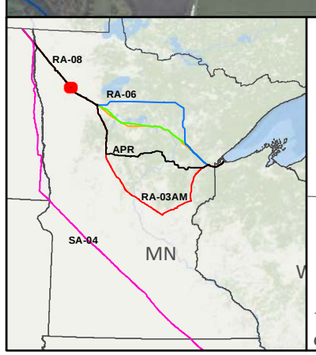
T152 R43W S27

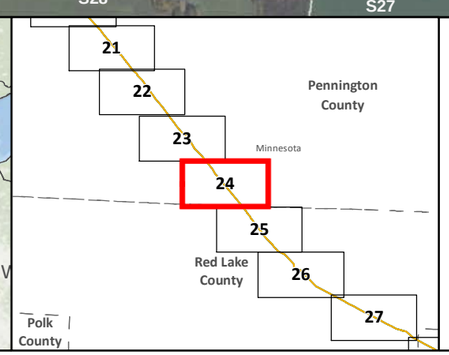
T152 R43W S26

T152 R43W S25

T152 R42W S30

Emardville Twsp
Red Lake Co.





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

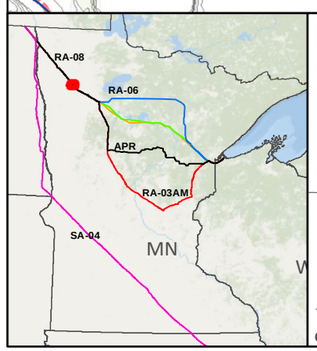
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

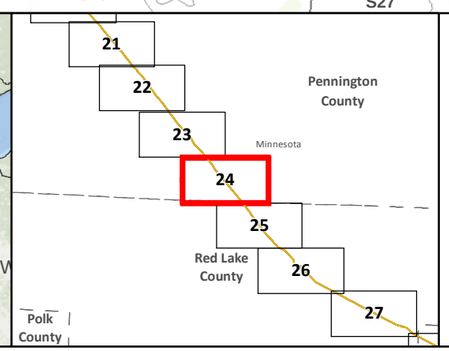
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 24A of 82

T152 R43W S3
T152 R43W S2
T152 R43W S1
T152 R42W S6
T152 R42W S5
T152 R43W S8
T152 R43W S9
T152 R43W S10
T152 R43W S11
T152 R43W S12
T152 R42W S7
T152 R42W S8
T152 R43W S15
APR
RA-03AM
RA-06
RA-07
RA-08
T152 R43W S17
T152 R43W S16
River Falls Twsp
Pennington Co.
T152 R43W S14
Unnamed Creek
T152 R43W S13
T152 R42W S18
T152 R42W S17
Wyandotte Twsp
Pennington Co.
T152 R43W S20
T152 R43W S21
T152 R43W S22
T152 R43W S23
T152 R43W S24
T152 R42W S19
T152 R42W S20
Red Lake River
T152 R43W S29
T152 R43W S28
T152 R43W S27
River Twsp Red Lake Co.
T152 R43W S26
T152 R43W S25
T152 R42W S30
Emardville Twsp
Red Lake Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

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Navigable Waterway Crossings
National River Inventory Crossing

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Designated Trout Stream
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Public Water Basin
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Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

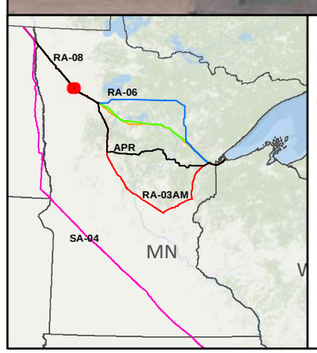
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

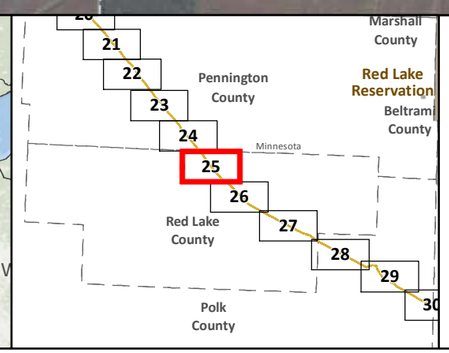
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 24B of 82

T152 R43W S27
T152 R43W S26
T152 R43W S25
T152 R42W S30
T152 R42W S29
T152 R42W S20
Wyandotte Twsp Pennington Co.
T152 R42W S21
T152 R42W S22
T152 R42W S28
T152 R42W S27
River Twsp Red Lake Co.
T152 R43W S34
T152 R43W S35
T152 R43W S36
T152 R42W S31
T152 R42W S32
Emardville Twsp Red Lake Co.
T152 R42W S33
T152 R42W S34
Unnamed Creek
Clearwater River
100
101
59
APR
RA-03AM
RA-06
RA-07
RA-08
T151 R43W S2
Gervais Twsp Red Lake Co.
T151 R43W S1
T151 R42W S6
T151 R42W S5
102
T151 R42W S4
Plummer Twsp Red Lake Co.
T151 R42W S3
T151 R43W S11
T151 R43W S12
T151 R42W S7
T151 R42W S8
T151 R42W S9
T151 R42W S10





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

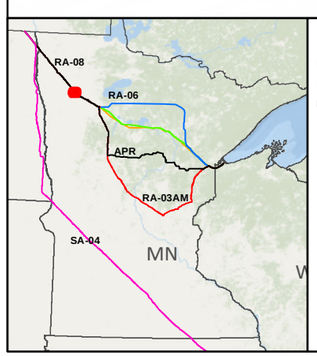
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

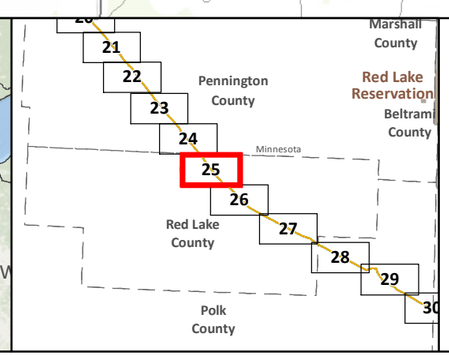
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 25A of 82

T152 R43W S27
T152 R43W S26
T152 R43W S25
T152 R42W S30
T152 R42W S20
Wyandotte Twsp Pennington Co.
T152 R42W S21
T152 R42W S22
T152 R42W S29
T152 R42W S28
T152 R42W S27
River Twsp Red Lake Co.
T152 R43W S34
T152 R43W S35
T152 R43W S36
T152 R42W S31
T152 R42W S32
Emardville Twsp Red Lake Co.
T152 R42W S33
T152 R42W S34
Unnamed Creek
Clearwater River
100
101
59
APR
RA-03AM
RA-06
RA-07
RA-08
T151 R43W S2
Gervais Twsp Red Lake Co.
T151 R43W S1
T151 R42W S6
T151 R42W S5
102
T151 R42W S4
T151 R42W S3
Plummer Twsp Red Lake Co.
T151 R43W S11
T151 R43W S12
T151 R42W S7
T151 R42W S8
T151 R42W S9
T151 R42W S10





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

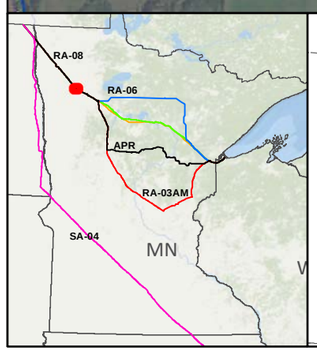
APR

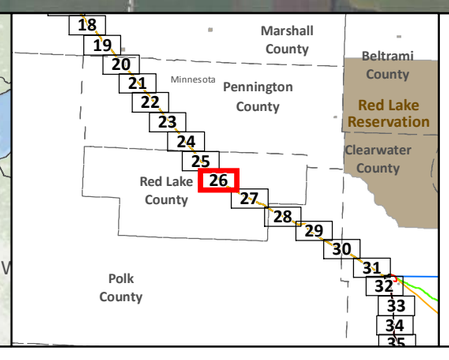
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 25B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

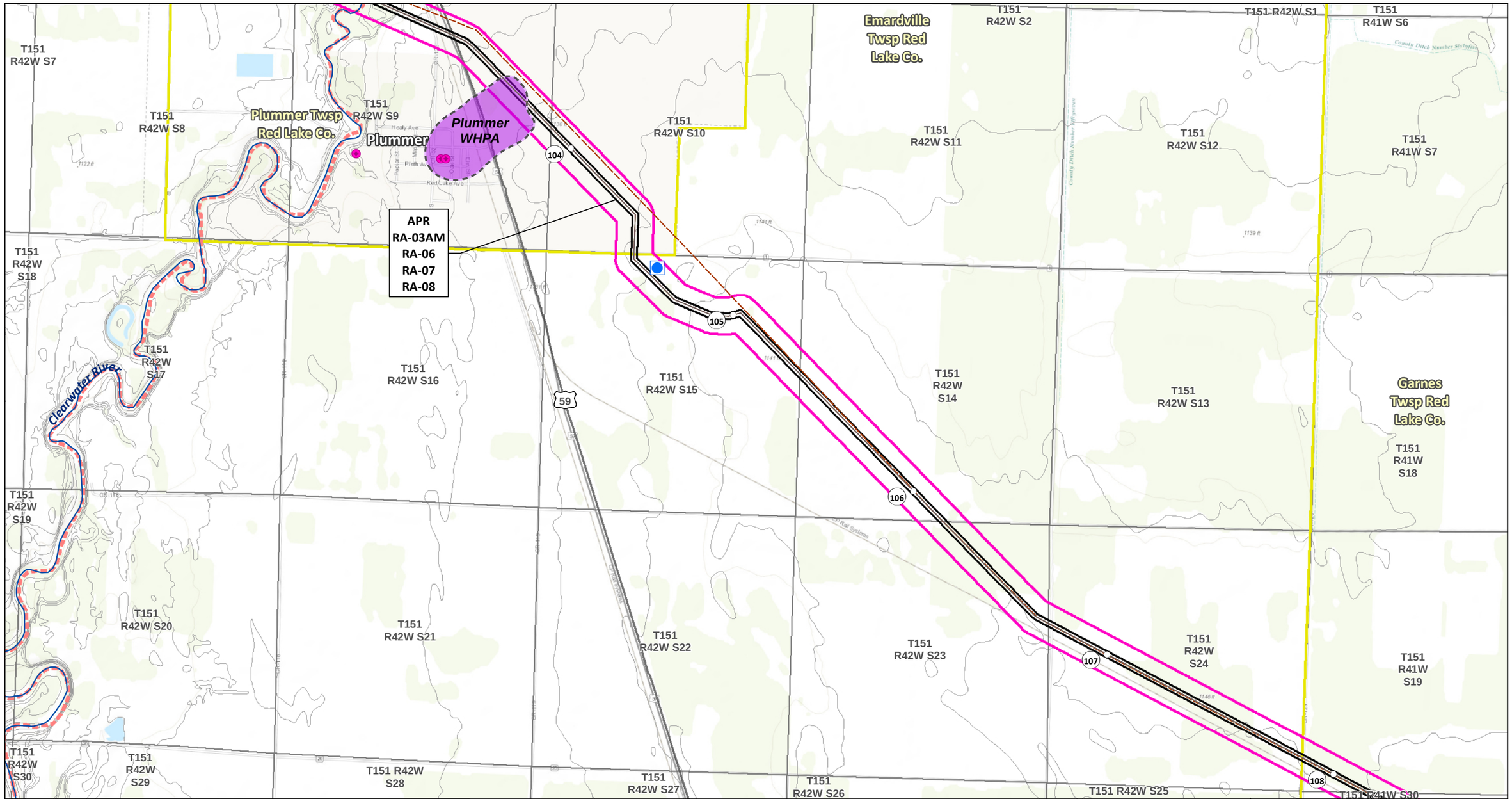
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

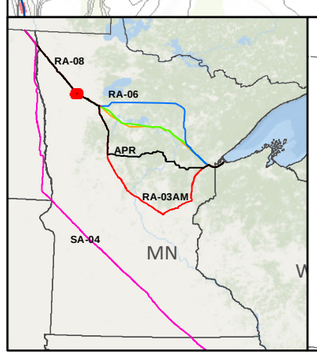
Data Sources: MNDNR, NHD, Enbridge

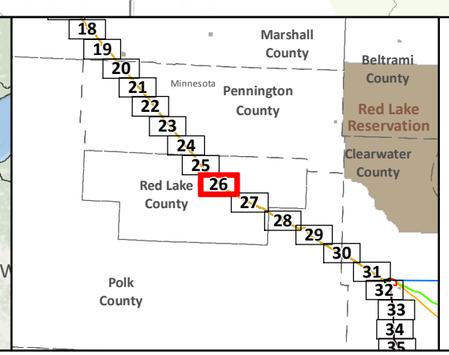
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

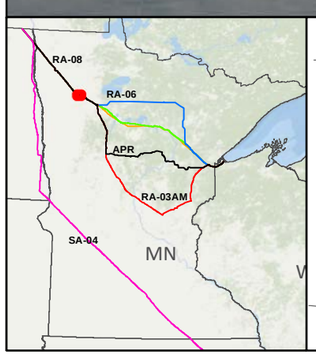
APR

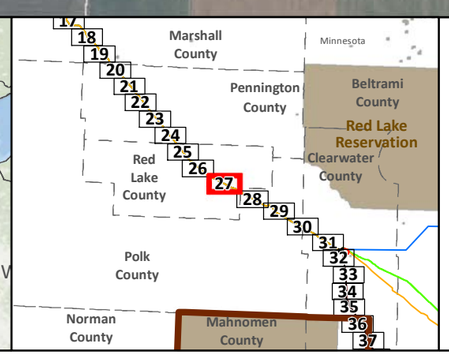
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 26B of 82

T151 R41W S19
T151 R41W S20
T151 R41W S21
T151 R41W S22
T151 R41W S23
T151 R41W S24
Emardville Twsp Red Lake Co.
T151 R41W S30
T151 R41W S29
T151 R41W S28
T151 R41W S27
T151 R41W S26
T151 R41W S25
T151 R42W S25
T151 R42W S36
Garnes Twsp Red Lake Co.
APR
RA-03AM
RA-06
RA-07
RA-08
T151 R41W S31
T151 R41W S32
T151 R41W S33
T151 R41W S34
T151 R41W S35
T151 R41W S36
108
109
110
111
112
113
114
222
Lost River
Unnamed Creek
T150 R41W S6
T150 R41W S5
T150 R41W S4
Lambert Twsp Red Lake Co.
T150 R41W S3
T150 R41W S2
T150 R41W S1
Oklee Twsp Red Lake Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 27A of 82

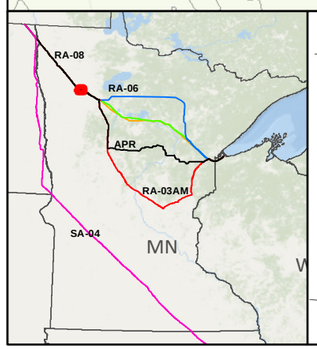
T151 R41W S19
T151 R41W S20
T151 R41W S21
T151 R41W S22
T151 R41W S23
T151 R41W S24
T151 R42W S25
T151 R41W S30
T151 R41W S29
T151 R41W S28
T151 R41W S27
T151 R41W S26
T151 R41W S25
T151 R42W S36
T151 R41W S31
T151 R41W S32
T151 R41W S33
T151 R41W S34
T151 R41W S35
T151 R41W S36
T150 R41W S6
T150 R41W S5
T150 R41W S4
T150 R41W S3
T150 R41W S2
T150 R41W S1

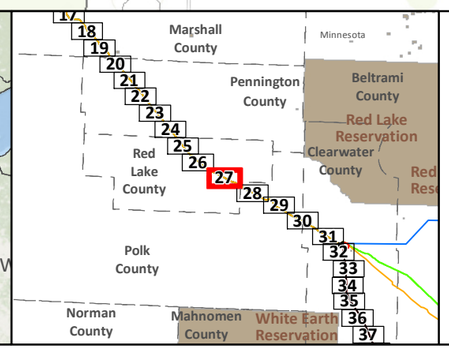
APR
RA-03AM
RA-06
RA-07
RA-08

Garnes Twsp Red Lake Co.
Lambert Twsp Red Lake Co.
Oklee Twsp Red Lake Co.
Oklee
Oklee 2 WHPA

Lost River
Unnamed Creek

108 109 110 111 112 113 114 222





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

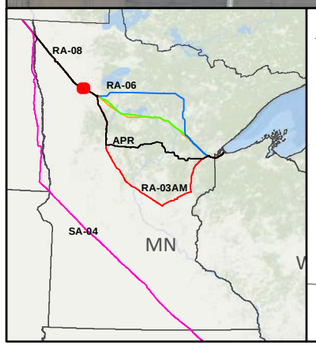
Data Sources: MNDNR, USGS, NHD, Enbridge

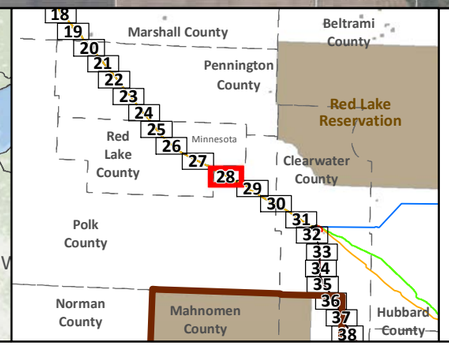
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 28A of 82

Oklee 2 WHPA
Oklee Twsp
Red Lake Co.

T150 R41W S1
T150 R40W S6
T150 R40W S5
T150 R40W S4
T150 R40W S3
T150 R40W S2
T150 R40W S1
Lost River

APR
RA-03AM
RA-06
RA-07
RA-08

T150 R41W S12
T150 R40W S7
T150 R40W S8
T150 R40W S9
T150 R40W S10
T150 R40W S11
T150 R40W S12

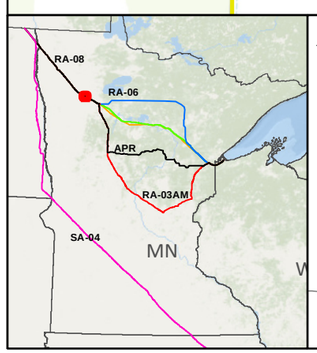
Chester Twsp
Polk Co.

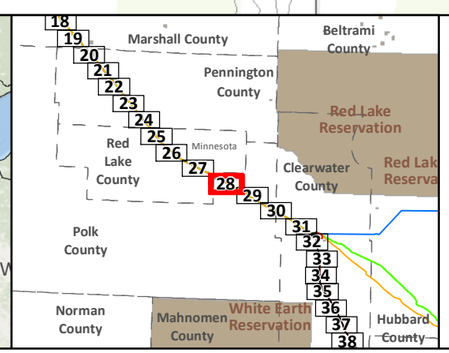
Unnamed Creek

Lambert Twsp
Red Lake Co.

T150 R41W S13
T150 R40W S18
T150 R40W S17
T150 R40W S16
T150 R40W S15
T150 R40W S14
T150 R40W S13

T150 R41W S24
T150 R40W S19
T150 R40W S20
T150 R40W S21
T150 R40W S22
T150 R40W S23
T150 R40W S24





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

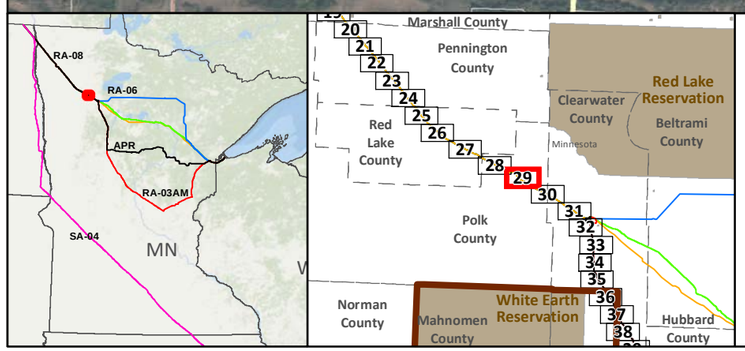
Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

T150 R40W S14
T150 R40W S13
T150 R39W S18
T150 R39W S17
T150 R39W S16
T150 R39W S15
T150 R39W S14
T150 R40W S23
T150 R40W S24
T150 R39W S19
T150 R39W S20
T150 R39W S21
T150 R39W S22
T150 R39W S23
Chester Twsp Polk Co.
Gully Twsp Polk Co.
T150 R40W S26
T150 R40W S25
T150 R39W S30
Trail Twsp Polk Co.
Trail
T150 R39W S29
T150 R39W S28
T150 R39W S27
T150 R39W S26
T150 R40W S35
T150 R40W S36
T150 R39W S31
T150 R39W S32
T150 R39W S33
T150 R39W S34
T150 R39W S35
Gully
120
121
122
123
124
125
92
APR
RA-03AM
RA-06
RA-07
RA-08



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

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- RA-06
- RA-07
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- State Forest
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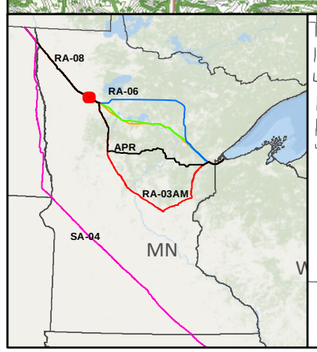
Data Sources: MNDNR, NHD, Enbridge

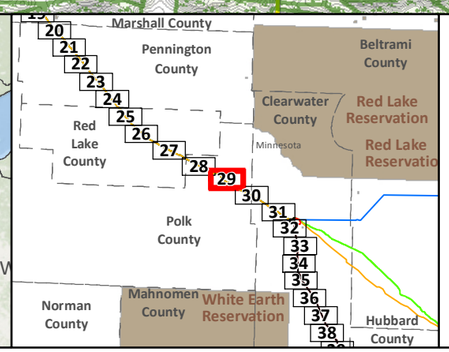
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T150 R40W S14
T150 R40W S13
T150 R39W S18
T150 R39W S17
T150 R39W S16
T150 R39W S15
Gully Fen SNA
T150 R39W S14
T150 R40W S23
T150 R40W S24
Chester 24
T150 R39W S19
T150 R39W S20
T150 R39W S21
T150 R39W S22
T150 R39W S23
Larix WMA
Gully Fen SNA
Gully 30
Gully Twsp Polk Co.
Chester Twsp Polk Co.
T150 R40W S26
T150 R40W S25
T150 R39W S30
Trail Twsp Polk Co.
T150 R39W S29
T150 R39W S28
T150 R39W S27
T150 R39W S26
Trail
APR
RA-03AM
RA-06
RA-07
RA-08
T150 R40W S35
T150 R40W S36
T150 R39W S31
T150 R39W S32
T150 R39W S33
T150 R39W S34
T150 R39W S35
Hangaard WMA
Gully





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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State Managed Lands
- WMA - Wildlife Management Areas
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Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

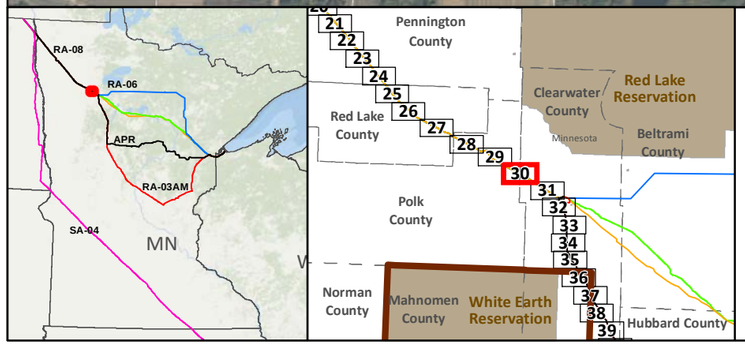
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 29B of 82

Gully
T150 R39W S34
T150 R39W S35
Gully Twsp Polk Co.
T150 R39W S36
T150 R38W S31
Winsor Twsp Clearwater Co.
T150 R38W S32
T150 R38W S33
126
127
92
T149 R39W S3
T149 R39W S2
T149 R39W S1
T149 R38W S6
APR
RA-03AM
RA-06
RA-07
RA-08
T149 R38W S5
Unnamed Creek
T149 R38W S4
128
129
Eden Twsp Polk Co.
Pine Lake Twsp Clearwater Co.
T149 R39W S10
T149 R39W S11
T149 R39W S12
T149 R38W S7
T149 R38W S8
130
T149 R38W S9
Gonvick Twsp Clearwater Co.
Lost River
T149 R38W S10
T149 R39W S15
T149 R39W S14
T149 R39W S13
T149 R38W S18
T149 R38W S17
131
T149 R38W S16
T149 R38W S15



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Gully

T150 R39W S34

T150 R39W S35

Gully Twsp Polk Co.

T150 R39W S36

T150 R38W S31

T150 R38W S32

Winsor Twsp Clearwater Co.

T150 R38W S33

126

127

128

129

130

131

92

T149 R39W S3

T149 R39W S2

T149 R39W S1

T149 R38W S6

APR
RA-03AM
RA-06
RA-07
RA-08

T149 R38W S5

Unnamed Creek

T149 R38W S4

Eden Twsp Polk Co.

T149 R39W S10

T149 R39W S11

T149 R39W S12

T149 R38W S7

Pine Lake Twsp Clearwater Co.

T149 R38W S8

T149 R38W S9

Gonvick Twsp Clearwater Co.

Lost River

T149 R38W S10

T149 R39W S15

T149 R39W S14

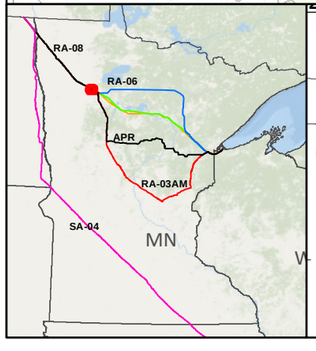
T149 R39W S13

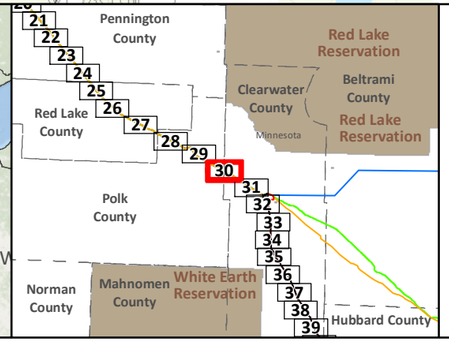
T149 R38W S18

T149 R38W S17

T149 R38W S16

T149 R38W S15





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Route Segment Alternatives (RSA)

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding

High

Moderate

Native Plant Communities with Biodiversity Significance

Outstanding

High

Moderate

Terminal

Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

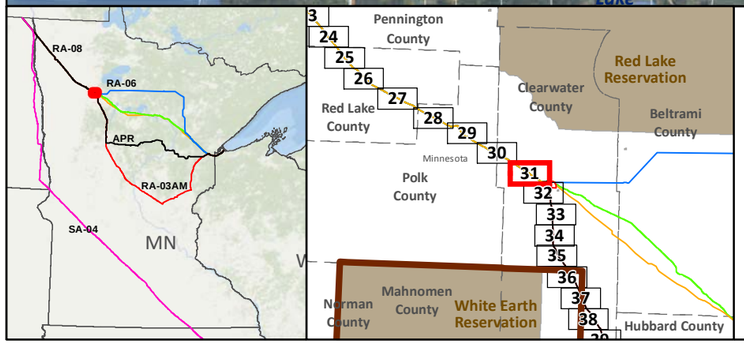
APR

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters 10ft Contours

T149 R38W S16
T149 R38W S15
T149 R38W S14
T149 R38W S13
T149 R37W S18
T149 R37W S17
Lost River
132
133
APR
RA-03AM
RA-06
RA-07
RA-08
Klongerbo Lake
T149 R38W S21
T149 R38W S22
T149 R38W S24
Unnamed Creek
92
Leon Twsp Clearwater Co.
T149 R37W S19
T149 R37W S20
Pine Lake Twsp Clearwater Co.
T149 R38W S23
134
Bruhjell Lake
Erie Lake
135
T149 R38W S28
Pine Lake
T149 R38W S27
Taflin Lake
T149 R38W S26
T149 R38W S25
T149 R37W S30
Clearbrook Twsp Clearwater Co.
T149 R37W S29
Clearbrook Terminal
136
137
T149 R38W S33
T149 R38W S34
Stony Lake
Johnson Lake
T149 R38W S35
T149 R38W S36
T149 R37W S31
APR
T149 R37W S32



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

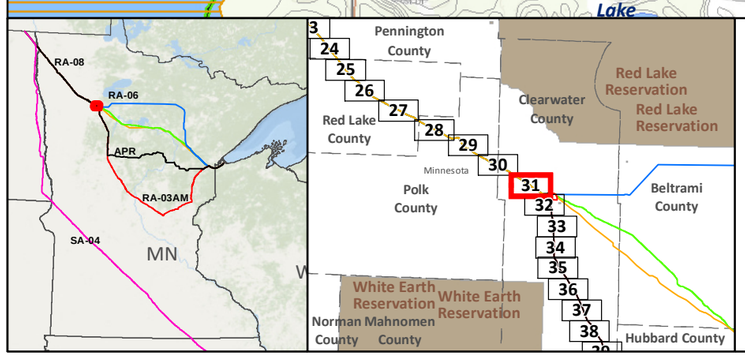
APR

T149 R38W S16
T149 R38W S15
T149 R38W S14
T149 R38W S13
T149 R37W S18
T149 R37W S17
T149 R38W S21
T149 R38W S22
T149 R38W S23
T149 R38W S24
T149 R37W S19
T149 R37W S20
T149 R38W S28
T149 R38W S27
T149 R38W S26
T149 R38W S25
T149 R37W S30
T149 R37W S29
T149 R38W S33
T149 R38W S34
T149 R38W S35
T149 R38W S36
T149 R37W S31
T149 R37W S32

132
133
134
135
136
92

APR
RA-03AM
RA-06
RA-07
RA-08

Lost River
Klongerbo Lake
Unnamed Creek
Pine Lake Twsp
Clearwater Co.
Leon Twsp
Clearwater Co.
Bruhjell Lake
Erie Lake
Pine Lake
Taflin Lake
Stony Lake
Johnson Lake
Clearbrook Twsp
Clearwater Co.
Clearbrook
Clearbrook Terminal
APR



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

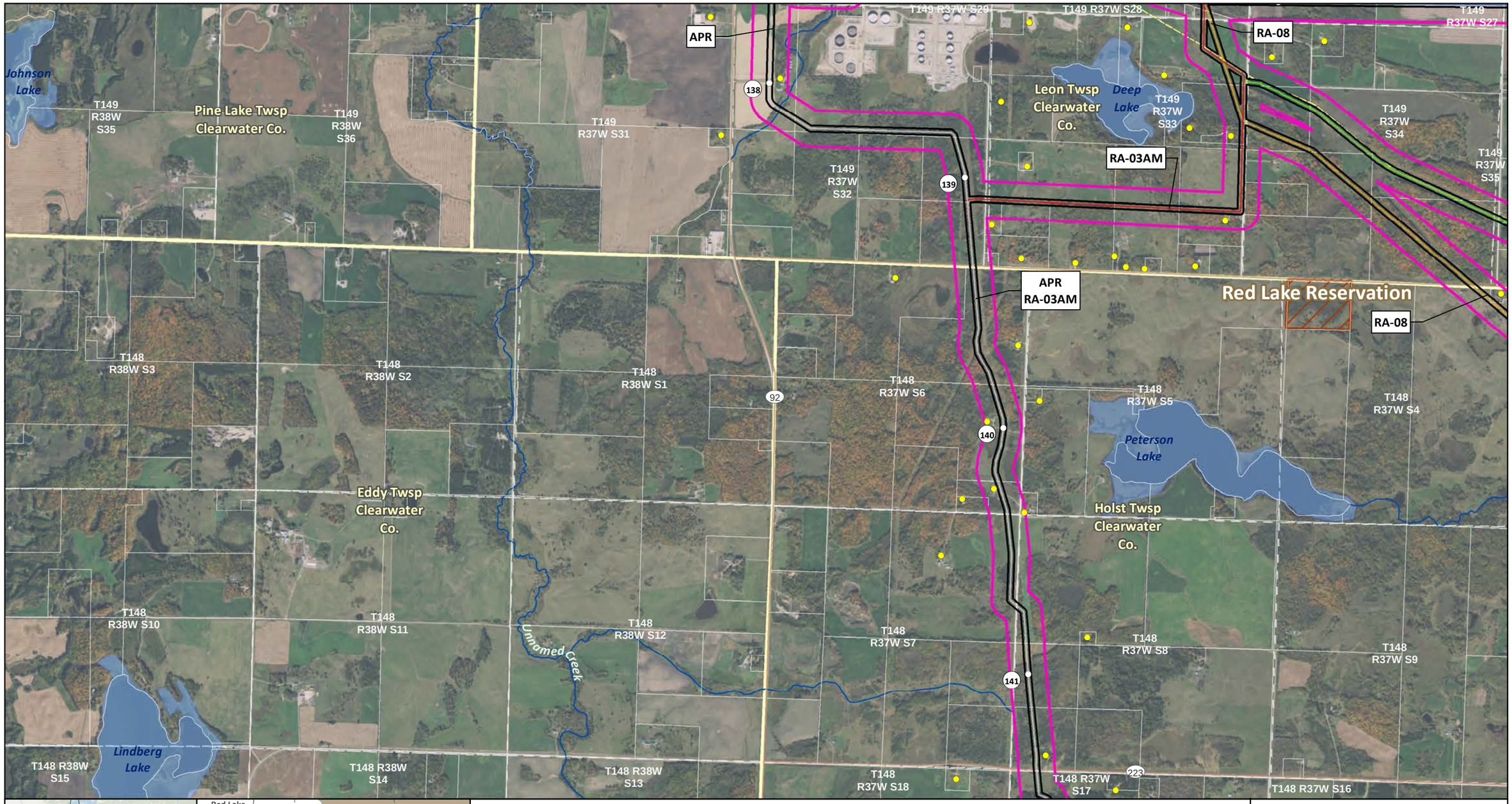
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

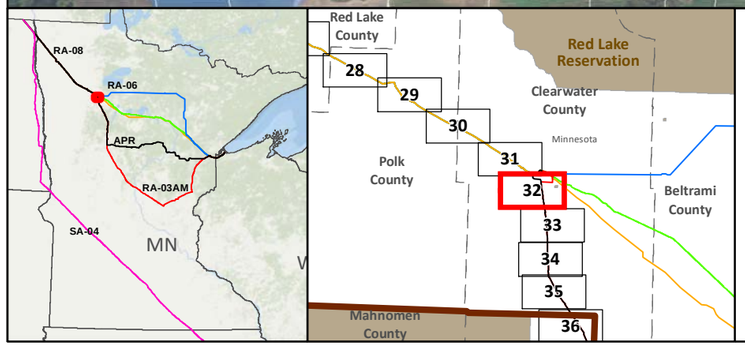
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 31B of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

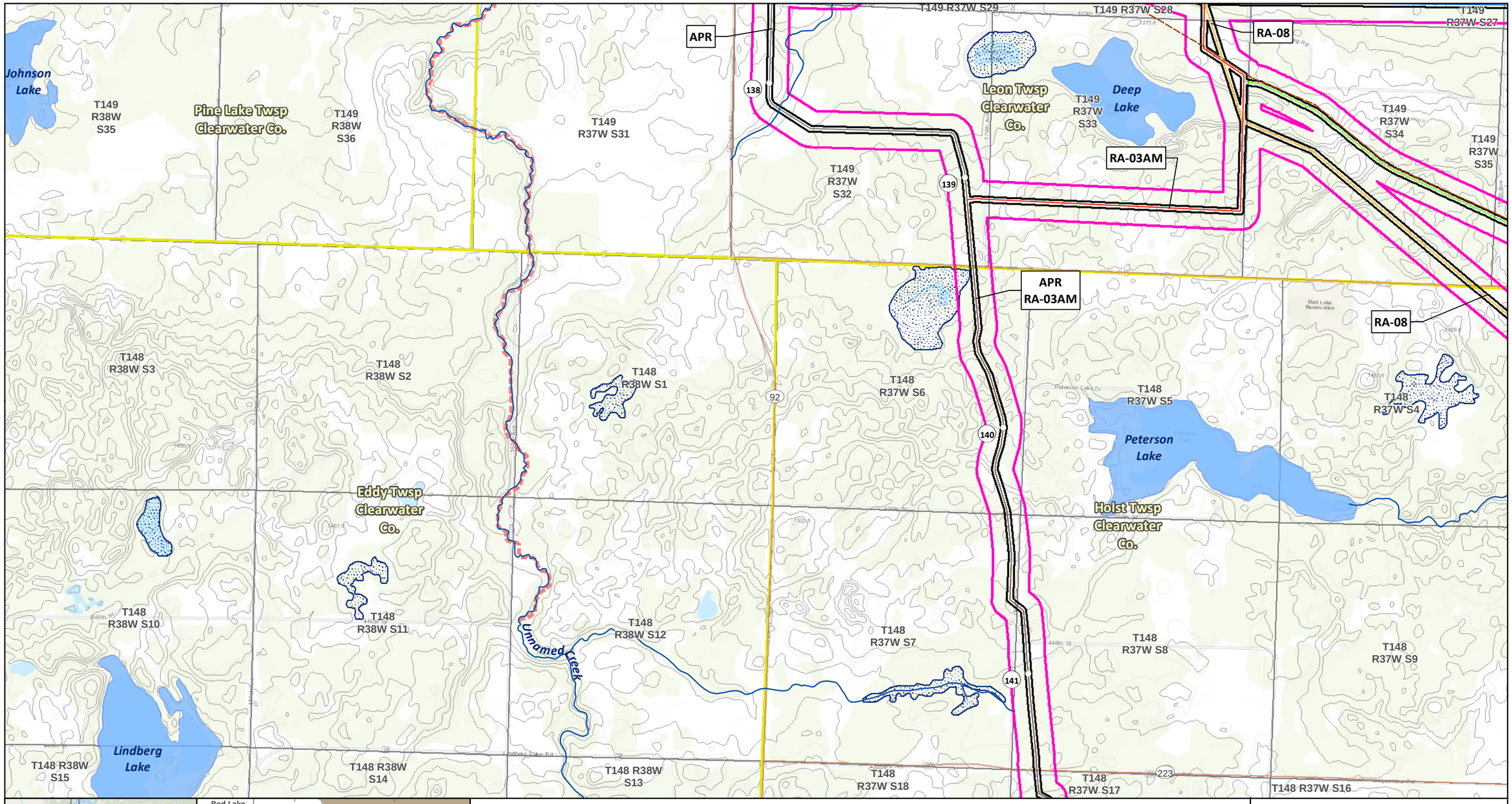
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

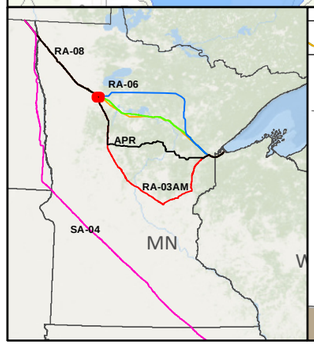
Data Sources:
MNDNR, NHD, Enbridge

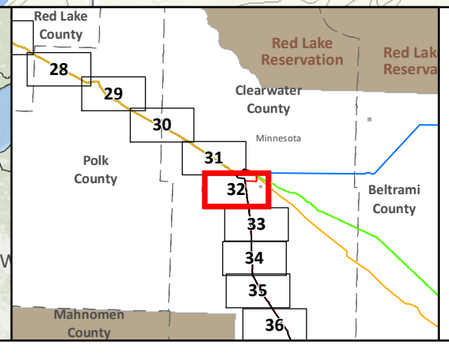
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

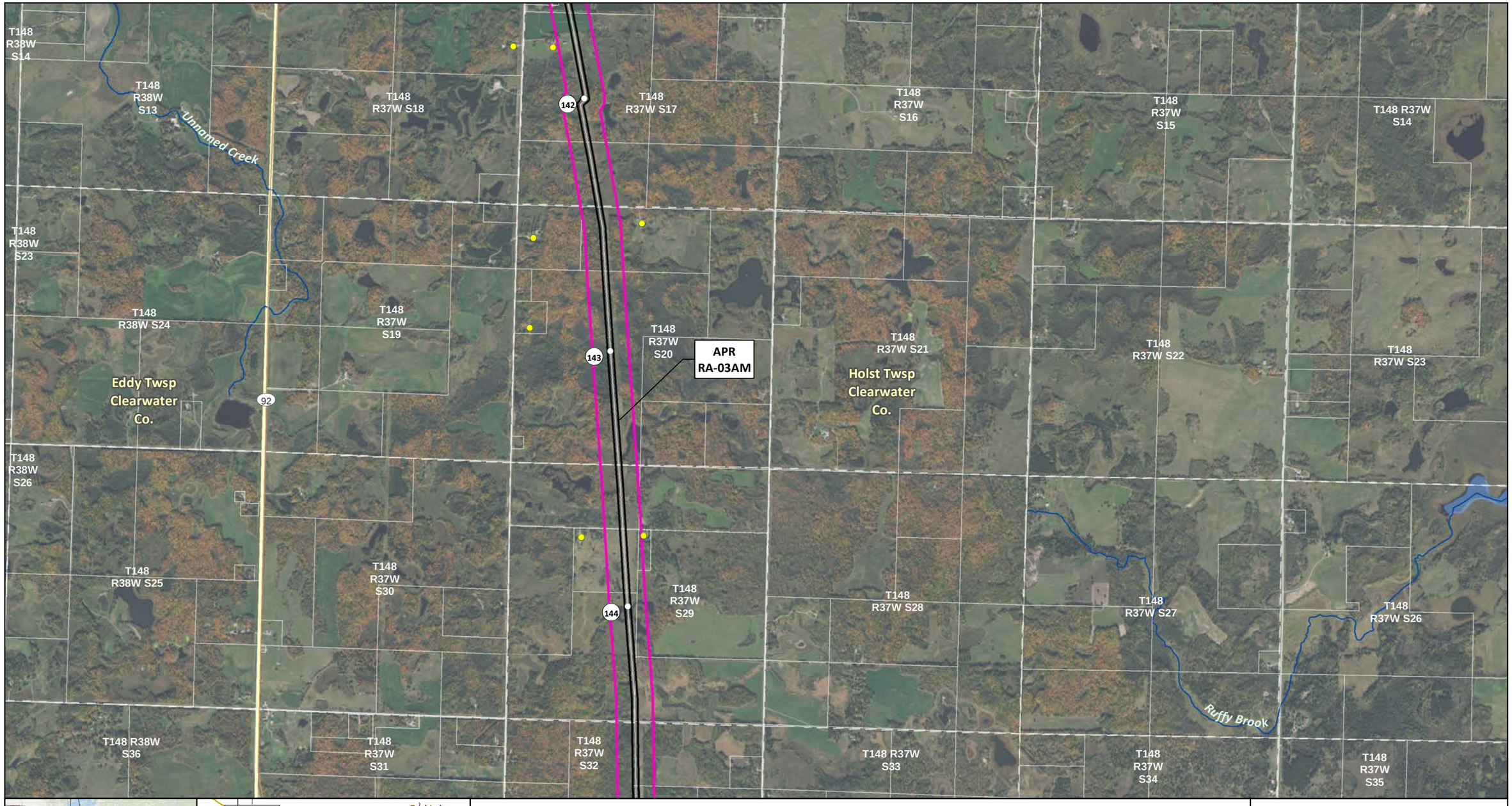
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

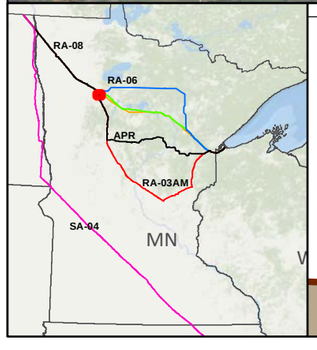
APR

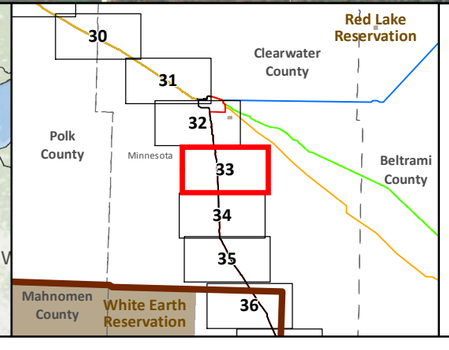
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 32B of 82







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

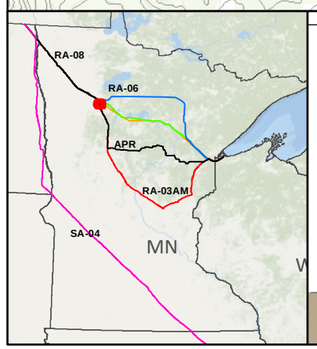
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

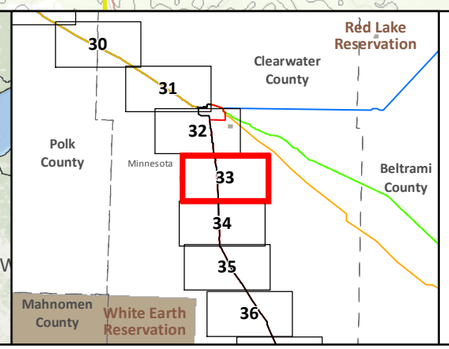
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 33A of 82

T148 R38W S14
T148 R38W S13
Unnamed Creek
T148 R37W S18
142
T148 R37W S17
T148 R37W S16
T148 R37W S15
T148 R37W S14
T148 R38W S23
T148 R38W S24
T148 R37W S19
143
T148 R37W S20
APR RA-03AM
T148 R37W S21
T148 R37W S22
T148 R37W S23
Old Red Lake Trail WMA
Eddy Twsp Clearwater Co.
92
Holst Twsp Clearwater Co.
T148 R38W S26
T148 R38W S25
T148 R37W S30
144
T148 R37W S29
T148 R37W S28
T148 R37W S27
T148 R37W S26
Old Red Lake Trail WMA
Ruffy Brook
T148 R38W S36
T148 R37W S31
T148 R37W S32
T148 R37W S33
T148 R37W S34
T148 R37W S35





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

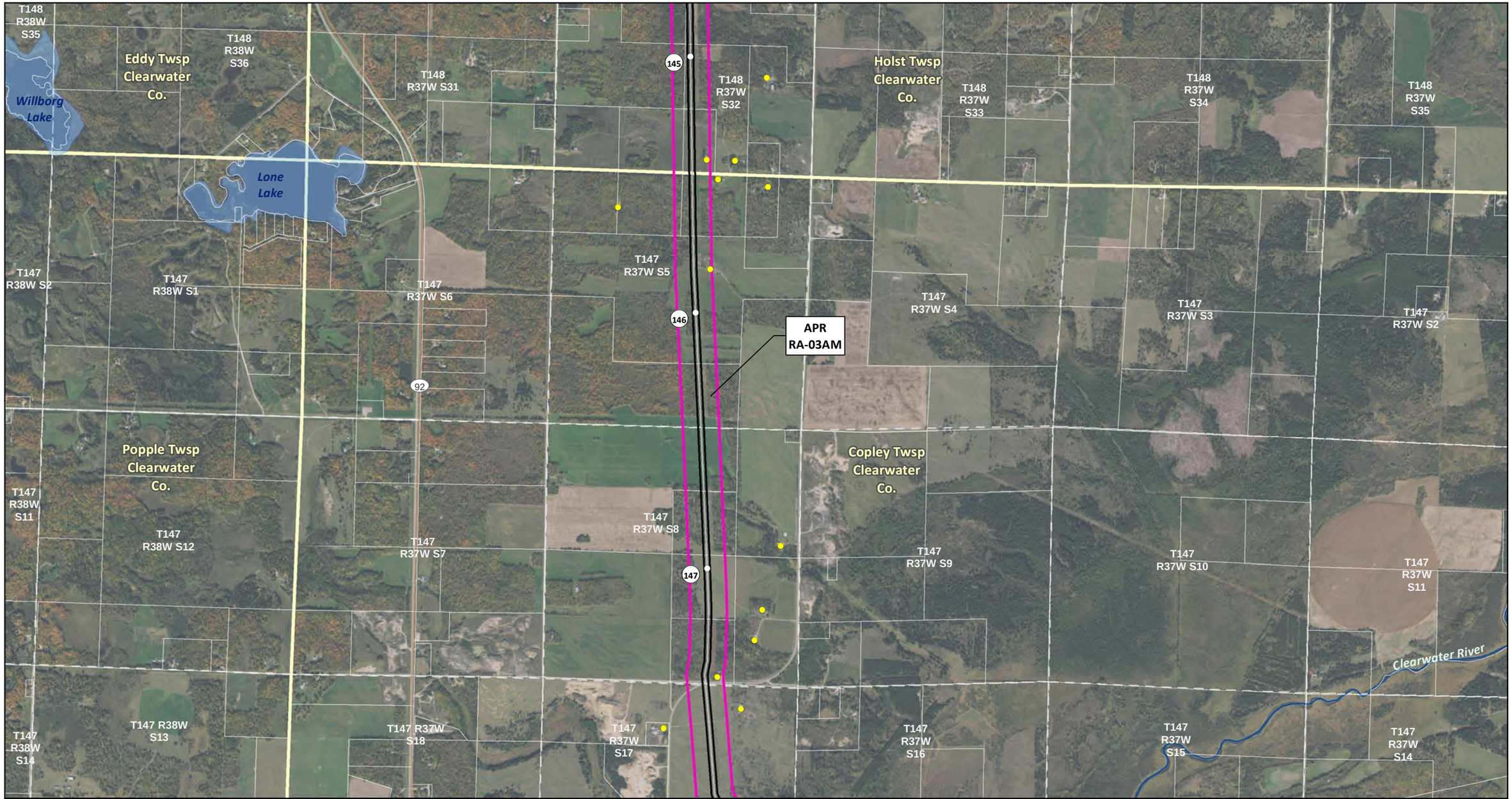
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

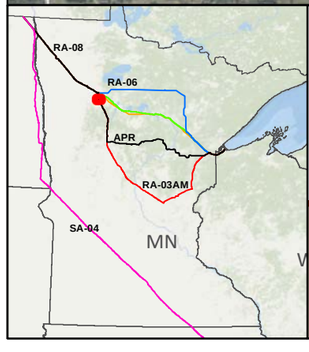
APR

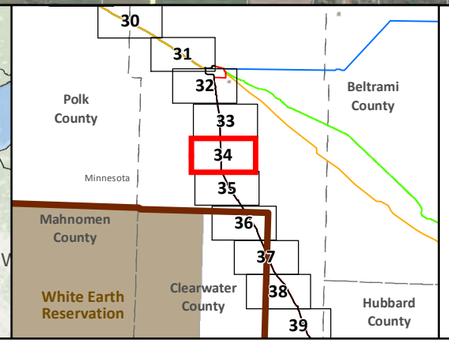
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 33B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

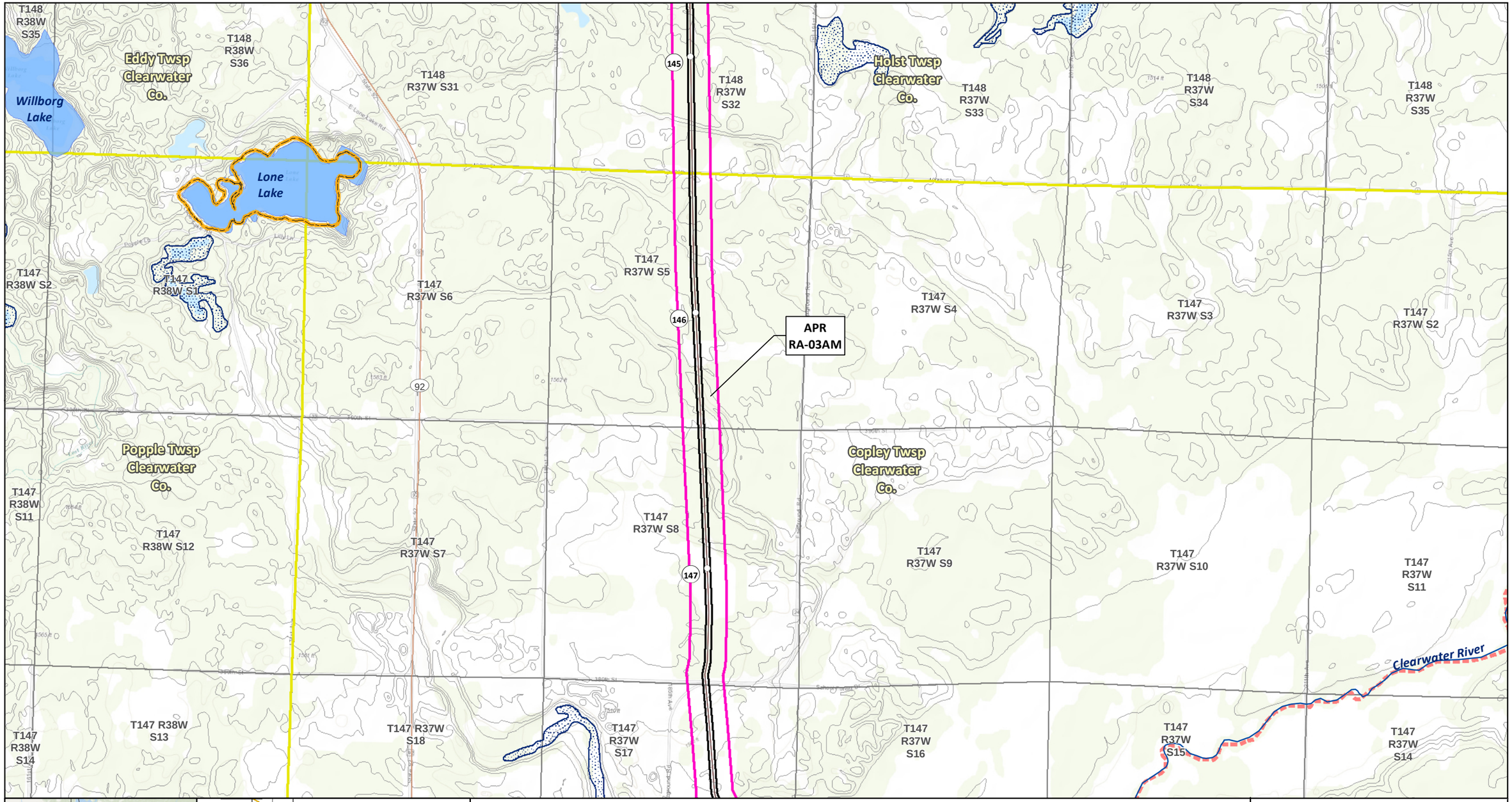
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

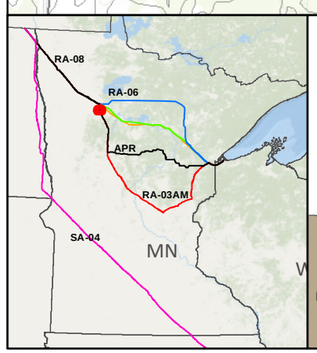
Data Sources: MNDNR, NHD, Enbridge

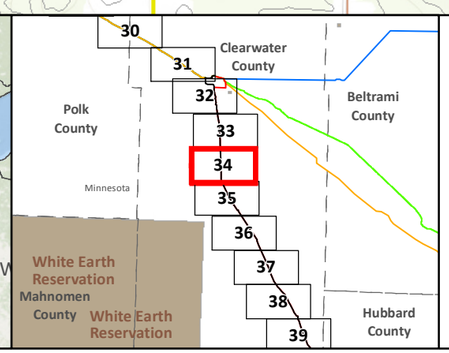
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 34B of 82

T147 R38W S13
T147 R37W S18
T147 R37W S17
T147 R37W S16
T147 R37W S15
T147 R37W S14
T147 R37W S13
T147 R38W S24
T147 R37W S19
T147 R37W S20
T147 R37W S21
T147 R37W S22
T147 R37W S23
T147 R37W S24
T147 R38W S25
T147 R37W S30
T147 R37W S29
T147 R37W S28
T147 R37W S27
T147 R37W S26
T147 R37W S25
T147 R38W S36
T147 R37W S31
T147 R37W S32
T147 R37W S33
T147 R37W S34
T147 R37W S35
T147 R37W S36

148
149
150
151
92
2

APR
RA-03AM

Popple Twsp
Clearwater
Co.

Copley Twsp
Clearwater
Co.

Bagley Twsp
Clearwater
Co.

Bagley

Lake
Lomond

Sabe
Lake

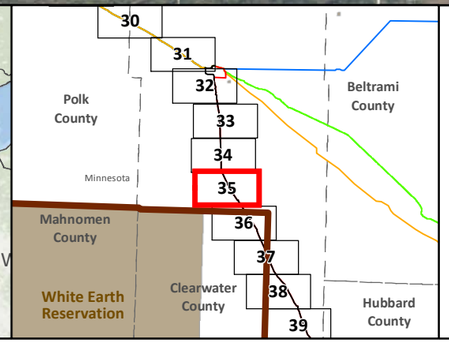
Unnamed Creek

Clearwater River

Mud
Lake

Walker Brook





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T147 R38W S13
T147 R37W S18
T147 R37W S17
T147 R37W S16
T147 R37W S15
T147 R37W S14
T147 R37W S13
T147 R38W S24
T147 R37W S19
T147 R37W S20
T147 R37W S21
T147 R37W S22
T147 R37W S23
T147 R37W S24
T147 R38W S25
T147 R37W S30
T147 R37W S29
T147 R37W S28
T147 R37W S27
T147 R37W S26
T147 R37W S25
T147 R38W S36
T147 R37W S31
T147 R37W S32
T147 R37W S33
T147 R37W S34
T147 R37W S35
T147 R37W S36

148
149
150
151
92
2

APR
RA-03AM

Popple Twsp
Clearwater
Co.

Copley Twsp
Clearwater
Co.

Sabe
Lake

Lake
Lomond

Bagley Twsp
Clearwater
Co.

Bagley

Bagley
WHPA

Unnamed Creek

Clearwater River

Mud
Lake

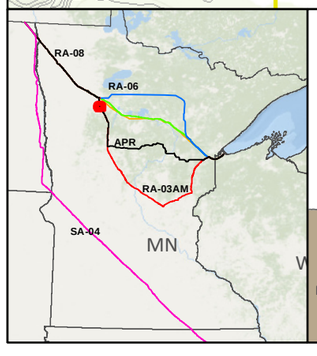
Walker Brook

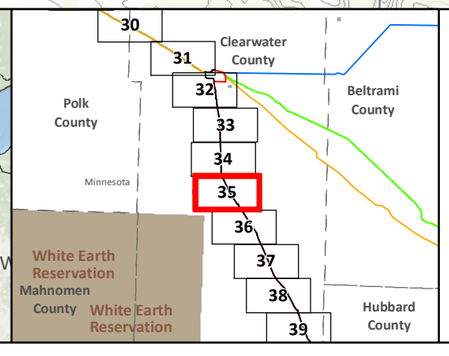
Saint
Joseph/Bagley
Cemetery

Twin Pines
Country
Club

Bagley City
Park &
Campground

Burlington Northern Santa Fe





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

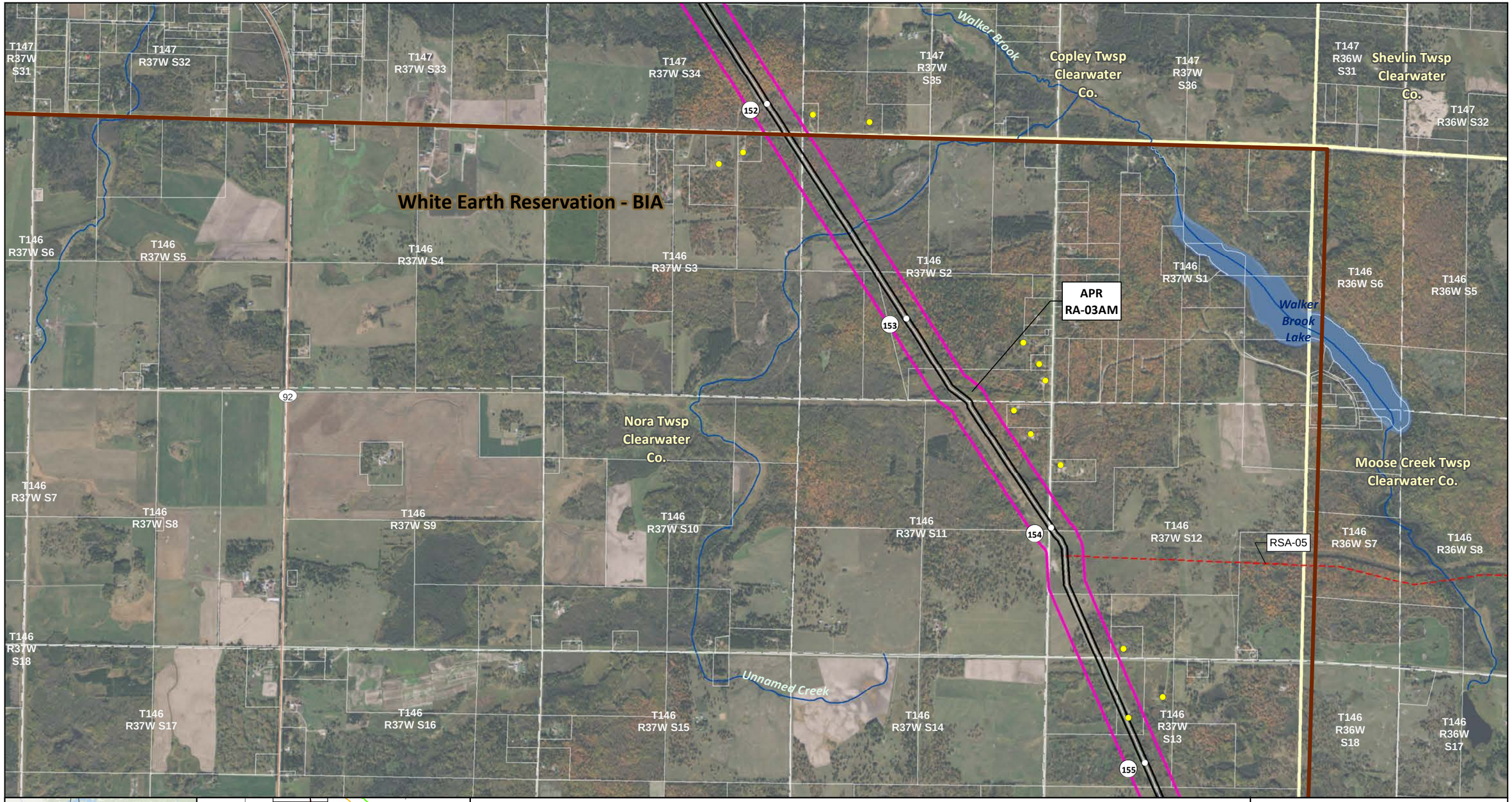
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

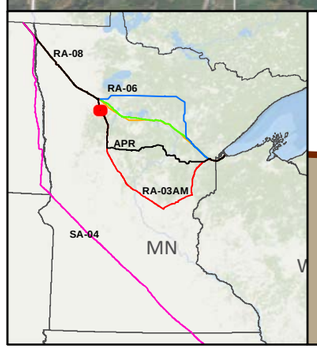
APR

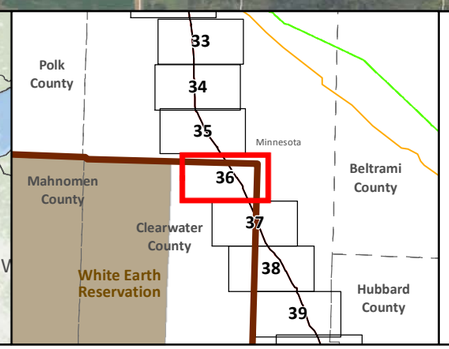
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 35B of 82







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road

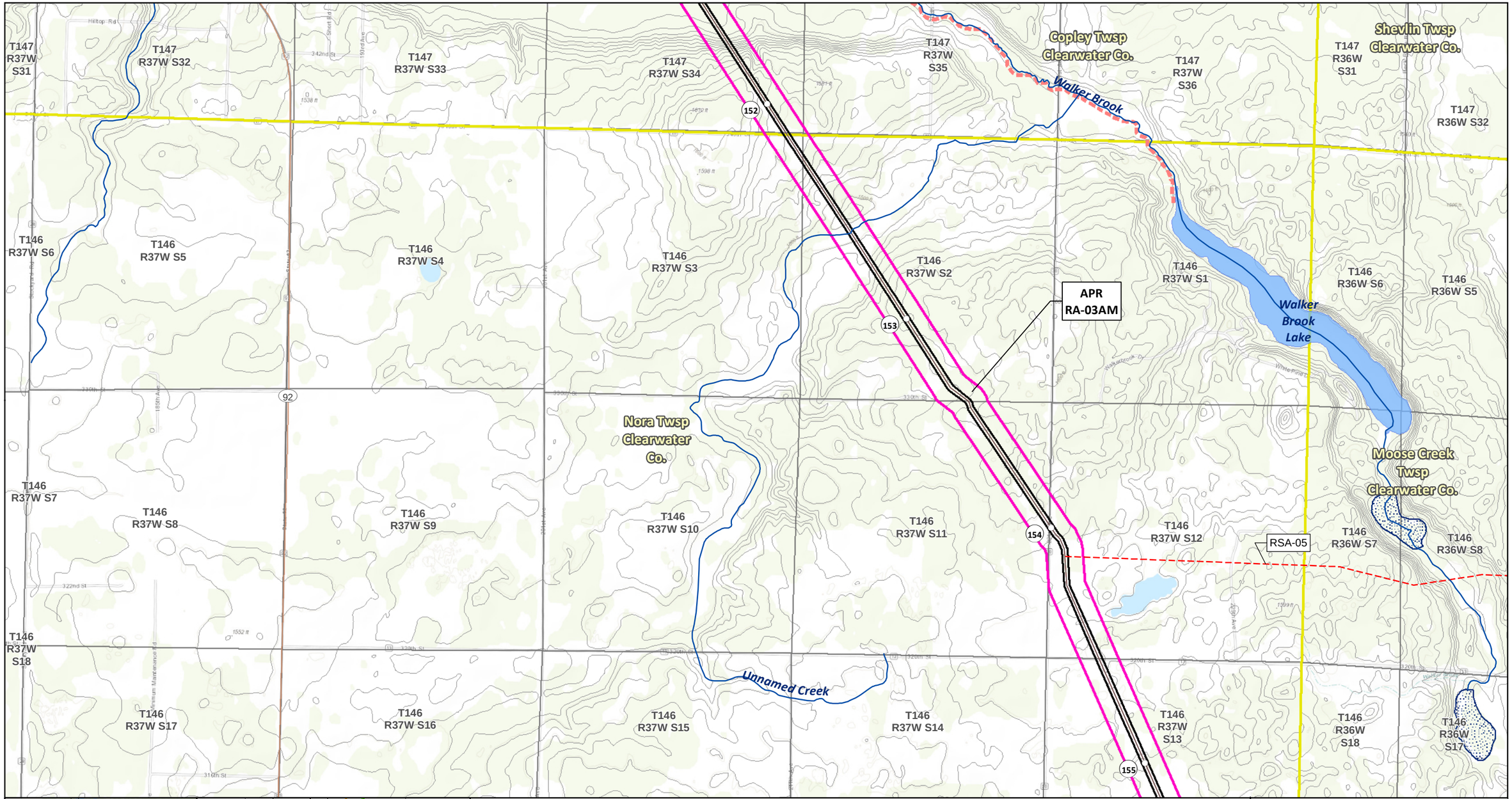
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

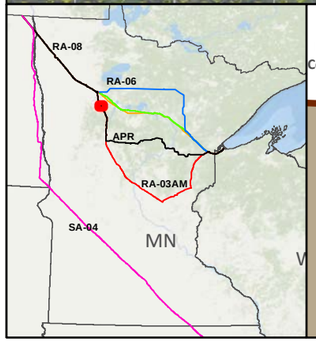
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

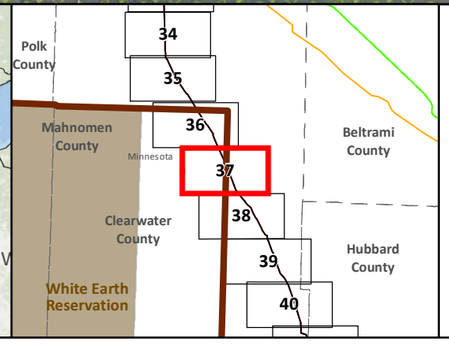
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T147 R37W S31
T147 R37W S32
T147 R37W S33
T147 R37W S34
T147 R37W S35
Copley Twsp Clearwater Co.
T147 R37W S36
T147 R36W S31
Shevlin Twsp Clearwater Co.
T147 R36W S32
Walker Brook
152
T146 R37W S6
T146 R37W S5
T146 R37W S4
T146 R37W S3
T146 R37W S2
APR RA-03AM
T146 R37W S1
T146 R36W S6
T146 R36W S5
Walker Brook Lake
153
92
Nora Twsp Clearwater Co.
Moose Creek Twsp Clearwater Co.
T146 R37W S7
T146 R37W S8
T146 R37W S9
T146 R37W S10
T146 R37W S11
154
T146 R37W S12
RSA-05
T146 R36W S7
T146 R36W S8
T146 R37W S18
Unnamed Creek
T146 R37W S17
T146 R37W S16
T146 R37W S15
T146 R37W S14
T146 R37W S13
T146 R36W S18
T146 R36W S17
155
RA-08
RA-06
APR
RA-03AM
SA-04
MN
33
34
35
36
37
38
39
Polk County
Minnesota
Beltrami County
Mahnomen County
Clearwater County
White Earth Reservation
Hubbard County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 36B of 82

T146 R37W S16
T146 R37W S15
T146 R37W S14
T146 R37W S13
T146 R36W S18
T146 R36W S17
T146 R36W S16
T146 R36W S15
T146 R37W S21
T146 R37W S22
T146 R37W S23
T146 R37W S24
T146 R36W S19
T146 R36W S20
T146 R36W S21
T146 R36W S22
Mosquito Creek
White Earth Reservation - BIA
156
APR RA-03AM
Nora Twsp Clearwater Co.
Moose Creek Twsp Clearwater Co.
157
T146 R37W S27
T146 R37W S26
T146 R37W S25
T146 R36W S30
T146 R36W S29
T146 R36W S28
Unnamed Stream
T146 R36W S27
Mud Lake
White Earth State Forest
158
T146 R37W S34
T146 R37W S35
T146 R37W S36
T146 R36W S31
T146 R36W S32
T146 R36W S33
T146 R36W S34





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T146 R37W S16
T146 R37W S15
T146 R37W S14
T146 R37W S13
T146 R36W S18
T146 R36W S17
T146 R36W S16
T146 R36W S15
T146 R37W S21
T146 R37W S22
T146 R37W S23
T146 R37W S24
T146 R36W S19
T146 R36W S20
T146 R36W S21
T146 R36W S22
Mosquito Creek
156
APR
RA-03AM
Nora Twsp
Clearwater Co.
Moose Creek Twsp
Clearwater Co.
157
T146 R37W S27
T146 R37W S26
T146 R37W S25
T146 R36W S30
T146 R36W S29
T146 R36W S28
Unnamed Stream
T146 R36W S27
Mud Lake
Mud Lake WMA
158
T146 R37W S34
T146 R37W S35
T146 R37W S36
T146 R36W S31
T146 R36W S32
T146 R36W S33
T146 R36W S34

RA-08
RA-06
APR
RA-03AM
SA-04
MN
Polk County
Minnesota
Mahnomen County
Beltrami County
Clearwater County
Hubbard County
White Earth Reservation
34
35
36
37
38
39
40

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

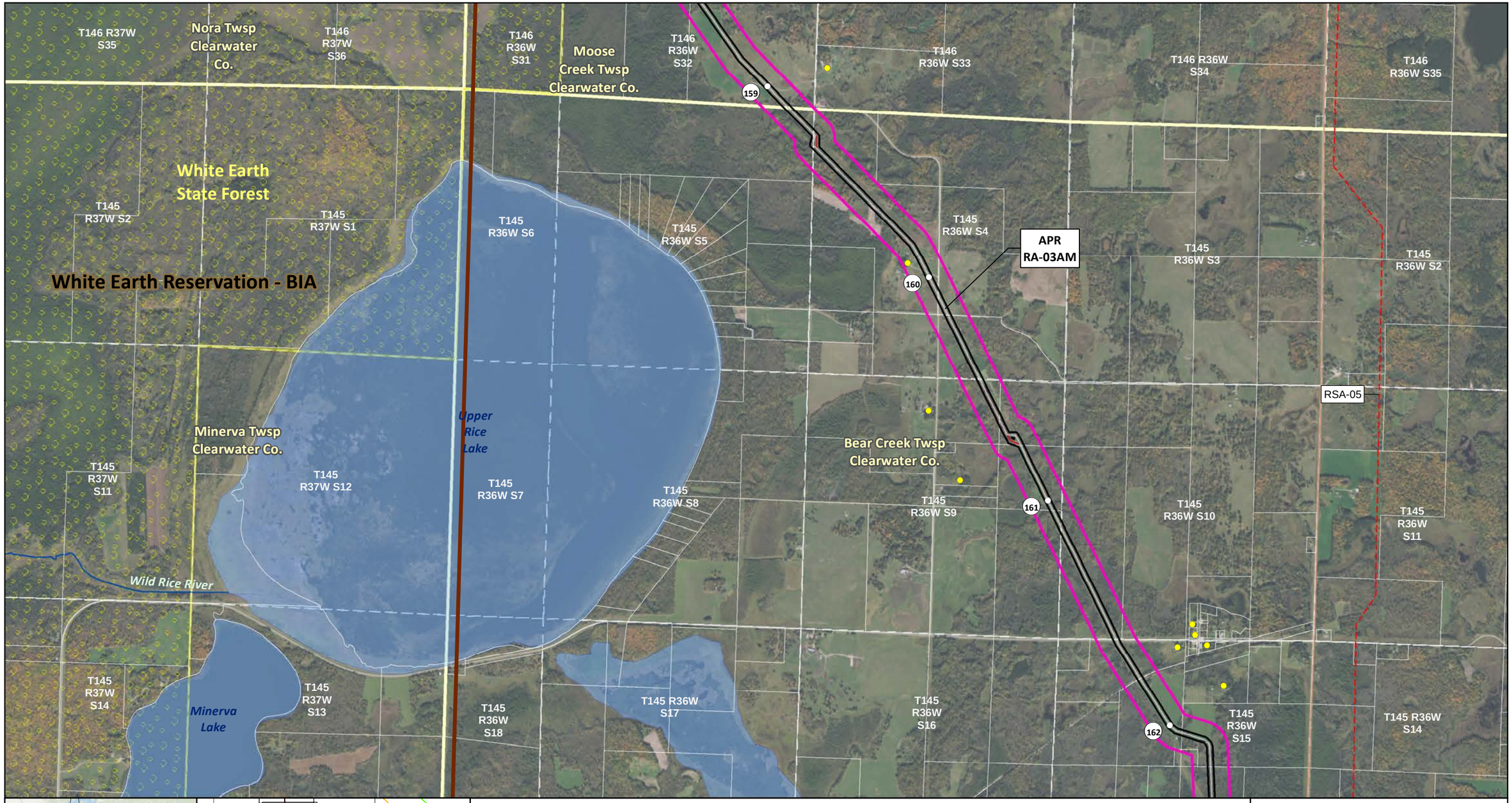
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

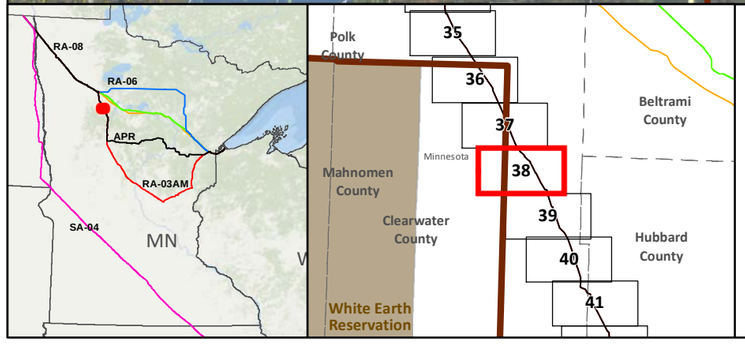
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 37B of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

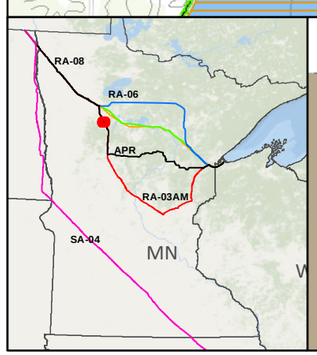
Data Sources: MNDNR, NHD, Enbridge

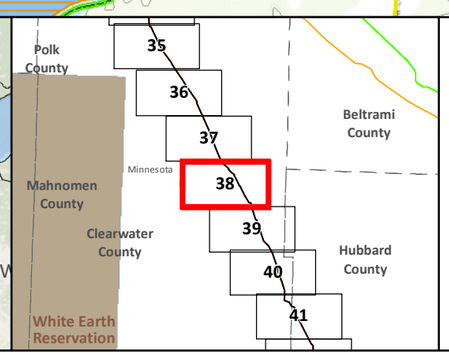
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T146 R37W S35
Nora Twsp Clearwater Co.
T146 R37W S36
T146 R36W S31
T146 R36W S32
T146 R36W S33
T146 R36W S34
T146 R36W S35
Moose Creek Twsp Clearwater Co.
159
Upper Rice WMA
Upper Rice WMA
T145 R37W S2
T145 R37W S1
T145 R36W S6
T145 R36W S5
T145 R36W S4
APR RA-03AM
T145 R36W S3
T145 R36W S2
160
RSA-05
Upper Rice Lake
Minerva Twsp clearwater Co.
T145 R37W S11
T145 R37W S12
T145 R36W S7
T145 R36W S8
Bear Creek Twsp Clearwater Co.
T145 R36W S9
161
T145 R36W S10
T145 R36W S11
Upper Rice WMA
Wild Rice River
T145 R37W S14
Minerva Lake
T145 R37W S13
T145 R36W S18
T145 R36W S17
T145 R36W S16
162
T145 R36W S15
T145 R36W S14





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

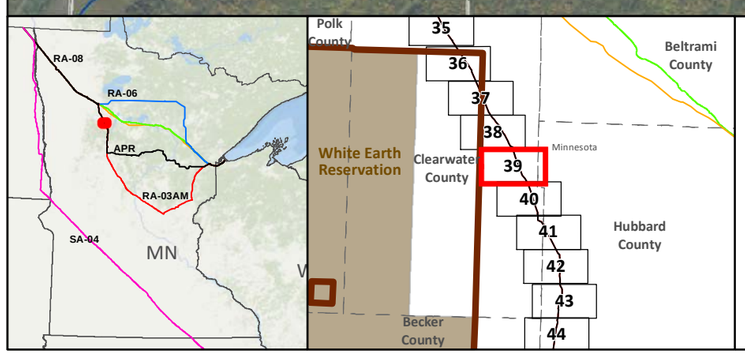
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 38B of 82





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Township Boundary

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

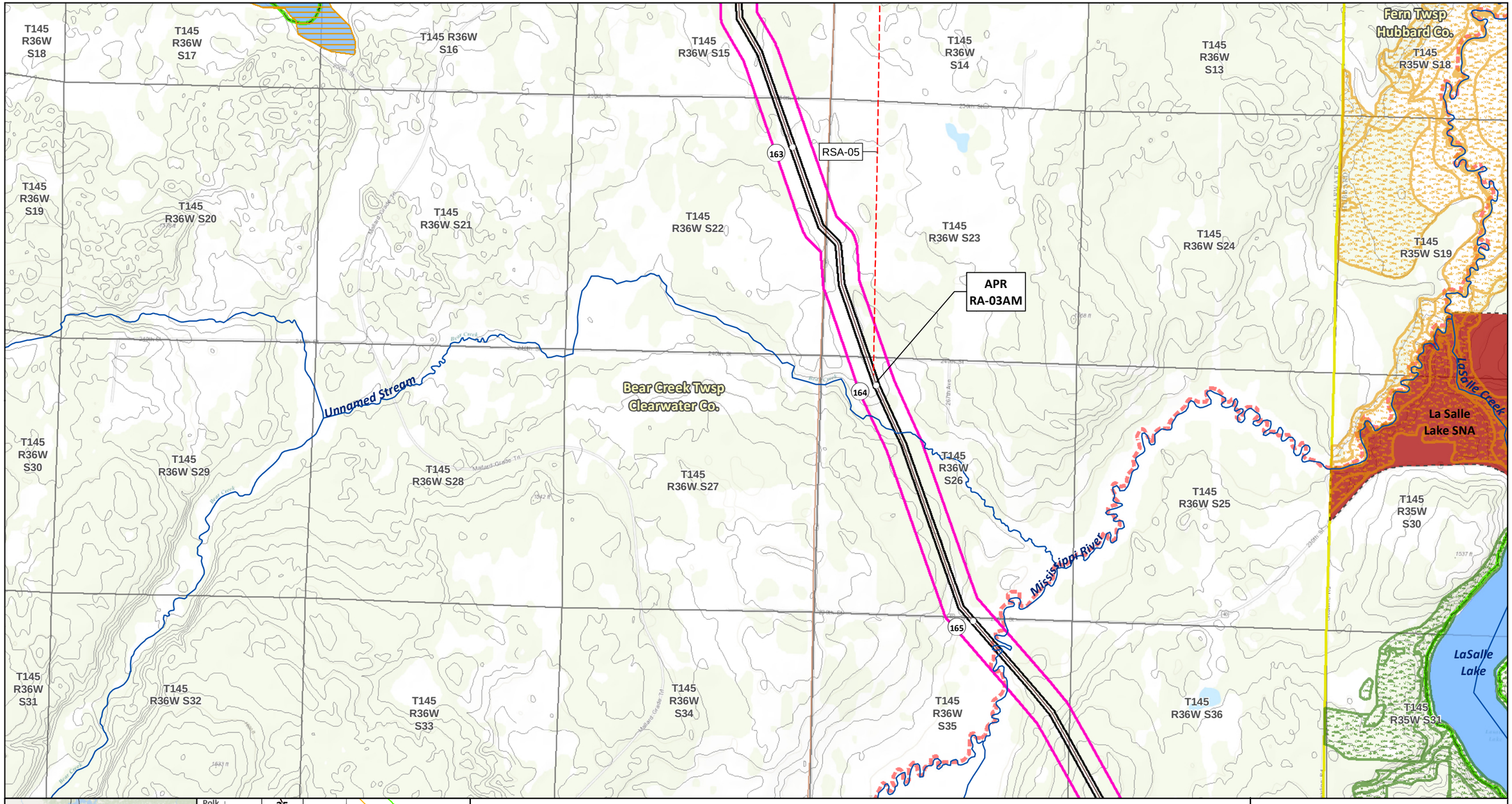
1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 39A of 82



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles

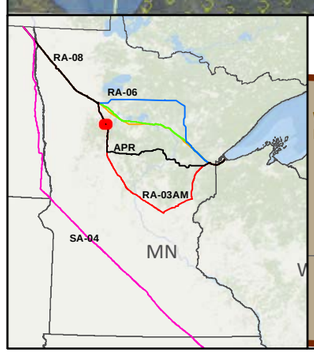
1:24,000

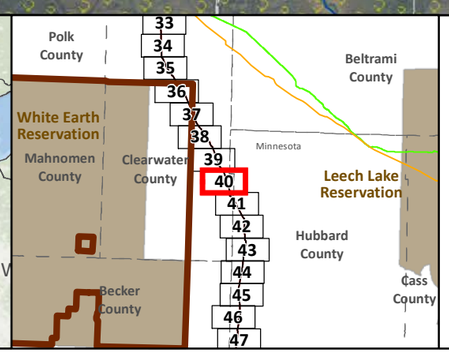
0 125 250 500 Meters 10ft Contours

N

Map 39B of 82







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Township Boundary

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

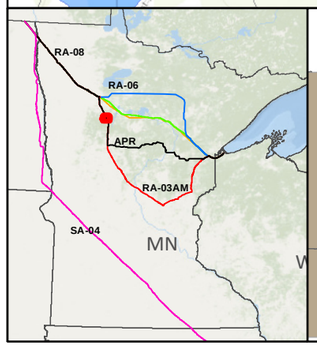
0 125 250 500 Meters

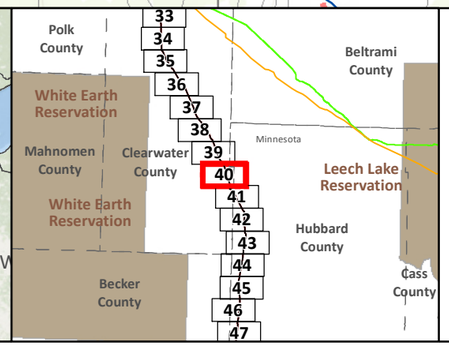
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 40A of 82

T145 R36W S33
T145 R36W S34
T145 R36W S35
Bear Creek Twsp Clearwater Co.
T145 R36W S36
Fern Twsp Hubbard Co.
T145 R35W S31
LaSalle Lake
T145 R35W S32
T145 R35W S33
Mississippi River
Itasca Twsp Clearwater Co.
T144 R36W S5
Robinson Lake
T144 R36W S4
T144 R36W S3
T144 R36W S2
T144 R36W S1
T144 R35W S6
T144 R35W S5
166
167
APR RA-03AM
Middle LaSalle Lake
Lake Hattie Twsp Hubbard Co.
T144 R36W S8
T144 R36W S9
T144 R36W S10
Unnamed Stream
T144 R36W S11
T144 R36W S12
LaSalle Creek
T144 R35W S7
T144 R35W S8
168
RSA-10
Big LaSalle Lake
T144 R36W S17
T144 R36W S16
T144 R36W S15
T144 R36W S14
T144 R36W S13
T144 R35W S18
T144 R35W S17





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

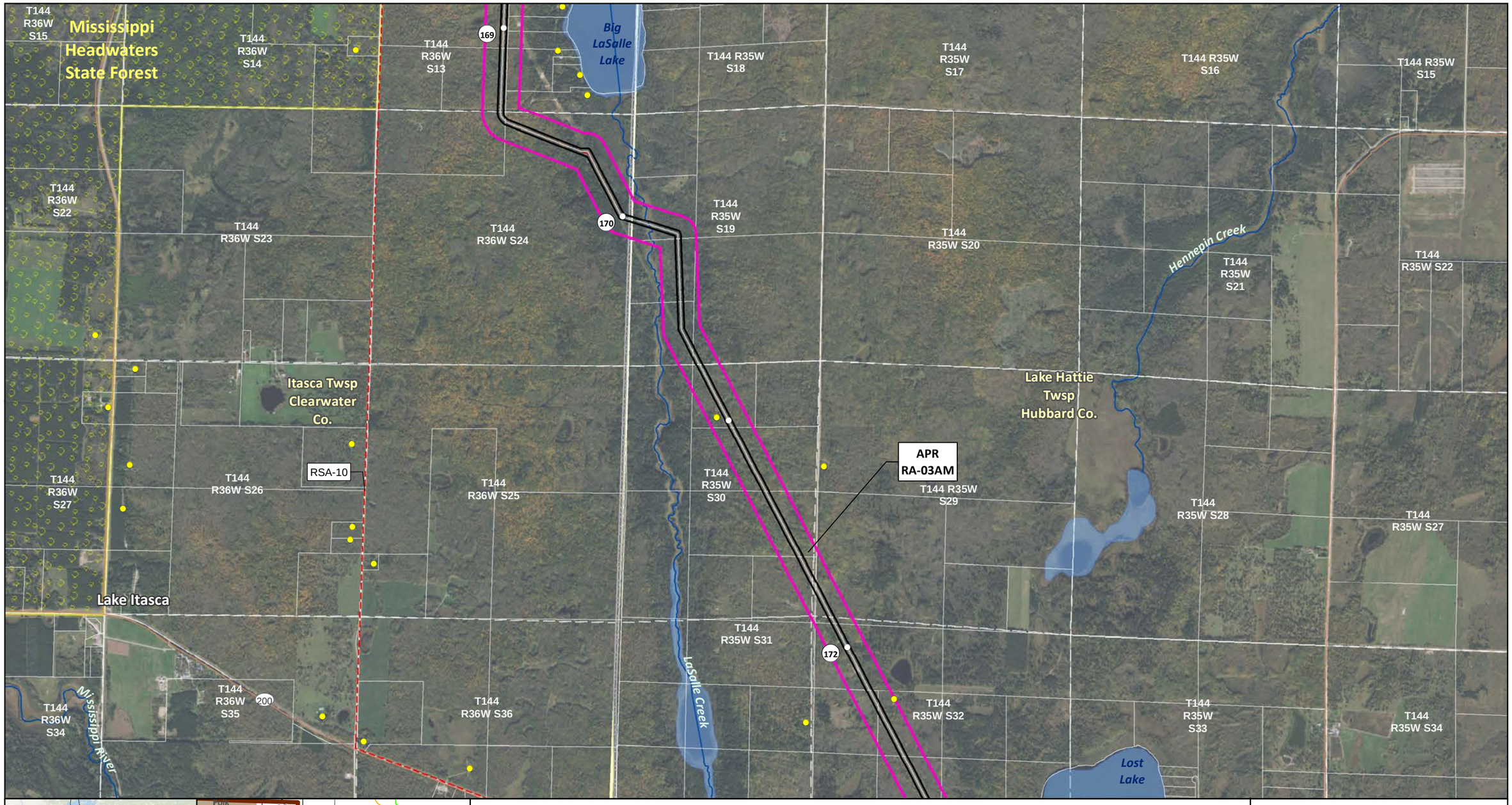
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

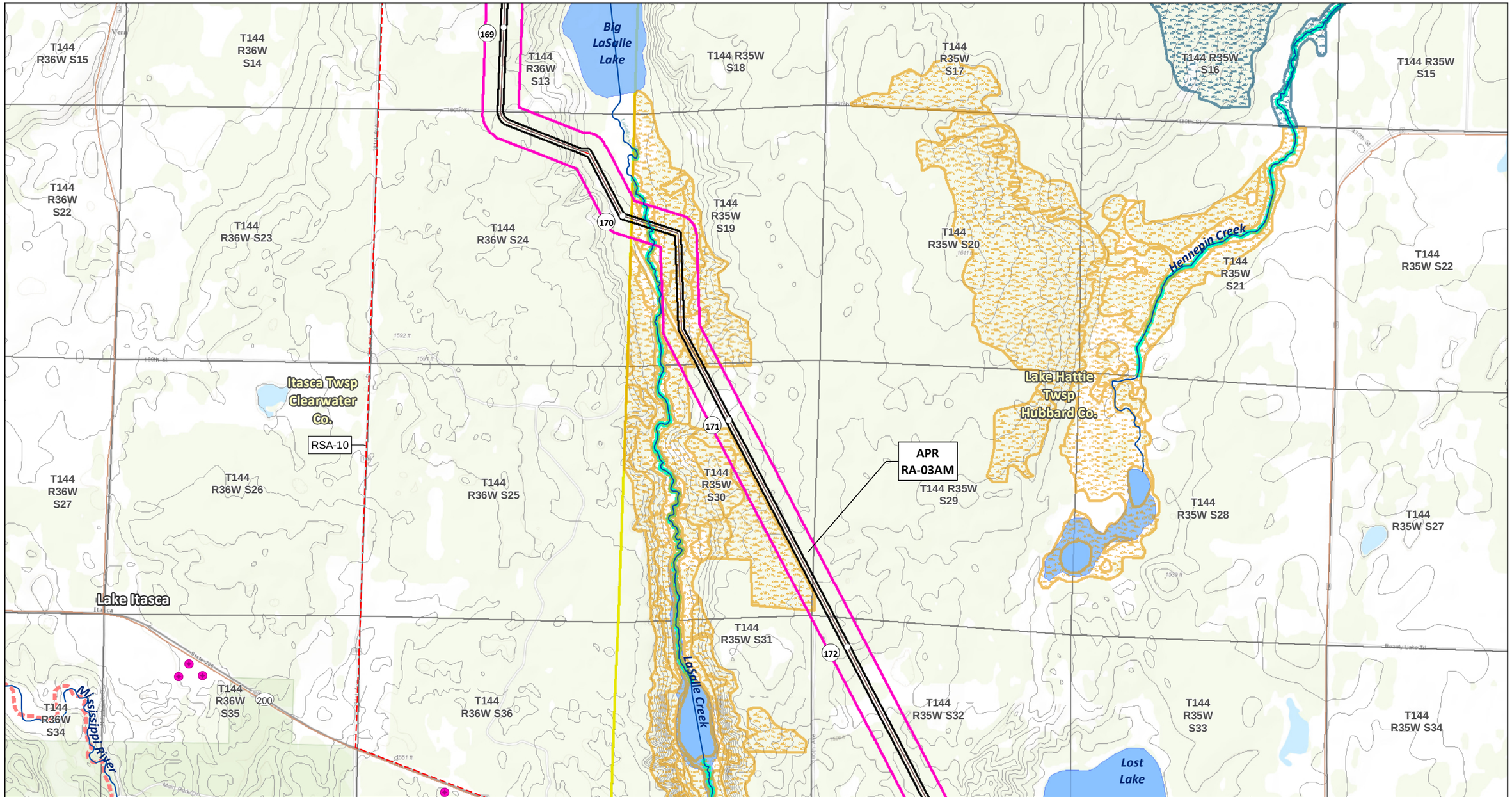
Map 40B of 82

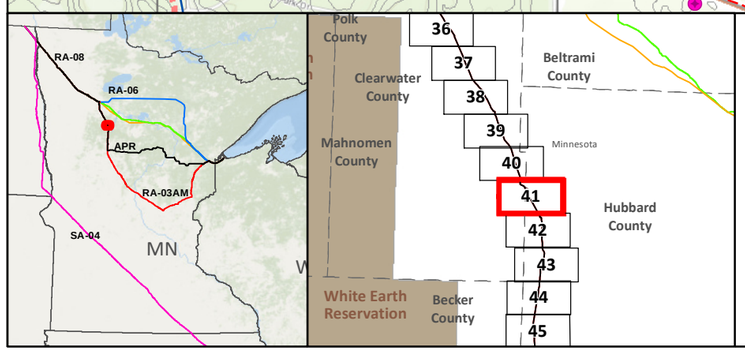


LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 41A of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

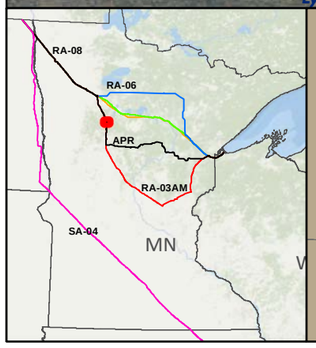
APR

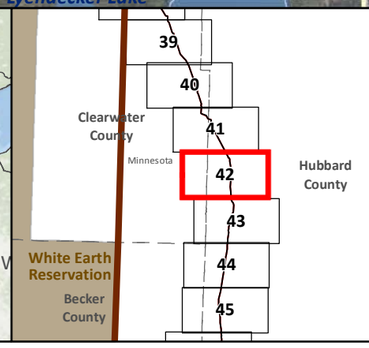
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 41B of 82

T144 R36W S35
Itasca Twsp Clearwater Co.
T144 R36W S36
T144 R35W S31
RSA-10
Lake Hattie Twsp Hubbard Co.
T144 R35W S32
Lost Lake
T144 R35W S33
T144 R35W S34
Bond Lake
T144 R35W S35
173
T143 R36W S2
T143 R36W S1
T143 R35W S6
T143 R35W S5
T143 R35W S4
T143 R35W S3
T143 R35W S2
174
T143 R36W S12
200
LaSalle Creek
Unnamed Stream
T143 R36W S11
South Clearwater Twsp Clearwater Co.
Lake Itasca
T143 R35W S7
T143 R35W S8
Lake Alice Twsp Hubbard Co.
APR RA-03AM
T143 R35W S9
T143 R35W S10
Lake Alice
Birch Creek
T143 R35W S11
175
T143 R36W S13
T143 R36W S14
T143 R35W S18
T143 R35W S17
T143 R35W S16
Paul Bunyan State Forest
T143 R35W S15
T143 R35W S14
Lyendecker Lake





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

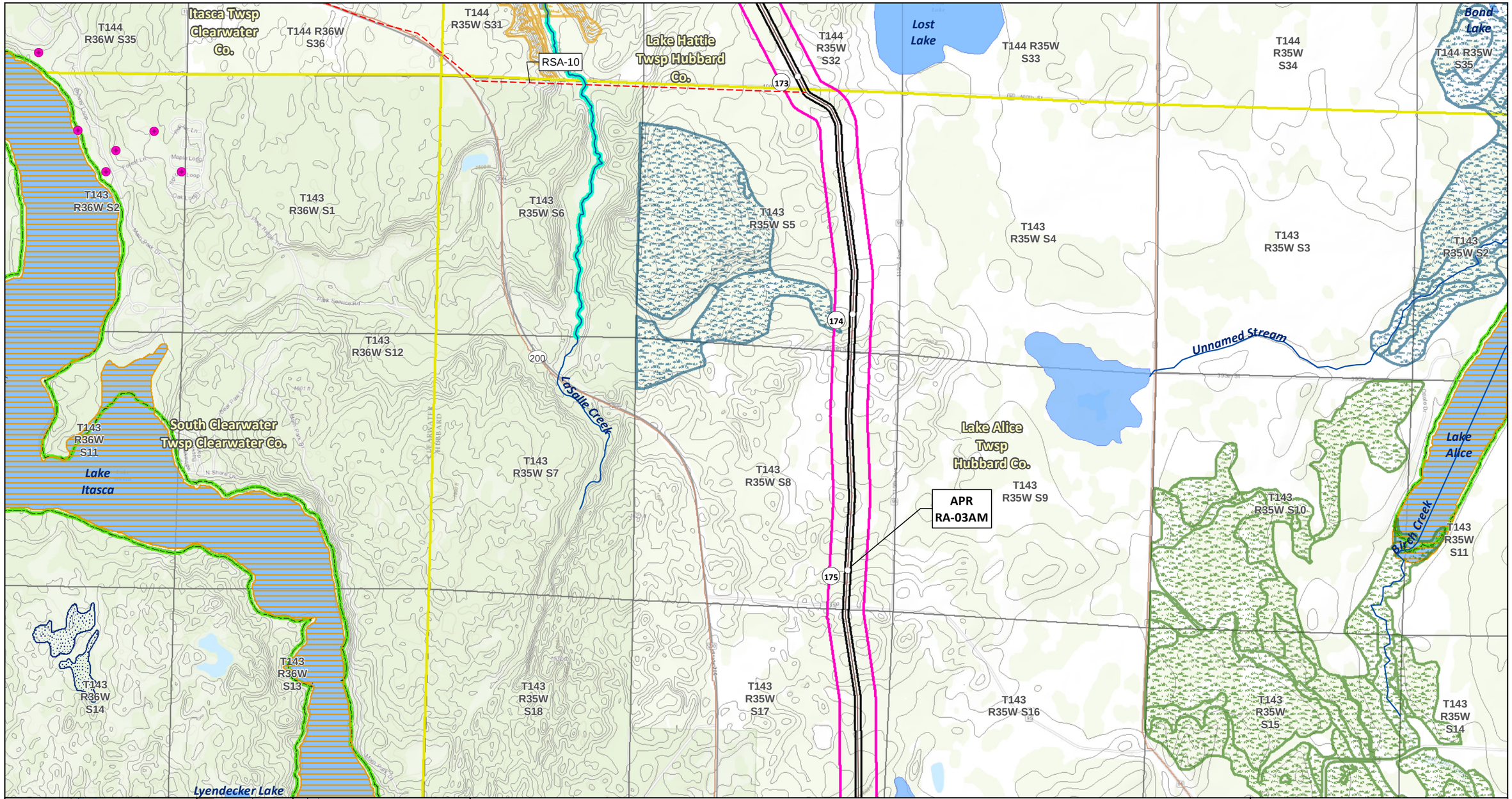
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

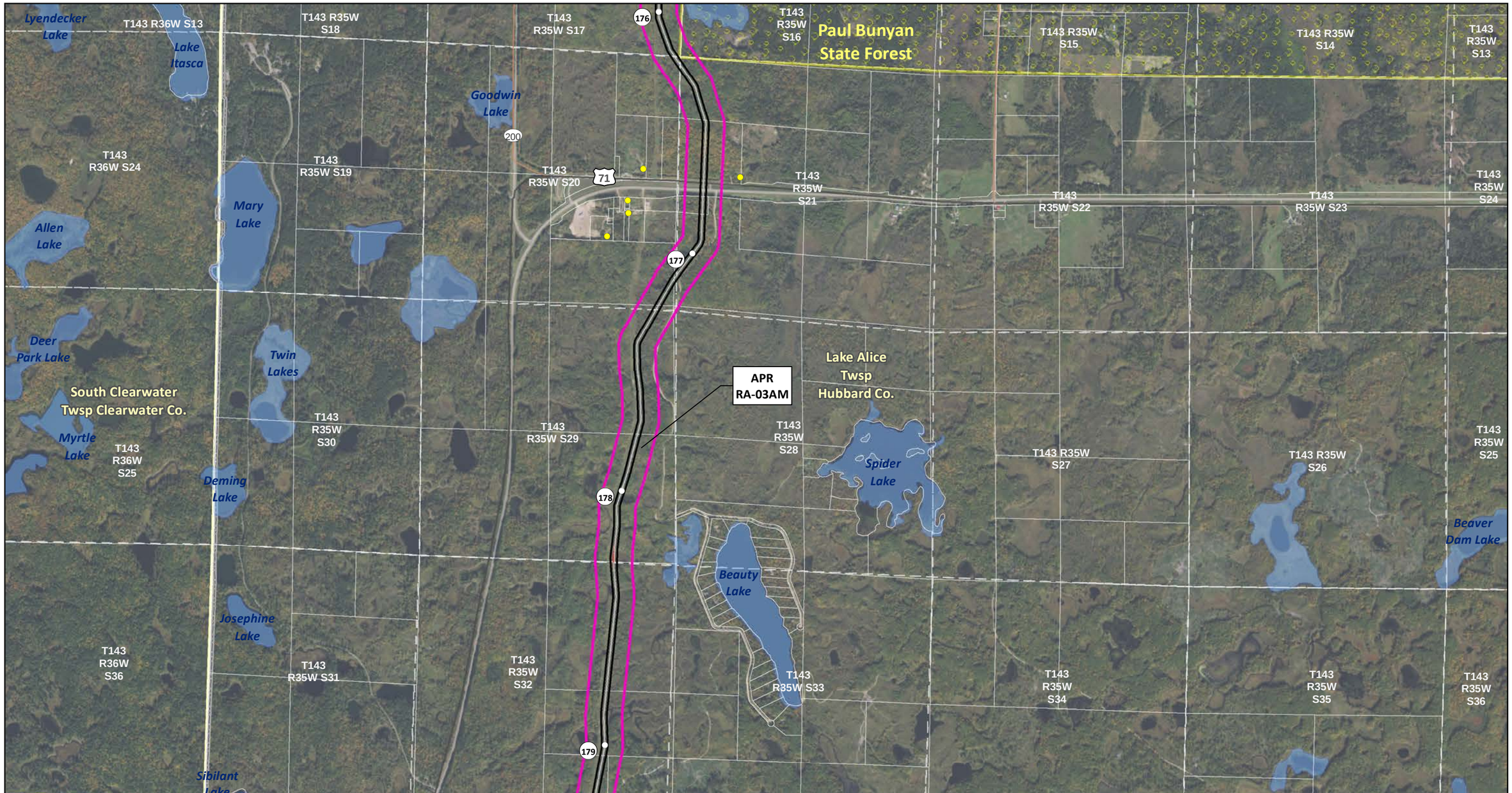
Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

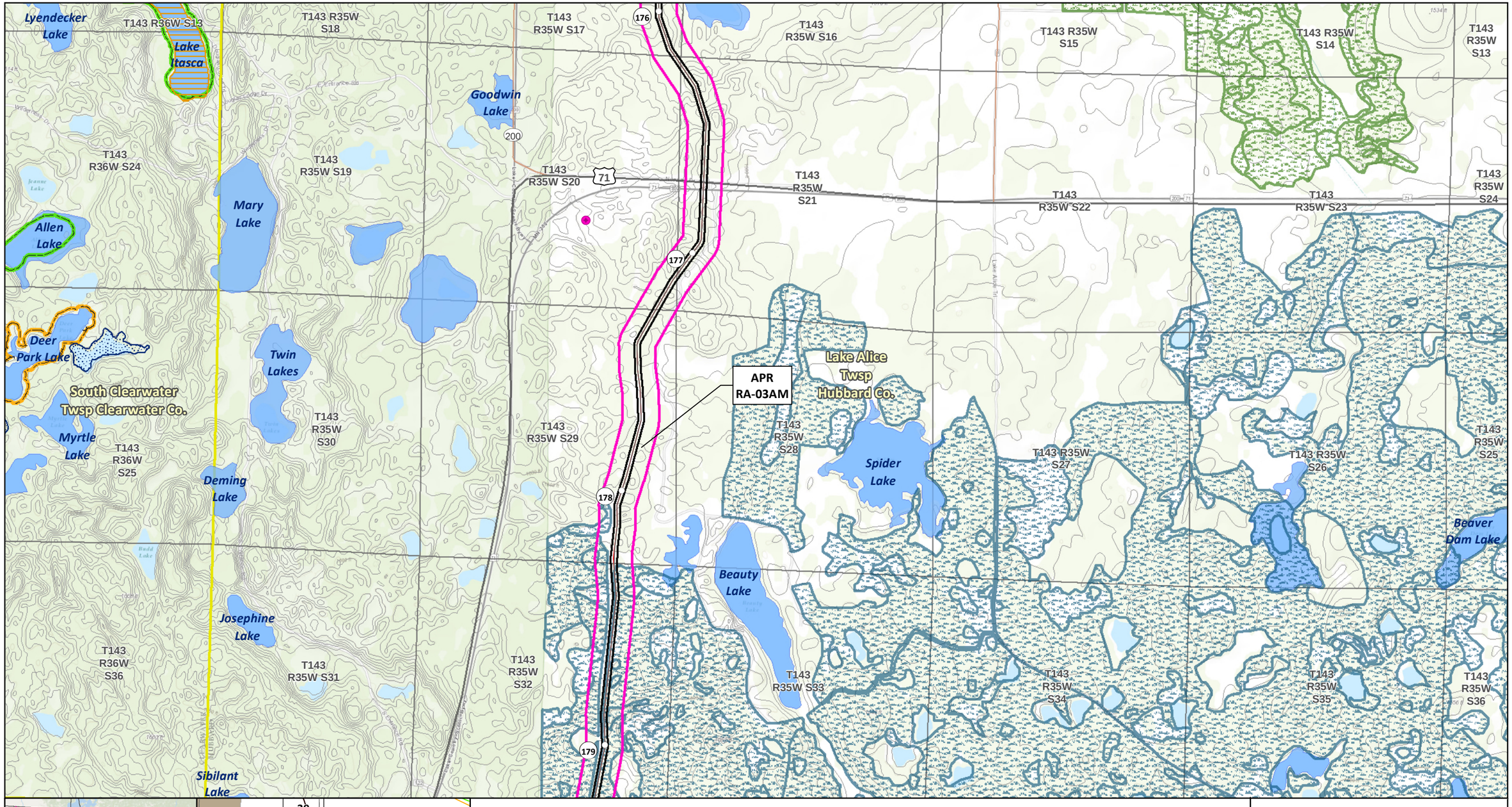

T144 R36W S35
Itasca Twsp Clearwater Co.
T144 R36W S36
T144 R35W S31
RSA-10
Lake Hattie Twsp Hubbard Co.
T144 R35W S32
Lost Lake
T144 R35W S33
T144 R35W S34
Bond Lake
T144 R35W S35
173
T143 R36W S2
T143 R36W S1
T143 R35W S6
T143 R35W S5
T143 R35W S4
T143 R35W S3
T143 R35W S2
174
T143 R36W S12
200
LaSalle Creek
Unnamed Stream
T143 R36W S11
South Clearwater Twsp Clearwater Co.
Lake Itasca
T143 R35W S7
T143 R35W S8
Lake Alice Twsp Hubbard Co.
APR
RA-03AM
T143 R35W S9
T143 R35W S10
Lake Alice
Bird Creek
T143 R35W S11
175
T143 R36W S13
T143 R36W S14
T143 R35W S18
T143 R35W S17
T143 R35W S16
T143 R35W S15
T143 R35W S14
Lyendecker Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
39
40
41
42
43
44
45
Clearwater County
Minnesota
Hubbard County
White Earth Reservation
Becker County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
Map 42B of 82

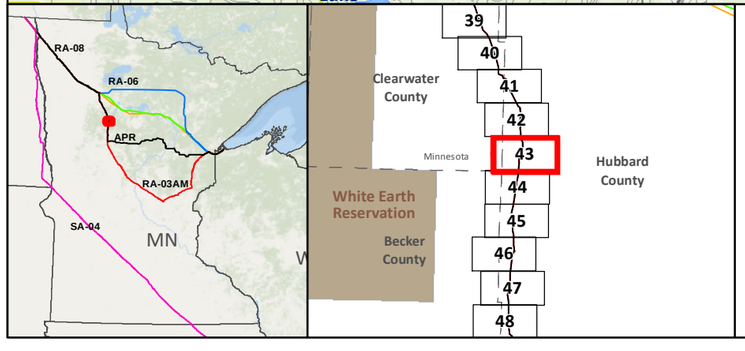


LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 43A of 82





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

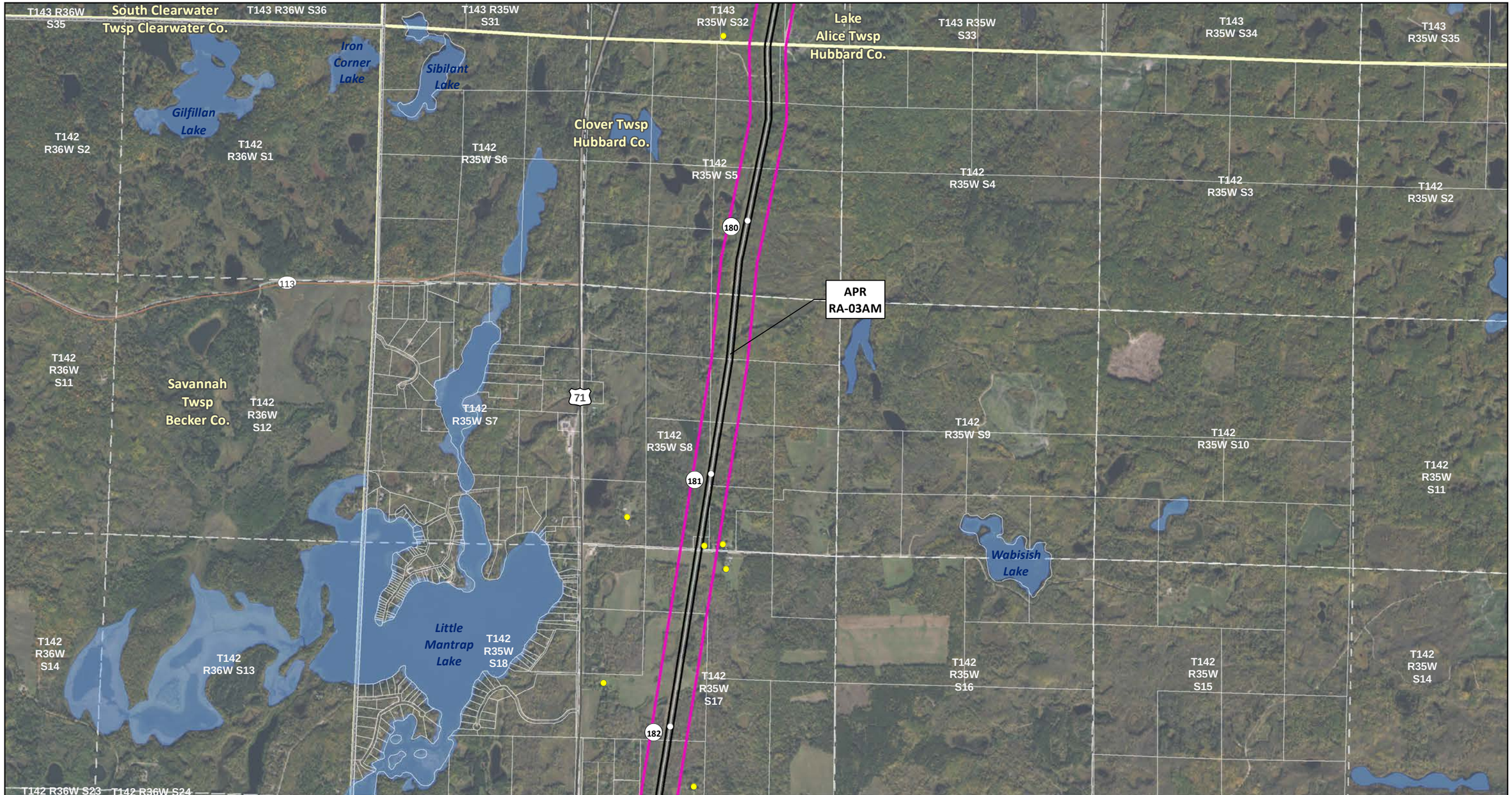
Data Sources: MNDNR, USGS, NHD, Enbridge

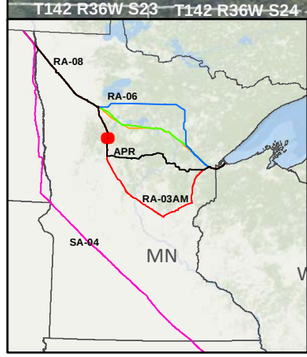
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

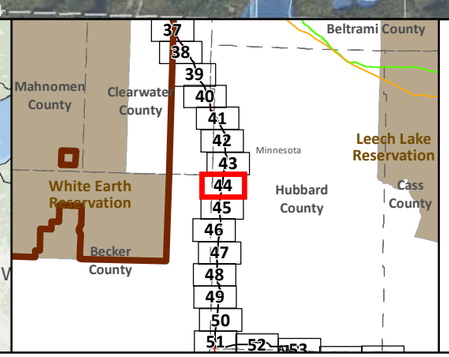
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 43B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

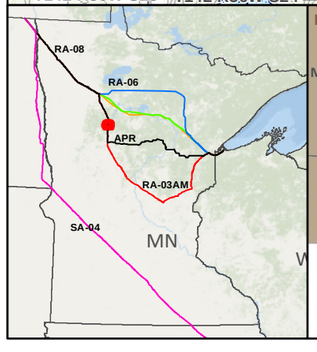
Data Sources: MNDNR, NHD, Enbridge

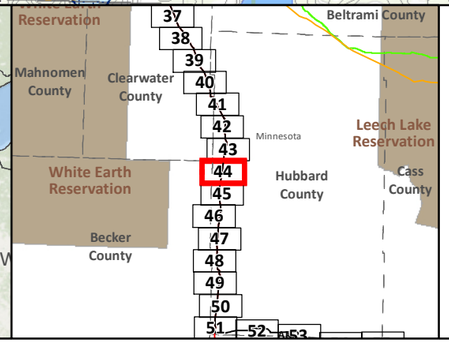
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T143 R36W S35
South Clearwater Twsp Clearwater Co.
T143 R36W S36
T143 R35W S31
T143 R35W S32
Lake Alice Twsp Hubbard Co.
T143 R35W S33
T143 R35W S34
T143 R35W S35
Iron Corner Lake
Sibilant Lake
Gilfillan Lake
T142 R36W S2
T142 R36W S1
T142 R35W S6
T142 R35W S5
T142 R35W S4
T142 R35W S3
T142 R35W S2
180
113
APR RA-03AM
T142 R35W S9
T142 R36W S11
Savannah Twsp Becker Co.
T142 R36W S12
71
T142 R35W S7
T142 R35W S8
Clover Twsp Hubbard Co.
T142 R35W S10
181
T142 R35W S11
Wabisish Lake
T142 R36W S14
T142 R36W S13
Little Mantrap Lake
T142 R35W S18
T142 R35W S17
T142 R35W S16
T142 R35W S15
T142 R35W S14
182
T142 R36W S23
T142 R36W S24





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

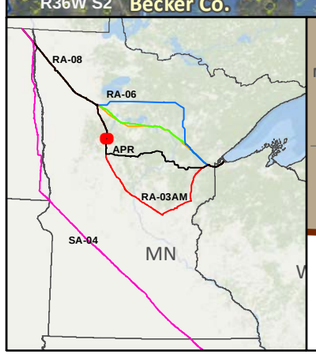
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

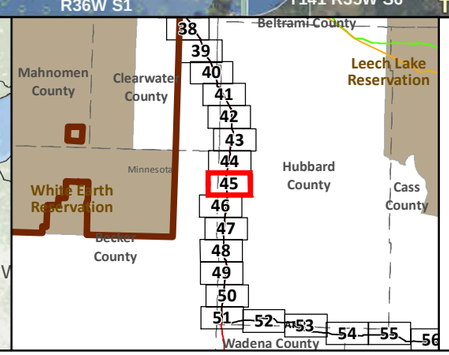
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

T142 R36W S13
T142 R35W S18
T142 R35W S17
T142 R35W S16
T142 R35W S15
T142 R35W S14
Little Mantrap Lake
Coon Lake
T142 R36W S24
T142 R35W S19
T142 R35W S20
T142 R35W S21
T142 R35W S22
T142 R35W S23
T142 R36W S23
183
Upper Camel Lake
APR
RA-03AM
T142 R36W S26
Savannah Twsp Becker Co.
T142 R36W S25
T142 R35W S30
71
T142 R35W S29
Clover Twsp Hubbard Co.
T142 R35W S28
T142 R35W S27
T142 R35W S26
184
Two Inlets State Forest
Unnamed Creek
Rose Lake
T142 R36W S35
T142 R36W S36
T142 R35W S31
T142 R35W S32
T142 R35W S33
T142 R35W S34
T142 R35W S35
185
Cedar Lake
Two Inlets Twsp Becker Co.
Hungry Man Lakes
T141 R36W S2
T141 R36W S1
T141 R35W S6
Arago Twsp Hubbard Co.
T141 R35W S5
T141 R35W S4
Lower Mud Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

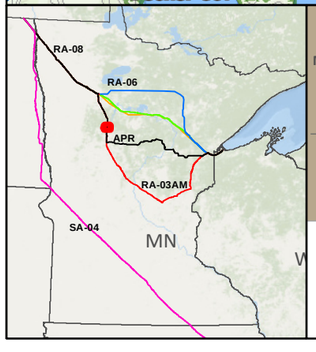
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

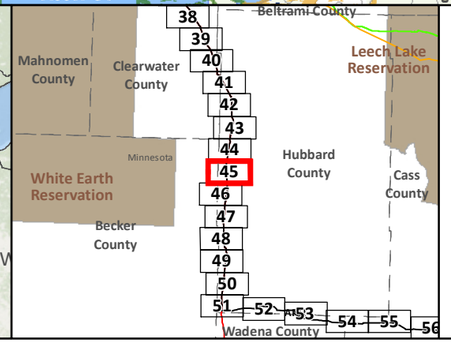
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 45A of 82

T142 R36W S13
T142-R35W-S18
T142 R35W S17
T142 R35W S16
T142 R35W S15
T142 R35W S14
Little Mantrap Lake
Coon Lake
T142 R36W S24
T142 R35W S19
T142 R35W S20
T142 R35W S21
T142 R35W S22
T142 R35W S23
T142 R36W S23
183
Upper Camel Lake
APR RA-03AM
T142 R36W S26
Savannah Twsp Becker Co.
T142 R36W S25
T142 R35W S30
71
T142 R35W S29
Clover Twsp Hubbard Co.
T142 R35W S28
T142 R35W S27
T142 R35W S26
184
Unnamed Creek
Rose Lake
T142 R36W S35
T142 R36W S36
T142 R35W S31
T142 R35W S32
T142 R35W S33
T142 R35W S34
T142 R35W S35
185
Cedar Lake
Two Inlets Twsp Becker Co.
Hungry Man Lakes
T141 R36W S2
T141 R36W S1
T141 R35W S6
Arago Twsp Hubbard Co.
T141 R35W S5
T141 R35W S4
Lower Mud Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

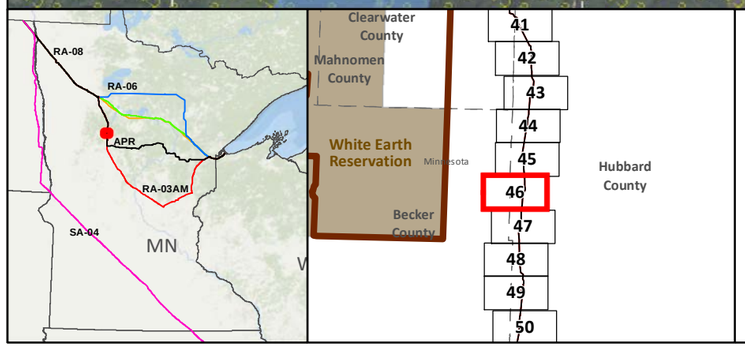
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 45B of 82

Cedar Lake
Hungry Man Lakes
T142 R35W S31
T142 R35W S32
T142 R35W S33
T142 R35W S34
T141 R36W S3
T141 R36W S2
T141 R36W S1
T141 R35W S6
T141 R35W S5
T141 R35W S4
T141 R35W S3
Two Inlets
186
APR RA-03AM
Two Inlets State Forest
Island Lake
T141 R36W S10
T141 R36W S11
Two Inlets Twsp Becker Co.
T141 R36W S12
T141 R35W S7
T141 R35W S8
T141 R35W S9
T141 R35W S10
187
Arago Twsp Hubbard Co.
71
Two Inlets Lake
Unnomed Creek
Eagle Lake
T141 R36W S15
T141 R36W S14
T141 R36W S13
T141 R35W S18
T141 R35W S17
T141 R35W S16
T141 R35W S15
188
T141 R36W S22
T141 R36W S23
T141 R36W S24
T141 R35W S19
T141 R35W S20
T141 R35W S21
T141 R35W S22



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

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- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
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- Residences within 1/2 mile
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- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

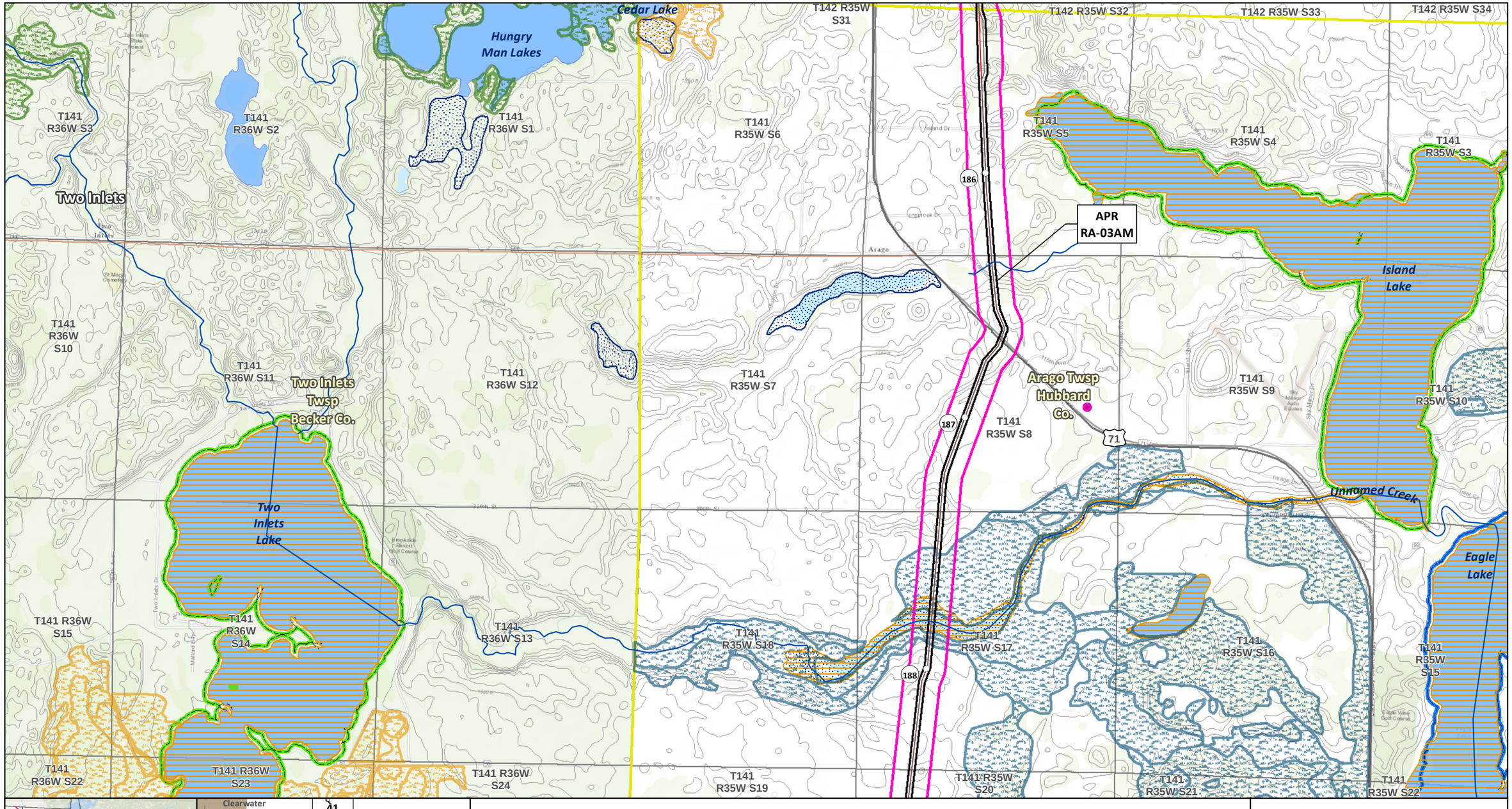
Data Sources: MNDNR, NHD, Enbridge

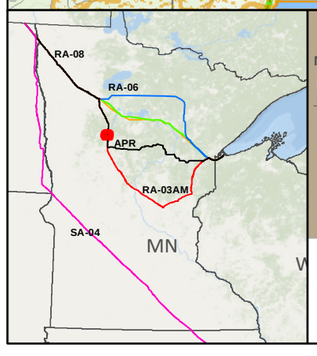
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

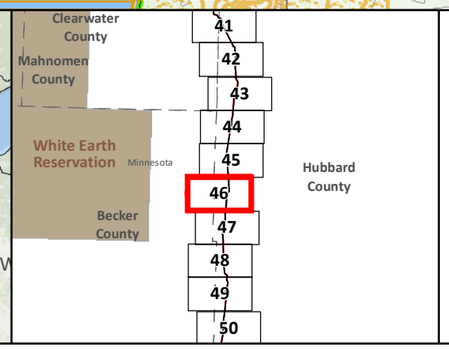
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 46A of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

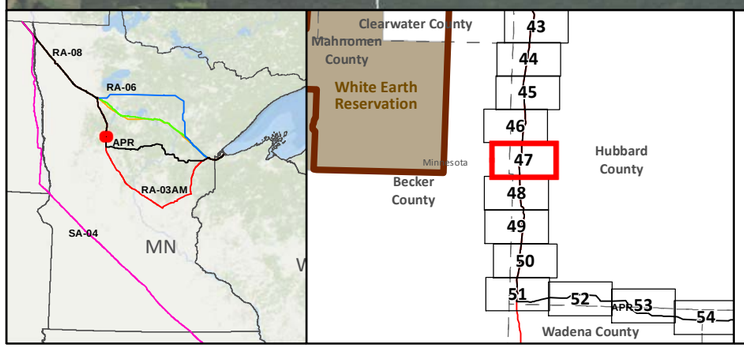
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Two Inlets Lake
Unnamed Creek
T141 R36W S23
T141 R36W S24
Mud Lake
Ten Acre Lake
T141 R36W S26
T141 R36W S25
Two Inlets Twsp Becker Co.
Two Inlets State Forest
T141 R36W S35
Fools Lake
Horseshoe Lake
T141 R36W S36
T141 R35W S19
T141 R35W S20
APR RA-03AM
189
T141 R35W S21
Eagle Lake
T141 R35W S22
T141 R35W S23
Potato Lake
T141 R35W S30
T141 R35W S29
190
Beden Lake
Arago Twsp Hubbard Co.
T141 R35W S28
T141 R35W S27
T141 R35W S26
71
Sloan Lake
T141 R35W S31
191
T141 R35W S32
T141 R35W S33
T141 R35W S34
T141 R35W S35
T140 R36W S2
Osage Twsp Becker Co.
T140 R36W S1
T140 R35W S6
Portage Lake
T140 R35W S5
Todd Twsp Hubbard Co.
T140 R35W S4
T140 R35W S3



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

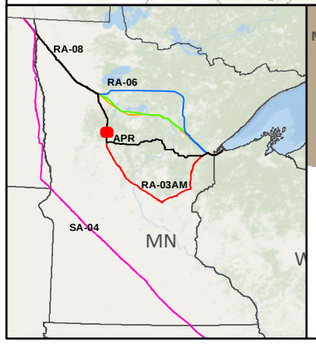
Data Sources: MNDNR, NHD, Enbridge

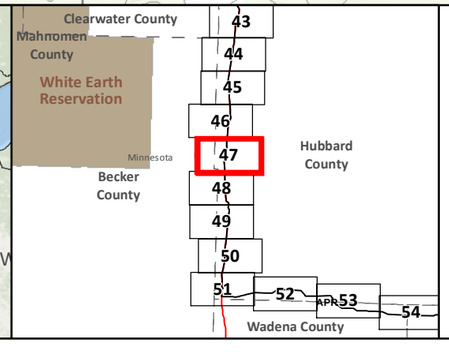
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Two Inlets Lake
Unnamed Creek
T141 R36W S23
T141 R36W S24
Mud Lake
Ten Acre Lake
T141 R36W S26
T141 R36W S25
Two Inlets Twsp Becker Co.
T141 R35W S19
T141 R35W S20
APR RA-03AM
189
T141 R35W S21
Eagle Lake
T141 R35W S22
T141 R35W S23
Potato Lake
T141 R35W S30
190
T141 R35W S29
Beden Lake
Arago Twsp Hubbard Co.
T141 R35W S28
71
T141 R35W S27
T141 R35W S26
T141 R36W S35
Fools Lake
Horseshoe Lake
T141 R36W S36
T141 R35W S31
191
Sloan Lake
T141 R35W S32
T141 R35W S33
T141 R35W S34
T141 R35W S35
T140 R36W S2
Osage Twsp Becker Co.
T140 R36W S1
T140 R35W S6
Portage Lake
T140 R35W S5
Todd Twsp Hubbard Co.
T140 R35W S4
T140 R35W S3





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

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303d Imparied Waters
Designated Trout Stream
Calcareous Fens
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Lakes of Biological Significance
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High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

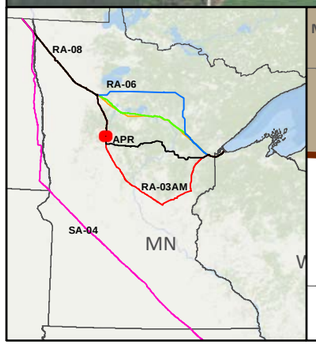
APR

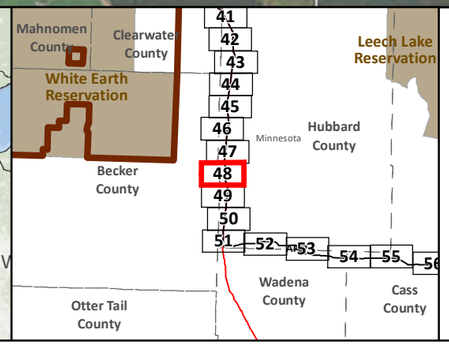
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 47B of 82

T140 R36W S3
T140 R36W S2
T140 R36W S1
T140 R35W S6
T140 R35W S5
T140 R35W S4
T140 R35W S3
Portage Lake
Unnamed Creek
T140 R36W S10
T140 R36W S11
T140 R36W S12
T140 R35W S7
T140 R35W S8
T140 R35W S9
T140 R35W S10
Fishhook Lake
APR RA-03AM
Osage Twsp Becker Co.
Todd Twsp Hubbard Co.
T140 R36W S15
T140 R36W S14
T140 R36W S13
T140 R35W S18
T140 R35W S17
T140 R35W S16
T140 R35W S15
T140 R36W S22
T140 R36W S23
T140 R36W S24
T140 R35W S19
T140 R35W S20
T140 R35W S21
T140 R35W S22
192
193
194
71
225





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 48A of 82

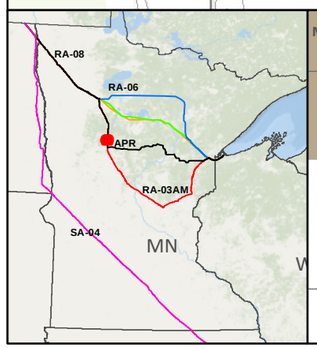
T140 R36W S3
T140 R36W S2
T140 R36W S1
T140 R35W S6
T140 R35W S5
T140 R35W S4
T140 R35W S3
T140 R36W S10
T140 R36W S11
T140 R36W S12
T140 R35W S7
T140 R35W S8
T140 R35W S9
T140 R35W S10
T140 R36W S15
T140 R36W S14
T140 R36W S13
T140 R35W S18
T140 R35W S17
T140 R35W S16
T140 R35W S15
T140 R36W S22
T140 R36W S23
T140 R36W S24
T140 R35W S19
T140 R35W S20
T140 R35W S21
T140 R35W S22

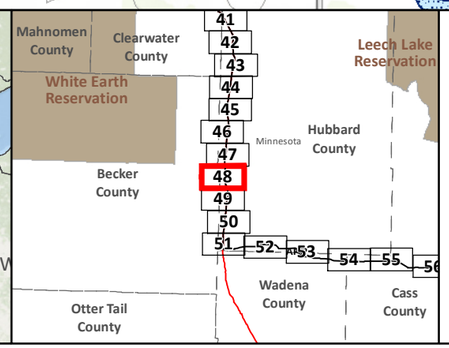
192
193
194
71
225

Portage Lake
Unnamed Creek
Fishhook Lake
Park Rapids Game Refuge
Sundsruds Court WHPA

APR
RA-03AM

Osage Twsp
Becker Co.
Todd Twsp
Hubbard Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

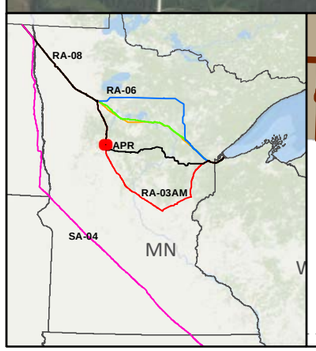
APR

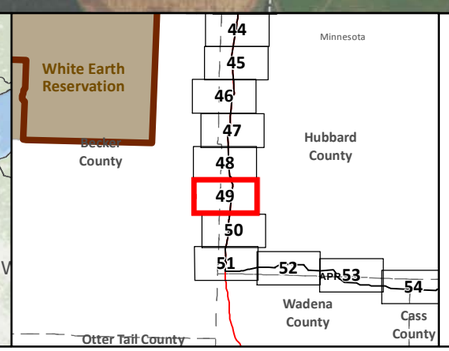
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 48B of 82

T140 R36W S22
T140 R36W S23
T140 R36W S24
T140 R35W S19
T140 R35W S20
T140 R35W S21
T140 R35W S22
225
34
195
APR RA-03AM
196
T140 R36W S27
T140 R36W S26
T140 R36W S25
T140 R35W S30
T140 R35W S29
T140 R35W S28
T140 R35W S27
Osage Twsp Becker Co.
Todd Twsp Hubbard Co.
Park Rapids Twsp Hubbard Co.
Straight River
T140 R36W S34
T140 R36W S35
T140 R36W S36
T140 R35W S31
T140 R35W S32
T140 R35W S33
T140 R35W S34
197
T139 R36W S3
T139 R36W S2
T139 R36W S1
T139 R35W S6
T139 R35W S5
T139 R35W S4
T139 R35W S3
Green Valley Twsp Becker Co.
Straight River Twsp Hubbard Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
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Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
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Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 49A of 82

T140 R36W S22
T140 R36W S23
T140 R36W S24
T140 R35W S19
T140 R35W S20
T140 R35W S21
T140 R35W S22
T140 R36W S27
T140 R36W S26
T140 R36W S25
T140 R35W S30
T140 R35W S29
T140 R35W S28
T140 R35W S27
T140 R36W S34
T140 R36W S35
T140 R36W S36
T140 R35W S31
T140 R35W S32
T140 R35W S33
T140 R35W S34
T139 R36W S3
T139 R36W S2
T139 R36W S1
T139 R35W S6
T139 R35W S5
T139 R35W S4
T139 R35W S3

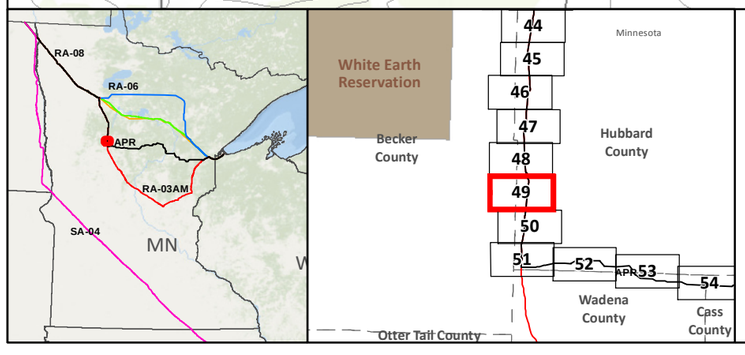
Osage Twsp Becker Co.
Todd Twsp Hubbard Co.
Park Rapids Twsp Hubbard Co.
Green Valley Twsp Becker Co.
Straight River Twsp Hubbard Co.

APR RA-03AM

Straight River

Edgewood Loop
Everlasting Dr
Eureka Rd
Gilligan St
170th St
Lake Country Scenic Byway

225 34 195 196 197



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

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Public Waters Watercourse
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Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
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Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

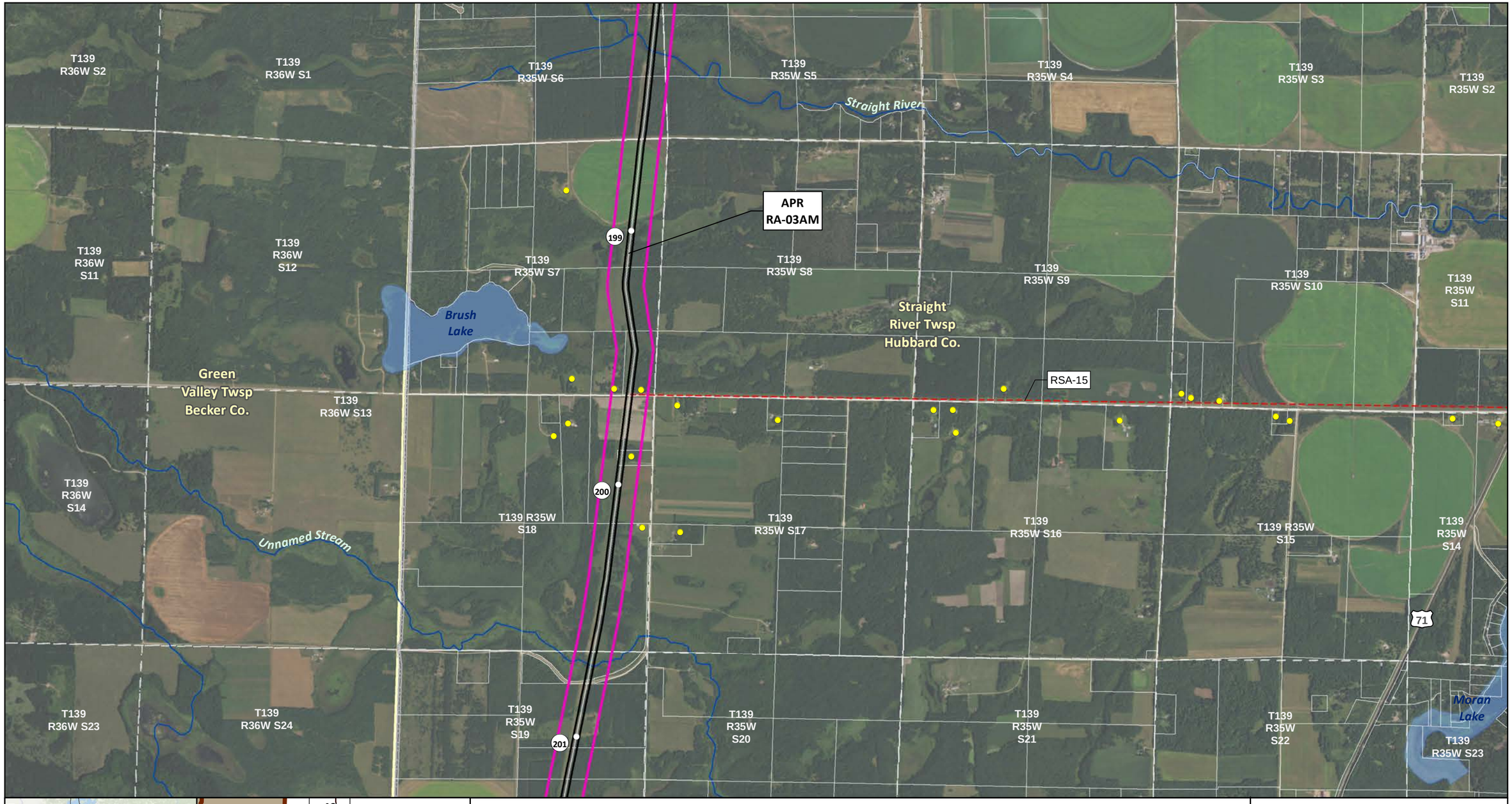
Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

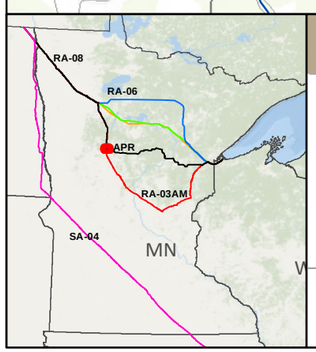


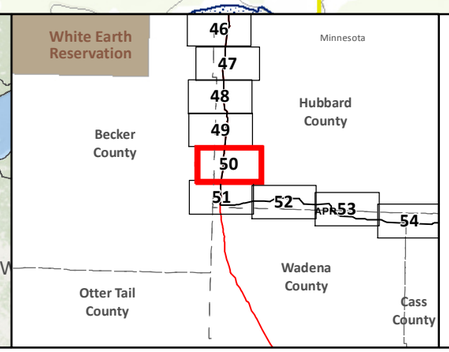
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 50A of 82

T139 R36W S2
T139 R36W S1
T139 R35W S6
T139 R35W S5
T139 R35W S4
T139 R35W S3
T139 R35W S2
Straight River
APR RA-03AM
199
T139 R36W S11
T139 R36W S12
T139 R35W S7
T139 R35W S8
T139 R35W S9
T139 R35W S10
T139 R35W S11
Brush Lake
Straight River Twsp Hubbard Co.
RSA-15
Green Valley Twsp Becker Co.
T139 R36W S13
T139 R36W S14
200
T139 R35W S18
T139 R35W S17
T139 R35W S16
T139 R35W S15
T139 R35W S14
Unnamed Stream
71
T139 R36W S23
T139 R36W S24
T139 R35W S19
201
T139 R35W S20
T139 R35W S21
T139 R35W S22
Moran Lake
T139 R35W S23





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

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High
Moderate

Terminal
Pump Station

Data Sources:
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

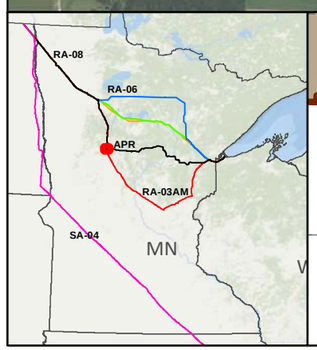
APR

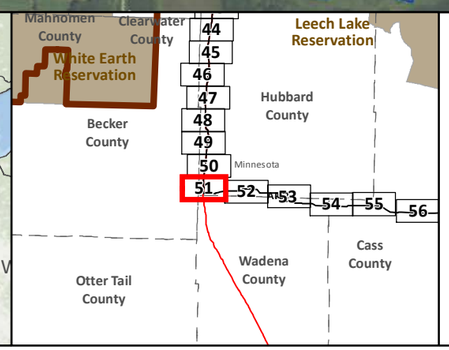
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 50B of 82







SA-04

Applicant's Preferred Route (APR)

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- RA-08
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Pump Station

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Major Road

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0 0.125 0.25 0.5 Miles

1:24,000

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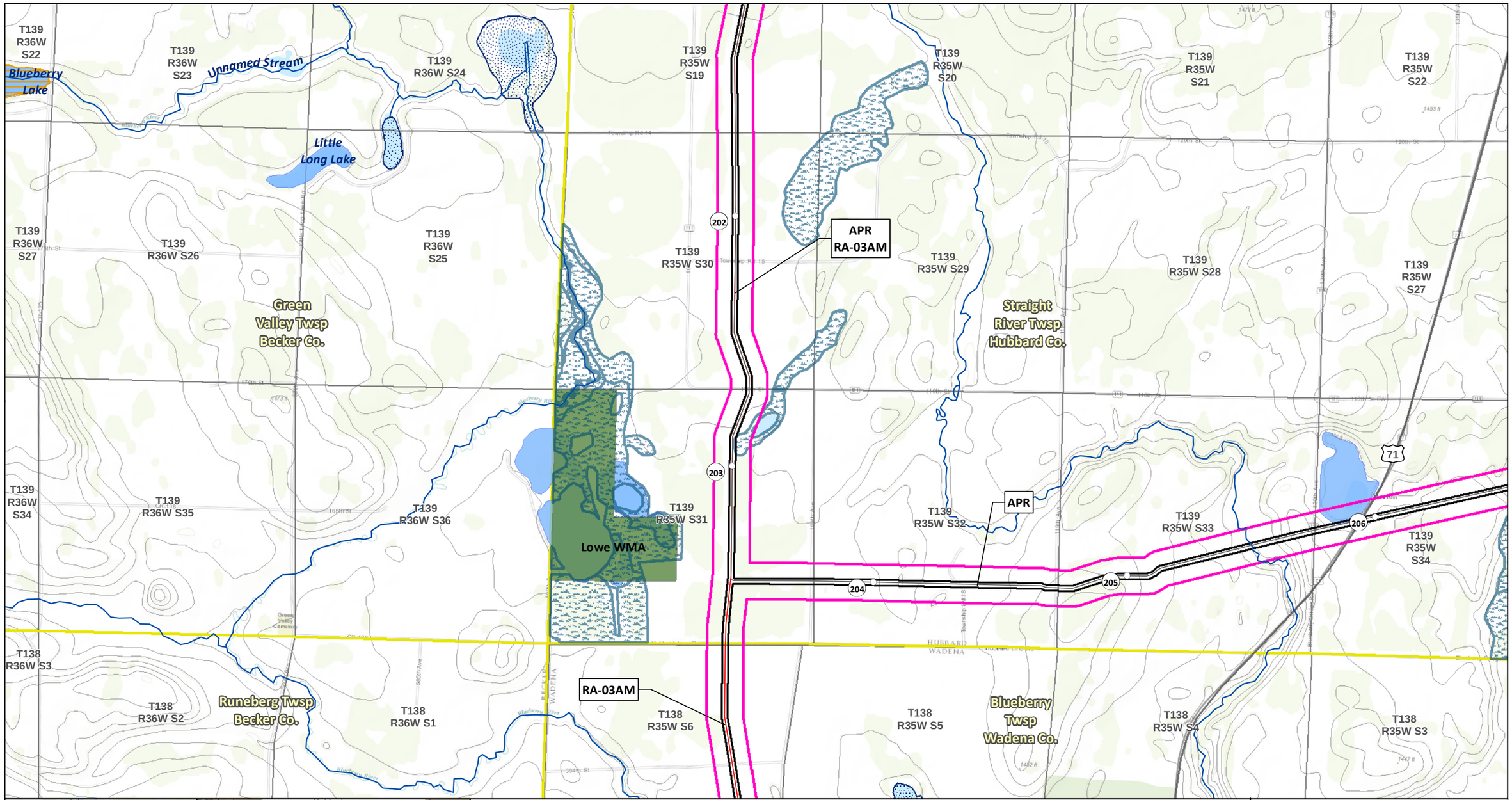
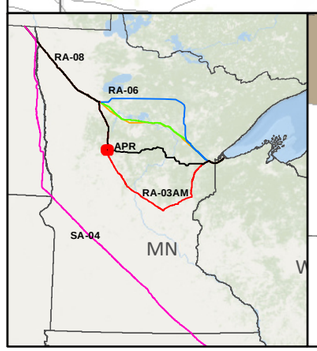
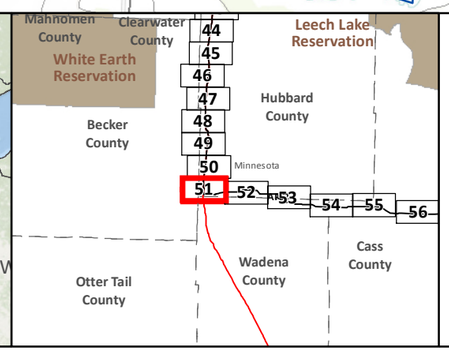
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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RA-06
RA-07
RA-08
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Anticipated 120' Construction ROW
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High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

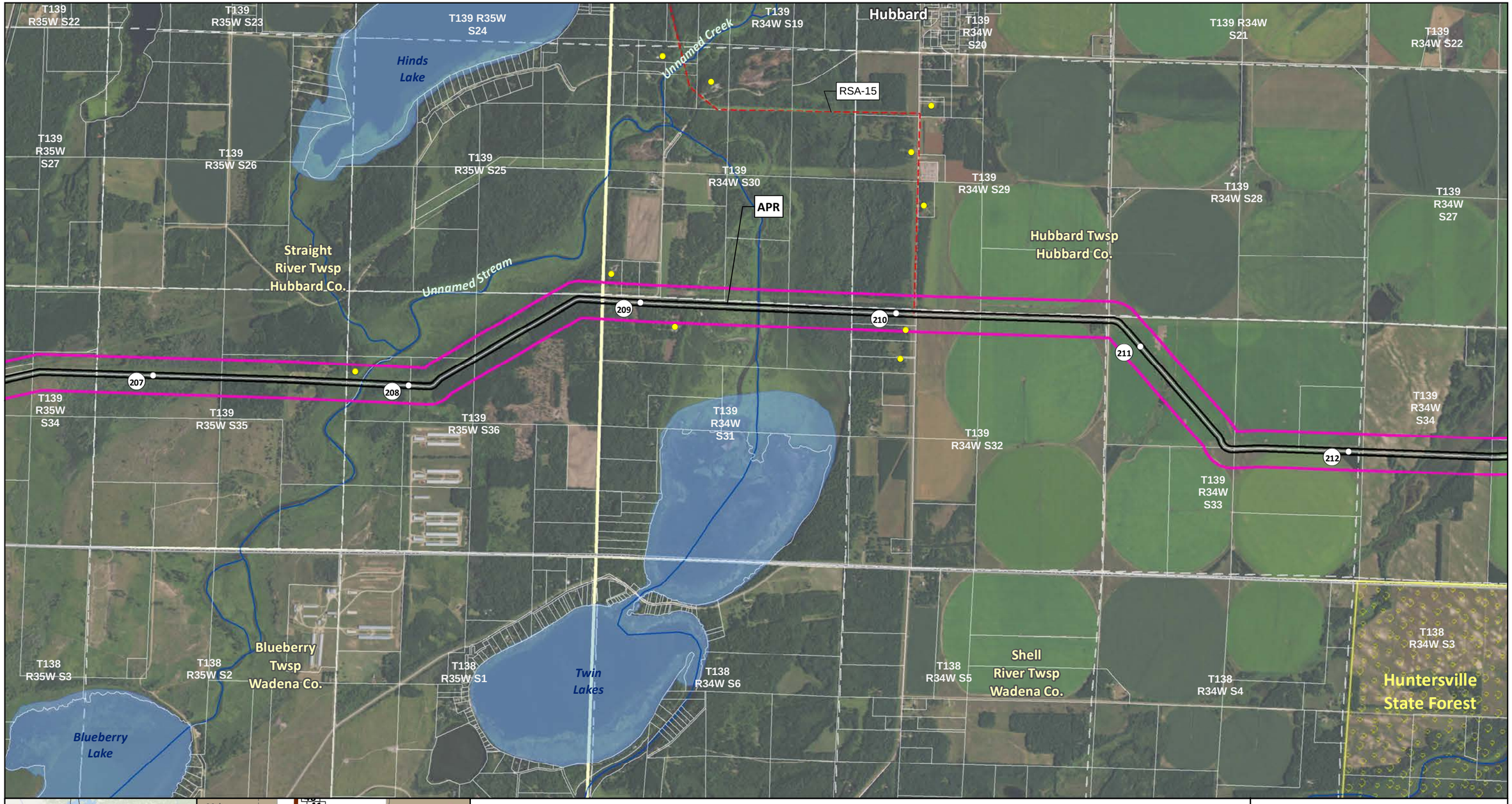
Data Sources:
MNDNR, USGS, NHD, Enbridge

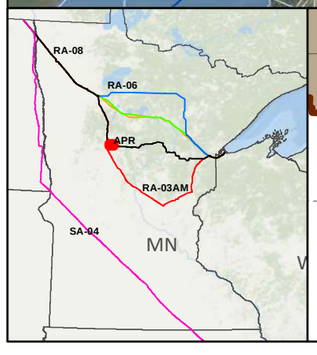
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

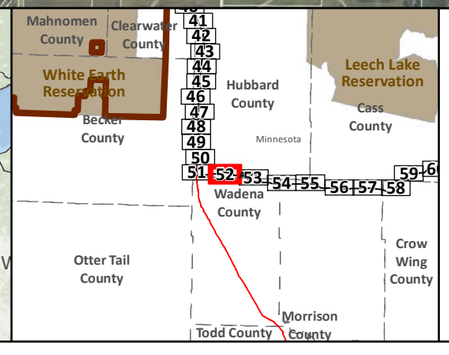
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 51B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

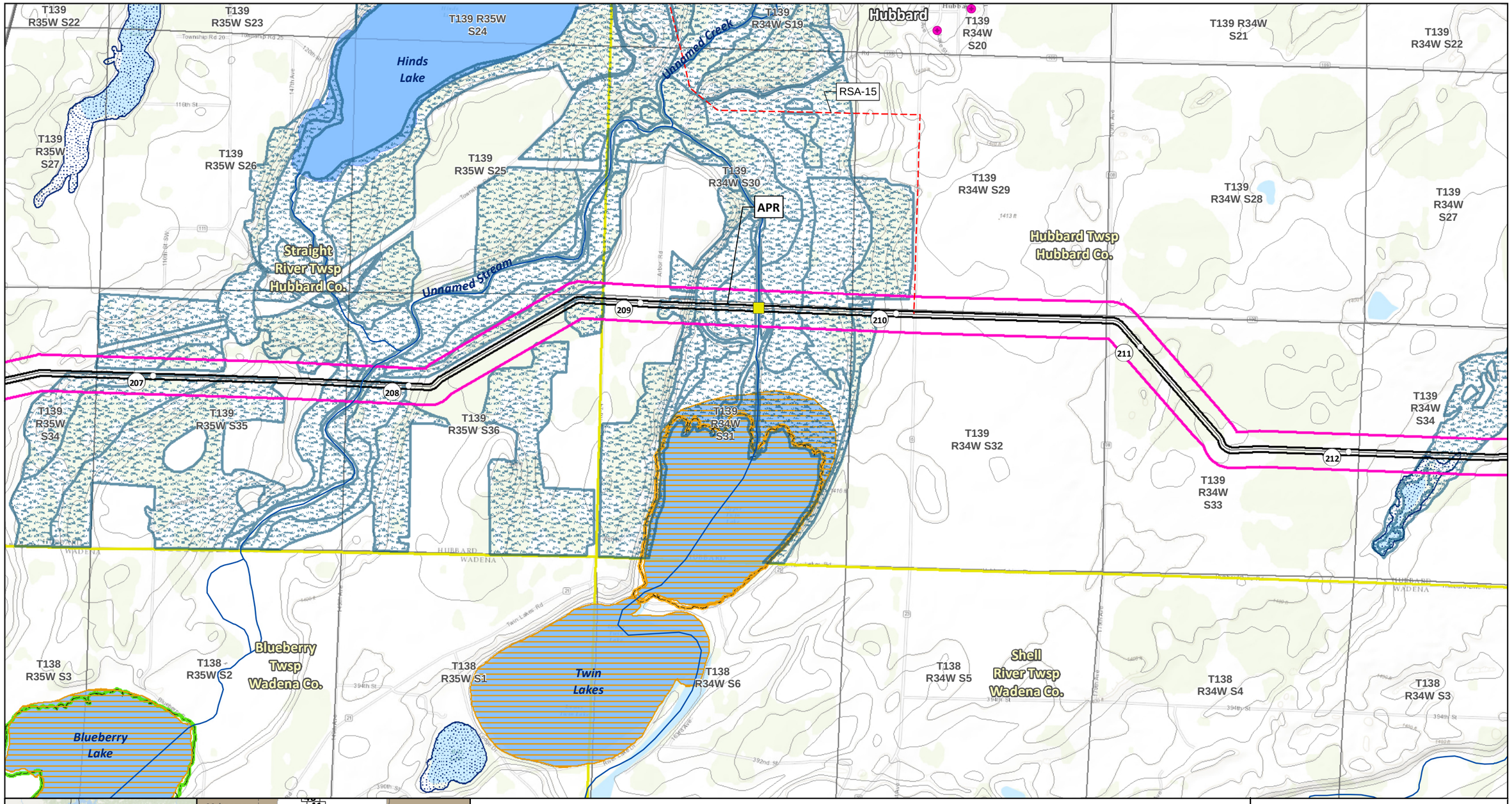
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

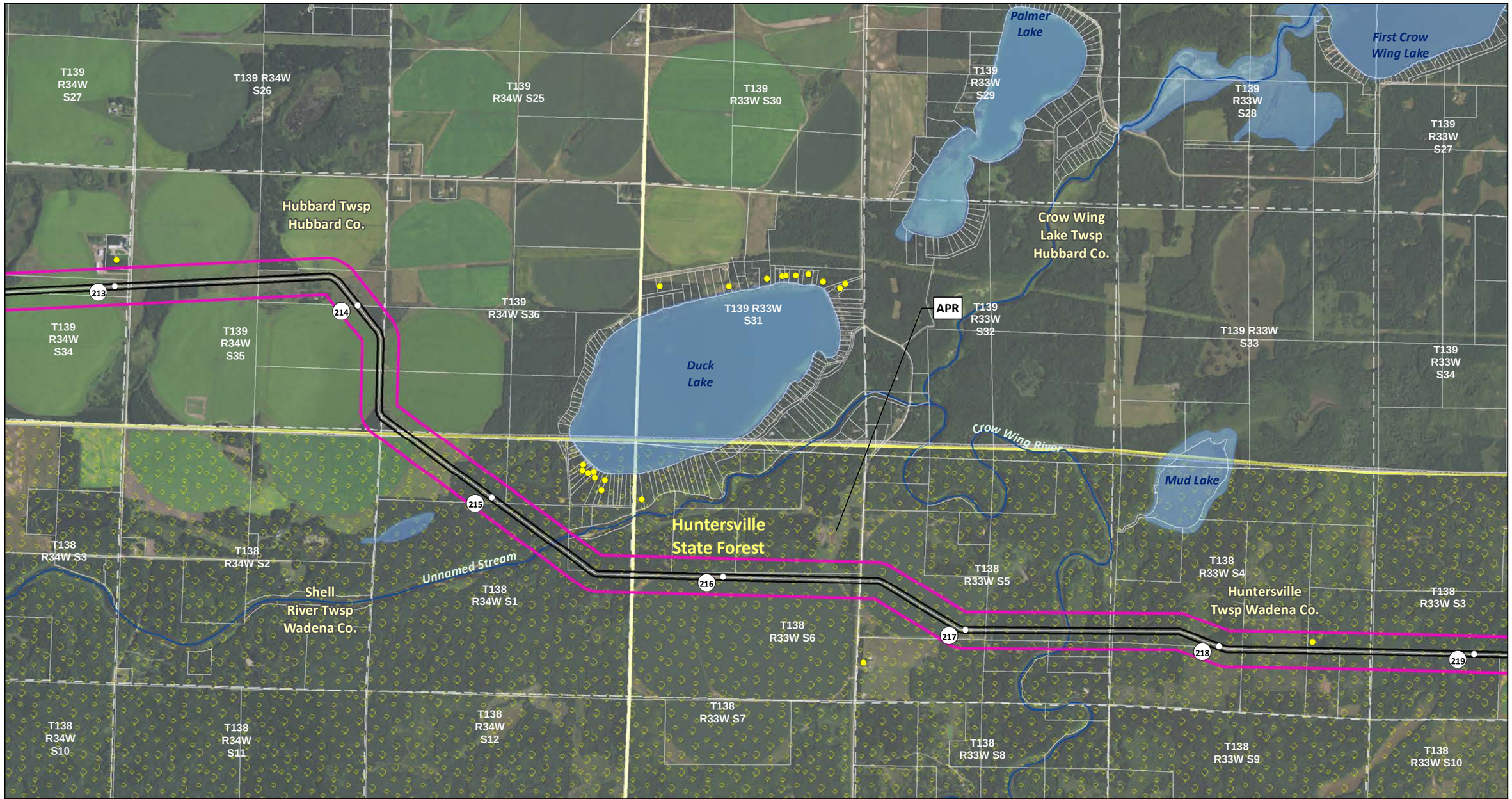
Data Sources: MNDNR, NHD, Enbridge

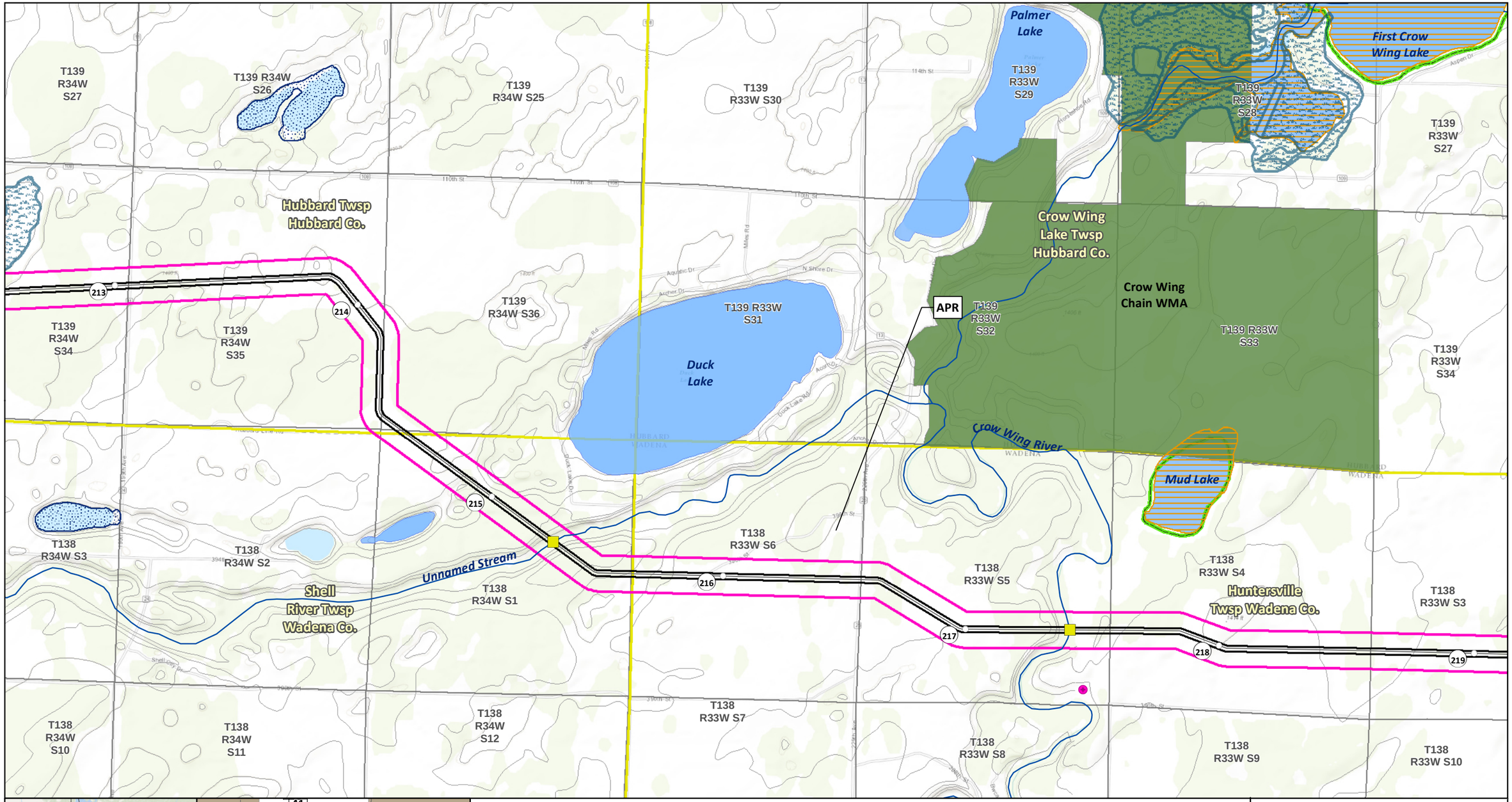
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

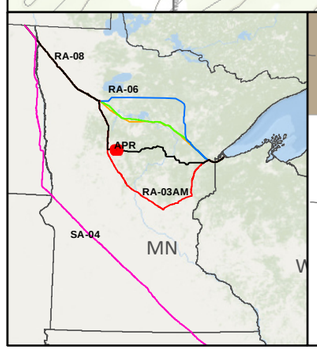
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

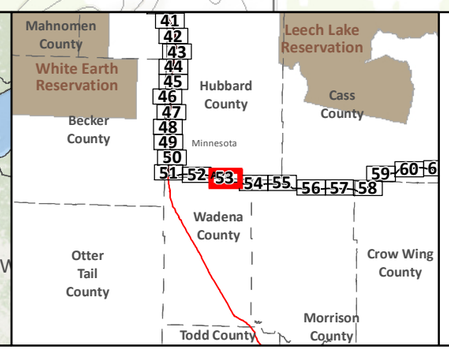
APR


T139 R35W S22
T139 R35W S23
T139 R35W S24
Hinds Lake
Unnamed Creek
T139 R34W S19
Hubbard
T139 R34W S20
T139 R34W S21
T139 R34W S22
RSA-15
T139 R35W S27
T139 R35W S26
T139 R35W S25
T139 R34W S30
APR
T139 R34W S29
T139 R34W S28
T139 R34W S27
Straight River Twsp Hubbard Co.
Unnamed Stream
Hubbard Twsp Hubbard Co.
209
210
211
207
208
212
T139 R35W S34
T139 R35W S35
T139 R35W S36
T139 R34W S31
T139 R34W S32
T139 R34W S33
T139 R34W S34
T138 R35W S3
T138 R35W S2
Blueberry Twsp Wadena Co.
T138 R35W S1
Twin Lakes
T138 R34W S6
T138 R34W S5
Shell River Twsp Wadena Co.
T138 R34W S4
T138 R34W S3
Blueberry Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Mahnomen County
Clearwater County
White Earth Reservation
Becker County
Hubbard County
Leech Lake Reservation
Cass County
Minnesota
Wadena County
Otter Tail County
Crow Wing County
Todd County
Morrison County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 52B of 82


T139 R34W S27
T139 R34W S26
T139 R34W S25
T139 R33W S30
Palmer Lake
T139 R33W S29
First Crow Wing Lake
T139 R33W S28
T139 R33W S27
Hubbard Twsp Hubbard Co.
Crow Wing Lake Twsp Hubbard Co.
213
214
T139 R34W S36
T139 R33W S31
APR
T139 R33W S32
T139 R33W S33
T139 R34W S34
T139 R34W S35
Duck Lake
T139 R33W S34
Crow Wing River
Mud Lake
215
Huntersville State Forest
T138 R34W S3
T138 R34W S2
Unnamed Stream
T138 R34W S1
T138 R33W S5
T138 R33W S4
Huntersville Twsp Wadena Co.
T138 R33W S3
Shell River Twsp Wadena Co.
216
T138 R33W S6
217
218
219
T138 R34W S10
T138 R34W S11
T138 R34W S12
T138 R33W S7
T138 R33W S8
T138 R33W S9
T138 R33W S10
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Mahnomen County
White Earth Reservation
Becker County
Hubbard County
Leech Lake Reservation
Cass County
Minnesota
Wadena County
Otter Tail County
Crow Wing County
Todd County
Morrison County
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 6
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary
Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA
Data Sources: MNDNR, NHD, Enbridge
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL
APR
Map 53A of 82
N







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding High Moderate

Native Plant Communities with Biodiversity Significance
Outstanding High Moderate

Terminal Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 53B of 82

Crow Wing Lake Twsp Hubbard Co.

T139 R33W S34

T139 R33W S35

T139 R33W S36

T139 R32W S31

T139 R32W S32

Badoura Twsp Hubbard Co.

T139 R32W S33

Badoura State Forest

64

T139 R32W S34

T138 R33W S3

T138 R33W S2

T138 R33W S1

T138 R32W S6

APR

T138 R32W S5

T138 R32W S4

T138 R32W S3

220

221

222

223

224

Huntersville Twsp Wadena Co.

Huntersville State Forest

T138 R33W S10

T138 R33W S11

T138 R33W S12

T138 R32W S7

T138 R32W S8

T138 R32W S9

T138 R32W S10

McKinley Twsp Cass Co.

Unnamed Stream

Big Swamp Creek

T138 R33W S15

T138 R33W S14

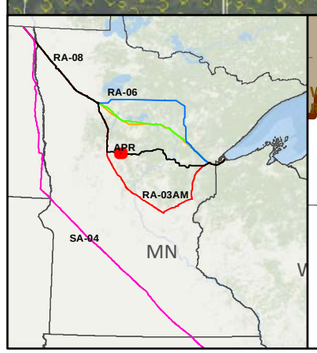
T138 R33W S13

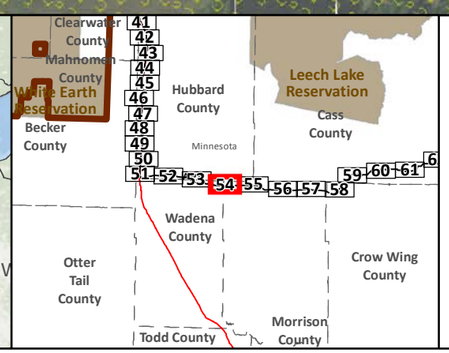
T138 R32W S18

T138 R32W S17

T138 R32W S16

T138 R32W S15





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Crow Wing Lake Twsp Hubbard Co.

T139 R33W S34 | T139 R33W S35 | T139 R33W S36 | T139 R32W S31 | T139 R32W S32 | T139 R32W S33 | T139 R32W S34

Badoura Twsp Hubbard Co.

T138 R33W S3 | T138 R33W S2 | T138 R33W S1 | T138 R32W S6 | T138 R32W S5 | T138 R32W S4 | T138 R32W S3

APR

220 221 222 223 224

Huntersville Twsp Wadena Co.

McKinley Twsp Cass Co.

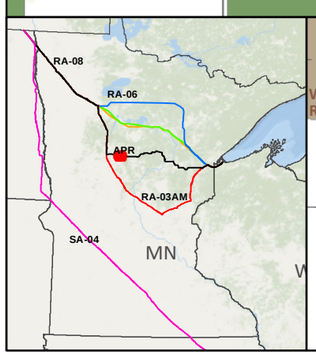
T138 R33W S10 | T138 R33W S11 | T138 R33W S12 | T138 R32W S7 | T138 R32W S8 | T138 R32W S9 | T138 R32W S10

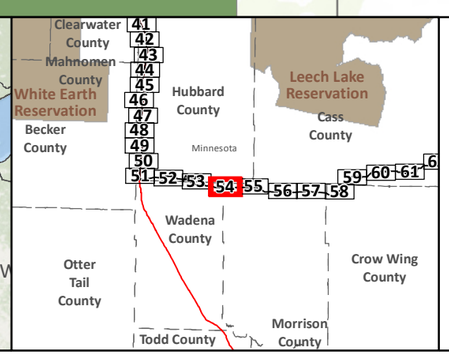
Huntersville WMA

Unnamed Stream

Big Swamp Creek

T138 R33W S15 | T138 R33W S14 | T138 R33W S13 | T138 R32W S18 | T138 R32W S17 | T138 R32W S16 | T138 R32W S15





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

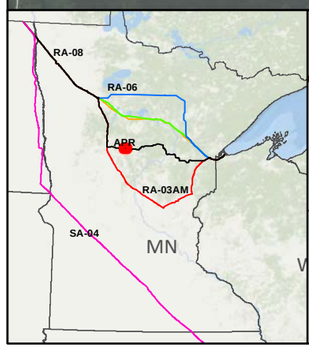
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

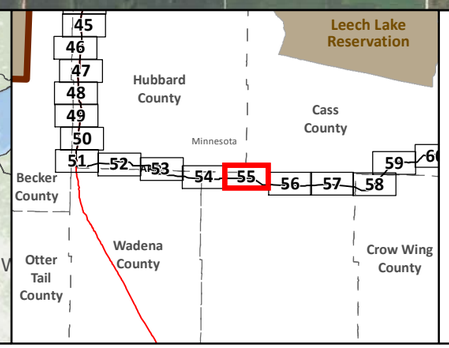
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 54B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

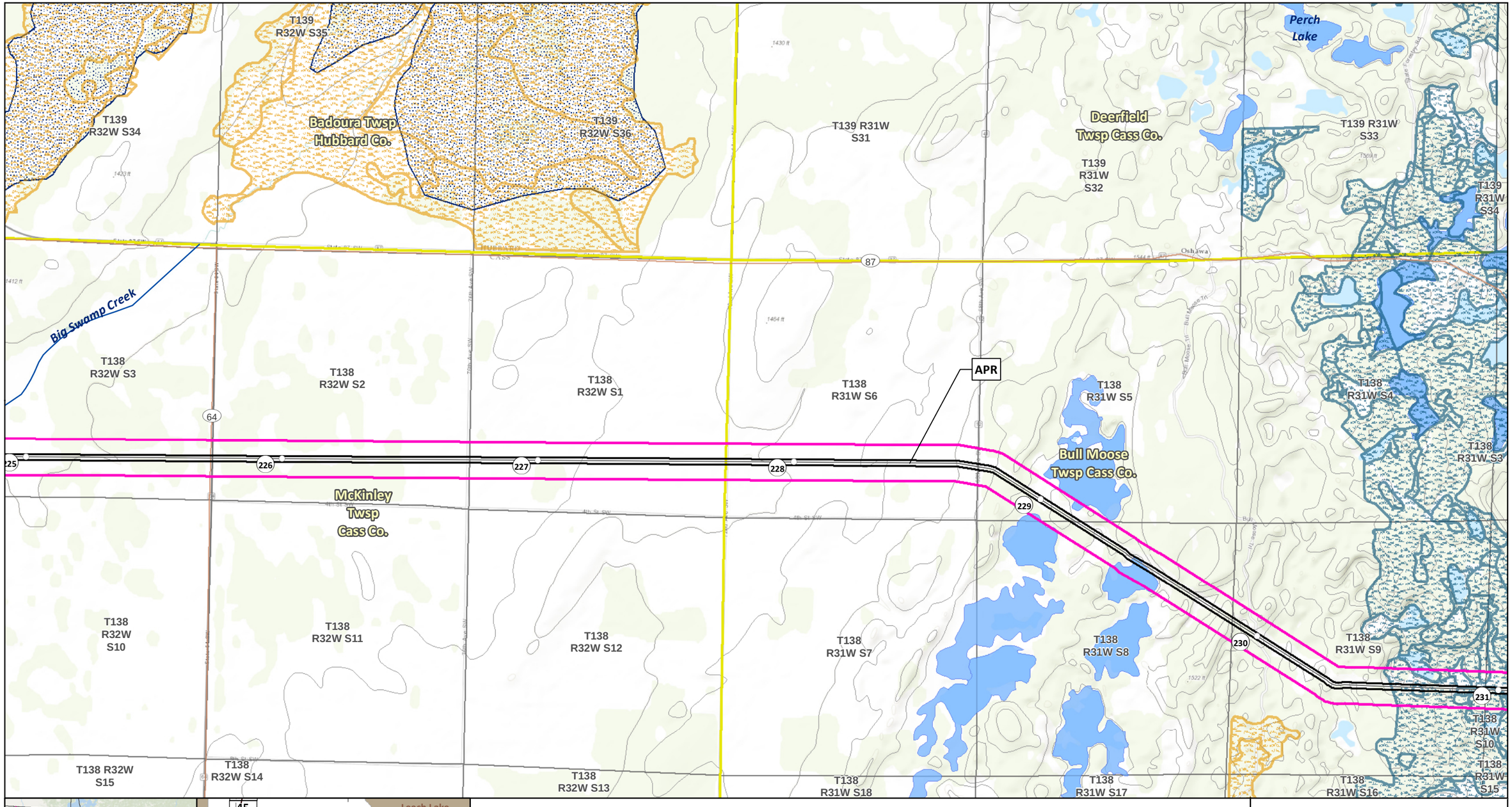
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

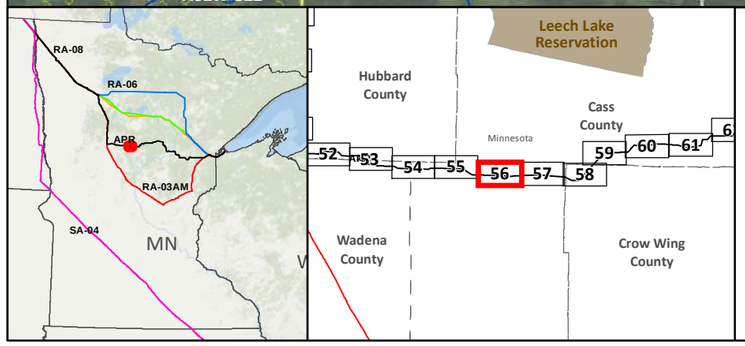
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 55A of 82


T139 R32W S35
T139 R32W S34
Badoura Twsp Hubbard Co.
T139 R32W S36
T139 R31W S31
Deerfield Twsp Cass Co.
T139 R31W S32
Perch Lake
T139 R31W S33
T139 R31W S34
87
Oshawa
Big Swamp Creek
T138 R32W S3
T138 R32W S2
T138 R32W S1
T138 R31W S6
APR
T138 R31W S5
T138 R31W S4
T138 R31W S3
64
225
226
227
228
229
Bull Moose Twsp Cass Co.
McKinley Twsp Cass Co.
T138 R32W S10
T138 R32W S11
T138 R32W S12
T138 R31W S7
T138 R31W S8
T138 R31W S9
230
231
T138 R31W S10
T138 R31W S15
T138 R32W S15
T138 R32W S14
T138 R32W S13
T138 R31W S18
T138 R31W S17
T138 R31W S16
RA-08
RA-06
APR
RA-03AM
SA-04
MN
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
Leech Lake Reservation
Hubbard County
Cass County
Minnesota
Becker County
Otter Tail County
Wadena County
Crow Wing County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
N
Map 55B of 82

T139 R31W S34
T139 R31W S35
T139 R31W S36
Pine Mountain Lake
T139 R30W S31
Pine River
Powers Twsp Cass Co.
T139 R30W S32
Bowen Lake
T139 R30W S33
T139 R30W S34
T138 R30W S3
Minnow Lake
T138 R31W S3
T138 R31W S2
87
T138 R31W S1
T138 R30W S6
T138 R30W S5
T138 R30W S4
Scribner Lake
T138 R30W S10
Pig Lake
T138 R31W S11
Foot Hills State Forest
Bull Moose Twsp Cass Co.
T138 R30W S8
T138 R31W S10
T138 R31W S12
T138 R30W S7
APR
Pine River Twsp Cass Co.
371
T138 R30W S9
232
233
234
235
236
237
Abel Lake
T138 R31W S14
T138 R31W S15
T138 R31W S13
T138 R30W S18
Cow Lake
T138 R30W S17
T138 R30W S16
T138 R30W S15
Unnamed Stream
Pine River, South Fork
Dick Lake
Boot Lake
T138 R31W S22
T138 R31W S23
T138 R31W S24
T138 R30W S19
T138 R30W S20
T138 R30W S21



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

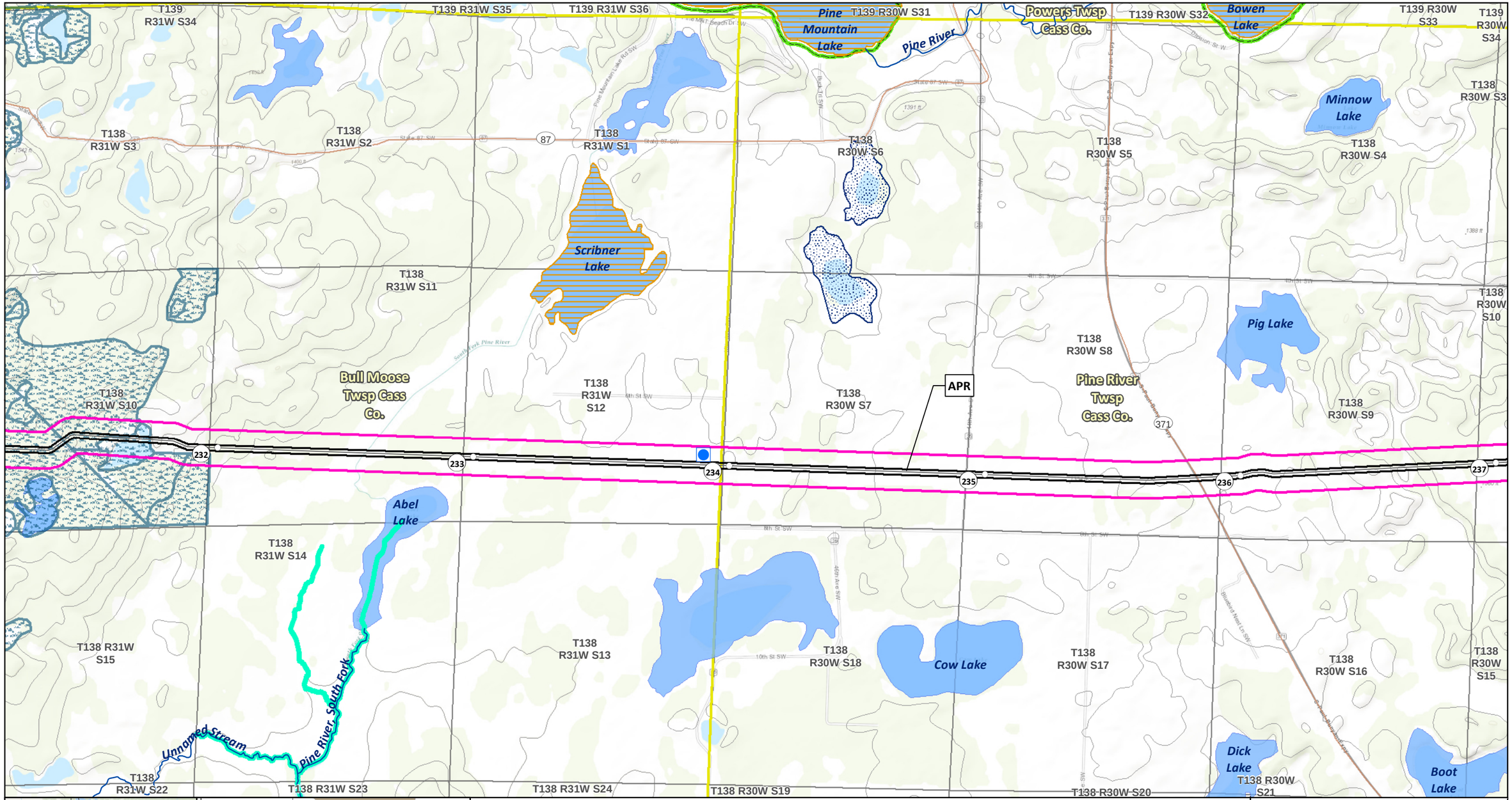
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

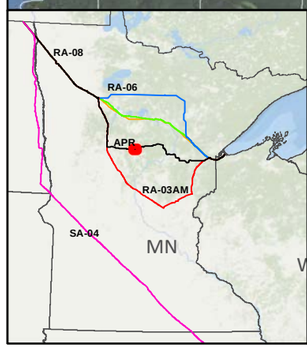
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

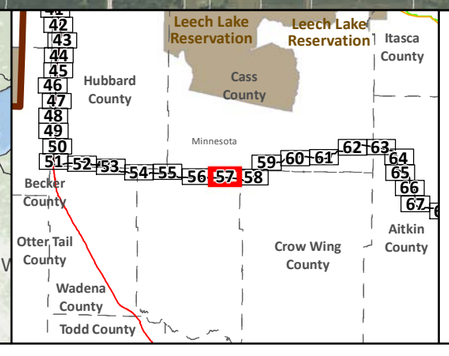
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T139 R31W S34
T139 R31W S35
T139 R31W S36
Pine Mountain Lake
T139 R30W S31
Pine River
Powers Twsp Cass Co.
T139 R30W S32
Bowen Lake
T139 R30W S33
T139 R30W S34
Minnow Lake
T138 R30W S3
T138 R31W S3
T138 R31W S2
T138 R31W S1
T138 R30W S6
T138 R30W S5
T138 R30W S4
Scribner Lake
T138 R31W S11
Pig Lake
T138 R30W S10
T138 R30W S8
Bull Moose Twsp Cass Co.
T138 R31W S10
T138 R31W S12
T138 R30W S7
APR
Pine River Twsp Cass Co.
T138 R30W S9
232
233
234
235
236
237
371
Abel Lake
T138 R31W S14
T138 R31W S15
T138 R31W S13
T138 R30W S18
Cow Lake
T138 R30W S17
T138 R30W S16
T138 R30W S15
Unnamed Stream
Pine River, South Fork
T138 R31W S22
T138 R31W S23
T138 R31W S24
T138 R30W S19
T138 R30W S20
T138 R30W S21
Dick Lake
Boot Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Hubbard County
Leech Lake Reservation
Minnesota
Cass County
Wadena County
Crow Wing County
52
53
54
55
56
57
58
59
60
61
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 56B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

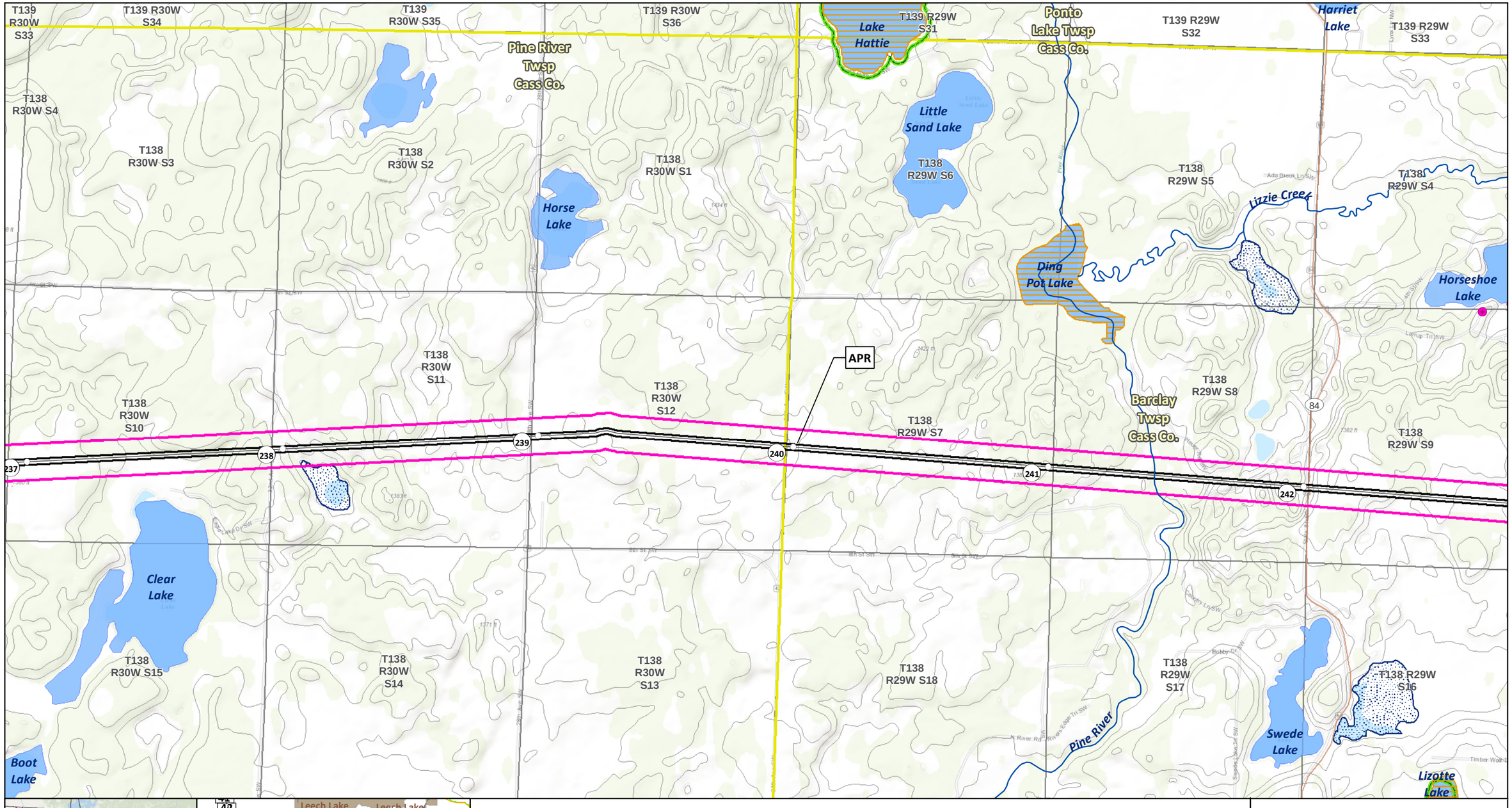
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 57A of 82


T139 R30W S33
T139 R30W S34
T139 R30W S35
T139 R30W S36
T139 R29W S31
T139 R29W S32
T139 R29W S33
Lake Hattie
Ponto Lake Twsp Cass Co.
Harriet Lake
Pine River Twsp Cass Co.
T138 R30W S4
T138 R30W S3
T138 R30W S2
T138 R30W S1
Little Sand Lake
T138 R29W S6
T138 R29W S5
T138 R29W S4
Lizzie Creek
Horse Lake
Ding Pot Lake
Horseshoe Lake
APR
T138 R30W S11
T138 R30W S12
T138 R30W S10
T138 R29W S7
T138 R29W S8
T138 R29W S9
Barclay Twsp Cass Co.
237
238
239
240
241
242
84
Clear Lake
T138 R30W S15
T138 R30W S14
T138 R30W S13
T138 R29W S18
T138 R29W S17
T138 R29W S16
Pine River
Swede Lake
Boot Lake
Lizotte Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Leech Lake Reservation
Leech Lake Reservation
Itasca County
Hubbard County
Cass County
Minnesota
Becker County
Otter Tail County
Wadena County
Todd County
Crow Wing County
Aitkin County
42
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44
45
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62
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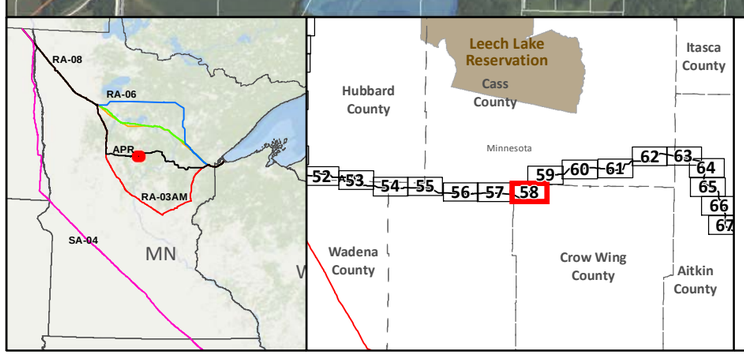
64
65
66
67
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 57B of 82

T139 R29W S33
T139 R29W S34
T139 R29W S35
Ponto Lake Twsp Cass Co.
T139 R29W S36
T139 R28W S31
Blind Lake Twsp Cass Co.
T139 R28W S32
T139 R28W S33
Barclay Twsp Cass Co.
Lizzie Lake
T138 R29W S4
T138 R29W S3
T138 R29W S2
Jail Lake
T138 R29W S1
T138 R28W S6
T138 R28W S5
Island Lake
T138 R28W S4
Lizzie Creek
Unnamed Stream
Horseshoe Lake
APR
Stewart Lake
Clough Lake
Gail Lake Twsp Crow Wing Co.
T138 R29W S9
T138 R29W S10
T138 R29W S12
T138 R28W S7
Timothy Twsp Crow Wing Co.
T138 R28W S8
T138 R28W S9
T138 R29W S11
T138 R29W S16
T138 R29W S15
T138 R29W S14
T138 R29W S13
T138 R28W S18
T138 R28W S17
T138 R28W S16
243
244
245
246
247
248



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

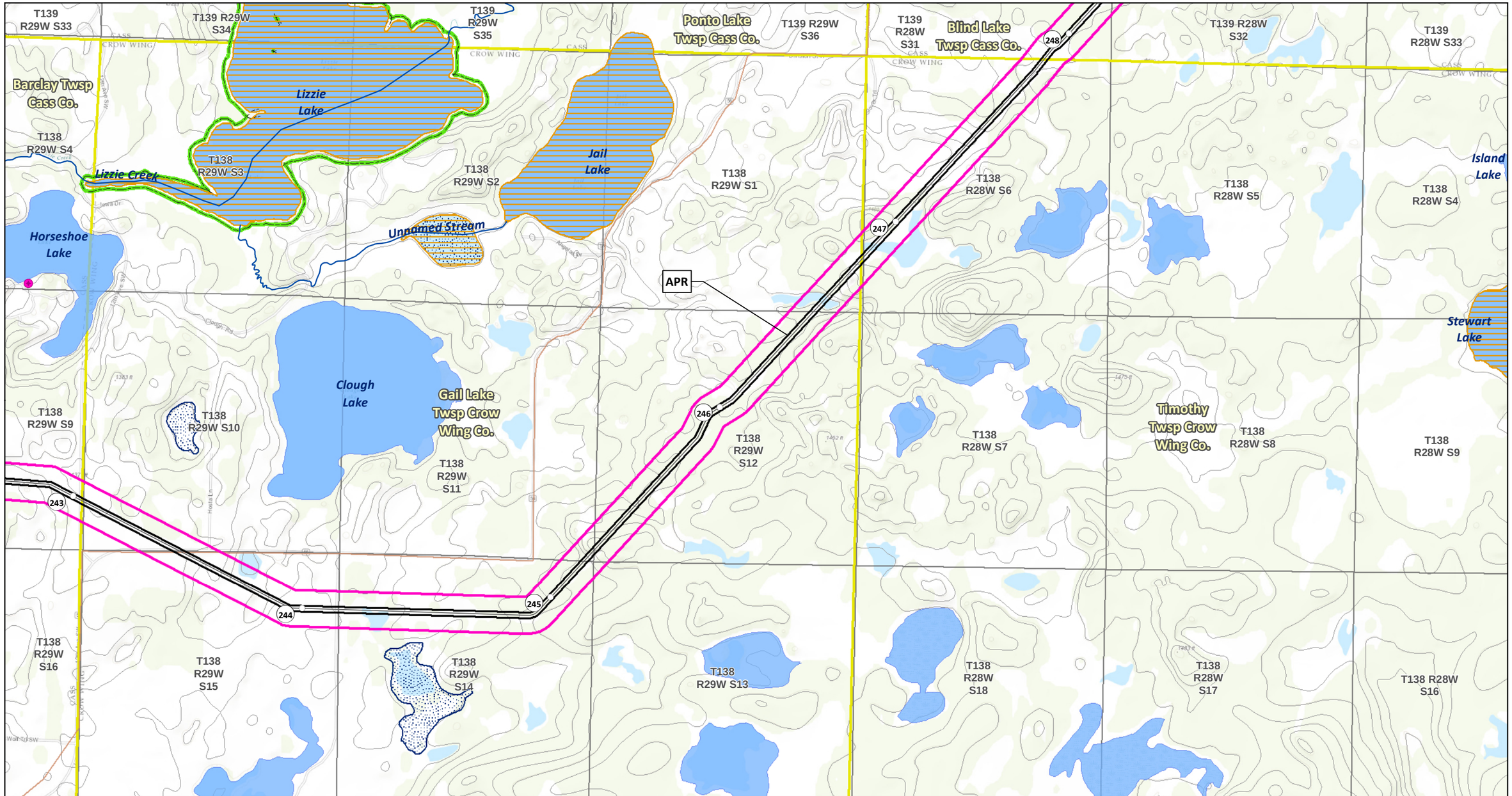
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

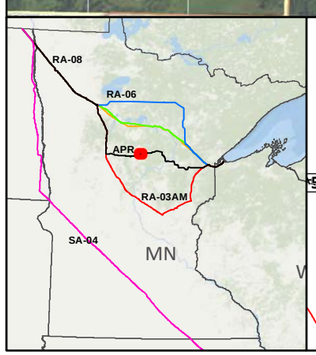
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

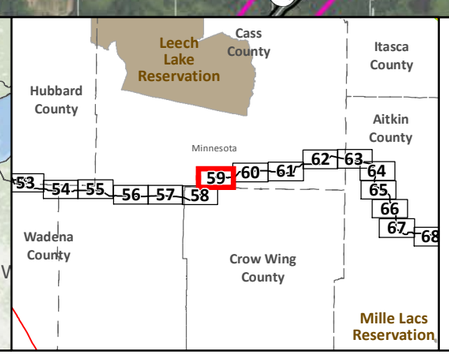
APR

Map 58A of 82


T139 R29W S33
T139 R29W S34
T139 R29W S35
Ponto Lake Twsp Cass Co.
T139 R29W S36
T139 R28W S31
Blind Lake Twsp Cass Co.
T139 R28W S32
T139 R28W S33
Barclay Twsp Cass Co.
Lizzie Lake
T138 R29W S4
T138 R29W S3
Lizzie Creek
T138 R29W S2
Jail Lake
T138 R29W S1
T138 R28W S6
T138 R28W S5
Island Lake
T138 R28W S4
Horseshoe Lake
Unnamed Stream
APR
Stewart Lake
Clough Lake
Gail Lake Twsp Crow Wing Co.
T138 R29W S9
T138 R29W S10
T138 R29W S11
T138 R29W S12
T138 R28W S7
Timothy Twsp Crow Wing Co.
T138 R28W S8
T138 R28W S9
T138 R29W S16
T138 R29W S15
T138 R29W S14
T138 R29W S13
T138 R28W S18
T138 R28W S17
T138 R28W S16
243
244
245
246
247
248
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Leech Lake Reservation
Cass County
Hubbard County
Itasca County
Minnesota
Wadena County
Crow Wing County
Aitkin County
52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
Map 58B of 82

T139 R29W S13
T139 R28W S18
T139 R28W S17
T139 R28W S16
T139 R28W S15
T139 R28W S14
T139 R28W S13
Tamarack Lake
Swede Lake
Blind Lake Twsp Cass Co.
T139 R29W S24
T139 R28W S19
T139 R28W S20
T139 R28W S21
T139 R28W S22
T139 R28W S23
T139 R28W S24
APR
Blind Lake Creek
Louise Lake
Ponto Lake Twsp Cass Co.
T139 R28W S30
T139 R28W S29
T139 R28W S28
T139 R28W S27
T139 R28W S26
T139 R28W S25
T139 R29W S25
Peterson Lake
Blind Lake
Stony Lake
Big Cranberry Lake
T139 R29W S36
T139 R28W S31
T139 R28W S32
T139 R28W S33
T139 R28W S34
T139 R28W S35
T139 R28W S36
Land O'Lakes State Forest
Little Cranberry Lake
250
249
248
252
253





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

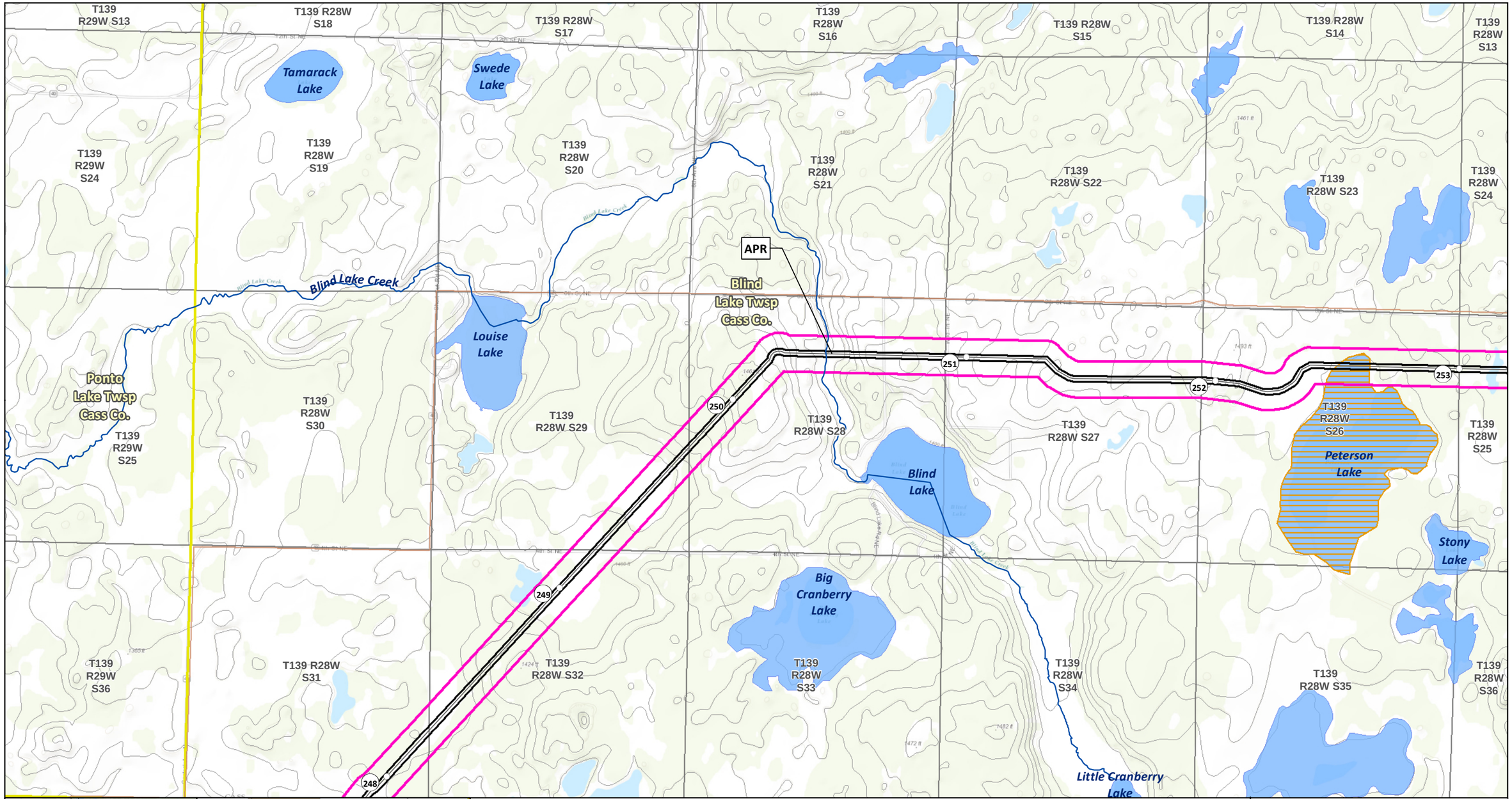
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 59A of 82


T139 R29W S13
T139 R28W S18
T139 R28W S17
T139 R28W S16
T139 R28W S15
T139 R28W S14
T139 R28W S13
Tamarack Lake
Swede Lake
T139 R29W S24
T139 R28W S19
T139 R28W S20
T139 R28W S21
T139 R28W S22
T139 R28W S23
T139 R28W S24
APR
Blind Lake Creek
Blind Lake Twsp Cass Co.
Louise Lake
Ponto Lake Twsp Cass Co.
T139 R28W S30
T139 R28W S29
T139 R28W S28
T139 R28W S27
T139 R28W S26
T139 R28W S25
Peterson Lake
Blind Lake
Stony Lake
Big Cranberry Lake
T139 R29W S25
T139 R29W S36
T139 R28W S31
T139 R28W S32
T139 R28W S33
T139 R28W S34
T139 R28W S35
T139 R28W S36
Little Cranberry Lake
250
251
252
253
249
248
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Leech Lake Reservation
Cass County
Itasca County
Hubbard County
Aitkin County
Minnesota
53
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61
62
63
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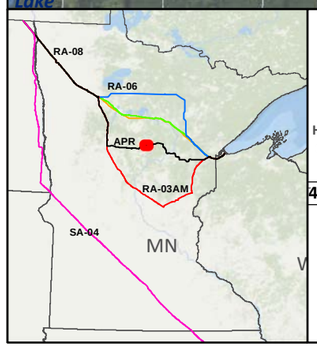
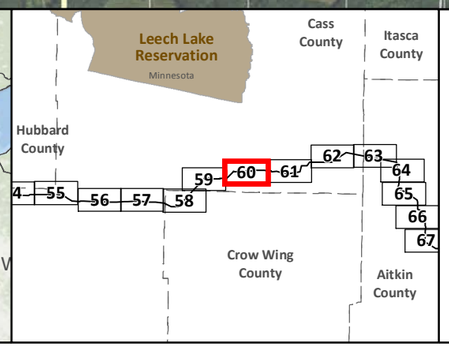
65
66
67
68
Wadena County
Crow Wing County
Mille Lacs Reservation
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
Map 59B of 82

T139 R28W S12
T139 R27W S7
T139 R27W S8
T139 R27W S9
T139 R27W S10
T139 R27W S11
T139 R27W S12
Land O'Lakes State Forest
T139 R28W S13
T139 R27W S18
T139 R27W S17
APR
T139 R27W S16
T139 R27W S15
T139 R27W S14
T139 R27W S13
256
255
257
258
259
Blind Lake Twsp Cass Co.
T139 R28W S24
T139 R27W S19
T139 R27W S20
First Dog Lake
T139 R27W S21
Trelipe Twsp Cass Co.
T139 R27W S22
T139 R27W S23
West Dog Lake
Second Dog Lake
254
T139 R28W S25
T139 R27W S30
T139 R27W S29
T139 R27W S28
T139 R27W S27
T139 R27W S26
T139 R27W S24
T139 R27W S25
Unnamed Stream
Hay Creek
Dirty House Lake
Lee Lake
Stony Lake
Pistol Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

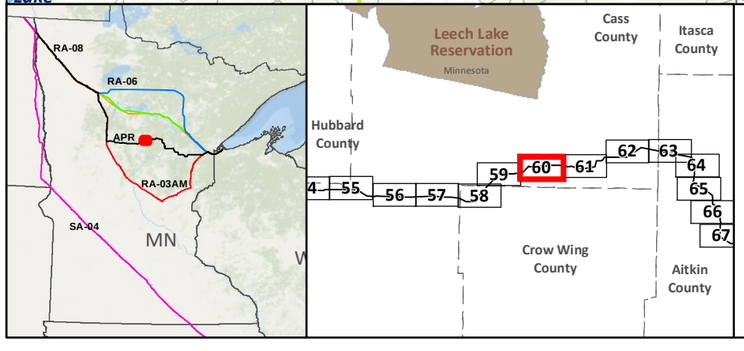
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T139 R28W S12
T139 R27W S7
T139 R27W S8
T139 R27W S9
T139 R27W S10
T139 R27W S11
T139 R27W S12
T139 R28W S13
T139 R27W S18
T139 R27W S17
T139 R27W S16
T139 R27W S15
T139 R27W S14
T139 R27W S13
APR
Trelipe Twsp Cass Co.
256
255
257
258
259
Blind Lake Twsp Cass Co.
T139 R28W S24
T139 R27W S19
T139 R27W S20
First Dog Lake
T139 R27W S21
West Dog Lake
Second Dog Lake
T139 R27W S22
T139 R27W S23
254
T139 R28W S25
T139 R27W S30
T139 R27W S29
T139 R27W S28
T139 R27W S27
T139 R27W S26
T139 R27W S24
T139 R27W S25
Unnamed Stream
Hay Creek
Dirty House Lake
Lee Lake
Stony Lake
Pistol Lake



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

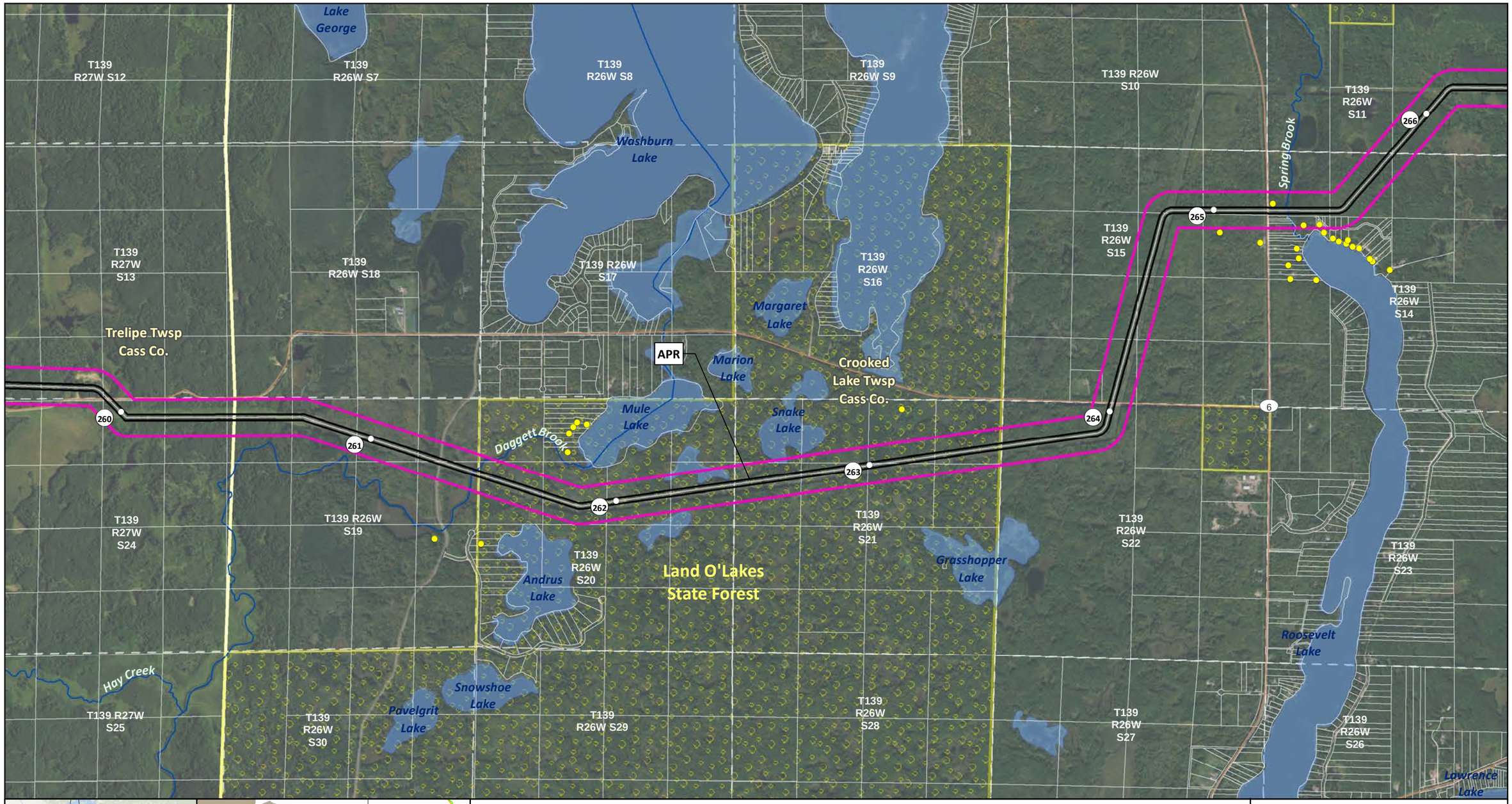
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

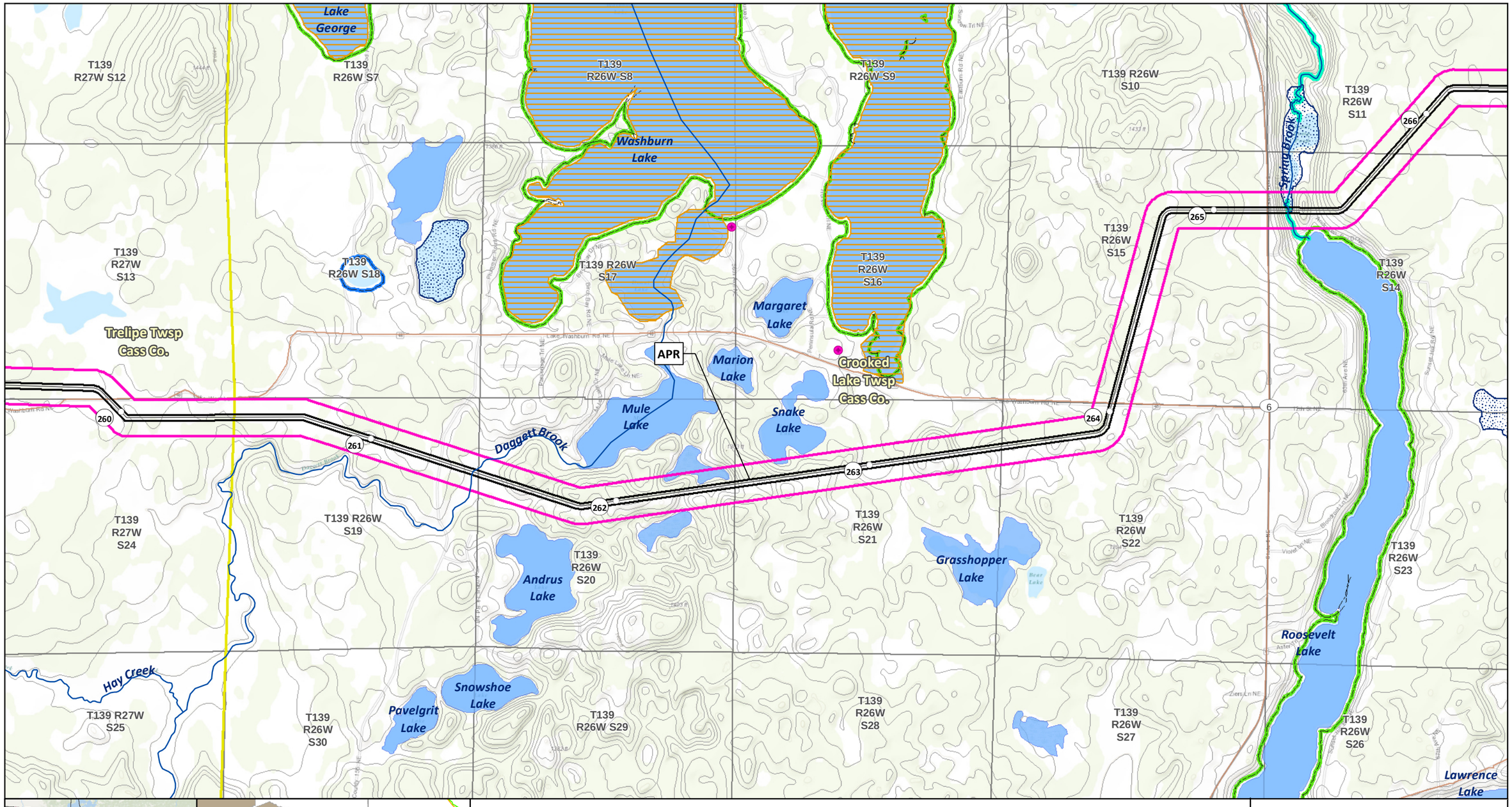
Map 60B of 82



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 61A of 82



SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Route Segment Alternatives (RSA)

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding High Moderate

Native Plant Communities with Biodiversity Significance

Outstanding High Moderate

Terminal Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

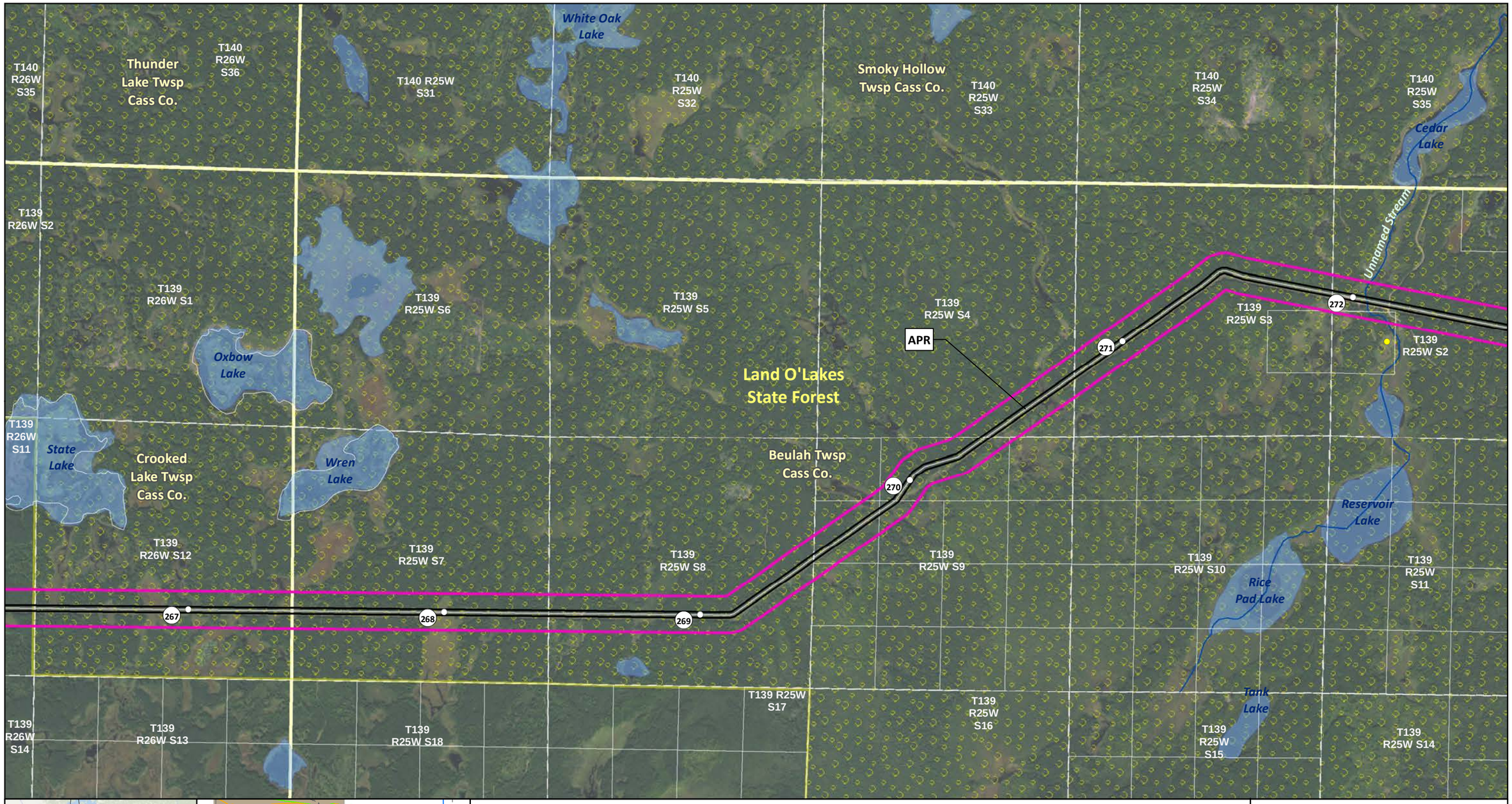
0 0.125 0.25 0.5 Miles

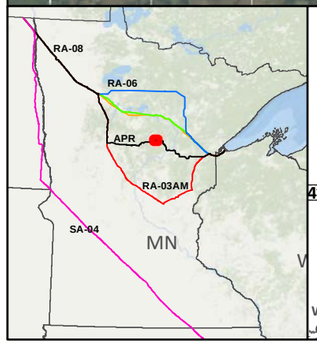
1:24,000

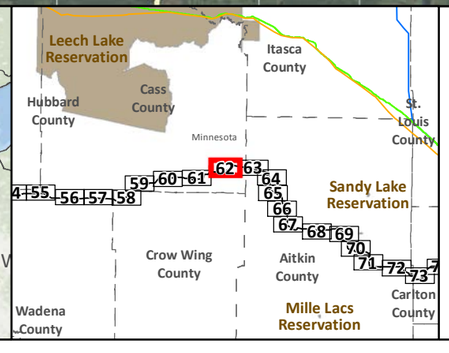
0 125 250 500 Meters 10ft Contours

N

Map 61B of 82







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

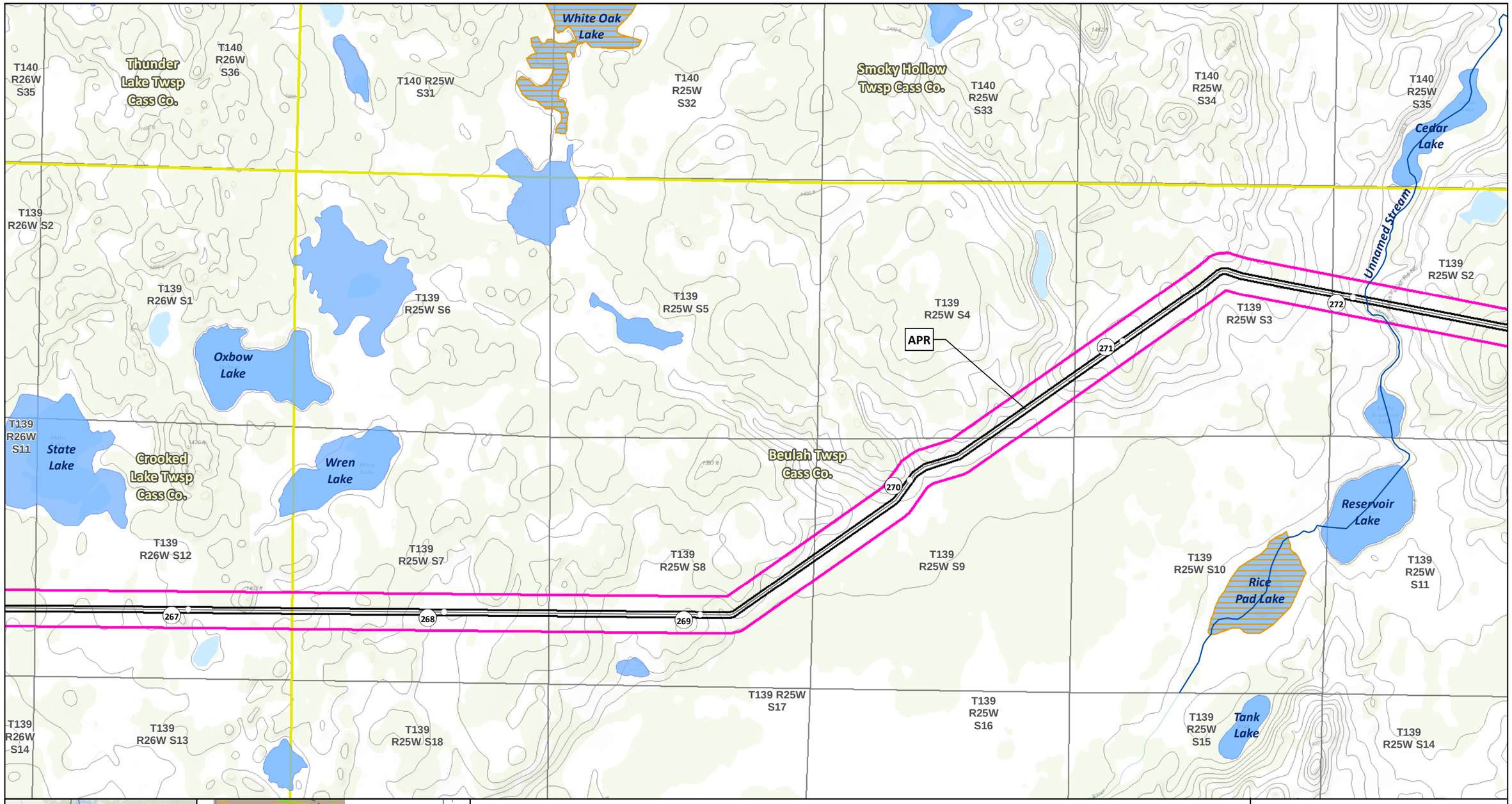
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

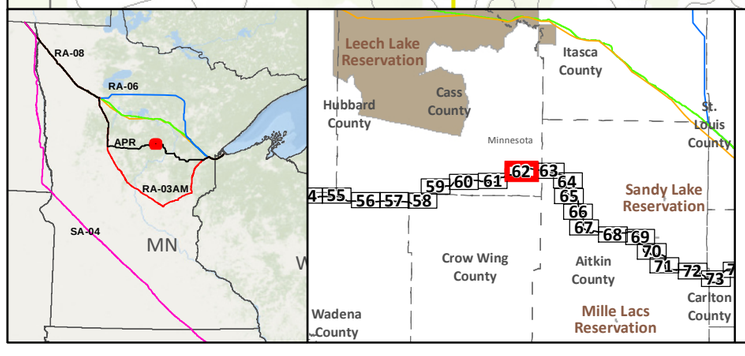
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

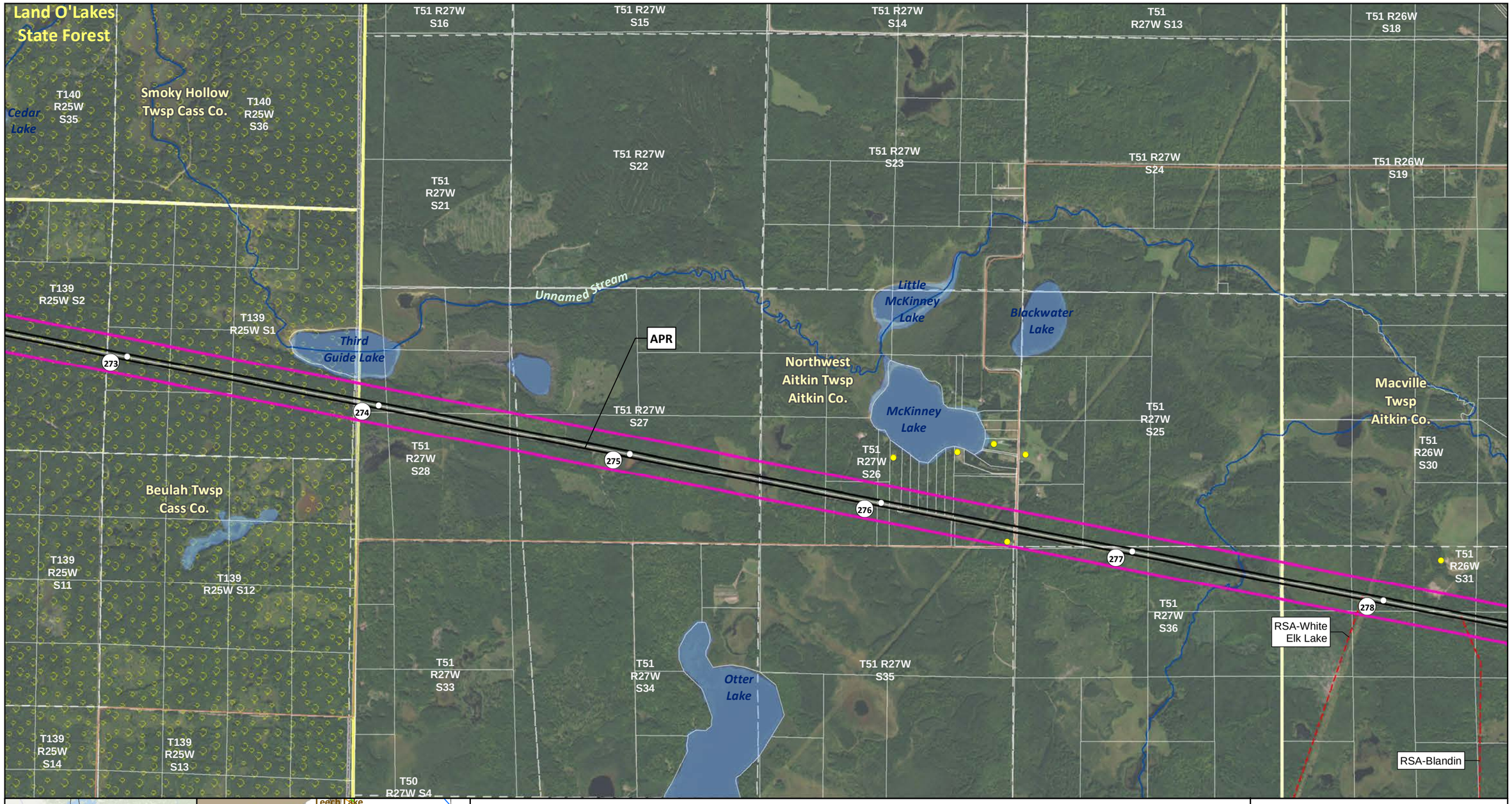
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

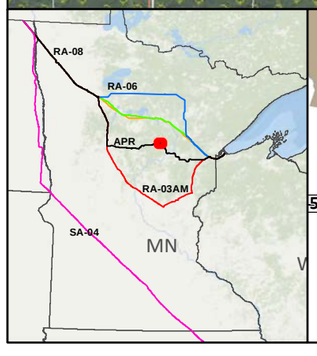
APR

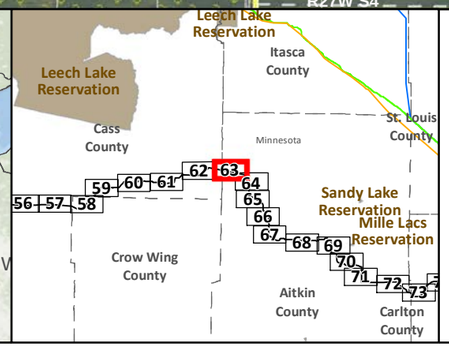
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 62B of 82







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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- RA-08
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- Route Segment Alternatives (RSA)

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- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

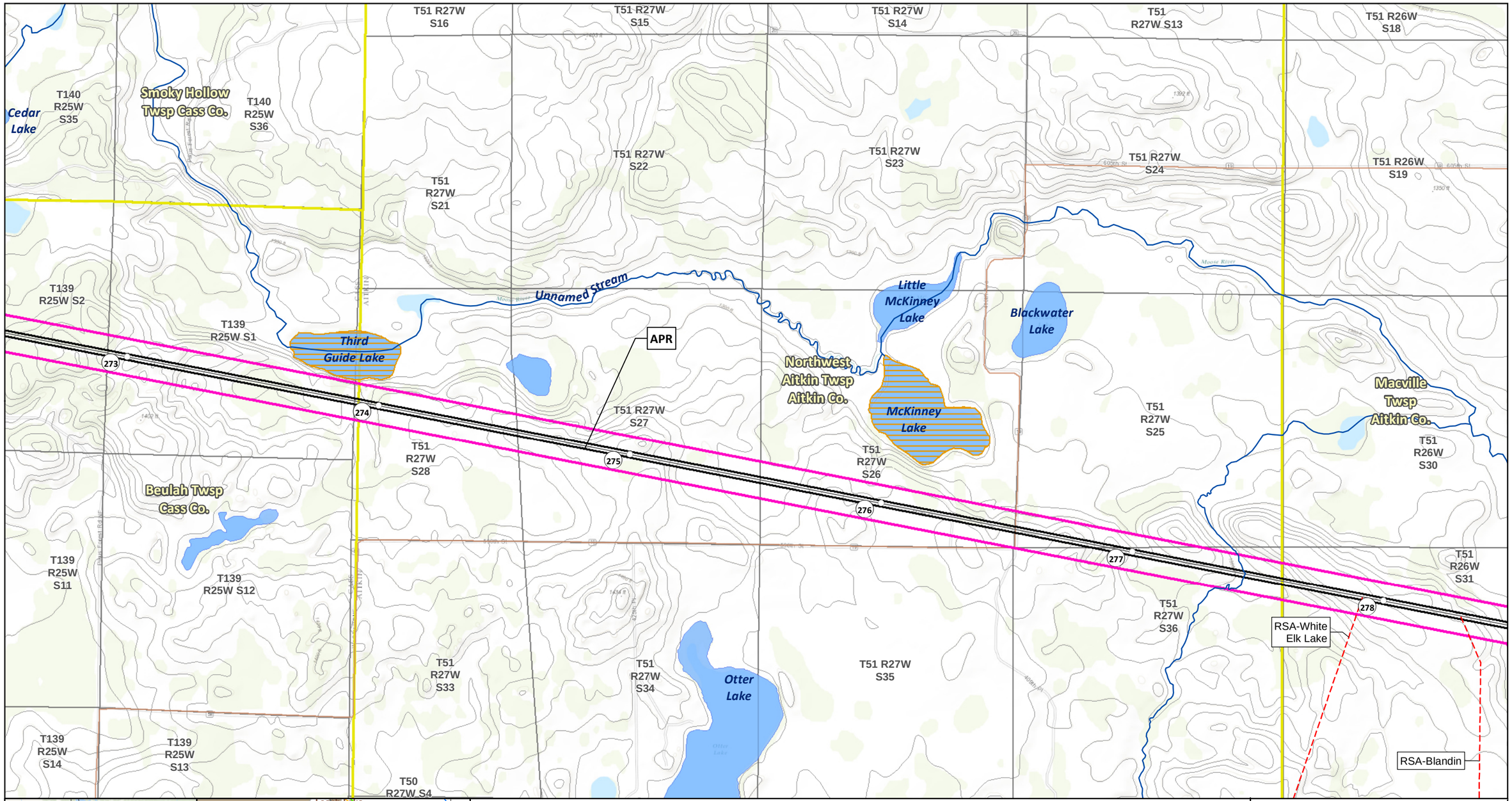
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

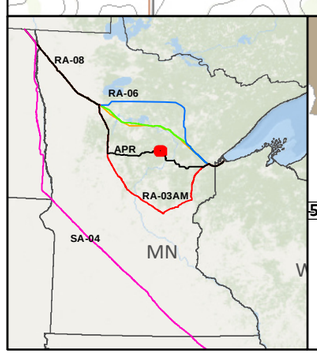
Data Sources: MNDNR, NHD, Enbridge

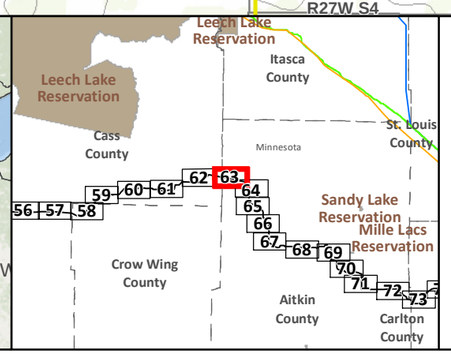
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







- SA-04
- Applicant's Preferred Route (APR)

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Native Plant Communities with Biodiversity Significance
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

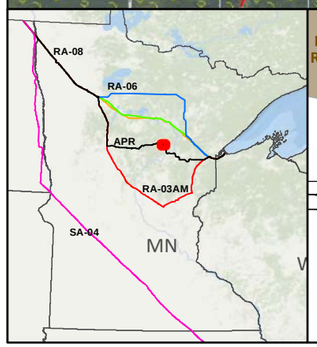
APR

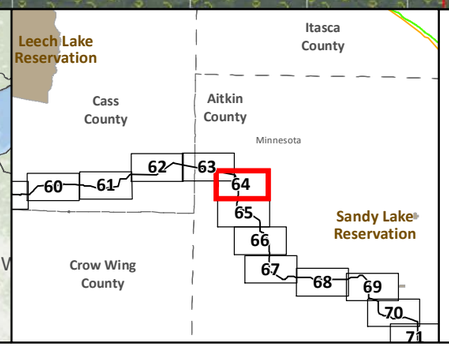
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 63B of 82

T51 R27W S26
T51 R27W S25
T51 R26W S30
T51 R26W S29
T51 R26W S28
T51 R26W S27
T51 R26W S26
277
278
Unnamed Stream
Moose Lake
Macville Twsp Aitkin Co.
RSA-22
RSA-21
T51 R27W S36
T51 R27W S35
T51 R26W S31
T51 R26W S32
T51 R26W S34
T51 R26W S33
T51 R26W S35
RSA-23
Buss Lake
RSA-White Elk Lake
T50 R27W S2
T50 R27W S1
T50 R26W S6
T50 R26W S5
T50 R26W S4
T50 R26W S3
T50 R26W S2
RSA-Blandin
280
APR
169
Hill River State Forest
Northwest Aitkin Twsp Aitkin Co.
T50 R27W S11
T50 R27W S12
T50 R26W S7
T50 R26W S8
T50 R26W S9
T50 R26W S10
T50 R26W S11
281





- SA-04
- Applicant's Preferred Route (APR)

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- RA-07
- RA-08
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- Route Width (750')
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- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

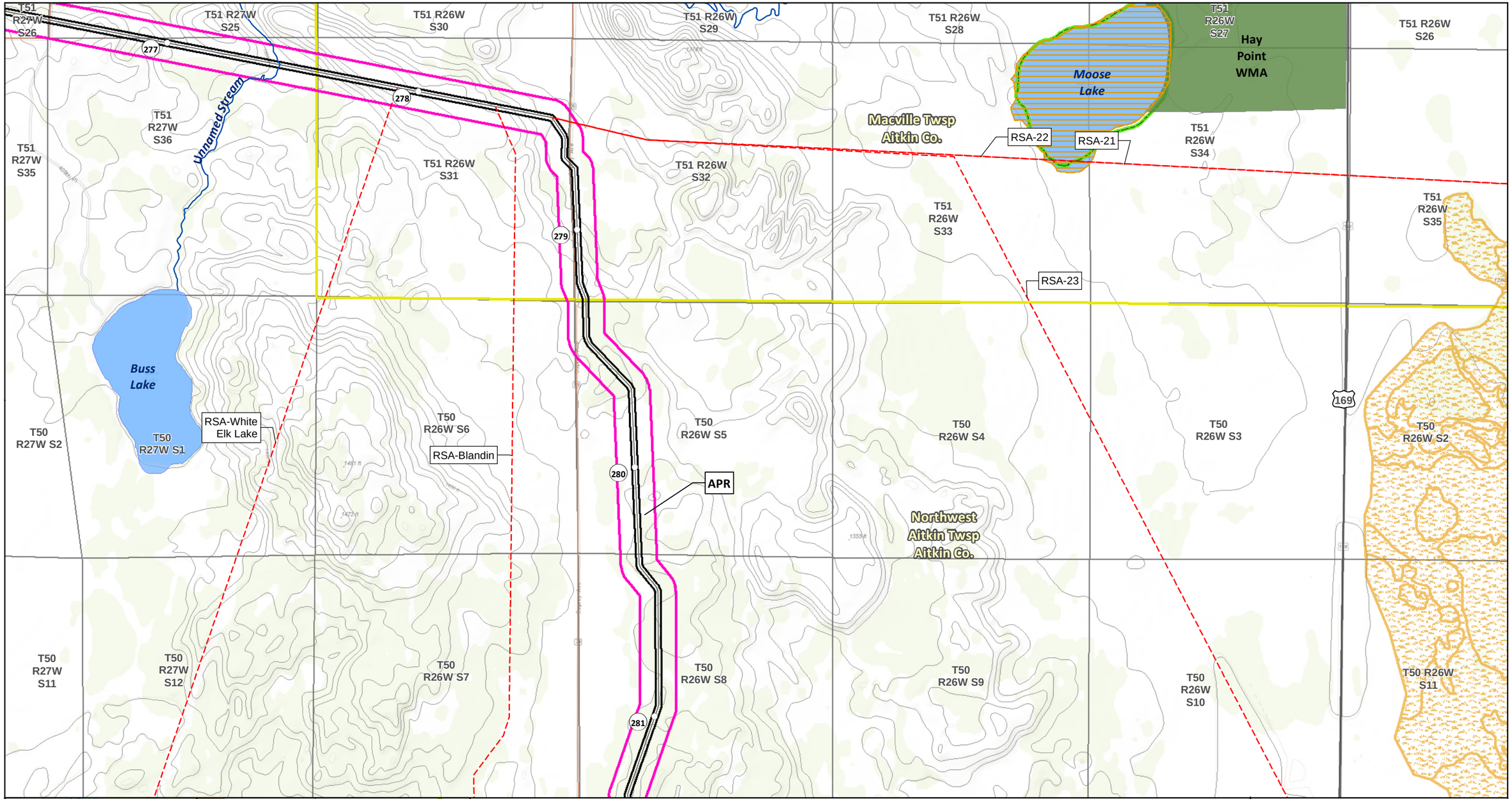
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T51 R27W S26
T51 R27W S25
T51 R26W S30
T51 R26W S29
T51 R26W S28
T51 R26W S27
T51 R26W S26
277
278
Unnamed Stream
T51 R27W S36
T51 R27W S35
T51 R26W S31
T51 R26W S32
Moose Lake
Hay Point WMA
Macville Twsp
Aitkin Co.
RSA-22
RSA-21
T51 R26W S34
T51 R26W S33
T51 R26W S35
RSA-23
279
Buss Lake
RSA-White Elk Lake
T50 R27W S2
T50 R27W S1
T50 R26W S6
RSA-Blandin
T50 R26W S5
T50 R26W S4
T50 R26W S3
169
280
APR
Northwest Aitkin Twsp
Aitkin Co.
T50 R26W S2
T50 R27W S11
T50 R27W S12
T50 R26W S7
T50 R26W S8
T50 R26W S9
T50 R26W S10
T50 R26W S11
281
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Leech Lake Reservation
Itasca County
Cass County
Aitkin County
Minnesota
Crow Wing County
Sandy Lake Reservation
60
61
62
63
64
65
66
67
68
69
70
71
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
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Mile Post
Anticipated 120' Construction ROW
Route Width (750')
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State Managed Lands
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303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
N
Map 64B of 82

RSA-White Elk Lake

T50 R27W S14

Hill River State Forest

T50 R27W S13

T50 R26W S18

RSA-Blandin

T50 R26W S8

T50 R26W S9

T50 R26W S10

T50 R26W S11

282

T50 R26W S17

T50 R26W S16

T50 R26W S15

T50 R26W S14

RSA-23

White Elk Lake

283

APR

T50 R26W S19

T50 R27W S24

T50 R26W S20

Northwest Aitkin Twsp Aitkin Co.

T50 R26W S21

T50 R26W S22

169

T50 R26W S23

284

T50 R27W S23

RSA-White Elk Lake

Unnamed Stream

T50 R27W S26

285

T50 R27W S25

T50 R26W S30

Kingsleys Pothole

T50 R26W S29

T50 R26W S28

T50 R26W S27

T50 R26W S26

T50 R27W S35

T50 R27W S36

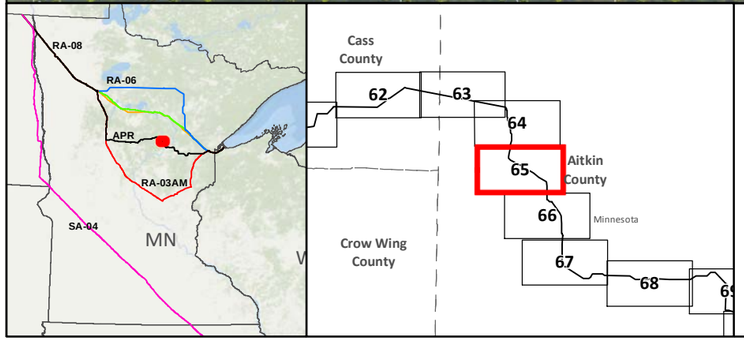
T50 R26W S31

T50 R26W S32

T50 R26W S33

T50 R26W S34

T50 R26W S35



- SA-04
- Applicant's Preferred Route (APR)

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- Tribal Reservation
- Tribal Trust Land
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Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 65A of 82

RSA-White Elk Lake

T50 R27W S14

T50 R27W S13

T50 R26W S18

RSA-Blandin

T50 R26W S8

T50 R26W S9

T50 R26W S10

T50 R26W S11

T50 R26W S17

T50 R26W S16

T50 R26W S15

T50 R26W S14

RSA-23

White Elk Lake

282

283

APR

T50 R26W S20

Northwest Aitkin Twsp Aitkin Co.

T50 R26W S21

T50 R26W S22

169

T50 R26W S23

T50 R27W S24

T50 R26W S19

T50 R27W S23

284

RSA-White Elk Lake

Unnamed Stream

285

T50 R27W S26

T50 R27W S25

T50 R26W S30

Kingsleys Pothole

T50 R26W S29

T50 R26W S28

T50 R26W S27

T50 R26W S26

T50 R27W S35

T50 R27W S36

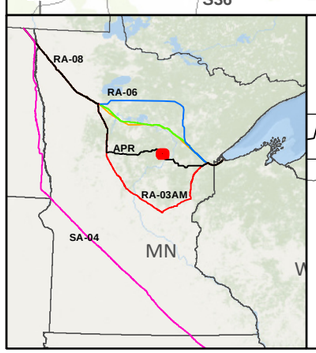
T50 R26W S31

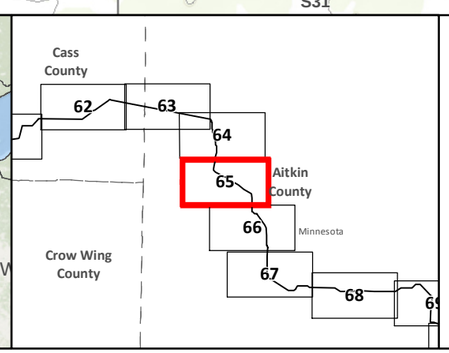
T50 R26W S32

T50 R26W S33

T50 R26W S34

T50 R26W S35





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Route Segment Alternatives (RSA)

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

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Navigable Waterway Crossings

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303d Imparied Waters

Designated Trout Stream

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Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding

High

Moderate

Native Plant Communities with Biodiversity Significance

Outstanding

High

Moderate

Terminal

Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

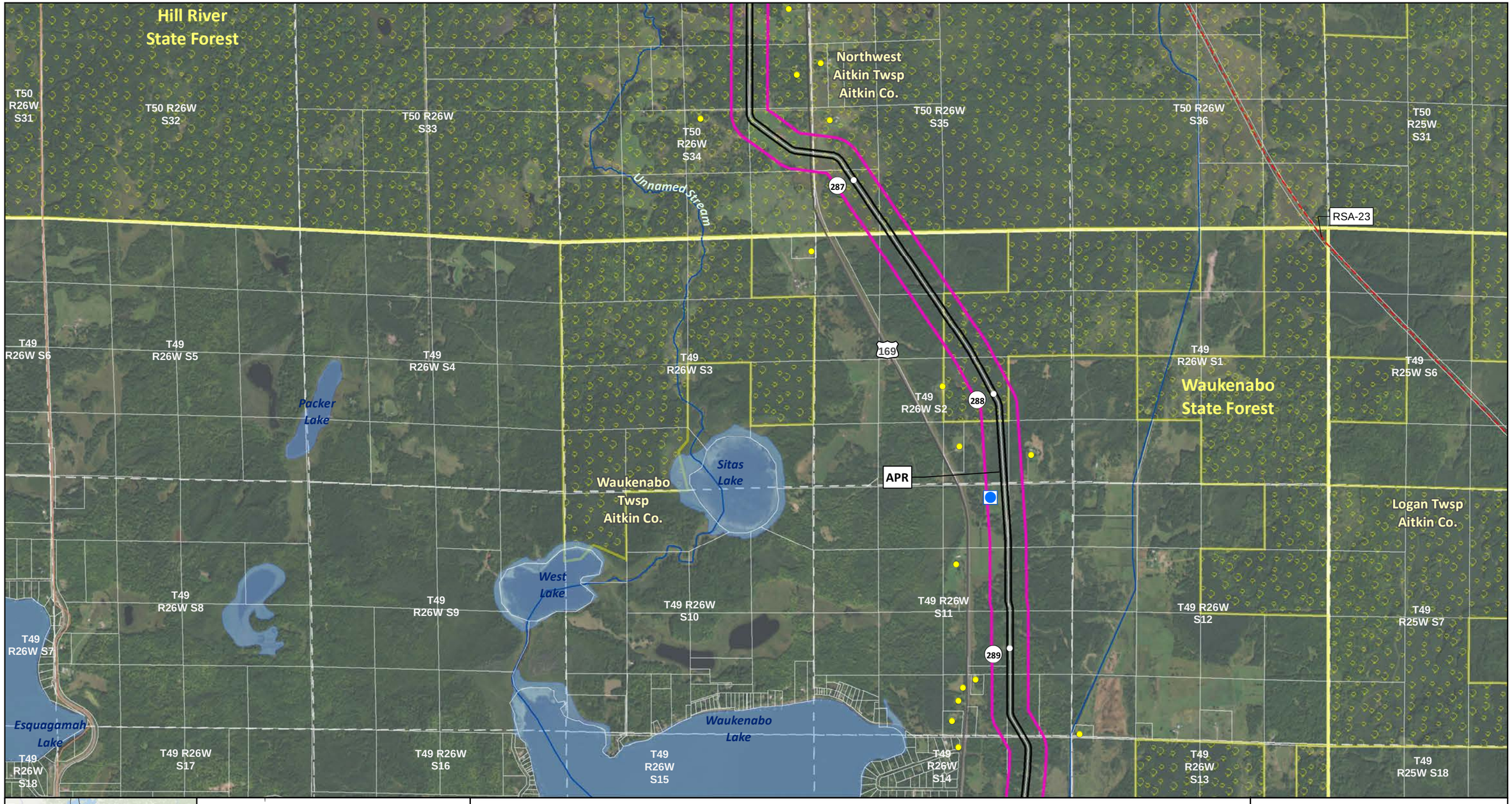
0 0.125 0.25 0.5 Miles

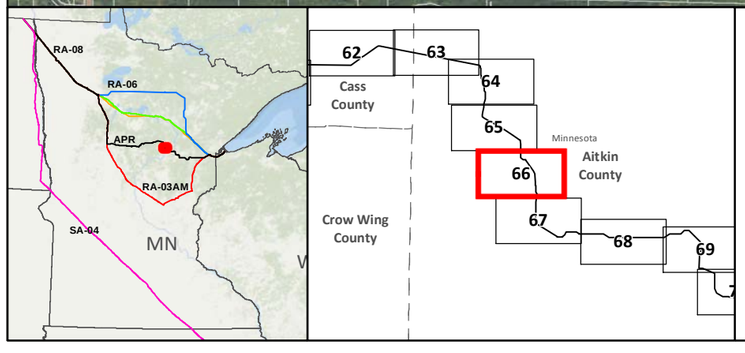
1:24,000

0 125 250 500 Meters 10ft Contours

N

Map 65B of 82





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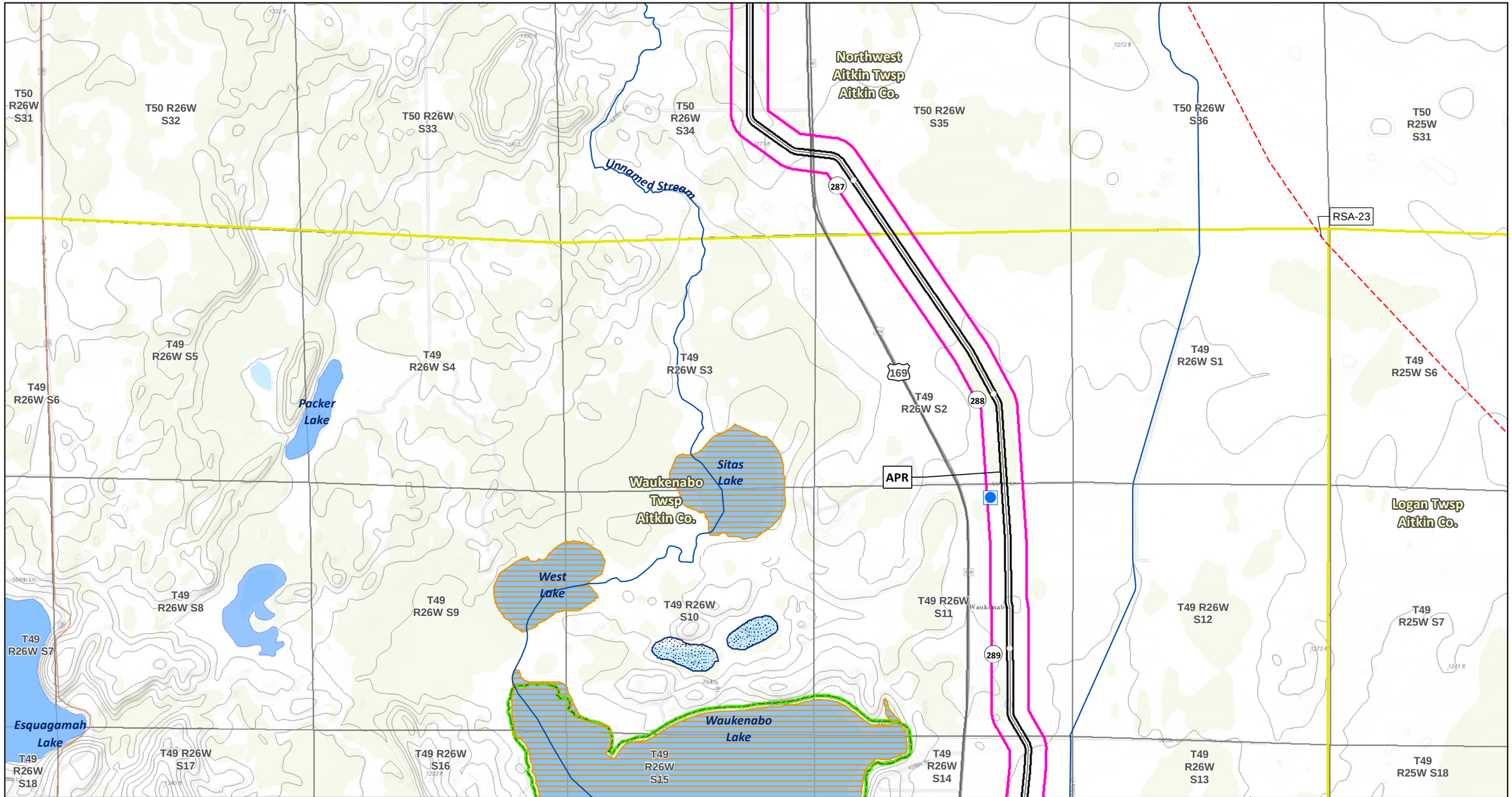

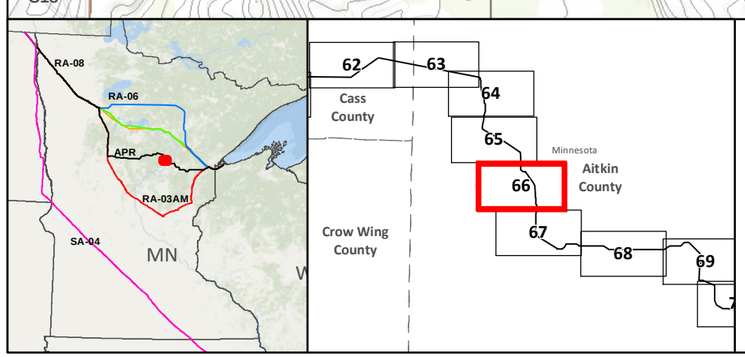

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APR

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1:24,000
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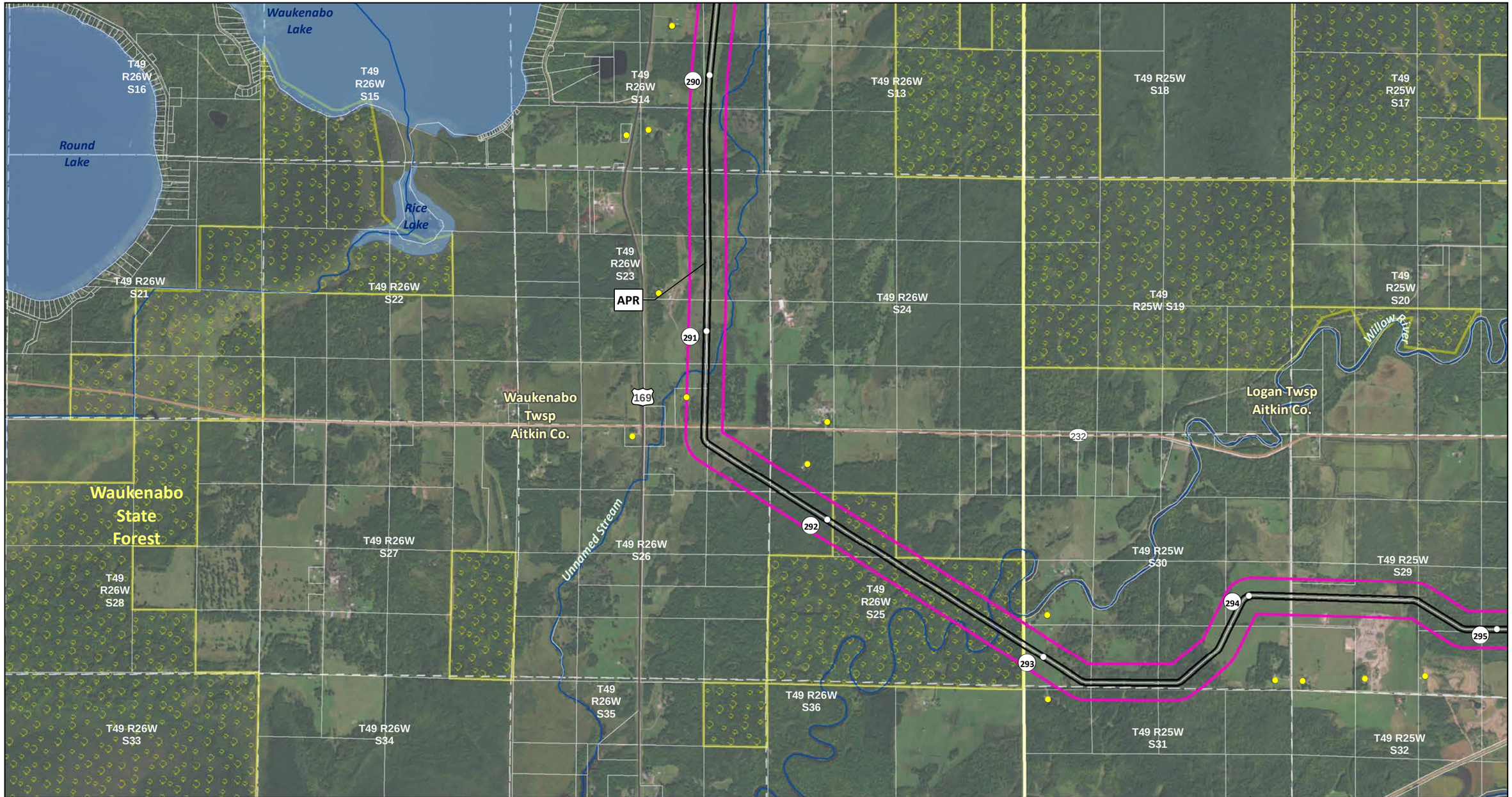
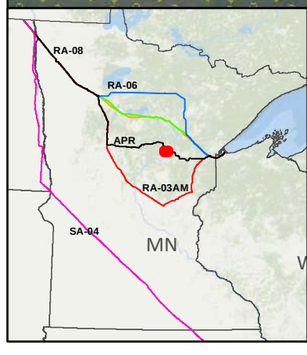
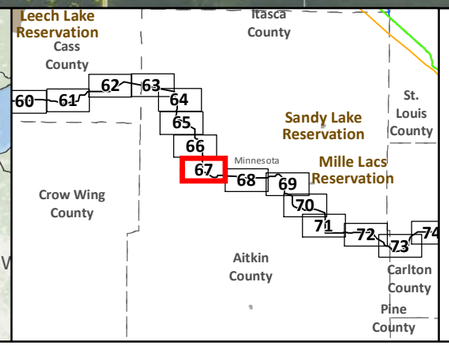
N

Map 66B of 82







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Residences within 1/2 mile
Mile Post
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Pump Station

Interstate
Highway
Major Road

Land Ownership
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0 0.125 0.25 0.5 Miles
1:24,000
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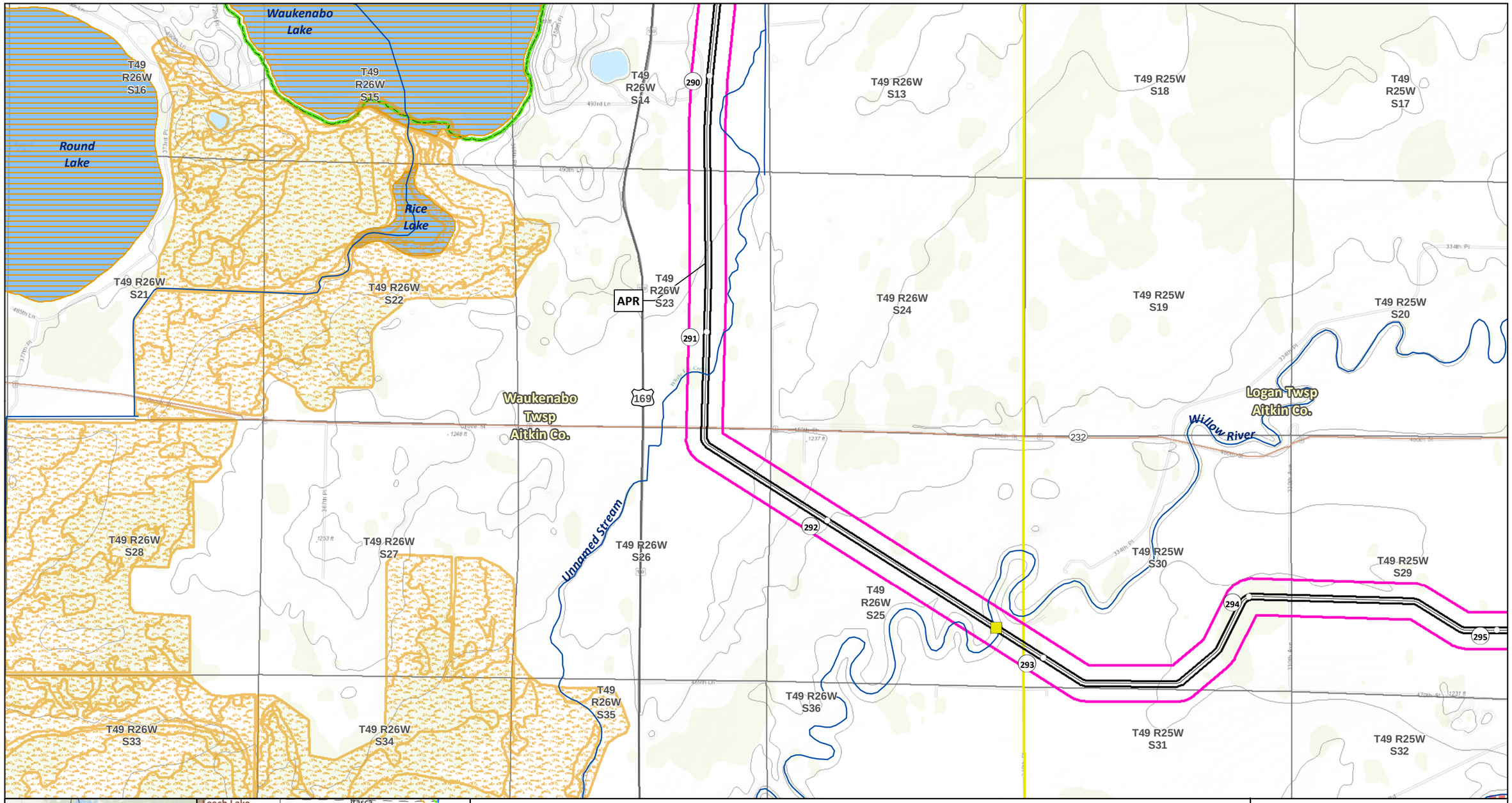
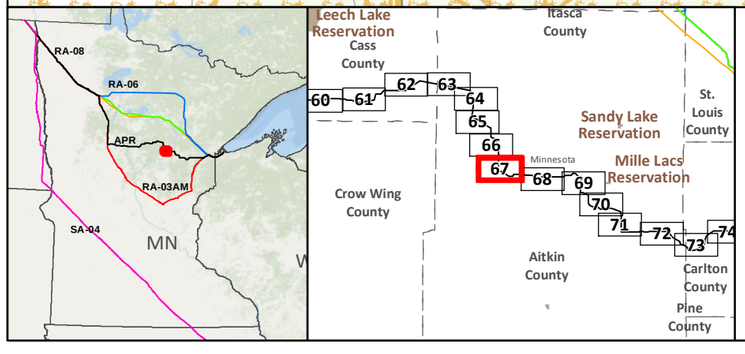
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 67A of 82





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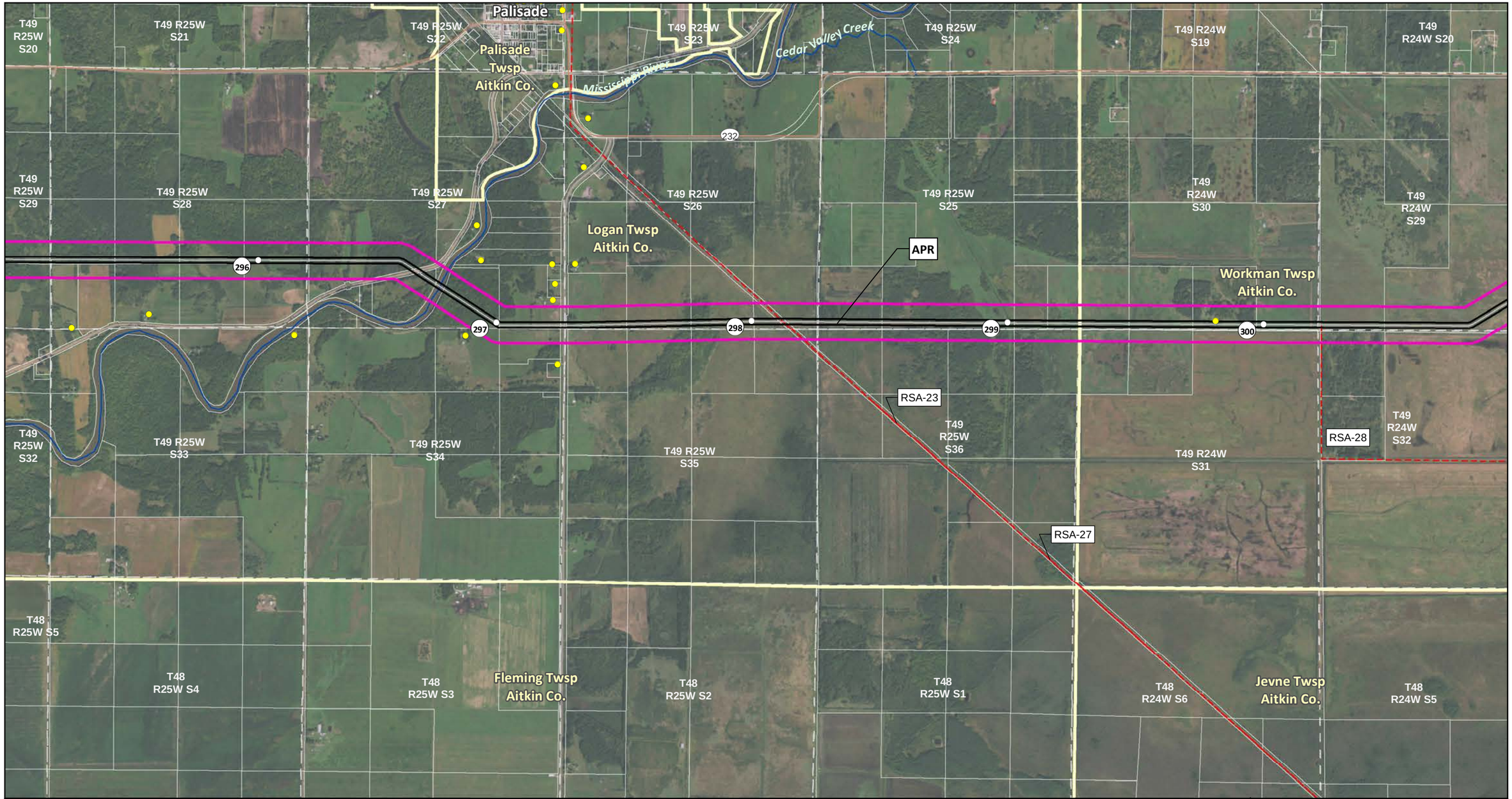
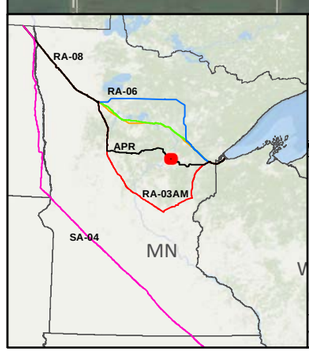
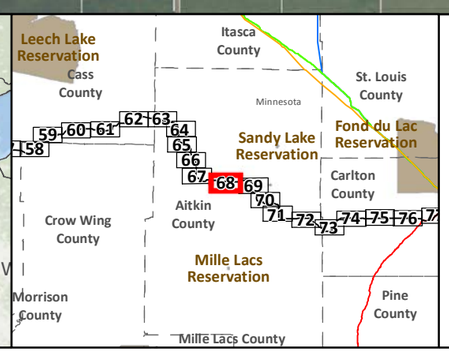
1:24,000
0 125 250 500 Meters 10ft Contours







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Township Boundary

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

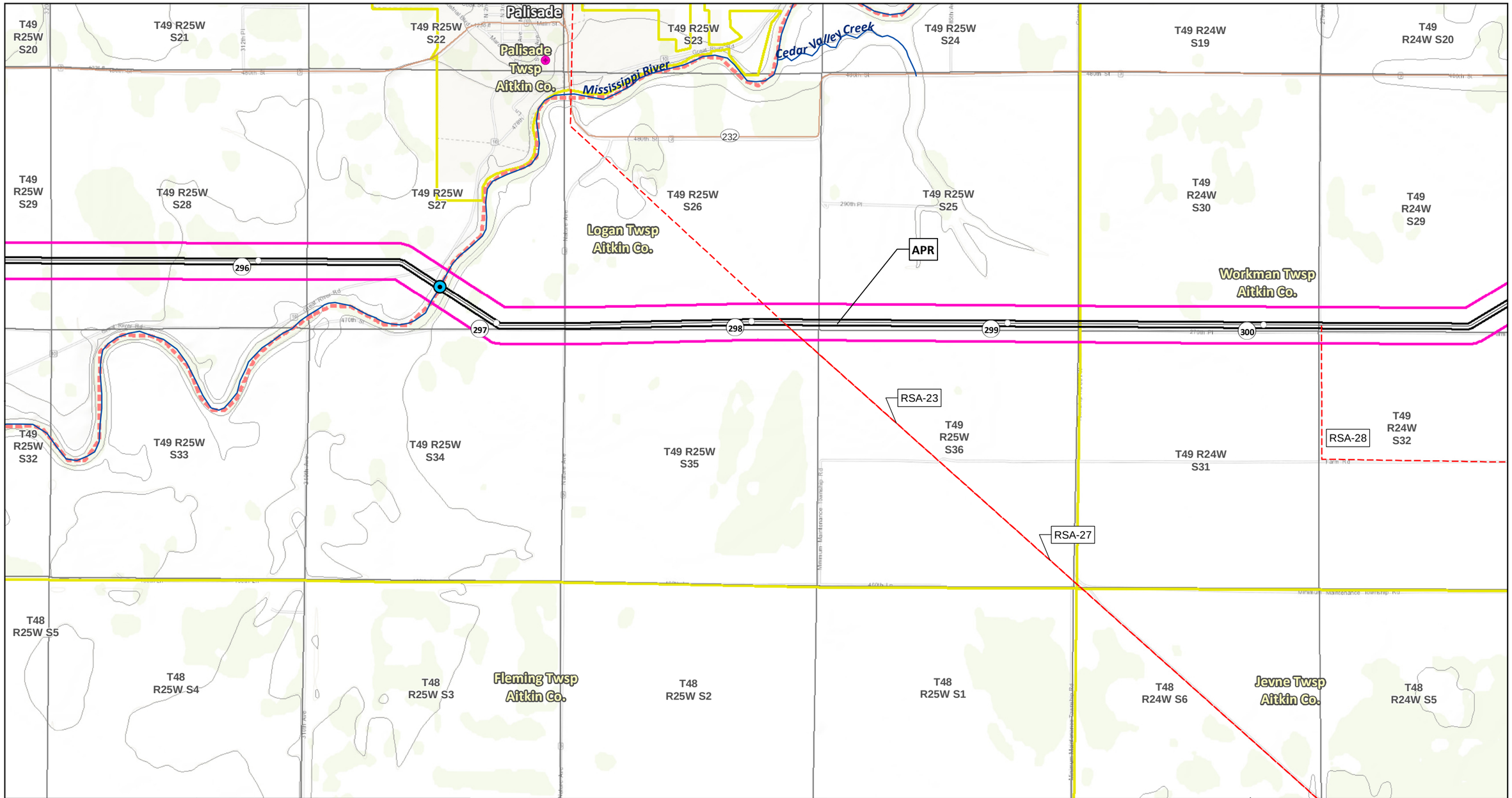
0 0.125 0.25 0.5 Miles

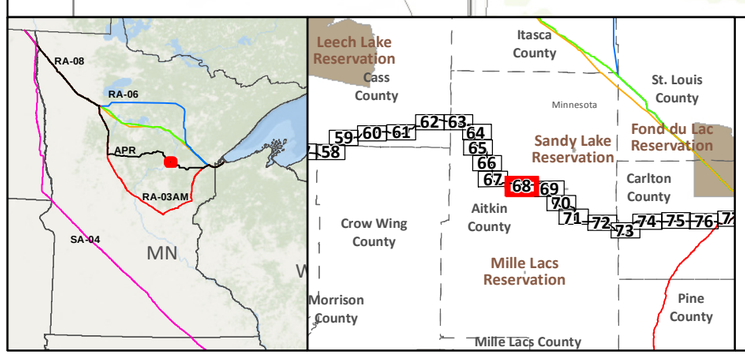
1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

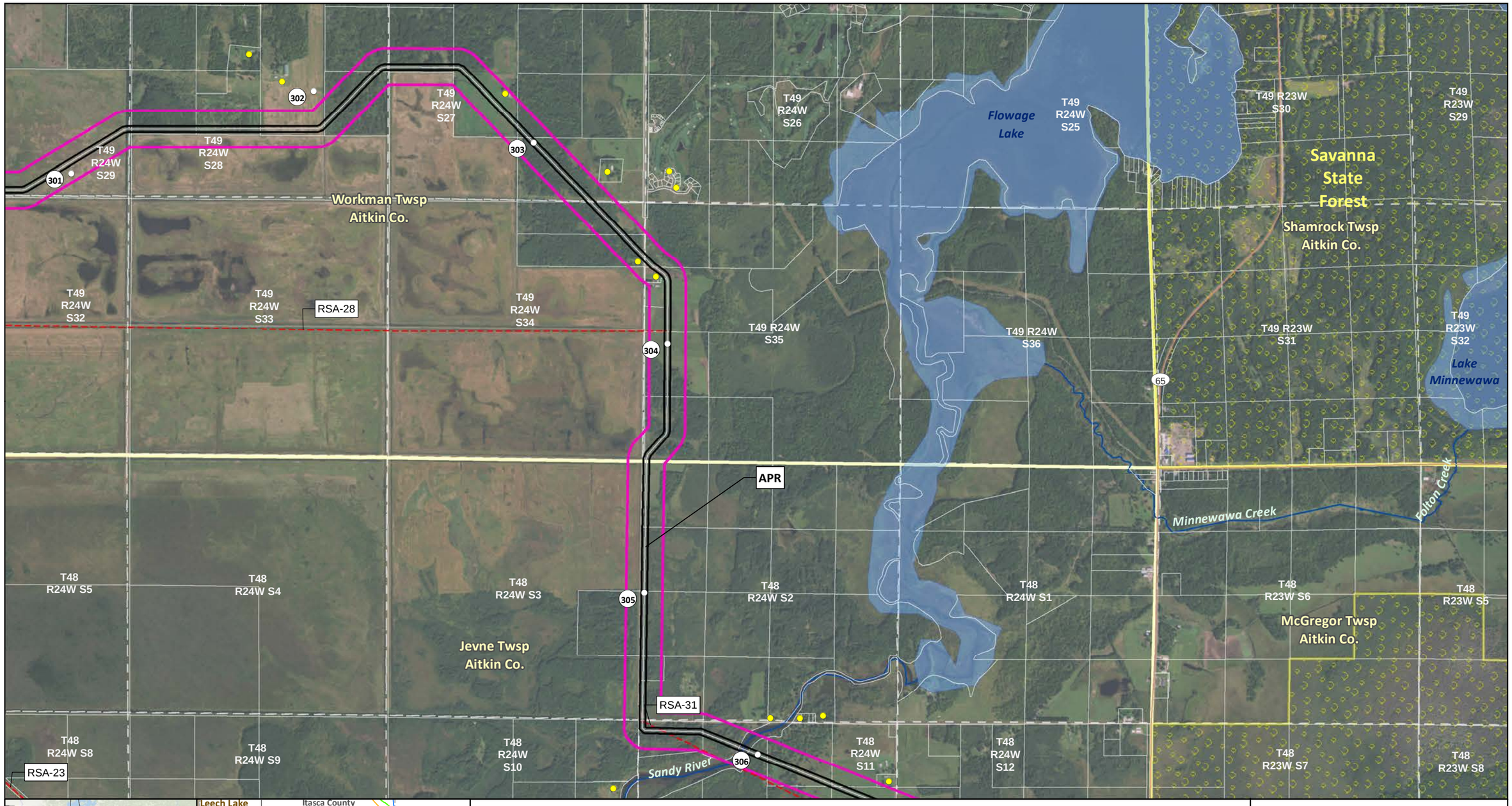
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

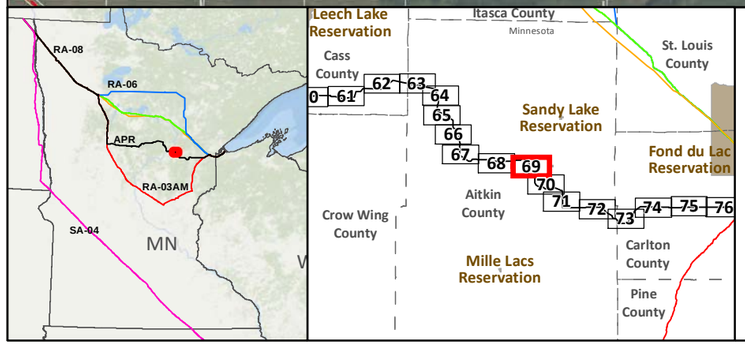
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 68B of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

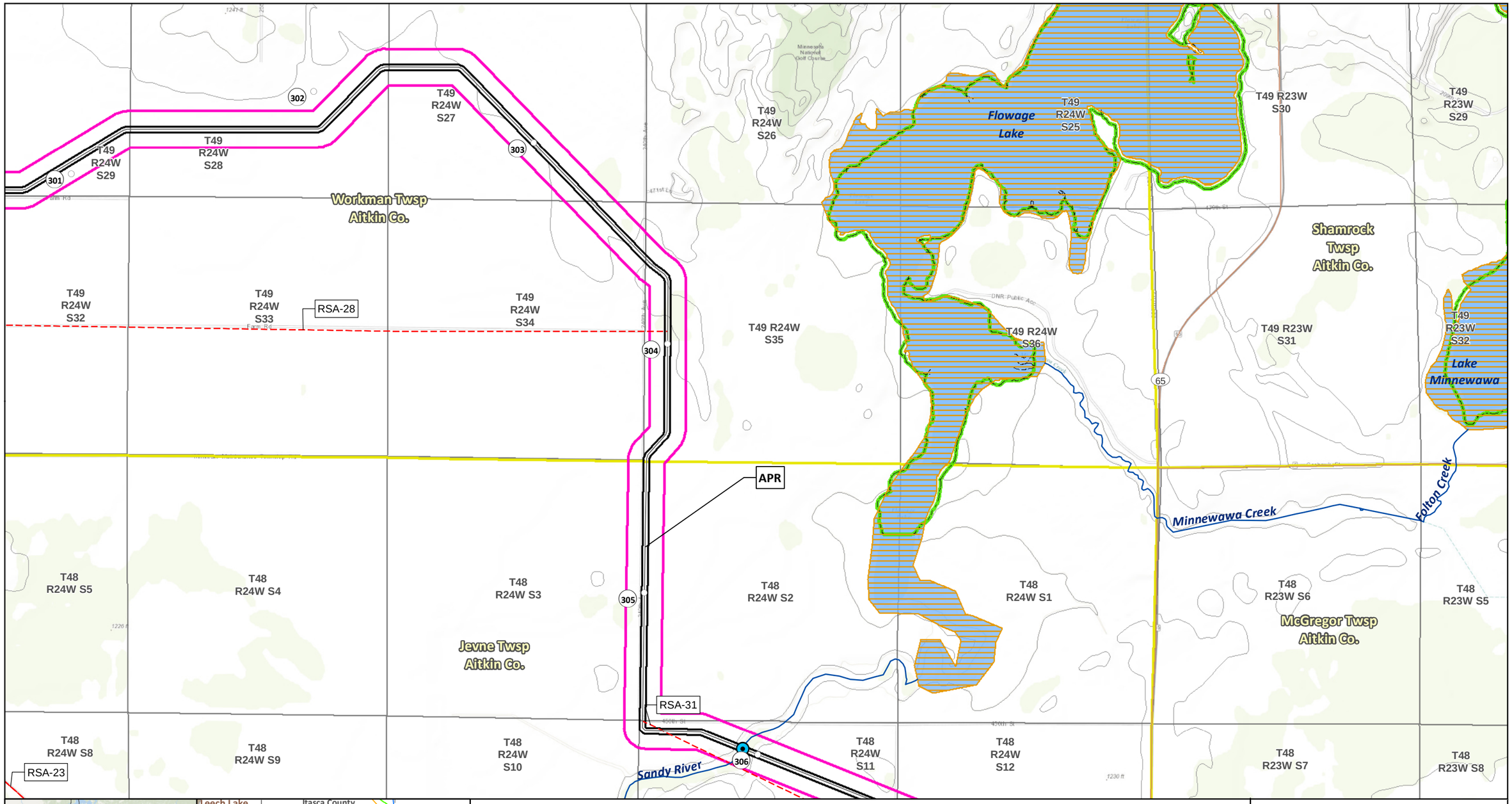
Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

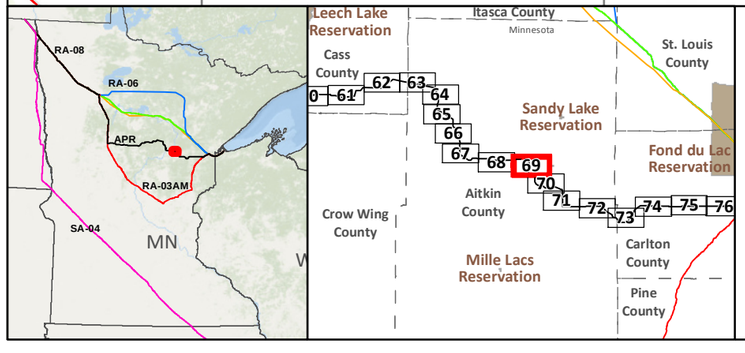
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

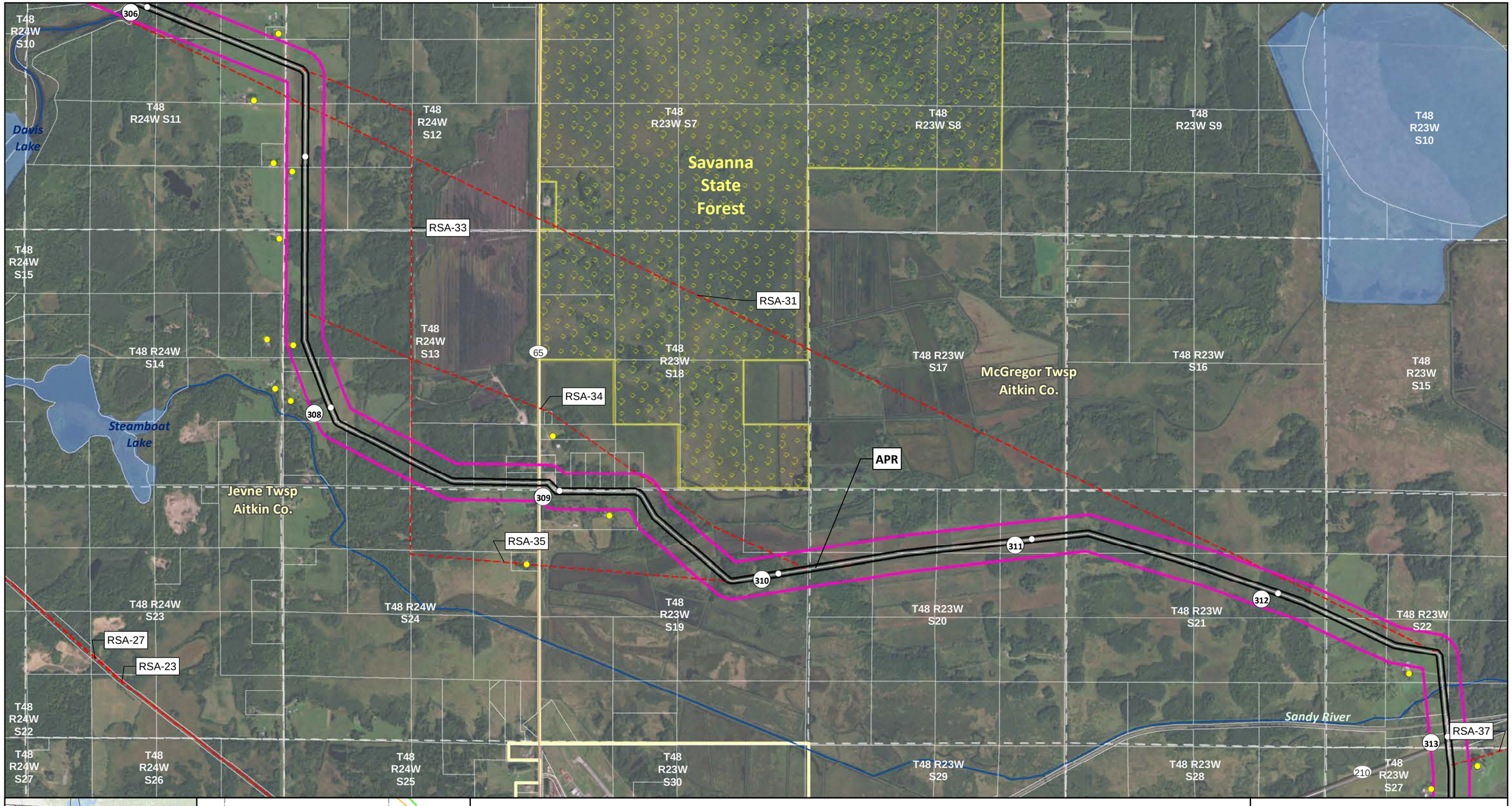
Data Sources:
MNDNR, USGS, NHD, Enbridge

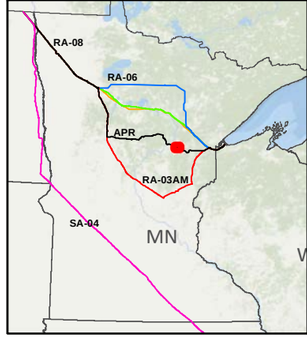
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

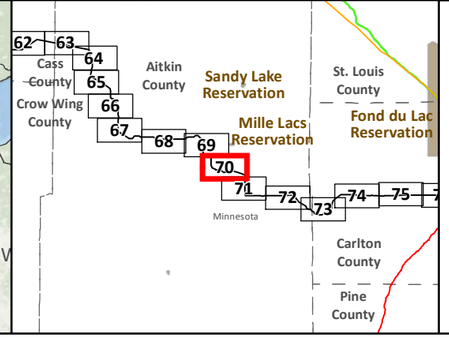
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 69B of 82







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

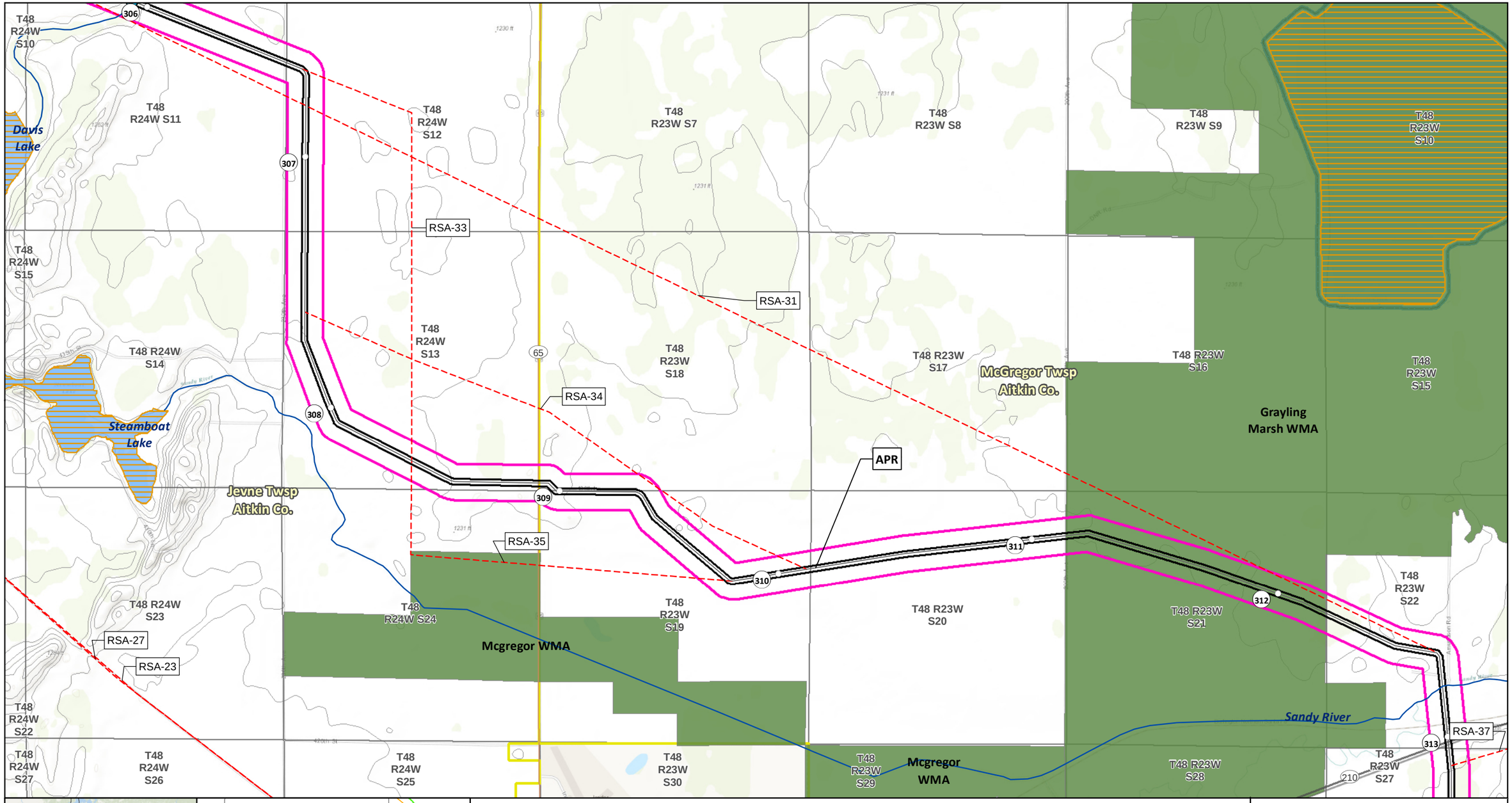
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

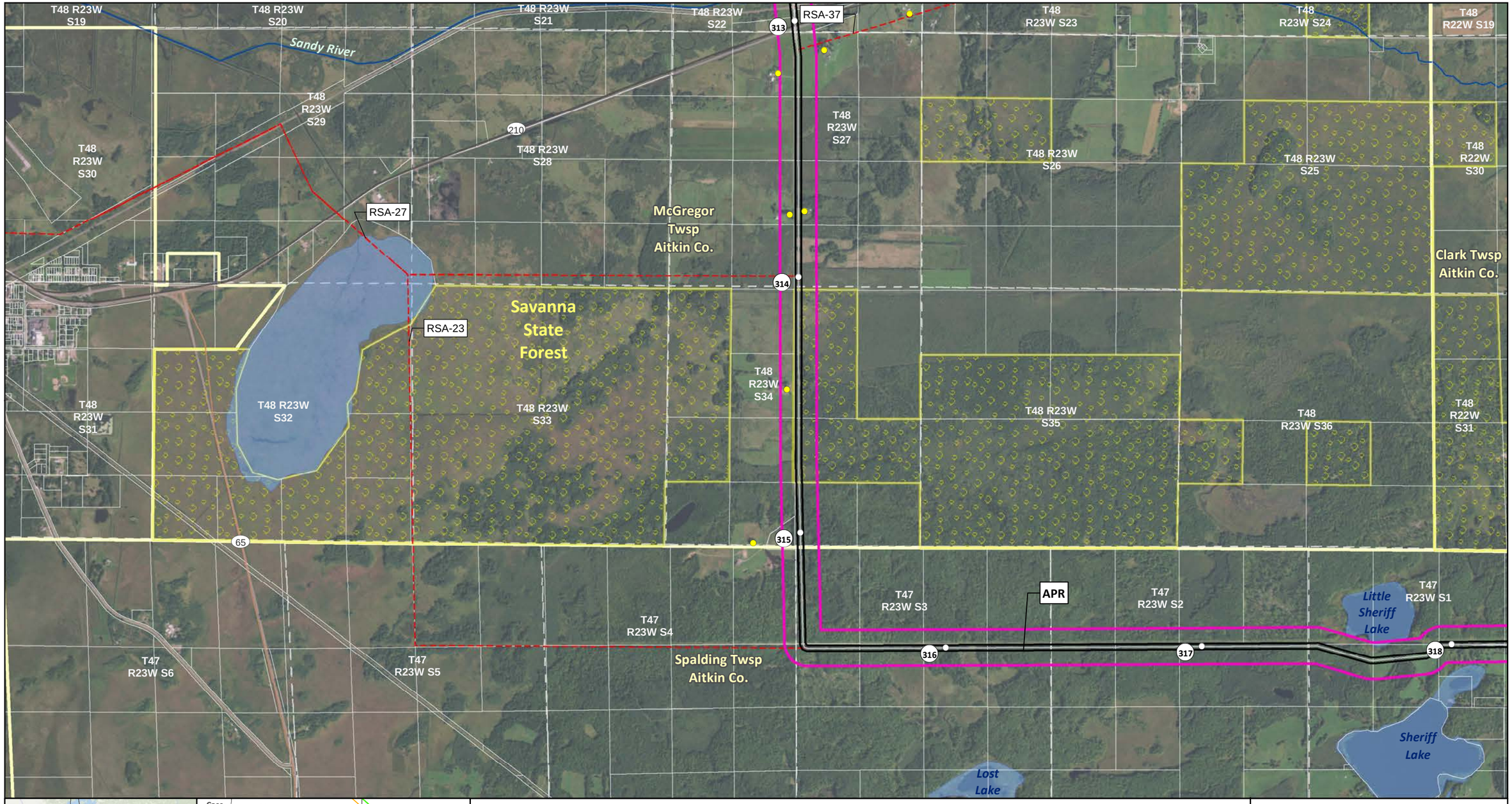
Data Sources: MNDNR, NHD, Enbridge

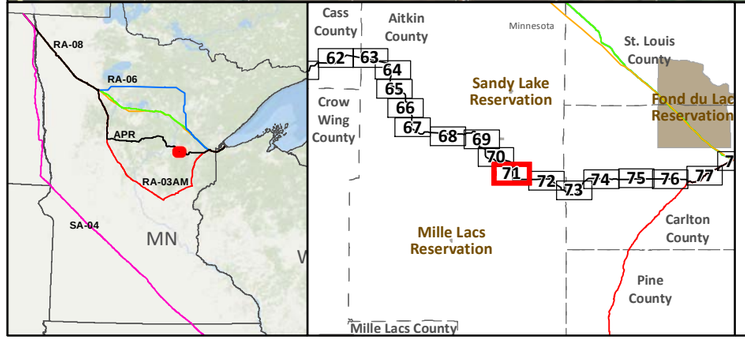
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T48 R24W S10
T48 R24W S11
T48 R24W S12
T48 R23W S7
T48 R23W S8
T48 R23W S9
T48 R23W S10
Davis Lake
306
307
RSA-33
T48 R24W S15
RSA-31
T48 R24W S13
T48 R23W S18
T48 R23W S17
T48 R23W S16
T48 R23W S15
T48 R24W S14
65
RSA-34
McGregor Twsp Aitkin Co.
Grayling Marsh WMA
Steamboat Lake
308
APR
309
Jevne Twsp Aitkin Co.
RSA-35
310
311
312
T48 R24W S23
T48 R23W S19
T48 R23W S20
T48 R23W S21
T48 R23W S22
RSA-27
RSA-23
Mcgregor WMA
T48 R24W S24
Sandy River
T48 R24W S22
T48 R24W S27
T48 R24W S26
T48 R24W S25
T48 R23W S30
T48 R23W S29
Mcgregor WMA
T48 R23W S28
313
RSA-37
210
T48 R23W S27
RA-08
RA-06
APR
RA-03AM
SA-04
MN
62
63
64
65
66
67
68
69
70
71
72
73
74
75
Cass County
Crow Wing County
Aitkin County
Sandy Lake Reservation
Mille Lacs Reservation
St. Louis County
Fond du Lac Reservation
Minnesota
Carlton County
Pine County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 70B of 82





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road

Land Ownership

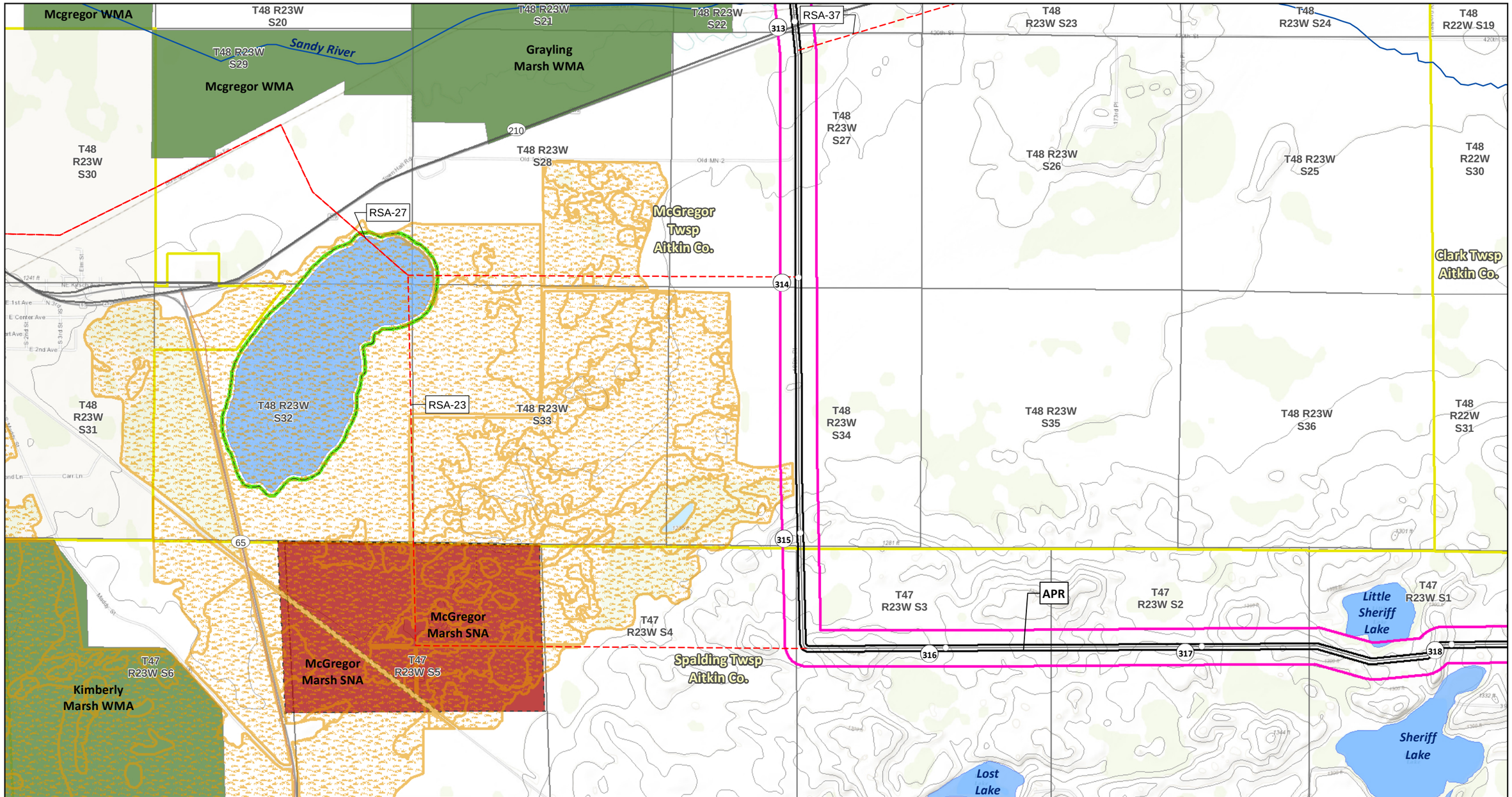
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

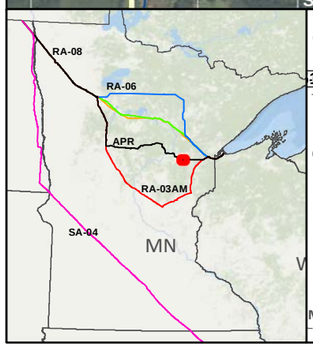
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

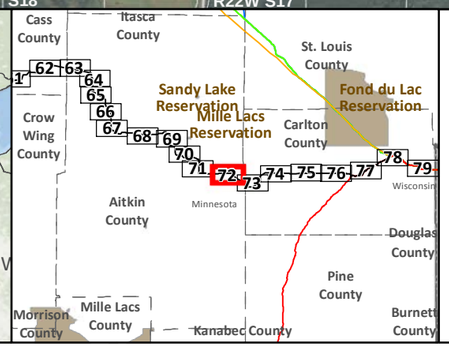
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


Mcgregor WMA
T48 R23W S20
T48 R23W S21
T48 R23W S22
RSA-37
T48 R23W S23
T48 R23W S24
T48 R22W S19
T48 R23W S29
Sandy River
Mcgregor WMA
Grayling Marsh WMA
313
210
T48 R23W S27
T48 R23W S30
T48 R23W S28
T48 R23W S26
T48 R23W S25
T48 R22W S30
RSA-27
McGregor Twsp Aitkin Co.
314
Clark Twsp Aitkin Co.
T48 R23W S32
RSA-23
T48 R23W S33
T48 R23W S31
T48 R23W S34
T48 R23W S35
T48 R23W S36
T48 R22W S31
65
315
McGregor Marsh SNA
T47 R23W S4
T47 R23W S3
APR
T47 R23W S2
T47 R23W S1
Little Sheriff Lake
T47 R23W S6
Kimberly Marsh WMA
McGregor Marsh SNA
T47 R23W S5
Spalding Twsp Aitkin Co.
316
317
318
Sheriff Lake
Lost Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Cass County
Aitkin County
Minnesota
St. Louis County
Crow Wing County
Sandy Lake Reservation
Fond du Lac Reservation
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
Mille Lacs Reservation
Carlton County
Pine County
Mille Lacs County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 71B of 82

Savanna State Forest
Clark Twsp Aitkin Co.
Lakeview Twsp Carlton Co.
Sandy River
Rice Lake
Unnamed Stream
APR
T48 R22W S31
T48 R22W S32
T48 R22W S33
T48 R22W S34
T48 R22W S35
T48 R22W S36
T48 R21W S31
T47 R23W S1
T47 R22W S6
T47 R22W S5
T47 R22W S4
T47 R22W S3
T47 R22W S2
T47 R22W S1
Spalding Twsp Aitkin Co.
Salo Twsp Aitkin Co.
T47 R23W S12
T47 R22W S7
T47 R22W S8
T47 R22W S9
T47 R22W S10
T47 R22W S11
T47 R22W S12
Wakefield Brook
T47 R23W S13
T47 R22W S18
T47 R22W S17
T47 R22W S16
T47 R22W S15
T47 R22W S14
T47 R22W S13
319
320
321
322
323
324





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
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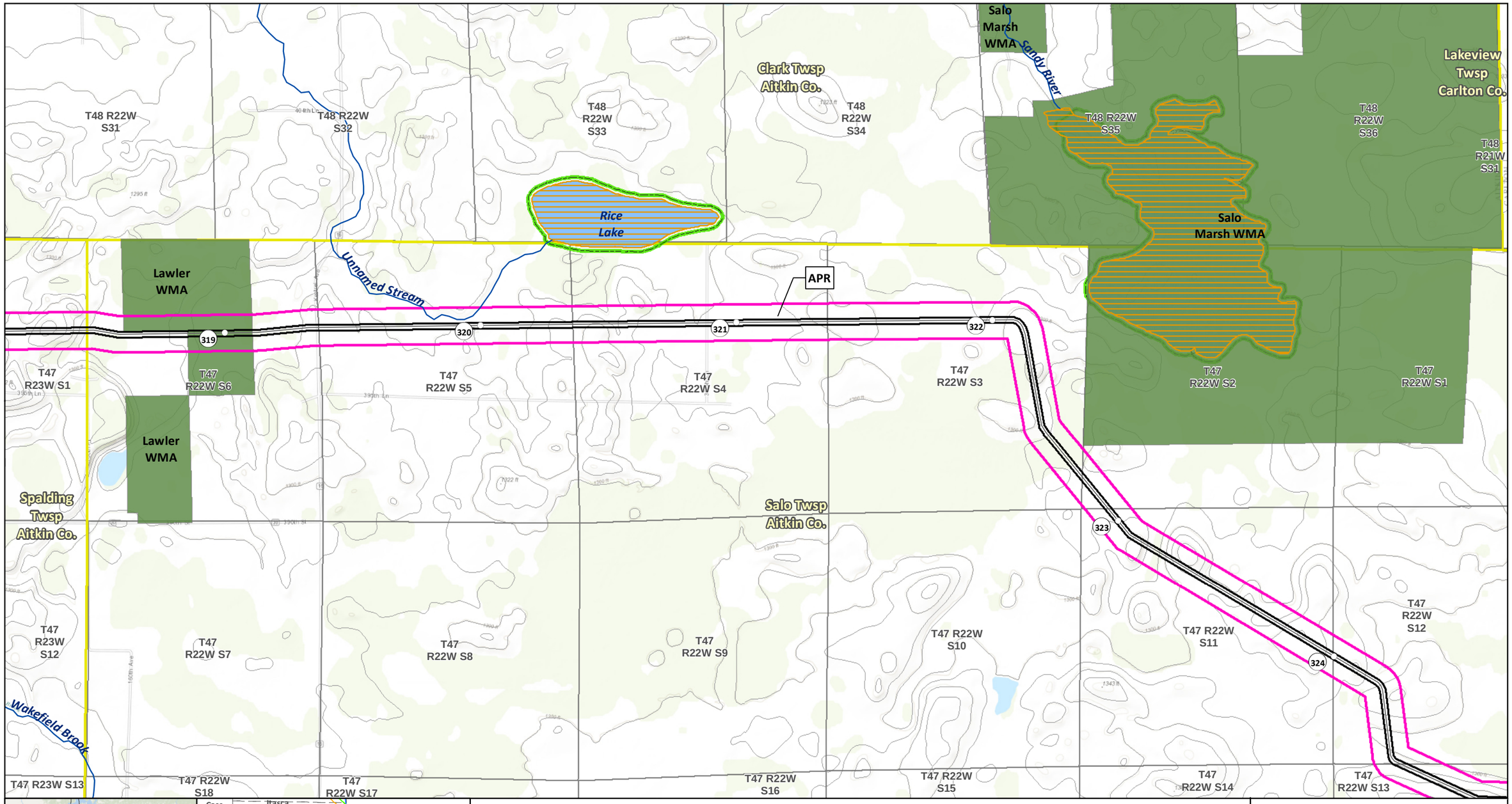
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

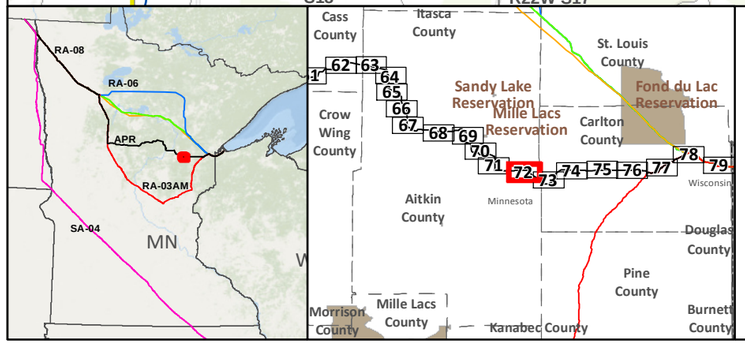
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
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- RA-08
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Lakes of Biological Significance
- Outstanding
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- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 72B of 82

T47 R22W S2
T47 R22W S1
T47 R21W S6
T47 R21W S5
T47 R21W S4
T47 R21W S3
T47 R21W S2
T47 R21W S9
T47 R22W S12
T47 R21W S7
T47 R21W S8
T47 R21W S10
T47 R21W S11
T47 R22W S11
T47 R22W S13
T47 R21W S18
T47 R21W S17
T47 R21W S16
T47 R21W S15
T47 R22W S14
T47 R21W S14
T47 R22W S24
T47 R21W S19
T47 R21W S20
T47 R21W S21
T47 R21W S22
T47 R22W S23
T47 R21W S23

Automba Twsp
Carlton Co.

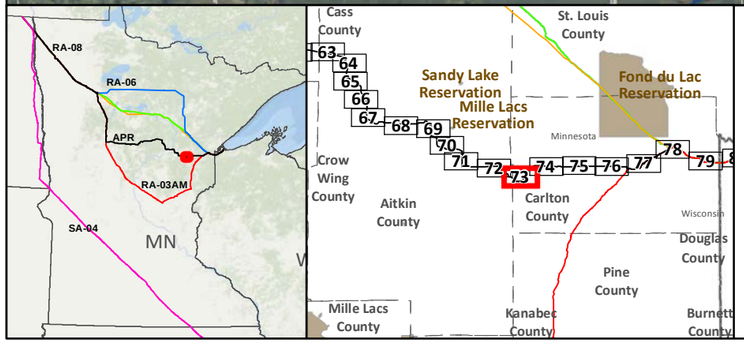
Salo Twsp
Aitkin Co.

APR

Dead Moose River

Kettle River, West Branch

324 325 326 327 328 329 330



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
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Public Water Basin
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Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 73A of 82

Salo
Marsh WMA

T47 R22W S2
T47 R22W S1
T47 R21W S6
T47 R21W S5
T47 R21W S4
T47 R21W S3
T47 R21W S2
T47 R21W S9
T47 R21W S11
T47 R21W S10
T47 R22W S12
T47 R21W S7
T47 R21W S8
T47 R22W S11
T47 R22W S13
T47 R21W S18
T47 R21W S17
T47 R21W S16
T47 R21W S15
T47 R22W S14
T47 R21W S14
T47 R22W S23
T47 R22W S24
T47 R21W S19
T47 R21W S20
T47 R21W S21
T47 R21W S22
T47 R21W S23

Salo Twsp
Aitkin Co.

Automba Twsp
Carlton Co.

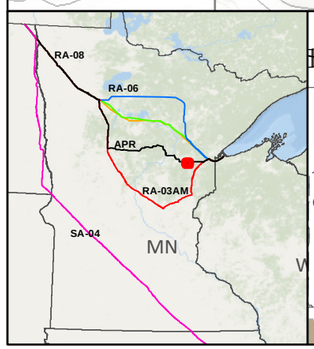
APR

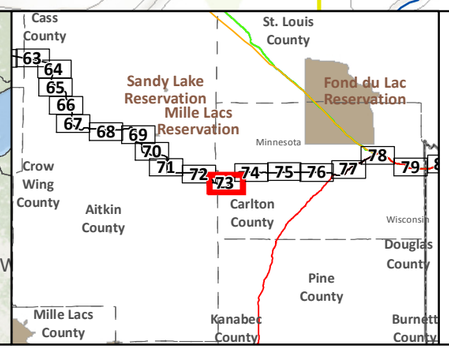
Kettle River, West Branch

Dead Moose River

AITKIN
CARLTON

324
325
326
327
328
329
330





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

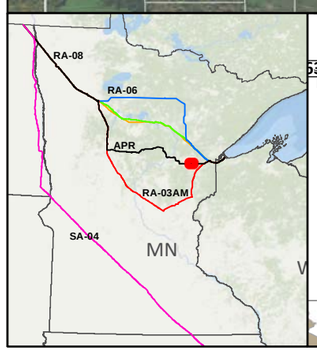
APR

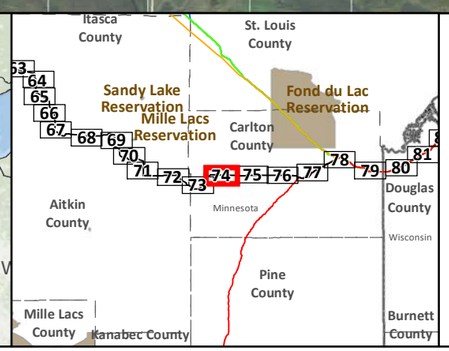
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 73B of 82







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Township Boundary

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Land Ownership

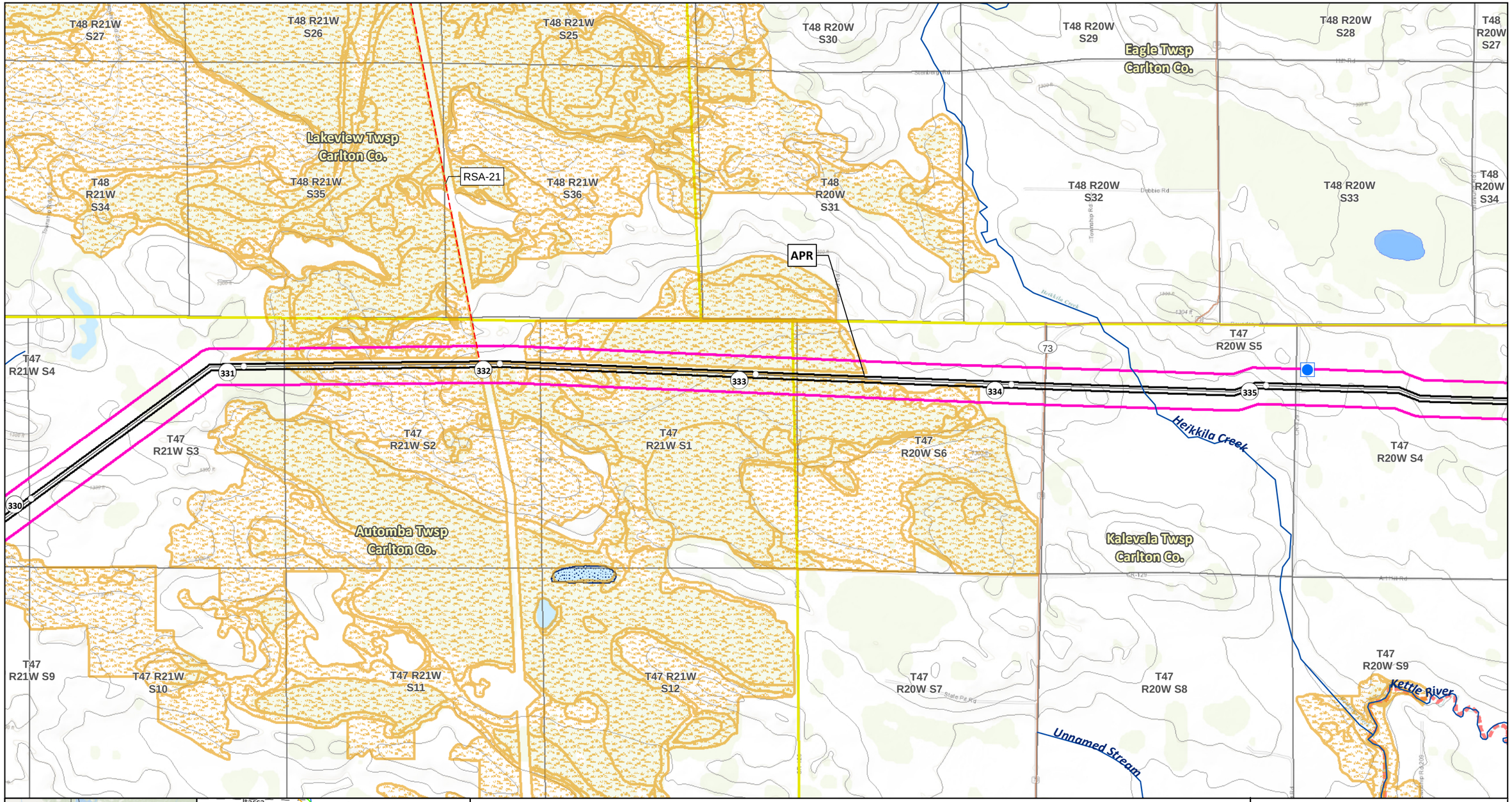
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

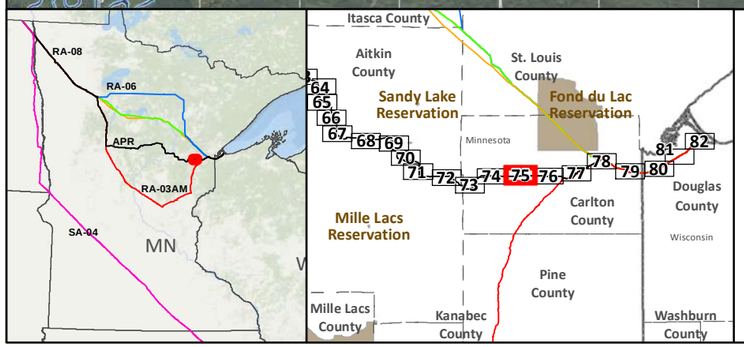
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR


T48 R21W S27
T48 R21W S26
T48 R21W S25
T48 R20W S30
T48 R20W S29
Eagle Twsp Carlton Co.
T48 R20W S28
T48 R20W S27
Lakeview Twsp Carlton Co.
RSA-21
T48 R21W S34
T48 R21W S35
T48 R21W S36
T48 R20W S31
T48 R20W S32
T48 R20W S33
T48 R20W S34
APR
T47 R21W S4
T47 R20W S5
331
332
333
334
335
73
T47 R21W S3
T47 R21W S2
T47 R21W S1
T47 R20W S6
Herikkila Creek
T47 R20W S4
330
Automba Twsp Carlton Co.
Kalevala Twsp Carlton Co.
T47 R21W S9
T47 R21W S10
T47 R21W S11
T47 R21W S12
T47 R20W S7
T47 R20W S8
T47 R20W S9
Kettle River
Unnamed Stream
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Itasca County
St. Louis County
Sandy Lake Reservation
Mille Lacs Reservation
Carlton County
Fond du Lac Reservation
Aitkin County
Minnesota
Douglas County
Wisconsin
Pine County
Mille Lacs County
Kanabec County
Burnett County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
APR
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours
Map 74B of 82

T48 R20W S27
T48 R20W S26
T48 R20W S25
T48 R19W S30
T48 R19W S29
T48 R19W S28
Eagle Twsp Carlton Co.
Fond du Lac State Forest
North Carlton Twsp Carlton Co.
T48 R20W S34
T48 R20W S35
T48 R20W S36
T48 R19W S31
T48 R19W S32
T48 R19W S33
APR
336
337
338
339
340
341
T47 R20W S4
T47 R20W S3
T47 R20W S2
T47 R20W S1
T47 R19W S6
T47 R19W S5
T47 R19W S4
Kettle River
Kalevala Twsp Carlton Co.
Skelton Twsp Carlton Co.
T47 R20W S9
T47 R20W S10
T47 R20W S11
T47 R20W S12
T47 R19W S7
T47 R19W S8
T47 R19W S9
Moose Horn River, West Fork



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

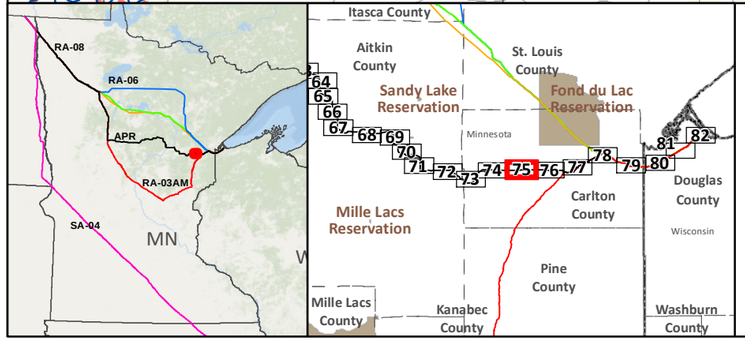
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

T48 R20W S27
T48 R20W S26
T48 R20W S25
T48 R19W S30
T48 R19W S29
T48 R19W S28
Eagle Twsp Carlton Co.
North Carlton Twsp Carlton Co.
T48 R20W S34
T48 R20W S35
T48 R20W S36
T48 R19W S31
T48 R19W S32
T48 R19W S33
APR
336
337
338
339
340
341
T47 R20W S4
T47 R20W S3
T47 R20W S2
T47 R20W S1
T47 R19W S6
T47 R19W S5
T47 R19W S4
Kettle River
Kalevala Twsp Carlton Co.
Skelton Twsp Carlton Co.
Moose Horn River, West Fork
T47 R20W S9
T47 R20W S10
T47 R20W S11
T47 R20W S12
T47 R19W S7
T47 R19W S8
T47 R19W S9



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

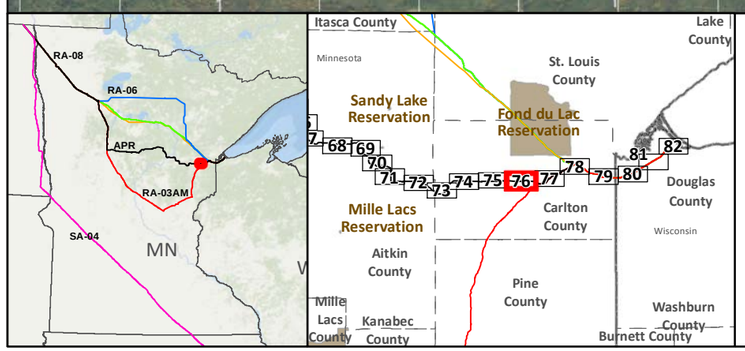
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

T48 R19W S28
T48 R19W S27
T48 R19W S26
T48 R19W S25
T48 R18W S30
T48 R18W S29
T48 R18W S28
Fond du Lac State Forest
North Carlton Twsp Carlton Co.
Atkinson Twsp Carlton Co.
T48 R19W S33
T48 R19W S34
T48 R19W S35
T48 R19W S36
T48 R18W S31
T48 R18W S32
T48 R18W S33
APR
Park Lake Creek
RSA-42
342
343
344
345
346
347
T47 R19W S4
Moose Horn River, West Fork
T47 R19W S3
T47 R19W S2
T47 R19W S1
Unnamed Stream
T47 R18W S6
T47 R18W S5
T47 R18W S4
King Creek
Skelton Twsp Carlton Co.
Mahtowa Twsp Carlton Co.
Moose Horn River
T47 R19W S9
T47 R19W S10
T47 R19W S11
T47 R19W S12
T47 R18W S7
RA-03AM
T47 R18W S8
T47 R18W S9



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Township Boundary

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station

- Interstate
- Highway
- Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

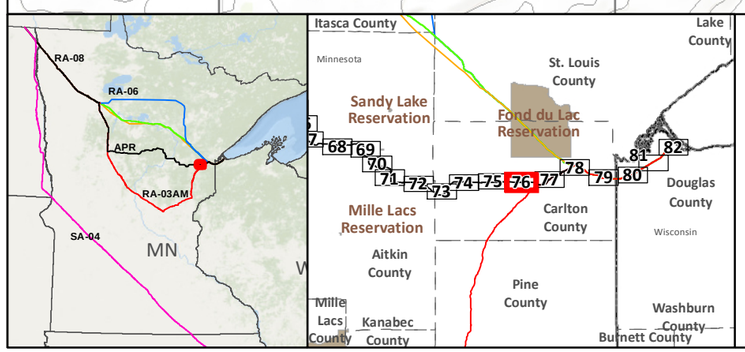
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 76A of 82

T48 R19W S28
T48 R19W S27
T48 R19W S26
T48 R19W S25
T48 R18W S30
T48 R18W S29
T48 R18W S28
North Carlton Twsp Carlton Co.
T48 R19W S33
T48 R19W S34
T48 R19W S35
T48 R19W S36
T48 R18W S31
T48 R18W S32
T48 R18W S33
Atkinson Twsp Carlton Co.
Park Lake Creek
APR
RSA-42
342
343
344
345
346
347
T47 R19W S4
T47 R19W S3
T47 R19W S2
T47 R19W S1
T47 R18W S6
T47 R18W S5
T47 R18W S4
Moose Horn River, West Fork
Unnamed Stream
King Creek
Skelton Twsp Carlton Co.
Mahtowa Twsp Carlton Co.
Moose Horn River
T47 R19W S9
T47 R19W S10
T47 R19W S11
T47 R19W S12
T47 R18W S7
RA-03AM
T47 R18W S8
T47 R18W S9
Mahtowa



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Route Segment Alternatives (RSA)
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

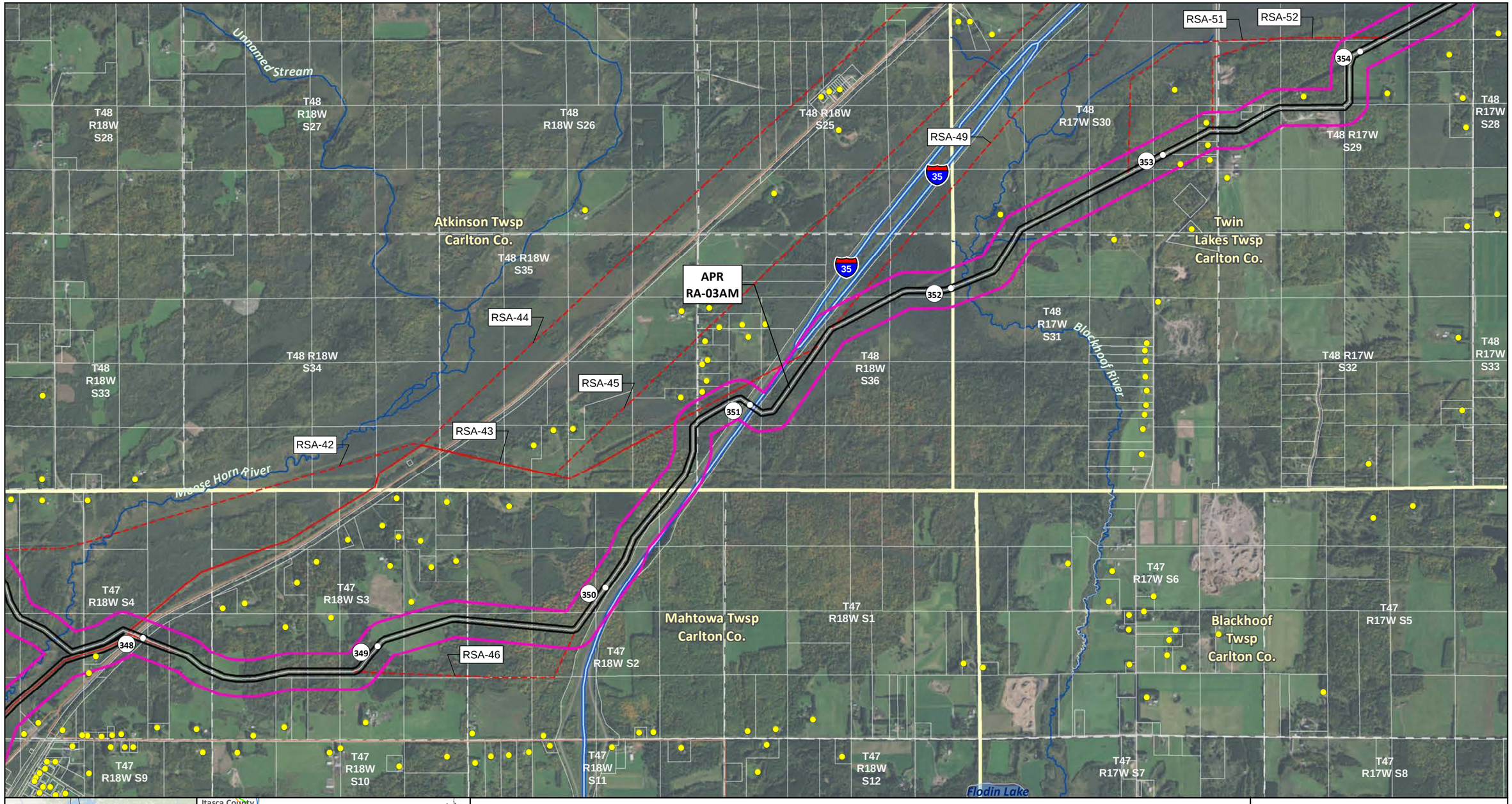
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

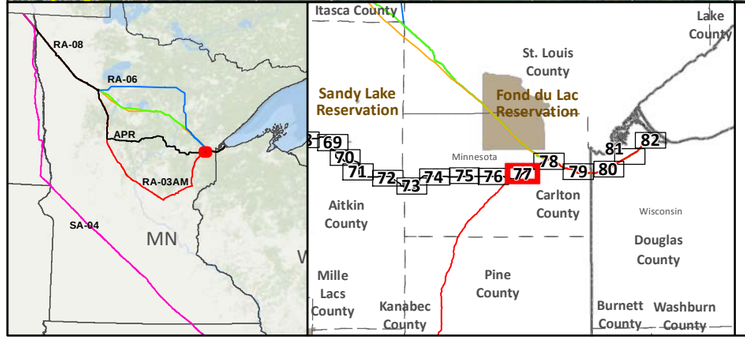
APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 76B of 82





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Township Boundary

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

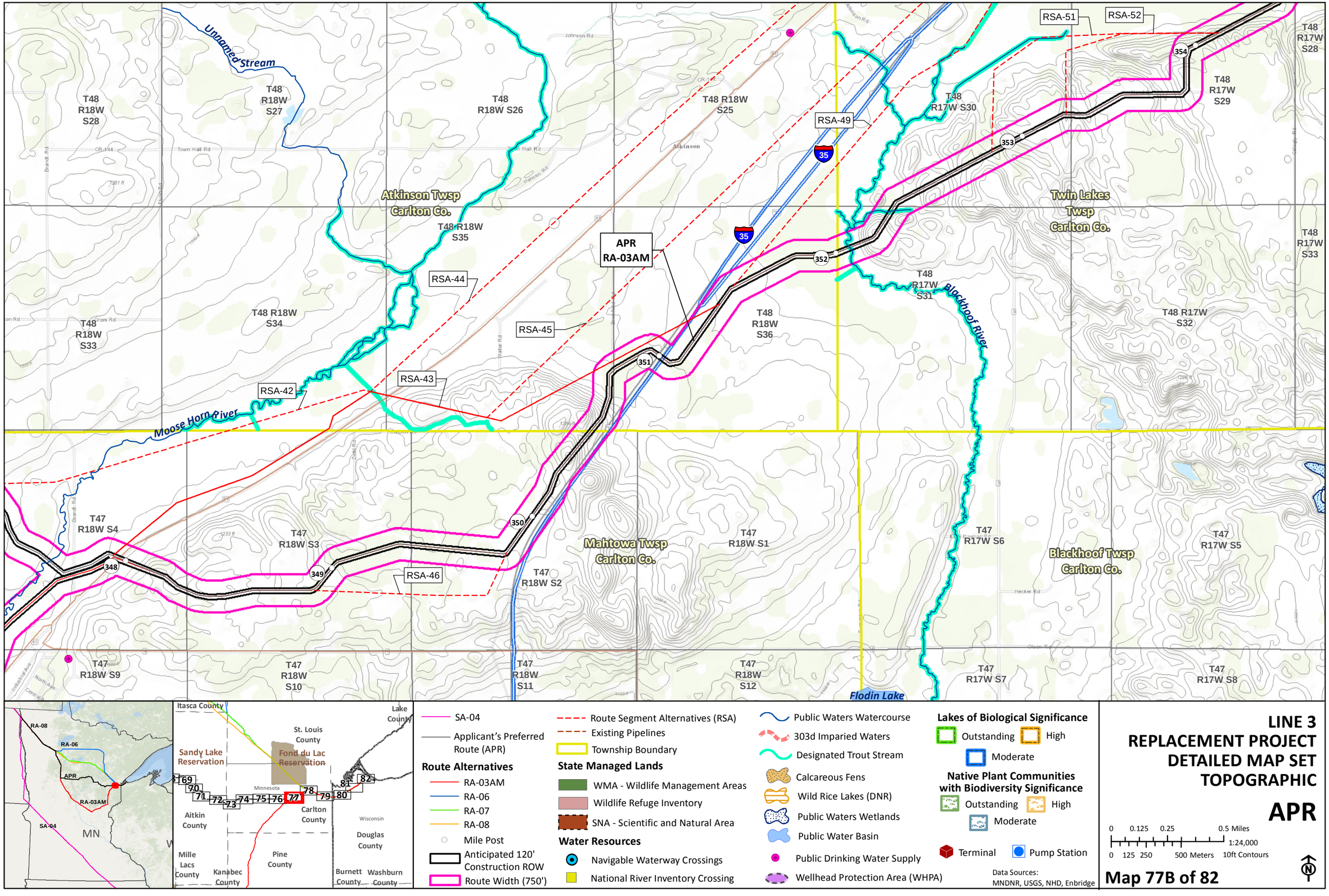
0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding High Moderate

Native Plant Communities with Biodiversity Significance
Outstanding High Moderate

Terminal Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 77B of 82

RSA-37
RSA-22
RA-08
RSA-44
RA-06
RA-07
RSA-49
RSA-45
RA-06
RA-07
RA-08
APR
RA-03AM
RA-06
RA-07
RA-08
APR
RA-03AM
RSA-51
Otter Creek
Little Otter Creek
Twin Lakes Twsp Carlton Co.
Chub Lake
Venoah Lake
Hay Lake
Carlton Twsp Carlton Co.
Silver Brook Twsp Carlton Co.
T48 R17W S8
T48 R17W S9
T48 R17W S10
T48 R17W S11
T48 R17W S12
T48 R16W S7
T48 R16W S8
T48 R17W S17
T48 R17W S15
T48 R17W S16
T48 R17W S14
T48 R17W S13
T48 R16W S18
T48 R16W S17
T48 R17W S21
T48 R17W S20
T48 R17W S22
T48 R17W S23
T48 R17W S24
T48 R16W S19
T48 R16W S20
T48 R17W S28
T48 R17W S29
T48 R17W S27
T48 R17W S26
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T48 R16W S29
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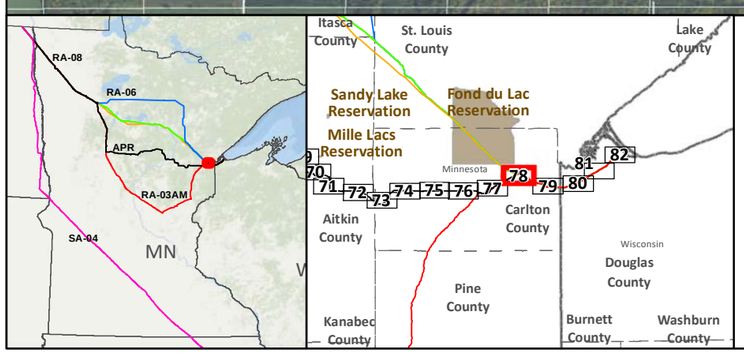


SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

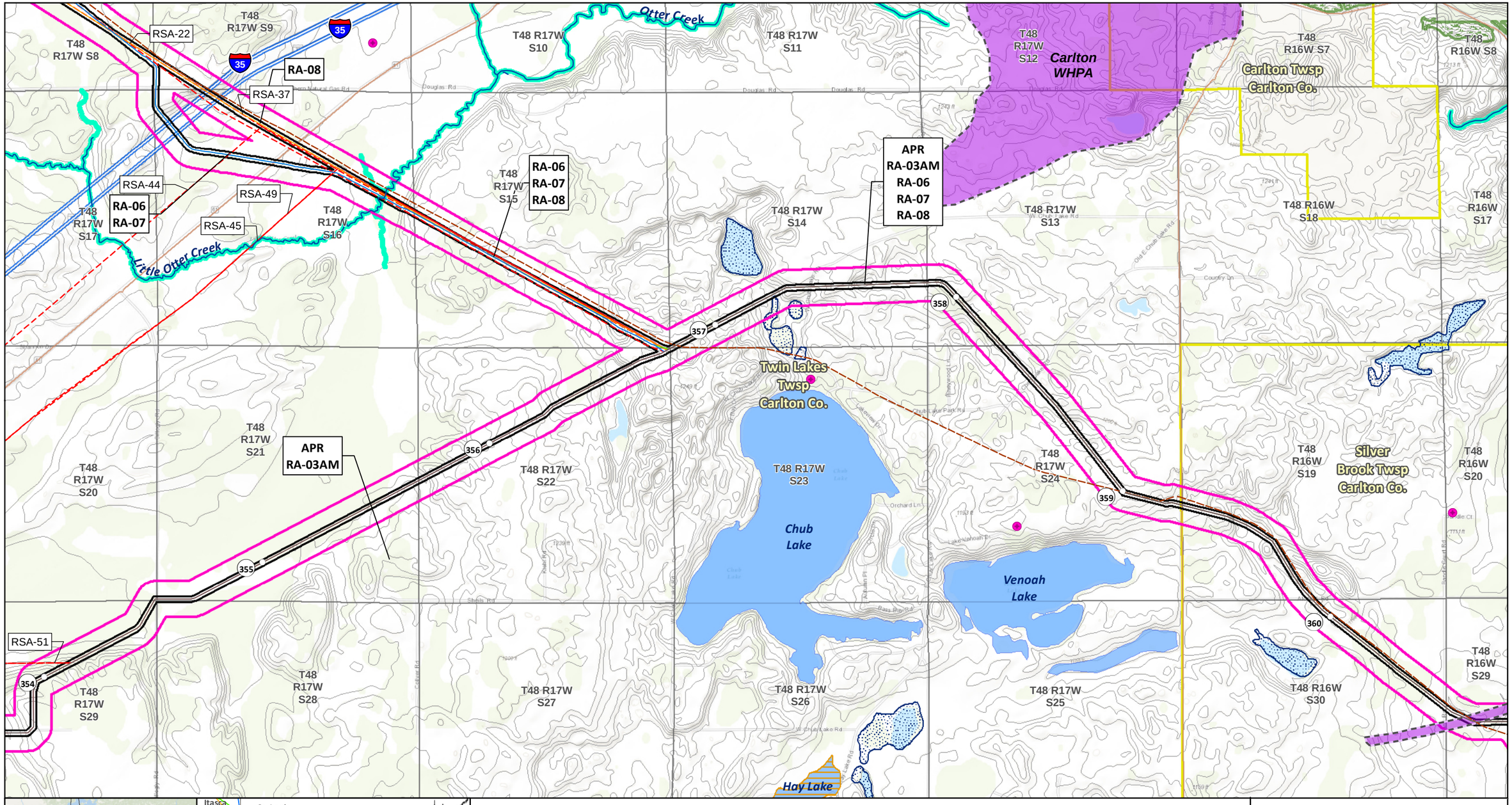
Data Sources:
MNDNR, NHD, Enbridge

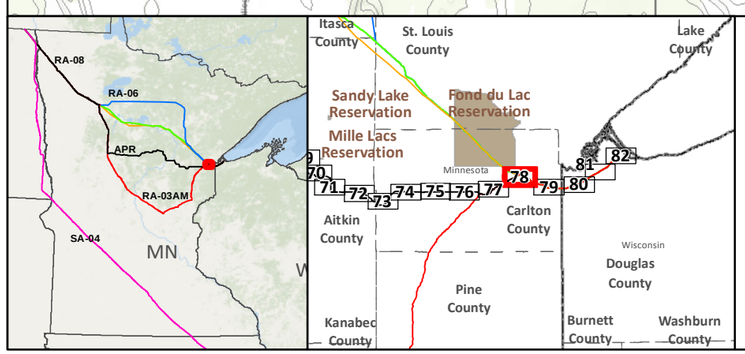
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 78A of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

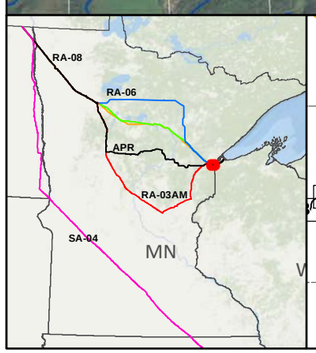
APR

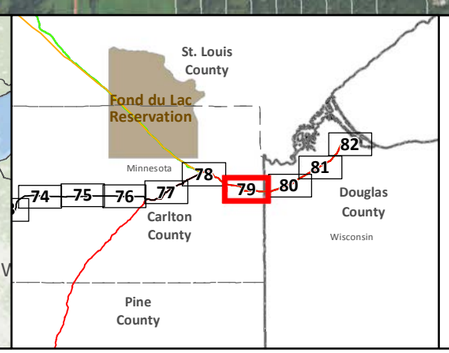
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 78B of 82

T48 R16W S20
T48 R16W S21
T48 R16W S22
T48 R16W S23
T48 R16W S24
T48 R15W S19
T48 R15W S20
T48 R16W S27
T48 R16W S29
T48 R16W S28
T48 R16W S26
T48 R16W S25
T48 R15W S30
T48 R15W S29
Fond du Lac State Forest
Red River
Silver Brook Twsp Carlton Co.
APR
RA-03AM
RA-06
RA-07
RA-08
T48 R16W S33
T48 R16W S35
T48 R16W S36
T48 R15W S31
T48 R15W S32
T48 R16W S32
T48 R16W S34
361
362
364
365
366
23
Unnamed Stream
Clear Creek
Wrenshall Twsp Carlton Co.
T47 R16W S5
T47 R16W S4
T47 R16W S3
T47 R16W S2
T47 R16W S1
T47 R15W S6
T47 R15W S5
Mud Creek





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

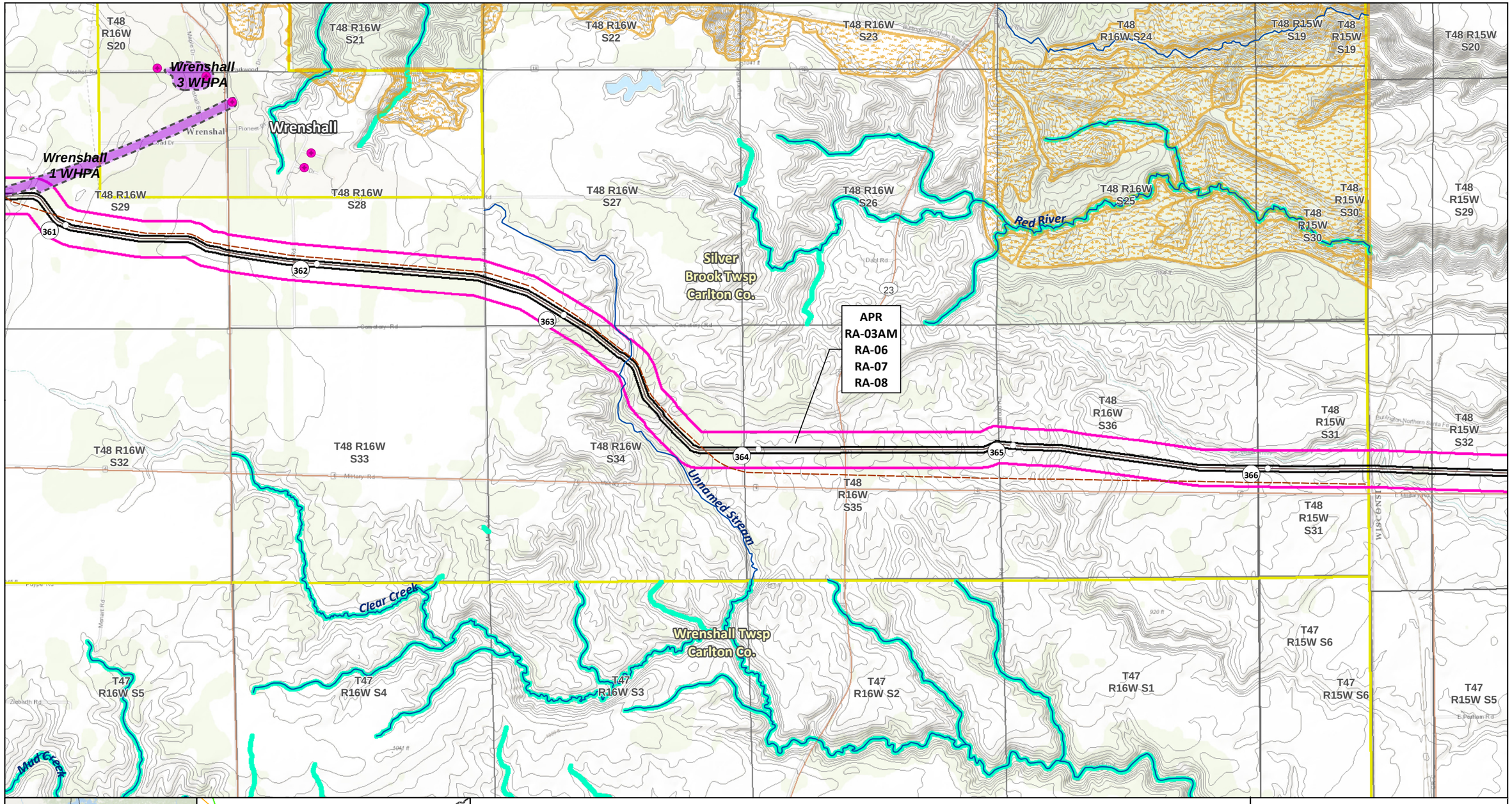
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

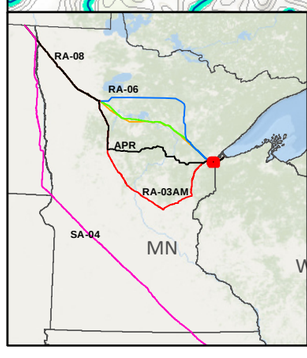
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

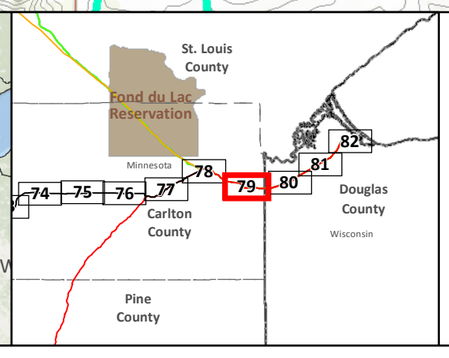
Data Sources:
MNDNR, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

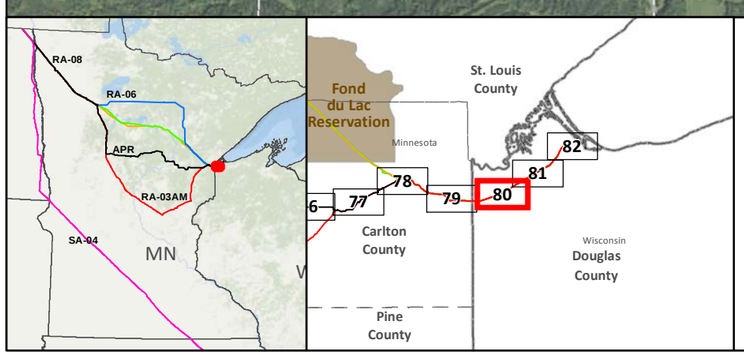
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 79B of 82

T48 R15W S20
T48 R15W S21
T48 R15W S22
T48 R15W S23
T48 R15W S24
T48 R14W S19
T48 R14W S20
T48 R15W S27
T48 R15W S26
T48 R15W S28
T48 R15W S29
T48 R15W S25
T48 R14W S30
T48 R14W S29
T48 R15W S33
T48 R15W S34
T48 R15W S35
T48 R15W S36
T48 R14W S31
T48 R14W S32
T48 R15W S32
T47 R15W S5
T47 R15W S4
T47 R15W S3
T47 R15W S2
T47 R15W S1
T47 R14W S6
T47 R14W S5

APR
RA-03AM
RA-06
RA-07
RA-08

369
370
371
368



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

Anticipated 120' Construction ROW
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Parcels
Public Water Basin
Public Waters Watercourse
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Mile Post
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Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

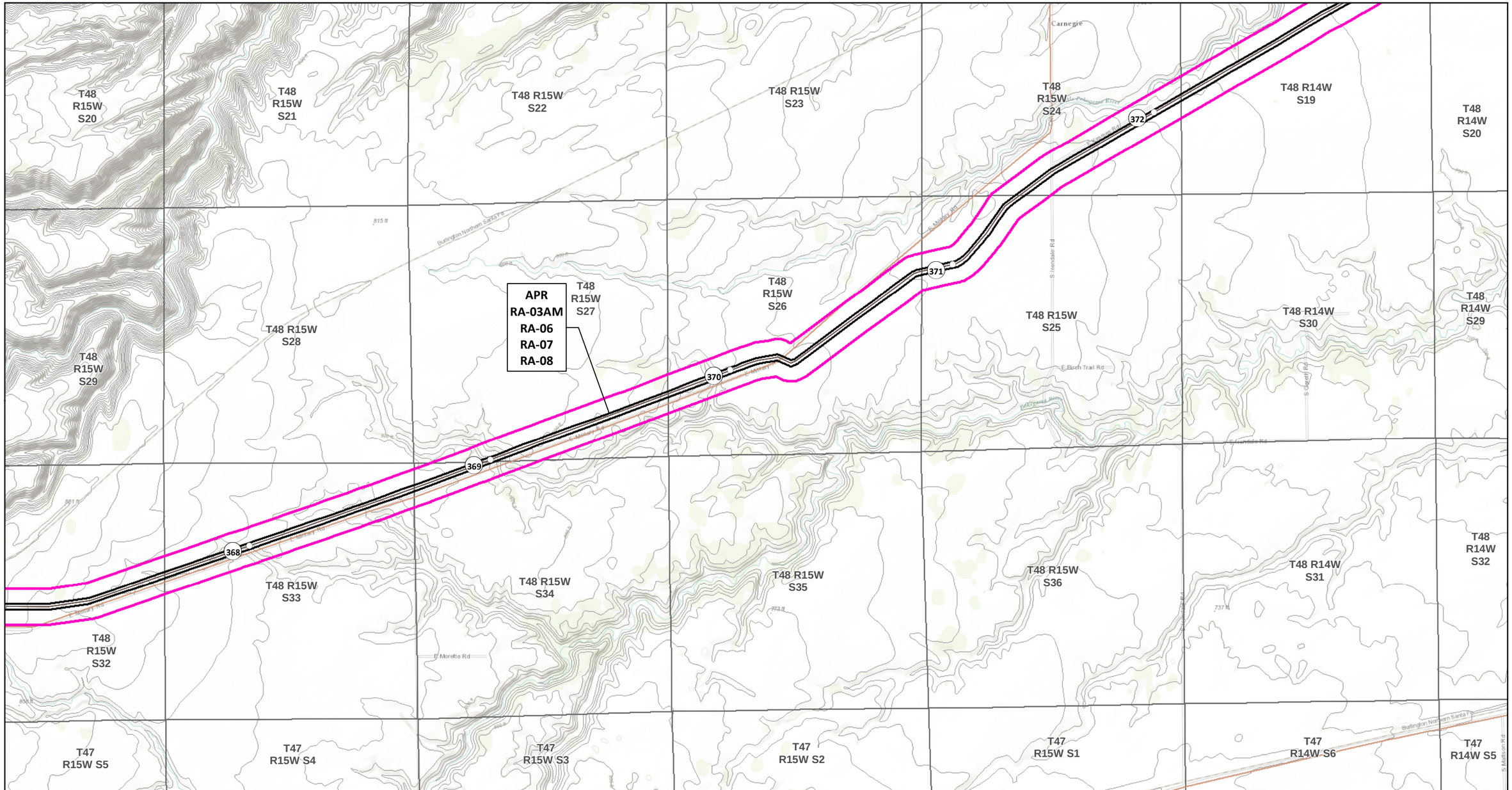
Data Sources:
MNDNR, NHD, Enbridge

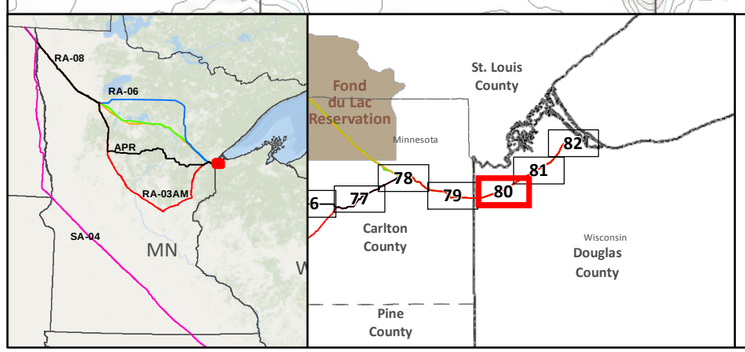
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 80A of 82





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
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National River Inventory Crossing

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High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

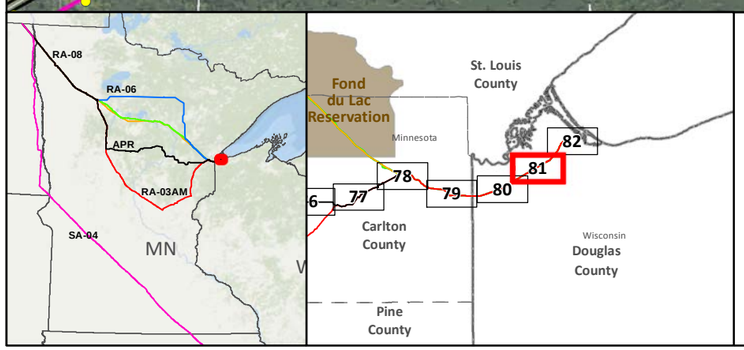
N

Map 80B of 82

T48 R15W S1
T48 R14W S6
T48 R14W S5
T48 R14W S4
T48 R14W S3
T48 R14W S2
T48 R14W S1
T48 R15W S12
T48 R14W S7
T48 R14W S8
T48 R14W S9
T48 R14W S10
T48 R14W S11
T48 R14W S12
T48 R15W S13
T48 R14W S18
T48 R14W S17
T48 R14W S16
T48 R14W S15
T48 R14W S14
T48 R14W S13
T48 R15W S24
T48 R14W S19
T48 R14W S20
T48 R14W S21
T48 R14W S22
T48 R14W S23
T48 R14W S24

APR
RA-03AM
RA-06
RA-07
RA-08

105 377 376 375 374 373 35



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Public Waters Watercourse
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Pump Station

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Major Road

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National Forest
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Tribal Trust Land
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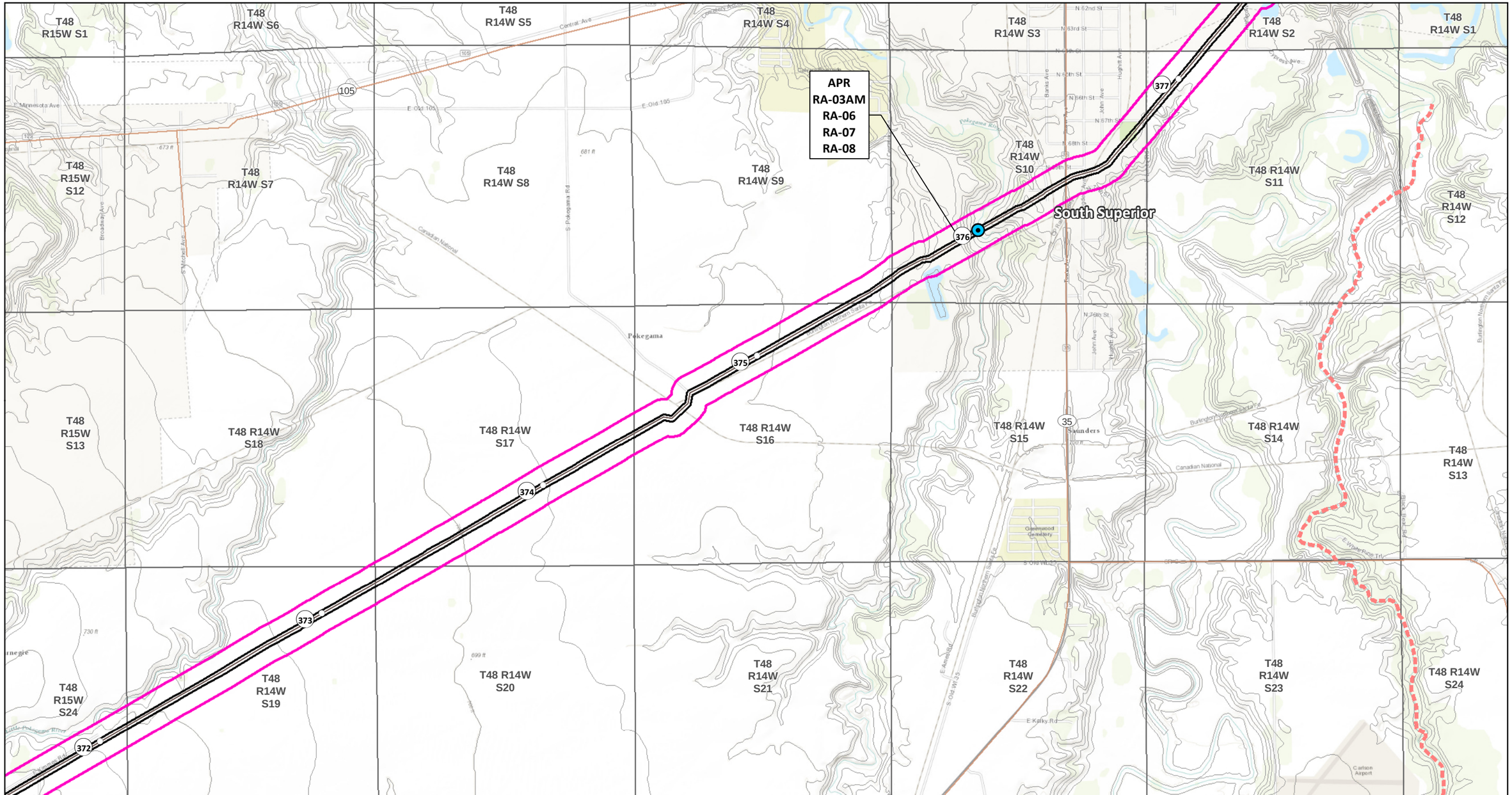
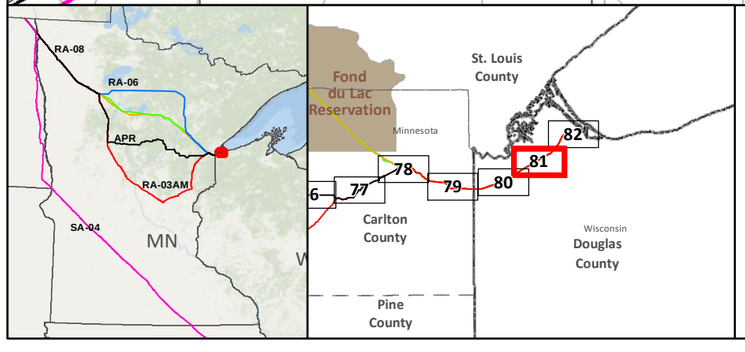
Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR





SA-04
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RA-07
RA-08
Mile Post
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SNA - Scientific and Natural Area

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Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
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High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

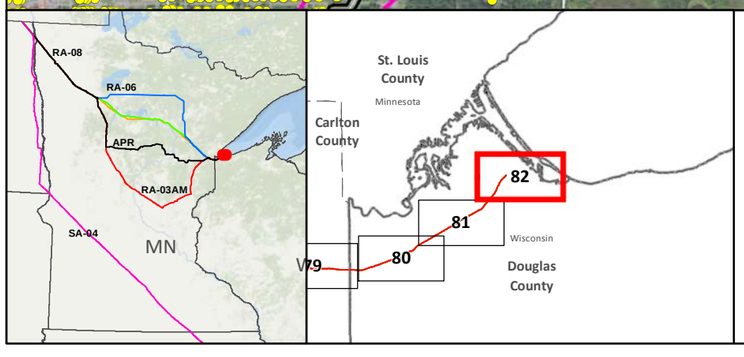
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

Map 81B of 82

T49 R14W S22
T49 R14W S23
T49 R14W S24
T49 R13W S19
T49 R13W S20
Saint Louis River
Duluth Twsp
St. Louis Co.
T49 R13W S20
Lake Superior
T49 R13W S21
T49 R13W S22
T49 R13W S29
T49 R14W S27
T49 R14W S26
T49 R14W S25
T49 R13W S30
T49 R13W S29
T49 R13W S28
T49 R13W S27
APR
RA-03AM
RA-06
RA-07
RA-08
Superior Terminal
2
35
T49 R14W S34
T49 R14W S35
379
T49 R14W S36
T49 R13W S31
T49 R13W S32
T49 R13W S33
T49 R13W S34
T48 R14W S2
378
T48 R14W S1
T48 R13W S6
T48 R13W S5
T48 R13W S4
T48 R13W S3
T48 R14W S3



SA-04
Applicant's Preferred Route (APR)

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RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Route Segment Alternatives (RSA)

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Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Township Boundary

Residences within 1/2 mile
Mile Post
Terminal
Pump Station

Interstate
Highway
Major Road

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

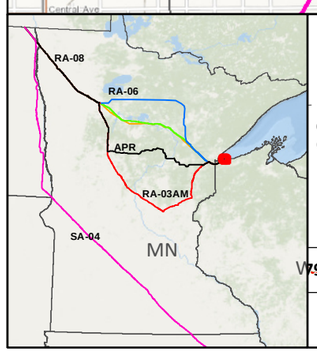
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

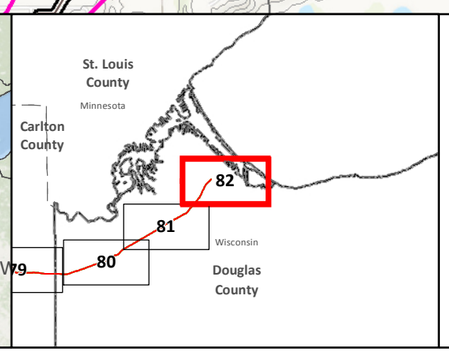
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

APR

Map 82A of 82

T49 R14W S22
T49 R14W S23
T49 R14W S24
T49 R13W S19
T49 R13W S20
Saint Louis River
Duluth Twsp
St. Louis Co.
T49 R13W S20
Lake Superior
T49 R13W S21
T49 R13W S22
T49 R13W S29
T49 R14W S27
T49 R14W S26
T49 R14W S25
T49 R13W S30
T49 R13W S29
T49 R13W S28
T49 R13W S27
APR
RA-03AM
RA-06
RA-07
RA-08
Superior Terminal
Allouez
T49 R14W S34
T49 R14W S35
T49 R14W S36
T49 R13W S31
T49 R13W S32
T49 R13W S33
T49 R13W S34
T48 R14W S3
T48 R14W S2
T48 R14W S1
T48 R13W S6
T48 R13W S5
T48 R13W S4
T48 R13W S3
South Superior
Nemadji Golf Course
Bear Creek Park
Wisconsin Point Rd
Moccasin Mike Rd
Macara Rd
Central Ave
Richard I Bong Airport
Mariner Mall
University of Wisconsin Superior
Heritage Park
Barker's Island
Pokegama Bay
Allouez Bay
East End
Randy Johnson St
Grand Ave
Belknap St
Tower Ave
Hammond Ave
Cumming Ave
Baxter Ave
Lambert Ave
Ogden Ave
Wadena Ave
Stinson Ave
Scharte Dr
Railroad Ave
Canadian National
CP Rail Systems
Burlington Northern Santa Fe
Union Pacific
Wisconsin Point Rd
35
2
379
378





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Route Segment Alternatives (RSA)
Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

APR

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters 10ft Contours

N

Map 82B of 82

Minnesota Department of Commerce
Energy Environmental Review and Analysis

Draft Environmental Impact Statement
Line 3 Project

Mapbook
RA-03AM

Docket Nos. PPL-15-137/CN-14-916

May 15, 2017

MINNESOTA

Clearbrook Terminal
Clearbrook
Erskine
McIntosh
Polk County
Fosston
Winger
Lengby
Bagley
Fhro
Leonard
Puposky
Beltrami County
Blackduck
Alvwood
Hines
Tenstrike
Buena Vista State Forest
Blackduck State Forest
Pinewood
Turtle River
Itasca County
Shevlin
Solway
Wilton
Lavinia
Bemidji
Chippewa National Forest
Pennington
Mississippi Headwaters State Forest
Norman County
Bejou
White Earth Reservation
Mahnomen
Beaulieu
Mahnomen County
Naytahwaush
Clearwater County
White Earth Reservation - BIA
Waubun
White Earth Reservation
White Earth State Forest
Becker County
Becida
Lake Itasca
Lake George
Hubbard County
Guthrie
Cass Lake
Schley
Bowstring State Forest
Welsh Lake State Forest
Witkinson
Laporte
Leech Lake Reservation
Cass County
Leech Lake
Battleground State Forest
Benedict
Paul Bunyan State Forest
Walker
Two Inlets
Two Inlets State Forest
Two Inlets Pump Station
Whipholt
1
2
3
4
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6
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8
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12
13
14
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RA-08
APR
RA-03AM
2
92
223
89
197
59
200
113
71
64
46
371
290
34

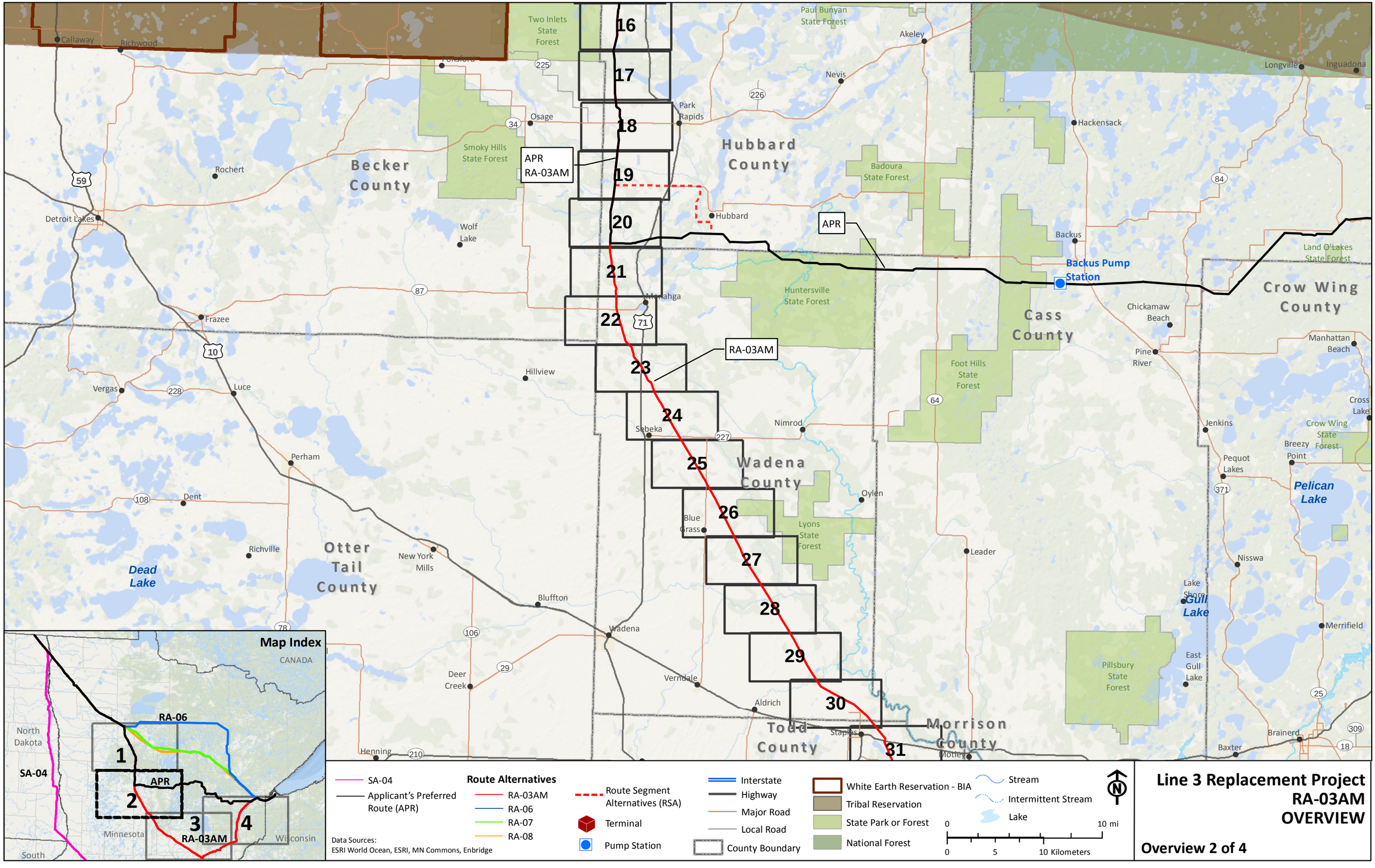
Map Index
CANADA
North Dakota
SA-04
RA-06
APR
RA-03AM
Minnesota
Wisconsin
South

SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Route Segment Alternatives (RSA)
Terminal
Pump Station
Interstate
Highway
Major Road
Local Road
County Boundary
White Earth Reservation - BIA
Tribal Reservation
State Park or Forest
National Forest
Stream
Intermittent Stream
Lake
0 10 mi
0 5 10 Kilometers
N

Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge

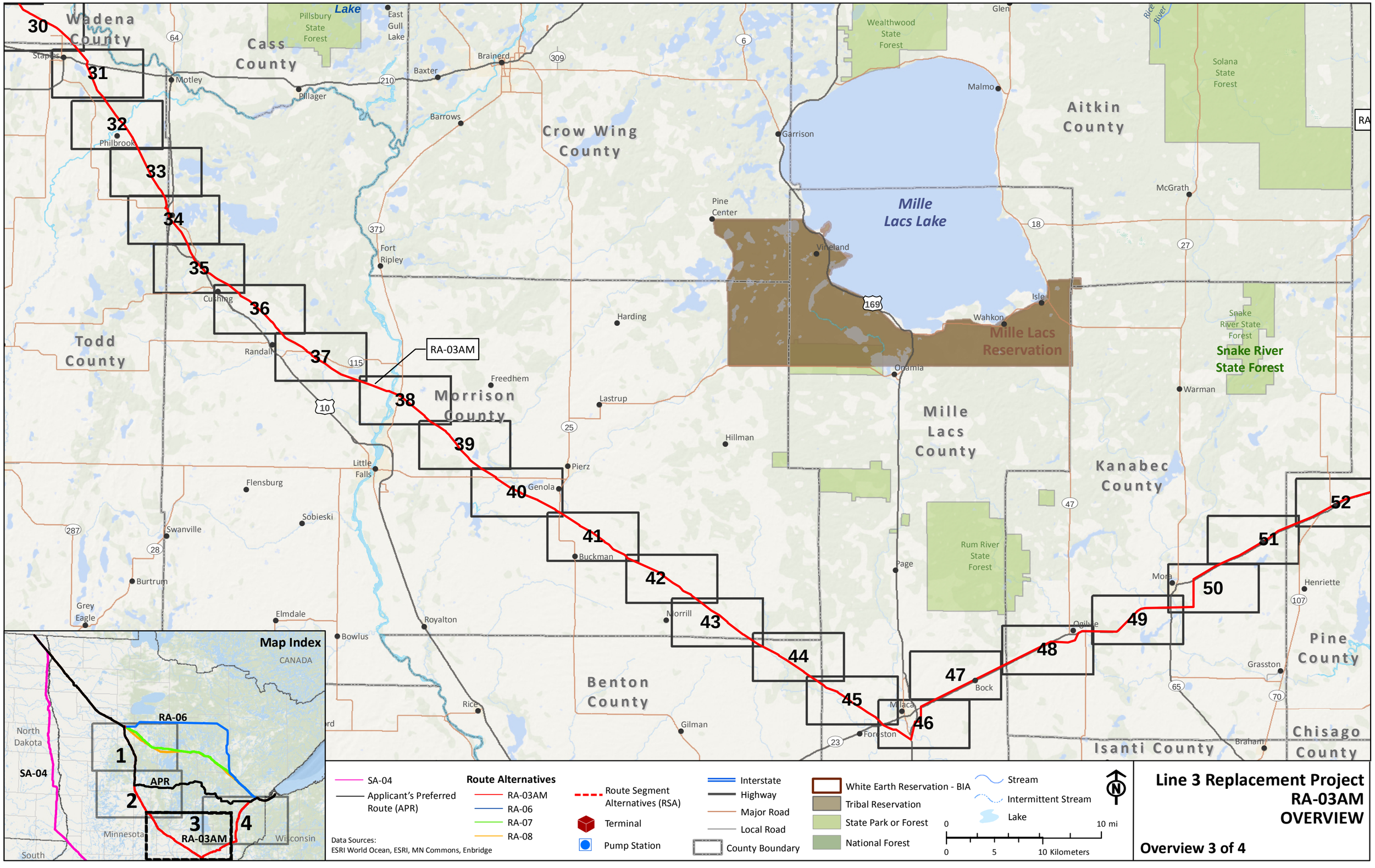
Line 3 Replacement Project
RA-03AM
OVERVIEW

Overview 1 of 4



Line 3 Replacement Project
RA-03AM OVERVIEW

Overview 2 of 4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RA-03AM
Wadena County
Cass County
Crow Wing County
Aitkin County
Todd County
Morrison County
Mille Lacs County
Kanabec County
Benton County
Isanti County
Pine County
Chisago County
Mille Lacs Lake
Mille Lacs Reservation
Snake River State Forest
Pillsbury State Forest
Wealthwood State Forest
Solana State Forest
Rum River State Forest
Snake River State Forest
Staples
Motley
Pillager
Baxter
Brainerd
East Gull Lake
Barrows
Garrison
Malmo
Glen
McGrath
Pine Center
Vineland
Isle
Wahkon
Onamia
Warman
Fort Ripley
Cushing
Randall
Harding
Freedhem
Lastrup
Hillman
Pierz
Genola
Little Falls
Flensburg
Sobieski
Swanville
Burtrum
Grey Eagle
Elmdale
Bowlus
Royalton
Buckman
Morrill
Rice
Gilman
Page
Milaca
Foreston
Bock
Ogilvie
Mora
Henriette
Grasston
Braham
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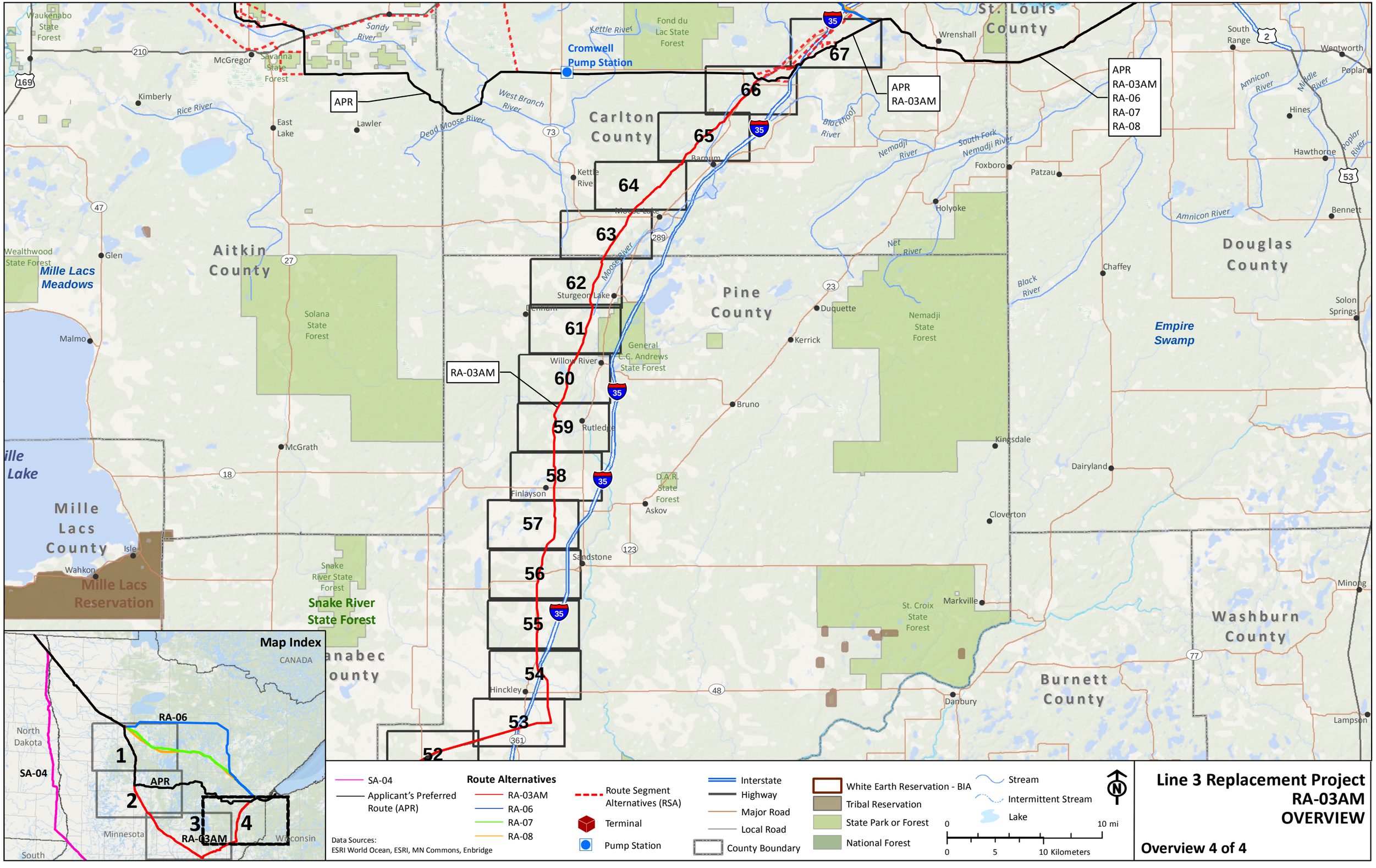
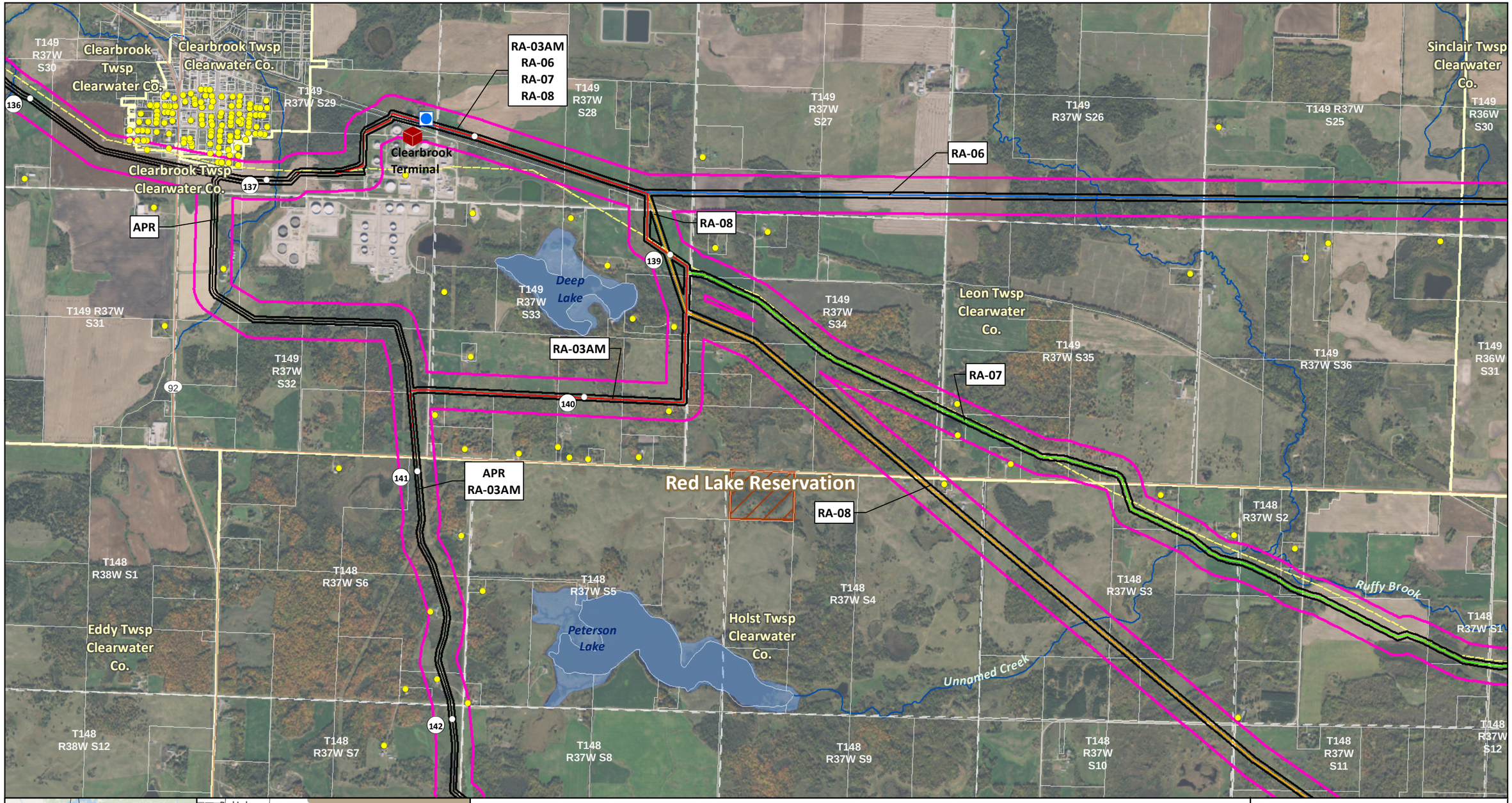
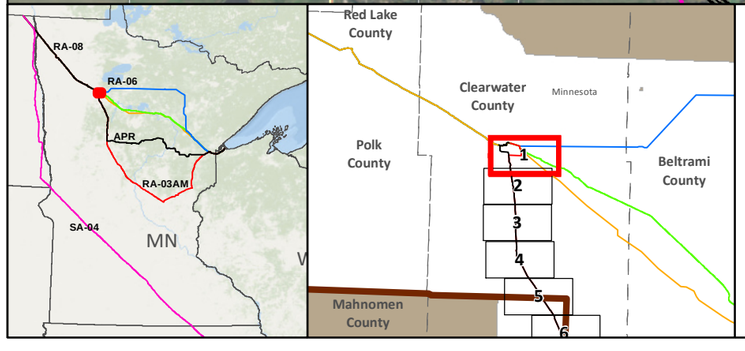
South
Minnesota
Wisconsin
RA-06
APR
SA-04
RA-03AM
1
2
3
4
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Route Segment Alternatives (RSA)
Terminal
Pump Station
Interstate
Highway
Major Road
Local Road
County Boundary
White Earth Reservation - BIA
Tribal Reservation
State Park or Forest
National Forest
Stream
Intermittent Stream
Lake
0 10 mi
0 5 10 Kilometers
N
Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge
Line 3 Replacement Project
RA-03AM
OVERVIEW
Overview 3 of 4



Line 3 Replacement Project
RA-03AM OVERVIEW

Overview 4 of 4





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
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- RA-07
- RA-08
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0 0.125 0.25 0.5 Miles
1:24,000
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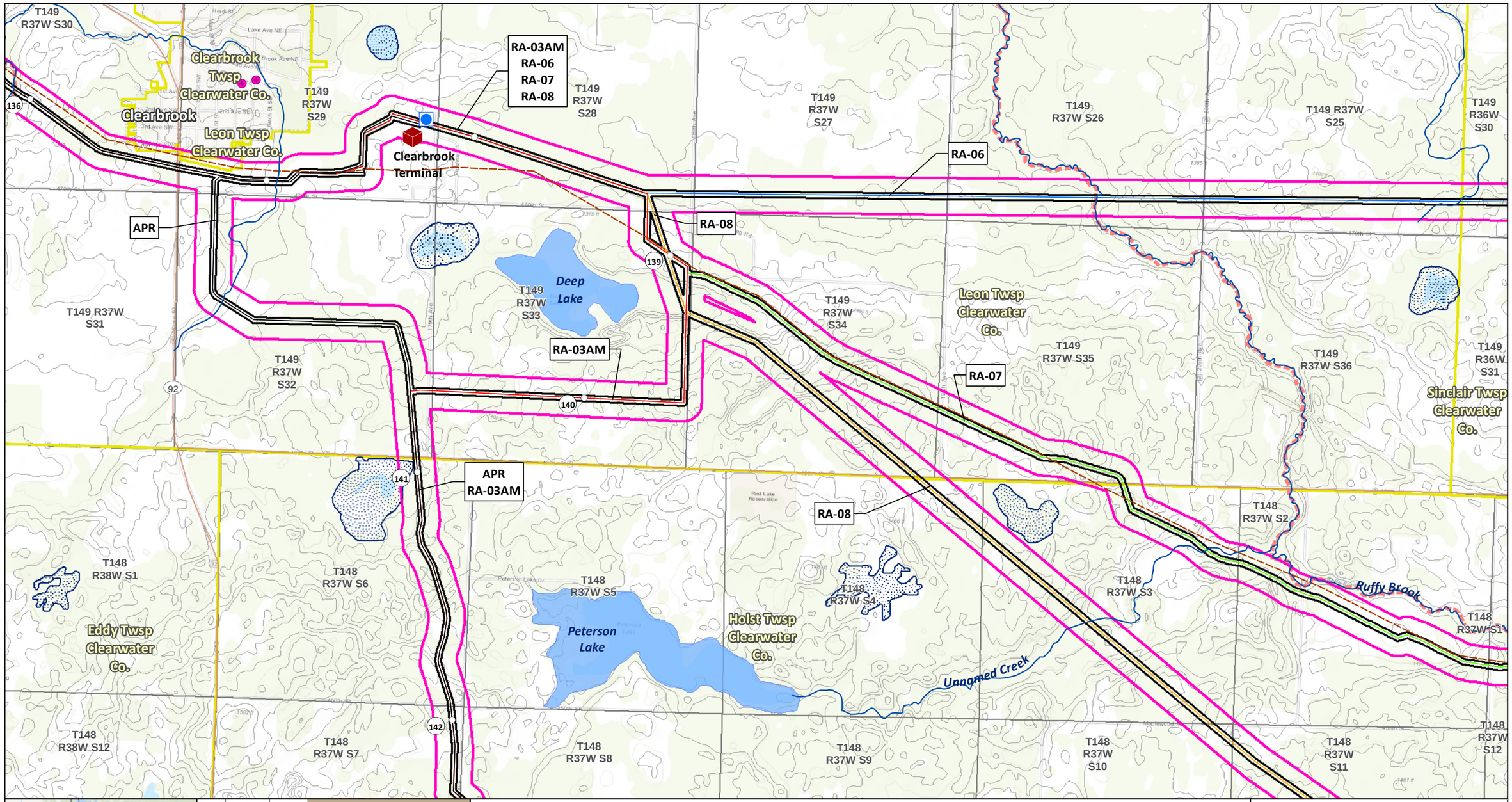
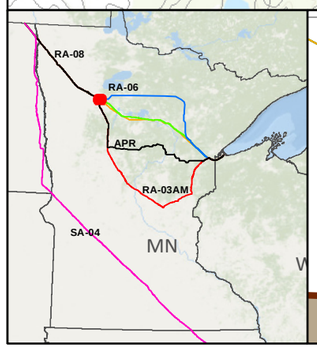
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

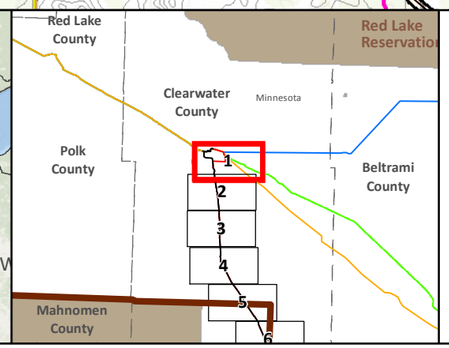
RA-03AM

CLEARBROOK TO CARLTON

Map 1A of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding · High · Moderate

Native Plant Communities with Biodiversity Significance

Outstanding · High · Moderate

Terminal · Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

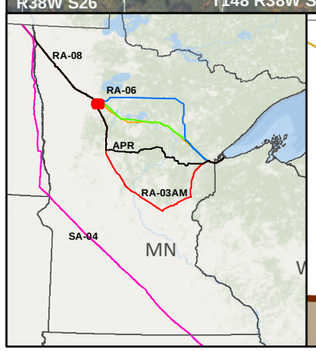
0 125 250 500 Meters

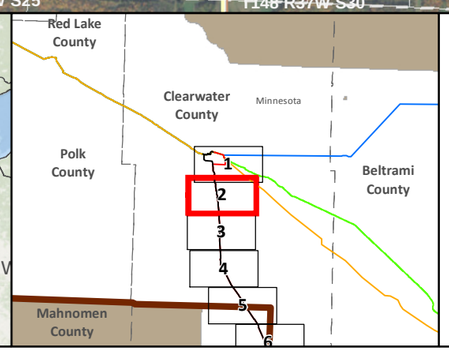
1:24,000

10ft Contours

Map 1B of 67

T148 R38W S2
T148 R38W S1
T148 R37W S6
T148 R37W S5
Peterson Lake
T148 R37W S4
T148 R37W S3
T148 R37W S2
Eddy Twsp
Clearwater Co.
142
T148 R38W S11
T148 R38W S12
T148 R37W S7
T148 R37W S8
T148 R37W S9
T148 R37W S10
T148 R37W S11
143
223
T148 R38W S14
T148 R38W S13
92
T148 R37W S18
T148 R37W S17
Holst Twsp Clearwater Co.
T148 R37W S16
T148 R37W S15
T148 R37W S14
Unnamed Creek
144
T148 R38W S23
T148 R38W S24
T148 R37W S19
T148 R37W S20
APR
RA-03AM
T148 R37W S21
T148 R37W S22
T148 R37W S23
T148 R38W S26
T148 R38W S25
T148 R37W S30





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

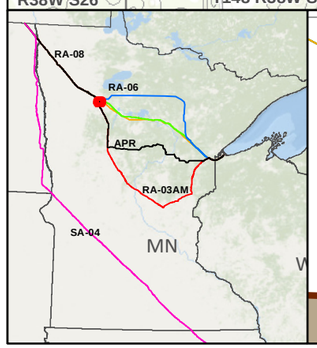
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

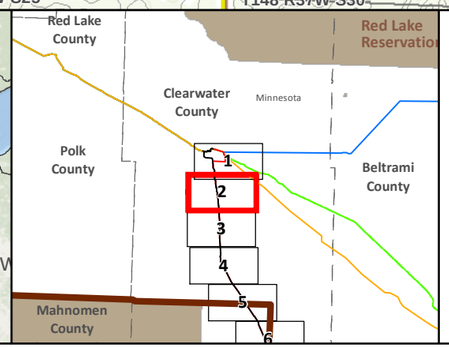
RA-03AM

CLEARBROOK TO CARLTON

Map 2A of 67

T148 R38W S2
T148 R38W S1
T148 R37W S6
T148 R37W S5
Peterson Lake
T148 R37W S4
T148 R37W S3
T148 R37W S2
T148 R38W S11
T148 R38W S12
T148 R37W S7
T148 R37W S8
T148 R37W S9
T148 R37W S10
T148 R37W S11
142
143
223
T148 R38W S13
T148 R38W S14
Eddy Twsp Clearwater Co.
92
T148 R37W S18
T148 R37W S17
Holst Twsp Clearwater Co.
T148 R37W S16
T148 R37W S15
T148 R37W S14
Unnamed Creek
144
T148 R38W S24
T148 R37W S19
T148 R37W S20
APR RA-03AM
T148 R37W S21
T148 R37W S22
T148 R37W S23
Old Red Lake Trail WMA
T148 R38W S23
T148 R38W S26
T148 R38W S25
T148 R37W S30





SA-04
Applicant's Preferred Route (APR)

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RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

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Public Water Basin
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Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

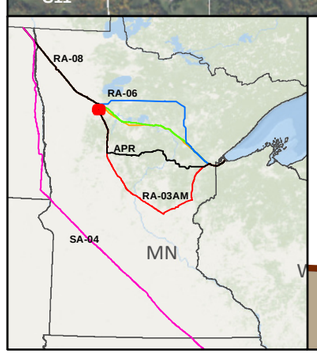
CLEARBROOK TO CARLTON

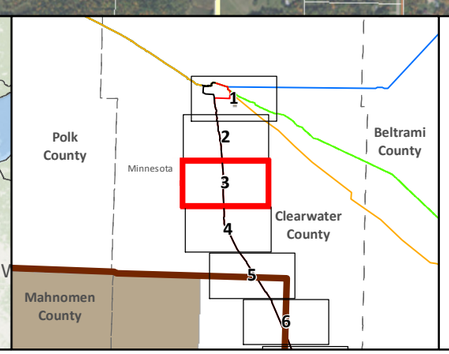
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 2B of 67

T148 R38W S26
T148 R38W S25
T148 R37W S30
T148 R37W S29
T148 R37W S28
T148 R37W S27
T148 R37W S26
T148 R37W S23
T148 R37W S22
T148 R37W S21
Eddy Twsp Clearwater Co.
Holst Twsp Clearwater Co.
Ruffy Brook
146
T148 R38W S35
T148 R38W S36
T148 R37W S31
T148 R37W S32
T148 R37W S33
T148 R37W S34
T148 R37W S35
92
Willborg Lake
Lone Lake
147
T147 R38W S2
T147 R38W S1
T147 R37W S6
T147 R37W S5
T147 R37W S4
T147 R37W S3
T147 R37W S2
Popple Twsp Clearwater Co.
Copley Twsp Clearwater Co.
APR RA-03AM
148
T147 R38W S11
T147 R38W S12
T147 R37W S7
T147 R37W S8
T147 R37W S9
T147 R37W S10
T147 R37W S11





SA-04
Applicant's Preferred Route (APR)

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RA-03AM
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RA-07
RA-08
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Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
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Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

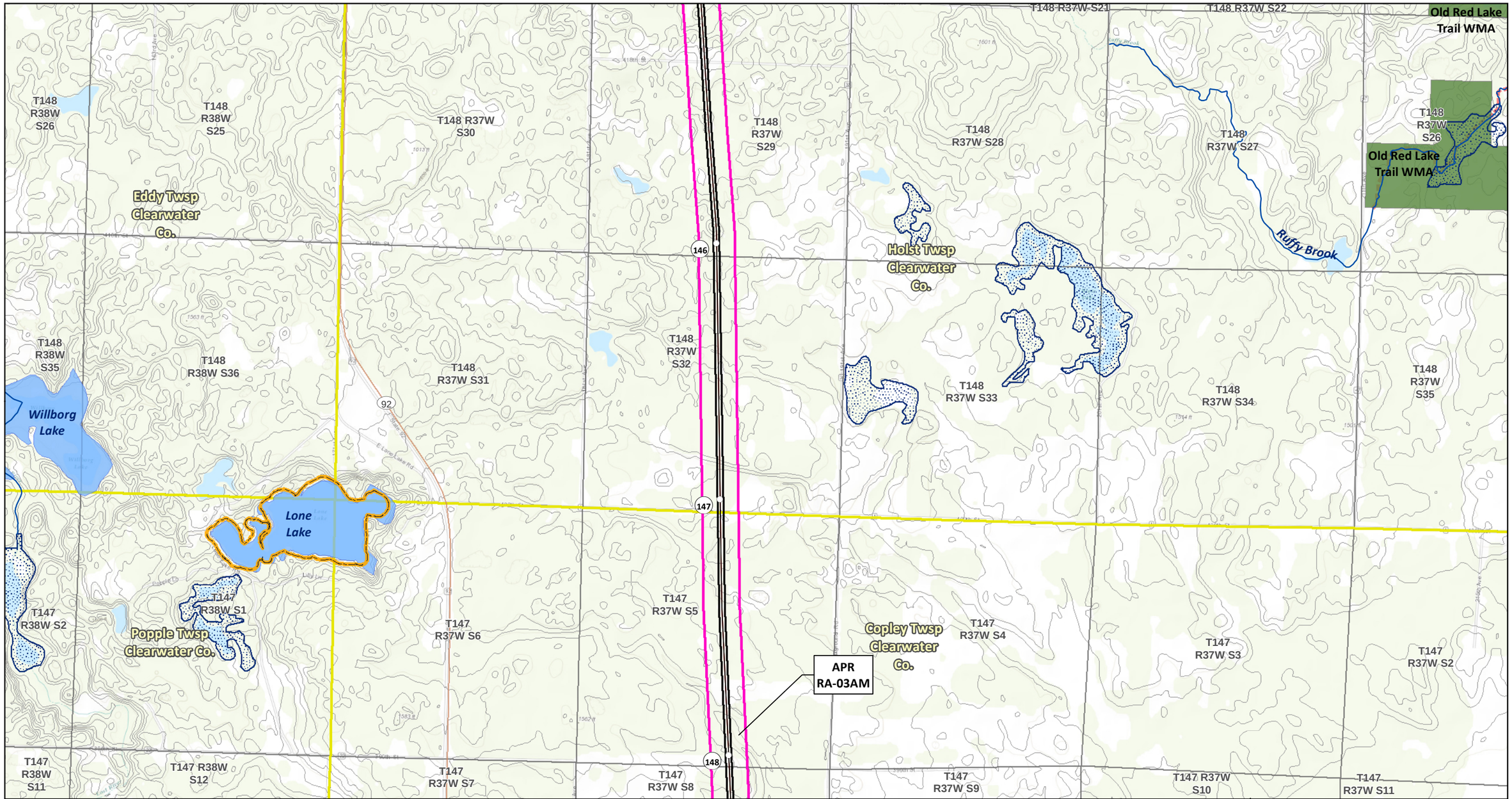
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

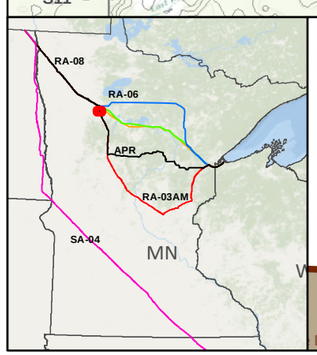
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

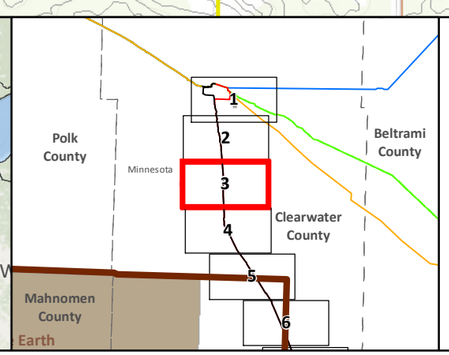
RA-03AM

CLEARBROOK TO CARLTON

Map 3A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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Mile Post
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Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
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Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

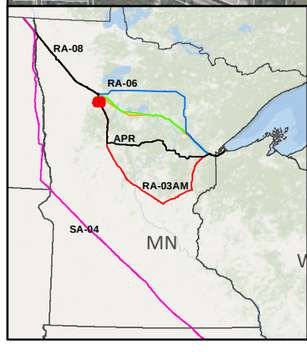
CLEARBROOK TO CARLTON

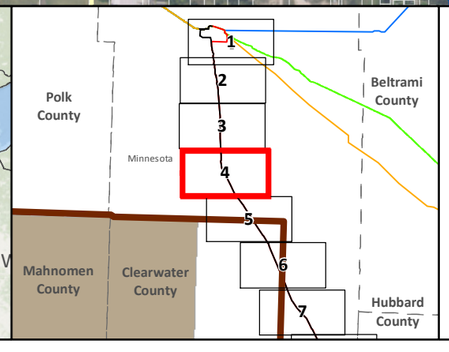
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 3B of 67







SA-04

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Public Waters Watercourse

Residences within 1/2 mile

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Highway

Major Road

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0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

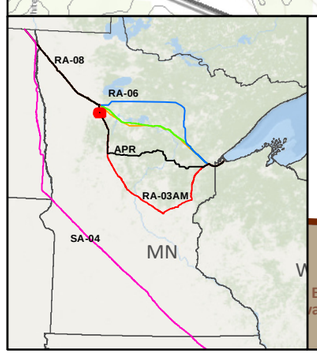
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

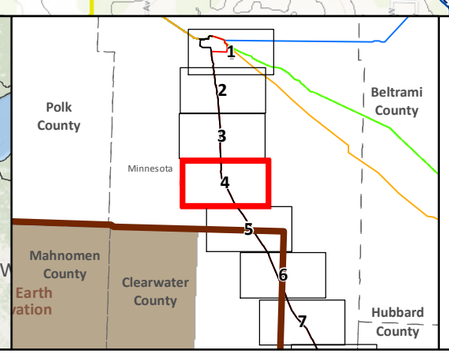
RA-03AM

CLEARBROOK TO CARLTON

Map 4A of 67

T147 R38W S12
T147 R37W S7
T147 R37W S8
T147 R37W S9
T147 R37W S10
T147 R37W S11
T147 R38W S11
T147 R38W S14
T147 R38W S13
T147 R37W S18
T147 R37W S17
T147 R37W S16
T147 R37W S15
T147 R37W S14
Clearwater River
149
150
92
Popple Twsp Clearwater Co.
Copley Twsp Clearwater Co.
T147 R38W S24
T147 R37W S19
T147 R37W S20
T147 R37W S21
T147 R37W S22
T147 R37W S23
Lake Lomond
Copley Twsp Clearwater Co.
Copley Twsp Clearwater Co.
Copley Twsp Clearwater Co.
APR RA-03AM
151
2
Sabe Lake
Unnamed Creek
Bagley Twsp Clearwater Co.
T147 R38W S25
T147 R37W S30
T147 R37W S29
T147 R37W S28
T147 R37W S27
T147 R37W S26





- SA-04
- Applicant's Preferred Route (APR)

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- National River Inventory Crossing
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- 303d Imparied Waters
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- Public Waters Wetlands
- Public Water Basin
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

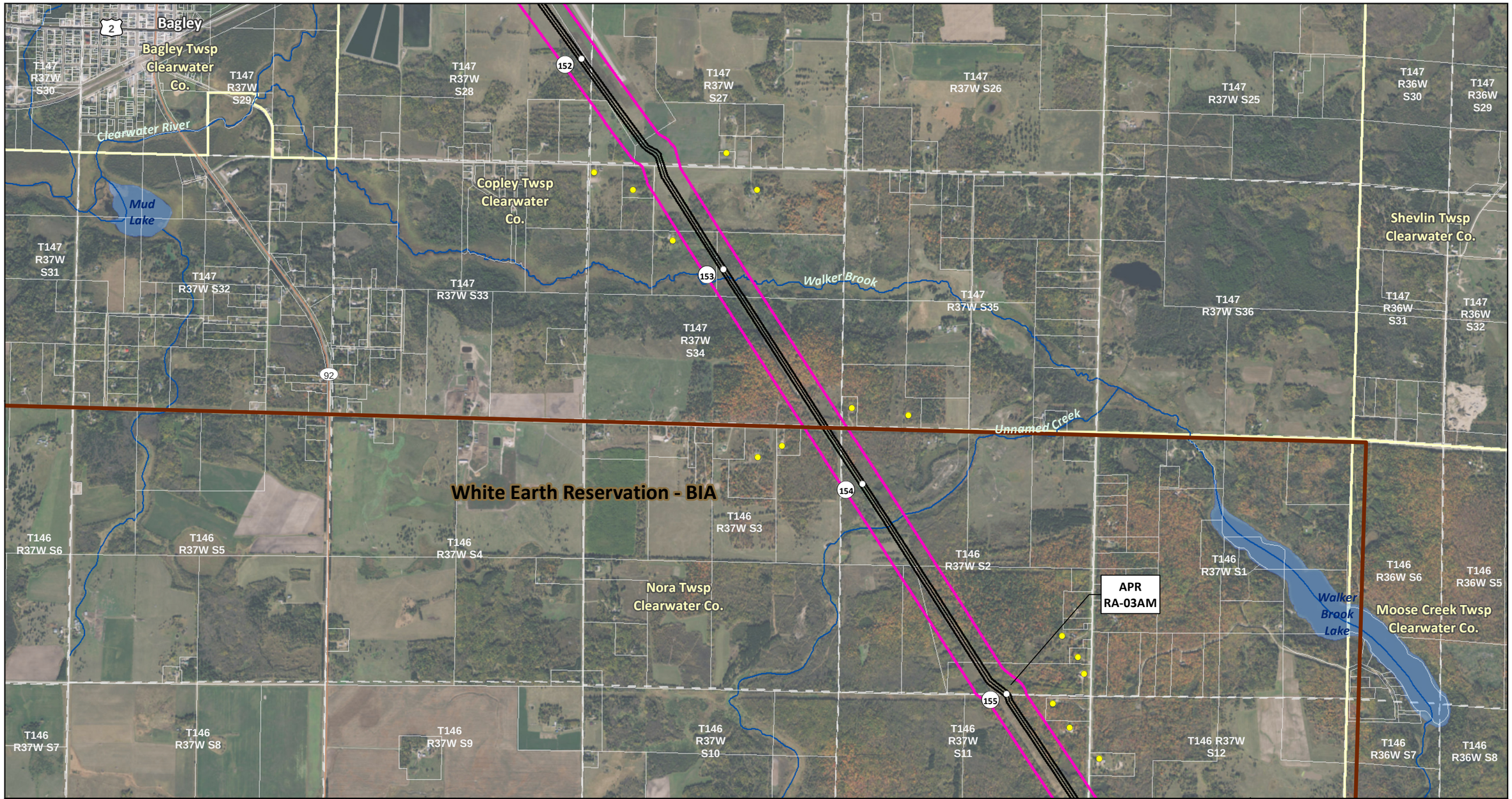
RA-03AM

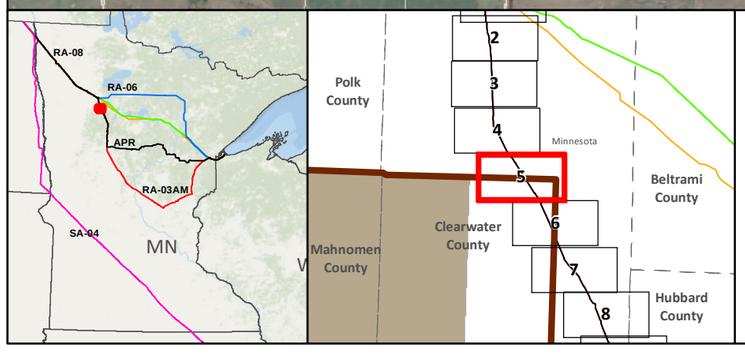
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 4B of 67





- SA-04
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Land Ownership

- State Forest
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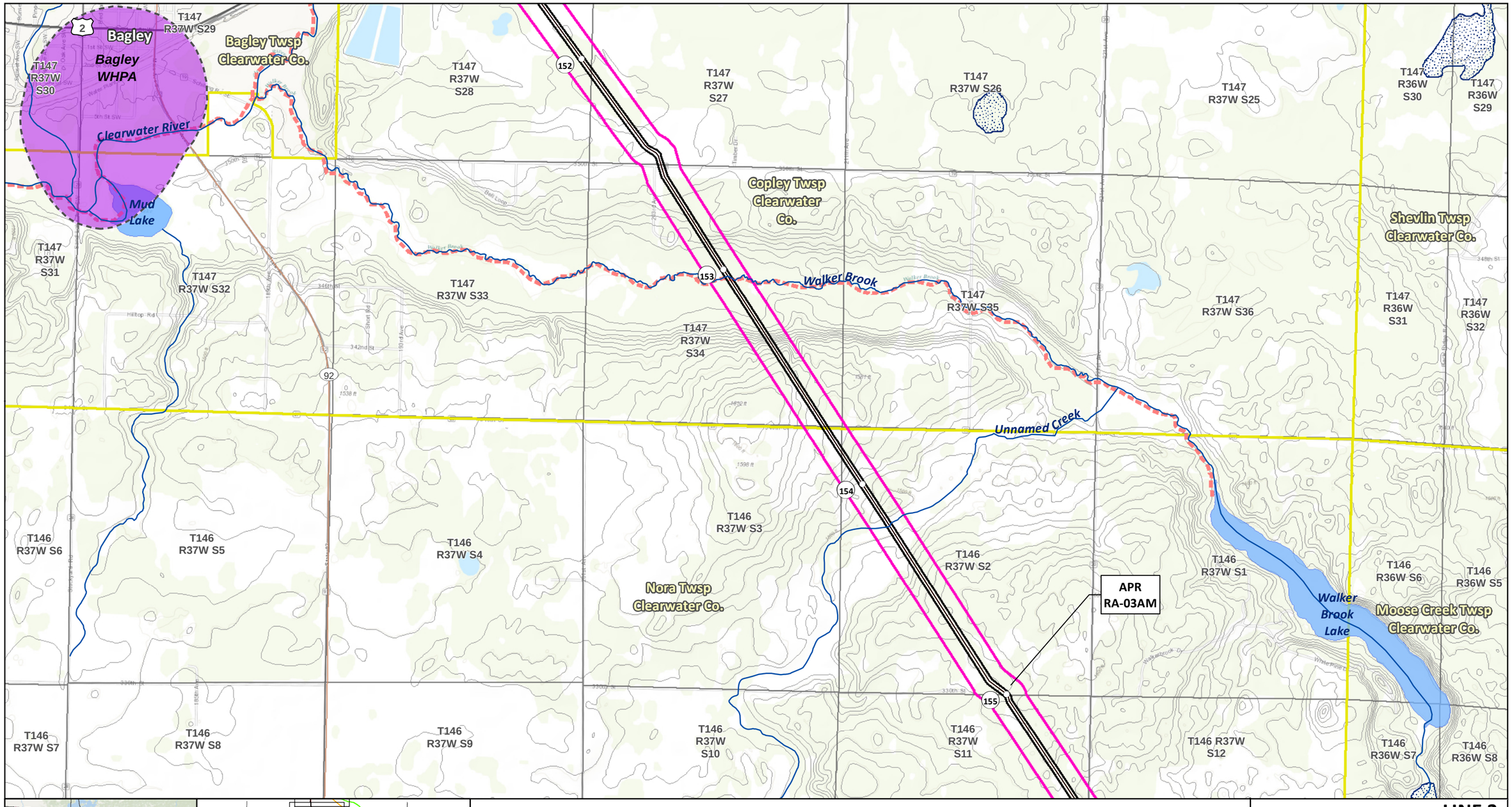
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

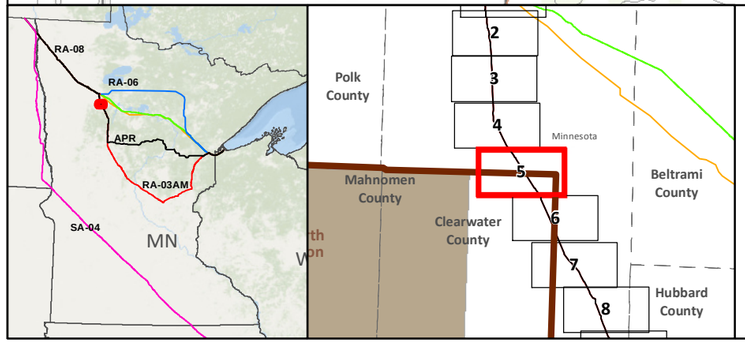
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 5A of 67





- SA-04
- Applicant's Preferred Route (APR)

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RA-03AM

CLEARBROOK TO CARLTON

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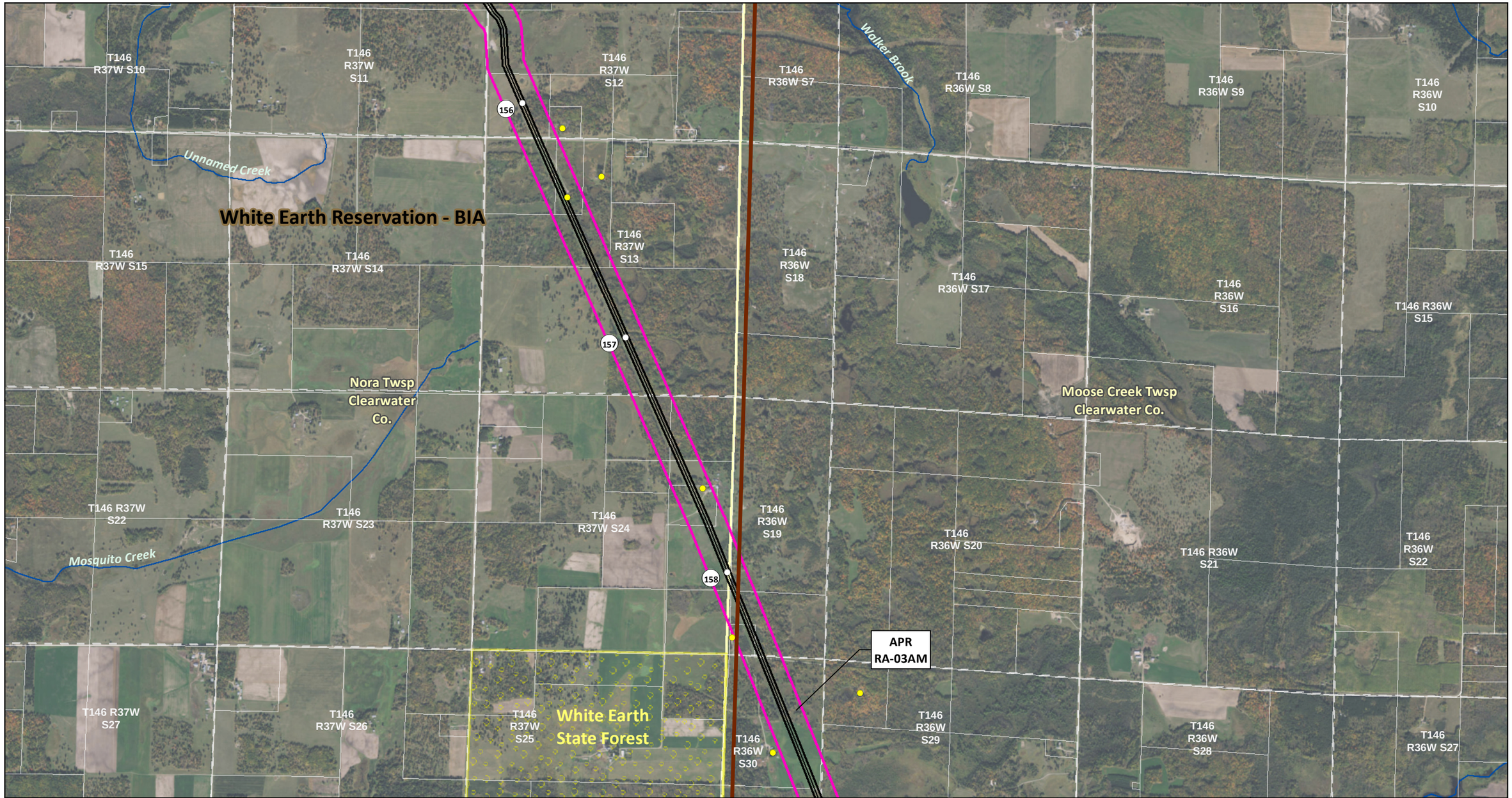
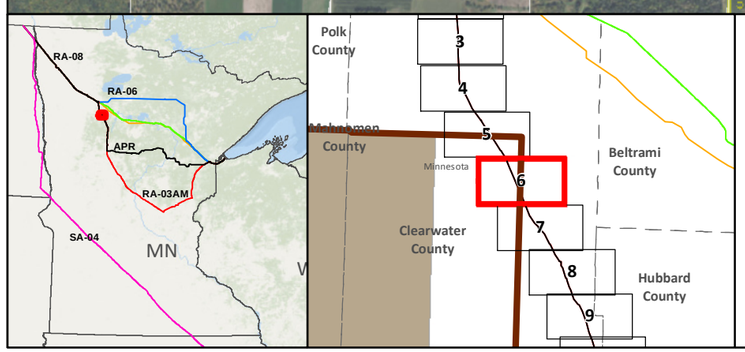
1:24,000

10ft Contours

N

Map 5B of 67





SA-04
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0 0.125 0.25 0.5 Miles
1:24,000
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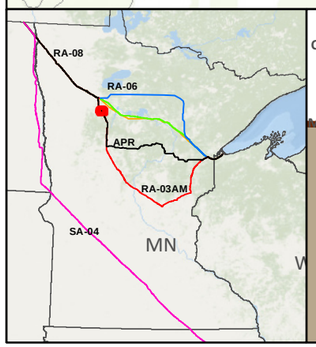
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

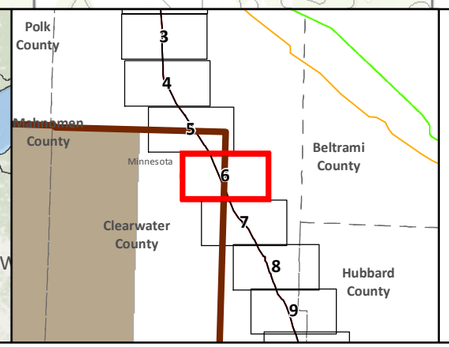
RA-03AM

CLEARBROOK TO CARLTON

Map 6A of 67

T146 R37W S10
T146 R37W S11
T146 R37W S12
T146 R36W S7
T146 R36W S8
T146 R36W S9
T146 R36W S10
Unnamed Creek
Walker Brook
156
T146 R37W S13
T146 R36W S18
T146 R37W S15
T146 R37W S14
T146 R36W S17
T146 R36W S16
T146 R36W S15
157
Nora Twsp
Clearwater
Co.
Moose Creek Twsp
Clearwater Co.
T146 R37W S22
T146 R37W S23
T146 R37W S24
T146 R36W S19
T146 R36W S20
T146 R36W S21
T146 R36W S22
Mosquito Creek
158
APR
RA-03AM
T146 R37W S27
T146 R37W S26
T146 R37W S25
T146 R36W S29
T146 R36W S28
T146 R36W S27
T146 R36W S30





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Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

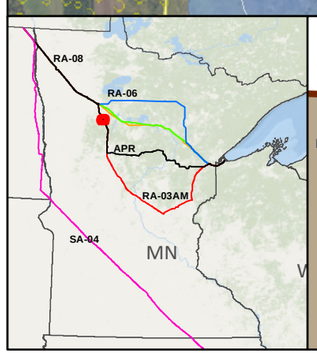
CLEARBROOK TO CARLTON

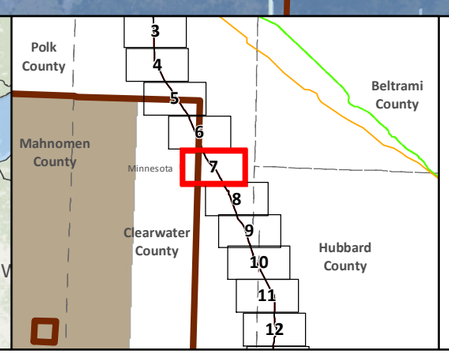
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 6B of 67

T146 R37W S26
T146 R37W S25
T146 R36W S30
T146 R36W S29
T146 R36W S28
T146 R36W S27
T146 R36W S26
T146 R36W S25
Mud Lake
Nora Twsp
Clearwater Co.
T146 R36W S31
T146 R36W S32
Moose Creek Twsp
Clearwater Co.
T146 R37W S35
T146 R37W S36
160
T146 R36W S33
T146 R36W S34
T146 R36W S35
White Earth Reservation - BIA
White Earth
State Forest
T146 R36W S36
161
T145 R37W S2
T145 R37W S1
T145 R36W S6
T145 R36W S5
T145 R36W S4
APR
RA-03AM
T145 R36W S3
T145 R36W S2
T145 R36W S1
Minerva Twsp
Clearwater Co.
Upper
Rice Lake
Bear Creek Twsp
Clearwater Co.
162
T145 R37W S11
T145 R37W S12
T145 R36W S7
T145 R36W S8
T145 R36W S9
T145 R36W S10
T145 R36W S11
T145 R36W S12





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

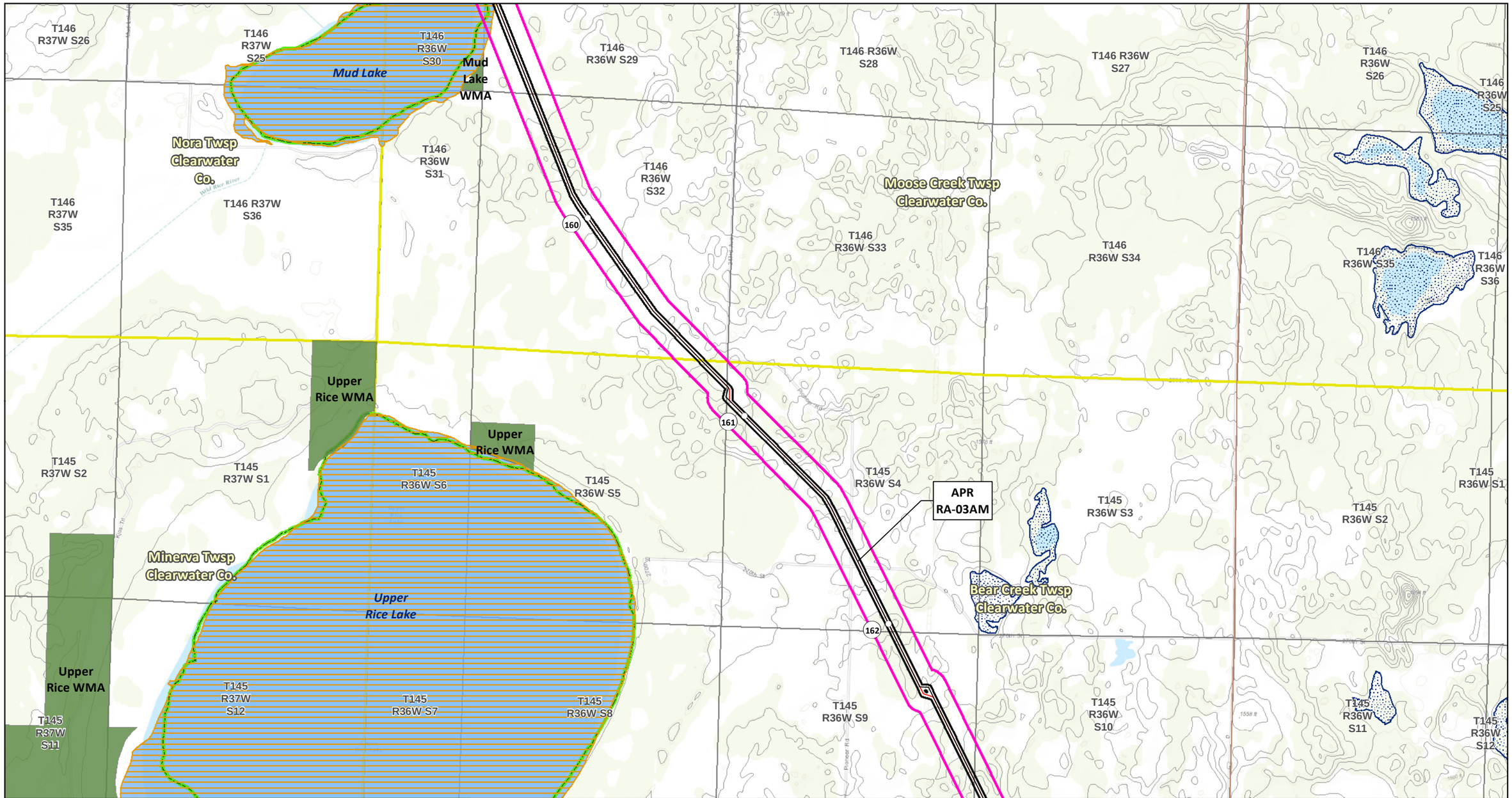
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

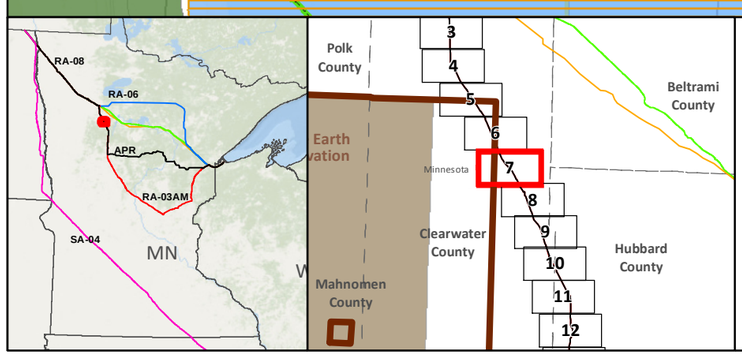
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 7A of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

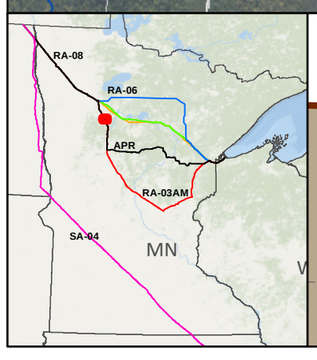
1:24,000

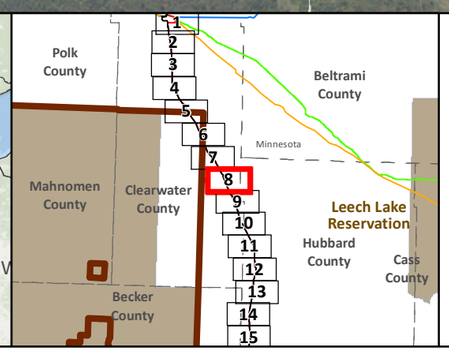
10ft Contours

N

Map 7B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 8A of 67

T145 R36W S8
T145 R36W S9
T145 R36W S10
T145 R36W S11
T145 R36W S12
T145 R35W S7
T145 R35W S8
T145 R36W S17
T145 R36W S16
T145 R36W S15
T145 R36W S14
T145 R36W S13
T145 R35W S18
T145 R35W S17
T145 R36W S20
T145 R36W S21
T145 R36W S22
T145 R36W S23
T145 R36W S24
T145 R35W S19
T145 R35W S20
T145 R36W S29
T145 R36W S28
T145 R36W S27
T145 R36W S26
T145 R36W S25
T145 R35W S30
T145 R35W S29

163
164
165
166

Alida

Bear Creek Twsp
Clearwater Co.

Fern Twsp
Hubbard Co.

APR
RA-03AM

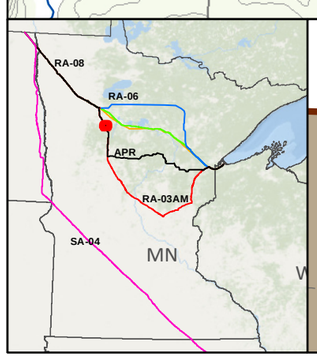
Unnamed Stream

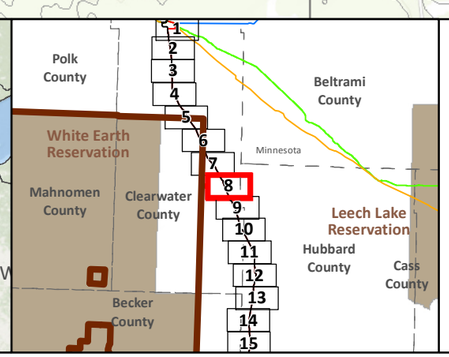
La Salle
Lake SNA

Mississippi River

LaSalle Creek

LaSalle Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters

1:24,000
10ft Contours

N

Map 8B of 67

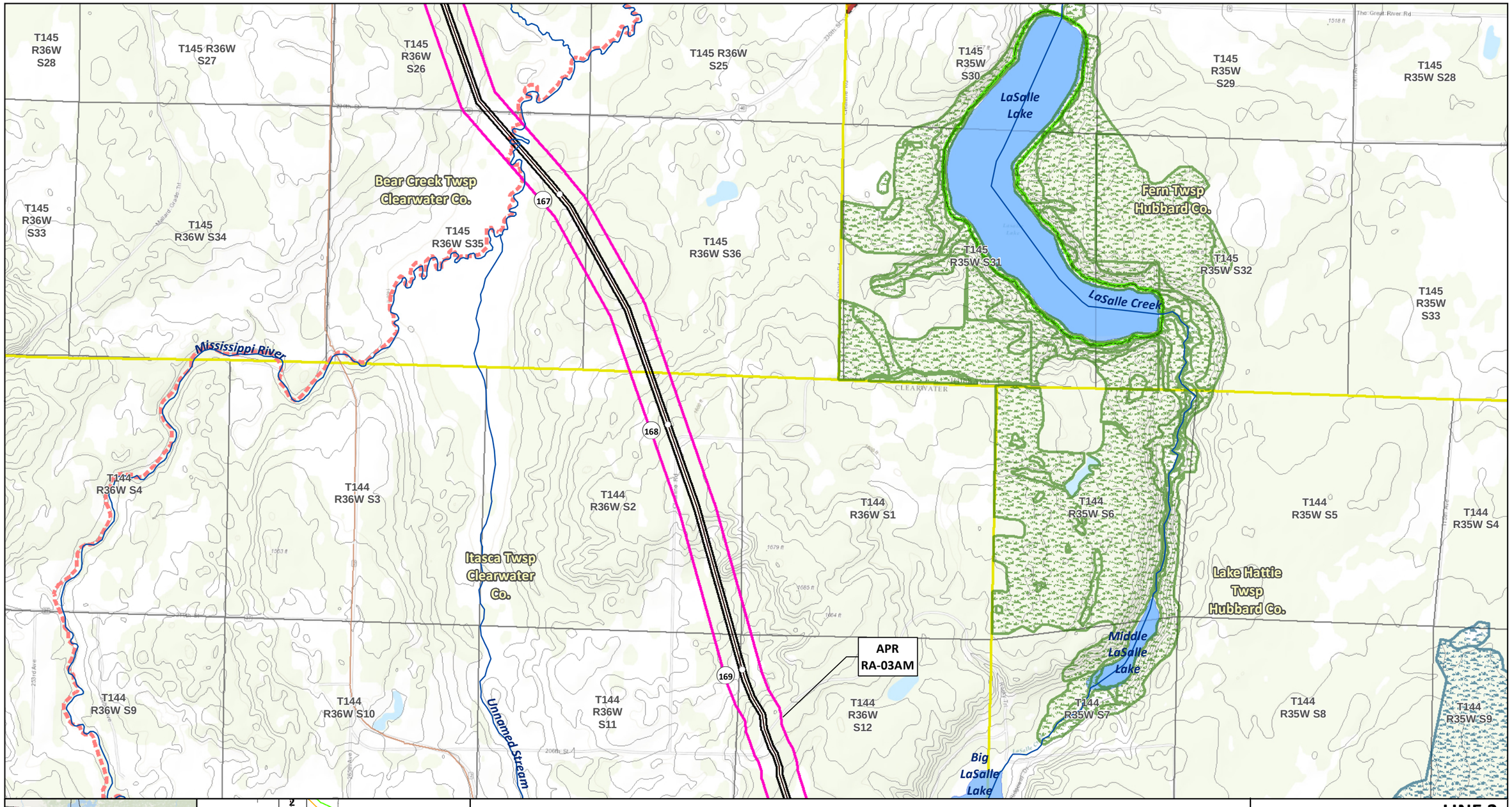


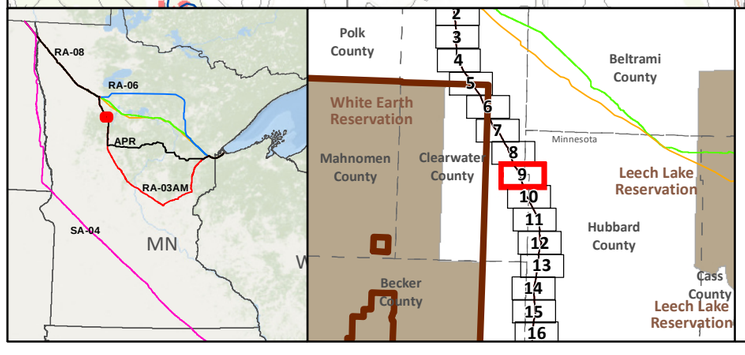
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 9A of 67





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding High Moderate

Native Plant Communities with Biodiversity Significance

Outstanding High Moderate

Terminal Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

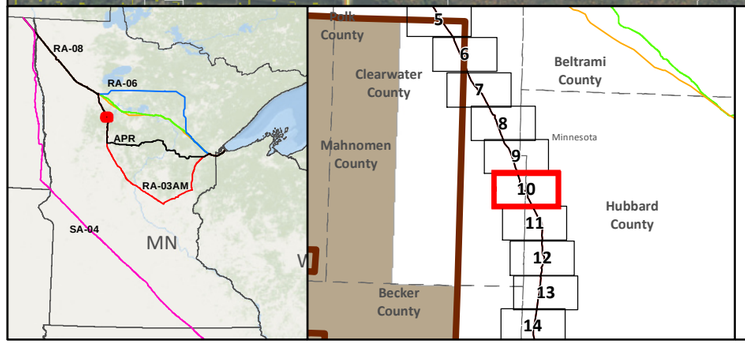
0 125 250 500 Meters

1:24,000

10ft Contours

N

T144 R36W S10
T144 R36W S11
T144 R36W S12
T144 R35W S7
T144 R35W S8
T144 R35W S9
T144 R35W S10
Unnamed Stream
Mississippi River
Big LaSalle Lake
LaSalle Creek
170
T144 R36W S13
T144 R36W S15
Mississippi Headwaters State Forest
T144 R36W S14
T144 R35W S18
T144 R35W S17
T144 R35W S16
T144 R35W S15
Itasca Twsp Clearwater Co.
171
Lake Hattie Twsp Hubbard Co.
T144 R36W S22
T144 R36W S23
T144 R36W S24
T144 R35W S19
T144 R35W S20
Hennepin Creek
T144 R35W S21
T144 R35W S22
172
T144 R36W S27
T144 R36W S26
T144 R36W S25
T144 R35W S30
T144 R35W S29
T144 R35W S28
T144 R35W S27
APR
RA-03AM
173



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

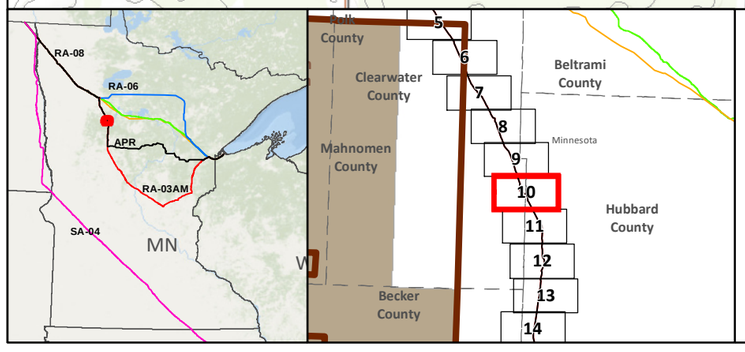
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 10A of 67

T144 R36W S10
Unnamed Stream
T144 R36W S11
T144 R36W S12
LaSalle Creek
T144 R35W S7
T144 R35W S8
T144 R35W S9
T144 R35W S10
Mississippi River
170
Big LaSalle Lake
T144 R36W S15
T144 R36W S14
T144 R36W S13
T144 R35W S18
T144 R35W S17
T144 R35W S16
T144 R35W S15
Itasca Twsp Clearwater Co.
171
Lake Hattie Twsp Hubbard Co.
T144 R36W S22
T144 R36W S23
T144 R36W S24
T144 R35W S19
T144 R35W S20
Hennepin Creek
T144 R35W S21
T144 R35W S22
172
T144 R36W S27
T144 R36W S26
T144 R36W S25
T144 R35W S30
T144 R35W S29
T144 R35W S28
T144 R35W S27
APR RA-03AM
173



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

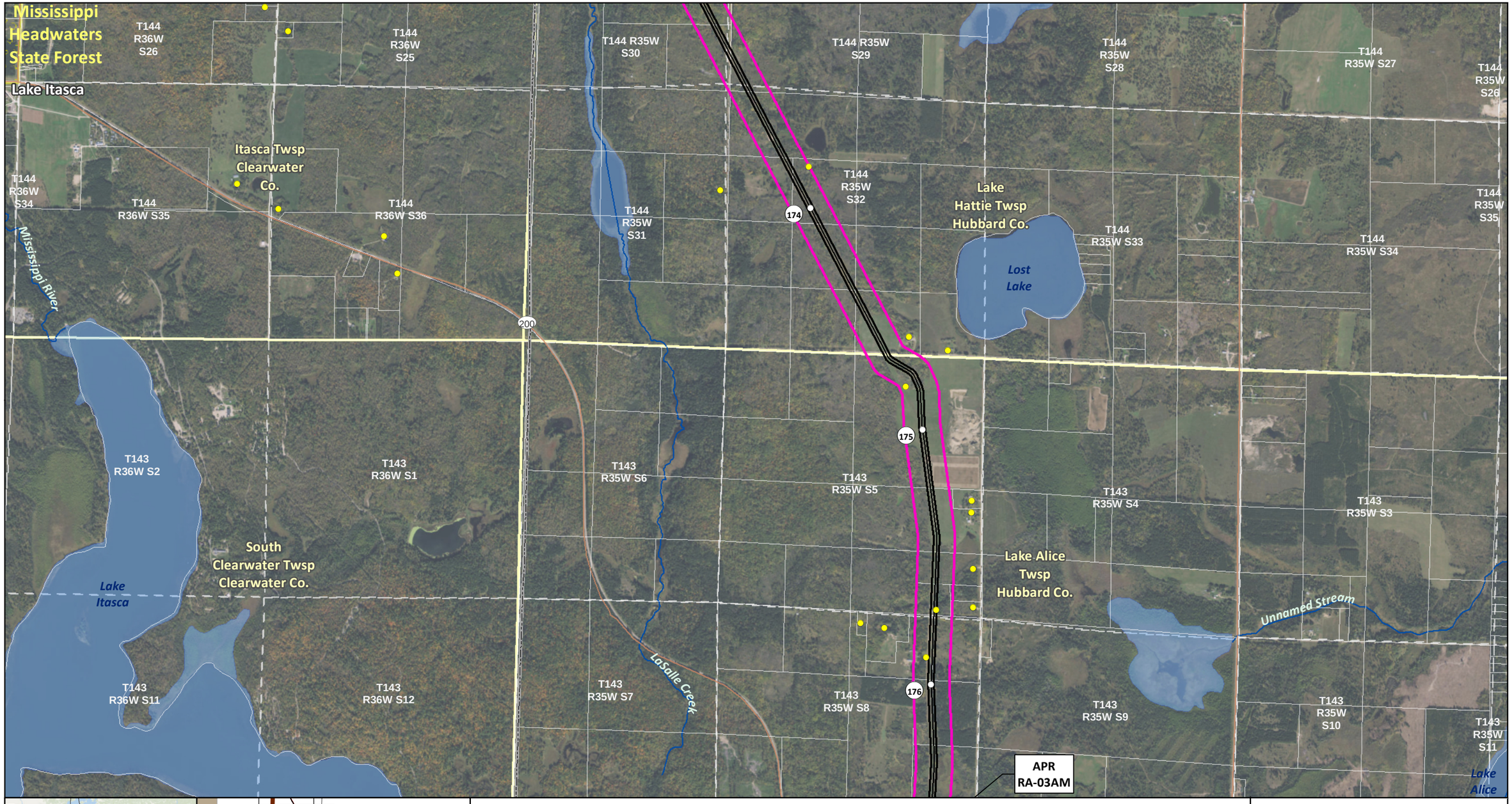
RA-03AM

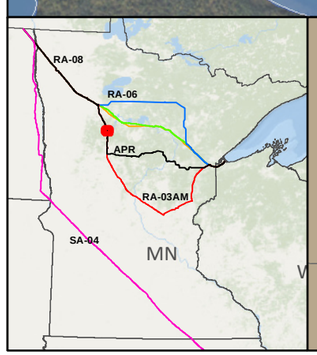
CLEARBROOK TO CARLTON

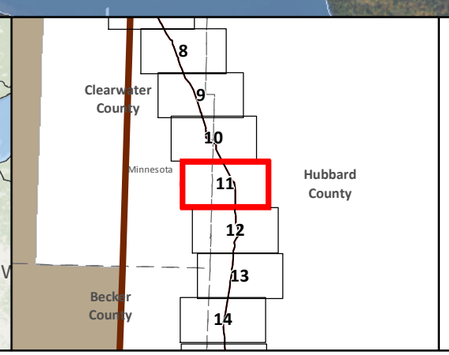
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 10B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

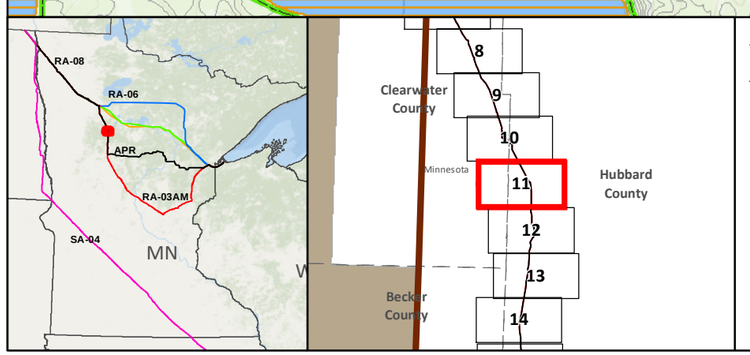
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 11A of 67

T144 R36W S27
T144 R36W S26
T144 R36W S25
T144 R35W S30
T144 R35W S29
T144 R35W S28
T144 R35W S27
T144 R35W S26
Lake Itasca
Itasca Twsp Clearwater Co.
T144 R36W S34
T144 R36W S35
T144 R36W S36
T144 R35W S31
T144 R35W S32
Lake Hattie Twsp Hubbard Co.
T144 R35W S33
T144 R35W S34
T144 R35W S35
Lost Lake
Mississippi River
200
174
175
Lake Itasca
T143 R36W S2
T143 R36W S1
T143 R35W S6
T143 R35W S5
T143 R35W S4
T143 R35W S3
South Clearwater Twsp Clearwater Co.
Itasca Wilderness Sanctuary SNA
T143 R36W S11
T143 R36W S12
T143 R35W S7
LaSalle Creek
T143 R35W S8
176
T143 R35W S9
T143 R35W S10
T143 R35W S11
Lake Alice Twsp Hubbard Co.
Unnamed Stream
Lake Alice
APR
RA-03AM



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
- RA-07
- RA-08
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- National River Inventory Crossing
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- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Waters Wetlands
- Public Water Basin
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- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate
- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

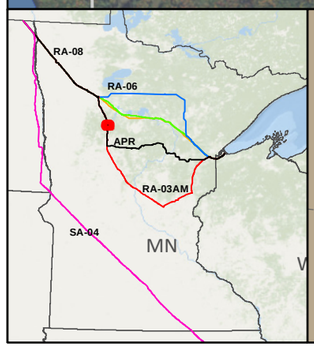
CLEARBROOK TO CARLTON

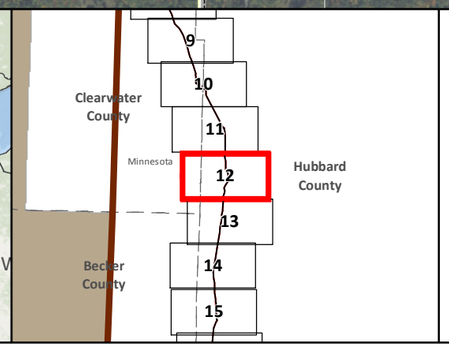
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 11B of 67

T143 R36W S11
T143 R36W S12
Lake Itasca
T143 R35W S7
T143 R35W S8
T143 R35W S9
T143 R35W S10
Lake Alice
T143 R35W S11
T143 R36W S14
T143 R36W S13
T143 R35W S18
T143 R35W S17
T143 R35W S16
Paul Bunyan State Forest
T143 R35W S15
T143 R35W S14
Birch Creek
177
200
Lyendecker Lake
Goodwin Lake
178
Lake Alice Twsp Hubbard Co.
T143 R36W S23
South Clearwater Twsp Clearwater Co.
Wettersten Lake
T143 R36W S24
T143 R35W S19
T143 R35W S20
T143 R35W S21
71
T143 R35W S22
T143 R35W S23
Mary Lake
Allen Lake
Deer Park Lake
Clarke Lake
T143 R36W S26
T143 R36W S25
Myrtle Lake
Twin Lakes
T143 R35W S30
T143 R35W S29
179
APR RA-03AM
T143 R35W S28
Spider Lake
T143 R35W S27
T143 R35W S26
Deming Lake
McKay Lake
Beauty Lake





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

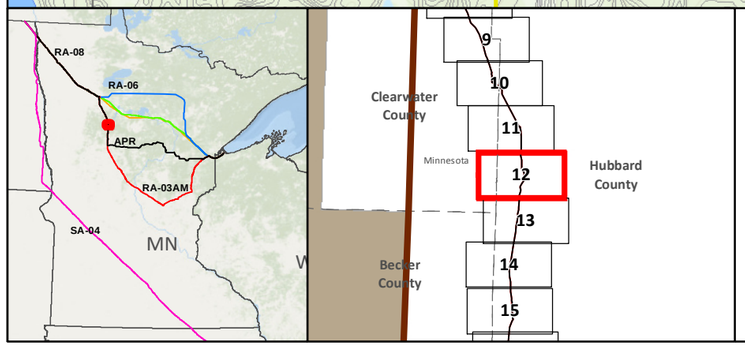
Map 12A of 67

T143 R36W S11
T143 R36W S12
T143 R35W S7
T143 R35W S8
T143 R35W S9
T143 R35W S10
T143 R35W S11
T143 R36W S14
T143 R36W S13
T143 R35W S18
T143 R35W S17
T143 R35W S16
T143 R35W S15
T143 R35W S14
T143 R36W S23
T143 R36W S24
T143 R35W S19
T143 R35W S20
T143 R35W S21
T143 R35W S22
T143 R35W S23
T143 R36W S26
T143 R36W S25
T143 R35W S30
T143 R35W S29
T143 R35W S28
T143 R35W S27
T143 R35W S26

Lake Itasca
Lyendecker Lake
Goodwin Lake
Lake Alice
Birch Creek
South Clearwater Twsp Clearwater Co.
Lake Alice Twsp Hubbard Co.
Wettersten Lake
Mary Lake
Allen Lake
Deer Park Lake
Clarke Lake
Myrtle Lake
Twin Lakes
Deming Lake
McKay Lake
Spider Lake
Beauty Lake

177
178
179
200
71

APR
RA-03AM



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 12B of 67

South Clearwater Twsp Clearwater Co.

T143 R36W S36

T143 R35W S30

T143 R35W S29

T143 R35W S28

T143 R35W S27

T143 R35W S26

Beaver Dam Lake

Josephine Lake

Beauty Lake

Lake Alice Twsp Hubbard Co.

T143 R35W S31

T143 R35W S32

T143 R35W S33

T143 R35W S34

T143 R35W S35

T143 R35W S36

Iron Corner Lake

Sibilant Lake

Gilfillan Lake

T142 R36W S1

T142 R35W S6

T142 R35W S5

T142 R35W S4

T142 R35W S3

T142 R35W S2

T142 R35W S1

Savannah Twsp Becker Co.

Clover Twsp Hubbard Co.

APR RA-03AM

T142 R36W S12

T142 R35W S7

T142 R35W S8

T142 R35W S9

T142 R35W S10

T142 R35W S11

T142 R35W S12

Little Mantrap Lake

T142 R36W S13

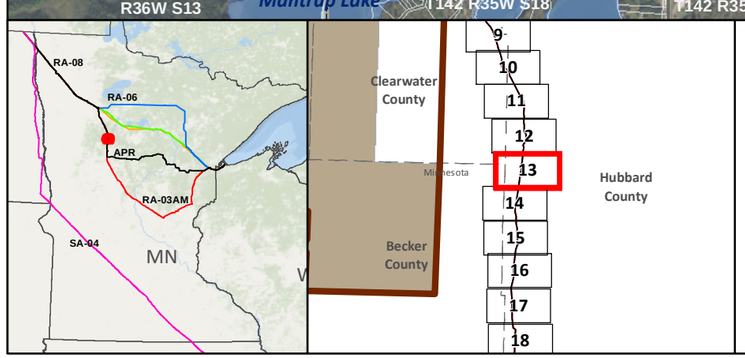
T142 R35W S18

T142 R35W S17

T142 R35W S16

Wabisish Lake

T142 R35W S15



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

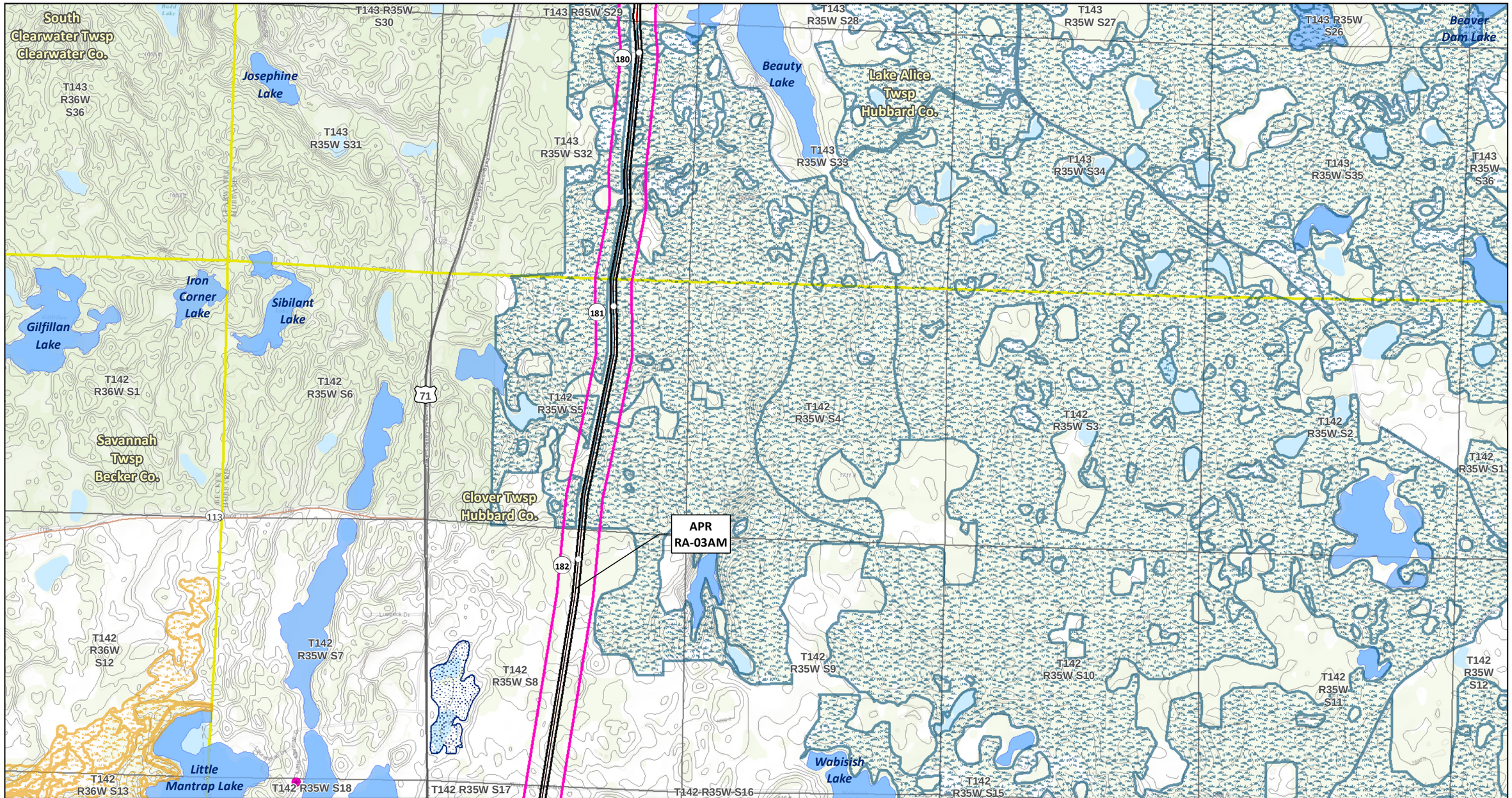
0 125 250 500 Meters

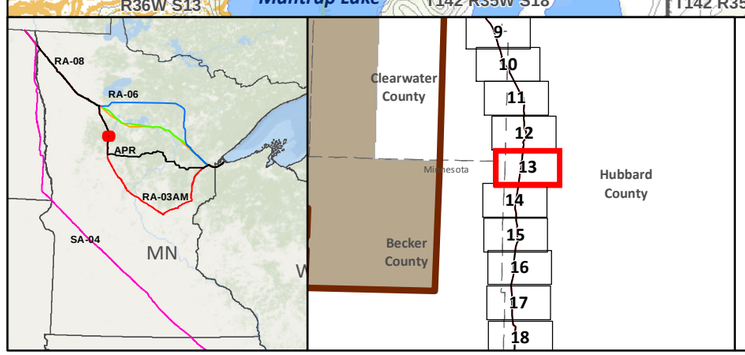
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 13A of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate
- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

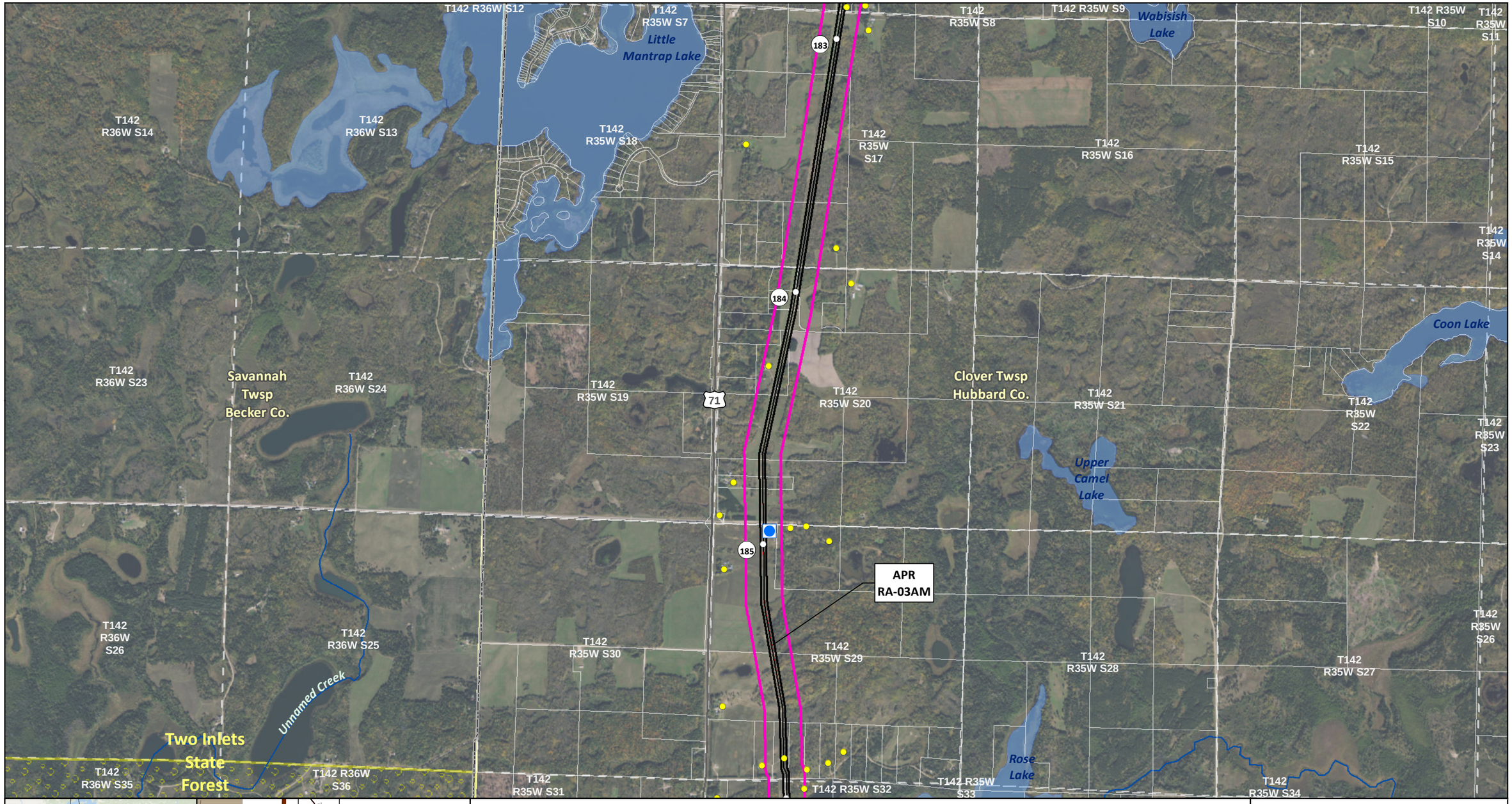
RA-03AM

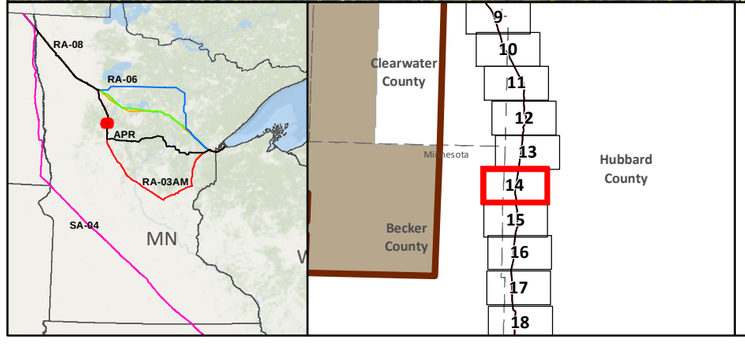
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 13B of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

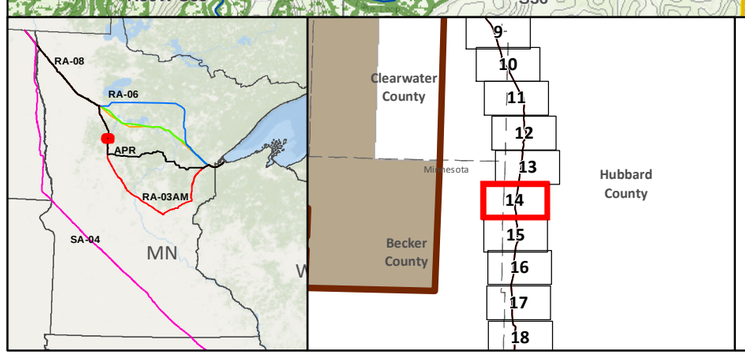
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 14A of 67

T142 R36W S12
T142 R35W S7
T142 R35W S8
T142 R35W S9
Wabisish Lake
T142 R35W S10
T142 R35W S11
Little Mantrap Lake
T142 R36W S14
T142 R36W S13
T142 R35W S18
T142 R35W S17
T142 R35W S16
T142 R35W S15
T142 R35W S14
T142 R36W S23
Savannah Twsp Becker Co.
T142 R36W S24
T142 R35W S19
Clover Twsp Hubbard Co.
T142 R35W S20
T142 R35W S21
Coon Lake
T142 R35W S22
T142 R35W S23
Upper Camel Lake
APR RA-03AM
T142 R36W S26
T142 R36W S25
T142 R35W S30
T142 R35W S29
T142 R35W S28
T142 R35W S27
T142 R35W S26
Unnamed Creek
T142 R36W S35
T142 R36W S36
T142 R35W S31
T142 R35W S32
T142 R35W S33
Rose Lake
T142 R35W S34
183
184
185
71



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

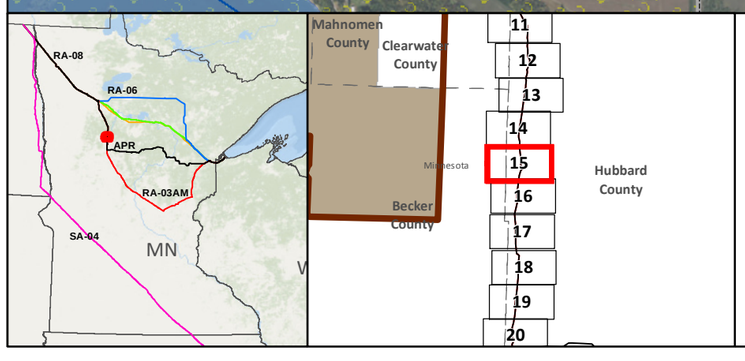
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 14B of 67





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

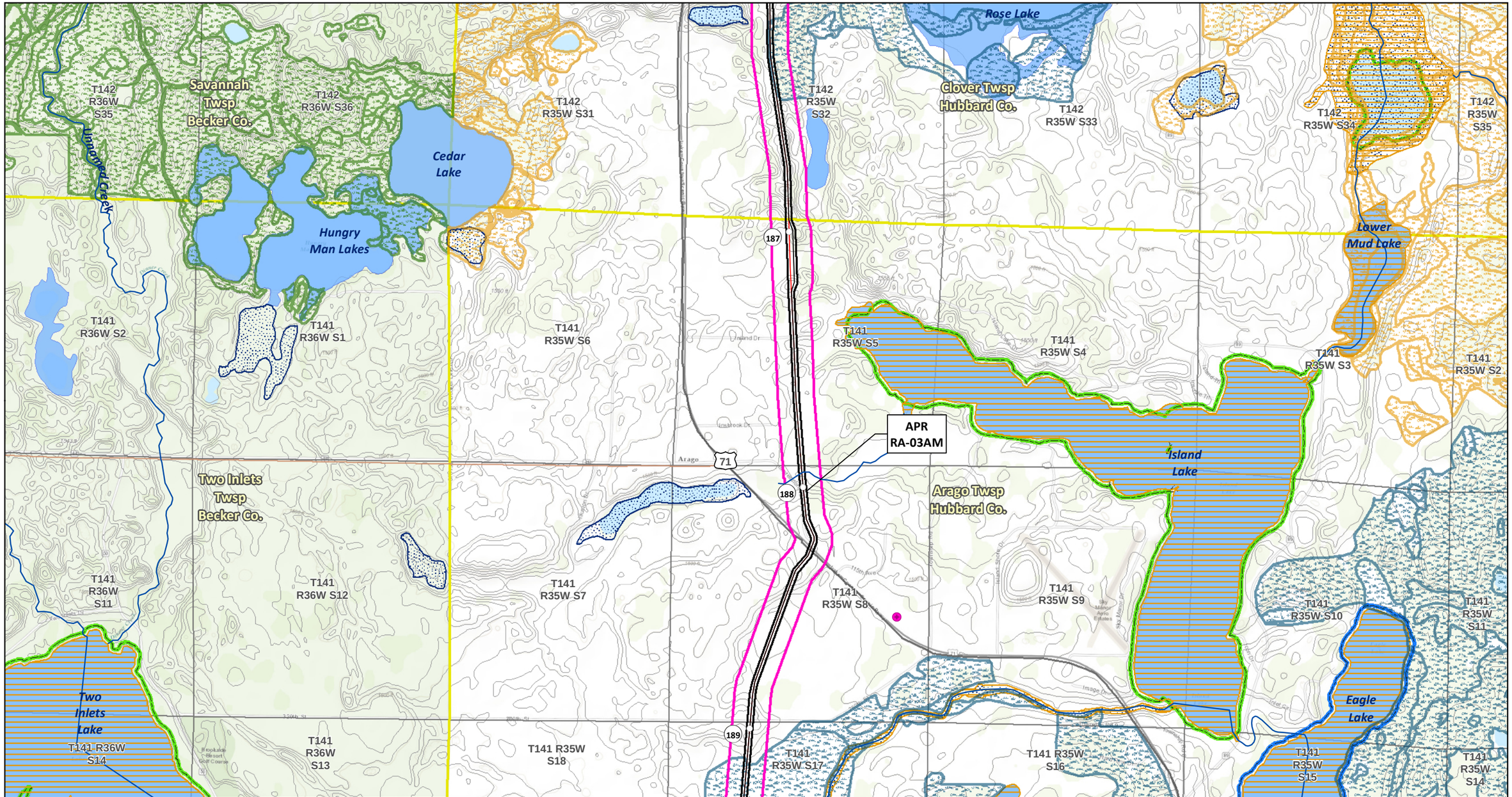
0 125 250 500 Meters

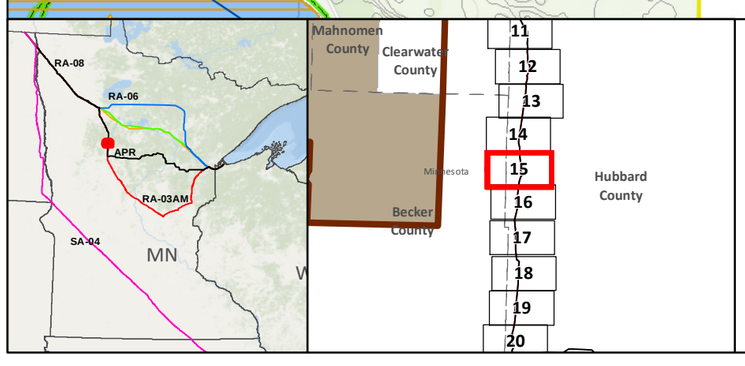
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 15A of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

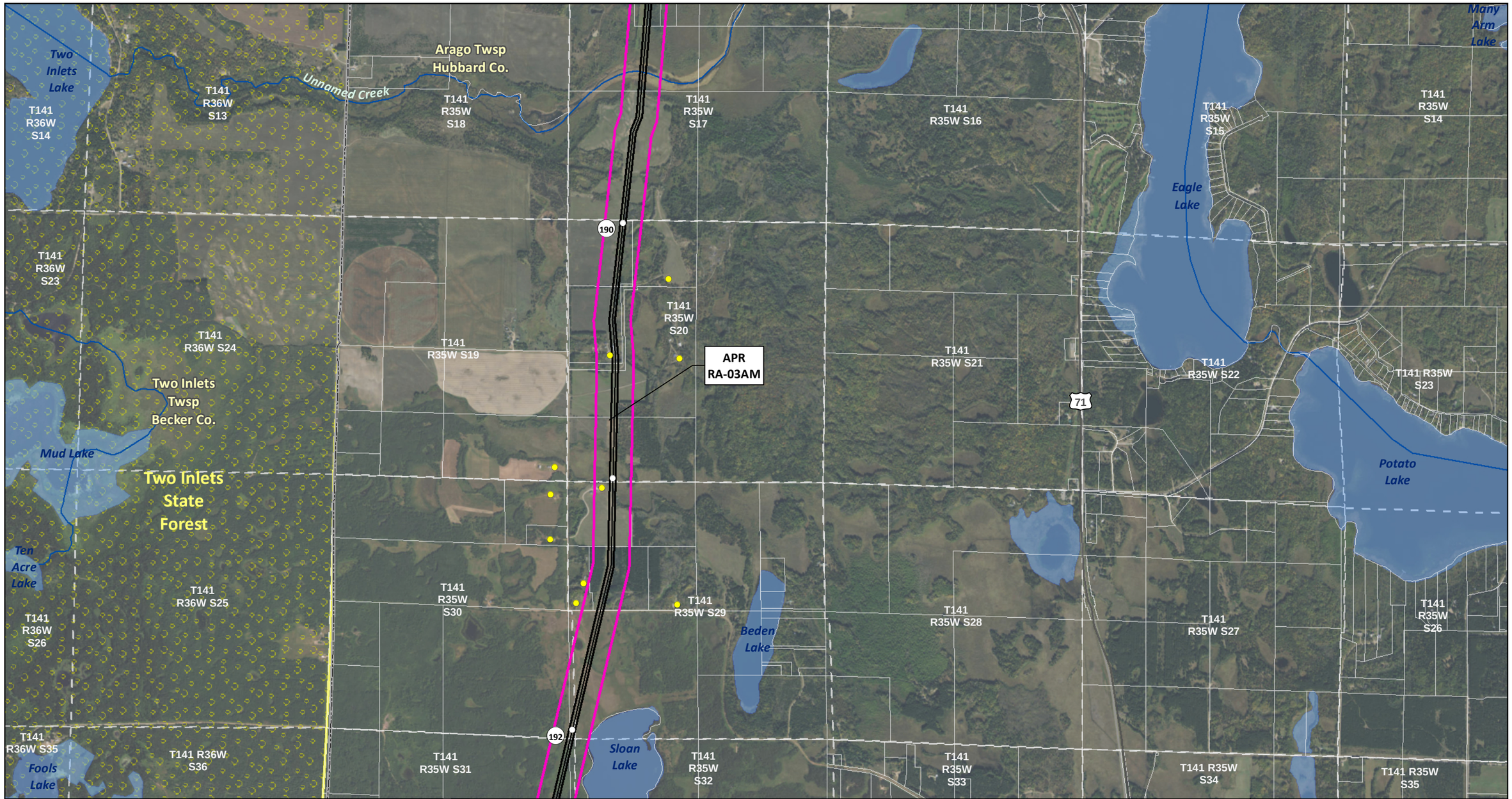
0 0.125 0.25 0.5 Miles

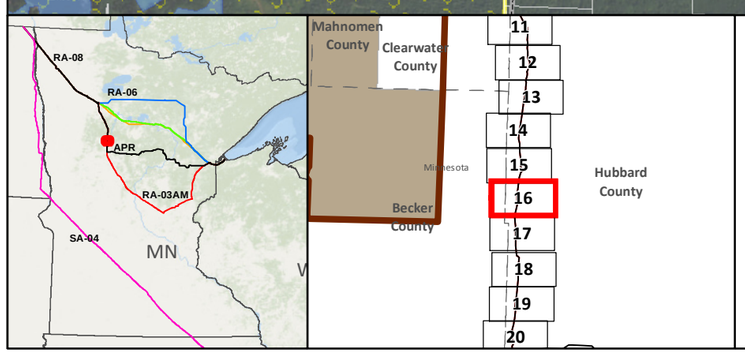
1:24,000

0 125 250 500 Meters

10ft Contours

Map 15B of 67





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

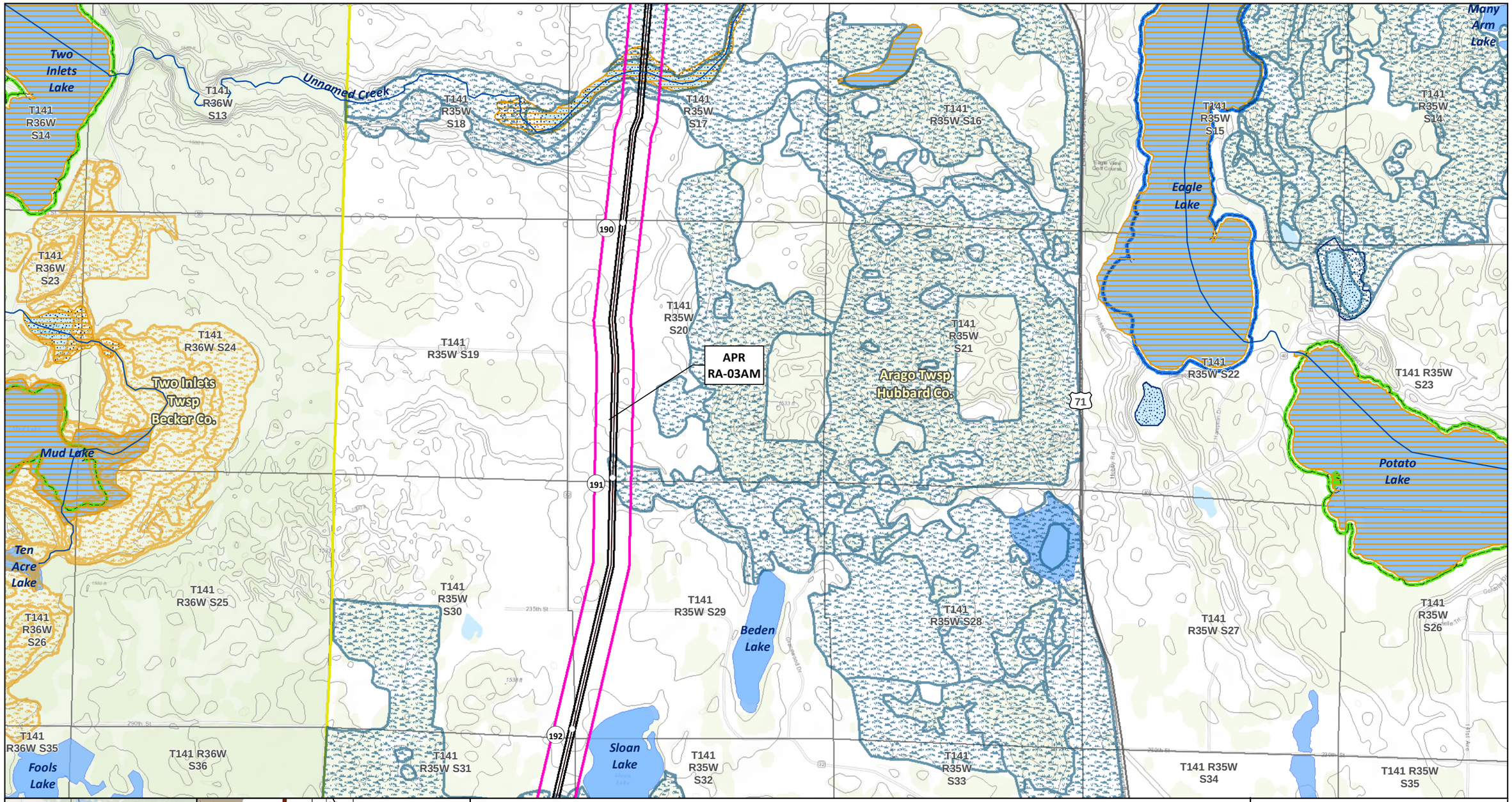
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 16A of 67


Two Inlets Lake
T141 R36W S14
T141 R36W S13
Unnamed Creek
T141 R35W S18
T141 R35W S17
T141 R35W S16
T141 R35W S15
Many Arm Lake
T141 R35W S14
Eagle Lake
T141 R36W S23
T141 R36W S24
T141 R35W S19
T141 R35W S20
APR RA-03AM
T141 R35W S21
Arago Twsp Hubbard Co.
T141 R35W S22
T141 R35W S23
Two Inlets Twsp Becker Co.
Mud Lake
Potato Lake
190
191
192
71
Ten Acre Lake
T141 R36W S25
T141 R35W S30
T141 R35W S29
Beden Lake
T141 R35W S28
T141 R35W S27
T141 R35W S26
T141 R36W S26
T141 R36W S35
T141 R36W S36
T141 R35W S31
Sloan Lake
T141 R35W S32
T141 R35W S33
T141 R35W S34
T141 R35W S35
Fools Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Mahnomen County
Clearwater County
Becker County
Hubbard County
11
12
13
14
15
16
17
18
19
20
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
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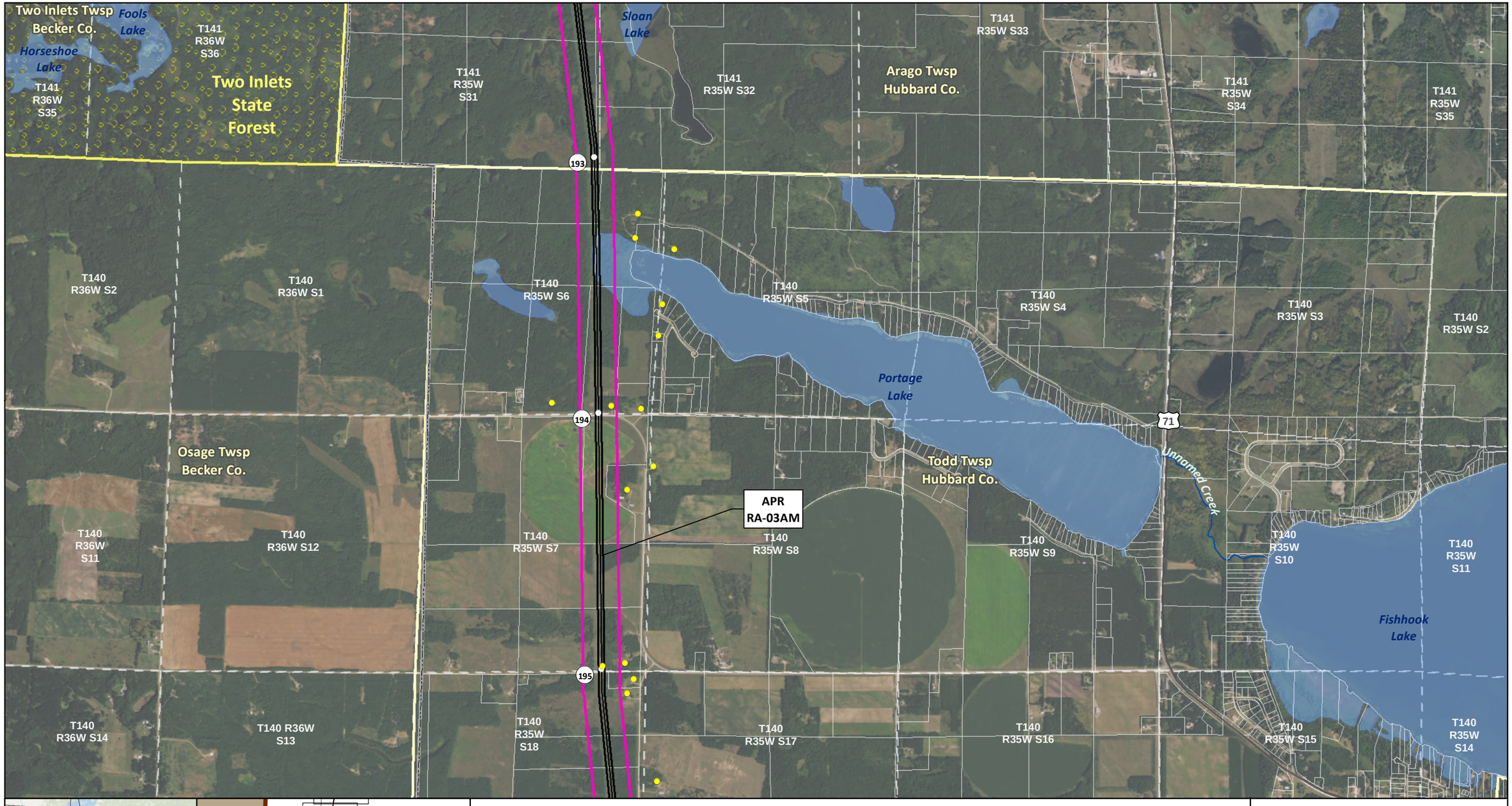
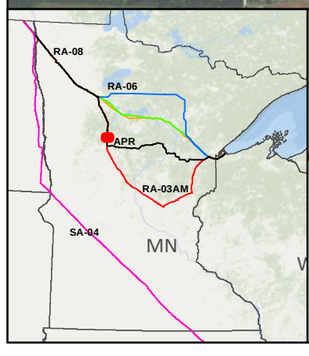
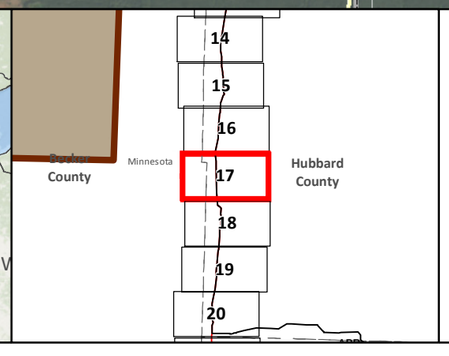
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 16B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources:
MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

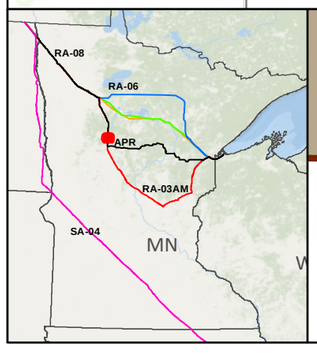
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

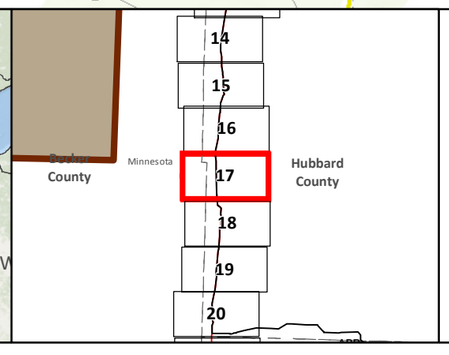
RA-03AM

CLEARBROOK TO CARLTON

Map 17A of 67

Fools Lake
Horseshoe Lake
Two Inlets Twsp Becker Co.
T141 R36W S35
T141 R36W S36
T141 R35W S31
Sloan Lake
T141 R35W S32
Arago Twsp Hubbard Co.
T141 R35W S33
T141 R35W S34
T141 R35W S35
193
T140 R36W S2
T140 R36W S1
T140 R35W S6
T140 R35W S5
T140 R35W S4
T140 R35W S3
T140 R35W S2
Portage Lake
194
71
Osage Twsp Becker Co.
Todd Twsp Hubbard Co.
Unnamed Creek
APR RA-03AM
T140 R36W S11
T140 R36W S12
T140 R35W S7
T140 R35W S8
T140 R35W S9
T140 R35W S10
T140 R35W S11
Fishhook Lake
Park Rapids Game Refuge
195
T140 R36W S14
T140 R36W S13
T140 R35W S18
T140 R35W S17
T140 R35W S16
T140 R35W S15
T140 R35W S14





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

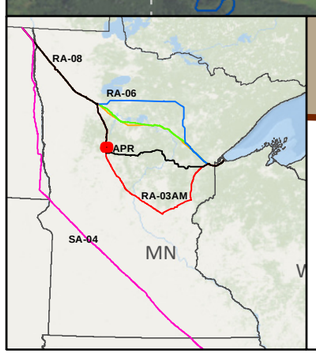
CLEARBROOK TO CARLTON

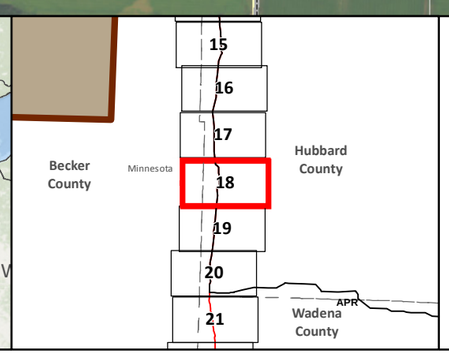
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 17B of 67

T140 R36W S14
T140 R36W S13
T140 R35W S18
T140 R35W S17
T140 R35W S16
T140 R35W S15
T140 R35W S14
Park Rapids Twsp Hubbard Co.
225
196
T140 R36W S23
T140 R36W S24
T140 R35W S19
T140 R35W S20
T140 R35W S21
T140 R35W S22
T140 R35W S23
197
34
Osage Twsp Becker Co.
Todd Twsp Hubbard Co.
APR RA-03AM
T140 R36W S26
T140 R36W S25
T140 R35W S30
T140 R35W S29
T140 R35W S28
T140 R35W S27
T140 R35W S26
198
Park Rapids Twsp Hubbard Co.
T140 R36W S35
T140 R36W S36
T140 R35W S31
T140 R35W S32
T140 R35W S33
T140 R35W S34
T140 R35W S35
Straight River





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

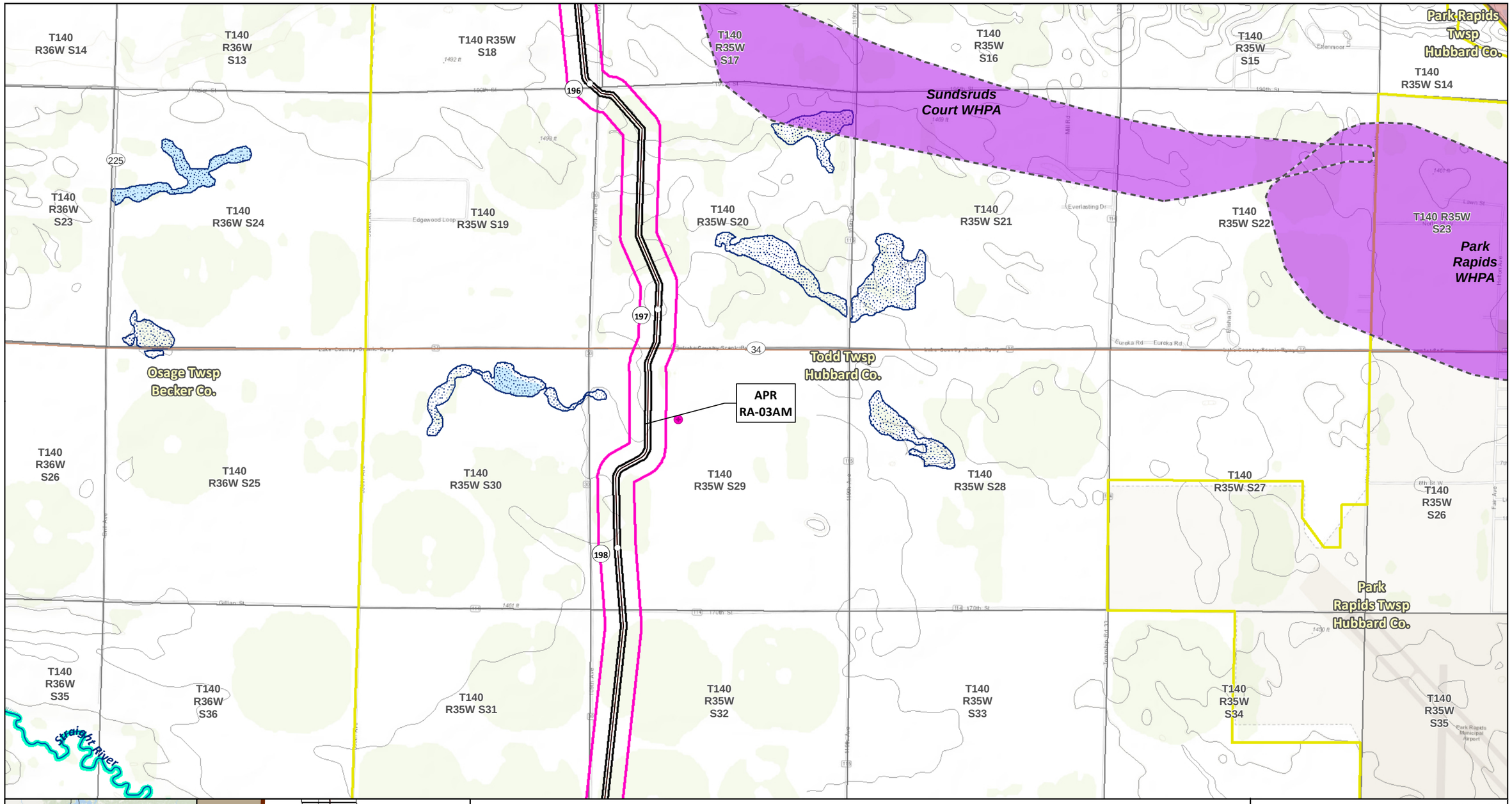
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

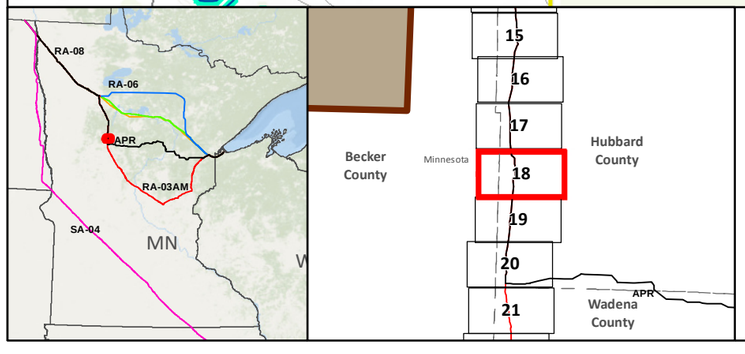
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 18A of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC RA-03AM

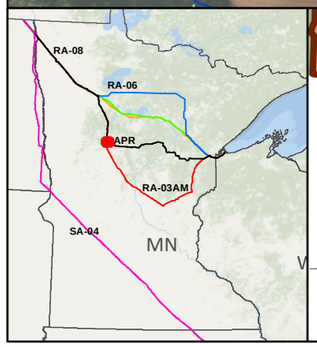
CLEARBROOK TO CARLTON

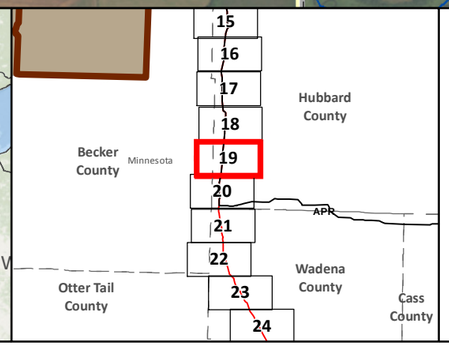
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 18B of 67

T140 R36W S35
T140 R36W S36
T140 R35W S31
T140 R35W S32
Todd Twsp Hubbard Co.
T140 R35W S33
T140 R35W S34
Park Rapids Twsp Hubbard Co.
Osage Twsp Becker Co.
Green Valley Twsp Becker Co.
T139 R36W S2
T139 R36W S1
T139 R35W S6
T139 R35W S5
T139 R35W S4
T139 R35W S3
T139 R35W S2
200
Straight River
APR RA-03AM
T139 R36W S11
T139 R36W S12
T139 R35W S7
T139 R35W S8
Straight River Twsp Hubbard Co.
T139 R35W S9
T139 R35W S10
T139 R35W S11
Brush Lake
201
T139 R36W S14
T139 R36W S13
T139 R35W S18
T139 R35W S17
T139 R35W S16
T139 R35W S15
T139 R35W S14
71
Unnamed Stream
202
Moran Lake





- SA-04
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- RA-03AM
- RA-06
- RA-07
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Land Ownership
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- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

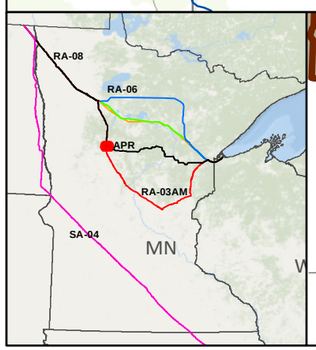
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

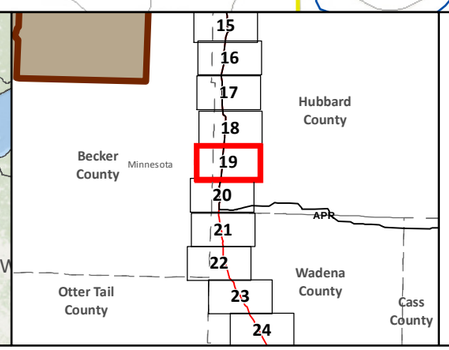
RA-03AM

CLEARBROOK TO CARLTON

Map 19A of 67

T140 R36W S35
T140 R36W S36
Osage Twsp Becker Co.
T140 R35W S31
T140 R35W S32
Todd Twsp Hubbard Co.
T140 R35W S33
T140 R35W S34
Park Rapids Twsp Hubbard Co.
Green Valley Twsp Becker Co.
T139 R36W S2
T139 R36W S1
T139 R35W S6
T139 R35W S5
T139 R35W S4
T139 R35W S3
T139 R35W S2
200
Straight River
APR RA-03AM
T139 R36W S11
T139 R36W S12
T139 R35W S7
T139 R35W S8
Straight River Twsp Hubbard Co.
T139 R35W S9
T139 R35W S10
T139 R35W S11
Brush Lake
201
T139 R36W S14
T139 R36W S13
T139 R35W S18
T139 R35W S17
T139 R35W S16
T139 R35W S15
T139 R35W S14
71
Unnamed Stream
202
Moran Lake





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- Applicant's Preferred Route (APR)

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- RA-06
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- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

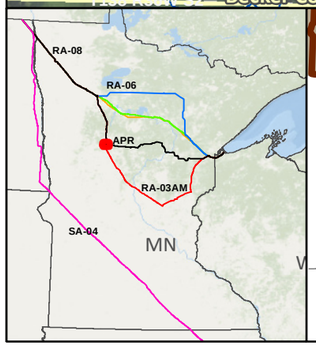
RA-03AM

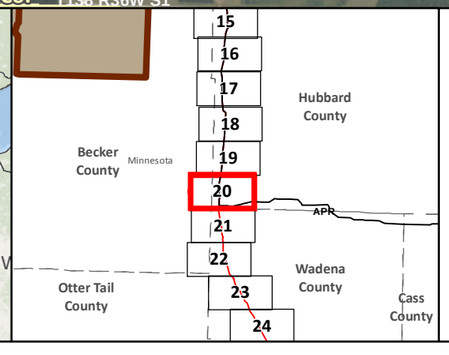
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 19B of 67

T139 R36W S15
T139 R36W S14
T139 R36W S13
T139 R35W S18
Unnamed Stream
T139 R35W S17
T139 R35W S16
T139 R35W S15
T139 R36W S22
T139 R36W S23
T139 R36W S24
T139 R35W S19
T139 R35W S20
T139 R35W S21
T139 R35W S22
203
Little Long Lake
Green Valley Twsp Becker Co.
Straight River Twsp Hubbard Co.
APR RA-03AM
T139 R36W S26
T139 R36W S25
T139 R35W S30
T139 R35W S29
T139 R35W S28
T139 R35W S27
204
71
T139 R36W S35
T139 R36W S36
T139 R35W S31
T139 R35W S32
APR
T139 R35W S33
T139 R35W S34
205
Runeberg Twsp Becker Co.
T138 R36W S2
T138 R36W S1





- SA-04
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Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

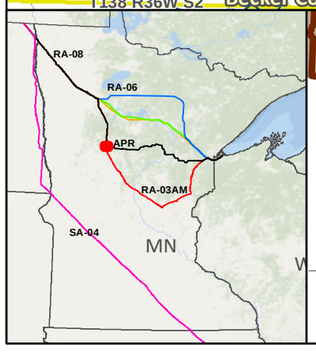
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

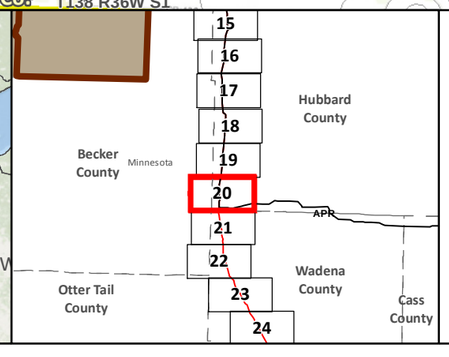
RA-03AM

CLEARBROOK TO CARLTON

Map 20A of 67

T139 R36W S15
T139 R36W S14
T139 R36W S13
T139 R35W S18
Unnamed Stream
T139 R35W S17
T139 R35W S16
T139 R35W S15
T139 R36W S22
T139 R36W S23
T139 R36W S24
T139 R35W S19
T139 R35W S20
T139 R35W S21
T139 R35W S22
203
Little Long Lake
T139 R35W S27
Straight River Twsp Hubbard Co.
Green Valley Twsp Becker Co.
APR RA-03AM
T139 R36W S26
T139 R36W S25
T139 R35W S30
T139 R35W S29
T139 R35W S28
204
71
T139 R36W S35
T139 R36W S36
T139 R35W S31
Lowe WMA
T139 R35W S32
APR
T139 R35W S33
T139 R35W S34
205
Runeberg Twsp Becker Co.
T138 R36W S2
T138 R36W S1





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- Outstanding
- High
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Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

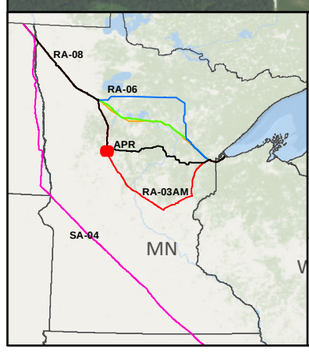
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

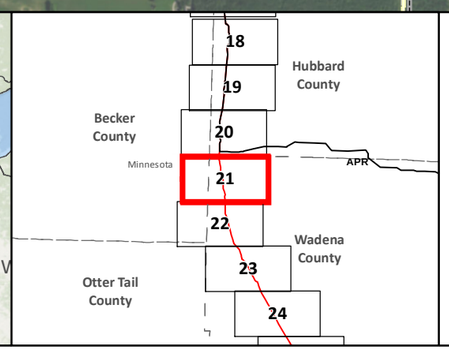
RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







- SA-04
- Applicant's Preferred Route (APR)

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Land Ownership

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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

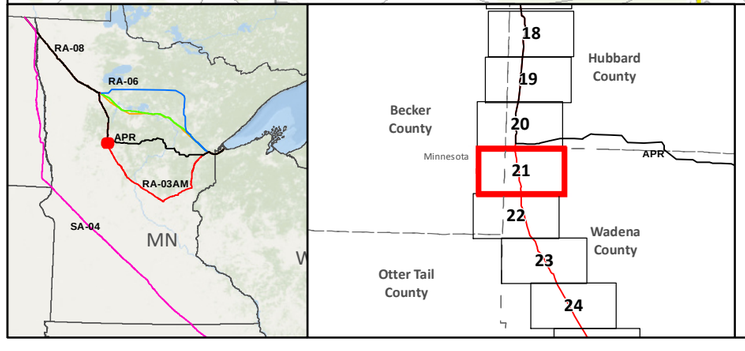
Map 21A of 67

RA-03AM

T138 R36W S2
T138 R36W S1
T138 R35W S6
T138 R35W S5
T138 R35W S4
T138 R35W S3
T138 R35W S2
T138 R35W S11
T138 R36W S11
T138 R36W S12
T138 R35W S7
T138 R35W S8
T138 R35W S9
T138 R35W S10
T138 R36W S14
T138 R36W S13
T138 R35W S18
T138 R35W S17
T138 R35W S16
T138 R35W S15
T138 R35W S14
T138 R36W S23
T138 R36W S24
T138 R35W S19
T138 R35W S20
T138 R35W S21
T138 R35W S22
T138 R35W S23

Runeberg Twsp Becker Co.
Blueberry Twsp Wadena Co.
Menahga Twsp Wadena Co.
Unnamed Stream
Blueberry Lake
Blueberry Pines Golf Club

206
207
208
71



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Lakes of Biological Significance
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Native Plant Communities with Biodiversity Significance
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

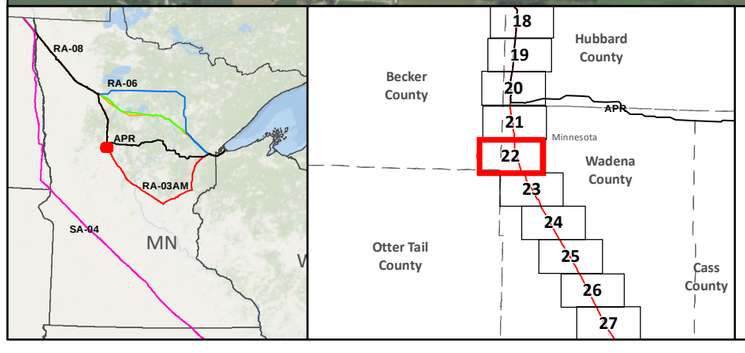
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 21B of 67





- SA-04
- Applicant's Preferred Route (APR)

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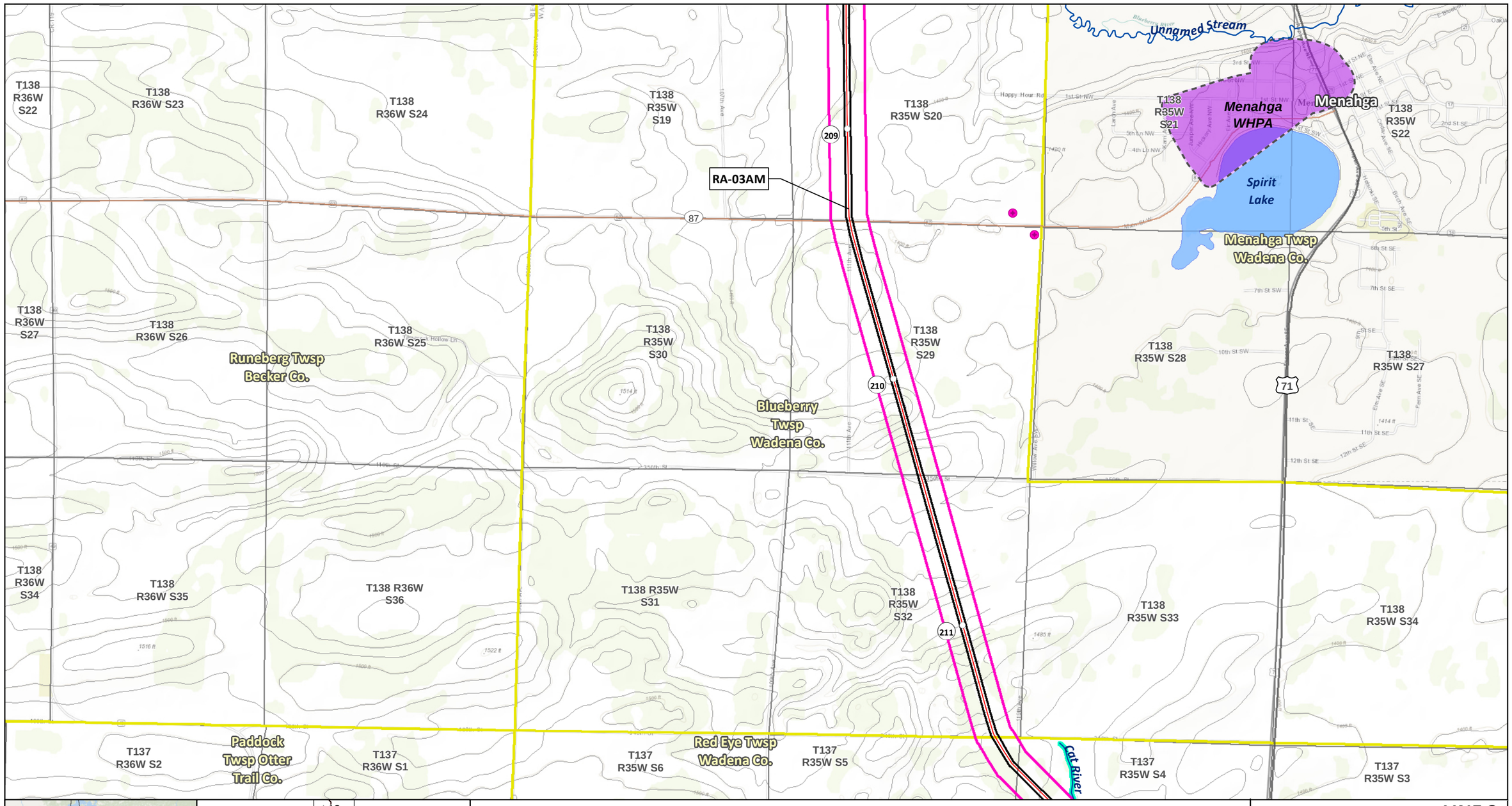
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

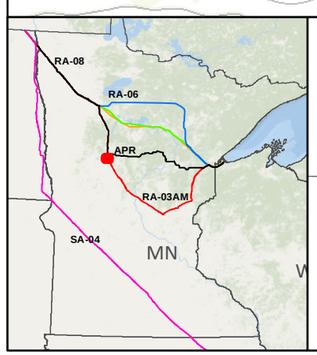
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

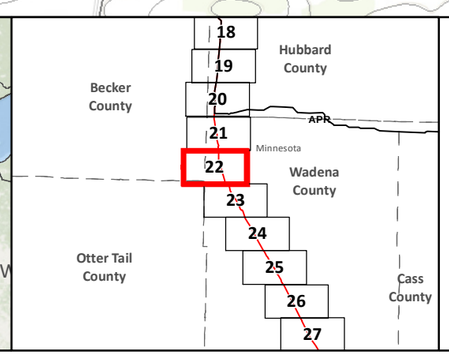
RA-03AM

CLEARBROOK TO CARLTON

Map 22A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
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Public Drinking Water Supply
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Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 22B of 67

T137 R36W S1

Paddock Twsp Otter Trail Co.

T137 R35W S6

Red Eye Twsp Wadena Co.

T137 R35W S5

T137 R35W S4

T137 R35W S3

T137 R35W S2

T137 R35W S1

T137 R36W S12

T137 R35W S7

T137 R35W S8

T137 R35W S9

T137 R35W S10

T137 R35W S11

Cat River

T137 R35W S12

T137 R35W S18

T137 R35W S17

T137 R35W S16

T137 R35W S15

T137 R35W S14

T137 R35W S13

T137 R35W S19

T137 R35W S20

T137 R35W S21

T137 R35W S22

T137 R35W S23

T137 R35W S24

Unnamed Stream

212

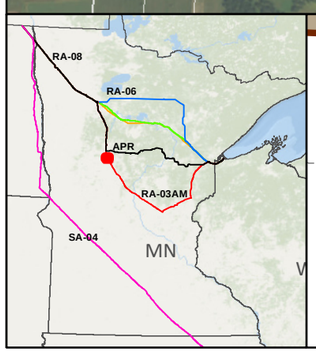
213

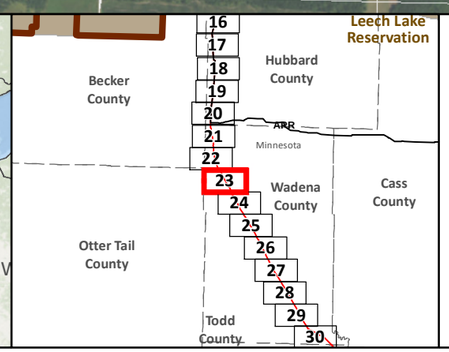
214

215

71

RA-03AM





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

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0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 23A of 67

T137 R36W S1

Paddock Twsp Otter Trail Co.

T137 R35W S6

Red Eye Twsp Wadena Co.

T137 R35W S5

T137 R35W S4

T137 R35W S3

T137 R35W S2

T137 R35W S1

T137 R36W S12

212

213

RA-03AM

T137 R35W S7

T137 R35W S8

T137 R35W S9

T137 R35W S10

Red Eye WMA

T137 R35W S11

Cat River

T137 R35W S12

71

214

T137 R35W S18

T137 R35W S17

T137 R35W S16

RED EYE MEADOW

T137 R35W S15

215

Unnamed Stream

T137 R35W S14

T137 R35W S13

T137 R35W S19

T137 R35W S20

RED EYE MEADOW

T137 R35W S21

T137 R35W S22

T137 R35W S23

Kitten Creek WMA

T137 R35W S24

RA-08

RA-06

APR

RA-03AM

SA-04

MN

Becker County

Hubbard County

Leech Lake Reservation

Minnesota

Wadena County

Cass County

Otter Tail County

Todd County

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding High Moderate

Native Plant Communities with Biodiversity Significance

Outstanding High Moderate

Terminal Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

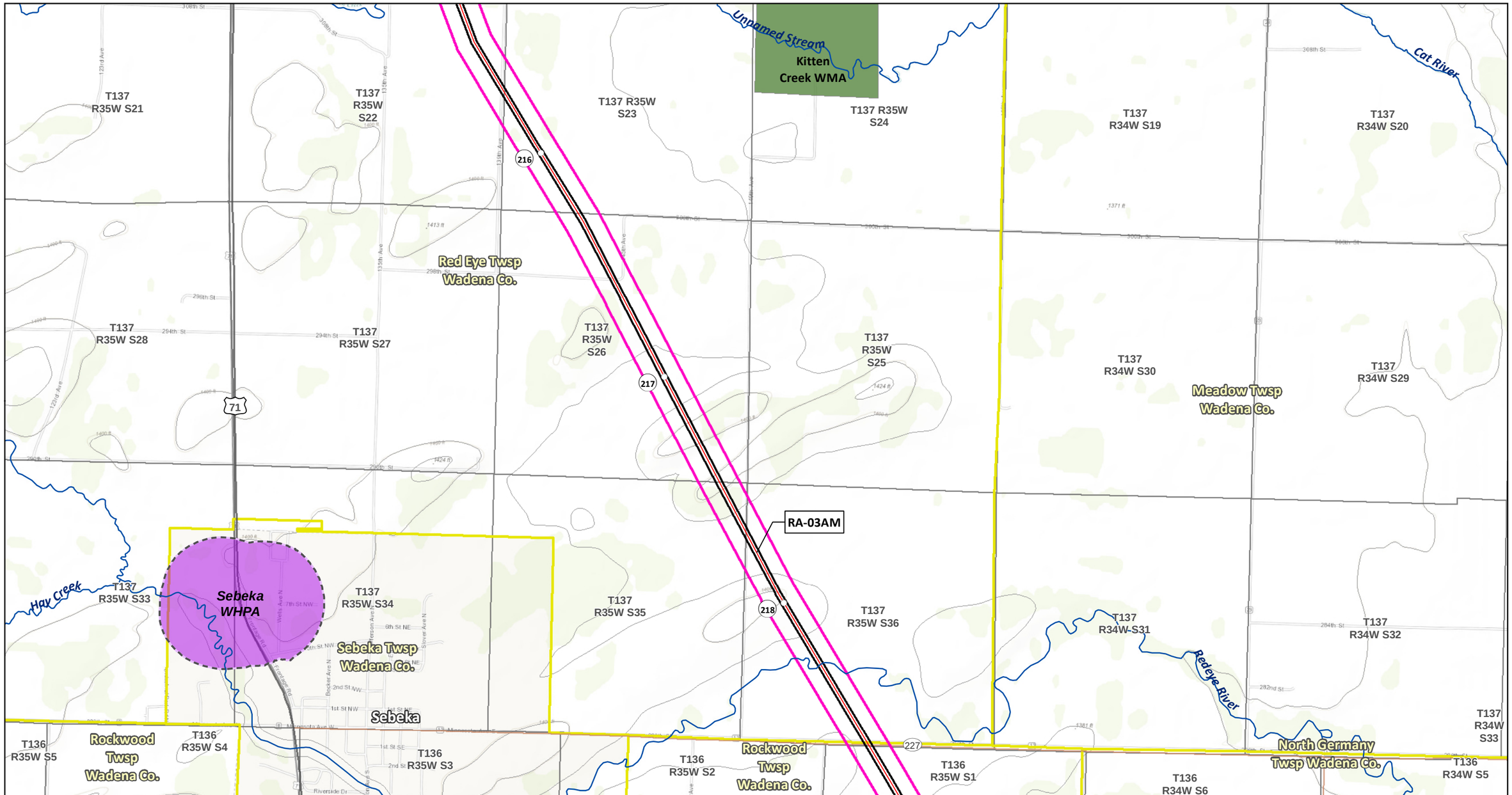


LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 24A of 67


Unnamed Stream
Kitten Creek WMA
Cat River
T137 R35W S21
T137 R35W S22
T137 R35W S23
T137 R35W S24
T137 R34W S19
T137 R34W S20
Red Eye Twsp Wadena Co.
T137 R35W S28
T137 R35W S27
T137 R35W S26
T137 R35W S25
T137 R34W S30
T137 R34W S29
Meadow Twsp Wadena Co.
RA-03AM
Hay Creek
T137 R35W S33
Sebeka WHPA
T137 R35W S34
T137 R35W S35
T137 R35W S36
T137 R34W S31
T137 R34W S32
Redeye River
Sebeka Twsp Wadena Co.
Sebeka
T136 R35W S5
Rockwood Twsp Wadena Co.
T136 R35W S4
T136 R35W S3
T136 R35W S2
Rockwood Twsp Wadena Co.
T136 R35W S1
T136 R34W S6
North Germany Twsp Wadena Co.
T136 R34W S5
T137 R34W S33
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Becker County
Hubbard County
Minnesota
Wadena County
Otter Tail County
Cass County
19
20
21
22
23
24
25
26
27
28
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 24B of 67

Sebeka Twsp
Wadena Co.

T136 R35W S3
T136 R35W S2
T136 R35W S1
T136 R34W S6
T136 R34W S5
T136 R34W S4
T136 R34W S3
Redeye River

219
220
221
222

T136 R35W S11
T136 R35W S12
T136 R34W S7
T136 R34W S8
T136 R34W S9
T136 R34W S10
T136 R35W S10

RA-03AM

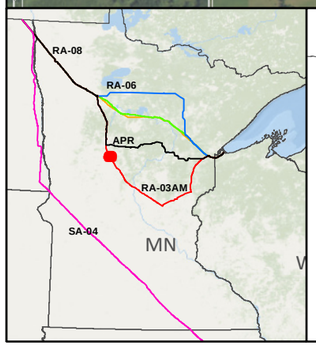
Rockwood Twsp
Wadena Co.

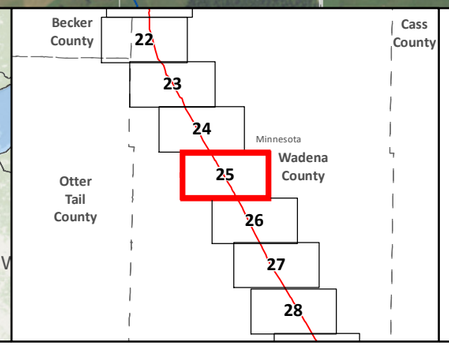
North
Germany Twsp
Wadena Co.

T136 R35W S14
T136 R35W S13
T136 R34W S18
T136 R34W S17
T136 R34W S16
T136 R34W S15
T136 R35W S15

Unnamed Stream
Hay Creek

T136 R35W S22
T136 R35W S23
T136 R35W S24
T136 R34W S19
T136 R34W S20
T136 R34W S21
T136 R34W S22





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 25A of 67

Sebeka Twsp
Wadena Co.

T136 R35W S3

T136 R35W S2

T136 R35W S1

T136 R34W S6

T136 R34W S5

T136 R34W S4

T136 R34W S3

Redeye River

NORTH GERMANY MEADOW

219

220

221

222

T136 R35W S10

T136 R35W S11

T136 R35W S12

T136 R34W S7

T136 R34W S8

T136 R34W S9

T136 R34W S10

RA-03AM

Rockwood Twsp
Wadena Co.

North
Germany Twsp
Wadena Co.

Hay Creek

T136 R35W S15

T136 R35W S14

T136 R35W S13

T136 R34W S18

T136 R34W S17

T136 R34W S16

T136 R34W S15

Unnamed Stream

T136 R35W S22

T136 R35W S23

T136 R35W S24

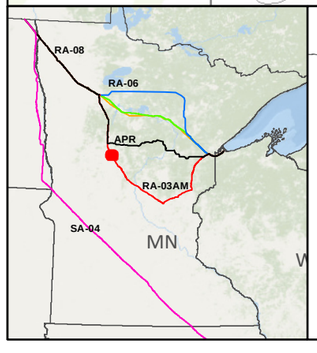
Sebeka WMA

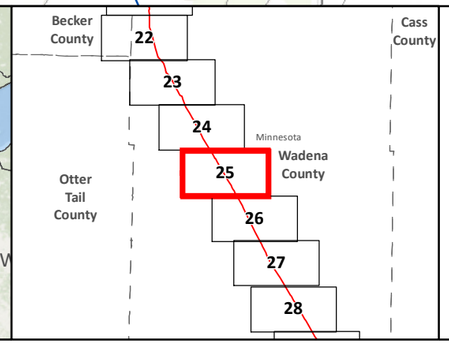
T136 R34W S19

T136 R34W S20

T136 R34W S21

T136 R34W S22





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate
- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 25B of 67

North Germany Twsp Wadena Co.

T136 R35W S24

T136 R34W S19

T136 R34W S20

T136 R34W S21

T136 R34W S22

T136 R34W S23

T136 R34W S24

Hay Creek

Unnamed Stream

Redeye River

T136 R35W S25

Rockwood Twsp Wadena Co.

T136 R34W S30

T136 R34W S29

T136 R34W S28

T136 R34W S27

T136 R34W S26

T136 R34W S25

Lyons State Forest

223

224

225

RA-03AM

T136 R35W S36

T136 R34W S31

T136 R34W S32

T136 R34W S33

T136 R34W S34

T136 R34W S35

T136 R34W S36

Blue Grass

Leaf River Twsp Wadena Co.

T135 R35W S1

T135 R34W S6

T135 R34W S5

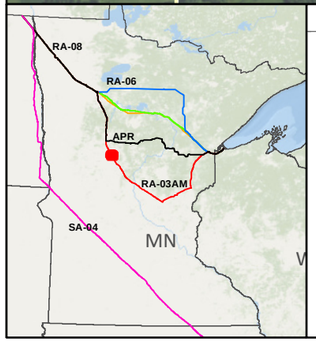
Wing River Twsp Wadena Co.

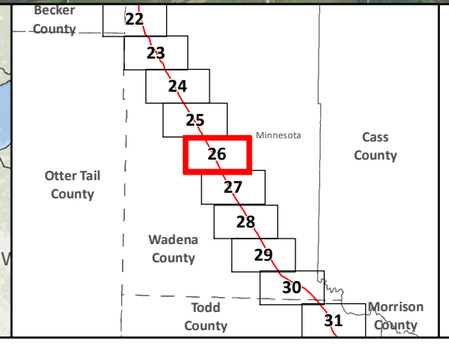
T135 R34W S4

T135 R34W S3

T135 R34W S2

T135 R34W S1





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 26A of 67

Sebeka WMA

North Germany Twsp Wadena Co.

North Germany WMA

T136 R35W S24 | T136 R34W S19 | T136 R34W S20 | T136 R34W S21 | T136 R34W S22 | T136 R34W S23 | T136 R34W S24

Hay Creek

Unnamed Stream

Redeye River

T136 R35W S25 | T136 R34W S30 | T136 R34W S29 | T136 R34W S28 | T136 R34W S27 | T136 R34W S26 | T136 R34W S25

Rockwood Twsp Wadena Co.

223

224

225

RA-03AM

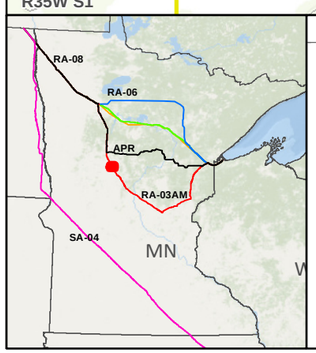
T136 R35W S36 | T136 R34W S31 | T136 R34W S32 | T136 R34W S33 | T136 R34W S34 | T136 R34W S35 | T136 R34W S36

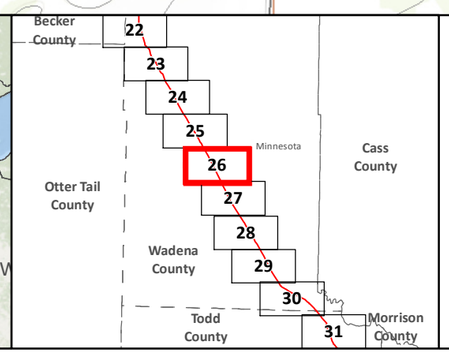
Blue Grass

Leaf River Twsp Wadena Co.

Wing River Twsp Wadena Co.

T135 R35W S1 | T135 R34W S6 | T135 R34W S5 | T135 R34W S4 | T135 R34W S3 | T135 R34W S2 | T135 R34W S1





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

10ft Contours

N

Map 26B of 67

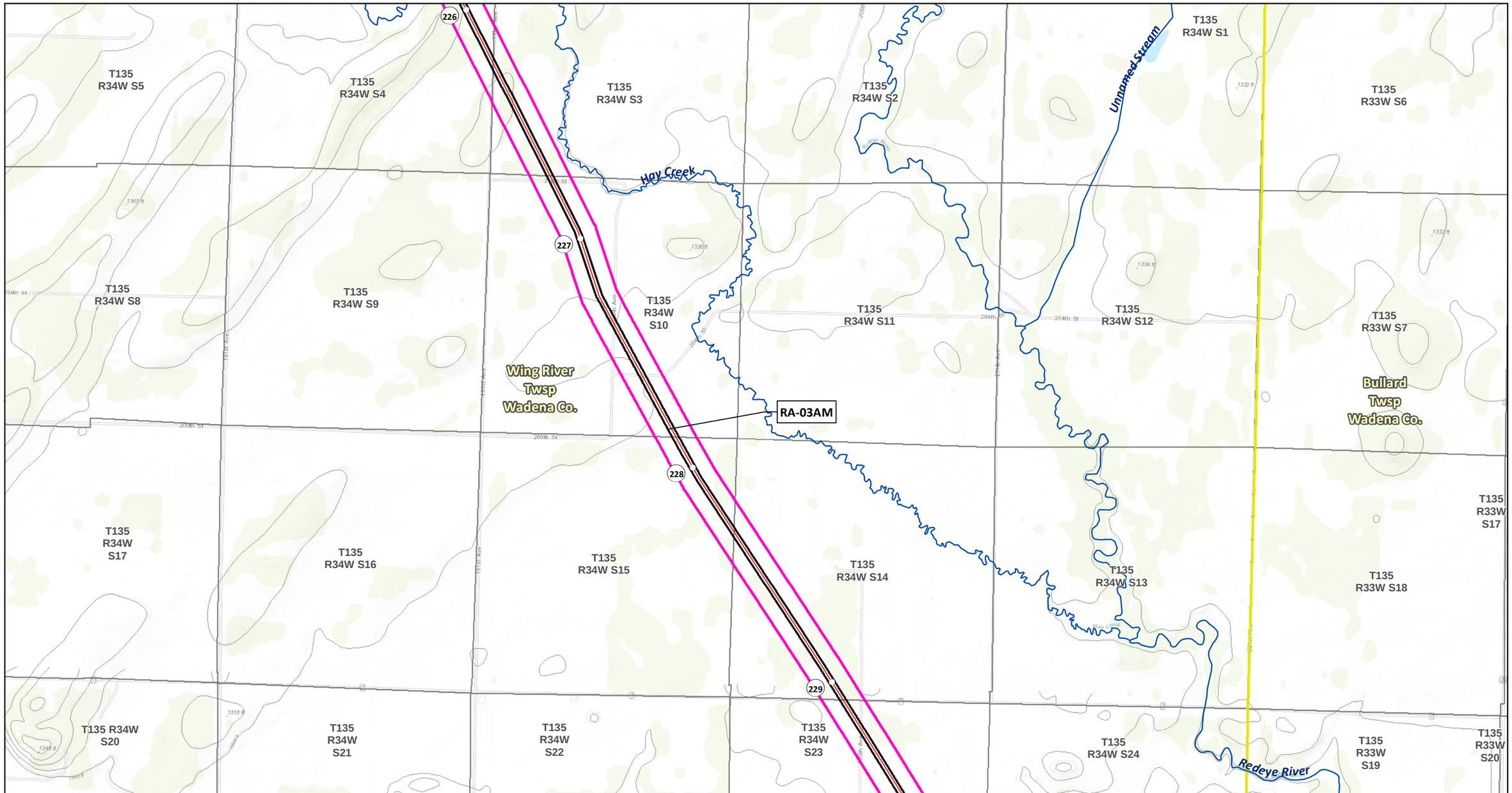


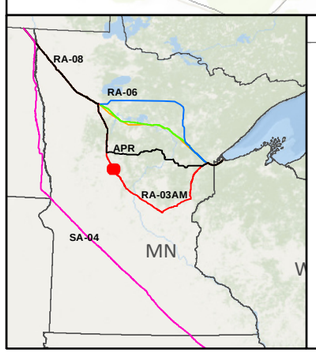
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

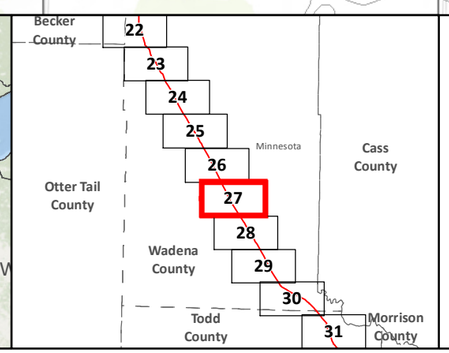
RA-03AM

CLEARBROOK TO CARLTON

Map 27A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

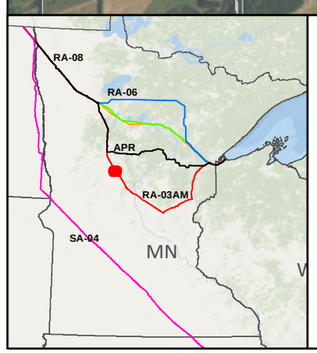
Data Sources:
MNDNR, USGS, NHD, Enbridge

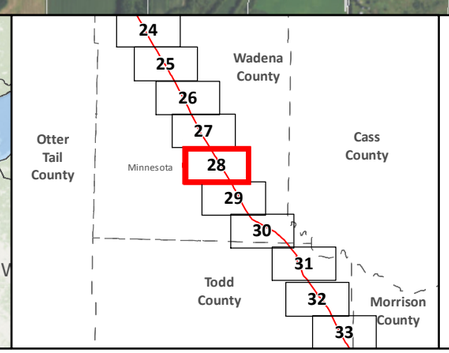
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 27B of 67

T135 R34W S21
T135 R34W S22
T135 R34W S23
T135 R34W S24
Bullard Twsp Wadena Co.
T135 R33W S19
Redeye River
T135 R33W S20
T135 R33W S21
T135 R34W S28
T135 R34W S27
Leaf River
T135 R34W S26
Wing River Twsp Wadena Co.
T135 R34W S25
RA-03AM
T135 R33W S30
T135 R33W S29
T135 R33W S28
Bullard Twsp Wadena Co.
Thomastown Twsp Wadena Co.
T135 R34W S33
T135 R34W S34
T135 R34W S35
T135 R34W S36
T135 R33W S31
T135 R33W S32
T135 R33W S33
T134 R34W S4
T134 R34W S3
Aldrich Twsp Wadena Co.
T134 R34W S2
T134 R34W S1
T134 R33W S6
T134 R33W S5
T134 R33W S4
230
231
232
233





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources: MNDNR, NHD, Enbridge

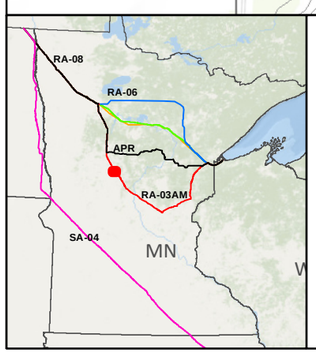
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

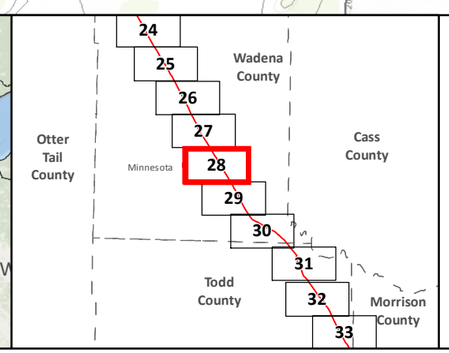
RA-03AM

CLEARBROOK TO CARLTON

Map 28A of 67

T135 R34W S21
T135 R34W S22
T135 R34W S23
T135 R34W S24
T135 R33W S19
T135 R33W S20
T135 R33W S21
Bullard Twsp Wadena Co.
Redeye River
T135 R34W S28
T135 R34W S27
T135 R34W S26
Leaf River
Wing River Twsp Wadena Co.
T135 R34W S25
RA-03AM
T135 R33W S30
T135 R33W S29
T135 R33W S28
Bullard Twsp Wadena Co.
Thomastown Twsp Wadena Co.
T135 R34W S33
T135 R34W S34
T135 R34W S35
T135 R34W S36
T135 R33W S31
T135 R33W S32
T135 R33W S33
T134 R34W S4
T134 R34W S3
Aldrich Twsp Wadena Co.
T134 R34W S2
T134 R34W S1
T134 R33W S6
T134 R33W S5
T134 R33W S4
230
231
232
233





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

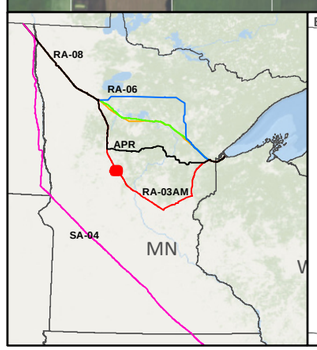
RA-03AM

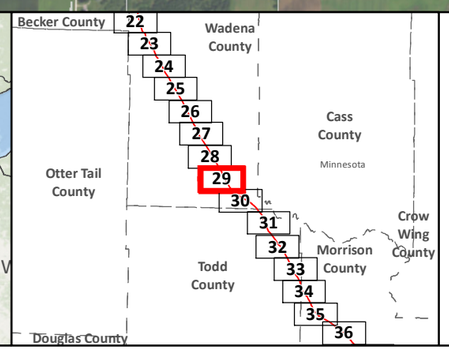
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 28B of 67

T134 R34W S2
T134 R34W S1
T134 R33W S6
T134 R33W S5
T134 R33W S4
T134 R33W S3
Leaf River
T134 R34W S11
T134 R34W S12
T134 R33W S7
T134 R33W S8
T134 R33W S9
T134 R33W S10
234
RA-03AM
235
Aldrich Twsp
Wadena Co.
Thomastown
Twsp
Wadena Co.
Hay Creek
T134 R34W S14
T134 R34W S13
T134 R33W S18
T134 R33W S17
T134 R33W S16
Partridge River
Crow Wing River
T134 R33W S15
Unnamed Stream
Lovejoy Lake
Fawn Creek
T134 R34W S23
T134 R34W S24
T134 R33W S19
T134 R33W S20
T134 R33W S21
T134 R33W S22





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 29A of 67

T134 R34W S2
T134 R34W S1
T134 R33W S6
T134 R33W S5
T134 R33W S4
T134 R33W S3
T134 R34W S11
T134 R34W S12
T134 R33W S7
T134 R33W S8
T134 R33W S9
T134 R33W S10
T134 R34W S14
T134 R34W S13
T134 R33W S18
T134 R33W S17
T134 R33W S16
T134 R33W S15
T134 R34W S23
T134 R34W S24
T134 R33W S19
T134 R33W S20
T134 R33W S21
T134 R33W S22

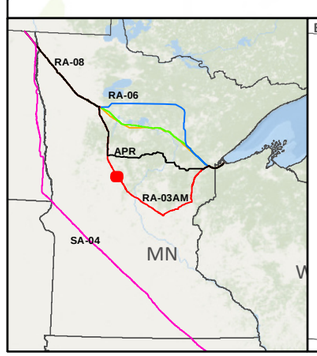
RA-03AM

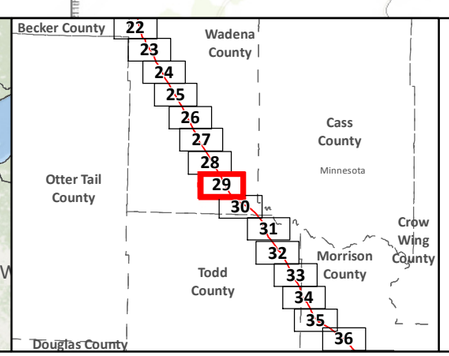
Aldrich Twsp
Wadena Co.

Thomastown
Twsp
Wadena Co.

Hay Creek
Unnamed Stream
Leaf River
Partridge River
Crow Wing River
Fawn Creek
Lovejoy Lake

234
235
236





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

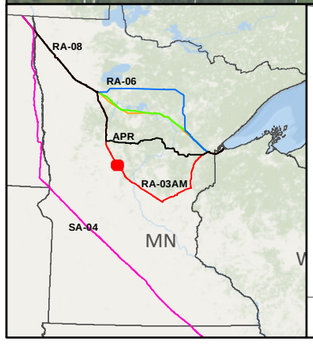
CLEARBROOK TO CARLTON

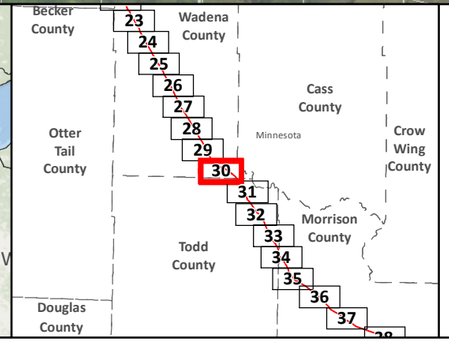
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 29B of 67

T134 R33W S19
T134 R33W S20
Partridge River
T134 R33W S21
T134 R33W S22
T134 R33W S23
T134 R33W S24
T134 R32W S19
Becker Twsp
Cass Co.
RA-03AM
T134 R32W S30
Crow Wing River
T134 R33W S30
T134 R33W S29
T134 R33W S28
Thomastown Twsp
Wadena Co.
T134 R33W S27
T134 R33W S26
T134 R33W S25
T134 R32W S30
Hayden Creek
T134 R33W S36
Staples Twsp
Wadena Co.
T134 R33W S31
T134 R33W S32
T134 R33W S33
T134 R33W S34
T134 R33W S35
T134 R32W S31
Fawn Creek
T133 R33W S2
T133 R33W S6
T133 R33W S5
Staples Twsp Todd Co.
T133 R33W S4
T133 R33W S3
Staples Twsp Todd Co.
Staples Twsp Todd Co.
T133 R33W S1
Staples Twsp Todd Co.
Villard Twsp Todd Co.
T133 R32W S6
237
238
239
241
10





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

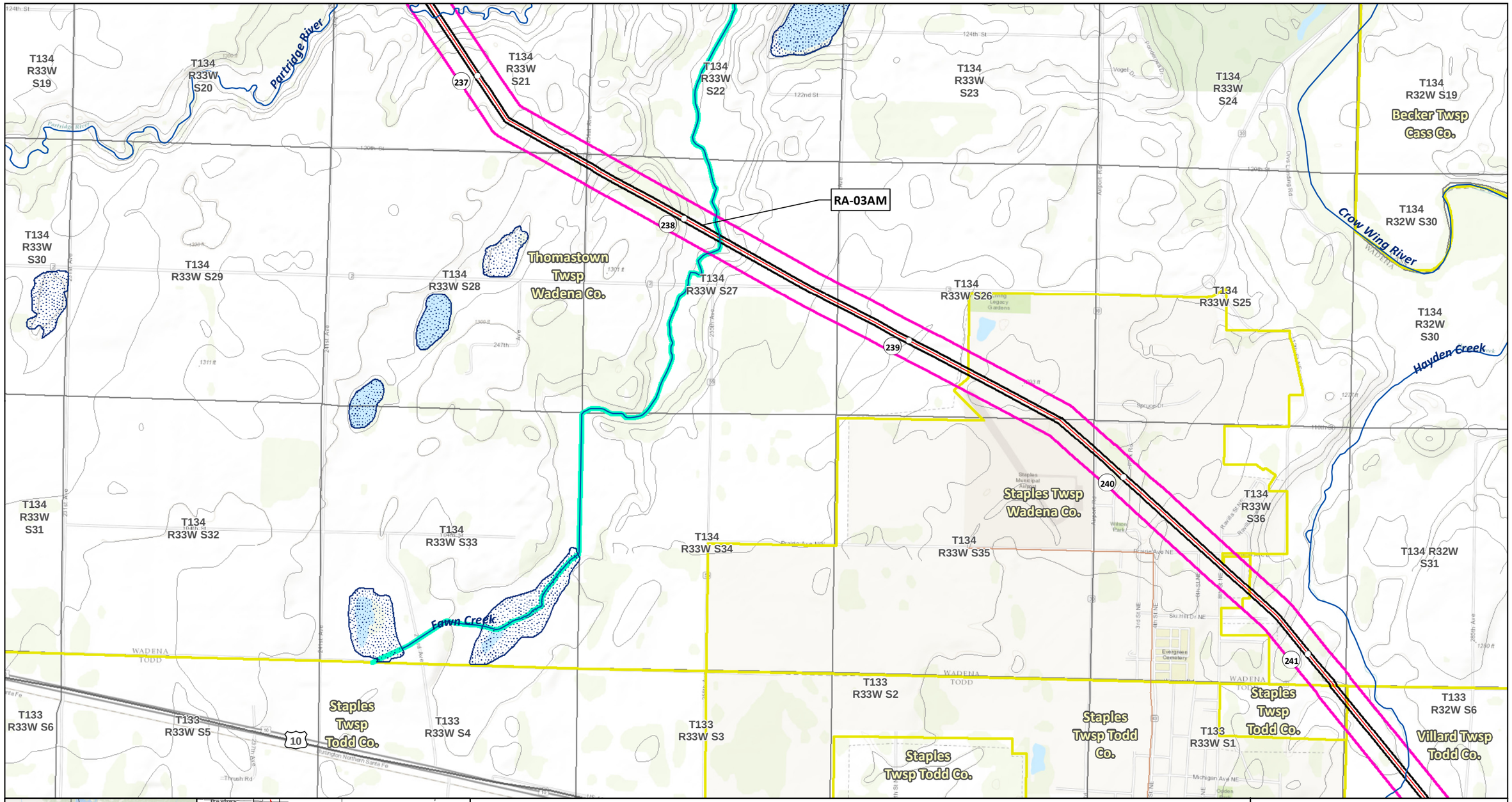
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

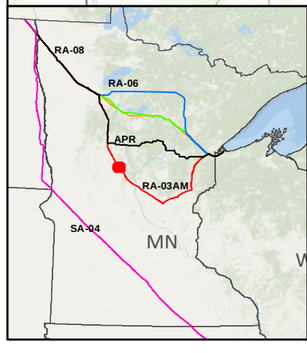
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

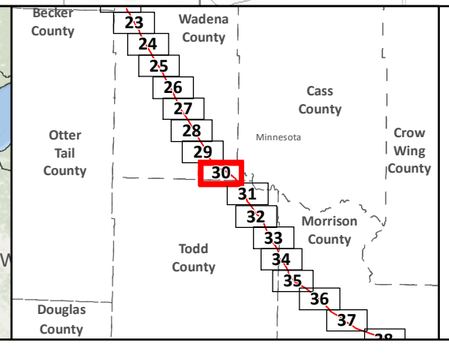
RA-03AM

CLEARBROOK TO CARLTON

Map 30A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

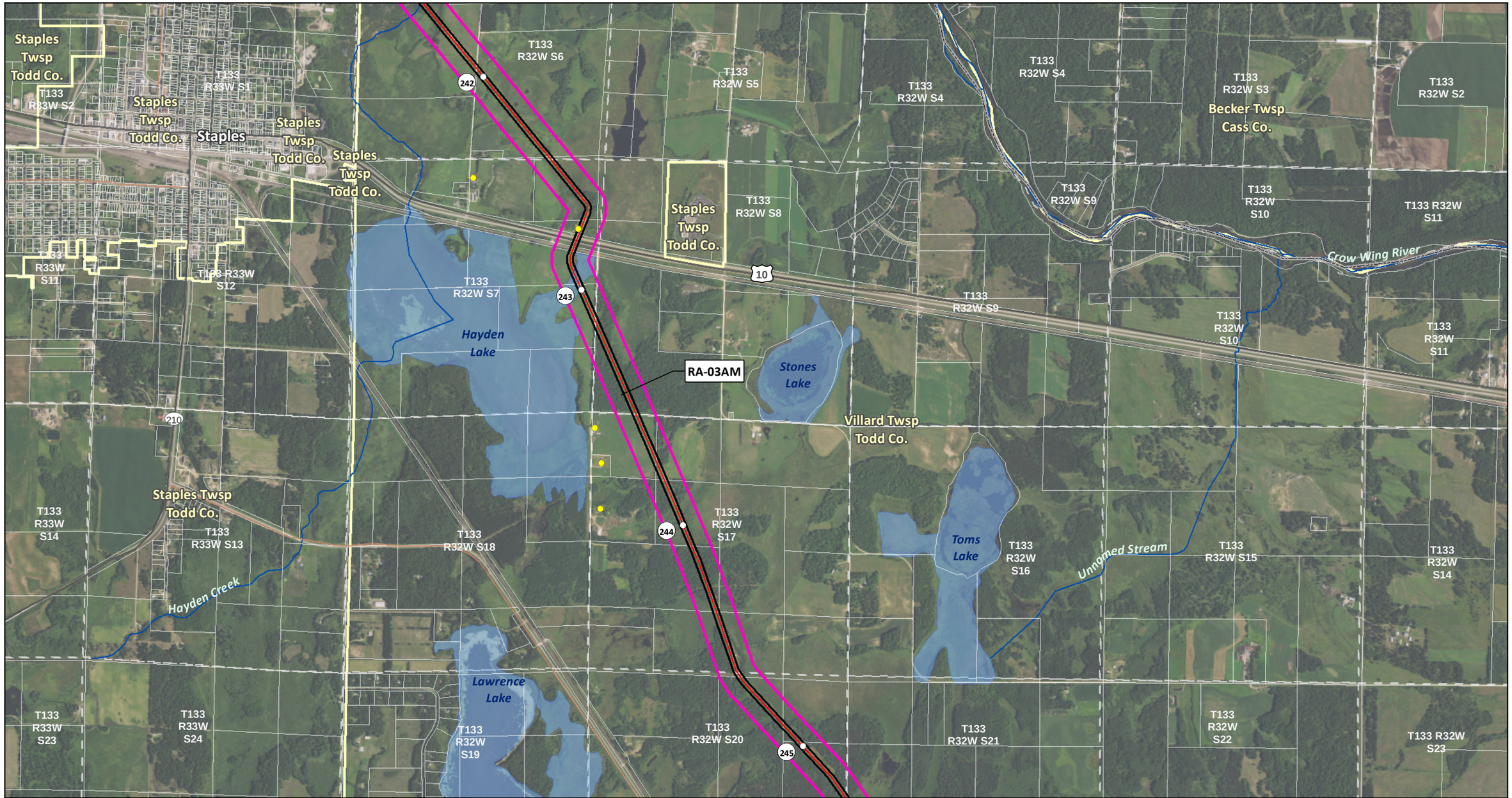
Data Sources: MNDNR, USGS, NHD, Enbridge

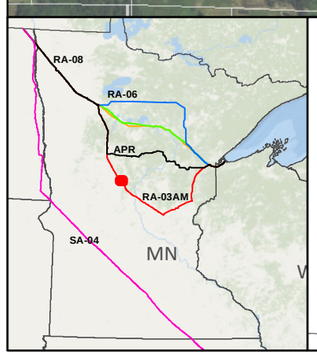
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON

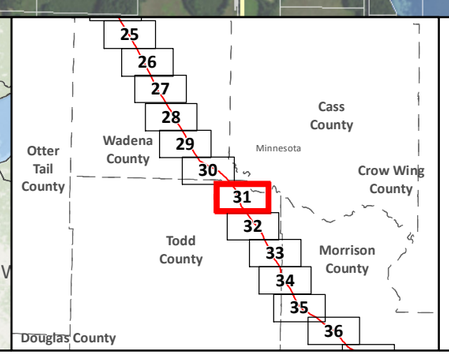
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 30B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

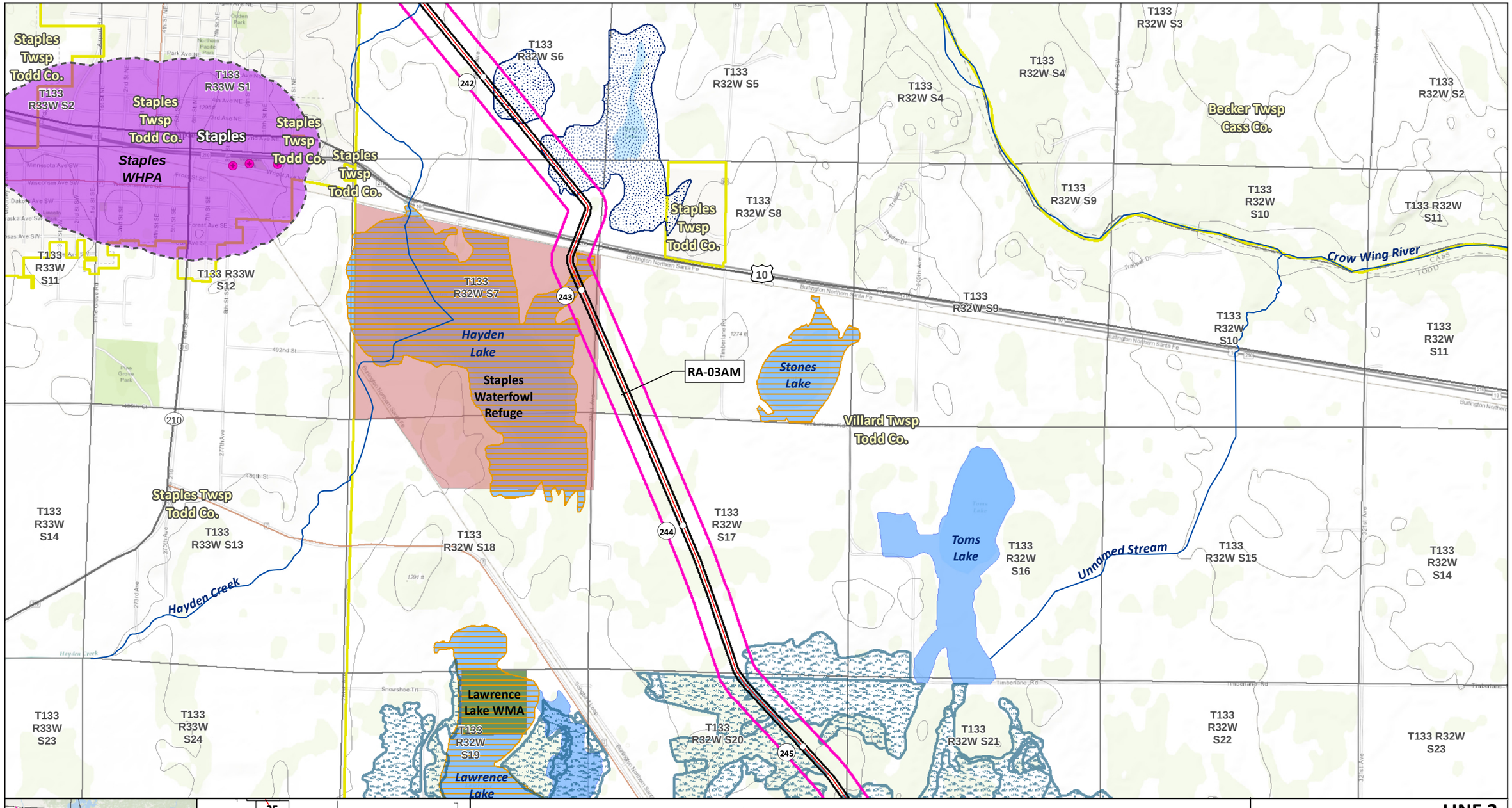
Data Sources: MNDNR, NHD, Enbridge

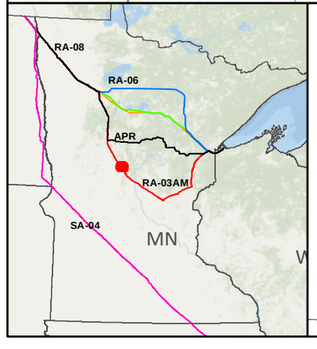
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

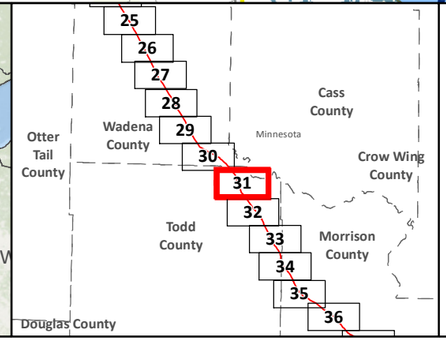
RA-03AM

CLEARBROOK TO CARLTON

Map 31A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

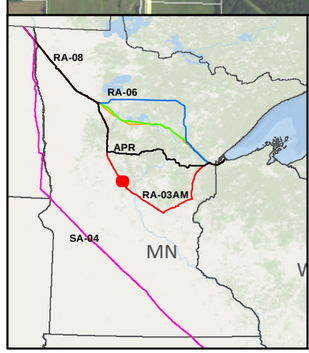
RA-03AM

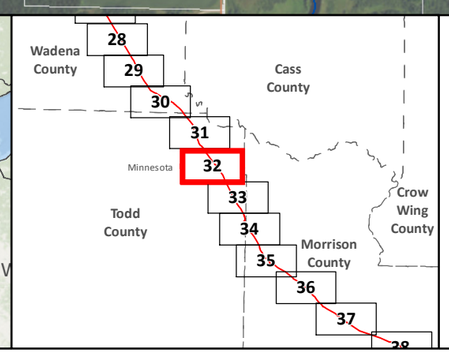
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 31B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

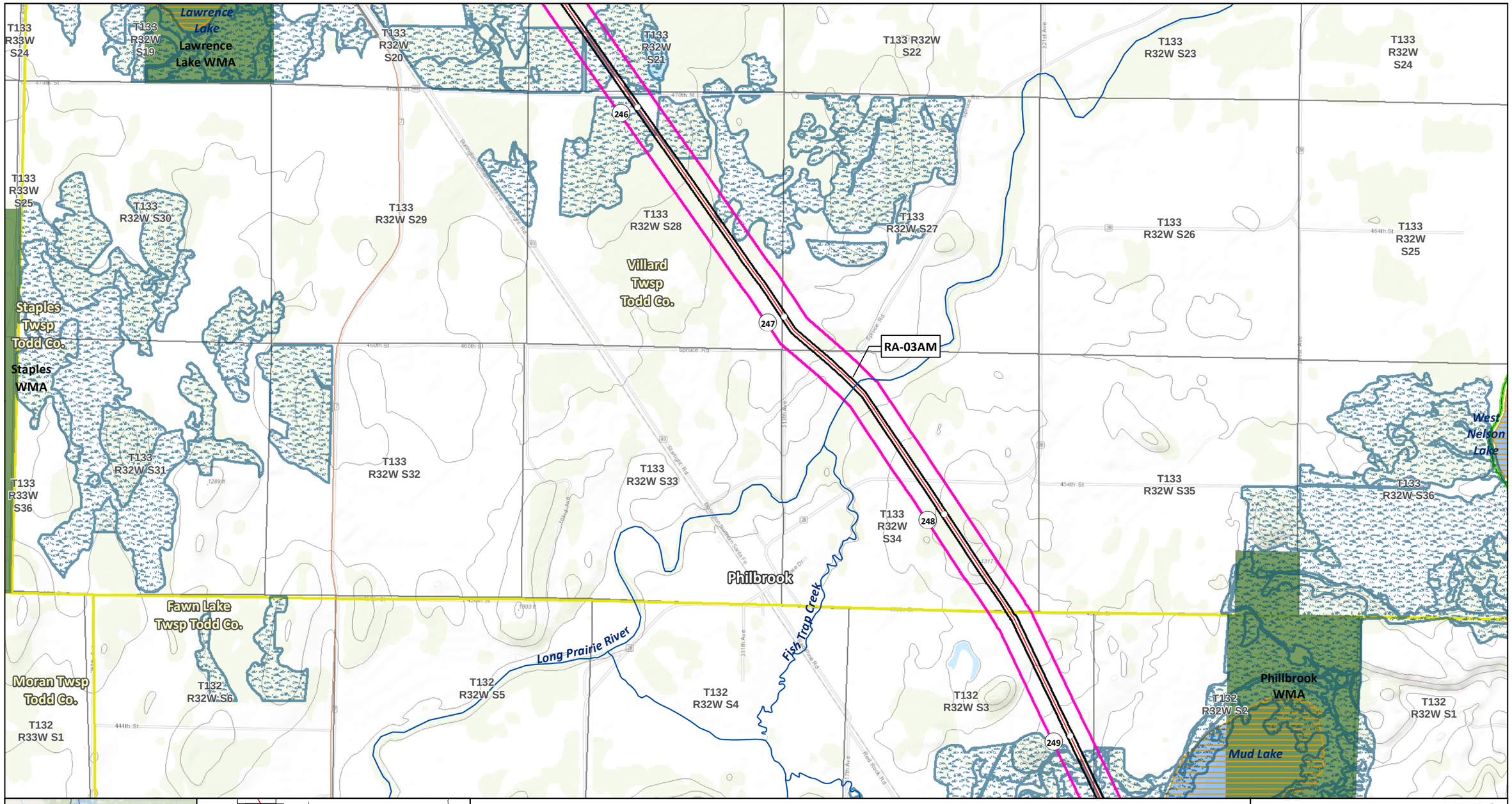
0 125 250 500 Meters

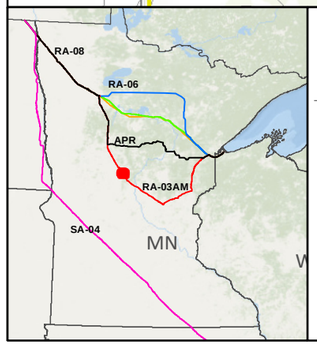
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

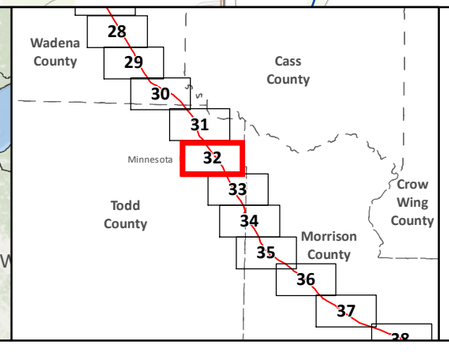
RA-03AM

CLEARBROOK TO CARLTON

Map 32A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
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Existing Pipelines
Township Boundary

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Lakes of Biological Significance
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Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

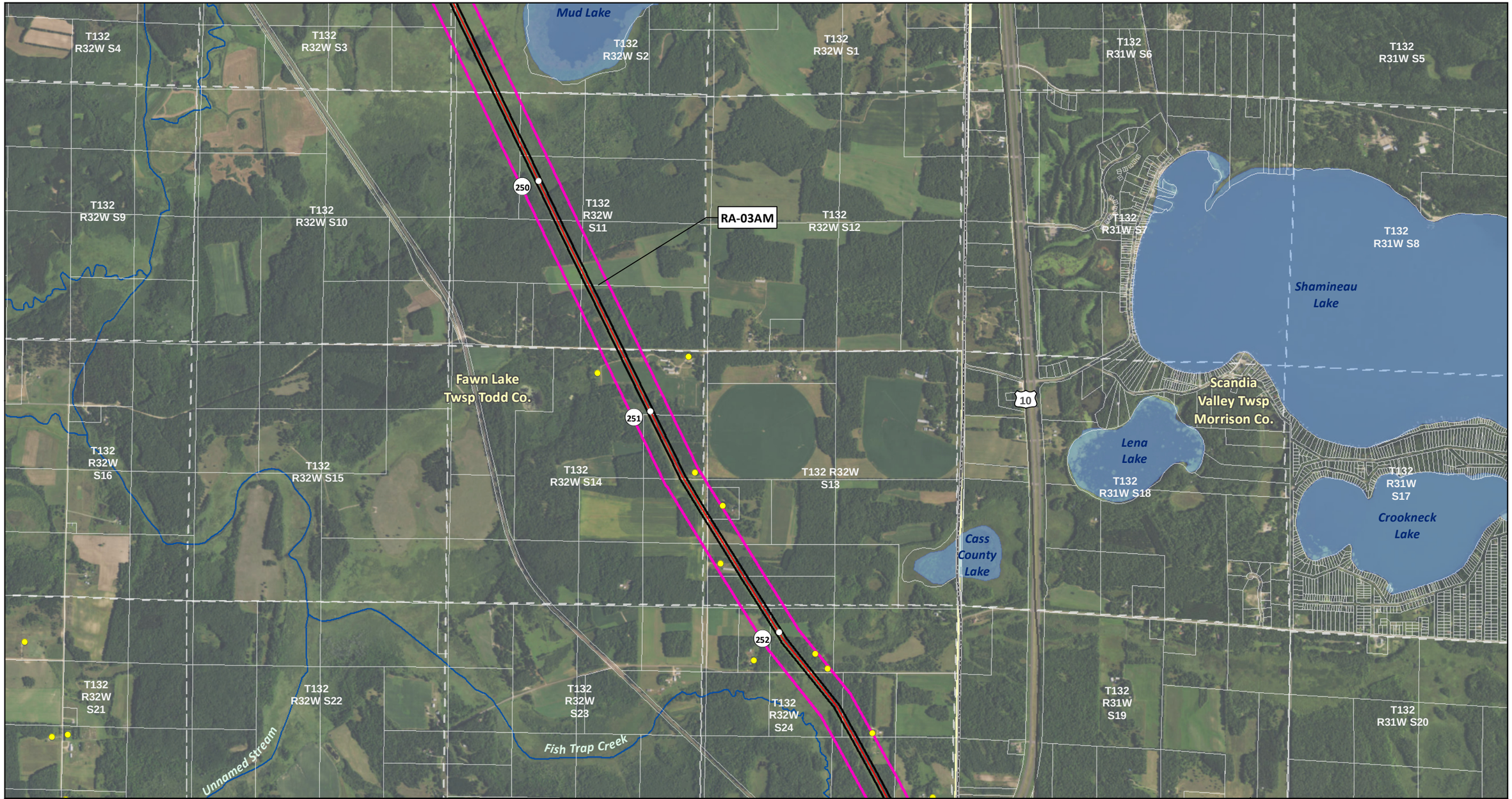
RA-03AM

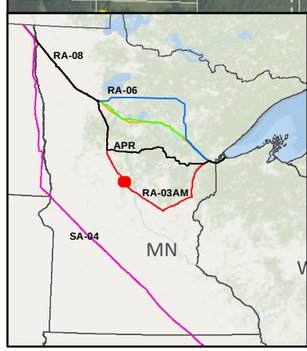
CLEARBROOK TO CARLTON

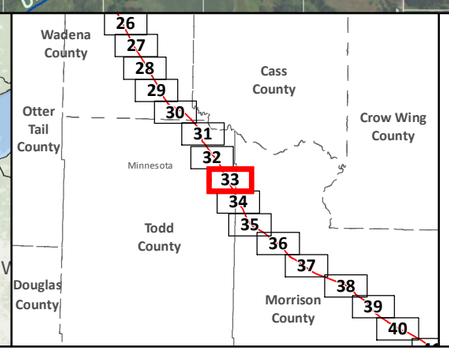
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 32B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

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- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

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Public Water Basin

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Residences within 1/2 mile

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Major Road

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- Tribal Trust Land
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Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

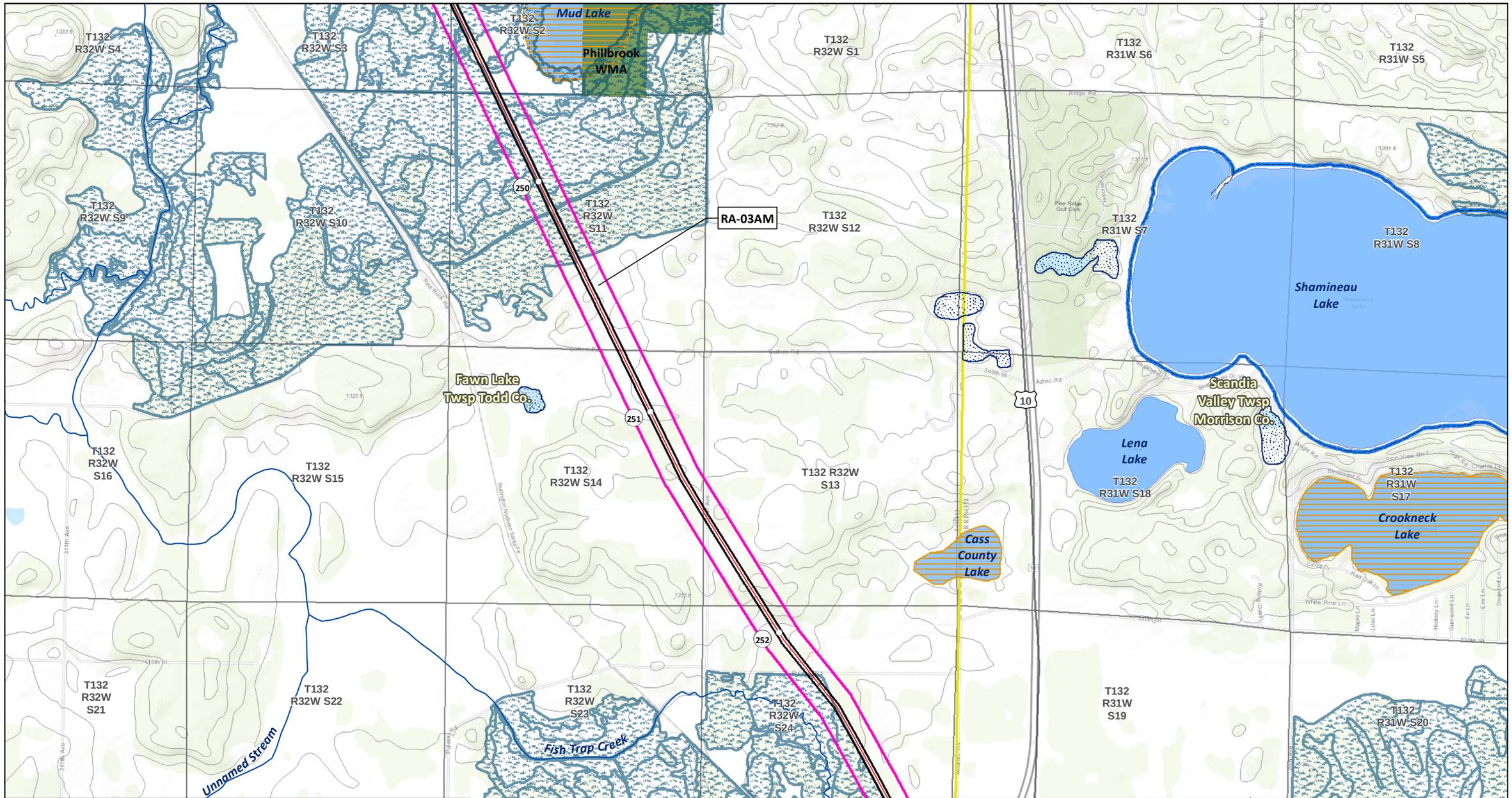
0 125 250 500 Meters

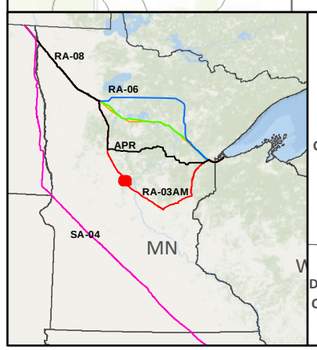
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

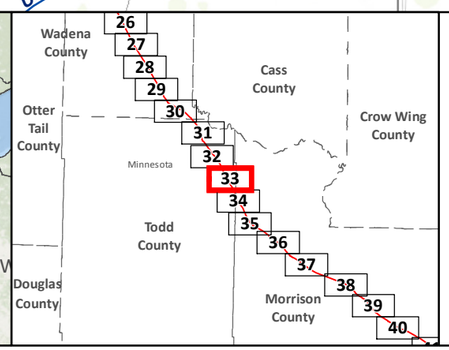
RA-03AM

CLEARBROOK TO CARLTON

Map 33A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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WMA - Wildlife Management Areas
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Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
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Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
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Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
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Pump Station

Data Sources:
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

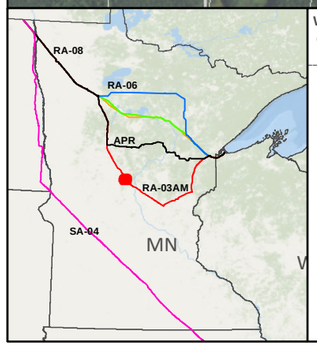
CLEARBROOK TO CARLTON

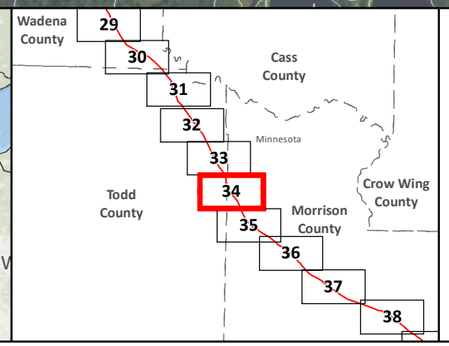
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 33B of 67

T132 R32W S22
T132 R32W S23
T132 R32W S24
T132 R31W S19
T132 R31W S20
T132 R31W S21
T132 R32W S27
T132 R32W S26
T132 R32W S25
T132 R31W S30
T132 R31W S29
T132 R31W S28
T132 R31W S27
Fish Trap Creek
Ham Lake
Lake Alexander
Fawn Lake Twsp Todd Co.
Fish Trap Lake
Scandia Valley Twsp Morrison Co.
Lincoln
Rodgers Lake
RA-03AM
T132 R32W S34
T132 R32W S35
T132 R32W S36
T132 R31W S31
T132 R31W S32
T132 R31W S33
T132 R31W S34
Long Lake
253
254
10
255
256
Turtle Creek Twsp Todd Co.
T131 R32W S3
T131 R32W S2
T131 R32W S1
T131 R31W S6
T131 R31W S5
T131 R31W S4
Cushing Twsp Morrison Co.
Unnamed Stream





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
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Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

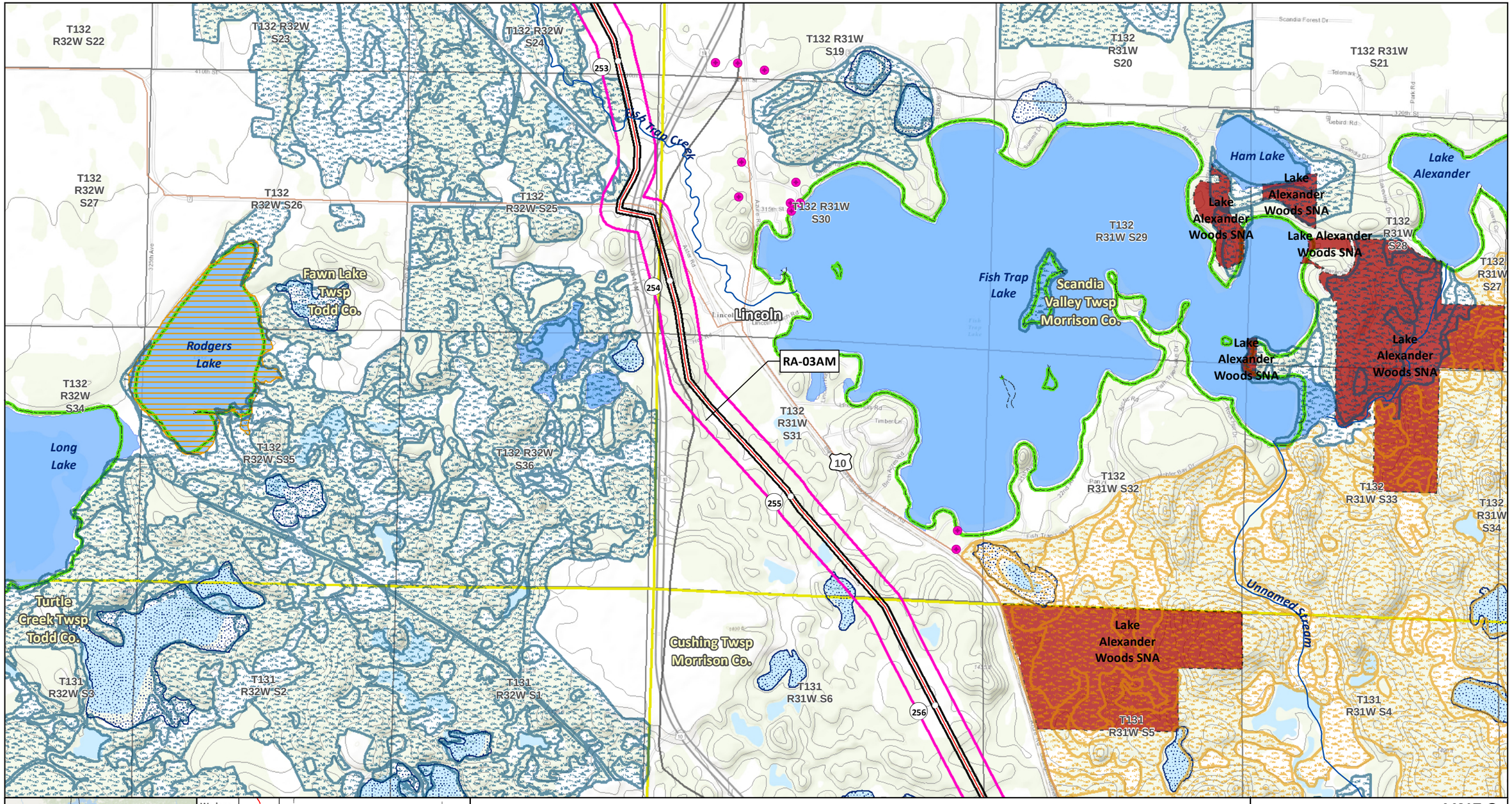
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

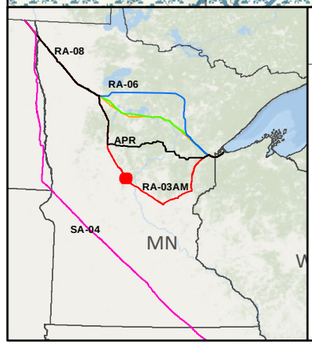
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

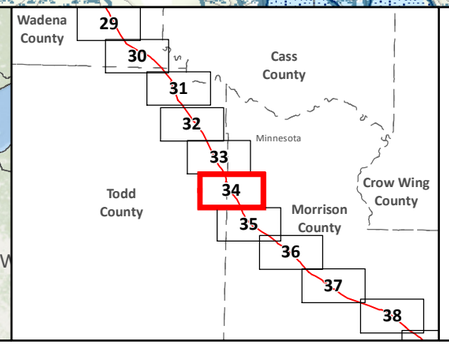
RA-03AM

CLEARBROOK TO CARLTON

Map 34A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

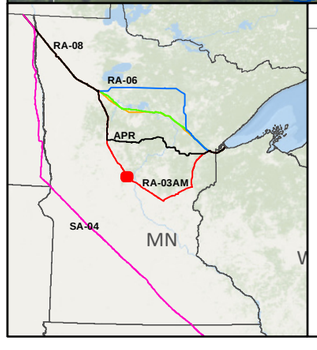
RA-03AM

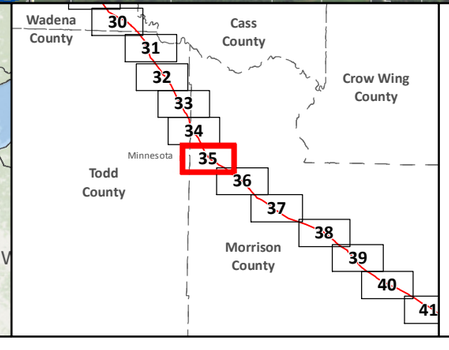
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 34B of 67

T131 R32W S1
T131 R31W S6
T131 R31W S5
T131 R31W S4
T131 R31W S3
T131 R31W S2
Lake Madaline
T131 R32W S12
T131 R31W S7
T131 R31W S8
T131 R31W S9
T131 R31W S10
T131 R31W S11
RA-03AM
258
10
Cushing Twsp
Morrison Co.
Turtle Creek Twsp
Todd Co.
T131 R31W S18
T131 R31W S17
T131 R31W S16
Millers Lake
T131 R31W S15
T131 R31W S14
T131 R32W S13
259
260
T131 R32W S24
T131 R31W S19
Little Elk River
Unnamed Stream
T131 R31W S20
T131 R31W S21
T131 R31W S22
T131 R31W S23
261





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

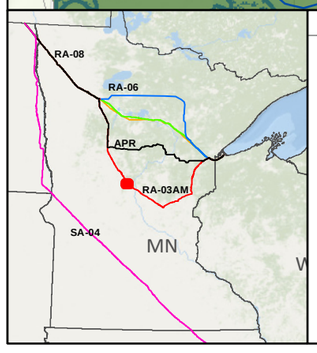
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

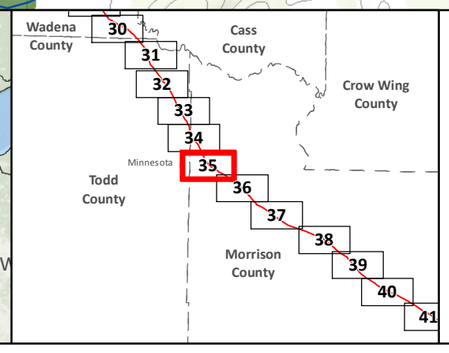
RA-03AM

CLEARBROOK TO CARLTON

Map 35A of 67

T131 R32W S1
T131 R31W S6
T131 R31W S5
T131 R31W S4
T131 R31W S3
T131 R31W S2
Lake Madaline
257
T131 R32W S12
T131 R31W S7
T131 R31W S8
T131 R31W S9
Lake Alexander Woods SNA
T131 R31W S10
T131 R31W S11
RA-03AM
258
10
Cushing Twsp Morrison Co.
Millers Lake
T131 R31W S15
T131 R31W S14
Turtle Creek Twsp Todd Co.
T131 R31W S18
T131 R31W S17
T131 R31W S16
T131 R32W S13
259
T131 R32W S24
Ruff-Nik WMA
T131 R31W S19
T131 R31W S20
T131 R31W S21
T131 R31W S22
T131 R31W S23
260
Unnamed Stream
Little Elk River
Cushing
261





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
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- Township Boundary

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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

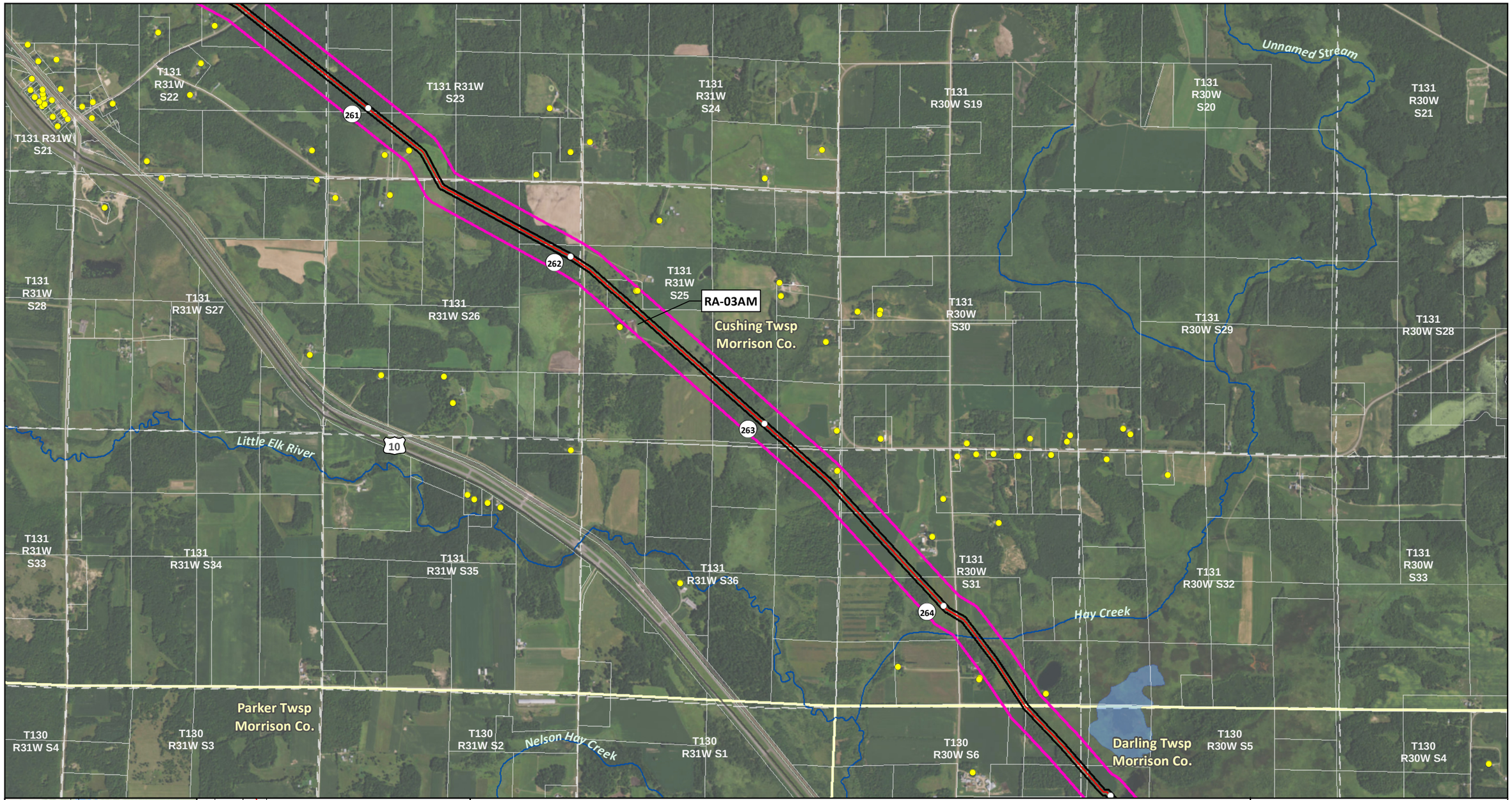
RA-03AM

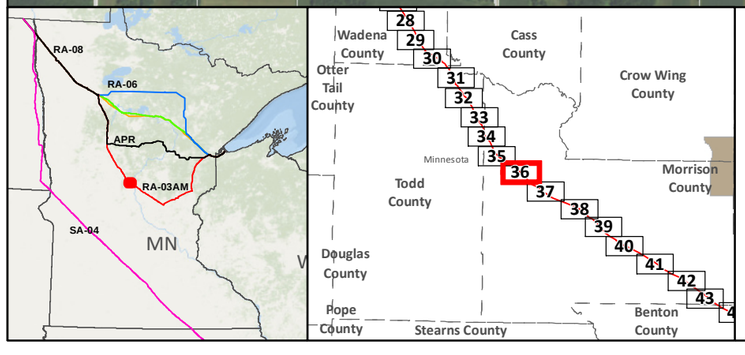
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 35B of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

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- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

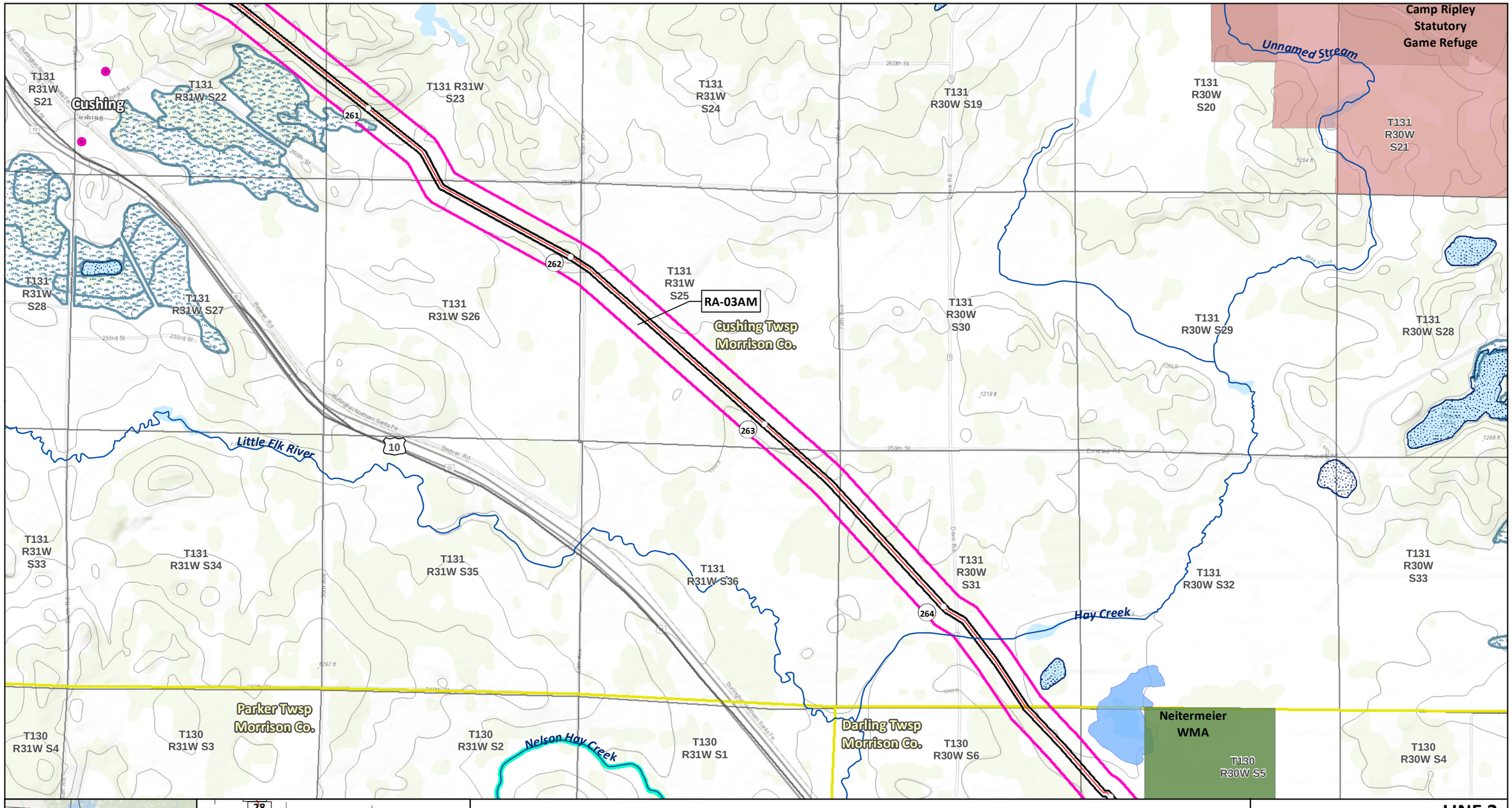
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 36A of 67


Camp Ripley
Statutory
Game Refuge
Unnamed Stream
T131
R31W
S21
Cushing
T131
R31W S22
T131 R31W
S23
T131
R31W
S24
T131
R30W S19
T131
R30W
S20
T131
R30W
S21
T131
R31W
S28
T131
R31W S27
T131
R31W S26
T131
R31W
S25
RA-03AM
Cushing Twsp
Morrison Co.
T131
R30W
S30
T131
R30W S29
T131
R30W S28
Little Elk River
T131
R31W
S33
T131
R31W S34
T131
R31W S35
T131
R31W S36
T131
R30W
S31
T131
R30W S32
T131
R30W
S33
Hay Creek
Parker Twsp
Morrison Co.
Darling Twsp
Morrison Co.
Neitermeier
WMA
T130
R31W S4
T130
R31W S3
T130
R31W S2
T130
R31W S1
T130
R30W S6
T130
R30W S5
T130
R30W S4
Nelson Hay Creek
261
262
263
264
10
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Wadena County
Cass County
Crow Wing County
Otter Tail County
Minnesota
Todd County
Morrison County
Douglas County
Pope County
Stearns County
Benton County
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
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Water Resources
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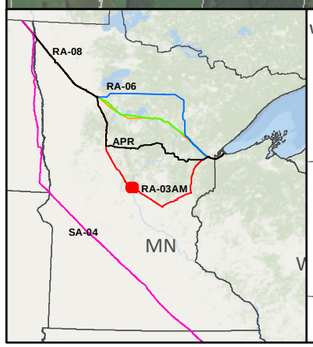
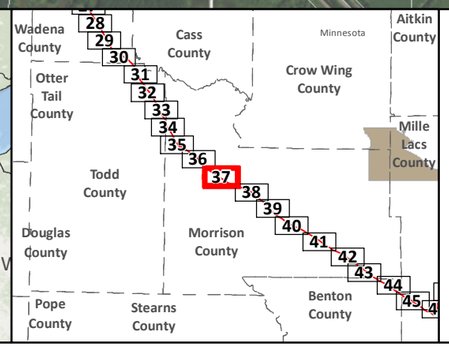
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 36B of 67

T130 R30W S6
T130 R30W S5
T130 R30W S4
T130 R30W S3
T130 R30W S2
T130 R30W S1
T130 R29W S6
T130 R30W S9
Randall Twsp Morrison Co.
T130 R30W S7
T130 R30W S8
T130 R30W S10
T130 R30W S11
T130 R30W S12
T130 R29W S7
Darling Twsp Morrison Co.
Green Prairie Twsp Morrison Co.
Little Elk River
RA-03AM
266
267
268
115
T130 R30W S18
T130 R30W S17
T130 R30W S16
T130 R30W S15
T130 R30W S14
T130 R30W S13
T130 R29W S18
Green Prairie Fish Lake
10
269
270
T130 R30W S19
T130 R30W S20
T130 R30W S21
T130 R30W S22
T130 R30W S23
T130 R30W S24
T130 R29W S19





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 37A of 67

Neitermeier WMA

Camp Ripley Statutory Game Refuge

T130 R30W S6
T130 R30W S5
T130 R30W S4
T130 R30W S3
T130 R30W S2
T130 R30W S1
T130 R29W S6
T130 R30W S9
T130 R30W S7
T130 R30W S8
T130 R30W S10
T130 R30W S11
T130 R30W S12
T130 R29W S7
T130 R30W S18
T130 R30W S17
T130 R30W S16
T130 R30W S15
T130 R30W S14
T130 R30W S13
T130 R29W S18
T130 R30W S19
T130 R30W S20
T130 R30W S21
T130 R30W S22
T130 R30W S23
T130 R30W S24
T130 R29W S19

Randall Twsp
Morrison Co.

Darling Twsp
Morrison Co.

Green Prairie Twsp
Morrison Co.

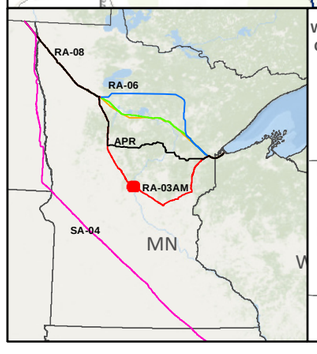
Little Elk River

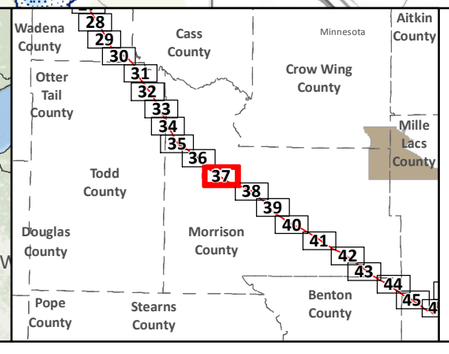
Green Prairie Fish Lake

RA-03AM

266 267 268 269 270

10 115





- SA-04
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- RA-08
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- Outstanding
- High
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Native Plant Communities with Biodiversity Significance
- Outstanding
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- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

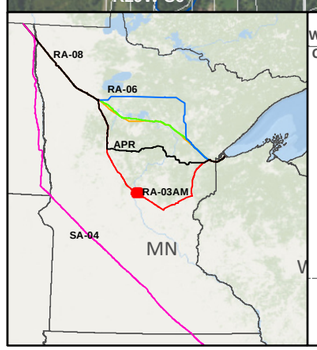
CLEARBROOK TO CARLTON

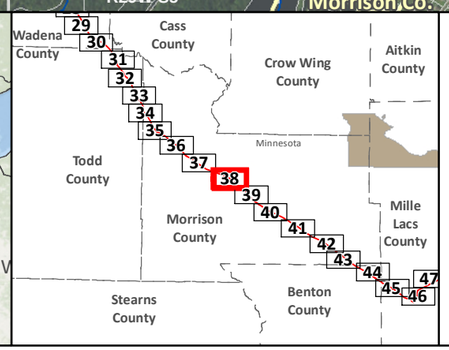
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 37B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

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- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

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Residences within 1/2 mile

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0 0.125 0.25 0.5 Miles

1:24,000

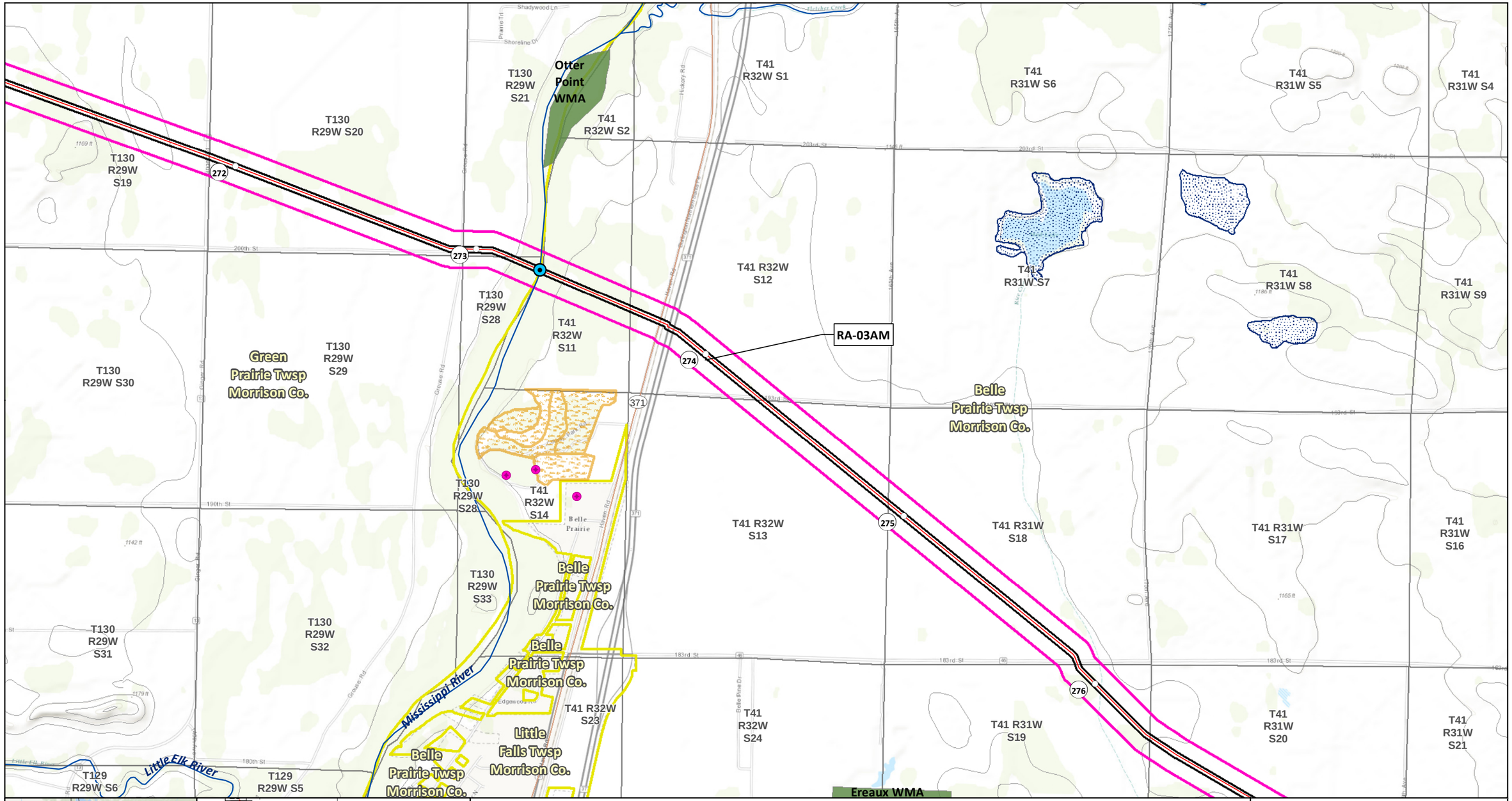
0 125 250 500 Meters

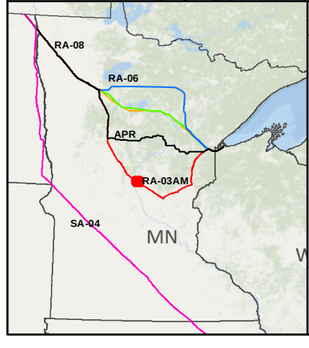
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

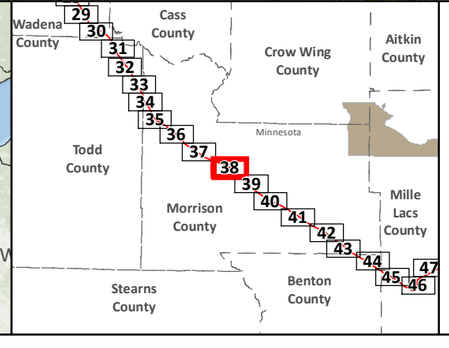
RA-03AM

CLEARBROOK TO CARLTON

Map 38A of 67







SA-04
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RA-03AM

CLEARBROOK TO CARLTON

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1:24,000
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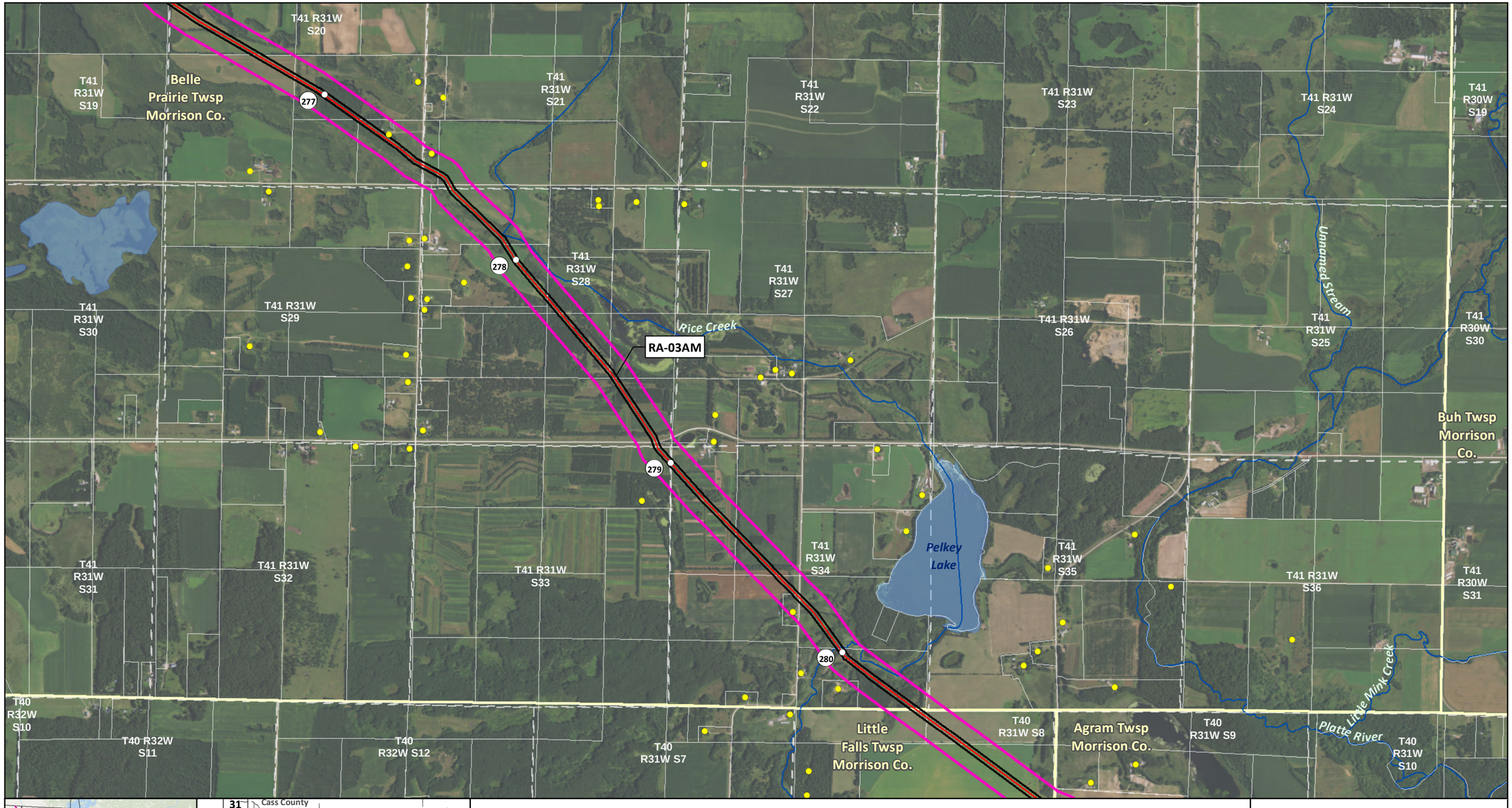
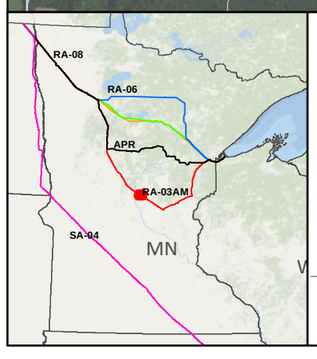
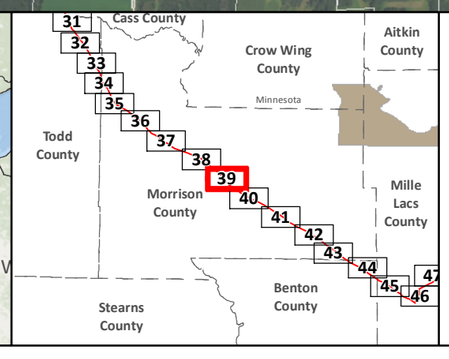
10ft Contours

Map 38B of 67







SA-04

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- RA-08

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Anticipated 120' Construction ROW

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Residences within 1/2 mile

Mile Post

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Highway

Major Road

Township Boundary

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- Tribal Trust Land
- White Earth Reservation - BIA

0 0.125 0.25 0.5 Miles

1:24,000

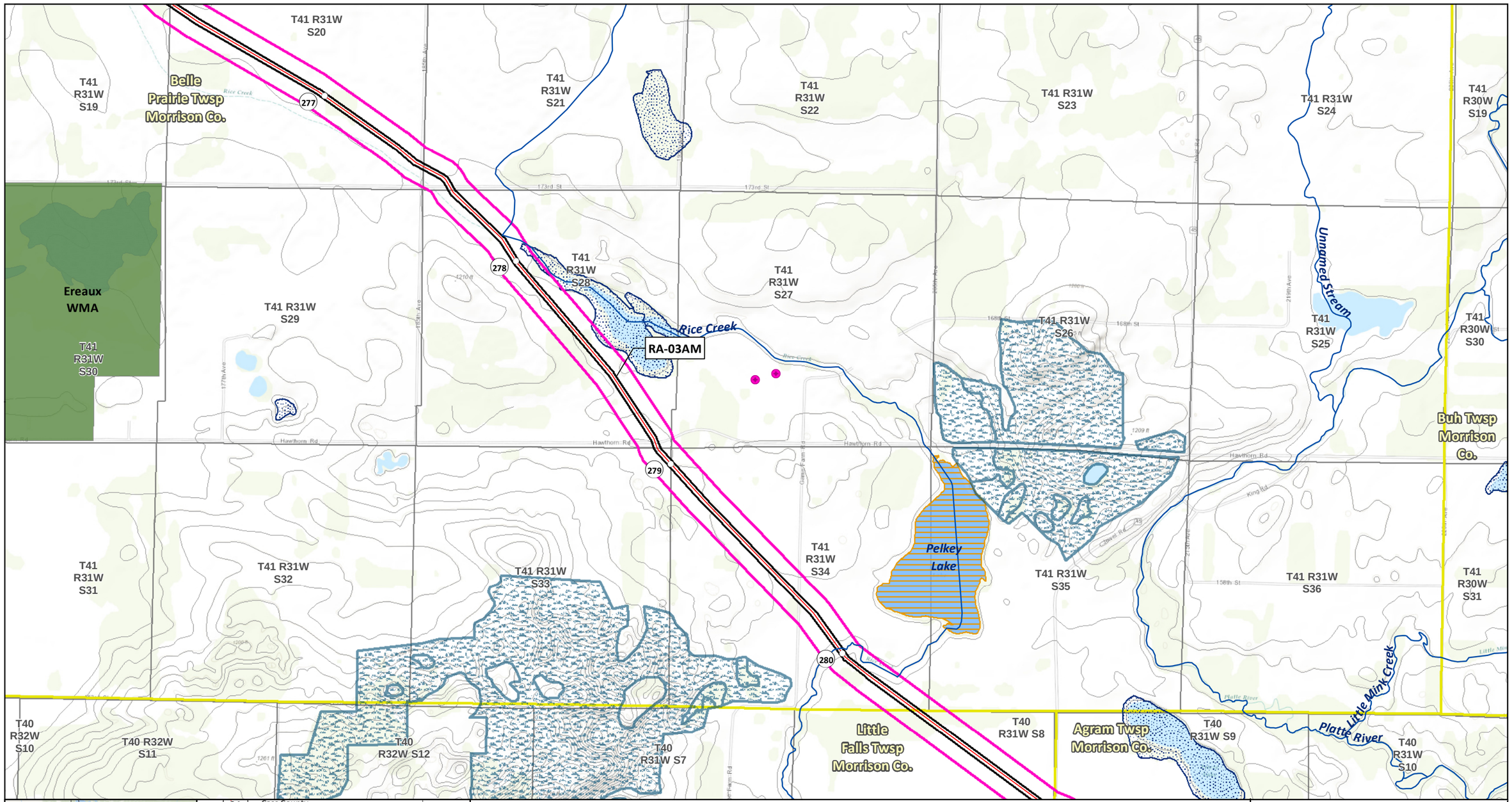
0 125 250 500 Meters

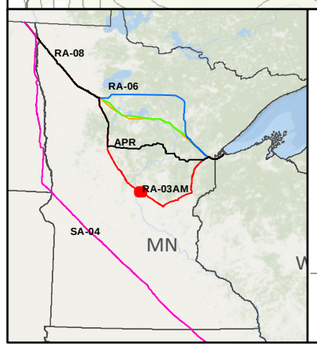
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

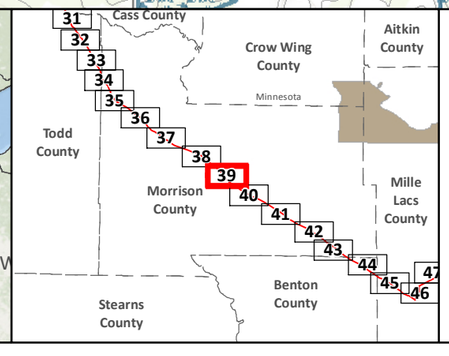
RA-03AM

CLEARBROOK TO CARLTON

Map 39A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

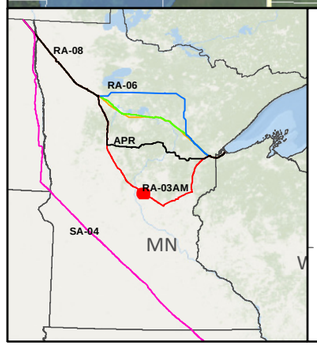
RA-03AM

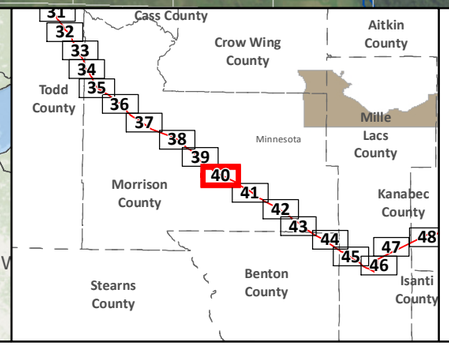
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 39B of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

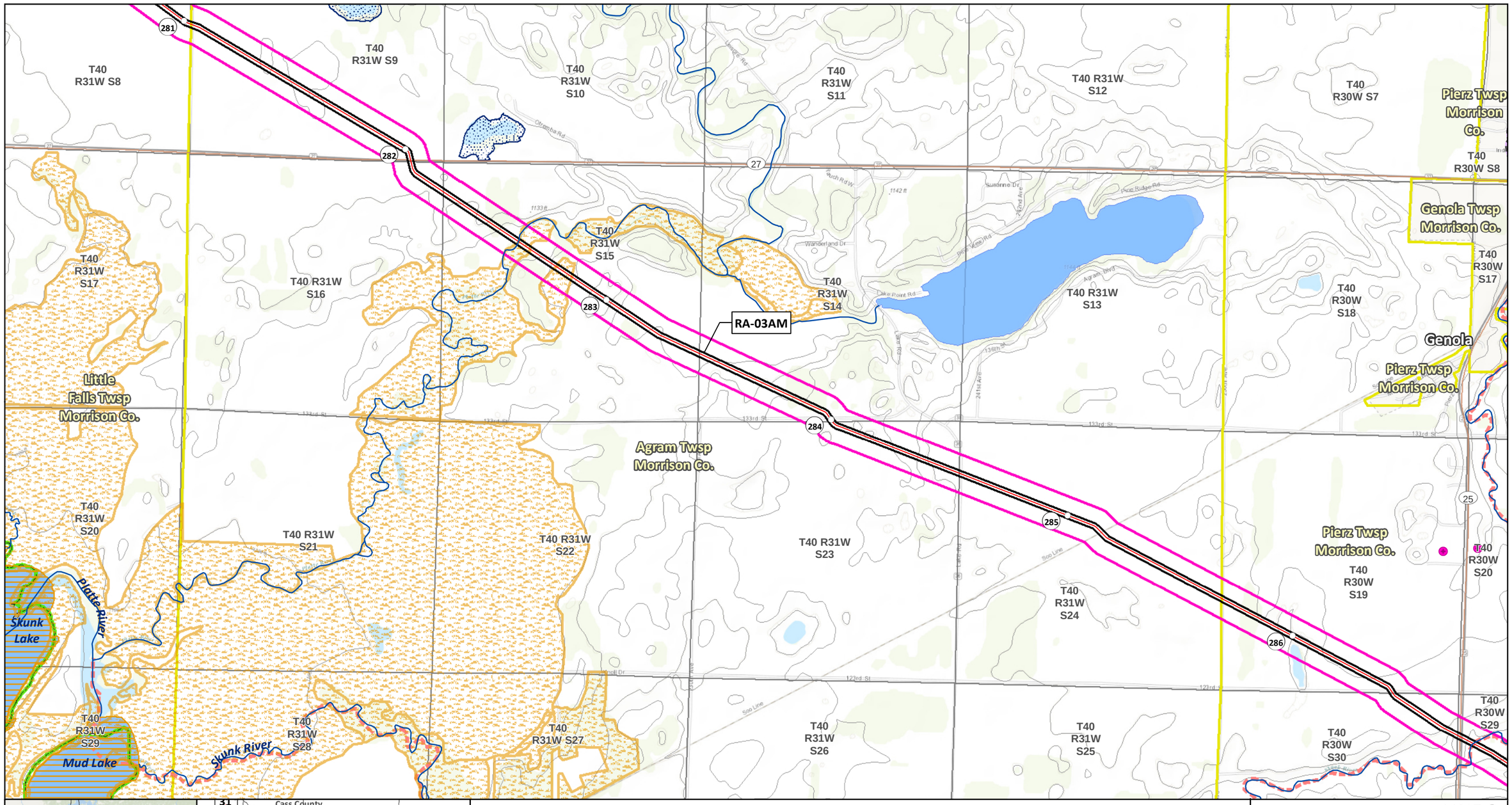
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

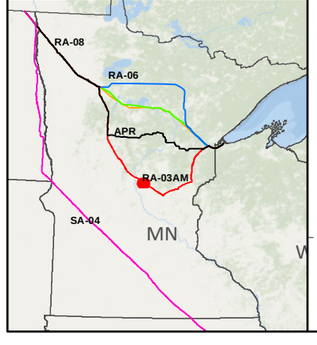
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

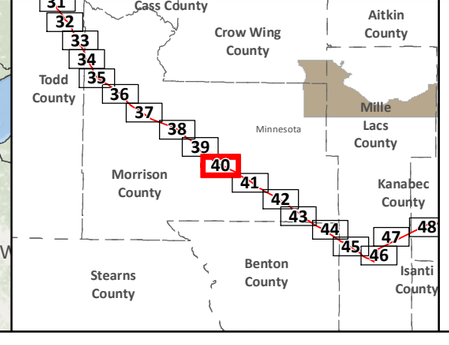
RA-03AM

CLEARBROOK TO CARLTON

Map 40A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 40B of 67

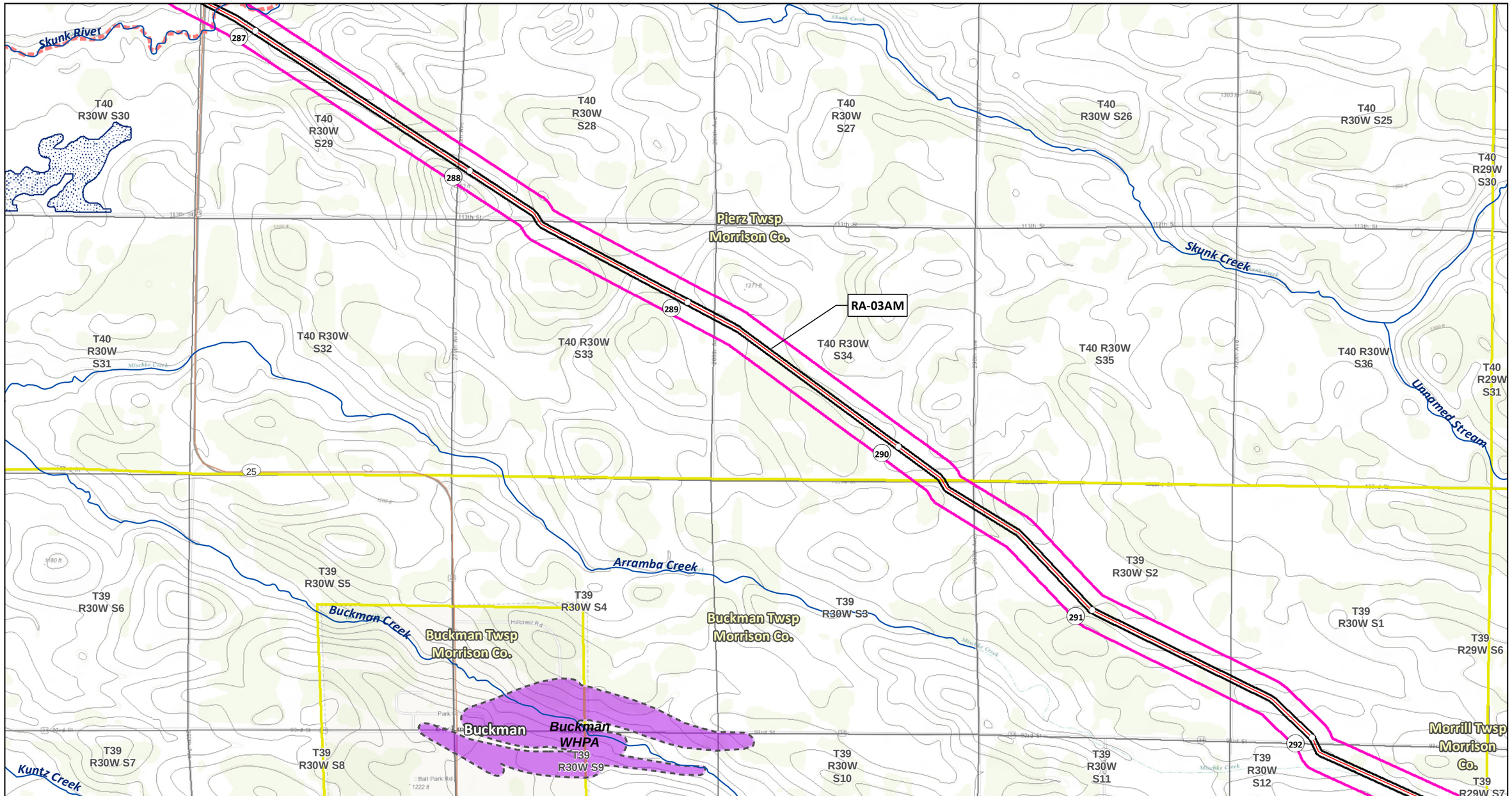


LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 41A of 67


Skunk River
T40 R30W S30
T40 R30W S29
T40 R30W S28
T40 R30W S27
T40 R30W S26
T40 R30W S25
T40 R29W S30
Pierz Twsp Morrison Co.
RA-03AM
Skunk Creek
T40 R30W S31
T40 R30W S32
T40 R30W S33
T40 R30W S34
T40 R30W S35
T40 R30W S36
T40 R29W S31
Unnamed Stream
Arramba Creek
T39 R30W S5
T39 R30W S4
T39 R30W S3
T39 R30W S2
T39 R30W S1
T39 R29W S6
Buckman Creek
Buckman Twsp Morrison Co.
Buckman
Buckman WHPA
T39 R30W S6
T39 R30W S7
T39 R30W S8
T39 R30W S9
T39 R30W S10
T39 R30W S11
T39 R30W S12
Morrill Twsp Morrison Co.
T39 R29W S7
Kuntz Creek
287
288
289
290
291
292
25
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Cass County
Crow Wing County
Aitkin County
Minnesota
Todd County
Morrison County
Mille Lacs County
Kanabec County
Benton County
Stearns County
Isanti County
Sherburne County
31
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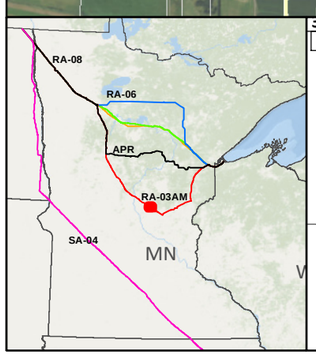
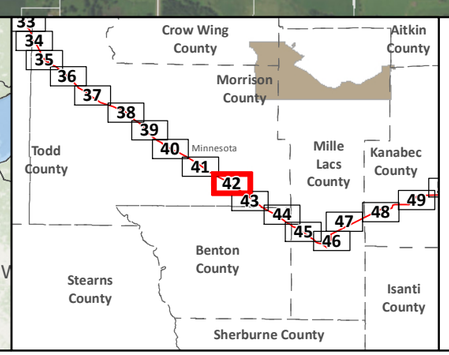
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 41B of 67

T39 R30W S1
T39 R29W S6
T39 R29W S5
T39 R29W S4
T39 R29W S3
T39 R29W S2
T39 R29W S1
T39 R30W S12
T39 R29W S7
T39 R29W S8
T39 R29W S9
T39 R29W S10
T39 R29W S11
T39 R29W S12
293
294
295
296
297
RA-03AM
Buckman Twsp
Morrison Co.
Morrill Twsp
Morrison Co.
T39 R30W S13
T39 R29W S18
T39 R29W S17
T39 R29W S16
T39 R29W S15
T39 R29W S14
T39 R29W S13
T39 R30W S24
T39 R29W S19
T39 R29W S20
T39 R29W S21
T39 R29W S22
T39 R29W S23
T39 R29W S24





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

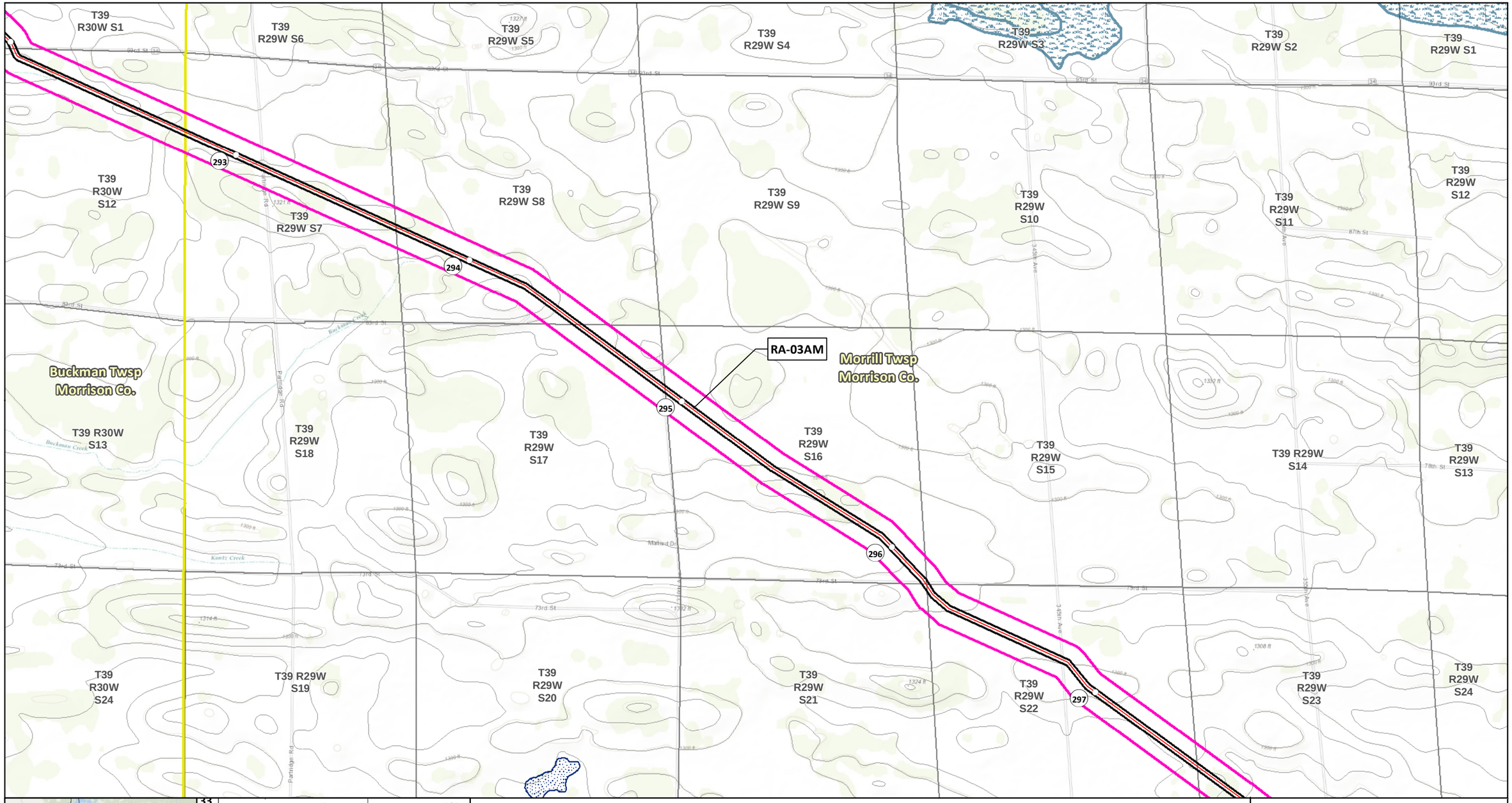
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

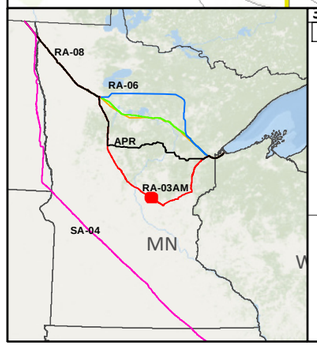
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

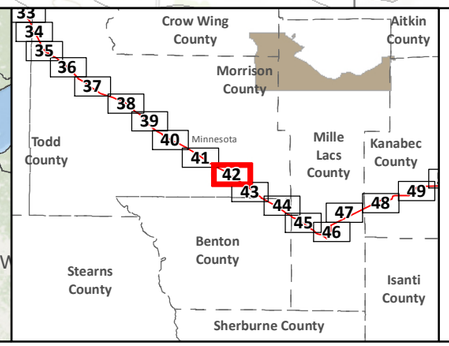
RA-03AM

CLEARBROOK TO CARLTON

Map 42A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 42B of 67

T39 R29W S21
T39 R29W S22
T39 R29W S23
T39 R29W S24
T39 R28W S19
T39 R28W S20
T39 R28W S21
T39 R29W S28
T39 R29W S27
T39 R29W S26
T39 R29W S25
T39 R28W S30
T39 R28W S29
T39 R28W S28
T39 R29W S33
T39 R29W S34
T39 R29W S35
T39 R29W S36
T39 R28W S32
T39 R28W S33
T38 R29W S4
T38 R29W S3
T38 R29W S2
T38 R29W S1
T38 R28W S6
T38 R28W S5
T38 R28W S4

298
299
300
301
302

RA-03AM

Morrill Twsp
Morrison Co.

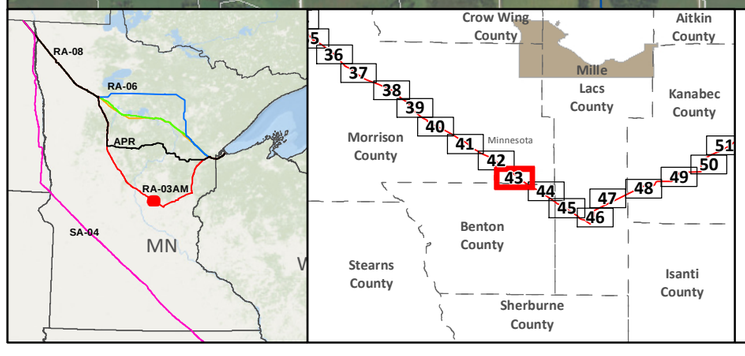
Lakin Twsp
Morrison Co.

Alberta Twsp
Benton Co.

Granite Ledge Twsp
Benton Co.

Unnamed Stream

Elk River



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 43A of 67

T39 R29W S21
T39 R29W S22
T39 R29W S23
T39 R29W S24
T39 R28W S19
T39 R28W S20
T39 R28W S21
T39 R29W S28
T39 R29W S27
T39 R29W S26
T39 R29W S25
T39 R28W S30
T39 R28W S29
T39 R28W S28
T39 R29W S33
T39 R29W S34
T39 R29W S35
T39 R29W S36
T39 R28W S32
T39 R28W S33
T39 R28W S31
T38 R29W S4
T38 R29W S3
T38 R29W S2
T38 R29W S1
T38 R28W S5
T38 R28W S6
T38 R28W S4

Adams WMA

RA-03AM

298 299 300 301 302

Morrill Twsp Morrison Co.

Lakin Twsp Morrison Co.

Alberta Twsp Benton Co.

Granite Ledge Twsp Benton Co.

Unnamed Stream

Elk River

Nature Rd

63rd St

53rd St

345th Ave

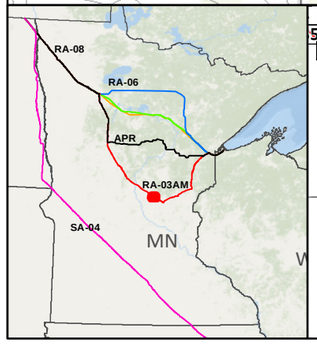
355th Ave

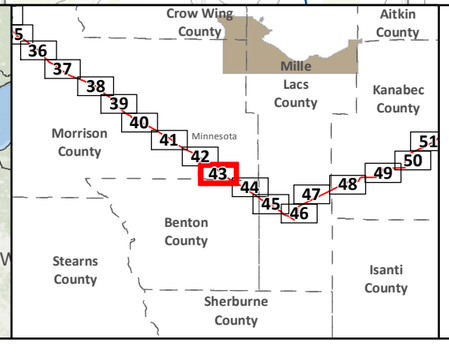
365th Ave

170th St NE

Ramey

MORRISON
BENTON





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

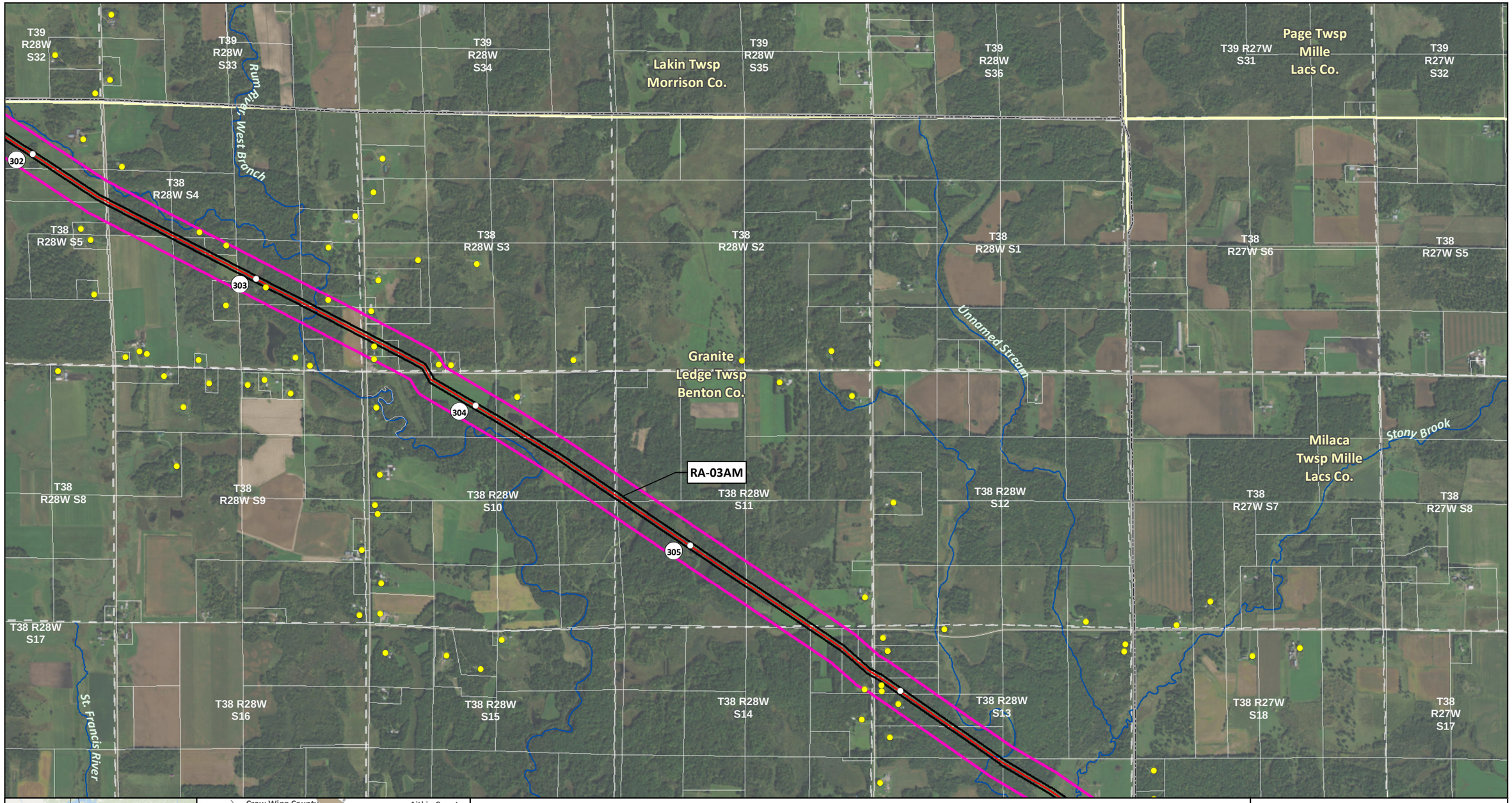
RA-03AM

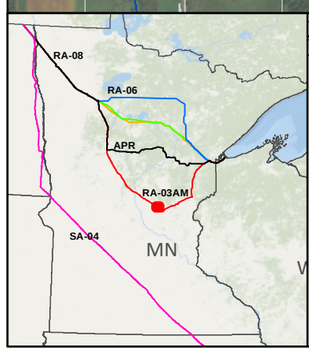
CLEARBROOK TO CARLTON

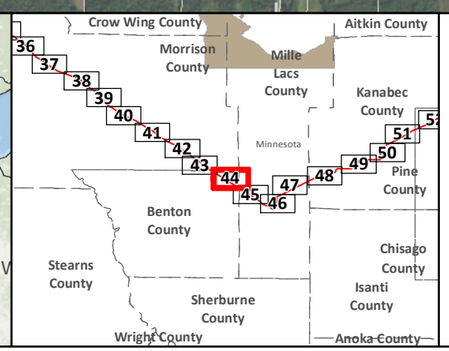
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 43B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

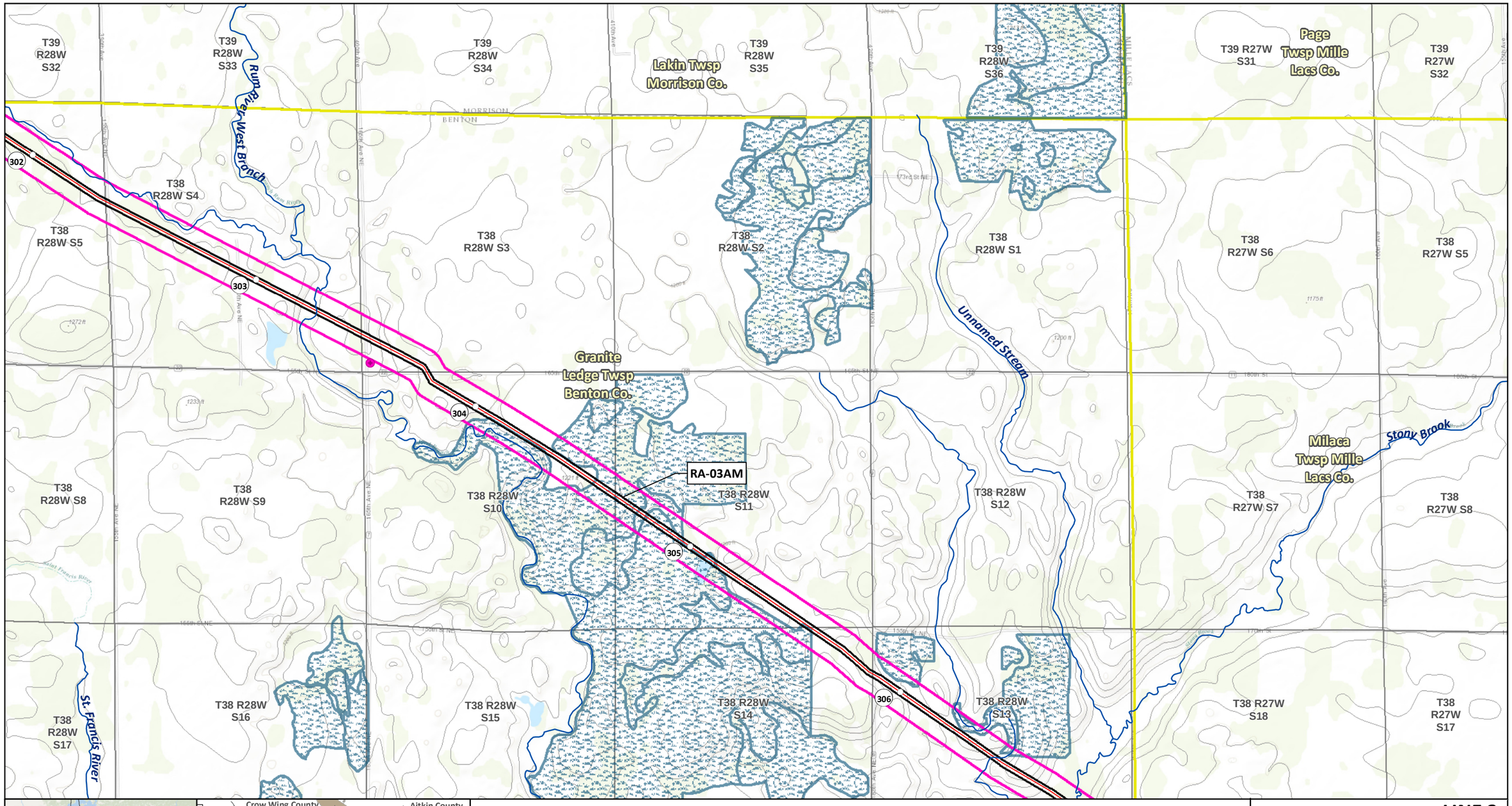
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 44A of 67


T39 R28W S32
T39 R28W S33
T39 R28W S34
T39 R28W S35
T39 R28W S36
T39 R27W S31
T39 R27W S32
Lakin Twsp Morrison Co.
Page Twsp Mille Lacs Co.
Rum River, West Branch
MORRISON
BENTON
302
303
304
305
306
T38 R28W S4
T38 R28W S5
T38 R28W S3
T38 R28W S2
T38 R28W S1
T38 R27W S6
T38 R27W S5
Granite Ledge Twsp Benton Co.
RA-03AM
T38 R28W S8
T38 R28W S9
T38 R28W S10
T38 R28W S11
T38 R28W S12
T38 R27W S7
T38 R27W S8
Unnamed Stream
Stony Brook
Milaca Twsp Mille Lacs Co.
St. Francis River
T38 R28W S16
T38 R28W S15
T38 R28W S14
T38 R28W S13
T38 R27W S18
T38 R28W S17
T38 R27W S17
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Crow Wing County
Aitkin County
Morrison County
Mille Lacs County
Kanabec County
Minnesota
Pine County
Benton County
Chisago County
Stearns County
Isanti County
Sherburne County
Wright County
Anoka County
36
37
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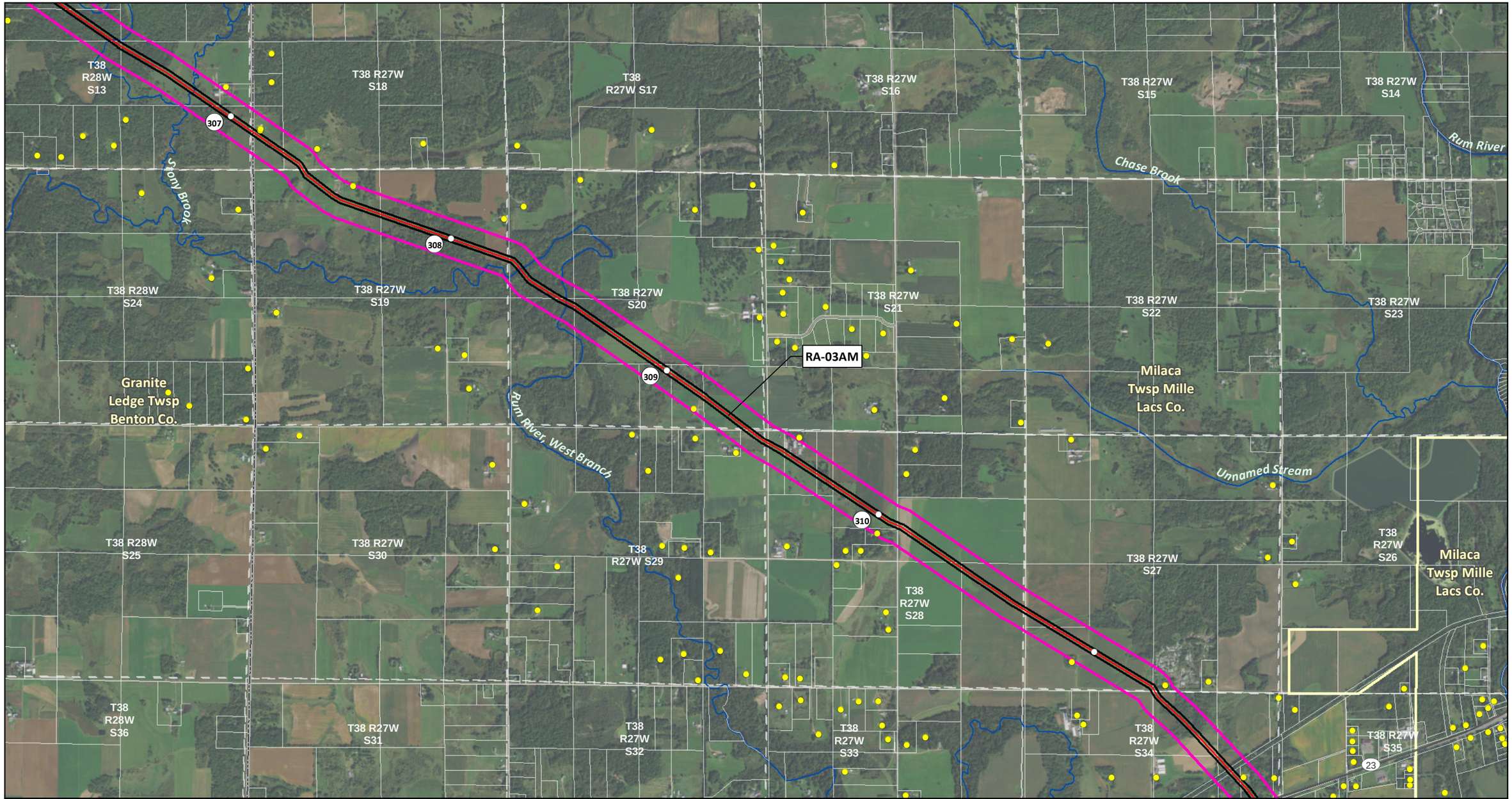
51
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 44B of 67



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 45A of 67

T38 R28W S13
T38 R27W S18
T38 R27W S17
T38 R27W S16
T38 R27W S15
T38 R27W S14
T38 R28W S24
T38 R27W S19
T38 R27W S20
T38 R27W S21
T38 R27W S22
T38 R27W S23
T38 R28W S25
T38 R27W S30
T38 R27W S29
T38 R27W S28
T38 R27W S27
T38 R27W S26
T38 R28W S36
T38 R27W S31
T38 R27W S32
T38 R27W S33
T38 R27W S34
T38 R27W S35

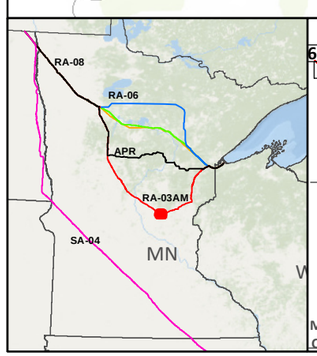
Stony Brook
Rum River
Chase Brook
Rum River West Branch
Unnamed Stream

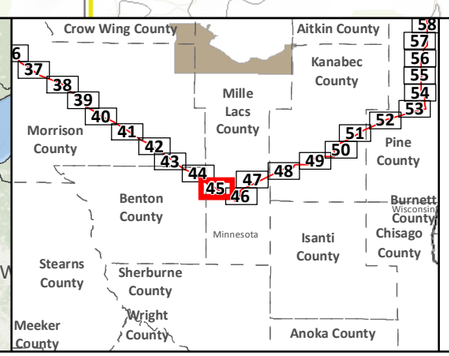
Granite Ledge Twsp Benton Co.
Milaca Twsp Mille Lacs Co.
Milaca Twsp Mille Lacs Co.
Milaca WHPA

RA-03AM

307 308 309 310 311 23

145th St NE 150th St 155th St 160th St 140th St 145th St
162nd Ave 160th Ave 150th Ave 145th Ave 130th Ave
1140 ft 1138 ft 1152 ft 1123 ft 1101 ft





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

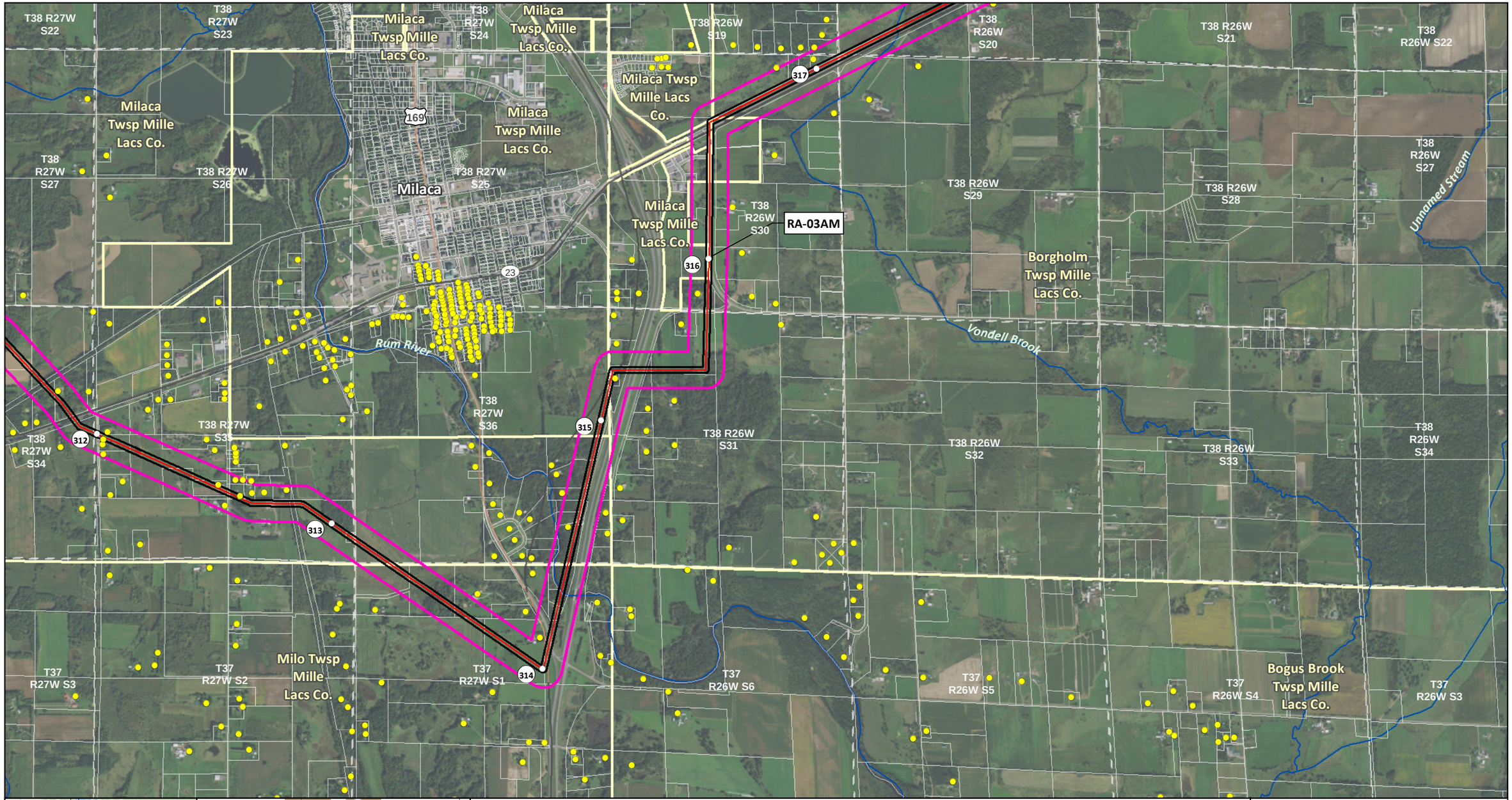
RA-03AM

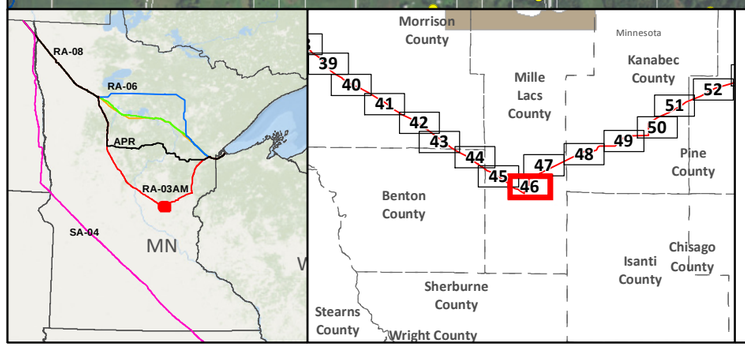
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 45B of 67





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

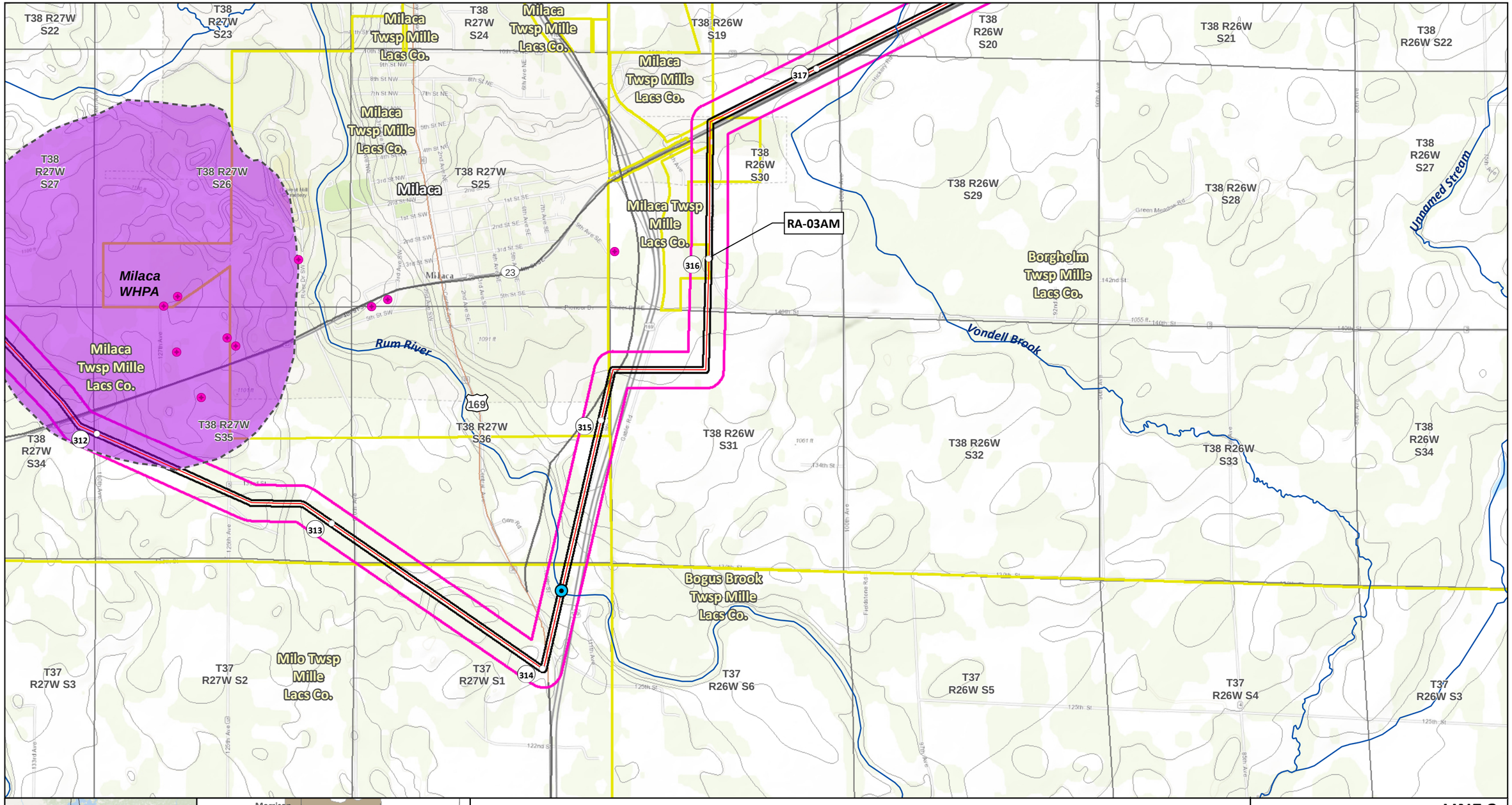
0 125 250 500 Meters

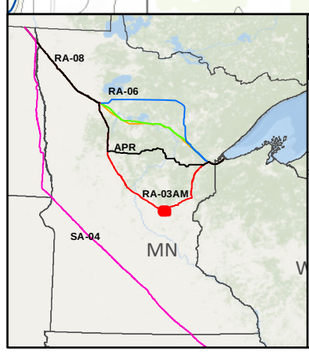
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

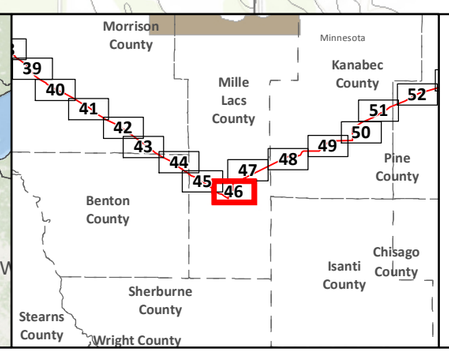
RA-03AM

CLEARBROOK TO CARLTON

Map 46A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

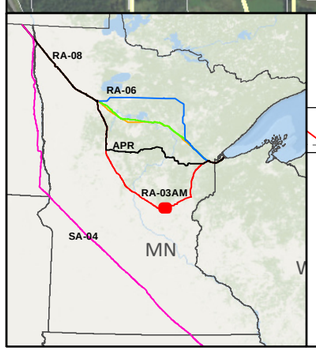
CLEARBROOK TO CARLTON

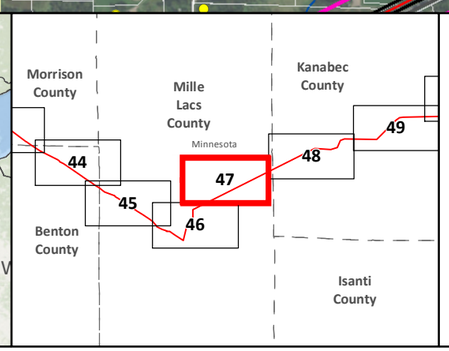
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 46B of 67

T38 R27W S1
T38 R26W S6
T38 R26W S5
T38 R26W S4
T38 R26W S3
T38 R26W S2
T38 R26W S1
T38 R27W S12
T38 R26W S7
T38 R26W S8
T38 R26W S9
T38 R26W S10
T38 R26W S11
T38 R26W S12
Vondell Brook
RA-03AM
322
321
Milaca Twsp Mille Lacs Co.
Borgholm Twsp Mille Lacs Co.
T38 R27W S13
T38 R26W S18
T38 R26W S17
T38 R26W S16
T38 R26W S15
T38 R26W S14
T38 R26W S13
Bogus Brook
23
Bock
320
Bock Twsp Mille Lacs Co.
O'Neill Brook
Milaca Twsp Mille Lacs Co.
T38 R27W S24
T38 R26W S19
T38 R26W S20
T38 R26W S21
T38 R26W S22
T38 R26W S23
T38 R26W S24
Unnamed Stream
319
318
Borgholm Twsp Mille Lacs Co.





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

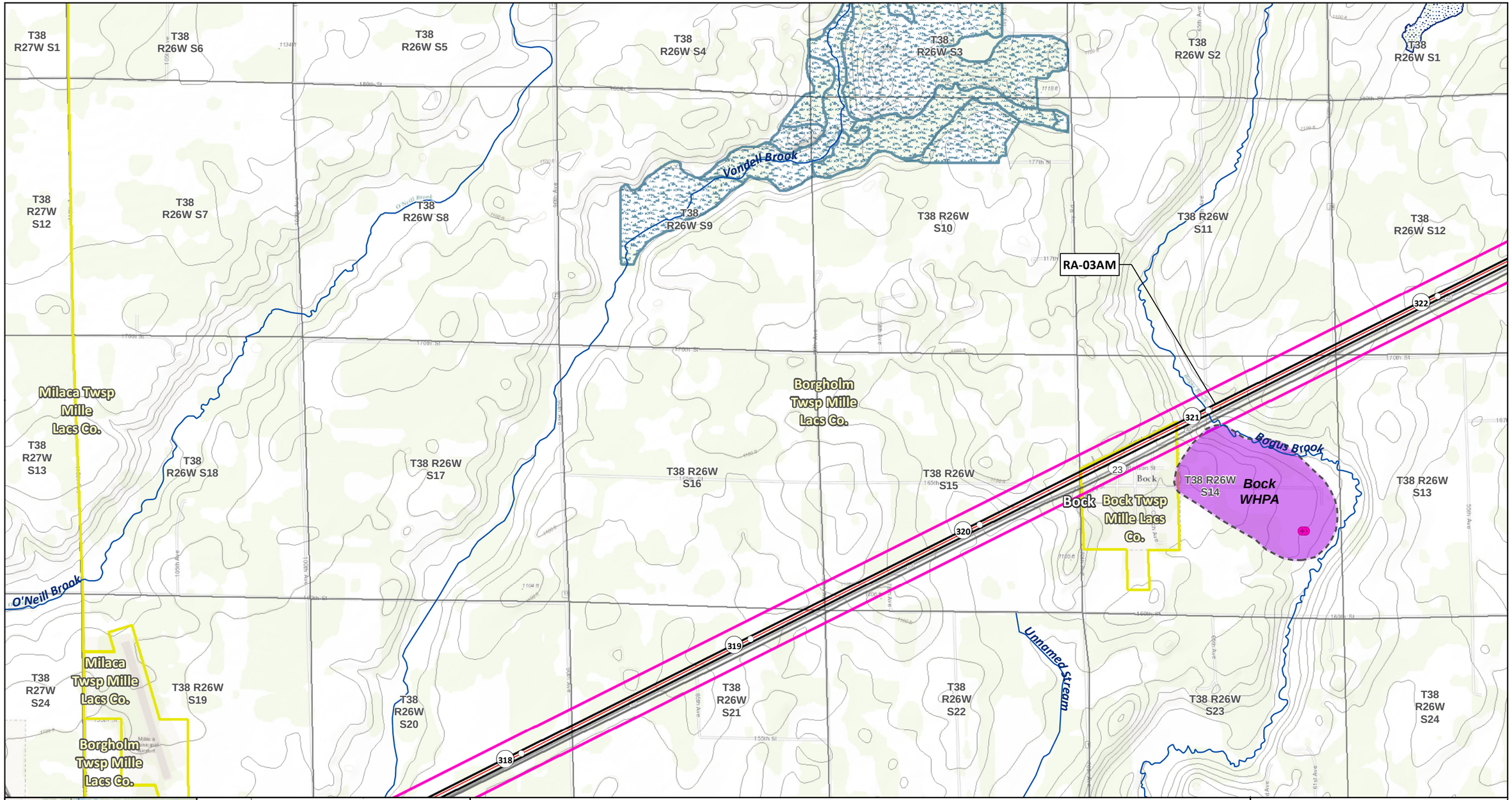
Data Sources:
MNDNR, NHD, Enbridge

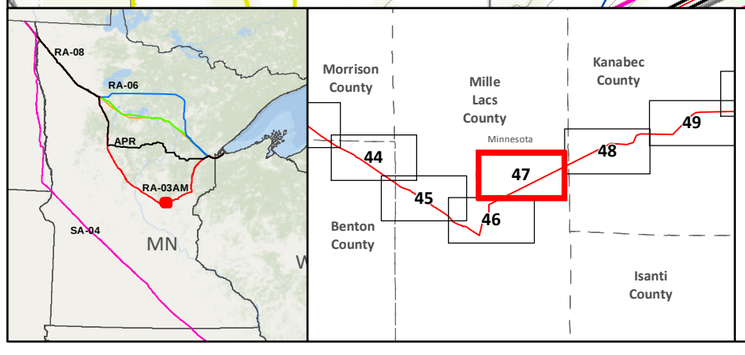
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 47A of 67





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

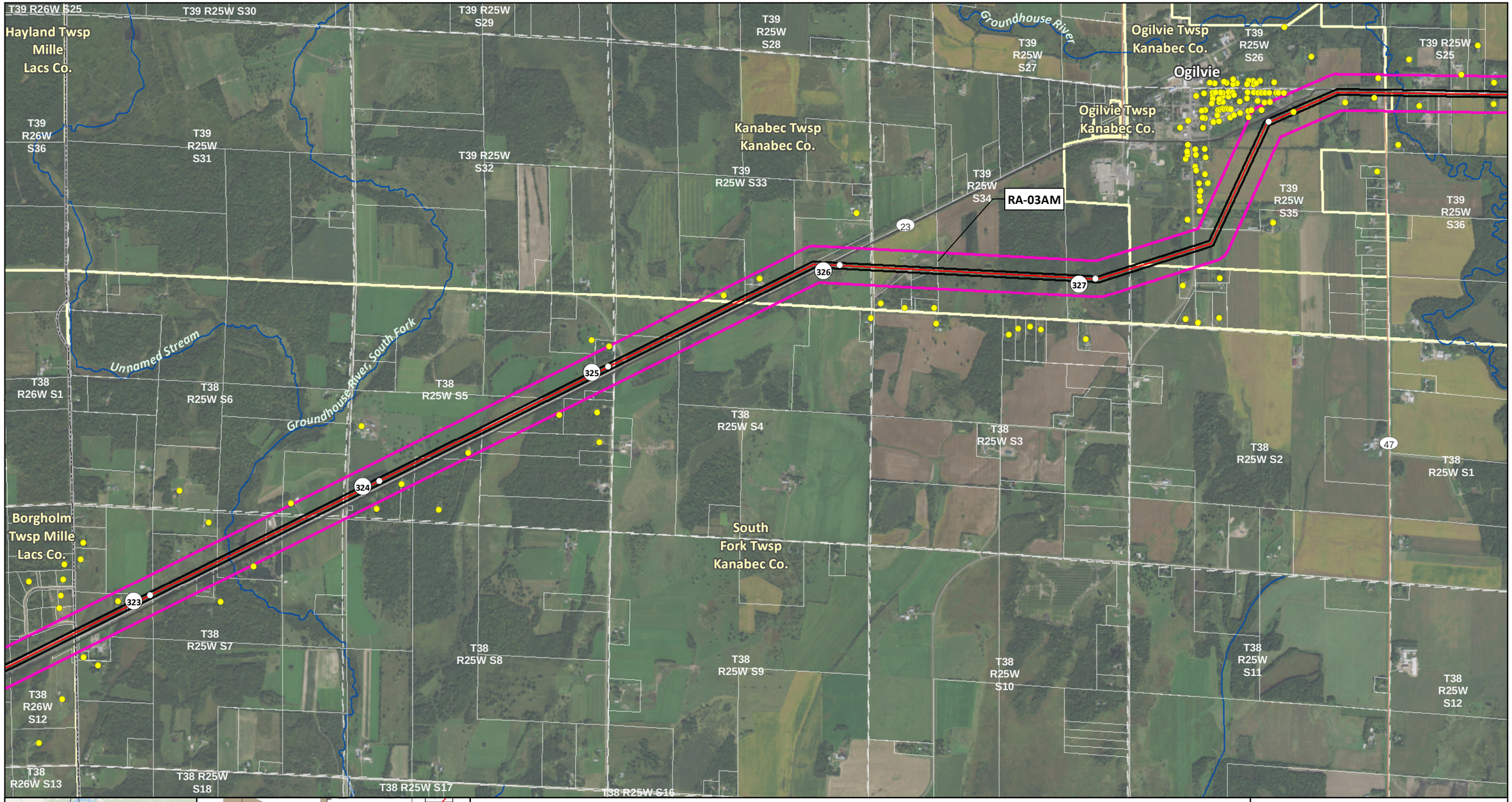
RA-03AM

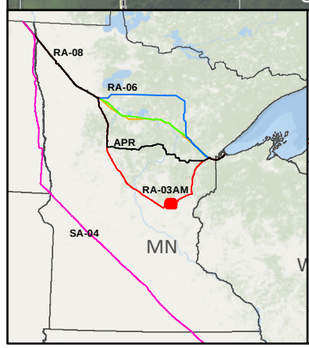
CLEARBROOK TO CARLTON

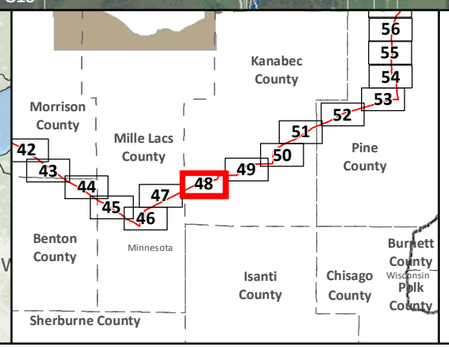
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 47B of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

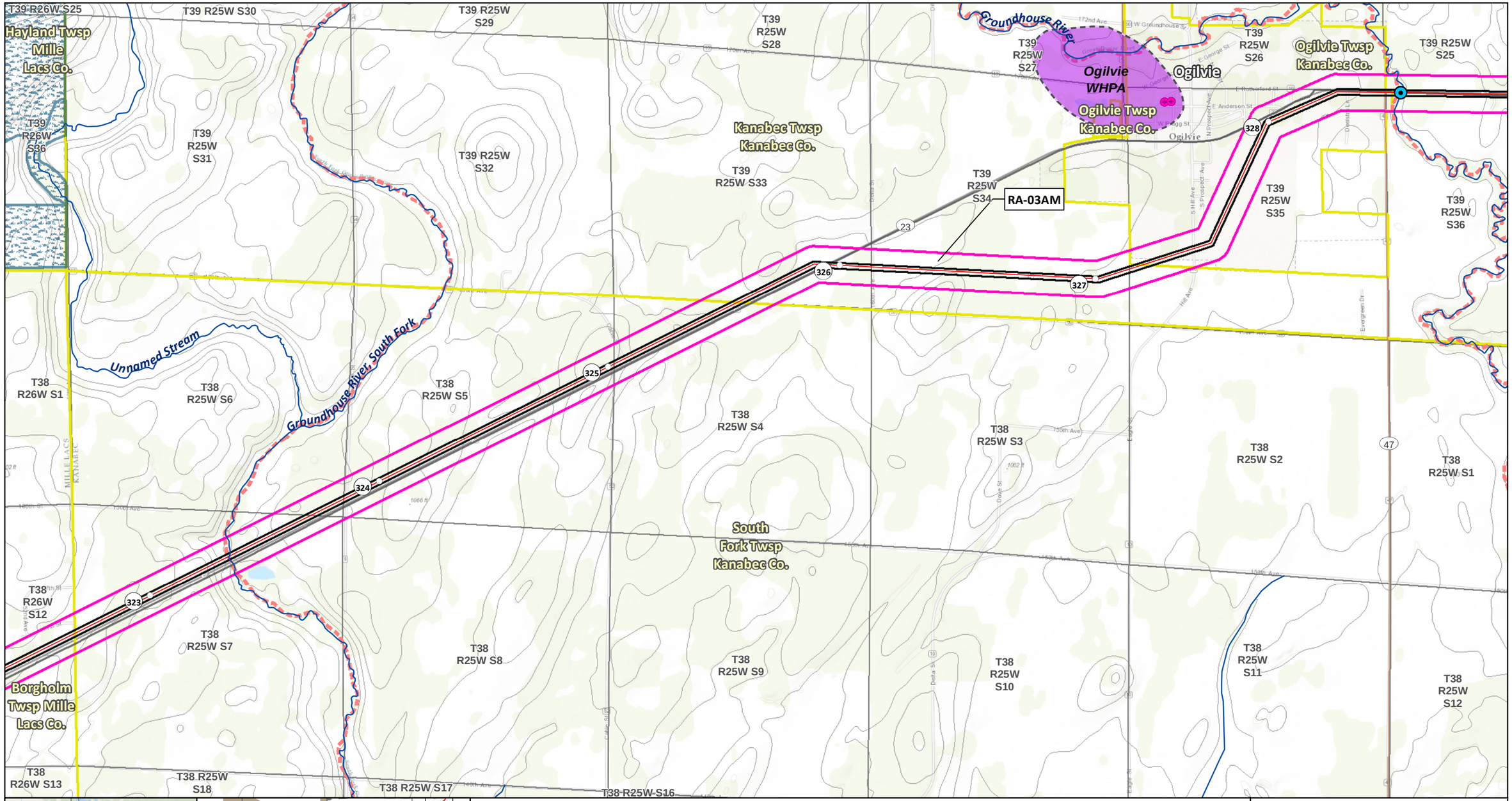
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 48A of 67


T39 R26W S25
T39 R25W S30
T39 R25W S29
T39 R25W S28
T39 R25W S27
T39 R25W S26
T39 R25W S25
Hayland Twsp Mille Lacs Co.
Groundhouse River
Ogilvie WHPA
Ogilvie Twsp Kanabec Co.
Ogilvie
Ogilvie Twsp Kanabec Co.
T39 R26W S36
T39 R25W S31
T39 R25W S32
Kanabec Twsp Kanabec Co.
T39 R25W S33
T39 R25W S34
RA-03AM
T39 R25W S35
T39 R25W S36
Unnamed Stream
Groundhouse River, South Fork
T38 R26W S1
T38 R25W S6
T38 R25W S5
T38 R25W S4
T38 R25W S3
T38 R25W S2
T38 R25W S1
South Fork Twsp Kanabec Co.
T38 R26W S12
T38 R25W S7
T38 R25W S8
T38 R25W S9
T38 R25W S10
T38 R25W S11
T38 R25W S12
Borgholm Twsp Mille Lacs Co.
T38 R26W S13
T38 R25W S18
T38 R25W S17
T38 R25W S16
23
47
323
324
325
326
327
328
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Morrison County
Mille Lacs County
Kanabec County
Pine County
Benton County
Isanti County
Chisago County
Burnett County
Polk County
Sherburne County
Minnesota
Wisconsin
42
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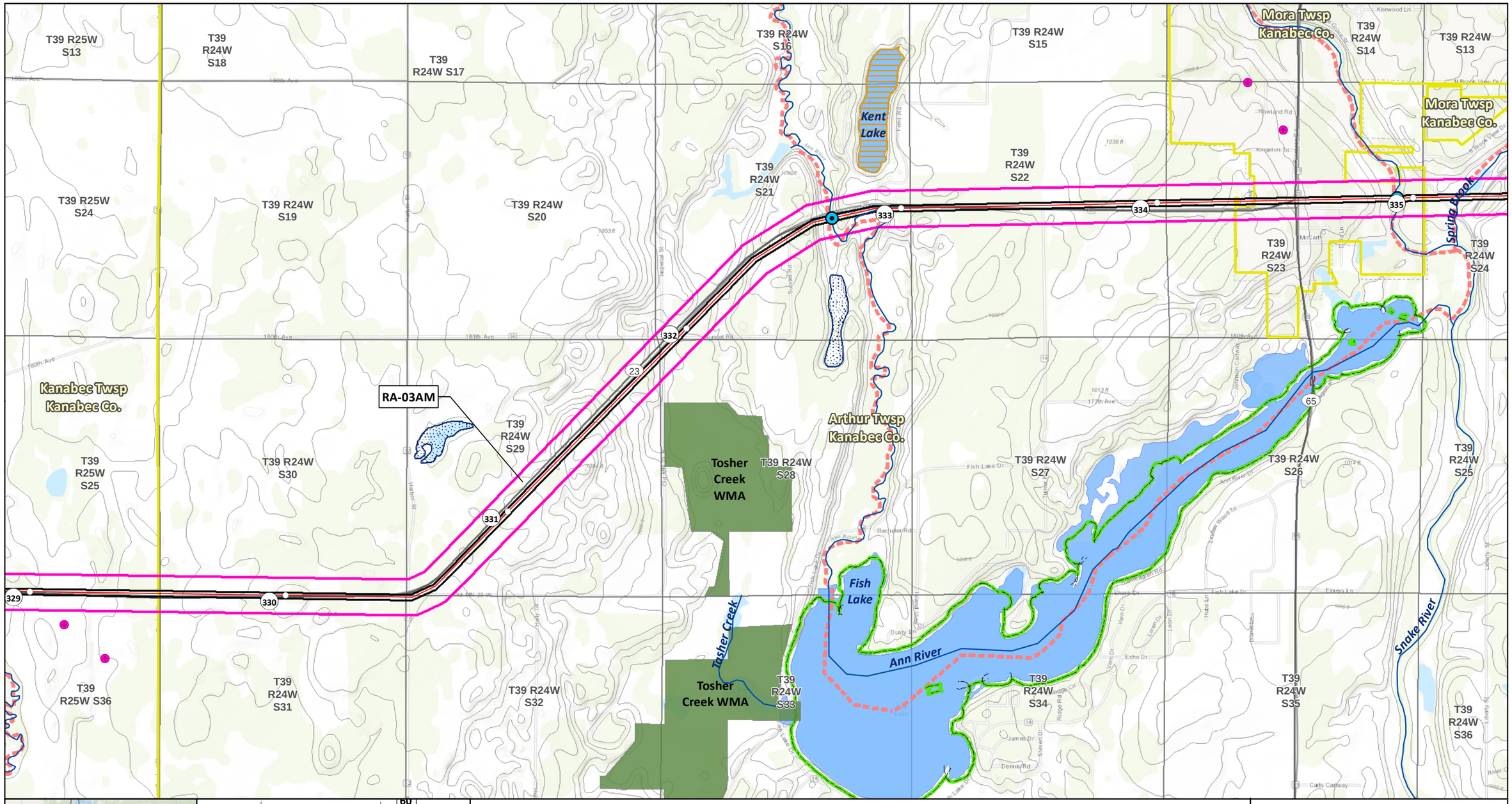
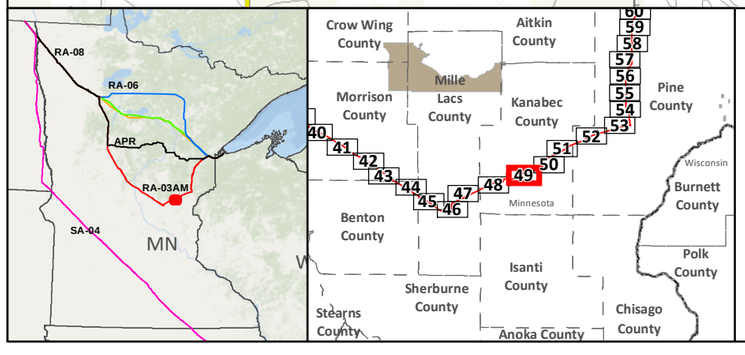
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 48B of 67





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

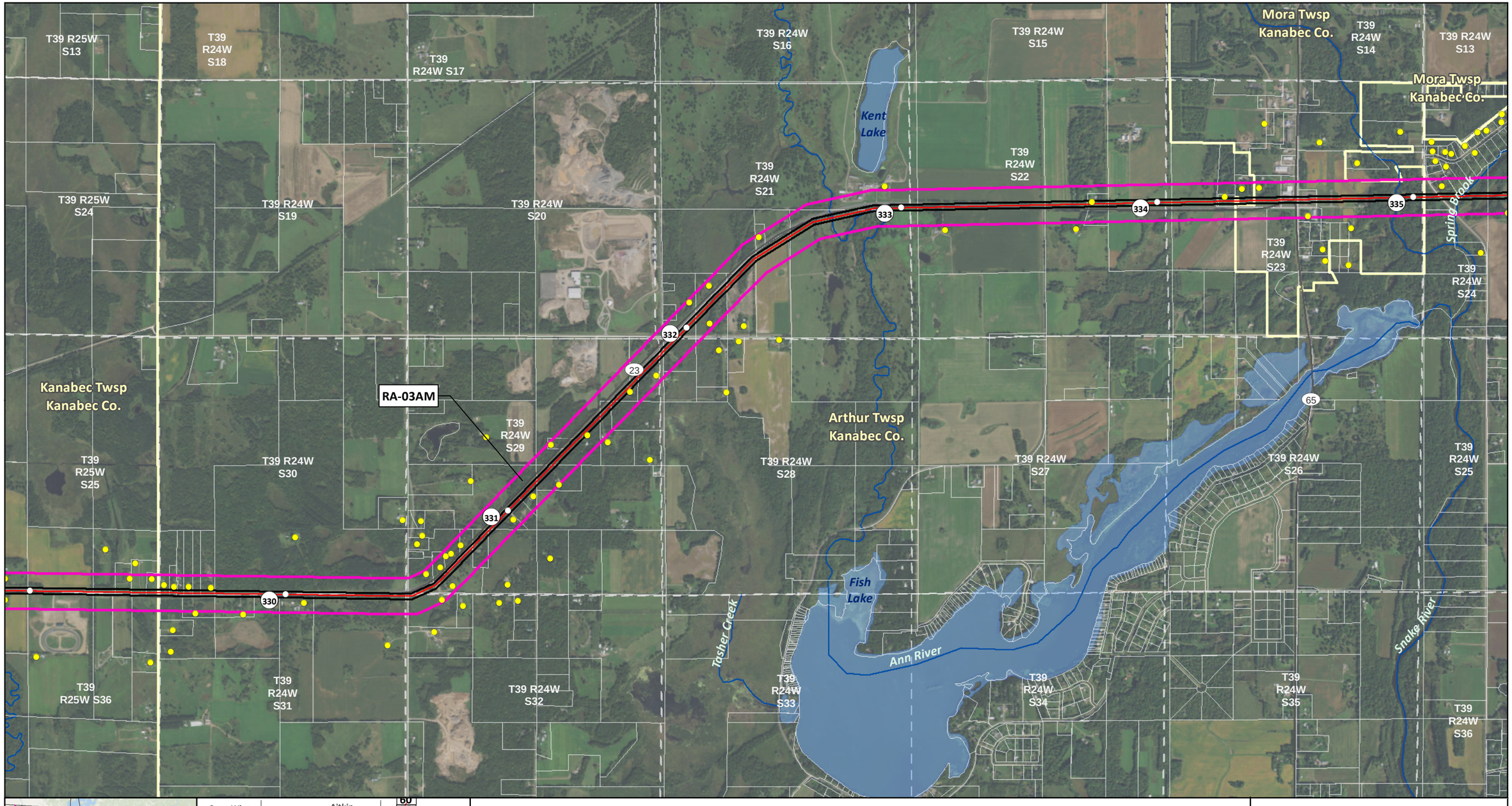
RA-03AM

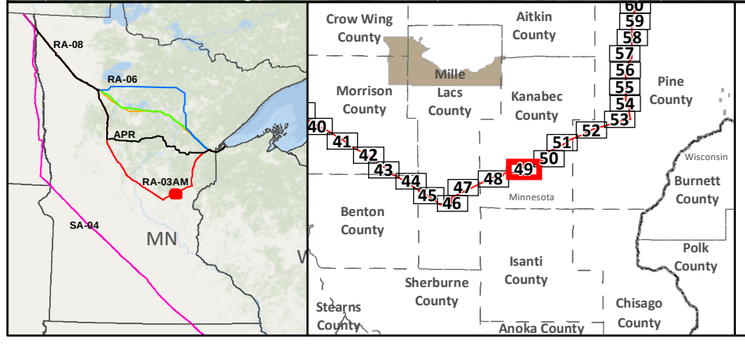
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 49B of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

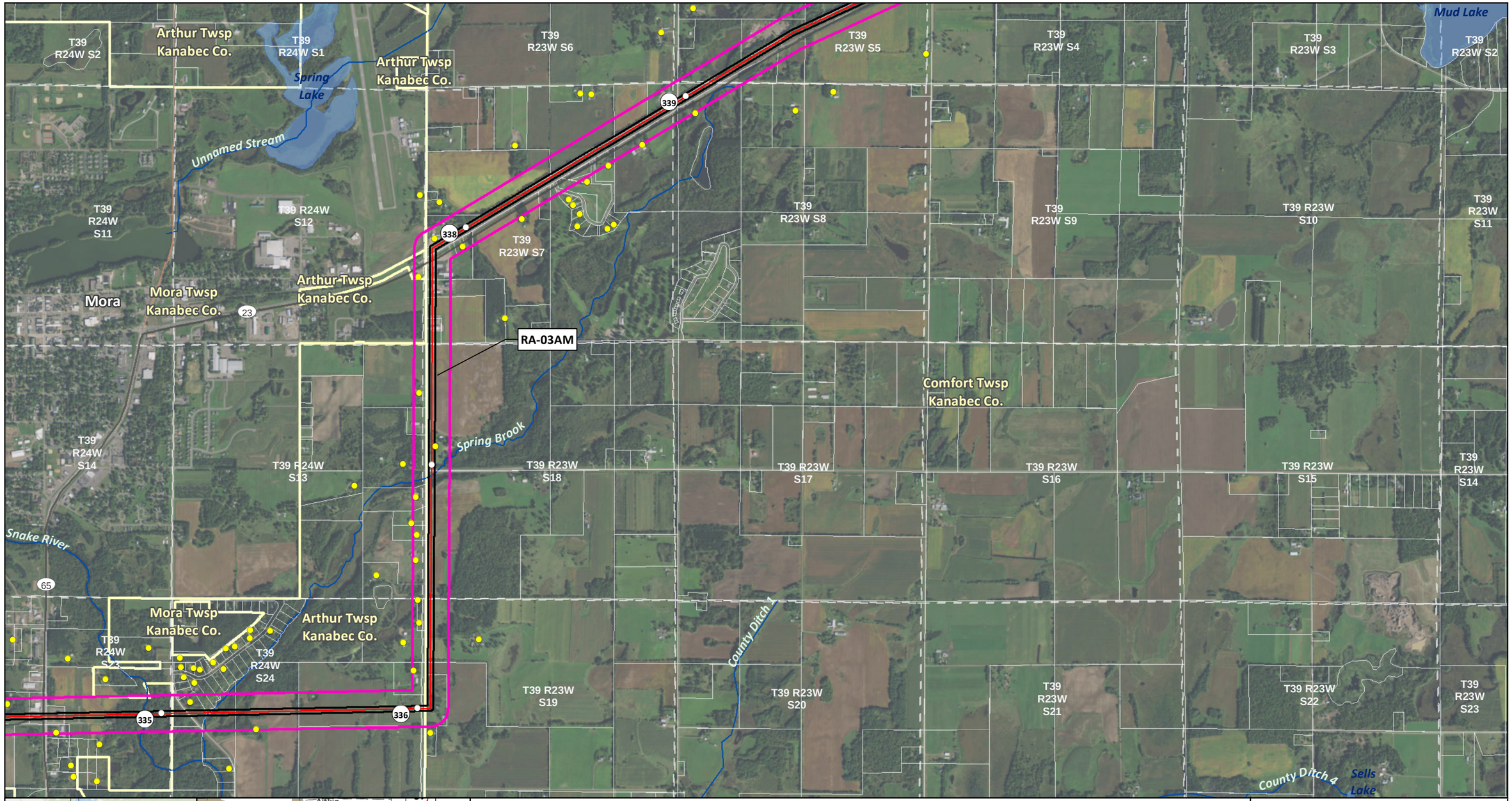
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

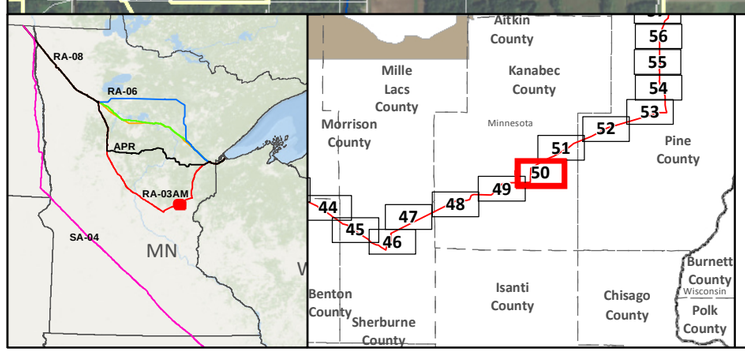
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 49A of 67





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

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- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

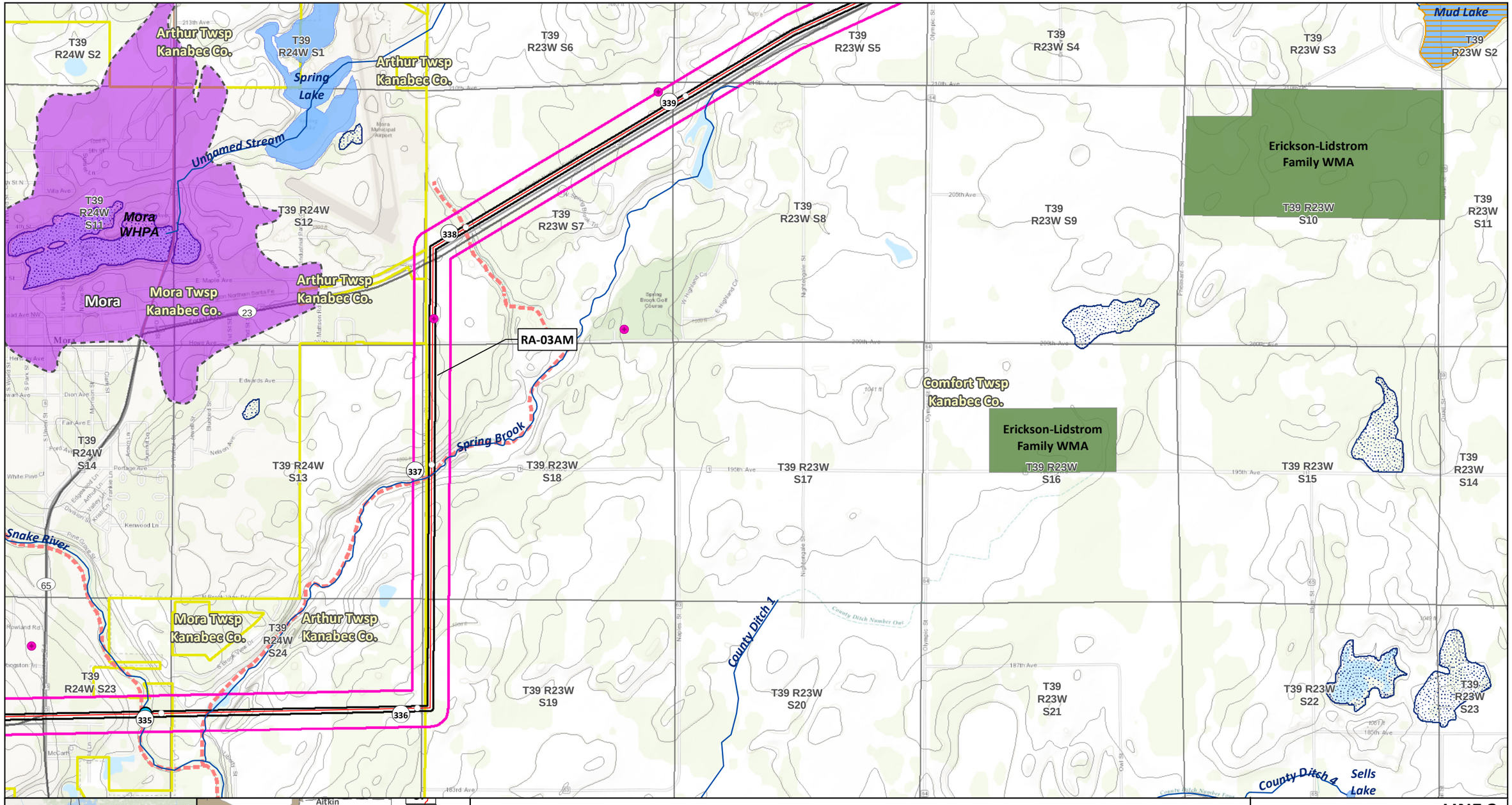
0 125 250 500 Meters

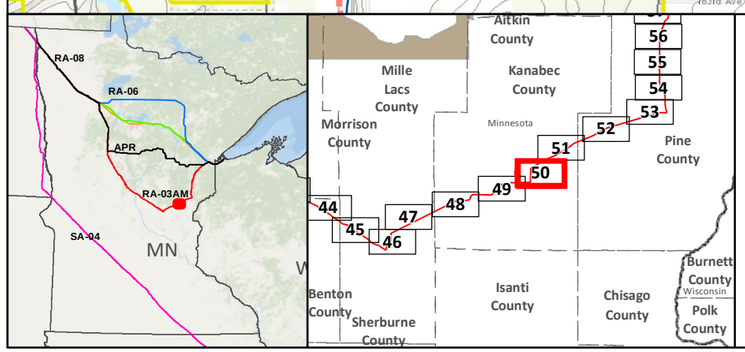
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 50A of 67





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
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- Public Water Basin
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

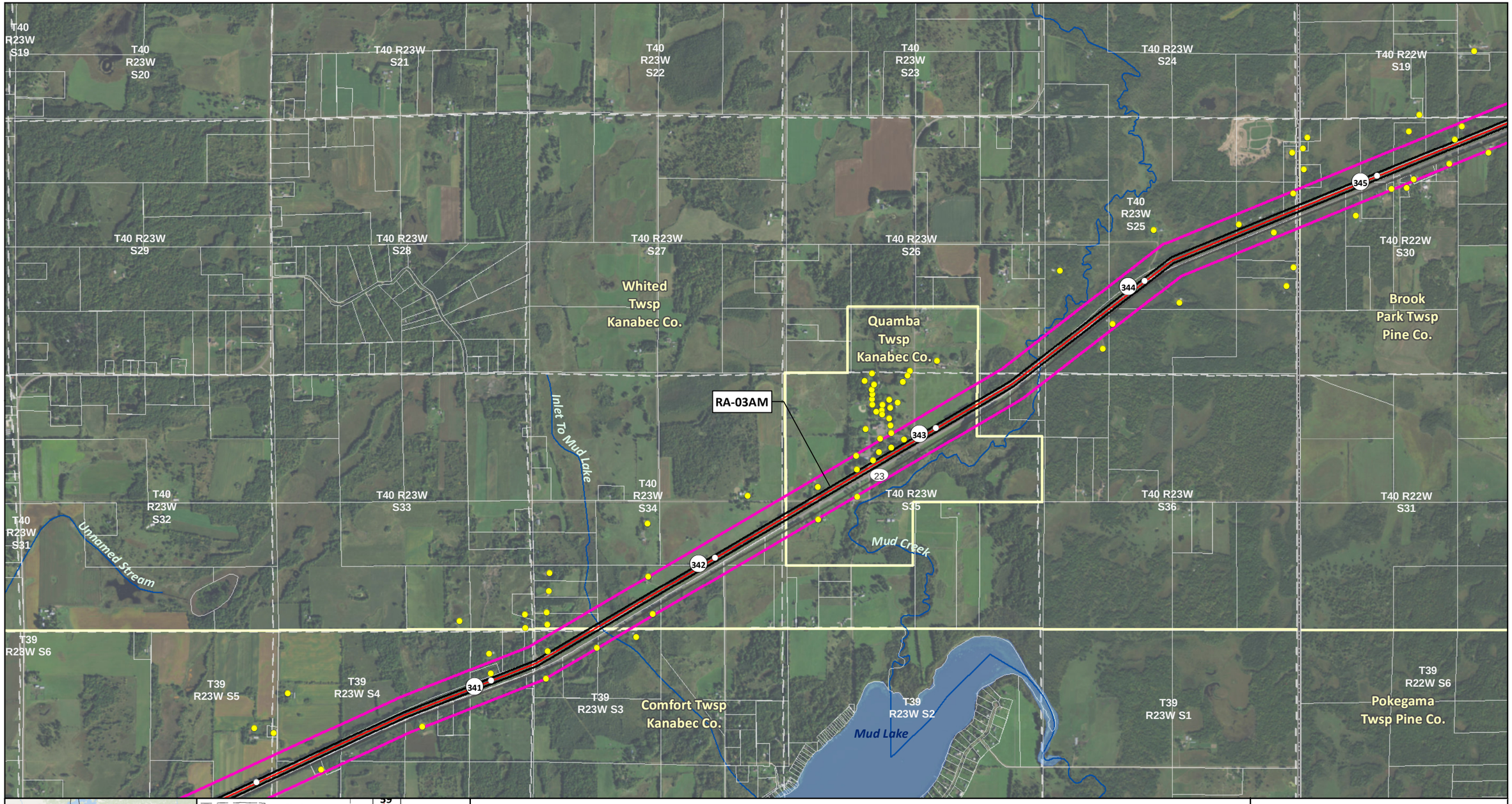
RA-03AM

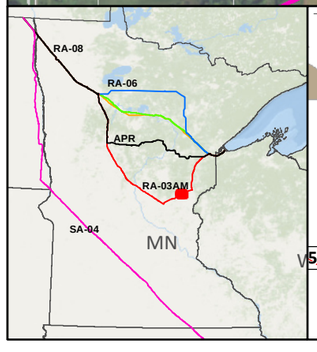
CLEARBROOK TO CARLTON

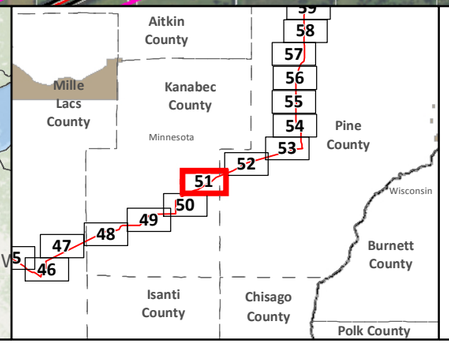
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 50B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 51A of 67

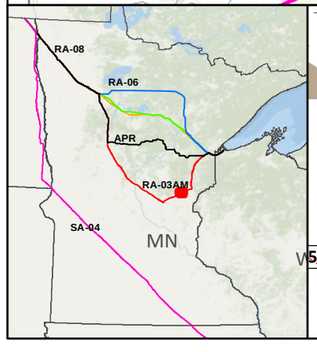
T40 R23W S19
T40 R23W S20
T40 R23W S21
T40 R23W S22
T40 R23W S23
T40 R23W S24
T40 R22W S19
T40 R23W S29
T40 R23W S28
T40 R23W S27
T40 R23W S26
T40 R23W S25
T40 R22W S30
T40 R23W S32
T40 R23W S33
T40 R23W S34
T40 R23W S35
T40 R23W S36
T40 R22W S31
T39 R23W S6
T39 R23W S5
T39 R23W S4
T39 R23W S3
T39 R23W S2
T39 R23W S1
T39 R22W S6

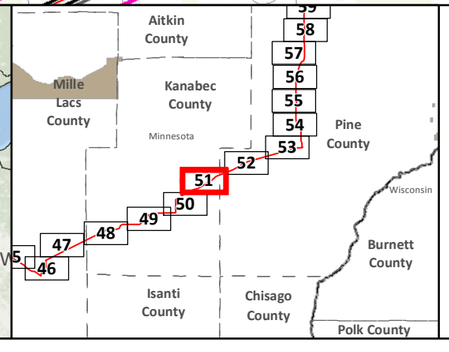
Whited Twsp Kanabec Co.
Quamba Twsp Kanabec Co.
Brook Park Twsp Pine Co.
Comfort Twsp Kanabec Co.
Pokegama Twsp Pine Co.

RA-03AM
Inlet To Mud Lake
Unnamed Stream
Mud Creek
Mud Lake
Quamba

Woodmor Rd
240th Ave
235th Ave
230th Ave
225th Ave
220th Ave
215th Ave
Naples St
Maple St
Plum St
Quail St
Orchard St
Oriole St
Lakeview Dr
Northern St
Quamba St
Pleasant St
Cedar St
240th Ave
Cedar St

343
344
345
342
341
23





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

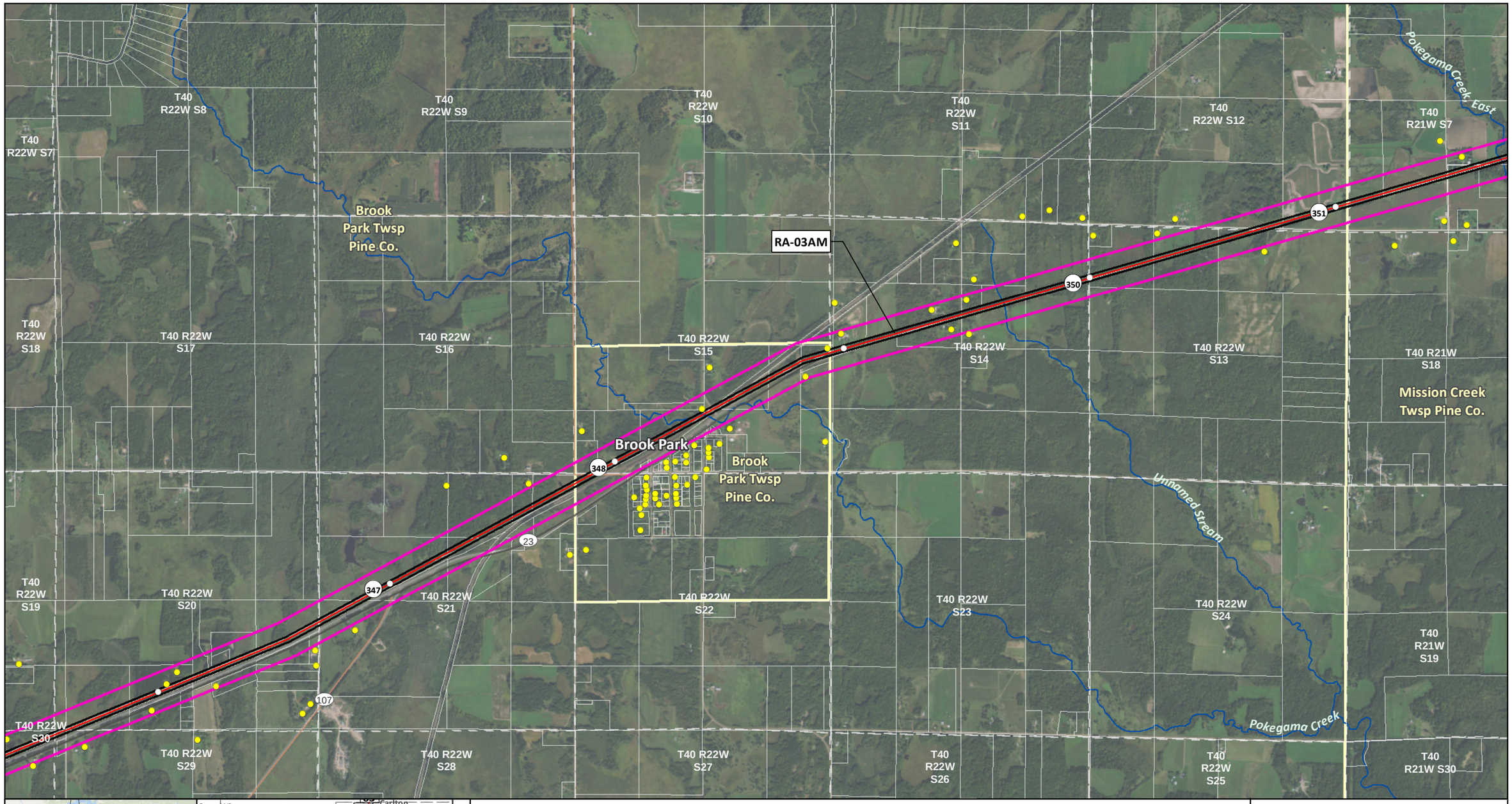
RA-03AM

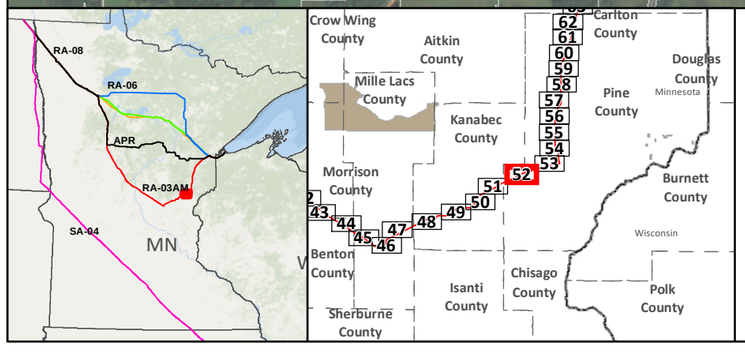
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 51B of 67





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM
RA-06
RA-07
RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Tribal Trust Land

White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

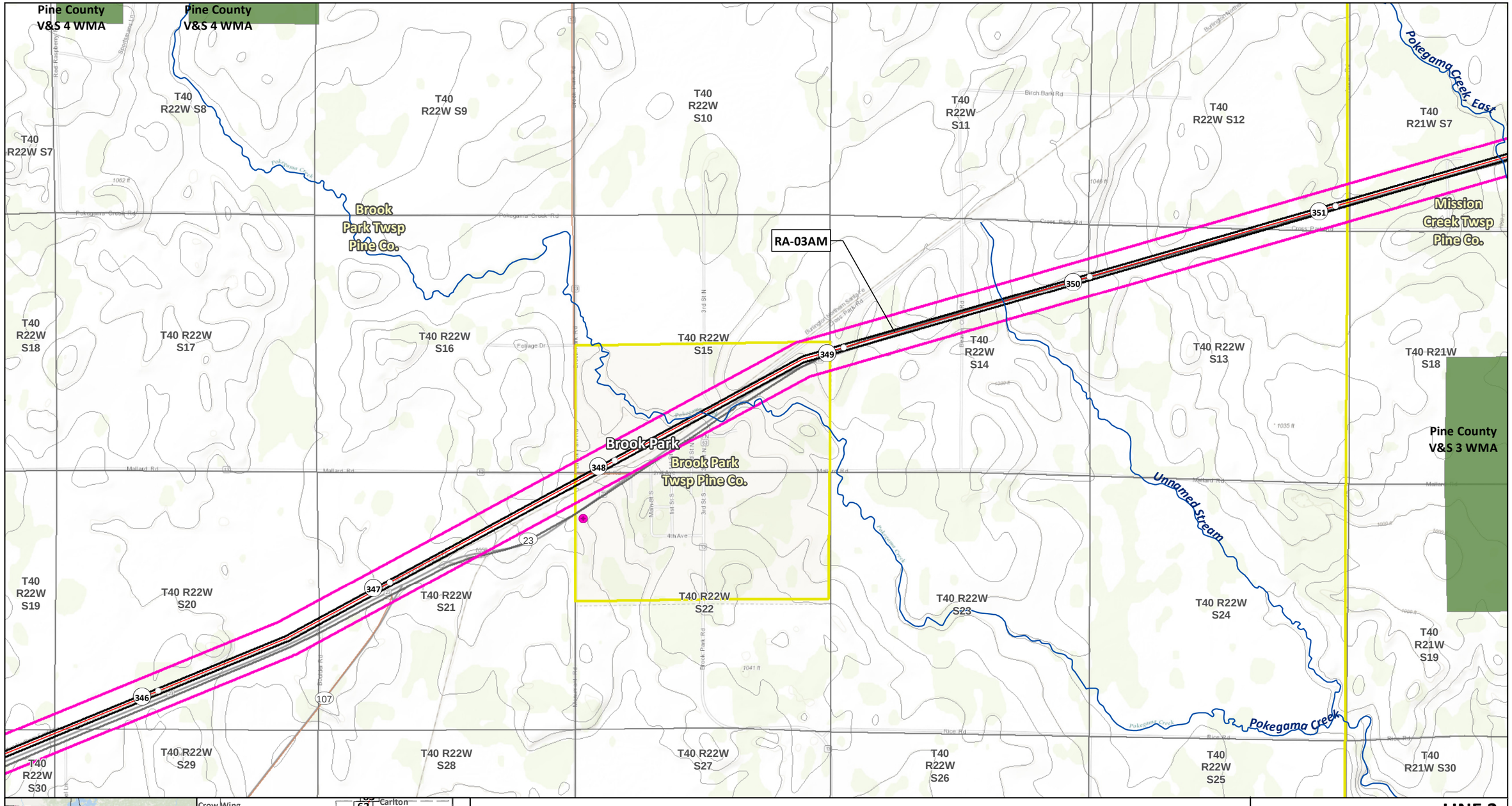
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

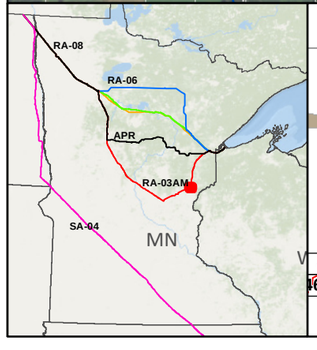
RA-03AM

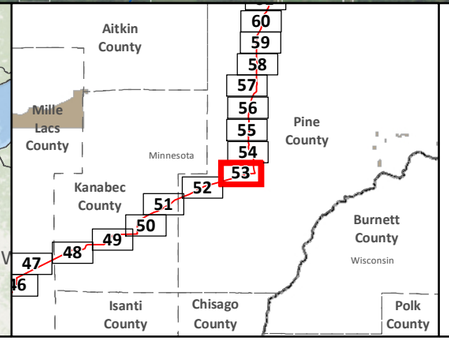
CLEARBROOK TO CARLTON

Map 52A of 67


Pine County V&S 4 WMA
Pine County V&S 4 WMA
T40 R22W S8
T40 R22W S9
T40 R22W S10
T40 R22W S11
T40 R22W S12
T40 R21W S7
T40 R22W S7
Pokegama Creek East
Brook Park Twsp Pine Co.
RA-03AM
Mission Creek Twsp Pine Co.
T40 R22W S18
T40 R22W S17
T40 R22W S16
T40 R22W S15
T40 R22W S14
T40 R22W S13
T40 R21W S18
Brook Park
Brook Park Twsp Pine Co.
Unnamed Stream
Pine County V&S 3 WMA
T40 R22W S19
T40 R22W S20
T40 R22W S21
T40 R22W S22
T40 R22W S23
T40 R22W S24
T40 R21W S19
Pokegama Creek
T40 R22W S30
T40 R22W S29
T40 R22W S28
T40 R22W S27
T40 R22W S26
T40 R22W S25
T40 R21W S30
348
349
350
351
346
347
23
107
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Crow Wing County
Aitkin County
Carlton County
Mille Lacs County
Kanabec County
Pine County
Douglas County
Minnesota
Morrison County
Burnett County
Wisconsin
Benton County
Chisago County
Isanti County
Polk County
Sherburne County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 52B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

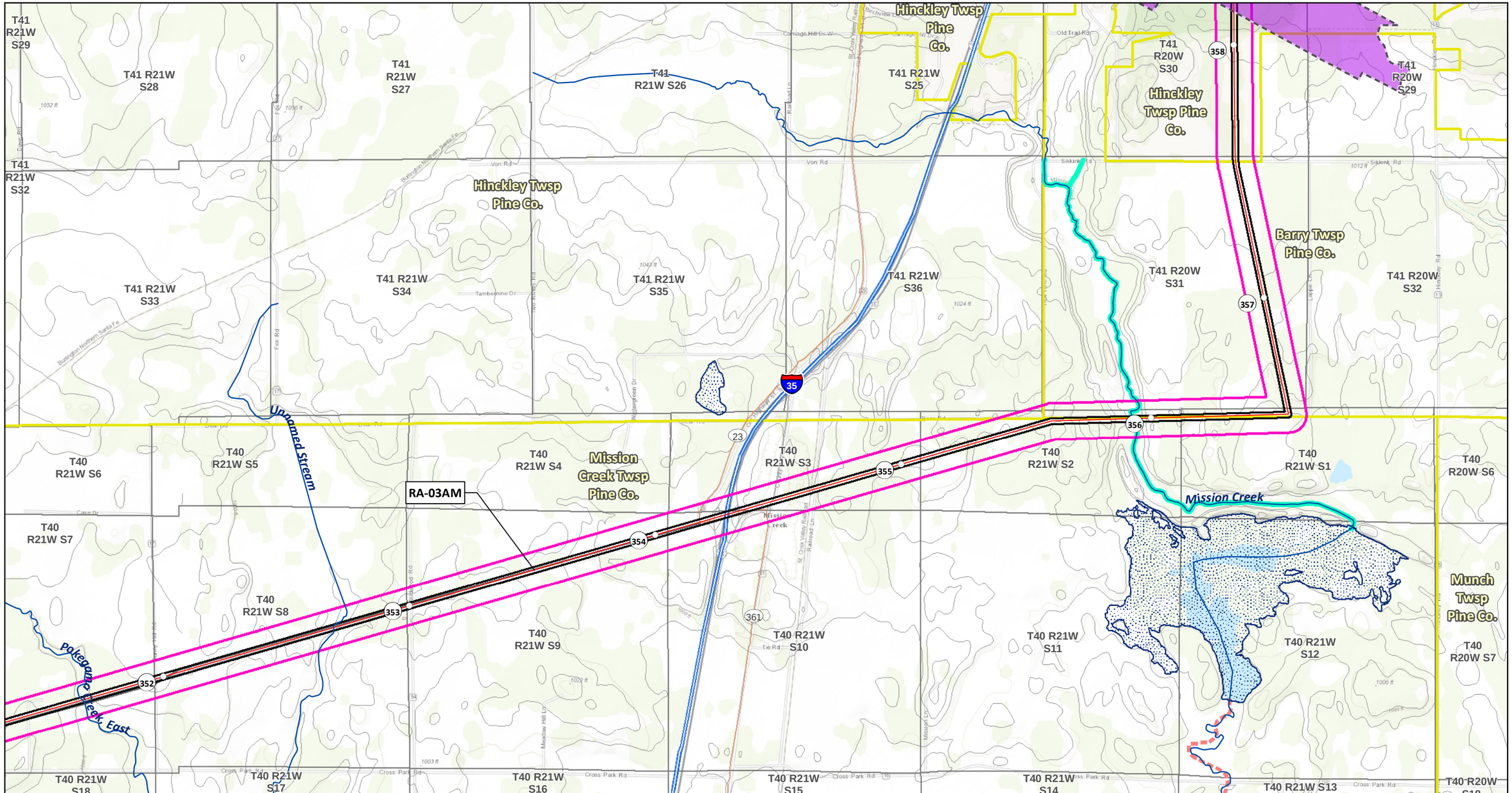
0 125 250 500 Meters

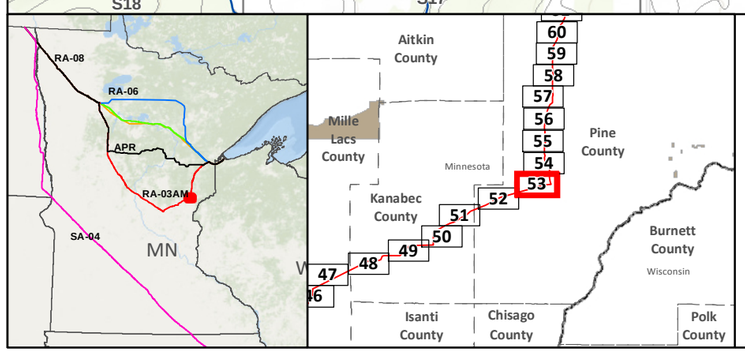
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 53A of 67





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding, High, Moderate

Native Plant Communities with Biodiversity Significance

Outstanding, High, Moderate

Terminal, Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

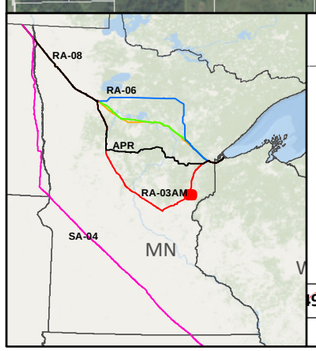
Map 53B of 67

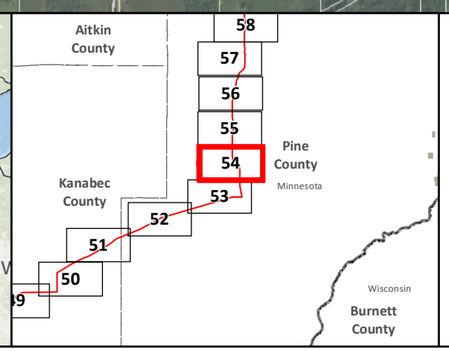
RA-03AM

T41 R21W S10
T41 R21W S11
T41 R21W S12
T41 R20W S7
T41 R20W S8
T41 R20W S9
T41 R21W S16
T41 R21W S14
Hinckley Twsp Pine Co.
T41 R21W S15
T41 R21W S13
T41 R20W S18
T41 R20W S17
Barry Twsp Pine Co.
T41 R20W S16
T41 R21W S24
T41 R21W S21
T41 R21W S23
Hinckley Twsp Pine Co.
T41 R21W S22
T41 R20W S19
T41 R20W S20
T41 R20W S21
T41 R21W S27
T41 R21W S26
T41 R21W S25
Barry Twsp Pine Co.
T41 R20W S30
T41 R20W S29
T41 R20W S28

Spring Creek
Unnamed Stream
Kettle River
Grindstone River, South Branch
Grindstone River

35
360
23
48





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08

Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 54A of 67

RA-03AM

Hinckley WHPA

Spring Creek

Unnamed Stream

Kettle River

Grindstone River, South Branch

Grindstone River

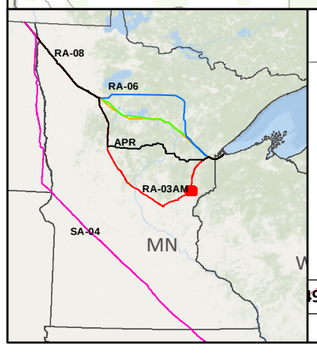
T41 R21W S10
T41 R21W S11
T41 R21W S12
T41 R20W S7
T41 R20W S8
T41 R20W S9
T41 R21W S14
T41 R21W S16
T41 R21W S15
T41 R21W S13
T41 R20W S18
T41 R20W S17
T41 R20W S16
T41 R21W S21
T41 R21W S22
T41 R21W S23
T41 R21W S24
T41 R20W S19
T41 R20W S20
T41 R20W S21
T41 R21W S27
T41 R21W S26
T41 R21W S25
T41 R20W S30
T41 R20W S29
T41 R20W S28

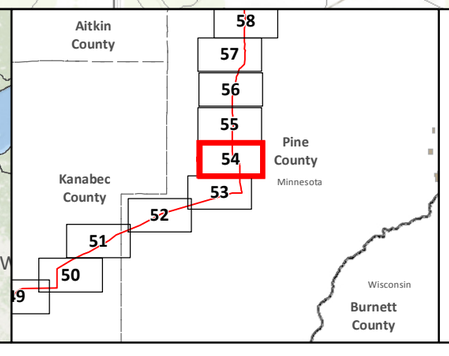
Hinckley Twsp Pine Co.
Barry Twsp Pine Co.

Hinckley

Carnie Rd
Emma Rd
Two Rivers Rd
Township 1026
Dahl Rd
Tower Rd
Nelson Dr
King Rail Dr
Rabe Dr
Main St
1st St NE
1st St SE
2nd St SE
3rd St SE
5th St SE
Morris Ave N
Grindstone Lake Rd
Old Cheese Rd
Darling Ln
Burlington Northern Santa Fe
1112 ft
1038 ft

35
361
360
359
23
48





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

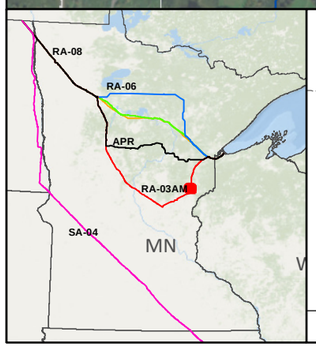
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

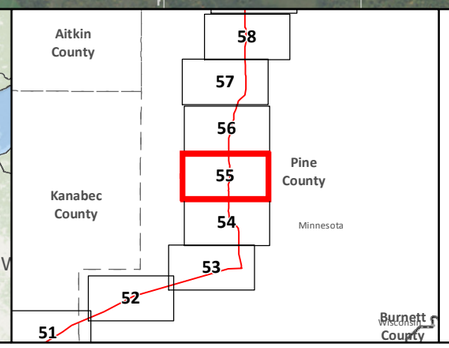
RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

T42 R21W S28
T42 R21W S27
T42 R21W S26
T42 R21W S25
T42 R20W S30
T42 R20W S29
Sandstone Twsp Pine Co.
T42 R20W S28
Dell Grove Twsp Pine Co.
364
Friesland Ditch
T42 R21W S33
T42 R21W S34
T42 R21W S35
T42 R21W S36
RA-03AM
T42 R20W S31
T42 R20W S32
35
35
T42 R20W S33
Grindstone River
T41 R21W S4
T41 R21W S3
T41 R21W S2
Hinckley Twsp Pine Co.
T41 R21W S1
T41 R20W S6
T41 R20W S5
Barry Twsp Pine Co.
T41 R20W S4
362
Deer Creek
T41 R21W S9
T41 R21W S10
T41 R21W S11
T41 R21W S12
T41 R20W S7
T41 R20W S8
T41 R20W S9





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

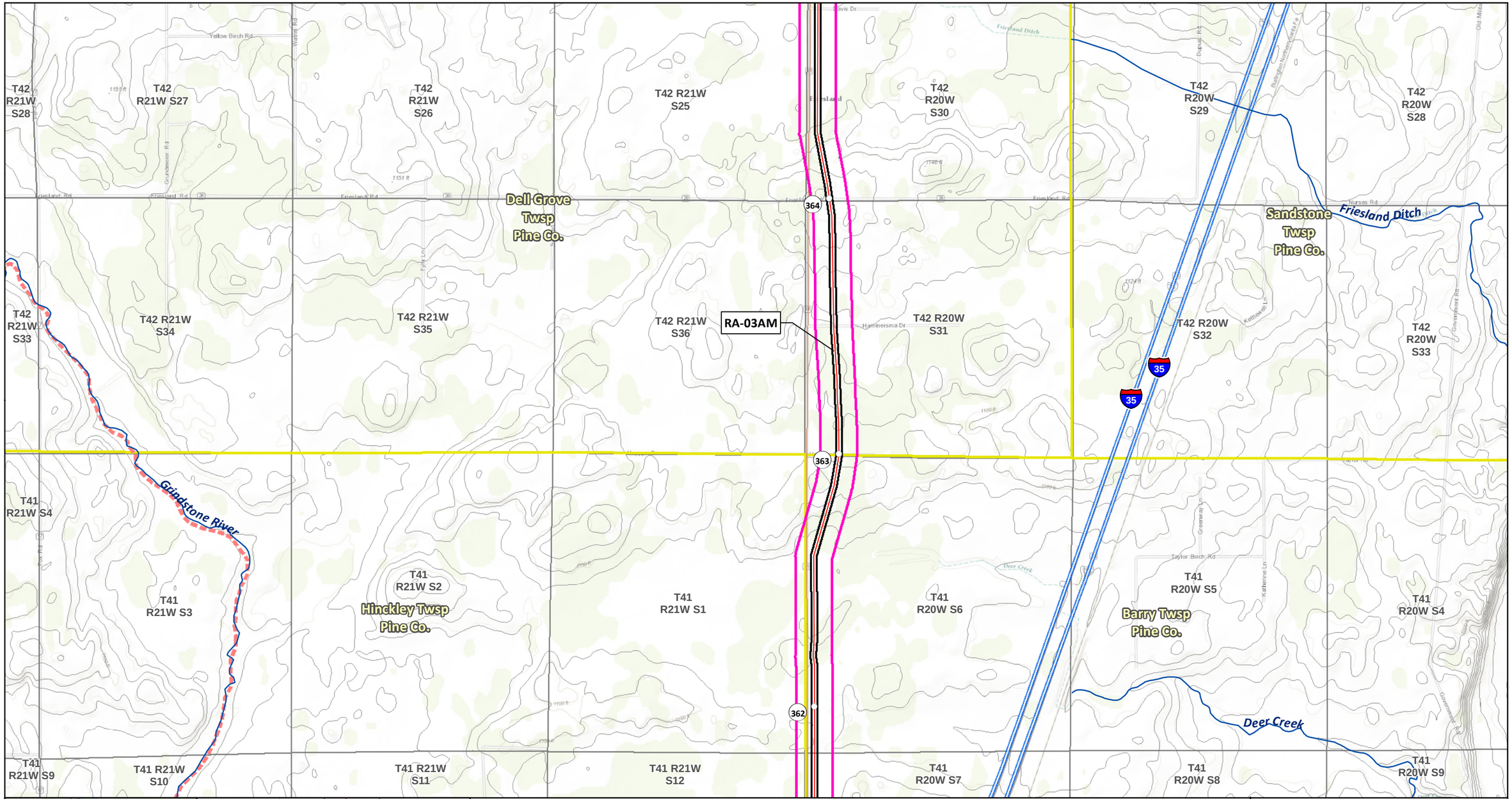
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

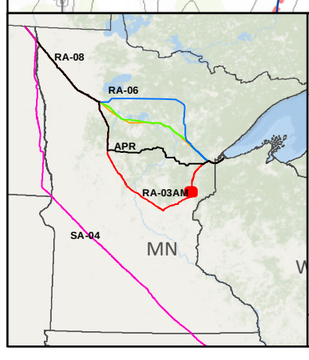
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

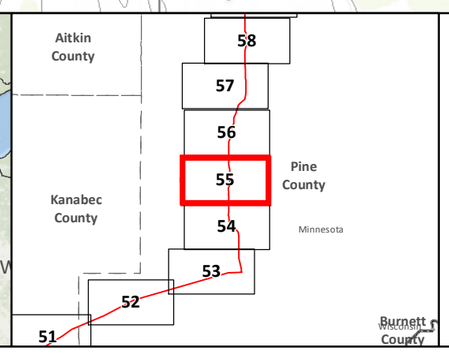
RA-03AM

CLEARBROOK TO CARLTON

Map 55A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

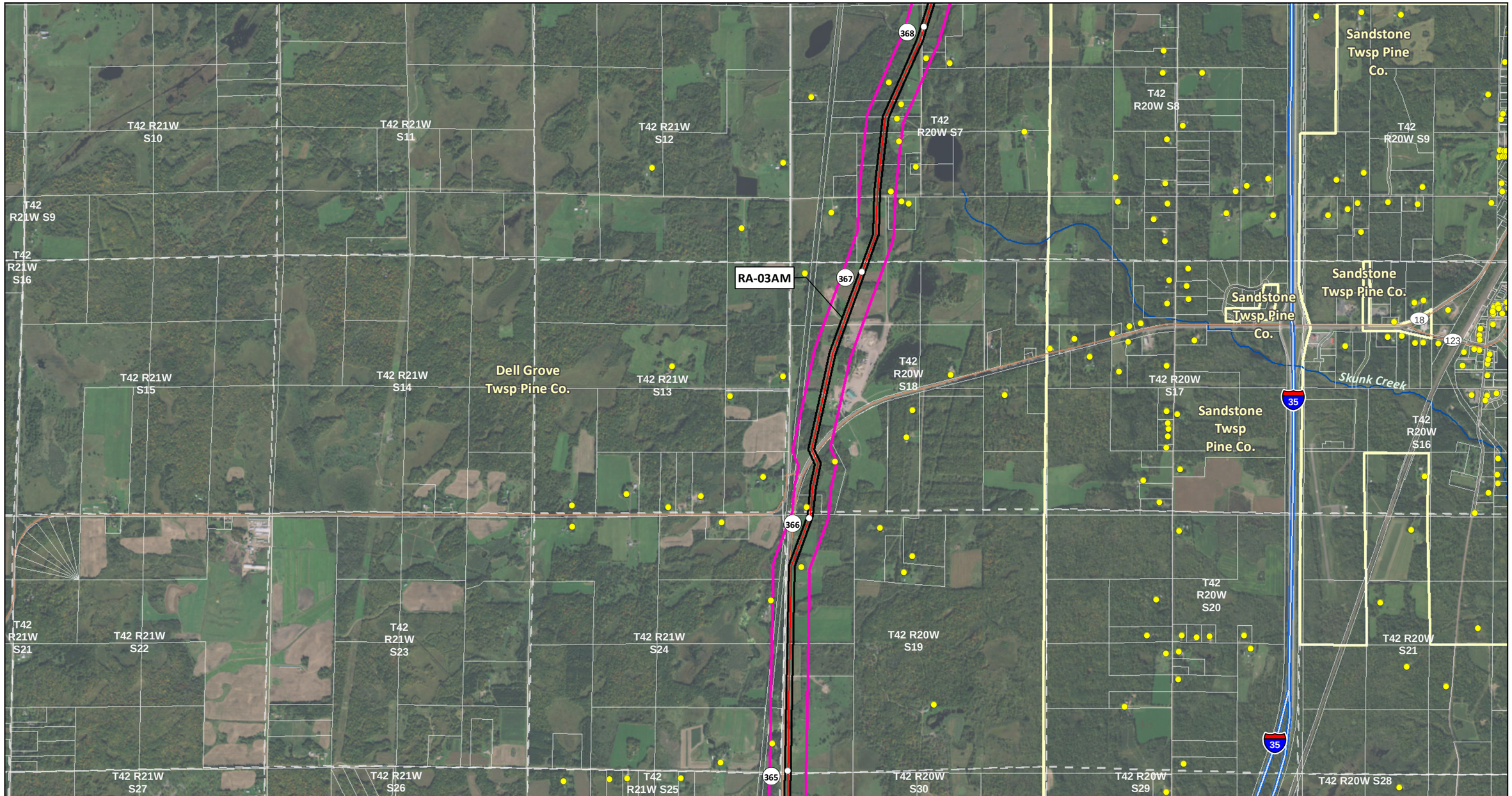
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

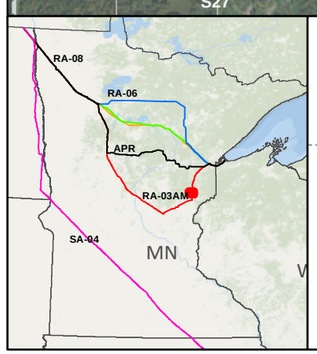
RA-03AM

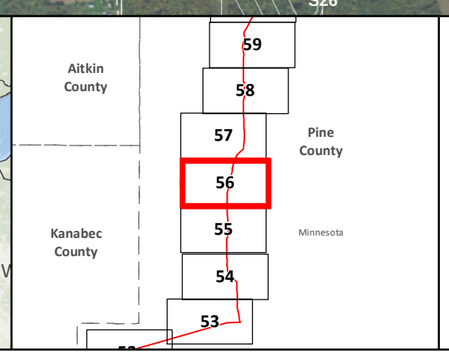
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 55B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Tribal Trust Land

White Earth Reservation - BIA

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

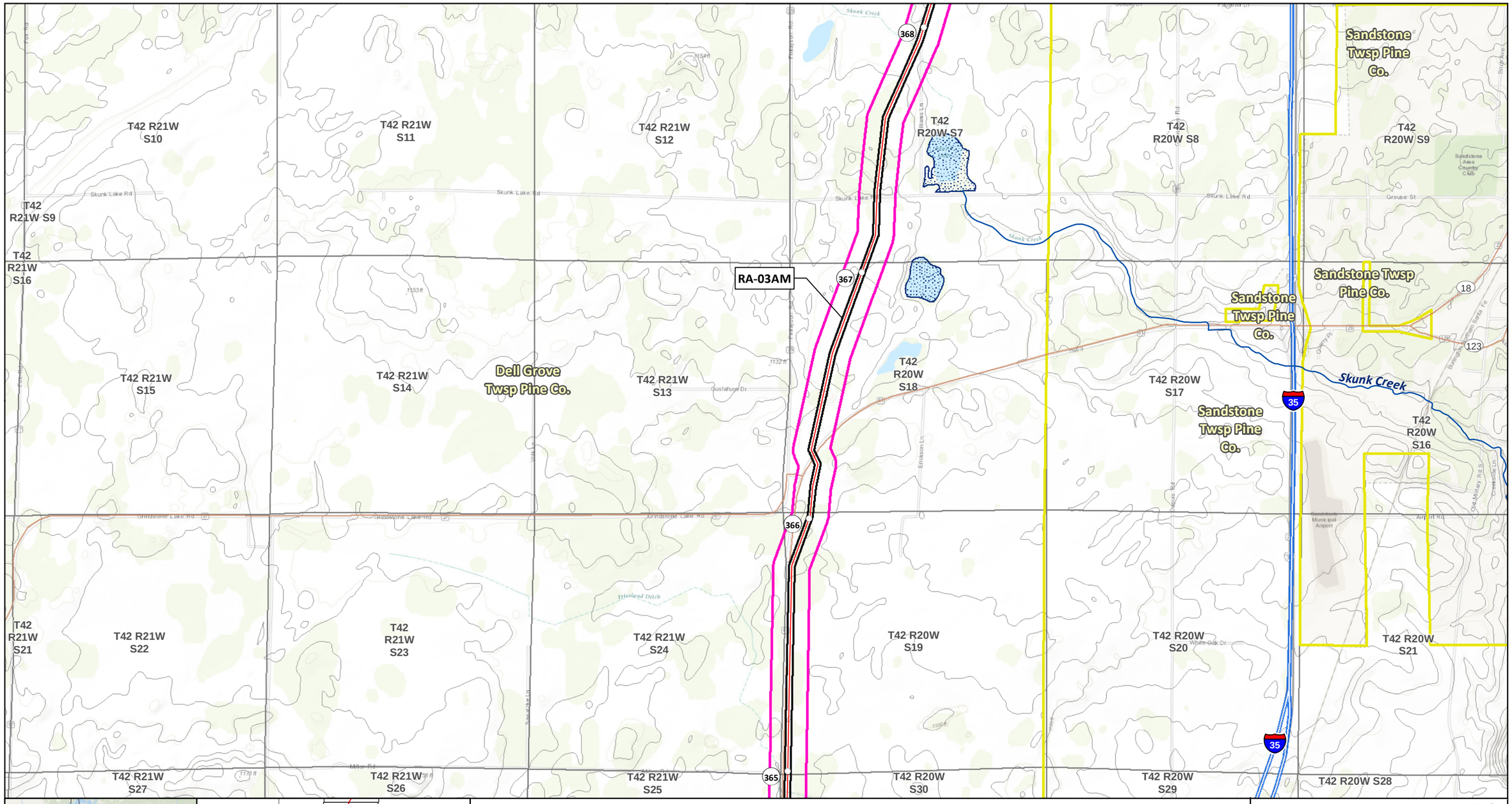
Data Sources: MNDNR, NHD, Enbridge

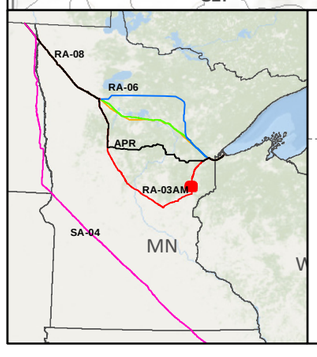
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

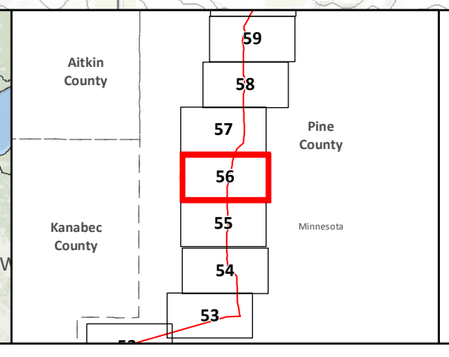
RA-03AM

CLEARBROOK TO CARLTON

Map 56A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

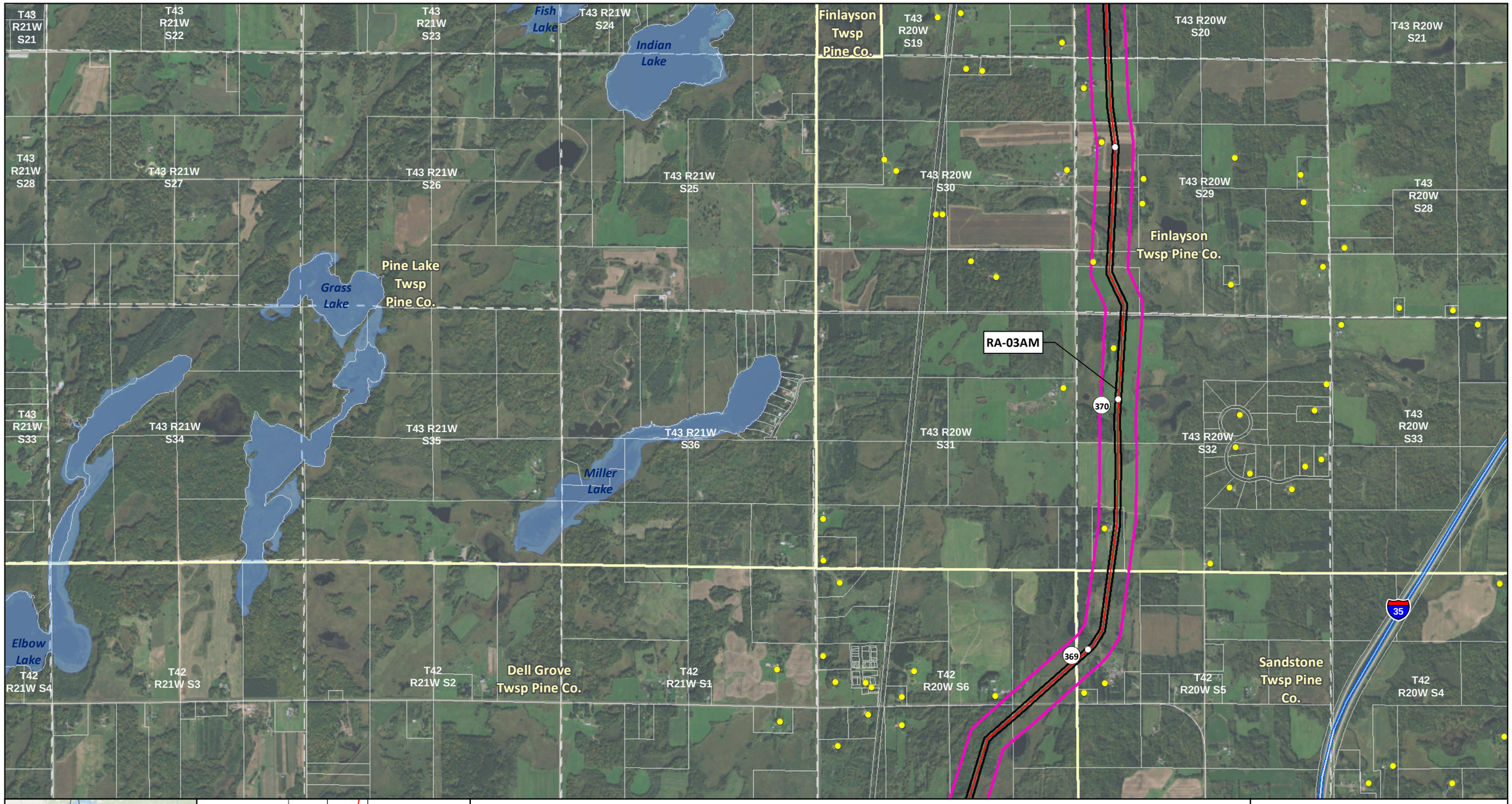
Data Sources: MNDNR, USGS, NHD, Enbridge

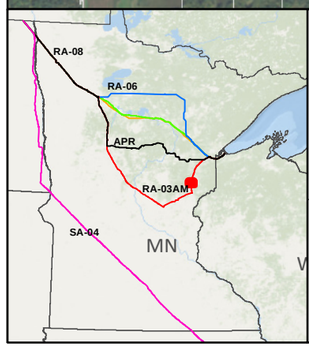
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON

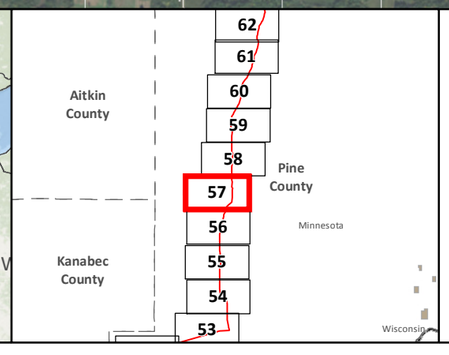
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 56B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

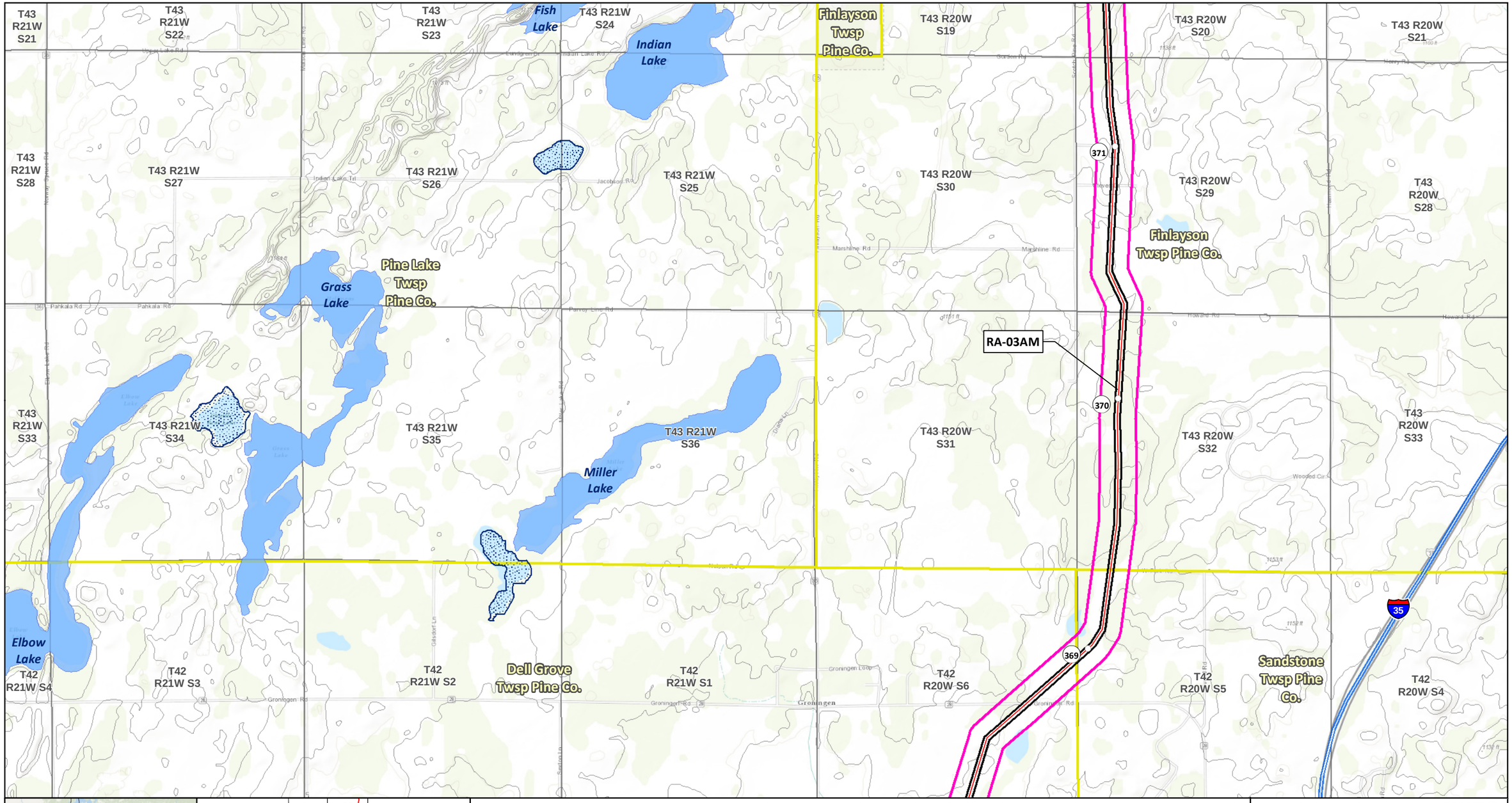
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

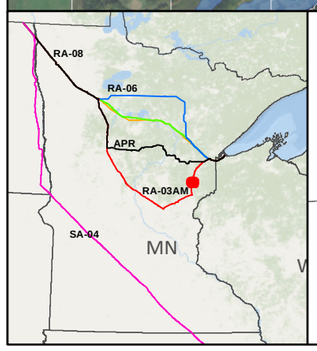
RA-03AM

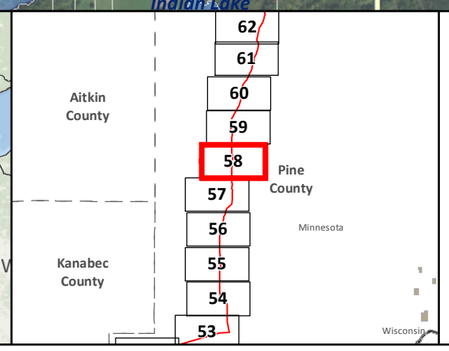
CLEARBROOK TO CARLTON

Map 57A of 67


T43 R21W S21
T43 R21W S22
T43 R21W S23
Fish Lake
T43 R21W S24
Indian Lake
Finlayson Twsp Pine Co.
T43 R20W S19
T43 R20W S20
T43 R20W S21
T43 R21W S28
T43 R21W S27
T43 R21W S26
T43 R21W S25
T43 R20W S30
T43 R20W S29
T43 R20W S28
Finlayson Twsp Pine Co.
Grass Lake
Pine Lake Twsp Pine Co.
RA-03AM
371
370
T43 R21W S33
T43 R21W S34
T43 R21W S35
T43 R21W S36
Miller Lake
T43 R20W S31
T43 R20W S32
T43 R20W S33
Elbow Lake
T42 R21W S4
T42 R21W S3
T42 R21W S2
Dell Grove Twsp Pine Co.
T42 R21W S1
T42 R20W S6
T42 R20W S5
Sandstone Twsp Pine Co.
T42 R20W S4
369
35
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Aitkin County
Kanabec County
Pine County
Minnesota
Wisconsin
62
61
60
59
58
57
56
55
54
53
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 57B of 67

T43 R21W S2
T43 R21W S1
Pine Lake Twsp Pine Co.
T43 R20W S6
T43 R20W S5
Q'mix Creek
T43 R20W S4
T43 R20W S3
Kettle River
T43 R20W S2
T43 R21W S11
T43 R21W S12
T43 R20W S7
374
T43 R20W S8
T43 R20W S9
T43 R20W S10
T43 R20W S11
Finlayson Twsp Pine Co.
RA-03AM
Finlayson Twsp Pine Co.
T43 R21W S14
T43 R21W S13
T43 R20W S18
373
T43 R20W S17
T43 R20W S16
T43 R20W S15
T43 R20W S14
Clear Lake
Finlayson
18
35
35
T43 R21W S23
Fish Lake
T43 R21W S24
T43 R20W S19
372
T43 R20W S20
T43 R20W S21
T43 R20W S22
T43 R20W S23
Indian Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

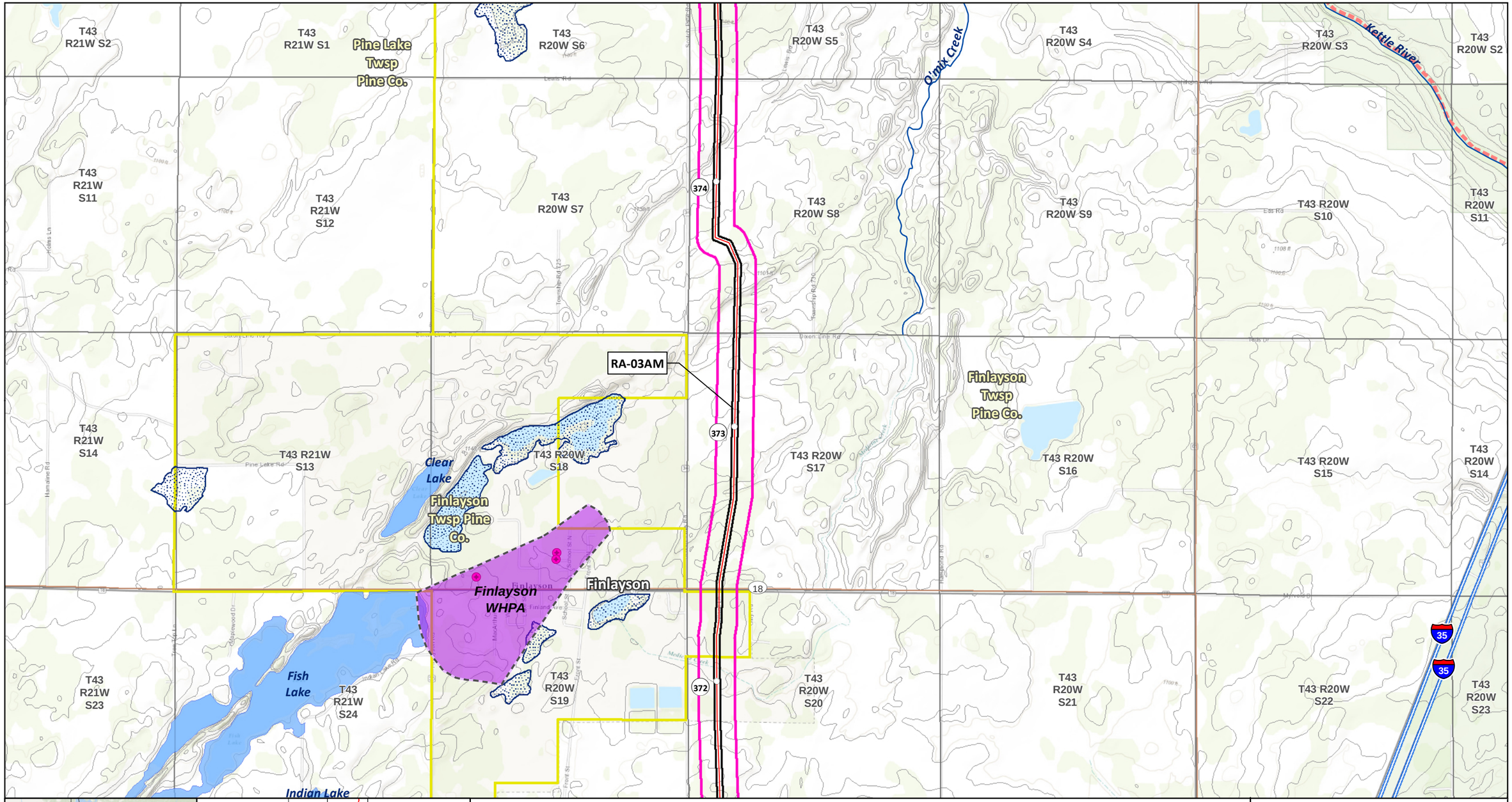
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

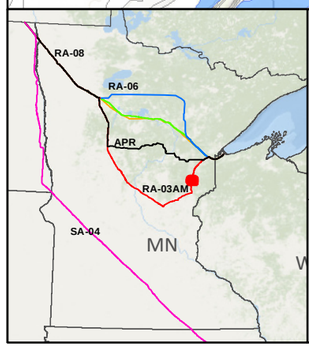
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

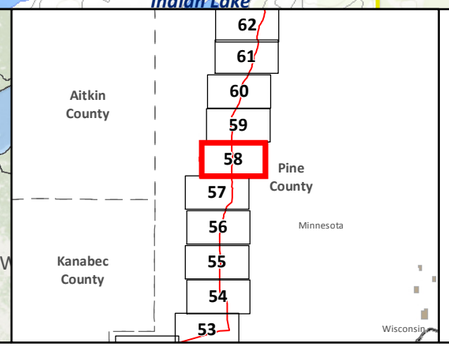
RA-03AM

CLEARBROOK TO CARLTON

Map 58A of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM
RA-06
RA-07
RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance

Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

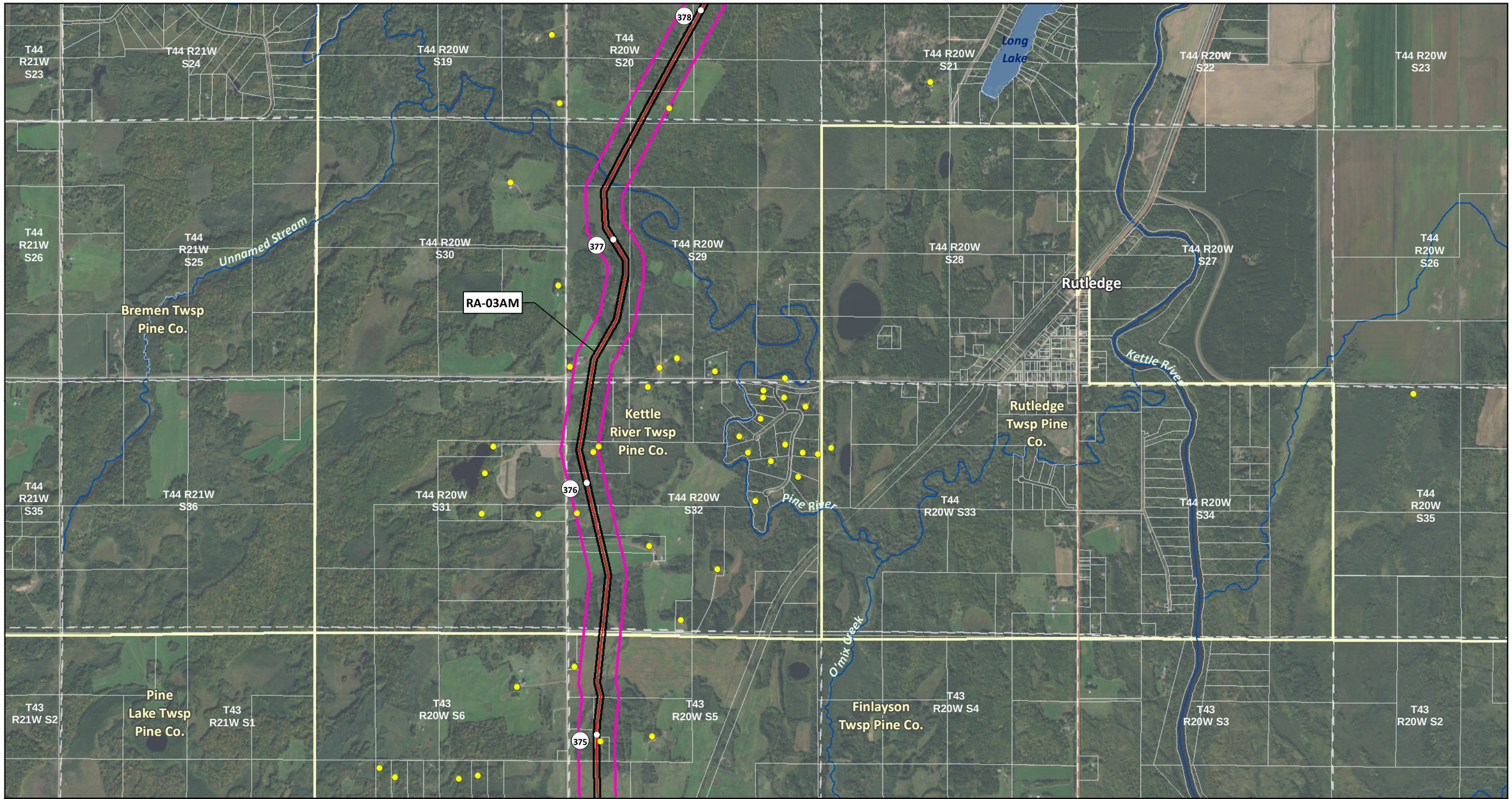
CLEARBROOK TO CARLTON

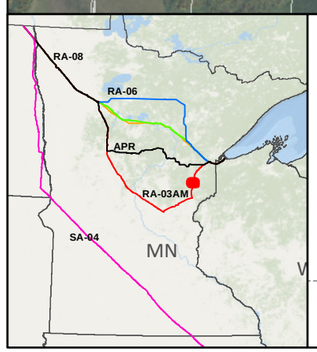
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters

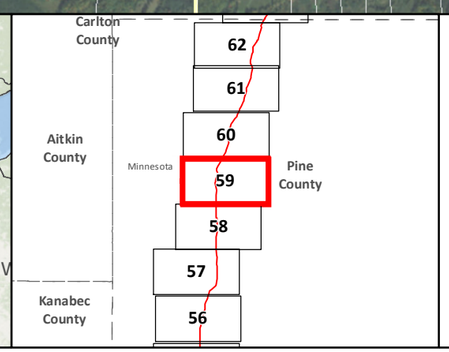
1:24,000
10ft Contours

N

Map 58B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

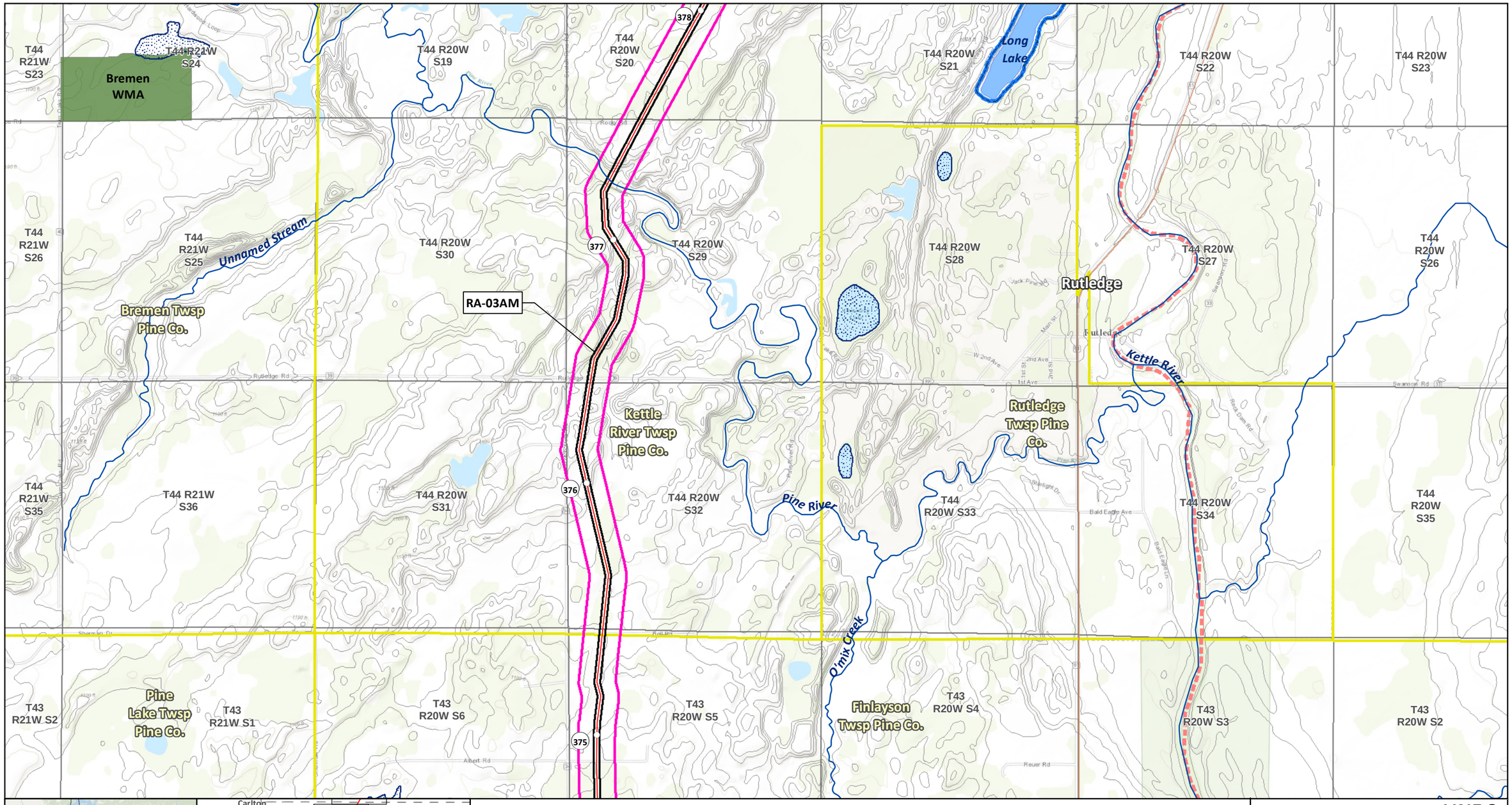
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

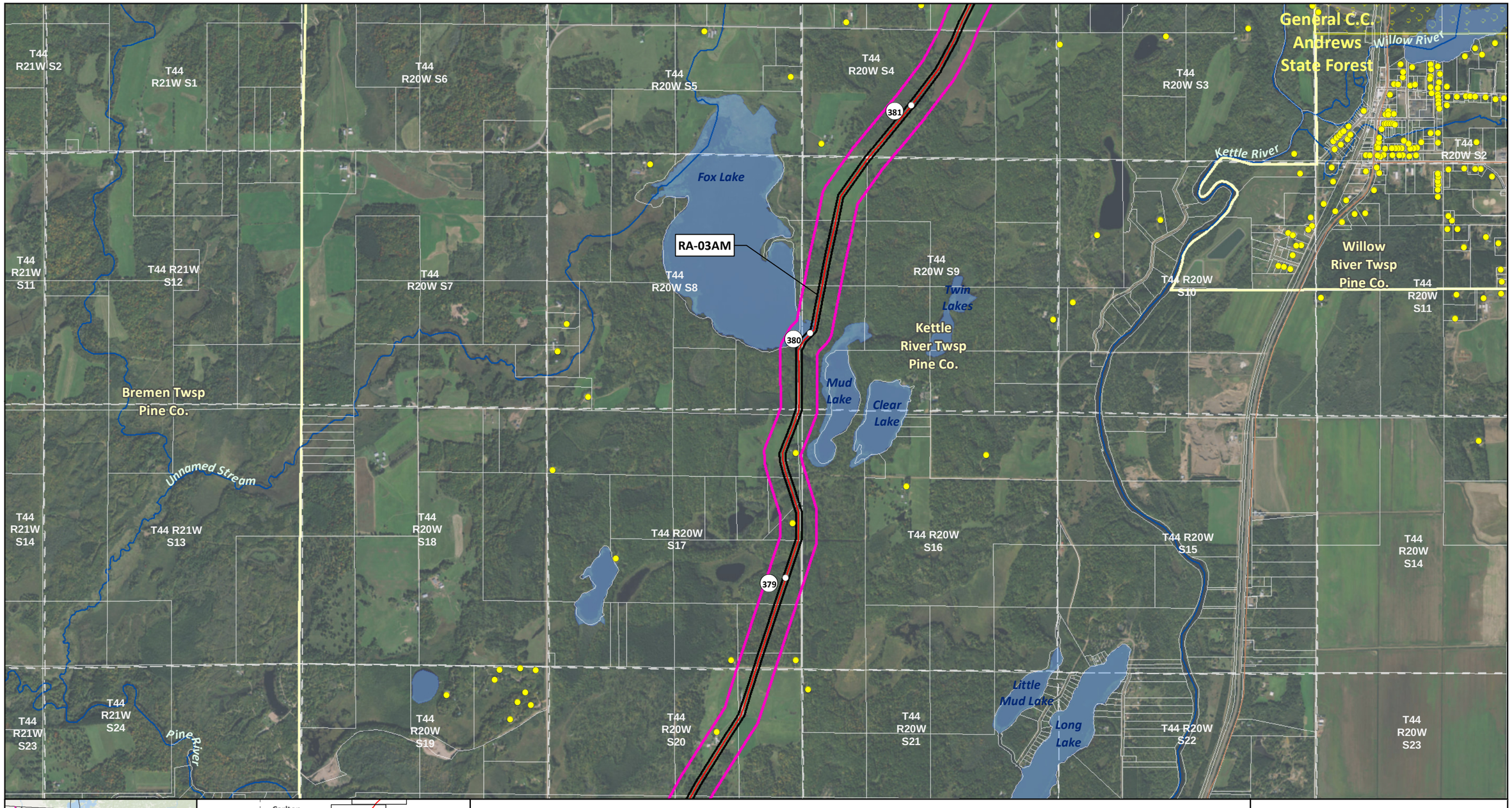
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

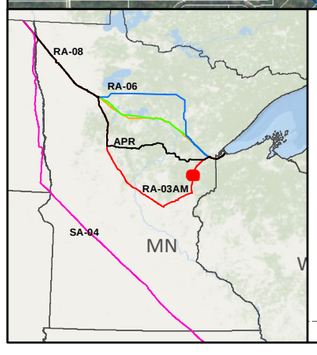
RA-03AM

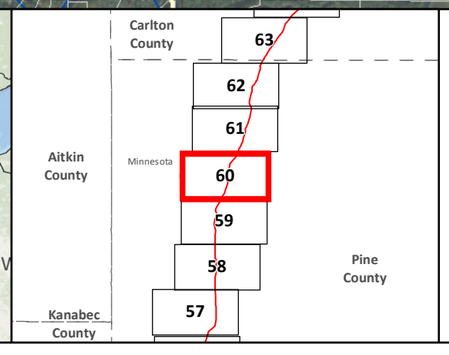
CLEARBROOK TO CARLTON

Map 59A of 67


T44 R21W S23
T44 R21W S24
Bremen WMA
T44 R20W S19
T44 R20W S20
T44 R20W S21
Long Lake
T44 R20W S22
T44 R20W S23
T44 R21W S26
T44 R21W S25
Unnamed Stream
T44 R20W S30
T44 R20W S29
T44 R20W S28
T44 R20W S27
T44 R20W S26
Bremen Twsp Pine Co.
RA-03AM
Rutledge
Kettle River
Kettle River Twsp Pine Co.
Rutledge Twsp Pine Co.
T44 R21W S35
T44 R21W S36
T44 R20W S31
T44 R20W S32
Pine River
T44 R20W S33
T44 R20W S34
T44 R20W S35
O'mix Creek
Pine Lake Twsp Pine Co.
T43 R21W S2
T43 R21W S1
T43 R20W S6
T43 R20W S5
Finlayson Twsp Pine Co.
T43 R20W S4
T43 R20W S3
T43 R20W S2
378
377
376
375
Carlton County
Aitkin County
Pine County
Kanabec County
Minnesota
62
61
60
59
58
57
56
RA-08
RA-06
APR
RA-03AM
SA-04
MN
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 59B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM
RA-06
RA-07
RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

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Interstate

Highway

Major Road

Township Boundary

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State Forest

National Forest

Tribal Reservation

Tribal Trust Land

White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

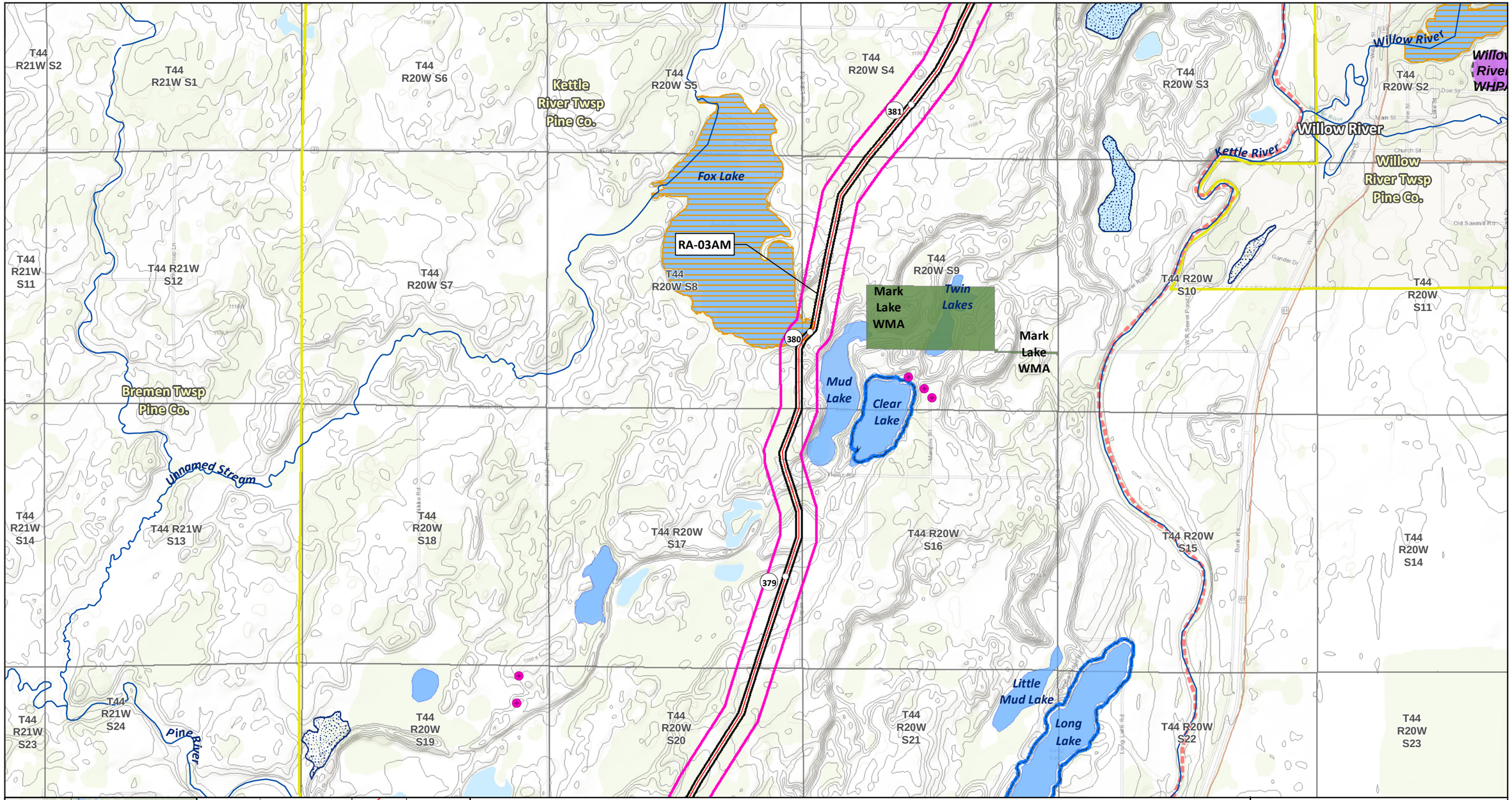
0 125 250 500 Meters

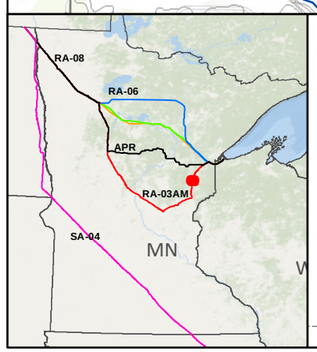
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

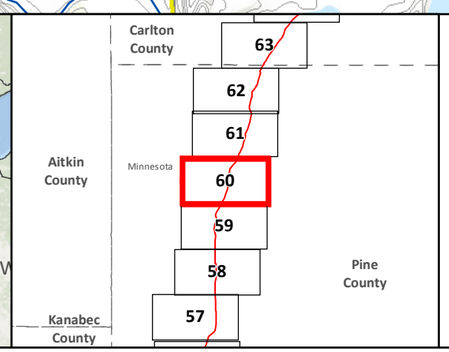
RA-03AM

CLEARBROOK TO CARLTON

Map 60A of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
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Public Water Basin
Public Drinking Water Supply
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High
Moderate

Native Plant Communities with Biodiversity Significance
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High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

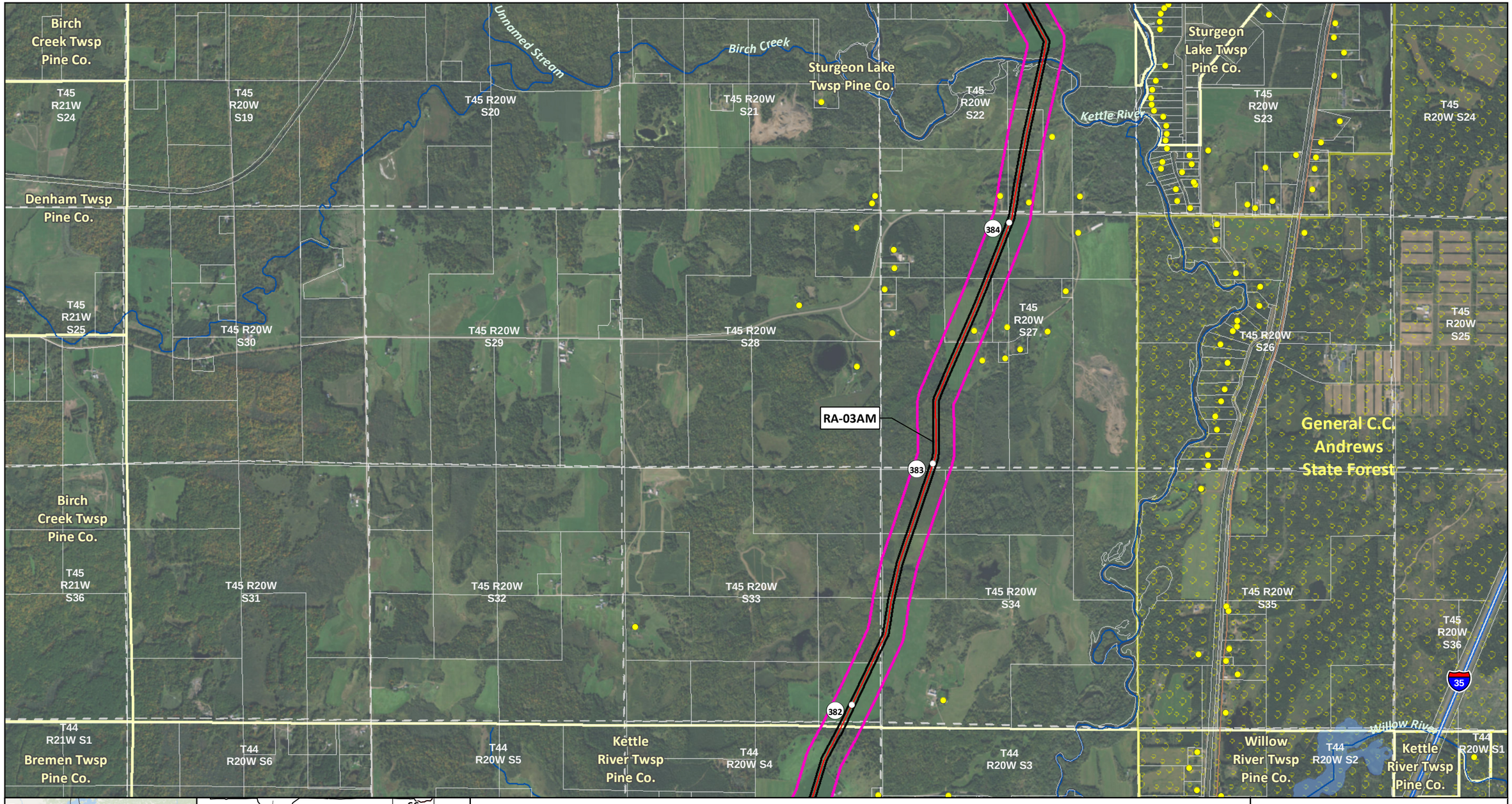
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

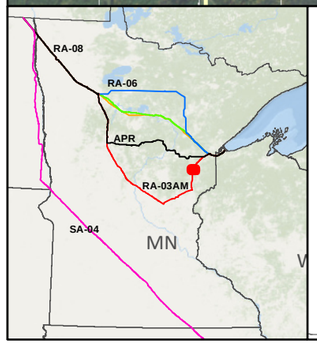
RA-03AM

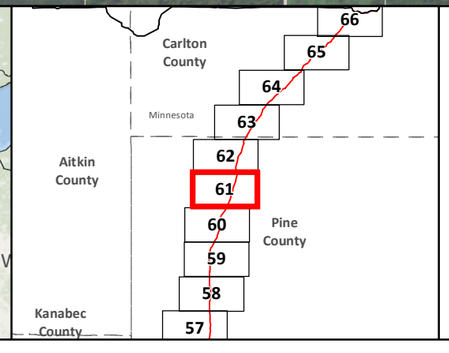
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 60B of 67







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

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Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

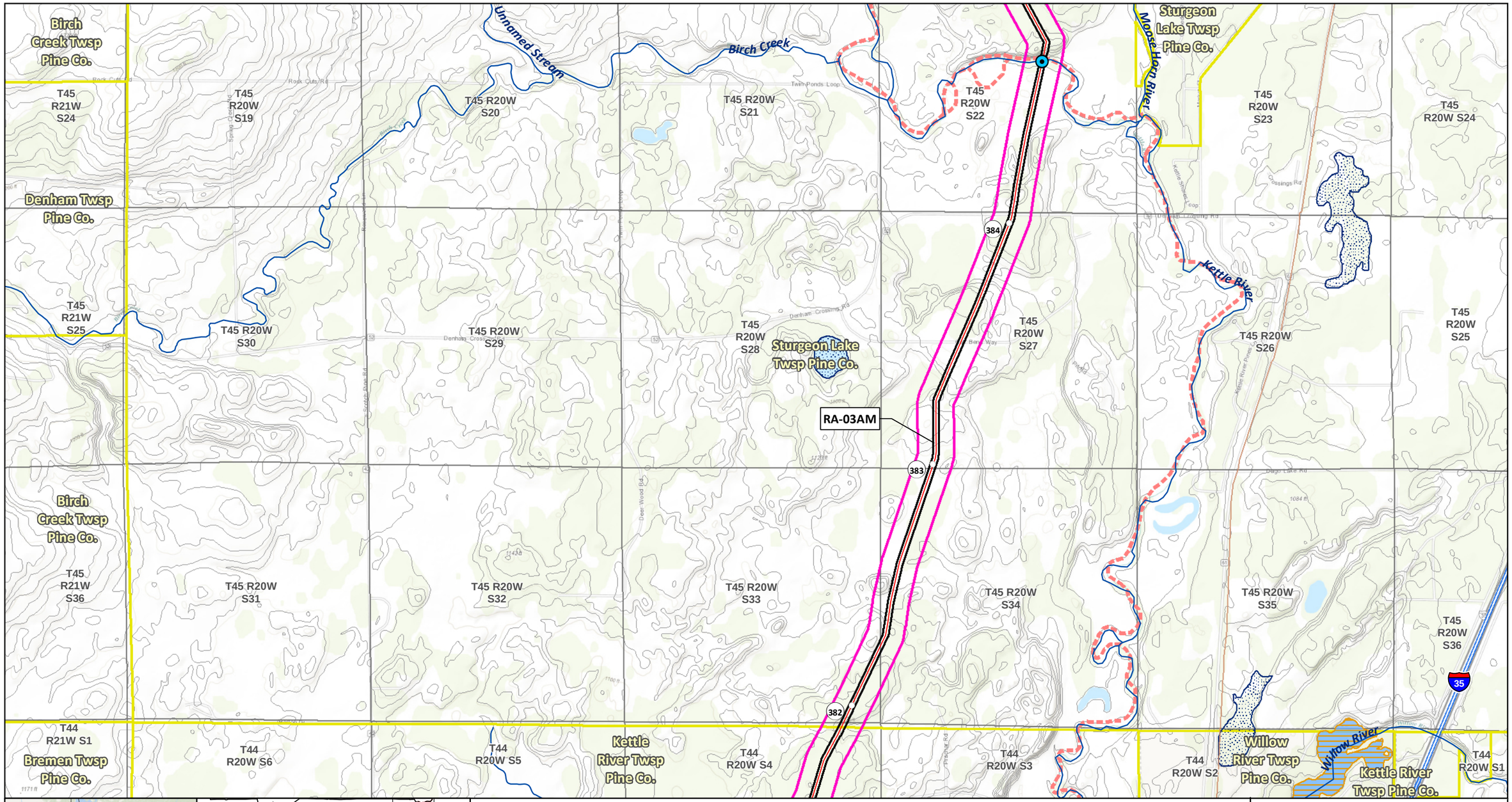
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

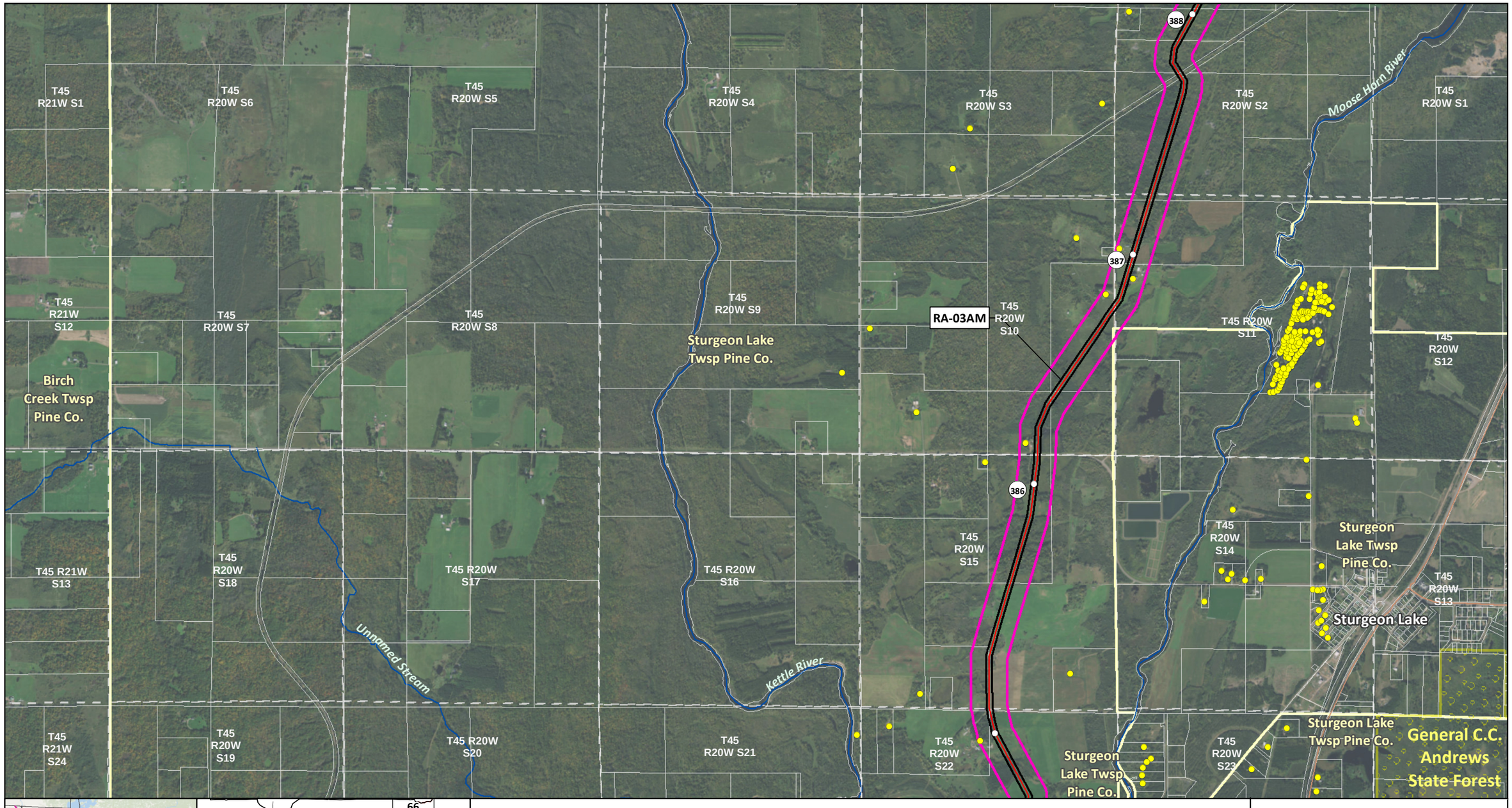
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

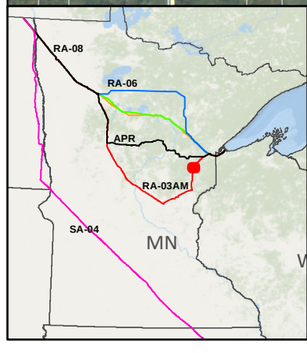
RA-03AM

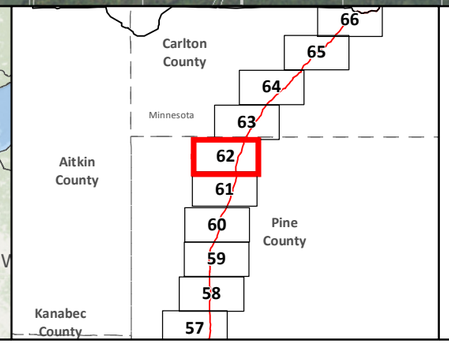
CLEARBROOK TO CARLTON

Map 61A of 67


Birch Creek Twsp Pine Co.
T45 R21W S24
T45 R20W S19
T45 R20W S20
T45 R20W S21
T45 R20W S22
Sturgeon Lake Twsp Pine Co.
T45 R20W S23
T45 R20W S24
Unnamed Stream
Birch Creek
Moose Horn River
Denham Twsp Pine Co.
T45 R21W S25
T45 R20W S30
T45 R20W S29
T45 R20W S28
Sturgeon Lake Twsp Pine Co.
T45 R20W S27
T45 R20W S26
T45 R20W S25
Kettle River
RA-03AM
384
383
382
Birch Creek Twsp Pine Co.
T45 R21W S36
T45 R20W S31
T45 R20W S32
T45 R20W S33
T45 R20W S34
T45 R20W S35
T45 R20W S36
T44 R21W S1
Bremen Twsp Pine Co.
T44 R20W S6
T44 R20W S5
Kettle River Twsp Pine Co.
T44 R20W S4
T44 R20W S3
T44 R20W S2
Willow River Twsp Pine Co.
Willow River
Kettle River Twsp Pine Co.
T44 R20W S1
35
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Carlton County
Aitkin County
Pine County
Kanabec County
Minnesota
66
65
64
63
62
61
60
59
58
57
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 61B of 67







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 62A of 67

T45 R21W S1
T45 R20W S6
T45 R20W S5
T45 R20W S4
T45 R20W S3
T45 R20W S2
T45 R20W S1
T45 R21W S12
T45 R20W S7
T45 R20W S8
T45 R20W S9
T45 R20W S10
T45 R20W S11
T45 R20W S12
T45 R21W S13
T45 R20W S18
T45 R20W S17
T45 R20W S16
T45 R20W S15
T45 R20W S14
T45 R21W S24
T45 R20W S19
T45 R20W S20
T45 R20W S21
T45 R20W S22
T45 R20W S23
T45 R20W S24
T45 R20W S13

RA-03AM

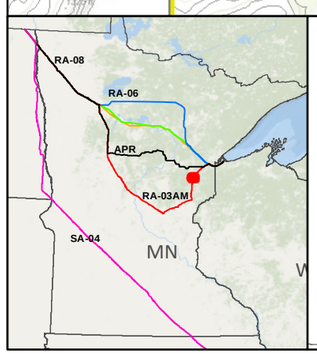
Sturgeon Lake Twsp Pine Co.
Birch Creek Twsp Pine Co.
Sturgeon Lake WHPA
Sturgeon Lake WMA
Sturgeon Lake WMA
Sturgeon Lake Twsp Pine Co.
Sturgeon Lake
Sturgeon Lake Twsp Pine Co.
Sturgeon Lake Twsp Pine Co.

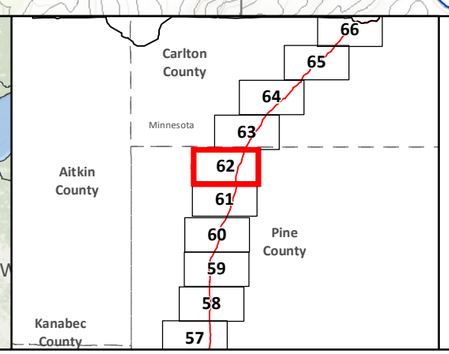
Moose Horn River
Unnamed Stream
Kettle River

388
387
386
385

Marsh Rd
Northview Rd
Farm To Market Rd
Mark Rd
Green Bay Rd
Logan Dr
Lantern Ln
Agate Ave
Dynamite Ln
Moose Horn Dr
Cardinal Pines Dr
Tabor Hills Dr
Tabor Hills Rd
Yellow Cedar Rd
Meadow Rd
Wander Rd
Rustic Ln
Deer Run Rd
Stella Maris Rd
Trail Ave
Trail St
Market St
Maple St
Pine St
Tamarack St
Larimer

1223 ft
1172 ft
1151 ft
1195 ft
1131 ft
1151 ft
1213 ft





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

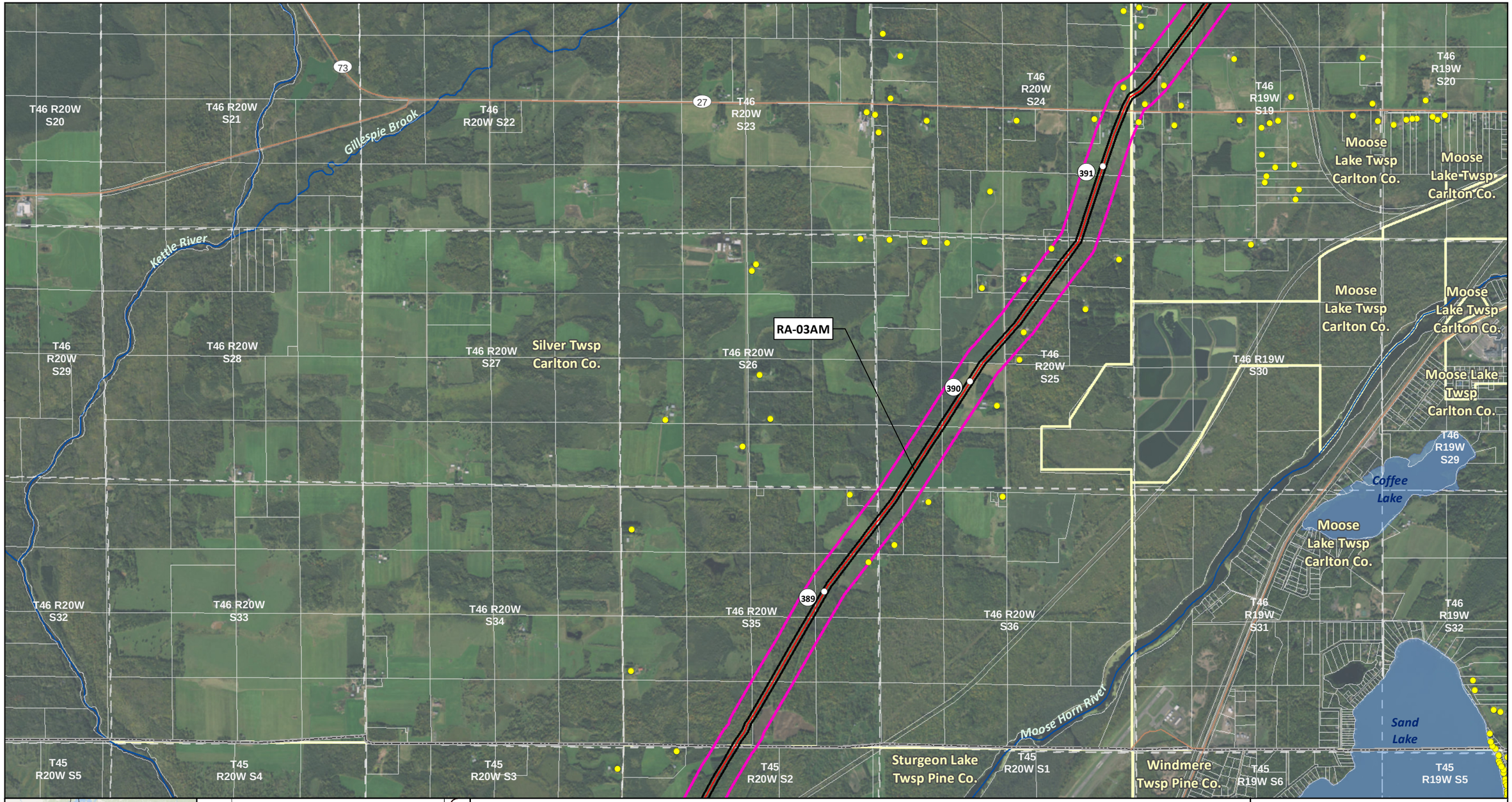
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

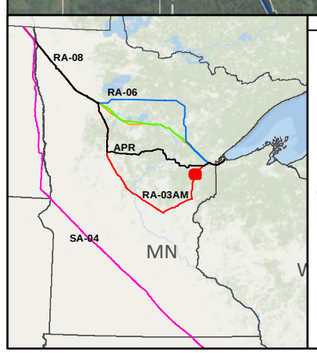
RA-03AM

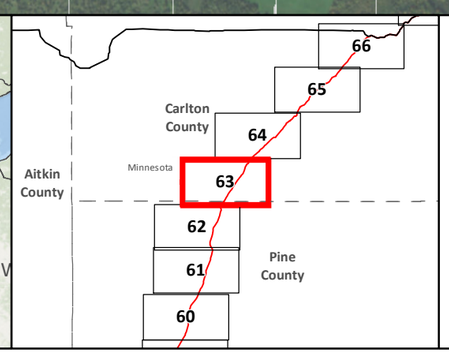
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 62B of 67







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

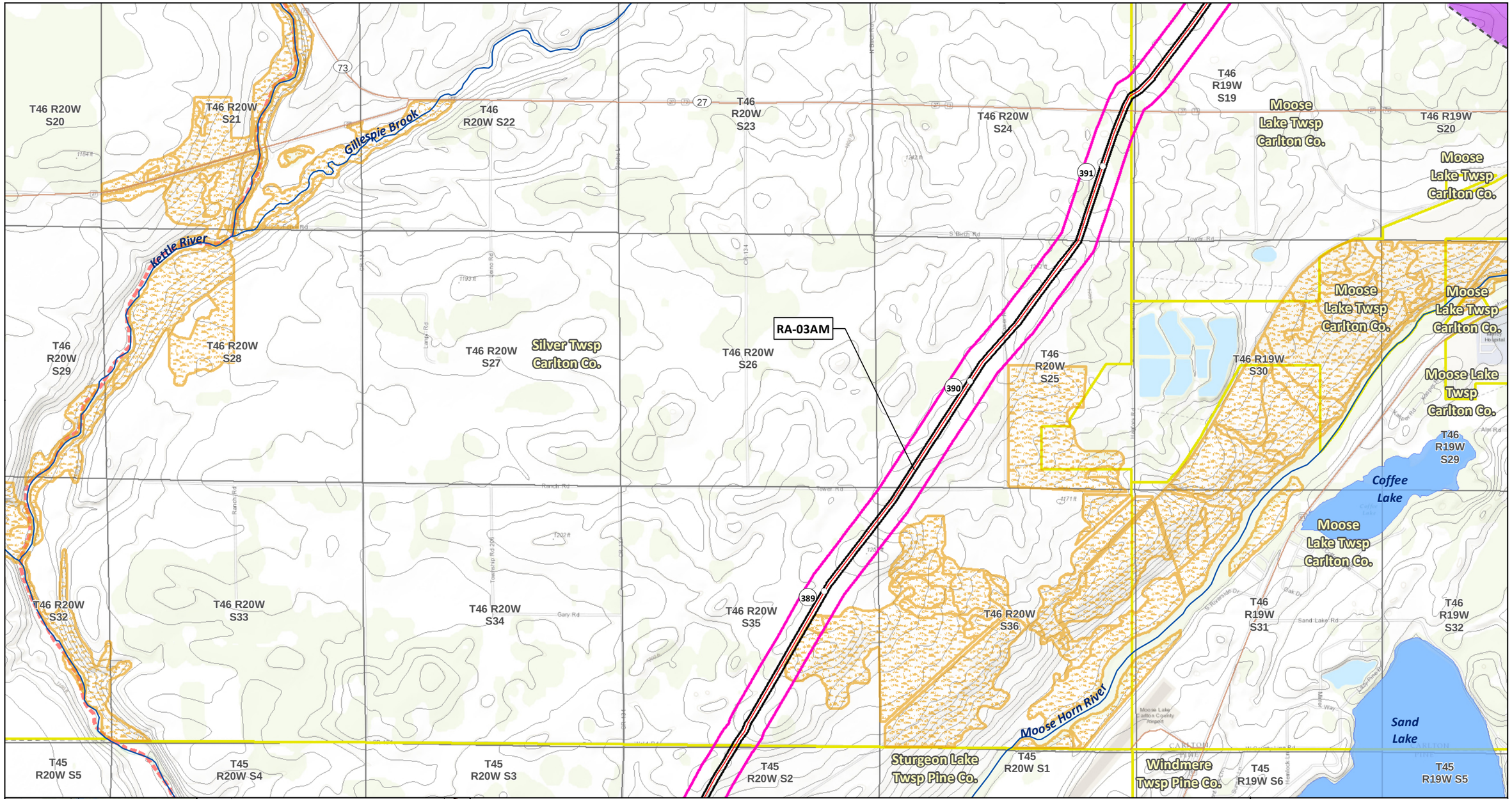
0 125 250 500 Meters

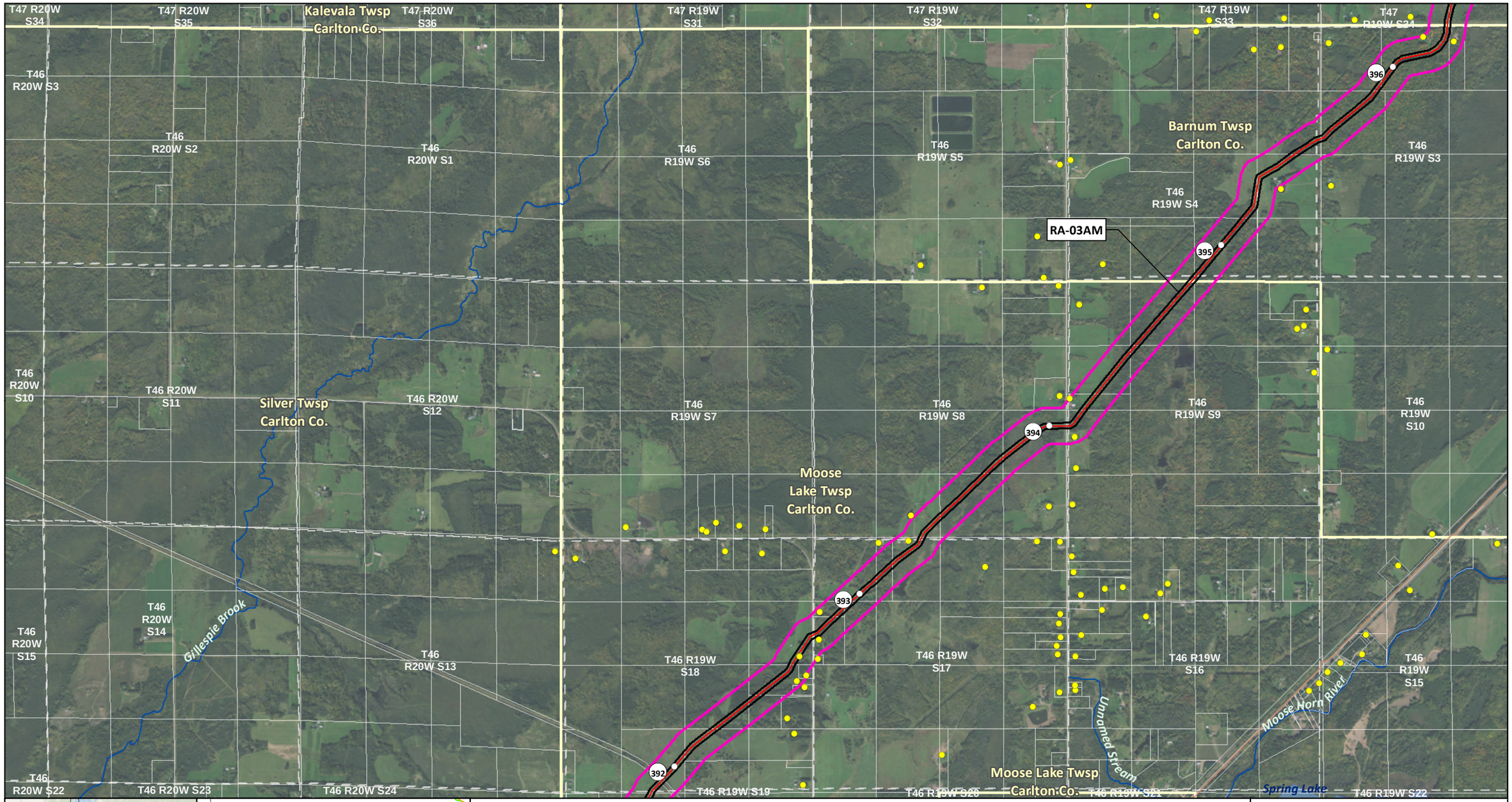
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

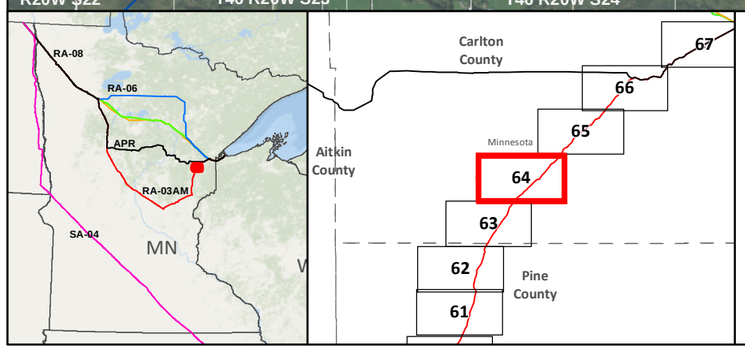
RA-03AM

CLEARBROOK TO CARLTON

Map 63A of 67


T46 R20W S20
T46 R20W S21
Gillespie Brook
T46 R20W S22
T46 R20W S23
T46 R20W S24
T46 R19W S19
Moose Lake Twsp Carlton Co.
T46 R19W S20
Kettle River
T46 R20W S29
T46 R20W S28
T46 R20W S27
Silver Twsp Carlton Co.
T46 R20W S26
RA-03AM
T46 R20W S25
T46 R19W S30
Coffee Lake
T46 R19W S29
T46 R20W S32
T46 R20W S33
T46 R20W S34
T46 R20W S35
T46 R20W S36
T46 R19W S31
T46 R19W S32
Moose Horn River
Sand Lake
T45 R20W S5
T45 R20W S4
T45 R20W S3
T45 R20W S2
Sturgeon Lake Twsp Pine Co.
T45 R20W S1
Windmere Twsp Pine Co.
T45 R19W S6
T45 R19W S5
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Carlton County
Aitkin County
Minnesota
Pine County
66
65
64
63
62
61
60
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 63B of 67





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

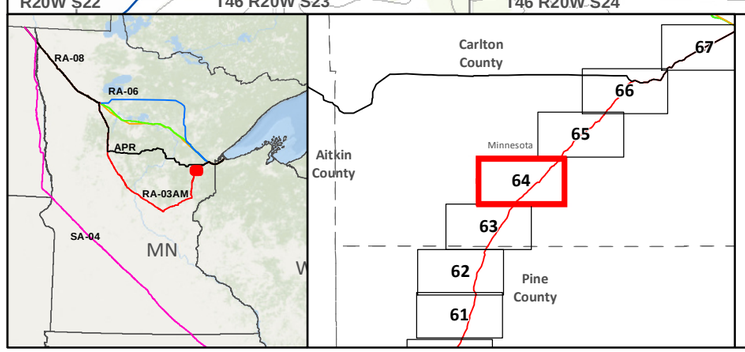
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 64A of 67

T47 R20W S34
T47 R20W S35
Kalevala Twsp Carlton Co.
T47 R20W S36
T47 R19W S31
T47 R19W S32
T47 R19W S33
T47 R19W S34
T46 R20W S3
T46 R20W S2
T46 R20W S1
T46 R19W S6
T46 R19W S5
T46 R19W S4
T46 R19W S3
Barnum Twsp Carlton Co.
RA-03AM
396
395
T46 R20W S10
T46 R20W S11
Silver Twsp Carlton Co.
T46 R20W S12
T46 R19W S7
T46 R19W S8
T46 R19W S9
T46 R19W S10
394
Moose Lake Twsp Carlton Co.
393
T46 R20W S14
T46 R20W S15
Gillespie Brook
T46 R20W S13
T46 R19W S18
T46 R19W S17
T46 R19W S16
T46 R19W S15
Moose Lake WHPA
Moose Horn River
392
T46 R20W S22
T46 R20W S23
T46 R20W S24
T46 R19W S19
T46 R19W S20
T46 R19W S21
Spring Lake
T46 R19W S22



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

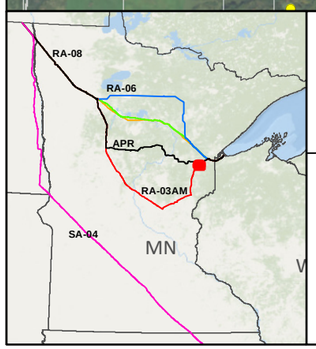
CLEARBROOK TO CARLTON

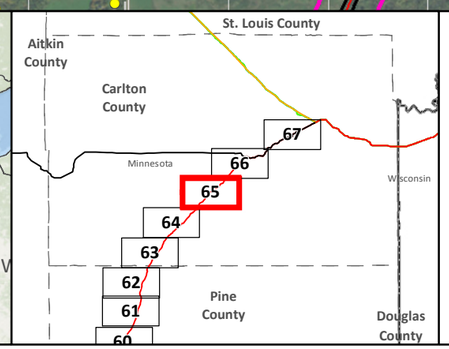
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 64B of 67

T47 R19W S17
T47 R19W S16
T47 R19W S15
T47 R19W S14
T47 R19W S13
T47 R18W S18
T47 R18W S17
King Creek
Moose Horn River
Moose Horn River, West Fork
T47 R19W S21
T47 R19W S22
T47 R19W S23
T47 R19W S24
T47 R18W S19
Mahtowa Twsp
Carlton Co.
T47 R18W S20
T47 R19W S20
Skelton Twsp
Carlton Co.
RA-03AM
400
399
Barnum Twsp
Carlton Co.
T47 R19W S28
T47 R19W S27
T47 R19W S26
T47 R19W S25
T47 R18W S30
T47 R18W S29
398
Lake Twentynine
T47 R19W S29
T47 R19W S32
T47 R19W S33
T47 R19W S34
T47 R19W S35
T47 R19W S36
T47 R18W S31
T47 R18W S32
397
35
35
Barnum Twsp
Carlton Co.





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

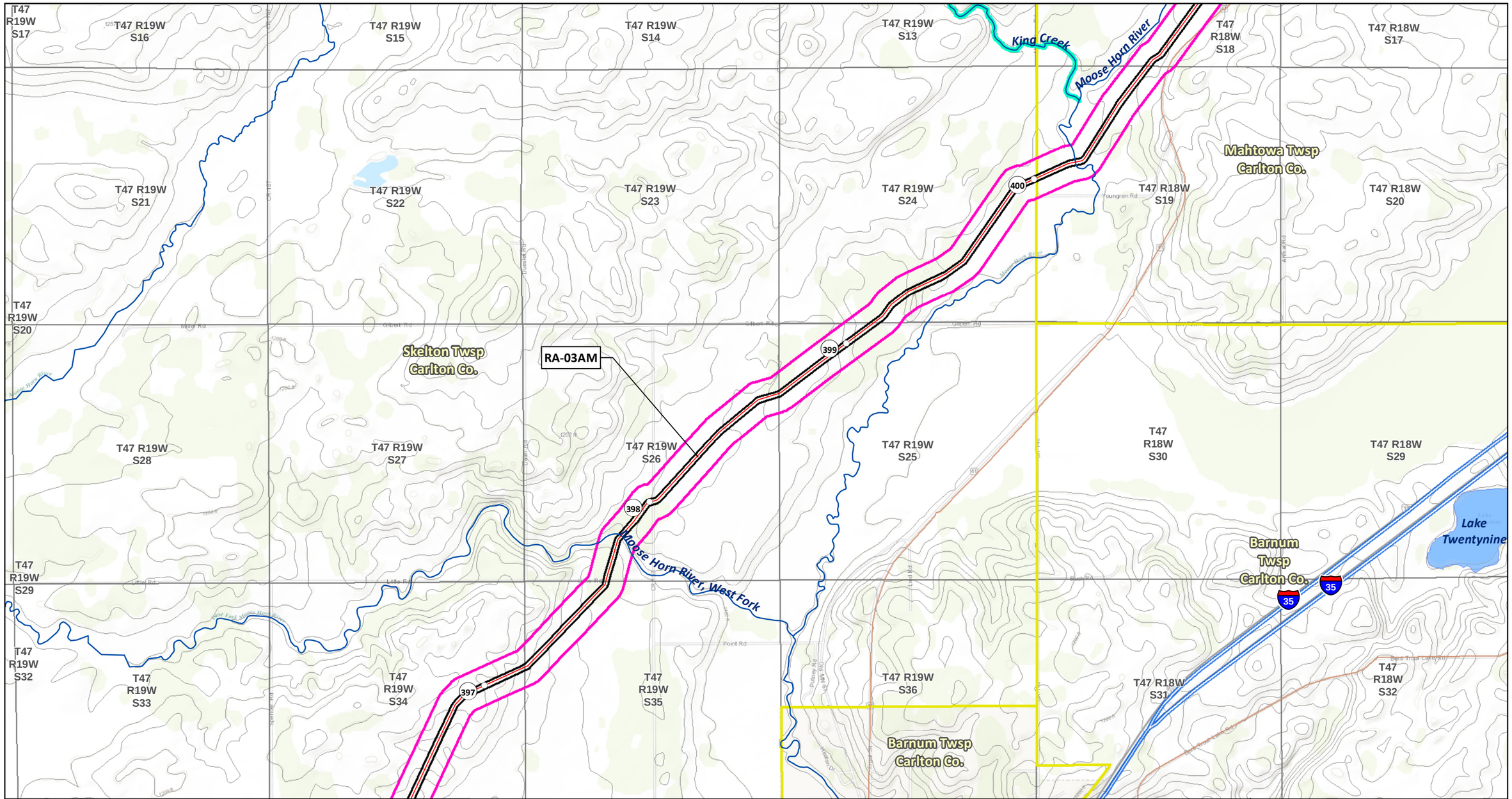
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 65A of 67


T47 R19W S17
T47 R19W S16
T47 R19W S15
T47 R19W S14
T47 R19W S13
T47 R18W S18
T47 R18W S17
King Creek
Moose Horn River
T47 R19W S21
T47 R19W S22
T47 R19W S23
T47 R19W S24
T47 R18W S19
T47 R18W S20
Mahtowa Twsp
Carlton Co.
T47 R19W S20
Skelton Twsp
Carlton Co.
RA-03AM
399
400
T47 R19W S28
T47 R19W S27
T47 R19W S26
T47 R19W S25
T47 R18W S30
T47 R18W S29
398
Moose Horn River, West Fork
Lake Twentynine
T47 R19W S29
T47 R19W S32
T47 R19W S33
T47 R19W S34
T47 R19W S35
T47 R19W S36
T47 R18W S31
T47 R18W S32
Barnum Twsp
Carlton Co.
397
35
RA-08
RA-06
APR
RA-03AM
SA-04
MN
St. Louis County
Aitkin County
Carlton County
Minnesota
Wisconsin
Pine County
Douglas County
67
66
65
64
63
62
61
60
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
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Water Resources
Navigable Waterway Crossings
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Public Waters Watercourse
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Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-03AM
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 65B of 67

APR

North Carlton Twsp Carlton Co.

Atkinson Twsp Carlton Co.

T48 R19W S36

T48 R18W S31

T48 R18W S32

T48 R18W S33

T48 R18W S34

T48 R18W S35

T48 R18W S36

Moose Horn River

T47 R19W S1

T47 R18W S6

T47 R18W S5

Park Lake Creek

T47 R18W S4

T47 R18W S3

T47 R18W S2

King Creek

404

405

406

403

RA-03AM

Mahtowa Twsp Carlton Co.

T47 R18W S11

T47 R19W S12

Skelton Twsp Carlton Co.

T47 R18W S7

T47 R18W S8

T47 R18W S9

T47 R18W S10

35

Unnamed Stream

Hizer Lake

402

T47 R19W S13

T47 R18W S18

T47 R18W S17

T47 R18W S16

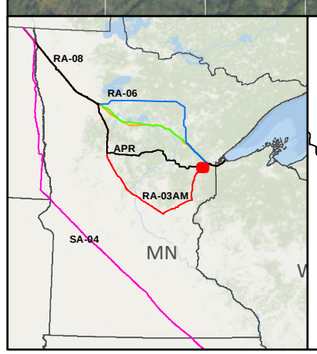
T47 R18W S15

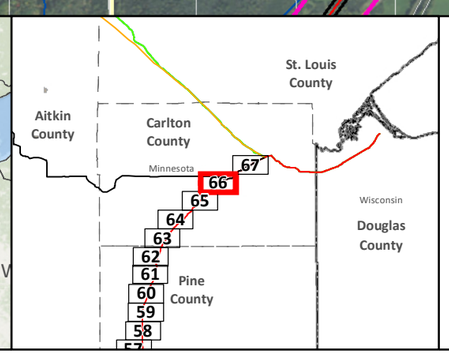
T47 R18W S14

Fond du Lac State Forest

401

Munson Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land
- White Earth Reservation - BIA

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-03AM

CLEARBROOK TO CARLTON

Map 66A of 67

APR

North Carlton Twsp Carlton Co.

T48 R19W S36

T48 R18W S31

T48 R18W S32

Atkinson Twsp Carlton Co.

T48 R18W S33

T48 R18W S34

T48 R18W S35

T48 R18W S36

Moose Horn River

T47 R18W S3

T47 R18W S2

T47 R19W S1

T47 R18W S6

T47 R18W S5

Park Lake Creek

T47 R18W S4

Mahtowa Twsp Carlton Co.

King Creek

404

405

406

T47 R18W S11

RA-03AM

403

Mahtowa

T47 R19W S12

Skelton Twsp Carlton Co.

T47 R18W S7

T47 R18W S8

T47 R18W S9

T47 R18W S10

35

Unnamed Stream

Hizer Lake

402

T47 R19W S13

T47 R18W S18

T47 R18W S17

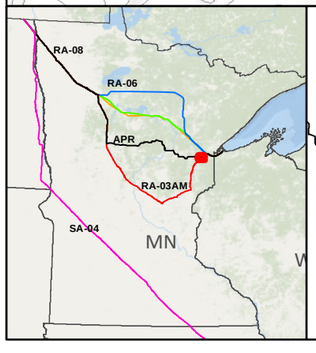
T47 R18W S16

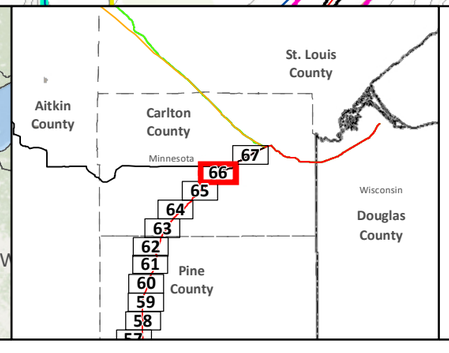
T47 R18W S15

T47 R18W S14

401

Munson Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

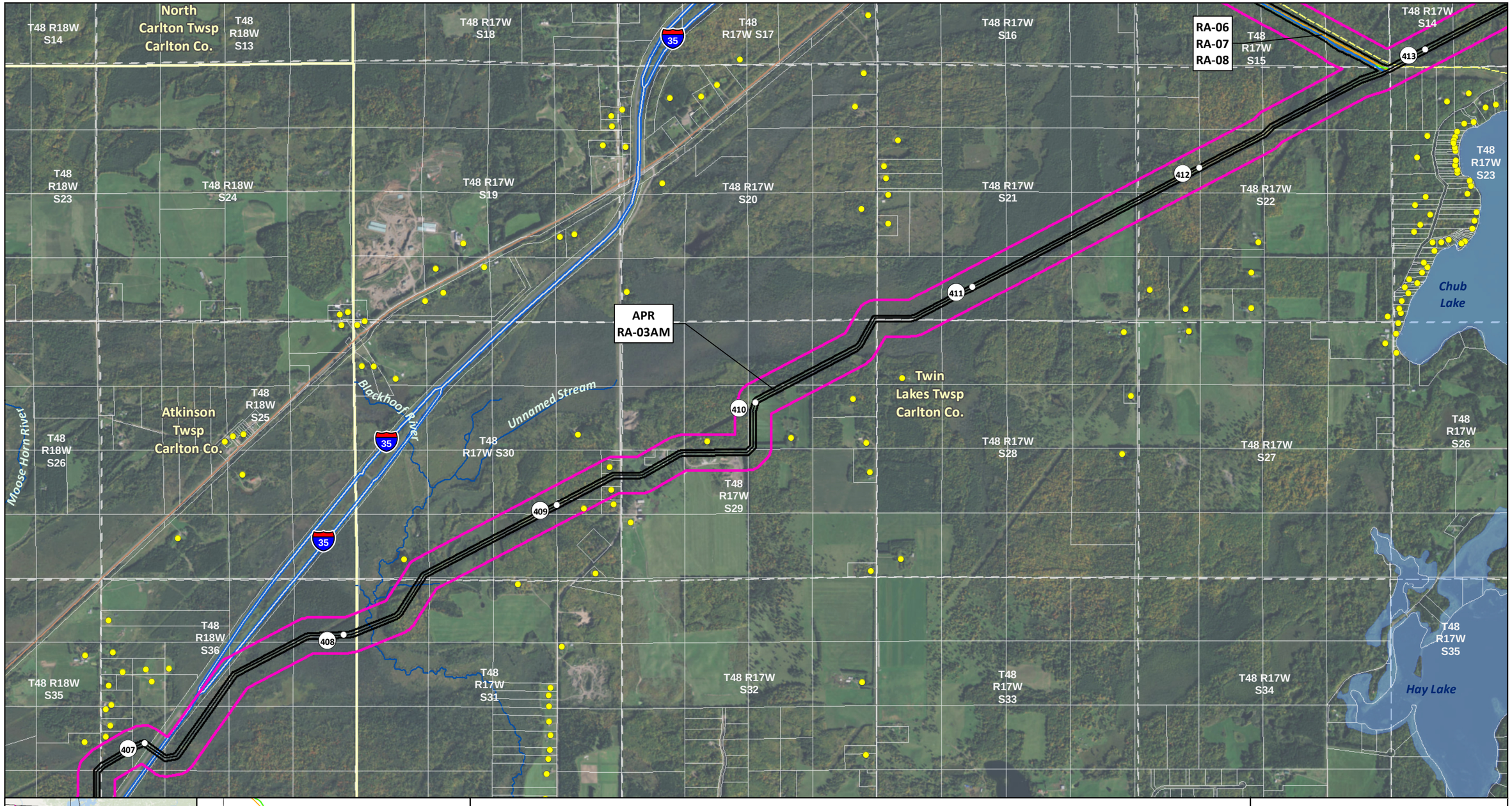
0 125 250 500 Meters

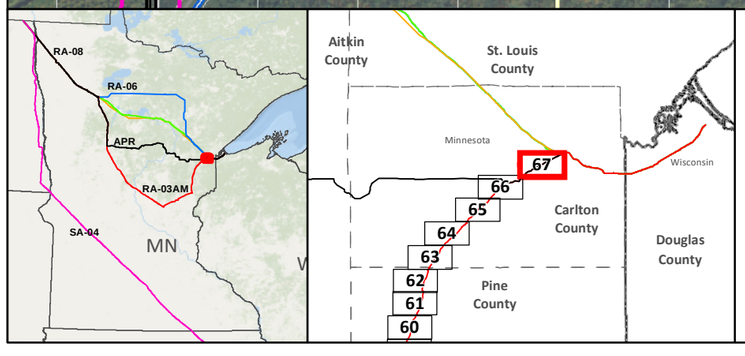
1:24,000

10ft Contours

N

Map 66B of 67





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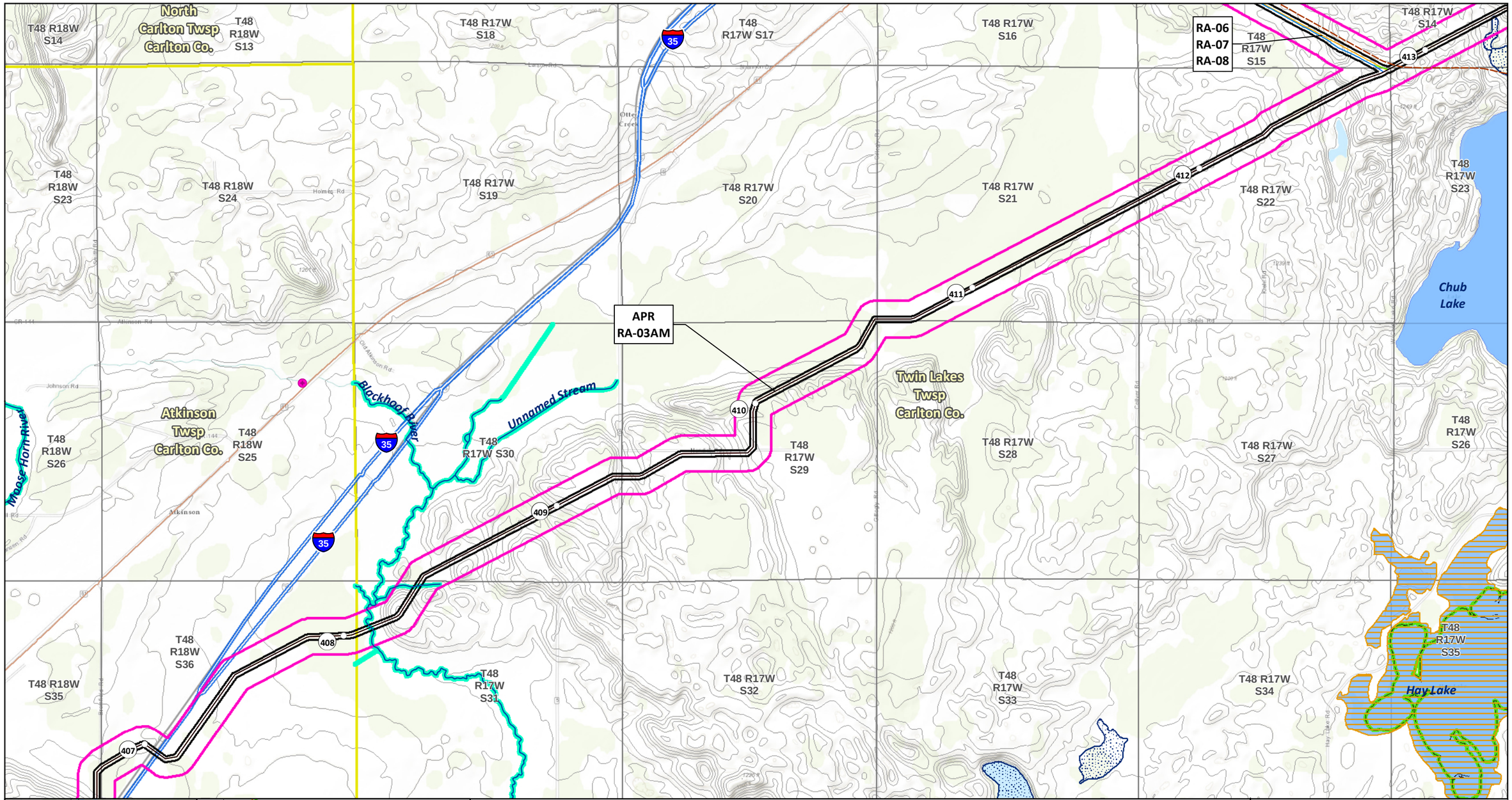
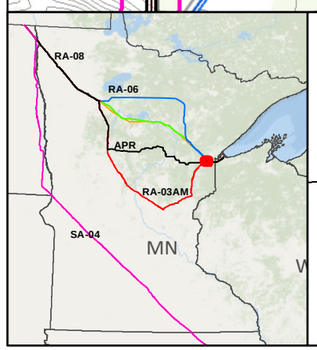
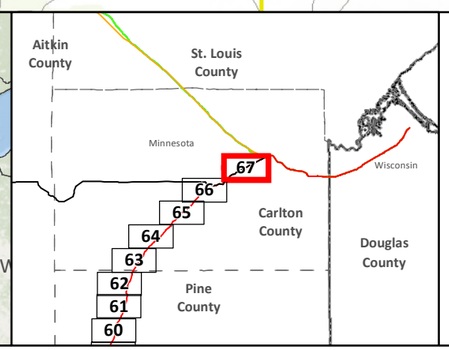
RA-03AM

CLEARBROOK TO CARLTON







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

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Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
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Public Water Basin
Public Drinking Water Supply
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Native Plant Communities with Biodiversity Significance
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High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-03AM

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 67B of 67

Minnesota Department of Commerce
Energy Environmental Review and Analysis

Draft Environmental Impact Statement
Line 3 Project

Mapbook
RA-06

Docket Nos. PPL-15-137/CN-14-916

May 15, 2017

MINNESOTA

Red Lake Reservation
Upper Red Lake
Ponemah
Red Lake River
Little Rock
Red Lake
Redby
1
Red Lake State Forest
72
Lost River
Margie
Koochiching State Forest
Pine Island State Forest
Big Fork River
Gemmell
Kelliher
South Branch Battle River
Mizpah
Caldwell Brook
Shooks
Northome
71
Blackduck River
South Cormorant River
Funkley
Big Fork State Forest
Big Fork River
Lost River
Gonvick
Sandy River
Clearwater River
Clearbrook Terminal
Clearbrook
Mud River
Blackduck
Alvwood
Wirt
Bowstring River
Bowstring River
89
Puposky
Hines
Tenstrike
223
Leonard
Blackduck State Forest
46
Squaw Lake
Spring Lake
6
286
Marcell
Max
92
Pinewood
Turtle River
Buena Vista State Forest
Leech Lake Reservation
Inger
Bowstring Lake
Chippewa National Forest
Bowstring State Forest
Wilton
Lavinia
Mississippi River
197
Bemidji
Pennington
Mississippi Headwaters State Forest
Mississippi River
Sugar Lake
371
Mississippi River
Leech Lake Reservation

APR
RA-03AM
RA-06
RA-07
RA-08

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APR
RA-03AM

RA-08

RA-07

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RA-03AM

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08

Route Segment Alternatives (RSA)
Terminal
Pump Station

Interstate
Highway
Major Road
Local Road

County Boundary
Tribal Reservation
State Park or Forest
National Forest

Stream
Intermittent Stream
Lake

0 10 mi
0 5 10 Kilometers

Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge

Line 3 Replacement Project
RA-06
OVERVIEW

Overview 1 of 3

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RA-08
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Bigfork
Big Fork State Forest
Bear River
George Washington State Forest
Sturgeon River
Sturgeon River State Forest
Lost Lake Swamp
Angora
Tower
Soudan
Bear Island State Forest
Rice River
Pike River
Embarrass
Embarrass River
Britt
East Branch Sturgeon River
Spring Lake
Marcell
Inger
Bowstring Lake
Bowstring State Forest
Leech Lake Reservation
Shannon River
Bog Brook
Prairie River
Deer Creek
Mountain Iron
Franklin
Virginia
Biwabik
Aurora
Kinney
Chisholm
Buhl
McKinley
Gilbert
Leonidas
Eveleth
East Two River
Embarrass River
Partridge River
Saint Louis River
Iron Junction
Hibbing
Stevenson
Kelly Lake
Keewatin
Barber Creek
Nashwauk
Prairie River
Forbes
West Two River
Mud Hen Creek
Makinen
Water Hen Creek
Ball Club
Deer River
Zemple
Leech Lake River
Mississippi River
Marble
Calumet
Taconite
Pengilly
Coleraine
Bovey
Swan River
West Swan River
East Swan River
Zim
Melrude
Cloquet Valley State Forest
Cohasset
Grand Rapids
La Prairie
Blackberry
Goodland
Toivola
Cotton
Kelsey
Whiteface River
Shaw
Us-Kob-Wan-Ka River
Golden Anniversary State Forest
Warba
Floodwood River
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RA-07
RA-08
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Highway
Major Road
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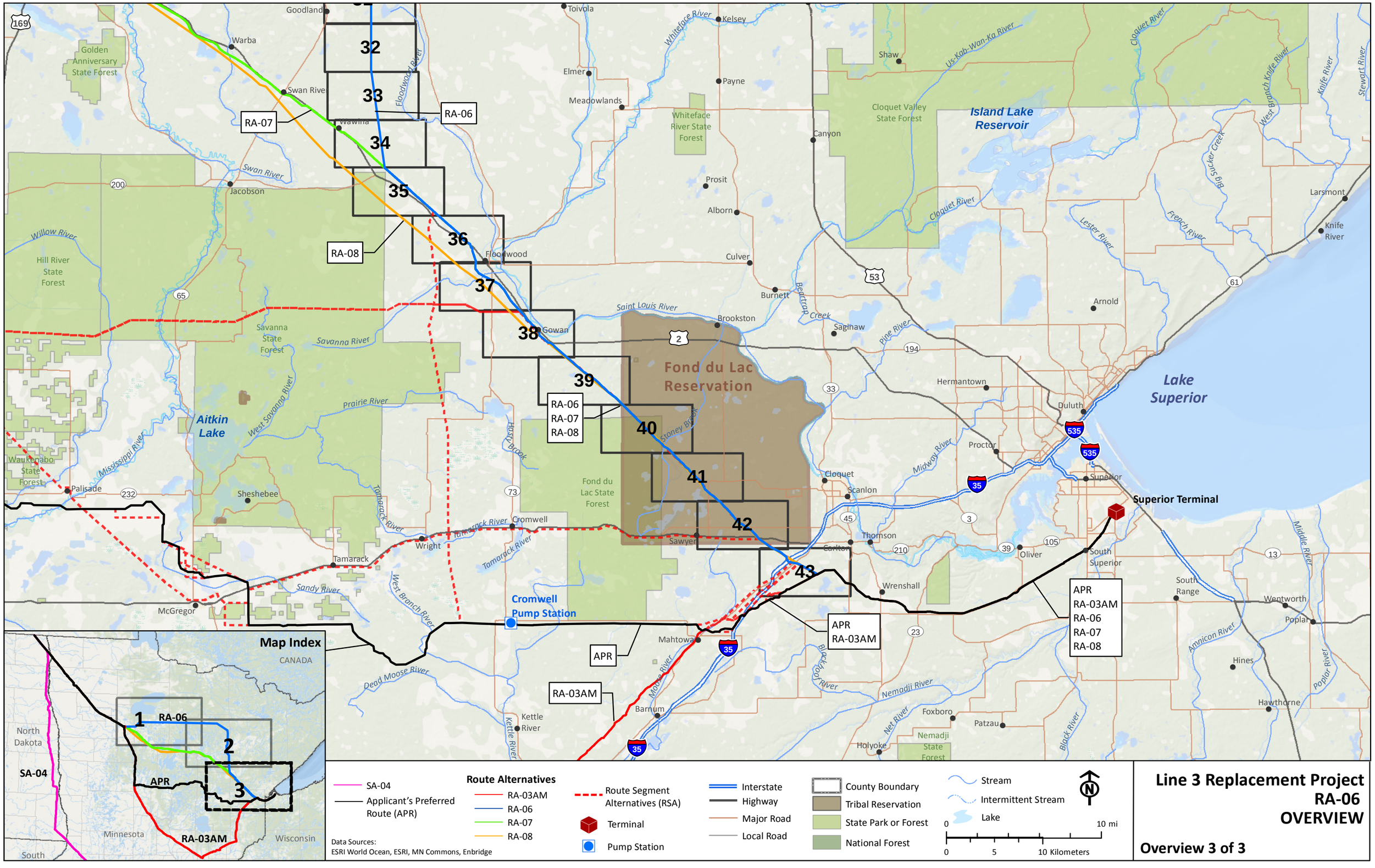
State Park or Forest
National Forest
Stream
Intermittent Stream
Lake
0 10 mi
0 5 10 Kilometers
N
Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge

Line 3 Replacement Project
RA-06
OVERVIEW

Overview 2 of 3



Line 3 Replacement Project
RA-06
OVERVIEW

Overview 3 of 3

T149 R37W S16
T149 R37W S15
T149 R37W S14
T149 R37W S13
T149 R36W S18
T149 R36W S17
Nels Olson Lake
T149 R37W S21
T149 R37W S22
T149 R37W S23
T149 R37W S24
T149 R36W S19
T149 R36W S20
Falk Lake
T149 R37W S20
T149 R37W S29
Unnamed Creek
RA-03AM
RA-06
RA-07
RA-08
T149 R37W S28
Leon Twsp Clearwater Co.
T149 R37W S27
T149 R37W S26
T149 R37W S25
Sinclair Twsp Clearwater Co.
T149 R36W S30
T149 R36W S29
Ruffy Brook
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142
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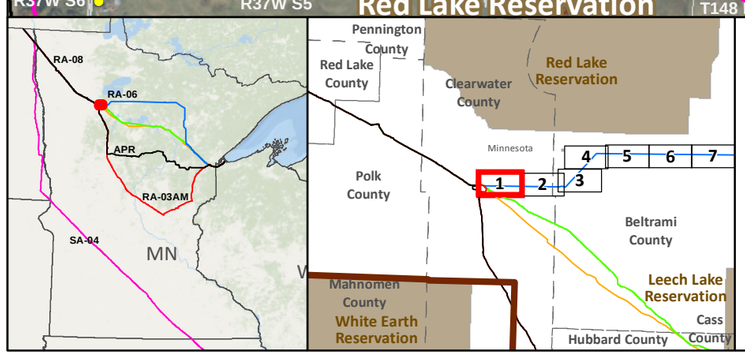
RA-06
RA-08
Deep Lake
T149 R37W S33
T149 R37W S32
RA-03AM
T149 R37W S34
T149 R37W S35
T149 R37W S36
T149 R36W S31
T149 R36W S32
RA-07
RA-08
T148 R37W S6
T148 R37W S5
Red Lake Reservation
T148 R37W S4
T148 R37W S3
Holst Twsp Clearwater Co.
T148 R37W S2



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
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- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 1A of 43

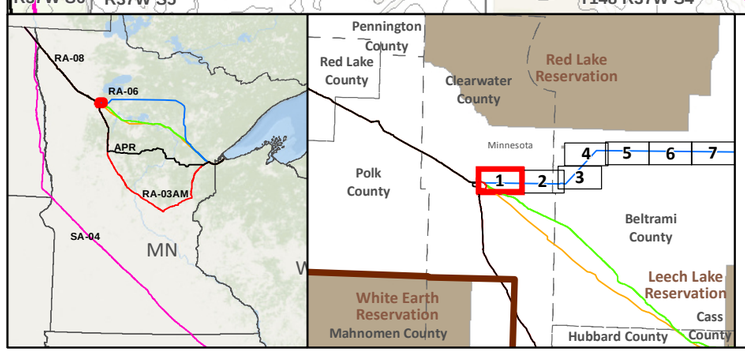
T149 R37W S16
T149 R37W S15
T149 R37W S14
T149 R37W S13
T149 R36W S18
T149 R36W S17
T149 R37W S21
T149 R37W S22
T149 R37W S23
T149 R37W S24
T149 R36W S19
T149 R36W S20
T149 R37W S20
T149 R37W S29
T149 R37W S28
T149 R37W S27
T149 R37W S26
T149 R37W S25
T149 R36W S30
T149 R36W S29
T149 R37W S32
T149 R37W S33
T149 R37W S34
T149 R37W S35
T149 R37W S36
T149 R36W S31
T149 R36W S32
T148 R37W S6
T148 R37W S5
T148 R37W S4
T148 R37W S3
T148 R37W S2

Nels Olson Lake
Falk Lake
Deep Lake
Unnamed Creek
Ruffy Brook

Leon Twsp Clearwater Co.
Sinclair Twsp Clearwater Co.
Holst Twsp Clearwater Co.

RA-03AM
RA-06
RA-07
RA-08

138 139 140 141 142 143



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
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RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

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303d Imparied Waters
Designated Trout Stream
Calcareous Fens
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Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 1B of 43

T149 R36W S15
T149 R36W S14
T149 R36W S13
T149 R35W S18
Clearwater Lake
T149 R35W S17
Unnamed Creek
T149 R36W S20
T149 R36W S21
T149 R36W S22
T149 R36W S23
T149 R36W S24
T149 R35W S19
T149 R35W S20
Clearwater River
T149 R36W S29
T149 R36W S28
T149 R36W S27
Sinclair Twsp Clearwater Co.
RA-06
T149 R36W S26
T149 R36W S25
T149 R35W S30
Roosevelt Twsp Beltrami Co.
T149 R35W S29
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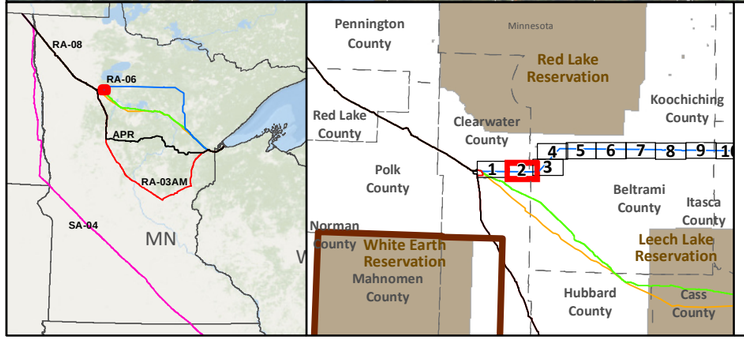
T149 R36W S32
T149 R36W S33
T149 R36W S34
T149 R36W S35
T149 R36W S36
T149 R35W S31
T149 R35W S32
Dudley Twsp Clearwater Co.
T148 R36W S5
Stenlund Lake
T148 R36W S4
T148 R36W S3
T148 R36W S2
T148 R36W S1



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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 2A of 43

T149 R36W S15
T149 R36W S14
T149 R36W S13
T149 R35W S18
Clearwater Lake
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T149 R36W S33
T149 R36W S34
T149 R36W S35
T149 R36W S36
T149 R35W S31
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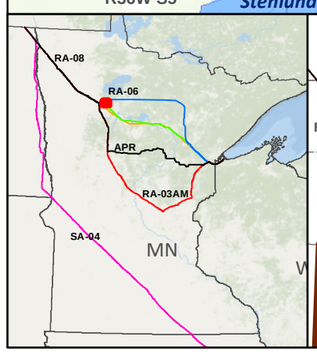
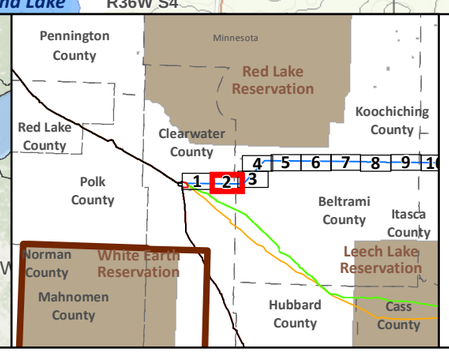
T148 R36W S4
T148 R36W S3
T148 R36W S2
T148 R36W S1





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High
Moderate

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Data Sources:
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

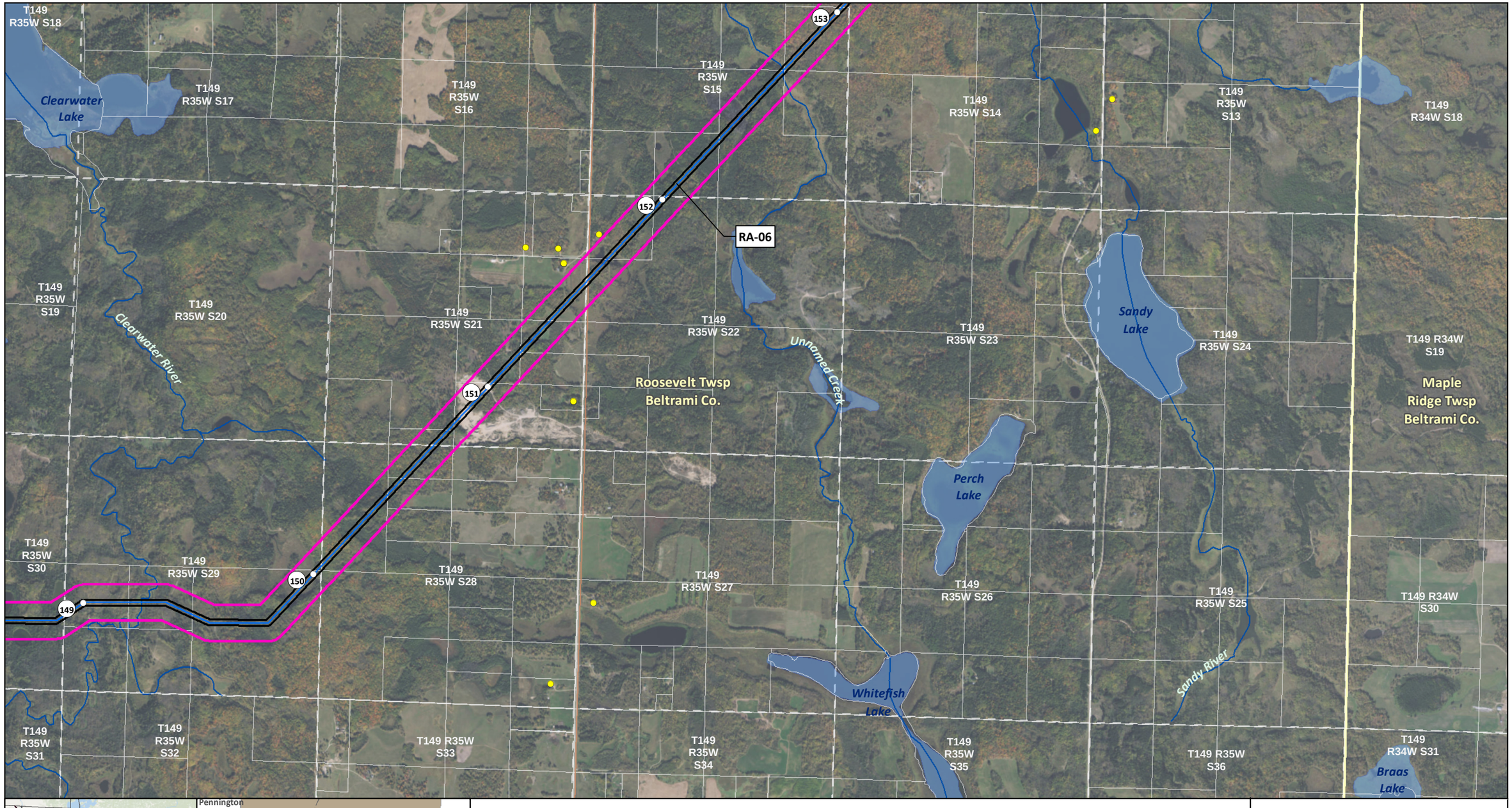
RA-06

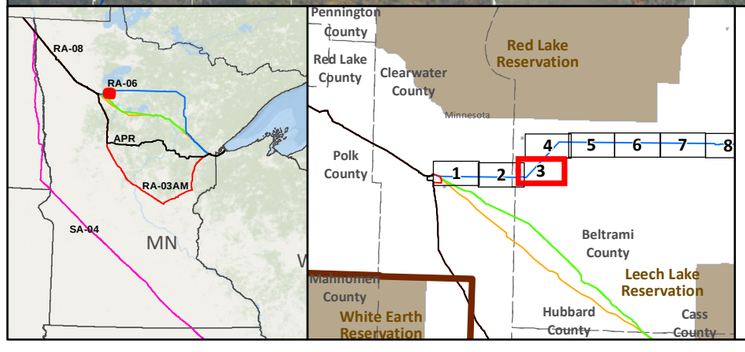
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 2B of 43





SA-04

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- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

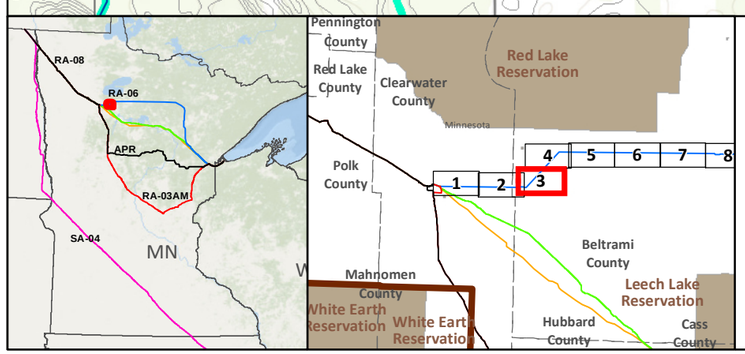
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 3A of 43

T149 R35W S18
Clearwater Lake
T149 R35W S17
T149 R35W S16
T149 R35W S15
T149 R35W S14
T149 R35W S13
T149 R34W S18
153
152
RA-06
T149 R35W S19
T149 R35W S20
Clearwater River
T149 R35W S21
T149 R35W S22
Unnamed Creek
T149 R35W S23
Sandy Lake
T149 R35W S24
T149 R34W S19
Roosevelt Twsp Beltrami Co.
Maple Ridge Twsp Beltrami Co.
151
Perch Lake
T149 R35W S30
T149 R35W S29
150
149
T149 R35W S28
T149 R35W S27
T149 R35W S26
T149 R35W S25
T149 R34W S30
Sandy River
Whitefish Lake
T149 R35W S31
T149 R35W S32
T149 R35W S33
T149 R35W S34
T149 R35W S35
T149 R35W S36
T149 R34W S31
Braas Lake



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

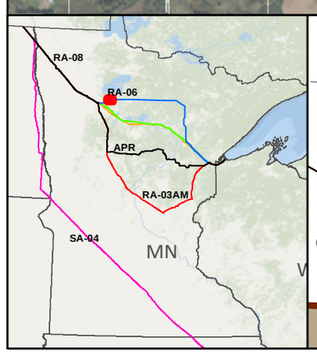
1:24,000

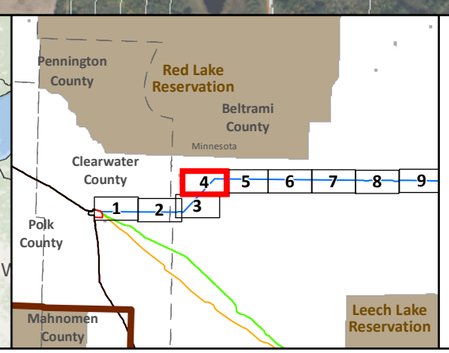
10ft Contours

N

Map 3B of 43

T150 R35W S32
T150 R35W S33
T150 R35W S34
Alaska Twsp Beltrami Co.
T150 R35W S35
T150 R35W S36
T150 R34W S31
T150 R34W S32
Island Lake
T150 R34W S29
Unnamed Creek
156
157
RA-06
T149 R35W S5
T149 R35W S4
T149 R35W S3
T149 R35W S2
T149 R35W S1
T149 R34W S6
T149 R34W S5
155
Sandy River
Myrtle Lake
Roosevelt Twsp Beltrami Co.
Maple Ridge Twsp Beltrami Co.
T149 R35W S11
154
T149 R35W S8
T149 R35W S9
T149 R35W S10
T149 R35W S12
T149 R34W S7
T149 R34W S8
T149 R35W S17
T149 R35W S16
T149 R35W S15
T149 R35W S14
T149 R35W S13
T149 R34W S18
T149 R34W S17





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

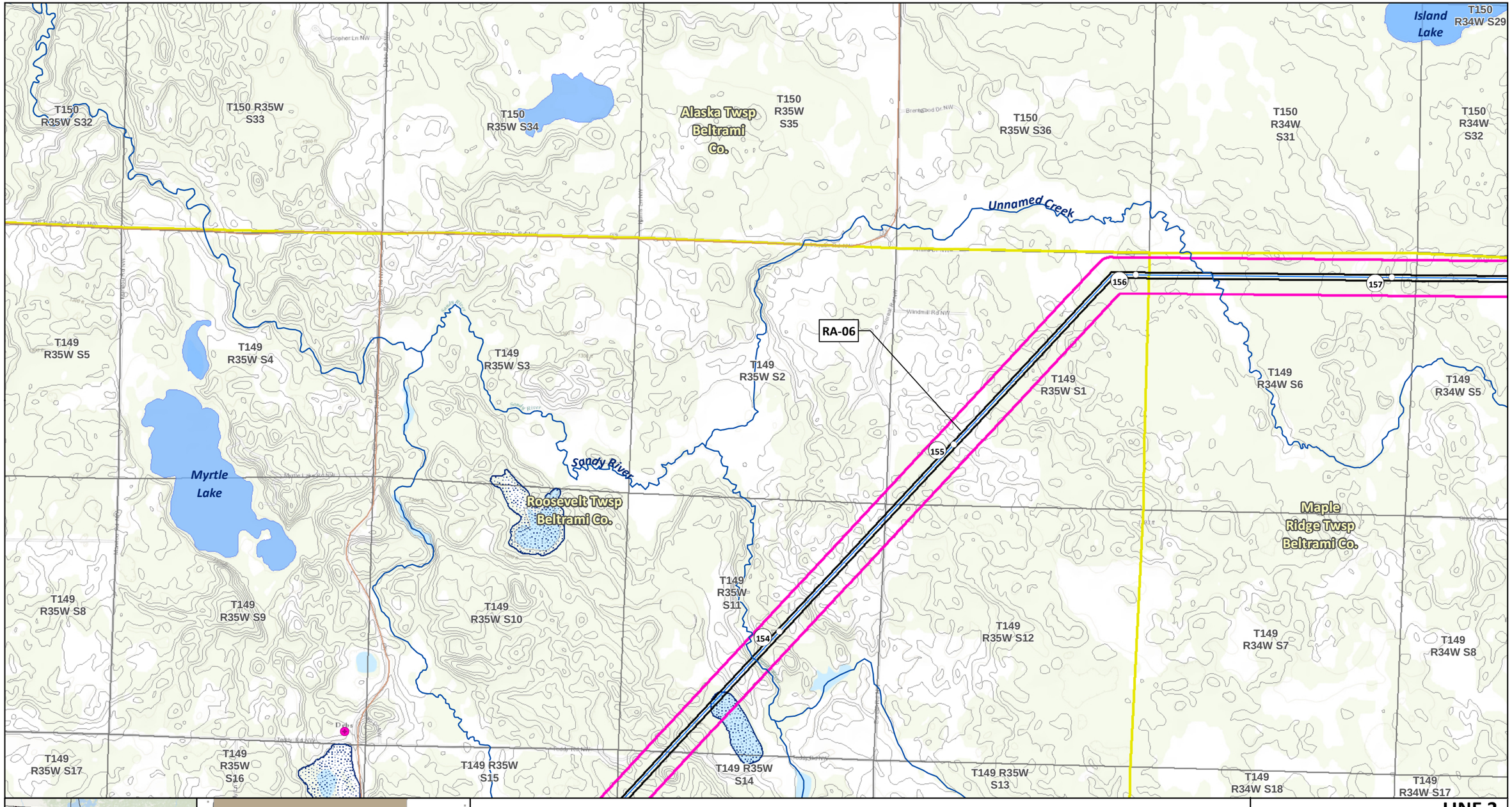
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

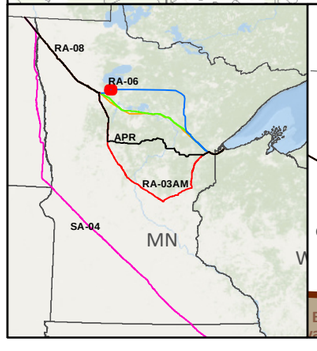
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

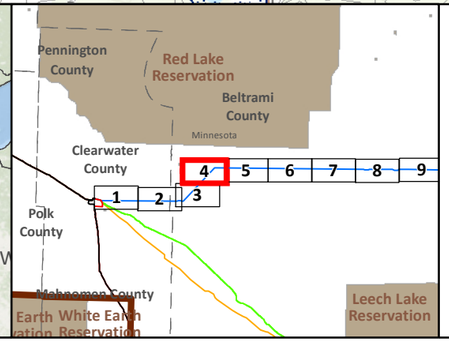
RA-06

CLEARBROOK TO CARLTON

Map 4A of 43







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

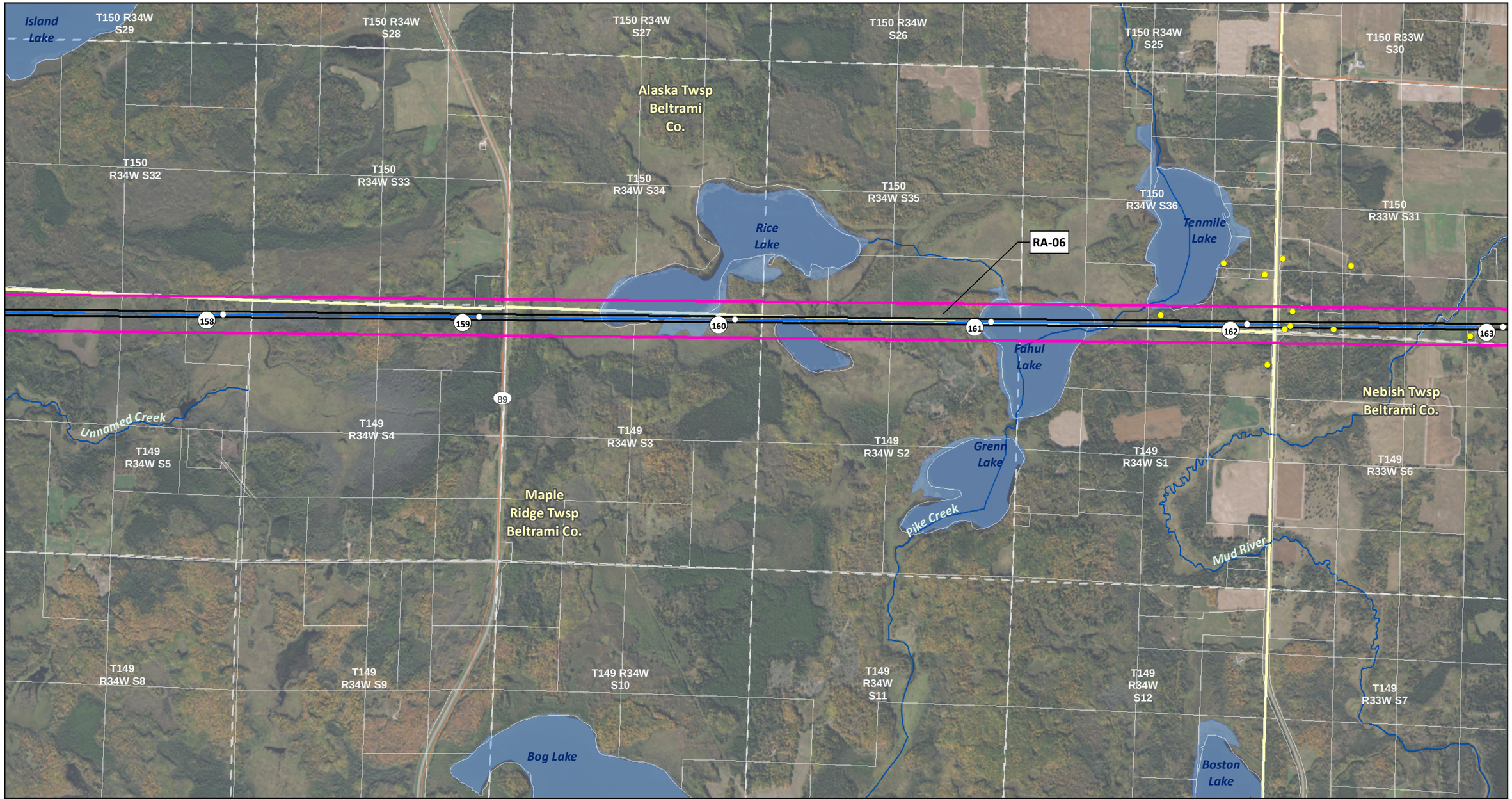
Pump Station

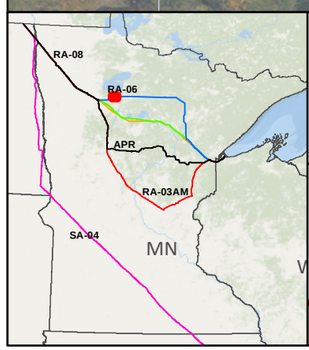
Data Sources:
MNDNR, USGS, NHD, Enbridge

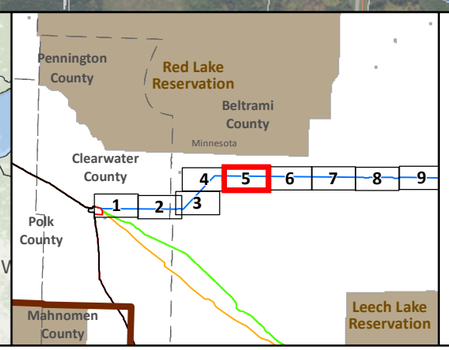
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 4B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

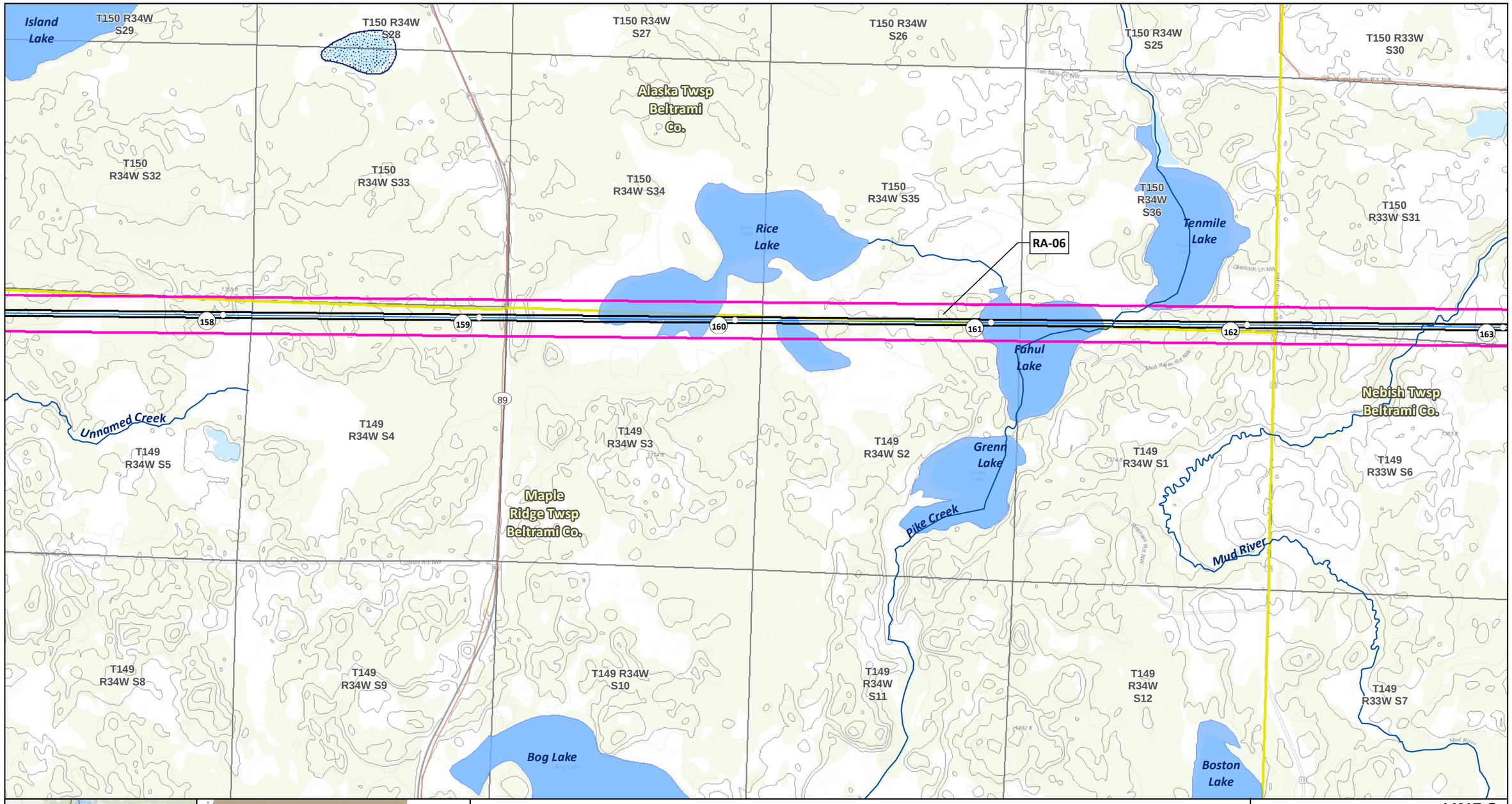
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

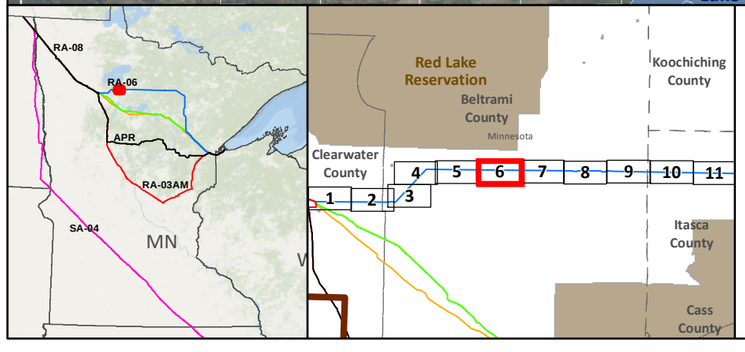
RA-06

CLEARBROOK TO CARLTON

Map 5A of 43


Island Lake
T150 R34W S29
T150 R34W S28
T150 R34W S27
T150 R34W S26
T150 R34W S25
T150 R33W S30
Alaska Twsp Beltrami Co.
T150 R34W S32
T150 R34W S33
T150 R34W S34
T150 R34W S35
T150 R34W S36
T150 R33W S31
Rice Lake
Tenmile Lake
RA-06
158
159
160
161
162
163
Fahul Lake
Unnamed Creek
89
T149 R34W S4
T149 R34W S3
T149 R34W S2
T149 R34W S1
T149 R33W S6
Nebish Twsp Beltrami Co.
Grenn Lake
T149 R34W S5
Maple Ridge Twsp Beltrami Co.
Pike Creek
Mud River
T149 R34W S8
T149 R34W S9
T149 R34W S10
T149 R34W S11
T149 R34W S12
T149 R33W S7
Bog Lake
Boston Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Pennington County
Red Lake Reservation
Beltrami County
Minnesota
Clearwater County
Polk County
Mahnomen County
Leech Lake Reservation
1
2
3
4
5
6
7
8
9
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 5B of 43





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

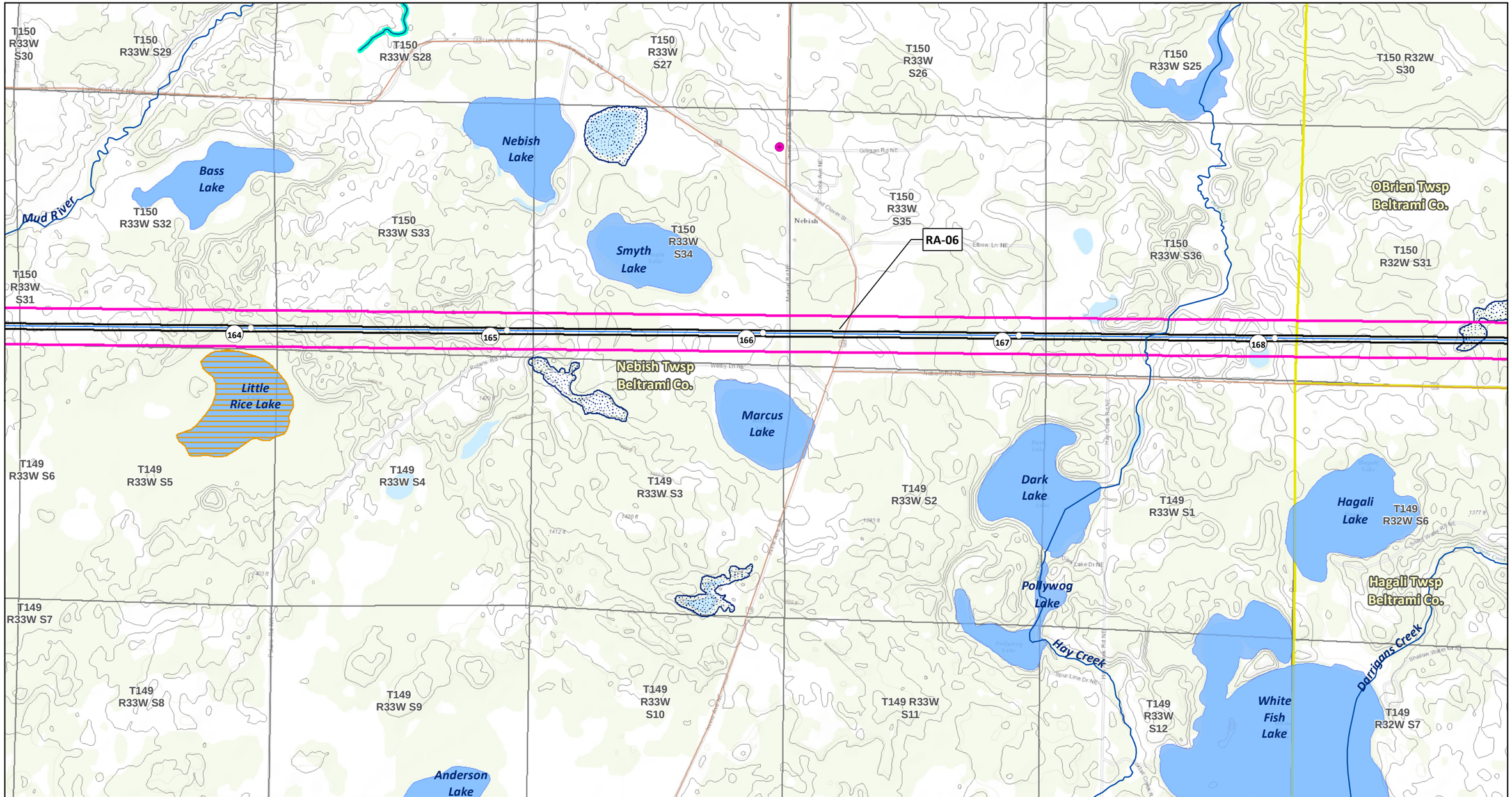
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 6A of 43


T150 R33W S30
T150 R33W S29
T150 R33W S28
T150 R33W S27
T150 R33W S26
T150 R33W S25
T150 R32W S30
Nebish Lake
Bass Lake
Mud River
T150 R33W S32
T150 R33W S33
Smyth Lake
T150 R33W S34
T150 R33W S35
RA-06
T150 R33W S36
OBrien Twsp Beltrami Co.
T150 R32W S31
T150 R33W S31
164
165
166
167
168
Nebish Twsp Beltrami Co.
Little Rice Lake
Marcus Lake
T149 R33W S6
T149 R33W S5
T149 R33W S4
T149 R33W S3
T149 R33W S2
T149 R33W S1
Dark Lake
Hagali Lake
T149 R32W S6
Pollywog Lake
Hagali Twsp Beltrami Co.
Hay Creek
Partridge Creek
T149 R33W S7
T149 R33W S8
T149 R33W S9
T149 R33W S10
T149 R33W S11
T149 R33W S12
White Fish Lake
T149 R32W S7
Anderson Lake
RA-08
APR
RA-03AM
SA-04
MN
Red Lake Reservation
Beltrami County
Minnesota
Koochiching County
Clearwater County
Itasca County
Cass County
1 2 3 4 5 6 7 8 9 10 11
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
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Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
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303d Imparied Waters
Designated Trout Stream
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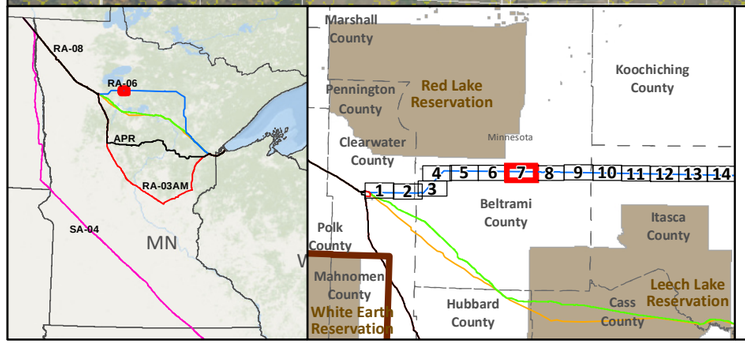
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 6B of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

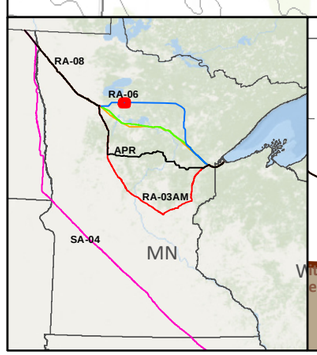
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

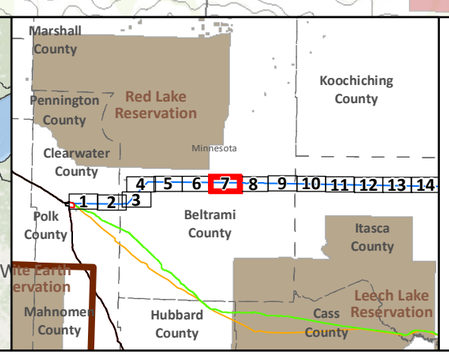
RA-06

CLEARBROOK TO CARLTON

Map 7A of 43

T150 R32W S30
T150 R32W S29
T150 R32W S28
T150 R32W S27
T150 R32W S26
T150 R32W S25
T150 R31W S30
Unnamed Creek
O'Brien Twsp Beltrami Co.
Langor Twsp Beltrami Co.
T150 R32W S31
T150 R32W S32
T150 R32W S33
RA-06
T150 R32W S34
T150 R32W S35
T150 R32W S36
T150 R31W S31
169
170
171
172
173
174
T149 R32W S6
T149 R32W S5
T149 R32W S4
T149 R32W S3
T149 R32W S2
T149 R32W S1
T149 R31W S6
Hagali Twsp Beltrami Co.
Hines Twsp Beltrami Co.
Darrigans Creek
Rice Lake
Hagli-Rice State Game Refuge
O'Brien Creek
T149 R32W S7
T149 R32W S8
T149 R32W S9
T149 R32W S10
T149 R32W S11
T149 R32W S12
T149 R31W S7





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-08
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Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

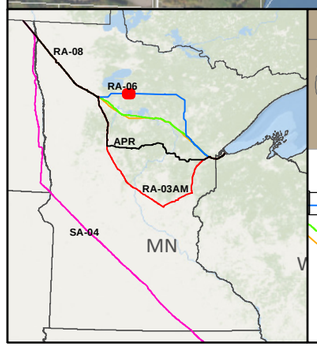
CLEARBROOK TO CARLTON

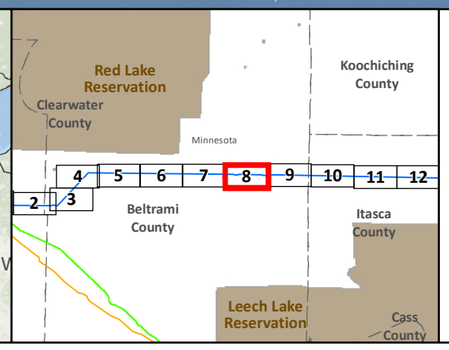
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 7B of 43

T150 R31W S30
T150 R31W S29
T150 R31W S28
T150 R31W S27
T150 R31W S26
T150 R31W S25
T150 R30W S30
Langor Twsp Beltrami Co.
Hornet Twsp Beltrami Co.
T150 R31W S31
T150 R31W S32
T150 R31W S33
T150 R31W S34
T150 R31W S35
T150 R31W S36
T150 R30W S31
RA-06
175
176
177
178
179
180
72
Unnamed Creek
Smith Lake
T149 R31W S6
T149 R31W S5
T149 R31W S4
T149 R31W S3
Hines Twsp Beltrami Co.
T149 R31W S2
T149 R31W S1
T149 R30W S6
Summit Twsp Beltrami Co.
Blackduck River
Blackduck Lake
T149 R31W S7
T149 R31W S8
T149 R31W S9
T149 R31W S10
T149 R31W S11
T149 R31W S12
T149 R30W S7
Blackduck Twsp Beltrami Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
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Pump Station
Interstate
Highway
Major Road
Township Boundary

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State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

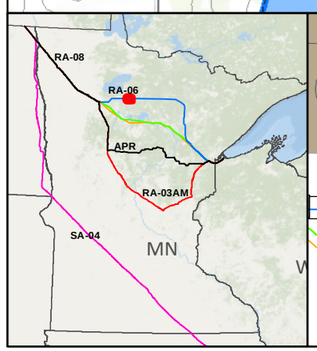
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

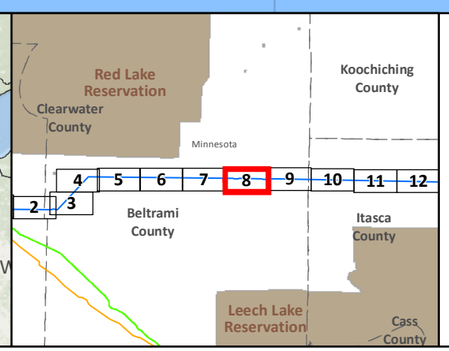
RA-06

CLEARBROOK TO CARLTON

Map 8A of 43

T150 R31W S30
T150 R31W S29
T150 R31W S28
T150 R31W S27
T150 R31W S26
T150 R31W S25
T150 R30W S30
Langor Twsp Beltrami Co.
Hornet Twsp Beltrami Co.
T150 R31W S31
T150 R31W S32
T150 R31W S33
T150 R31W S34
T150 R31W S35
T150 R31W S36
T150 R30W S31
RA-06
175
176
177
178
179
180
72
Unnamed Creek
Smith Lake
T149 R31W S6
T149 R31W S5
T149 R31W S4
T149 R31W S3
Hines Twsp Beltrami Co.
T149 R31W S2
T149 R31W S1
T149 R30W S6
Summit Twsp Beltrami Co.
Blackduck River
Blackduck Lake
T149 R31W S7
T149 R31W S8
T149 R31W S9
T149 R31W S10
T149 R31W S11
T149 R31W S12
T149 R30W S7
Blackduck Twsp Beltrami Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

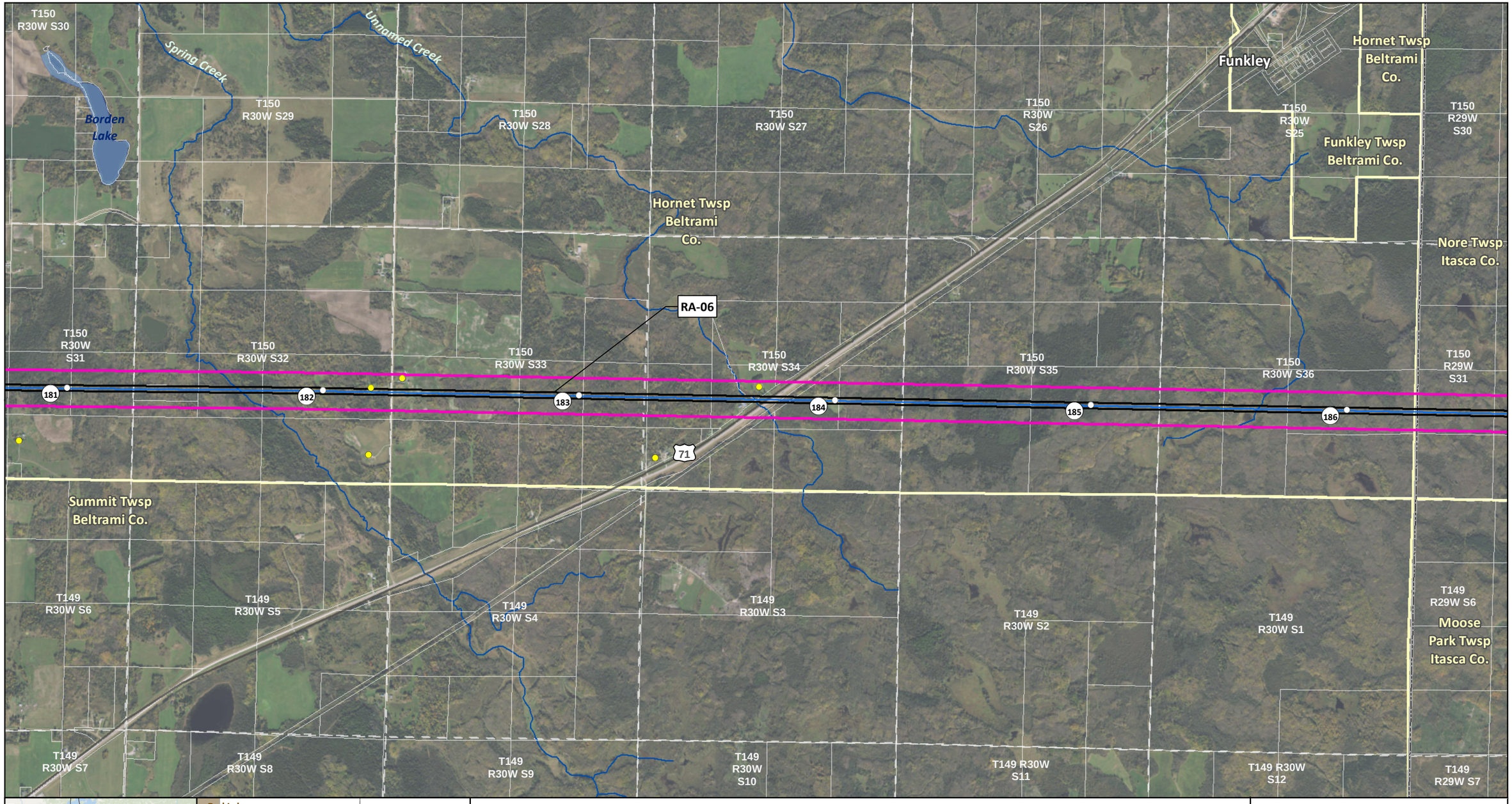
RA-06

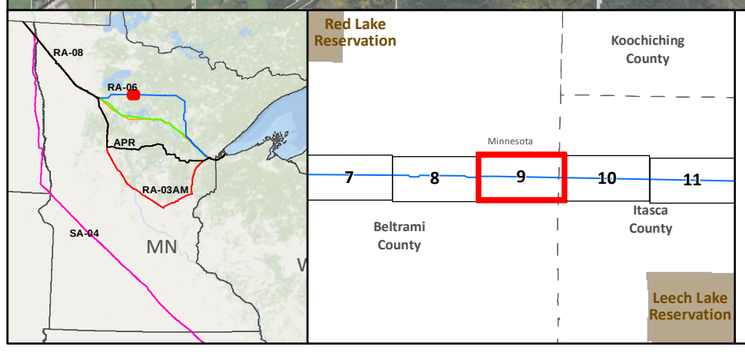
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 8B of 43





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM
RA-06
RA-07
RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

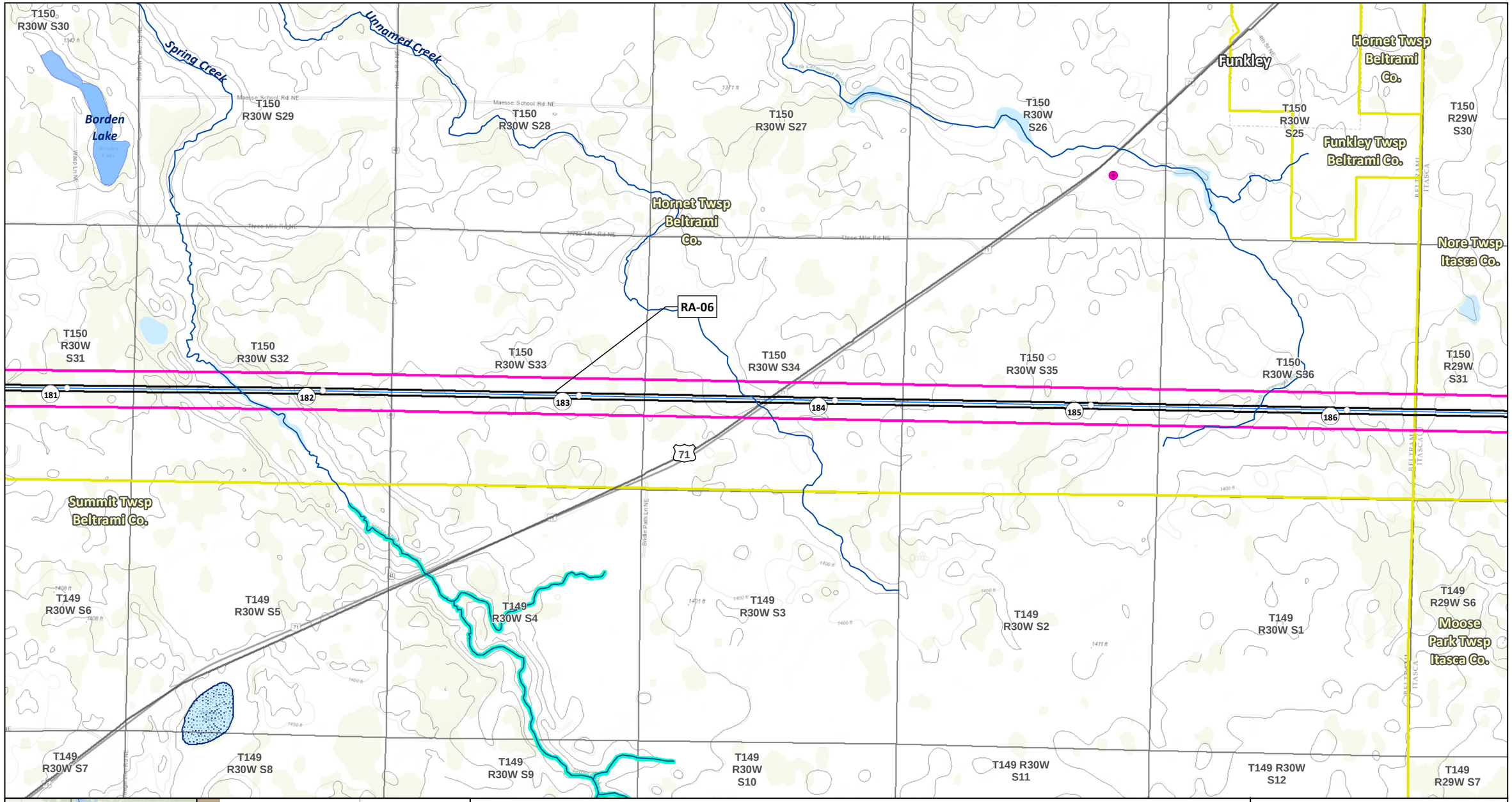
0 125 250 500 Meters

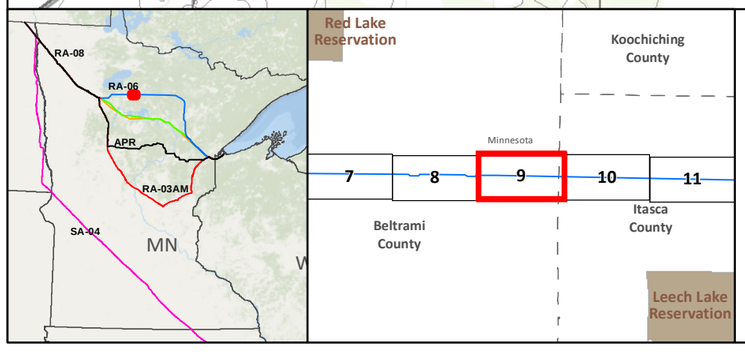
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 9A of 43





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
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Native Plant Communities with Biodiversity Significance
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- High
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Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

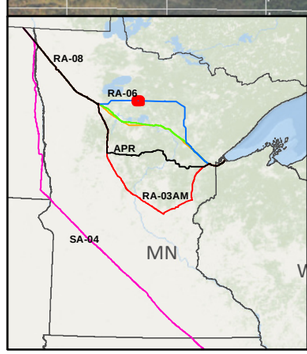
CLEARBROOK TO CARLTON

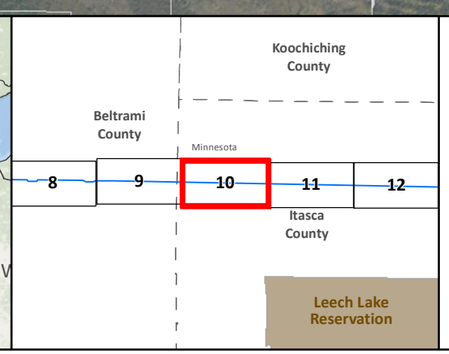
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 9B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

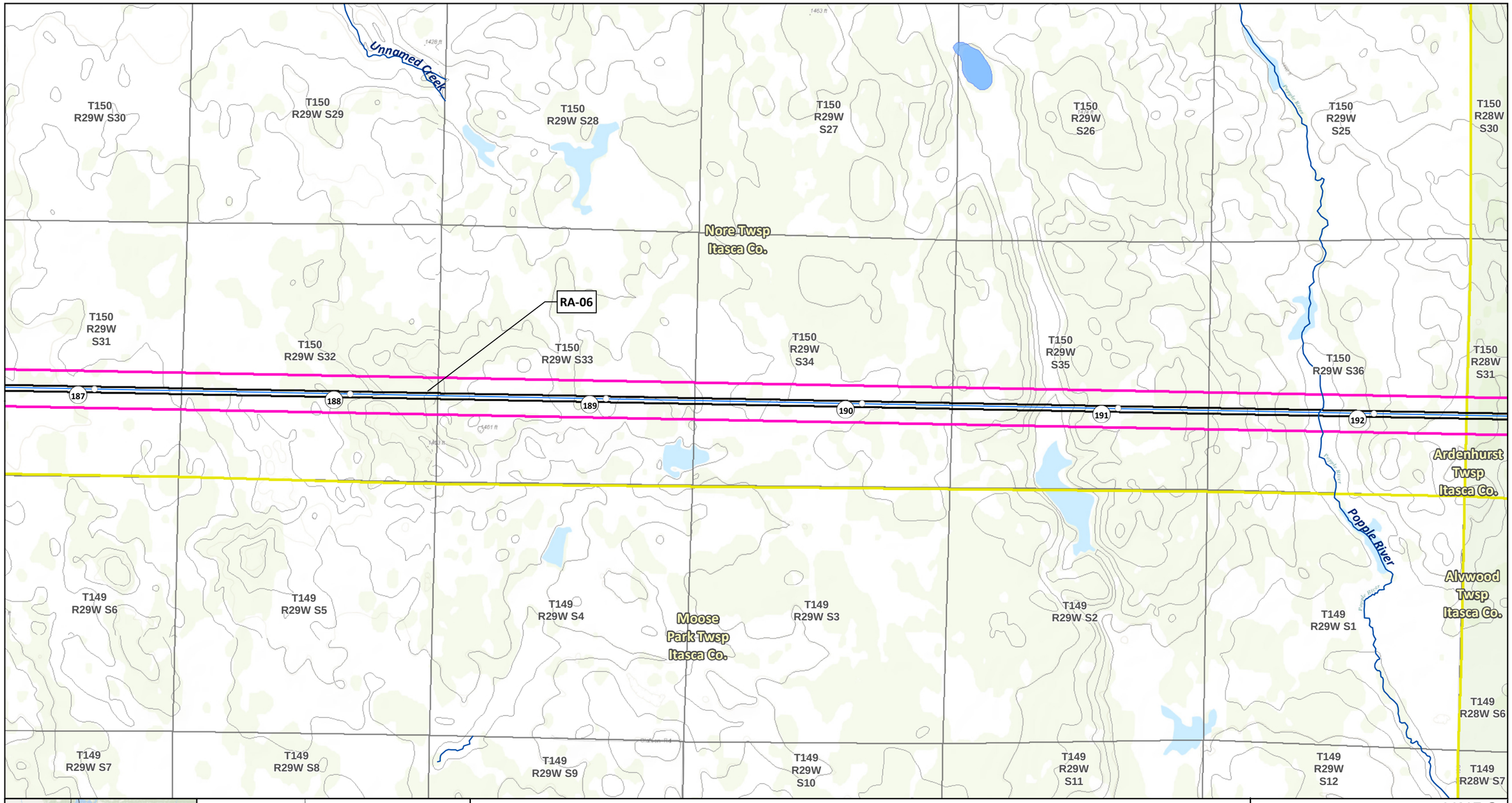
Data Sources: MNDNR, NHD, Enbridge

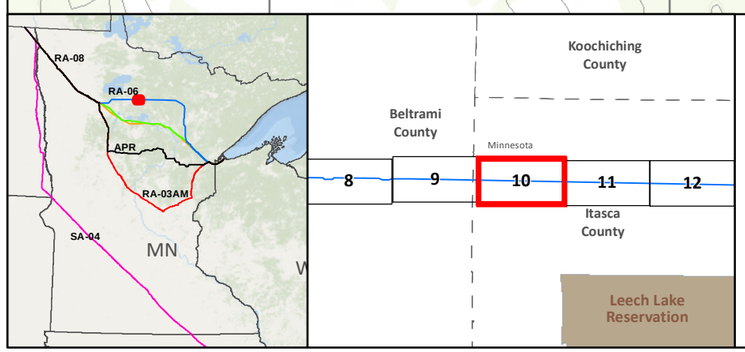
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 10A of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
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Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

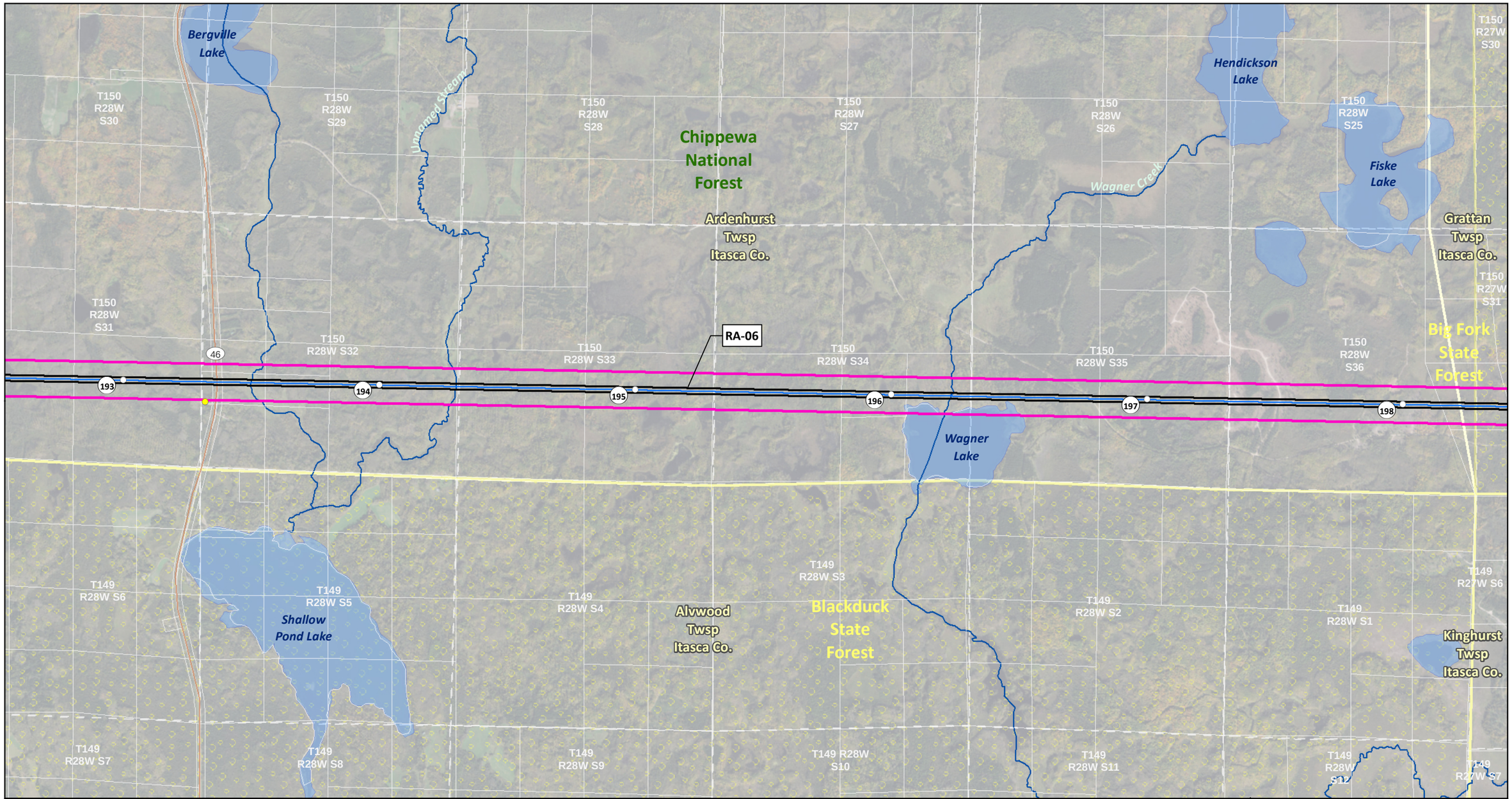
0 125 250 500 Meters

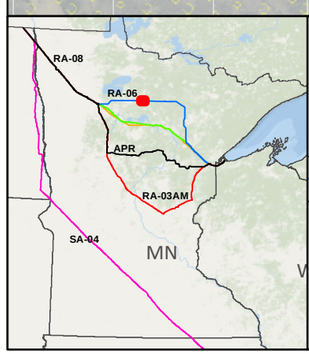
1:24,000

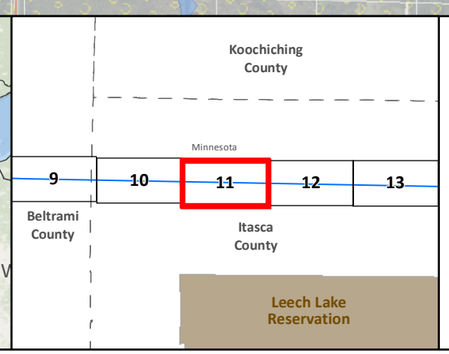
10ft Contours

N

Map 10B of 43







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

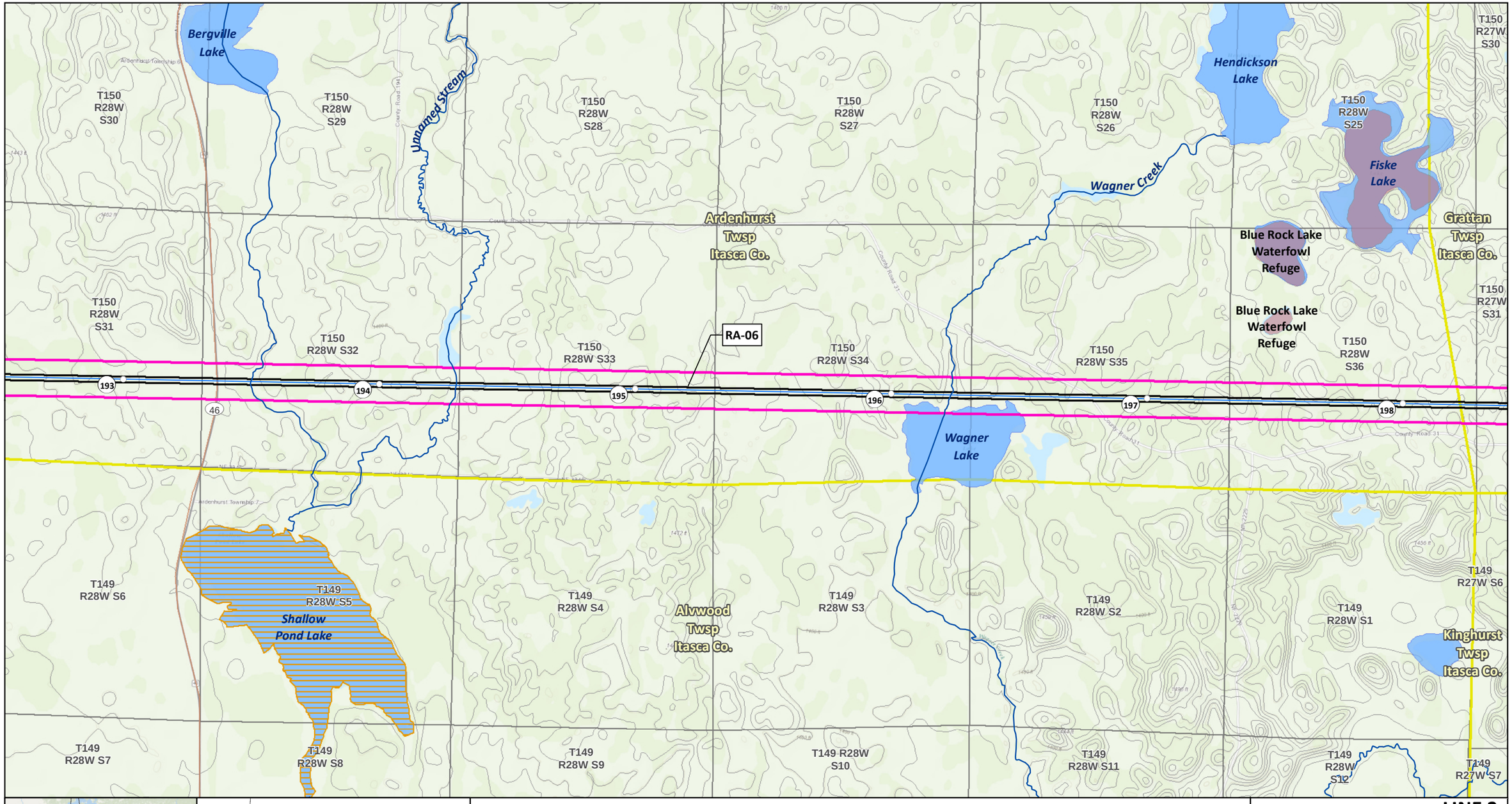
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

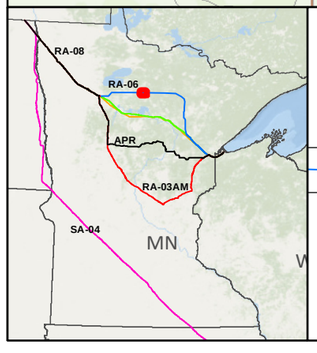
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

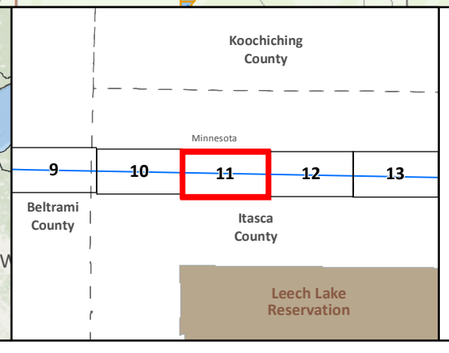
RA-06

CLEARBROOK TO CARLTON

Map 11A of 43







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

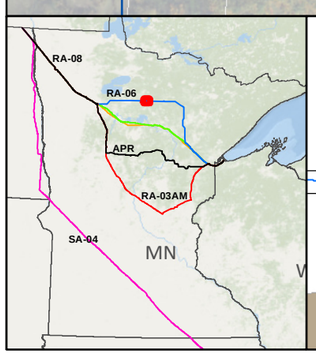
RA-06

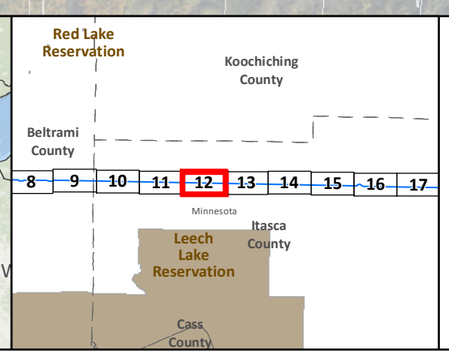
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 11B of 43

T150 R27W S30
T150 R27W S29
Wildlife Marsh
T150 R27W S28
Unnamed Stream
T150 R27W S27
T150 R27W S26
T150 R27W S25
T150 R26W S30
Big Fork State Forest
Grattan Twsp Itasca Co.
Dishpan Lake
Moose Brook
Windego Creek
Chippewa National Forest
RA-06
T150 R27W S31
T150 R27W S32
T150 R27W S33
T150 R27W S34
T150 R27W S35
T150 R27W S36
T150 R26W S31
199
200
201
202
203
Pomroy Twsp Itasca Co.
Coddington Lake
Dora Lake
T149 R27W S6
T149 R27W S5
T149 R27W S4
Kinghurst Twsp Itasca Co.
T149 R27W S3
T149 R27W S2
T149 R27W S1
T149 R26W S6
Wirt Twsp Itasca Co.
Big Fork River
T149 R27W S7
T149 R27W S8
T149 R27W S9
T149 R27W S10
T149 R27W S11
T149 R27W S12
T149 R26W S7





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources: MNDNR, NHD, Enbridge

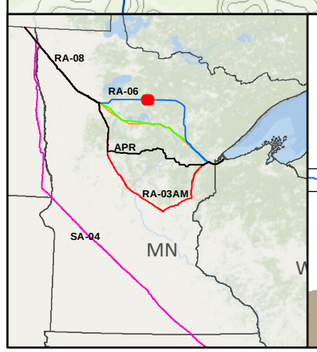
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

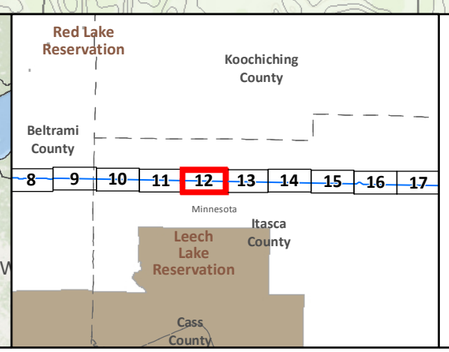
RA-06

CLEARBROOK TO CARLTON

Map 12A of 43

T150 R27W S30
T150 R27W S29
T150 R27W S28
T150 R27W S27
T150 R27W S26
T150 R27W S25
T150 R26W S30
Wildlife Marsh
Unnamed Stream
Dishpan WMA
Grattan Twsp Itasca Co.
Dishpan Lake
Moose Brook
Lost 40 SNA
Windego Creek
RA-06
T150 R27W S31
T150 R27W S32
T150 R27W S33
T150 R27W S34
T150 R27W S35
T150 R27W S36
T150 R26W S31
199
200
201
202
203
Pomroy Twsp Itasca Co.
Coddington Lake
Dora Lake
T149 R27W S6
T149 R27W S5
T149 R27W S4
T149 R27W S3
T149 R27W S2
T149 R27W S1
T149 R26W S6
Kinghurst Twsp Itasca Co.
Wirt Twsp Itasca Co.
Big Fork River
T149 R27W S7
T149 R27W S8
T149 R27W S9
T149 R27W S10
T149 R27W S11
T149 R27W S12
T149 R26W S7





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

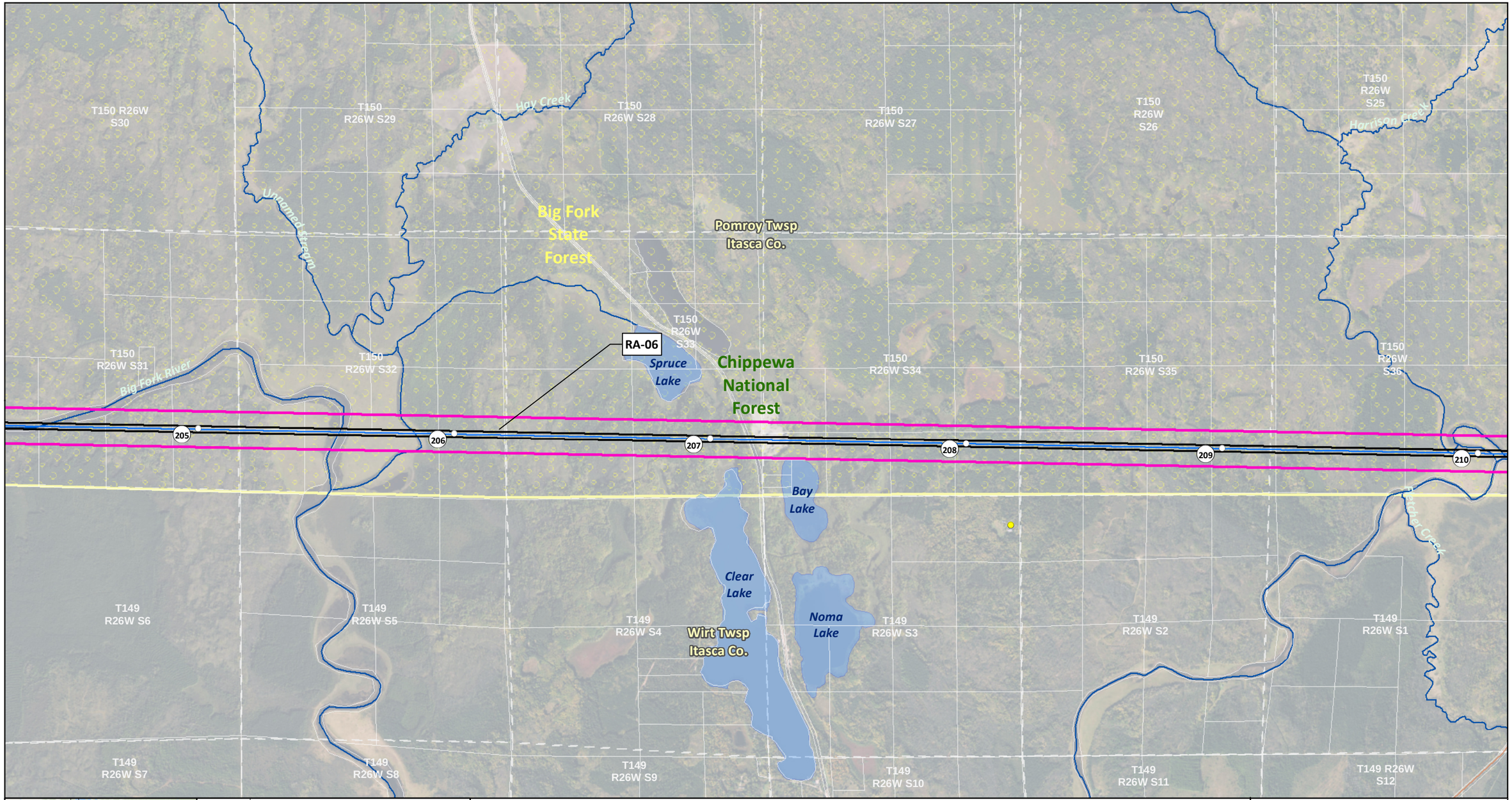
RA-06

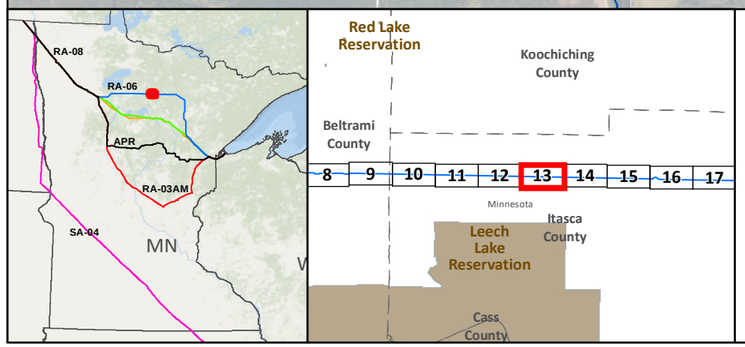
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 12B of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
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- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
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- County Boundary
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- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
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- Interstate
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Land Ownership

- State Forest
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- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

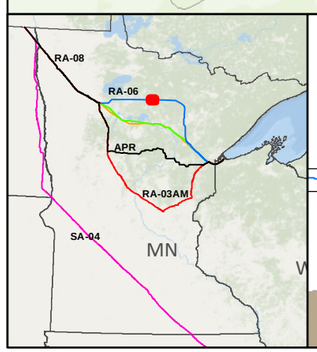
RA-06

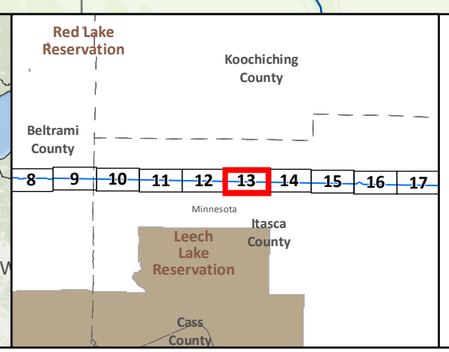
CLEARBROOK TO CARLTON

Map 13A of 43

T150 R26W S30
T150 R26W S29
T150 R26W S28
T150 R26W S27
T150 R26W S26
T150 R26W S25
T150 R26W S31
T150 R26W S32
T150 R26W S33
T150 R26W S34
T150 R26W S35
T150 R26W S36
T149 R26W S6
T149 R26W S5
T149 R26W S4
T149 R26W S3
T149 R26W S2
T149 R26W S1
T149 R26W S7
T149 R26W S8
T149 R26W S9
T149 R26W S10
T149 R26W S11
T149 R26W S12

Hay Creek
Unnamed Stream
Harrison Creek
Big Fork River
Fletcher Creek
Pomroy Twsp
Itasca Co.
Wirt Twsp
Itasca Co.
Spruce Lake
Bay Lake
Clear Lake
Noma Lake
RA-06
205
206
207
208
209
210





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Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
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1:24,000
10ft Contours

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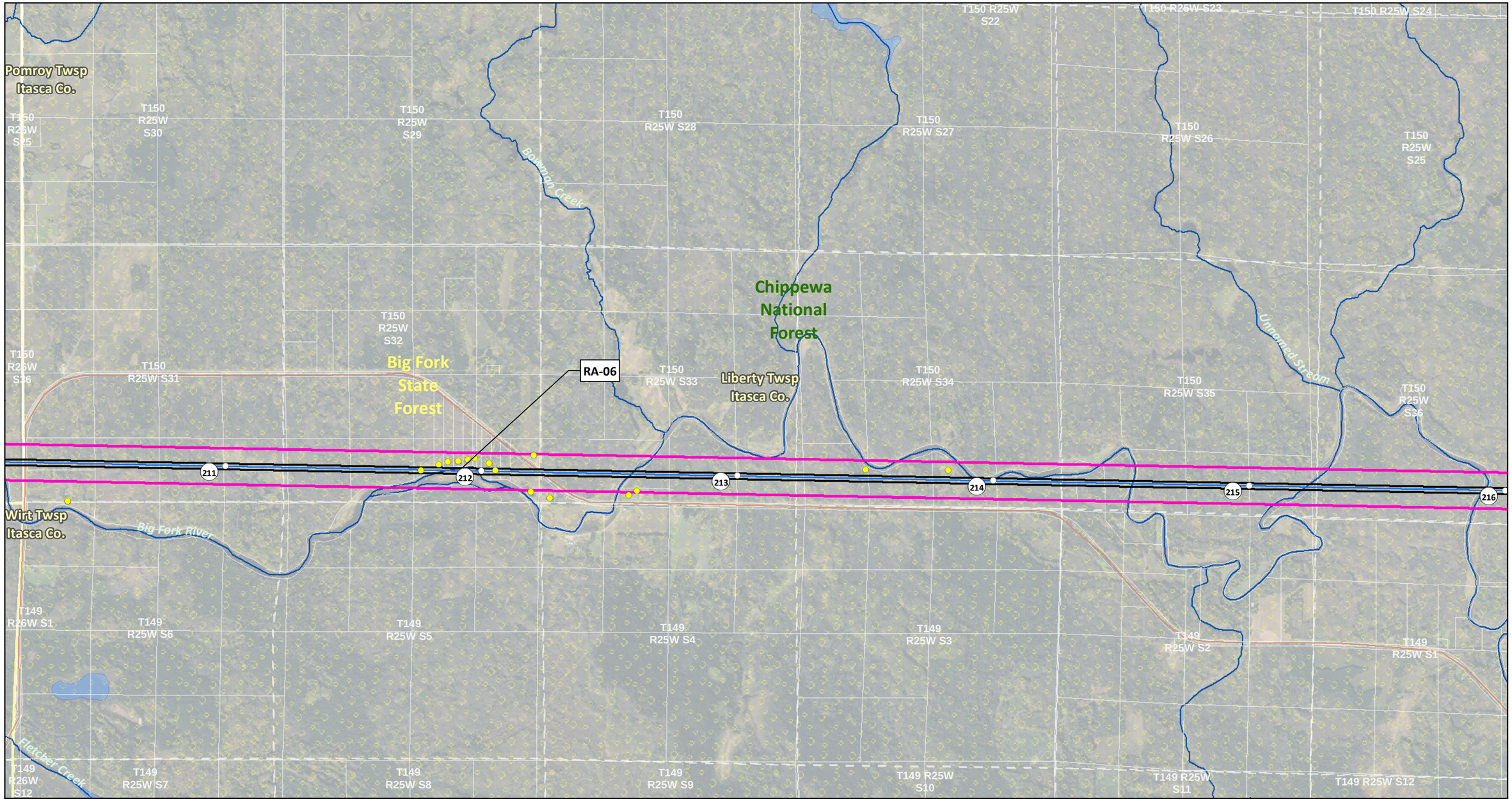
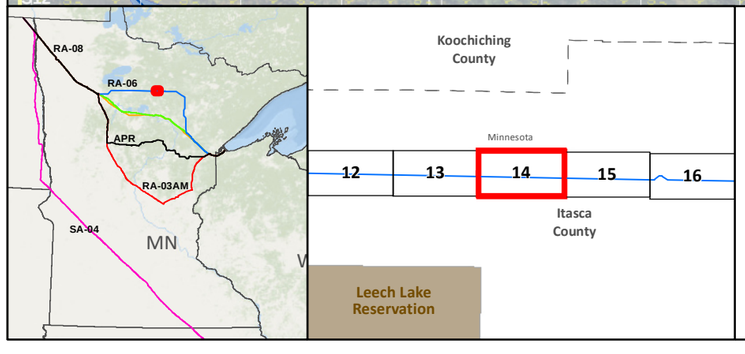
Map 13B of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

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- RA-06
- RA-07
- RA-08
- Existing Pipelines

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- Tribal Reservation
- Tribal Trust Land

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 14A of 43

Pomroy Twsp
Itasca Co.

T150 R26W S25
T150 R25W S30
T150 R25W S29
T150 R25W S28
T150 R25W S27
T150 R25W S22
T150 R25W S23
T150 R25W S24
T150 R25W S26
T150 R25W S25
T150 R26W S36
T150 R25W S31
T150 R25W S32
T150 R25W S33
T150 R25W S34
T150 R25W S35
T150 R25W S36

Bowman Creek
Unnamed Stream
Liberty Twsp
Itasca Co.

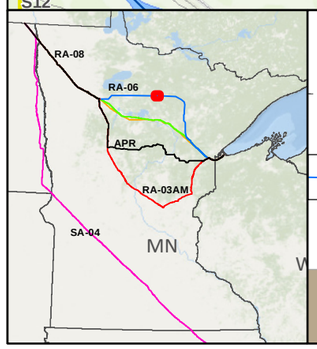
RA-06

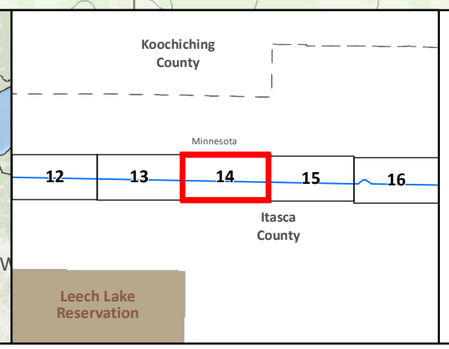
211 212 213 214 215 216

Wirt Twsp
Itasca Co.

Big Fork River
Fletcher Creek

T149 R26W S1
T149 R25W S6
T149 R25W S5
T149 R25W S4
T149 R25W S3
T149 R25W S2
T149 R25W S1
T149 R26W S12
T149 R25W S7
T149 R25W S8
T149 R25W S9
T149 R25W S10
T149 R25W S11
T149 R25W S12





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

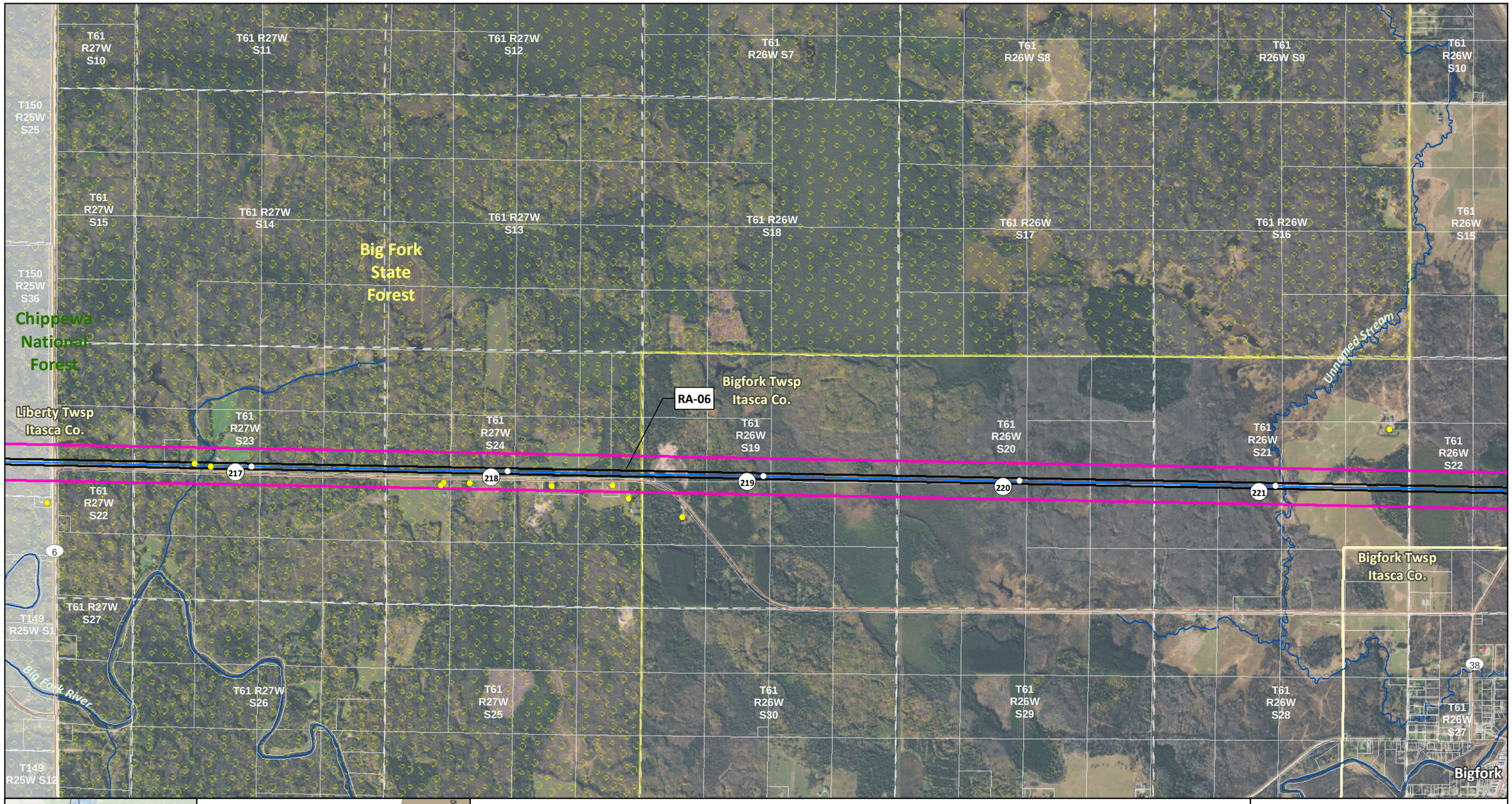
RA-06

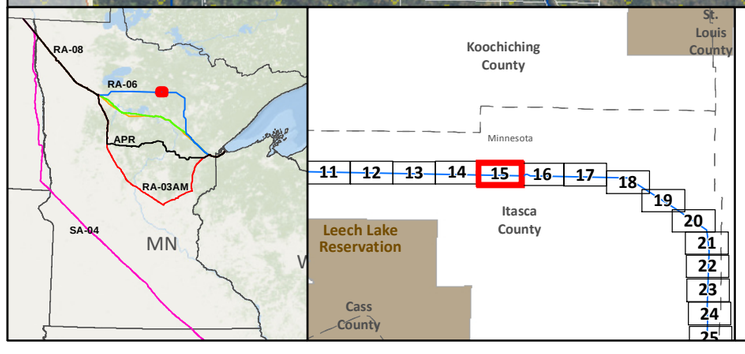
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 14B of 43





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

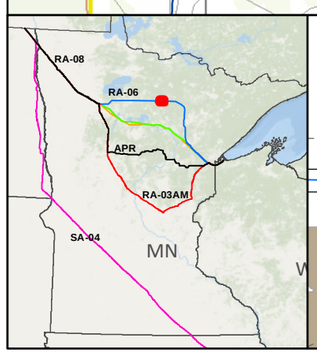
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

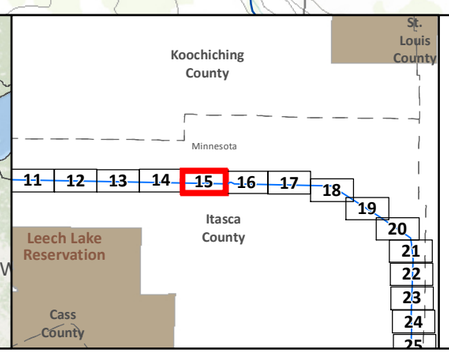
RA-06

CLEARBROOK TO CARLTON

Map 15A of 43

T61 R27W S10
T61 R27W S11
T61 R27W S12
T61 R26W S7
T61 R26W S8
T61 R26W S9
T61 R26W S10
T150 R25W S25
T61 R27W S15
T61 R27W S14
T61 R27W S13
T61 R26W S18
T61 R26W S17
T61 R26W S16
T61 R26W S15
6
T150 R25W S36
Liberty Twsp Itasca Co.
T61 R27W S23
T61 R27W S24
RA-06
Bigfork Twsp Itasca Co.
T61 R26W S19
T61 R26W S20
T61 R26W S21
T61 R26W S22
Unnamed Stream
217
218
219
220
221
T61 R27W S22
Bigfork Twsp Itasca Co.
T149 R25W S1
T61 R27W S27
Big Fork River
T61 R27W S26
T61 R27W S25
T61 R26W S30
T61 R26W S29
T61 R26W S28
38
T61 R26W S27
Bigfork
T149 R25W S12





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- Applicant's Preferred Route (APR)

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- RA-06
- RA-07
- RA-08
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- Township Boundary

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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
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- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

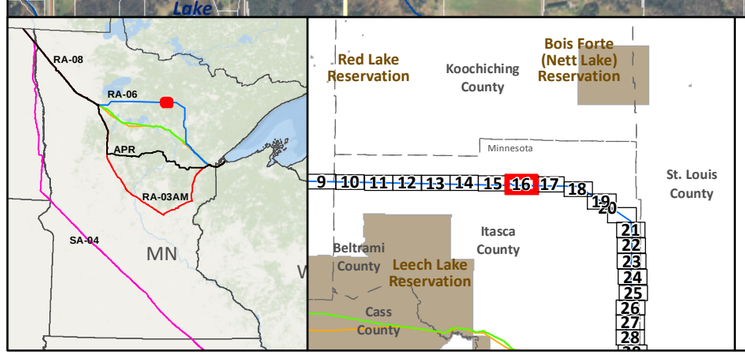
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 15B of 43





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
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Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

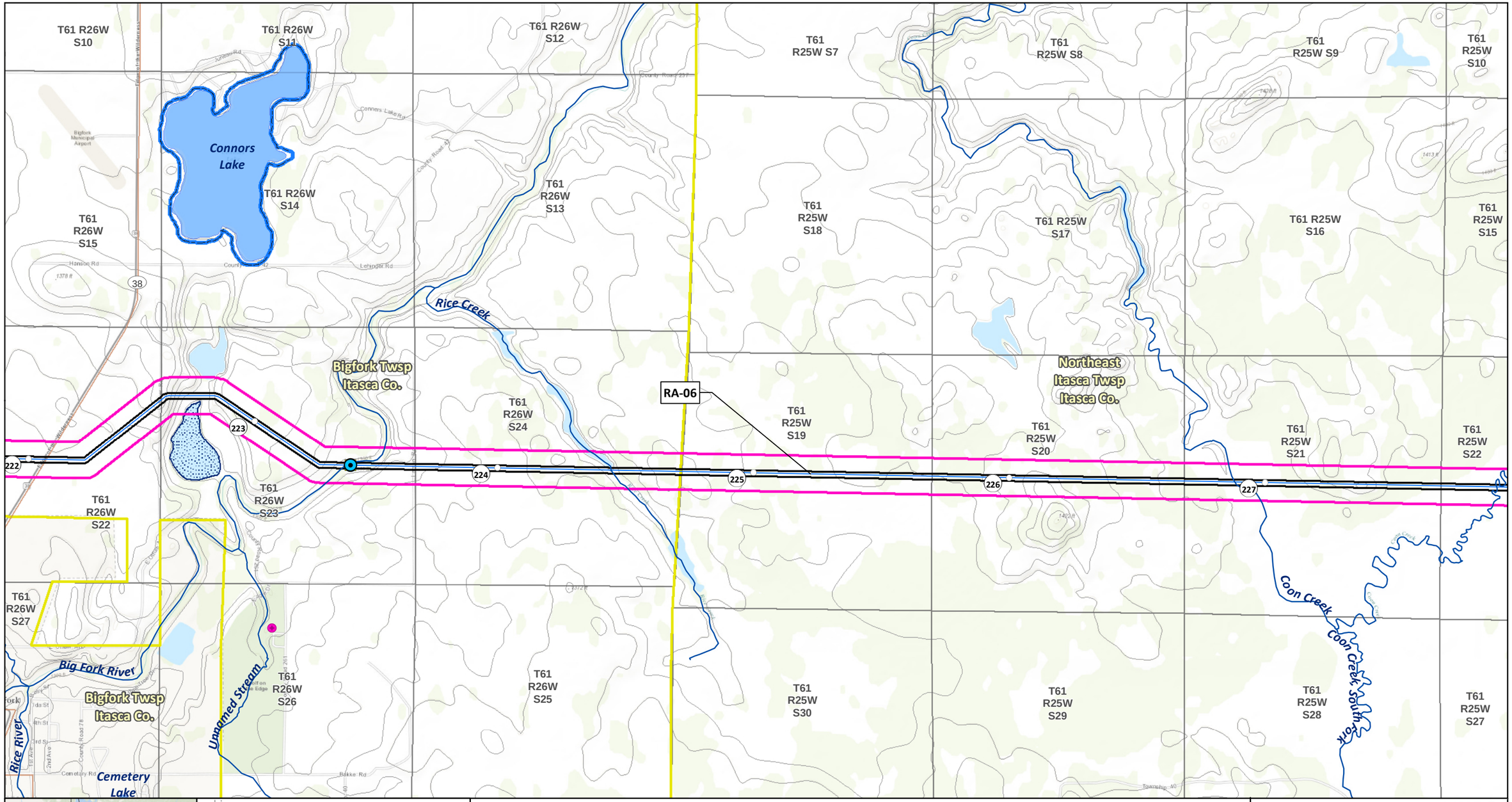
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 16A of 43


T61 R26W S10
T61 R26W S11
T61 R26W S12
T61 R25W S7
T61 R25W S8
T61 R25W S9
T61 R25W S10
Connors Lake
T61 R26W S14
T61 R26W S13
T61 R25W S18
T61 R25W S17
T61 R25W S16
T61 R25W S15
T61 R26W S15
38
Rice Creek
Bigfork Twsp Itasca Co.
RA-06
Northeast Itasca Twsp Itasca Co.
T61 R26W S24
T61 R25W S19
T61 R25W S20
T61 R25W S21
T61 R25W S22
222
223
224
225
226
227
T61 R26W S22
T61 R26W S23
T61 R26W S27
Big Fork River
Unnamed Stream
T61 R26W S26
T61 R26W S25
T61 R25W S30
T61 R25W S29
T61 R25W S28
T61 R25W S27
Coon Creek
Coon Creek South Fork
Bigfork Twsp Itasca Co.
Rice River
Cemetery Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Red Lake Reservation
Koochiching County
Bois Forte (Nett Lake) Reservation
Minnesota
St. Louis County
Itasca County
Beltrami County
Leech Lake Reservation
Cass County
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
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SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
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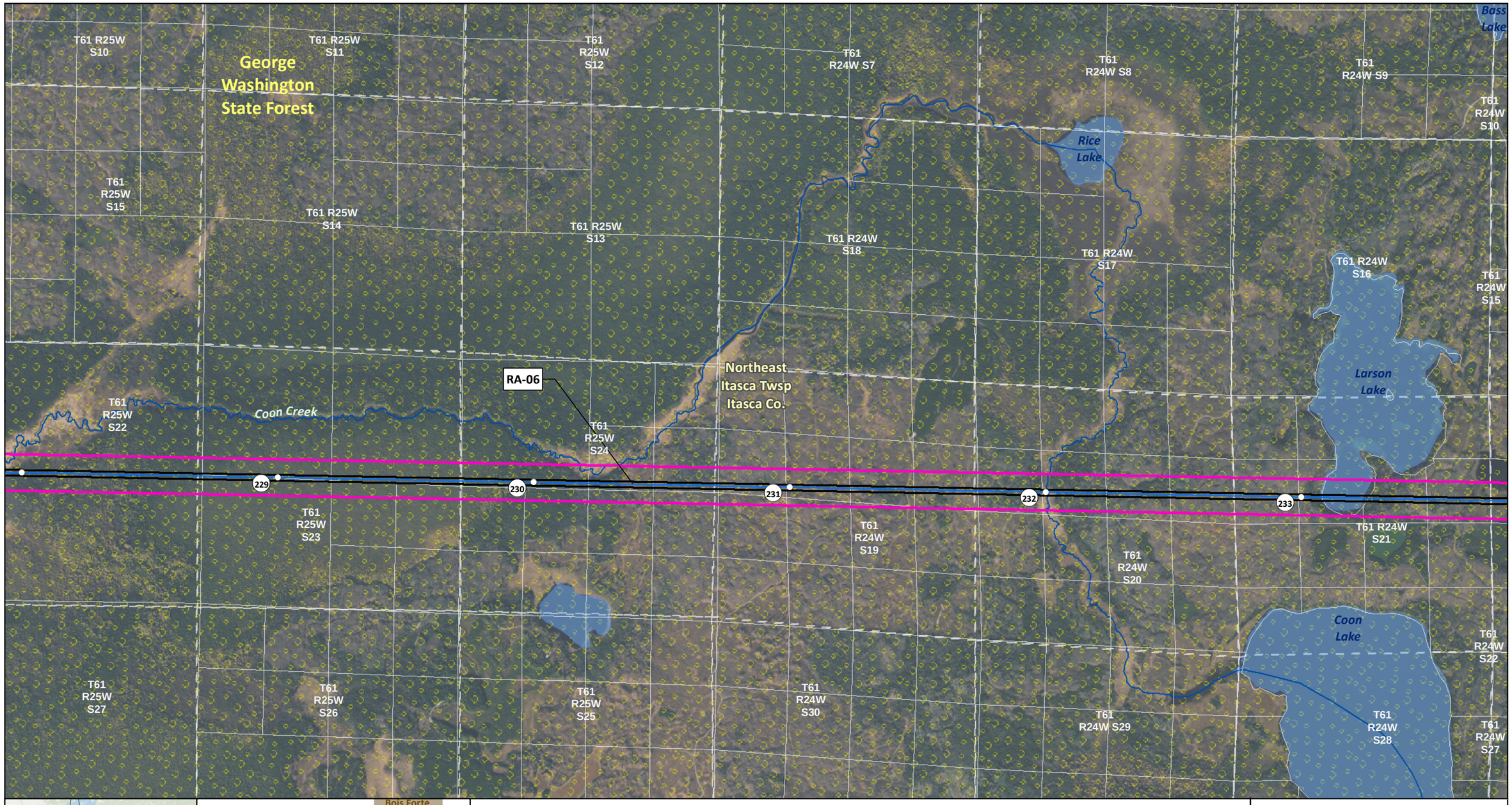
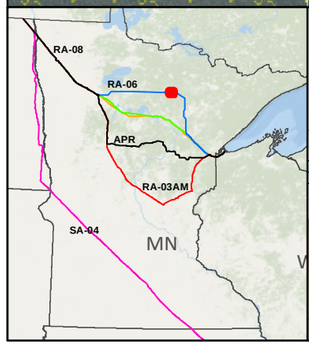
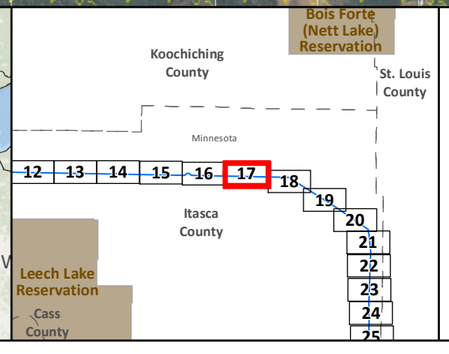
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 16B of 43







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

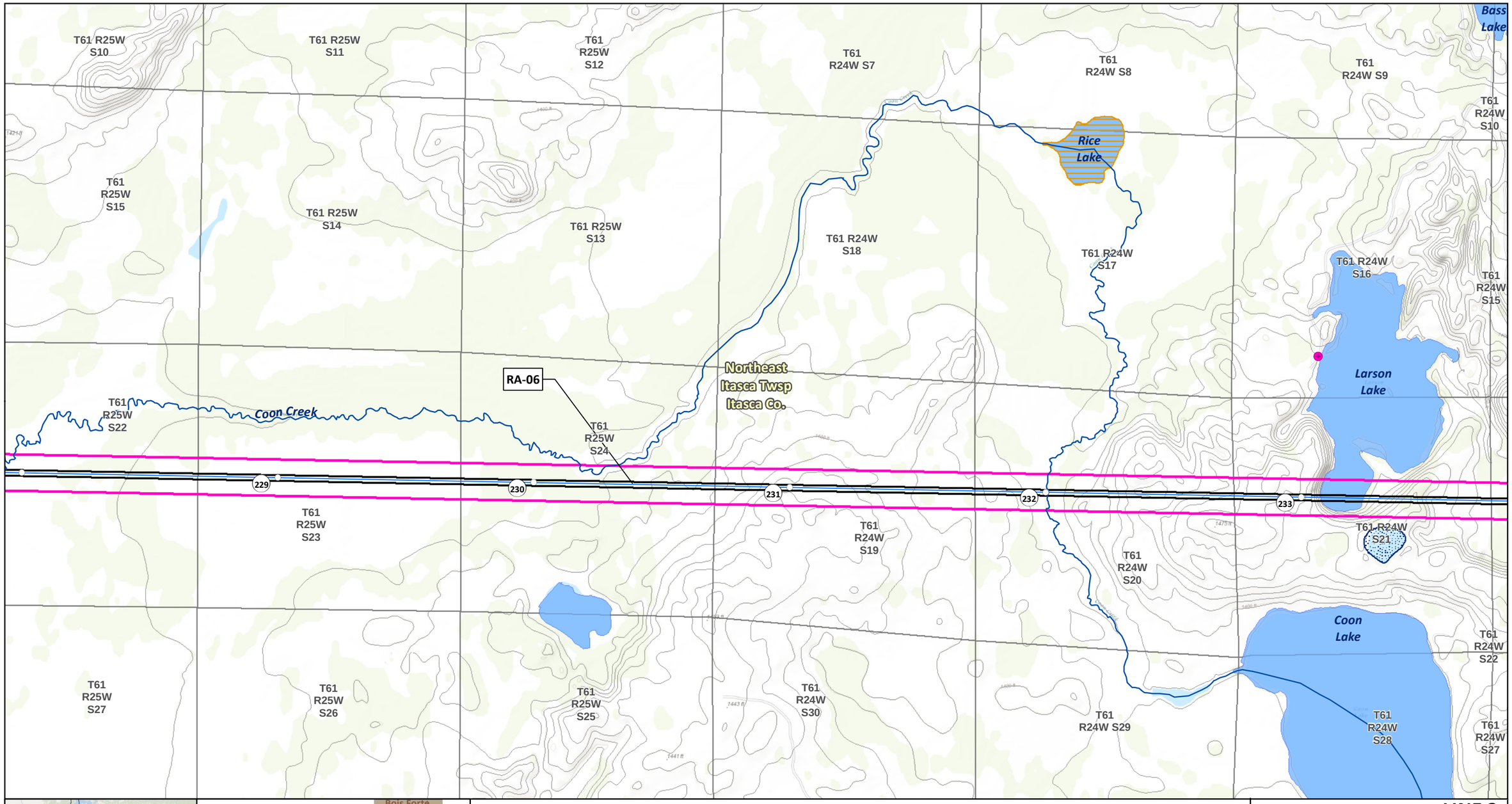
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

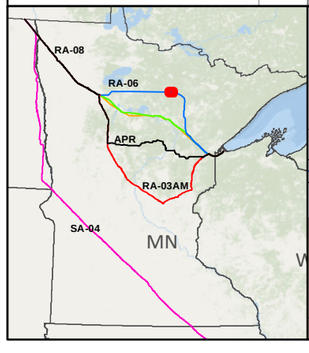
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

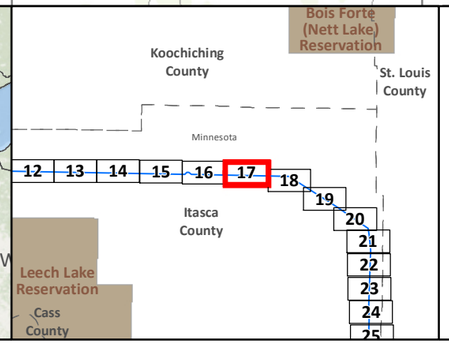
RA-06

CLEARBROOK TO CARLTON

Map 17A of 43







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

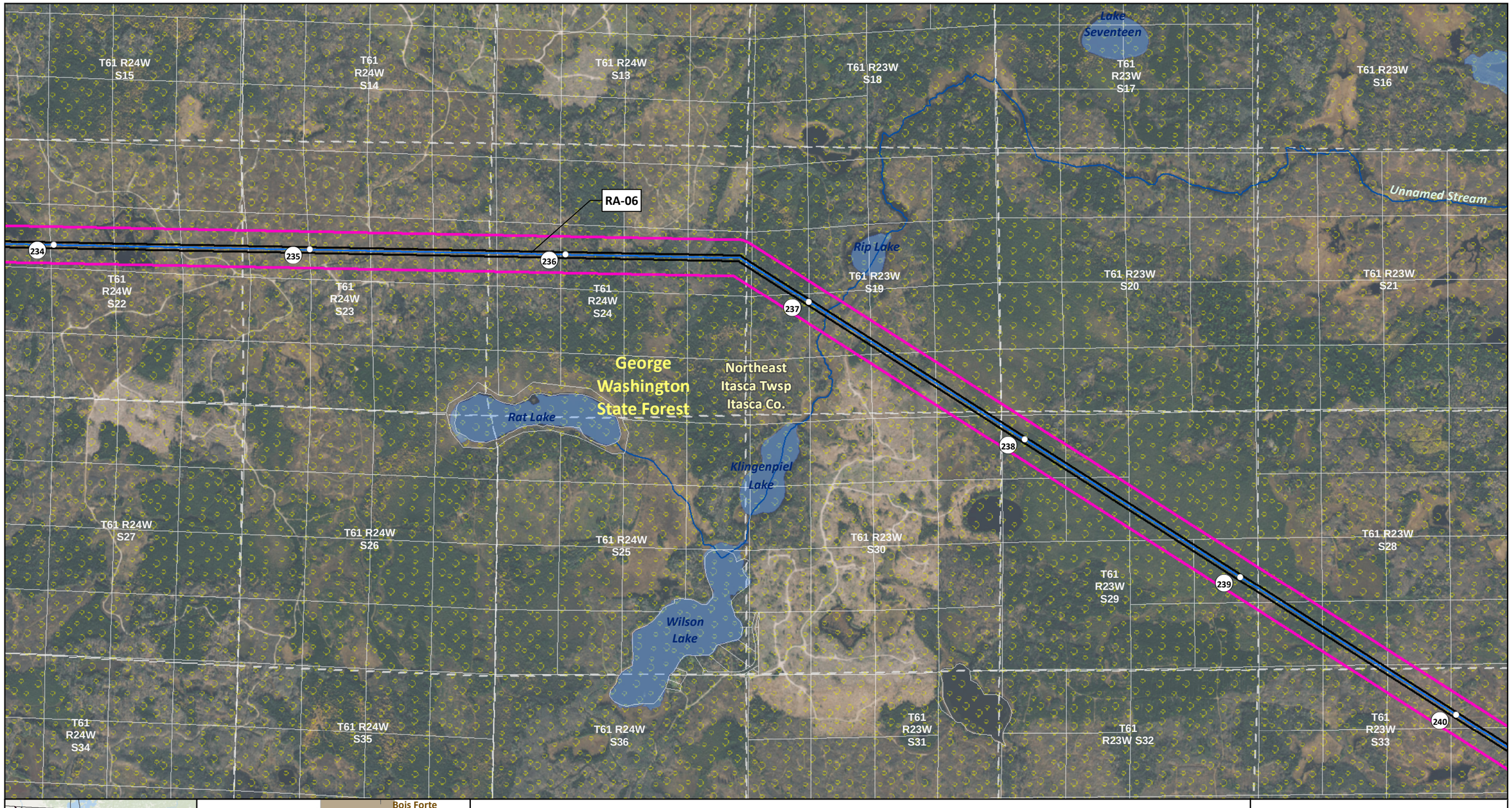
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

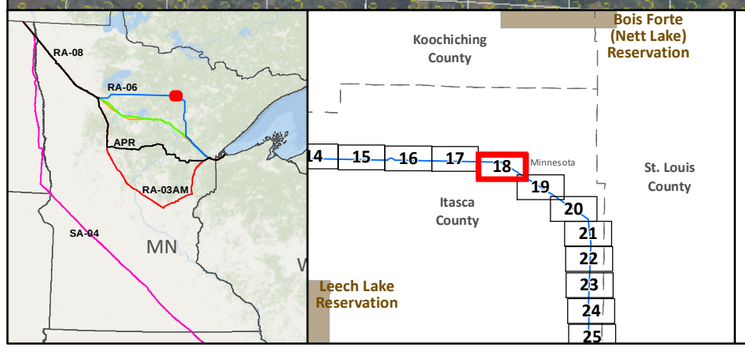
RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 17B of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
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- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
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- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

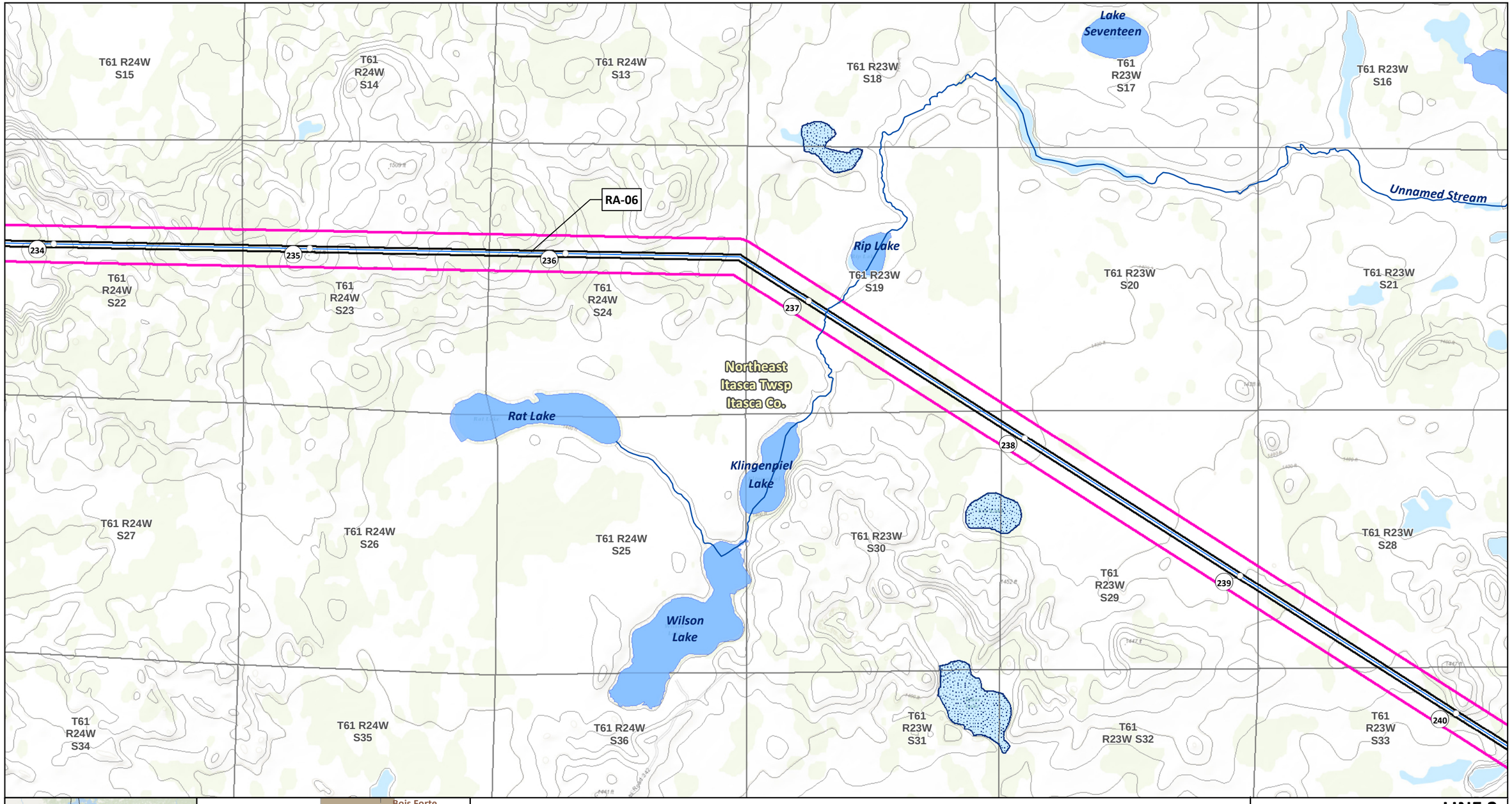
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

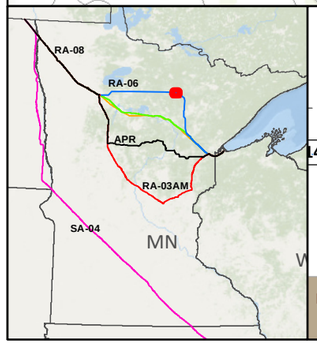
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

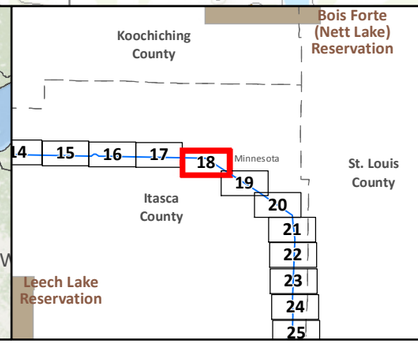
RA-06

CLEARBROOK TO CARLTON

Map 18A of 43







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
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Existing Pipelines
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Native Plant Communities with Biodiversity Significance
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Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

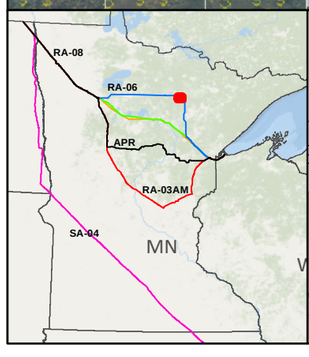
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC RA-06

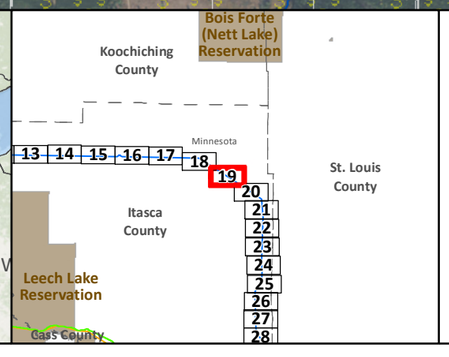
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 18B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

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Tribal Trust Land

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0 0.125 0.25 0.5 Miles

1:24,000

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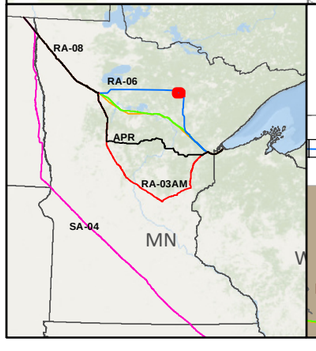
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

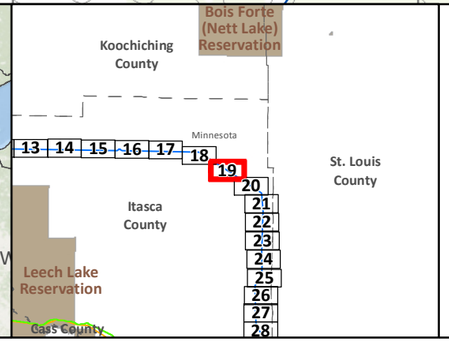
RA-06

CLEARBROOK TO CARLTON

Map 19A of 43

T61 R23W S29
T61 R23W S28
T61 R23W S27
T61 R23W S26
T61 R23W S25
T61 R22W S30
T61 R22W S29
Northeast Itasca Twsp Itasca Co.
T61 R23W S32
T61 R23W S33
T61 R23W S34
T61 R23W S35
T61 R23W S36
T61 R22W S31
T61 R22W S32
240
241
242
243
244
245
Unnamed Stream
RA-06
Bearville Twsp Itasca Co.
65
T60 R23W S5
T60 R23W S4
T60 R23W S3
T60 R23W S2
T60 R23W S1
T60 R22W S6
Bear River
Venning Creek
Little Bear Lake
T60 R23W S8
T60 R23W S9
T60 R23W S10
T60 R23W S11
T60 R23W S12
T60 R22W S7
Lime Bear Lake Rd
County Road 502
Link Lake Rd





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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

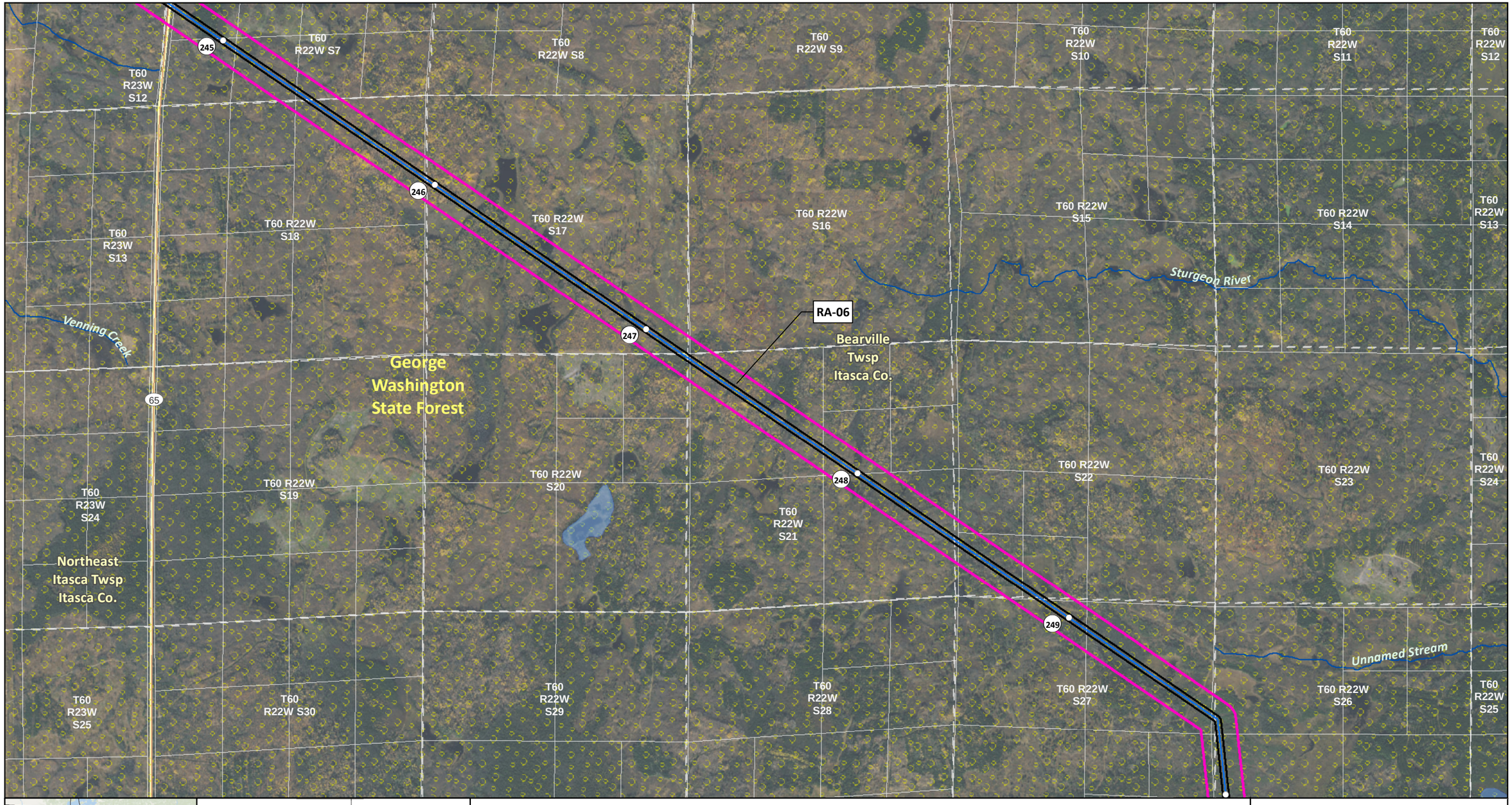
RA-06

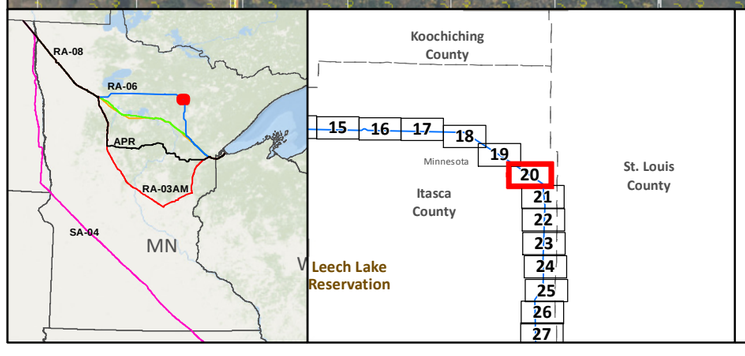
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 19B of 43





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08

Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

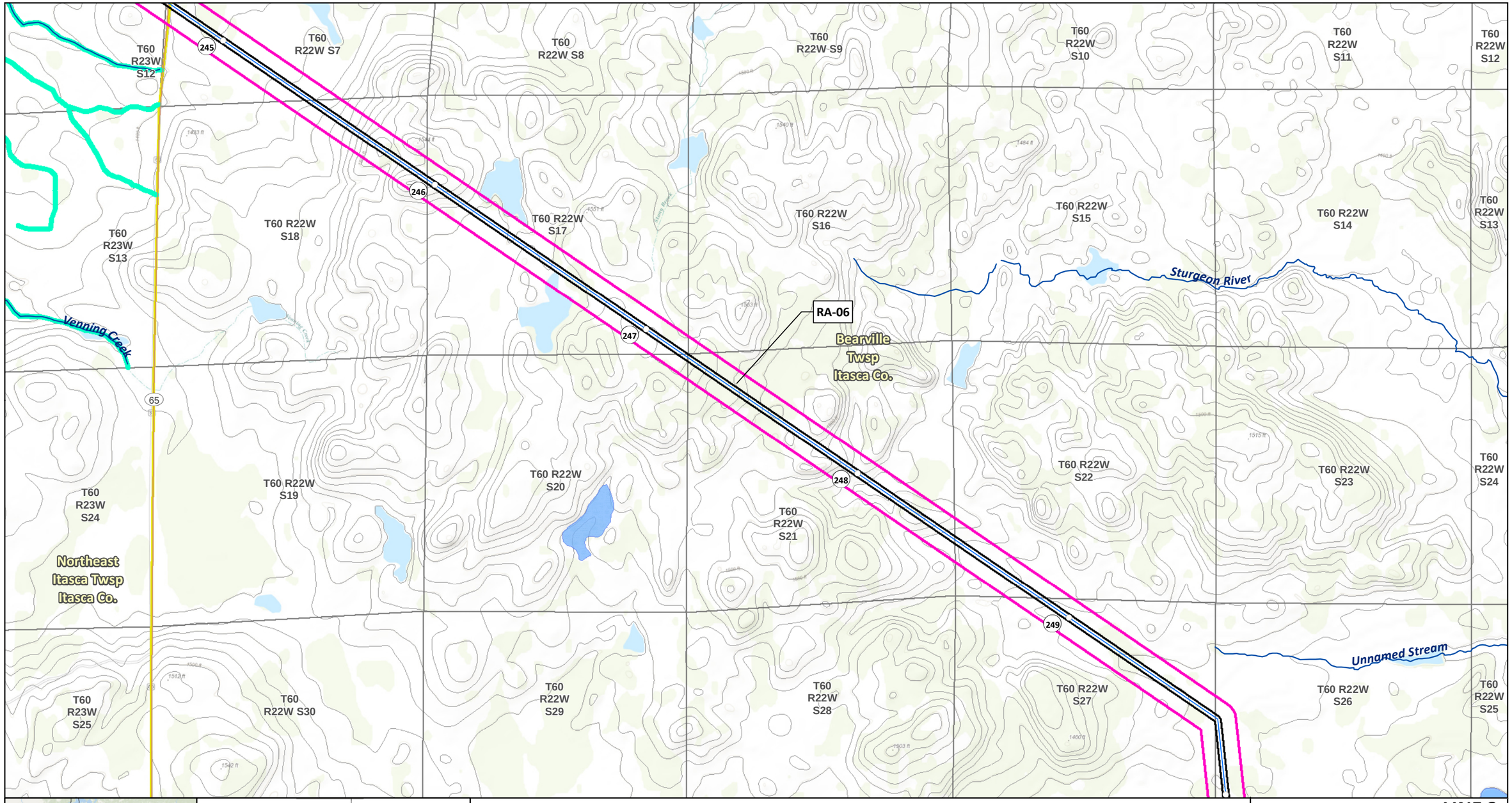
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

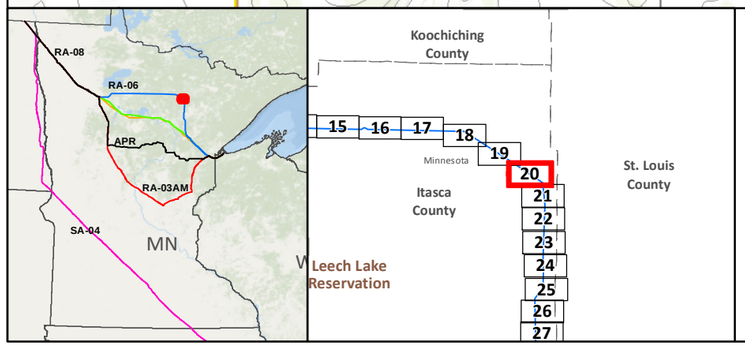
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 20A of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
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- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

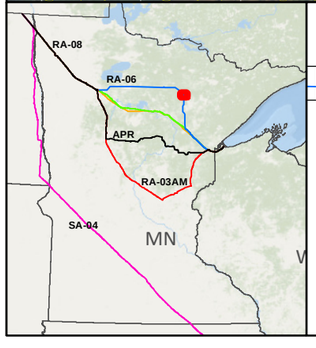
1:24,000

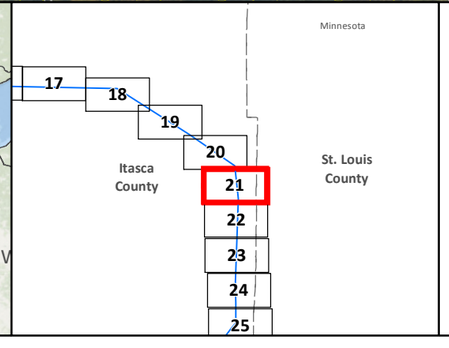
10ft Contours

N

Map 20B of 43

T60 R22W S29
T60 R22W S28
T60 R22W S27
T60 R22W S26
T60 R22W S25
T60 R21W S30
Sturgeon River State Forest
Bearville Twsp Itasca Co.
French Twsp St. Louis Co.
T60 R21W S31
T60 R22W S32
T60 R22W S33
T60 R22W S34
T60 R22W S35
T60 R22W S36
250
251
RA-06
South Sturgeon Lake
Sherry Lake
George Washington State Forest
Unnamed Stream
T59 R22W S5
T59 R22W S4
T59 R22W S3
T59 R22W S2
T59 R22W S1
T59 R21W S6
252
Northeast Itasca Twsp Itasca Co.
McCormack Twsp St. Louis Co.
T59 R22W S8
T59 R22W S9
T59 R22W S10
T59 R22W S11
T59 R22W S12
T59 R21W S7
253





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- Applicant's Preferred Route (APR)

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- RA-03AM
- RA-06
- RA-07
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- State Forest
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Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

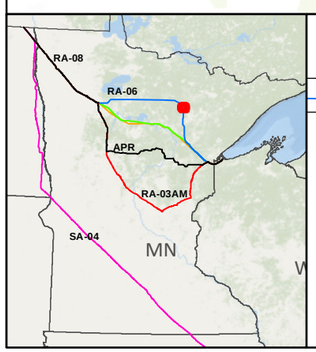
RA-06

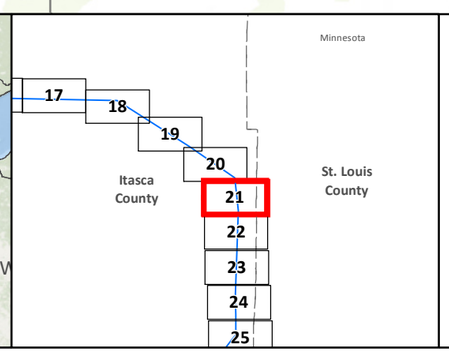
CLEARBROOK TO CARLTON

N

Map 21A of 43

T60 R22W S29
T60 R22W S28
T60 R22W S27
T60 R22W S26
T60 R22W S25
T60 R21W S30
T60 R21W S31
Bearville Twsp Itasca Co.
French Twsp St. Louis Co.
T60 R22W S32
T60 R22W S33
T60 R22W S34
T60 R22W S35
T60 R22W S36
South Sturgeon Lake
RA-06
Sherry Lake
Unnamed Stream
T59 R22W S5
T59 R22W S4
T59 R22W S3
T59 R22W S2
T59 R22W S1
T59 R21W S6
McCormack Twsp St. Louis Co.
Northeast Itasca Twsp Itasca Co.
T59 R22W S8
T59 R22W S9
T59 R22W S10
T59 R22W S11
T59 R22W S12
T59 R21W S7





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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

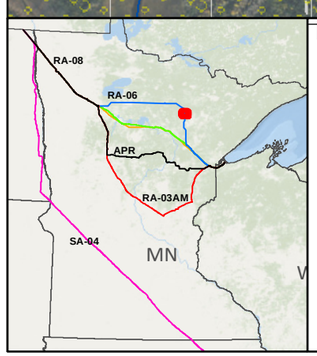
CLEARBROOK TO CARLTON

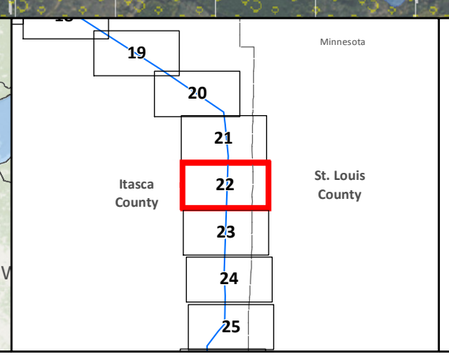
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 21B of 43

T59 R22W S8
T59 R22W S9
T59 R22W S10
T59 R22W S11
T59 R22W S12
T59 R21W S7
T59 R21W S8
Northeast Itasca Twsp Itasca Co.
Prairie River
Unnamed Stream
Stingy Lake
T59 R22W S15
T59 R22W S16
T59 R22W S17
Bower Lake
T59 R22W S14
T59 R22W S13
Sturgeon River State Forest
T59 R21W S17
T59 R21W S18
254
RA-06
George Washington State Forest
T59 R22W S20
T59 R22W S21
T59 R22W S22
T59 R22W S23
T59 R22W S24
Lake Twentyfour
McCormack Twsp St. Louis Co.
T59 R21W S19
T59 R21W S20
255
Gansey Lake
T59 R22W S29
T59 R22W S28
T59 R22W S27
T59 R22W S26
T59 R22W S25
T59 R21W S30
T59 R21W S29
Stuart Lake
256
Day Brook





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- Applicant's Preferred Route (APR)

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- RA-07
- RA-08
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- State Forest
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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

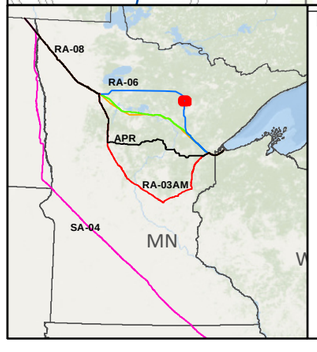
RA-06

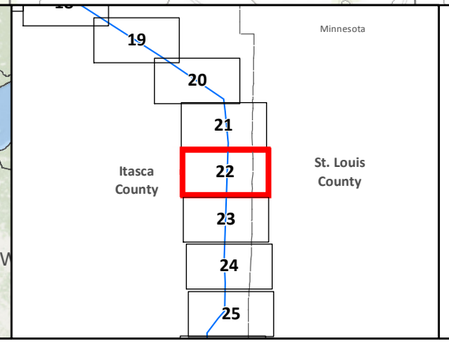
CLEARBROOK TO CARLTON

N

Map 22A of 43

T59 R22W S8
T59 R22W S9
T59 R22W S10
T59 R22W S11
T59 R22W S12
T59 R21W S7
T59 R21W S8
Prairie River
Unnamed Stream
Stingy Lake
T59 R22W S16
T59 R22W S15
T59 R22W S17
T59 R22W S14
T59 R22W S13
T59 R21W S18
T59 R21W S17
Bower Lake
Bower Lake Forest Rd
RA-06
254
County Road 544
T59 R22W S22
Northeast Itasca Twsp Itasca Co.
T59 R22W S21
T59 R22W S20
T59 R22W S23
T59 R22W S24
McCormack Twsp St. Louis Co.
T59 R21W S20
T59 R21W S19
255
Lake Twentyfour
Gansey Lake
Day Brook
T59 R22W S29
T59 R22W S28
T59 R22W S27
T59 R22W S26
T59 R22W S25
T59 R21W S29
T59 R21W S30
256
Stuart Lake
ITASCA
ST LOUIS





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- High
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Native Plant Communities with Biodiversity Significance
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 22B of 43

Northeast Itasca Twsp Itasca Co.

George Washington State Forest

T59 R22W S33

T59 R22W S32

Day Brook

T59 R22W S34

257

T59 R22W S35

Unnamed Stream

T59 R22W S36

McCormack Twsp St. Louis Co.

T59 R21W S31

T59 R21W S32

RA-06

T58 R22W S3

T58 R22W S5

T58 R22W S4

T58 R22W S2

258

T58 R22W S1

T58 R21W S6

T58 R21W S5

Hibbing Twsp St. Louis Co.

Rock Lake

Moran Lake

T58 R22W S8

T58 R22W S9

T58 R22W S10

T58 R22W S11

T58 R22W S12

T58 R21W S7

T58 R21W S8

East River

259

T58 R22W S17

T58 R22W S16

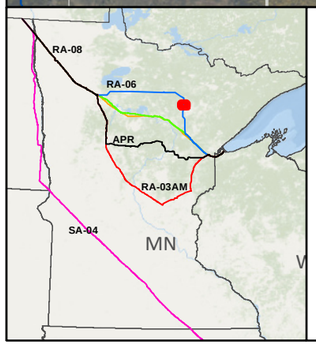
T58 R22W S15

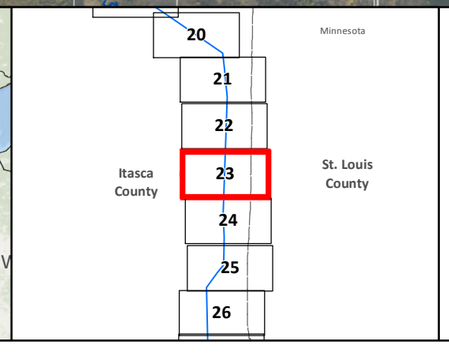
T58 R22W S14

T58 R22W S13

T58 R21W S18

T58 R21W S17





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0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 23A of 43

Northeast Itasca Twsp Itasca Co.

McCormack Twsp St. Louis Co.

Hibbing Twsp St. Louis Co.

T59 R22W S32

T59 R22W S33

T59 R22W S34

T59 R22W S35

T59 R22W S36

T59 R21W S31

T59 R21W S32

Day Brook

Unnamed Stream

257

258

259

RA-06

T58 R22W S5

T58 R22W S4

T58 R22W S3

T58 R22W S2

T58 R22W S1

T58 R21W S6

T58 R21W S5

T58 R22W S8

T58 R22W S9

T58 R22W S10

T58 R22W S11

T58 R22W S12

T58 R21W S7

T58 R21W S8

T58 R22W S17

T58 R22W S16

T58 R22W S15

T58 R22W S14

T58 R22W S13

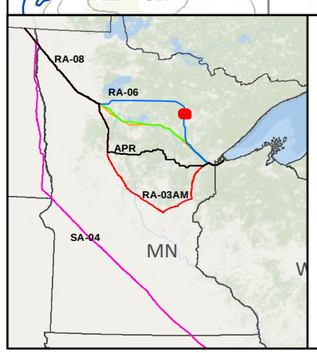
T58 R21W S18

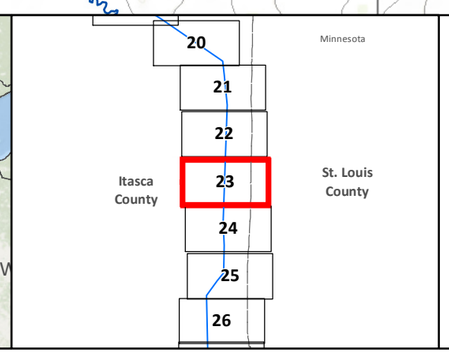
T58 R21W S17

East River

Rock Lake

Moran Lake





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- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

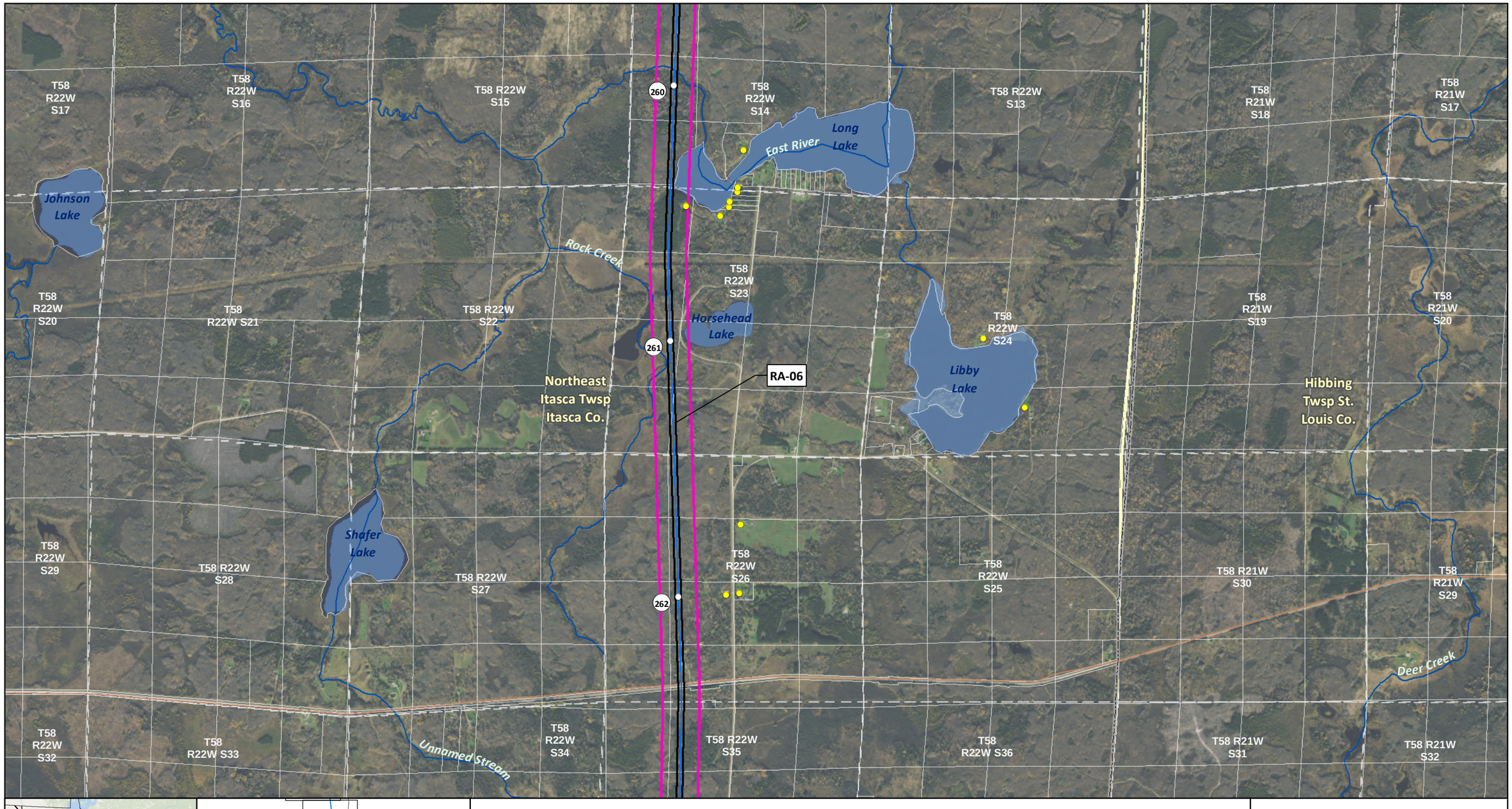
0 125 250 500 Meters

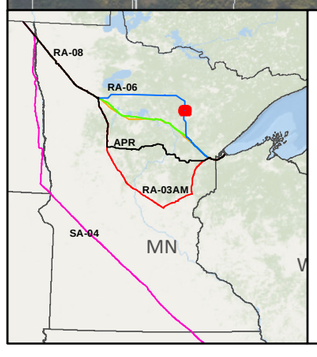
1:24,000

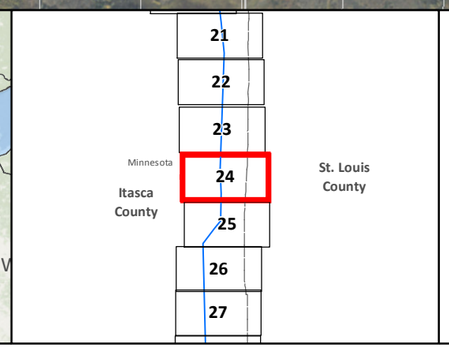
10ft Contours

N

Map 23B of 43







SA-04

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0 0.125 0.25 0.5 Miles

1:24,000

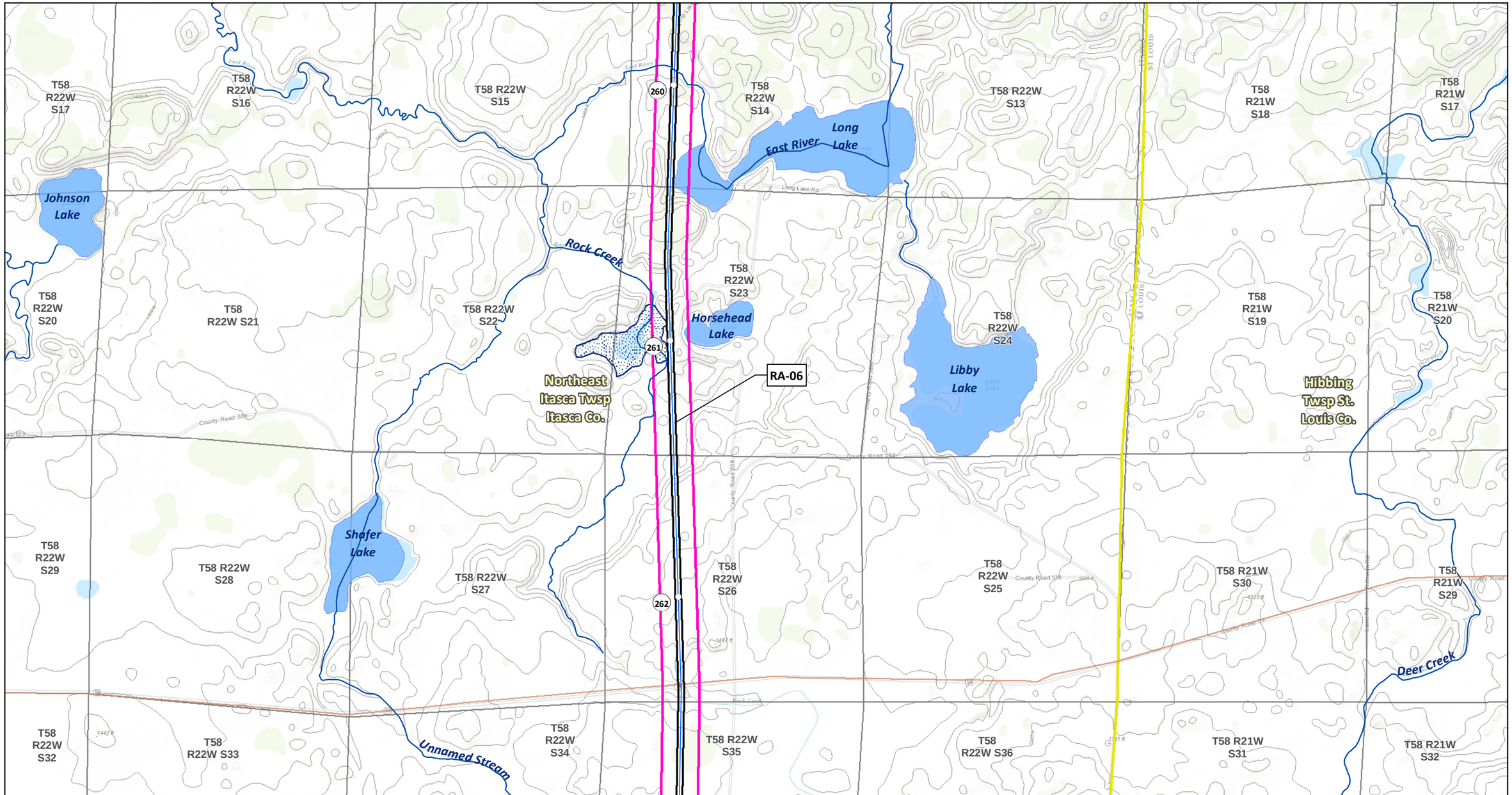
0 125 250 500 Meters

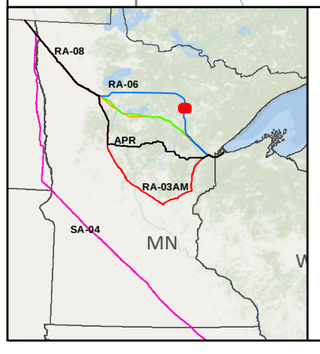
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

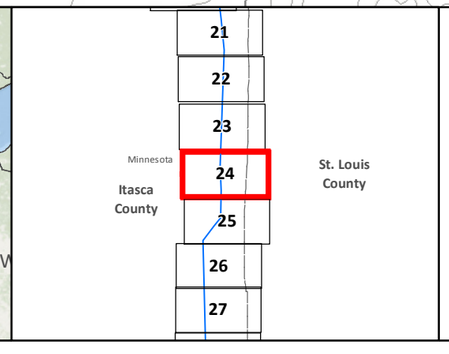
RA-06

CLEARBROOK TO CARLTON

Map 24A of 43







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Moderate

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Data Sources:
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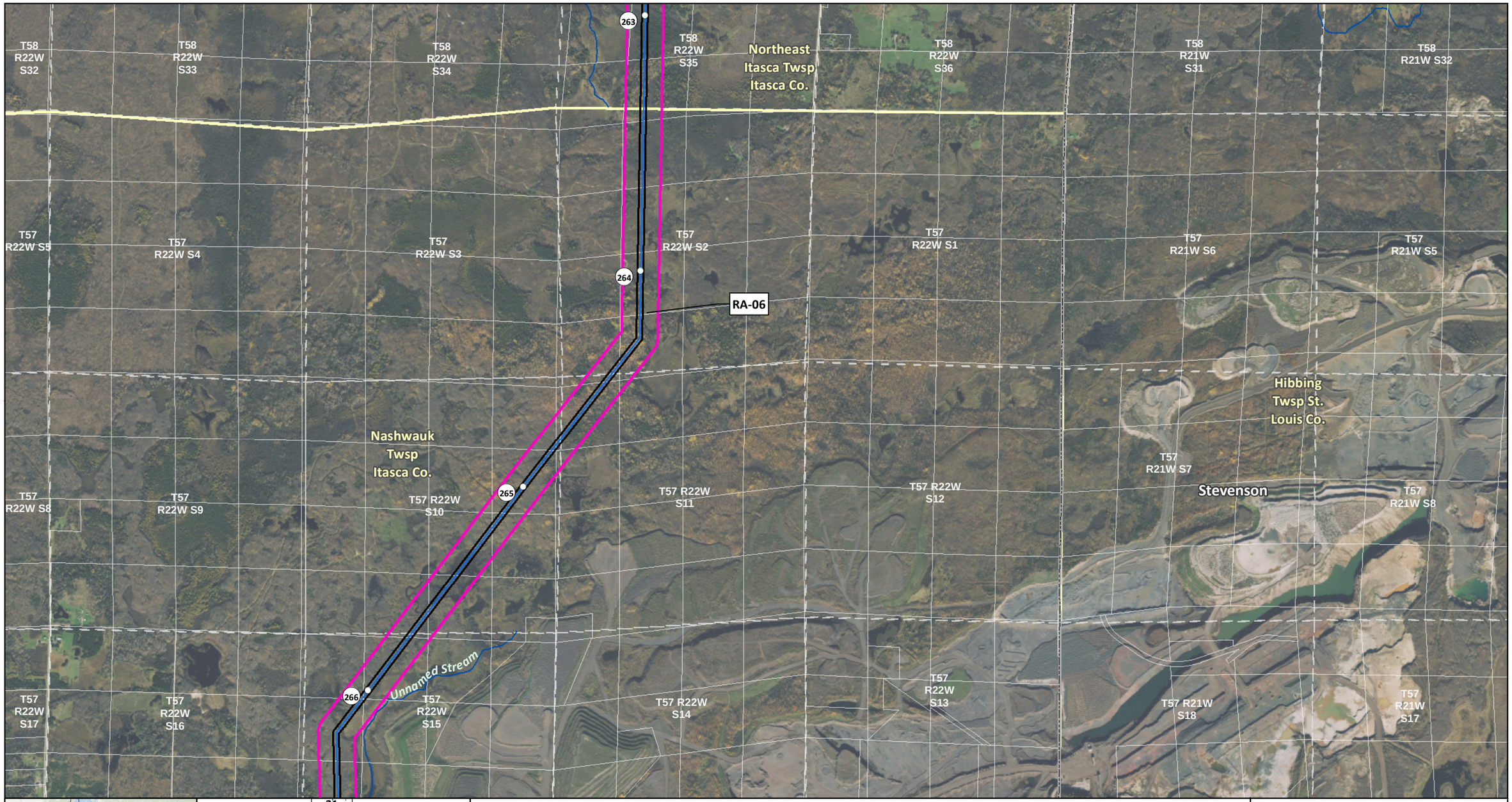
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 24B of 43

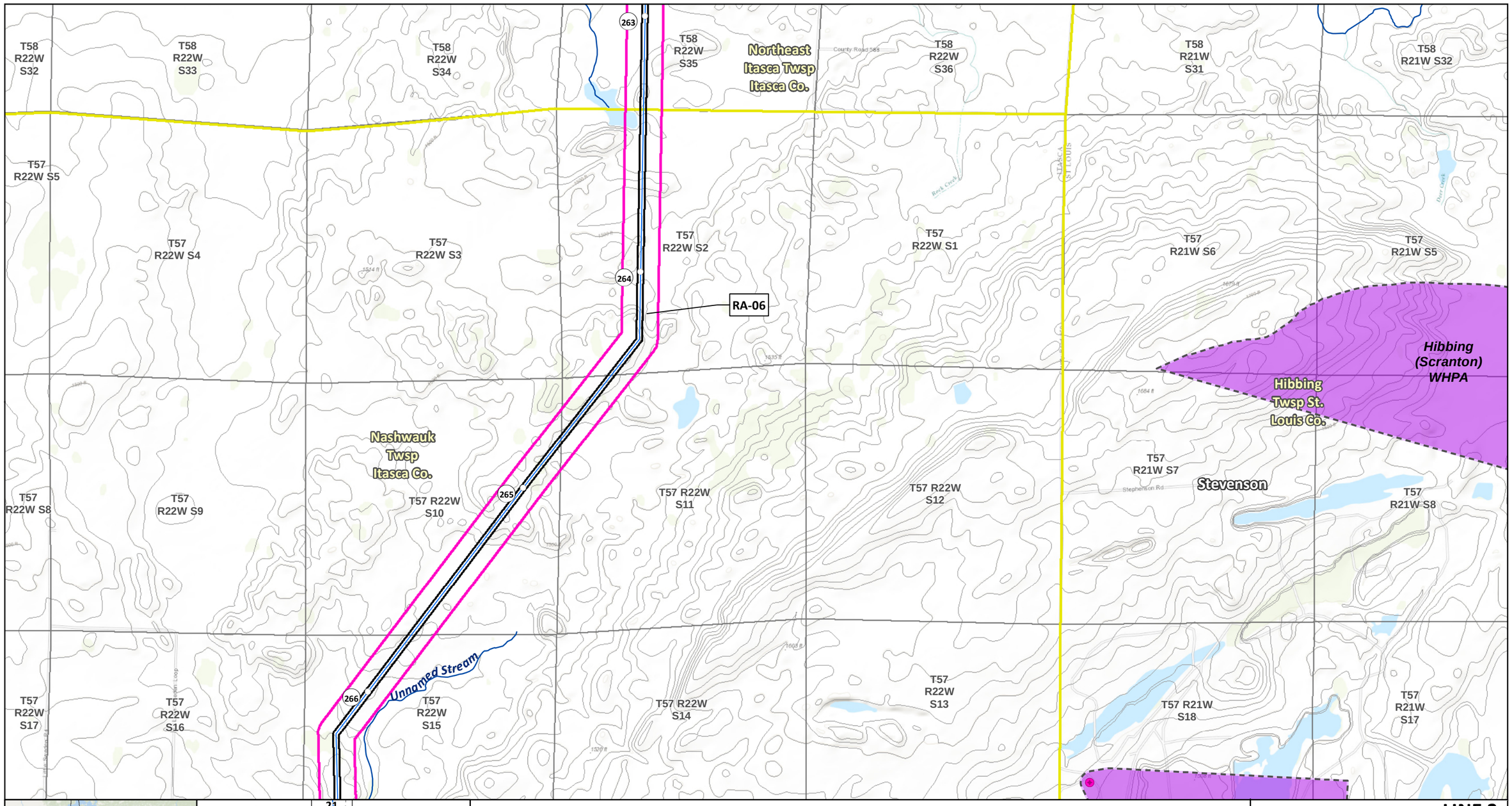


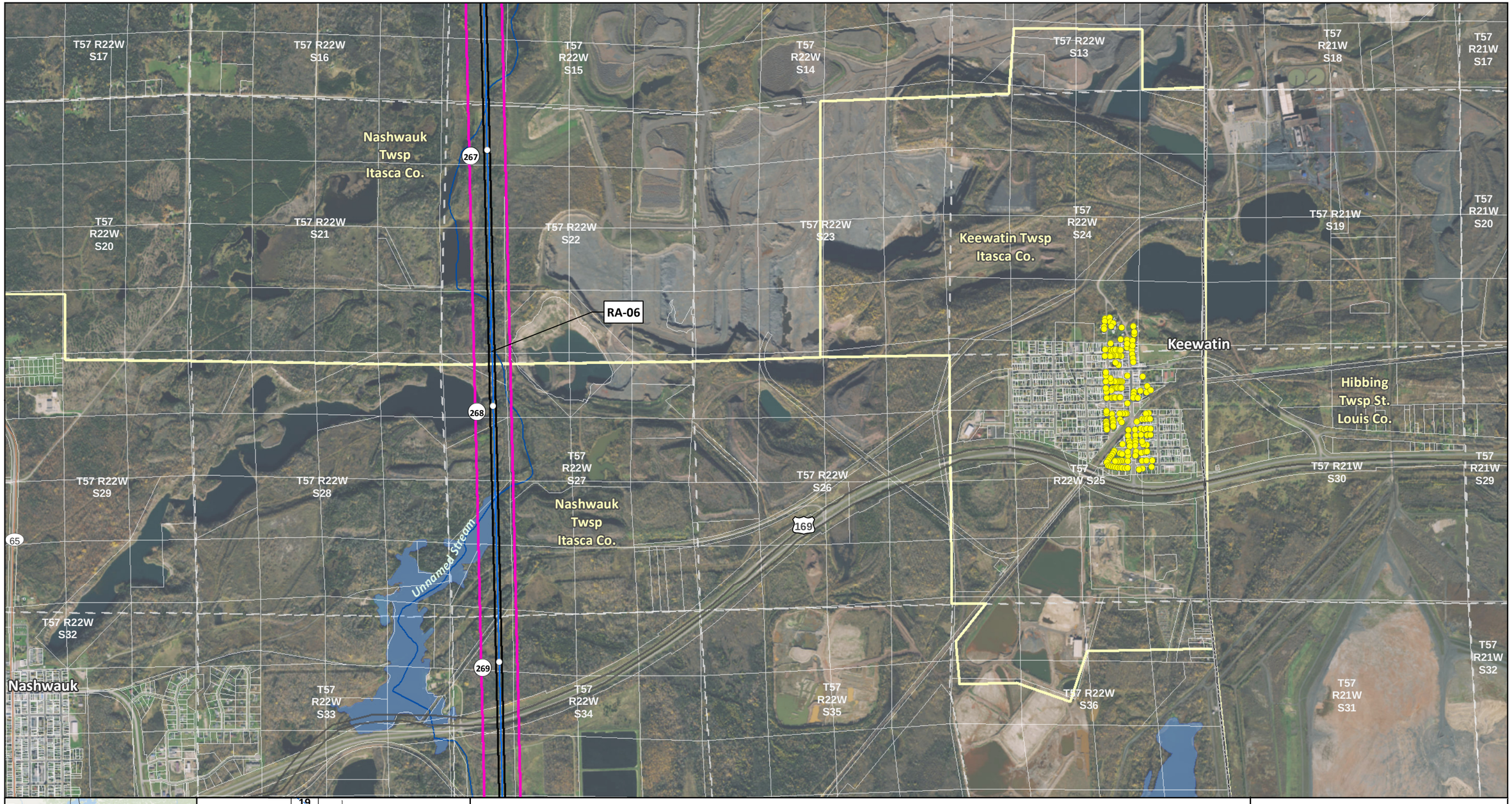
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

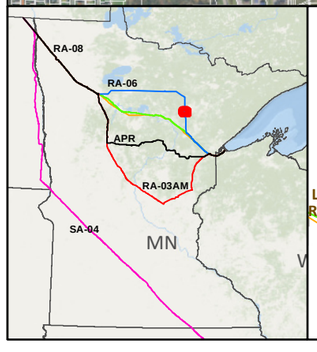
RA-06

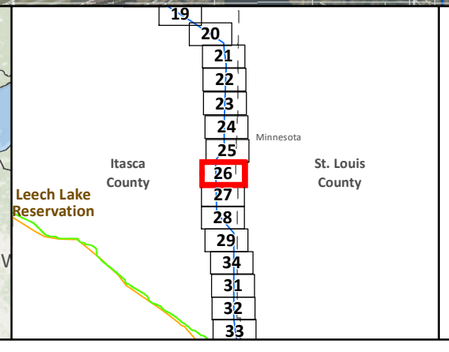
CLEARBROOK TO CARLTON

Map 25A of 43


T58 R22W S32
T58 R22W S33
T58 R22W S34
T58 R22W S35
Northeast Itasca Twsp Itasca Co.
T58 R22W S36
T58 R21W S31
T58 R21W S32
T57 R22W S5
T57 R22W S4
T57 R22W S3
T57 R22W S2
T57 R22W S1
T57 R21W S6
T57 R21W S5
263
264
265
266
RA-06
Hibbing (Scranton) WHPA
Hibbing Twsp St. Louis Co.
Nashwauk Twsp Itasca Co.
T57 R22W S8
T57 R22W S9
T57 R22W S10
T57 R22W S11
T57 R22W S12
T57 R21W S7
Stevenson
T57 R21W S8
Unnamed Stream
T57 R22W S17
T57 R22W S16
T57 R22W S15
T57 R22W S14
T57 R22W S13
T57 R21W S18
T57 R21W S17
Itasca County
St. Louis County
Minnesota
21
22
23
24
25
26
27
28
29
34
RA-08
RA-06
APR
RA-03AM
SA-04
MN
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 25B of 43







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

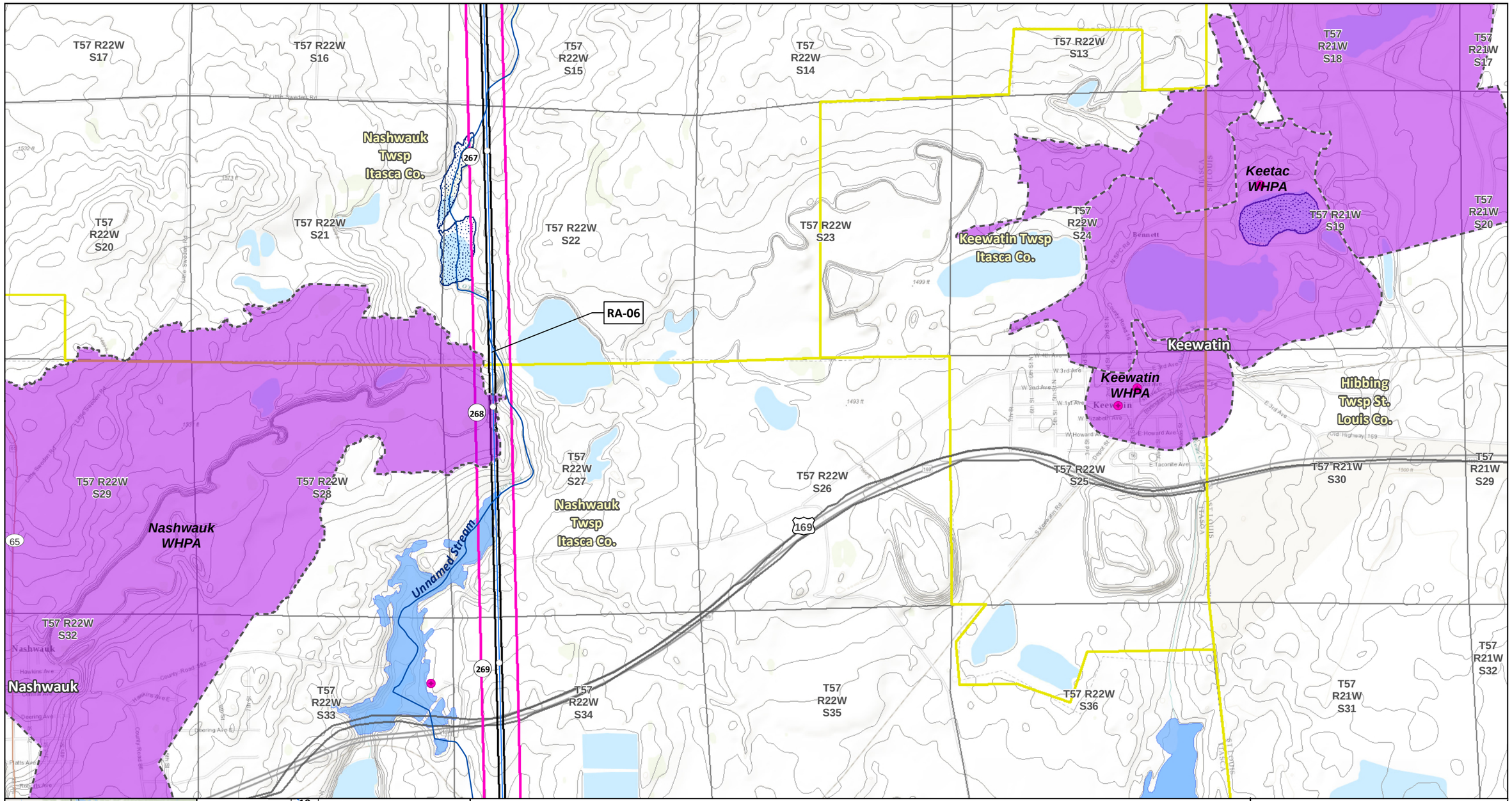
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

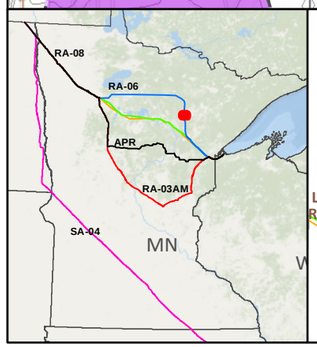
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

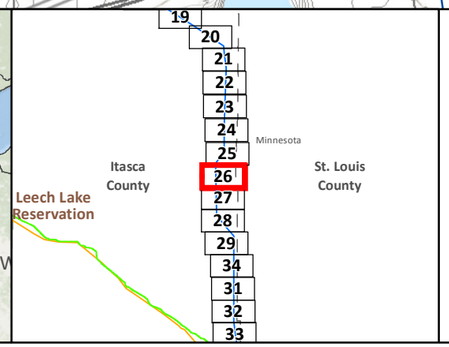
RA-06

CLEARBROOK TO CARLTON

Map 26A of 43







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

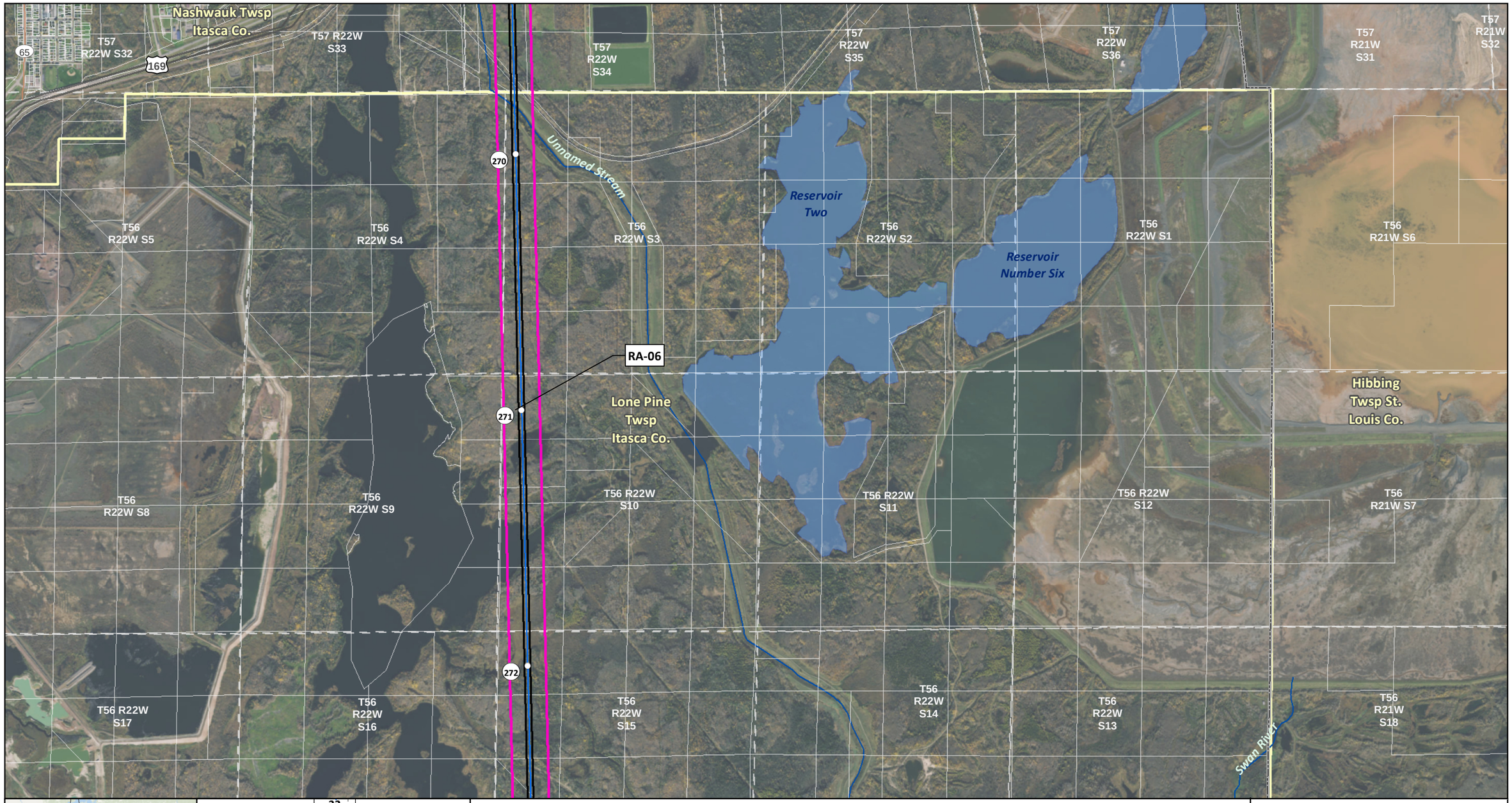
RA-06

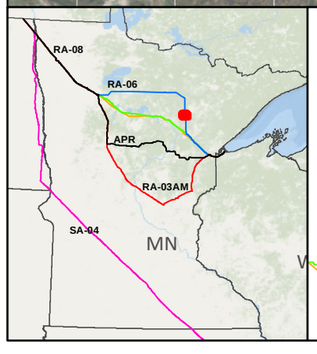
CLEARBROOK TO CARLTON

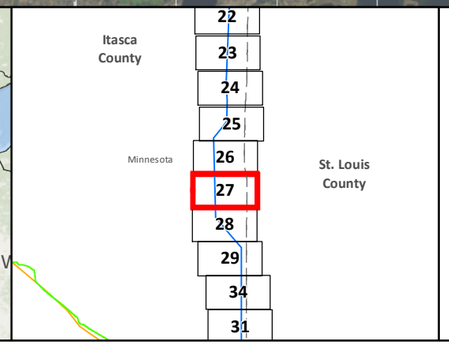
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 26B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources:
MNDNR, NHD, Enbridge

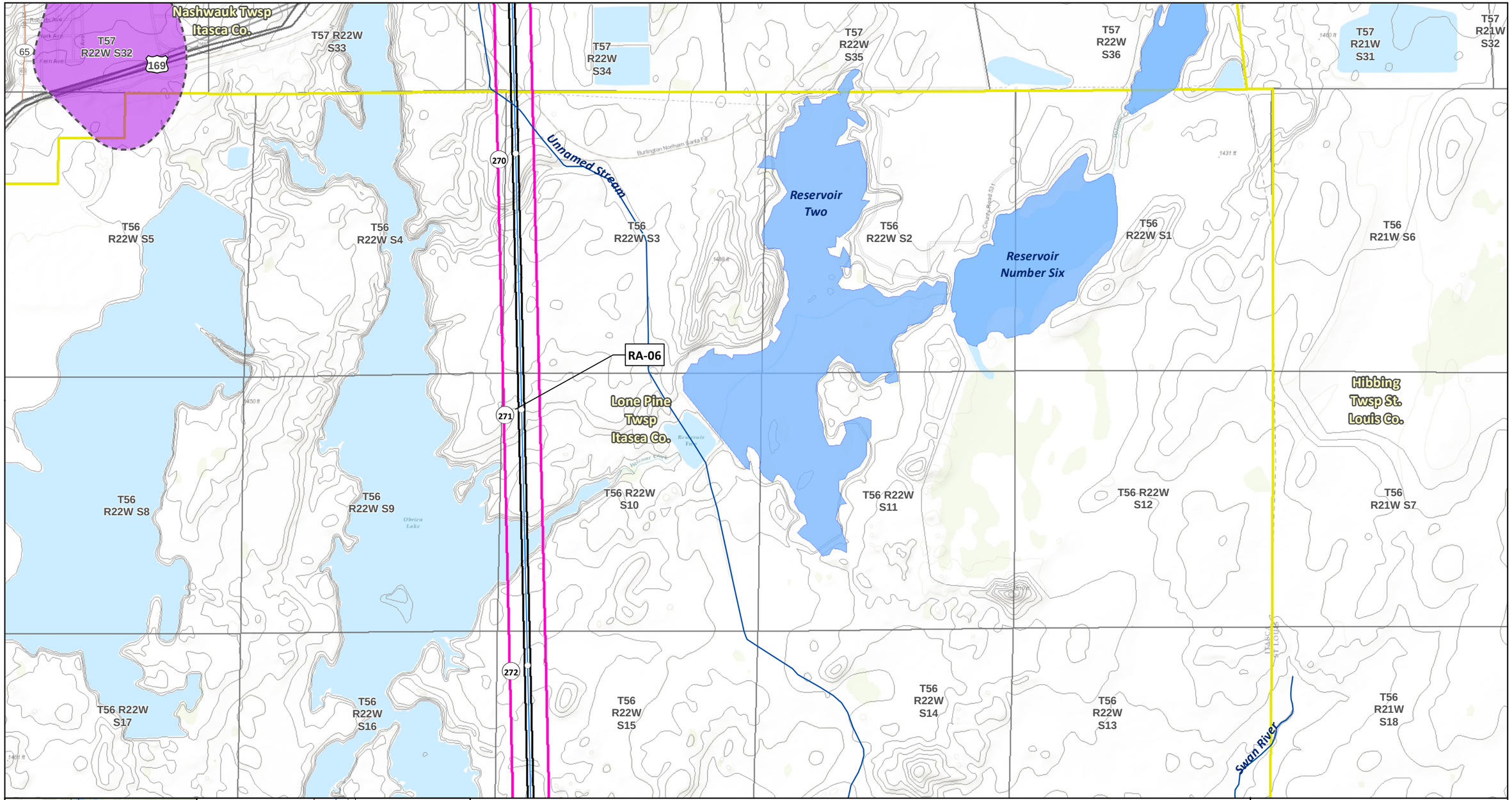
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 27A of 43


Nashwauk Twsp
Itasca Co.
T57 R22W S32
T57 R22W S33
T57 R22W S34
T57 R22W S35
T57 R22W S36
T57 R21W S31
T57 R21W S32
65
169
270
271
272
Unnamed Stream
Burlington Northern Santa Fe
Reservoir Two
Reservoir Number Six
T56 R22W S5
T56 R22W S4
T56 R22W S3
T56 R22W S2
T56 R22W S1
T56 R21W S6
RA-06
Lone Pine Twsp Itasca Co.
Hibbing Twsp St. Louis Co.
T56 R22W S8
T56 R22W S9
T56 R22W S10
T56 R22W S11
T56 R22W S12
T56 R21W S7
T56 R22W S17
T56 R22W S16
T56 R22W S15
T56 R22W S14
T56 R22W S13
T56 R21W S18
Swan River
Itasca
St. Louis
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Itasca County
Minnesota
St. Louis County
22
23
24
25
26
27
28
29
34
31
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 27B of 43

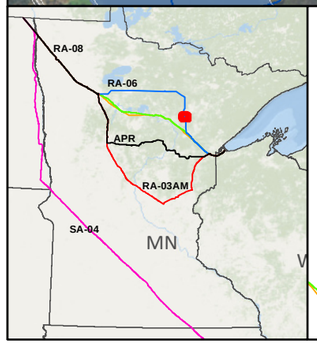
T56 R22W S17
T56 R22W S16
T56 R22W S15
T56 R22W S14
T56 R22W S13
T56 R21W S18
T56 R22W S20
T56 R22W S21
T56 R22W S22
T56 R22W S23
T56 R22W S24
T56 R21W S19
T56 R22W S26
T56 R22W S29
T56 R22W S28
T56 R22W S27
T56 R22W S25
T56 R21W S30
T56 R22W S32
T56 R22W S33
T56 R22W S34
T56 R22W S35
T56 R22W S36
T56 R21W S31

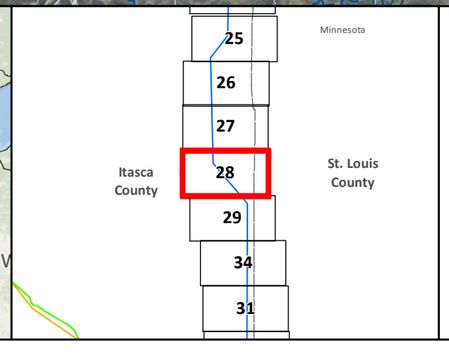
Unnamed Stream
O'Brien Creek
Swan River
West Swan River
Swan Lake

273
274
275
276

Lone Pine Twsp Itasca Co.
Hibbing Twsp St. Louis Co.

RA-06





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

N

Map 28A of 43

T56 R22W S17
T56 R22W S16
T56 R22W S15
T56 R22W S14
T56 R22W S13
T56 R21W S18
T56 R22W S20
T56 R22W S21
T56 R22W S22
T56 R22W S23
T56 R22W S24
T56 R21W S19
T56 R22W S26
T56 R22W S29
T56 R22W S28
T56 R22W S27
T56 R22W S25
T56 R21W S30
T56 R22W S32
T56 R22W S33
T56 R22W S34
T56 R22W S35
T56 R22W S36
T56 R21W S31

Unnamed Stream
O'Brien Creek
Swan River
West Swan River
Swan Lake
Little O'Brien Lake
Lone Pine Twsp Itasca Co.
Hibbing Twsp St. Louis Co.
RA-06
273
274
275
276
Town Hall Rd
Kalevala Beach
E Shore Dr
Mason Rd
County Road 16
ITASCA
ST LOUIS

RA-08
RA-06
APR
RA-03AM
SA-04
MN
Minnesota
25
26
27
28
29
34
31
Itasca County
St. Louis County

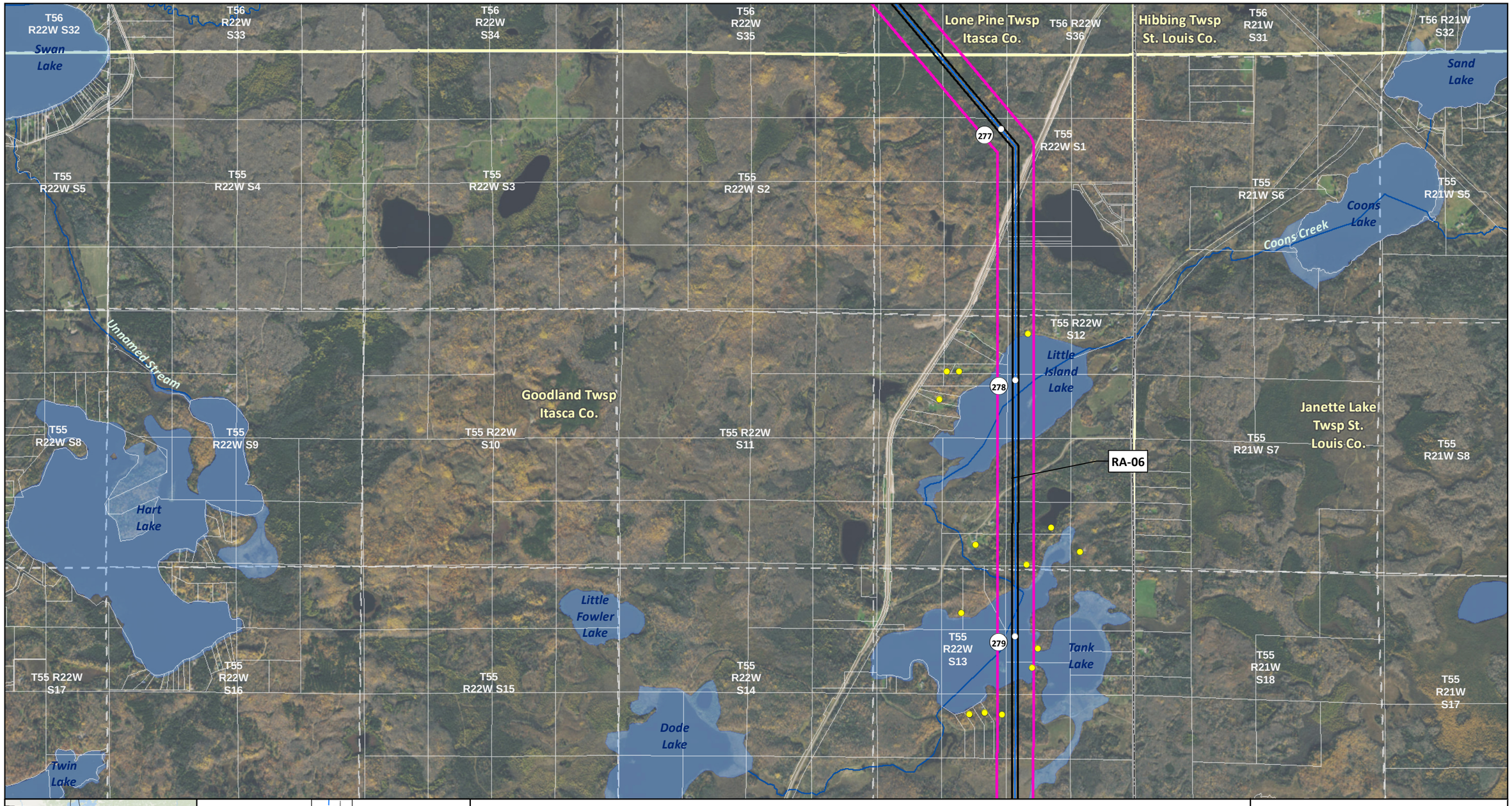
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge

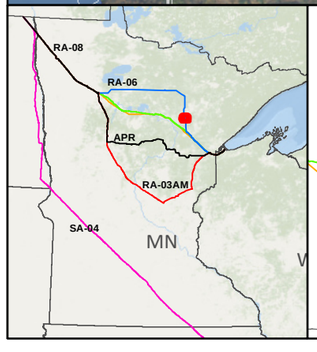
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON

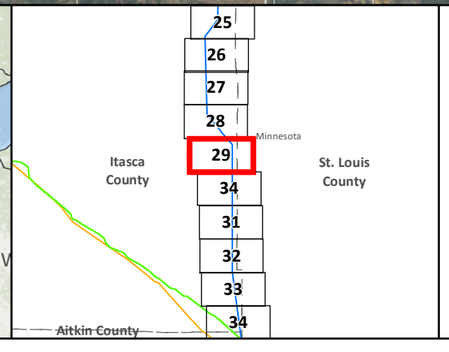
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 28B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

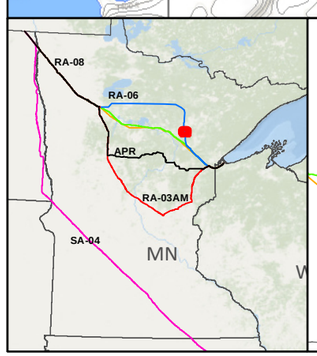
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

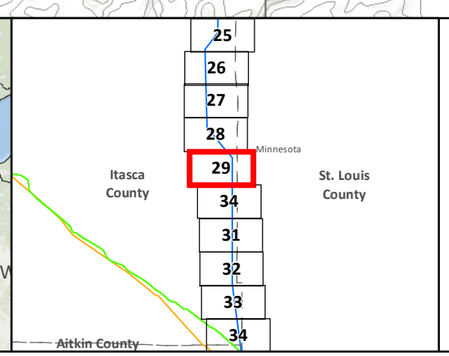
RA-06

CLEARBROOK TO CARLTON

Map 29A of 43

T56 R22W S32
T56 R22W S33
T56 R22W S34
T56 R22W S35
Lone Pine Twsp Itasca Co.
T56 R22W S36
Hibbing Twsp St. Louis Co.
T56 R21W S31
T56 R21W S32
Swan Lake
Sand Lake
277
T55 R22W S1
T55 R22W S5
T55 R22W S4
T55 R22W S3
T55 R22W S2
T55 R21W S6
T55 R21W S5
Coons Creek
Coons Lake
Unnamed Stream
Little Island Lake
278
T55 R22W S8
T55 R22W S9
Goodland Twsp Itasca Co.
T55 R22W S10
T55 R22W S11
T55 R22W S12
RA-06
T55 R21W S7
Janette Lake Twsp St. Louis Co.
T55 R21W S8
Hart Lake
Little Fowler Lake
279
Tank Lake
T55 R22W S17
T55 R22W S16
T55 R22W S15
T55 R22W S14
T55 R22W S13
T55 R21W S18
T55 R21W S17
Dode Lake
Twin Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

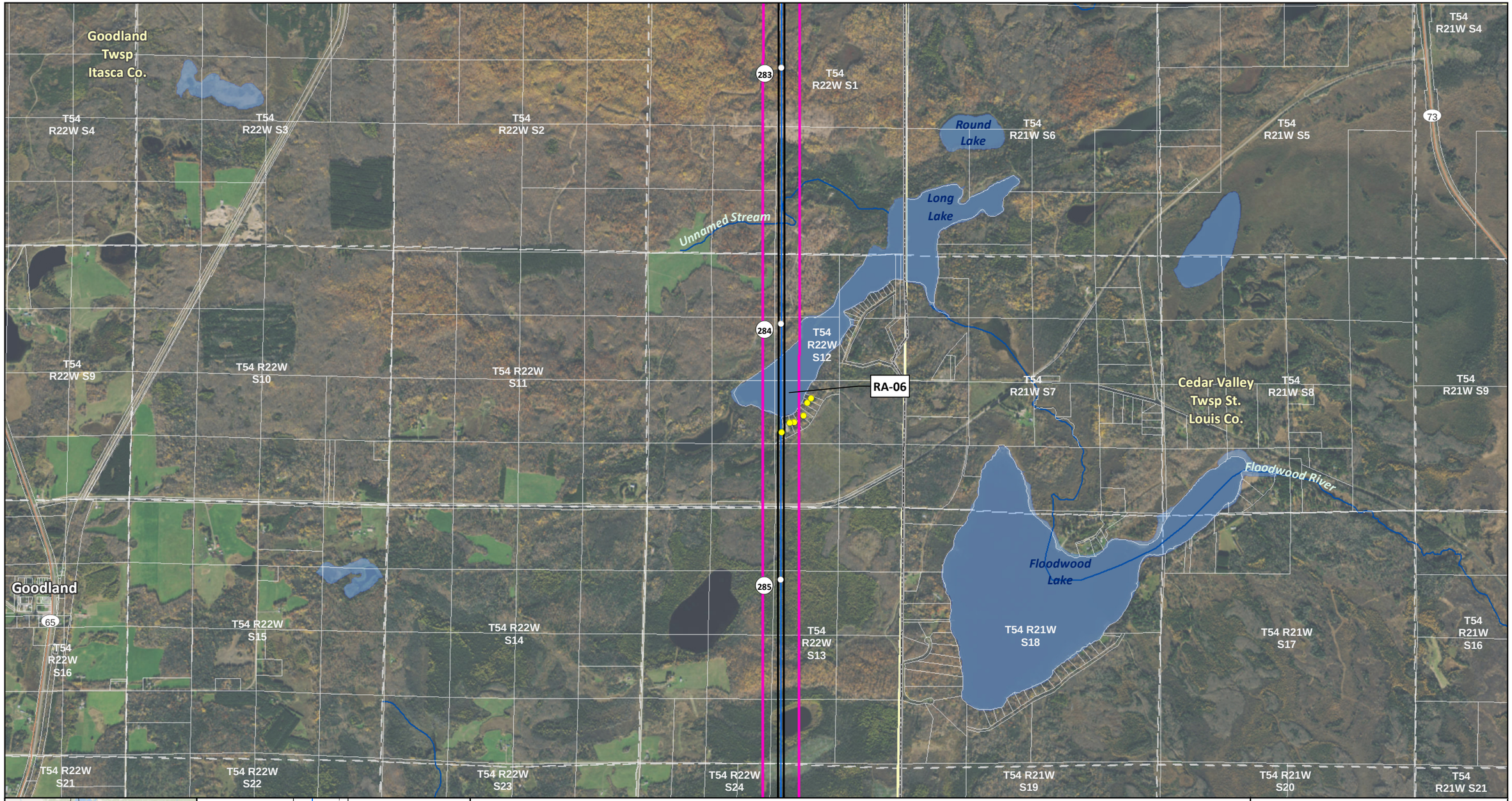
RA-06

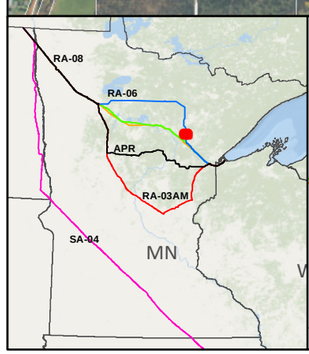
CLEARBROOK TO CARLTON

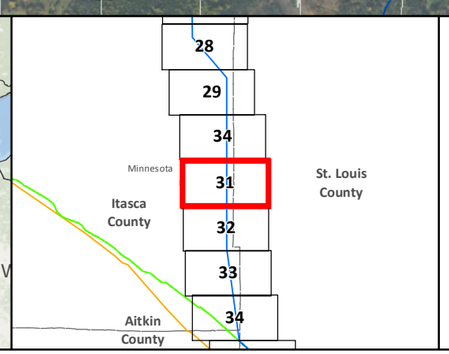
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 29B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 31A of 43

Goodland Twsp Itasca Co.

T54 R22W S4 | T54 R22W S3 | T54 R22W S2 | T54 R22W S1 | T54 R21W S4

T54 R22W S9 | T54 R22W S10 | T54 R22W S11 | T54 R22W S12 | T54 R21W S7 | T54 R21W S8 | T54 R21W S9

T54 R22W S15 | T54 R22W S14 | T54 R22W S13 | T54 R21W S18 | T54 R21W S17 | T54 R21W S16

T54 R22W S16 | T54 R22W S21 | T54 R22W S22 | T54 R22W S23 | T54 R22W S24 | T54 R21W S19 | T54 R21W S20 | T54 R21W S21

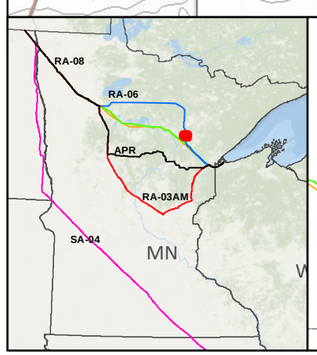
Goodland

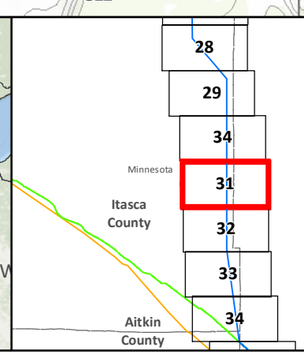
Cedar Valley Twsp St. Louis Co.

Round Lake | Long Lake | Floodwood Lake | Floodwood River | Unnamed Stream

RA-06

283 | 284 | 285 | 65 | 73





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

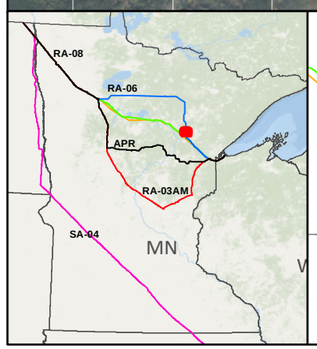
0 125 250 500 Meters

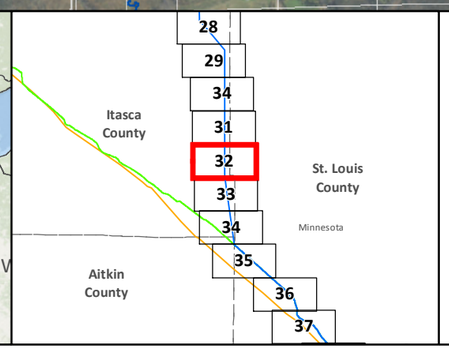
1:24,000

10ft Contours

Map 31B of 43

T54 R22W S22
T54 R22W S21
Unnamed Stream
Floodwood River, West Branch
T54 R22W S23
T54 R22W S24
286
T54 R21W S19
T54 R21W S20
T54 R21W S21
T54 R22W S26
T54 R22W S28
Pancake Lake
T54 R22W S27
Goodland Twsp Itasca Co.
287
T54 R22W S25
RA-06
T54 R21W S30
T54 R21W S29
T54 R21W S28
Cedar Valley Twsp St. Louis Co.
288
T54 R22W S36
T54 R22W S34
T54 R22W S35
T54 R22W S33
T54 R21W S31
T54 R21W S32
T54 R21W S33
T53 R22W S4
T53 R22W S3
T53 R22W S2
Wawina Twsp Itasca Co.
T53 R22W S1
T53 R21W S6
T53 R21W S5
T53 R21W S4





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

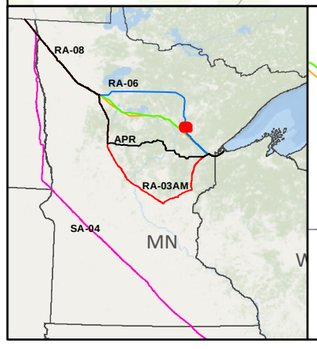
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

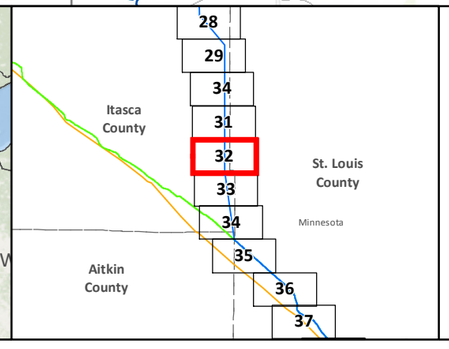
RA-06

CLEARBROOK TO CARLTON

Map 32A of 43

T54 R22W S22
T54 R22W S21
T54 R22W S23
T54 R22W S24
T54 R21W S19
T54 R21W S20
T54 R21W S21
Unnamed Stream
Floodwood River, West Branch
T54 R22W S26
T54 R22W S25
T54 R22W S28
T54 R22W S27
Goodland Twsp Itasca Co.
Pancake Lake
RA-06
T54 R21W S30
T54 R21W S29
T54 R21W S28
Cedar Valley Twsp St. Louis Co.
T54 R22W S34
T54 R22W S35
T54 R22W S36
T54 R21W S31
T54 R21W S32
T54 R21W S33
T54 R22W S33
T53 R22W S4
T53 R22W S3
T53 R22W S2
Wawina Twsp Itasca Co.
T53 R22W S1
T53 R21W S6
T53 R21W S5
T53 R21W S4





- SA-04
- Applicant's Preferred Route (APR)

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- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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- Township Boundary

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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

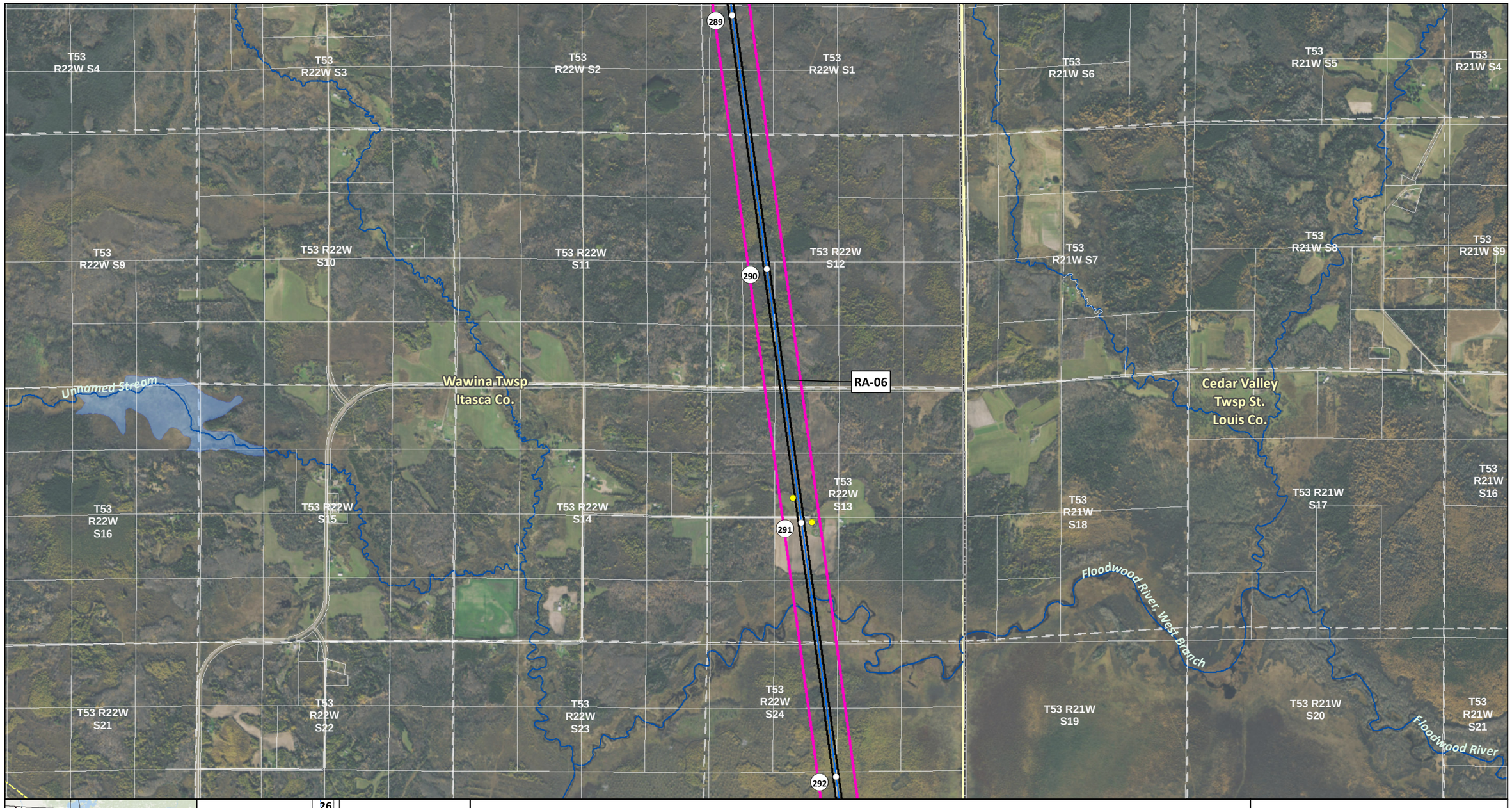
Data Sources: MNDNR, USGS, NHD, Enbridge

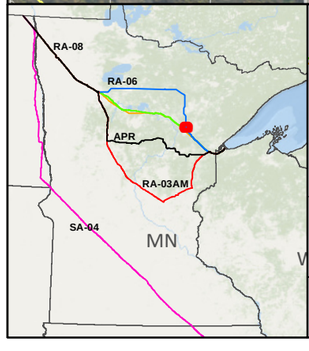
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON

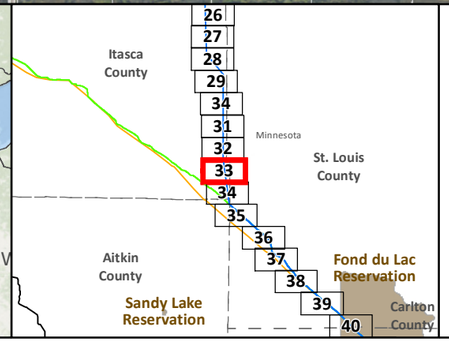
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 32B of 43







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 33A of 43

T53 R22W S4
T53 R22W S3
T53 R22W S2
T53 R22W S1
T53 R21W S6
T53 R21W S5
T53 R21W S4
T53 R22W S9
T53 R22W S10
T53 R22W S11
T53 R22W S12
T53 R21W S7
T53 R21W S8
T53 R21W S9
T53 R22W S16
T53 R22W S15
T53 R22W S14
T53 R22W S13
T53 R21W S18
T53 R21W S17
T53 R21W S16
T53 R22W S21
T53 R22W S22
T53 R22W S23
T53 R22W S24
T53 R21W S19
T53 R21W S20
T53 R21W S21
289
290
291
292
RA-06
Unnamed Stream
Wawina Twsp
Itasca Co.
Cedar Valley
Twsp St.
Louis Co.
Floodwood River, West Branch
Floodwood River
Township Rd E
Saari Rd
Township Road B
Township Road C
Township Road A
Hinekainen Rd
Cedar Valley Rd
Froehlich Rd
County Road 133
1286 ft
1276 ft
1211 ft
1263 ft

RA-08
RA-06
APR
RA-03AM
SA-04
MN
26
27
28
29
34
31
32
33
34
35
36
37
38
39
40
Itasca County
Minnesota
St. Louis County
Aitkin County
Fond du Lac Reservation
Sandy Lake Reservation
Carlton County

SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

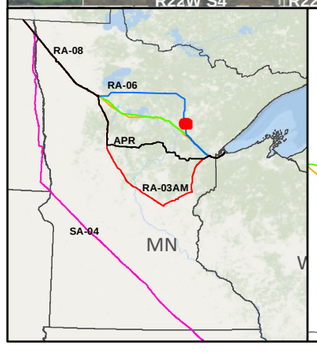
CLEARBROOK TO CARLTON

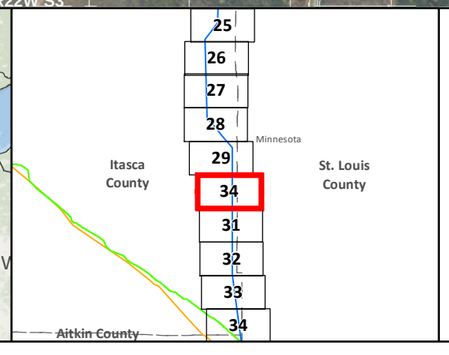
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 33B of 43

T55 R22W S16
T55 R22W S15
Dode Lake
T55 R22W S14
T55 R22W S13
Tank Lake
T55 R21W S18
Bay Lake
T55 R21W S17
T55 R21W S16
280
T55 R22W S24
T55 R22W S22
T55 R22W S23
T55 R21W S19
T55 R21W S20
T55 R21W S21
T55 R22W S21
Beauty Lake
Island Lake
281
T55 R22W S28
T55 R22W S27
Goodland Twsp Itasca Co.
T55 R22W S26
Mary Lake
T55 R22W S25
T55 R21W S30
Janette Lake Twsp St. Louis Co.
T55 R21W S29
Merrill Lake
T55 R21W S28
RA-06
282
T55 R22W S33
T55 R22W S34
T55 R22W S35
T55 R22W S36
T55 R21W S31
T55 R21W S32
73
T55 R21W S33
Finberg Lake
Unnamed Creek
T54 R22W S4
T54 R22W S3





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

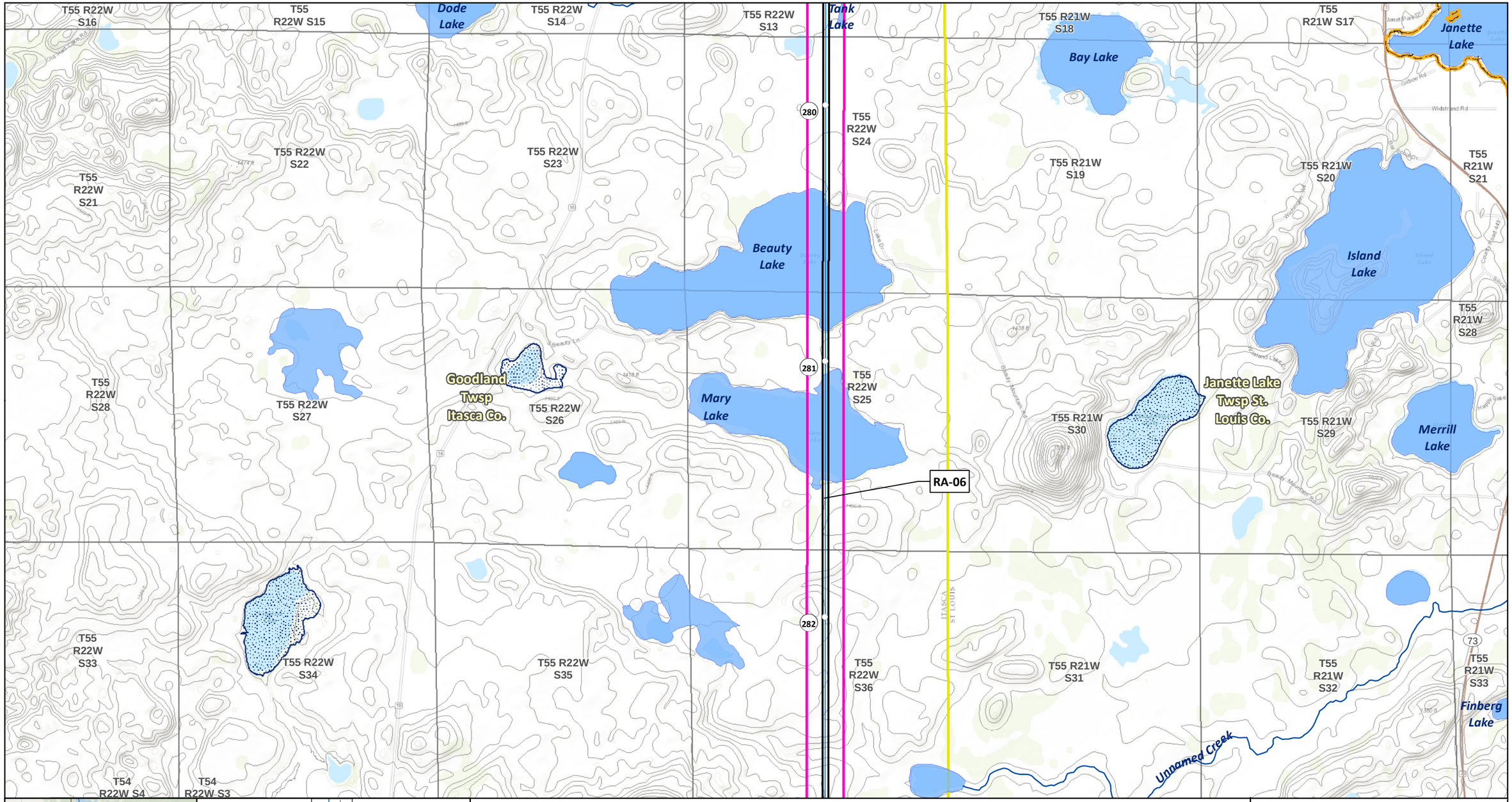
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 34A of 43


T55 R22W S16
T55 R22W S15
Dode Lake
T55 R22W S14
T55 R22W S13
Tank Lake
T55 R21W S18
Bay Lake
T55 R21W S17
Janette Lake
280
T55 R22W S24
T55 R22W S22
T55 R22W S23
T55 R21W S19
T55 R21W S20
T55 R21W S21
T55 R22W S21
Beauty Lake
Island Lake
T55 R21W S28
281
T55 R22W S28
T55 R22W S27
Goodland Twsp Itasca Co.
T55 R22W S26
Mary Lake
T55 R22W S25
T55 R21W S30
Janette Lake Twsp St. Louis Co.
T55 R21W S29
Merrill Lake
RA-06
282
T55 R22W S33
T55 R22W S34
T55 R22W S35
T55 R22W S36
T55 R21W S31
T55 R21W S32
T55 R21W S33
Finberg Lake
Unnamed Creek
T54 R22W S4
T54 R22W S3
RA-08
RA-06
APR
RA-03AM
SA-04
MN
25
26
27
28
29
34
31
32
33
34
Minnesota
Itasca County
St. Louis County
Aitkin County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
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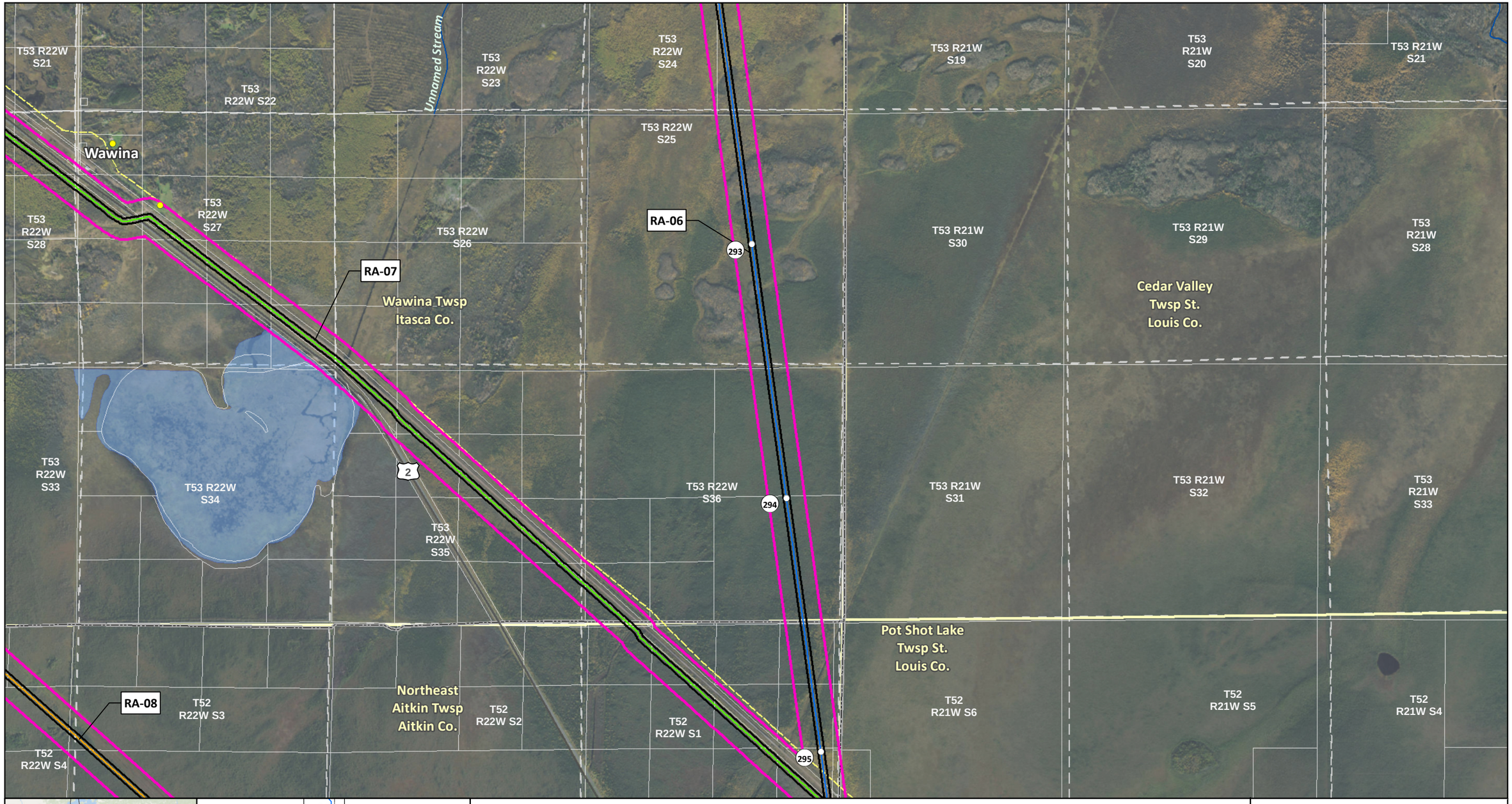
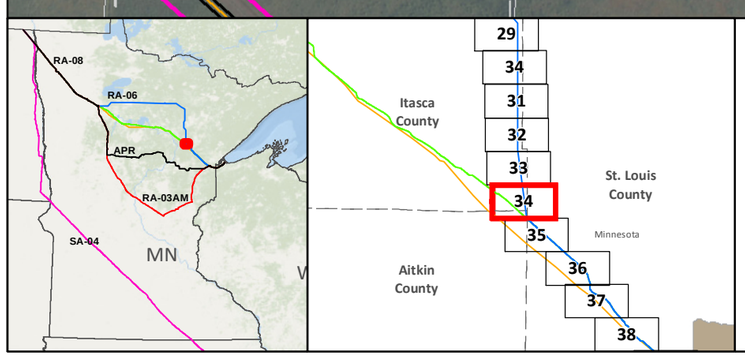
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 34B of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
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- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

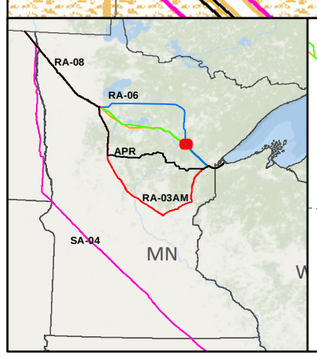
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

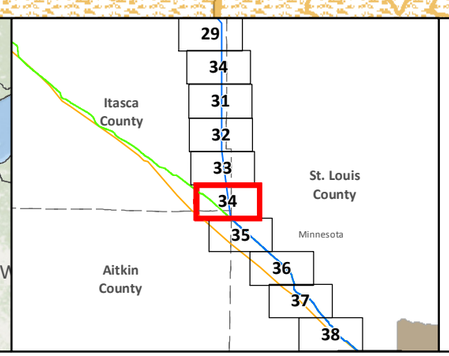
RA-06

CLEARBROOK TO CARLTON

Map 34A of 43

T53 R22W S21
T53 R22W S22
T53 R22W S23
T53 R22W S24
T53 R21W S19
T53 R21W S20
T53 R21W S21
Unnamed Stream
Wawina
T53 R22W S27
T53 R22W S28
T53 R22W S25
T53 R22W S26
RA-06
RA-07
Wawina Twsp
Itasca Co.
T53 R21W S30
T53 R21W S29
T53 R21W S28
Cedar Valley
Twsp St.
Louis Co.
T53 R22W S33
T53 R22W S34
T53 R22W S35
T53 R22W S36
T53 R21W S31
T53 R21W S32
Wawina
Peatland
SNA
T53 R21W S33
Pot Shot Lake
Twsp St.
Louis Co.
RA-08
T52 R22W S3
Northeast
Aitkin Twsp
Aitkin Co.
T52 R22W S2
T52 R22W S1
T52 R22W S4
T52 R21W S6
T52 R21W S5
T52 R21W S4
Wawina
Peatland
SNA
293
294
295
2





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- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

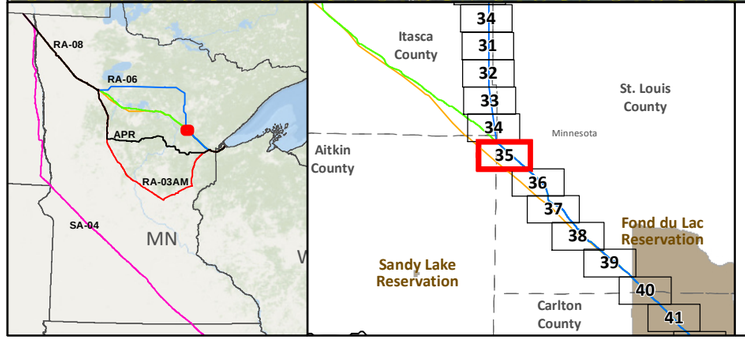
RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 34B of 43





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

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Pump Station

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Highway

Major Road

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State Forest

National Forest

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Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

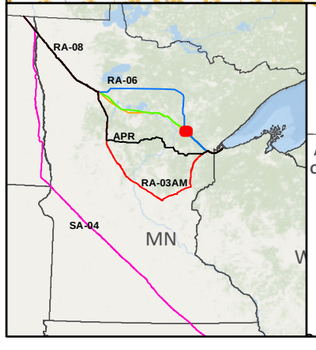
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

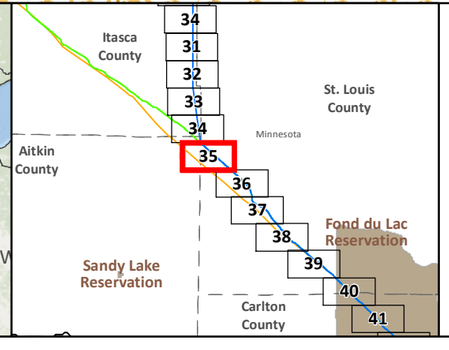
RA-06

CLEARBROOK TO CARLTON

Map 35A of 43

T52 R22W S2
T52 R22W S1
T52 R21W S6
Wawina Peatland SNA
T52 R21W S5
T52 R21W S4
Wawina Peatland SNA
T52 R21W S3
Wawina Peatland SNA
Wawina Peatland SNA
T52 R22W S11
T52 R22W S12
T52 R21W S7
T52 R21W S8
T52 R21W S9
T52 R21W S10
T52 R22W S10
RA-08
RA-06
RA-07
Hartley Spur
T52 R22W S15
Pot Shot Lake Twsp St. Louis Co.
T52 R22W S13
T52 R22W S14
Northeast Aitkin Twsp Aitkin Co.
T52 R21W S18
T52 R21W S17
T52 R21W S16
T52 R21W S15
T52 R22W S23
T52 R22W S24
T52 R21W S19
T52 R21W S20
T52 R21W S21
T52 R21W S22





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

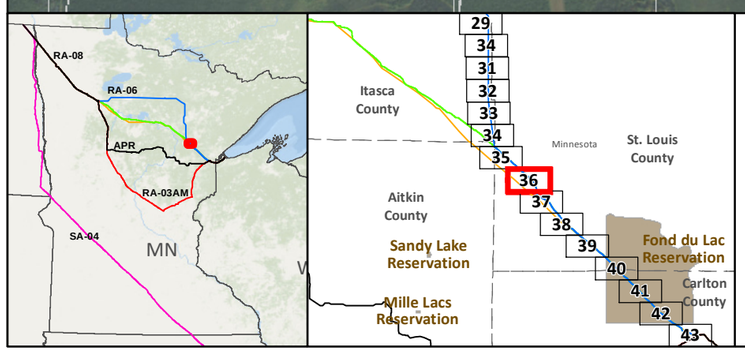
RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 35B of 43





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Residences within 1/2 mile
- Mile Post
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

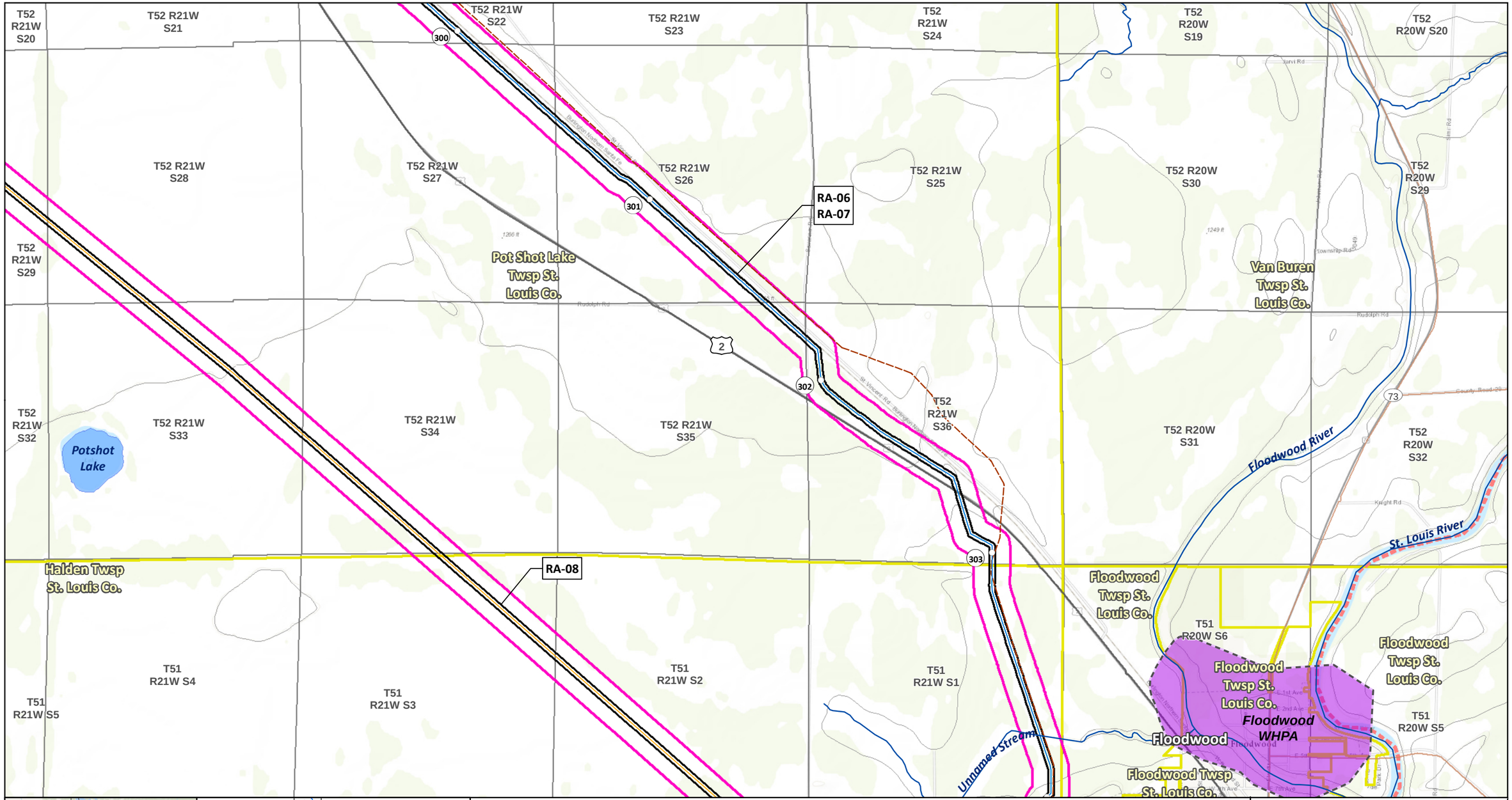
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

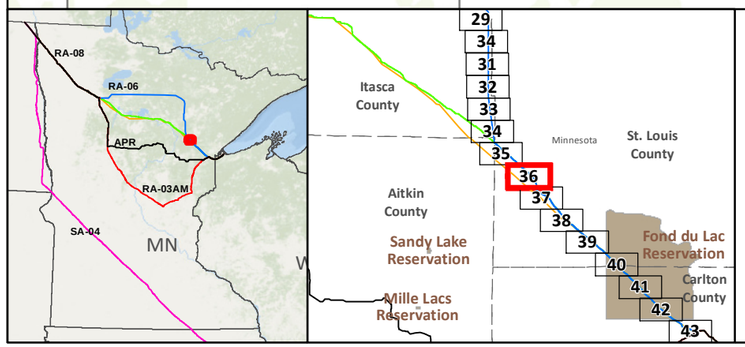
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 36A of 43





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
- RA-07
- RA-08
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Township Boundary

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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
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- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

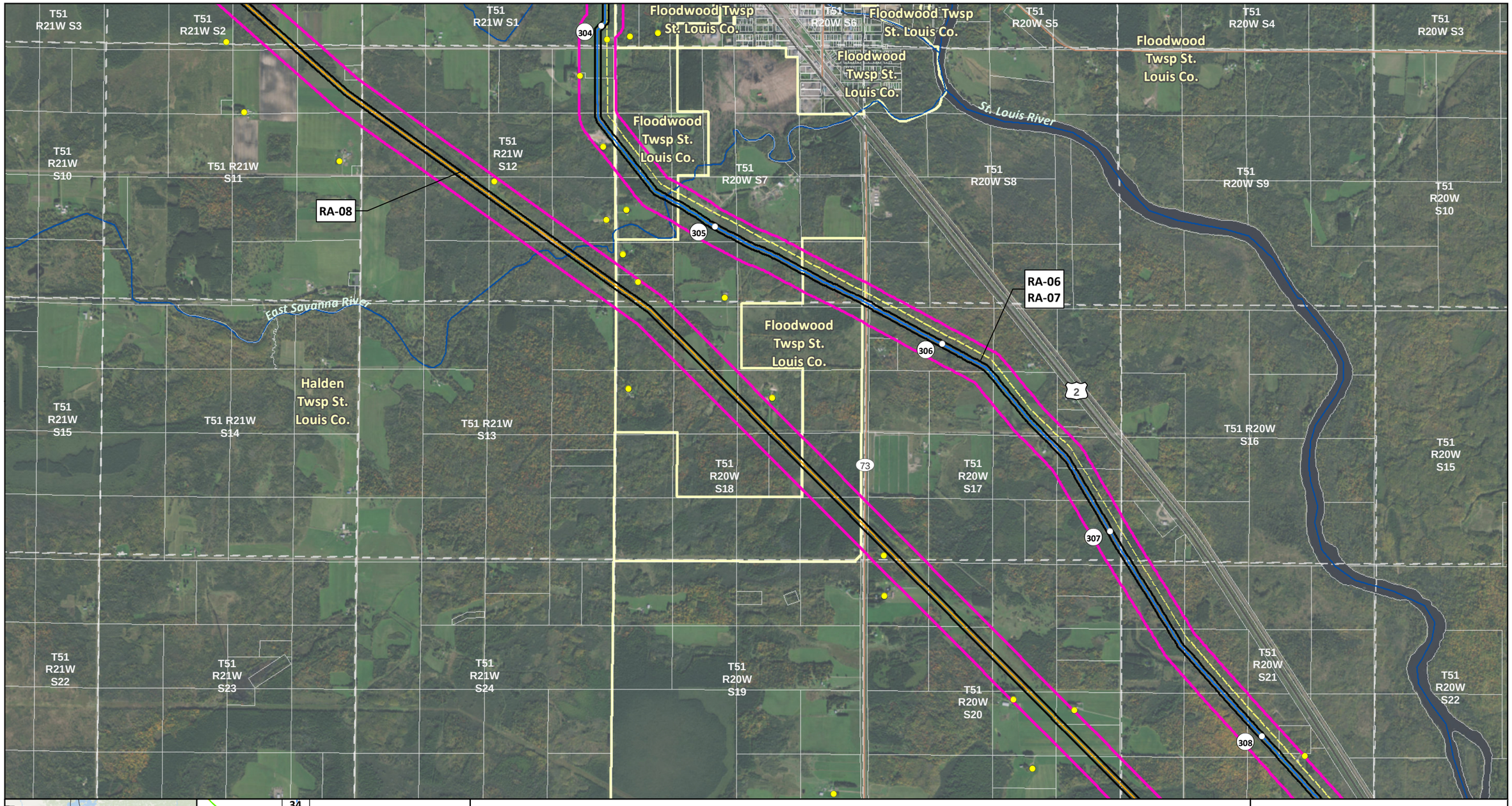
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

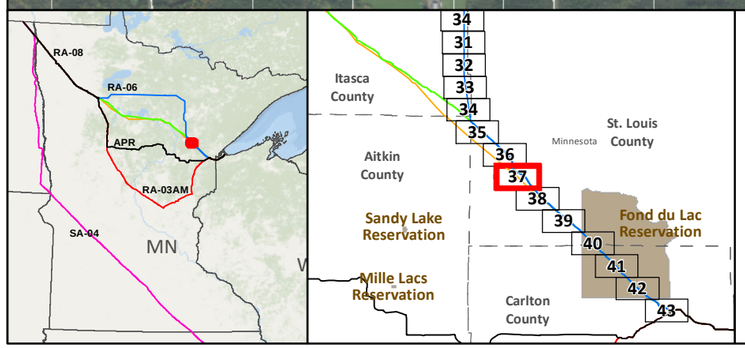
RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 36B of 43





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- Applicant's Preferred Route (APR)

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- RA-03AM
- RA-06
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- RA-08
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- State Forest
- National Forest
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- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

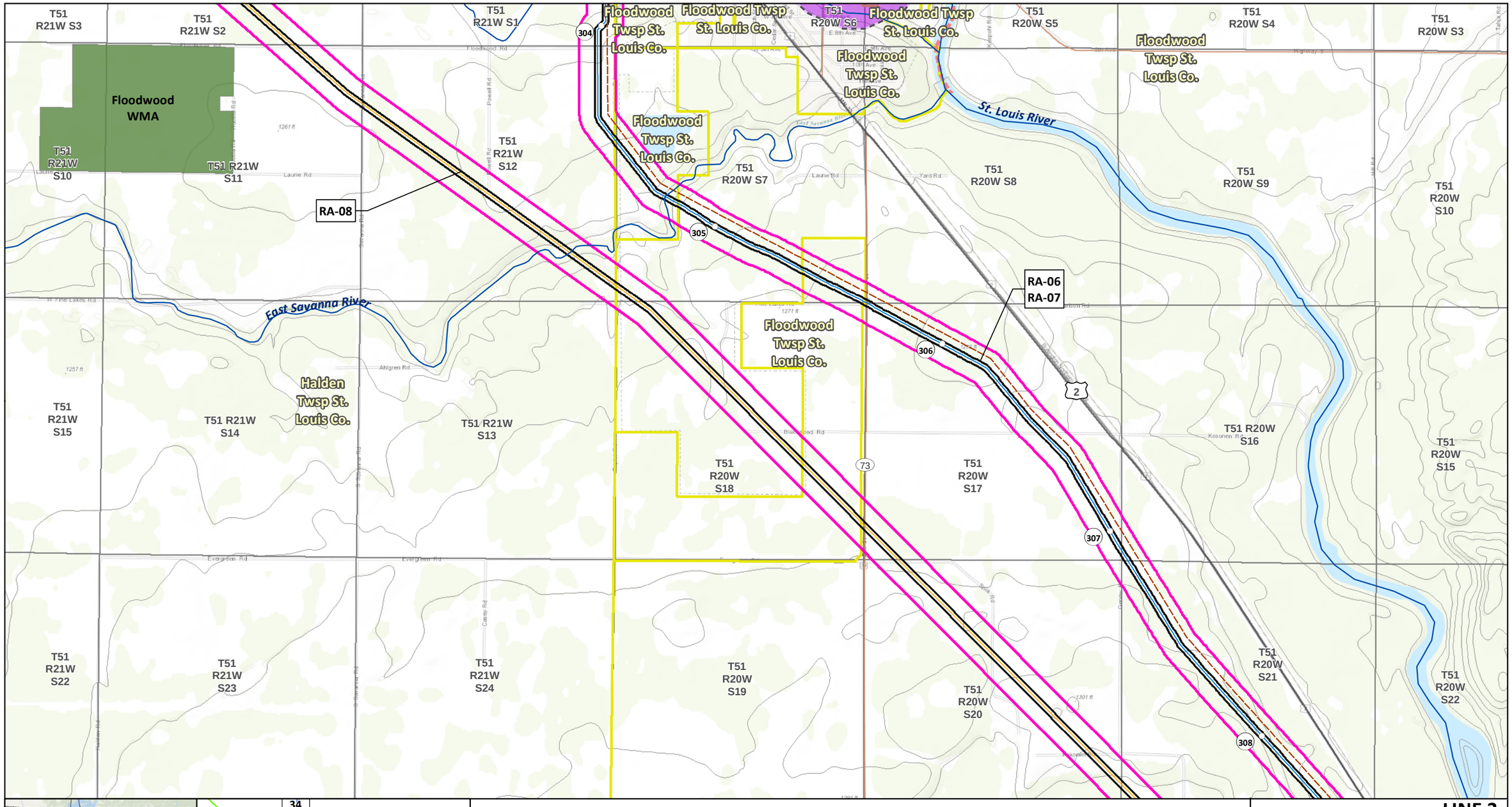
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

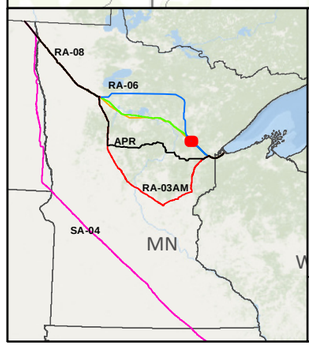
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

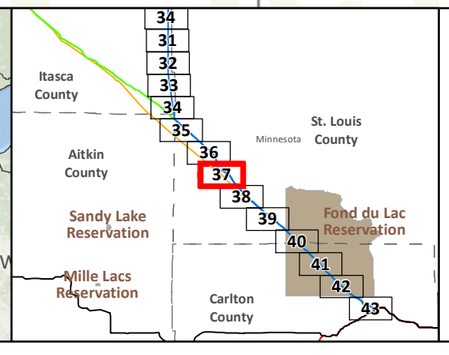
RA-06

CLEARBROOK TO CARLTON

Map 37A of 43







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

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- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

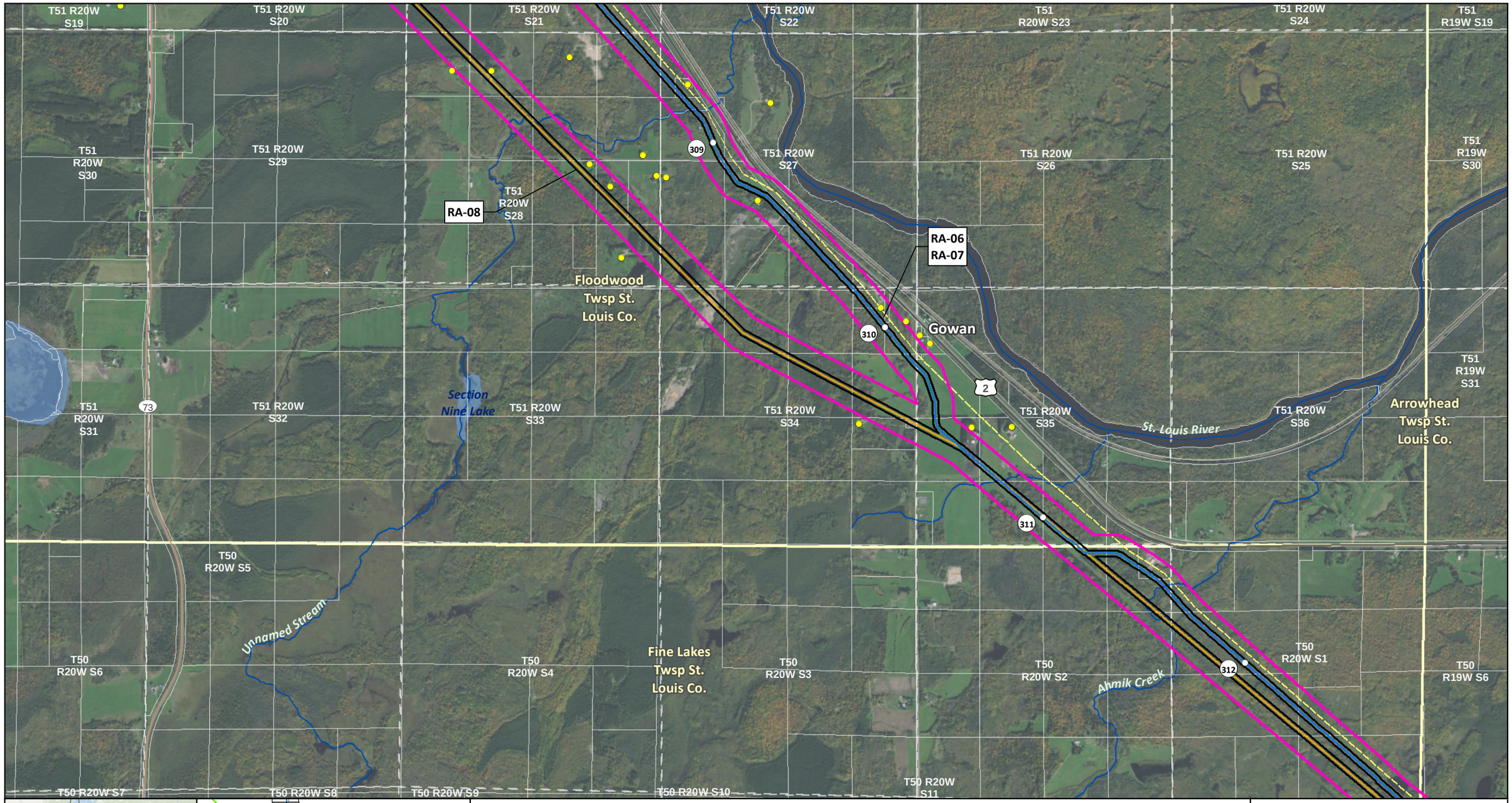
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

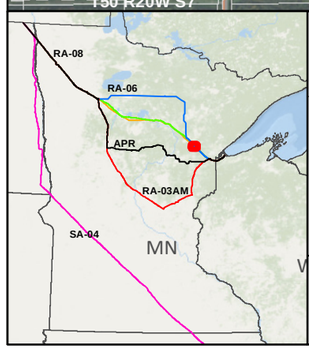
RA-06

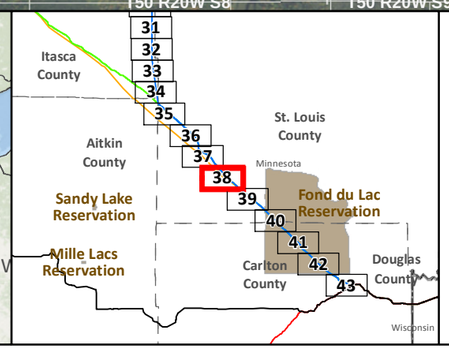
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 37B of 43







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
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- County Boundary
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- Public Waters Watercourse

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- Mile Post
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- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

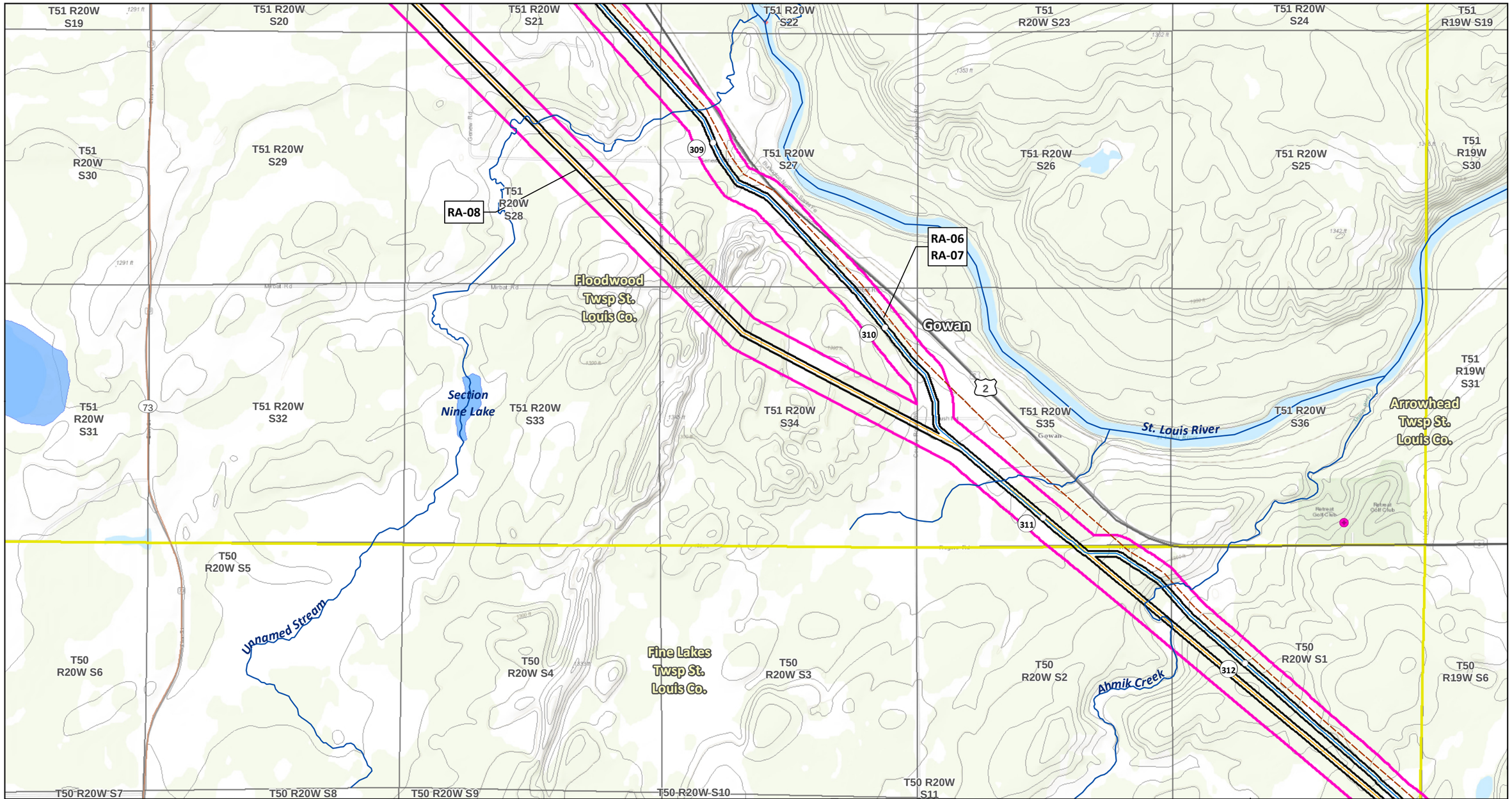
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

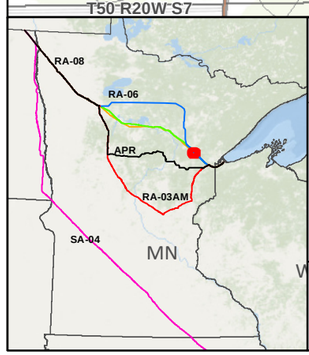
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

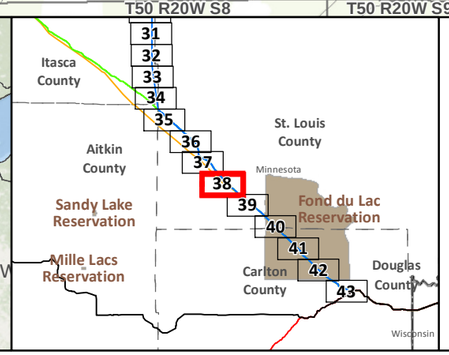
RA-06

CLEARBROOK TO CARLTON

Map 38A of 43







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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State Managed Lands
- WMA - Wildlife Management Areas
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Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
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- Designated Trout Stream
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

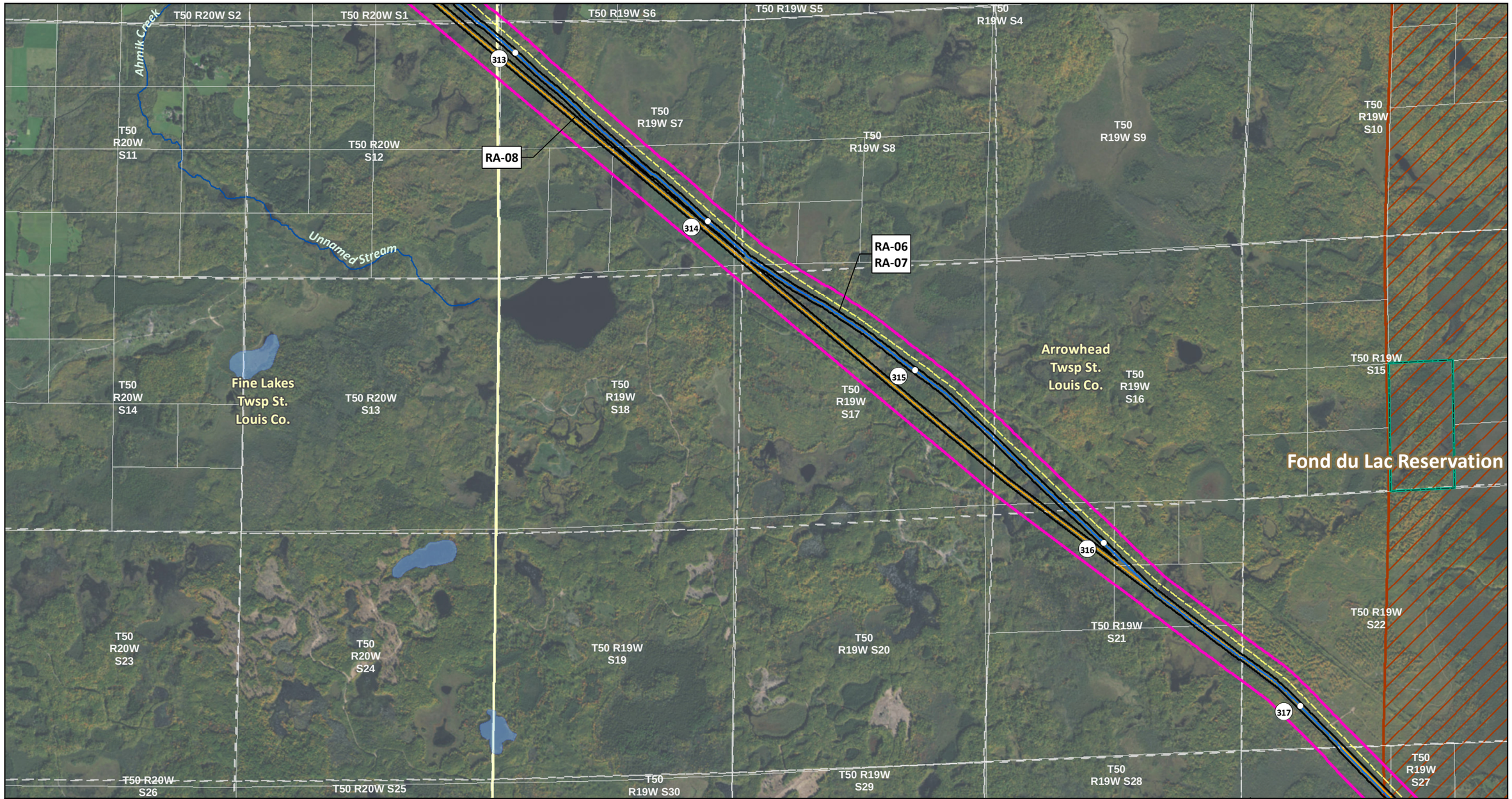
RA-06

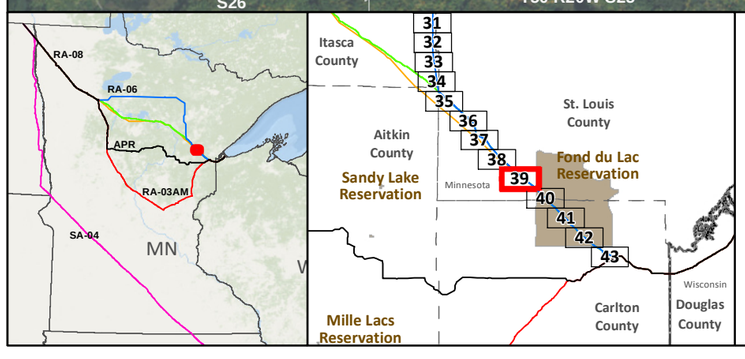
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 38B of 43





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

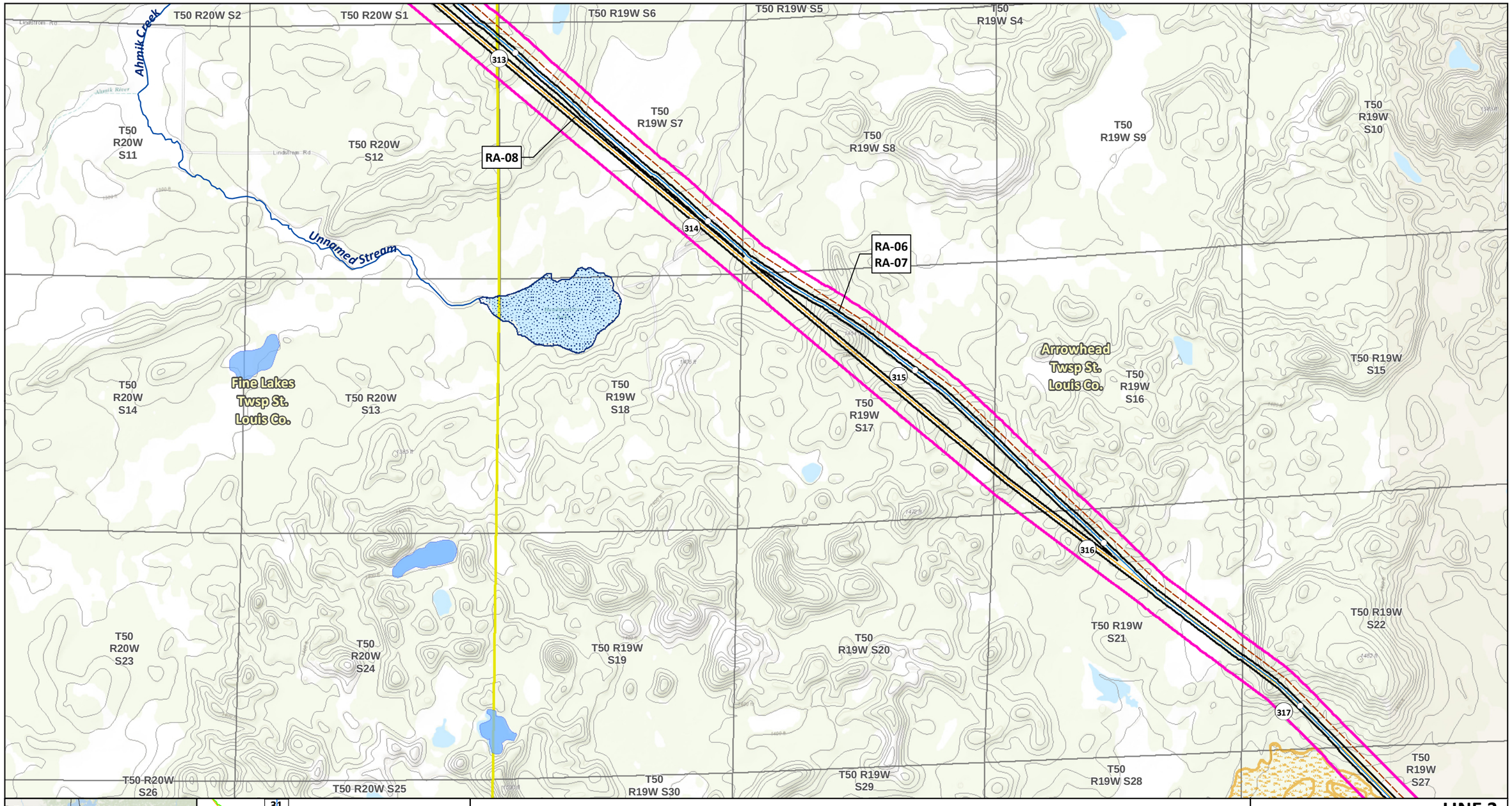
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

Map 39A of 43


T50 R20W S2
T50 R20W S1
T50 R19W S6
T50 R19W S5
T50 R19W S4
Ahmik Creek
313
T50 R20W S11
T50 R20W S12
T50 R19W S7
T50 R19W S8
T50 R19W S9
T50 R19W S10
RA-08
Unnamed Stream
314
RA-06
RA-07
T50 R20W S14
Fine Lakes Twsp St. Louis Co.
T50 R20W S13
T50 R19W S18
T50 R19W S17
Arrowhead Twsp St. Louis Co.
T50 R19W S16
T50 R19W S15
315
316
317
T50 R20W S23
T50 R20W S24
T50 R19W S19
T50 R19W S20
T50 R19W S21
T50 R19W S22
T50 R20W S26
T50 R20W S25
T50 R19W S30
T50 R19W S29
T50 R19W S28
T50 R19W S27
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Itasca County
Aitkin County
Sandy Lake Reservation
Minnesota
St. Louis County
Fond du Lac Reservation
Carlton County
Wisconsin
Douglas County
Mille Lacs Reservation
31
32
33
34
35
36
37
38
39
40
41
42
43
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
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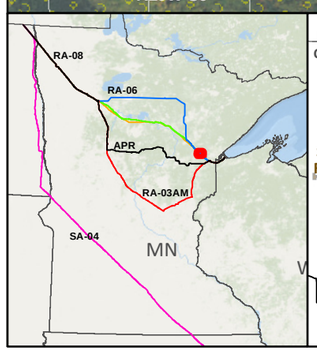
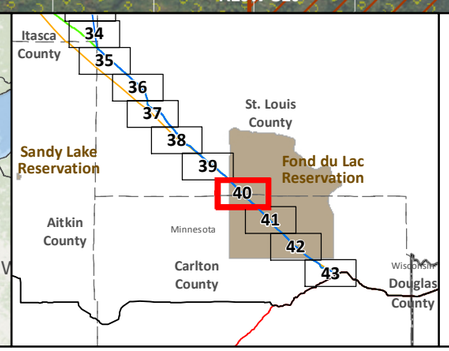
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-06
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 39B of 43

T50 R19W S28
T50 R19W S27
T50 R19W S26
T50 R19W S25
T50 R18W S30
T50 R18W S29
Lost Lake
318
Arrowhead Twsp St. Louis Co.
Unnamed Stream
Stoney Brook Twsp St. Louis Co.
319
RA-08
T50 R19W S33
T50 R19W S34
T50 R19W S35
T50 R19W S36
T50 R18W S31
T50 R18W S32
Fond du Lac Reservation
Stoney Brook
320
Fond du Lac State Forest
RA-06
RA-07
T49 R19W S4
T49 R19W S3
T49 R19W S2
T49 R19W S1
T49 R18W S6
T49 R18W S5
North Carlton Twsp Carlton Co.
Hardwood Lake
Perch Lake Twsp Carlton Co.
321
Dead Fish Lake
T49 R19W S9
T49 R19W S10
T49 R19W S11
T49 R19W S12
T49 R18W S7
T49 R18W S8





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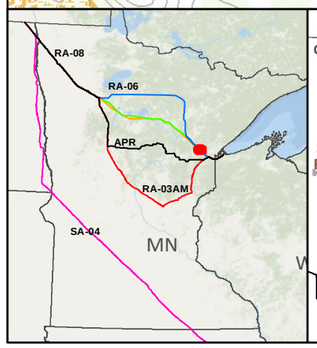
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

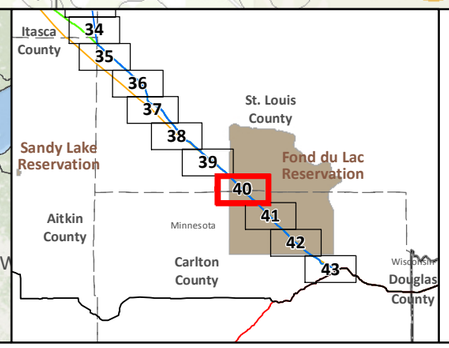
RA-06

CLEARBROOK TO CARLTON

Map 40A of 43

T50 R19W S28
T50 R19W S27
T50 R19W S26
T50 R19W S25
T50 R18W S30
T50 R18W S29
Lost Lake
Unnamed Stream
Stoney Brook Twsp St. Louis Co.
Arrowhead Twsp St. Louis Co.
318
319
320
321
RA-08
RA-06
RA-07
T50 R19W S33
T50 R19W S34
T50 R19W S35
T50 R19W S36
T50 R18W S31
T50 R18W S32
Stoney Brook
ST LOUIS CARLTON
T49 R19W S4
T49 R19W S3
T49 R19W S2
T49 R19W S1
T49 R18W S6
T49 R18W S5
North Carlton Twsp Carlton Co.
Hardwood Lake
Perch Lake Twsp Carlton Co.
Dead Fish Lake
T49 R19W S9
T49 R19W S10
T49 R19W S11
T49 R19W S12
T49 R18W S7
T49 R18W S8





SA-04
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

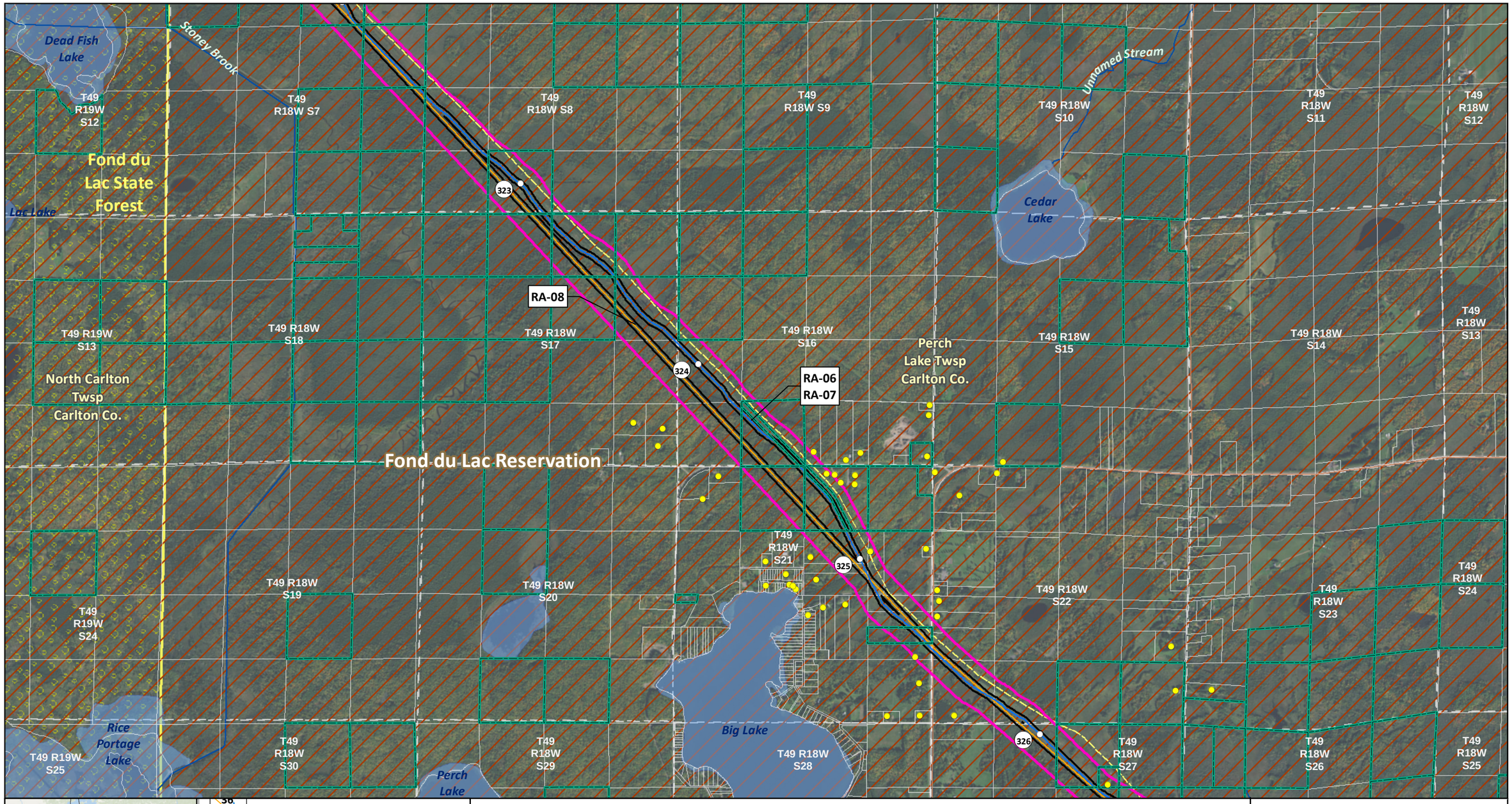
RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 40B of 43


Dead Fish Lake
Stoney Brook
Unnamed Stream
T49 R19W S12
T49 R18W S7
T49 R18W S8
T49 R18W S9
T49 R18W S10
T49 R18W S11
T49 R18W S12
Fond du Lac State Forest
Lac Lake
323
Cedar Lake
RA-08
T49 R19W S13
T49 R18W S18
T49 R18W S17
T49 R18W S16
T49 R18W S15
T49 R18W S14
T49 R18W S13
Perch Lake Twsp Carlton Co.
North Carlton Twsp Carlton Co.
324
RA-06
RA-07
Fond du Lac Reservation
T49 R18W S21
325
T49 R18W S19
T49 R18W S20
T49 R18W S22
T49 R18W S23
T49 R18W S24
T49 R19W S24
Big Lake
326
Rice Portage Lake
T49 R19W S25
T49 R18W S30
T49 R18W S29
T49 R18W S28
T49 R18W S27
T49 R18W S26
T49 R18W S25
Perch Lake
RA-08
RA-06
APR
RA-03AM
SA-04
MN
St. Louis County
Fond du Lac Reservation
Minnesota
Carlton County
Wisconsin
Douglas County
Aitkin County
36
37
38
39
40
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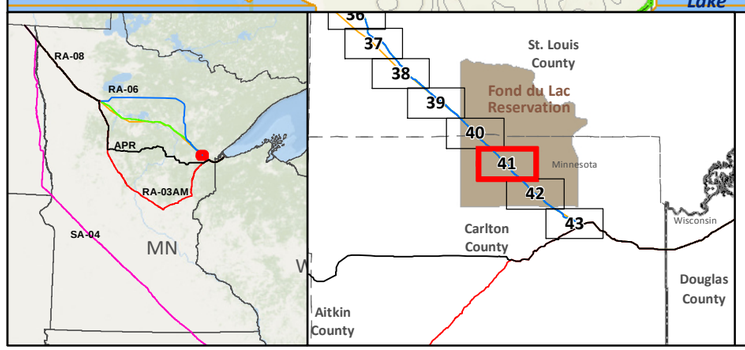
43
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
Data Sources: MNDNR, NHD, Enbridge
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL
RA-06
CLEARBROOK TO CARLTON
Map 41A of 43

Dead Fish Lake
Stoney Brook
Unnamed Stream
Lac Lake
Cedar Lake
Perch Lake Twsp Carlton Co.
North Carlton Twsp Carlton Co.
Rice Portage Lake
Big Lake
Perch Lake
RA-08
RA-06
RA-07
323
324
325
326
T49 R19W S12
T49 R18W S7
T49 R18W S8
T49 R18W S9
T49 R18W S10
T49 R18W S11
T49 R18W S12
T49 R19W S13
T49 R18W S18
T49 R18W S17
T49 R18W S16
T49 R18W S15
T49 R18W S14
T49 R18W S13
T49 R19W S24
T49 R18W S19
T49 R18W S20
T49 R18W S21
T49 R18W S22
T49 R18W S23
T49 R18W S24
T49 R19W S25
T49 R18W S30
T49 R18W S29
T49 R18W S28
T49 R18W S27
T49 R18W S26
T49 R18W S25



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

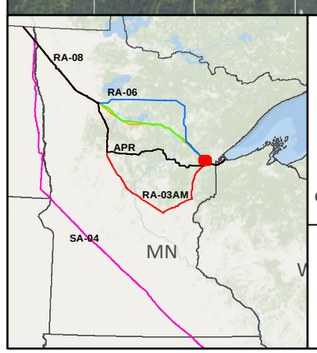
CLEARBROOK TO CARLTON

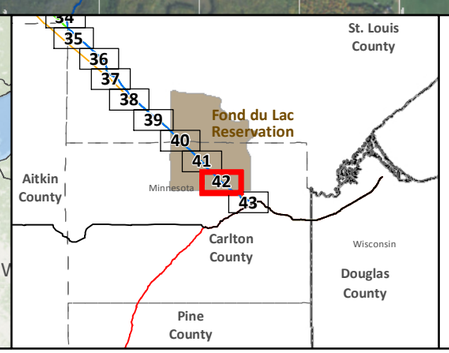
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 41B of 43

Big Lake
T49 R18W S28
T49 R18W S27
T49 R18W S26
T49 R18W S25
T49 R17W S30
T49 R17W S29
T49 R17W S28
327
Perch Lake Twsp Carlton Co.
Otter Creek
Cloquet Twsp Carlton Co.
T49 R18W S33
T49 R18W S34
T49 R18W S35
328
T49 R18W S36
T49 R17W S31
T49 R17W S32
T49 R17W S33
Fond du Lac Reservation
RA-06
RA-07
329
RA-08
Wild Rice Lake
Unnamed Stream
T48 R18W S4
T48 R18W S3
T48 R18W S2
T48 R18W S1
T48 R17W S6
T48 R17W S5
T48 R17W S4
210
North Carlton Twsp Carlton Co.
Twin Lakes Twsp Carlton Co.
330
Moose Horn River
T48 R18W S9
T48 R18W S10
T48 R18W S11
T48 R18W S12
T48 R17W S7
T48 R17W S8
T48 R17W S9
Little Otter Creek
331





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

N

Map 42A of 43

Big Lake

T49 R18W S28

T49 R18W S27

T49 R18W S26

T49 R18W S25

T49 R17W S30

T49 R17W S29

T49 R17W S28

Otter Creek

Perch Lake Twsp Carlton Co.

Cloquet Forest Game Refuge

Cloquet Twsp Carlton Co.

T49 R18W S33

T49 R18W S34

T49 R18W S35

T49 R18W S36

T49 R17W S31

T49 R17W S32

T49 R17W S33

327

328

329

330

331

RA-06
RA-07

RA-08

Unnamed Stream

Wild Rice Lake

T48 R18W S4

T48 R18W S3

T48 R18W S2

T48 R18W S1

T48 R17W S6

T48 R17W S5

T48 R17W S4

North Carlton Twsp Carlton Co.

Twin Lakes Twsp Carlton Co.

Moose Horn River

T48 R18W S9

T48 R18W S10

T48 R18W S11

T48 R18W S12

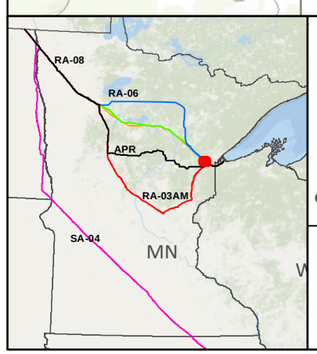
T48 R17W S7

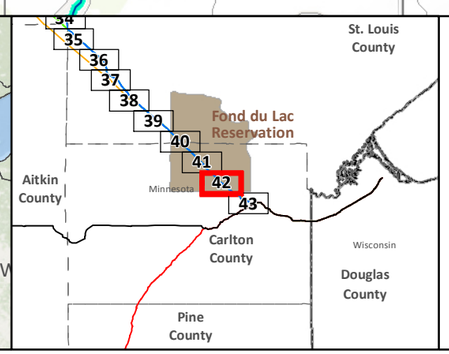
T48 R17W S8

T48 R17W S9

Little Otter Creek

210





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding

High

Moderate

Native Plant Communities with Biodiversity Significance

Outstanding

High

Moderate

Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

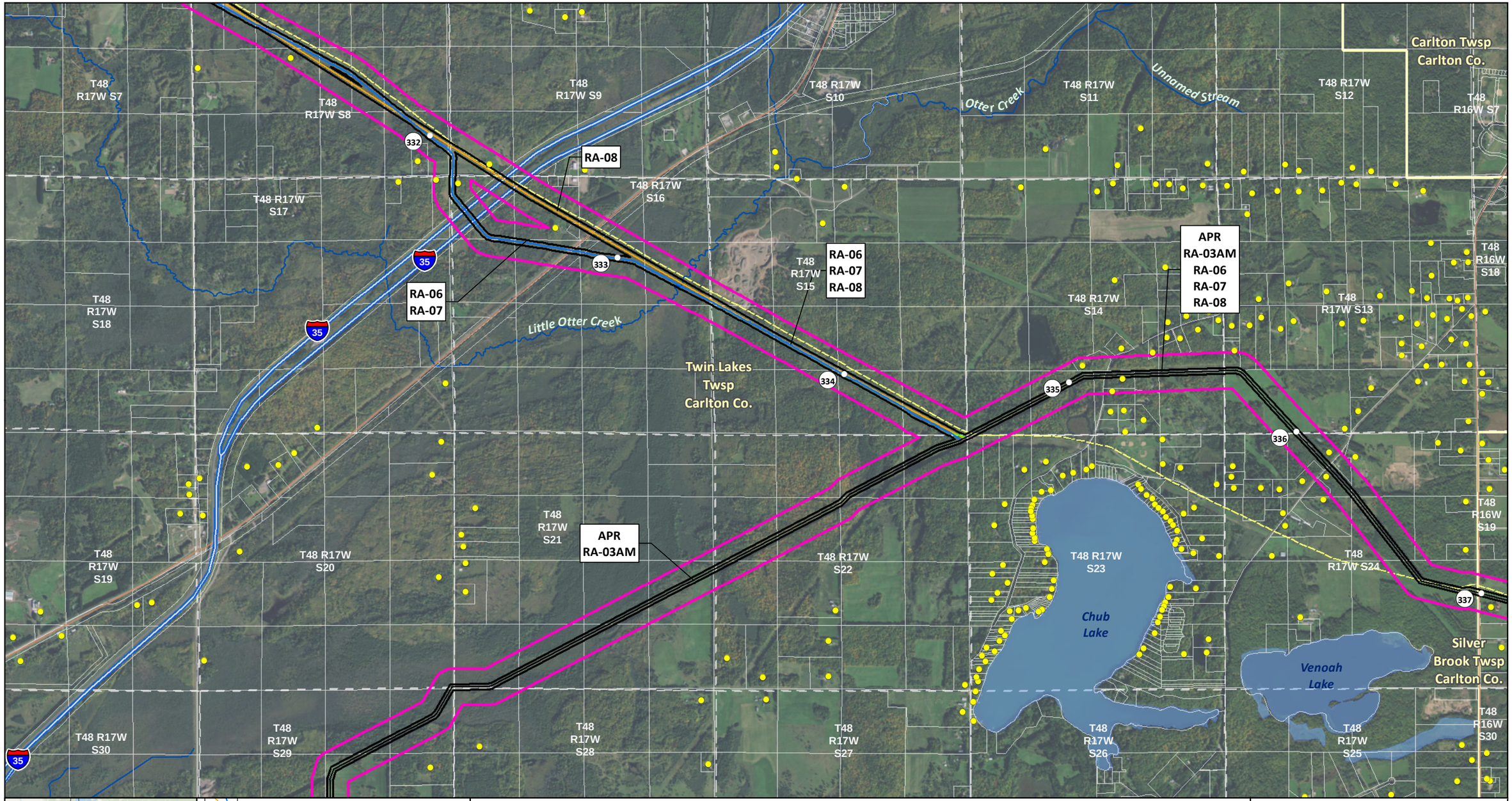
0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 42B of 43



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-06

CLEARBROOK TO CARLTON

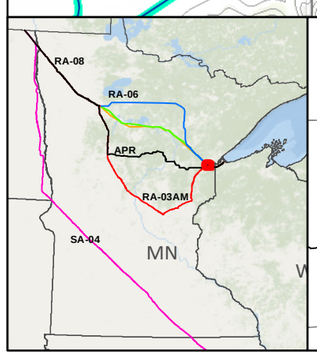
Map 43A of 43

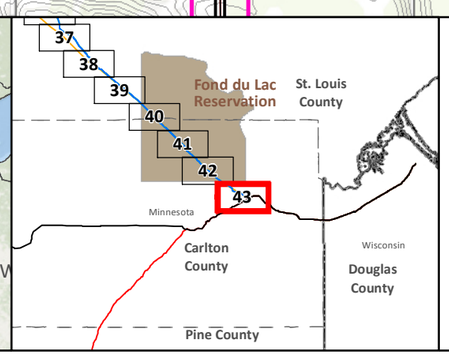
T48 R17W S7
T48 R17W S8
T48 R17W S9
T48 R17W S10
T48 R17W S11
T48 R17W S12
T48 R16W S7
T48 R16W S18
T48 R17W S17
T48 R17W S18
T48 R17W S16
T48 R17W S15
T48 R17W S14
T48 R17W S13
T48 R17W S19
T48 R17W S20
T48 R17W S21
T48 R17W S22
T48 R17W S23
T48 R17W S24
T48 R16W S19
T48 R16W S30
T48 R17W S30
T48 R17W S29
T48 R17W S28
T48 R17W S27
T48 R17W S26
T48 R17W S25

Otter Creek
Unnamed Stream
Little Otter Creek
Carlton Twsp
Carlton Co.
Carlton WHPA
Twin Lakes Twsp Carlton Co.
Silver Brook Twsp Carlton Co.
Chub Lake
Venoah Lake

RA-08
RA-06
RA-07
RA-06
RA-07
RA-08
APR
RA-03AM
RA-06
RA-07
RA-08
APR
RA-03AM

332
333
334
335
336
337
35
35
35





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-06

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 43B of 43

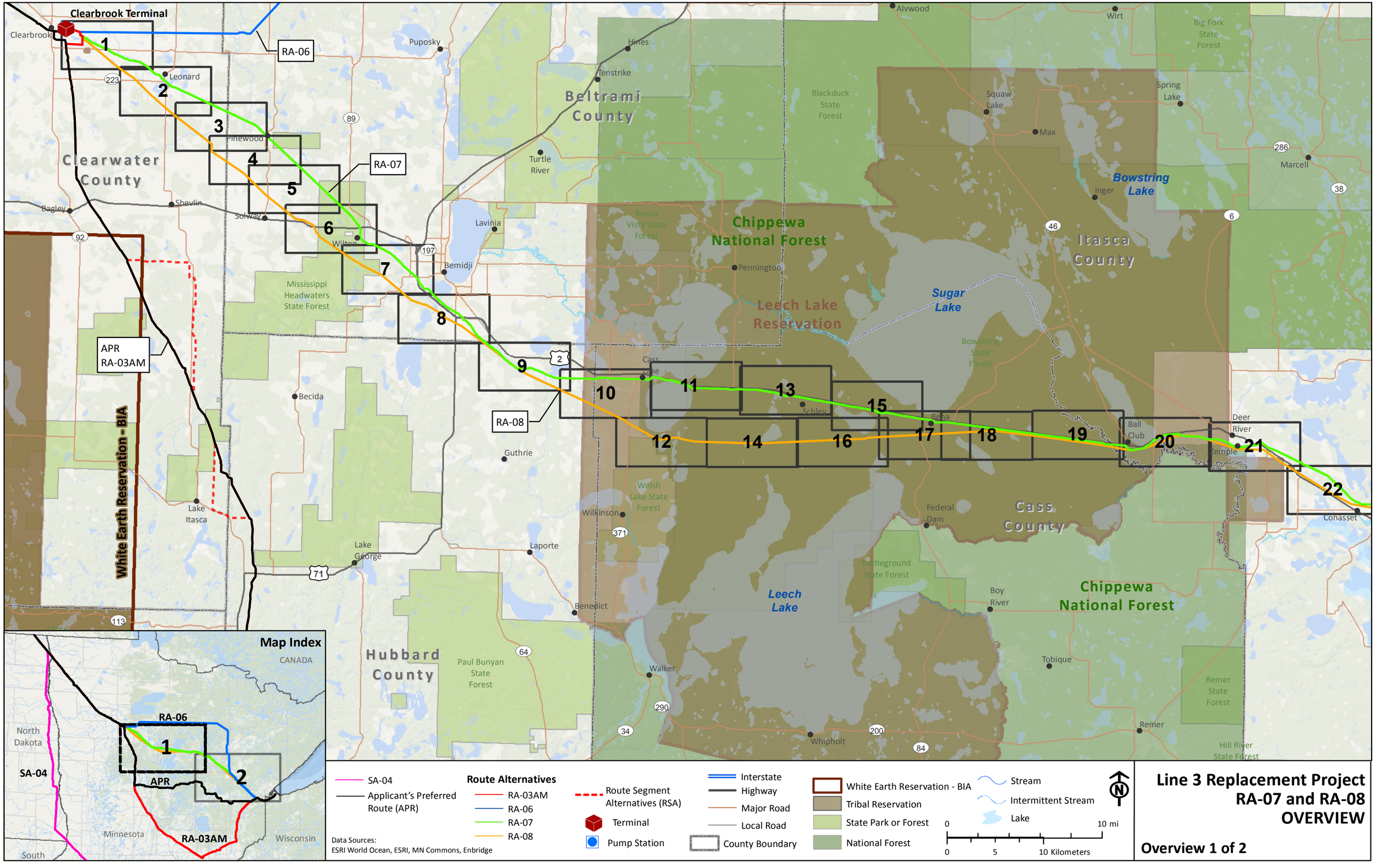
Minnesota Department of Commerce
Energy Environmental Review and Analysis

Draft Environmental Impact Statement
Line 3 Project

Mapbook
RA-07 and RA-08

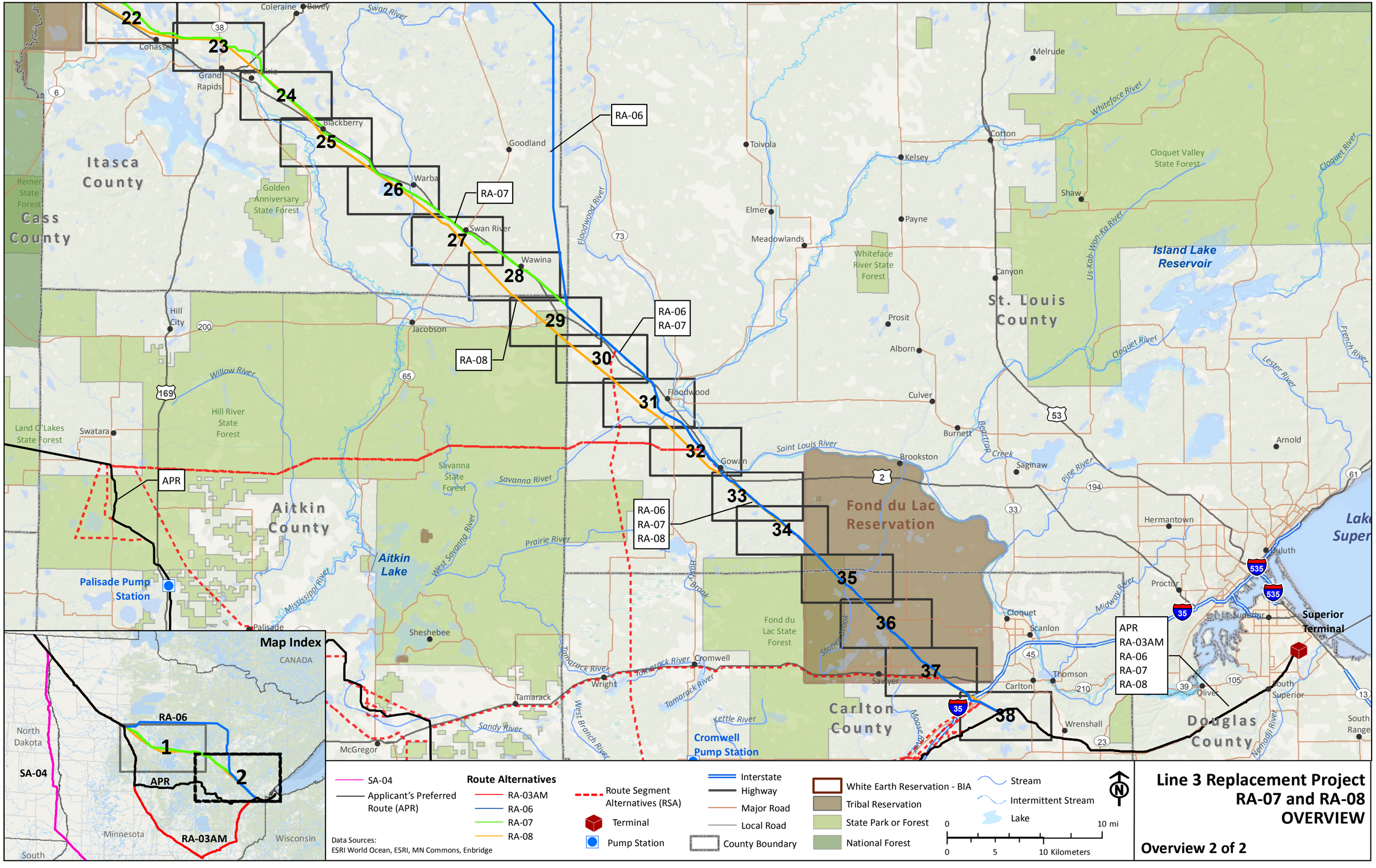
Docket Nos. PPL-15-137/CN-14-916

May 15, 2017



Line 3 Replacement Project
RA-07 and RA-08
OVERVIEW

Overview 1 of 2



Line 3 Replacement Project
RA-07 and RA-08
OVERVIEW
Overview 2 of 2
Map Index
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Route Segment Alternatives (RSA)
Terminal
Pump Station
Interstate
Highway
Major Road
Local Road
County Boundary
White Earth Reservation - BIA
Tribal Reservation
State Park or Forest
National Forest
Stream
Intermittent Stream
Lake
0 10 mi
0 5 10 Kilometers
Data Sources:
ESRI World Ocean, ESRI, MN Commons, Enbridge
Itasca County
Cass County
Aitkin County
St. Louis County
Carlton County
Douglas County
Fond du Lac Reservation
Island Lake Reservoir
Aitkin Lake
Palisade Pump Station
Cromwell Pump Station
Superior Terminal
Golden Anniversary State Forest
Whiteface River State Forest
Cloquet Valley State Forest
Hill River State Forest
Savanna State Forest
Land O'Lakes State Forest
Remer State Forest
Fond du Lac State Forest
Coleraine
Bovey
Cohasset
Grand Rapids
La Prairie
Blackberry
Goodland
Warba
Swan River
Wawina
Jacobson
Hill City
Swatara
Palisade
Sheshebee
Tamarack
Wright
Cromwell
McGregor
Floodwood
Gowan
Toivola
Elmer
Meadowlands
Kelsey
Payne
Prosit
Alborn
Culver
Burnett
Brookston
Saginaw
Melrude
Cotton
Shaw
Canyon
Arnold
Hermantown
Duluth
Proctor
Superior
Cloquet
Scanlon
Thomson
Carlton
Wrenshall
Oliver
South Superior
South Range
Swan River
Willow River
Mississippi River
Savanna River
Prairie River
West Savanna River
Tamarack River
Sandy River
West Branch River
Lettle River
Floodwood River
Saint Louis River
Whiteface River
Cloquet River
Us-Kab-Wan-Ka River
Lester River
French River
Beartrap Creek
Pine River
Midway River
Nemadji River
Moose River
Stoney Brook
Hasty Brook
RA-06
RA-07
RA-08
APR
RA-03AM
RA-06
RA-07
RA-08
1
2
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38

RA-03AM
RA-06
RA-07
RA-08

Clearbrook Terminal

RA-06

RA-08

RA-03AM

RA-07

RA-08

APR
RA-03AM

Red Lake Reservation

Leon Twsp Clearwater Co.

Sinclair Twsp Clearwater Co.

Holst Twsp Clearwater Co.

Dudley Twsp Clearwater Co.

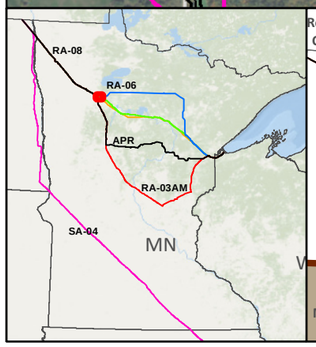
Deep Lake

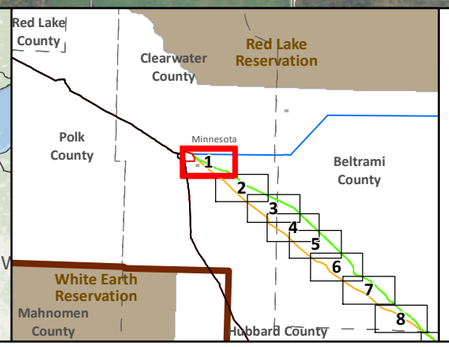
Peterson Lake

Unnamed Creek

Ruffy Brook

T149 R37W S29
T149 R37W S28
T149 R37W S27
T149 R37W S26
T149 R37W S25
T149 R36W S30
T149 R36W S29
T149 R37W S32
T149 R37W S33
T149 R37W S34
T149 R37W S35
T149 R37W S36
T149 R36W S31
T149 R36W S32
T148 R37W S6
T148 R37W S5
T148 R37W S4
T148 R37W S3
T148 R37W S2
T148 R37W S1
T148 R36W S6
T148 R36W S5
T148 R37W S7
T148 R37W S8
T148 R37W S9
T148 R37W S10
T148 R37W S11
T148 R37W S12
T148 R36W S7
T148 R36W S8





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 1A of 38

RA-03AM
RA-06
RA-07
RA-08

Clearbrook Terminal

RA-06

RA-08

RA-03AM

RA-07

RA-08

APR
RA-03AM

RA-08

Deep Lake

Peterson Lake

Holst Twsp Clearwater Co.

Leon Twsp Clearwater Co.

Sinclair Twsp Clearwater Co.

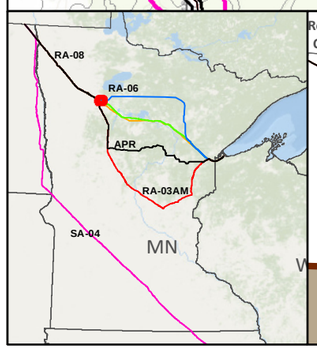
Dudley Twsp Clearwater Co.

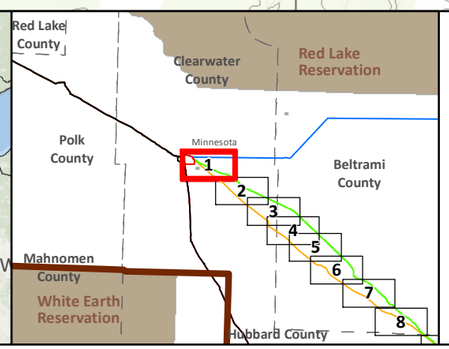
Unnamed Creek

Ruffy Brook

T149 R37W S29
T149 R37W S28
T149 R37W S27
T149 R37W S26
T149 R37W S25
T149 R36W S30
T149 R36W S29
T149 R37W S32
T149 R37W S33
T149 R37W S34
T149 R37W S35
T149 R37W S36
T149 R36W S31
T149 R36W S32
T148 R37W S5
T148 R37W S4
T148 R37W S3
T148 R37W S2
T148 R36W S6
T148 R37W S6
T148 R37W S7
T148 R37W S8
T148 R37W S9
T148 R37W S10
T148 R37W S11
T148 R37W S12
T148 R36W S1
T148 R36W S5
T148 R36W S7
T148 R36W S8

139 140 141 142 143





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

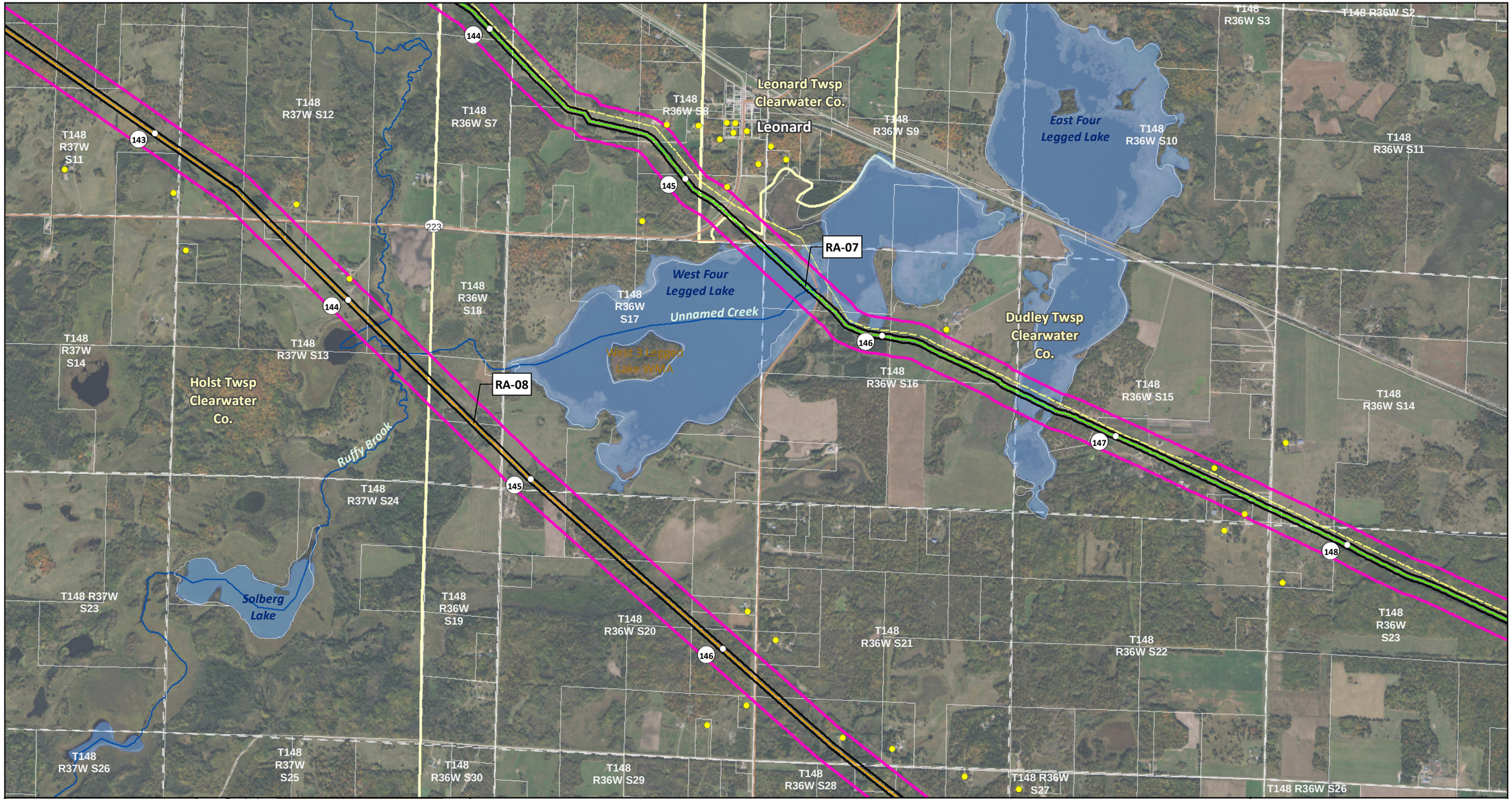
RA-07 AND RA-08

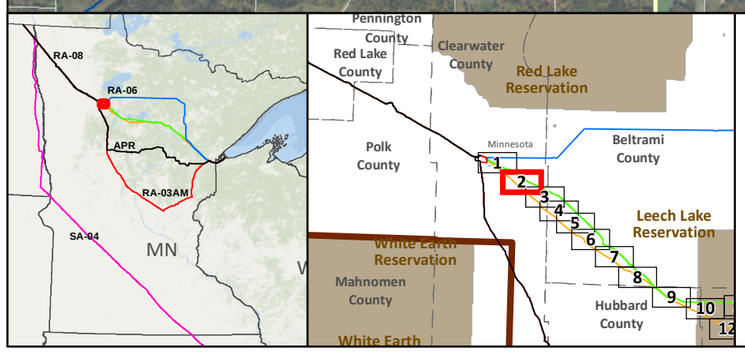
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 1B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 2A of 38

Leonard Twsp
Clearwater Co.

T148 R36W S2

T148 R36W S3

T148 R37W S12

T148 R36W S7

T148 R36W S8

Leonard

T148 R36W S9

East Four Legged Lake

T148 R36W S10

T148 R36W S11

T148 R37W S11

143

144

145

223

RA-07

T148 R36W S18

T148 R36W S17

Unnamed Creek

West Four Legged Lake

West 4 Legged LaKe WMA

Dudley Twsp Clearwater Co.

146

T148 R36W S16

T148 R36W S15

T148 R36W S14

147

T148 R37W S14

T148 R37W S13

Holst Twsp Clearwater Co.

RA-08

Ruffy Brook

148

T148 R37W S23

Old Red Lake Trail WMA

Solberg Lake

T148 R37W S24

T148 R36W S19

T148 R36W S20

T148 R36W S21

T148 R36W S22

T148 R36W S23

T148 R37W S26

Old Red Lake Trail WMA

T148 R37W S25

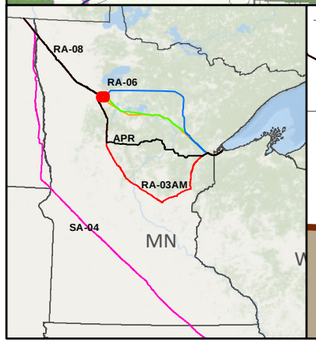
T148 R36W S30

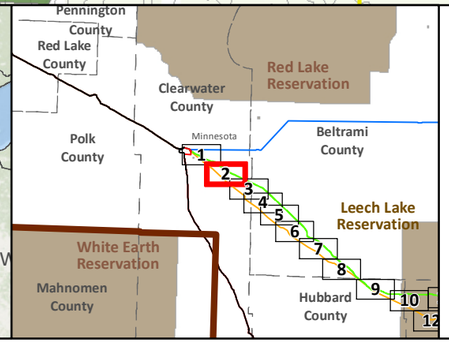
T148 R36W S29

T148 R36W S28

T148 R36W S27

T148 R36W S26





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

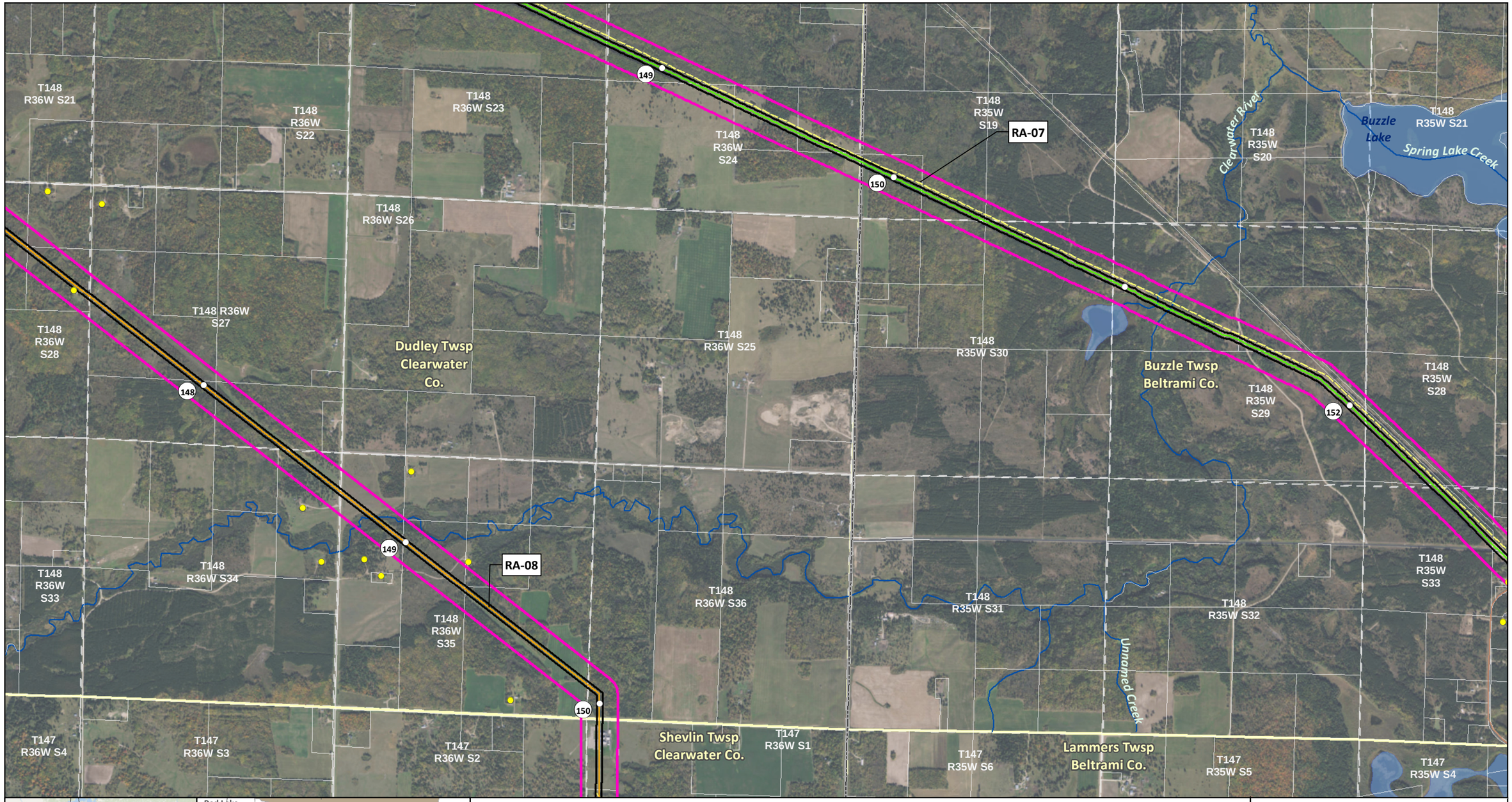
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08 CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 2B of 38

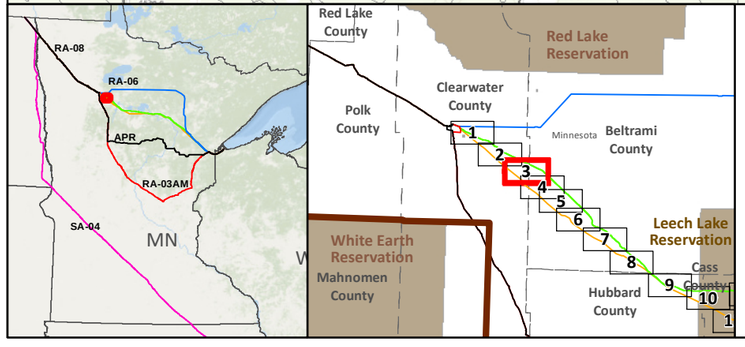


LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 3A of 38

T148 R36W S21
T148 R36W S22
T148 R36W S23
T148 R36W S24
T148 R35W S19
RA-07
T148 R35W S21
Buzzle Lake
Spring Lake Creek
Clearwater River
T148 R35W S20
T148 R36W S26
T148 R36W S27
T148 R36W S28
Dudley Twsp Clearwater Co.
T148 R36W S25
T148 R35W S30
Buzzle Twsp Beltrami Co.
T148 R35W S29
T148 R35W S28
T148 R36W S34
T148 R36W S33
RA-08
T148 R36W S35
T148 R36W S36
T148 R35W S31
T148 R35W S32
T148 R35W S33
Unnamed Creek
T147 R36W S4
T147 R36W S3
T147 R36W S2
Shevlin Twsp Clearwater Co.
T147 R36W S1
T147 R35W S6
Lammers Twsp Beltrami Co.
T147 R35W S5
T147 R35W S4
Pinewood Rd NW
149
150
148
152



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

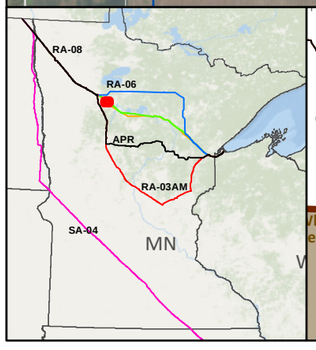
RA-07 AND RA-08

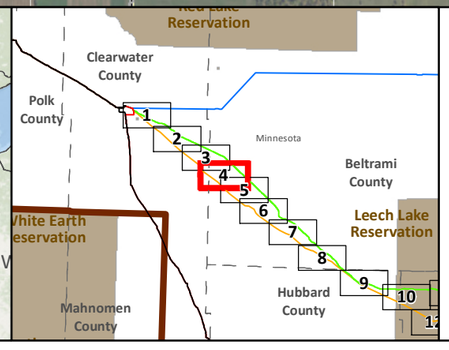
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 3B of 38

T148 R36W S35
Clearwater River
T148 R35W S31
T148 R35W S32
Buzzle Twsp Beltrami Co.
T148 R35W S33
T148 R35W S34
Mississippi Headwaters State Forest
Unnamed Creek
Spring Lake Creek
T148 R35W S35
Dudley Twsp Clearwater Co.
T148 R36W S36
150
154
RA-07
T147 R36W S1
T147 R35W S6
T147 R35W S5
T147 R35W S4
T147 R35W S3
T147 R35W S2
151
RA-08
T147 R35W S2
T147 R36W S11
Shevlin Twsp Clearwater Co.
Lammers Twsp Beltrami Co.
152
155
T147 R36W S12
T147 R35W S7
T147 R35W S8
T147 R35W S9
T147 R35W S10
Unnamed Stream
T147 R35W S11
153
T147 R36W S14
T147 R36W S13
T147 R35W S18
T147 R35W S17
T147 R35W S16
T147 R35W S15
T147 R35W S14





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

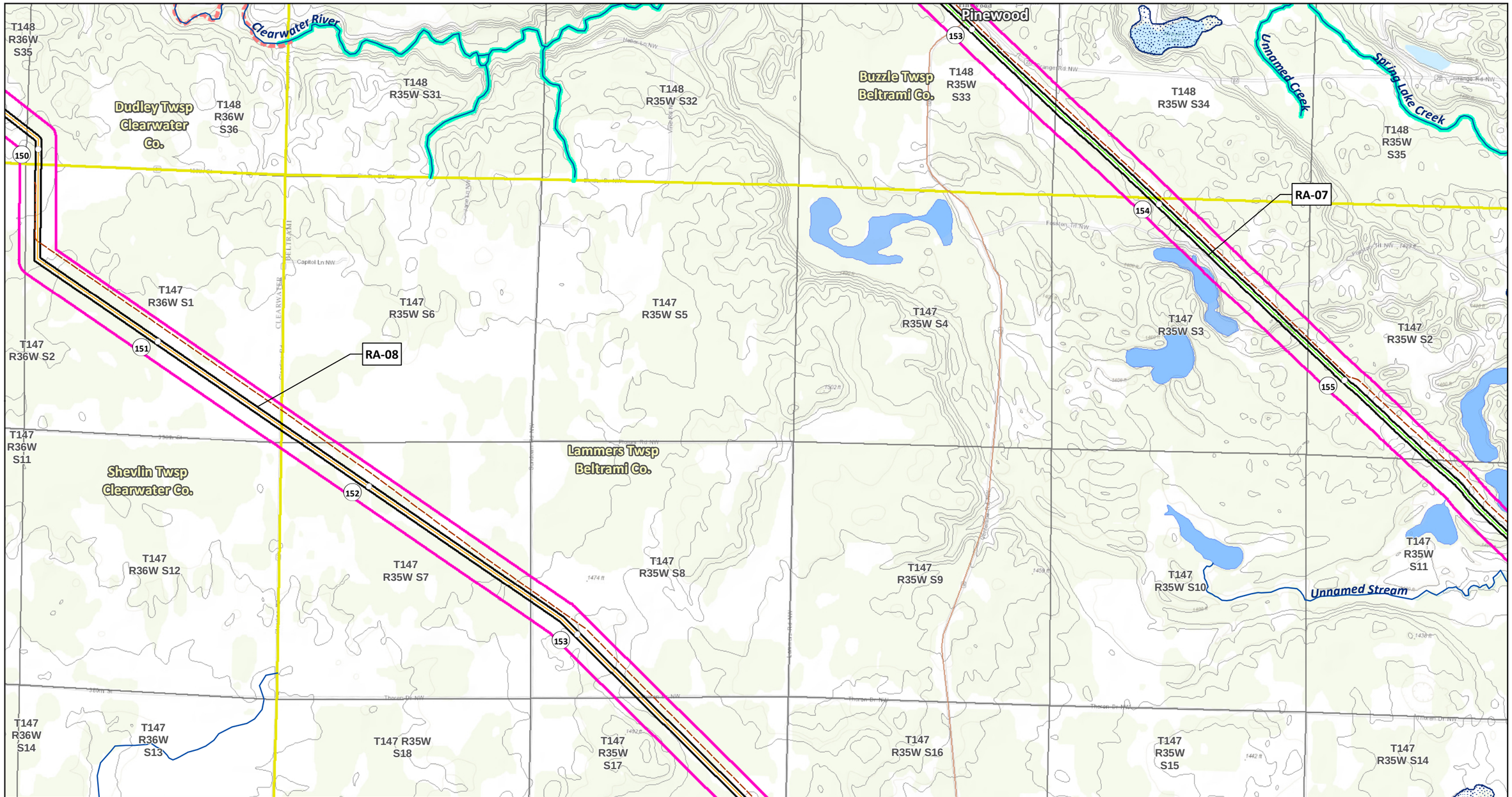
Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08
CLEARBROOK TO CARLTON

Map 4A of 38


T148 R36W S35
Clearwater River
Dudley Twsp Clearwater Co.
T148 R36W S36
T148 R35W S31
T148 R35W S32
Buzzle Twsp Beltrami Co.
T148 R35W S33
Pinewood
T148 R35W S34
Unnamed Creek
Spring Lake Creek
T148 R35W S35
150
153
154
RA-07
T147 R36W S1
T147 R35W S6
T147 R35W S5
T147 R35W S4
T147 R35W S3
T147 R35W S2
151
155
T147 R36W S2
RA-08
T147 R36W S11
Shevlin Twsp Clearwater Co.
Lammers Twsp Beltrami Co.
152
T147 R36W S12
T147 R35W S7
T147 R35W S8
T147 R35W S9
T147 R35W S10
Unnamed Stream
T147 R35W S11
T147 R36W S14
T147 R36W S13
T147 R35W S18
T147 R35W S17
T147 R35W S16
T147 R35W S15
T147 R35W S14
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Red Lake Reservation
Polk County
Minnesota
Beltrami County
Leech Lake Reservation
Clearwater County
Hubbard County
Mahnomen County
1
2
3
4
5
6
7
8
9
10
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
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Public Waters Watercourse
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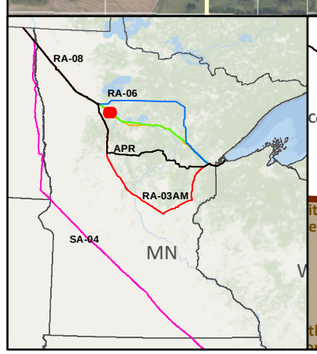
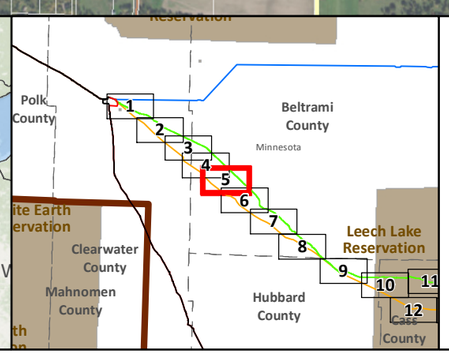
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-07 AND RA-08
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 4B of 38

T147 R34W S5
T147 R34W S6
Lammers Twsp
Beltrami Co.
T147 R35W S10
T147 R35W S11
T147 R35W S12
T147 R34W S7
T147 R34W S8
T147 R35W S9
T147 R35W S8
156
RA-07
157
Unnamed Stream
T147 R35W S17
154
RA-08
T147 R35W S16
T147 R35W S15
T147 R35W S14
T147 R35W S13
T147 R34W S18
Eckles Twsp
Beltrami Co.
T147 R34W S17
158
155
T147 R35W S20
T147 R35W S21
T147 R35W S22
T147 R35W S23
T147 R35W S24
Mississippi Headwaters State Forest
T147 R34W S20
159
T147 R34W S19
156
T147 R35W S29
T147 R35W S28
Solway Twsp
Beltrami Co.
T147 R35W S27
T147 R35W S26
T147 R35W S25
T147 R34W S30
T147 R34W S29





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

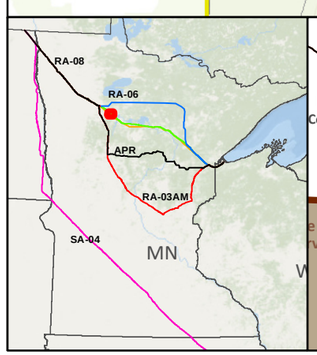
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

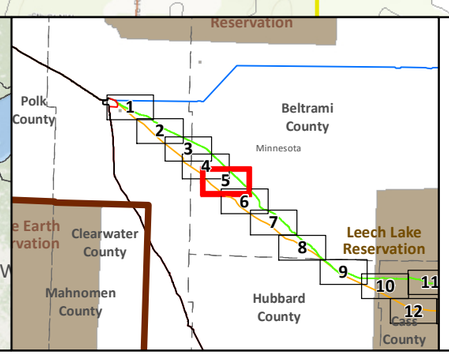
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 5A of 38

T147 R34W S5
T147 R34W S6
T147 R35W S10
T147 R35W S11
T147 R35W S12
Lammers Twsp Beltrami Co.
T147 R34W S7
T147 R34W S8
T147 R35W S9
T147 R35W S8
RA-07
Unnamed Stream
T147 R35W S17
RA-08
T147 R35W S16
T147 R35W S15
T147 R35W S14
T147 R35W S13
T147 R34W S18
T147 R34W S17
Eckles Twsp Beltrami Co.
T147 R35W S21
T147 R35W S22
T147 R35W S23
T147 R35W S24
T147 R34W S19
T147 R34W S20
T147 R35W S20
T147 R35W S29
T147 R35W S28
Solway Twsp Beltrami Co.
T147 R35W S27
T147 R35W S26
T147 R35W S25
T147 R34W S30
T147 R34W S29





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

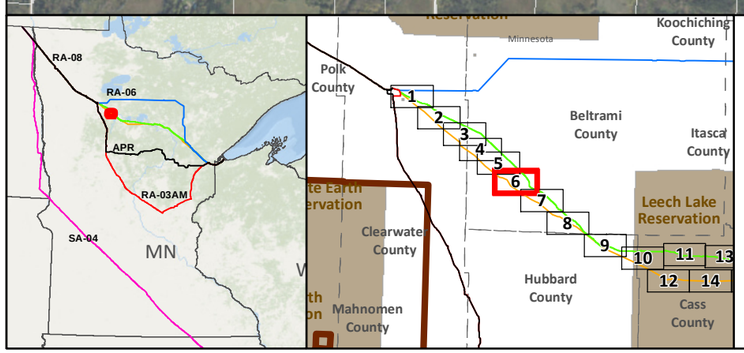
1:24,000

0 125 250 500 Meters

10ft Contours

Map 5B of 38

T147 R35W S22
T147 R35W S23
T147 R35W S24
T147 R34W S19
T147 R34W S20
T147 R34W S21
T147 R34W S22
T147 R35W S27
T147 R35W S26
T147 R35W S25
T147 R34W S30
Eckles Twsp Beltrami Co.
T147 R34W S29
T147 R34W S28
T147 R34W S27
RA-07
Lammers Twsp Beltrami Co.
Mississippi Headwaters State Forest
Unnamed Stream
RA-08
T147 R35W S35
T147 R35W S36
T147 R34W S31
T147 R34W S32
Wilton Twsp Beltrami Co.
T147 R34W S33
T147 R35W S34
T147 R34W S34
T146 R35W S3
T146 R35W S2
Jones Twsp Beltrami Co.
T146 R35W S1
T146 R34W S6
T146 R34W S5
Grant Valley Twsp Beltrami Co.
Grant Lake
T146 R34W S4
T146 R34W S3
157
158
159
160
161
163
2
89



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
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Highway
Major Road
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National Forest
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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

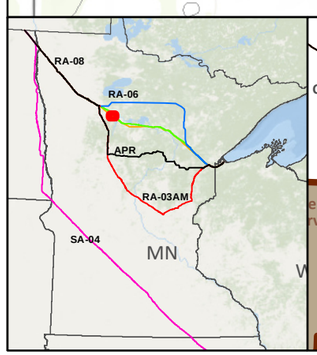
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08
CLEARBROOK TO CARLTON

Map 6A of 38

N

T147 R35W S22
T147 R35W S23
T147 R35W S24
T147 R34W S19
T147 R34W S20
T147 R34W S21
T147 R34W S22
Lammers Twsp Beltrami Co.
T147 R35W S27
T147 R35W S26
T147 R35W S25
T147 R34W S30
Eckles Twsp Beltrami Co.
T147 R34W S29
T147 R34W S28
T147 R34W S27
RA-07
RA-08
Unnamed Stream
T147 R35W S35
T147 R35W S36
T147 R34W S31
T147 R34W S32
Wilton Twsp Beltrami Co.
Wilton
T147 R34W S33
T147 R34W S34
T147 R35W S34
T146 R35W S3
T146 R35W S2
Jones Twsp Beltrami Co.
T146 R35W S1
T146 R34W S6
T146 R34W S5
Grant Valley Twsp Beltrami Co.
Grant Lake
T146 R34W S4
T146 R34W S3
157
158
159
160
161
162
163
89
2



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- Applicant's Preferred Route (APR)

Route Alternatives
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- High
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- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

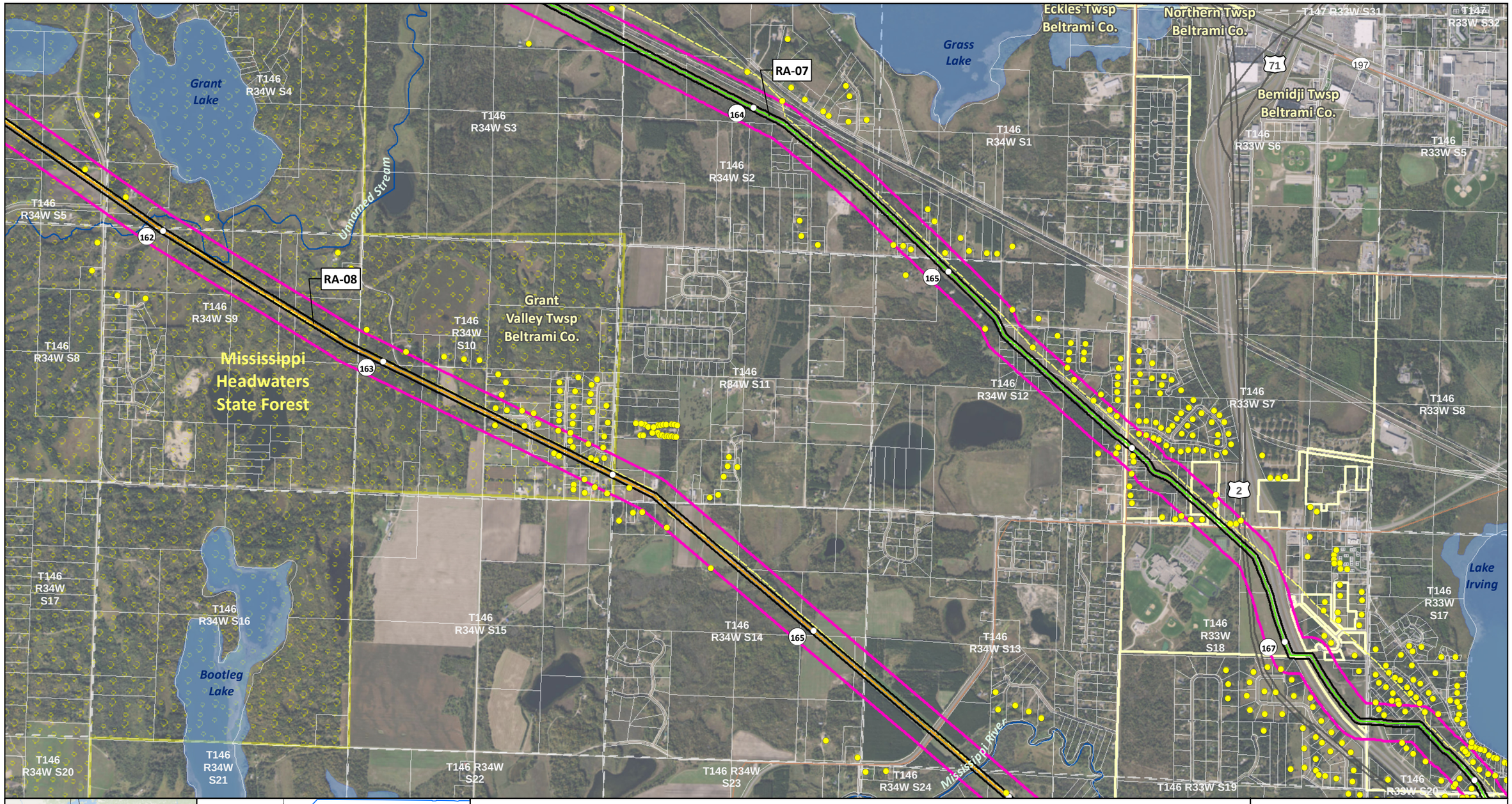
0 125 250 500 Meters

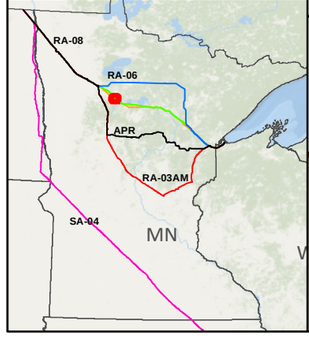
1:24,000

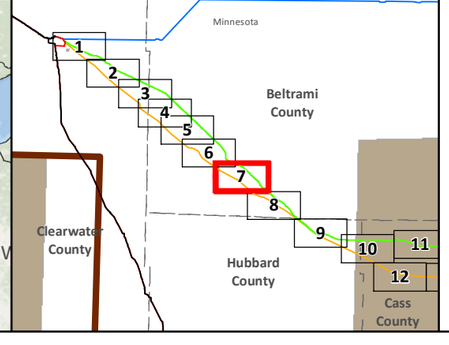
10ft Contours

N

Map 6B of 38







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

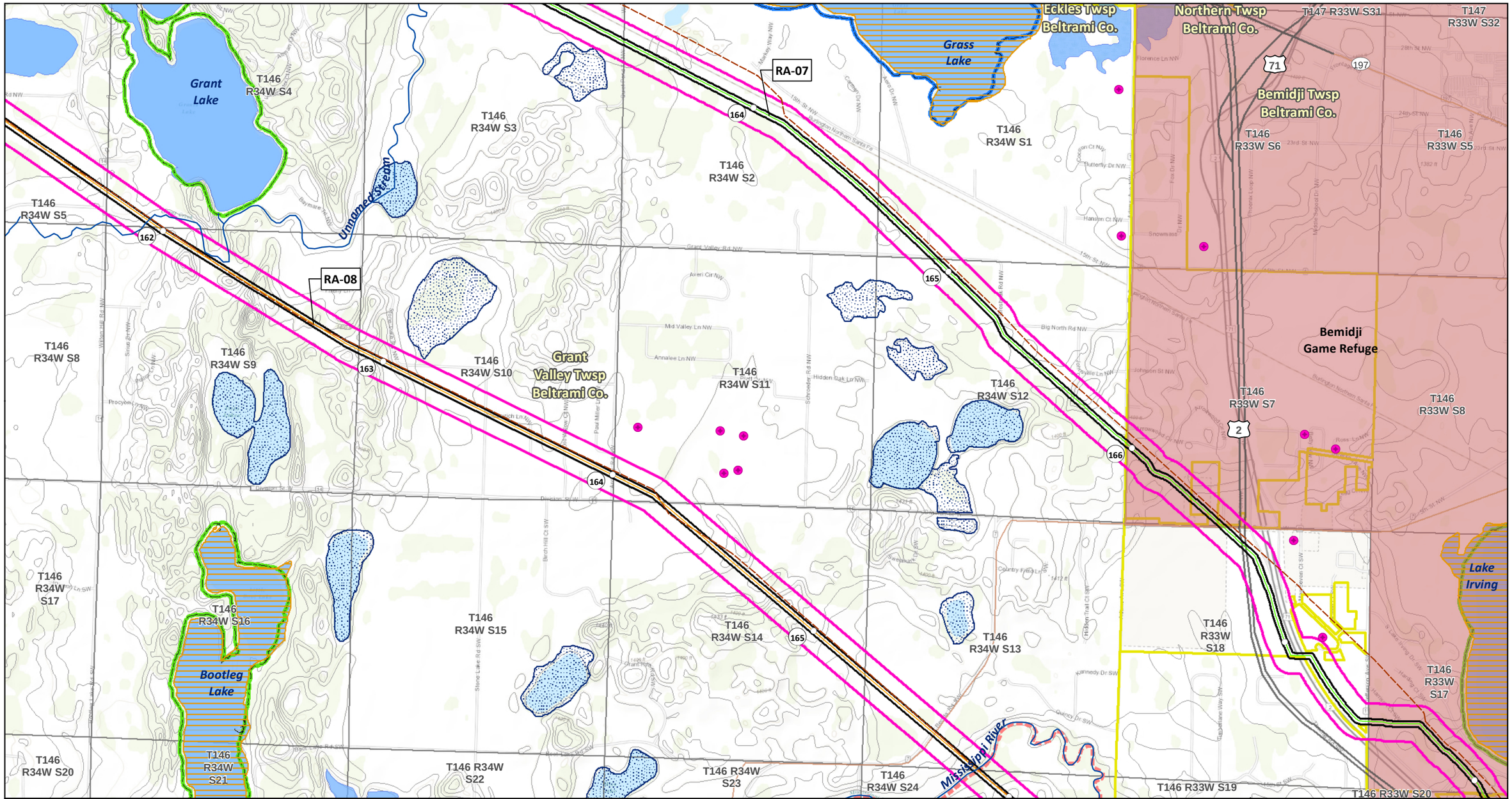
0 125 250 500 Meters

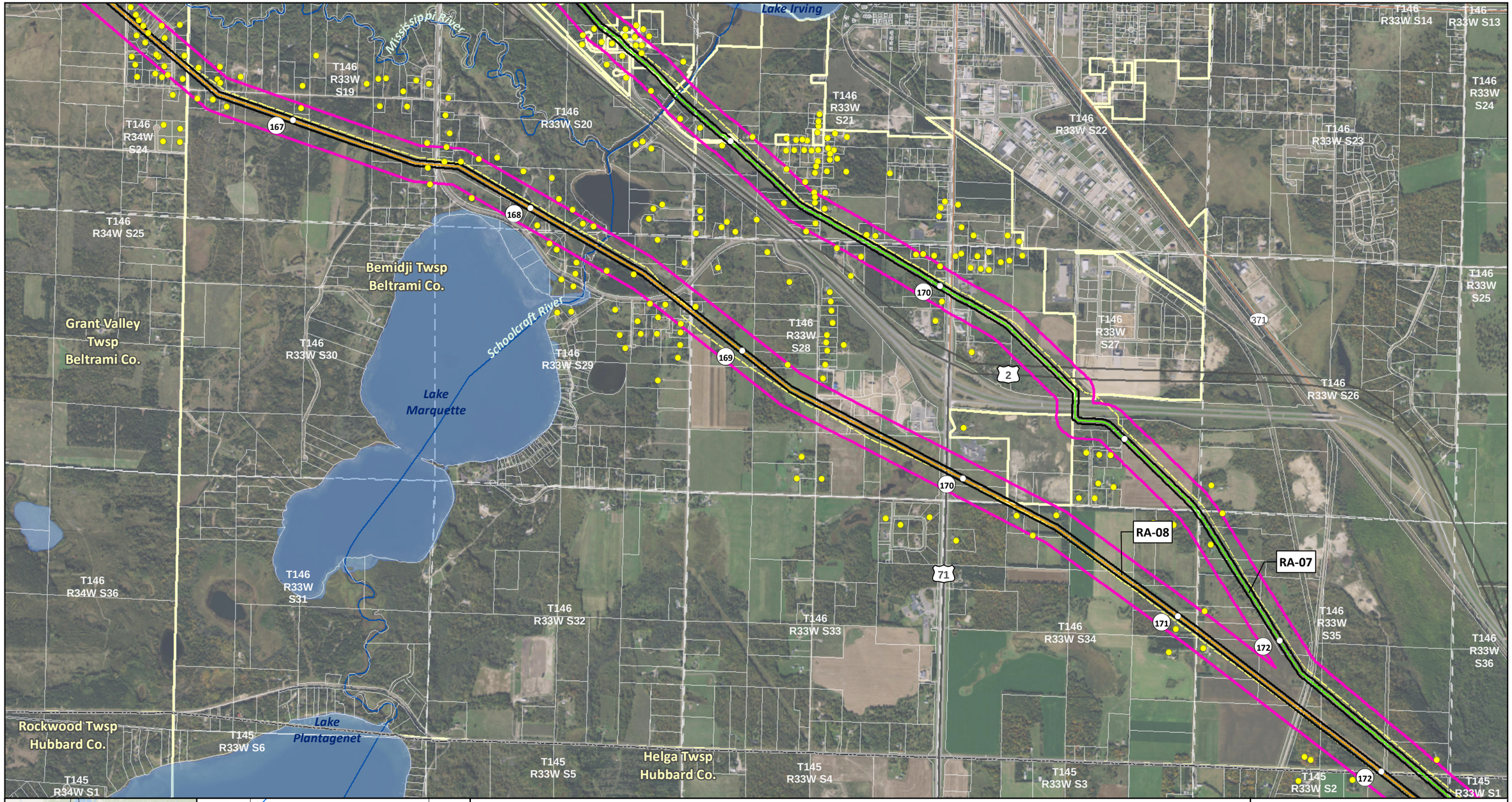
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

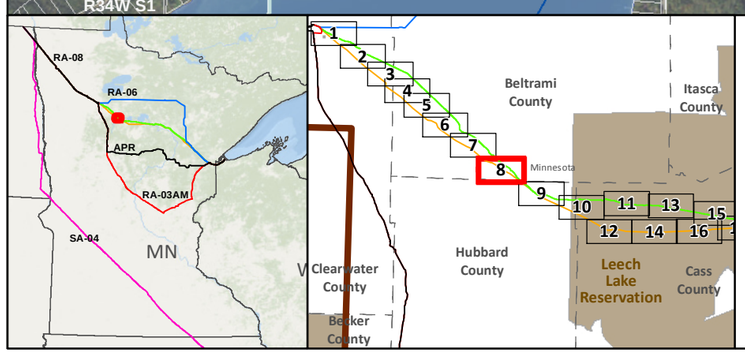
RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 7A of 38


Grant Lake
T146 R34W S4
T146 R34W S3
RA-07
Eckles Twsp Beltrami Co.
Grass Lake
Northern Twsp Beltrami Co.
T147 R33W S31
T147 R33W S32
Bemidji Twsp Beltrami Co.
T146 R34W S1
T146 R34W S2
T146 R33W S6
T146 R33W S5
T146 R34W S5
Unnamed Stream
RA-08
T146 R34W S8
T146 R34W S9
T146 R34W S10
Grant Valley Twsp Beltrami Co.
T146 R34W S11
T146 R34W S12
Bemidji Game Refuge
T146 R33W S7
T146 R33W S8
T146 R34W S17
T146 R34W S16
T146 R34W S15
T146 R34W S14
T146 R34W S13
T146 R33W S18
Lake Irving
Bootleg Lake
T146 R34W S21
T146 R34W S22
T146 R34W S23
T146 R34W S24
Mississippi River
T146 R33W S19
T146 R33W S20
T146 R33W S17
T146 R34W S20
Minnesota
Beltrami County
Clearwater County
Hubbard County
Cass County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-07 AND RA-08
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 7B of 38





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources:
MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

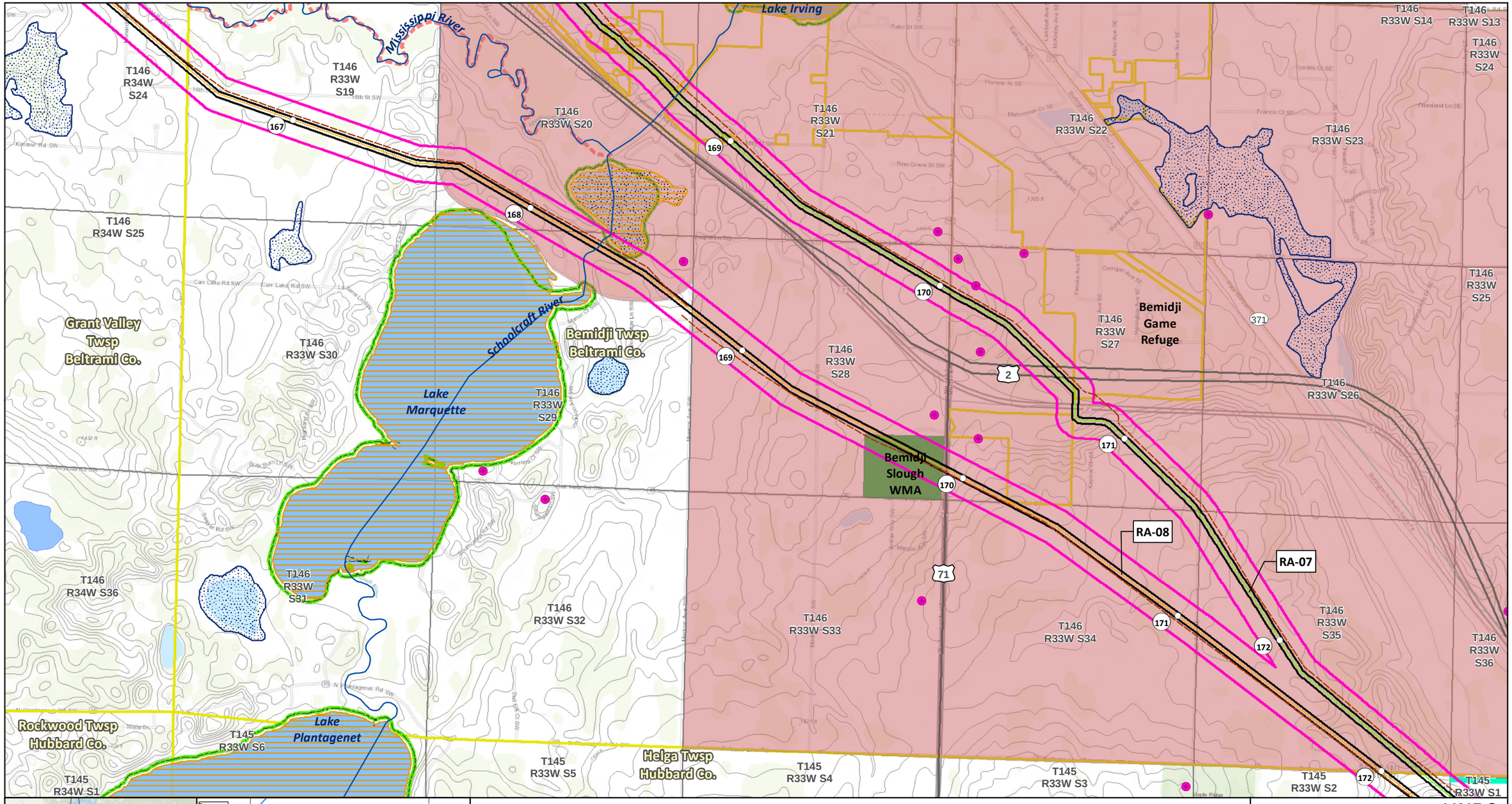
0 125 250 500 Meters

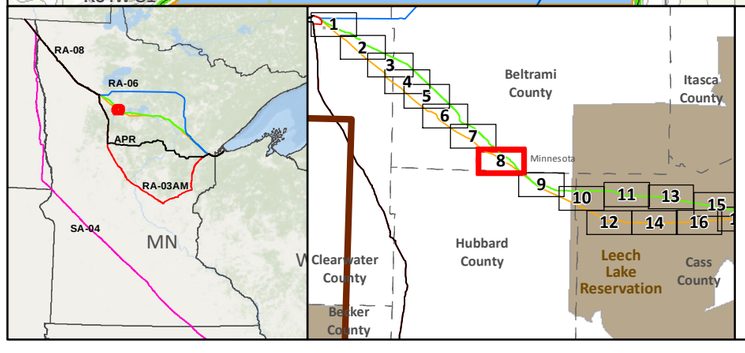
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 8A of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

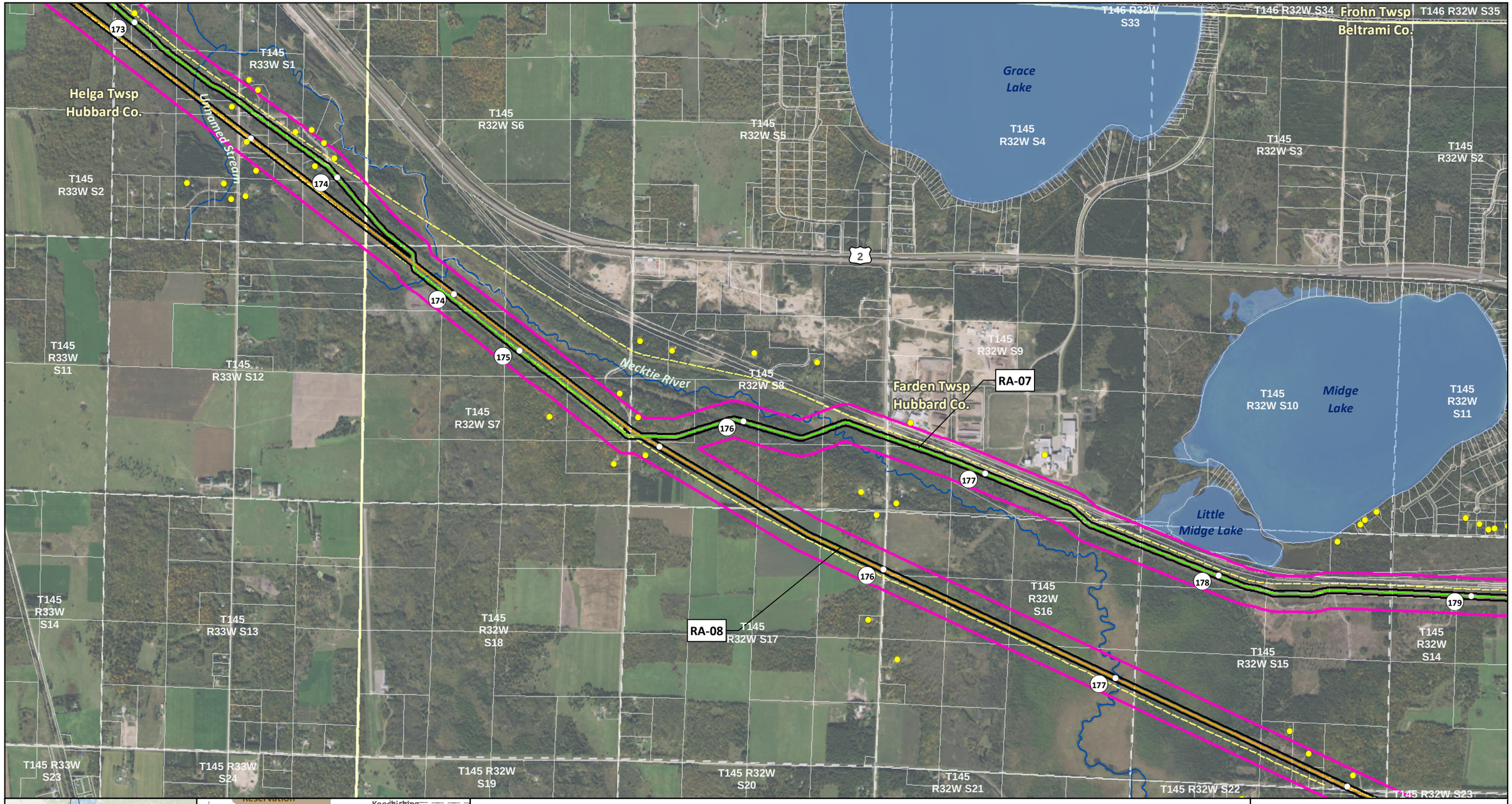
Data Sources: MNDNR, USGS, NHD, Enbridge

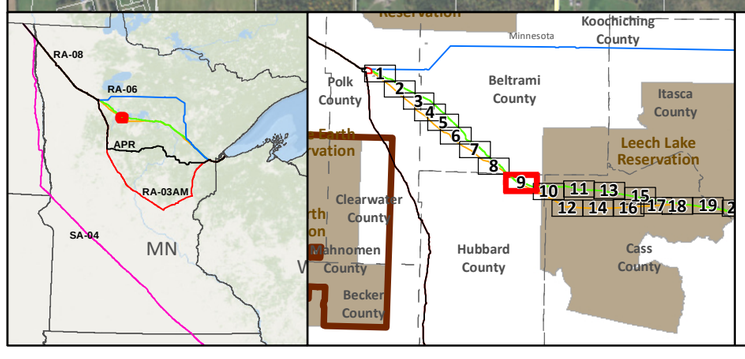
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08 CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 8B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

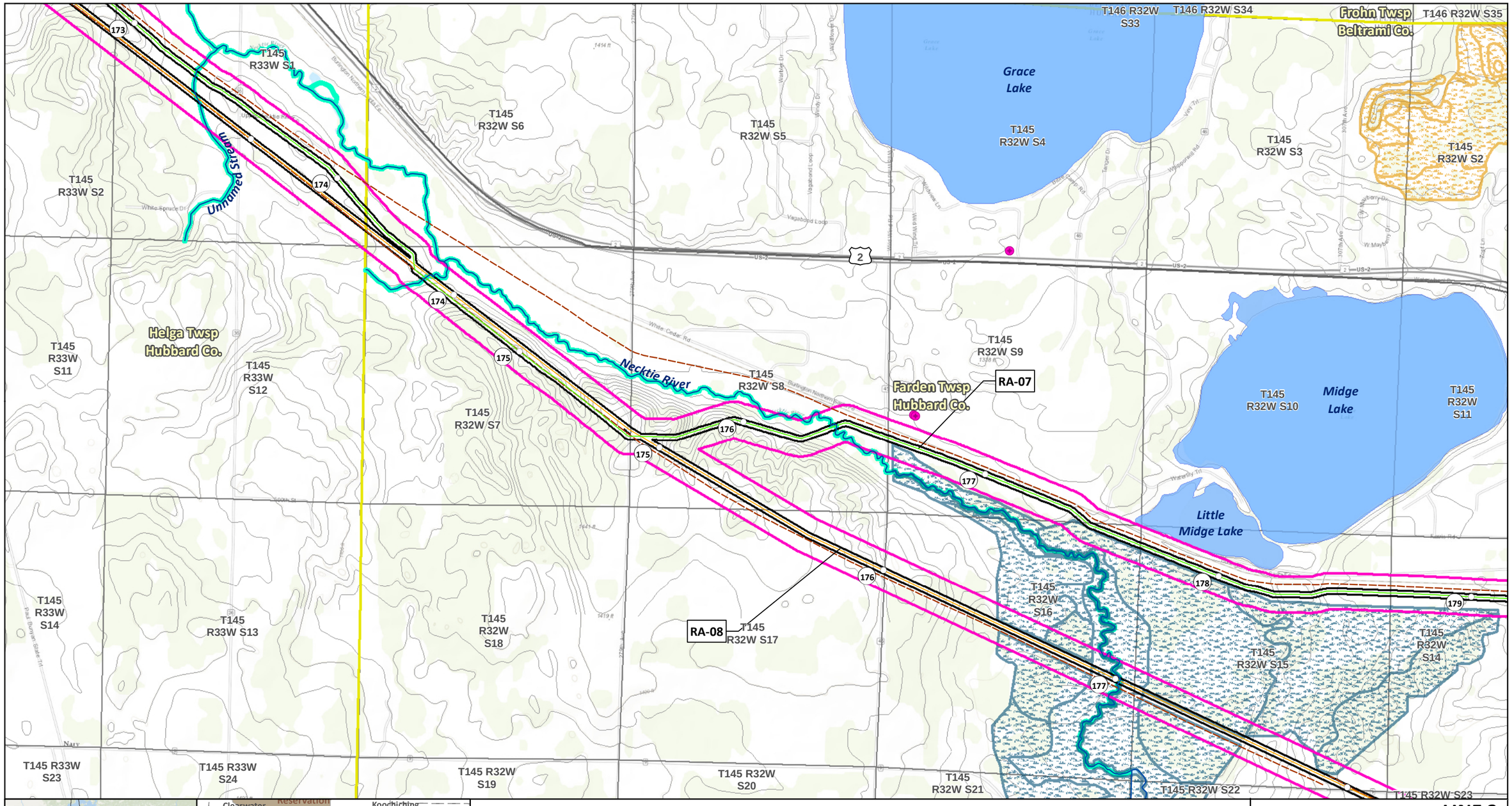
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

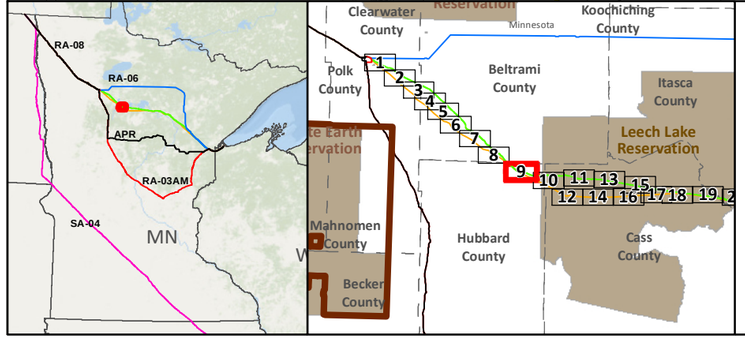
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 9A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate
- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

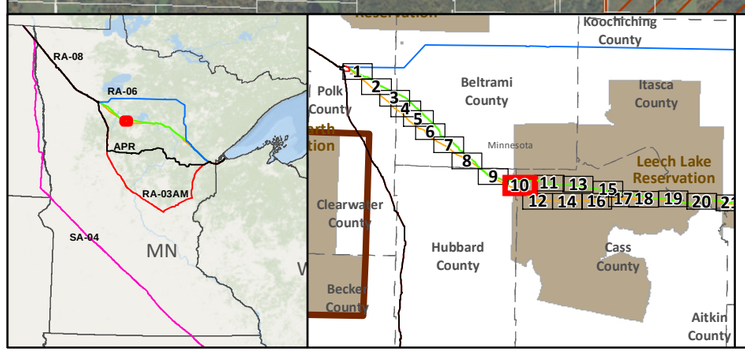
0 125 250 500 Meters

1:24,000

10ft Contours

Map 9B of 38

Midge Lake
T145 R32W S10
T145 R32W S11
T145 R32W S12
T145 R31W S7
Little Wolf Lake
T145 R31W S8
T145 R31W S9
Cass Lake Twsp
Cass Co.
T145 R31W S10
Cass Lake
RA-07
2
179
180
181
182
183
184
T145 R32W S15
T145 R32W S14
T145 R32W S13
T145 R31W S18
T145 R31W S17
T145 R31W S16
T145 R31W S15
Bowman Lake
Unnamed Stream
Farden Twsp
Hubbard Co.
Leech Lake Reservation
Pike Bay Twsp
Cass Co.
Chippewa National Forest
Pike Bay
371
T145 R32W S22
T145 R32W S23
T145 R32W S24
T145 R31W S19
T145 R31W S20
T145 R31W S21
T145 R31W S22
RA-08
T145 R32W S27
T145 R32W S26
T145 R32W S25
T145 R31W S30
T145 R31W S29
T145 R31W S28
T145 R31W S27



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

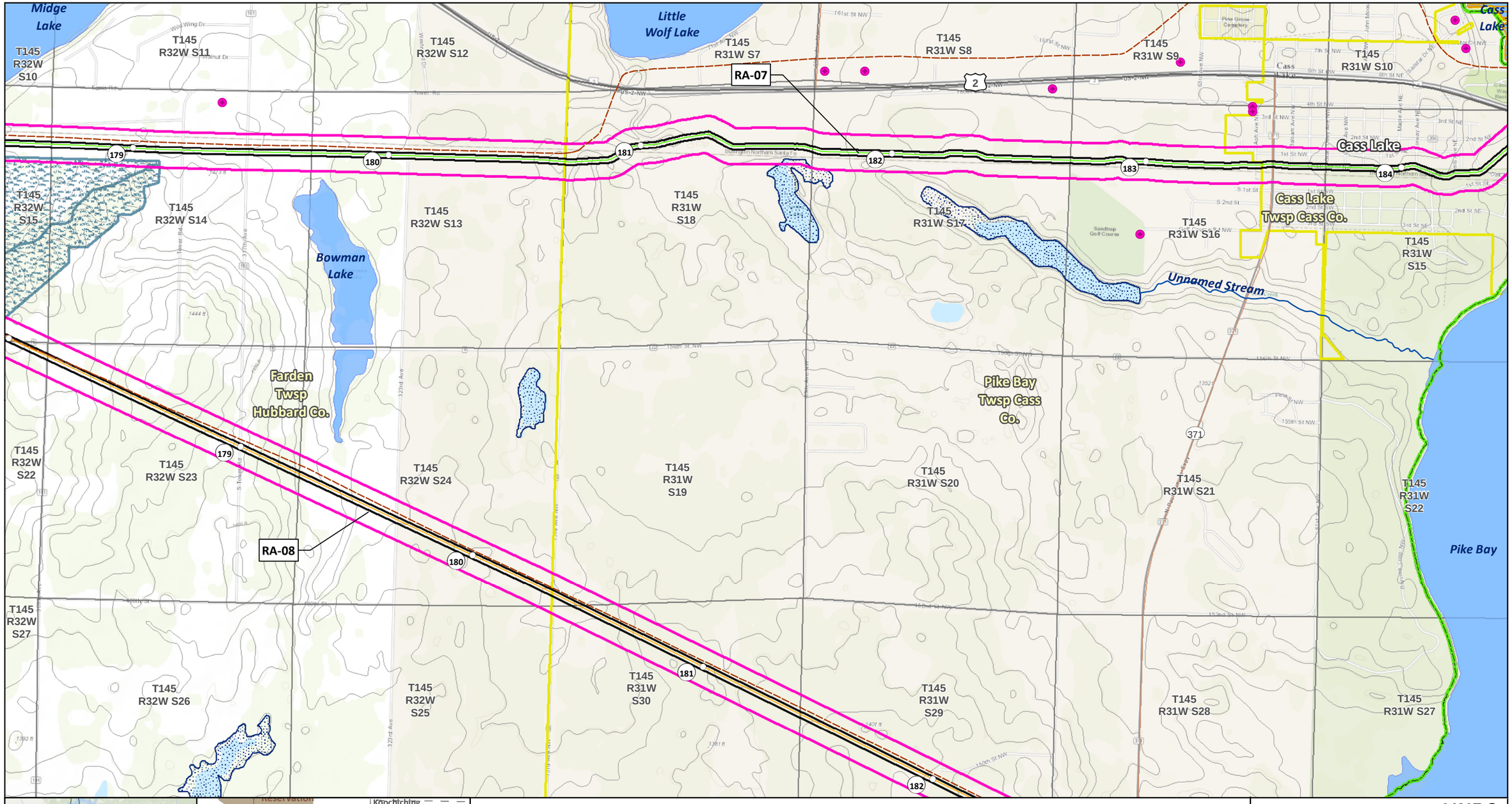
Data Sources: MNDNR, NHD, Enbridge

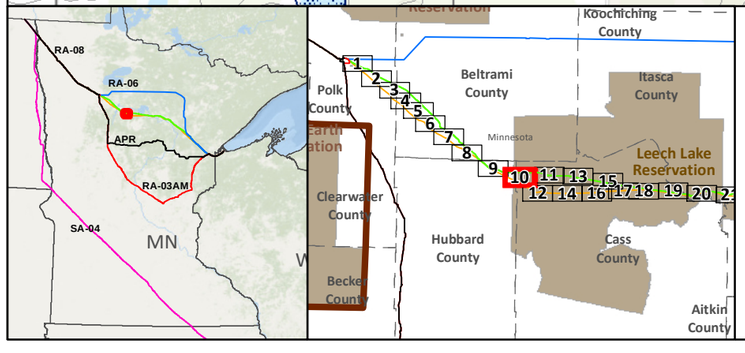
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08
CLEARBROOK TO CARLTON

Map 10A of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

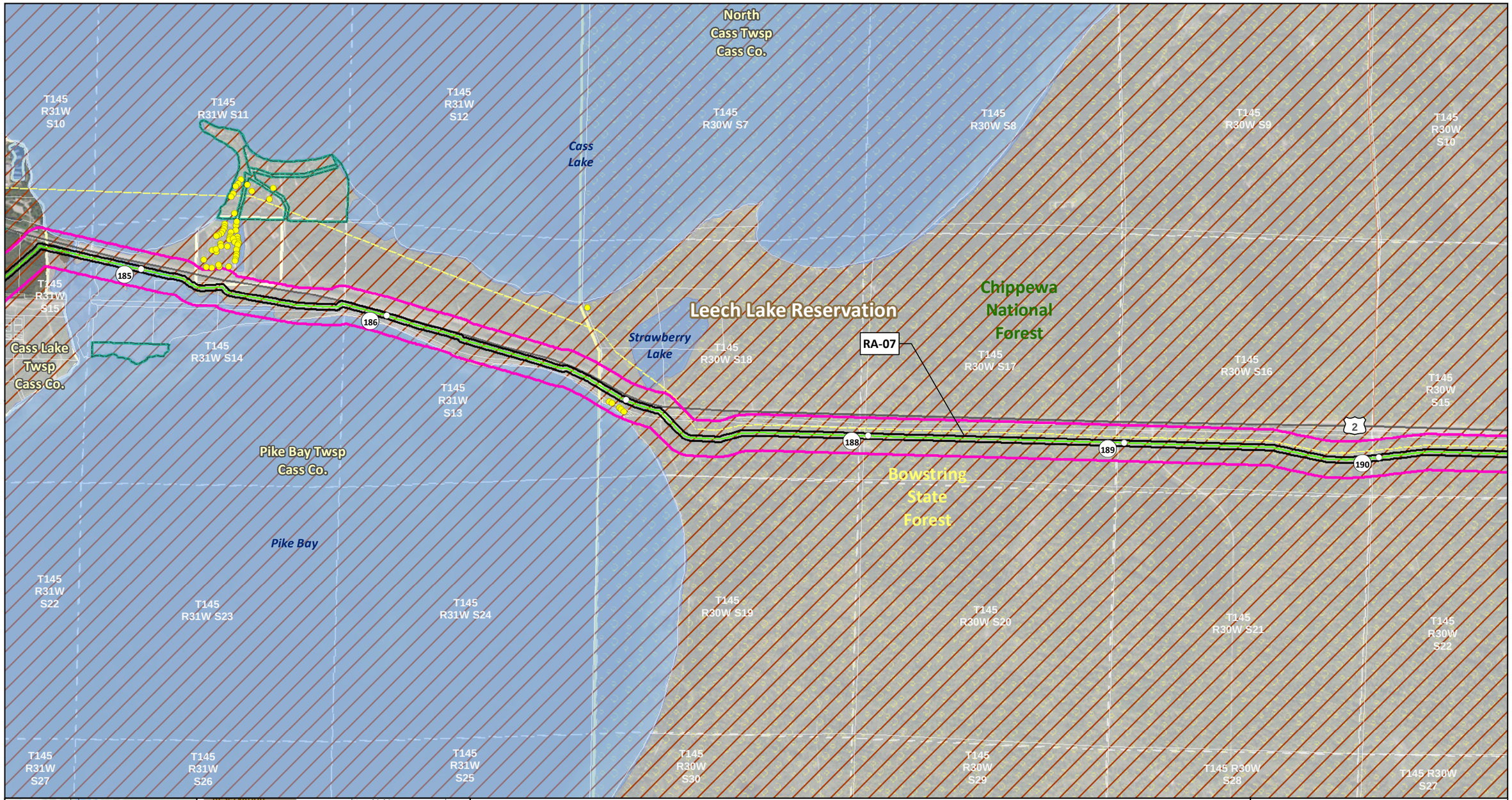
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 10B of 38



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 11A of 38

North Cass Twsp Cass Co.

T145 R31W S10 | T145 R31W S11 | T145 R31W S12 | T145 R30W S7 | T145 R30W S8 | T145 R30W S9 | T145 R30W S10

Cass Lake

T145 R31W S15 | T145 R31W S14 | T145 R31W S13 | T145 R30W S18 | T145 R30W S17 | T145 R30W S16 | T145 R30W S15

Strawberry Lake

RA-07

Cass Lake Twsp Cass Co.

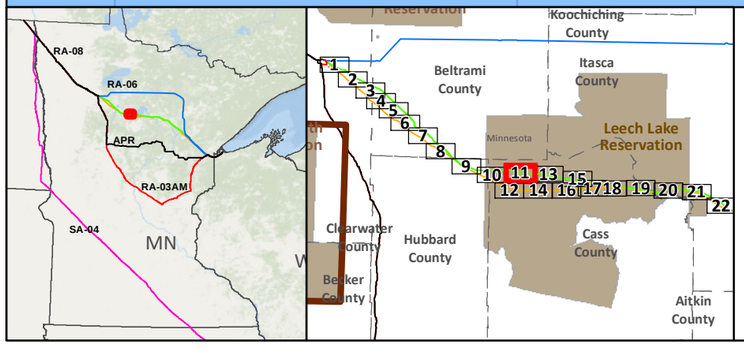
Pike Bay Twsp Cass Co.

Pike Bay

T145 R31W S22 | T145 R31W S23 | T145 R31W S24 | T145 R30W S19 | T145 R30W S20 | T145 R30W S21 | T145 R30W S22

T145 R31W S27 | T145 R31W S26 | T145 R31W S25 | T145 R30W S30 | T145 R30W S29 | T145 R30W S28 | T145 R30W S27

185 186 187 188 189 190 2



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08 CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

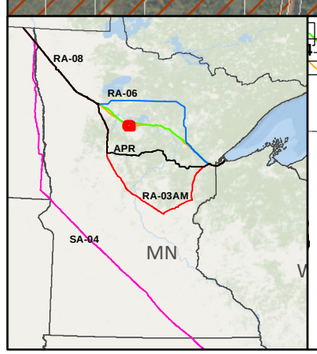
1:24,000

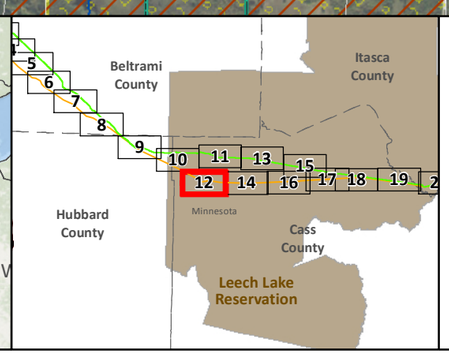
10ft Contours

N

Map 11B of 38

T145 R31W S28
T145 R31W S29
Leech Lake Reservation
T145 R31W S27
T145 R31W S26
T145 R31W S25
T145 R30W S30
T145 R30W S29
Pike Bay
Pike Bay Twsp Cass Co.
T145 R31W S32
T145 R31W S33
T145 R31W S34
T145 R31W S35
T145 R31W S36
North Cass Twsp Cass Co.
T145 R30W S31
T145 R30W S32
Unnamed Stream
Chippewa National Forest
183
184
185
186
187
188
RA-08
371
T144 R31W S5
T144 R31W S4
T144 R31W S3
Moss Lake
T144 R31W S2
T144 R31W S1
Bowstring State Forest
T144 R30W S6
Welsh Lake State Forest
Wilkinson Twsp Cass Co.
Otter Tail Peninsula Twsp Cass Co.
Twin Lake
Steamboat River
T144 R31W S8
T144 R31W S9
T144 R31W S10
Hessie Lake
T144 R31W S11
Little Twin Lake
T144 R31W S12
T144 R30W S7
Lake Thirteen





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

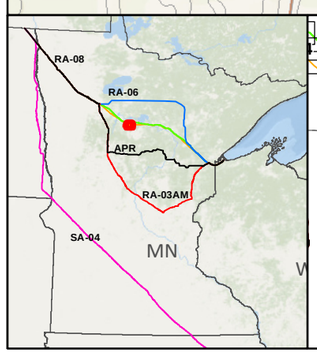
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

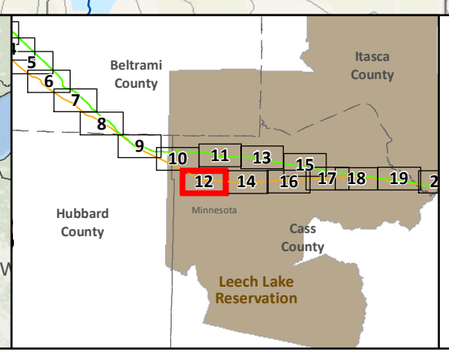
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08
CLEARBROOK TO CARLTON

Map 12A of 38

T145 R31W S29
T145 R31W S28
T145 R31W S27
T145 R31W S26
T145 R31W S25
North Cass Twsp Cass Co.
T145 R30W S30
T145 R30W S29
Pike Bay
Pike Bay Twsp Cass Co.
T145 R31W S32
T145 R31W S33
T145 R31W S34
T145 R31W S35
T145 R31W S36
T145 R30W S31
T145 R30W S32
Unnamed Stream
183
184
185
186
187
188
RA-08
371
T144 R31W S5
T144 R31W S4
T144 R31W S3
T144 R31W S2
T144 R31W S1
T144 R30W S6
Moss Lake
Wilkinson Twsp Cass Co.
Twin Lake
Otter Tail Peninsula Twsp Cass Co.
Steamboat River
T144 R31W S8
T144 R31W S9
T144 R31W S10
T144 R31W S11
T144 R31W S12
T144 R30W S7
Hessie Lake
Little Twin Lake
Lake Thirteen





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

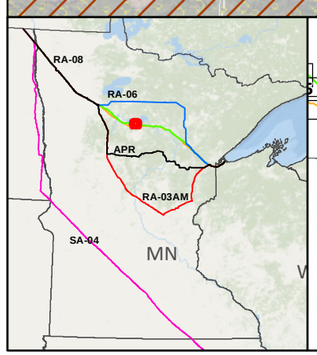
RA-07 AND RA-08

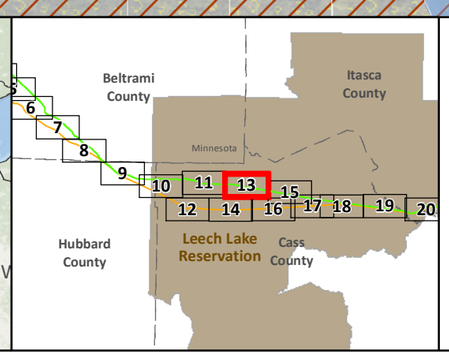
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 12B of 38

T145 R30W S10
T145 R30W S11
T145 R30W S12
T145 R29W S7
T145 R29W S8
T145 R29W S9
T145 R29W S10
Ten Lake
Leech Lake Reservation
T145 R29W S18
Grass Lake
Chippewa National Forest
Bowstring State Forest
T145 R30W S15
T145 R30W S14
T145 R30W S13
T145 R29W S17
T145 R29W S16
T145 R29W S15
North Cass Twsp Cass Co.
191
192
193
2
RA-07
194
195
196
T145 R30W S22
T145 R30W S23
T145 R30W S24
T145 R29W S19
T145 R29W S20
T145 R29W S21
T145 R29W S22
Foot Lake
Schley
T145 R30W S25
T145 R30W S26
T145 R30W S27
T145 R29W S30
T145 R29W S29
T145 R29W S28
T145 R29W S27





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

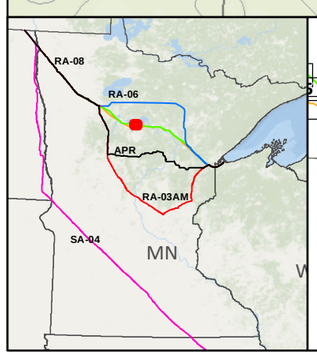
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

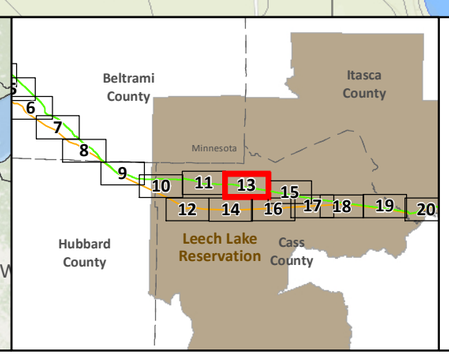
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08
CLEARBROOK TO CARLTON

Map 13A of 38

T145 R30W S10
T145 R30W S11
T145 R30W S12
T145 R29W S7
T145 R29W S8
T145 R29W S9
T145 R29W S10
Ten Lake
T145 R30W S15
T145 R30W S14
T145 R30W S13
Grass Lake
T145 R29W S18
T145 R29W S17
T145 R29W S16
T145 R29W S15
North Cass Twsp Cass Co.
RA-07
191
192
193
194
195
196
2
T145 R30W S22
T145 R30W S23
T145 R30W S24
T145 R29W S19
Foot Lake
T145 R29W S20
T145 R29W S21
T145 R29W S22
Schley
T145 R30W S27
T145 R30W S26
T145 R30W S25
T145 R29W S30
T145 R29W S29
T145 R29W S28
T145 R29W S27





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

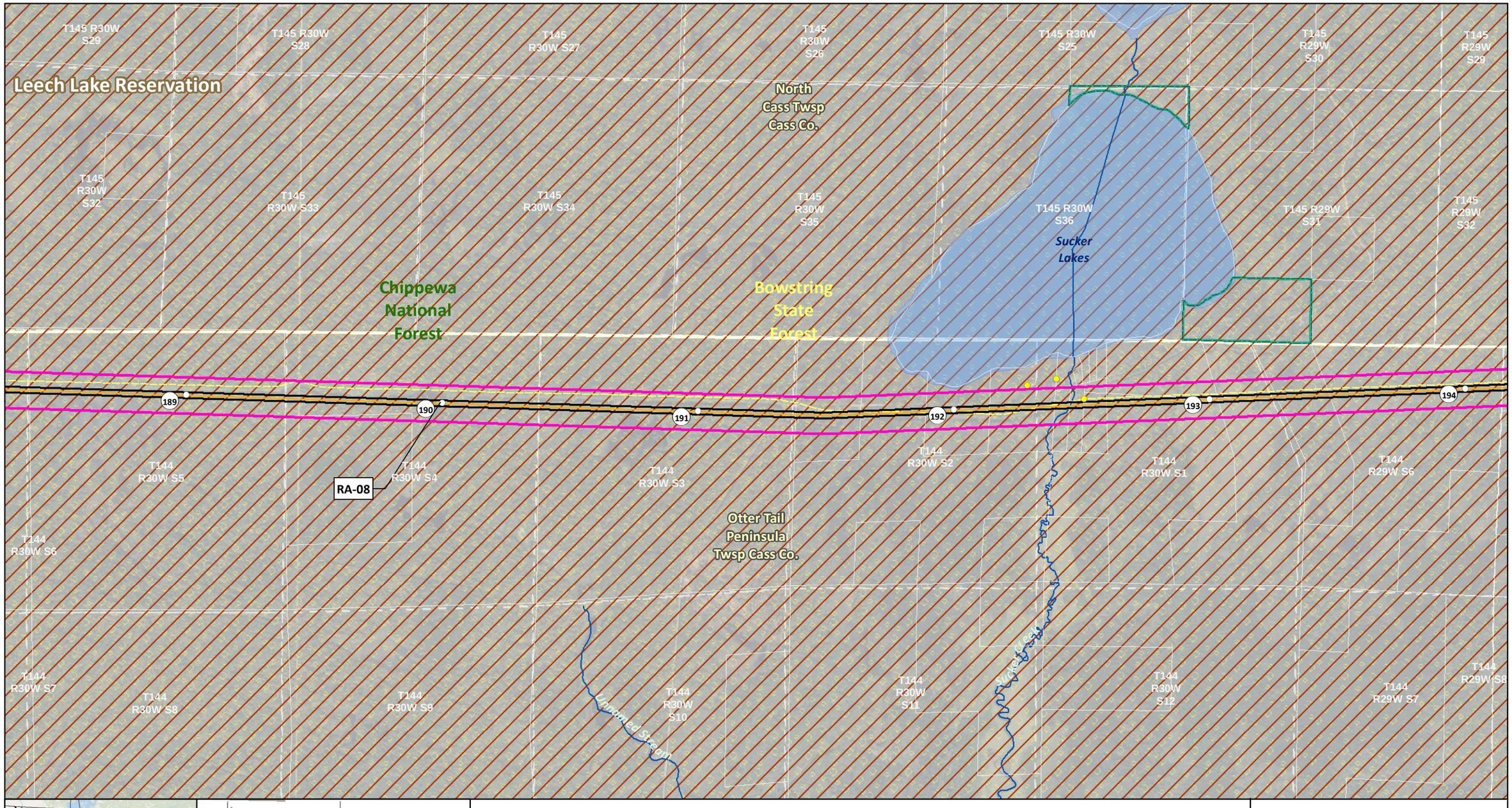
0 125 250 500 Meters

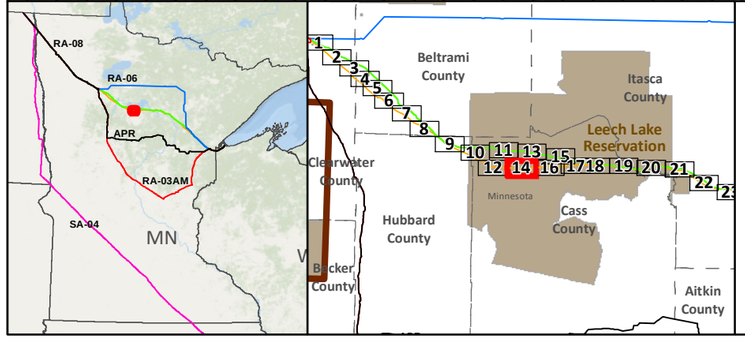
1:24,000

10ft Contours

N

Map 13B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

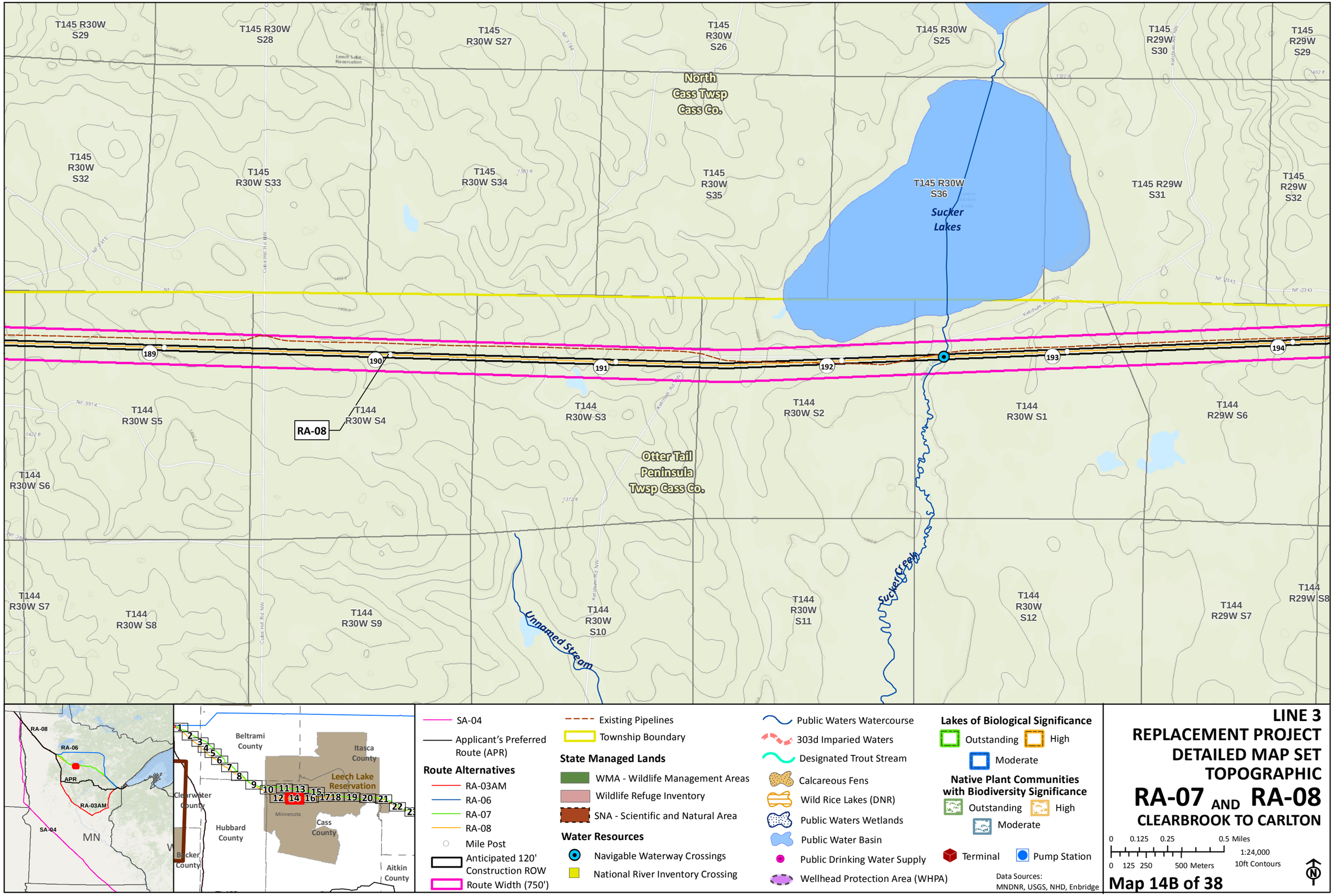
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 14A of 38



T145 R30W S29
T145 R30W S28
T145 R30W S27
T145 R30W S26
T145 R30W S25
T145 R29W S30
T145 R29W S29
North Cass Twsp Cass Co.
T145 R30W S32
T145 R30W S33
T145 R30W S34
T145 R30W S35
T145 R30W S36
T145 R29W S31
T145 R29W S32
Sucker Lakes
189
190
191
192
193
194
T144 R30W S5
T144 R30W S4
RA-08
T144 R30W S3
T144 R30W S2
T144 R30W S1
T144 R29W S6
Otter Tail Peninsula Twsp Cass Co.
T144 R30W S6
T144 R30W S7
T144 R30W S8
T144 R30W S9
T144 R30W S10
T144 R30W S11
T144 R30W S12
T144 R29W S7
T144 R29W S8
Unnamed Stream
Sucker Creek
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Beltrami County
Itasca County
Leech Lake Reservation
Clearwater County
Hubbard County
Cass County
Minnesota
Becker County
Aitkin County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
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Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
RA-07 AND RA-08
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 14B of 38

Bowstring State Forest

Little Portage Lake

Chippewa National Forest

RA-07

North Cass Twsp Cass Co.

Lake Winnibigoshish

Leech Lake Reservation

Portage Lake

T145 R29W S15 | T145 R29W S14 | T145 R29W S13 | T145 R28W S18 | T145 R28W S17 | T145 R28W S16 | T145 R28W S15

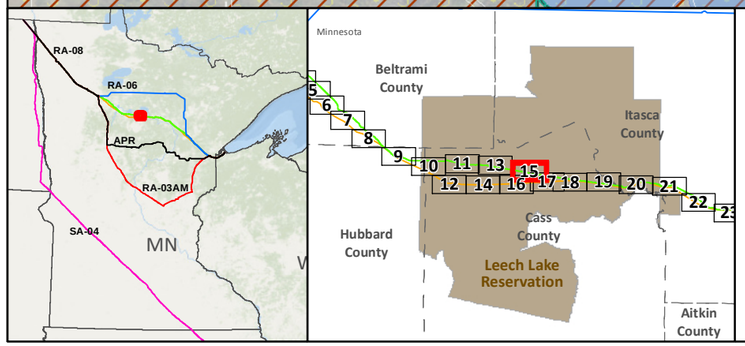
T145 R29W S22 | T145 R29W S23 | T145 R29W S24 | T145 R28W S19 | T145 R28W S20 | T145 R28W S21 | T145 R28W S22

T145 R29W S27 | T145 R29W S26 | T145 R29W S25 | T145 R28W S30 | T145 R28W S29 | T145 R28W S28 | T145 R28W S27

T145 R29W S34 | T145 R29W S35 | T145 R29W S36 | T145 R28W S31 | T145 R28W S32 | T145 R28W S33 | T145 R28W S34

197 198 199 200 201 202

2



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

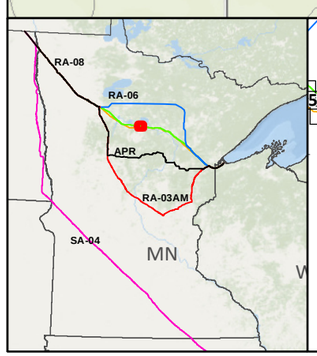
0 125 250 500 Meters

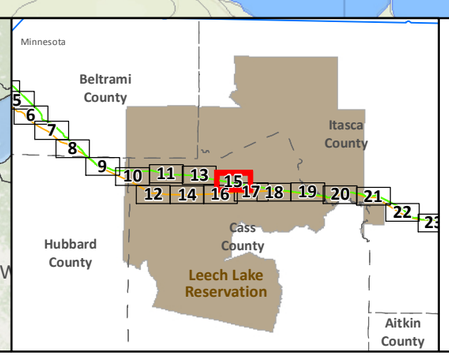
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 15A of 38

T145 R29W S15
T145 R29W S14
T145 R29W S13
T145 R28W S18
T145 R28W S17
T145 R28W S16
T145 R28W S15
Little Portage Lake
Lake Winnibigoshish
T145 R29W S22
T145 R29W S23
T145 R29W S24
T145 R28W S19
T145 R28W S20
T145 R28W S21
T145 R28W S22
RA-07
North Cass Twsp Cass Co.
197
198
199
200
201
202
2
T145 R29W S27
T145 R29W S26
T145 R29W S25
T145 R28W S30
T145 R28W S29
T145 R28W S28
T145 R28W S27
Portage Lake
T145 R29W S36
T145 R28W S31
T145 R29W S34
T145 R29W S35
T145 R28W S32
T145 R28W S33
T145 R28W S34





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

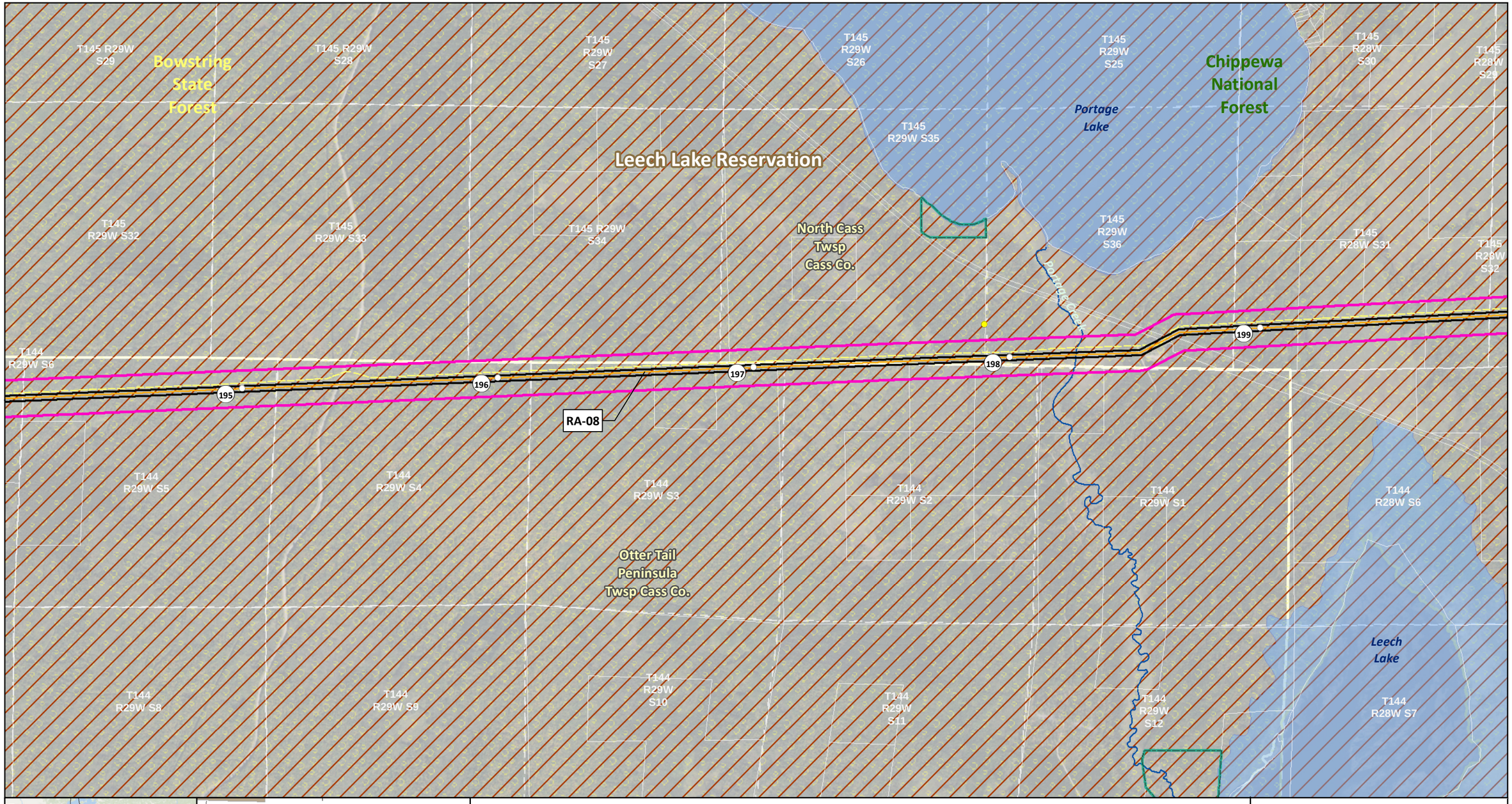
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

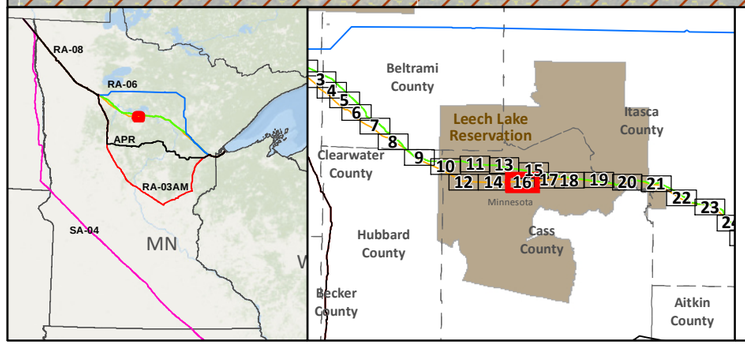
RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 15B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

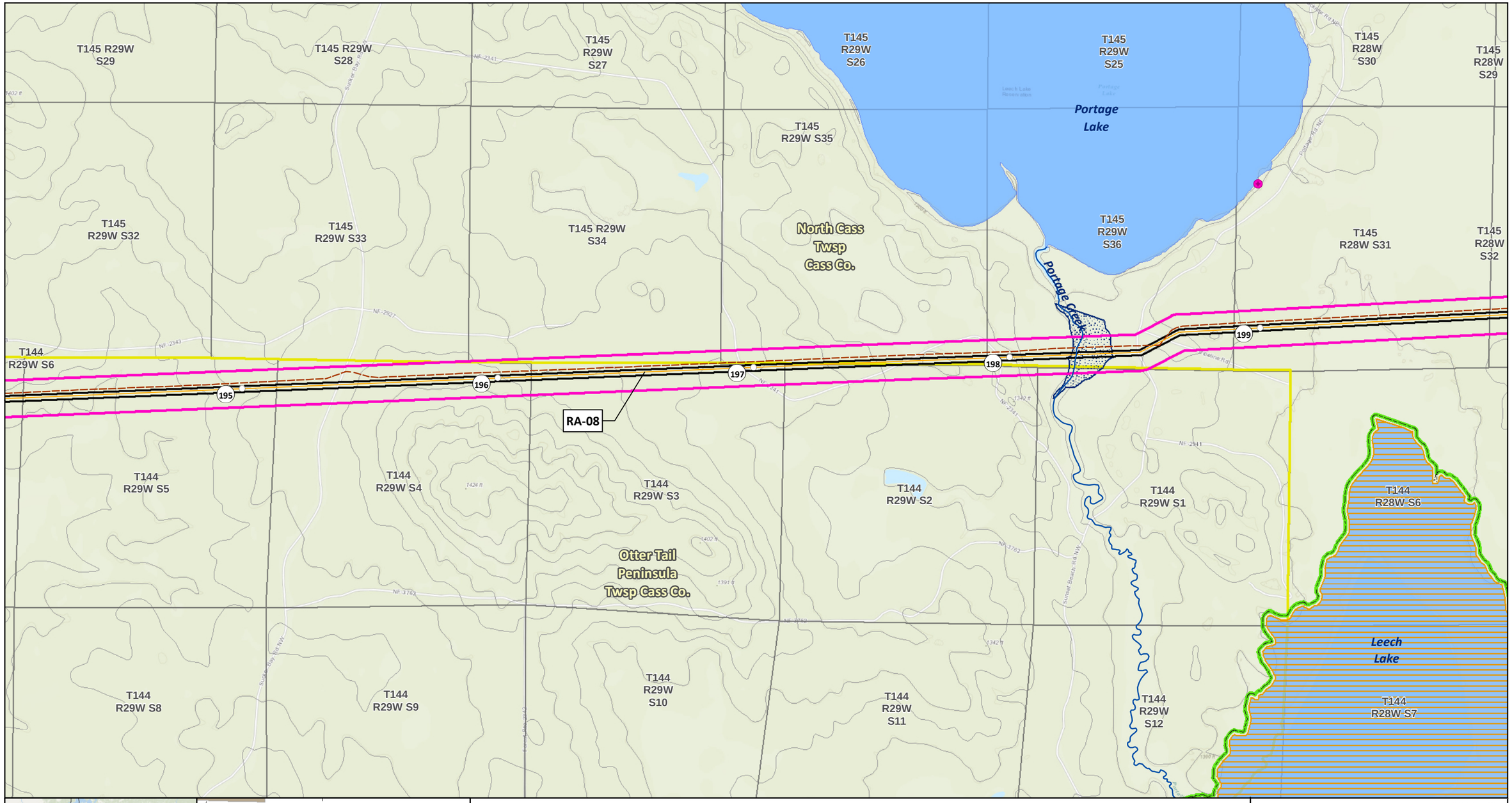
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 16A of 38



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

Map 16B of 38

Lake Winnibigoshish

T145 R28W S30

North Cass Twsp Cass Co.

T145 R28W S29

T145 R28W S28

T145 R28W S27

T145 R28W S26

T145 R28W S25

T145 R27W S30

RA-07

Bena

Bena Twsp Cass Co.

Leech Lake Reservation

T145 R28W S31

T145 R28W S32

T145 R28W S33

T145 R28W S34

T145 R28W S35

T145 R28W S36

T145 R27W S31

RA-08

Bowstring State Forest

Chippewa National Forest

Sixmile Lake

T144 R28W S6

T144 R28W S5

T144 R28W S4

T144 R28W S3

T144 R28W S2

T144 R28W S1

T144 R27W S6

Leech Lake

T144 R28W S7

T144 R28W S8

T144 R28W S9

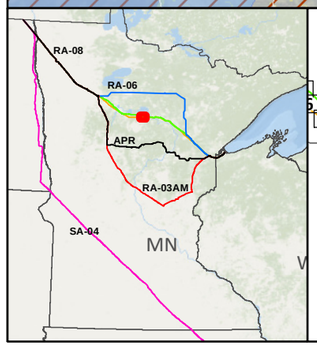
T144 R28W S10

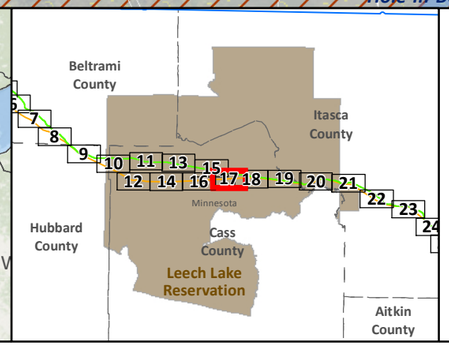
T144 R28W S11

T144 R28W S12

T144 R27W S7

Hole-in-Bog Lake





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

State Forest

National Forest

Tribal Reservation

Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

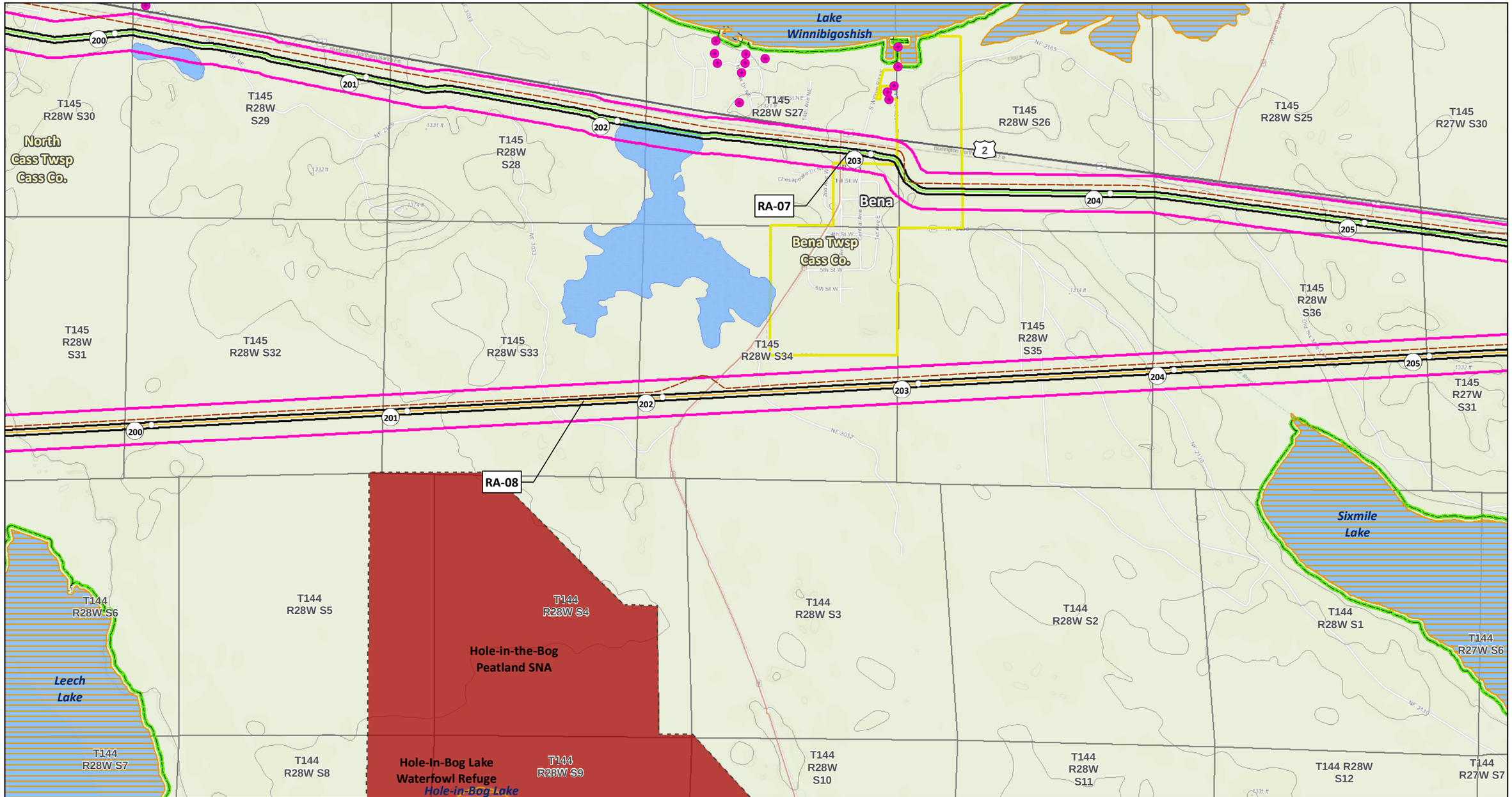
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

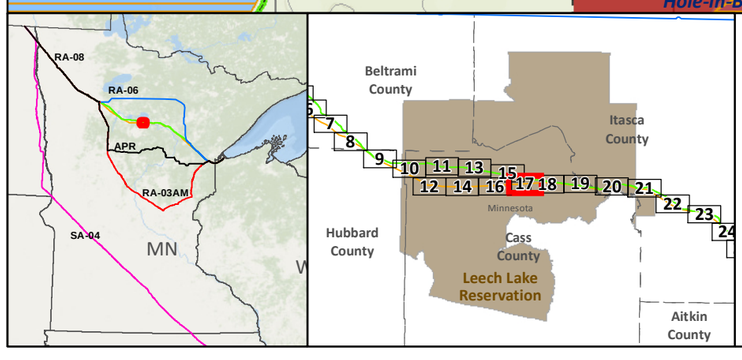
RA-07 AND RA-08

CLEARBROOK TO CARLTON

N

Map 17A of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

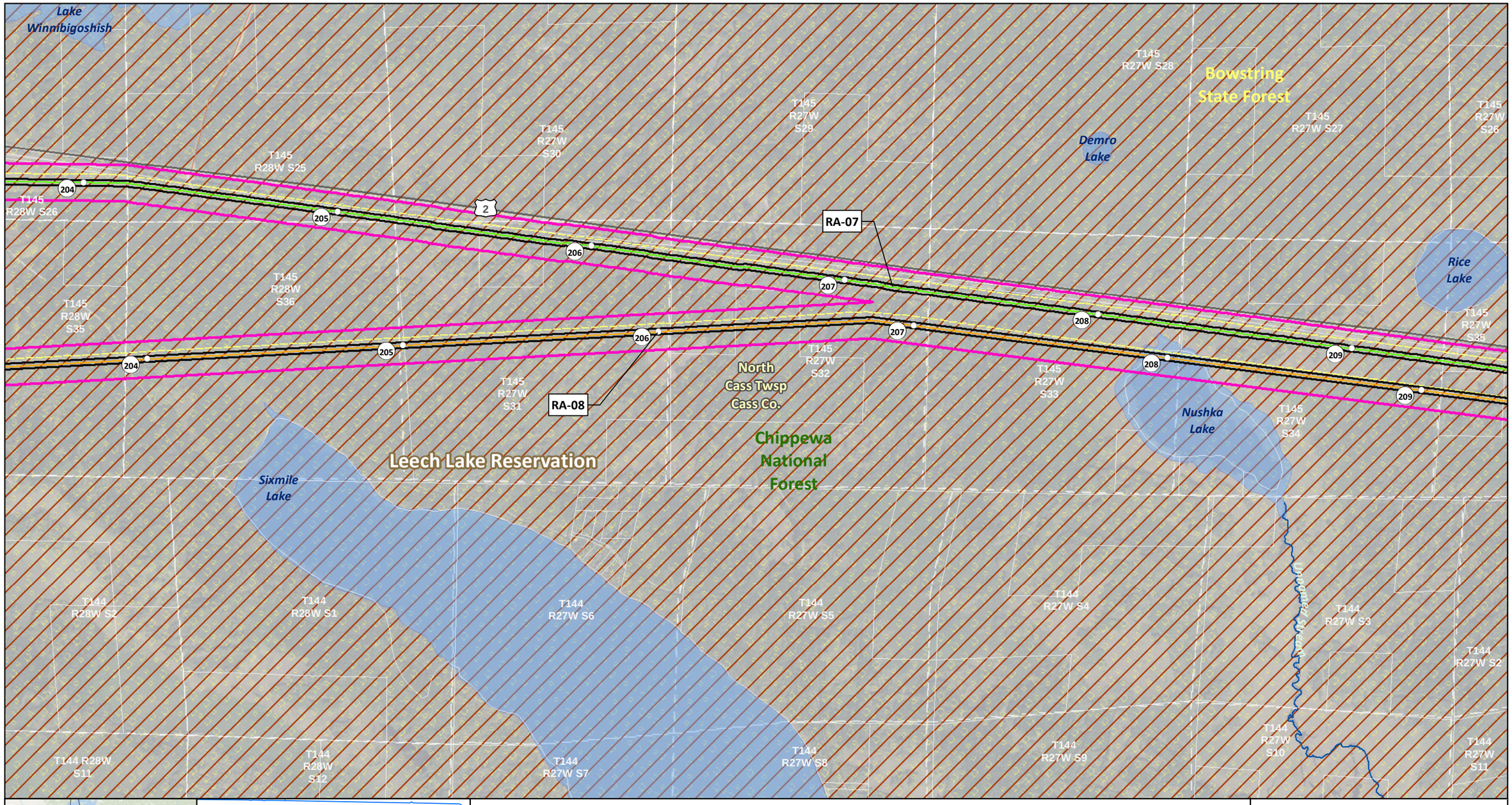
0 125 250 500 Meters

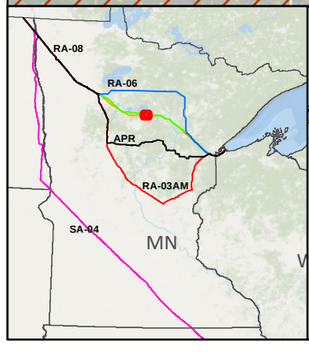
1:24,000

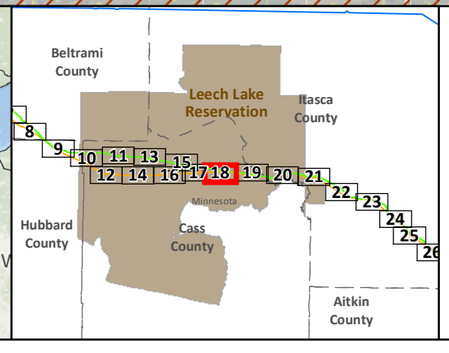
10ft Contours

N

Map 17B of 38







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

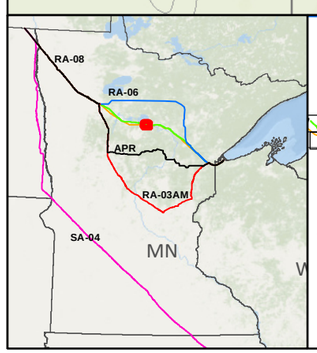
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

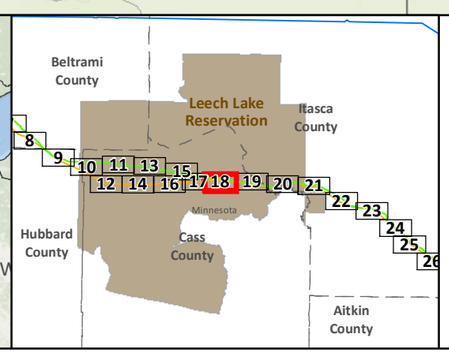
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 18A of 38

Lake Winnibigoshish
T145 R28W S26
T145 R28W S25
T145 R27W S30
T145 R27W S29
T145 R27W S28
Demro Lake
T145 R27W S27
T145 R27W S26
Rice Lake
T145 R28W S36
T145 R28W S35
T145 R27W S35
RA-07
RA-08
T145 R27W S31
T145 R27W S32
North Cass Twsp Cass Co.
T145 R27W S33
Nushka Lake
T145 R27W S34
Sixmile Lake
Unnamed Stream
T144 R28W S2
T144 R28W S1
T144 R27W S6
T144 R27W S5
T144 R27W S4
T144 R27W S3
T144 R27W S2
T144 R28W S11
T144 R28W S12
T144 R27W S7
T144 R27W S8
T144 R27W S9
T144 R27W S10
T144 R27W S11





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 18B of 38

North Cass Twsp Cass Co.

Bowstring Lake Twsp Itasca Co.

Rice Lake

Ball Club Lake

Leech Lake Reservation

Chippewa National Forest

Bowstring State Forest

RA-07

RA-08

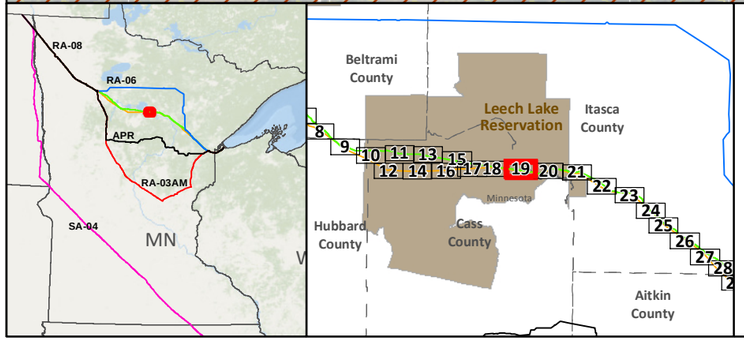
T145 R27W S24 | T145 R26W S19 | T145 R26W S30 | T145 R26W S20 | T145 R26W S21 | T145 R26W S22 | T145 R26W S23

T145 R27W S26 | T145 R27W S25 | T145 R26W S30 | T145 R26W S29 | T145 R26W S28 | T145 R26W S27 | T145 R26W S26

T145 R27W S35 | T145 R27W S36 | T145 R26W S31 | T145 R26W S32 | T145 R26W S33 | T145 R26W S34 | T145 R26W S35

T144 R27W S2 | T144 R27W S1 | T144 R26W S6 | T144 R26W S5 | T144 R26W S4 | T144 R26W S3 | T144 R26W S2

T144 R27W S11 | T144 R27W S12 | T144 R26W S7 | T144 R26W S8 | T144 R26W S9 | T144 R26W S10 | T144 R26W S1



SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

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Public Water Basin

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Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

State Forest

National Forest

Tribal Reservation

Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

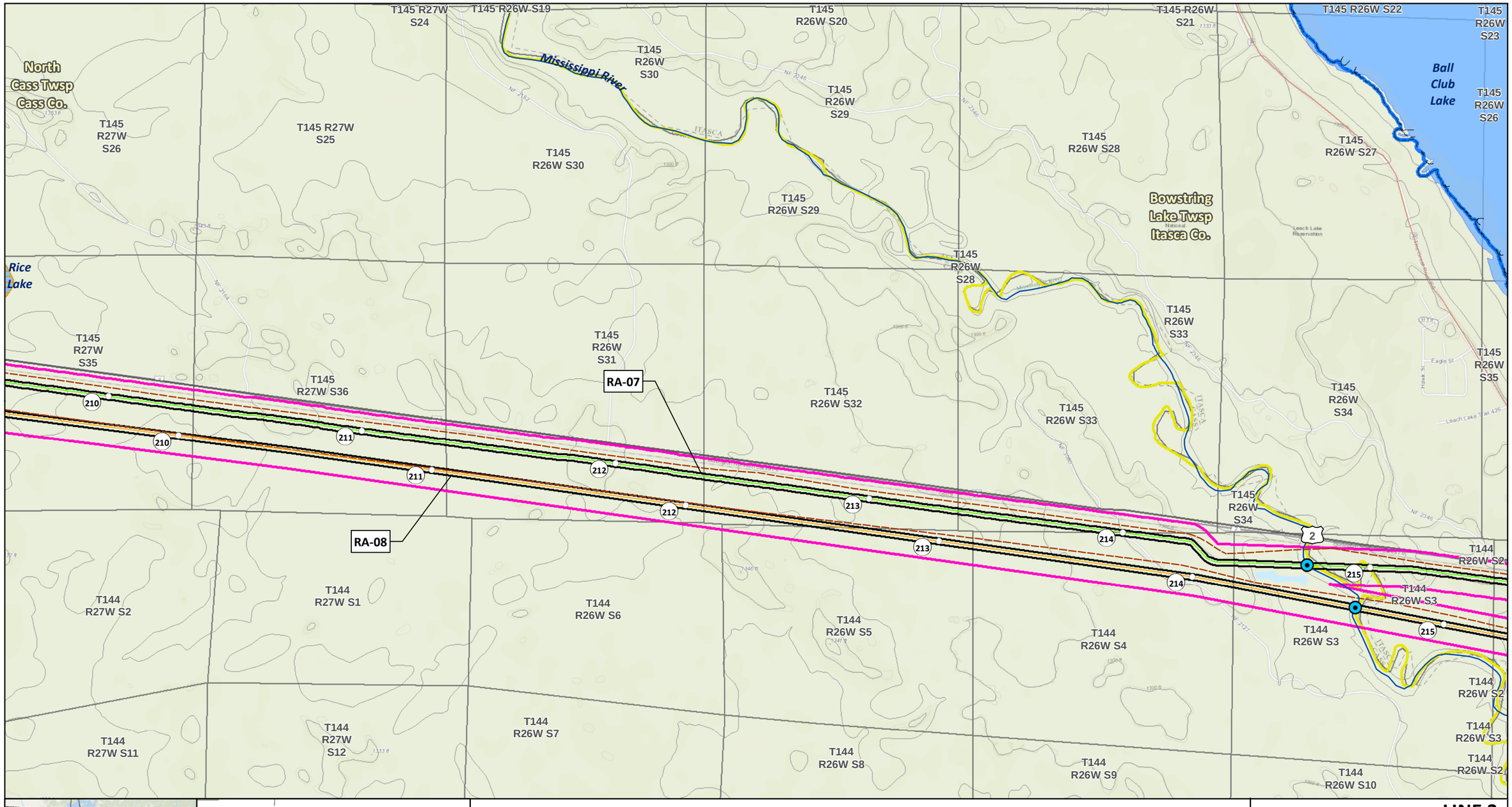
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

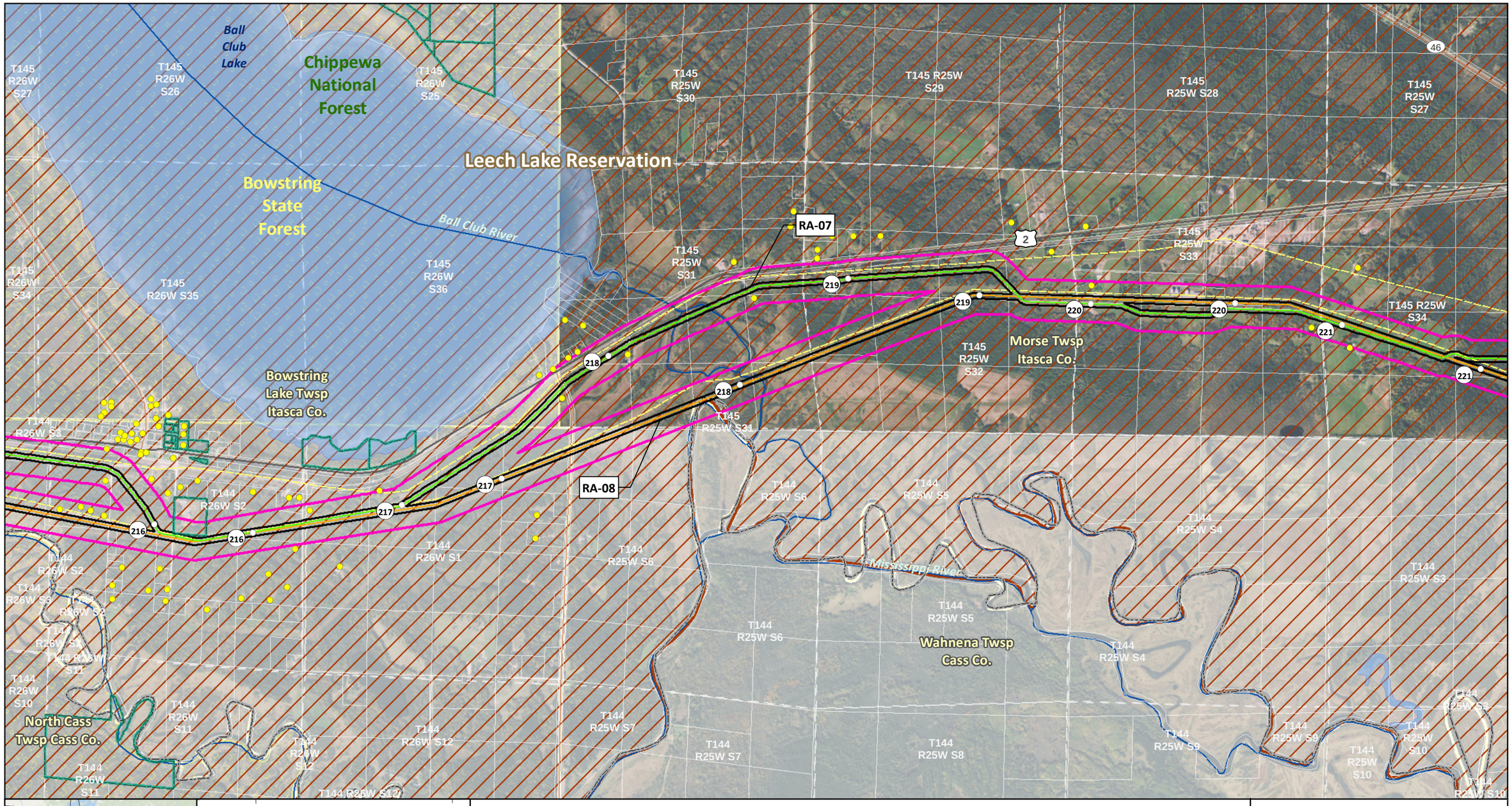
RA-07 AND RA-08

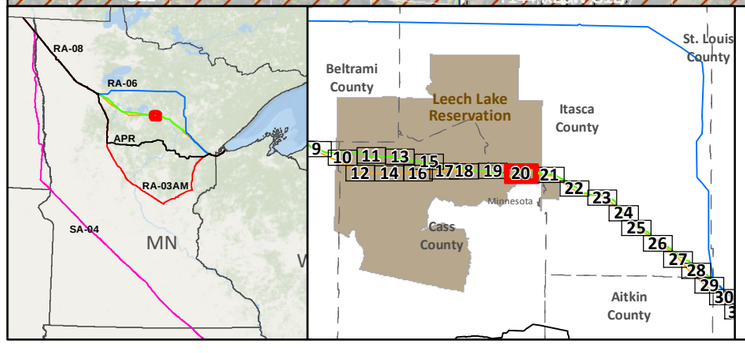
CLEARBROOK TO CARLTON

N

Map 19A of 38


T145 R27W S24
T145 R26W S19
T145 R26W S20
T145 R26W S21
T145 R26W S22
T145 R26W S23
North Cass Twsp Cass Co.
Mississippi River
T145 R26W S30
T145 R26W S29
Ball Club Lake
T145 R26W S26
T145 R27W S26
T145 R27W S25
T145 R26W S30
T145 R26W S28
T145 R26W S27
T145 R26W S29
Bowstring Lake Twsp Itasca Co.
Rice Lake
T145 R26W S28
T145 R26W S33
T145 R27W S35
T145 R26W S31
T145 R27W S36
RA-07
T145 R26W S32
T145 R26W S33
T145 R26W S34
T145 R26W S35
T145 R26W S34
RA-08
T144 R27W S2
T144 R27W S1
T144 R26W S6
T144 R26W S5
T144 R26W S4
T144 R26W S3
T144 R26W S2
T144 R26W S3
T144 R27W S11
T144 R27W S12
T144 R26W S7
T144 R26W S8
T144 R26W S9
T144 R26W S10
210
211
212
213
214
215
2
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Beltrami County
Leech Lake Reservation
Itasca County
Hubbard County
Cass County
Aitkin County
Minnesota
8 9 10 11 13 15 12 14 16 17 18 19 20 21 22 23 24 25 26 27 28
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-07 AND RA-08
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 19B of 38





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

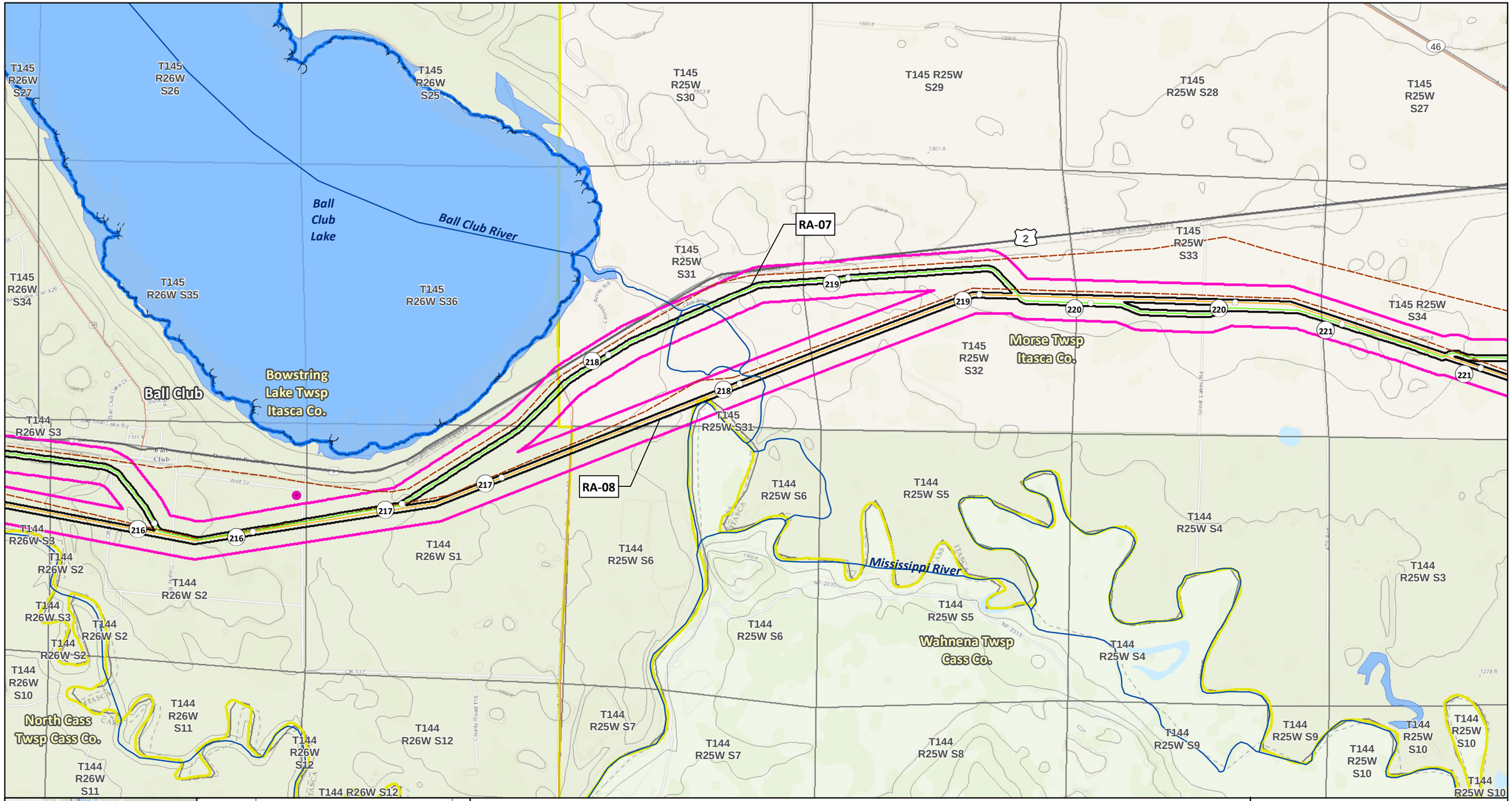
0 125 250 500 Meters

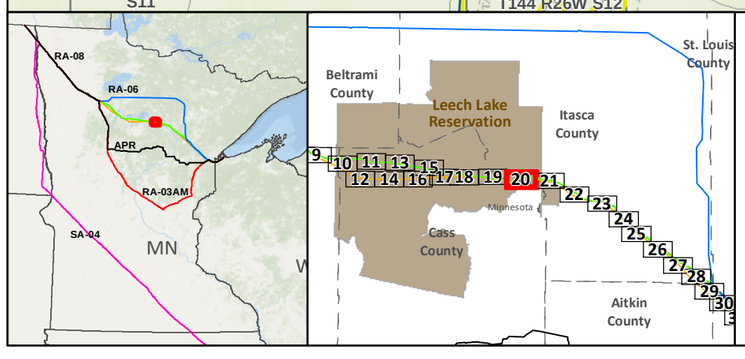
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 20A of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

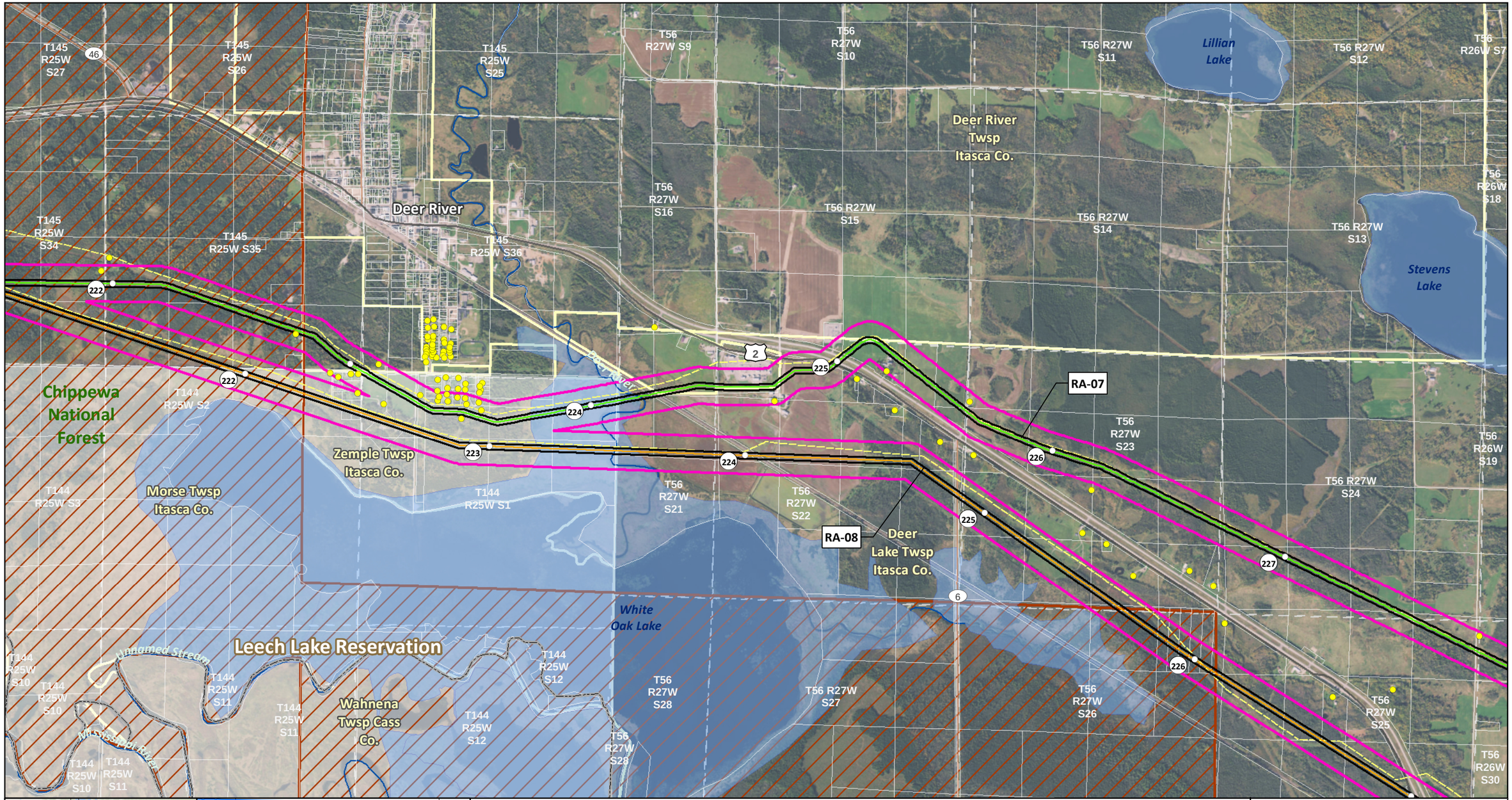
RA-07 AND RA-08

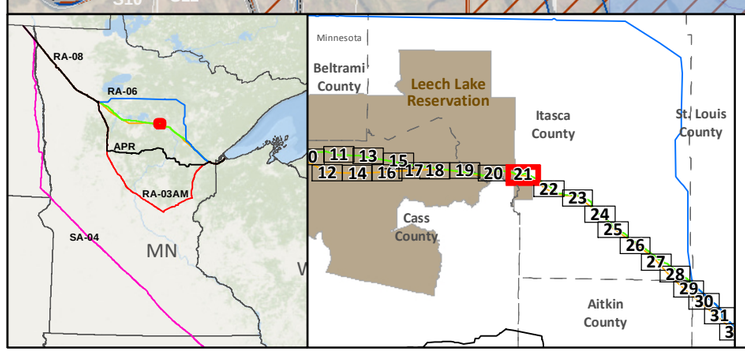
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 20B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

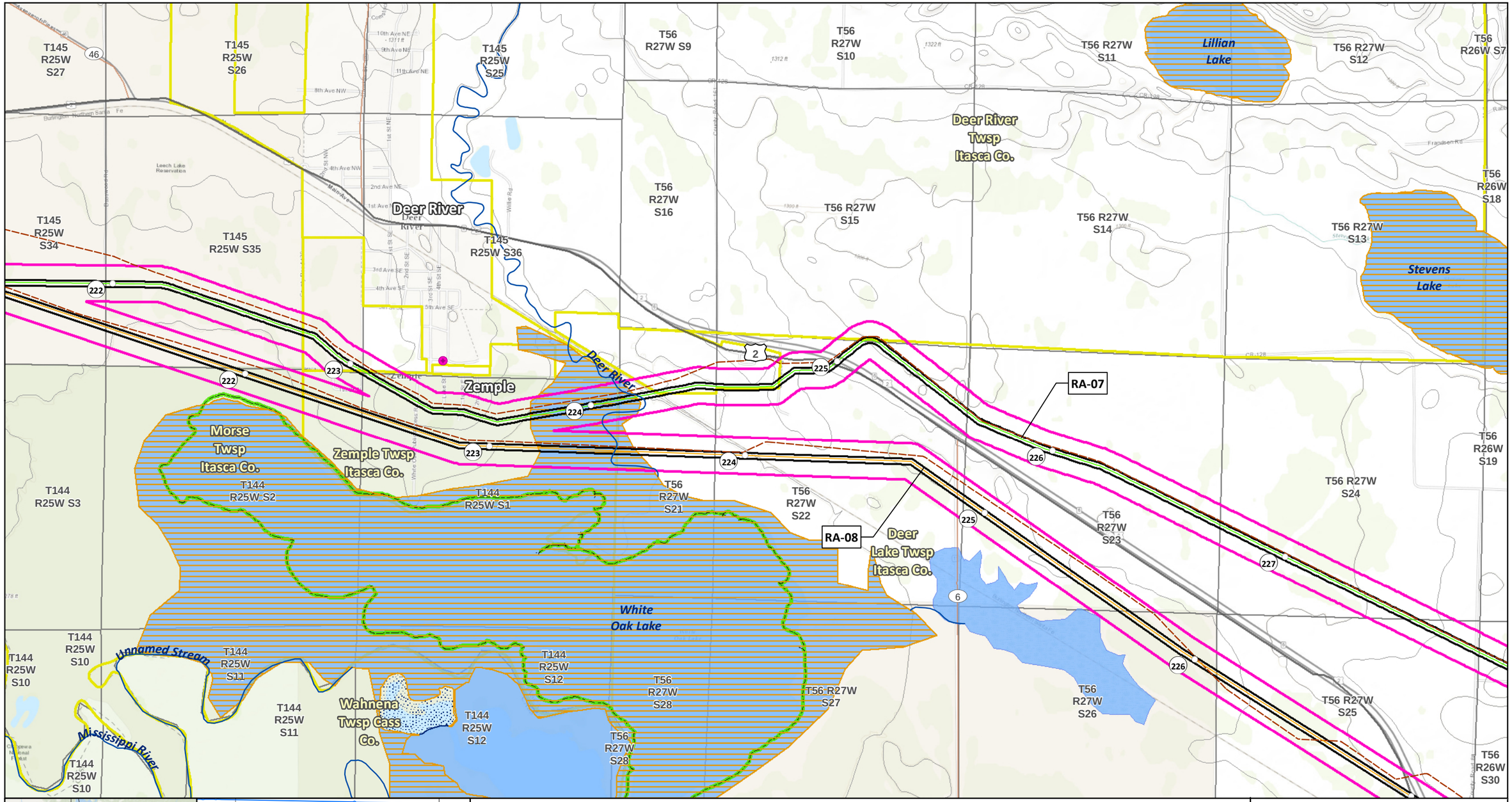
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 21A of 38


T145 R25W S27
T145 R25W S26
T145 R25W S25
T56 R27W S9
T56 R27W S10
T56 R27W S11
Lillian Lake
T56 R27W S12
T56 R26W S7
Deer River Twsp Itasca Co.
T56 R27W S16
T56 R27W S15
T56 R27W S14
T56 R27W S13
T56 R26W S18
Stevens Lake
T145 R25W S34
T145 R25W S35
T145 R25W S36
Deer River
Zemple
Deer River
RA-07
T56 R26W S19
Morse Twsp Itasca Co.
Zemple Twsp Itasca Co.
T144 R25W S3
T144 R25W S2
T144 R25W S1
T56 R27W S21
T56 R27W S22
RA-08
Deer Lake Twsp Itasca Co.
T56 R27W S24
T56 R27W S23
White Oak Lake
T144 R25W S10
Unnamed Stream
T144 R25W S11
T144 R25W S12
T56 R27W S28
T56 R27W S27
T56 R27W S26
T56 R27W S25
T56 R26W S30
Wahnena Twsp Cass Co.
Mississippi River
T144 R25W S10
T144 R25W S10
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Minnesota
Beltrami County
Leech Lake Reservation
Itasca County
St. Louis County
Cass County
Aitkin County
0 11 13 15 12 14 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 3
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
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Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
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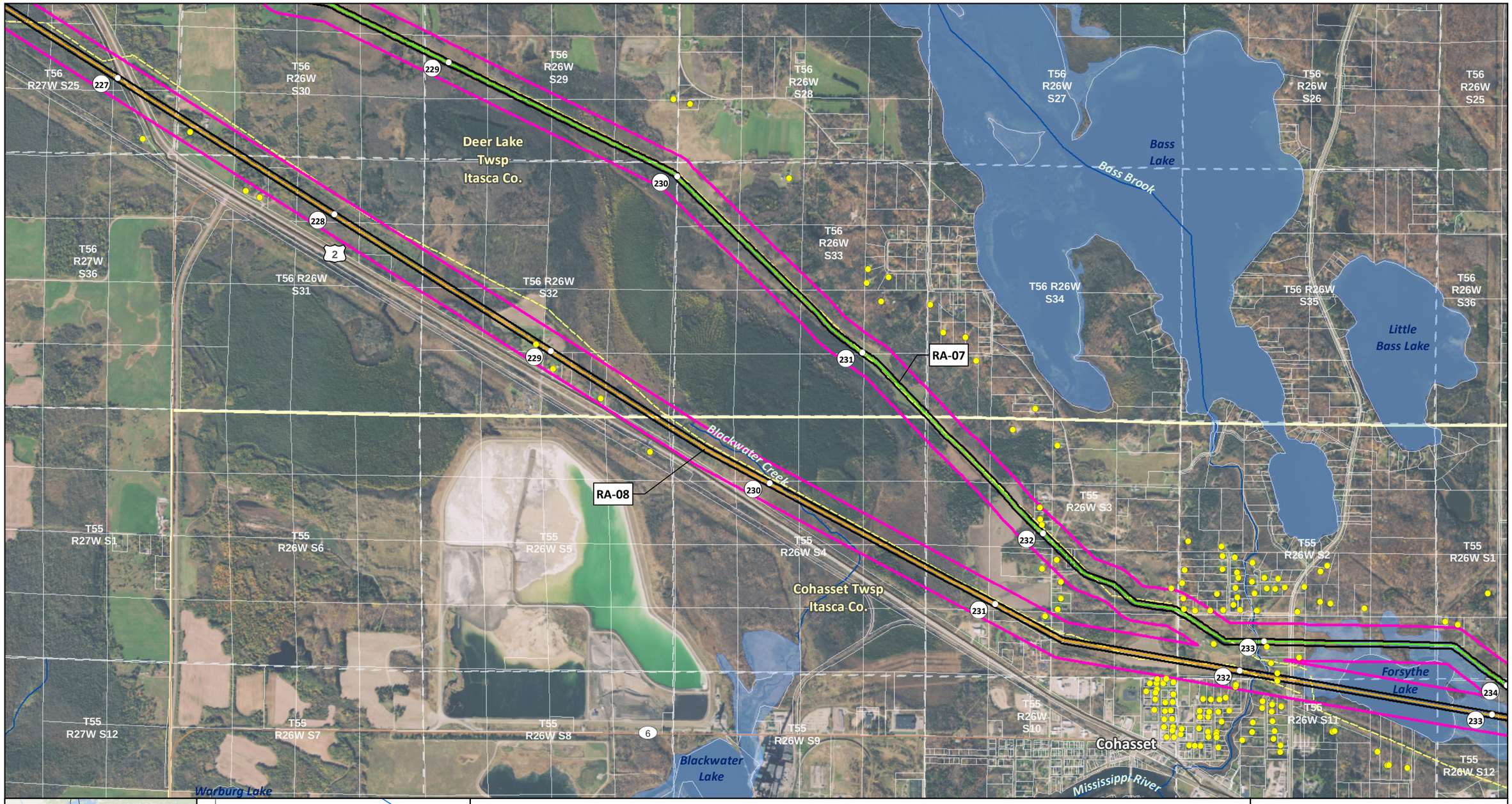
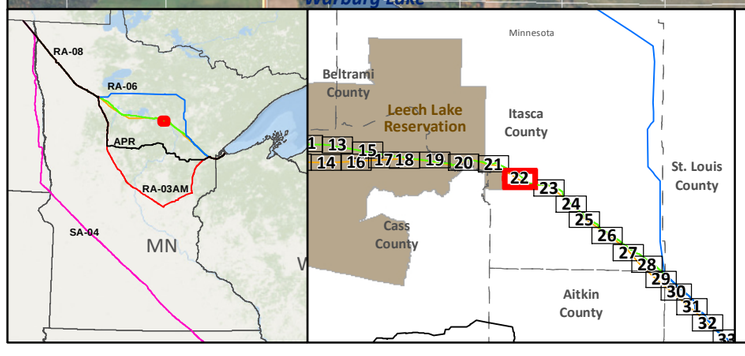
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-07 AND RA-08
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
N
Map 21B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

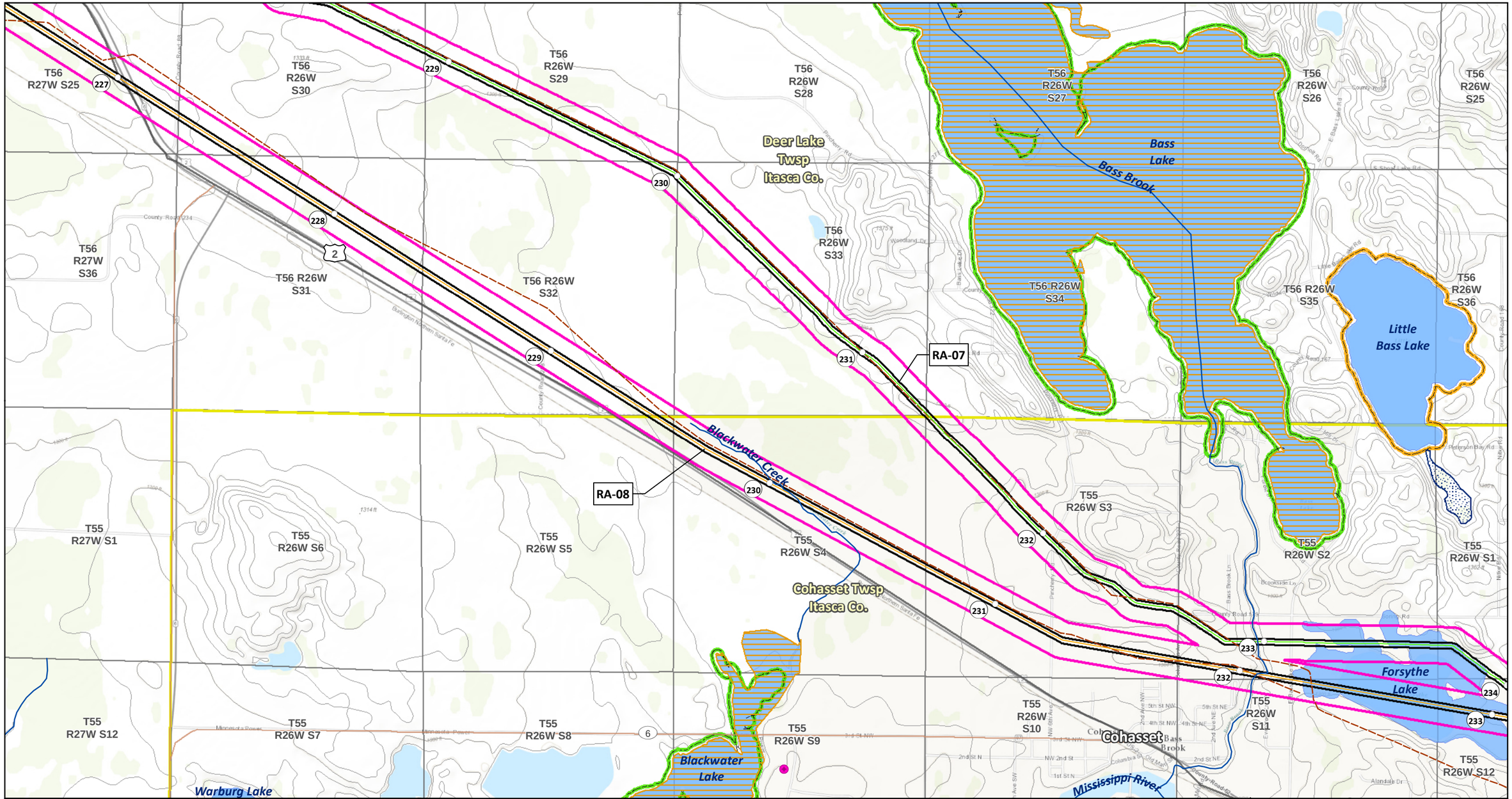
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 22A of 38


T56 R27W S25
T56 R26W S30
T56 R26W S29
T56 R26W S28
T56 R26W S27
T56 R26W S26
T56 R26W S25
Deer Lake Twsp Itasca Co.
Bass Lake
Bass Brook
T56 R27W S36
T56 R26W S31
T56 R26W S32
T56 R26W S33
T56 R26W S34
T56 R26W S35
T56 R26W S36
Little Bass Lake
RA-07
RA-08
Blackwater Creek
T55 R27W S1
T55 R26W S6
T55 R26W S5
T55 R26W S4
T55 R26W S3
T55 R26W S2
T55 R26W S1
Cohasset Twsp Itasca Co.
T55 R27W S12
T55 R26W S7
T55 R26W S8
T55 R26W S9
T55 R26W S10
T55 R26W S11
T55 R26W S12
Cohasset
Bass Brook
Forsythe Lake
Blackwater Lake
Warburg Lake
Mississippi River
RA-08
RA-06
APR
RA-03AM
SA-04
MN
Minnesota
Beltrami County
Leech Lake Reservation
Itasca County
Cass County
Aitkin County
St. Louis County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
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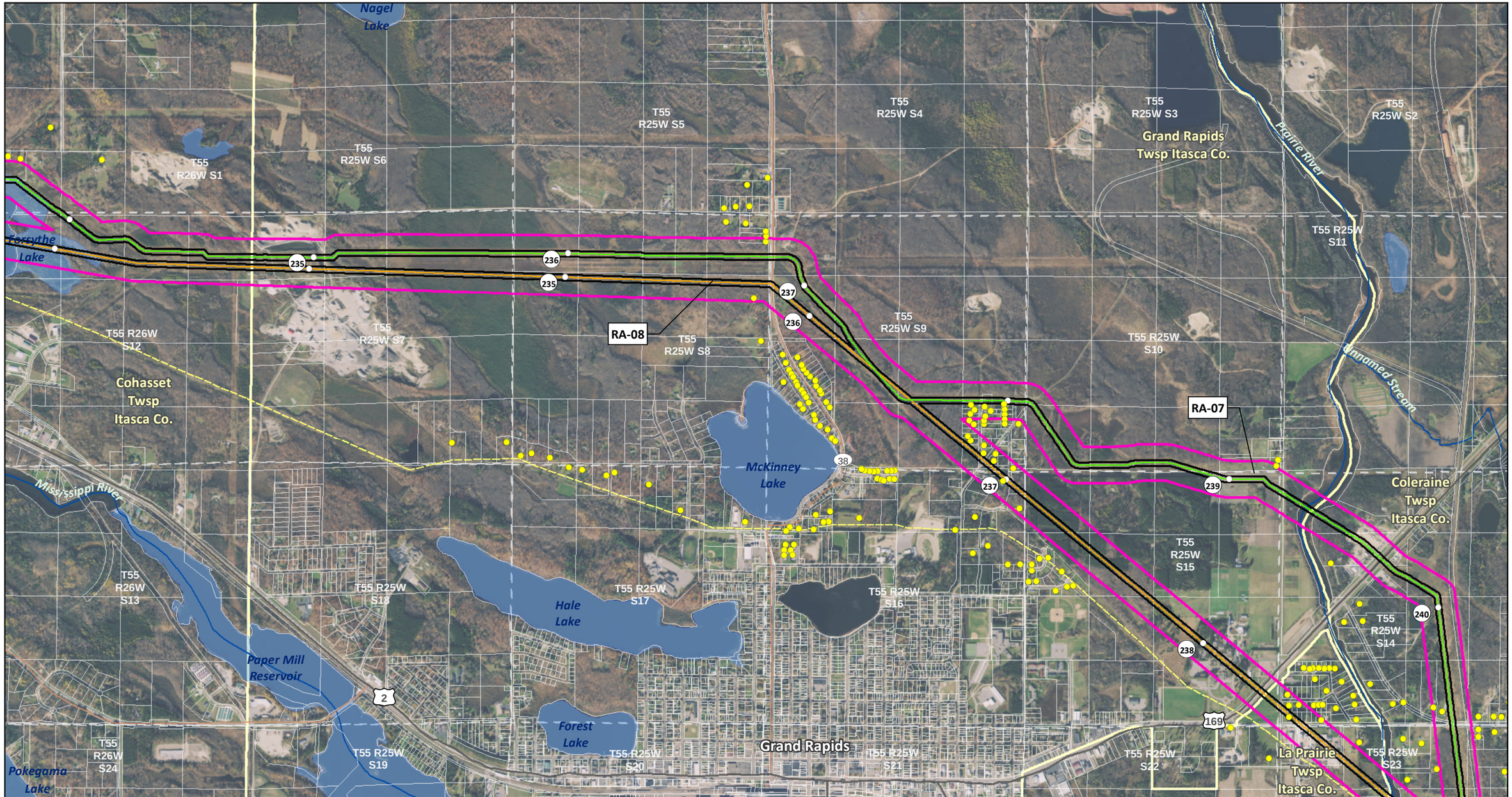
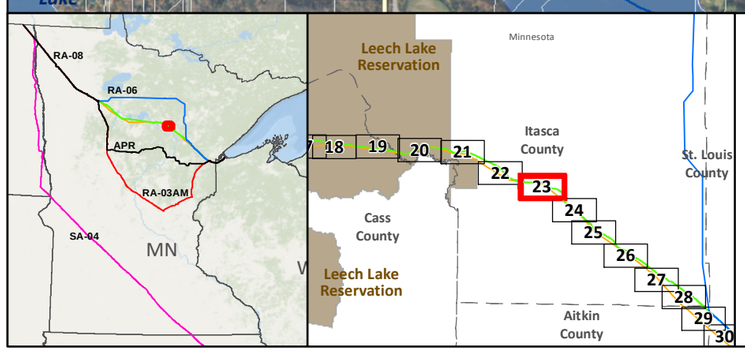
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Terminal
Pump Station
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
RA-07 AND RA-08
CLEARBROOK TO CARLTON
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 22B of 38





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

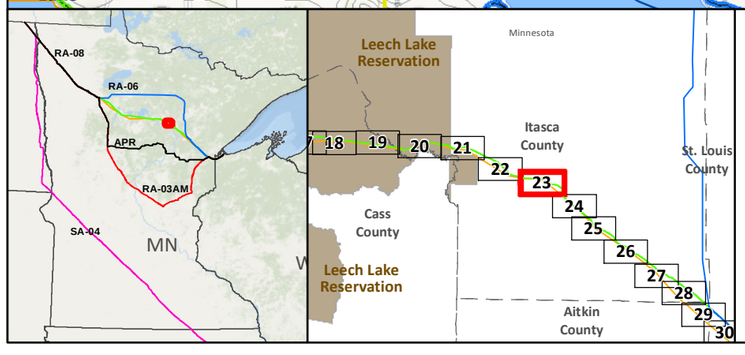
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 23A of 38

Nagel Lake
T55 R26W S1
T55 R25W S6
T55 R25W S5
T55 R25W S4
T55 R25W S3
T55 R25W S2
Prairie River
Forsythe Lake
T55 R25W S11
235
236
235
237
RA-08
T55 R25W S7
T55 R25W S8
T55 R25W S9
T55 R25W S10
T55 R26W S12
38
Grand Rapids Twsp Itasca Co.
238
RA-07
Cohasset Twsp Itasca Co.
McKinney Lake
237
239
Unnamed Stream
Coleraine Twsp Itasca Co.
Mississippi River
Bass Brook WMA
T55 R26W S13
T55 R25W S18
Grand Rapids 2 WHPA
T55 R25W S17
T55 R25W S16
T55 R25W S15
Hale Lake
240
238
T55 R25W S14
Paper Mill Reservoir
2
169
Forest Lake
Grand Rapids Central WHPA
Grand Rapids
T55 R26W S24
T55 R25W S19
T55 R25W S20
T55 R25W S21
T55 R25W S22
La Prairie Twsp Itasca Co.
T55 R25W S23
Pokegama Lake



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

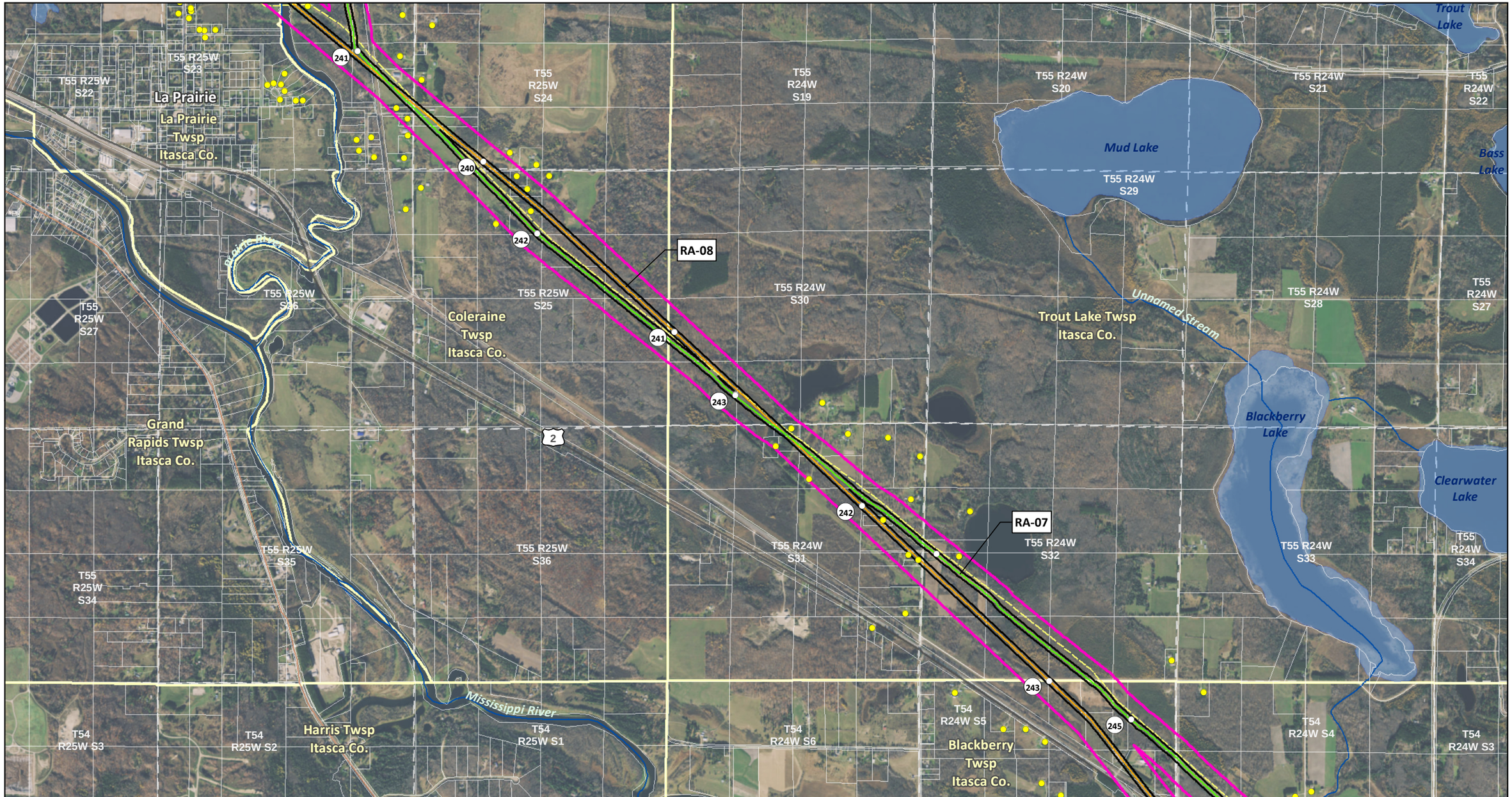
RA-07 AND RA-08

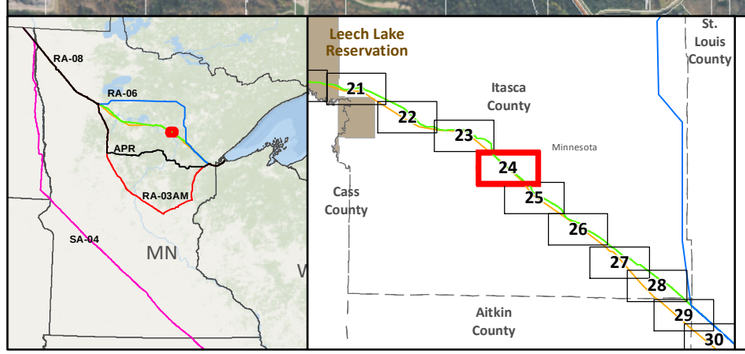
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 23B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

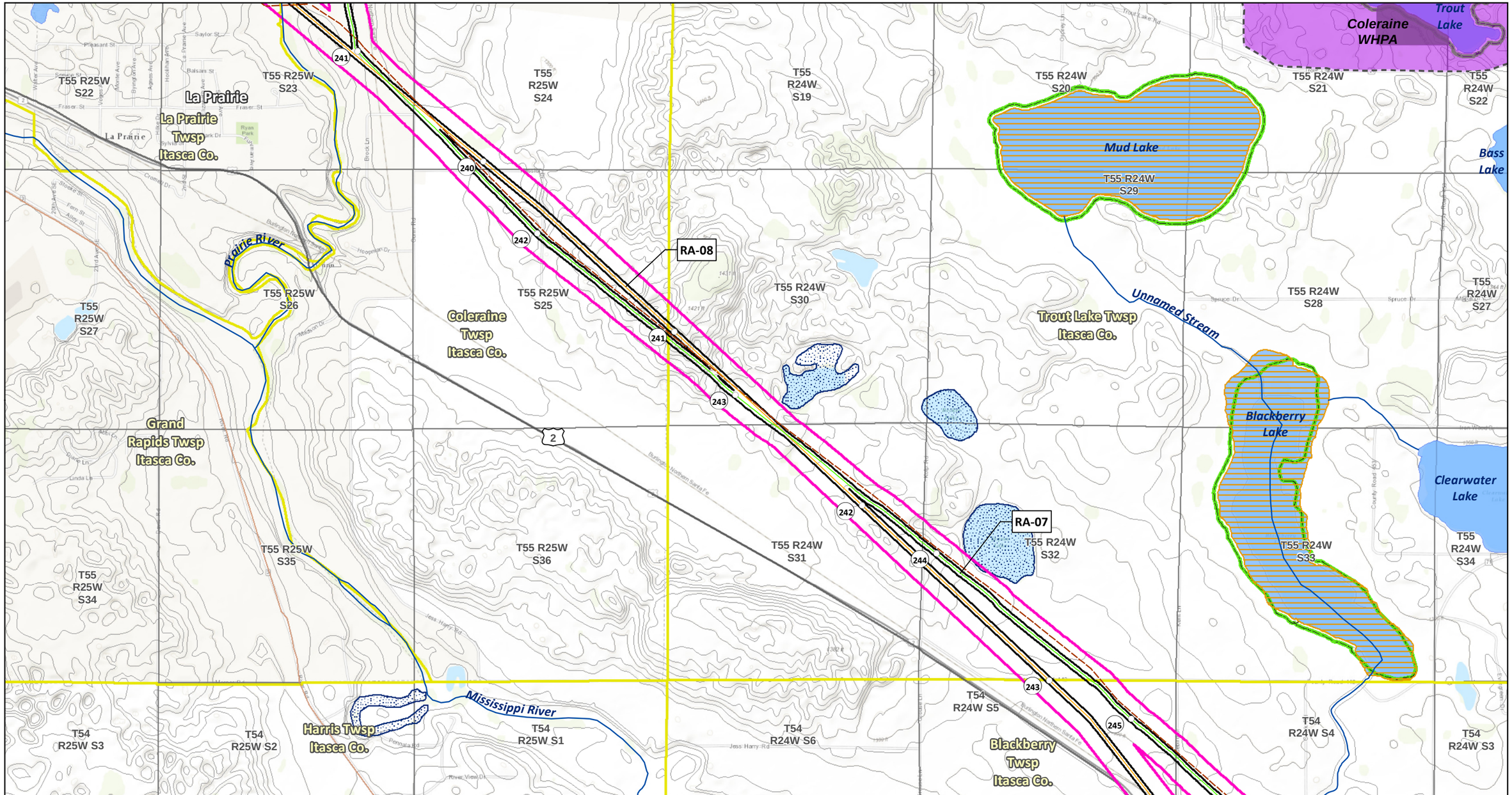
Data Sources: MNDNR, NHD, Enbridge

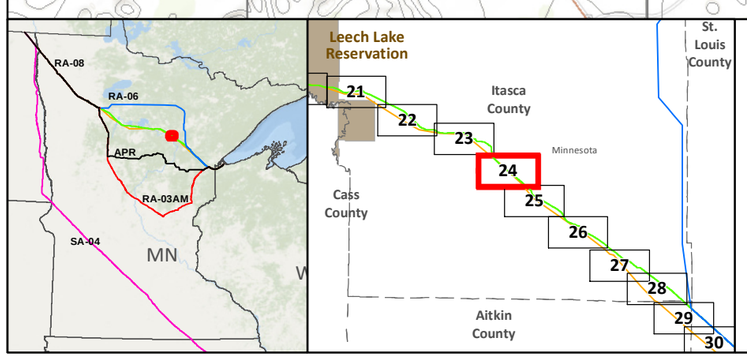
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 24A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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- Anticipated 120' Construction ROW
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- Designated Trout Stream
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Native Plant Communities with Biodiversity Significance
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- Moderate
- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

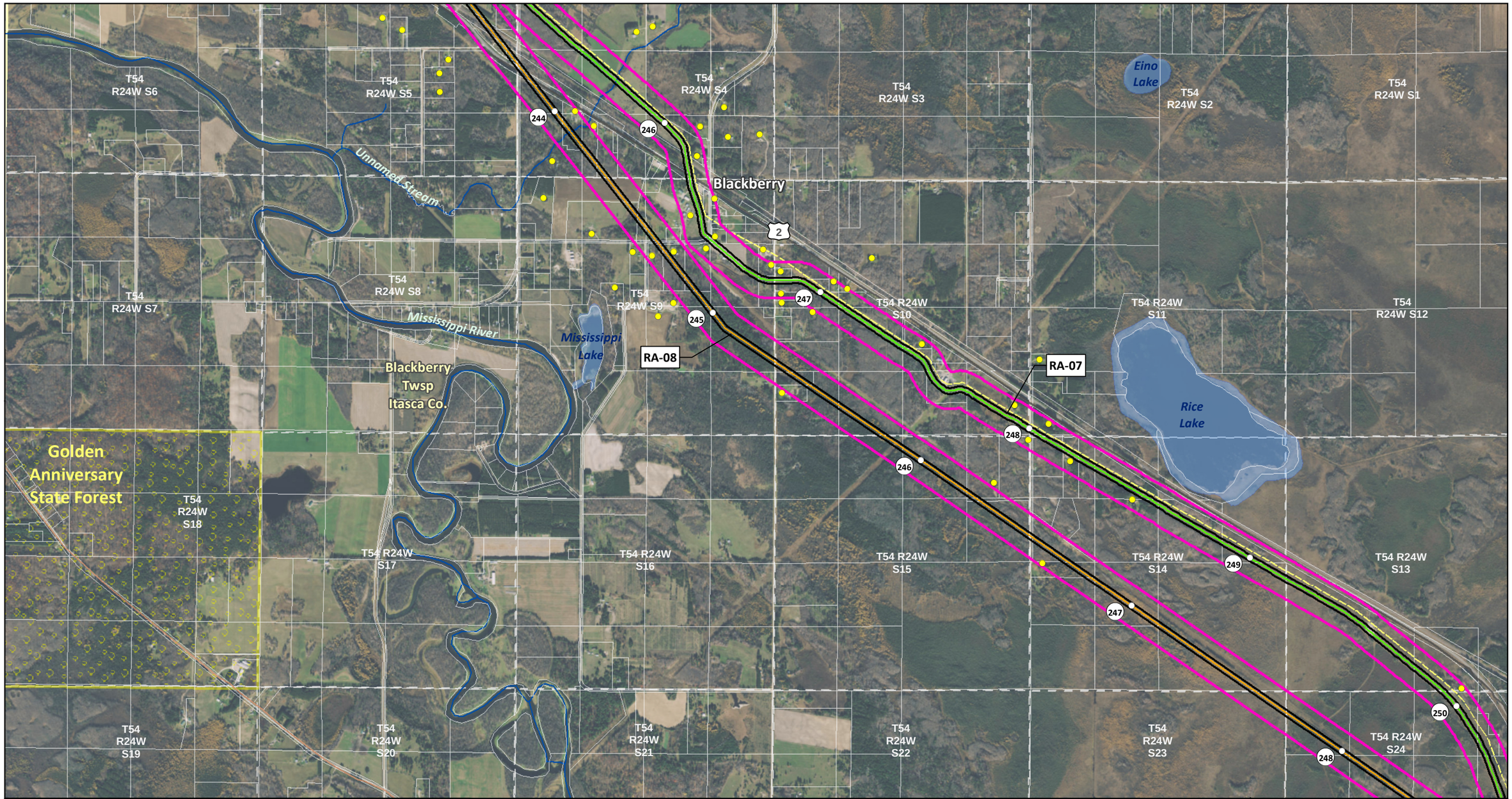
0 0.125 0.25 0.5 Miles

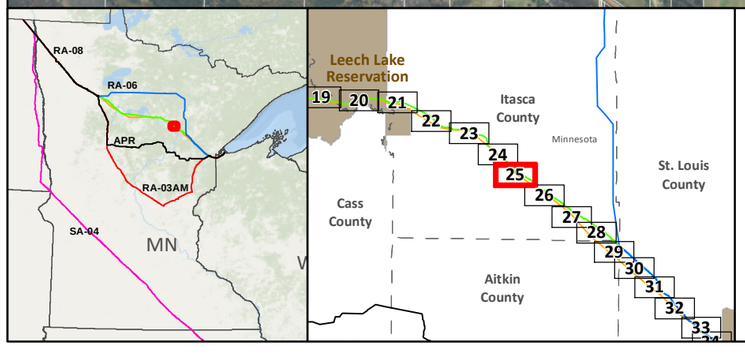
0 125 250 500 Meters

1:24,000

10ft Contours

Map 24B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
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- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

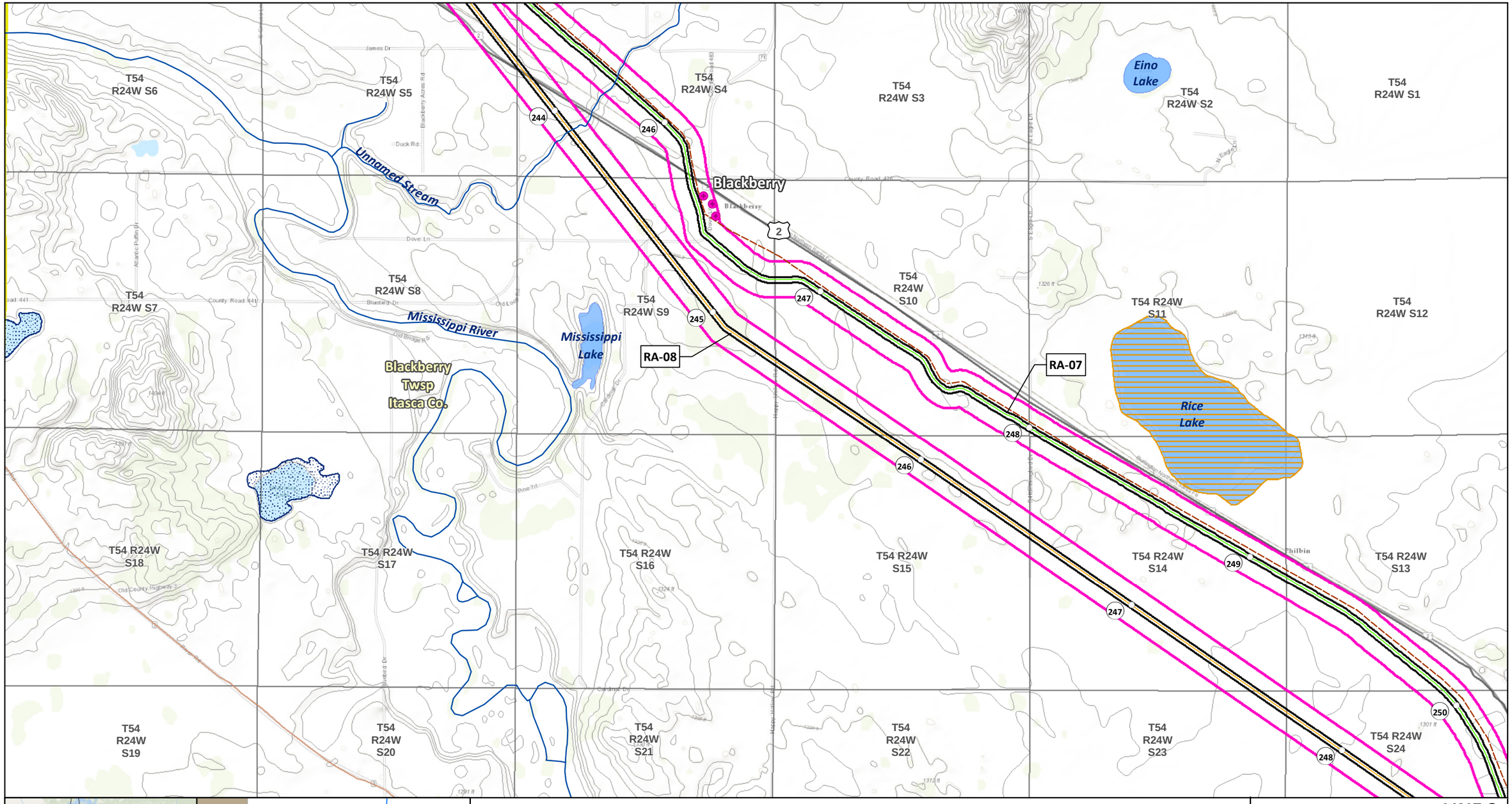
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

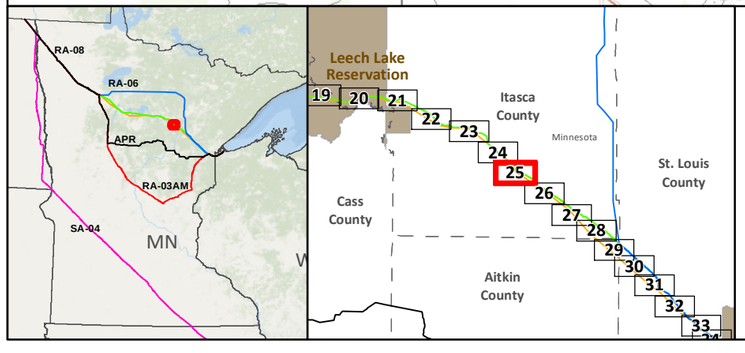
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 25A of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

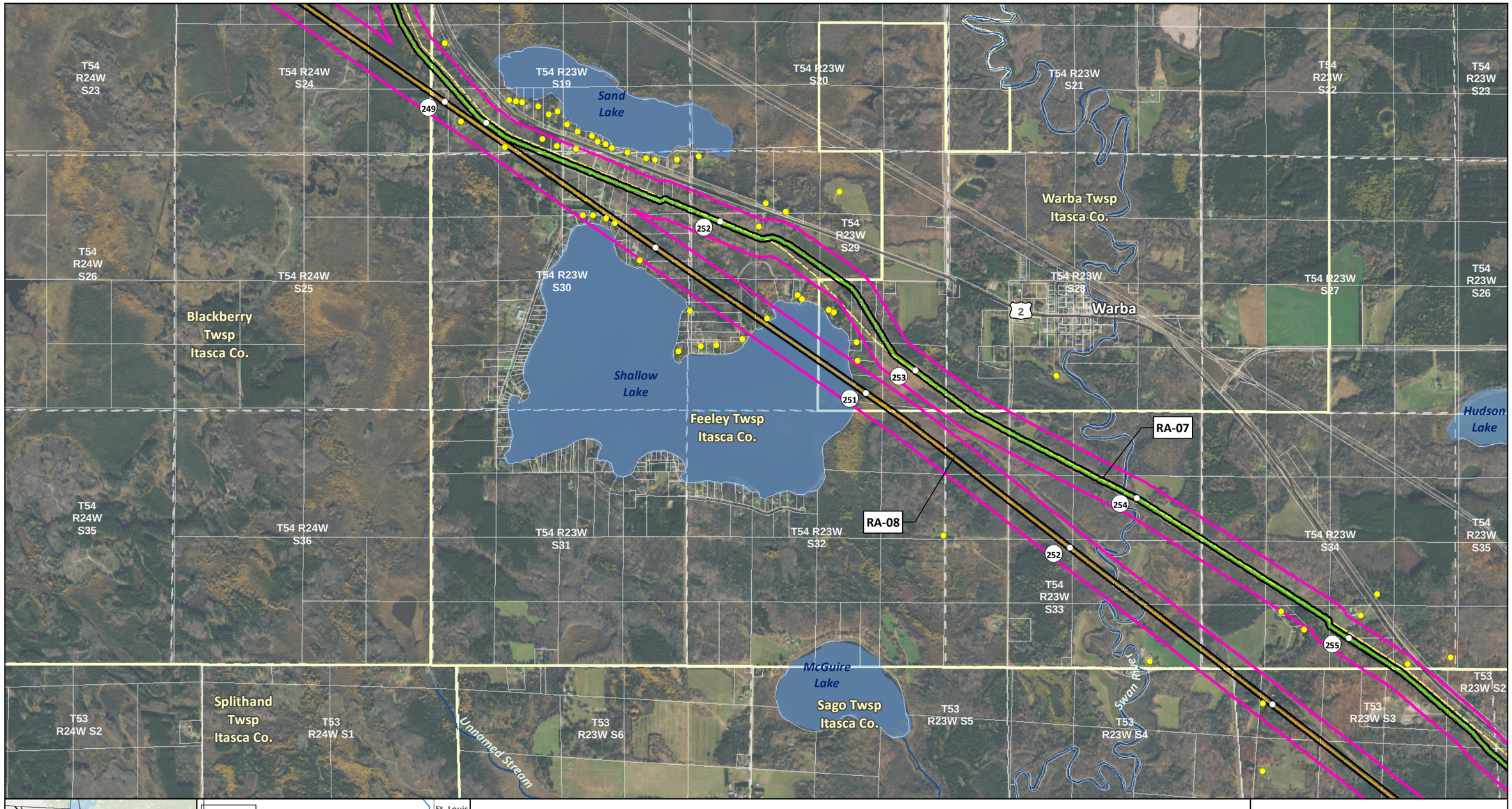
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

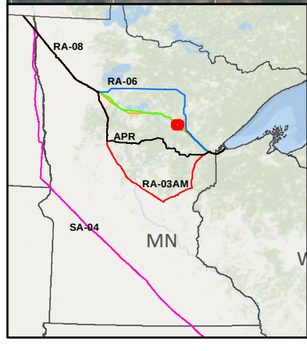
RA-07 AND RA-08 CLEARBROOK TO CARLTON

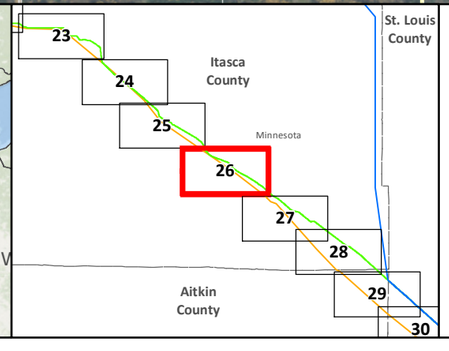
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 25B of 38







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 26A of 38

T54 R24W S23
T54 R24W S24
T54 R23W S19
T54 R23W S20
T54 R23W S21
T54 R23W S22
T54 R23W S23
T54 R24W S26
T54 R24W S25
T54 R23W S30
T54 R23W S29
T54 R23W S28
T54 R23W S27
T54 R23W S26
T54 R24W S35
T54 R24W S36
T54 R23W S31
T54 R23W S32
T54 R23W S33
T54 R23W S34
T54 R23W S35
T53 R24W S2
T53 R24W S1
T53 R23W S6
T53 R23W S5
T53 R23W S4
T53 R23W S3
T53 R23W S2

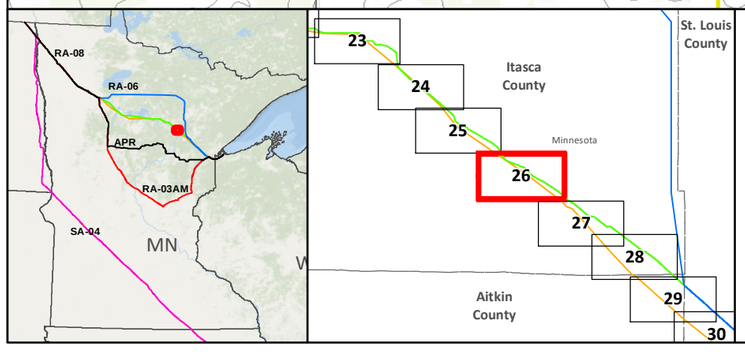
Sand Lake
Shallow Lake
Hudson Lake
McGuire Lake

Warba Twsp Itasca Co.
Warba
Blackberry Twsp Itasca Co.
Feeley Twsp Itasca Co.
Splithand Twsp Itasca Co.
Sago Twsp Itasca Co.

Unnamed Stream
Swan River

RA-07
RA-08

249 251 252 250 253 254 255



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

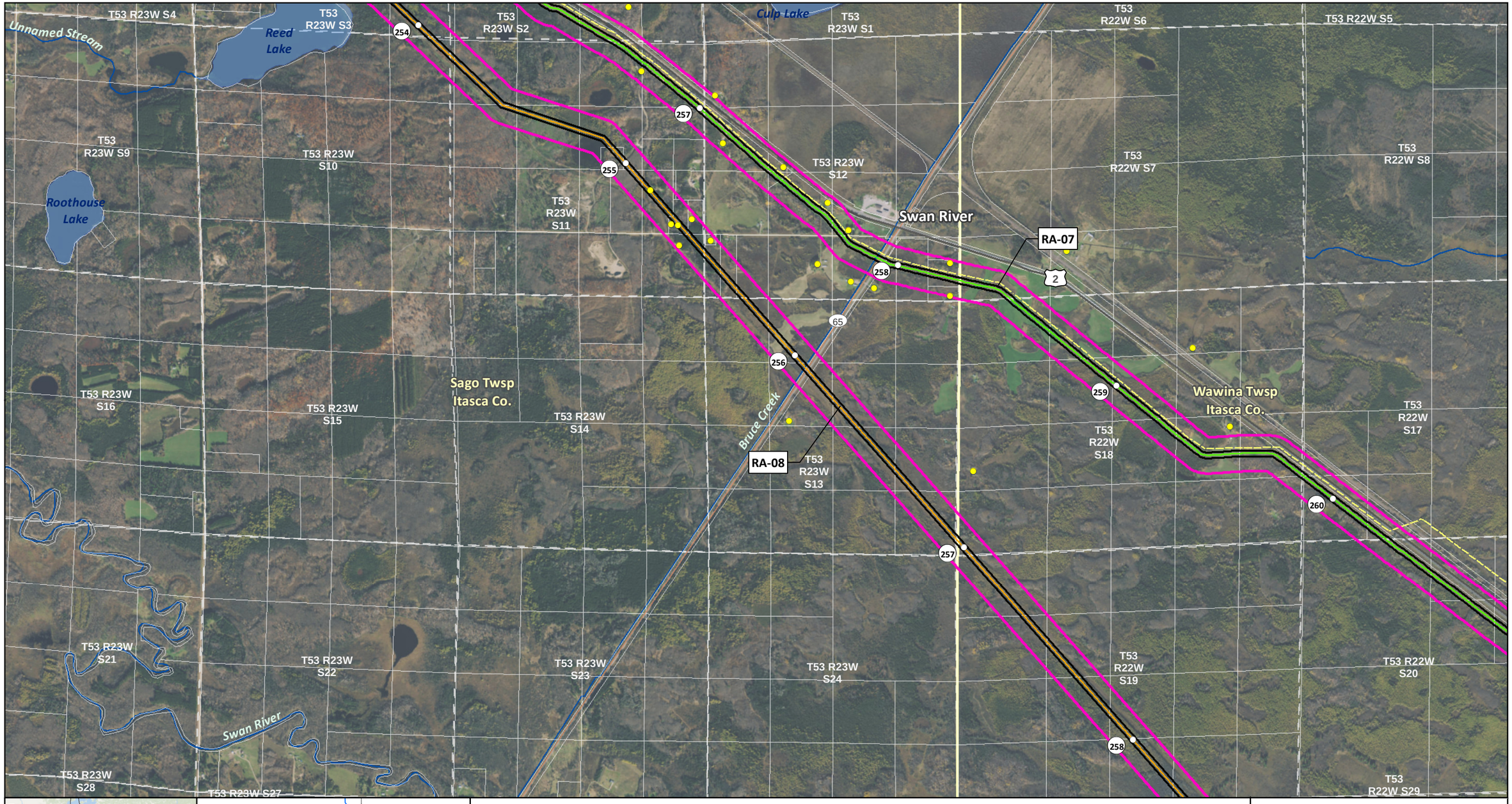
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

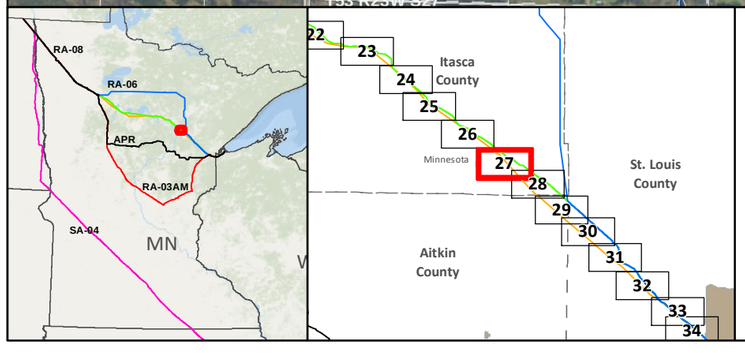
RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 26B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

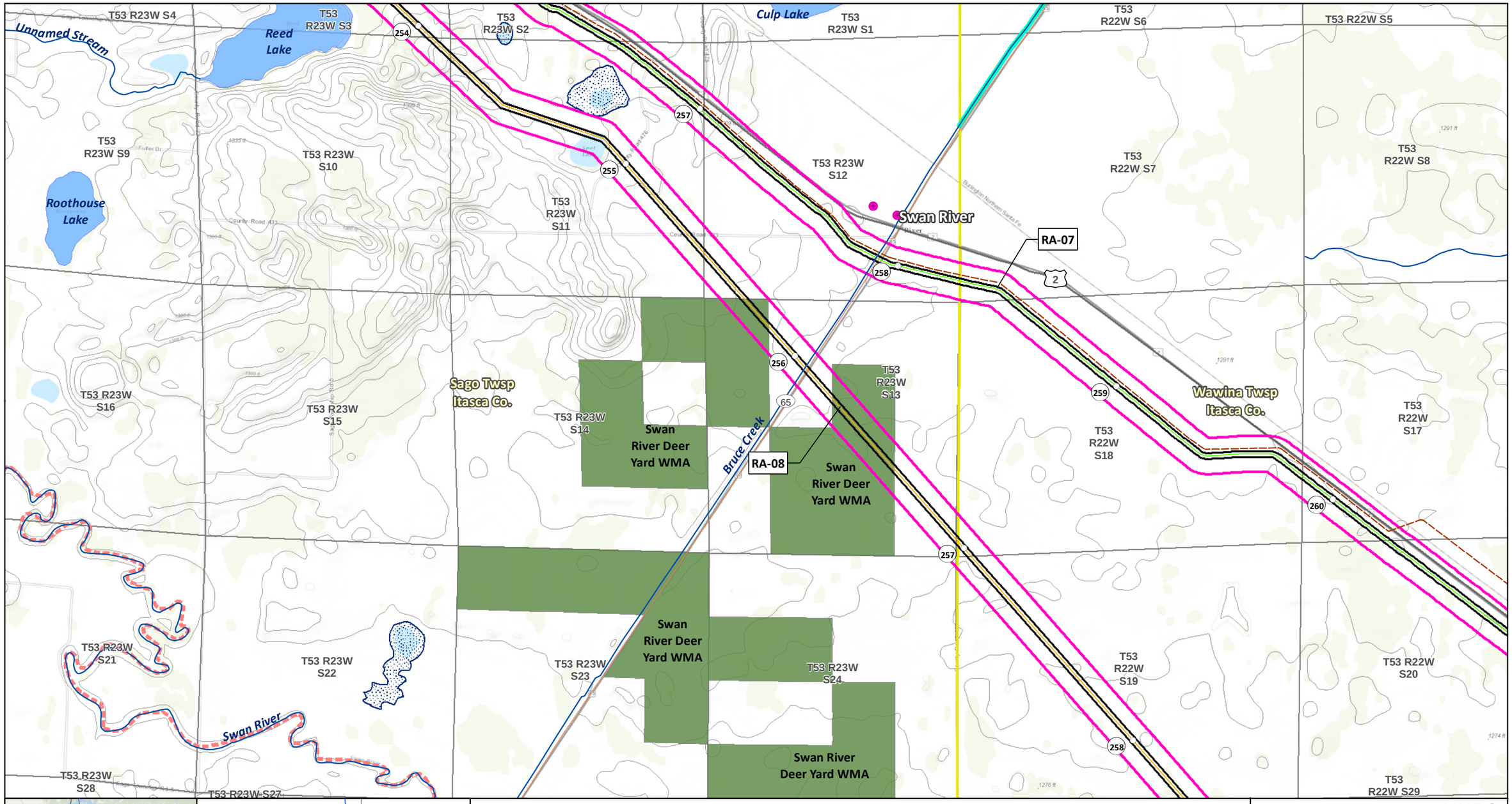
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

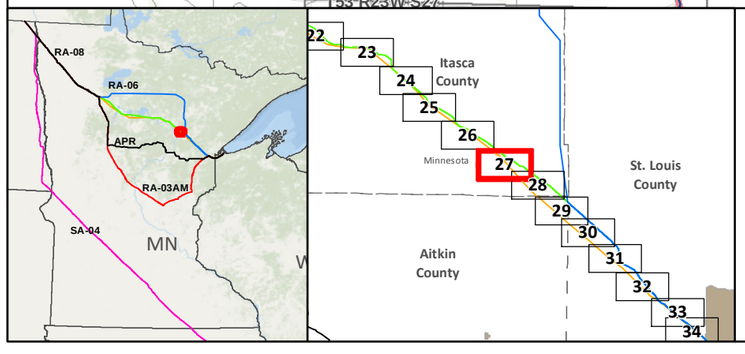
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 27A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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- Route Width (750')
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- Designated Trout Stream
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08 CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 27B of 38

T53 R22W S23
T53 R22W S19
T53 R22W S20
T53 R22W S21
T53 R22W S22
T53 R22W S24
T53 R23W S24
T53 R23W S25
T53 R22W S30
T53 R22W S29
T53 R22W S28
T53 R22W S27
T53 R22W S26
T53 R22W S25
T53 R22W S31
T53 R22W S32
T53 R22W S33
T53 R22W S34
T53 R22W S35
T53 R22W S36
T52 R22W S6
T52 R22W S5
T52 R22W S4
T52 R22W S3
T52 R22W S2
T52 R22W S1

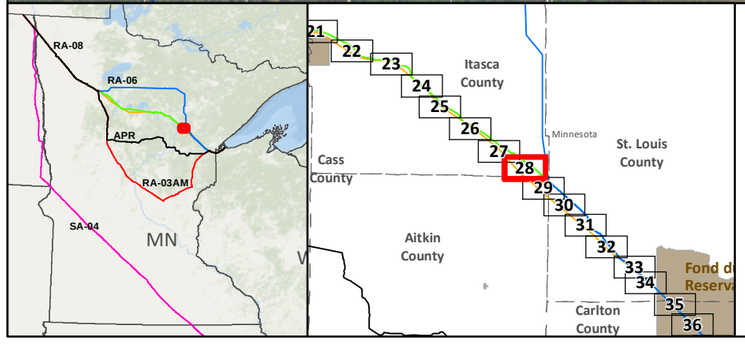
Unnamed Stream
Swan River

Wawina
Wawina Twsp
Itasca Co.
Northeast Aitkin Twsp
Aitkin Co.

RA-07
RA-08

258 259 260 261 262 263 264 265

2



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

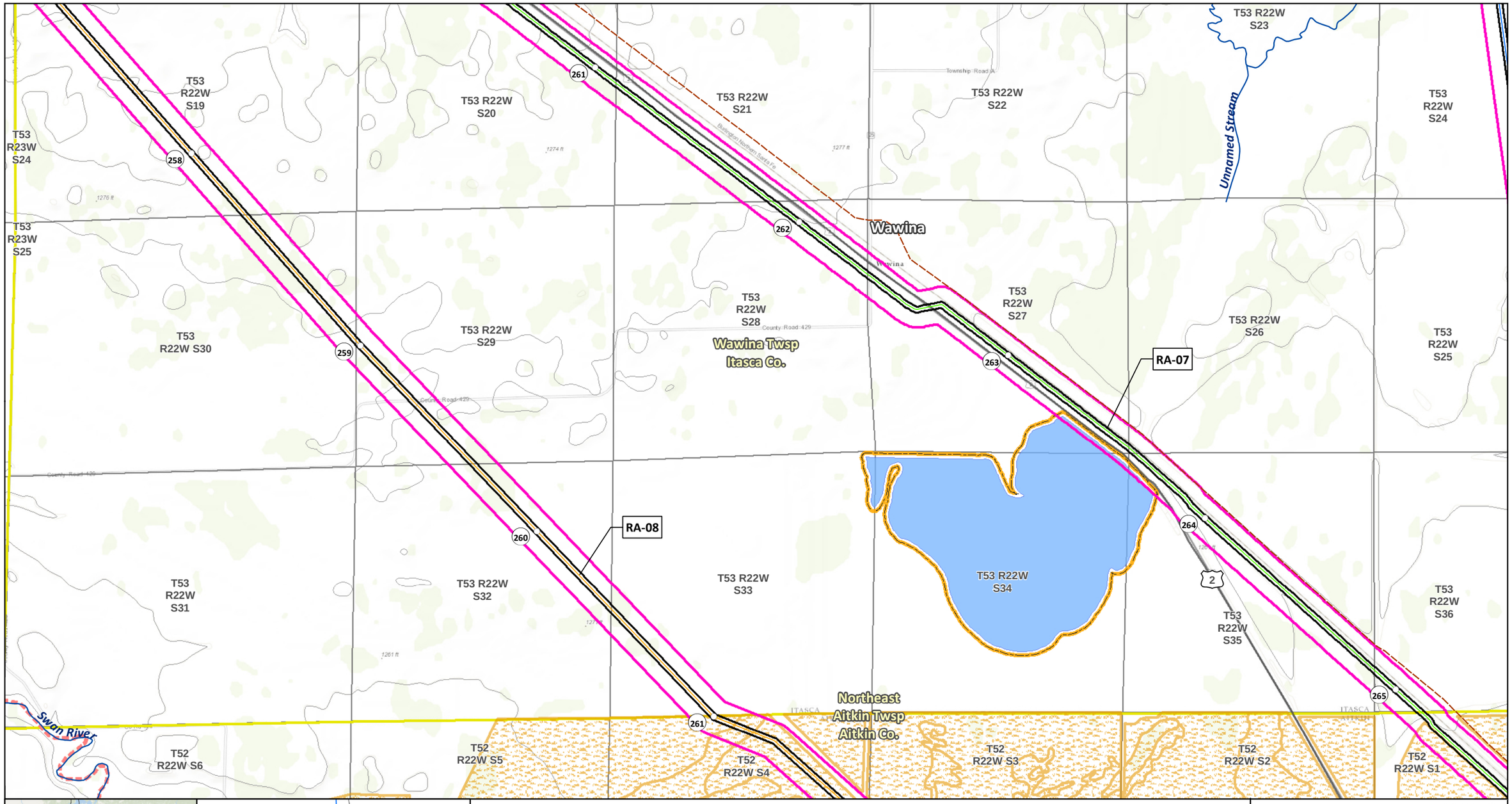
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

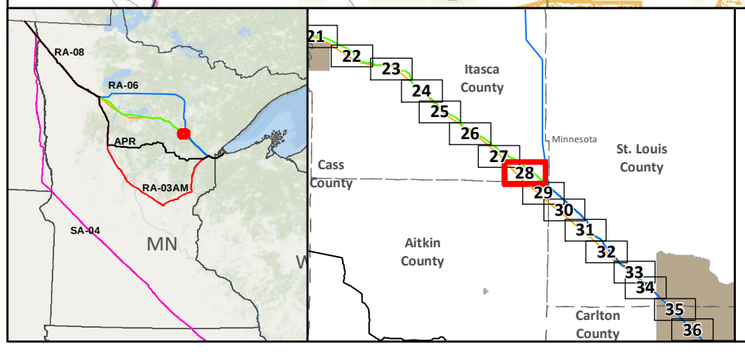
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 28A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08 CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 28B of 38

RA-06

RA-07

RA-08

RA-06
RA-07

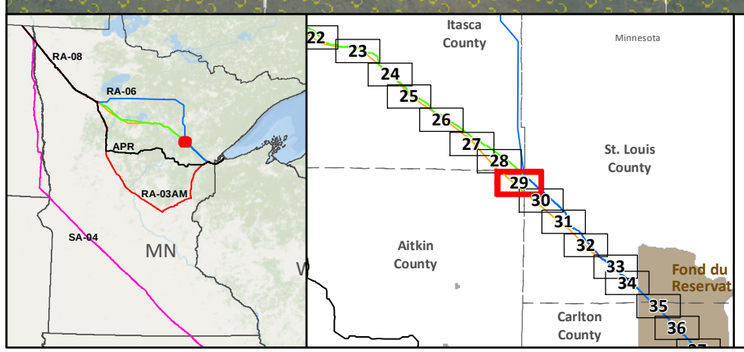
T52 R22W S3
T52 R22W S2
T52 R22W S1
T52 R21W S6
T52 R21W S5
T52 R21W S4
T52 R22W S4
T52 R22W S9
T52 R22W S10
T52 R22W S11
T52 R22W S12
T52 R21W S7
T52 R21W S8
T52 R21W S9
T52 R22W S16
T52 R22W S15
T52 R22W S14
T52 R22W S13
T52 R21W S18
T52 R21W S17
T52 R21W S16
T52 R22W S21
T52 R22W S22
T52 R22W S23
T52 R22W S24
T52 R21W S19
T52 R21W S20
T52 R21W S21

Northeast Aitkin Twsp Aitkin Co.

Savanna State Forest

Pot Shot Lake Twsp St. Louis Co.

262 263 264 265 266 267 268 269 200 2



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

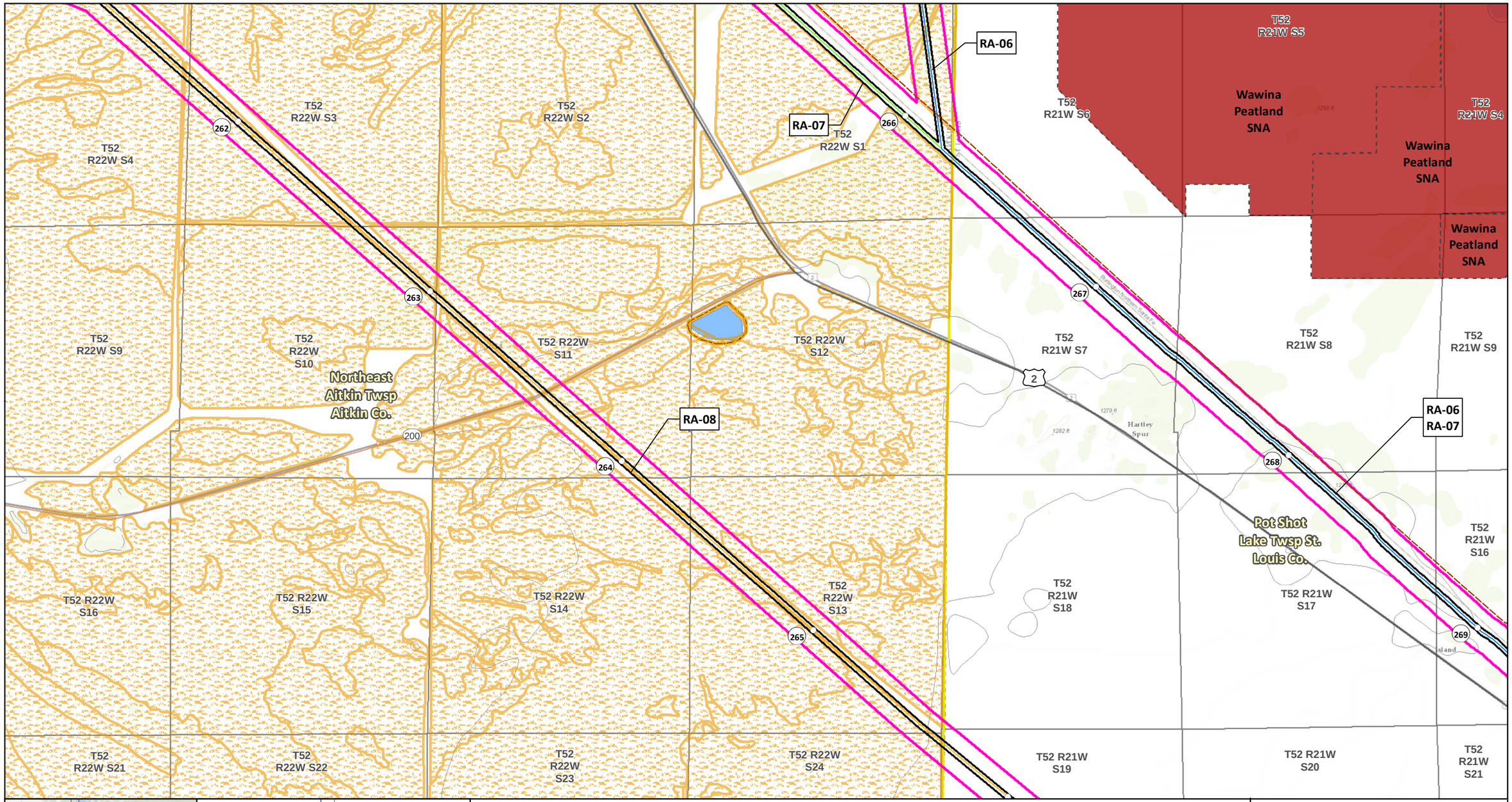
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

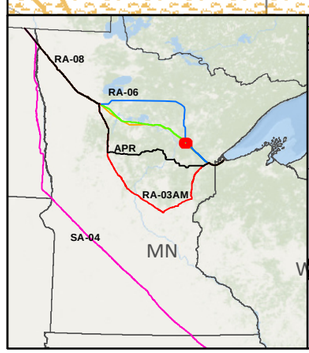
RA-07 AND RA-08

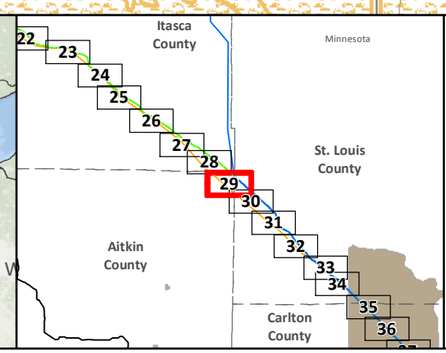
CLEARBROOK TO CARLTON

Map 29A of 38

N







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding

High

Moderate

Native Plant Communities with Biodiversity Significance

Outstanding

High

Moderate

Terminal

Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

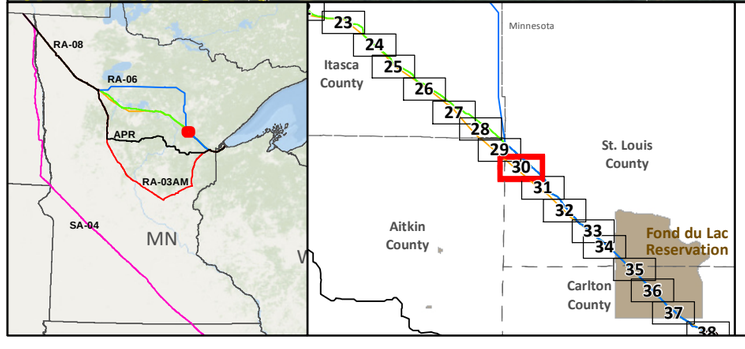
1:24,000

10ft Contours

N

Map 29B of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

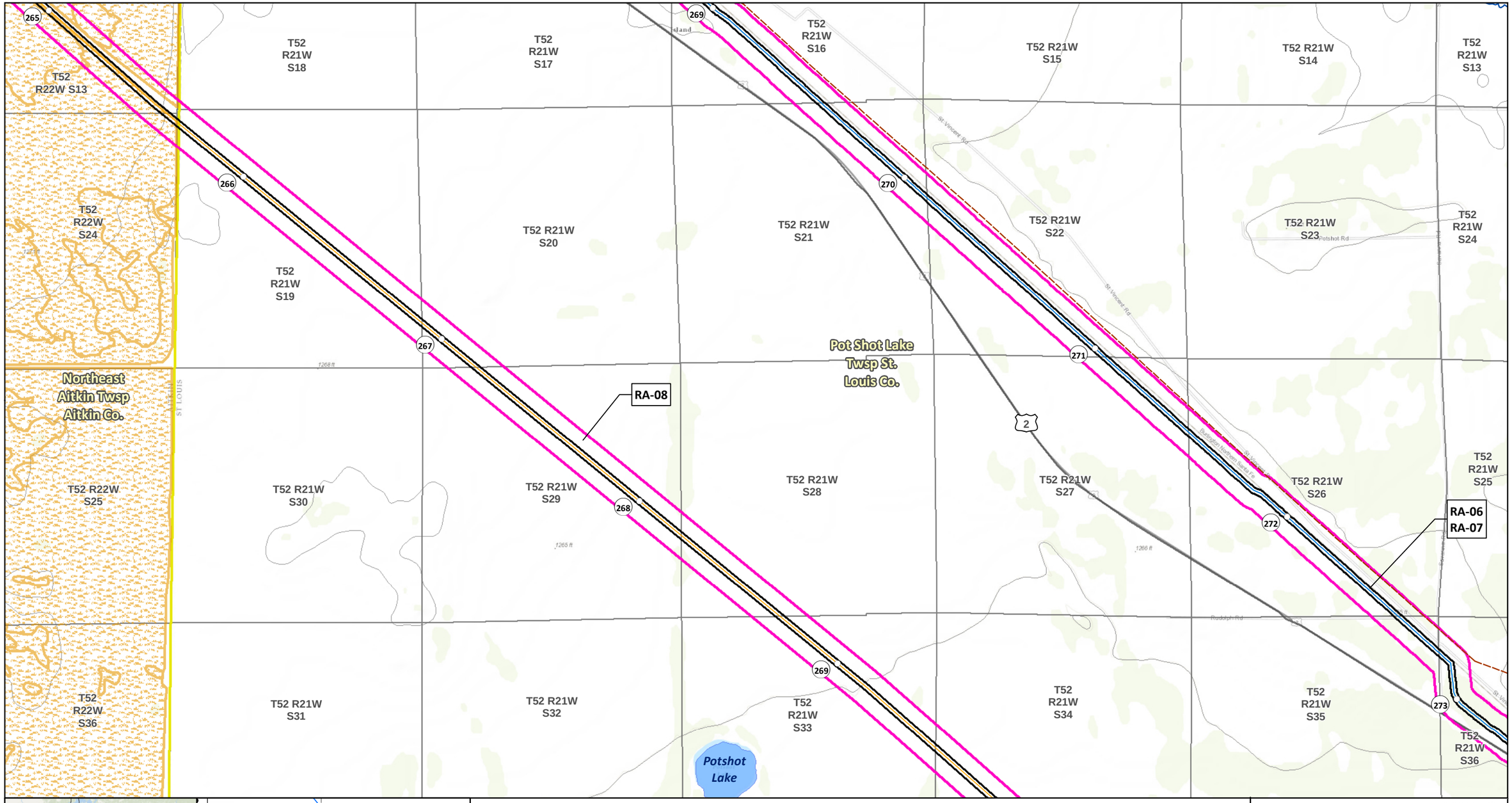
Data Sources: MNDNR, NHD, Enbridge

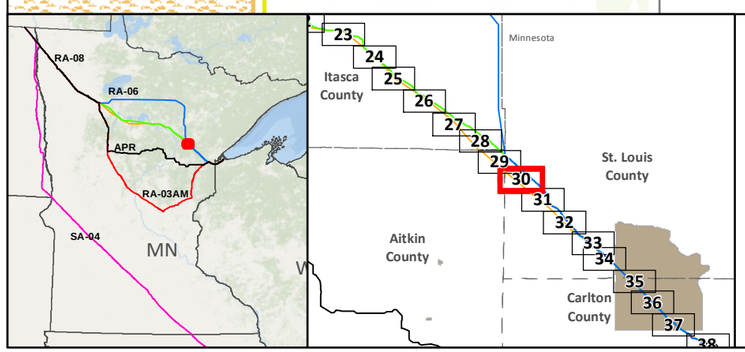
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 30A of 38





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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Wildlife Refuge Inventory
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Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 30B of 38

T52 R21W S33
T52 R21W S34
Pot Shot Lake Twsp St. Louis Co.
T52 R21W S35
T52 R21W S36
T52 R20W S31
Van Buren Twsp St. Louis Co.
T52 R20W S32
T52 R20W S33
270
RA-08
274
73
T51 R21W S3
271
T51 R21W S2
T51 R21W S1
T51 R20W S6
T51 R20W S5
T51 R20W S4
Unnamed Stream
Floodwood
Floodwood River
T51 R21W S4
275
2
St. Louis River
Halden Twsp St. Louis Co.
272
T51 R21W S12
T51 R20W S8
Floodwood Twsp St. Louis Co.
T51 R20W S9
T51 R21W S9
T51 R21W S10
T51 R21W S11
T51 R20W S7
273
276
RA-06
RA-07
East Savanna River
T51 R21W S16
T51 R21W S15
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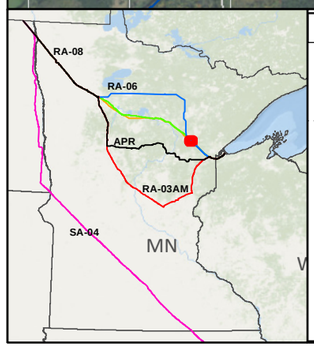
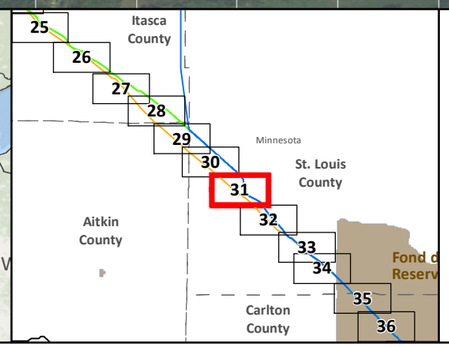
T51 R21W S13
T51 R20W S18
277
T51 R20W S17
T51 R20W S16
274





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Data Sources: MNDNR, NHD, Enbridge

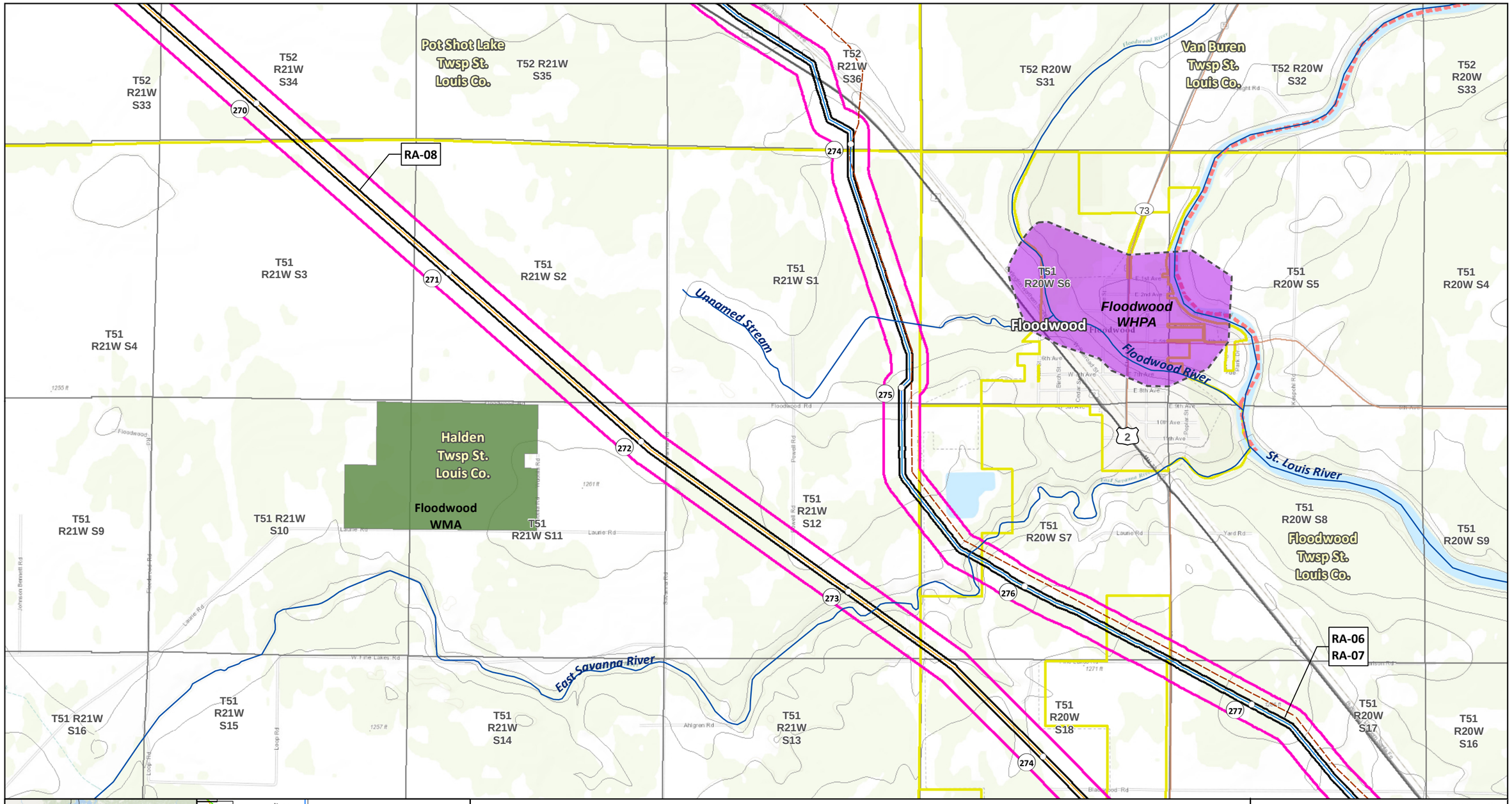
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

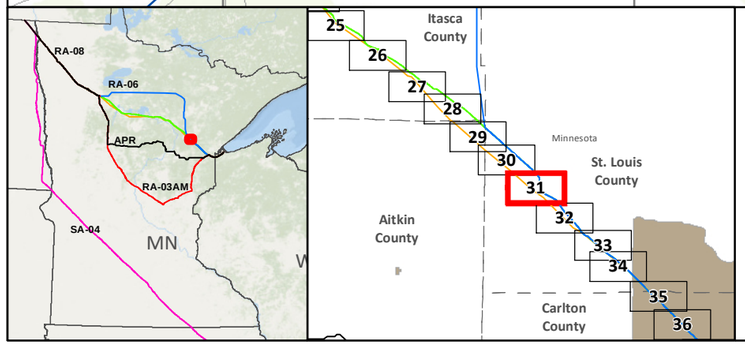
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 31A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

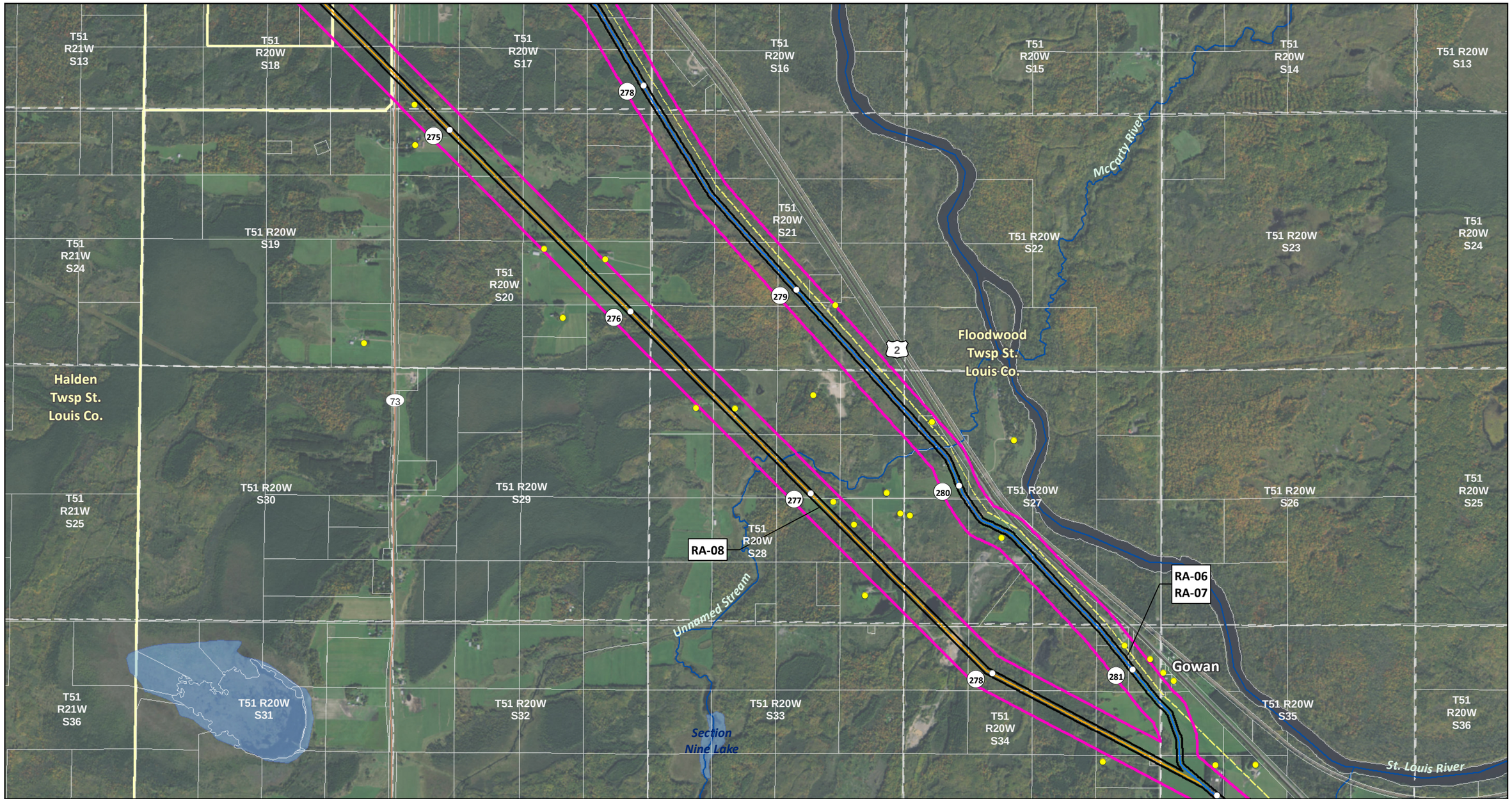
0 0.125 0.25 0.5 Miles

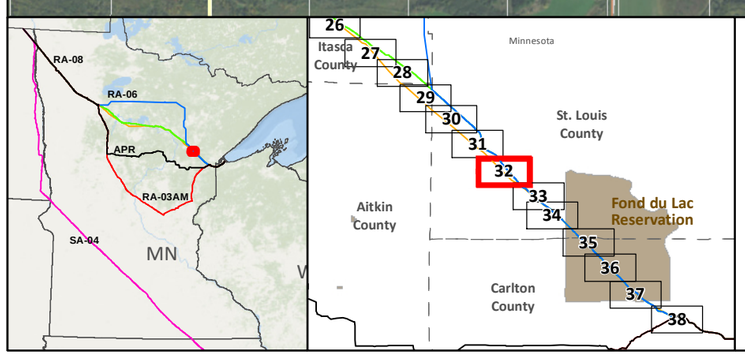
1:24,000

0 125 250 500 Meters

10ft Contours

Map 31B of 38





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Existing Pipelines

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Parcels

Public Water Basin

Public Waters Watercourse

Residences within 1/2 mile

Mile Post

Terminal

Pump Station

Interstate

Highway

Major Road

Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

Data Sources: MNDNR, NHD, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

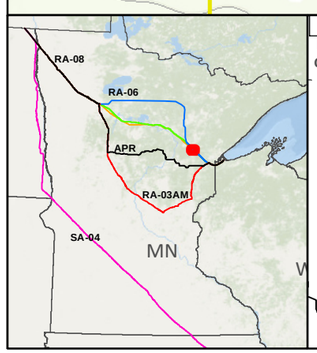
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

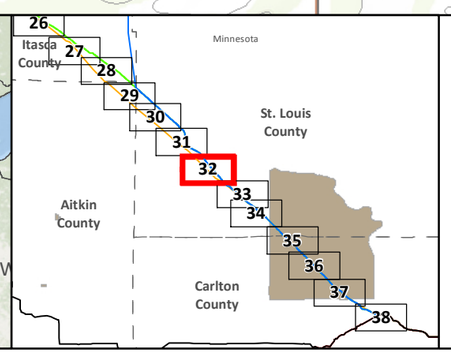
RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 32A of 38

T51 R21W S13
T51 R20W S18
T51 R20W S17
T51 R20W S16
T51 R20W S15
T51 R20W S14
T51 R20W S13
T51 R21W S24
T51 R20W S19
T51 R20W S20
T51 R20W S21
T51 R20W S22
T51 R20W S23
T51 R20W S24
T51 R21W S25
T51 R20W S30
T51 R20W S29
T51 R20W S28
T51 R20W S27
T51 R20W S26
T51 R20W S25
T51 R21W S36
T51 R20W S31
T51 R20W S32
T51 R20W S33
T51 R20W S34
T51 R20W S35
T51 R20W S36
Halden Twsp St. Louis Co.
Floodwood Twsp St. Louis Co.
Gowan
McCarty River
Unnamed Stream
Section Nine Lake
St. Louis River
RA-08
RA-06
RA-07
275
276
277
278
279
280
281
73
2





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Terminal
Pump Station

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

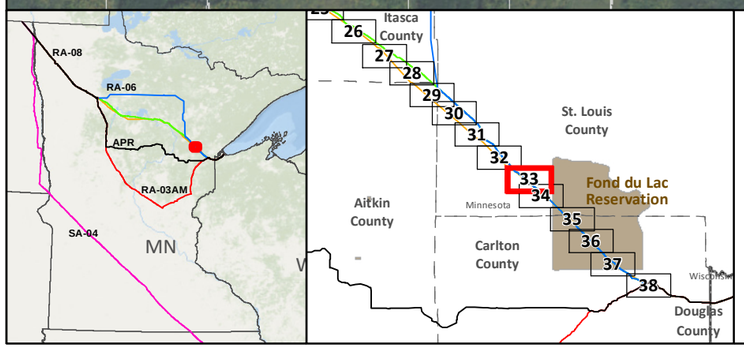
CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 32B of 38

St. Louis River
Floodwood Twsp St. Louis Co.
Kingburg Lake
T51 R20W S34
T51 R20W S35
T51 R20W S36
T51 R19W S31
T51 R19W S32
T51 R19W S33
T51 R19W S34
279
282
2
280
283
281
284
T50 R20W S1
T50 R20W S2
T50 R20W S3
Ahmik Creek
T50 R19W S6
T50 R19W S5
T50 R19W S4
T50 R19W S3
Unnamed Stream
Arrowhead Twsp St. Louis Co.
Fine Lakes Twsp St. Louis Co.
T50 R20W S11
T50 R20W S12
T50 R20W S10
RA-08
T50 R19W S7
T50 R19W S8
T50 R19W S9
T50 R19W S10
282
285
RA-06
RA-07
283
T50 R20W S15
T50 R20W S14
T50 R20W S13
T50 R19W S18
T50 R19W S17
T50 R19W S16
T50 R19W S15
286



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

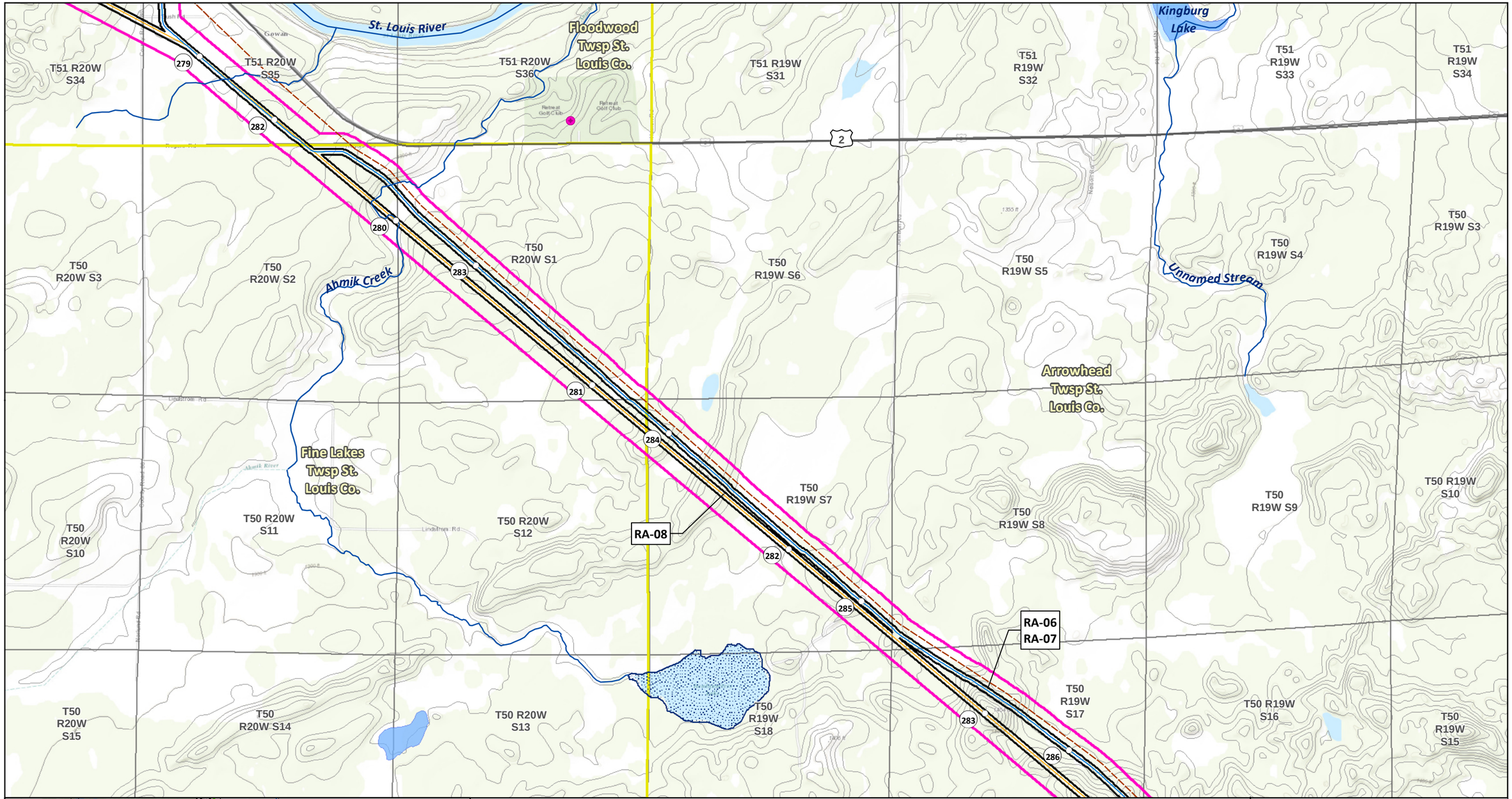
Data Sources: MNDNR, NHD, Enbridge

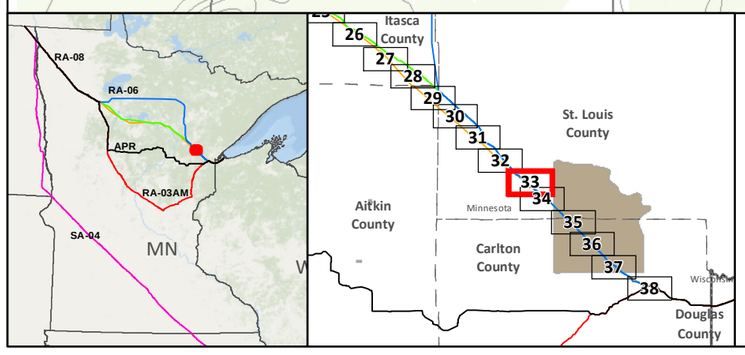
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 33A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 33B of 38

T50 R20W S12
T50 R19W S7
T50 R19W S8
T50 R19W S9
T50 R19W S10
T50 R19W S11
T50 R20W S13
T50 R19W S18
T50 R19W S17
T50 R19W S16
T50 R19W S15
T50 R19W S14
T50 R20W S24
T50 R19W S19
T50 R19W S20
T50 R19W S21
T50 R19W S22
T50 R19W S23
T50 R20W S25
T50 R19W S30
T50 R19W S29
T50 R19W S28
T50 R19W S27
T50 R19W S26

RA-06
RA-07
RA-08

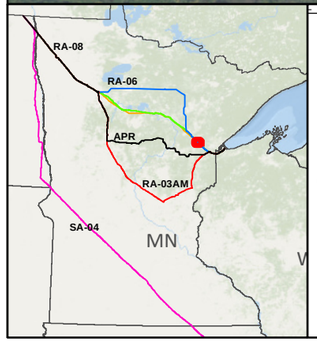
285
283
286
284
287
285
288
286
289

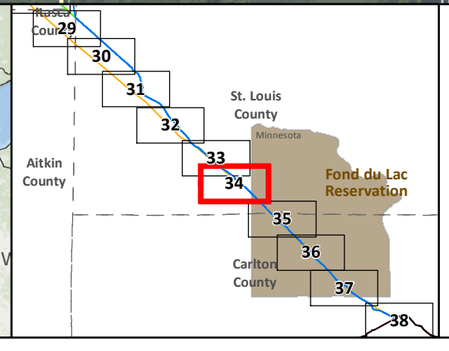
Arrowhead Twsp St. Louis Co.

Fine Lakes Twsp St. Louis Co.

Fond du Lac Reservation

Unnamed Stream





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08

Existing Pipelines

Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse

Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

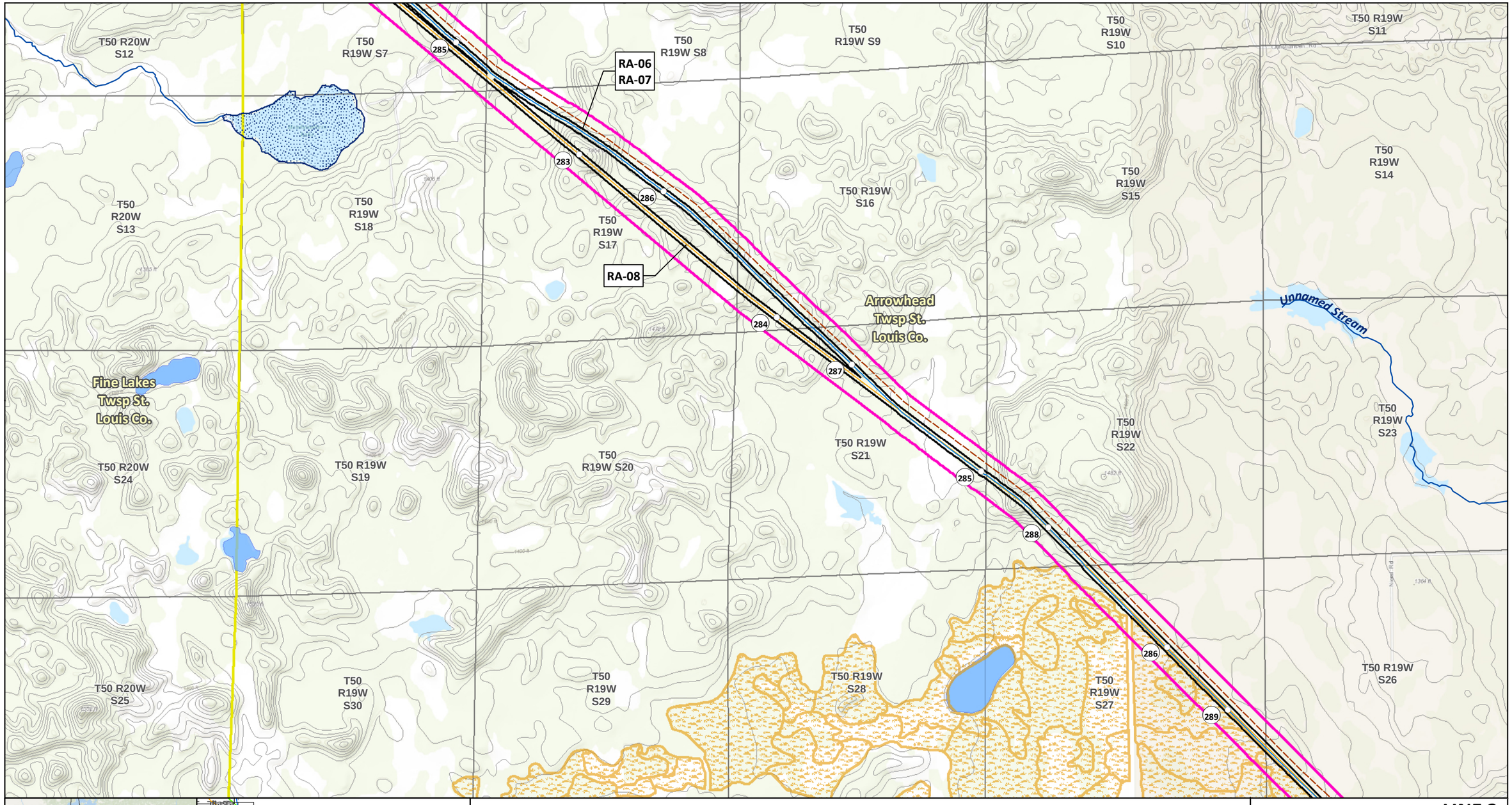
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

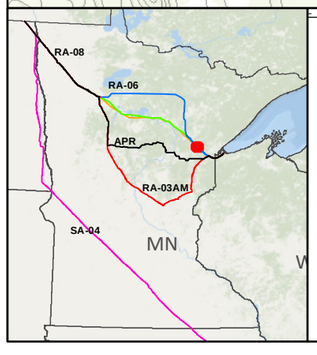
RA-07 AND RA-08

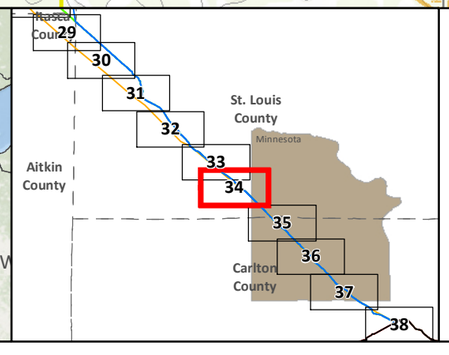
CLEARBROOK TO CARLTON

N

Map 34A of 38







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

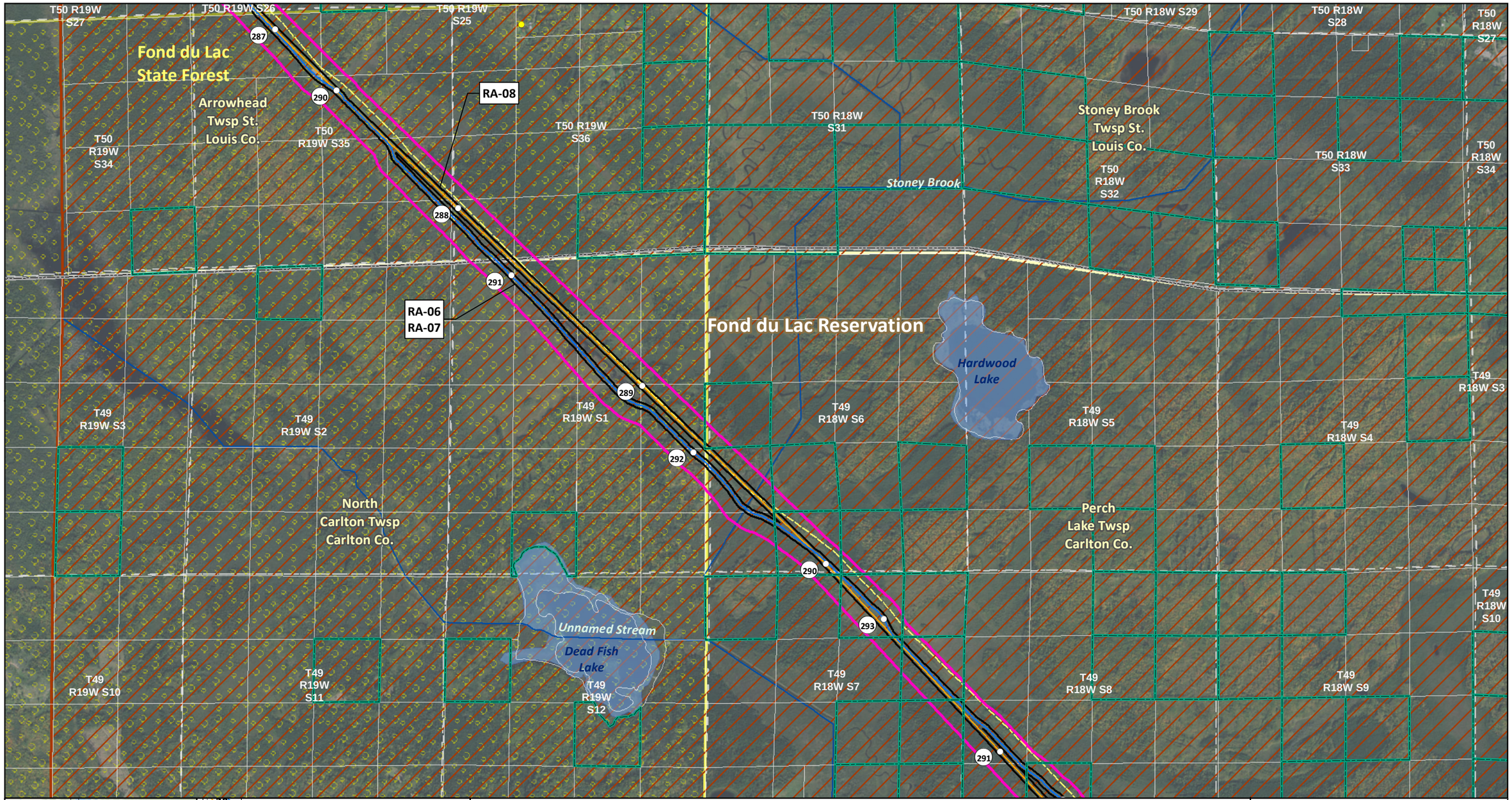
RA-07 AND RA-08

CLEARBROOK TO CARLTON

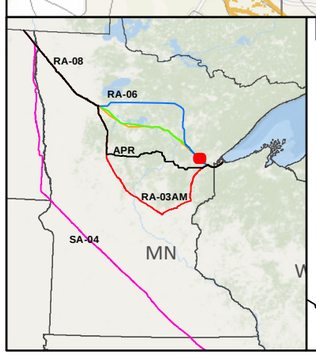
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

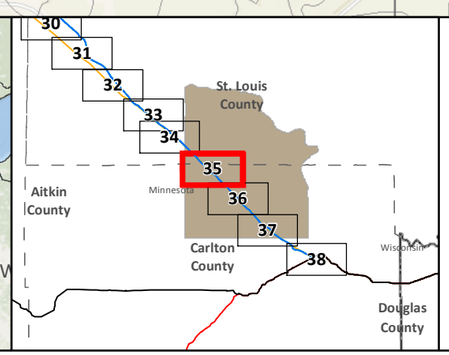
N

Map 34B of 38


T50 R19W S27
T50 R19W S26
T50 R19W S25
T50 R18W S29
T50 R18W S28
T50 R18W S27
Fond du Lac State Forest
Arrowhead Twsp St. Louis Co.
287
290
RA-08
T50 R19W S35
T50 R19W S36
T50 R18W S31
Stoney Brook Twsp St. Louis Co.
T50 R19W S34
T50 R18W S33
T50 R18W S34
Stoney Brook
T50 R18W S32
288
291
RA-06
RA-07
Fond du Lac Reservation
Hardwood Lake
289
T49 R19W S3
T49 R19W S2
T49 R19W S1
T49 R18W S6
T49 R18W S5
T49 R18W S4
T49 R18W S3
292
North Carlton Twsp Carlton Co.
Perch Lake Twsp Carlton Co.
290
T49 R18W S10
Unnamed Stream
Dead Fish Lake
293
T49 R19W S10
T49 R19W S11
T49 R19W S12
T49 R18W S7
T49 R18W S8
T49 R18W S9
291
RA-08
RA-06
APR
RA-03AM
SA-04
MN
30
31
32
33
34
35
36
37
38
St. Louis County
Fond du Lac Reservation
Aitkin County
Minnesota
Carlton County
Wisconsin
Douglas County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Existing Pipelines
Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Parcels
Public Water Basin
Public Waters Watercourse
Residences within 1/2 mile
Mile Post
Terminal
Pump Station
Interstate
Highway
Major Road
Township Boundary
Land Ownership
State Forest
National Forest
Tribal Reservation
Tribal Trust Land
Data Sources: MNDNR, NHD, Enbridge
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL
RA-07 AND RA-08
CLEARBROOK TO CARLTON
Map 35A of 38

T50 R19W S27
T50 R19W S26
T50 R19W S25
T50 R18W S29
T50 R18W S28
T50 R18W S27
287
290
RA-08
Arrowhead Twsp St. Louis Co.
T50 R19W S35
T50 R19W S36
T50 R18W S31
Stoney Brook Twsp St. Louis Co.
T50 R19W S34
T50 R18W S32
Stoney Brook
T50 R18W S33
T50 R18W S34
288
ST LOUIS CARLTON
T49 R19W S1
291
RA-06
RA-07
Hardwood Lake
T49 R19W S3
T49 R19W S2
T49 R18W S6
T49 R18W S5
T49 R18W S4
T49 R18W S3
289
292
North Carlton Twsp Carlton Co.
Perch Lake Twsp Carlton Co.
290
Unnamed Stream
Dead Fish Lake
T49 R19W S10
T49 R19W S11
T49 R19W S12
T49 R18W S7
T49 R18W S8
T49 R18W S9
T49 R18W S10
293
291
Fond du Lac Reservation





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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Water Resources
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

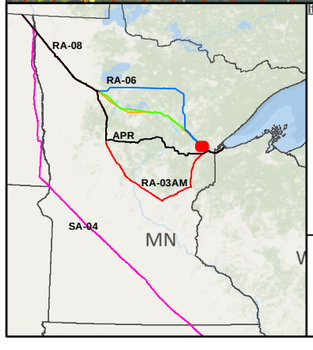
1:24,000

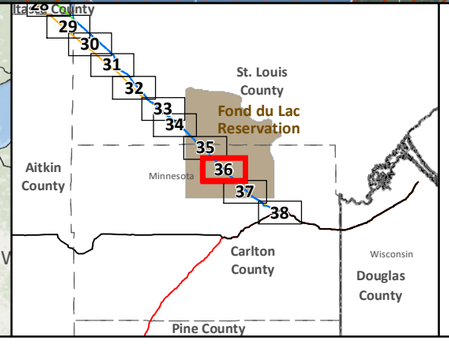
10ft Contours

N

Map 35B of 38

T49 R19W S12
T49 R18W S7
T49 R18W S8
T49 R18W S9
T49 R18W S10
T49 R18W S11
T49 R18W S12
Cedar Lake
RA-08
T49 R19W S13
T49 R18W S18
T49 R18W S17
T49 R18W S16
T49 R18W S15
T49 R18W S14
T49 R18W S13
RA-06
RA-07
North Carlton Twsp Carlton Co.
Perch Lake Twsp Carlton Co.
T49 R19W S24
T49 R18W S19
Fond du Lac Reservation
T49 R18W S20
T49 R18W S21
T49 R18W S22
T49 R18W S23
T49 R18W S24
294
292
295
293
296
297
298
Stoney Brook
Rice Portage Lake
T49 R19W S25
T49 R18W S30
Perch Lake
T49 R18W S29
Big Lake
T49 R18W S28
T49 R18W S27
T49 R18W S26
Otter Creek
T49 R18W S25
Sofie Lake





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines

- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse

- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

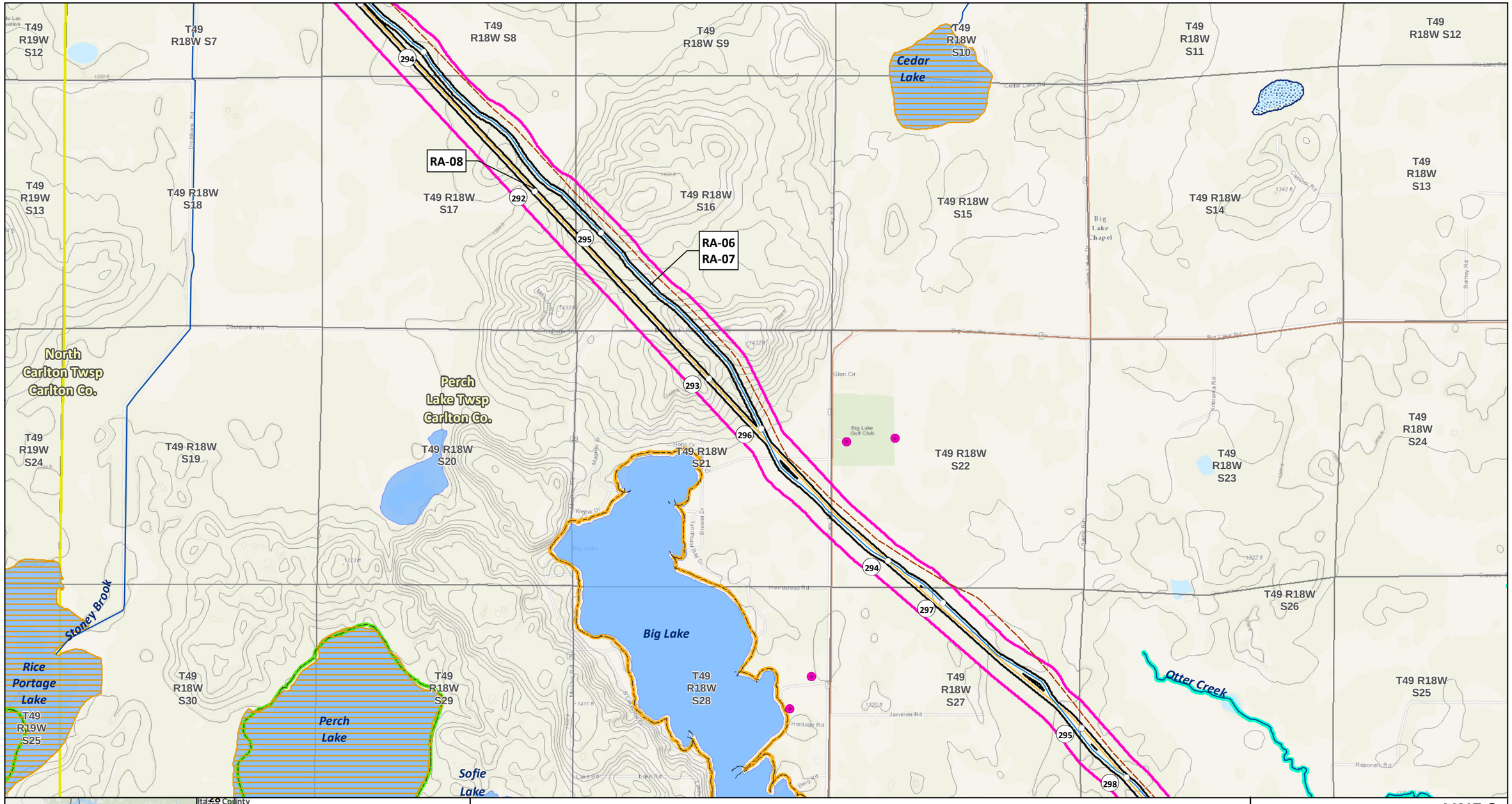
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

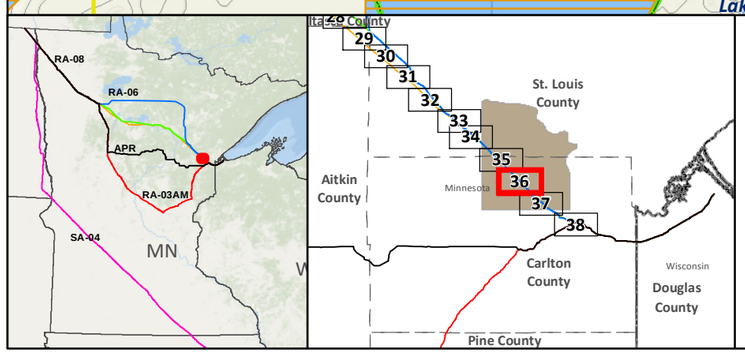
RA-07 AND RA-08

CLEARBROOK TO CARLTON

Map 36A of 38

N





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

- Terminal
- Pump Station

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

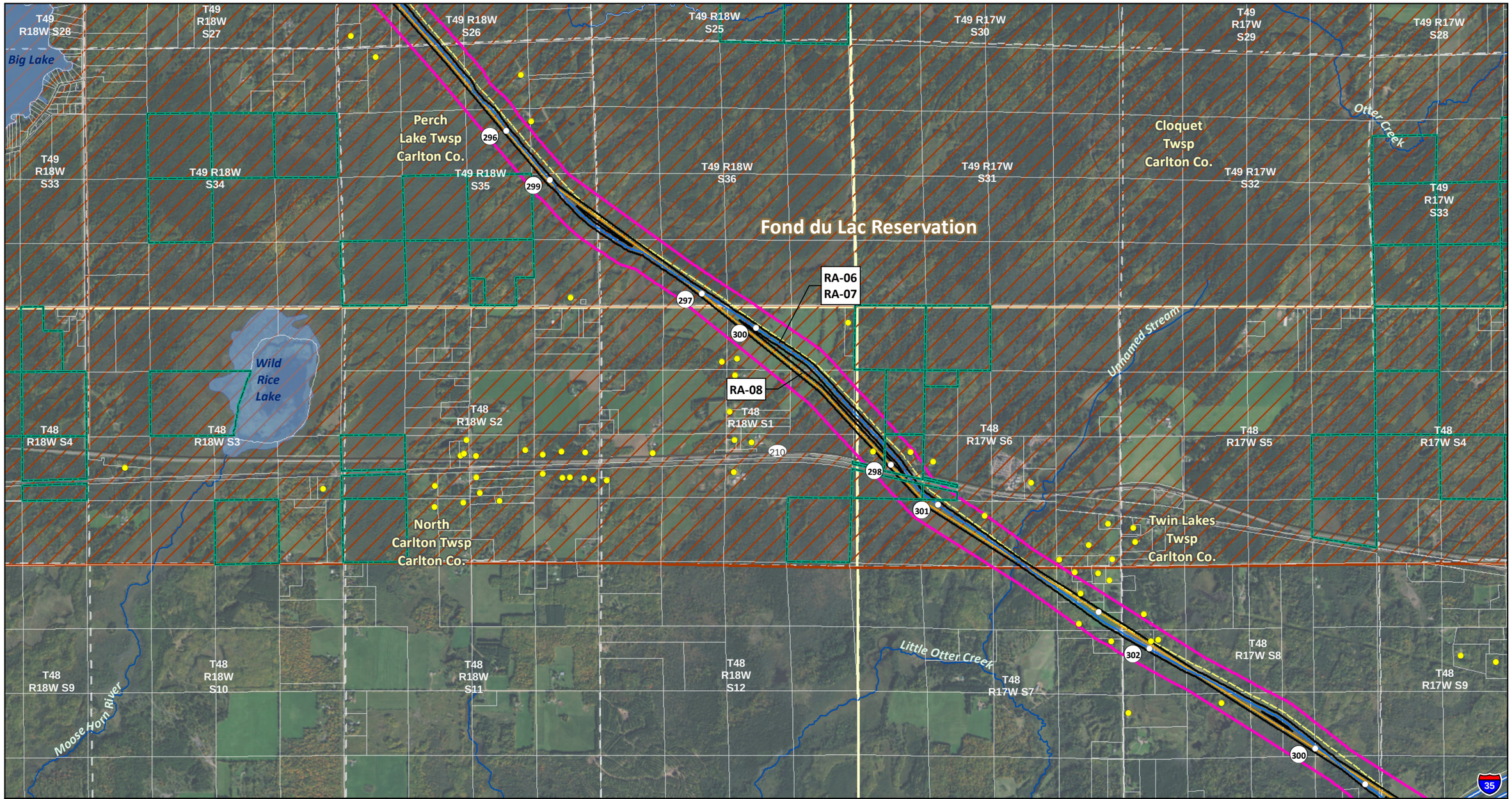
1:24,000

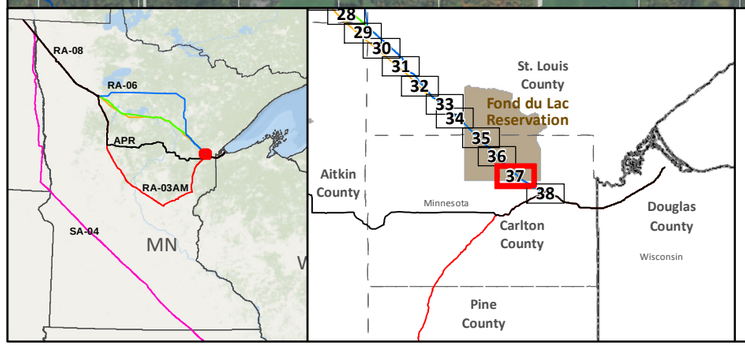
0 125 250 500 Meters

10ft Contours

N

Map 36B of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Existing Pipelines
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Parcels
- Public Water Basin
- Public Waters Watercourse
- Residences within 1/2 mile
- Mile Post
- Terminal
- Pump Station
- Interstate
- Highway
- Major Road
- Township Boundary

Data Sources: MNDNR, NHD, Enbridge

Land Ownership

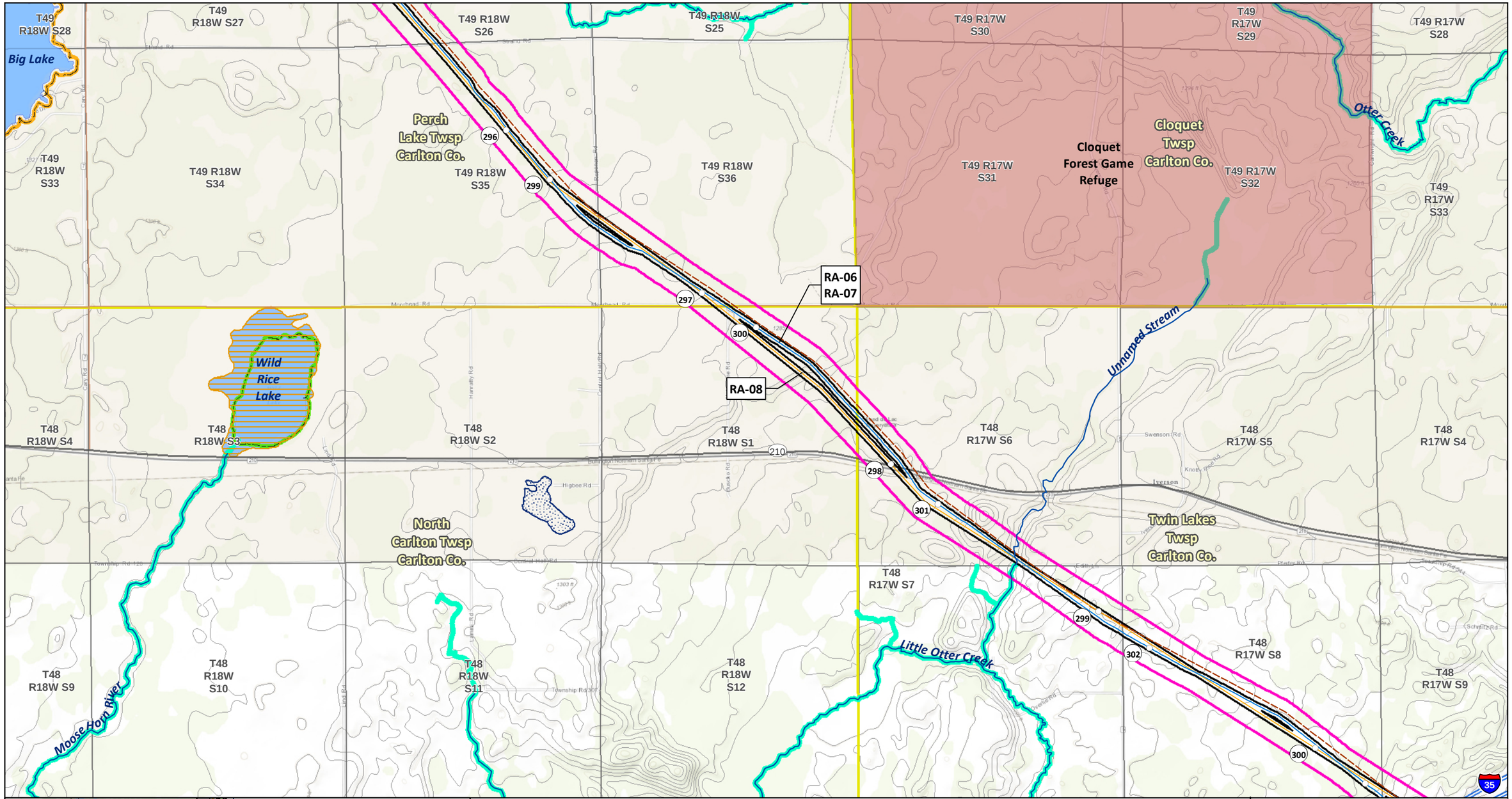
- State Forest
- National Forest
- Tribal Reservation
- Tribal Trust Land

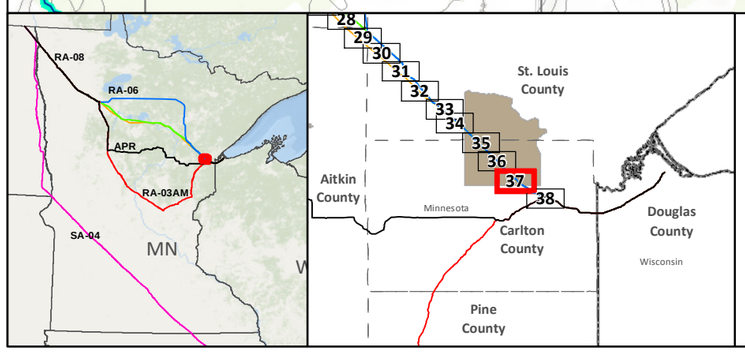
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 37A of 38





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles

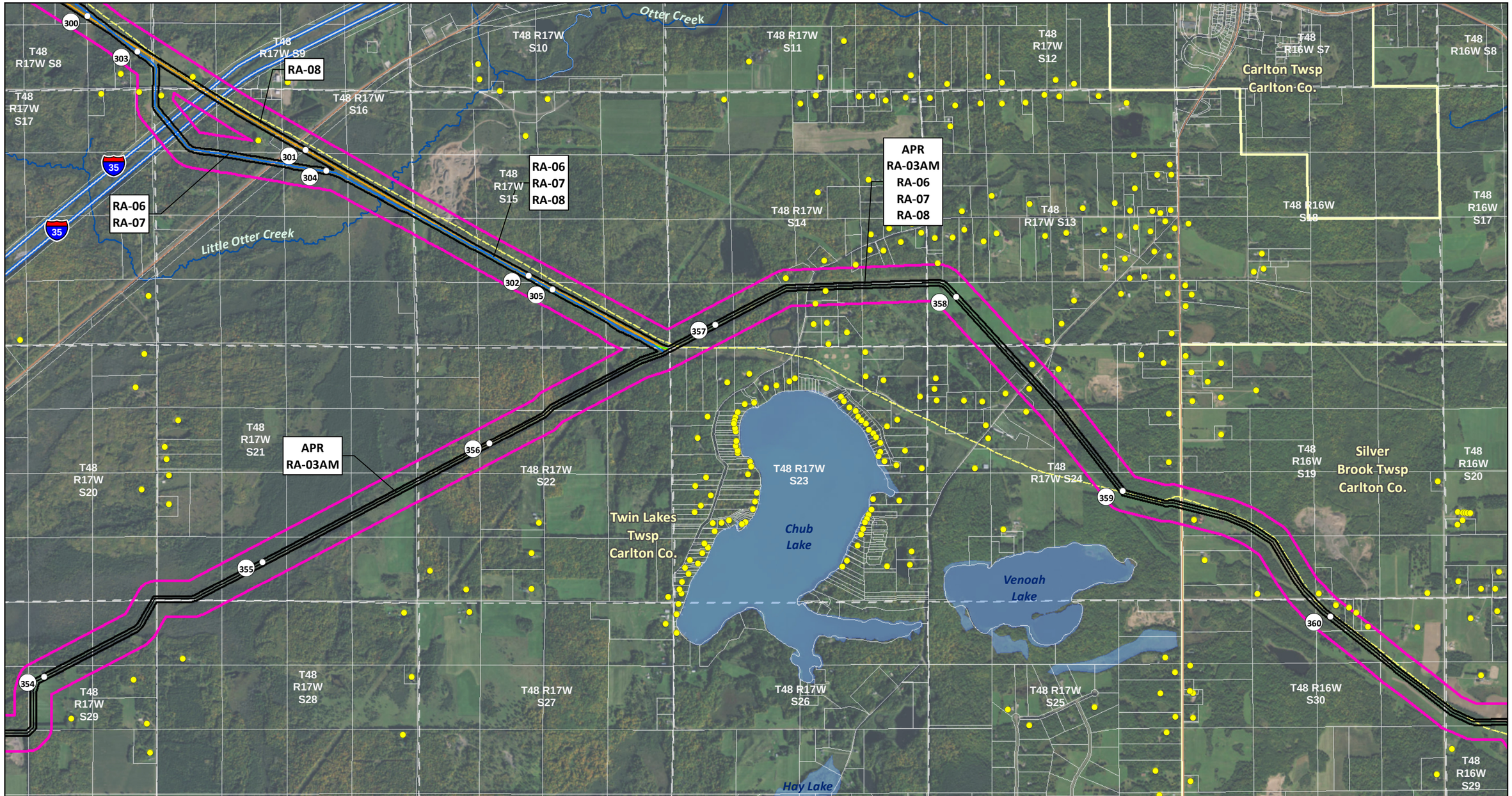
0 125 250 500 Meters

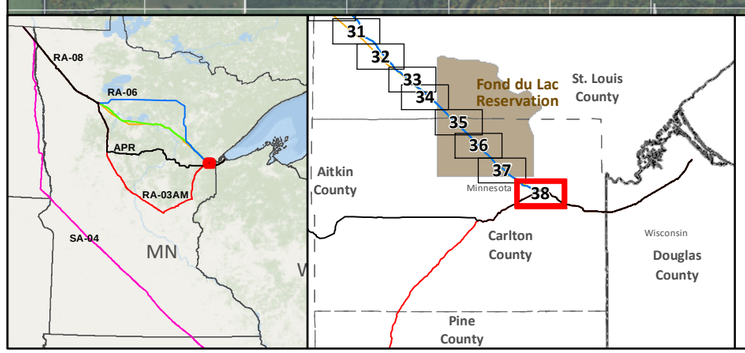
1:24,000

10ft Contours

N

Map 37B of 38





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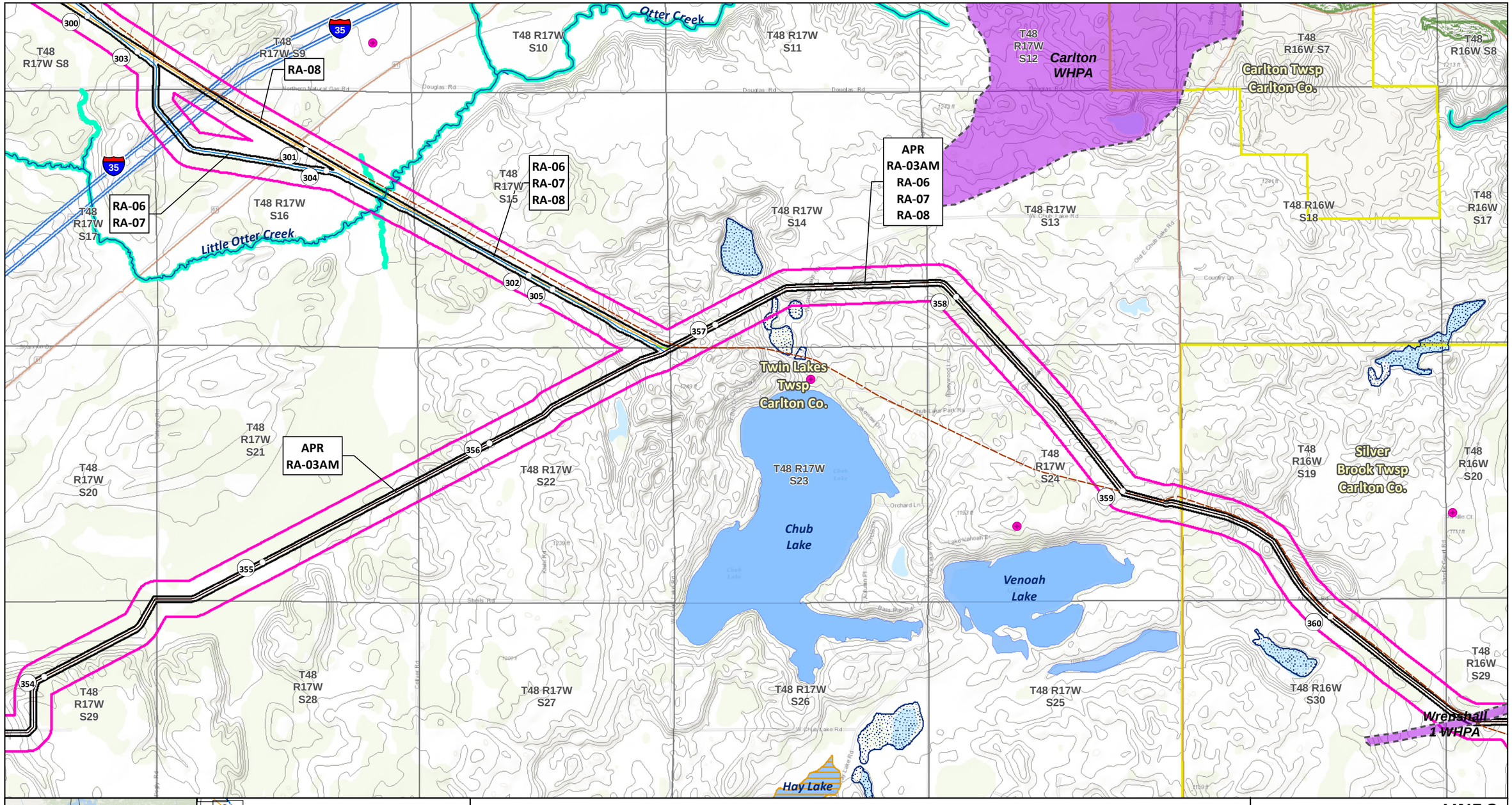
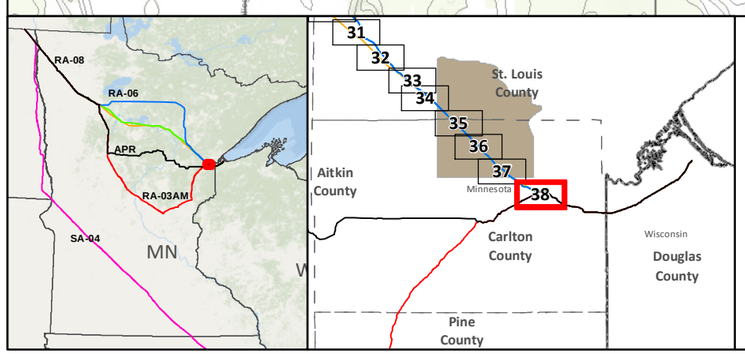
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

RA-07 AND RA-08 CLEARBROOK TO CARLTON

Map 38A of 38





SA-04
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RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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Terminal
Pump Station

Data Sources:
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

RA-07 AND RA-08

CLEARBROOK TO CARLTON

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 38B of 38

Minnesota Department of Commerce
Energy Environmental Review and Analysis

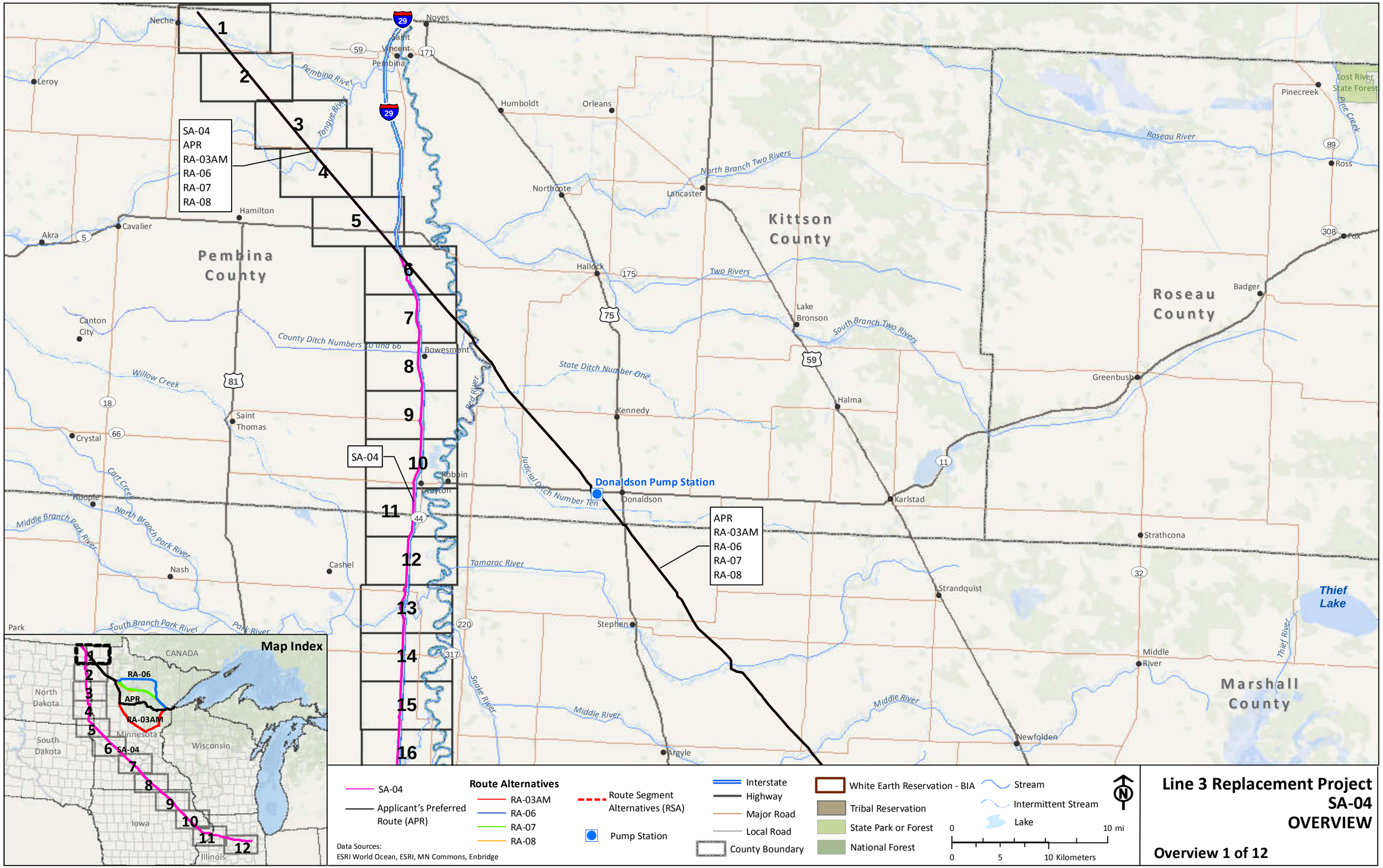
Draft Environmental Impact Statement
Line 3 Project

Mapbook
SA-04

Docket Nos. PPL-15-137/CN-14-916

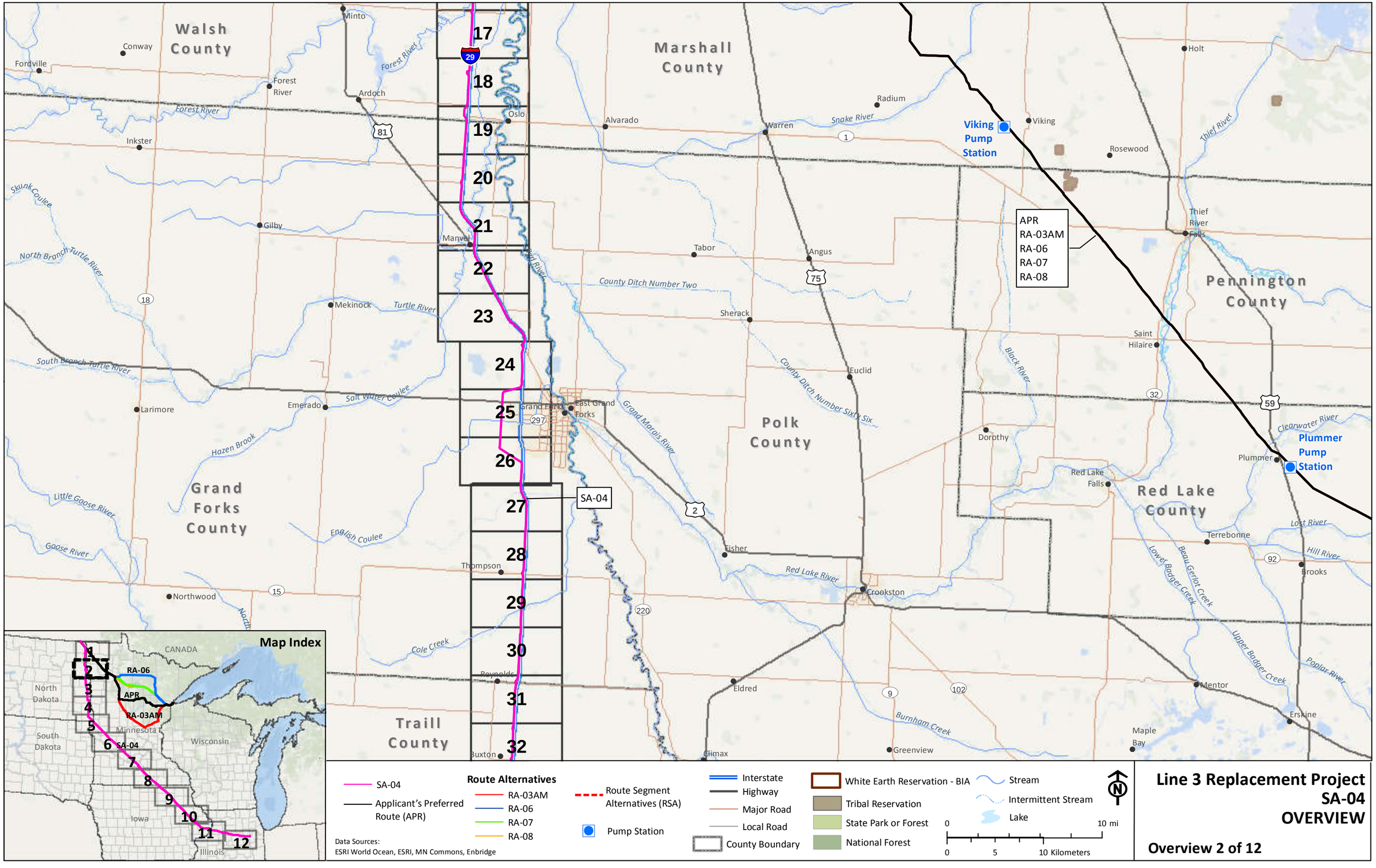
May 15, 2017

MINNESOTA



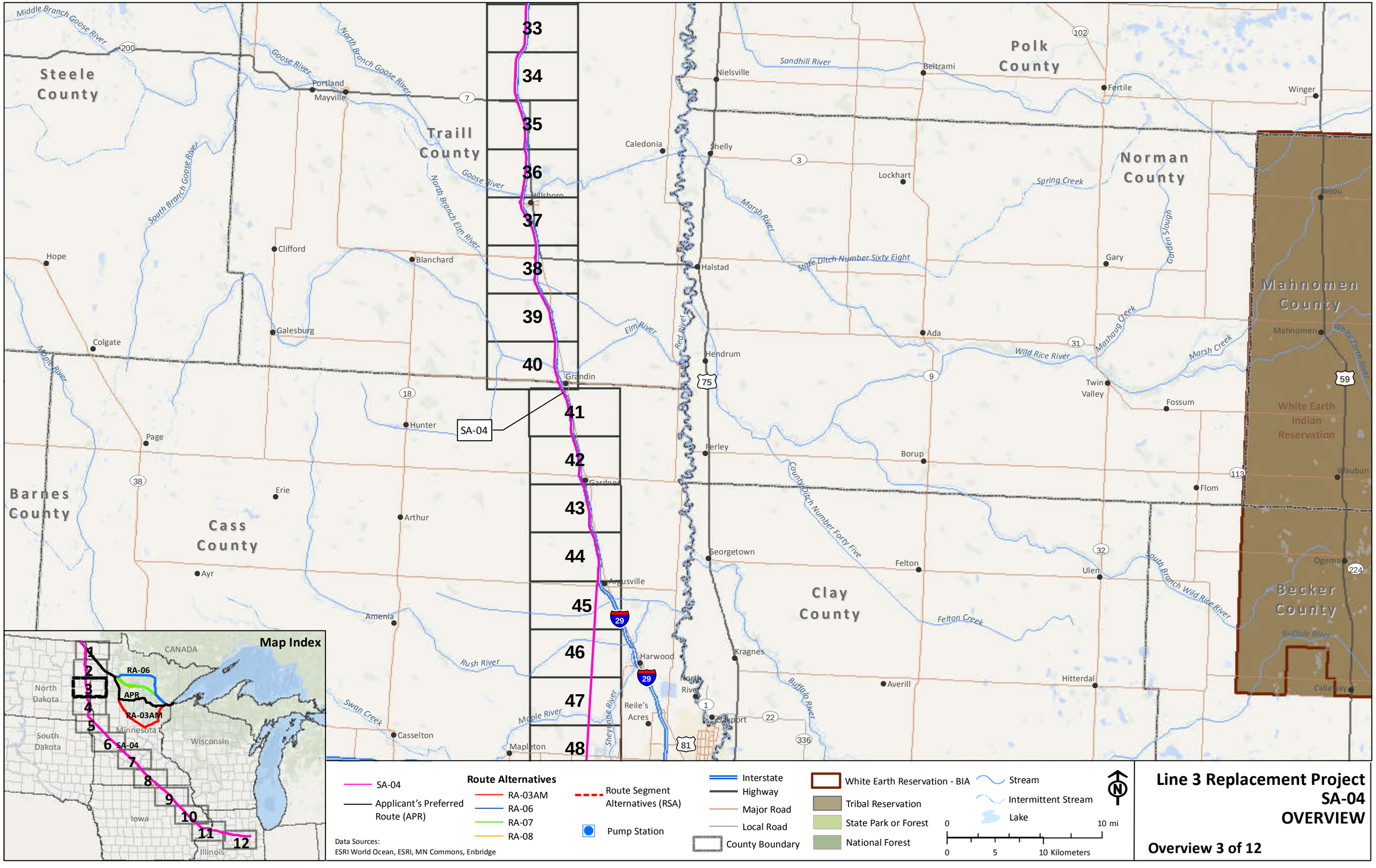
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 1 of 12



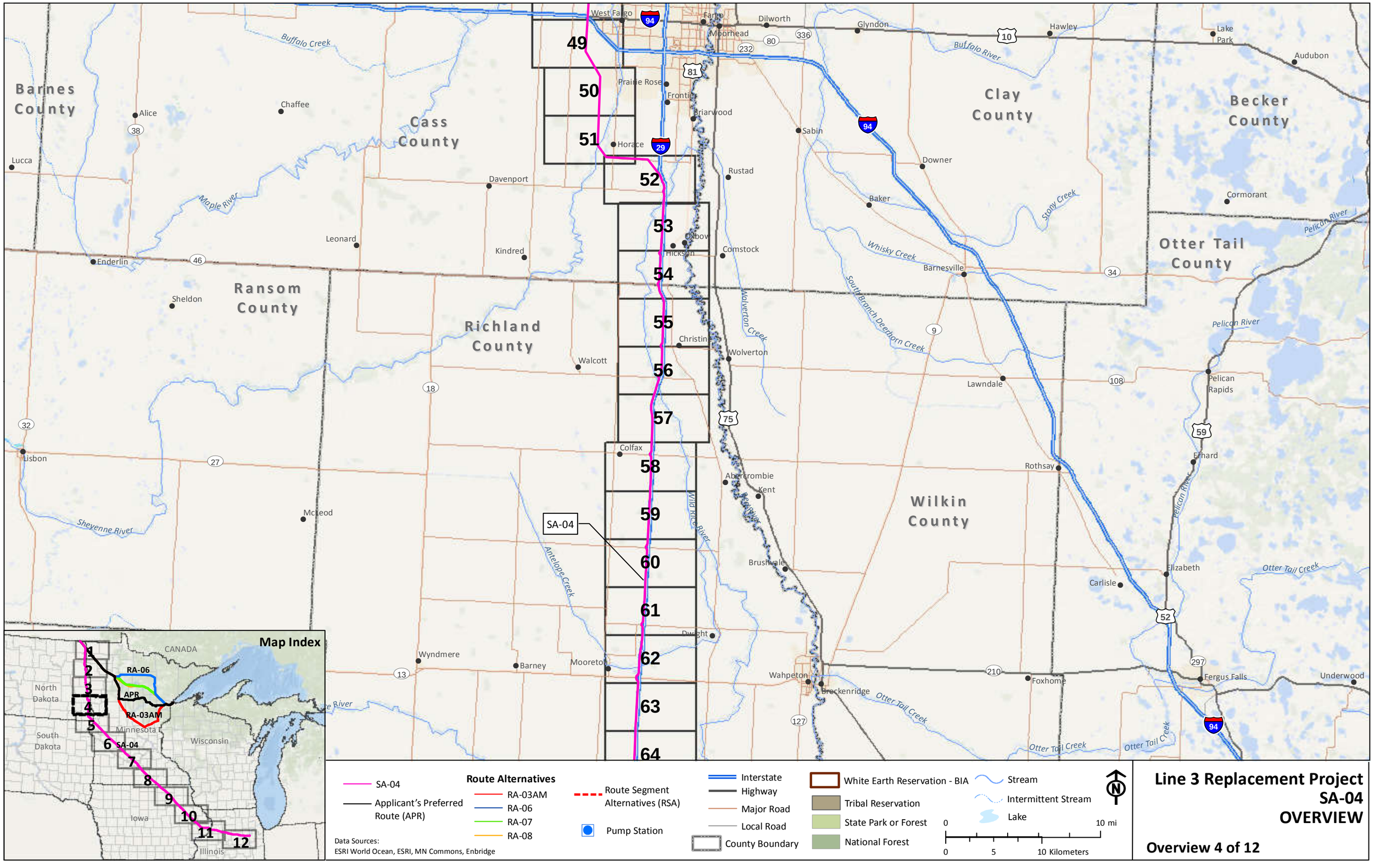
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 2 of 12



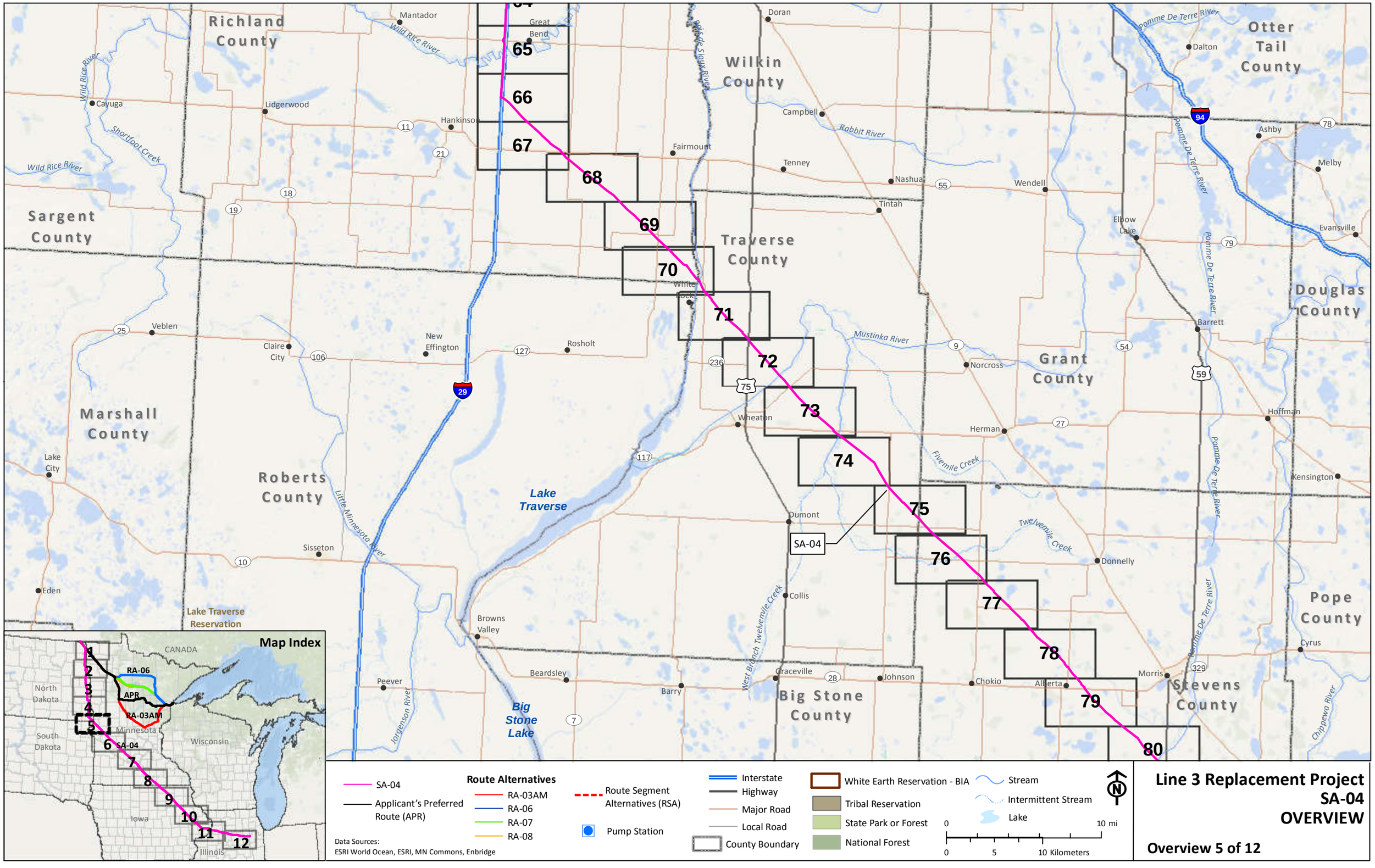
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 3 of 12



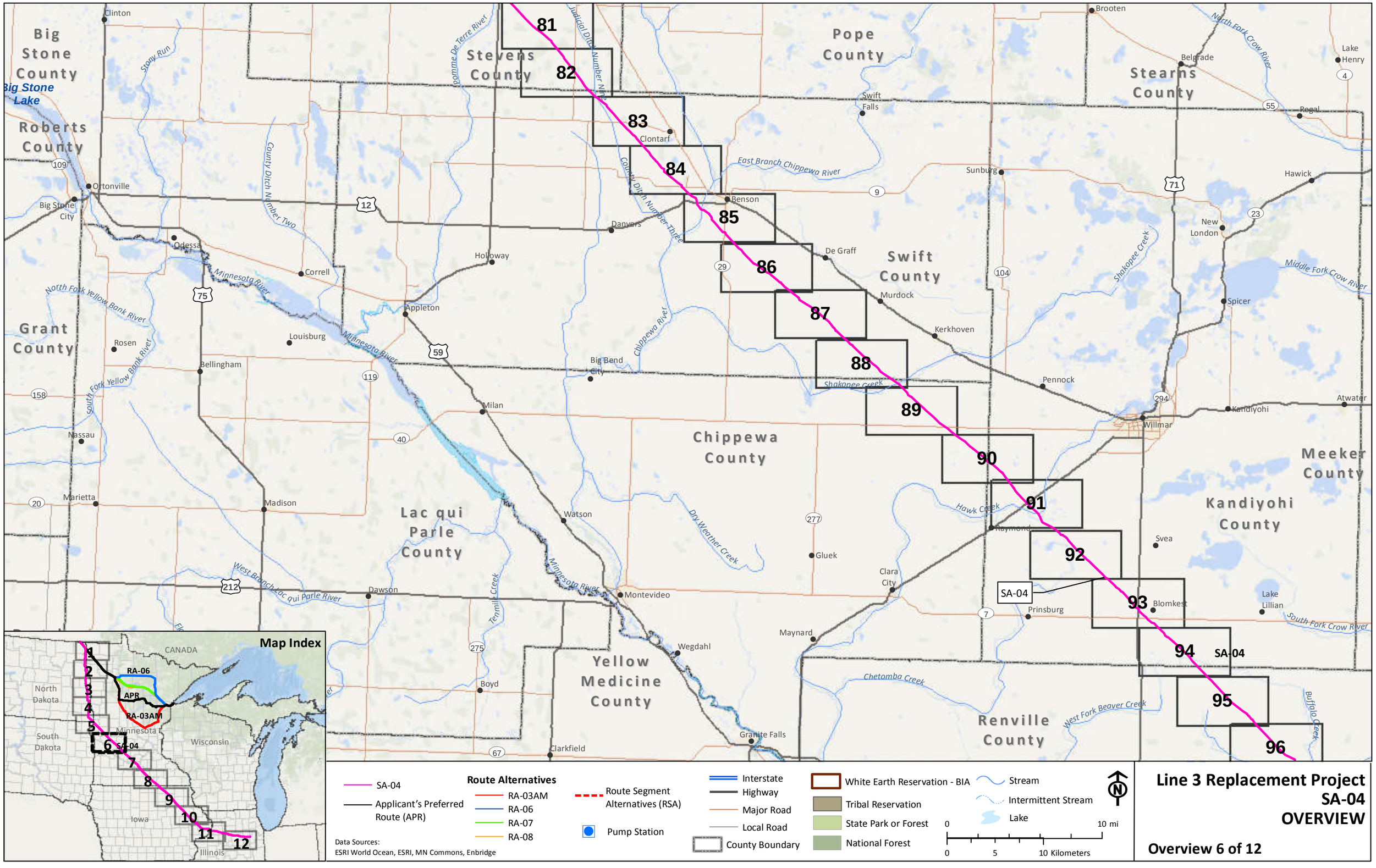
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 4 of 12



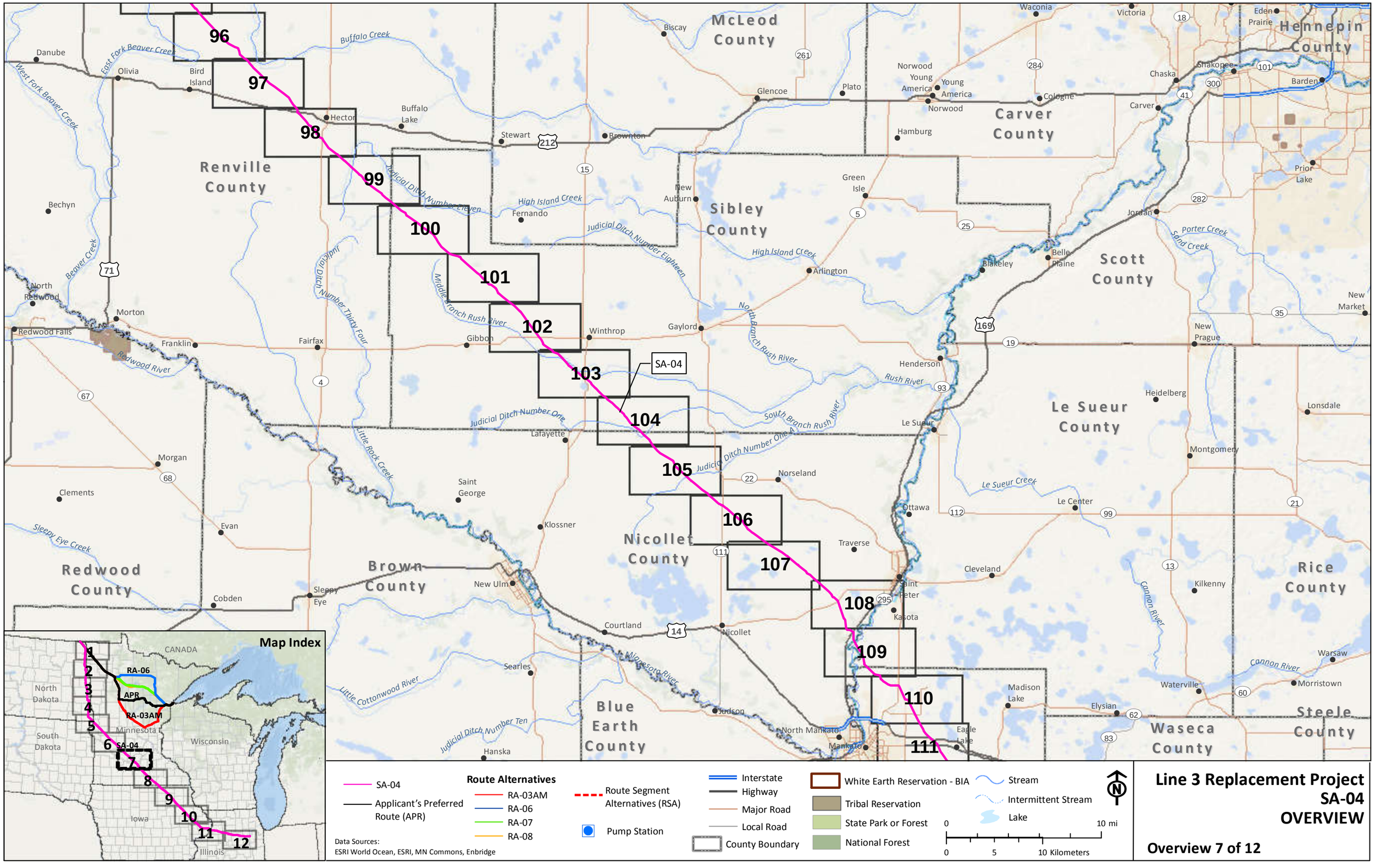
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 5 of 12



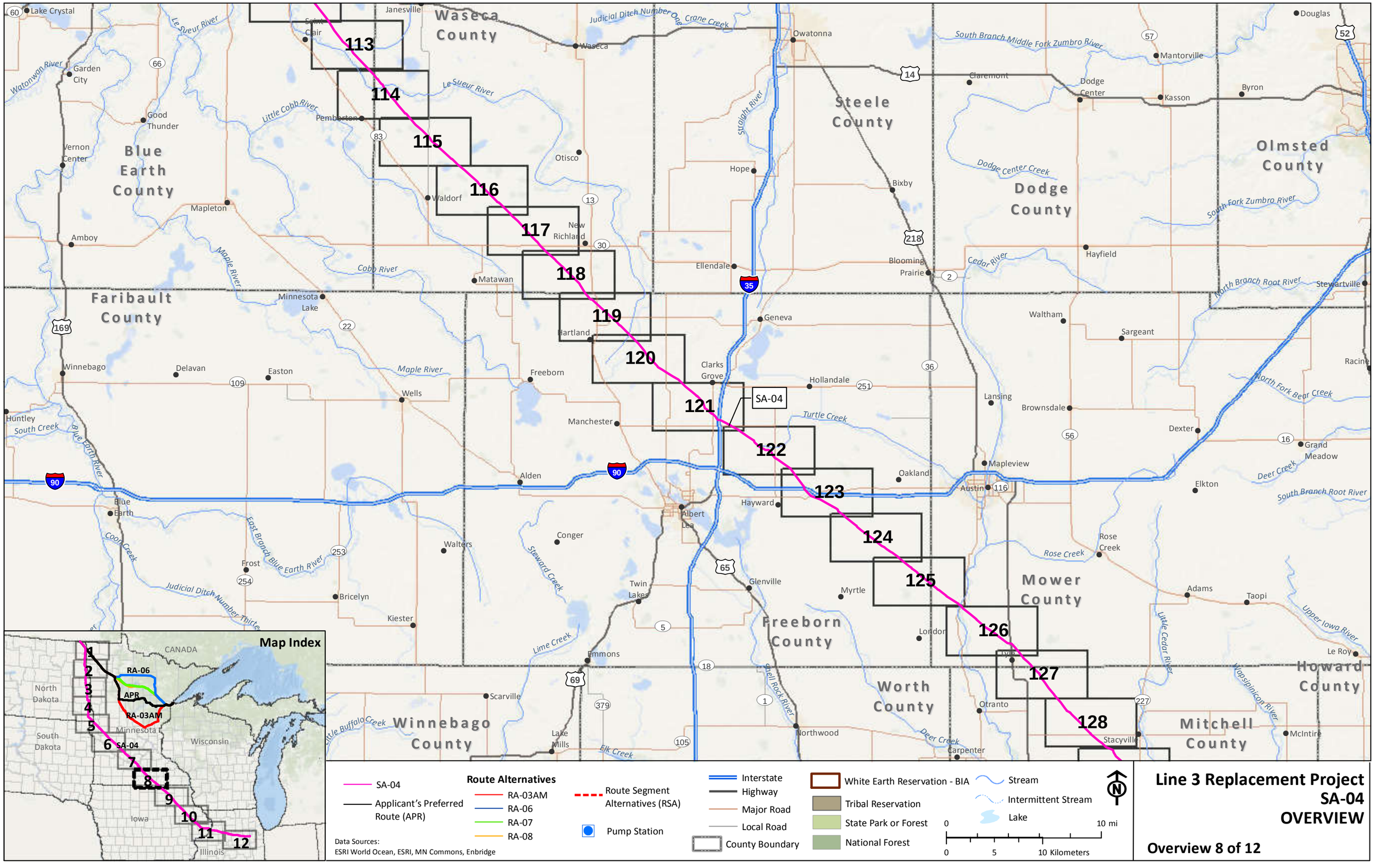
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 6 of 12



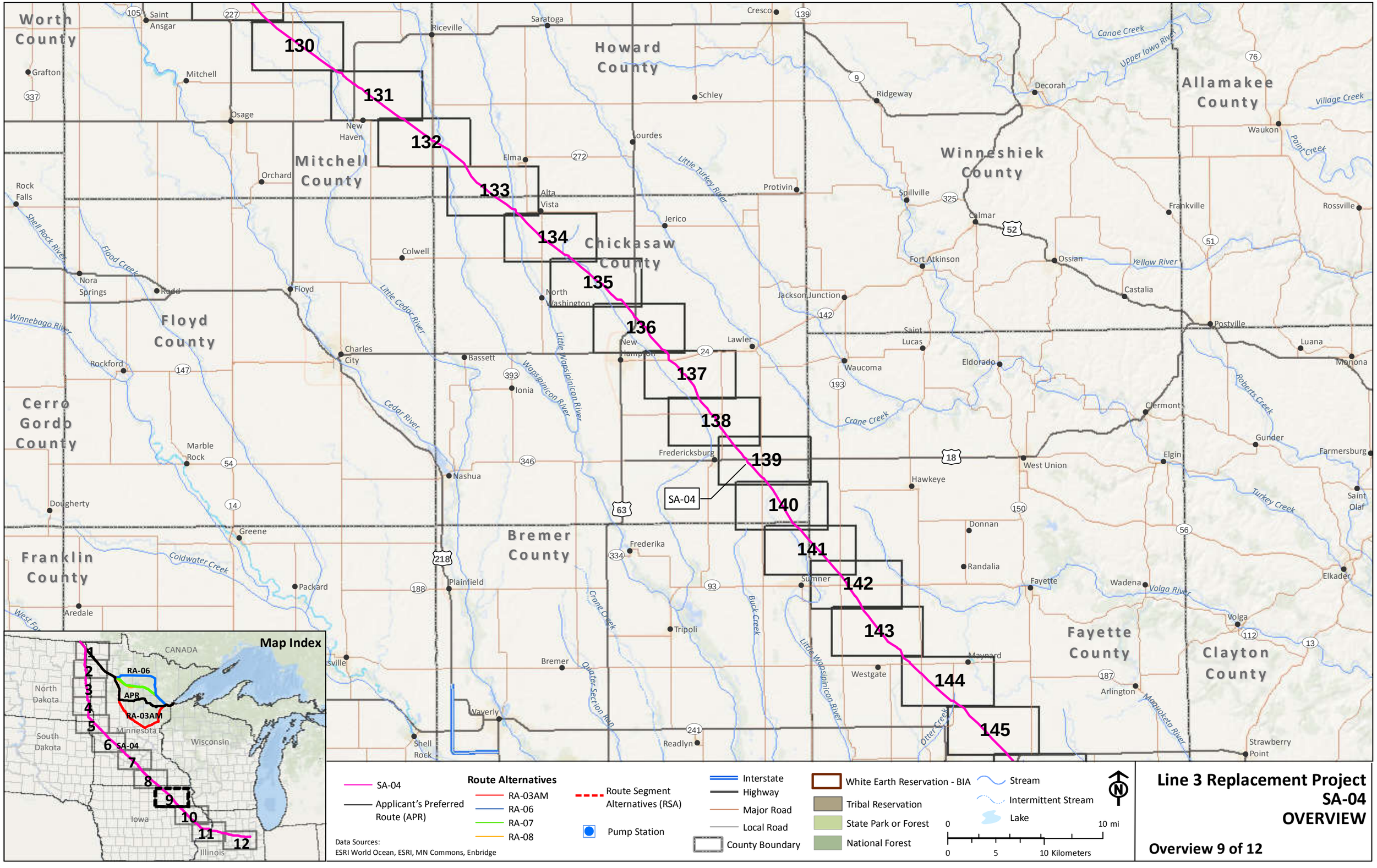
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 7 of 12



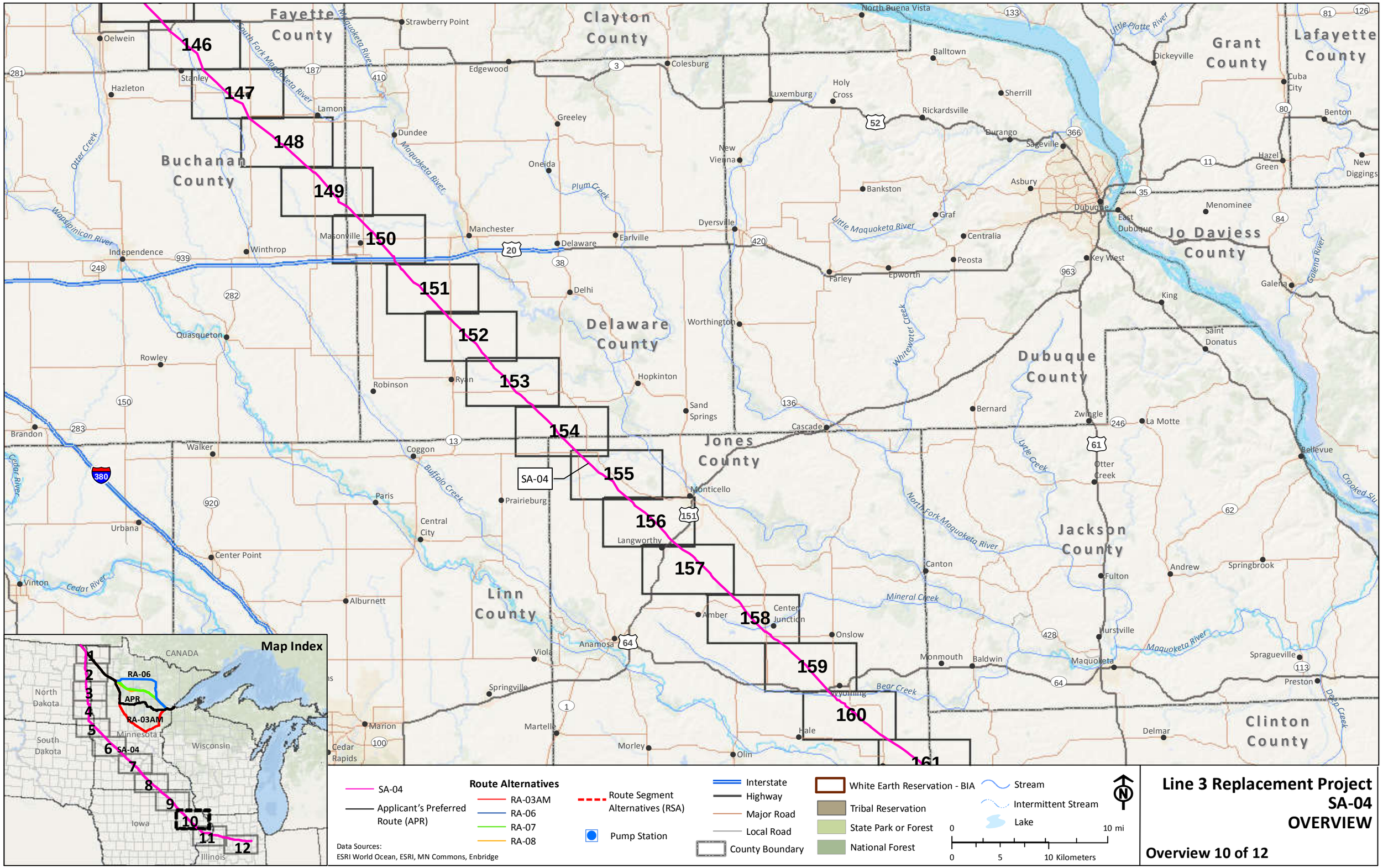
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 8 of 12



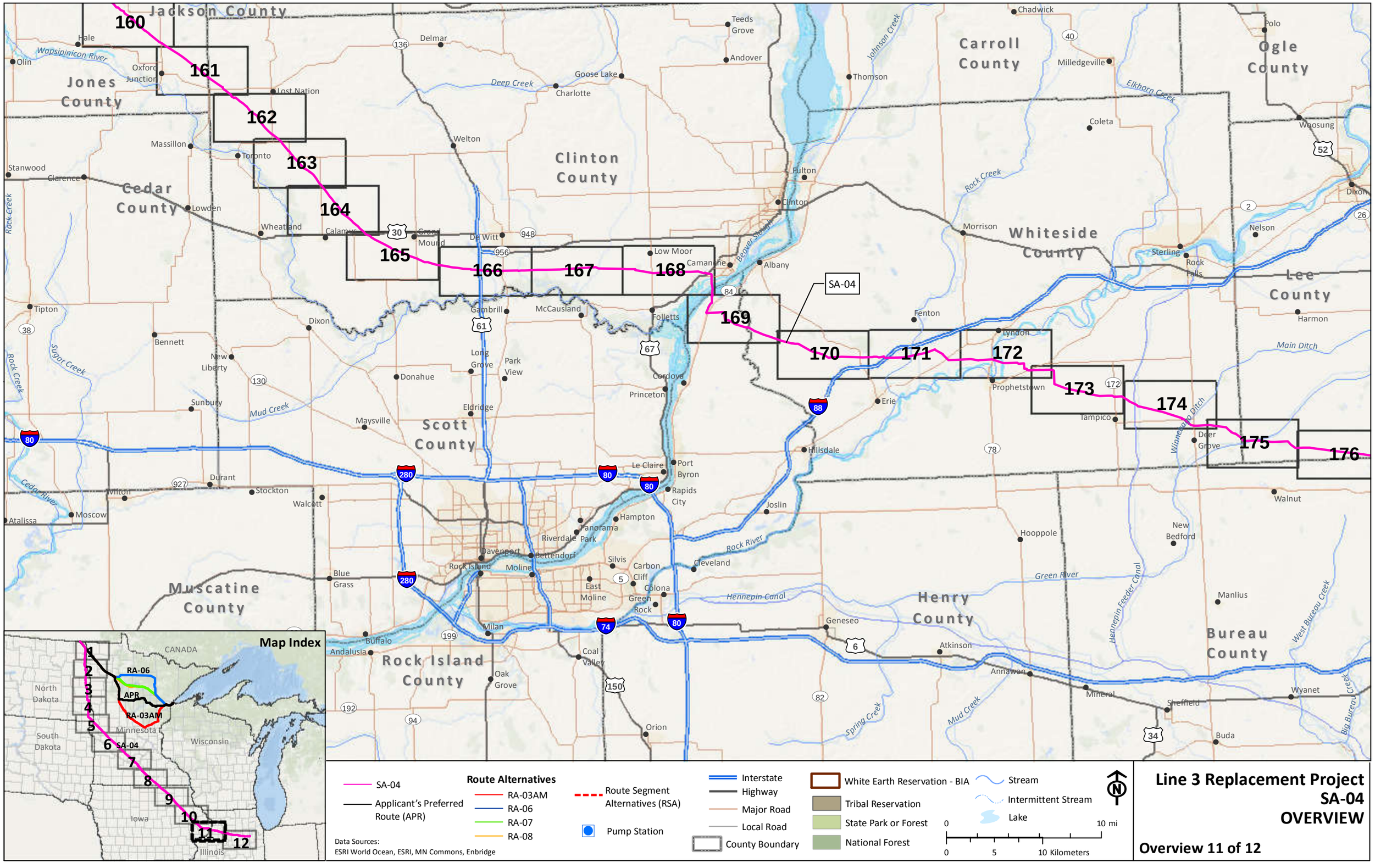
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 9 of 12



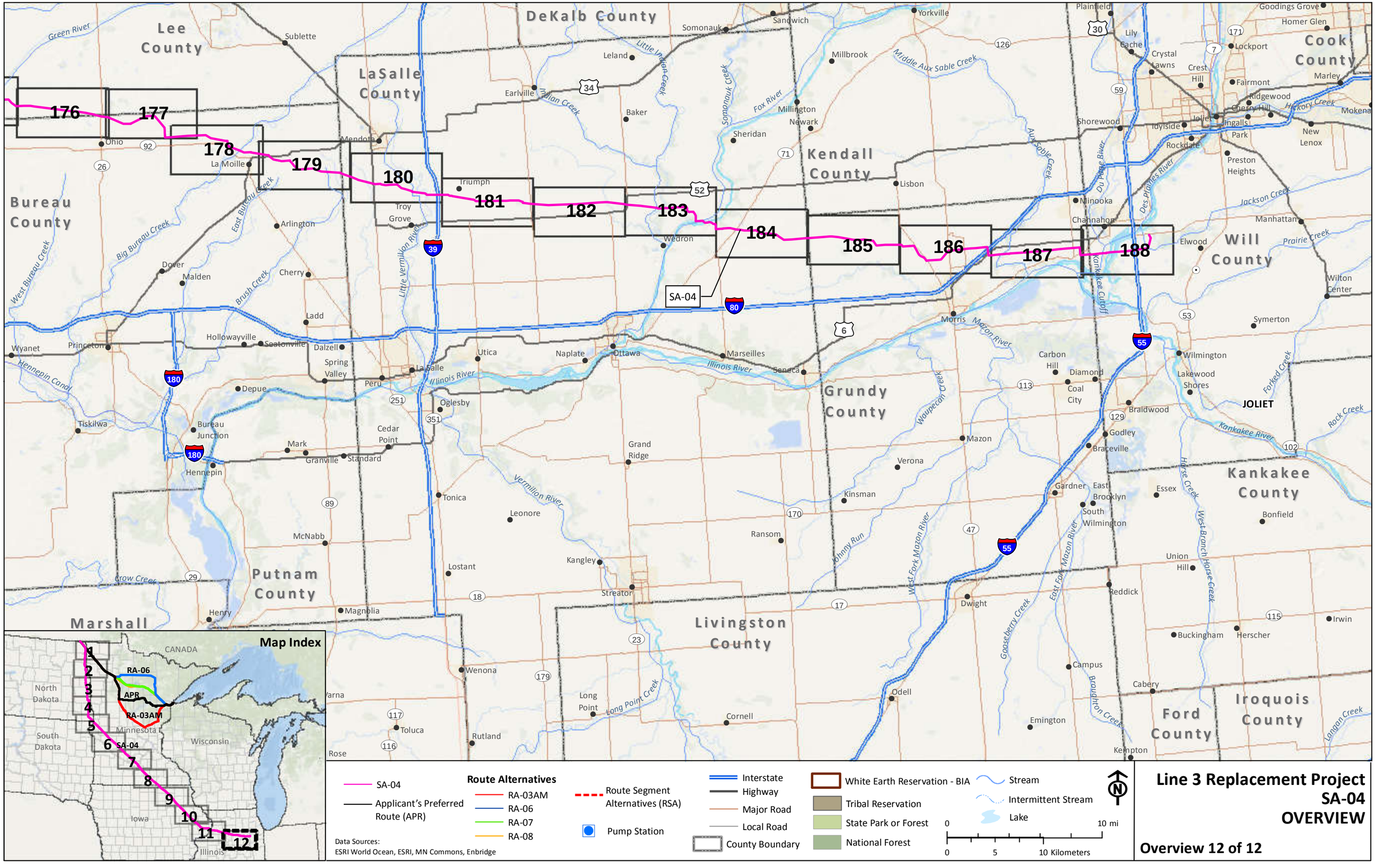
Line 3 Replacement Project
SA-04
OVERVIEW

Overview 10 of 12



Line 3 Replacement Project
SA-04
OVERVIEW

Overview 11 of 12



Line 3 Replacement Project
SA-04
OVERVIEW

Overview 12 of 12

CANADA

UNITED STATES

Neche Facility

T164N R53W S30

T164N R53W S29

T164N R53W S28

T164N R53W S27

T164N R53W S26

T164N R53W S25

T164N R52W S30

T164N R53W S31

T164N R53W S32

T164N R53W S33

T164N R53W S34

T164N R53W S35

T164N R53W S36

T164N R52W S31

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08

1

2

3

T163N R53W S6

T163N R53W S5

T163N R53W S4

T163N R53W S3

T163N R53W S2

T163N R53W S1

T163N R52W S6

Pembina River

107th

T163N R53W S7

T163N R53W S8

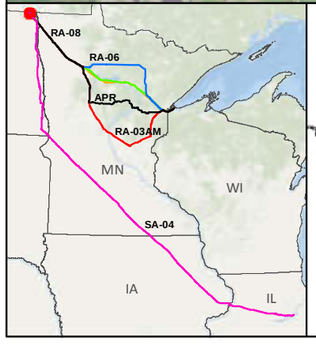
T163N R53W S9

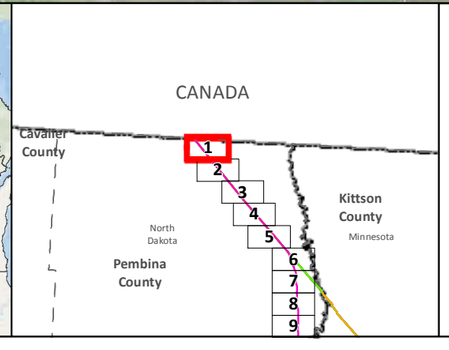
T163N R53W S10

T163N R53W S11

T163N R53W S12

55





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 1A of 188

N

CANADA

UNITED STATES

Neche Facility

T164N R53W S30 | T164N R53W S29 | T164N R53W S28 | T164N R53W S27 | T164N R53W S26 | T164N R53W S25 | T164N R52W S30

T164N R53W S31 | T164N R53W S32 | T164N R53W S33 | T164N R53W S34 | T164N R53W S35 | T164N R53W S36 | T164N R52W S31

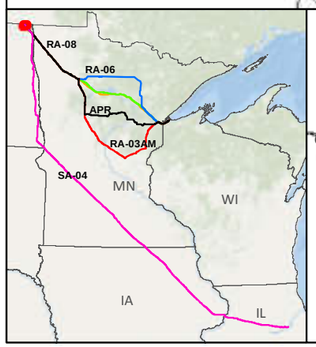
T163N R53W S6 | T163N R53W S5 | T163N R53W S4 | T163N R53W S3 | T163N R53W S2 | T163N R53W S1 | T163N R52W S6

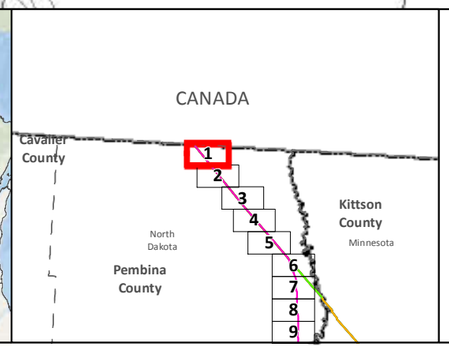
T163N R53W S7 | T163N R53W S8 | T163N R53W S9 | T163N R53W S10 | T163N R53W S11 | T163N R53W S12

Pembina River

1 2 3

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08





SA-04

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RA-06
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Mile Post

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Route Width (750')

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Moderate

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Moderate

Data Sources:
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 1B of 188

T163N R52W S5

T163N R53W S1

T163N R52W S6

T163N R53W S8

T163N R53W S9

T163N R53W S10

T163N R53W S11

T163N R53W S12

T163N R52W S7

T163N R52W S8

Pembina River

Pembina River

4

5

6

7

T163N R53W S17

T163N R53W S16

T163N R53W S15

T163N R53W S14

T163N R53W S13

T163N R52W S18

T163N R52W S17

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08

T163N R53W S20

T163N R53W S21

T163N R53W S22

T163N R53W S23

T163N R53W S24

T163N R52W S19

T163N R52W S20

T163N R53W S29

T163N R53W S28

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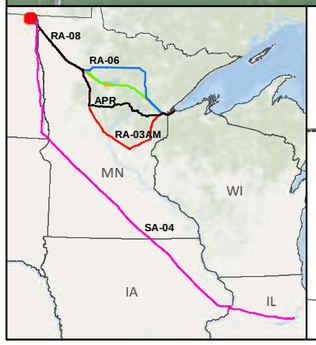
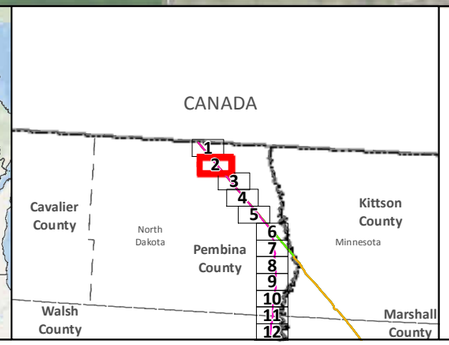
T163N R53W S26

T163N R53W S25

T163N R52W S30

T163N R52W S29





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0 0.125 0.25 0.5 Miles

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0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 2A of 188

T163N R53W S8
T163N R53W S9
T163N R53W S10
T163N R53W S11
T163N R53W S12
T163N R53W S1
T163N R52W S6
T163N R52W S5
Pembina River
T163N R52W S7
T163N R52W S8
T163N R53W S17
T163N R53W S16
T163N R53W S15
T163N R53W S14
T163N R53W S13
T163N R52W S18
T163N R52W S17
APR
SA-04
RA-03AM
RA-06
RA-07
RA-08
T163N R53W S20
T163N R53W S21
T163N R53W S22
T163N R53W S23
T163N R53W S24
T163N R52W S19
T163N R52W S20
T163N R53W S29
T163N R53W S28
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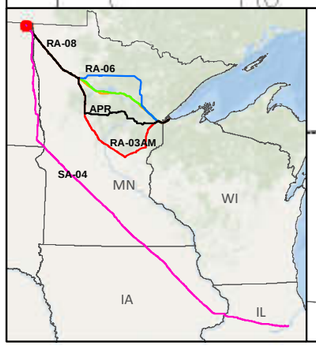
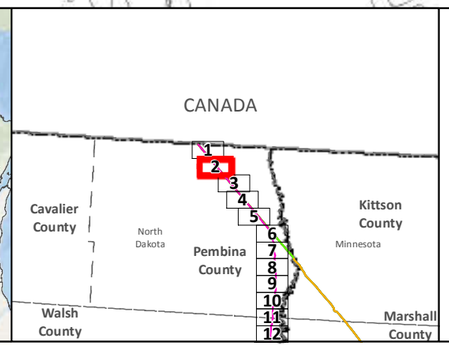
T163N R52W S30
T163N R52W S29





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- RA-06
- RA-07
- RA-08
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

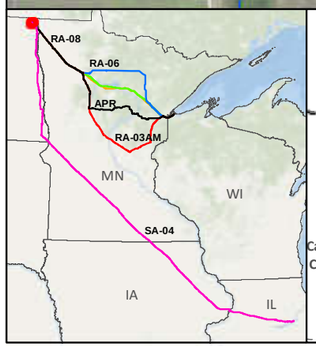
SA-04

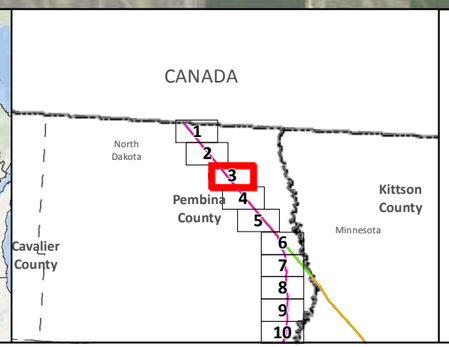
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 2B of 188

T163N R52W S20
T163N R52W S21
T163N R52W S22
T163N R52W S23
T163N R52W S24
T163N R53W S25
T163N R52W S30
T163N R52W S29
T163N R52W S28
T163N R52W S27
T163N R52W S26
T163N R52W S25
APR
SA-04
RA-03AM
RA-06
RA-07
RA-08
T163N R53W S36
T163N R52W S31
T163N R52W S32
T163N R52W S33
T163N R52W S34
T163N R52W S35
T163N R52W S36
Tongue River
T162N R53W S1
T162N R52W S6
T162N R52W S5
T162N R52W S4
T162N R52W S3
T162N R52W S2
T162N R52W S1
T162N R53W S12
T162N R52W S7
T162N R52W S8
T162N R52W S9
T162N R52W S10
Tongue River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

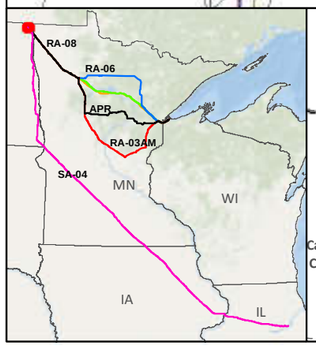
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

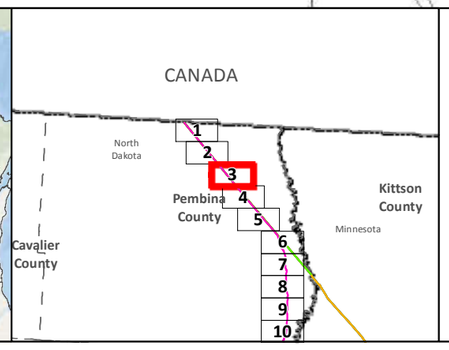
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 3A of 188

T163N R52W S20
T163N R52W S21
T163N R52W S22
T163N R52W S23
T163N R52W S24
T163N R53W S25
T163N R52W S30
T163N R52W S29
T163N R52W S28
T163N R52W S27
T163N R52W S26
T163N R52W S25
APR
SA-04
RA-03AM
RA-06
RA-07
RA-08
T163N R53W S36
T163N R52W S31
T163N R52W S32
T163N R52W S33
T163N R52W S34
T163N R52W S35
T163N R52W S36
Tongue River
T162N R53W S1
T162N R52W S6
T162N R52W S5
T162N R52W S4
T162N R52W S3
T162N R52W S2
T162N R52W S1
T162N R53W S12
T162N R52W S7
T162N R52W S8
T162N R52W S9
T162N R52W S10





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

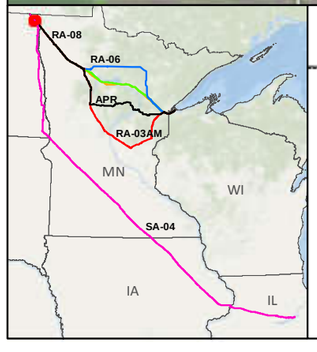
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

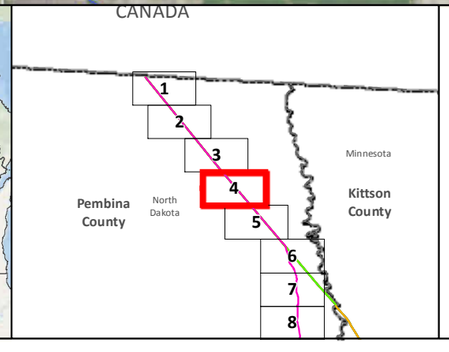
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 3B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

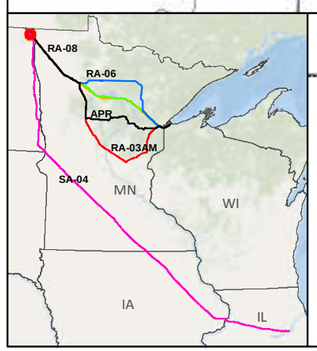
SA-04

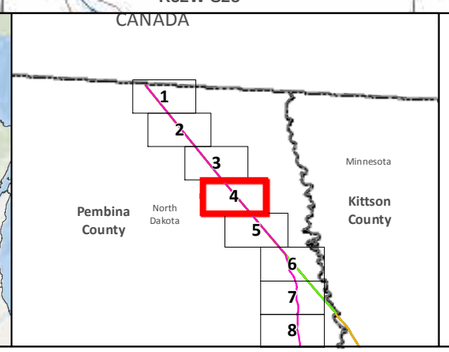
Map 4A of 188

T162N R52W S3
T162N R52W S2
T162N R52W S1
T162N R51W S6
T162N R52W S8
Tongue River
T162N R52W S9
T162N R52W S10
T162N R52W S11
T162N R52W S12
T162N R51W S7
T162N R51W S8
T162N R52W S17
T162N R52W S16
T162N R52W S15
T162N R52W S14
T162N R52W S13
T162N R51W S18
T162N R51W S17
T162N R52W S20
Big Slough
T162N R52W S21
T162N R52W S22
T162N R52W S23
T162N R52W S24
T162N R51W S19
T162N R52W S29
T162N R52W S28
T162N R52W S27
T162N R52W S26
T162N R51W S20

APR
SA-04
RA-03AM
RA-06
RA-07
RA-08

12
13
14
15





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
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Mile Post
Anticipated 120' Construction ROW
Route Width (750')

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303d Imparied Waters
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Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 4B of 188

T162N R52W S23
T162N R52W S24
T162N R51W S19
T162N R51W S20
T162N R51W S21
T162N R51W S22
T162N R52W S27
T162N R52W S26
T162N R52W S25
T162N R51W S30
T162N R51W S29
T162N R51W S28
T162N R51W S27
APR
SA-04
RA-03AM
RA-06
RA-07
RA-08
T162N R52W S34
T162N R52W S35
T162N R52W S36
T162N R51W S31
T162N R51W S32
T162N R51W S33
T162N R51W S34
T161N R52W S3
T161N R52W S2
T161N R52W S1
T161N R51W S6
T161N R51W S5
T161N R51W S4
T161N R51W S3
T161N R52W S10
T161N R52W S11
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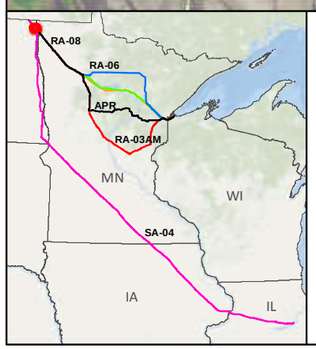
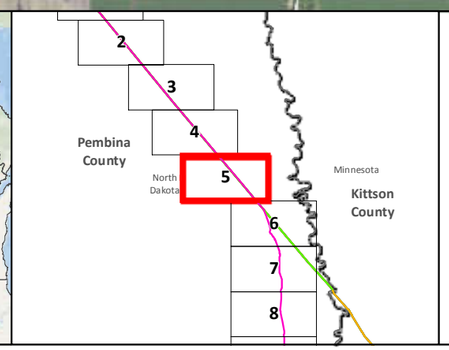
T161N R51W S8
Old
16
17
18
19
29
81
5





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 5A of 188

T162N R52W S23
T162N R52W S24
T162N R51W S19
T162N R51W S20
T162N R51W S21
T162N R51W S22
T162N R52W S27
T162N R52W S26
T162N R52W S25
T162N R51W S30
T162N R51W S29
T162N R51W S28
T162N R51W S27
APR
SA-04
RA-03AM
RA-06
RA-07
RA-08
T162N R52W S34
T162N R52W S35
T162N R52W S36
T162N R51W S31
T162N R51W S32
T162N R51W S33
T162N R51W S34
T161N R52W S3
T161N R52W S2
T161N R52W S1
T161N R51W S6
T161N R51W S5
T161N R51W S4
T161N R51W S3
T161N R52W S10
T161N R52W S11
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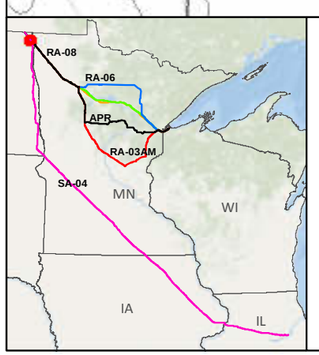
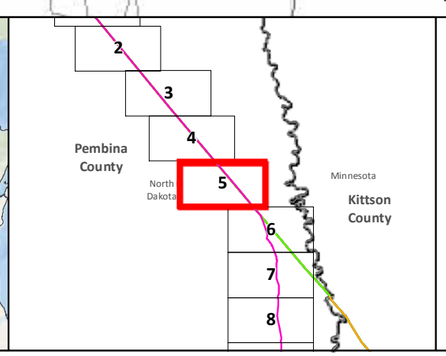
T161N R51W S7
T161N R51W S8
16
17
18
19
81
29
5





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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Wildlife Refuge Inventory
SNA - Scientific and Natural Area

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Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

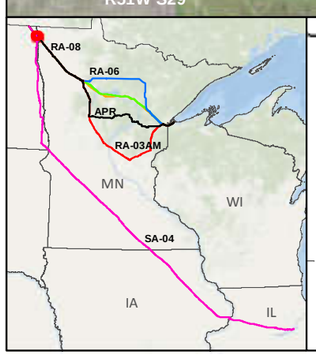
SA-04

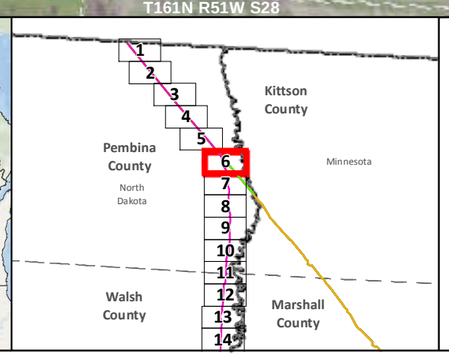
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 5B of 188

T161N R51W S4
T161N R51W S3
T161N R51W S2
T161N R51W S1
Red River of the North
T161N R50W S6
North Red River Twsp Kittson Co.
T161N R51W S8
T161N R51W S9
T161N R51W S10
T161N R51W S11
T161N R51W S12
T161N R51W S7
T161N R50W S7
T161N R51W S18
APR
RA-03AM
RA-06
RA-07
RA-08
T161N R51W S17
T161N R51W S16
T161N R51W S15
T161N R51W S14
T161N R51W S13
T161N R50W S18
SA-04
T161N R51W S20
T161N R51W S21
T161N R51W S22
T161N R51W S23
T161N R51W S24
T161N R50W S19
T161N R51W S29
T161N R51W S28
T161N R51W S27





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources:
MNDNR, NHD,USGS, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 6A of 188

T161N R51W S4
T161N R51W S3
T161N R51W S2
T161N R51W S1
T161 R50W S6
Red River
T161 R50W S5
T161 R50W S4
T161N R50W S6
North Red River Twsp Kittson Co.
T161 R50W S8
T161N R51W S8
T161N R51W S9
T161N R51W S10
T161N R51W S11
T161N R51W S12
T161N R51W S7
T161N R50W S7
T161N R51W S18
Red River of the North
T161 R50W S9
T161 R50W S8
T161 R50W S17
APR
RA-03AM
RA-06
RA-07
RA-08
T161N R51W S17
T161N R51W S16
T161N R51W S15
T161N R51W S14
T161N R51W S13
T161 R50W S16
T161N R50W S18
SA-04
T161N R51W S20
T161N R51W S21
T161N R51W S22
T161N R51W S23
T161N R51W S24
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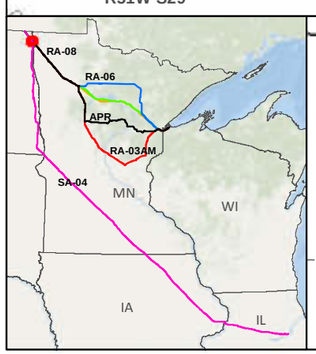
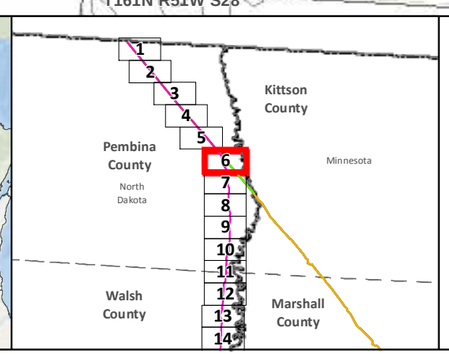
T161N R51W S27





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 6B of 188

T161N R51W S22
T161N R51W S23
T161N R51W S24
T161N R50W S19
T161N R51W S29
T161N R51W S28
T161N R51W S27
T161N R51W S26
T161N R51W S25
T161N R50W S30
T161N R51W S32
T161N R51W S33
T161N R51W S34
T161N R51W S35
T161N R51W S36
T161N R50W S31
T161N R50W S32
T160N R51W S6
T160N R51W S5
T160N R51W S4
T160N R51W S3
T160N R51W S2
T160N R51W S1
T160N R50W S6
T160N R51W S7
T160N R51W S8
T160N R51W S9
T160N R51W S10
T160N R51W S11
24
25
26
29
SA-04

APR
RA-03AM
RA-06
RA-07
RA-08

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

1
2
3
4
5
6
7
8
9
10
11
12
13
14
Kittson County
Pembina County
North Dakota
Minnesota
Walsh County
Marshall County

SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
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Highway
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Lake
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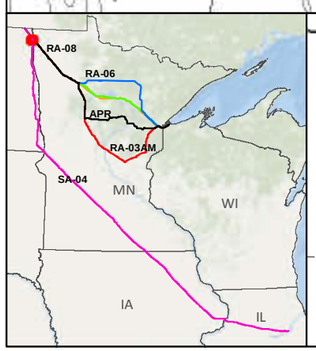
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

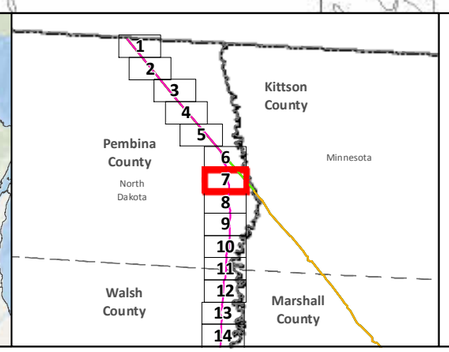
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 7A of 188

T161N R51W S22
T161N R51W S23
T161N R51W S24
T161N R50W S19
T161N R51W S29
T161N R51W S28
T161N R51W S27
T161N R51W S26
T161N R51W S25
T161N R50W S30
T161 R50W S28
SA-04
24
T161N R51W S32
T161N R51W S33
T161N R51W S34
T161N R51W S35
T161N R51W S36
T161N R50W S31
25
APR
RA-03AM
RA-06
RA-07
RA-08
T161N R50W S32
T160N R51W S6
T160N R51W S5
T160N R51W S4
T160N R51W S3
T160N R51W S2
T160N R51W S1
T160N R50W S6
26
29
T160N R51W S7
T160N R51W S8
T160N R51W S9
T160N R51W S10
T160N R51W S11
Red River





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

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Township Boundary

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Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

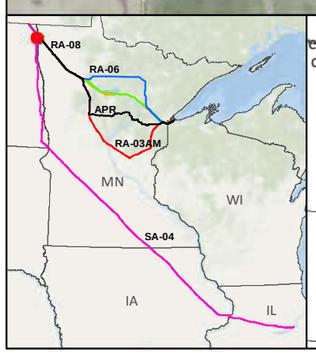
Map 7B of 188

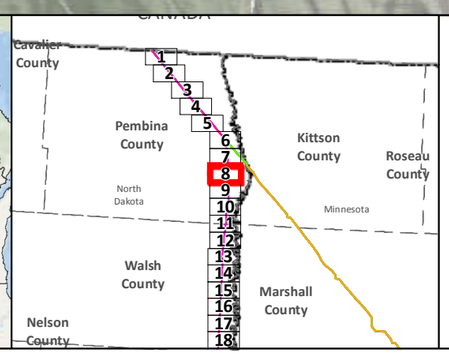
T160N R51W S7
T160N R51W S8
T160N R51W S9
T160N R51W S10
T160N R51W S11
T160N R51W S12
T160N R51W S1
T160N R51W S2
T160N R50W S6
T160N R50W S7
T160N R51W S18
T160N R51W S17
T160N R51W S16
T160N R51W S15
T160N R51W S14
T160N R51W S13
T160N R50W S18
T160N R51W S19
T160N R51W S20
T160N R51W S21
T160N R51W S22
T160N R51W S23
T160N R51W S24
T160N R50W S19
T160N R51W S30
T160N R51W S29
T160N R51W S28
T160N R51W S27
T160N R51W S26
T160N R51W S25
T160N R50W S30

Bowesmont

27
28
29
29

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 8A of 188

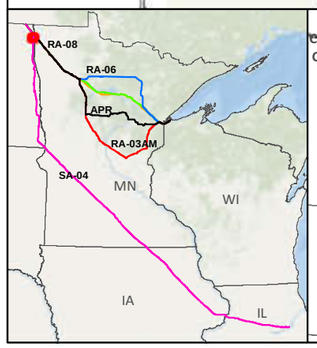
T160N R51W S7
T160N R51W S8
T160N R51W S9
T160N R51W S10
T160N R51W S11
T160N R51W S12
T160N R51W S1
T160N R51W S2
T160N R50W S6
T160N R50W S7
T160N R51W S18
T160N R51W S17
T160N R51W S16
T160N R51W S15
T160N R51W S14
T160N R51W S13
T160N R50W S18
T160N R51W S19
T160N R51W S20
T160N R51W S21
T160N R51W S22
T160N R51W S23
T160N R51W S24
T160N R50W S19
T160N R51W S30
T160N R51W S29
T160N R51W S28
T160N R51W S27
T160N R51W S26
T160N R51W S25
T160N R50W S30

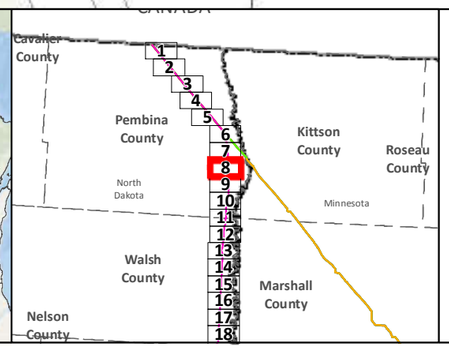
Bowesmont

27
28
29

SA-04

CANADA





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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- Wild Rice Lakes (DNR)
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- Public Water Basin
- Public Drinking Water Supply
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

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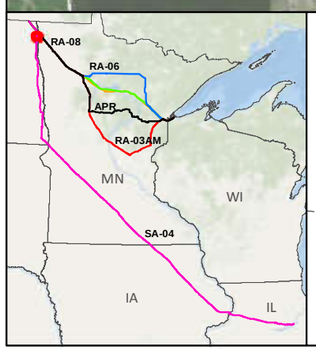
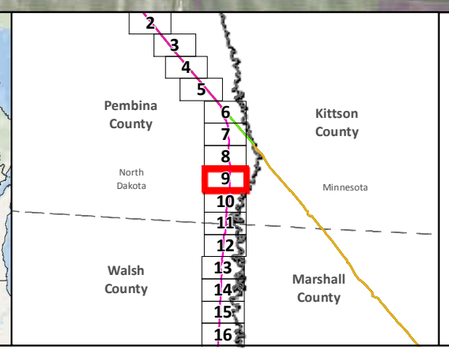
1:24,000
10ft Contours

N

T160N R51W S30
T160N R51W S29
T160N R51W S28
T160N R51W S27
T160N R51W S26
T160N R51W S25
T160N R50W S30
T160N R51W S31
T160N R51W S32
T160N R51W S33
T160N R51W S34
T160N R51W S35
T160N R51W S36
T160N R50W S31
T159N R51W S6
T159N R51W S5
T159N R51W S4
T159N R51W S3
T159N R51W S2
T159N R51W S1
T159N R50W S6
T159N R51W S7
T159N R51W S8
T159N R51W S9
T159N R51W S10
T159N R51W S11
T159N R51W S12
T159N R50W S7
Teien Twsp Kittson Co.
Teien Twsp Kittson Co.
SA-04
30
31
32
29
44
11





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 9A of 188

T160N R51W S30
T160N R51W S29
T160N R51W S28
T160N R51W S27
T160N R51W S26
T160N R51W S25
T160N R50W S30
T160N R51W S31
T160N R51W S32
T160N R51W S33
T160N R51W S34
T160N R51W S35
T160N R51W S36
T160N R50W S31
T159N R51W S6
T159N R51W S5
T159N R51W S4
T159N R51W S3
T159N R51W S2
T159N R51W S1
T159N R50W S6
T159N R51W S7
T159N R51W S8
T159N R51W S9
T159N R51W S10
T159N R51W S11
T159N R51W S12
T159N R50W S7
SA-04
30
31
29
44
32
Teien Twsp
Kittson Co.
Red River
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
Pembina County
North Dakota
Kittson County
Minnesota
Walsh County
Marshall County
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
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Water Resources
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National River Inventory Crossing
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Wellhead Protection Area (WHPA)
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High
Moderate
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 9B of 188

T159N R51W S7
T159N R51W S8
T159N R51W S9
T159N R51W S10
T159N R51W S11
T159N R51W S12
T159N R50W S7
T159N R51W S18
T159N R51W S17
T159N R51W S16
T159N R51W S15
T159N R51W S14
T159N R51W S13
T159N R50W S18
T159N R51W S19
T159N R51W S20
T159N R51W S21
T159N R51W S22
T159N R51W S23
T159N R51W S24
T159N R50W S19
T159N R51W S29
T159N R51W S28
T159N R51W S27
T159N R51W S26
T159N R51W S25

Red River of the North

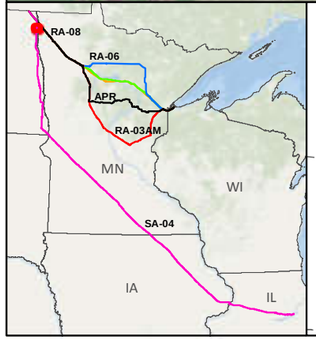
Teien Twsp
Kittson Co.

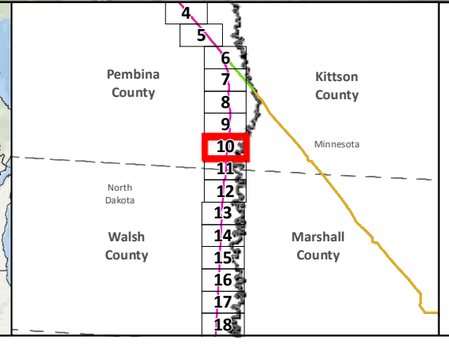
Drayton

Robbin

SA-04

33 34 35 44 66 29 11





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

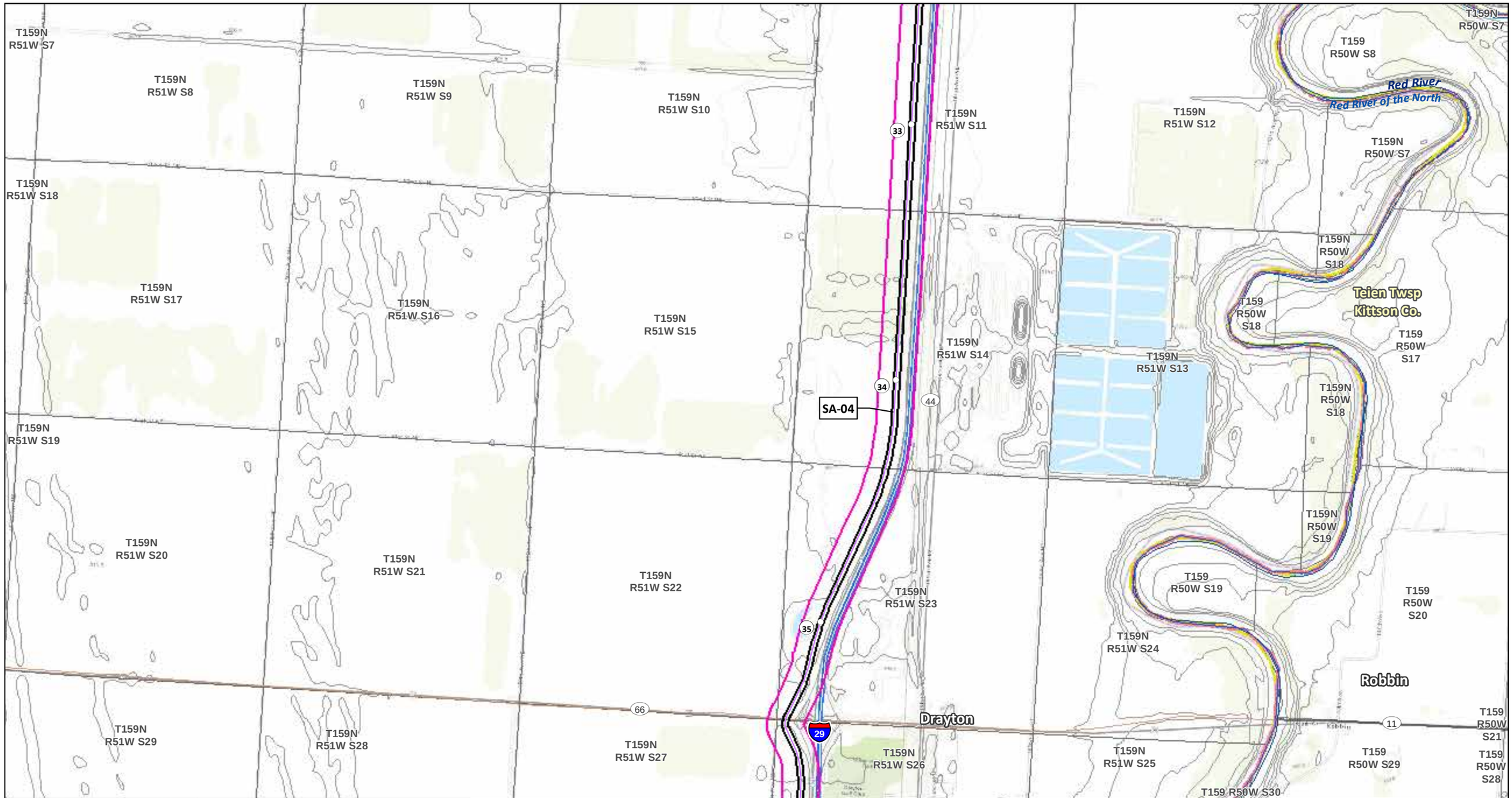
Water Resources
- Lake
- River

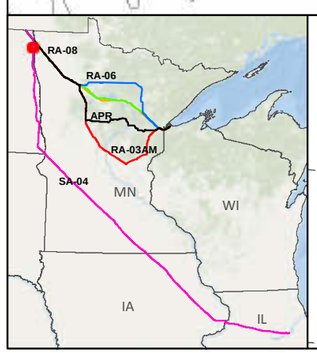
Data Sources: MNDNR, NHD,USGS, Enbridge

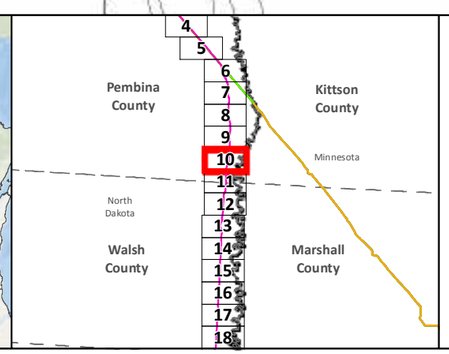
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

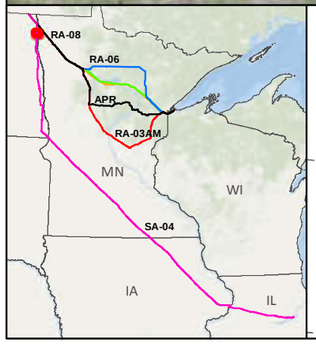
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

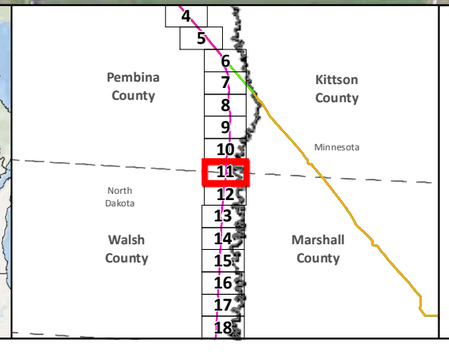
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 10B of 188

T159N R51W S29
T159N R51W S28
T159N R51W S27
T159N R51W S26
T159N R51W S25
Teien Twsp Kittson Co.
T159N R51W S32
T159N R51W S33
T159N R51W S34
T159N R51W S35
T159N R51W S36
T159N R51W S25
T159N R50W S30
T159N R50W S31
Red River of the North
29
36
37
44
T158N R51W S5
T158N R51W S4
T158N R51W S3
T158N R51W S2
T158N R51W S1
T158N R50W S6
Eagle Point Twsp Marshall Co.
T158N R51W S8
T158N R51W S9
T158N R51W S10
T158N R51W S11
T158N R51W S12
38
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

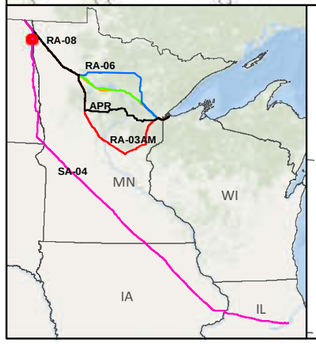
Data Sources: MNDNR, NHD,USGS, Enbridge

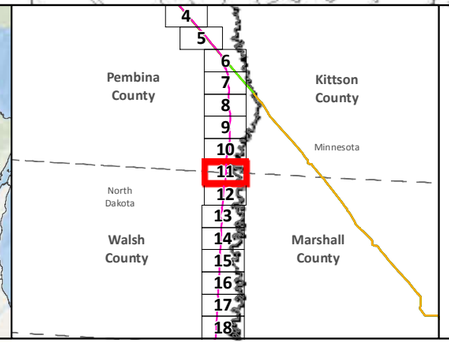
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T159N R51W S29
T159N R51W S28
T159N R51W S27
T159N R51W S26
T159N R51W S25
T159 R50W S30
T159 R50W S29
Teien Twsp Kittson Co.
T159 R50W S28
T159 R50W S31
Red River of the North
T159N R51W S25
T159N R50W S30
T159N R51W S36
T159N R50W S31
T159N R51W S32
T159N R51W S33
T159N R51W S34
T159N R51W S35
Red River
T159 R50W S31
T159 R50W S32
T159 R50W S33
T158 R50W S6
T158N R51W S5
T158N R51W S4
T158N R51W S3
T158N R51W S2
T158N R51W S1
T158N R50W S6
T158 R50W S5
T158 R50W S6
Eagle Point Twsp Marshall Co.
T158 R50W S4
T158 R50W S7
T158 R50W S8
T158 R50W S9
T158N R51W S8
T158N R51W S9
T158N R51W S10
T158N R51W S11
T158N R51W S12
SA-04
36
37
38
44
29





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

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Lakes of Biological Significance
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High
Moderate

Native Plant Communities with Biodiversity Significance
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Data Sources: MNDNR, USGS, NHD, Enbridge

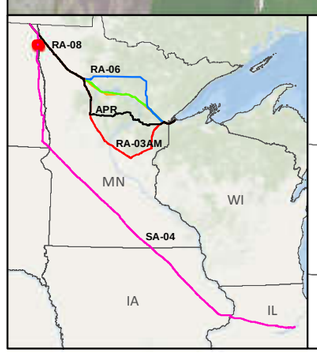
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

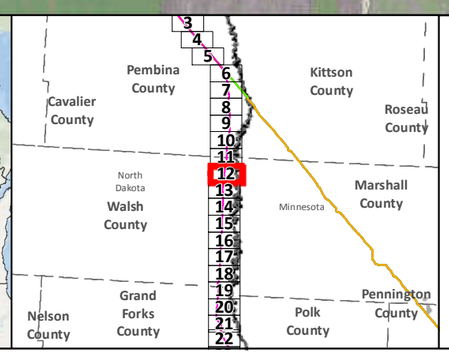
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

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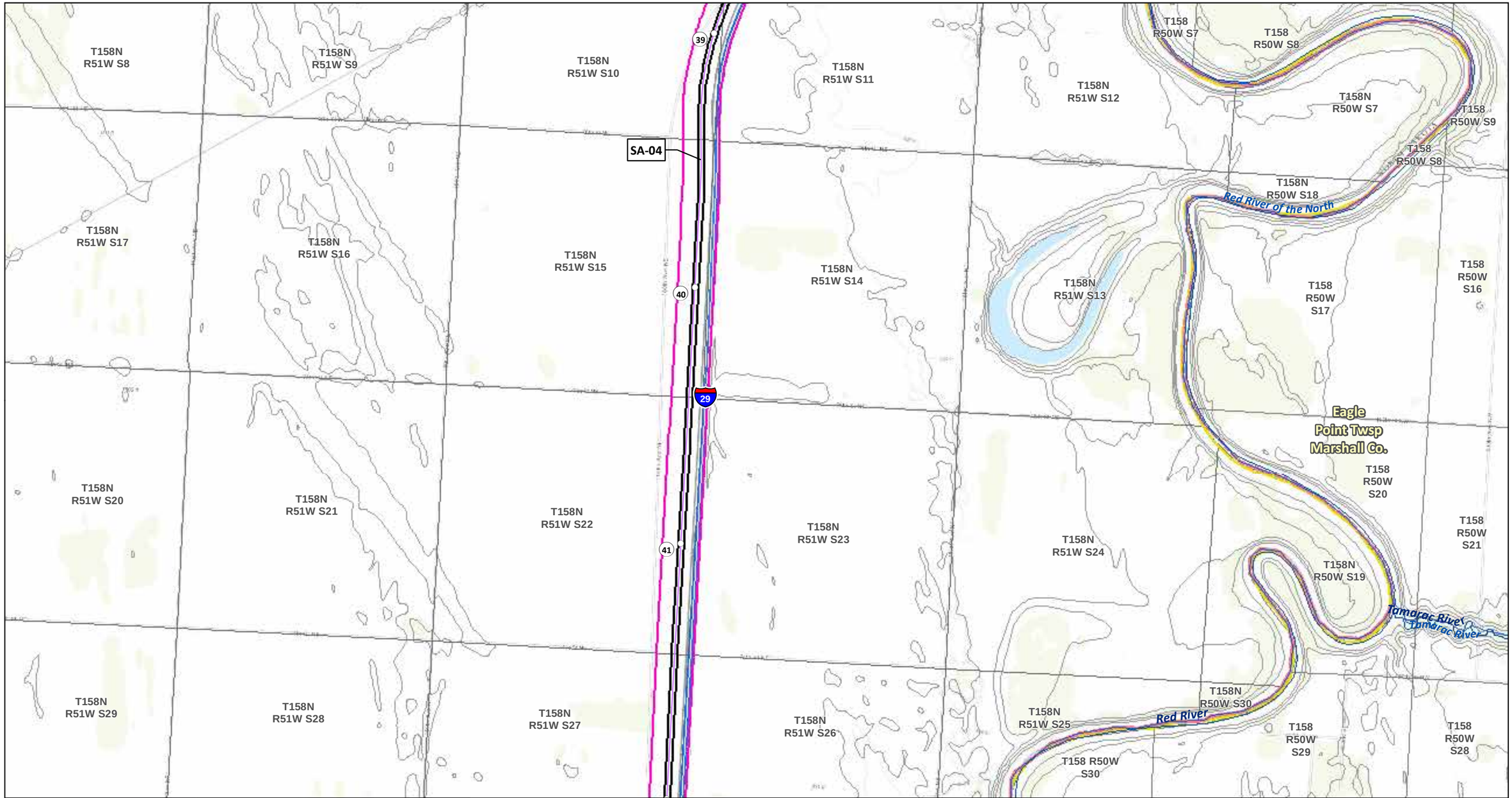

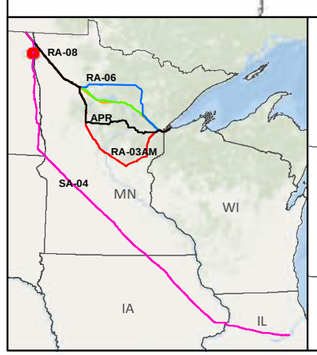

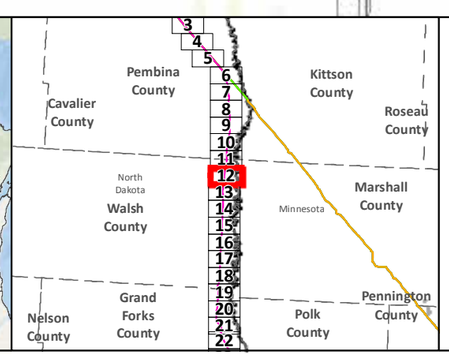

- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

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- RA-06
- RA-07
- RA-08
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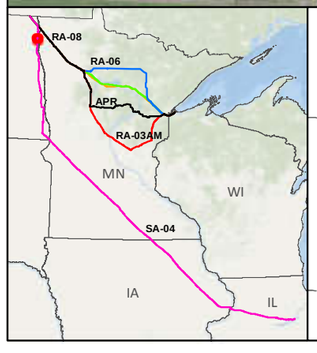

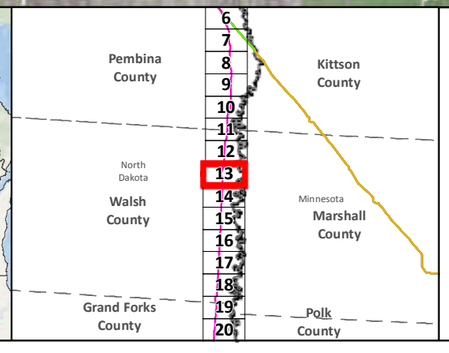

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County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

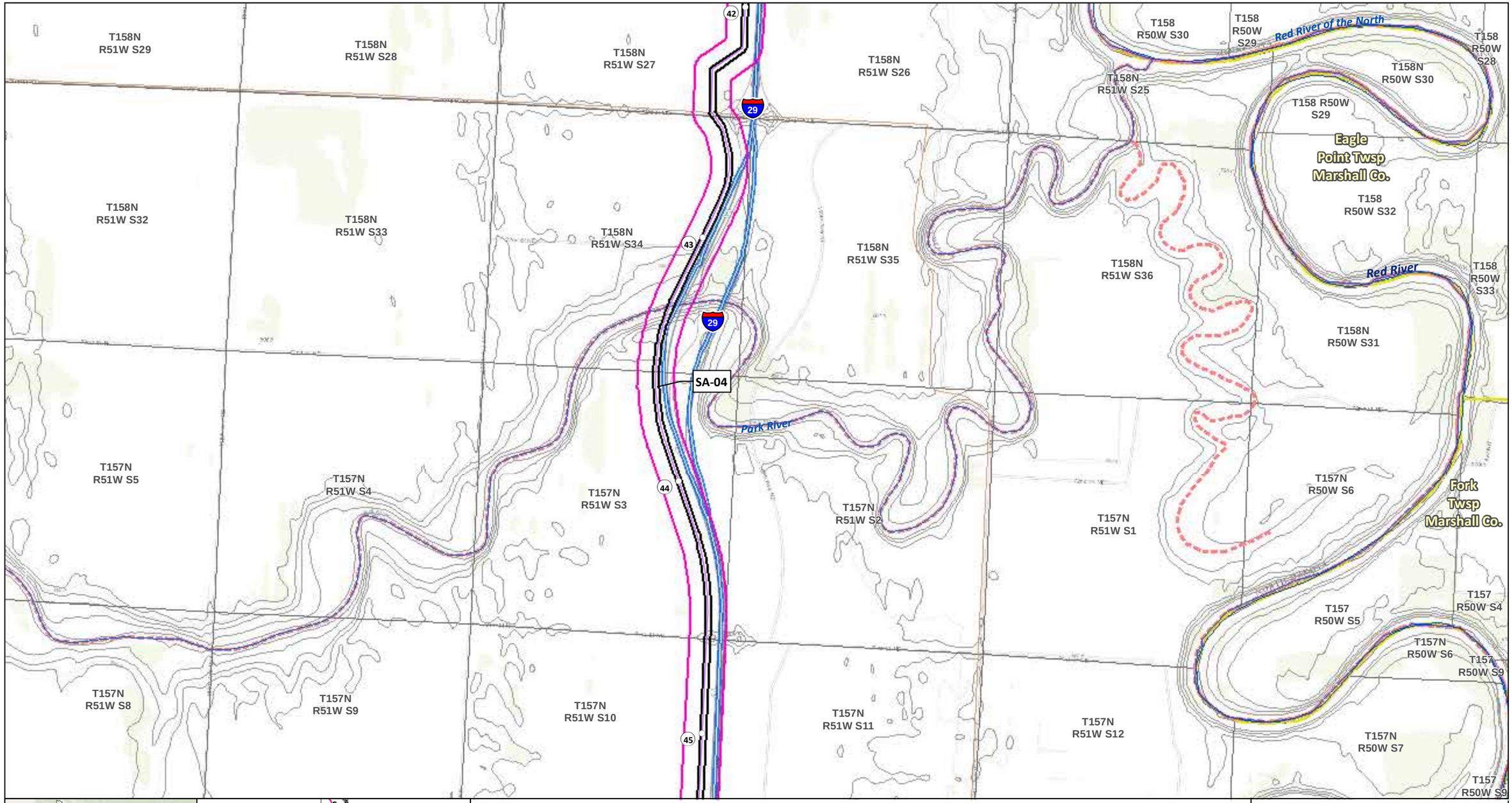
Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04



SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

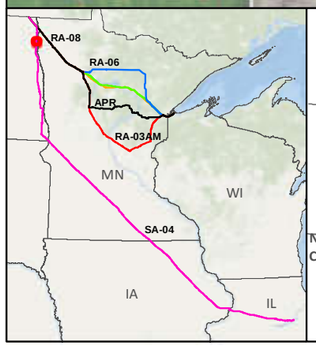
0 0.125 0.25 0.5 Miles

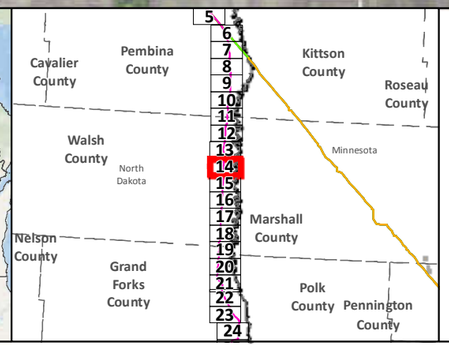
1:24,000

0 125 250 500 Meters

10ft Contours

T157N R51W S8
T157N R51W S9
T157N R51W S10
T157N R51W S11
T157N R51W S12
T157N R50W S7
Snake River
Fork Twsp Marshall Co.
T157N R51W S17
T157N R51W S16
T157N R51W S15
T157N R51W S14
T157N R51W S13
T157N R50W S18
SA-04
46
17
29
317
T157N R50W S18
T157N R51W S20
T157N R51W S21
T157N R51W S22
T157N R51W S23
T157N R51W S24
T157N R50W S19
47
T157N R51W S29
T157N R51W S28
T157N R51W S27
T157N R51W S26
T157N R51W S25
T157N R50W S30
Red River of the North
Fork Twsp Marshall Co.
48





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
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Lake
River

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0 0.125 0.25 0.5 Miles
1:24,000
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T157N R51W S8
T157N R51W S9
T157N R51W S10
T157N R51W S11
T157N R51W S12
T157N R50W S7
T157 R50W S8
T157 R50W S9
Fork Twsp Marshall Co.
Snake River
T157 R50W S17
Red River of the North WMA
T157N R51W S17
T157N R51W S16
T157N R51W S15
T157N R51W S14
T157N R51W S13
T157N R50W S18
Red River of the North
T157 R50W S18
T157 R50W S17
T157N R50W S18
T157 R50W S16
T157 R50W S19
T157 R50W S20
T157N R51W S20
T157N R51W S21
T157N R51W S22
T157N R51W S23
T157N R51W S24
T157N R50W S19
T157 R50W S21
T157 R50W S20
T157N R50W S30
Red River
Fork Twsp Marshall Co.
T157N R51W S29
T157N R51W S28
T157N R51W S27
T157N R51W S26
T157 R50W S30
T157 R50W S29
T157 R50W S28
T157N R51W S25
SA-04
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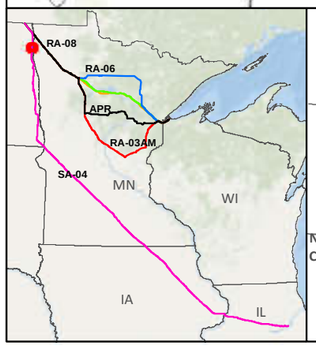
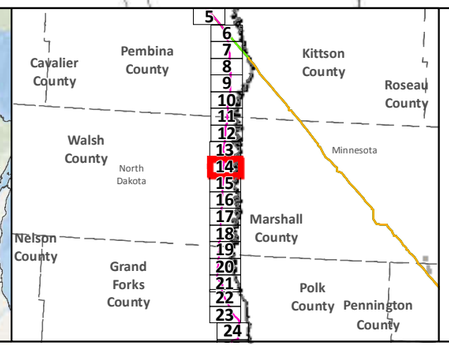
47
48
17
29
317





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- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

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- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 14B of 188

T157N R51W S29
T157N R51W S28
T157N R51W S27
T157N R51W S26
T157N R51W S25
T157N R51W S32
T157N R51W S33
T157N R51W S34
T157N R51W S35
T157N R51W S36
T157N R50W S31
Fork Twsp Marshall Co.
Red River of the North
66th
T156N R51W S6
T156N R51W S5
T156N R51W S4
T156N R51W S3
T156N R51W S2
Big Woods Twsp Marshall Co.
Forest River
65th
T156N R51W S7
T156N R51W S8
T156N R51W S9
T156N R51W S10
T156N R51W S11
T156N R51W S12
49
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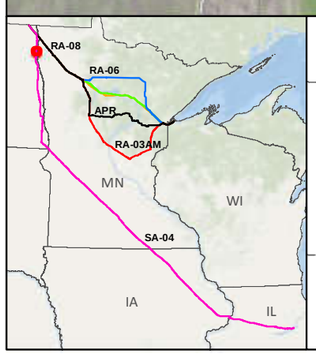
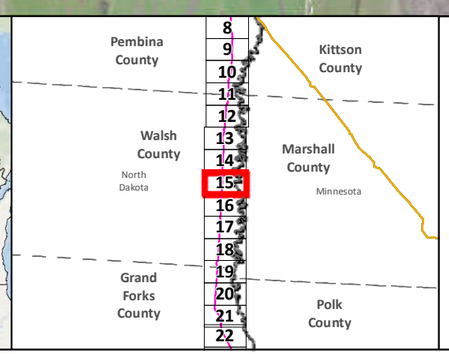
51
29
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
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Water Resources
Lake
River

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MNDNR, NHD,USGS, Enbridge

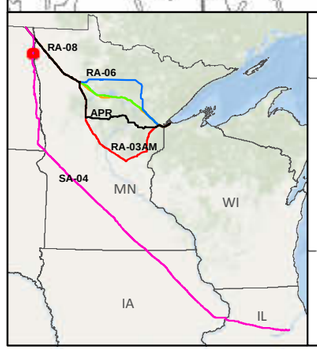
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

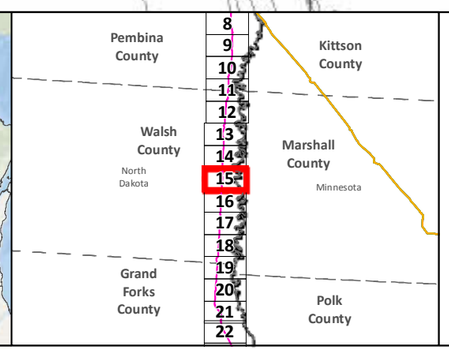
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 15A of 188

T157N R51W S29
T157N R51W S28
T157N R51W S27
T157N R51W S26
T157N R51W S25
T157 R50W S30
T157 R50W S29
T157 R50W S28
T157 R50W S31
Red River of the North
T157N R51W S32
T157N R51W S33
T157N R51W S34
T157N R51W S35
T157N R51W S36
Joliet Ferry
Fork Twsp Marshall Co.
T157 R50W S32
T157 R50W S33
T157N R50W S31
Red River
T156 R51W S1
T156N R51W S6
T156N R51W S5
T156N R51W S4
T156N R51W S3
T156 R50W S6
T156 R50W S5
T156N R51W S2
Big Woods Twsp Marshall Co.
Forest River
T156N R51W S1
T156N R51W S7
T156N R51W S8
T156N R51W S9
T156N R51W S10
T156N R51W S11
T156N R51W S12
T156 R50W S8
T156 R50W S7
SA-04
49
50
29
51





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
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- 303d Imparied Waters
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- Calcareous Fens
- Wild Rice Lakes (DNR)
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- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 15B of 188

T156N R51W S7
T156N R51W S8
T156N R51W S9
T156N R51W S10
T156N R51W S11
T156N R51W S12
T156N R51W S18
T156N R51W S17
T156N R51W S16
T156N R51W S15
T156N R51W S14
T156N R51W S13
SA-04
52
53
54
29
T156N R51W S19
T156N R51W S20
T156N R51W S21
T156N R51W S22
T156N R51W S23
T156N R51W S24
T156N R50W S18
T156N R50W S19
Red River of the North
Big Woods Twsp
Marshall Co.
Forest River
T156N R51W S24
T156N R50W S7
T156N R50W S30
North Morais River
T156N R51W S30
T156N R51W S29
T156N R51W S28
T156N R51W S27
T156N R51W S26
T156N R51W S25
T156N R51W S31
T156N R51W S32
Forest River
T156N R50W S30

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Pembina County
Cavalier County
Walsh County
Nelson County
Grand Forks County
North Dakota
Minnesota
Kittson County
Roseau County
Marshall County
Polk County
Pennington County
Red Lake County

SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
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Mile Post
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Highway
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River

Data Sources:
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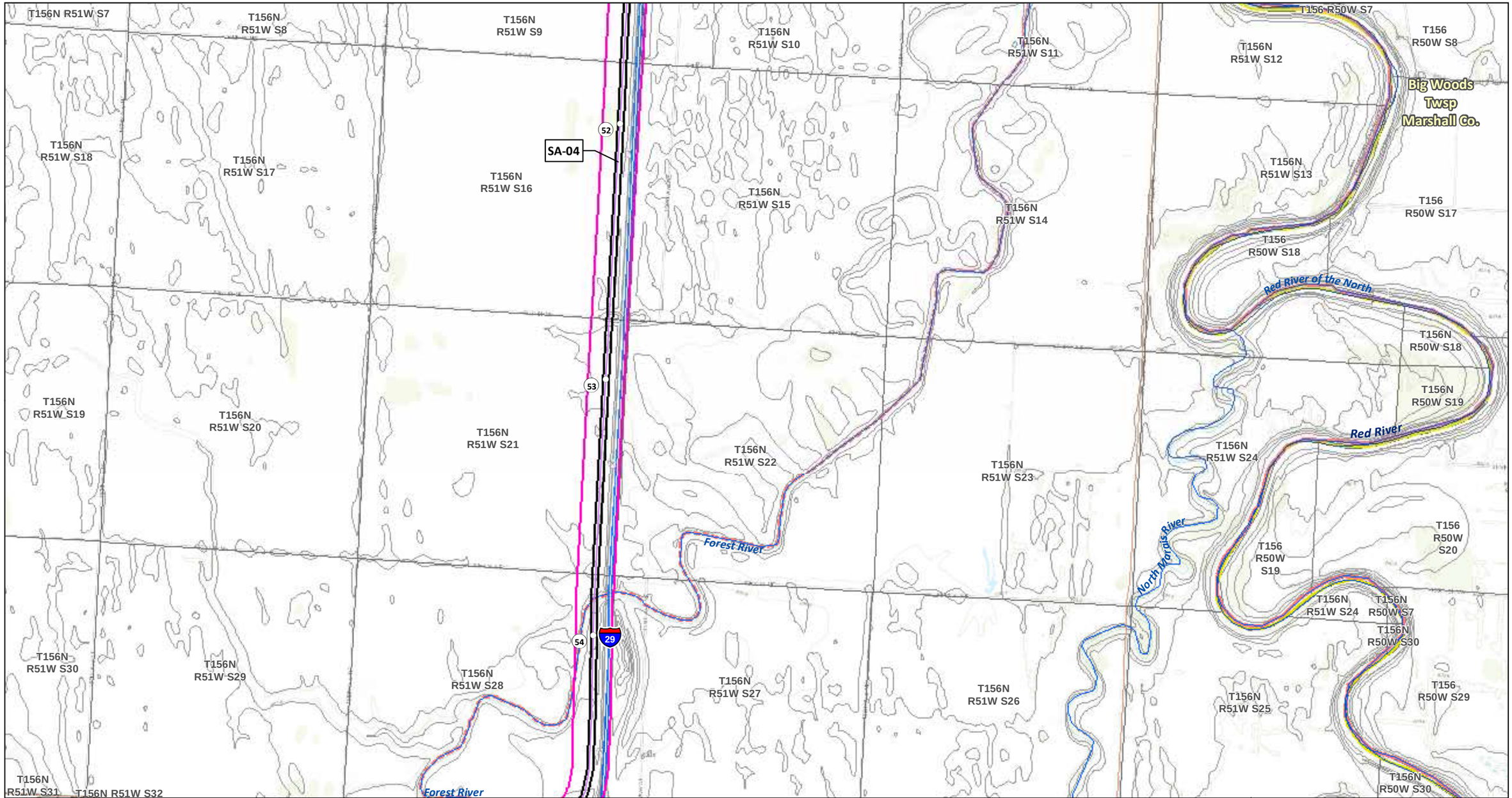
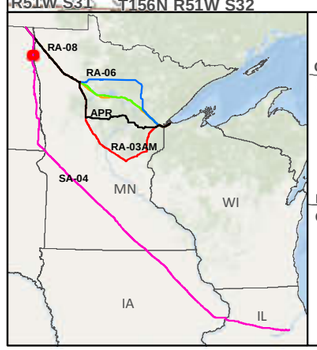
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

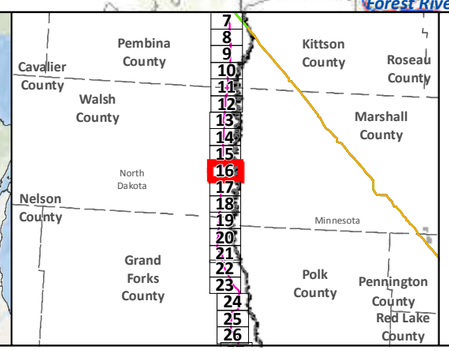
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 16A of 188







- SA-04
- Applicant's Preferred Route (APR)

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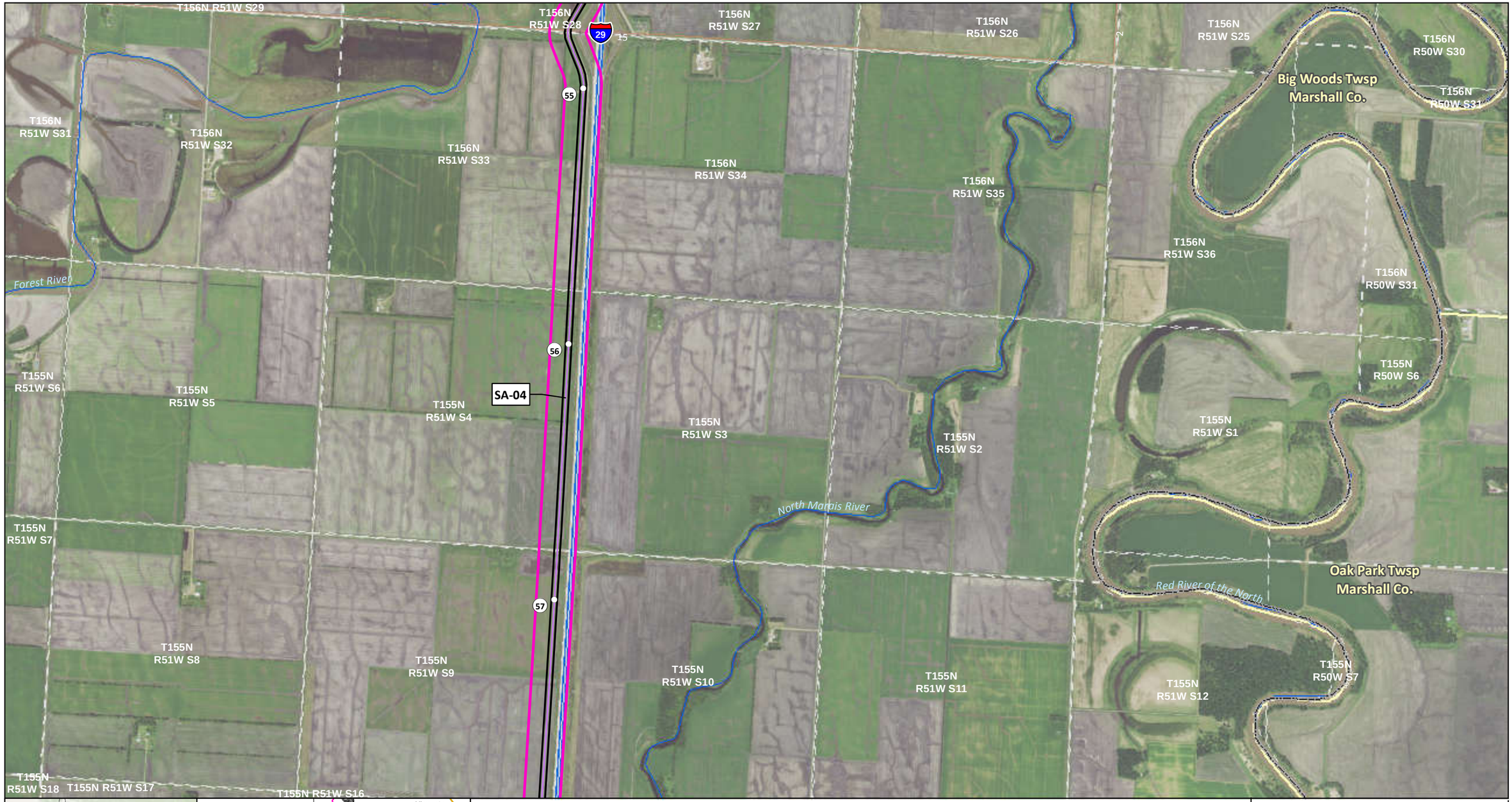
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

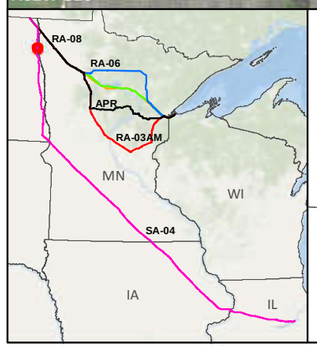
SA-04

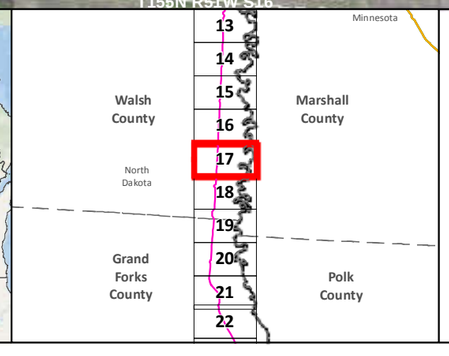
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 16B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
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Land Ownership
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Water Resources
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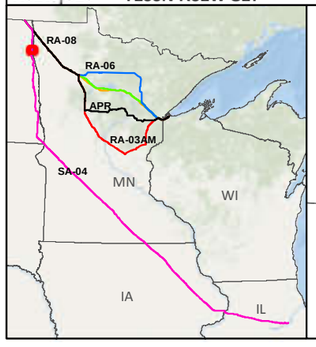
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

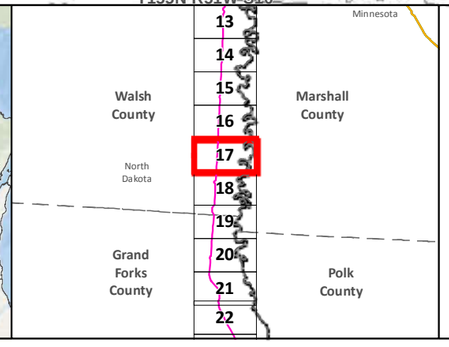
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 17A of 188

T156N R51W S29
T156N R51W S28
T156N R51W S27
T156N R51W S26
T156N R51W S25
T156 R50W S30
T156N R50W S30
T156 R50W S29
Forest River
29
55
Big Woods Twsp Marshall Co.
T156N R50W S31
T156N R51W S31
T156N R51W S32
T156N R51W S33
T156N R51W S34
T156N R51W S35
T156 R50W S31
T156 R50W S32
T156N R51W S36
T156N R50W S31
56
T155N R51W S6
T155N R51W S5
T155N R51W S4
SA-04
T155N R51W S3
T155N R51W S2
T155N R51W S1
T155N R50W S6
T155 R50W S5
Red River
T155 R50W S6
T155N R51W S7
57
T155 R50W S7
Oak Park Twsp Marshall Co.
Red River of the North
North Marais River
T155N R51W S8
T155N R51W S9
T155N R51W S10
T155N R51W S11
T155N R51W S12
T155N R50W S7
T155 R50W S8
T155N R51W S18
T155N R51W S17
T155N R51W S16





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10ft Contours

T155N R51W S18
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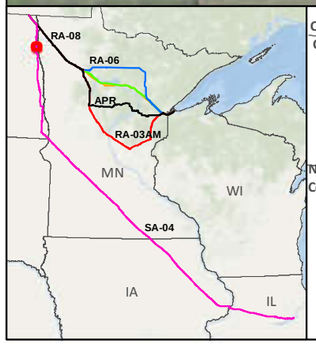
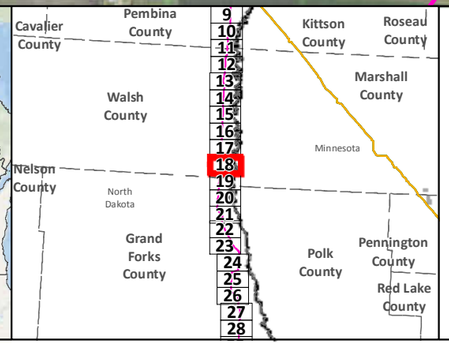
T155N R51W S10
T155N R51W S11
T155N R51W S12
T155N R51W S13
T155N R51W S17
T155N R51W S16
T155N R51W S15
T155N R51W S14
SA-04
Oak Park Twsp Marshall Co.
T155N R51W S19
T155N R51W S13
T155N R51W S20
T155N R51W S21
T155N R51W S22
T155N R51W S23
North Morais River
Red River of the North
T155N R51W S24
T155N R51W S30
T155N R51W S29
T155N R51W S28
T155N R51W S27
T155N R51W S26
T155N R51W S25
Red River of the North
Oak Park Twsp Marshall Co.
T155N R50W S30
T155N R51W S32
T155N R51W S33
T155N R51W S34
T155N R51W S35





SA-04
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Route Width (750')
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Mile Post
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0 0.125 0.25 0.5 Miles
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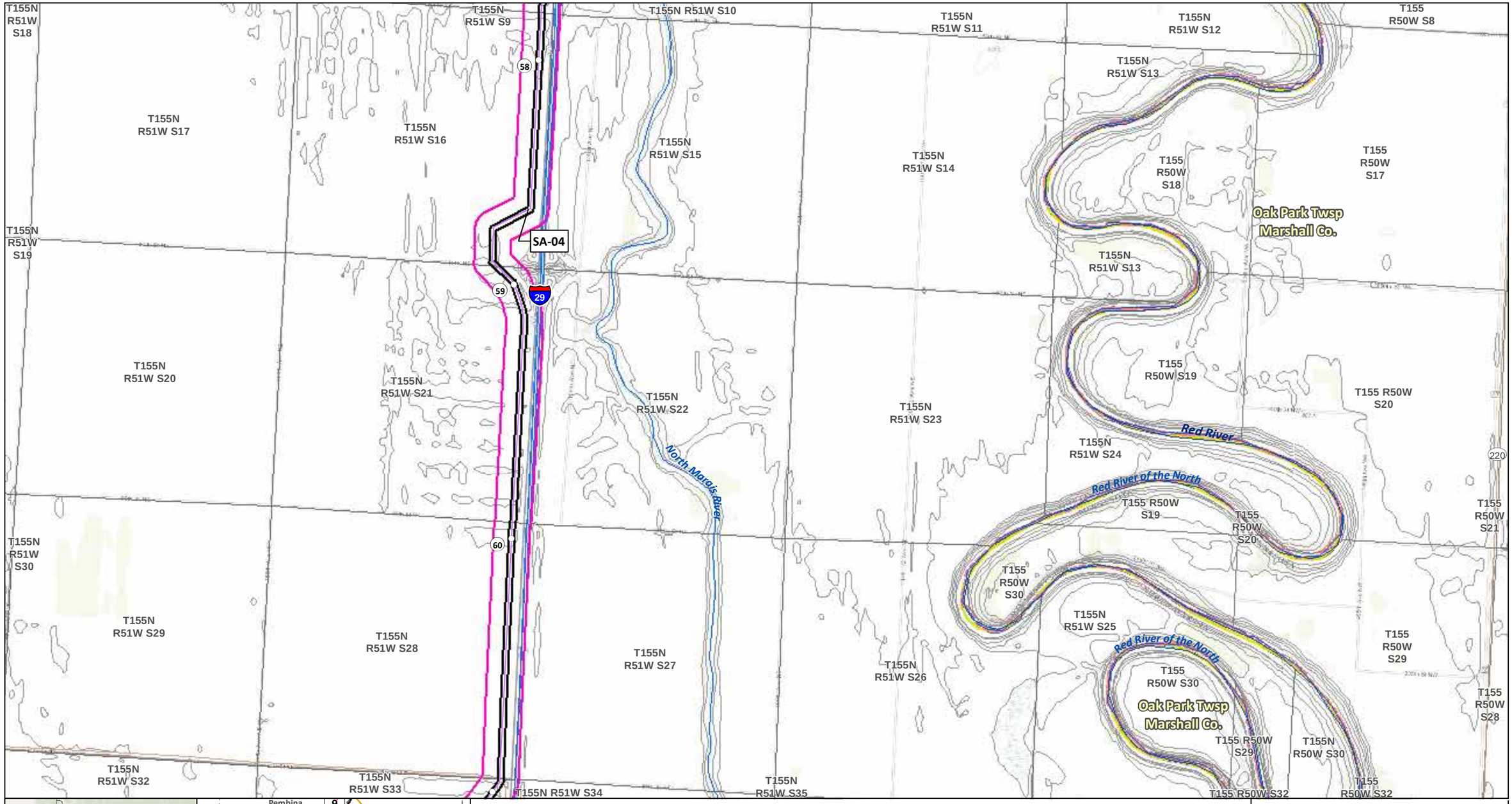
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04


T155N R51W S18
T155N R51W S9
T155N R51W S10
T155N R51W S11
T155N R51W S12
T155 R50W S8
T155N R51W S13
T155N R51W S17
T155N R51W S16
T155N R51W S15
T155N R51W S14
T155 R50W S18
T155 R50W S17
Oak Park Twsp Marshall Co.
SA-04
T155N R51W S19
T155N R51W S13
T155N R51W S20
T155N R51W S21
T155N R51W S22
T155N R51W S23
T155 R50W S19
T155 R50W S20
Red River
T155N R51W S24
Red River of the North
T155 R50W S19
T155 R50W S21
T155 R50W S20
T155N R51W S30
T155 R50W S30
T155N R51W S29
T155N R51W S28
T155N R51W S27
T155N R51W S26
T155N R51W S25
T155 R50W S29
T155 R50W S28
Oak Park Twsp Marshall Co.
T155 R50W S29
T155N R50W S30
T155N R51W S32
T155N R51W S33
T155N R51W S34
T155N R51W S35
T155 R50W S32
T155 R50W S32
North Marais River
58
59
29
60
220
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
Cavalier County
Pembina County
Walsh County
Nelson County
Grand Forks County
North Dakota
Minnesota
Kittson County
Roseau County
Marshall County
Polk County
Pennington County
Red Lake County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
SA-04
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 18B of 188

SA-04

T155N R51W S32
T155N R51W S33
T155N R51W S34
T155N R51W S35
T155N R51W S25
T155N R51W S26
T155N R50W S30
T155N R51W S36
T154N R51W S5
T154N R51W S4
T154N R51W S3
T154N R51W S2
T154N R51W S1
T154N R51W S8
T154N R51W S9
T154N R51W S10
T154N R51W S11
T154N R51W S12
T154N R51W S17
T154N R51W S16
T154N R51W S15
T154N R51W S14
T154N R51W S13

Oslo
Oslo Twsp Co.
Oak Park Twsp Marshall Co.
Higdem Twsp Co.

North Morads River
Red River of the North
Turtle River

19
29
54
62
63
64
2
1
220
15th
9
22

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Walsh County
Marshall County
Minnesota
North Dakota
Grand Forks County
Polk County
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

SA-04

T155N R51W S32 | T155N R51W S33 | T155N R51W S34 | T155N R51W S35 | T155N R51W S26 | T155N R51W S25 | T155N R51W S36

T155 R50W S31 | T155 R50W S32 | T155 R50W S33 | T155 R50W S29 | T155 R50W S28

T154N R51W S5 | T154N R51W S4 | T154N R51W S3 | T154N R51W S2 | T154N R51W S1

T154 R50W S5 | T154 R50W S6 | T154 R50W S4

T154N R51W S8 | T154N R51W S9 | T154N R51W S10 | T154N R51W S11 | T154N R51W S12

T154 R50W S7 | T154 R50W S8 | T154 R50W S9

T154N R51W S17 | T154N R51W S16 | T154N R51W S15 | T154N R51W S14 | T154N R51W S13

T154 R50W S18 | T154 R50W S17 | T154 R50W S16

Red River of the North

North Magis River

Red River

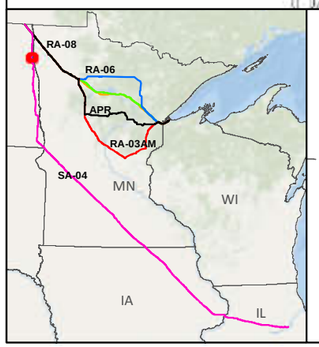
Turtle River

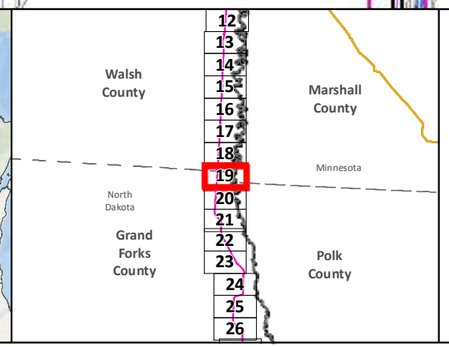
Oslo Twsp Co.

Oak Park Twsp Marshall Co.

Higdem Twsp Co.

29 | 62 | 63 | 64 | 54 | 1 | 220





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding

High

Moderate

Native Plant Communities with Biodiversity Significance

Outstanding

High

Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

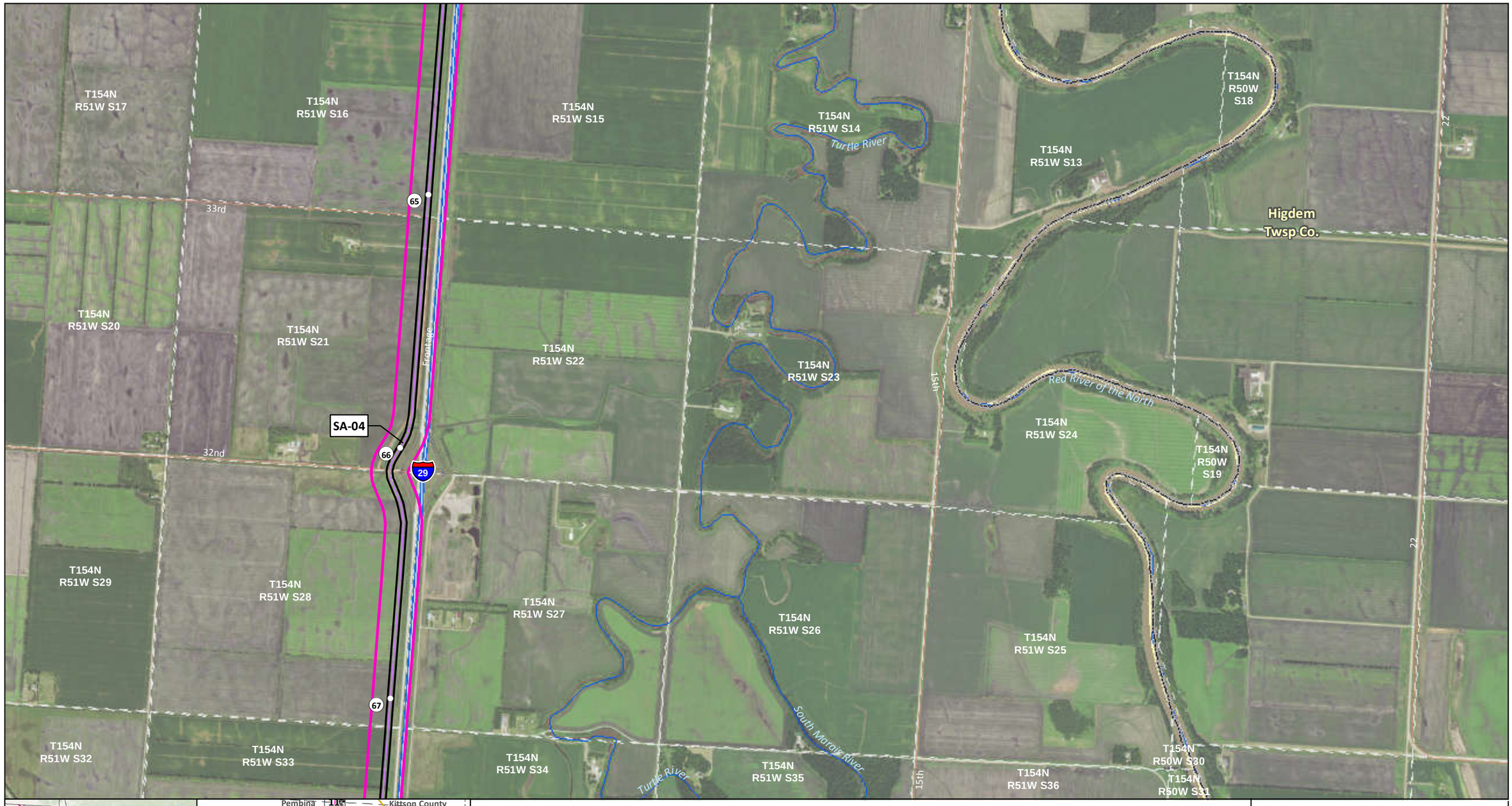
0 125 250 500 Meters

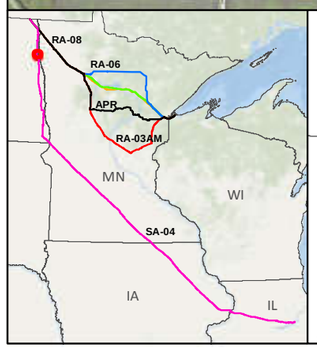
1:24,000

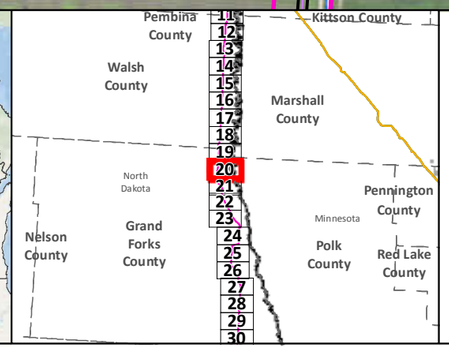
10ft Contours

N

Map 19B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

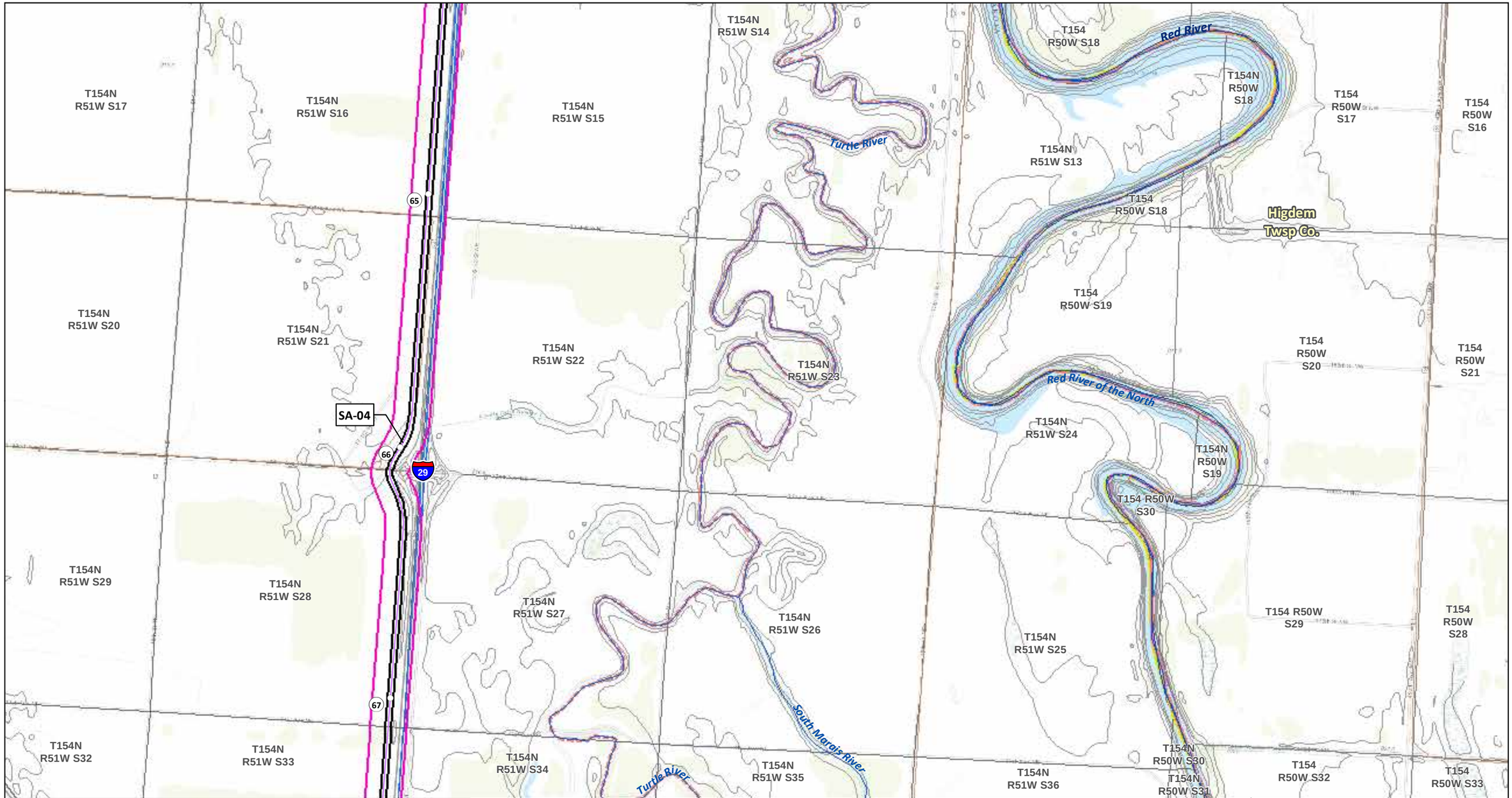
Water Resources
Lake
River

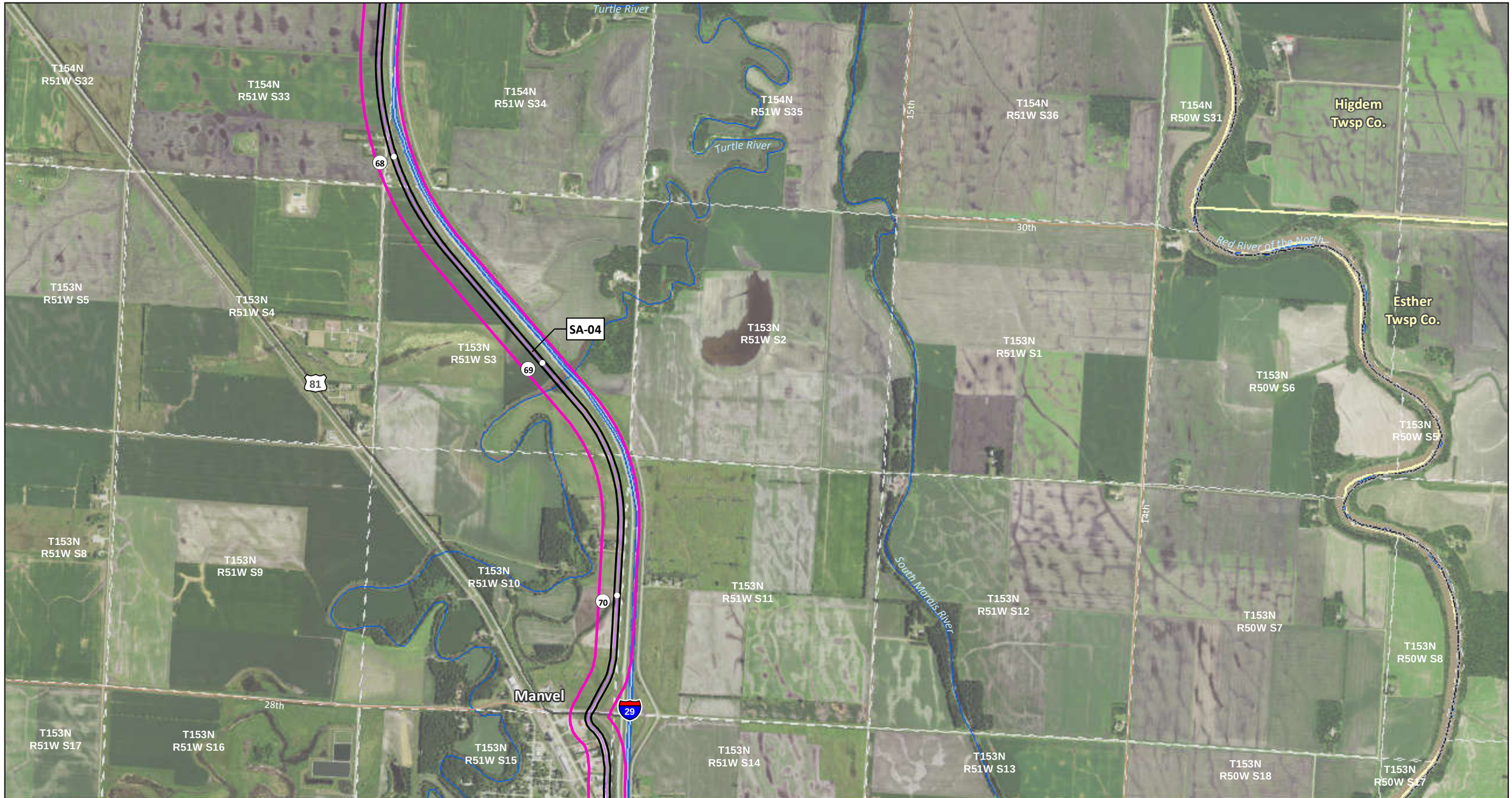
Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

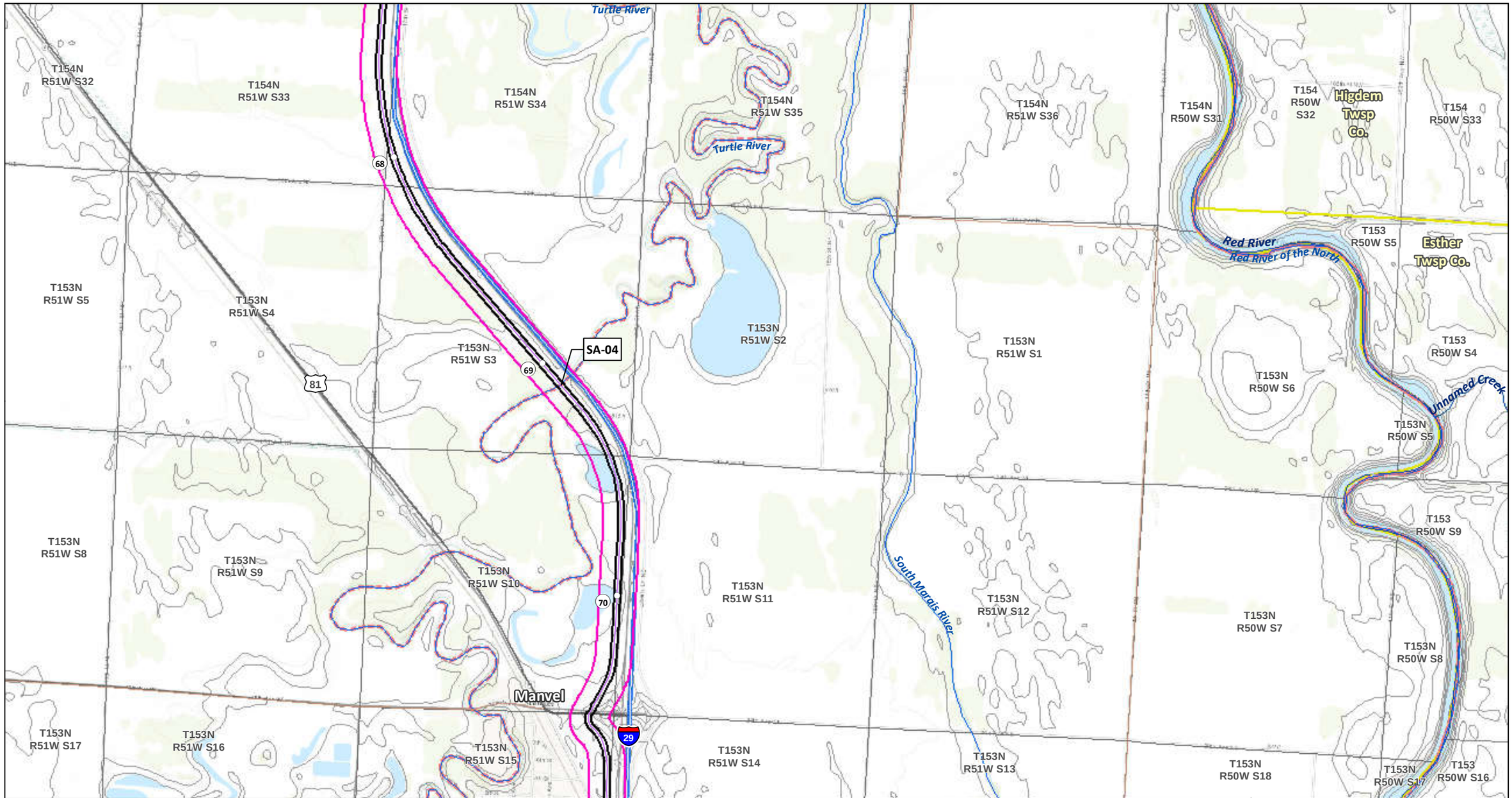

T154N R51W S17
T154N R51W S16
T154N R51W S15
T154N R51W S14
T154 R50W S18
Red River
T154N R50W S18
T154 R50W S17
T154 R50W S16
Turtle River
T154N R51W S13
T154 R50W S18
Higdem Twsp Co.
T154N R51W S20
T154N R51W S21
T154N R51W S22
T154N R51W S23
T154 R50W S19
T154 R50W S20
T154 R50W S21
Red River of the North
T154N R51W S24
T154N R50W S19
T154 R50W S30
SA-04
65
66
29
67
T154N R51W S29
T154N R51W S28
T154N R51W S27
T154N R51W S26
T154 R50W S29
T154 R50W S28
T154N R51W S25
T154N R51W S32
T154N R51W S33
T154N R51W S34
T154N R51W S35
T154N R51W S36
T154N R50W S30
T154N R50W S31
T154 R50W S32
T154 R50W S33
South Margis River
Turtle River
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
Pembina County
Kittson County
Walsh County
Marshall County
North Dakota
Minnesota
Grand Forks County
Nelson County
Polk County
Pennington County
Red Lake County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
SA-04
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
Map 20B of 188

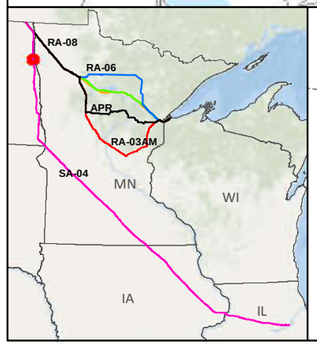


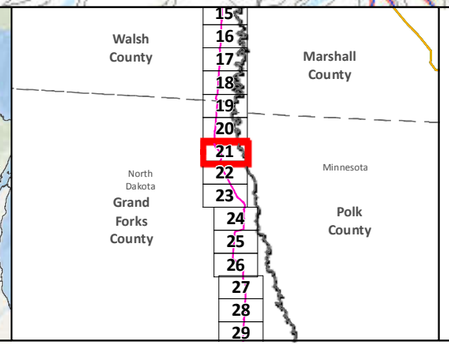
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 21A of 188







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM
RA-06
RA-07
RA-08

Mile Post

Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

303d Imparied Waters

Designated Trout Stream

Calcareous Fens

Wild Rice Lakes (DNR)

Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance

Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

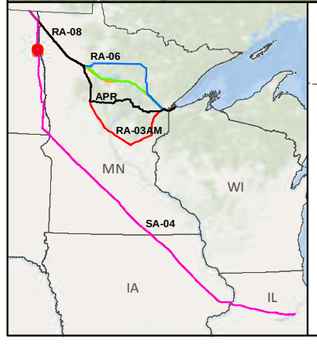
1:24,000

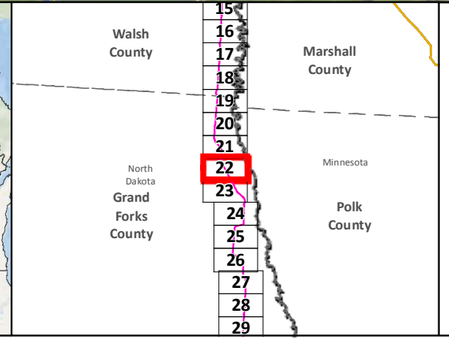
10ft Contours

N

Map 21B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 22A of 188

T153N R51W S9
T153N R51W S10
T153N R51W S11
T153N R51W S12
T153N R50W S7
T153N R50W S8
T153 R50W S9
T153N R50W S16
T153N R51W S17
T153N R51W S16
T153N R51W S15
T153N R51W S14
T153N R51W S13
T153N R50W S18
T153N R50W S17
T153N R51W S20
T153N R51W S21
T153N R51W S22
T153N R51W S23
T153N R51W S24
T153N R50W S19
T153N R50W S20
T153N R51W S29
T153N R51W S28
T153N R51W S27
T153N R51W S26
T153N R51W S25
T153N R50W S30
T153N R50W S29
T153N R51W S32
T153N R51W S33
T153N R51W S34
T153N R51W S35
T153N R51W S36

81
29
71
72
73

SA-04

Esther Twsp Co.
Red River
Red River of the North
South Marais River
Turtle River

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Walsh County
Marshall County
North Dakota
Minnesota
Grand Forks County
Polk County
15
16
17
18
19
20
21
22
23
24
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SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

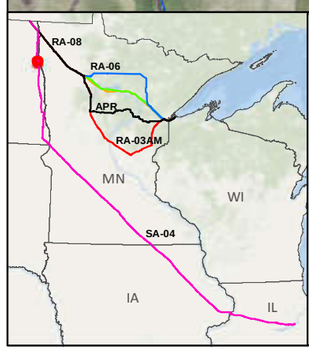
SA-04

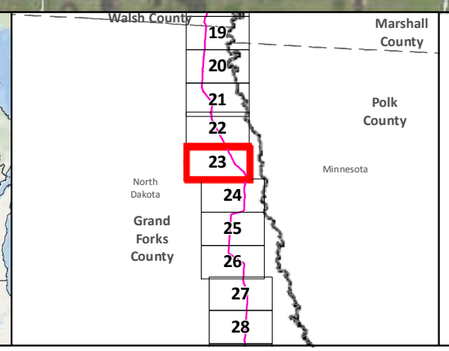
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 22B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

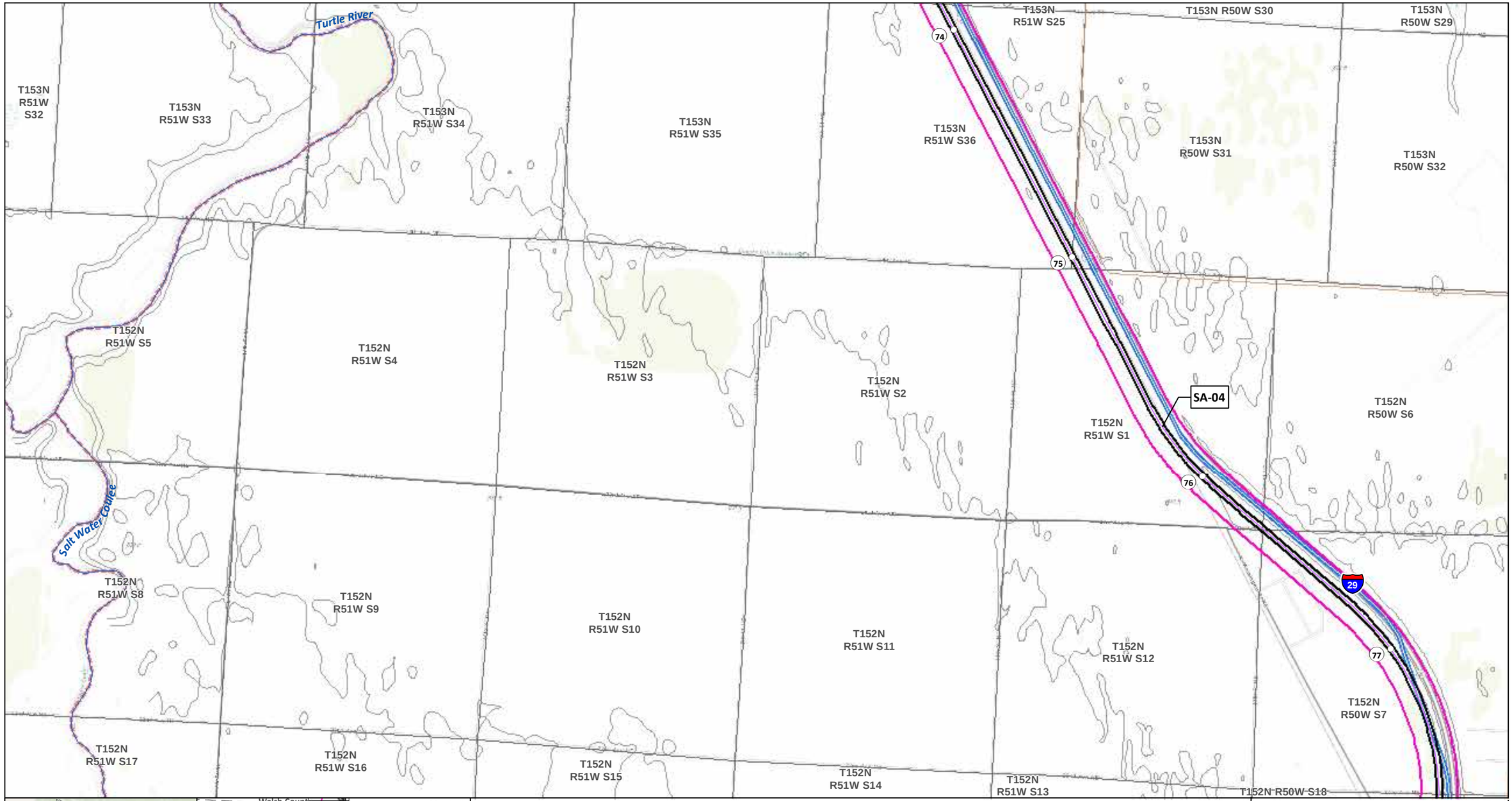
Data Sources:
MNDNR, NHD,USGS, Enbridge

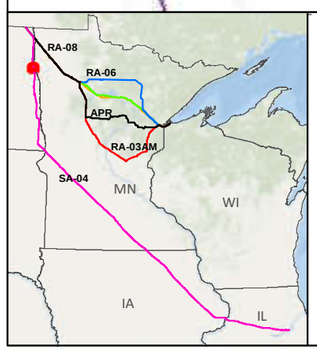
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

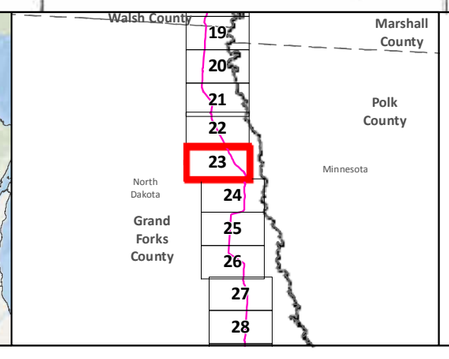
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 23A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

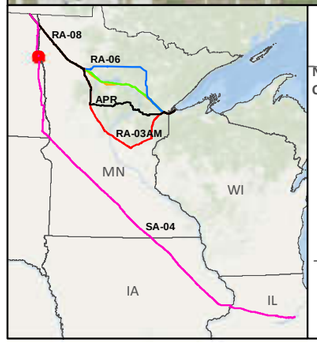
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

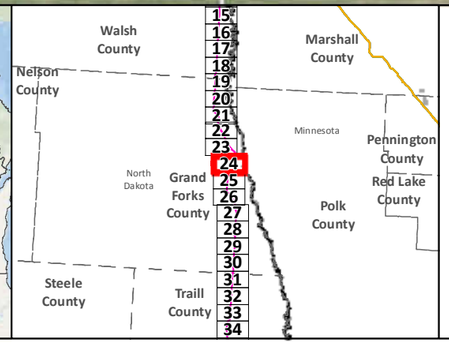
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 23B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

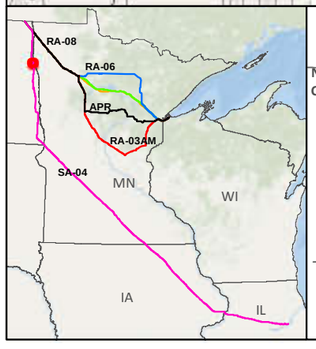
Data Sources:
MNDNR, NHD,USGS, Enbridge

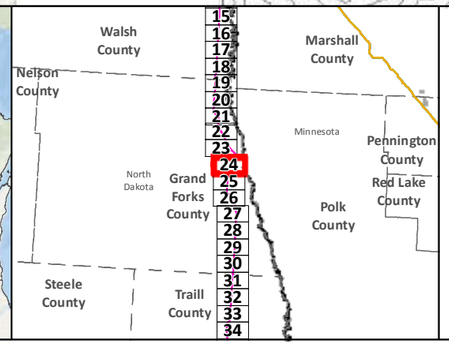
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T152N R51W S16
T152N R51W S15
T152N R51W S14
T152N R51W S13
T152N R50W S18
T152N R50W S17
T152N R50W S16
T152N R50W S9
T152N R50W S8
T152 R50W S15
T152 R50W S22
T152N R51W S21
T152N R51W S22
T152N R51W S23
T152N R51W S24
T152N R50W S19
T152N R50W S20
T152N R50W S21
T152N R51W S28
T152N R51W S27
T152N R51W S26
T152N R51W S25
T152N R50W S30
T152N R50W S29
T152N R50W S28
T152N R51W S33
T152N R51W S34
T152N R51W S35
T152N R51W S36
T152N R50W S31
T152N R50W S32
T152N R50W S33
78
29
79
81
80
Red River of the North
Red River
Grand Forks Twsp Co.
Grand Forks Twsp Co.
SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

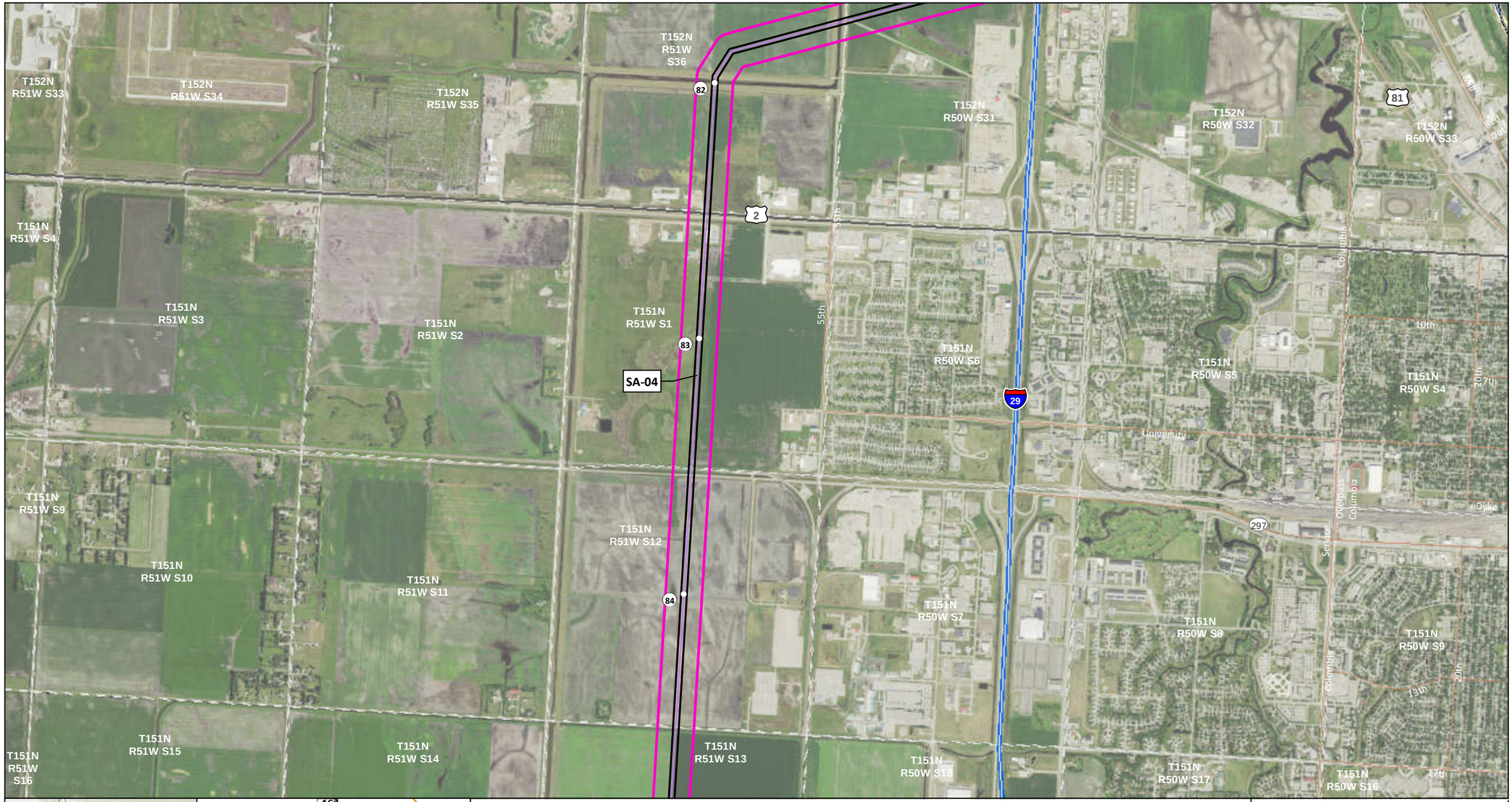
Data Sources: MNDNR, USGS, NHD, Enbridge

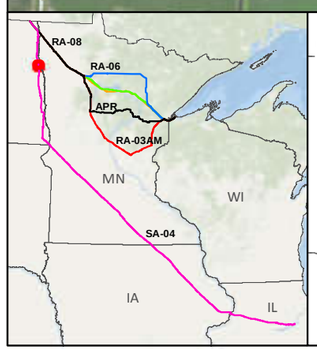
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

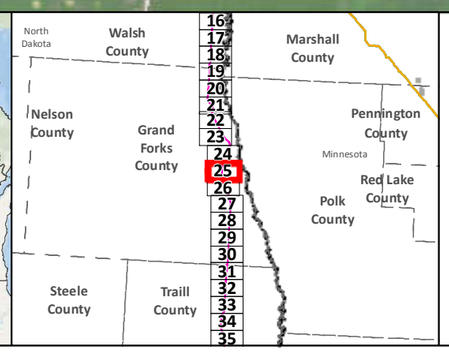
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 24B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

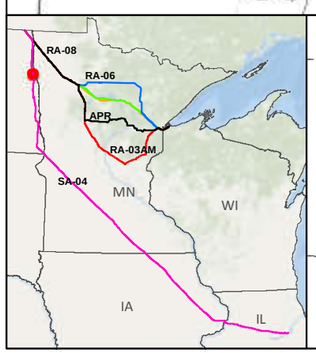
SA-04

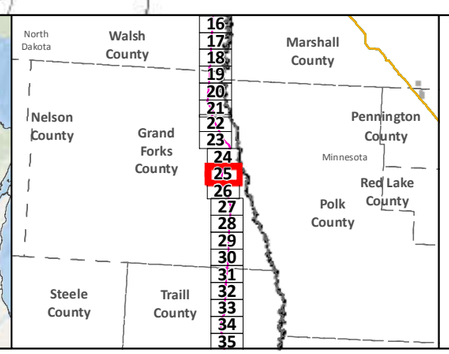
Map 25A of 188

T152N R51W S33
T152N R51W S34
T152N R51W S35
T152N R51W S36
T152N R50W S31
T152N R50W S32
T152N R50W S33
T152 R50W S34
T151N R51W S4
T151N R51W S3
T151N R51W S2
T151N R51W S1
T151N R50W S6
T151N R50W S5
T151N R50W S4
T151N R51W S9
T151N R51W S10
T151N R51W S11
T151N R51W S12
T151N R50W S7
T151N R50W S8
T151N R50W S9
T151N R51W S16
T151N R51W S15
T151N R51W S14
T151N R51W S13
T151N R50W S18
T151N R50W S17
T151N R50W S16

SA-04

82 2 81 83 84 29 297





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

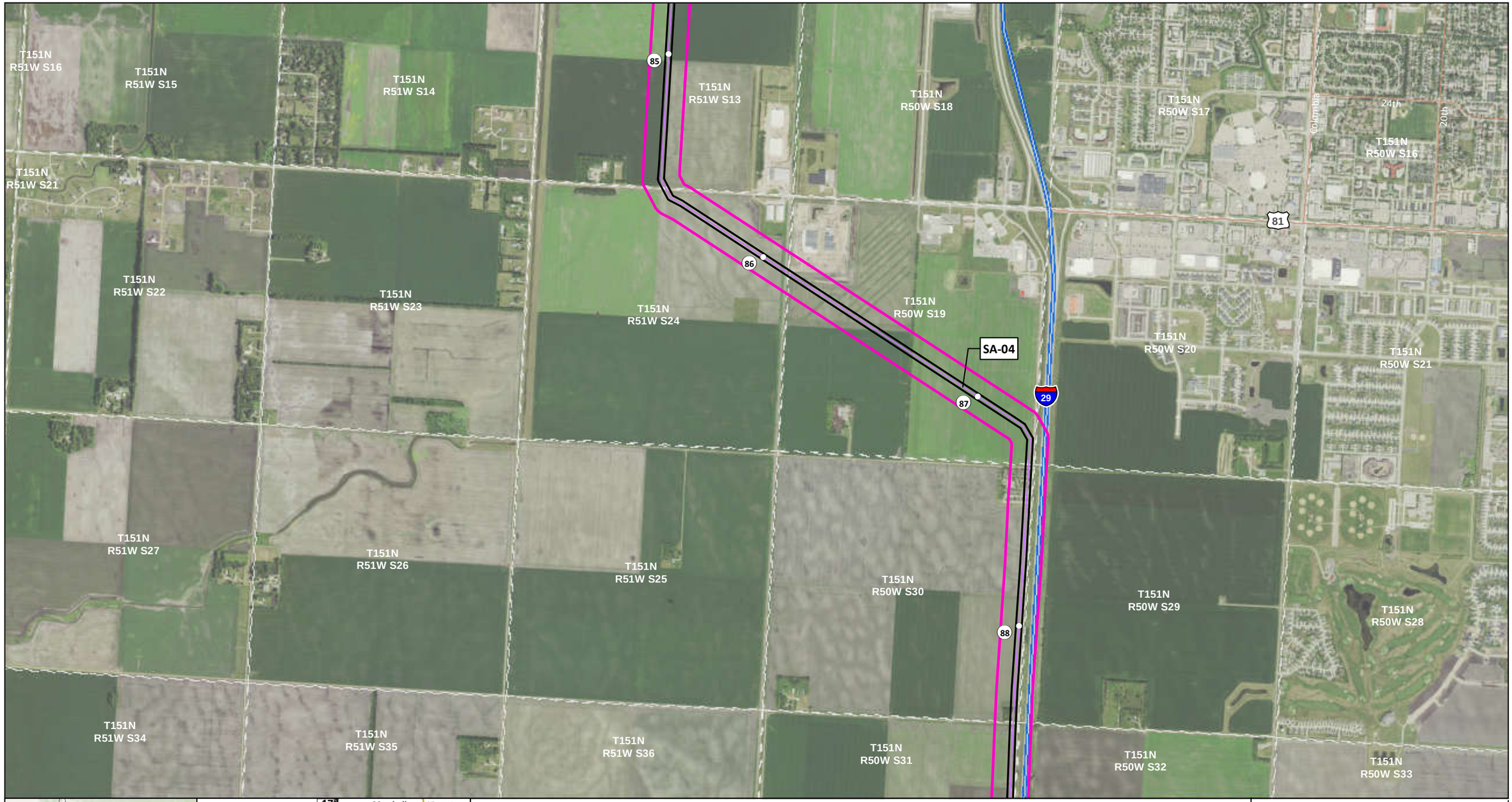
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

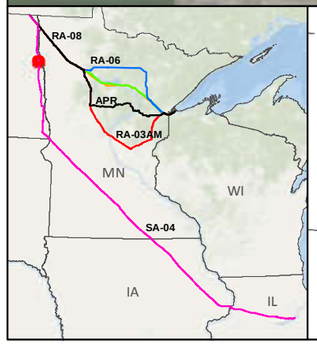
SA-04

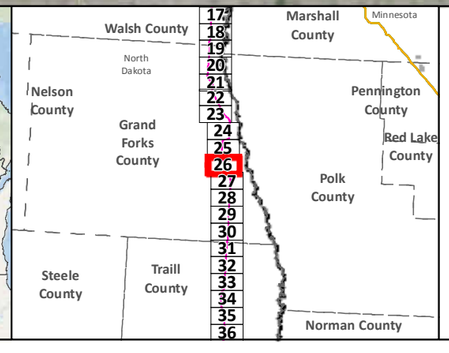
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 25B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

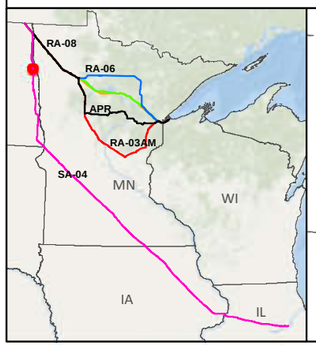
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

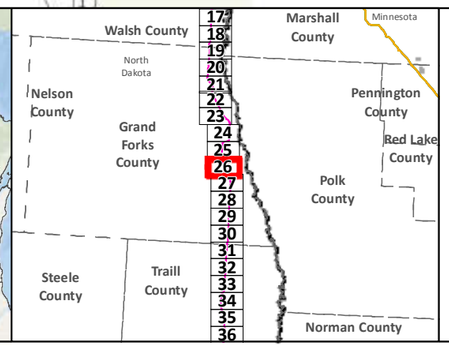
SA-04

T151N R51W S16
T151N R51W S15
T151N R51W S14
T151N R51W S13
T151N R50W S18
T151N R50W S17
T151N R50W S16
T151N R51W S21
T151N R51W S22
T151N R51W S23
T151N R51W S24
T151N R50W S19
T151N R50W S20
T151N R50W S21
T151N R51W S27
T151N R51W S26
T151N R51W S25
T151N R50W S30
T151N R50W S29
T151N R50W S28
T151N R51W S34
T151N R51W S35
T151N R51W S36
T151N R50W S31
T151N R50W S32
T151N R50W S33

85
86
87
88
81
29

SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

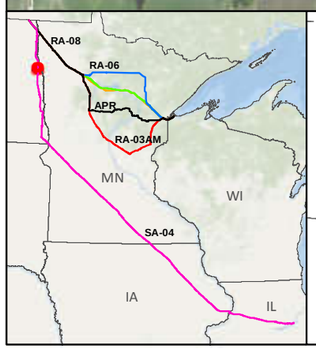
SA-04

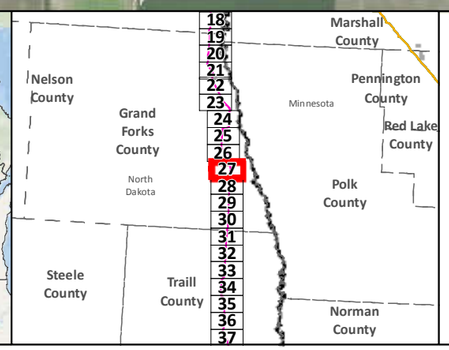
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

T151N R51W S34
T151N R51W S35
T151N R51W S36
T151N R50W S31
T151N R50W S32
T151N R50W S33
T151N R50W S34
T150N R51W S3
T150N R51W S2
T150N R51W S1
T150N R50W S6
T150N R50W S5
T150N R50W S4
T150N R50W S3
T150N R51W S10
T150N R51W S11
T150N R51W S12
T150N R50W S7
T150N R50W S8
T150N R50W S9
T150N R50W S10
T150N R51W S15
T150N R51W S14
T150N R51W S13
T150N R50W S18
T150N R50W S17
T150N R50W S16
T150N R50W S15

89
29
90
91

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 27A of 188

T151N R51W S34
T151N R51W S35
T151N R51W S36
T151N R50W S31
T151N R50W S32
T151N R50W S33
T151N R50W S34
SA-04
89
29
T150N R51W S3
T150N R51W S2
T150N R51W S1
T150N R50W S6
T150N R50W S5
T150N R50W S4
T150N R50W S3
90
T150N R51W S10
T150N R51W S11
T150N R51W S12
T150N R50W S7
T150N R50W S8
T150N R50W S9
T150N R50W S10
91
T150N R51W S15
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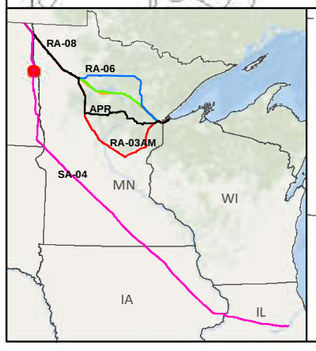
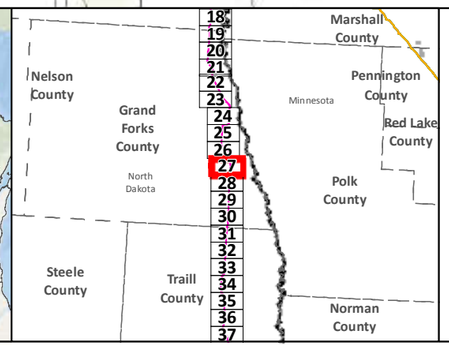
T150N R50W S15





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

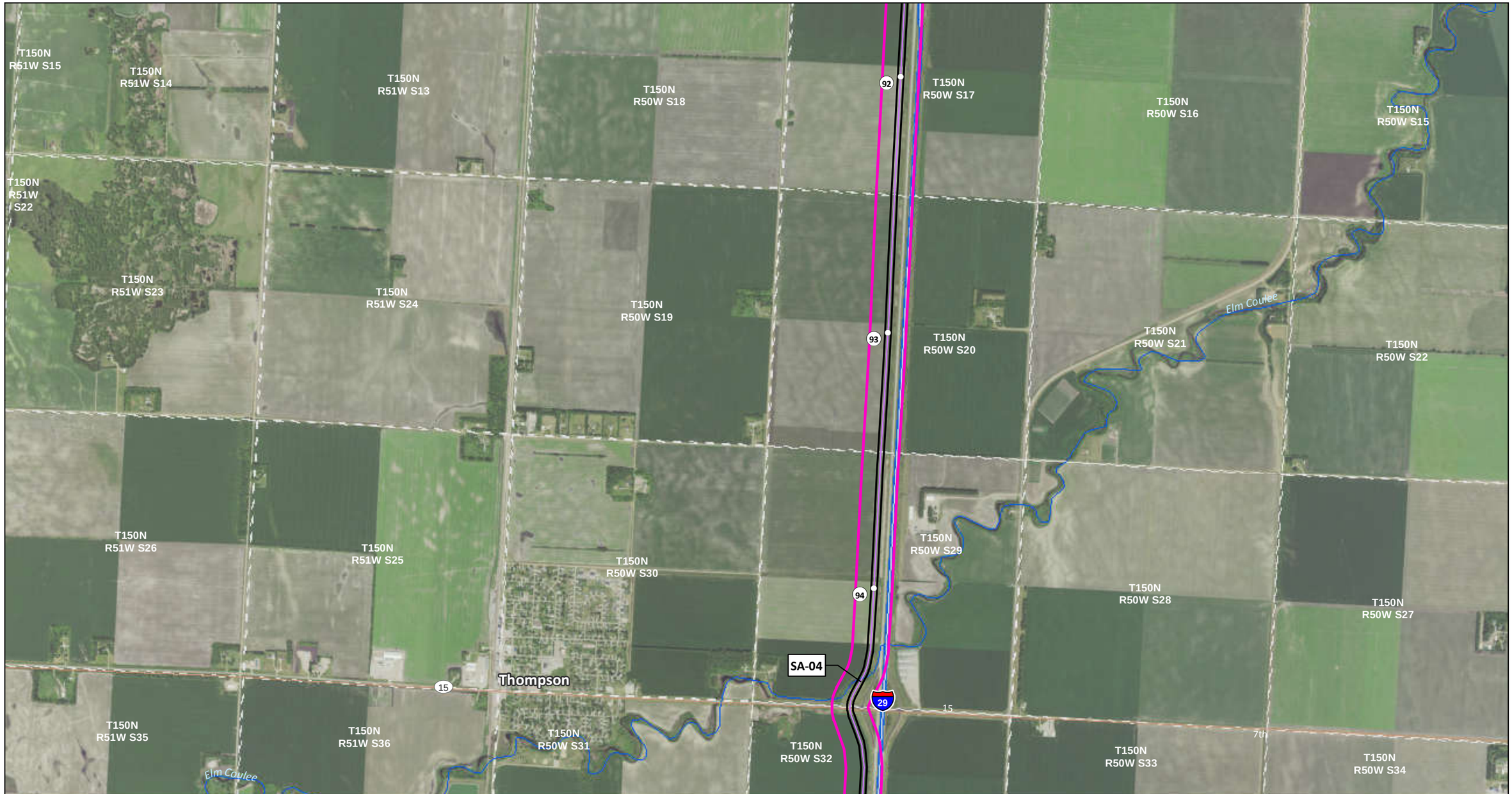
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

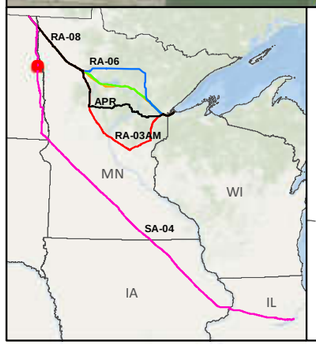
SA-04

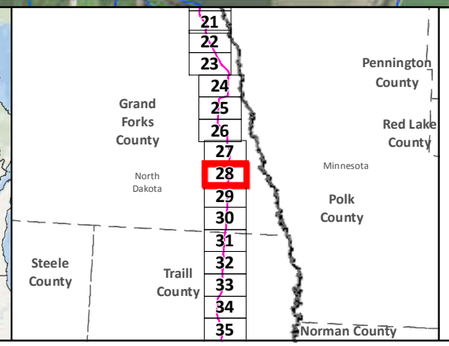
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 27B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 28A of 188

T150N R51W S15
T150N R51W S14
T150N R51W S13
T150N R50W S18
T150N R50W S17
T150N R50W S16
T150N R50W S15
T150N R51W S22
T150N R51W S23
T150N R51W S24
T150N R50W S19
T150N R50W S20
T150N R50W S21
T150N R50W S22
T150N R51W S26
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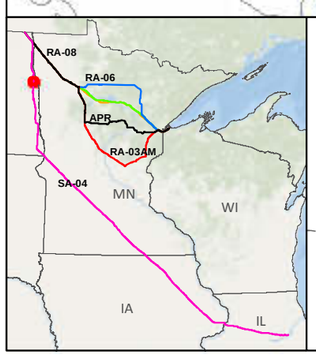
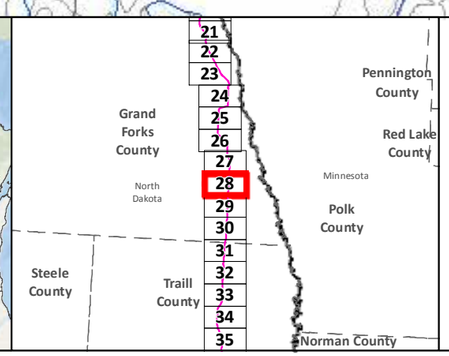
T150N R50W S30
T150N R50W S29
T150N R50W S28
T150N R50W S27
T150N R51W S35
T150N R51W S36
T150N R50W S31
T150N R50W S32
T150N R50W S33
T150N R50W S34

92
93
94
15
29

Elm Coulee
Elm Coulee
Thompson
SA-04





- SA-04
- Applicant's Preferred Route (APR)

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- Outstanding
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- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Elm Coulee

T150N R51W S35 | T150N R51W S36 | T150N R50W S31 | T150N R50W S32 | T150N R50W S33 | T150N R50W S34

T149N R51W S2 | T149N R51W S1 | T149N R50W S6 | T149N R50W S5 | T149N R50W S4 | T149N R50W S3

T149N R50W S2

95 96 97 29

Cole Creek

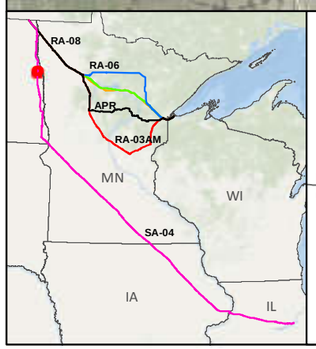
T149N R51W S11 | T149N R51W S12 | T149N R50W S7 | T149N R50W S8 | T149N R50W S9 | T149N R50W S10

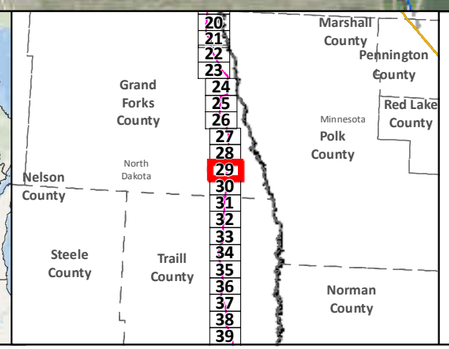
T149N R51W S14 | T149N R51W S13 | T149N R50W S18 | T149N R50W S17 | T149N R50W S16 | T149N R50W S15

T149N R50W S11

T149N R50W S14

SA-04





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

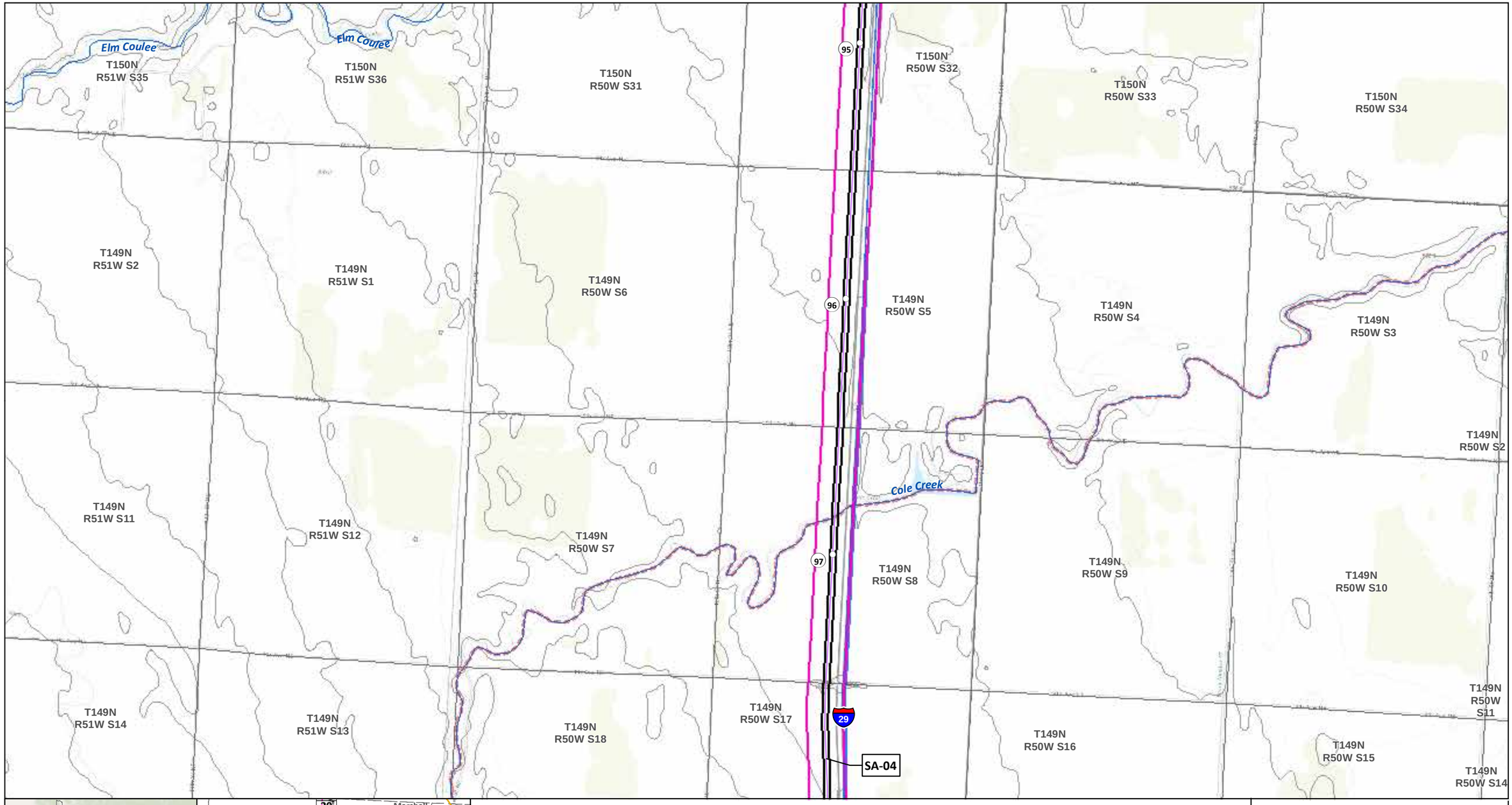
Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 29A of 188


Elm Coulee
Elm Coulee
T150N R51W S35
T150N R51W S36
T150N R50W S31
T150N R50W S32
T150N R50W S33
T150N R50W S34
95
T149N R51W S2
T149N R51W S1
T149N R50W S6
T149N R50W S5
T149N R50W S4
T149N R50W S3
96
Cole Creek
T149N R50W S2
T149N R51W S11
T149N R51W S12
T149N R50W S7
T149N R50W S8
T149N R50W S9
T149N R50W S10
97
T149N R51W S14
T149N R51W S13
T149N R50W S18
T149N R50W S17
T149N R50W S16
T149N R50W S15
T149N R50W S11
T149N R50W S14
29
SA-04
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
Grand Forks County
Nelson County
Steele County
Traill County
Norman County
Polk County
Red Lake County
Pennington County
Marshall County
North Dakota
Minnesota
SA-04
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Anticipated 120' Construction ROW
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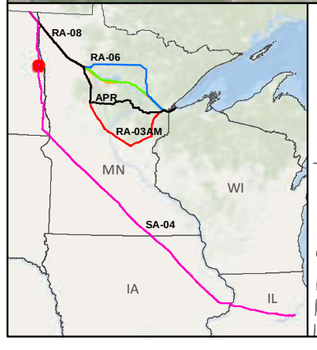
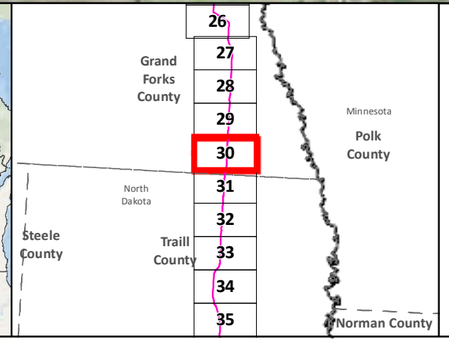
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
SA-04
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours
N
Map 29B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

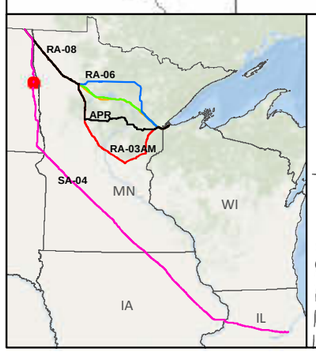
Map 30A of 188

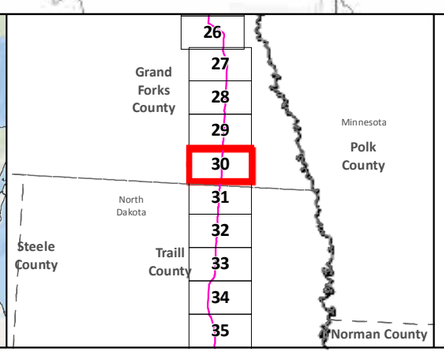
T149N R51W S14
T149N R51W S13
T149N R50W S18
T149N R50W S17
T149N R50W S16
T149N R50W S15
T149N R50W S14
T149N R51W S23
T149N R51W S24
T149N R50W S19
T149N R50W S20
T149N R50W S21
T149N R50W S22
T149N R50W S23
T149N R51W S26
T149N R51W S25
T149N R50W S30
T149N R50W S29
T149N R50W S28
T149N R50W S27
T149N R50W S26
T149N R51W S35
T149N R51W S36
T149N R50W S31
T149N R50W S32
T149N R50W S33
T149N R50W S34
T149N R50W S35

Cole Creek

98
29
99
100
101

SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

T149N R51W S35
T149N R51W S36
T149N R50W S31
T149N R50W S32
T149N R50W S33
T149N R50W S34
T149N R50W S35
Reynolds
Centennial
Eagle
SA-04
29
T148N R51W S3
T148N R51W S2
T148N R51W S1
T148N R50W S6
T148N R50W S5
T148N R50W S4
T148N R50W S3
102
T148N R51W S10
T148N R51W S11
T148N R51W S12
T148N R50W S7
T148N R50W S8
T148N R50W S9
T148N R50W S10
103
T148N R51W S15
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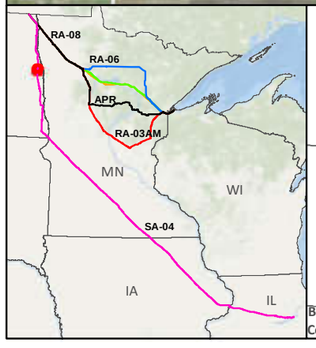
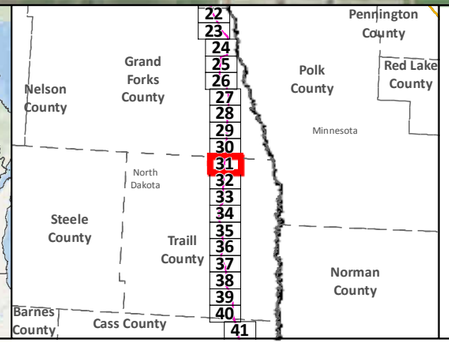
T148N R50W S15
104





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

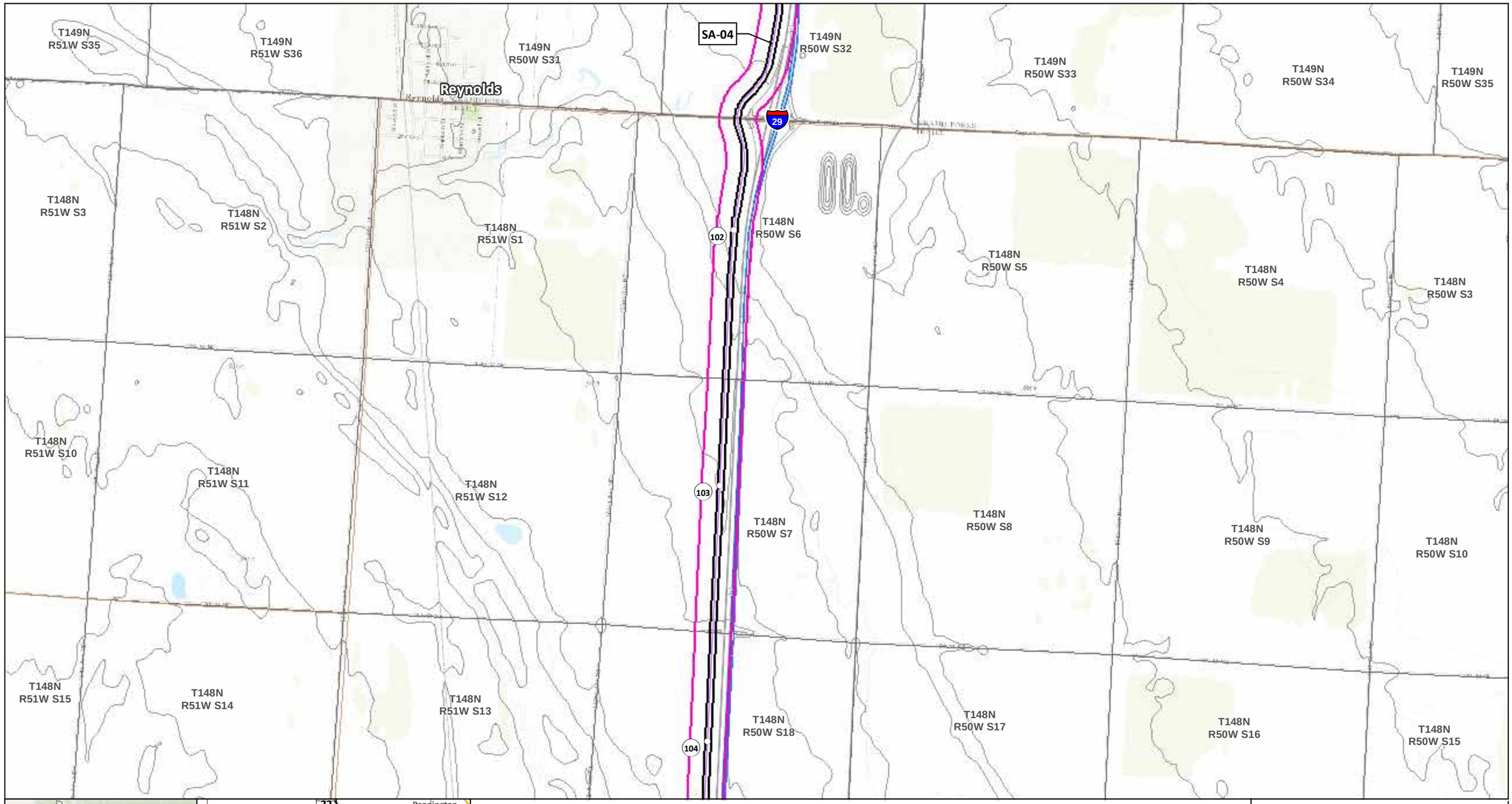
Water Resources
Lake
River

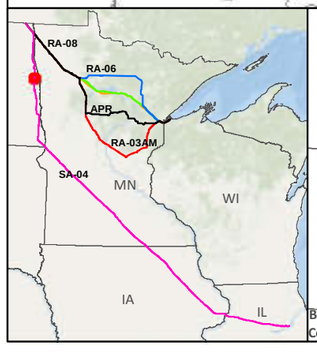
Data Sources:
MNDNR, NHD,USGS, Enbridge

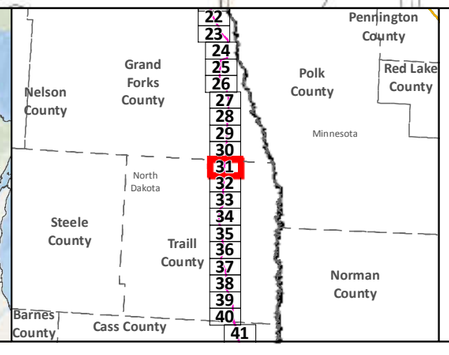
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

10ft Contours

N

Map 31B of 188



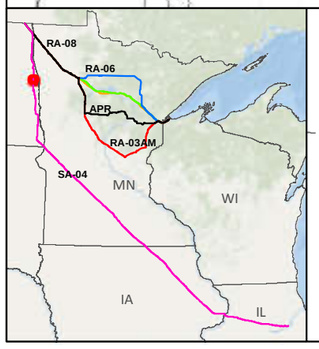
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

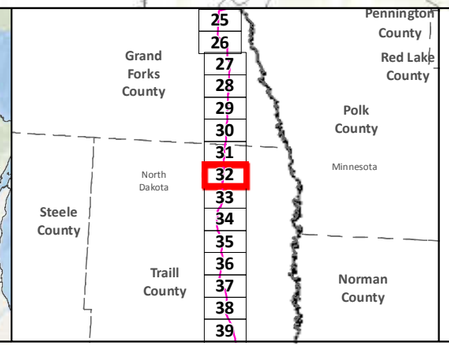
SA-04

Map 32A of 188

T148N R51W S15
T148N R51W S14
T148N R51W S13
T148N R50W S18
T148N R50W S17
T148N R50W S16
T148N R50W S15
T148N R51W S22
T148N R51W S23
T148N R51W S24
T148N R50W S19
T148N R50W S20
T148N R50W S21
T148N R50W S22
T148N R51W S27
T148N R51W S26
T148N R51W S25
T148N R50W S30
T148N R50W S29
T148N R50W S28
T148N R50W S27
T148N R51W S34
T148N R51W S35
T148N R51W S36
T148N R50W S31
T148N R50W S32
T148N R50W S33
T148N R50W S34

29
105
106
107
SA-04
Buxton





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

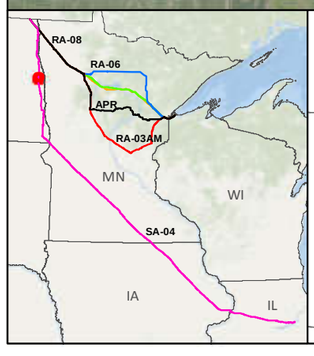
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

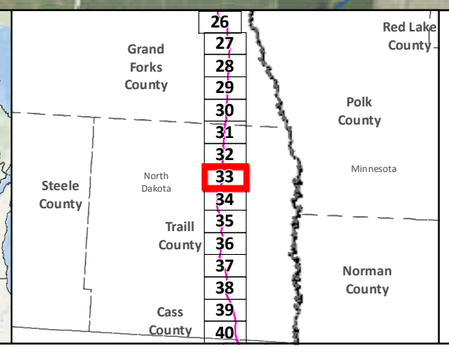
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

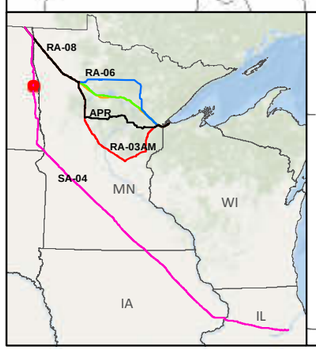
Data Sources:
MNDNR, NHD,USGS, Enbridge

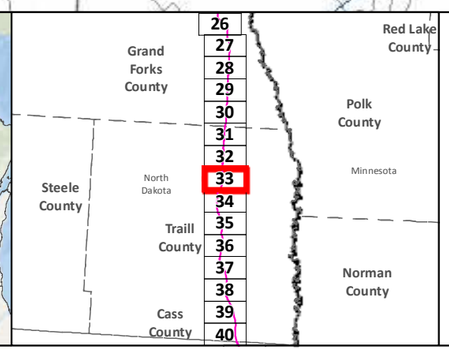
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T148N R51W S34
T148N R51W S35
T148N R51W S36
T148N R50W S31
T148N R50W S32
T148N R50W S33
T148N R50W S34
T147N R51W S3
T147N R51W S2
T147N R51W S1
T147N R50W S6
T147N R50W S5
T147N R50W S4
T147N R50W S3
T147N R51W S10
T147N R51W S11
T147N R51W S12
T147N R50W S8
T147N R50W S9
T147N R50W S10
T147N R50W S7
T147N R51W S14
T147N R51W S13
T147N R50W S18
T147N R50W S17
T147N R50W S16
T147N R50W S15
29
108
109
110
SA-04
Buffalo Coulee





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 33B of 188

T147N R51W S14
T147N R51W S13
T147N R50W S18
T147N R50W S17
T147N R50W S16
T147N R50W S15
Buffalo Coulee
111
T147N R51W S23
T147N R51W S24
T147N R50W S19
T147N R50W S20
T147N R50W S21
T147N R50W S22
112
T147N R51W S26
T147N R51W S25
T147N R50W S30
T147N R50W S29
T147N R50W S28
T147N R50W S27
T147N R50W S26
113
SA-04
T147N R51W S35
T147N R51W S36
T147N R50W S31
T147N R50W S32
T147N R50W S33
T147N R50W S34
T147N R50W S35
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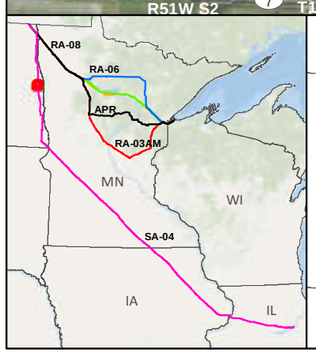
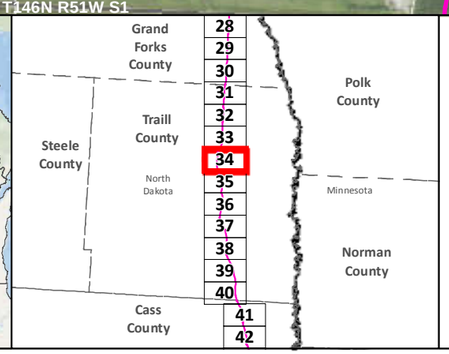
T146N R51W S2
7
T146N R51W S1





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 34A of 188

T147N R51W S14
T147N R51W S13
T147N R50W S18
T147N R50W S17
T147N R50W S16
T147N R50W S15
Buffalo Coulee
111
T147N R51W S23
T147N R51W S24
T147N R50W S19
T147N R50W S20
T147N R50W S21
T147N R50W S22
112
T147N R51W S26
T147N R51W S25
T147N R50W S30
T147N R50W S29
T147N R50W S28
T147N R50W S27
113
SA-04
T147N R51W S35
T147N R51W S36
T147N R50W S31
T147N R50W S32
T147N R50W S33
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T147N R50W S26
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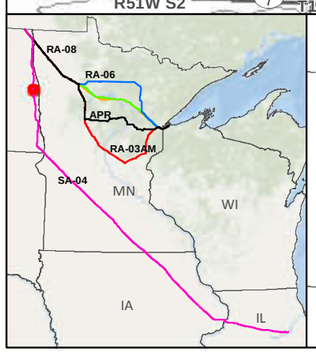
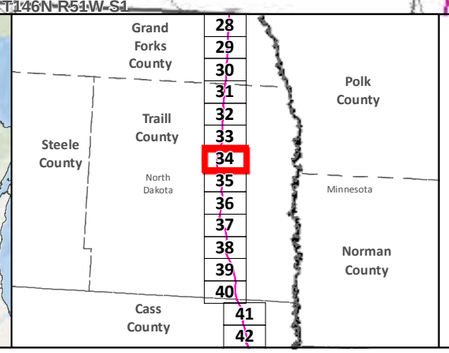
29
T146N R51W S2
7
T146N-R51W-S1





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
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Lakes of Biological Significance
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 34B of 188

T147N R51W S36
T147N R50W S31
T147N R50W S32
T147N R50W S33
T147N R50W S34
T147N R50W S35
T146N R51W S2
T146N R51W S1
T146N R50W S6
T146N R50W S5
T146N R50W S4
T146N R50W S3
T146N R50W S2
T146N R51W S11
T146N R51W S12
T146N R50W S7
T146N R50W S8
T146N R50W S9
T146N R50W S10
T146N R51W S14
T146N R51W S13
T146N R50W S18
T146N R50W S17
T146N R50W S16
T146N R50W S15
T146N R50W S14
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SA-04
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115
116
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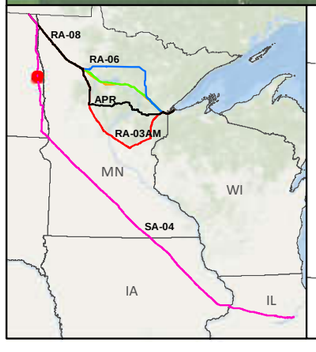

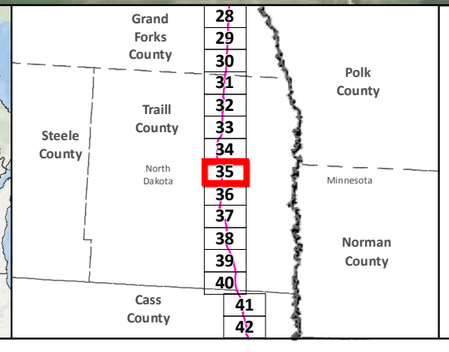

SA-04
Applicant's Preferred Route (APR)
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Route Width (750')
County Boundary

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State Forest
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River

Data Sources:
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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T147N R51W S36
T147N R50W S31
T147N R50W S32
T147N R50W S33
T147N R50W S34
T147N R50W S35
T146N R51W S2
T146N R51W S1
T146N R50W S6
T146N R50W S5
T146N R50W S4
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T146N R50W S2
SA-04
T146N R51W S11
T146N R51W S12
T146N R50W S7
T146N R50W S8
T146N R50W S9
T146N R50W S10
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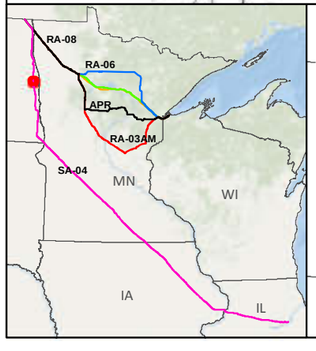
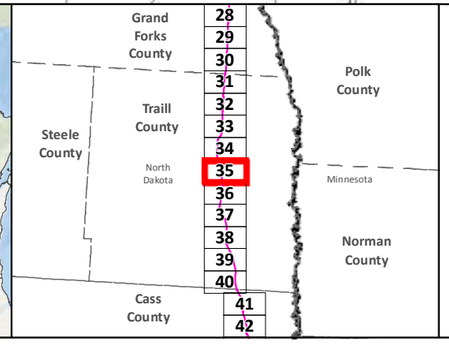
T146N R50W S20





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

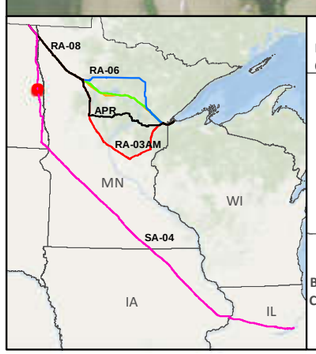
SA-04

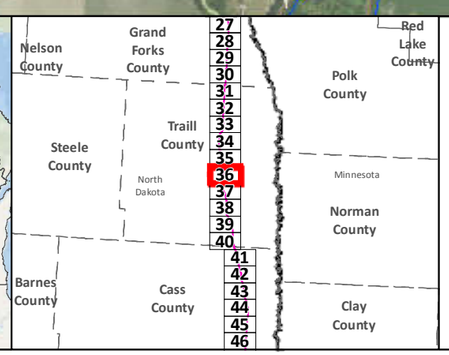
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 35B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

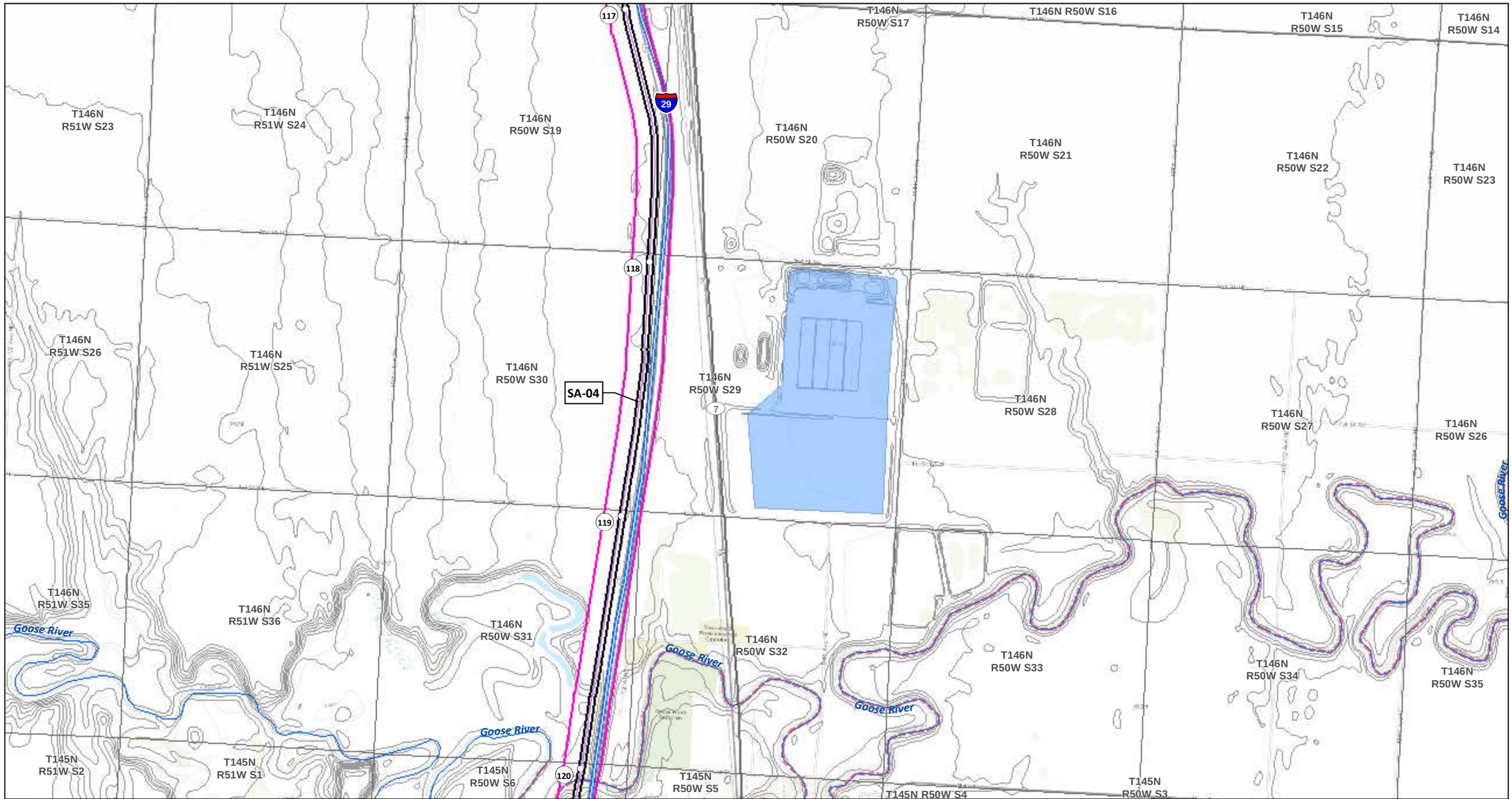
Data Sources:
MNDNR, NHD,USGS, Enbridge

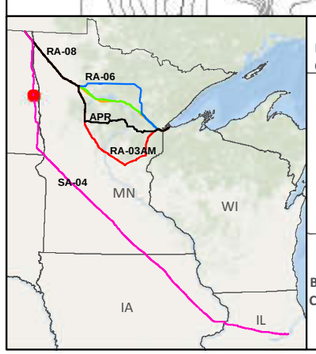
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

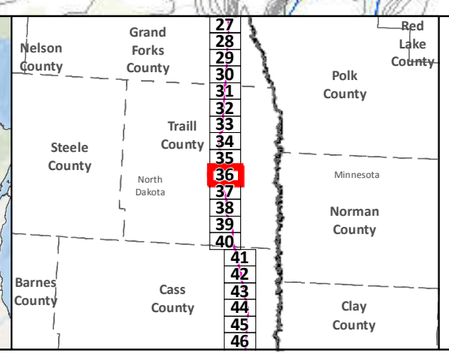
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 36A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

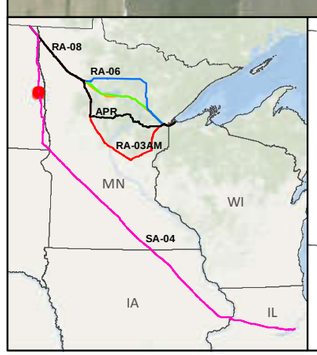
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

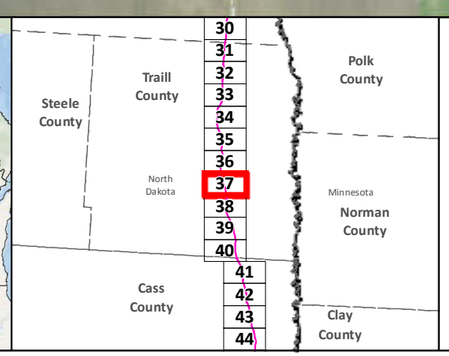
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 36B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

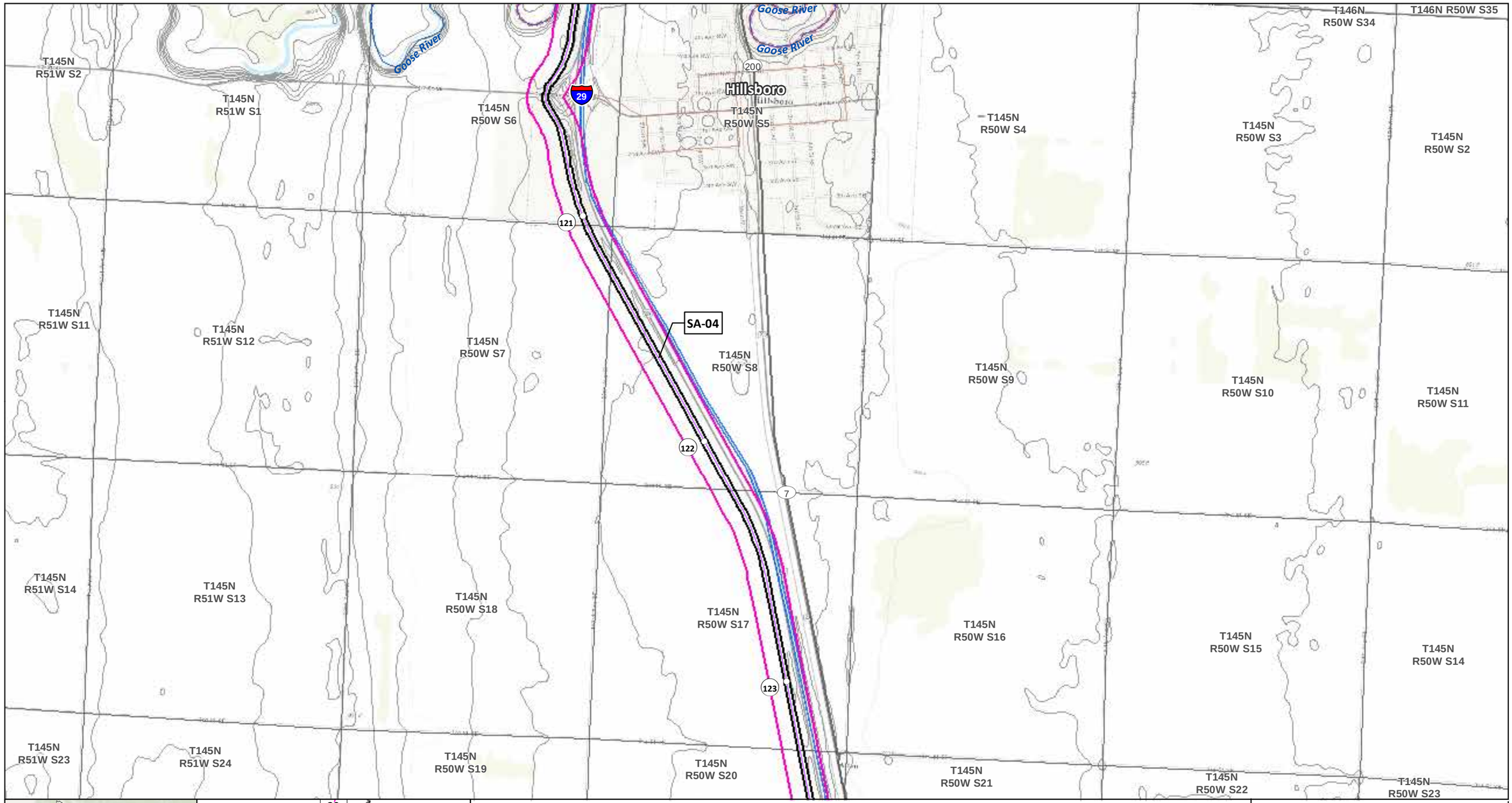
Data Sources:
MNDNR, NHD,USGS, Enbridge

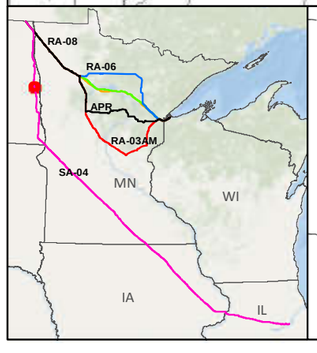
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

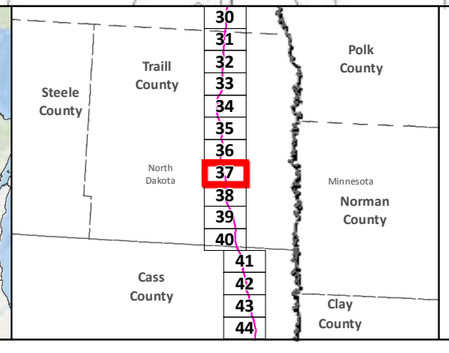
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 37A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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- Township Boundary

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- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

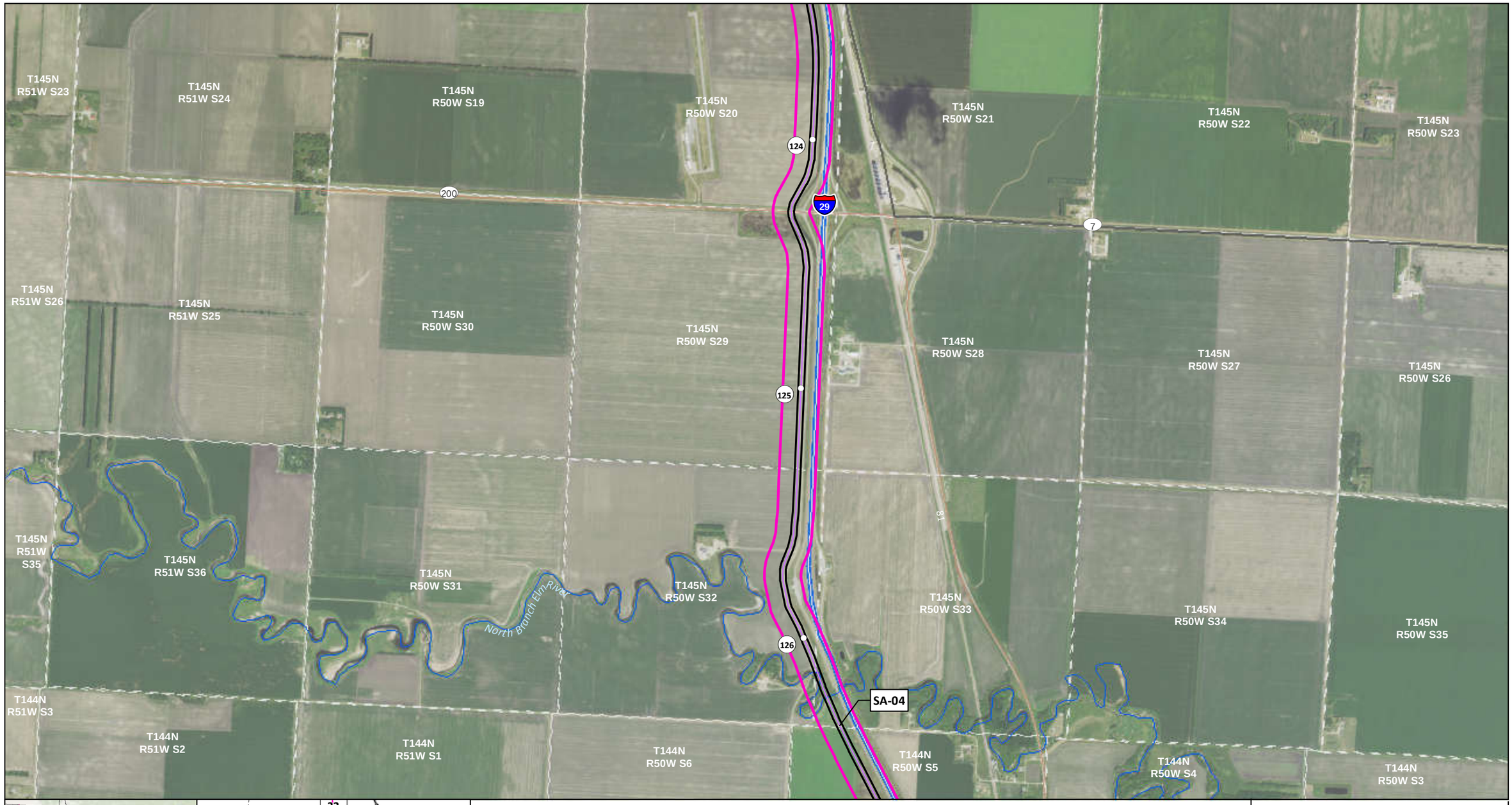
Data Sources: MNDNR, USGS, NHD, Enbridge

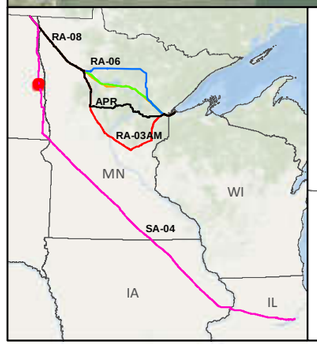
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

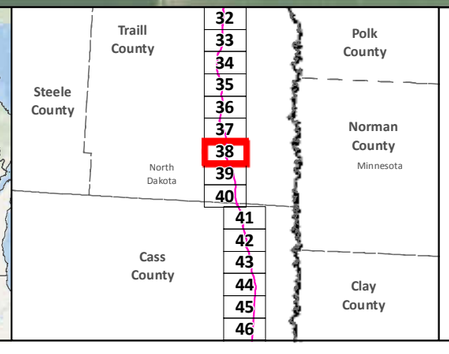
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 37B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

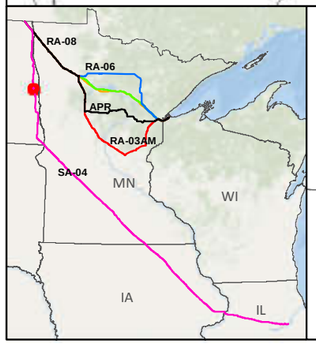
SA-04

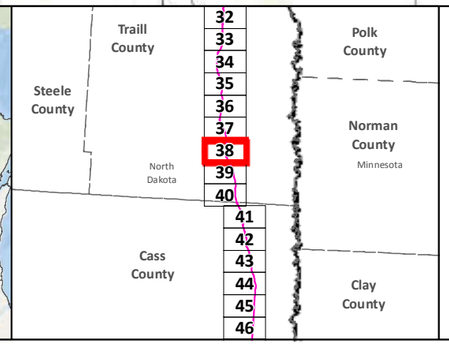
Map 38A of 188

T145N R51W S23
T145N R51W S24
T145N R50W S19
T145N R50W S20
T145N R50W S21
T145N R50W S22
T145N R50W S23
T145N R51W S26
T145N R51W S25
T145N R50W S30
T145N R50W S29
T145N R50W S28
T145N R50W S27
T145N R50W S26
T145N R51W S35
T145N R51W S36
T145N R50W S31
T145N R50W S32
T145N R50W S33
T145N R50W S34
T145N R50W S35
T144N R51W S3
T144N R51W S2
T144N R51W S1
T144N R50W S6
T144N R50W S5
T144N R50W S4
T144N R50W S3

200
124
29
7
125
126
SA-04

Elm River
North Branch





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 38B of 188

T144N R51W S3
T144N R51W S2
T144N R51W S1
T144N R50W S6
T144N R50W S5
T144N R50W S4
T144N R50W S3
T144N R51W S10
T144N R51W S11
T144N R51W S12
T144N R50W S7
T144N R50W S8
T144N R50W S9
T144N R50W S10
T144N R51W S15
T144N R51W S14
T144N R51W S13
T144N R50W S18
T144N R50W S17
T144N R50W S16
T144N R50W S15
T144N R51W S22
T144N R51W S23
T144N R51W S24
T144N R50W S19
T144N R50W S20
T144N R50W S21
T144N R50W S22

Elm River
North Branch Elm River

SA-04

127
128
129
29
81

RA-08
RA-06
APR
RA-03AM
MN
WI
SA-04
IA
IL

Traill County
Steele County
Polk County
Norman County
Minnesota
North Dakota
Cass County
Clay County
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SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 39A of 188

T144N R51W S2
T144N R51W S1
T144N R50W S6
T144N R50W S5
T144N R50W S4
T144N R50W S3
T144N R51W S3
T144N R51W S10
T144N R51W S11
T144N R51W S12
T144N R50W S7
T144N R50W S8
T144N R50W S9
T144N R50W S10
T144N R51W S15
T144N R51W S14
T144N R51W S13
T144N R50W S18
T144N R50W S17
T144N R50W S16
T144N R50W S15
T144N R51W S22
T144N R51W S23
T144N R51W S24
T144N R50W S19
T144N R50W S20
T144N R50W S21
T144N R50W S22

North Branch Elm River
Elm River

SA-04

127
128
129
29

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Traill County
Steele County
North Dakota
Cass County
Polk County
Norman County
Minnesota
Clay County

32
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46

SA-04
Applicant's Preferred Route (APR)

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Lakes of Biological Significance
Outstanding
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Moderate

Native Plant Communities with Biodiversity Significance
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High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 39B of 188



LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 40A of 188

T144N R51W S23
T144N R51W S24
T144N R50W S19
T144N R50W S20
T144N R50W S21
T144N R50W S22
T144N R51W S26
T144N R51W S25
T144N R50W S30
T144N R50W S29
T144N R50W S28
T144N R50W S27
T144N R50W S26
T144N R51W S35
T144N R51W S36
T144N R50W S31
T144N R50W S32
T144N R50W S33
T144N R50W S34
T144N R50W S35
T143N R51W S2
T143N R51W S1
T143N R50W S6
T143N R50W S5
T143N R50W S4
T143N R50W S3
T143N R50W S2

South Branch Elm River
Elm River

130
131
132
133
29

SA-04

Grandin

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Steele County
Traill County
Grand Forks County
Polk County
Norman County
Barnes County
North Dakota
Minnesota
Cass County
Clay County
Becker County
31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

SA-04
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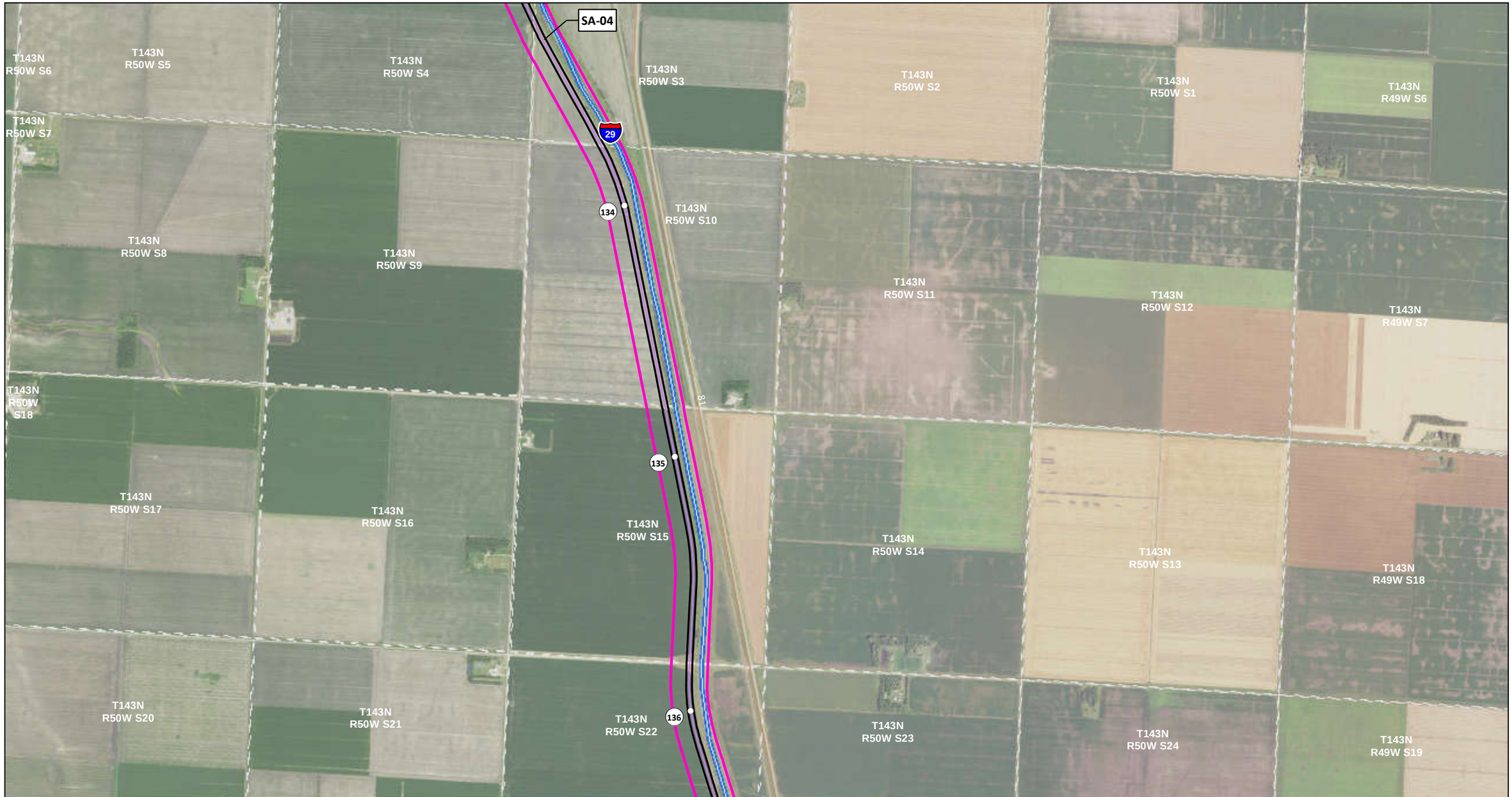
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

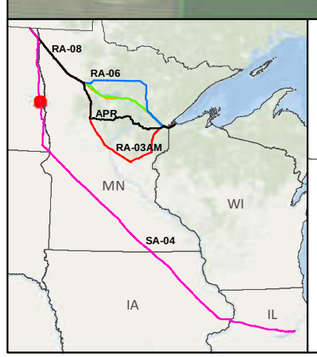
SA-04

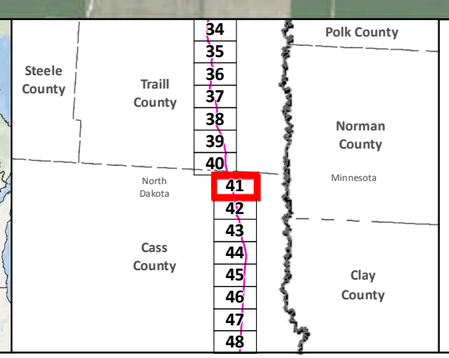
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 40B of 188







SA-04
Applicant's Preferred Route (APR)
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Route Width (750')
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Water Resources
Lake
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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 41A of 188

SA-04

T143N R50W S6
T143N R50W S5
T143N R50W S4
T143N R50W S3
T143N R50W S2
T143N R50W S1
T143N R49W S6
T143N R50W S7
T143N R50W S8
T143N R50W S9
T143N R50W S10
T143N R50W S11
T143N R50W S12
T143N R49W S7
T143N R50W S18
T143N R50W S17
T143N R50W S16
T143N R50W S15
T143N R50W S14
T143N R50W S13
T143N R49W S18
T143N R50W S20
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T143N R50W S23
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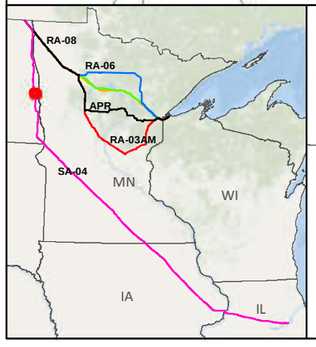
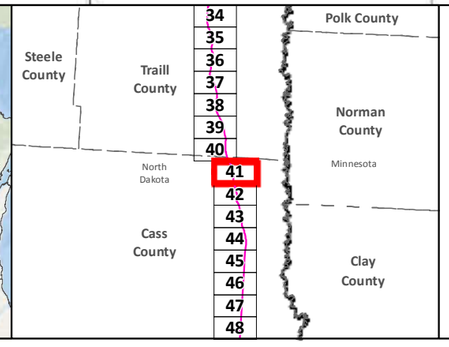
T143N R49W S19

29
134
135
136





SA-04
Applicant's Preferred Route (APR)

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- RA-07
- RA-08

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Anticipated 120' Construction ROW Route Width (750')

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Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

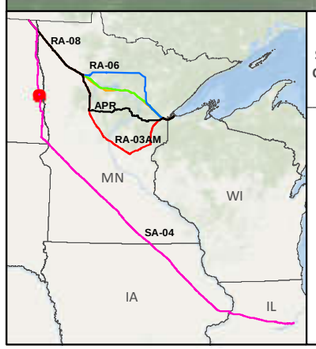
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

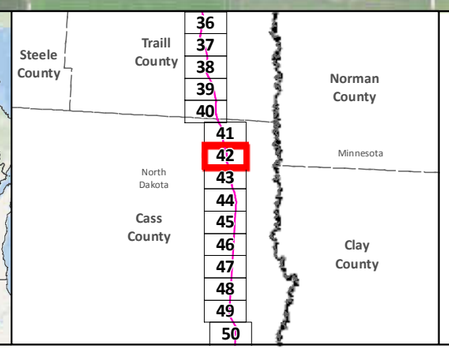
SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

T143N R50W S20
T143N R50W S21
T143N R50W S22
T143N R50W S23
T143N R50W S24
T143N R49W S19
T143N R50W S29
T143N R50W S28
T143N R50W S27
T143N R50W S26
T143N R50W S25
T143N R49W S30
T143N R50W S32
T143N R50W S33
T143N R50W S34
T143N R50W S35
T143N R50W S36
T143N R49W S31
T142N R50W S5
T142N R50W S4
T142N R50W S3
T142N R50W S2
T142N R50W S1
T142N R49W S6
T142N R49W S5
T143N R49W S32
137
138
139
29
SA-04
81
18th
26
Gardner





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 42A of 188

T143N R50W S20
T143N R50W S21
T143N R50W S22
T143N R50W S23
T143N R50W S24
T143N R49W S19
T143N R50W S29
T143N R50W S28
T143N R50W S27
T143N R50W S26
T143N R50W S25
T143N R49W S30
T143N R50W S32
T143N R50W S33
T143N R50W S34
T143N R50W S35
T143N R50W S36
T143N R49W S31
T143N R49W S32
T142N R50W S5
T142N R50W S4
T142N R50W S3
T142N R50W S2
T142N R50W S1
T142N R49W S6
T142N R49W S5

137
138
139
29

SA-04

Gardner

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Steele County
Traill County
Norman County
Minnesota
North Dakota
Cass County
Clay County
36
37
38
39
40
41
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43
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45
46
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49
50

- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

T142N R50W S5
T142N R50W S4
T142N R50W S3
T142N R50W S2
T142N R50W S1
T142N R49W S6
T142N R49W S5
T142N R50W S8
T142N R50W S9
T142N R50W S10
T142N R50W S11
T142N R50W S12
T142N R49W S7
T142N R49W S8
T142N R50W S17
T142N R50W S16
T142N R50W S15
T142N R50W S14
T142N R50W S13
T142N R49W S18
T142N R49W S17
T142N R50W S20
T142N R50W S21
T142N R50W S22
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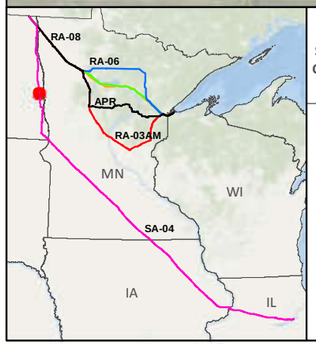
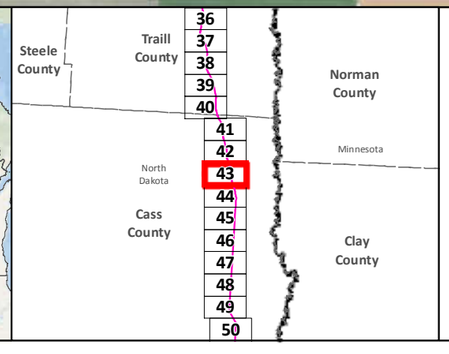
T142N R49W S20

140
141
142
29
81
SA-04





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

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- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T142N R50W S5
T142N R50W S4
T142N R50W S3
T142N R50W S2
T142N R50W S1
T142N R49W S6
T142N R49W S5
T142N R50W S8
T142N R50W S9
T142N R50W S10
T142N R50W S11
T142N R50W S12
T142N R49W S7
T142N R49W S8
T142N R50W S17
T142N R50W S16
T142N R50W S15
T142N R50W S14
T142N R50W S13
T142N R49W S18
T142N R49W S17
T142N R50W S20
T142N R50W S21
T142N R50W S22
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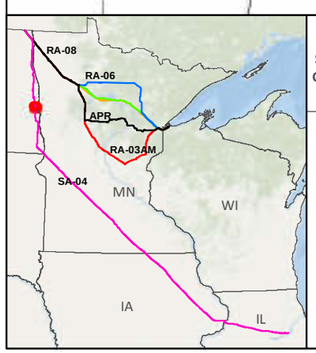
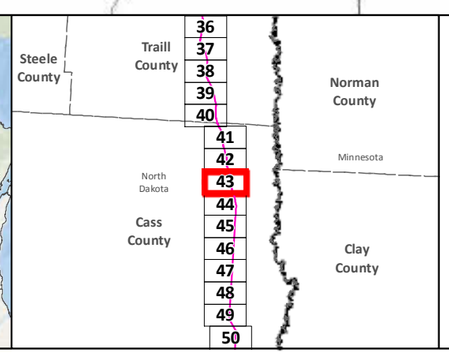
T142N R50W S24
T142N R49W S19
T142N R49W S20
140
141
142
29
SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

T142N R50W S20
T142N R50W S21
T142N R50W S22
T142N R50W S23
T142N R50W S24
T142N R49W S19
T142N R49W S20
T142N R50W S29
T142N R50W S28
T142N R50W S27
T142N R50W S26
T142N R50W S25
T142N R49W S30
T142N R49W S29
T142N R50W S32
T142N R50W S33
T142N R50W S34
T142N R50W S35
T142N R50W S36
T142N R49W S31
T142N R49W S32
T141N R50W S5
T141N R50W S4
T141N R50W S3
T141N R50W S2
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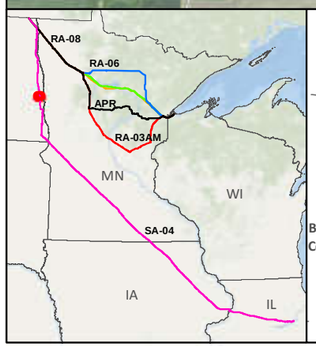
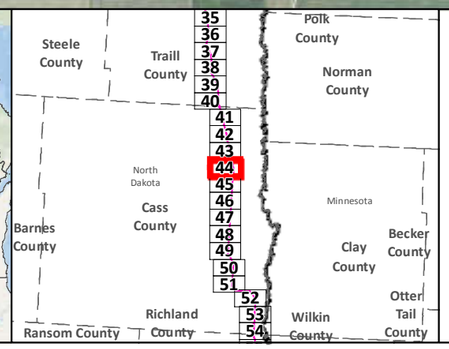
T141N R49W S5
143
144
145
29
81
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T142N R50W S20
T142N R50W S21
T142N R50W S22
T142N R50W S23
T142N R50W S24
T142N R49W S19
T142N R49W S20
T142N R50W S29
T142N R50W S28
T142N R50W S27
T142N R50W S26
T142N R50W S25
T142N R49W S30
T142N R49W S29
T142N R50W S32
T142N R50W S33
T142N R50W S34
T142N R50W S35
T142N R50W S36
T142N R49W S31
T142N R49W S32
T141N R50W S5
T141N R50W S4
T141N R50W S3
T141N R50W S2
T141N R50W S1
T141N R49W S6
T141N R49W S5

143
29
144
145
SA-04

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Steele County
Traill County
Polk County
Norman County
North Dakota
Minnesota
Cass County
Barnes County
Clay County
Becker County
Richland County
Wilkin County
Otter Tail County
Ransom County
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

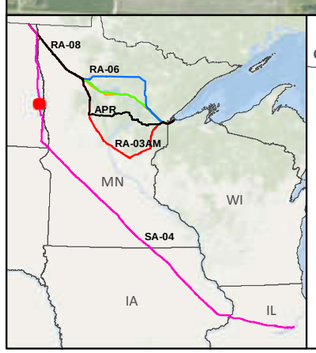
SA-04

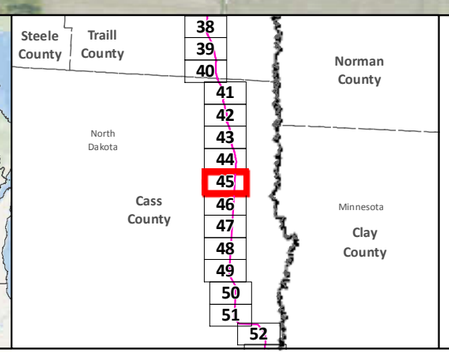
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 44B of 188

T141N R50W S5
T141N R50W S4
T141N R50W S3
T141N R50W S2
T141N R50W S1
Argusville
T141N R49W S6
T141N R49W S5
25th
T141N R50W S8
T141N R50W S9
T141N R50W S10
T141N R50W S11
T141N R50W S12
T141N R49W S7
T141N R49W S8
146
147
SA-04
29
T141N R50W S17
T141N R50W S16
T141N R50W S15
T141N R50W S14
T141N R50W S13
T141N R49W S18
T141N R49W S17
148
T141N R50W S20
T141N R50W S21
T141N R50W S22
T141N R50W S23
T141N R50W S24
T141N R49W S19
T141N R49W S20
149





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

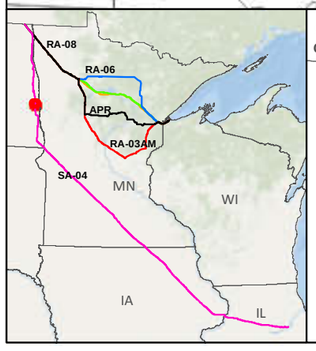
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

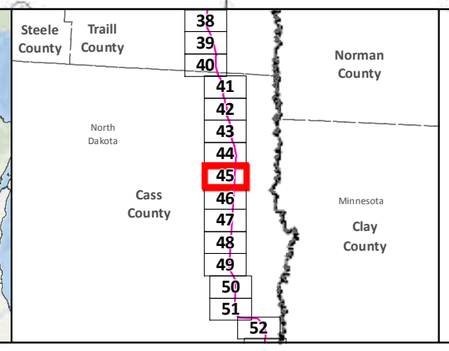
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 45A of 188

T141N R50W S5
T141N R50W S4
T141N R50W S3
T141N R50W S2
T141N R50W S1
Argusville
T141N R49W S6
T141N R49W S5
T141N R50W S8
T141N R50W S9
T141N R50W S10
T141N R50W S11
T141N R50W S12
T141N R49W S7
T141N R49W S8
T141N R50W S17
T141N R50W S16
T141N R50W S15
T141N R50W S14
T141N R50W S13
T141N R49W S18
T141N R49W S17
T141N R50W S20
T141N R50W S21
T141N R50W S22
T141N R50W S23
T141N R50W S24
T141N R49W S19
T141N R49W S20
146
147
148
149
29
SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

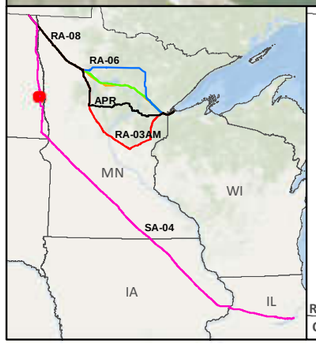
SA-04

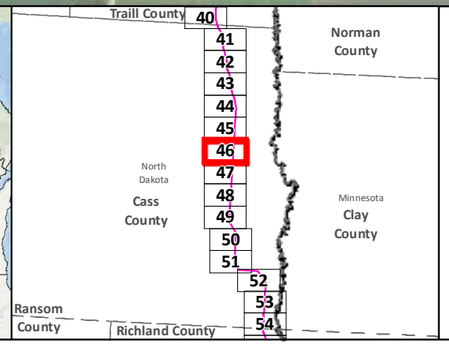
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 45B of 188

T141N R50W S20
T141N R50W S21
T141N R50W S22
T141N R50W S23
T141N R50W S24
T141N R49W S19
T141N R49W S20
T141N R50W S29
T141N R50W S28
T141N R50W S27
T141N R50W S26
Rush River
T141N R50W S25
T141N R49W S30
T141N R49W S29
150
SA-04
T141N R50W S32
T141N R50W S33
T141N R50W S34
T141N R50W S35
T141N R50W S36
T141N R49W S31
T141N R49W S32
151
T140N R50W S6
Lower Branch Rush River
T140N R50W S5
T140N R50W S4
T140N R50W S3
T140N R50W S2
T140N R50W S1
T140N R49W S6
152
T140N R50W S8
T140N R50W S9
T140N R50W S10
T140N R50W S11
T140N R50W S12





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

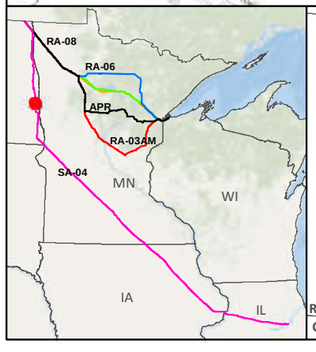
Data Sources:
MNDNR, NHD,USGS, Enbridge

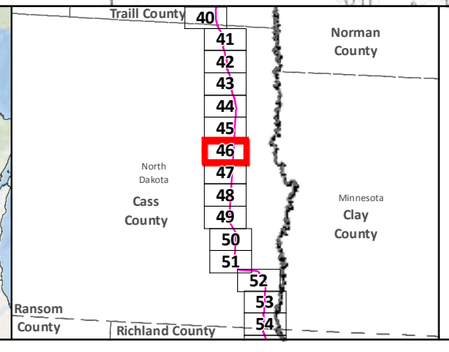
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T141N R50W S20
T141N R50W S21
T141N R50W S22
T141N R50W S23
T141N R50W S24
T141N R49W S19
T141N R49W S20
T141N R50W S29
T141N R50W S28
T141N R50W S27
T141N R50W S26
Rush River
T141N R50W S25
T141N R49W S30
T141N R49W S29
150
T141N R50W S32
T141N R50W S33
T141N R50W S34
T141N R50W S35
T141N R50W S36
SA-04
T141N R49W S31
T141N R49W S32
151
T140N R50W S6
Lower Branch Rush River
T140N R50W S5
T140N R50W S4
T140N R50W S3
T140N R50W S2
T140N R50W S1
T140N R49W S6
152
T140N R50W S8
T140N R50W S9
T140N R50W S10
T140N R50W S11
T140N R50W S12





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

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- Township Boundary

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- WMA - Wildlife Management Areas
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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- High
- Moderate

Native Plant Communities with Biodiversity Significance
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- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

T140N R50W S8
T140N R50W S9
T140N R50W S10
T140N R50W S11
T140N R50W S12
T140N R50W S1
T140N R49W S6
T140N R49W S7
T140N R50W S17
T140N R50W S16
T140N R50W S15
T140N R50W S14
T140N R50W S13
T140N R49W S18
T140N R50W S20
T140N R50W S21
T140N R50W S22
T140N R50W S23
T140N R50W S24
T140N R49W S19
T140N R50W S29
T140N R50W S28
T140N R50W S27
T140N R50W S26
T140N R50W S25
T140N R49W S30

Lower Branch Rush River
Maple River
Sheyenne River
Maple River

153
154
155

SA-04

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Traill County
Norman County
North Dakota
Cass County
Minnesota
Clay County
Ransom County
Richland County
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54

SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T140N R50W S8
T140N R50W S9
T140N R50W S10
T140N R50W S11
T140N R50W S12
T140N R50W S1
T140N R49W S6
T140N R49W S7
SA-04
153
Lower Branch Rush River
T140N R50W S17
T140N R50W S16
T140N R50W S15
T140N R50W S14
T140N R50W S13
T140N R49W S18
154
Sheyenne River
Maple River
T140N R50W S20
T140N R50W S21
T140N R50W S22
T140N R50W S23
T140N R50W S24
T140N R49W S19
155
T140N R50W S29
T140N R50W S28
T140N R50W S27
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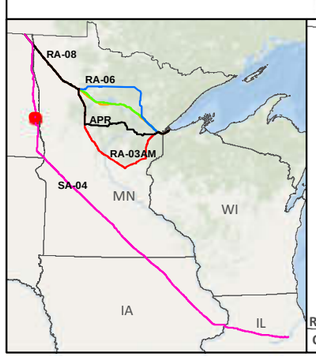
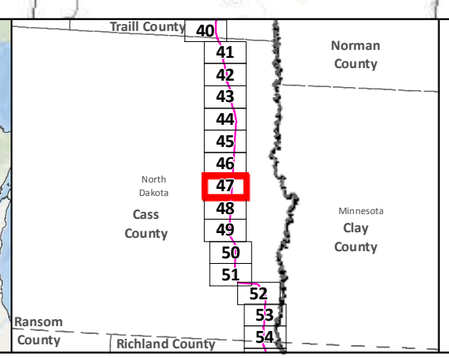
T140N R50W S25
T140N R49W S30





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

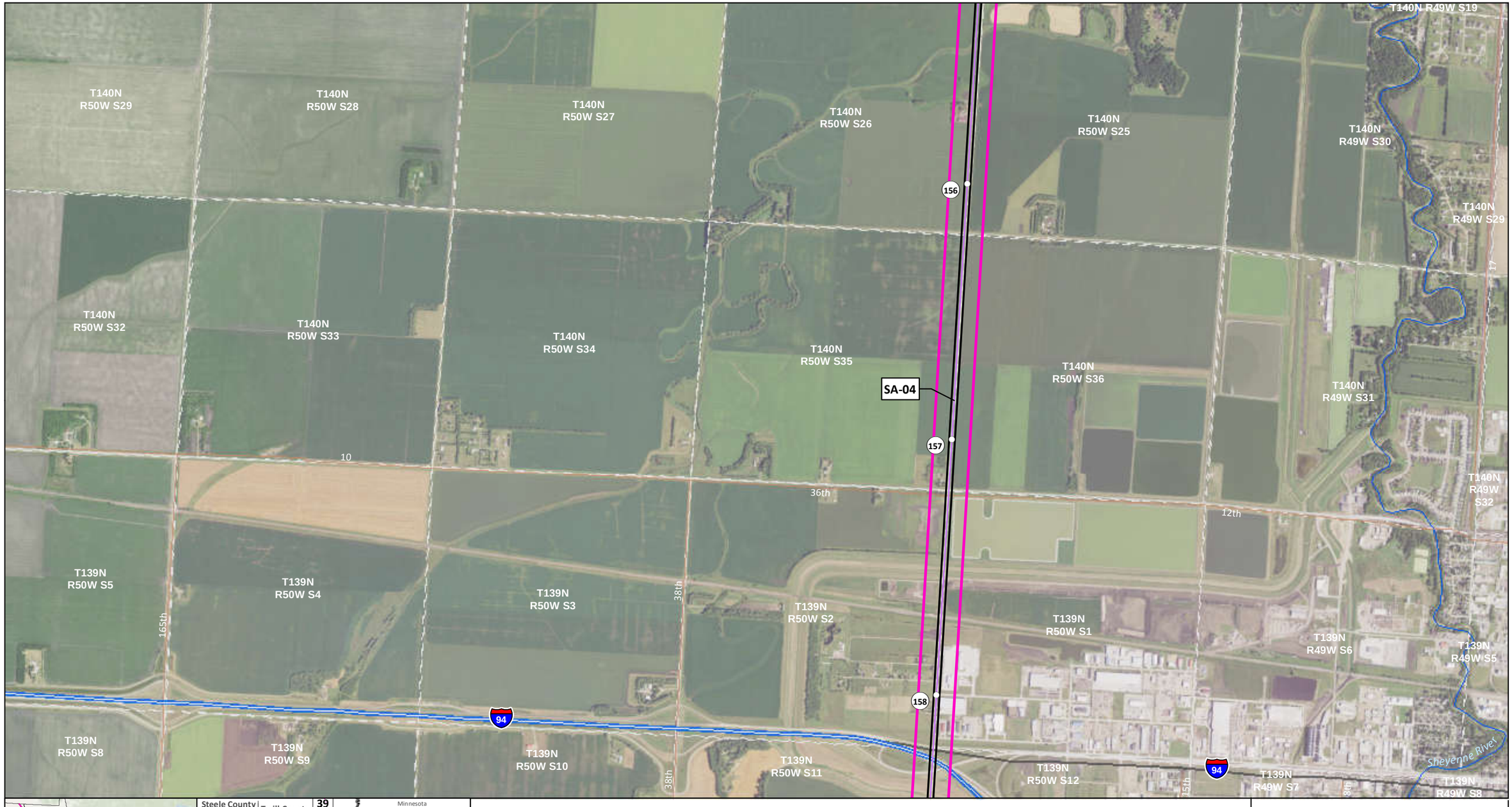
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

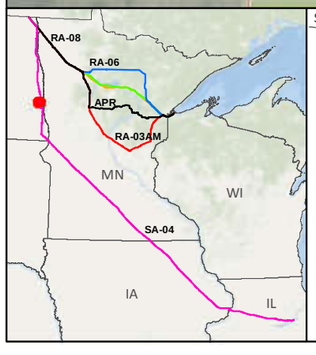
SA-04

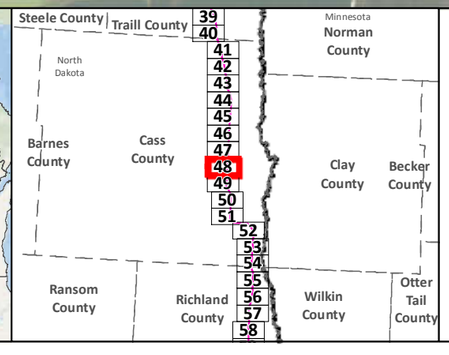
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 47B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

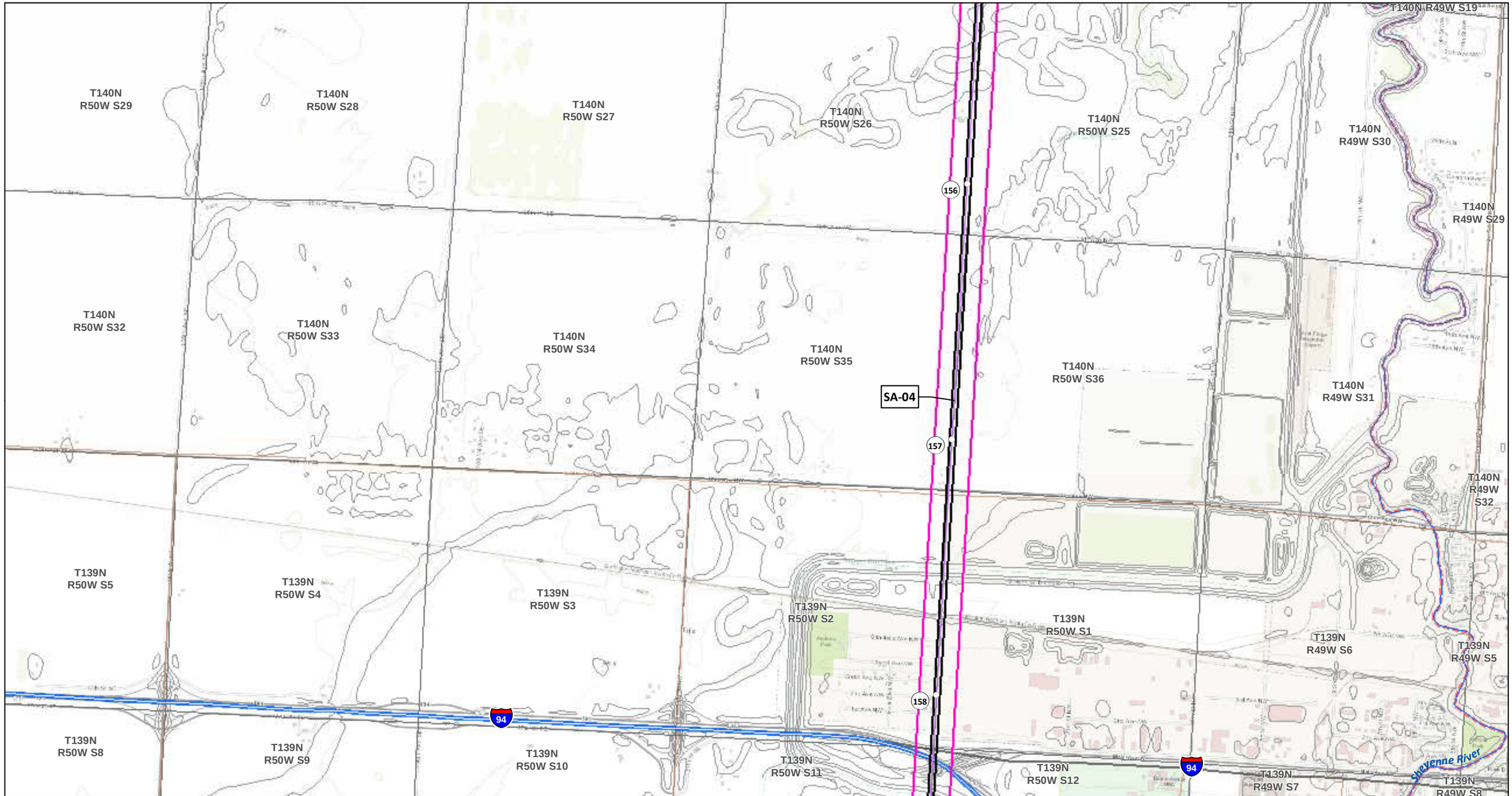
Water Resources
- Lake
- River

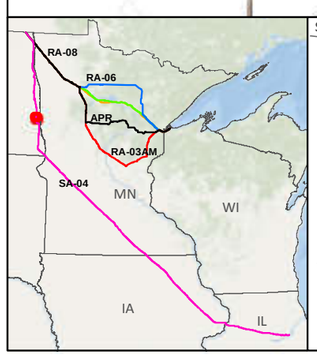
Data Sources: MNDNR, NHD,USGS, Enbridge

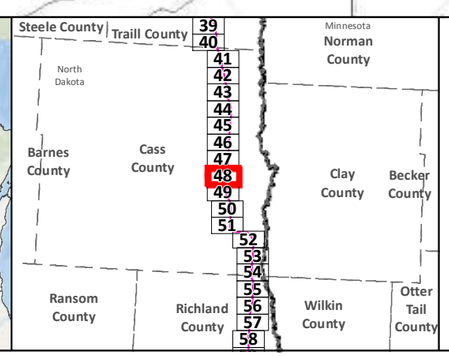
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

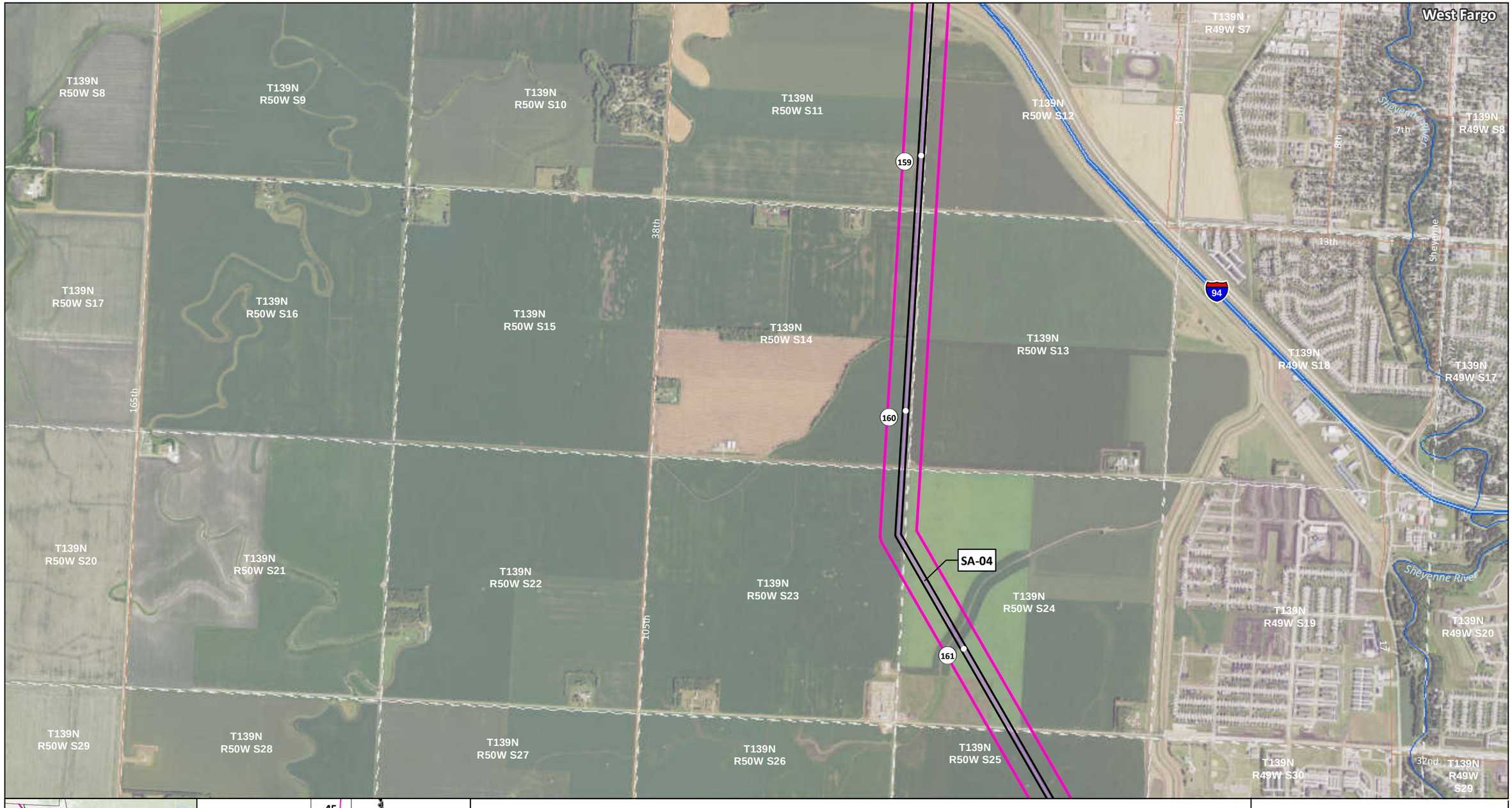
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

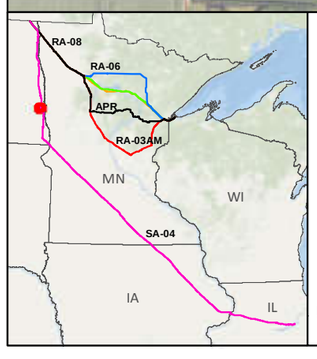
SA-04

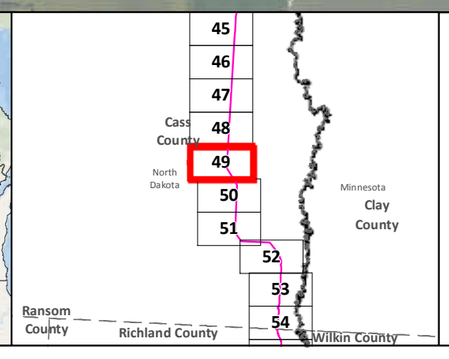
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 48B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

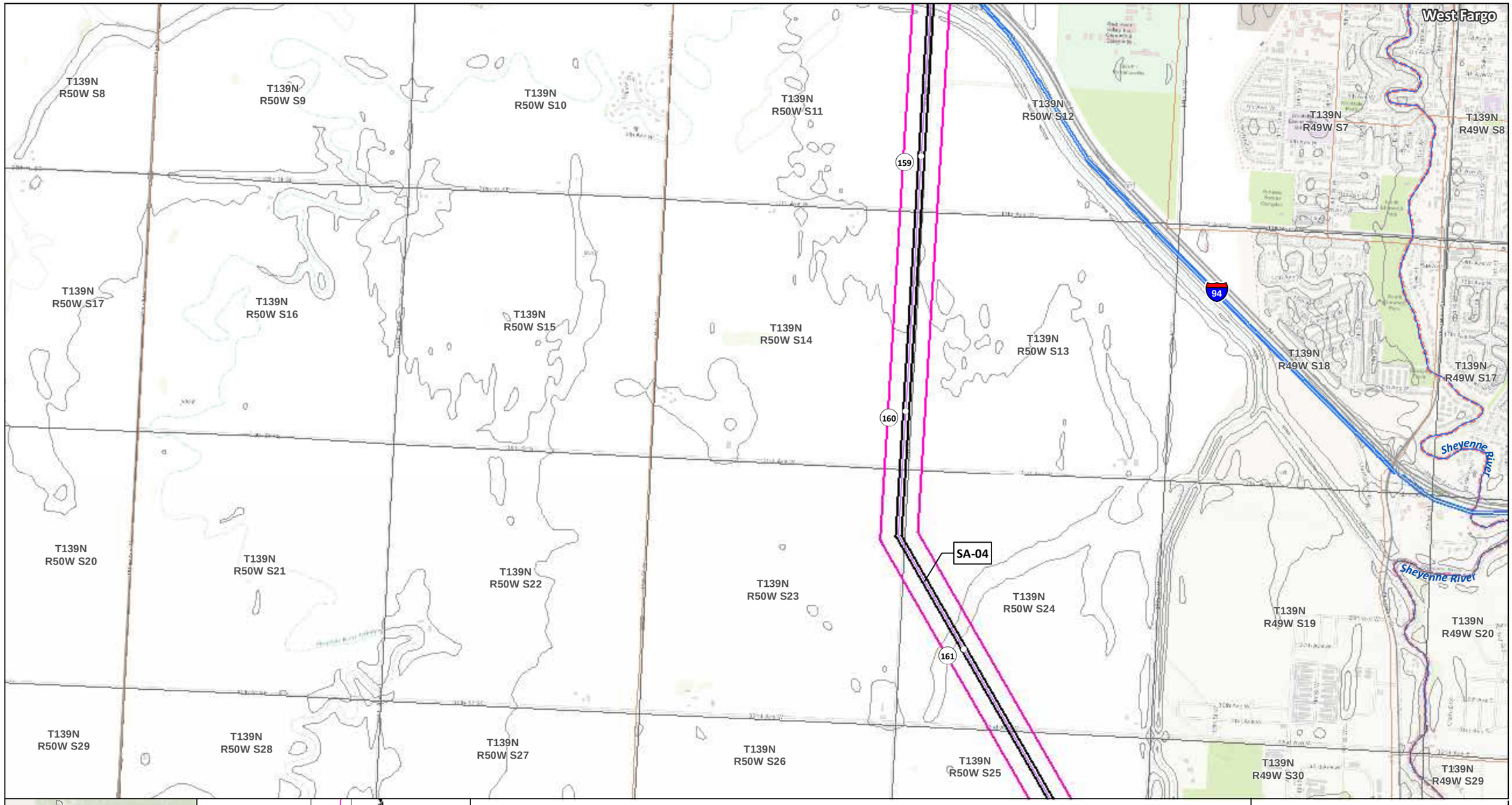
Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

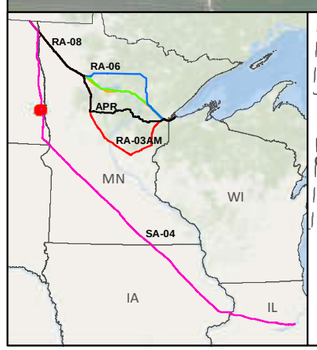
1:24,000

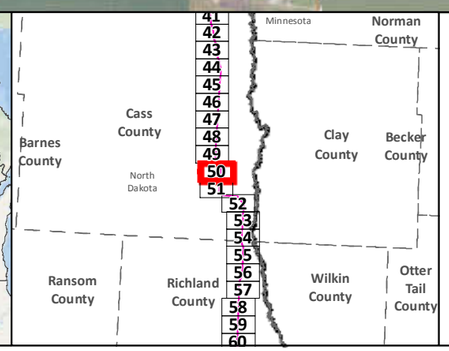
10ft Contours

N

Map 49B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

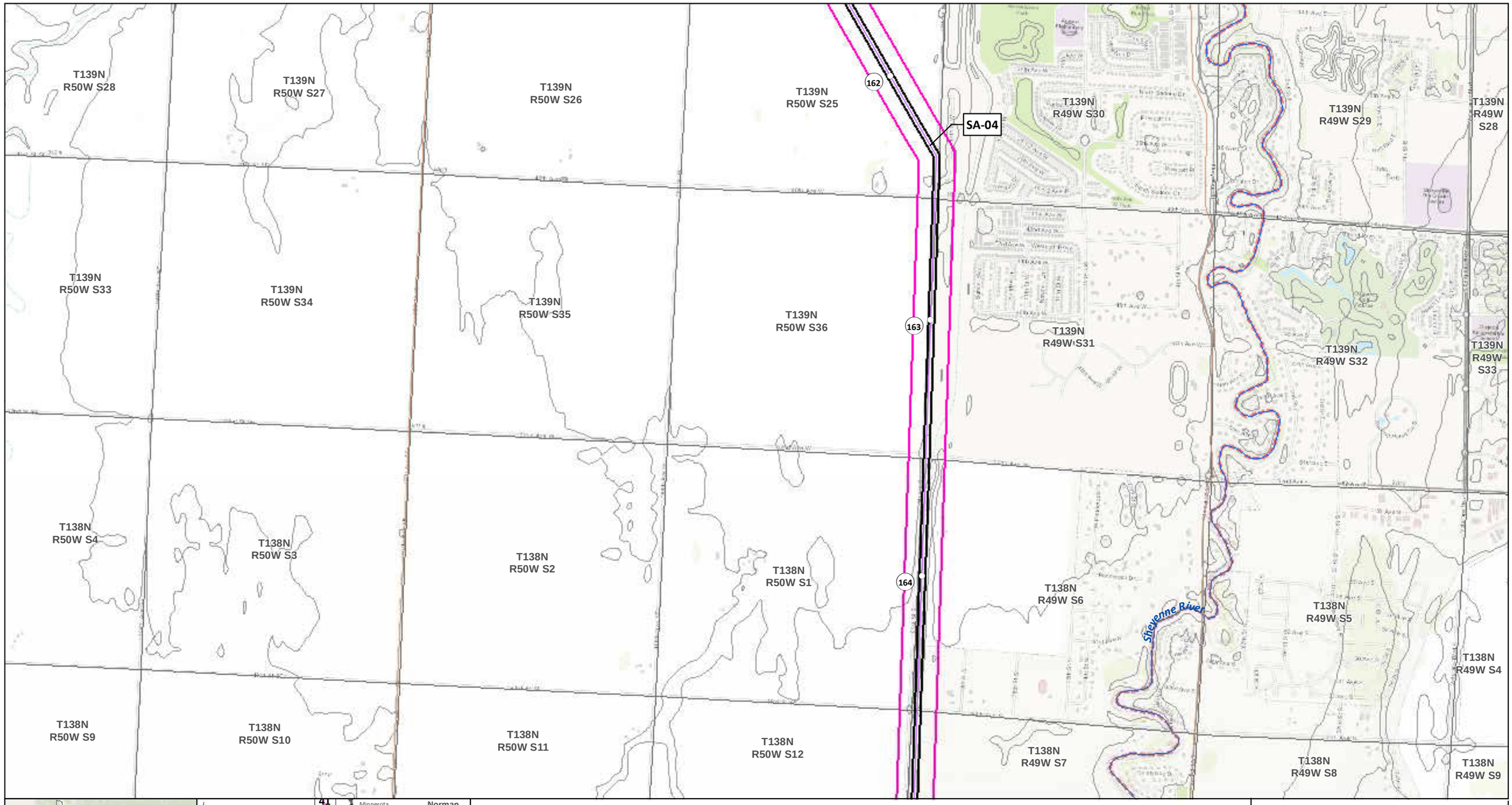
Data Sources:
MNDNR, NHD,USGS, Enbridge

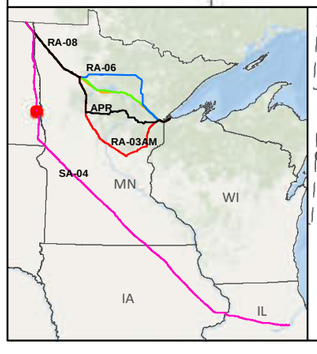
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

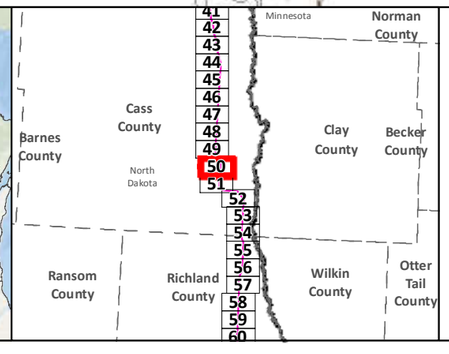
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 50A of 188







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

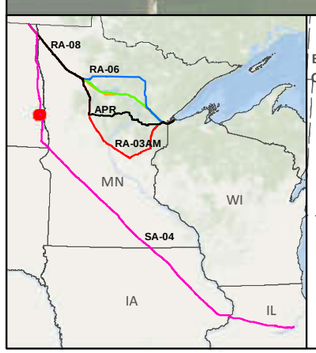
N

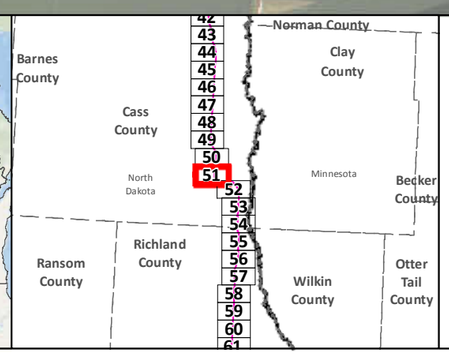
Map 50B of 188

T138N R50W S9
T138N R50W S10
T138N R50W S11
T138N R50W S12
T138N R49W S7
T138N R49W S8
T138N R49W S9
T138N R50W S16
T138N R50W S15
T138N R50W S14
T138N R50W S13
T138N R49W S18
T138N R49W S17
T138N R49W S16
T138N R50W S21
T138N R50W S22
T138N R50W S23
T138N R50W S24
T138N R49W S19
T138N R49W S20
T138N R49W S21
T138N R50W S28
T138N R50W S27
T138N R50W S26
T138N R50W S25
T138N R49W S30
T138N R49W S29
T138N R49W S28

165
166
167
168
169

73rd
17
167th
Main
Horace
Sheyenne River
170th
100th
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 51A of 188

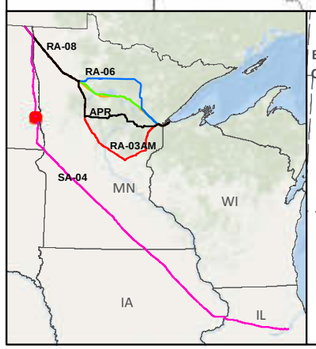
T138N R50W S9
T138N R50W S10
T138N R50W S11
T138N R50W S12
T138N R49W S7
T138N R49W S8
T138N R49W S9
T138N R50W S16
T138N R50W S15
T138N R50W S14
T138N R50W S13
T138N R49W S18
T138N R49W S17
T138N R49W S16
T138N R50W S21
T138N R50W S22
T138N R50W S23
T138N R50W S24
T138N R49W S19
T138N R49W S20
T138N R49W S21
T138N R50W S28
T138N R50W S27
T138N R50W S26
T138N R50W S25
T138N R49W S30
T138N R49W S29
T138N R49W S28

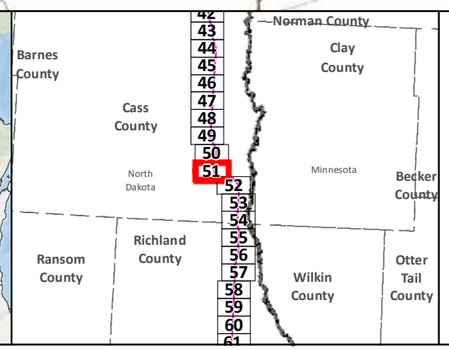
165
166
167
168
169

Horace

Sheyenne River

SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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State Managed Lands

- WMA - Wildlife Management Areas
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Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
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- 303d Imparied Waters
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- Public Waters Wetlands
- Public Water Basin
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- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

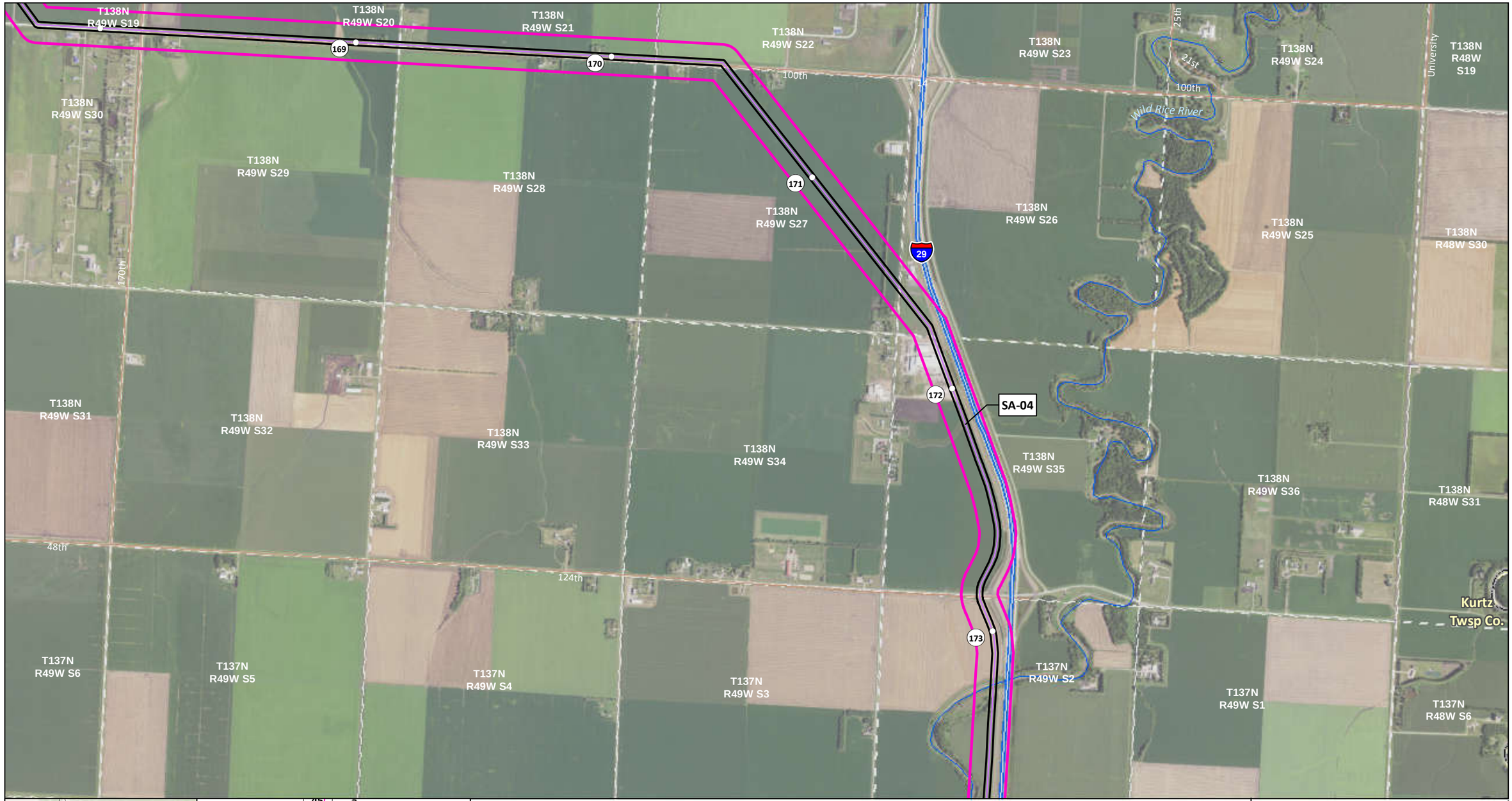
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

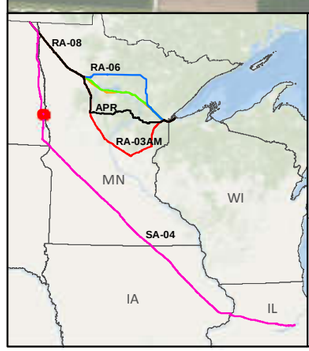
SA-04

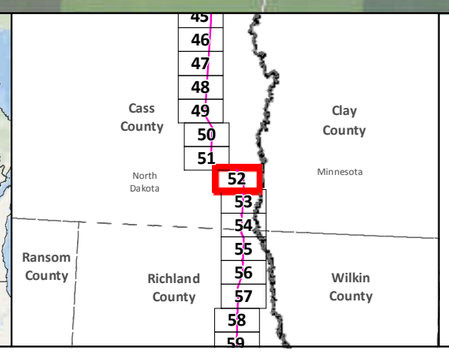
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 51B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

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Interstate
Highway
Major Road
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Water Resources
Lake
River

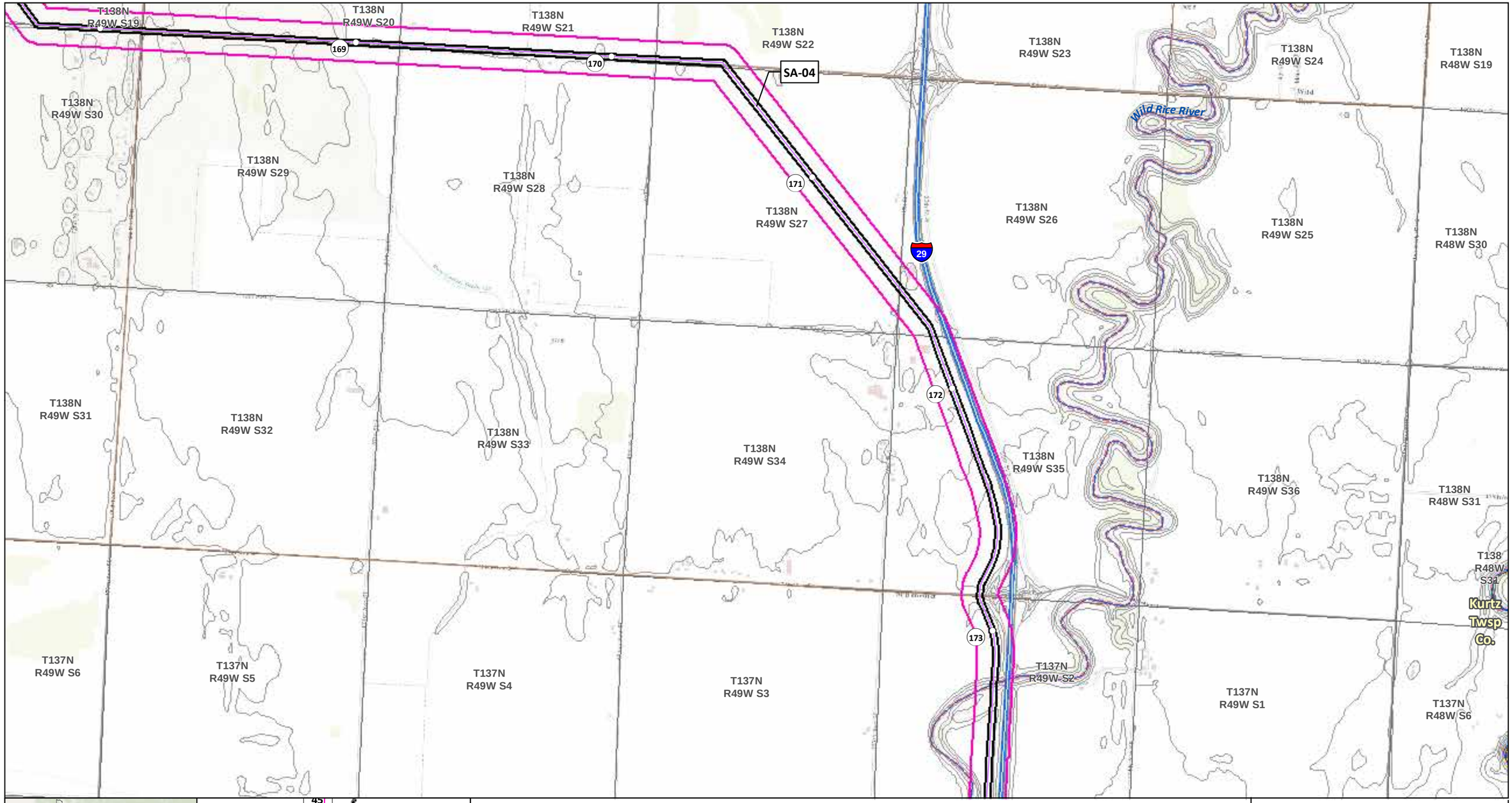
Data Sources: MNDNR, NHD,USGS, Enbridge

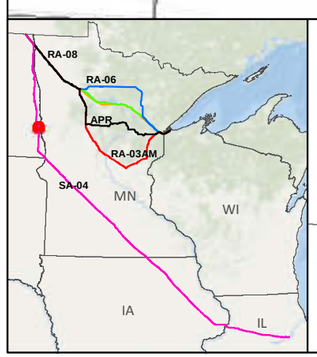
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

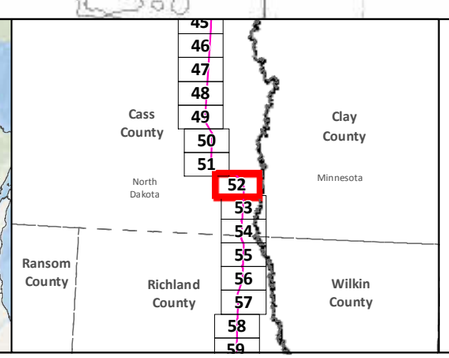
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 52A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

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- RA-06
- RA-07
- RA-08
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Native Plant Communities with Biodiversity Significance

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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

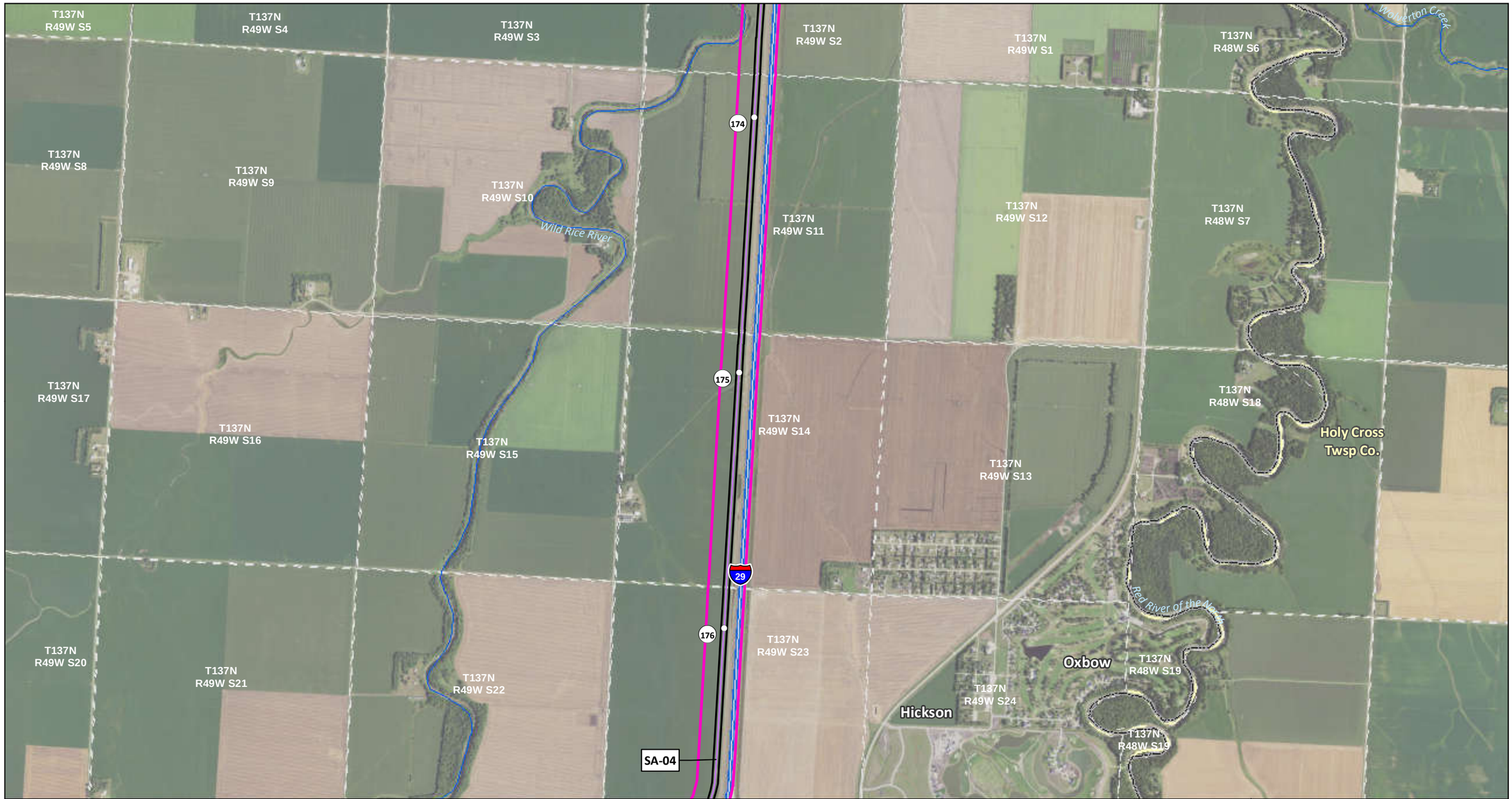
0 125 250 500 Meters

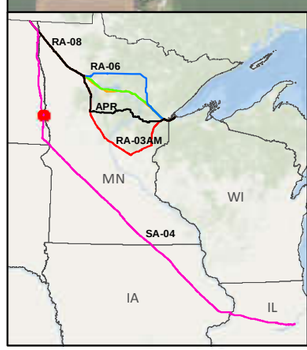
1:24,000

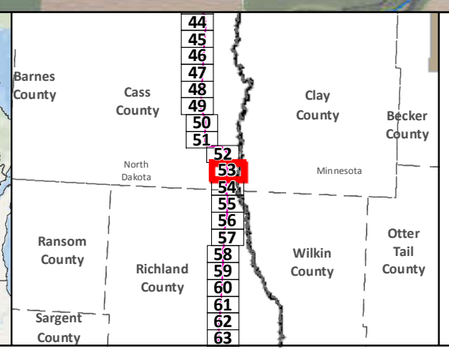
10ft Contours

N

Map 52B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

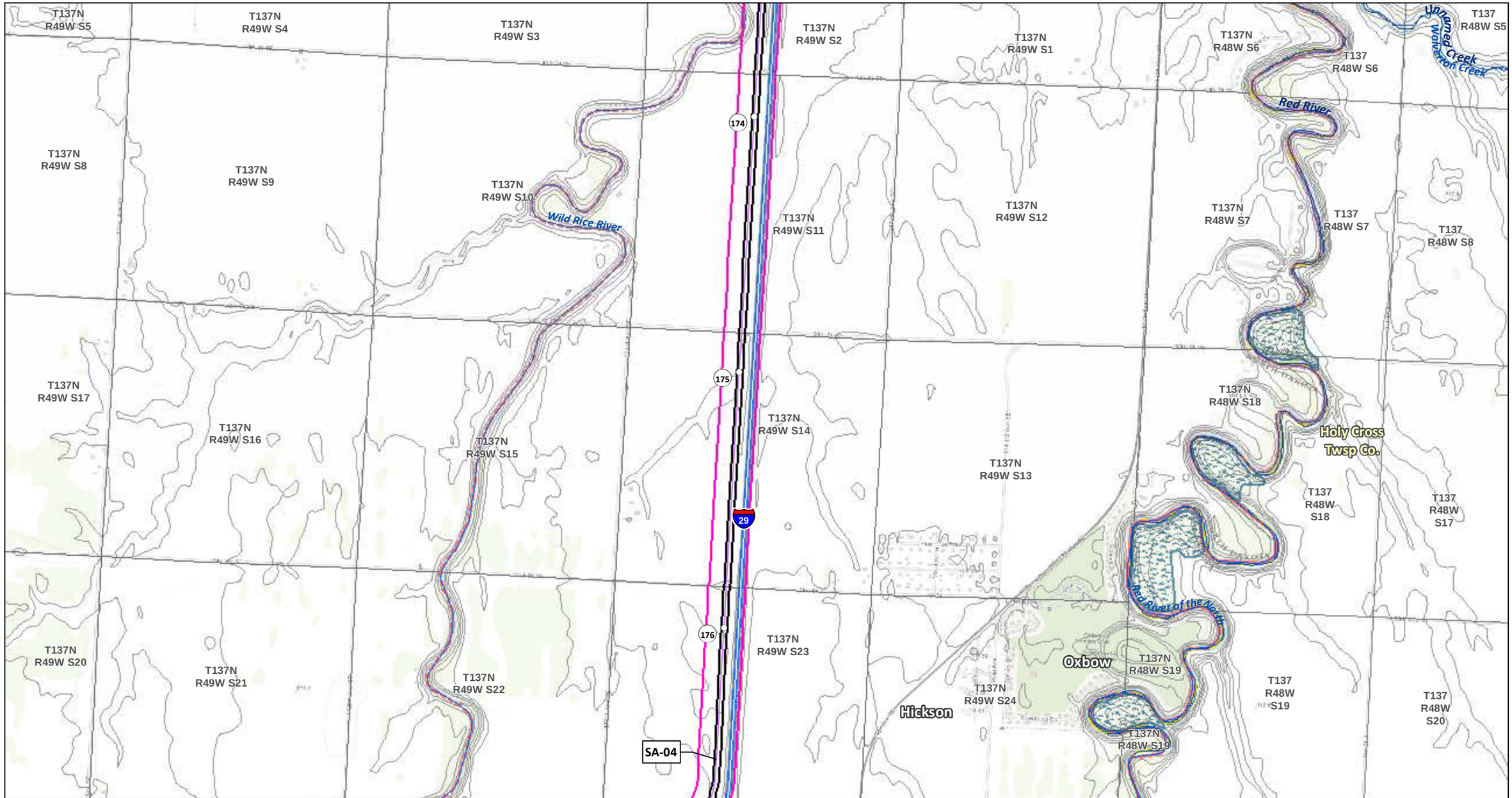
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

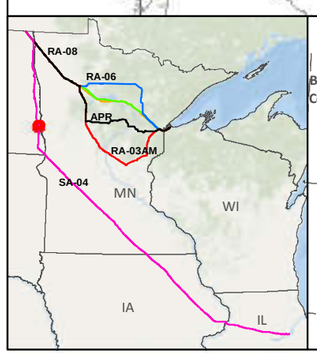
Data Sources:
MNDNR, NHD,USGS, Enbridge

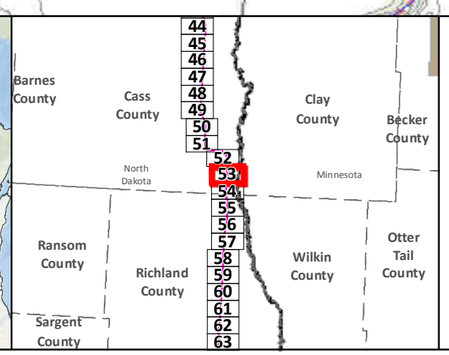
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 53A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

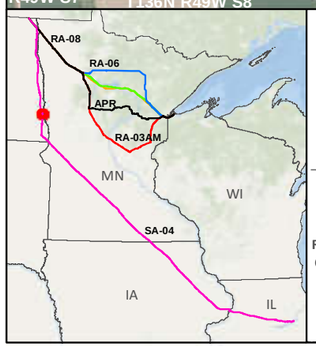
SA-04

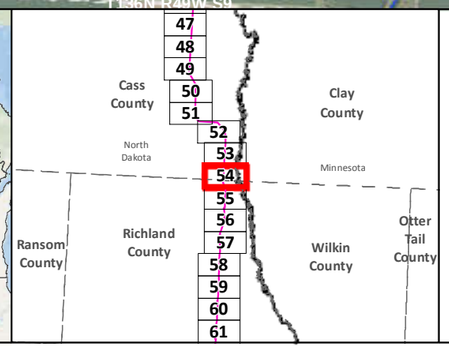
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 53B of 188

T137N R49W S20
T137N R49W S21
T137N R49W S22
T137N R49W S23
T137N R49W S24
T137N R48W S19
T137N R48W S19
160th
T137N R49W S29
T137N R49W S28
T137N R49W S27
T137N R49W S26
T137N R49W S25
T137N R48W S30
Holy Cross Twsp Co.
Wild Rice River
T137N R49W S32
T137N R49W S33
T137N R49W S34
T137N R49W S35
T137N R49W S36
T137N R48W S31
T136N R49W S6
54th
T137N R48W S31
T137N R48W S31
Wolverton Twsp Co.
T136N R49W S5
T136N R49W S4
T136N R49W S3
SA-04
T136N R49W S2
T136N R49W S1
Red River of the North
T136N R48W S6
169th
T136N R49W S7
T136N R49W S8
T136N R49W S9
T136N R48W S6





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

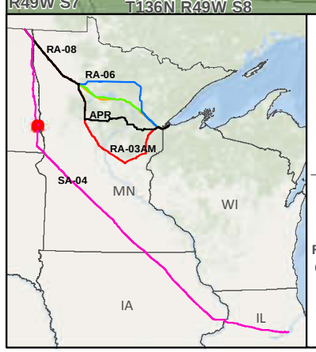
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

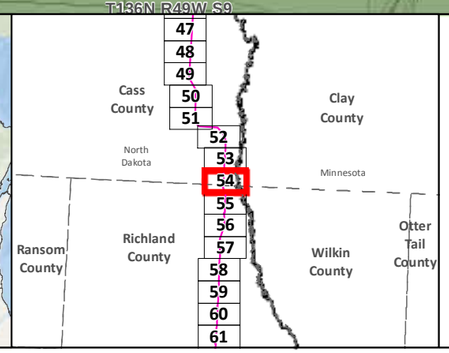
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 54A of 188

T137N R49W S20
T137N R49W S21
T137N R49W S22
T137N R49W S23
T137N R49W S24
T137N R48W S19
T137 R48W S19
T137 R48W S20
T137N R49W S29
T137N R49W S28
T137N R49W S27
T137N R49W S26
T137N R49W S25
T137 R48W S30
T137 R48W S29
T137N R48W S30
Red River of the North
Holy Cross Twsp Co.
Wild Rice River
T137N R49W S32
T137N R49W S33
T137N R49W S34
T137N R49W S35
T137N R49W S36
T137N R48W S31
T137 R48W S32
T137 R48W S31
T136N R49W S6
Dakota Tallgrass Prairie Wildlife Management Area
T136N R49W S5
T136N R49W S4
T136N R49W S3
T136N R49W S2
T136N R49W S1
T137N R48W S31
T136 R49W S1
Wolverton Twsp Co.
T136 R48W S6
Red River
T136N R48W S6
SA-04
T136N R49W S7
T136N R49W S8
T136N R49W S9
29
177
178
179
46





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

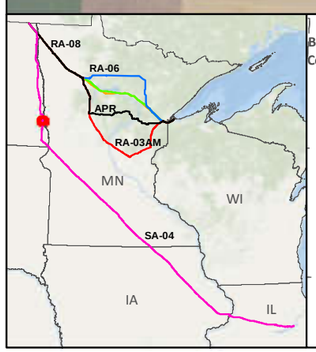
SA-04

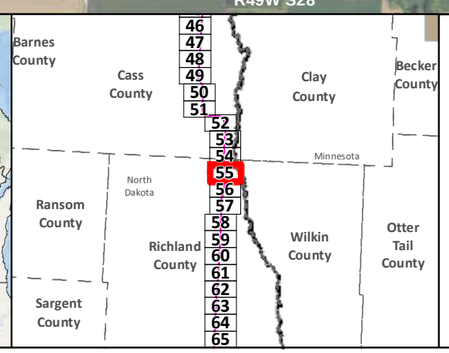
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 54B of 188

T136N R49W S7
T136N R49W S8
T136N R49W S9
T136N R49W S4
T136N R49W S3
T136N R49W S2
T136N R49W S1
T136N R48W S6
T136N R48W S7
Wolverton Twsp Co.
T136N R49W S10
T136N R49W S11
T136N R49W S12
Red River of the North
169th
T136N R49W S18
T136N R49W S17
T136N R49W S16
T136N R49W S15
T136N R49W S14
T136N R49W S13
T136N R48W S18
81
180
181
182
Wild Rice River
T136N R49W S20
T136N R49W S21
T136N R49W S22
T136N R49W S23
T136N R49W S24
T136N R48W S19
SA-04
29
T136N R49W S29
T136N R49W S28
T136N R49W S27
T136N R49W S26
58th
Christine
Wolverton Twsp Co.





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

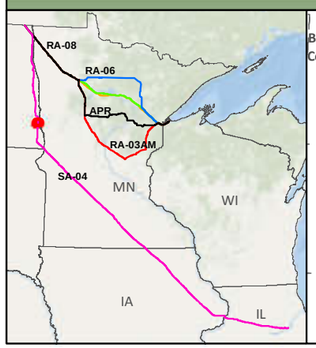
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

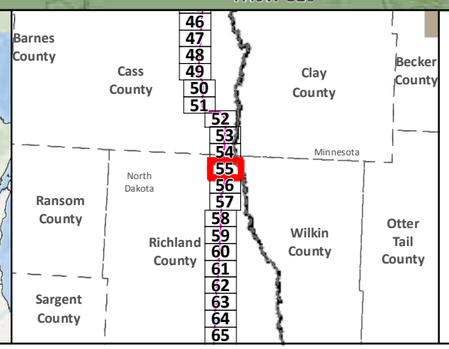
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 55A of 188

T136N R49W S4
T136N R49W S3
T136N R49W S2
T136N R49W S1
T136N R48W S6
T136 R48W S6
T136N R49W S7
T136 R48W S7
Wild Rice River
T136N R49W S8
T136N R49W S9
T136N R49W S10
T136N R49W S11
T136N R49W S12
Wolverton Twsp Co.
T136N R48W S7
T136 R48W S7
Red River
Red River of the North
T136N R49W S18
180
181
T136 R48W S18
T136N R49W S17
T136N R49W S16
T136N R49W S15
Dakota Tallgrass Prairie Wildlife Management Area
T136N R49W S14
T136N R49W S13
T136N R48W S18
Wolverton Twsp Co.
182
T136N R49W S20
T136N R49W S21
T136N R49W S22
T136N R49W S23
T136N R49W S24
T136N R48W S19
SA-04
29
T136N R49W S29
T136N R49W S28
T136N R49W S27
T136N R49W S26
Christine





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

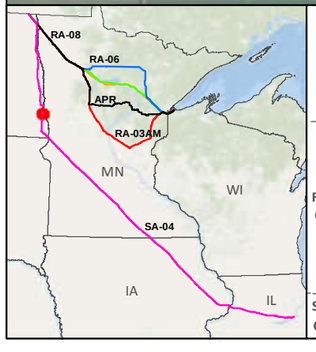
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

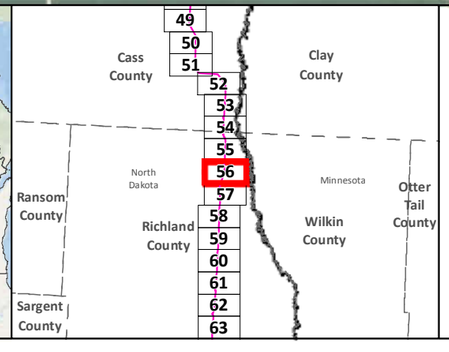
N

Map 55B of 188

T136N R49W S29
T136N R49W S28
T136N R49W S27
T136N R49W S26
T136N R49W S25
T136N R49W S24
T136N R49W S23
T136N R48W S19
T136N R48W S30
T136N R48W S31
T136N R49W S32
T136N R49W S33
T136N R49W S34
T136N R49W S35
T136N R49W S36
T135N R49W S5
T135N R49W S4
T135N R49W S3
T135N R49W S2
T135N R49W S1
T135N R48W S6
T135N R49W S8
T135N R49W S9
T135N R49W S10
T135N R49W S11
T135N R49W S12
T135N R48W S7

58th
60th
81
184
185
186
29
SA-04
Wild Rice River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

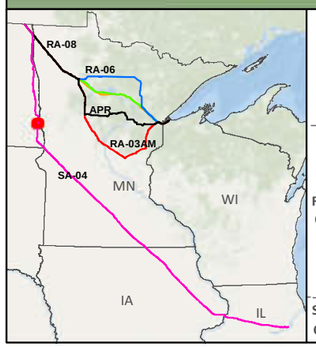
T136N R49W S29
T136N R49W S28
T136N R49W S27
T136N R49W S26
T136N R49W S25
T136N R49W S24
T136N R49W S23
T136N R48W S19
T136N R48W S30
T136N R48W S31
T136N R49W S32
T136N R49W S33
T136N R49W S34
T136N R49W S35
T136N R49W S36
T135N R49W S5
T135N R49W S4
T135N R49W S3
T135N R49W S2
T135N R49W S1
T135N R48W S6
T135N R49W S8
T135N R49W S9
T135N R49W S10
T135N R49W S11
T135N R49W S12
T135N R48W S7

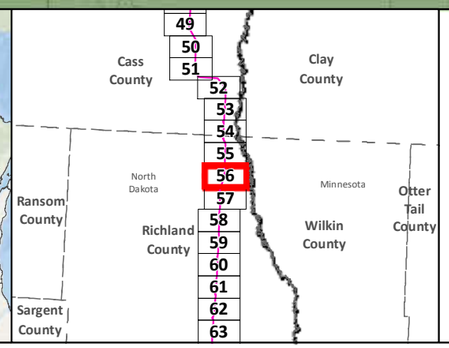
184
185
186
29

Dakota Tallgrass Prairie Wildlife Management Area

SA-04

Wild Rice River





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

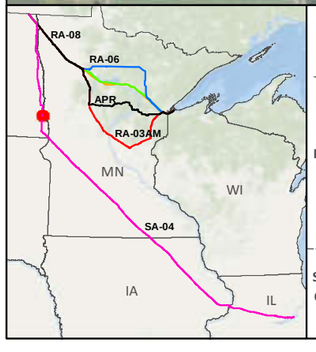
Map 56B of 188

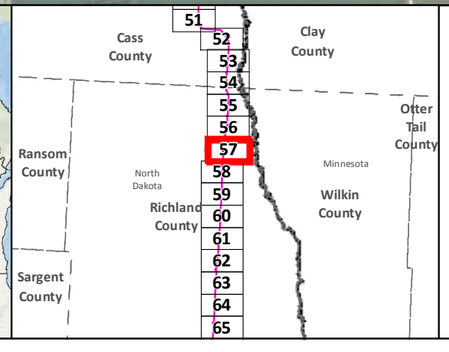
T135N R49W S8
T135N R49W S9
T135N R49W S10
T135N R49W S11
T135N R49W S12
T135N R48W S6
T135N R48W S7
T135N R48W S8
T135N R49W S17
T135N R49W S16
T135N R49W S15
T135N R49W S14
T135N R49W S13
T135N R48W S18
T135N R48W S17
T135N R49W S20
T135N R49W S21
T135N R49W S22
T135N R49W S23
T135N R49W S24
T135N R48W S19
T135N R48W S20
T135N R49W S29
T135N R49W S28
T135N R49W S27
T135N R49W S26
T135N R49W S25
T135N R48W S30
T135N R48W S29

Wild Rice River

187
188
189
29
81
63rd

SA-04





SA-04
Applicant's Preferred Route (APR)
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Route Width (750')
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Existing Pipeline
Interstate
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Lake
River

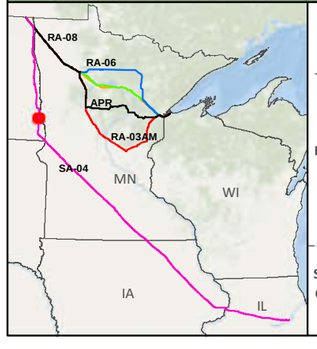
Data Sources: MNDNR, NHD,USGS, Enbridge

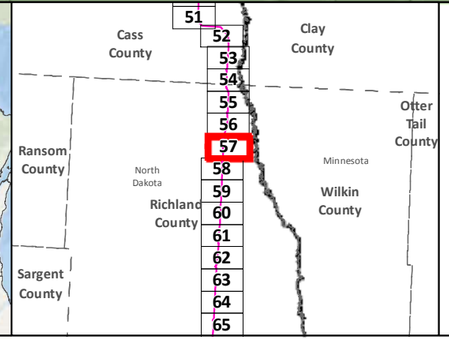
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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Existing Pipelines
Township Boundary

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- National River Inventory Crossing
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Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

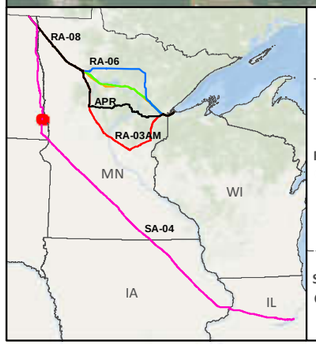
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

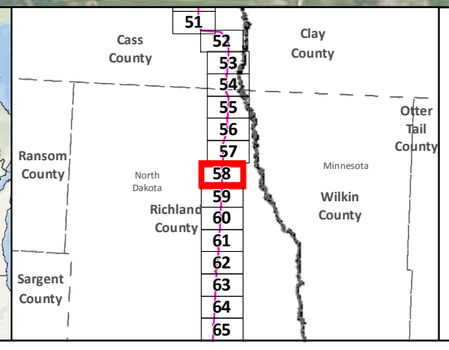
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 57B of 188

T135N R49W S30
T135N R49W S29
T135N R49W S28
T135N R49W S27
T135N R49W S26
T135N R49W S25
T135N R48W S30
65th
Colfax
4
190
29
Main
4
T135N R49W S31
T135N R49W S32
T135N R49W S33
T135N R49W S34
T135N R49W S35
T135N R49W S36
Wild Rice River
T135N R48W S31
191
169th
Pitcairn Creek
T134N R49W S6
T134N R49W S5
T134N R49W S4
T134N R49W S3
T134N R49W S2
T134N R49W S1
T134N R48W S6
SA-04
192
T134N R49W S7
T134N R49W S8
T134N R49W S9
T134N R49W S10
T134N R49W S11
T134N R49W S12
T134N R48W S7





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

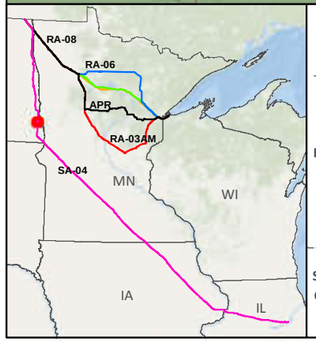
Data Sources:
MNDNR, NHD,USGS, Enbridge

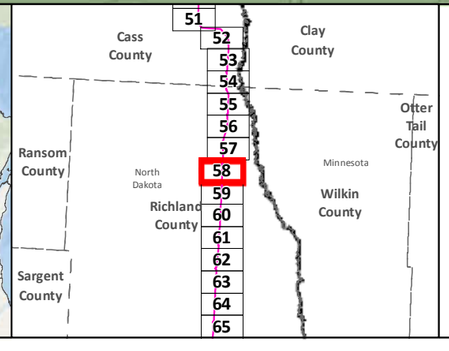
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T135N R49W S30
T135N R49W S29
T135N R49W S28
T135N R49W S27
T135N R49W S26
T135N R49W S25
T135N R48W S30
Colfax
190
29
T135N R49W S31
T135N R49W S32
T135N R49W S33
T135N R49W S34
T135N R49W S35
T135N R49W S36
Wild Rice River
T135N R48W S31
Dakota Tallgrass Prairie Wildlife Management Area
191
Pitcairn Creek
T134N R49W S6
T134N R49W S5
T134N R49W S4
T134N R49W S3
T134N R49W S2
T134N R49W S1
T134N R48W S6
SA-04
192
T134N R49W S7
T134N R49W S8
T134N R49W S9
T134N R49W S10
T134N R49W S11
T134N R49W S12
T134N R48W S7





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 58B of 188

T134N R49W S7
T134N R49W S8
T134N R49W S9
Pitcairn Creek
T134N R49W S10
T134N R49W S11
T134N R49W S12
Wild Rice River
T134N R48W S7
T134N R49W S18
T134N R49W S17
T134N R49W S16
T134N R49W S15
T134N R49W S14
T134N R49W S13
T134N R48W S18
169th
T134N R49W S19
T134N R49W S20
T134N R49W S21
T134N R49W S22
T134N R49W S23
T134N R49W S24
T134N R48W S19
T134N R49W S30
T134N R49W S29
T134N R49W S28
T134N R49W S27
T134N R49W S26
T134N R49W S25
T134N R48W S30
193
194
195
29
SA-04

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Cass County
Clay County
Ransom County
Richland County
North Dakota
Minnesota
Wilkin County
Otter Tail County
Sargent County
Grant County
53
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66
67

SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

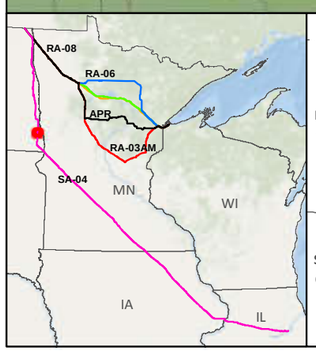
Data Sources:
MNDNR, NHD,USGS, Enbridge

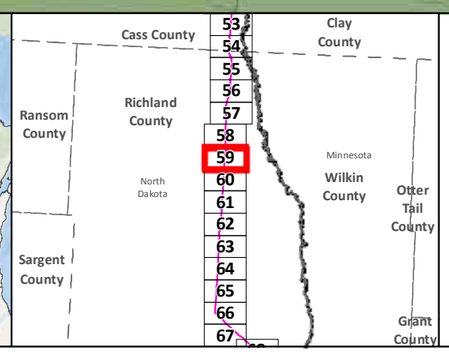
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T134N R49W S7
T134N R49W S8
T134N R49W S9
Pitcairn Creek
T134N R49W S10
T134N R49W S11
T134N R49W S12
T134N R48W S7
193
T134N R49W S18
T134N R49W S17
T134N R49W S16
T134N R49W S15
T134N R49W S14
T134N R49W S13
Wild Rice River
T134N R48W S18
Dakota Tallgrass Prairie Wildlife Management Area
194
29
T134N R49W S19
T134N R49W S20
T134N R49W S21
T134N R49W S22
T134N R49W S23
T134N R49W S24
T134N R48W S19
195
SA-04
T134N R49W S30
T134N R49W S29
T134N R49W S28
T134N R49W S27
T134N R49W S26
T134N R49W S25
T134N R48W S30





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

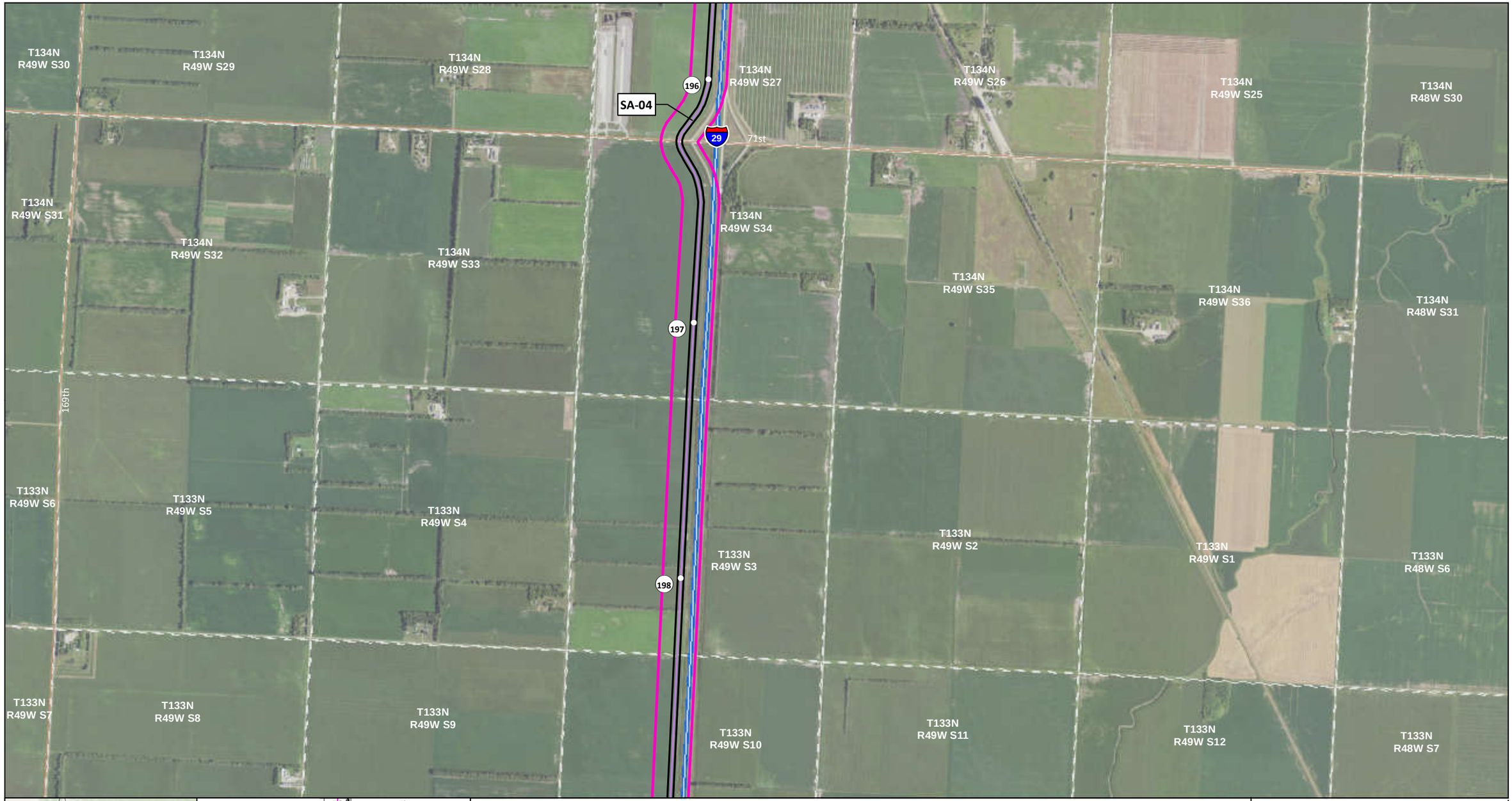
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

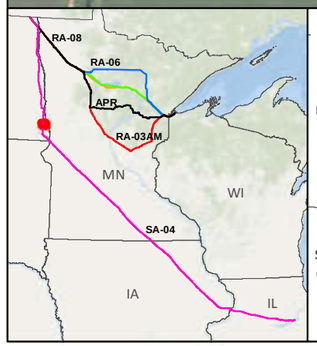
SA-04

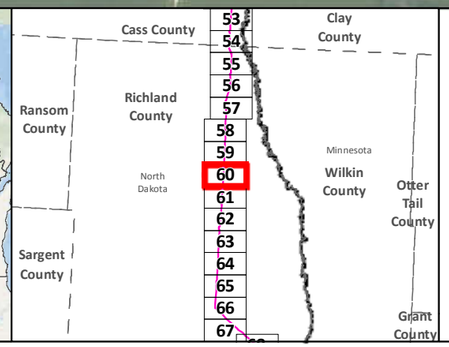
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 59B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

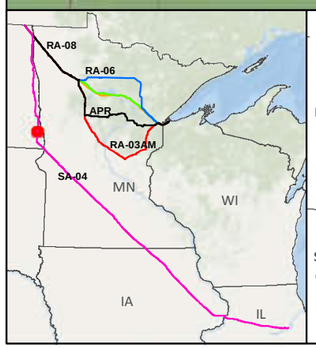
Map 60A of 188

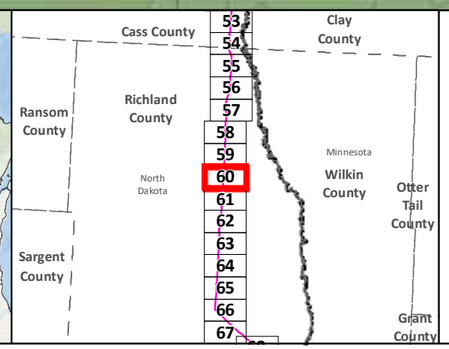
T134N R49W S30
T134N R49W S29
T134N R49W S28
T134N R49W S27
T134N R49W S26
T134N R49W S25
T134N R48W S30
T134N R49W S31
T134N R49W S32
T134N R49W S33
T134N R49W S34
T134N R49W S35
T134N R49W S36
T134N R48W S31
T133N R49W S6
T133N R49W S5
T133N R49W S4
T133N R49W S3
T133N R49W S2
T133N R49W S1
T133N R48W S6
T133N R49W S7
T133N R49W S8
T133N R49W S9
T133N R49W S10
T133N R49W S11
T133N R49W S12
T133N R48W S7

196
29
197
198

Dakota Tallgrass Prairie Wildlife Management Area

SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

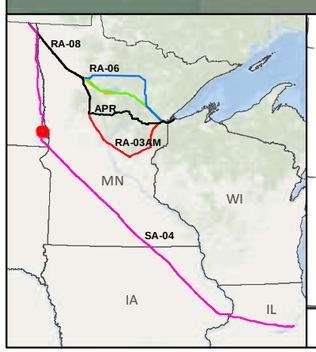
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

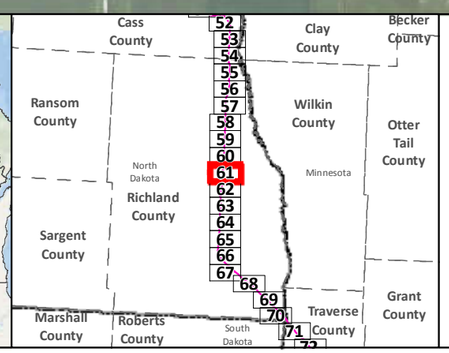
N

Map 60B of 188

T133N R49W S7
T133N R49W S8
T133N R49W S9
T133N R49W S10
T133N R49W S11
T133N R49W S12
T133N R48W S7
T133N R49W S18
T133N R49W S17
T133N R49W S16
T133N R49W S15
T133N R49W S14
T133N R49W S13
T133N R48W S18
T133N R49W S19
T133N R49W S20
T133N R49W S21
T133N R49W S22
T133N R49W S23
T133N R49W S24
T133N R48W S19
T133N R49W S30
T133N R49W S29
T133N R49W S28
T133N R49W S27
T133N R49W S26
T133N R49W S25
T133N R48W S30

199
200
201
29
SA-04
169th
75th
76th
171st





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 61A of 188

T133N R49W S7
T133N R49W S8
T133N R49W S9
T133N R49W S10
T133N R49W S11
T133N R49W S12
T133N R48W S7
T133N R49W S18
T133N R49W S17
T133N R49W S16
T133N R49W S15
T133N R49W S14
T133N R49W S13
T133N R48W S18
T133N R49W S19
T133N R49W S20
T133N R49W S21
T133N R49W S22
T133N R49W S23
T133N R49W S24
T133N R48W S19
T133N R49W S30
T133N R49W S29
T133N R49W S28
T133N R49W S27
T133N R49W S26
T133N R49W S25
T133N R48W S30

199
200
201
29

SA-04

Dakota Tallgrass Prairie Wildlife Management Area

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Cass County
Clay County
Becker County
Ransom County
Wilkin County
Otter Tail County
North Dakota
Minnesota
Richland County
Sargent County
Grant County
Traverse County
Marshall County
Roberts County
South Dakota

52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 61B of 188

T133N R49W S29
T133N R49W S28
T133N R49W S27
T133N R49W S26
T133N R49W S25
T133N R48W S30
T133N R49W S32
T133N R49W S33
T133N R49W S34
T133N R49W S35
T133N R49W S36
T133N R48W S31
T132N R49W S6
T132N R49W S5
T132N R49W S4
T132N R49W S3
T132N R49W S2
T132N R49W S1
T132N R48W S6
T132N R49W S7
T132N R49W S8
T132N R49W S9
T132N R49W S10
T132N R49W S11
T132N R49W S12
T132N R48W S7

171st
169th
78th
Antelope Creek
South Branch Antelope Creek
Mooreton
203
204
205
29
13
SA-04

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Ransom County
Sargent County
Marshall County
North Dakota
Minnesota
Richland County
Wilkin County
Otter Tail County
Grant County
Traverse County
55
56
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68
69

SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T133N R49W S29
T133N R49W S28
T133N R49W S27
T133N R49W S26
T133N R49W S25
T133N R48W S30
T133N R49W S32
T133N R49W S33
T133N R49W S34
T133N R49W S35
T133N R49W S36
T133N R48W S31
T132N R49W S6
T132N R49W S5
T132N R49W S4
T132N R49W S3
T132N R49W S2
T132N R49W S1
T132N R48W S6
T132N R49W S7
T132N R49W S8
T132N R49W S9
T132N R49W S10
T132N R49W S11
T132N R49W S12
T132N R48W S7

Antelope Creek

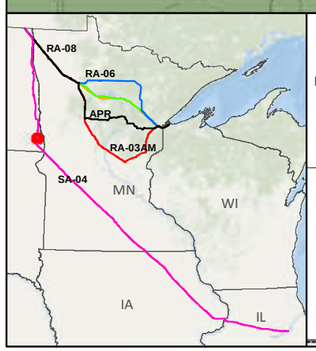
South Branch Antelope Creek

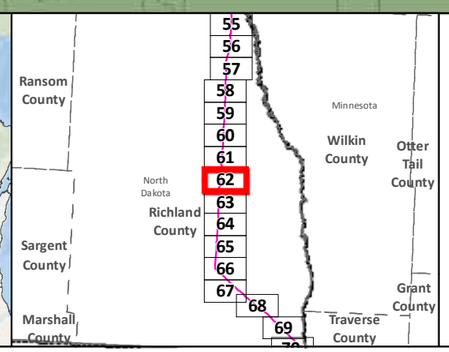
Dakota Tallgrass Prairie Wildlife Management Area

Mooreton

203
204
205
29
13

SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

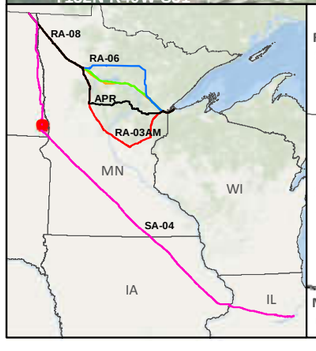
Map 62B of 188

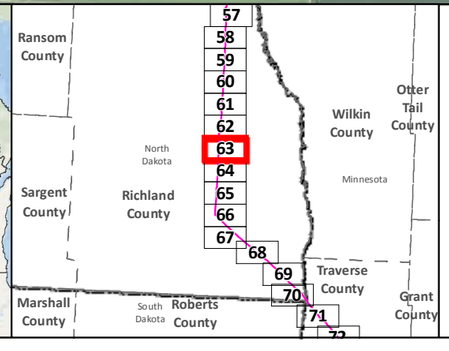
T132N R49W S7
T132N R49W S8
T132N R49W S9
T132N R49W S10
T132N R49W S11
T132N R49W S12
T132N R48W S7
T132N R49W S18
T132N R49W S17
T132N R49W S16
T132N R49W S15
T132N R49W S14
T132N R49W S13
T132N R48W S18
T132N R49W S19
T132N R49W S20
T132N R49W S21
T132N R49W S22
T132N R49W S23
T132N R49W S24
T132N R48W S19
T132N R49W S30
T132N R49W S29
T132N R49W S28
T132N R49W S27
T132N R49W S26
T132N R49W S25
T132N R48W S30
T132N R49W S31
T132N R49W S32

206
207
208
29

South Branch Antelope Creek

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

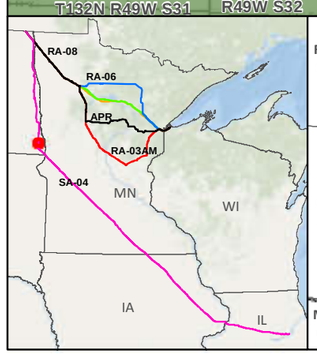
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

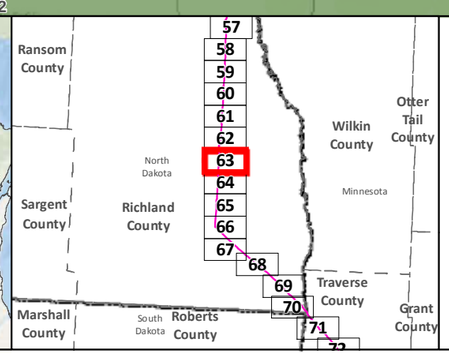
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 63A of 188

T132N R49W S7
T132N R49W S8
T132N R49W S9
T132N R49W S10
T132N R49W S11
T132N R49W S12
T132N R48W S7
T132N R49W S18
T132N R49W S17
T132N R49W S16
T132N R49W S15
T132N R49W S14
T132N R49W S13
T132N R48W S18
206
South Branch Antelope Creek
T132N R49W S21
Dakota Tallgrass Prairie Wildlife Management Area
SA-04
29
T132N R49W S19
T132N R49W S20
T132N R49W S22
T132N R49W S23
T132N R49W S24
T132N R48W S19
207
T132N R49W S30
T132N R49W S29
T132N R49W S28
T132N R49W S27
T132N R49W S26
T132N R49W S25
T132N R48W S30
208
T132N R49W S31
T132N R49W S32





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

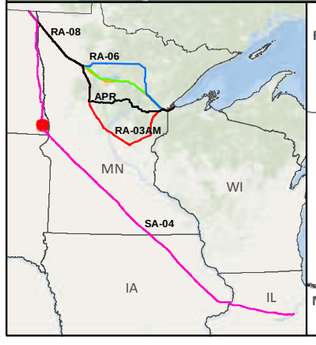
SA-04

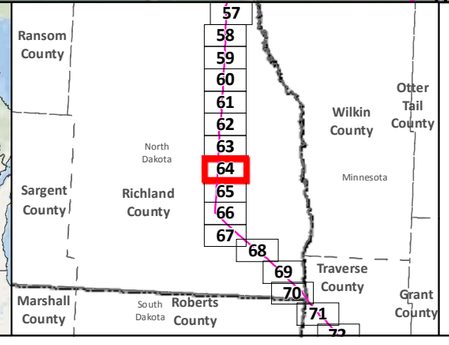
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 63B of 188

T132N R49W S29
T132N R49W S28
T132N R49W S27
T132N R49W S26
T132N R49W S25
T132N R48W S30
T132N R49W S31
T132N R49W S32
T132N R49W S33
T132N R49W S34
T132N R49W S35
T132N R49W S36
T132N R48W S31
T131N R49W S6
T131N R49W S5
T131N R49W S4
T131N R49W S3
T131N R49W S2
T131N R49W S1
T131N R48W S6
T131N R49W S7
T131N R49W S8
T131N R49W S9
T131N R49W S10
T131N R49W S11
T131N R49W S12
T131N R48W S7
T131N R49W S18
T131N R49W S17
T131N R49W S16
T131N R49W S15
209
210
211
29
SA-04
Wild Rice River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
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Tribal Reservation

Water Resources
Lake
River

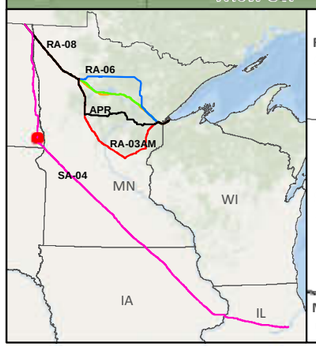
Data Sources:
MNDNR, NHD,USGS, Enbridge

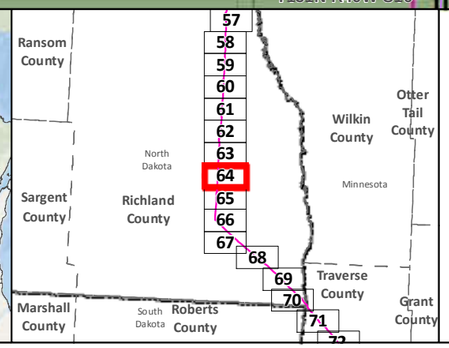
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T132N R49W S29
T132N R49W S28
T132N R49W S27
T132N R49W S26
T132N R49W S25
T132N R48W S30
T132N R49W S31
T132N R49W S32
T132N R49W S33
T132N R49W S34
T132N R49W S35
T132N R49W S36
T132N R48W S31
209
T131N R49W S6
T131N R49W S5
T131N R49W S4
T131N R49W S3
T131N R49W S2
T131N R49W S1
T131N R48W S6
Dakota Tallgrass Prairie Wildlife Management Area
210
SA-04
Wild Rice River
T131N R49W S7
T131N R49W S8
T131N R49W S9
T131N R49W S10
T131N R49W S11
T131N R49W S12
T131N R48W S7
211
29
T131N R49W S18
T131N R49W S17
T131N R49W S16
T131N R49W S15





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- RA-06
- RA-07
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- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

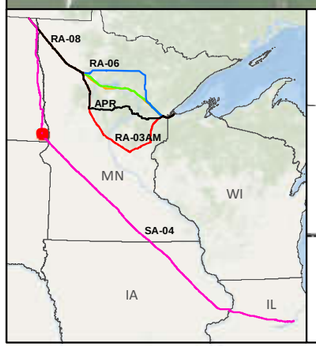
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

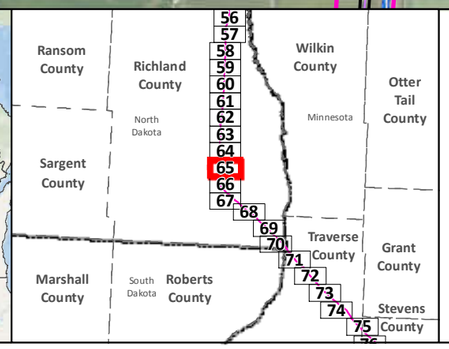
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

T131N R49W S10
T131N R49W S11
T131N R49W S12
T131N R48W S7
T131N R49W S18
T131N R49W S17
T131N R49W S16
T131N R49W S15
T131N R49W S14
T131N R49W S13
T131N R48W S18
Wild Rice River
212
SA-04
29
87th
Great Bend
1st
87th
T131N R49W S19
T131N R49W S20
T131N R49W S21
T131N R49W S22
T131N R49W S23
T131N R49W S24
T131N R48W S19
213
T131N R49W S30
T131N R49W S29
T131N R49W S28
T131N R49W S27
T131N R49W S26
T131N R49W S25
T131N R48W S30
214
T131N R49W S31
T131N R49W S32
T131N R49W S33
T131N R49W S34
T131N R49W S35
T131N R49W S36





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

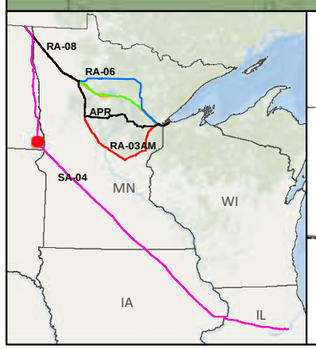
Data Sources:
MNDNR, NHD,USGS, Enbridge

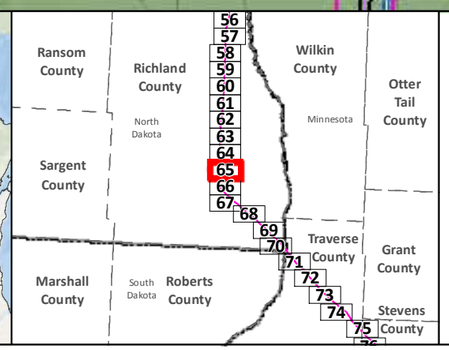
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T131N R49W S10
T131N R49W S11
T131N R49W S12
T131N R48W S7
T131N R49W S18
T131N R49W S17
T131N R49W S16
T131N R49W S15
T131N R49W S14
T131N R49W S13
T131N R48W S18
Wild Rice River
212
29
Great Bend
T131N R49W S19
T131N R49W S20
T131N R49W S21
T131N R49W S22
Dakota Tallgrass Prairie Wildlife Management Area
213
SA-04
T131N R49W S23
T131N R49W S24
T131N R48W S19
T131N R49W S30
T131N R49W S29
T131N R49W S28
T131N R49W S27
T131N R49W S26
T131N R49W S25
T131N R48W S30
214
T131N R49W S31
T131N R49W S32
T131N R49W S33
T131N R49W S34
T131N R49W S35
T131N R49W S36





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
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- 303d Imparied Waters
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 65B of 188

T131N R49W S33
T131N R49W S25
T131N R48W S30
T131N R49W S31
T131N R49W S32
T131N R49W S34
T131N R49W S35
T131N R49W S36
T131N R48W S31
T130N R49W S6
T130N R49W S5
T130N R49W S4
T130N R49W S3
T130N R49W S2
T130N R49W S1
T130N R48W S6
T130N R49W S7
T130N R49W S8
T130N R49W S9
T130N R49W S10
T130N R49W S11
T130N R49W S12
T130N R48W S7
T130N R49W S18
T130N R49W S17
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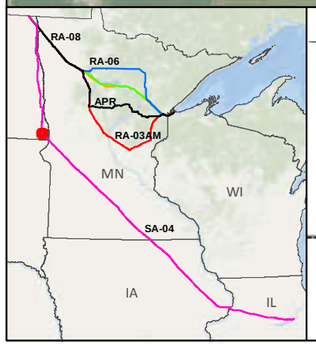
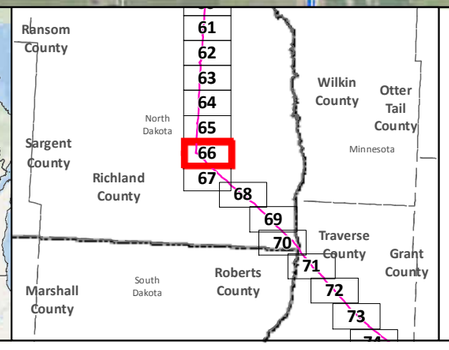
T130N R49W S14
T130N R49W S13
T130N R48W S18

215 216 217 218 29

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

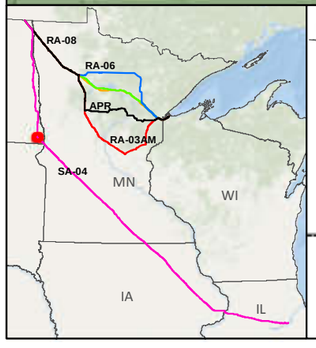
SA-04

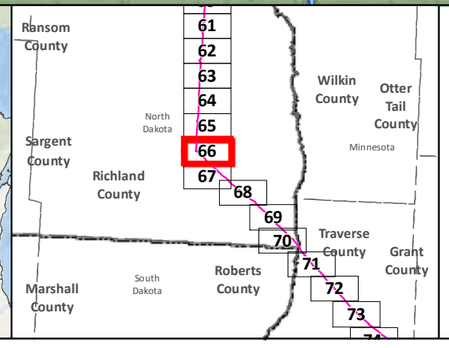
T131N R49W S33
T131N R49W S25
T131N R48W S30
T131N R49W S31
T131N R49W S32
T131N R49W S34
T131N R49W S35
T131N R49W S36
T131N R48W S31
T130N R49W S6
T130N R49W S5
T130N R49W S4
T130N R49W S3
T130N R49W S2
T130N R49W S1
T130N R48W S6
T130N R49W S7
T130N R49W S8
T130N R49W S9
T130N R49W S10
T130N R49W S11
T130N R49W S12
T130N R48W S7
T130N R49W S18
T130N R49W S17
T130N R49W S16
T130N R49W S15
T130N R49W S14
T130N R49W S13
T130N R48W S18

215
216
217
218
29

SA-04

Dakota Tallgrass Prairie Wildlife Management Area





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
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- Mile Post
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- WMA - Wildlife Management Areas
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

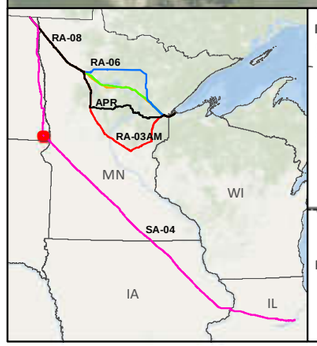
SA-04

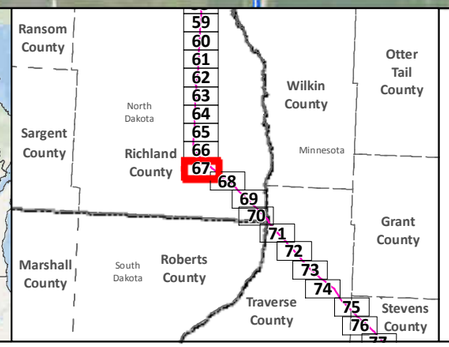
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 66B of 188







SA-04
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0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

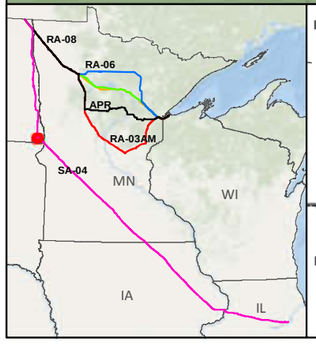
SA-04

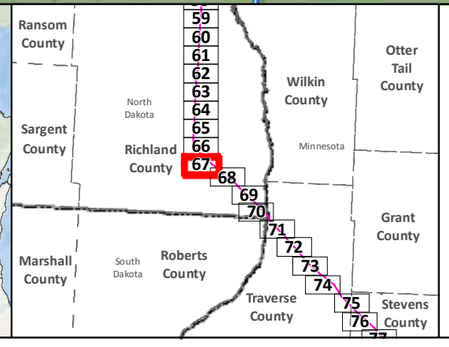
Map 67A of 188

T130N R49W S17
T130N R49W S16
T130N R49W S15
T130N R49W S14
T130N R49W S13
T130N R48W S18
T130N R49W S20
T130N R49W S21
T130N R49W S22
T130N R49W S23
T130N R49W S24
T130N R48W S19
T130N R49W S29
T130N R49W S28
T130N R49W S27
T130N R49W S26
T130N R49W S25
T130N R48W S30
T130N R49W S32
T130N R49W S33
T130N R49W S34
T130N R49W S35
T130N R49W S36
T130N R48W S31

219
220
221
222
SA-04
29
11

Dakota Tallgrass Prairie Wildlife Management Area





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RA-07
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0 0.125 0.25 0.5 Miles
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10ft Contours

T130N R49W S25
T130N R48W S30
T130N R48W S29
T130N R48W S28
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T130N R48W S22
T130N R48W S23
T130N R48W S24
T130N R48W S26
T130N R48W S25
T130N R49W S36
T130N R48W S31
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T130N R48W S33
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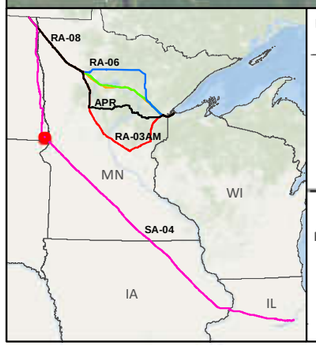
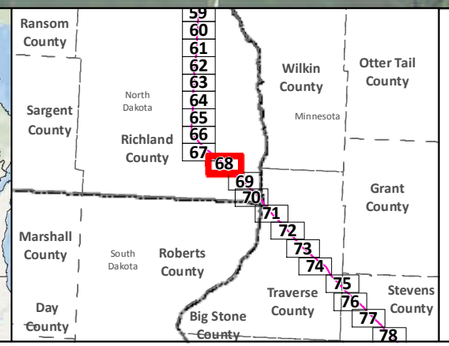
T129N R48W S5
T129N R48W S4
T129N R48W S3
T129N R48W S2
T129N R48W S1
T129N R49W S12
T129N R48W S7
T129N R48W S8
T129N R48W S9
T129N R48W S10
T129N R48W S11
T129N R48W S12
175th
176th
97th
222
223
224
225
226
11
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

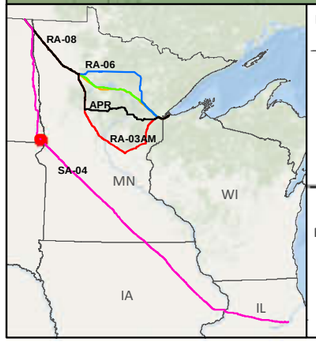
SA-04

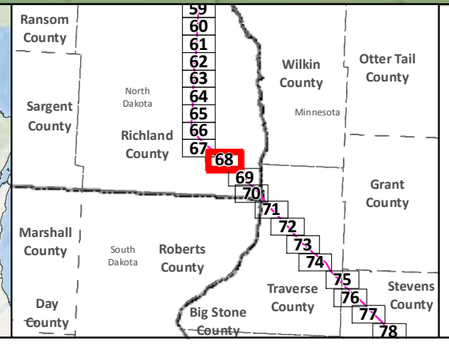
T130N R49W S25
T130N R48W S30
T130N R48W S29
T130N R48W S28
T130N R48W S27
T130N R48W S22
T130N R48W S23
T130N R48W S24
T130N R48W S26
T130N R48W S25
T130N R49W S36
T130N R48W S31
T130N R48W S32
T130N R48W S33
T130N R48W S34
T130N R48W S35
T130N R48W S36
T129N R49W S1
T129N R48W S6
T129N R48W S5
T129N R48W S4
T129N R48W S3
T129N R48W S2
T129N R48W S1
T129N R49W S12
T129N R48W S7
T129N R48W S8
T129N R48W S9
T129N R48W S10
T129N R48W S11
T129N R48W S12

222
223
224
225
226
11

Dakota Tallgrass Prairie Wildlife Management Area

SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

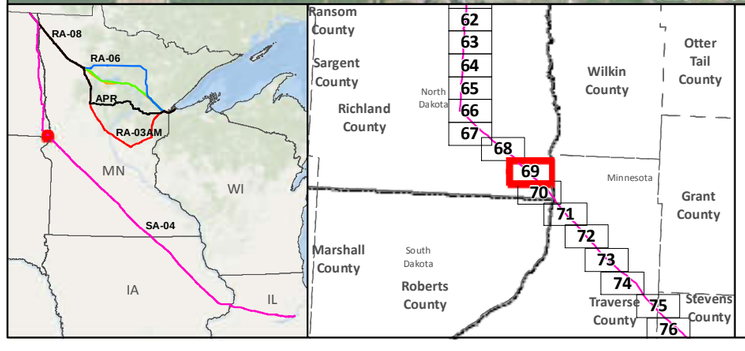
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 68B of 188





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 69A of 188

T129N R48W S2
T129N R48W S1
T129N R47W S6
T129N R47W S5
T129N R47W S4
T129 R47W S3
T129N R48W S10
T129N R48W S11
T129N R48W S12
T129N R47W S7
T129N R47W S8
T129N R47W S9
T129 R47W S10
Red River
Bois de Sioux River
227
228
229
230
127
SA-04
Taylor Twsp Co.
T129N R48W S15
T129N R48W S14
Dakota Tallgrass Prairie Wildlife Management Area
T129N R48W S13
T129N R47W S18
T129N R47W S17
T129N R47W S16
T129 R47W S15
T129N R47W S15
T129N R48W S22
T129N R48W S23
T129N R48W S24
T129N R47W S19
T129N R47W S20
T129N R47W S21
T129 R47W S22
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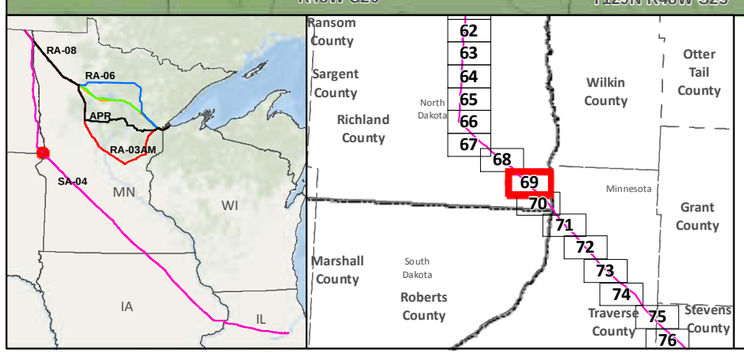
T129N R48W S26
T129N R48W S25
T129N R47W S30



- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
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- SNA - Scientific and Natural Area

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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

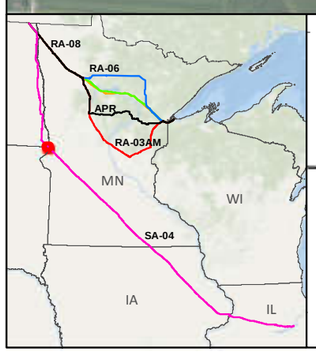
SA-04

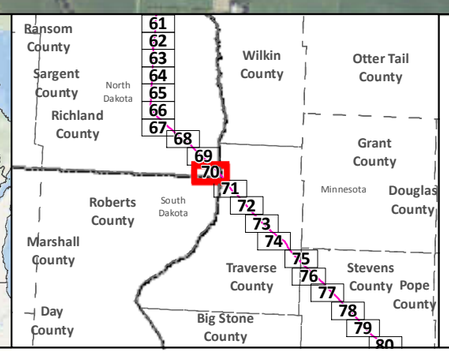
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 69B of 188

T129N R48W S23
T129N R48W S24
T129N R47W S19
T129N R47W S20
T129N R47W S21
T129N R47W S22
T129N R48W S26
T129N R48W S25
T129N R47W S30
T129N R47W S29
T129N R47W S28
T129N R47W S27
SA-04
231
232
233
234
127
Bois de Sioux River
Taylor Twsp Co.
Monson Twsp Co.
T129N R48W S35
T129N R48W S36
T129N R47W S31
T129N R47W S32
T129N R47W S33
T129N R47W S34





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

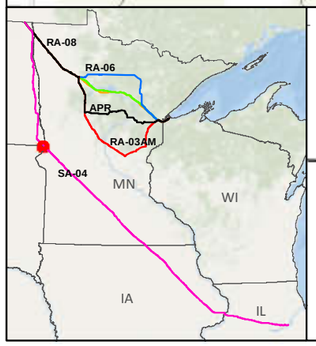
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

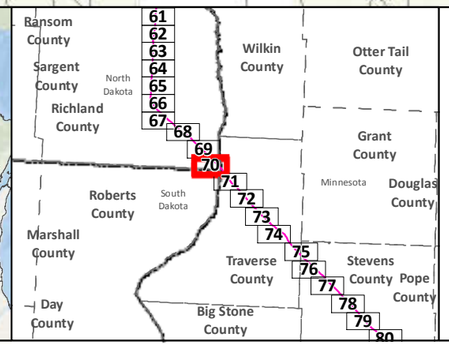
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 70A of 188

T129N R48W S23
T129N R48W S24
T129N R47W S19
T129N R47W S20
T129N R47W S21
T129N R47W S22
T129 R47W S22
T129 R47W S23
T129N R48W S26
T129N R48W S25
T129N R47W S30
T129N R47W S29
T129N R47W S28
T129 R47W S27
T129N R47W S27
T129 R47W S26
Red River
Dakota Tallgrass Prairie Wildlife Management Area
SA-04
231
232
233
234
127
Bois de Sioux River
Taylor Twsp Co.
T129N R48W S35
T129N R48W S36
T129N R47W S31
T129N R47W S32
T129N R47W S33
T129N R47W S34
T129 R47W S34
T129 R47W S35
T128 R47W S3
T128 R47W S2
Monson Twsp Co.
Unnamed Stream
SOUTH DAKOTA
NORTH DAKOTA





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 70B of 188

White Rock

Bois de Sioux River

235

236

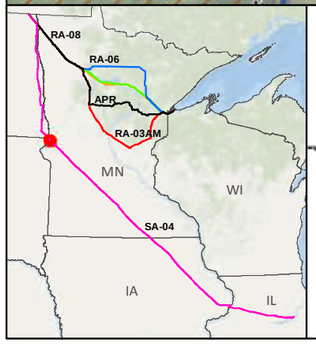
237

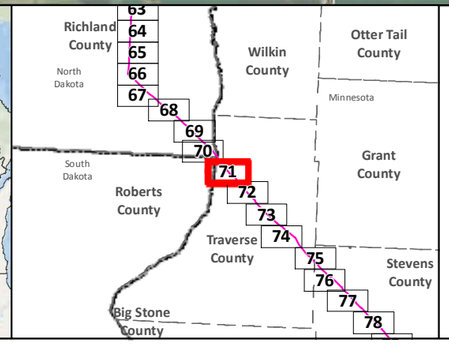
238

SA-04

Monson
Twsp Co.

75





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

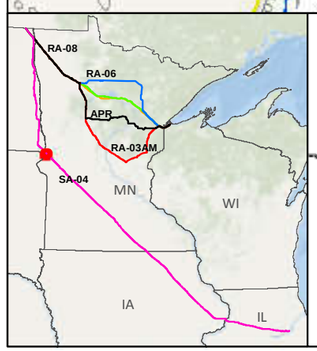
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

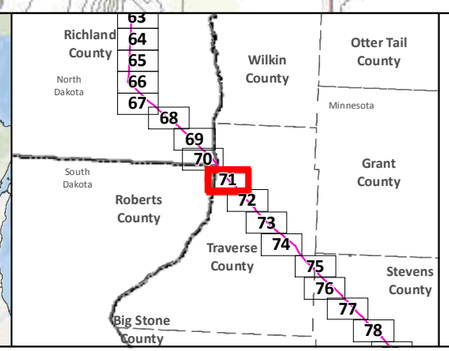
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 71A of 188

T128 R47W S3
T128 R47W S2
T128 R47W S1
T128 R46W S6
T128 R46W S5
T128 R46W S4
White Rock
Red River
Bois de Sioux River
T128 R47W S10
T128 R47W S11
T128 R47W S12
T128 R46W S7
T128 R46W S8
T128 R46W S9
SA-04
235
236
237
238
75
White Rock
Bois De Sioux WMA
Monson Twsp Co.
T128 R47W S15
T128 R47W S14
T128 R47W S13
T128 R46W S18
T128 R46W S17
T128 R46W S16
T128 R47W S22
T128 R47W S23
T128 R47W S24
T128 R46W S19
T128 R46W S20
T128 R46W S21
SOUTH DAKOTA





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

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- Township Boundary

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Water Resources
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

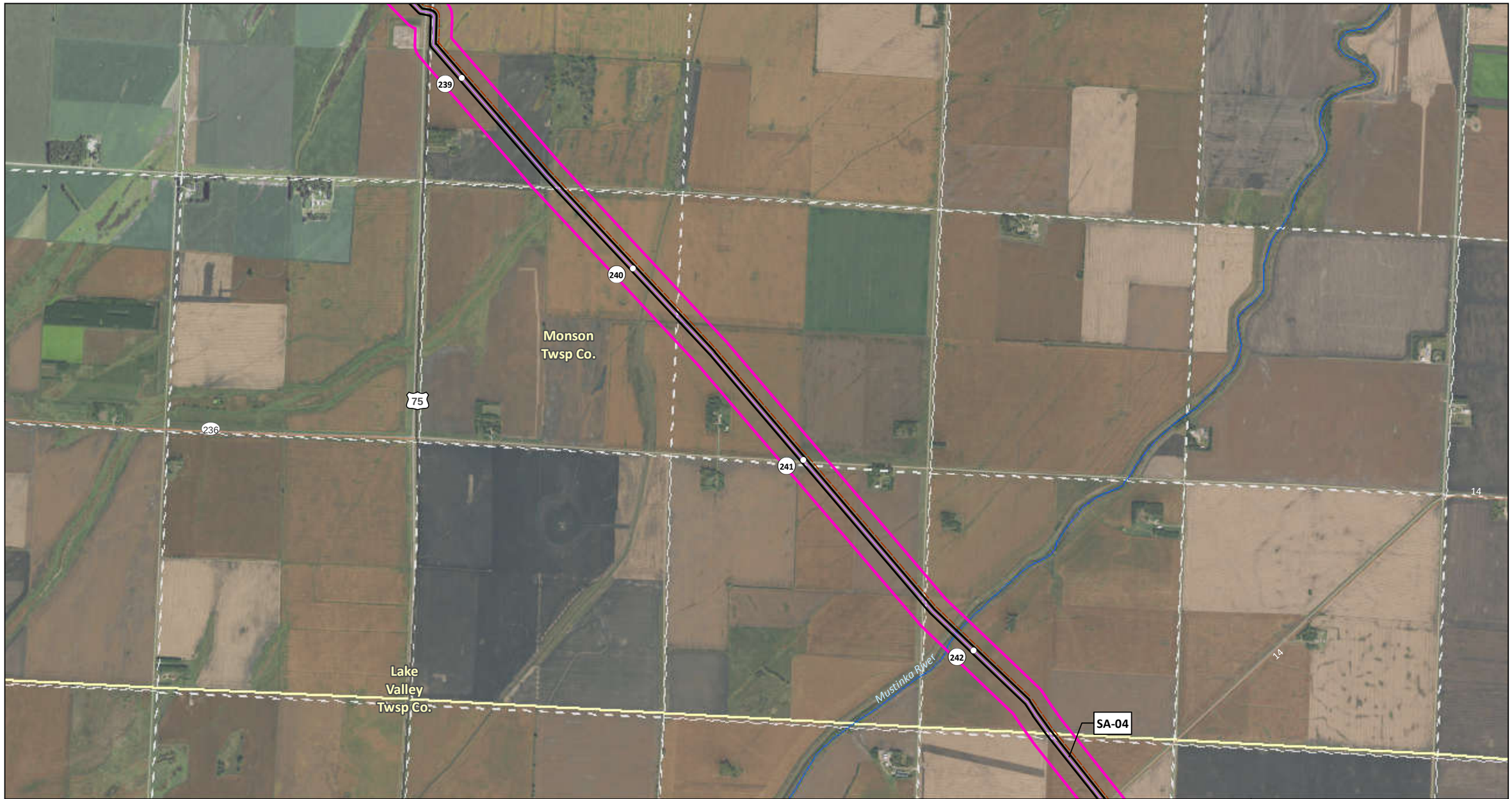
Data Sources: MNDNR, USGS, NHD, Enbridge

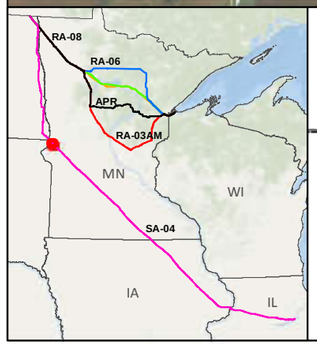
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

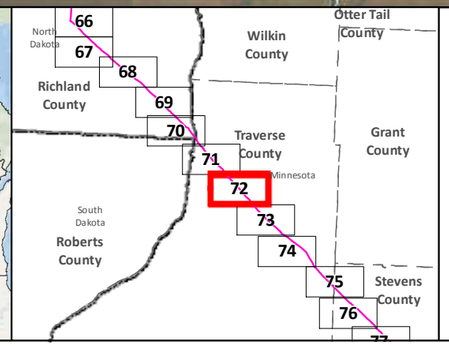
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
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Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

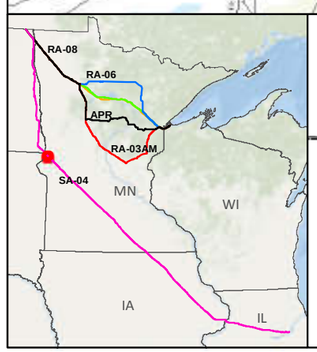
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

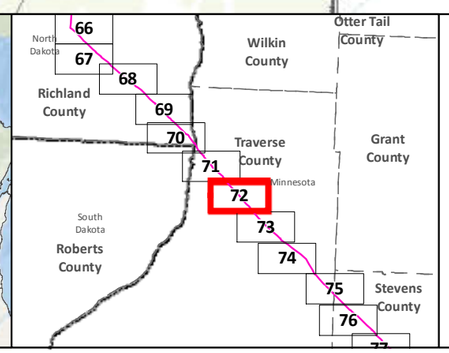
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 72A of 188

T128 R47W S24
T128 R46W S19
T128 R46W S20
T128 R46W S21
T128 R46W S22
T128 R46W S23
T128 R46W S24
Unnamed Stream
T128 R47W S25
T128 R46W S30
T128 R46W S29
Monson Twsp Co.
T128 R46W S28
T128 R46W S27
T128 R46W S26
T128 R46W S25
SA-04
239
240
241
242
75
236
T128 R47W S36
T128 R46W S31
T128 R46W S32
T128 R46W S33
T128 R46W S34
T128 R46W S35
T128 R46W S36
Lake Valley Twsp Co.
Mustinka River
Mustinka River
T127 R47W S1
T127 R46W S6
T127 R46W S5
T127 R46W S4
T127 R46W S3
T127 R46W S2
T127 R46W S1





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
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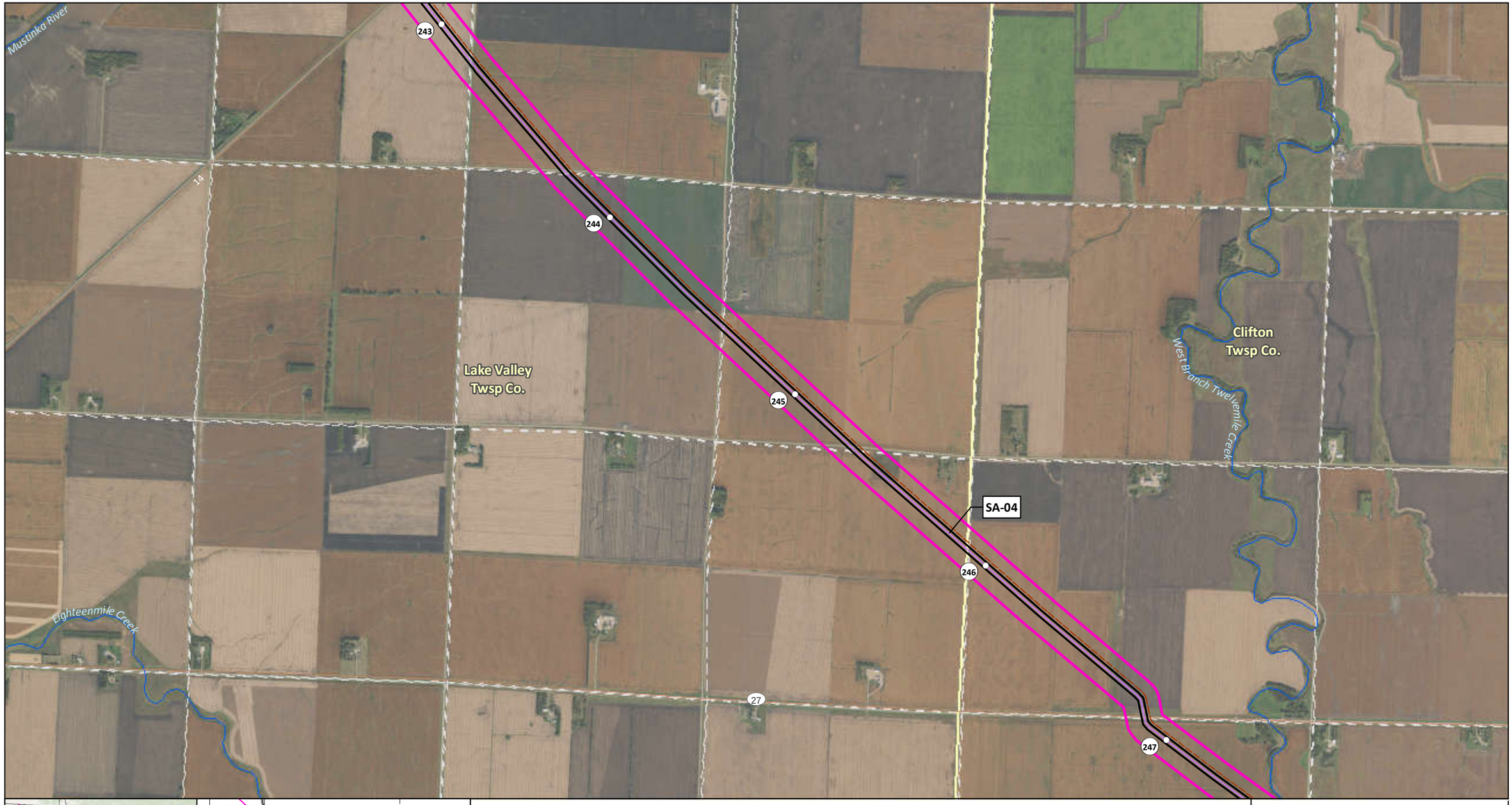
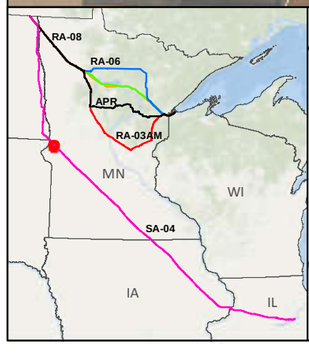
Data Sources: MNDNR, USGS, NHD, Enbridge

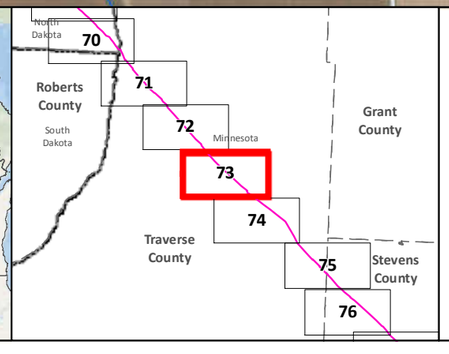
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
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Highway
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Data Sources:
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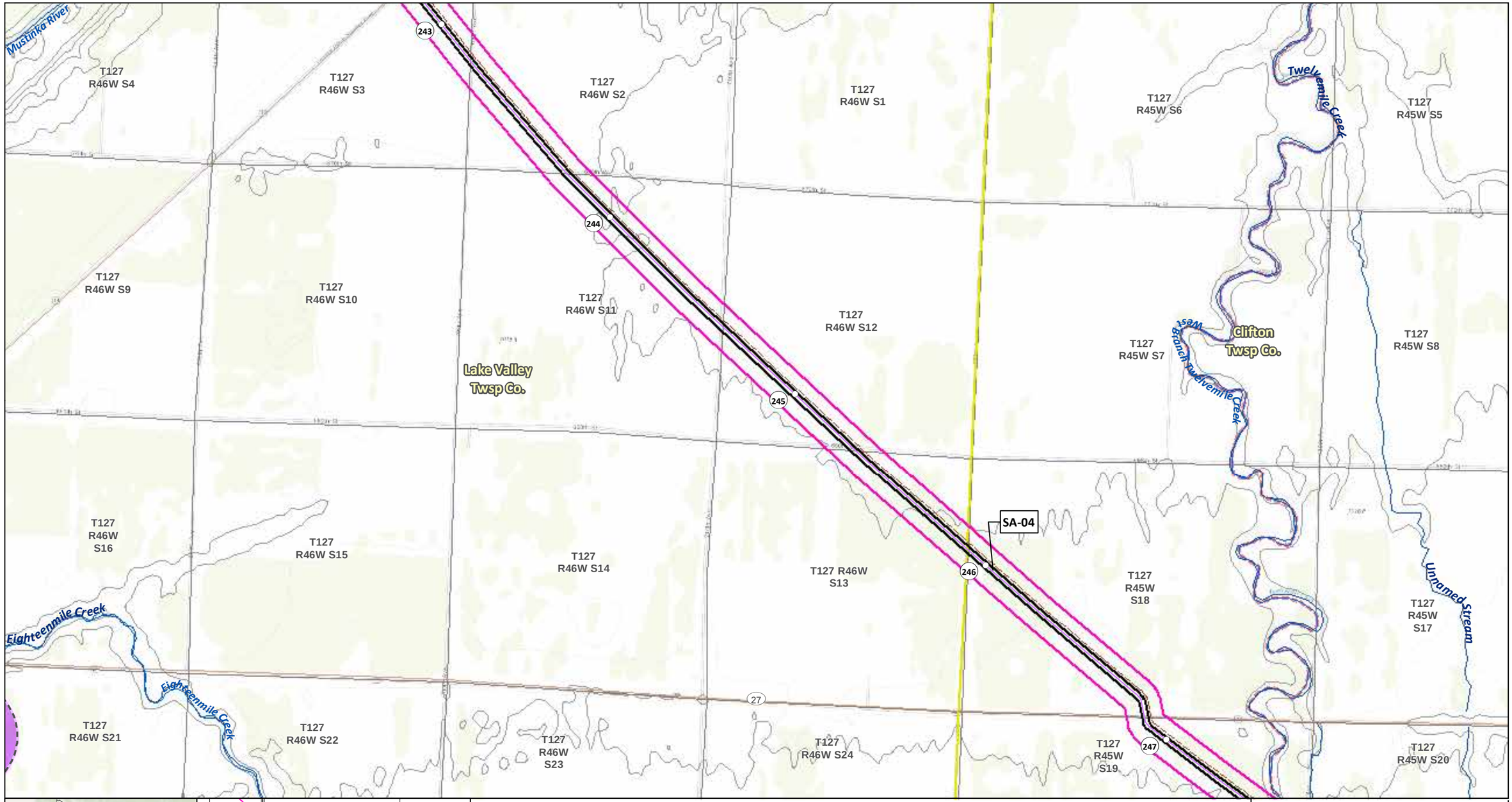
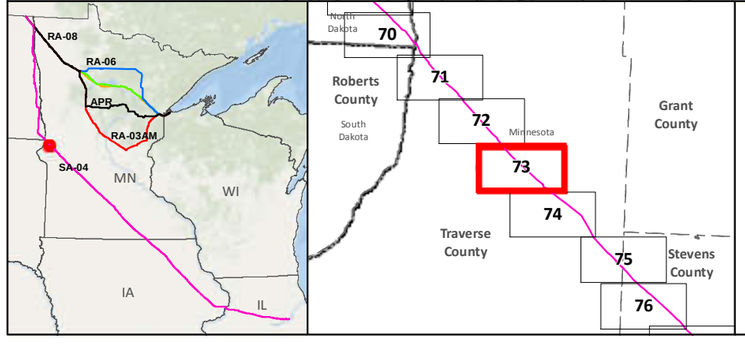
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 73A of 188





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- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

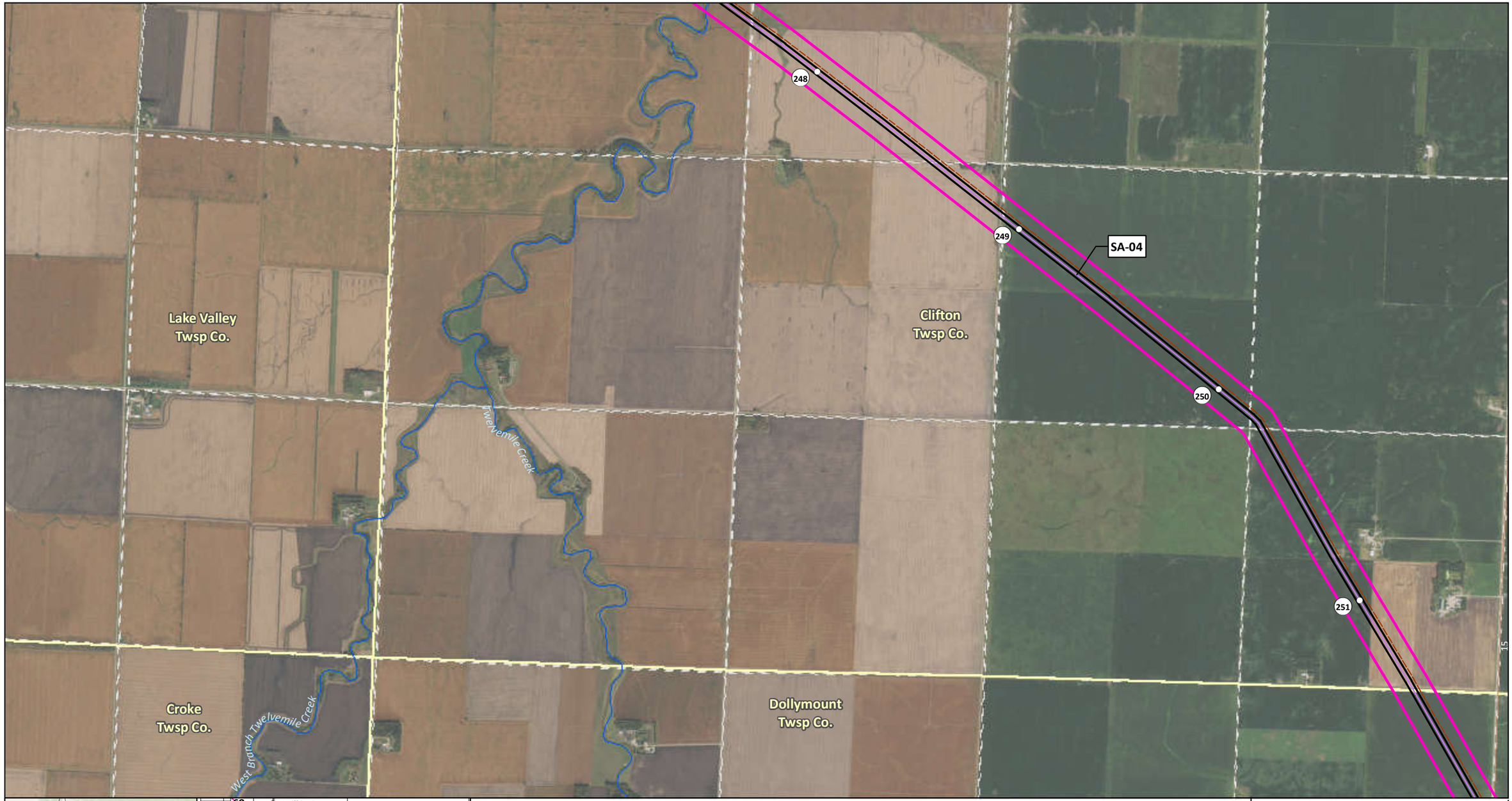
0 0.125 0.25 0.5 Miles

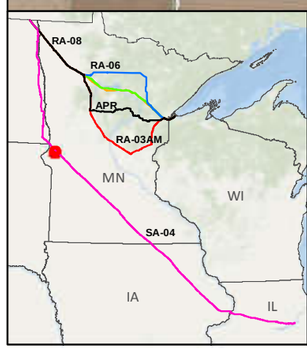
0 125 250 500 Meters

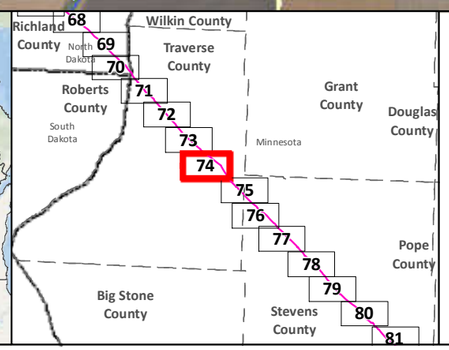
1:24,000

10ft Contours

Map 73B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

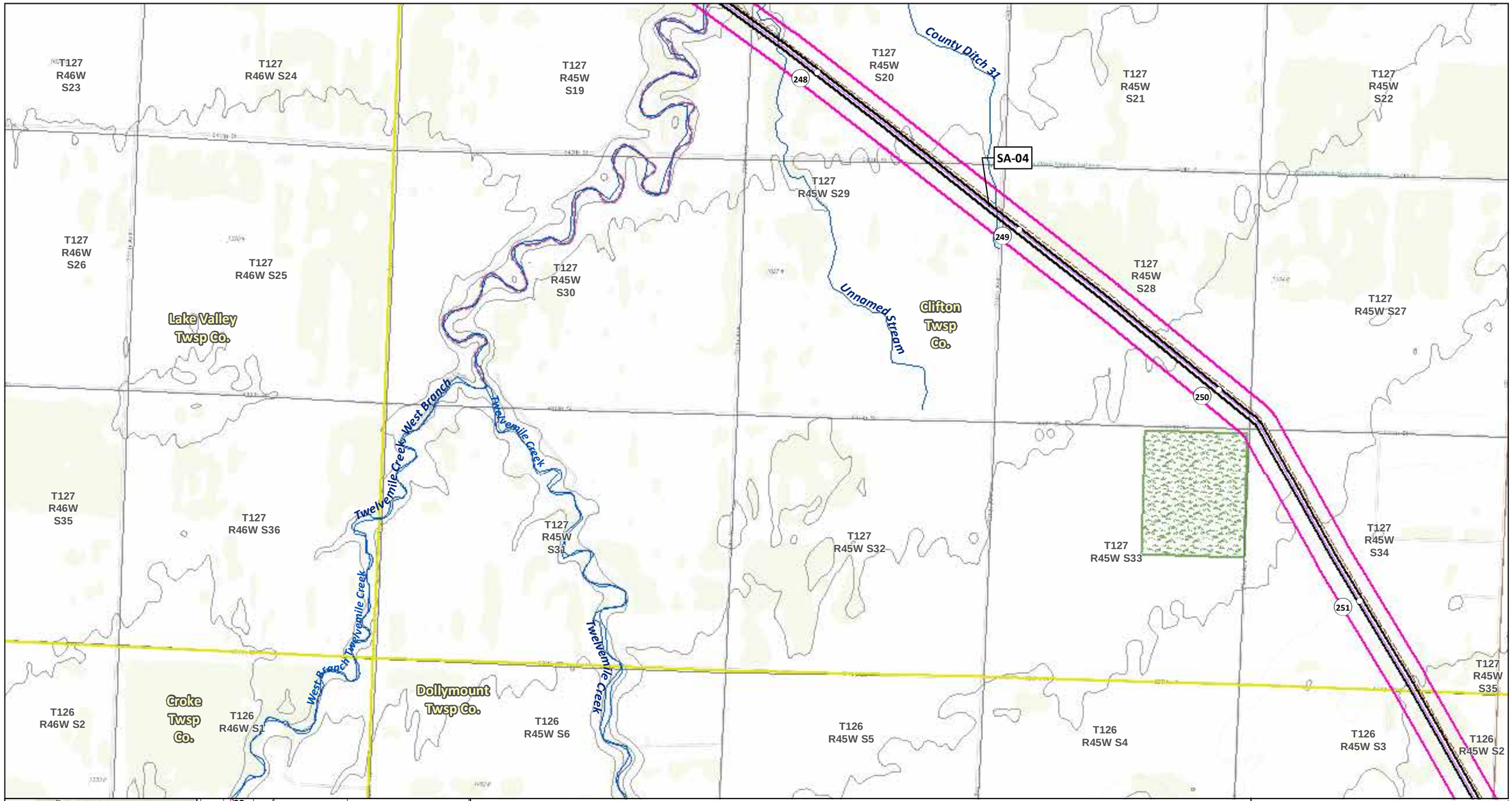
Water Resources
Lake
River

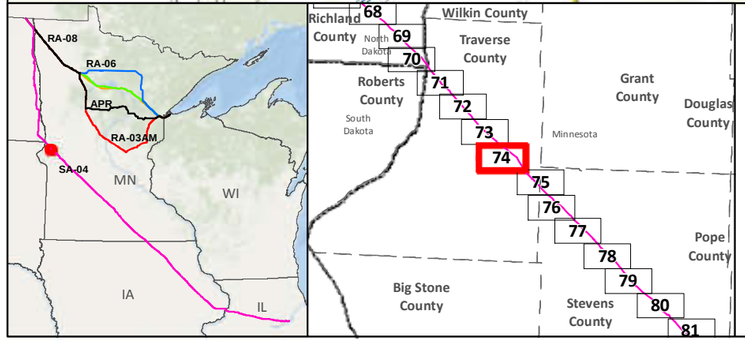
Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
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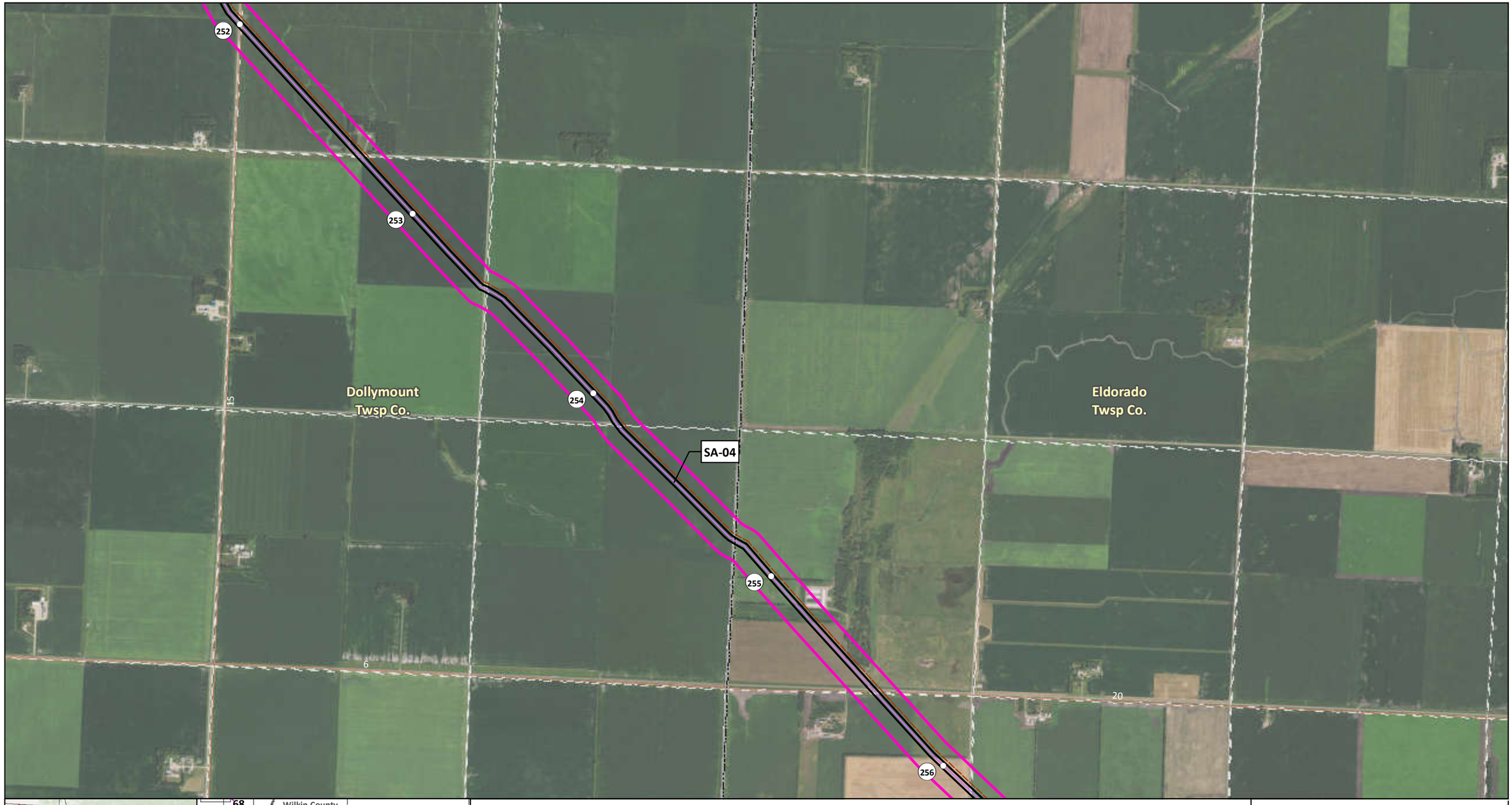
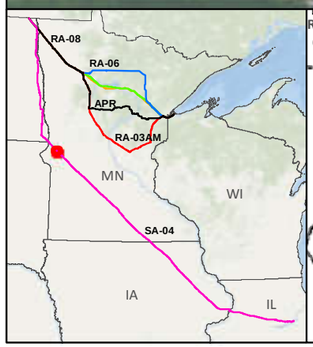
Data Sources: MNDNR, USGS, NHD, Enbridge

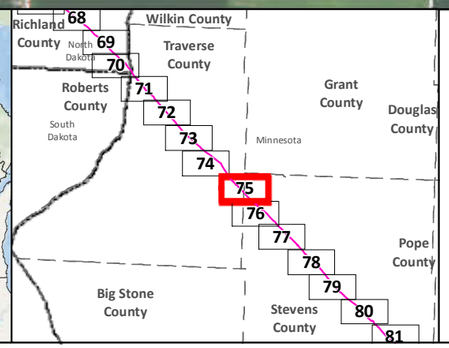
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

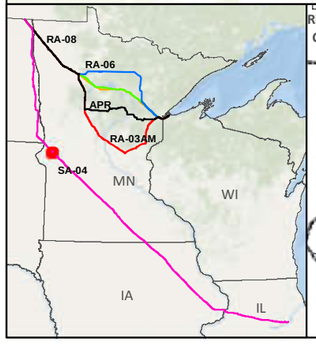
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

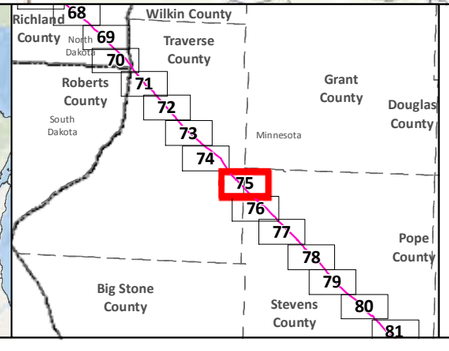
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 75A of 188

T126 R45W S3
T126 R45W S2
T126 R45W S1
T126 R44W S6
T126 R44W S5
T126 R44W S4
SA-04
252
253
T126 R45W S10
T126 R45W S11
T126 R45W S12
T126 R44W S7
T126 R44W S8
T126 R44W S9
T126 R44W S10
254
Dollymount Twsp Co.
Eldorado Twsp Co.
Horning Pit WMA
T126 R45W S15
T126 R45W S14
T126 R45W S13
T126 R44W S18
T126 R44W S17
T126 R44W S16
255
T126 R44W S15
T126 R45W S22
T126 R45W S23
T126 R45W S24
T126 R44W S19
T126 R44W S20
T126 R44W S21
T126 R44W S22
256





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

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- Township Boundary

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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours


SA-04
257
258
259
260
Dollymount
Twsp Co.
Eldorado
Twsp Co.
Leonardsville
Twsp Co.
Everglade
Twsp Co.
Twelvemile Creek
East Fork Twelvemile Creek
8
9
13
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
South Dakota
Minnesota
Roberts County
Grant County
Douglas County
Traverse County
Stevens County
Pope County
Big Stone County
71
72
73
74
75
76
77
78
79
80
81
82
SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary
Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary
Land Ownership
State Forest
National Forest
Tribal Reservation
Water Resources
Lake
River
Data Sources:
MNDNR, NHD,USGS, Enbridge
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
AERIAL
SA-04
Map 76A of 188
N

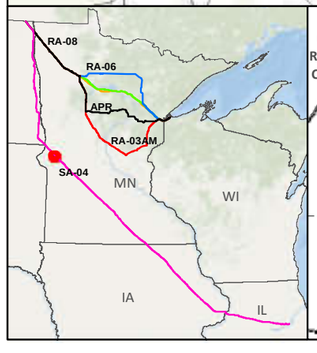
T126 R45W S23
T126 R45W S24
T126 R44W S19
T126 R44W S20
T126 R44W S21
T126 R44W S22
T126 R44W S23
T126 R45W S26
T126 R45W S25
T126 R44W S30
T126 R44W S29
T126 R44W S28
T126 R44W S27
T126 R44W S26
T126 R45W S35
T126 R45W S36
T126 R44W S31
T126 R44W S32
T126 R44W S33
T126 R44W S34
T126 R44W S35
T125 R45W S2
T125 R45W S1
T125 R44W S6
T125 R44W S5
T125 R44W S4
T125 R44W S3
T125 R44W S2

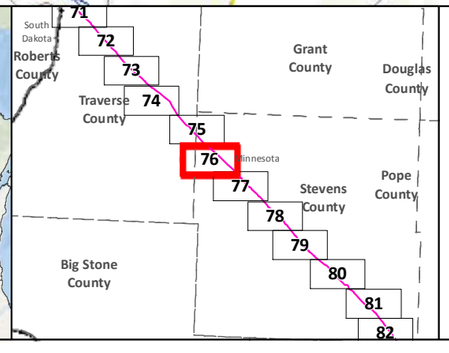
SA-04

257
258
259
260

Twelvemile Creek
Twelvemile Creek East Fork
Unnamed Stream

Dollymount Twsp Co.
Eldorado Twsp Co.
Leonardsville Twsp Co.
Everglade Twsp Co.





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

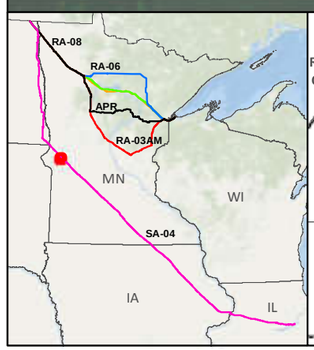
SA-04

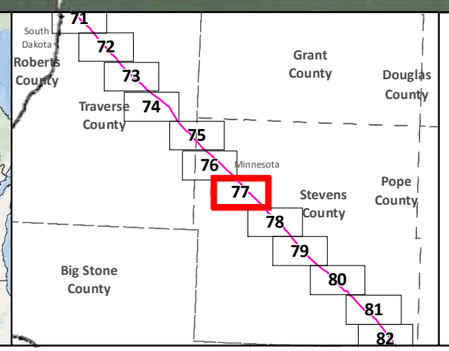
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 76B of 188

261
262
263
264
SA-04
Everglade
Twsp Co.
Pepperton
Twsp Co.
13
16





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

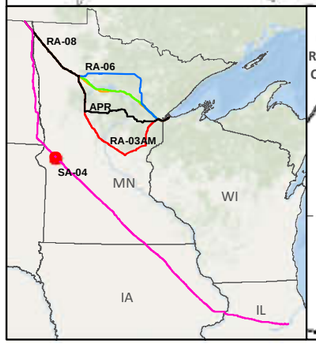
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

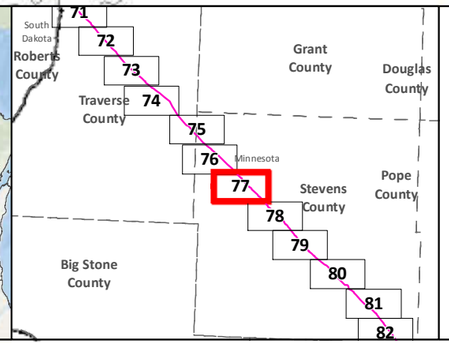
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 77A of 188

T125 R44W S4
T125 R44W S3
T125 R44W S2
T125 R44W S1
T125 R43W S6
T125 R43W S5
SA-04
261
262
263
264
T125 R44W S9
T125 R44W S10
T125 R44W S11
T125 R44W S12
T125 R43W S7
T125 R43W S8
Everglade Twsp Co.
Pepperton Twsp Co.
T125 R44W S16
T125 R44W S15
T125 R44W S14
T125 R44W S13
T125 R43W S18
T125 R43W S17
Unnamed Stream
T125 R44W S21
T125 R44W S22
T125 R44W S23
T125 R44W S24
T125 R43W S19
T125 R43W S20





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 77B of 188

Everglade Twsp Co.

Pepperton Twsp Co.

Baker Twsp Co.

Scott Twsp Co.

SA-04

266

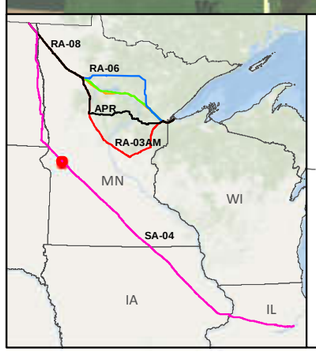
267

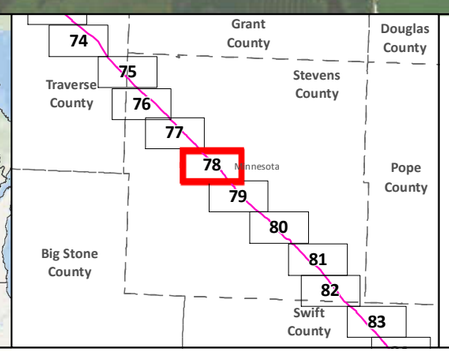
268

269

Muddy Creek

9





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

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- State Forest
- National Forest
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Water Resources
- Lake
- River

Data Sources: MNDNR, NHD,USGS, Enbridge

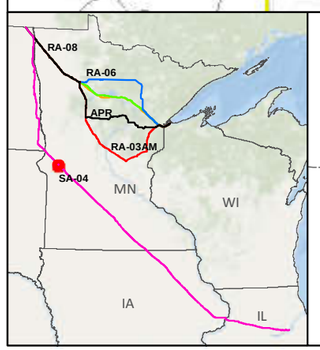
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

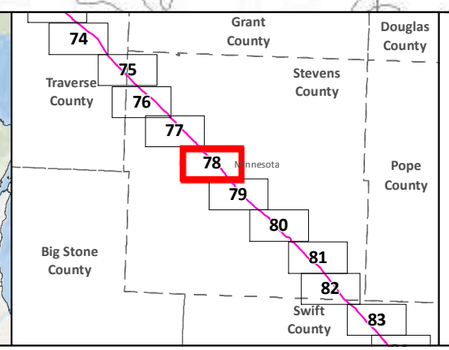
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 78A of 188

T125 R44W S24
T125 R43W S19
Cin WMA
T125 R43W S20
T125 R43W S21
T125 R43W S22
T125 R43W S23
Unnamed Stream
T125 R43W S24
266
Everglade Twsp Co.
T125 R43W S30
T125 R43W S29
T125 R43W S28
267
Pepperton Twsp Co.
T125 R43W S27
T125 R43W S26
T125 R43W S25
T125 R44W S25
T125 R44W S36
T125 R43W S34
268
T125 R43W S31
T125 R43W S32
T125 R43W S33
SA-04
Muddy Creek
T125 R43W S35
Muddy Creek
T125 R43W S36
Baker Twsp Co.
T124 R44W S1
T124 R43W S6
T124 R43W S5
Scott Twsp Co.
T124 R43W S4
T124 R43W S3
269
T124 R43W S2
T124 R43W S1





SA-04
Applicant's Preferred Route (APR)

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- RA-06
- RA-07
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Township Boundary

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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

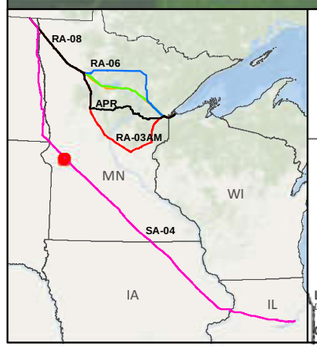
SA-04

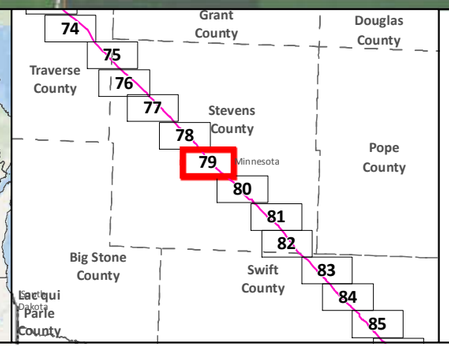
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 78B of 188







- SA-04
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- Route Width (750')
- County Boundary

- Mile Post
- Existing Pipeline
- Interstate
- Highway
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- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

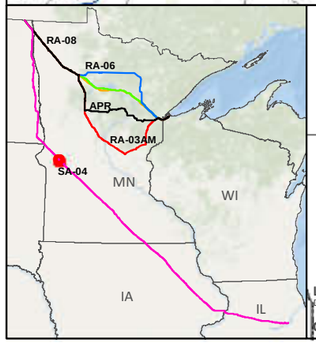
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

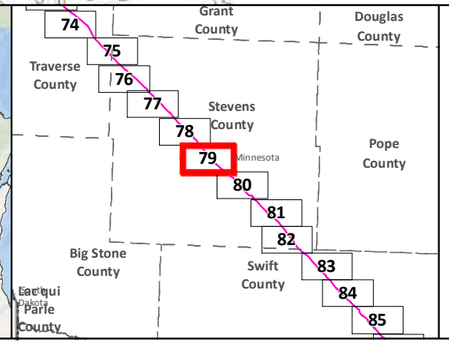
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 79A of 188

T124 R43W S4
Alberta Twsp Co.
T124 R43W S3
Alberta
T124 R43W S2
Unnamed Stream
T124 R43W S1
Muddy Creek
Muddy Creek
Brouillet WMA
T124 R42W S6
T124 R42W S5
270
28
T124 R43W S9
T124 R43W S10
T124 R43W S11
271
T124 R43W S12
T124 R42W S7
Muddy Creek WMA
T124 R42W S8
SA-04
Scott Twsp Co.
Darnen Twsp Co.
272
T124 R43W S16
T124 R43W S15
T124 R43W S14
T124 R43W S13
T124 R42W S18
T124 R42W S17
County Ditch 3
273
T124 R43W S21
T124 R43W S22
T124 R43W S23
T124 R43W S24
T124 R42W S19
T124 R42W S20
T124 R42W S16
T124 R42W S21





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

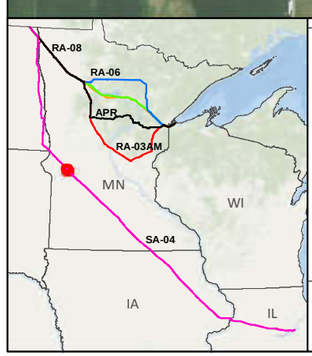
Data Sources: MNDNR, USGS, NHD, Enbridge

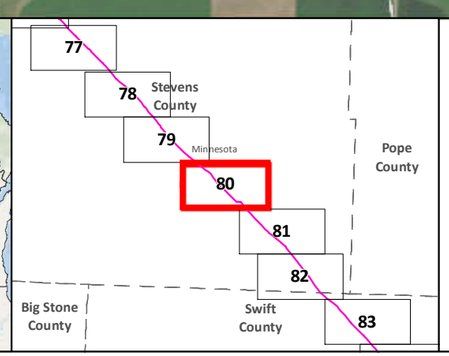
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

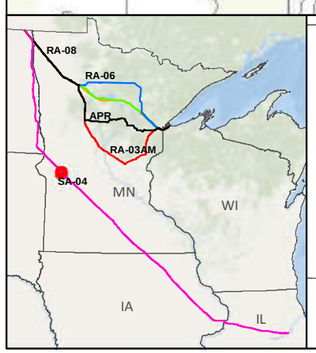
Data Sources:
MNDNR, NHD,USGS, Enbridge

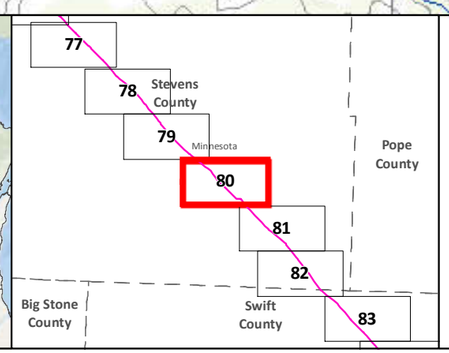
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 80A of 188

T124 R42W S19
T124 R42W S20
T124 R42W S21
T124 R42W S22
T124 R42W S23
T124 R42W S24
T124 R41W S19
T124 R42W S30
T124 R42W S29
T124 R42W S28
T124 R42W S27
T124 R42W S26
T124 R42W S25
T124 R41W S30
T124 R42W S31
T124 R42W S32
T124 R42W S33
T124 R42W S34
T124 R42W S35
T124 R42W S36
T124 R41W S31
T123 R42W S6
T123 R42W S5
T123 R42W S4
T123 R42W S3
T123 R42W S2
T123 R42W S1
Darnen Twsp Co.
Horton Twsp Co.
Hodges Twsp Co.
Moore Twsp Co.
Unnamed Stream
Muddy Creek
Pomme de Terre River
274
275
276
277
278
59
SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

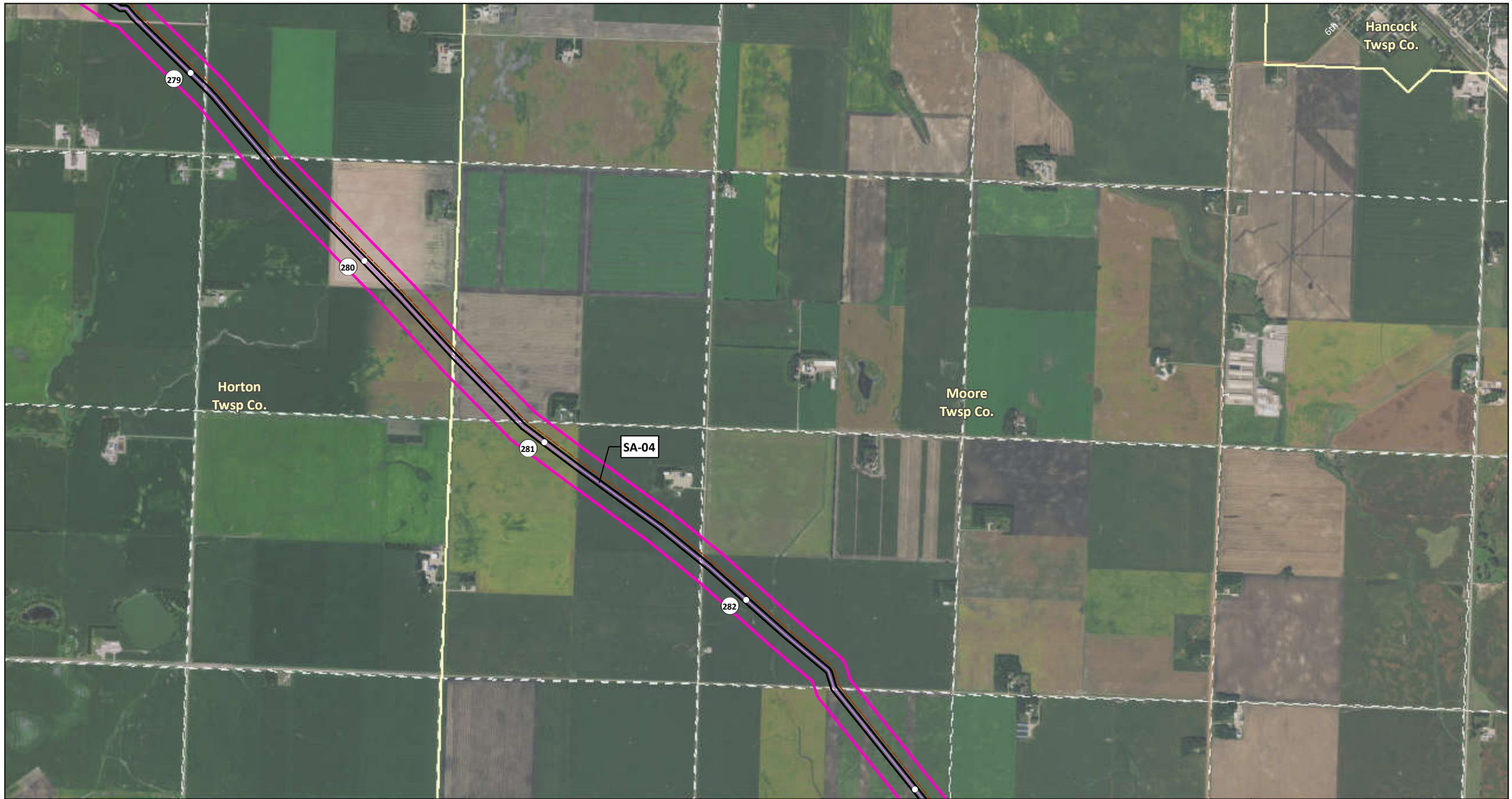
Data Sources: MNDNR, USGS, NHD, Enbridge

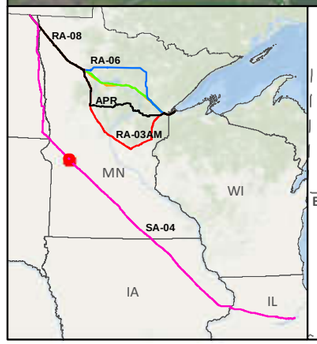
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

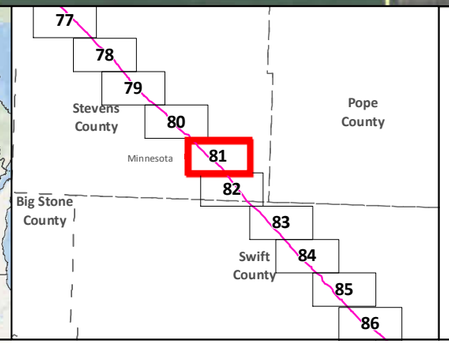
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 80B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

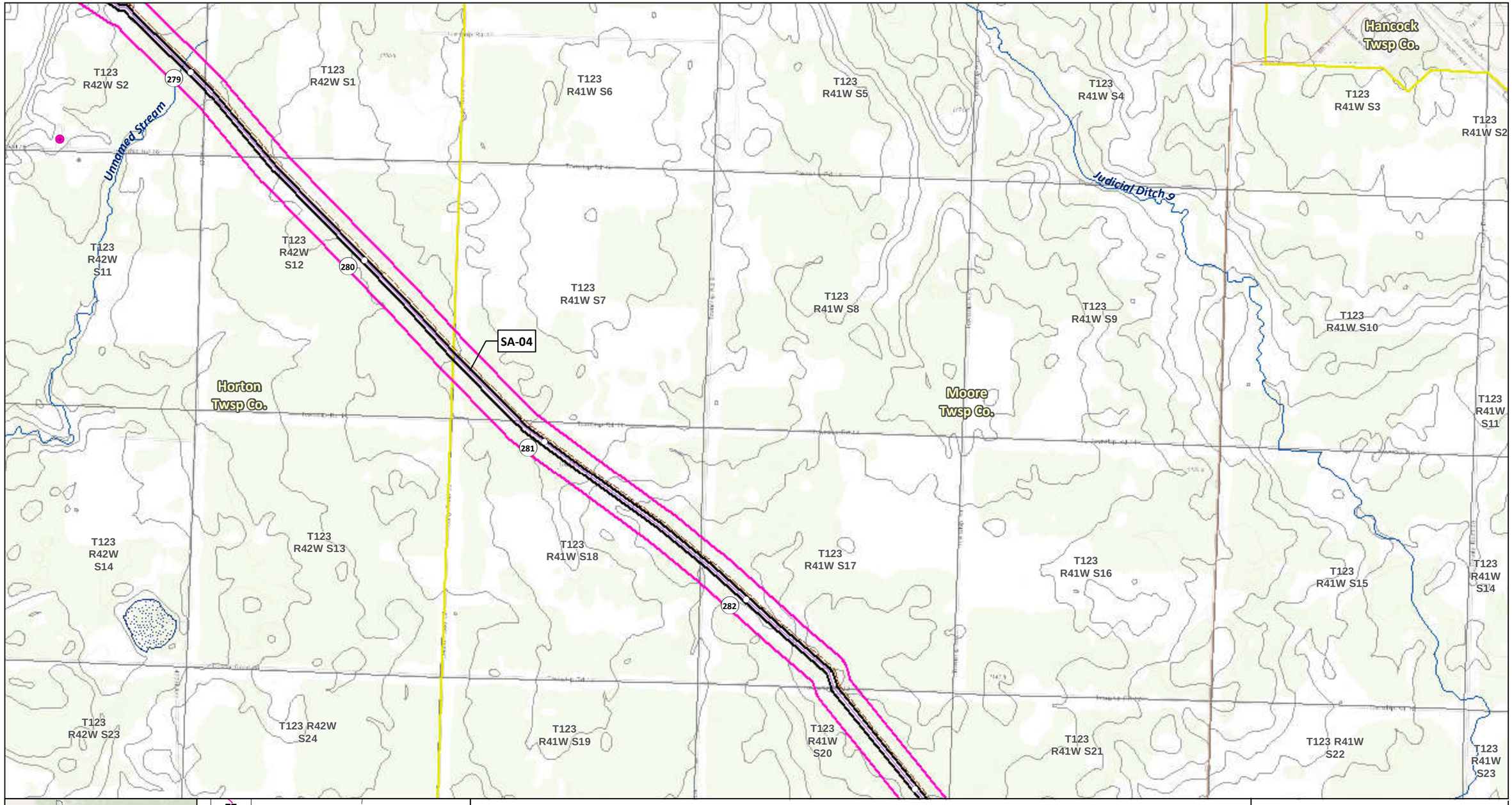
Data Sources:
MNDNR, NHD,USGS, Enbridge

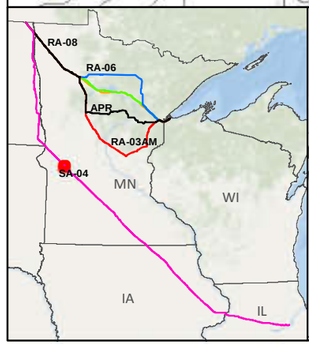
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

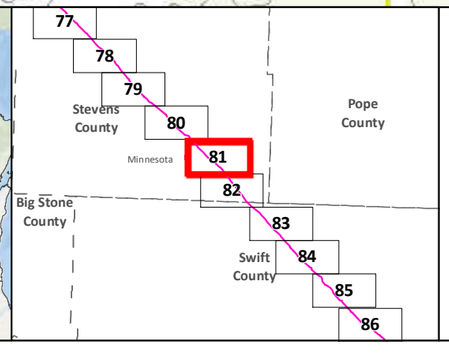
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 81A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 81B of 188

Horton Twsp Co.

Moore Twsp Co.

Fairfield Twsp Co.

Tara Twsp Co.

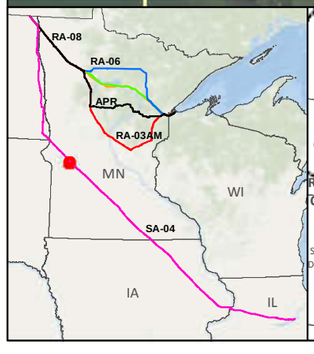
284

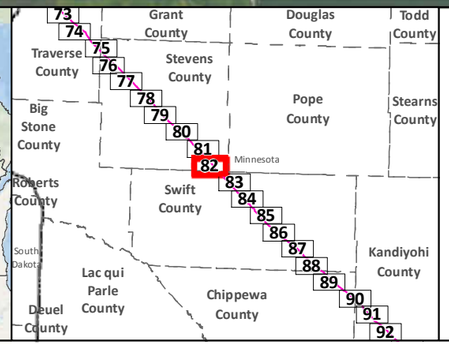
285

286

SA-04

110th





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

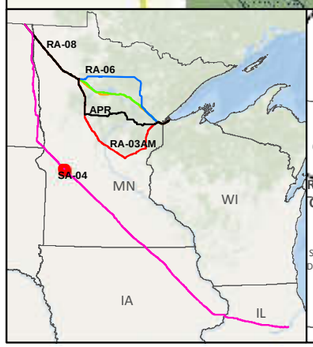
1:24,000

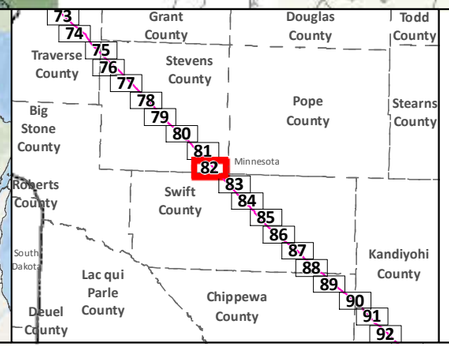
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T123 R42W S24
T123 R41W S19
T123 R41W S20
T123 R41W S21
T123 R41W S22
T123 R41W S23
T123 R41W S24
Judicial Ditch 9
284
T123 R42W S25
T123 R41W S30
Judicial Ditch 2
T123 R41W S29
T123 R41W S28
SA-04
Horton Twsp Co.
Moore Twsp Co.
T123 R41W S27
T123 R41W S26
T123 R41W S25
285
T123 R41W S35
T123 R42W S36
T123 R41W S31
T123 R41W S32
T123 R41W S33
Unnamed Stream
County Ditch 3
T123 R41W S34
286
T123 R41W S36
T122 R42W S1
Byrne Lake WMA
Fairfield Twsp Co.
T122 R41W S6
T122 R41W S5
Tara Twsp Co.
T122 R41W S4
T122 R41W S3
T122 R41W S2
T122 R41W S1





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

SA-04

288

289

290

291

Tara
Twsp
Co.

Clontarf
Twsp Co.

60th

9

22

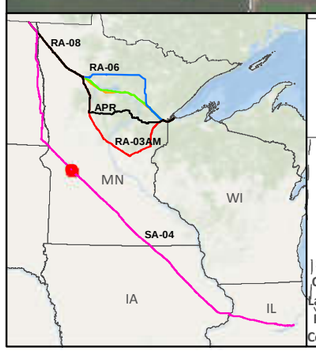
Chippewa River

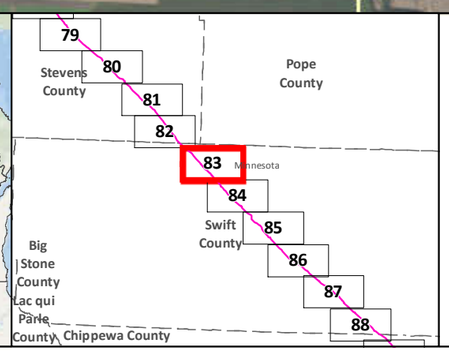
Grace

Clontarf

Grace

Clontarf
Twsp Co.





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

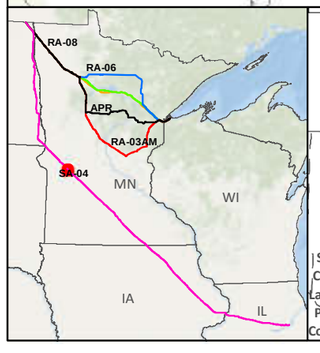
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

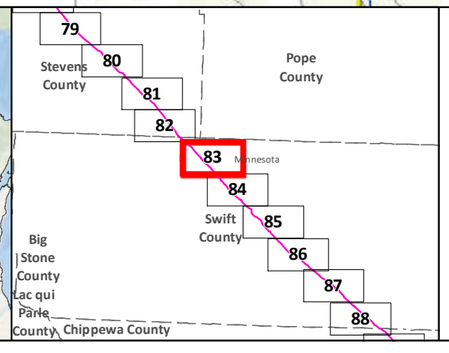
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 83A of 188

T122 R41W S2
T122 R41W S1
T122 R40W S6
T122 R40W S5
T122 R40W S4
T122 R40W S3
T122 R40W S2
Unnamed Stream
288
SA-04
T122 R41W S11
T122 R41W S12
T122 R40W S7
T122 R40W S8
T122 R40W S9
T122 R40W S10
Chippewa River
Clontarf Twsp Co.
County Ditch 3
289
Tara Twsp Co.
9
T122 R40W S11
T122 R40W S17
T122 R41W S14
T122 R41W S13
290
County Ditch 23
T122 R40W S18
T122 R40W S16
Clontarf
T122 R40W S15
Clontarf Twsp Co.
T122 R40W S14
T122 R41W S23
T122 R41W S24
T122 R40W S19
291
T122 R40W S20
T122 R40W S21
T122 R40W S22
T122 R40W S23





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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- Navigable Waterway Crossings
- National River Inventory Crossing
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- 303d Imparied Waters
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- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

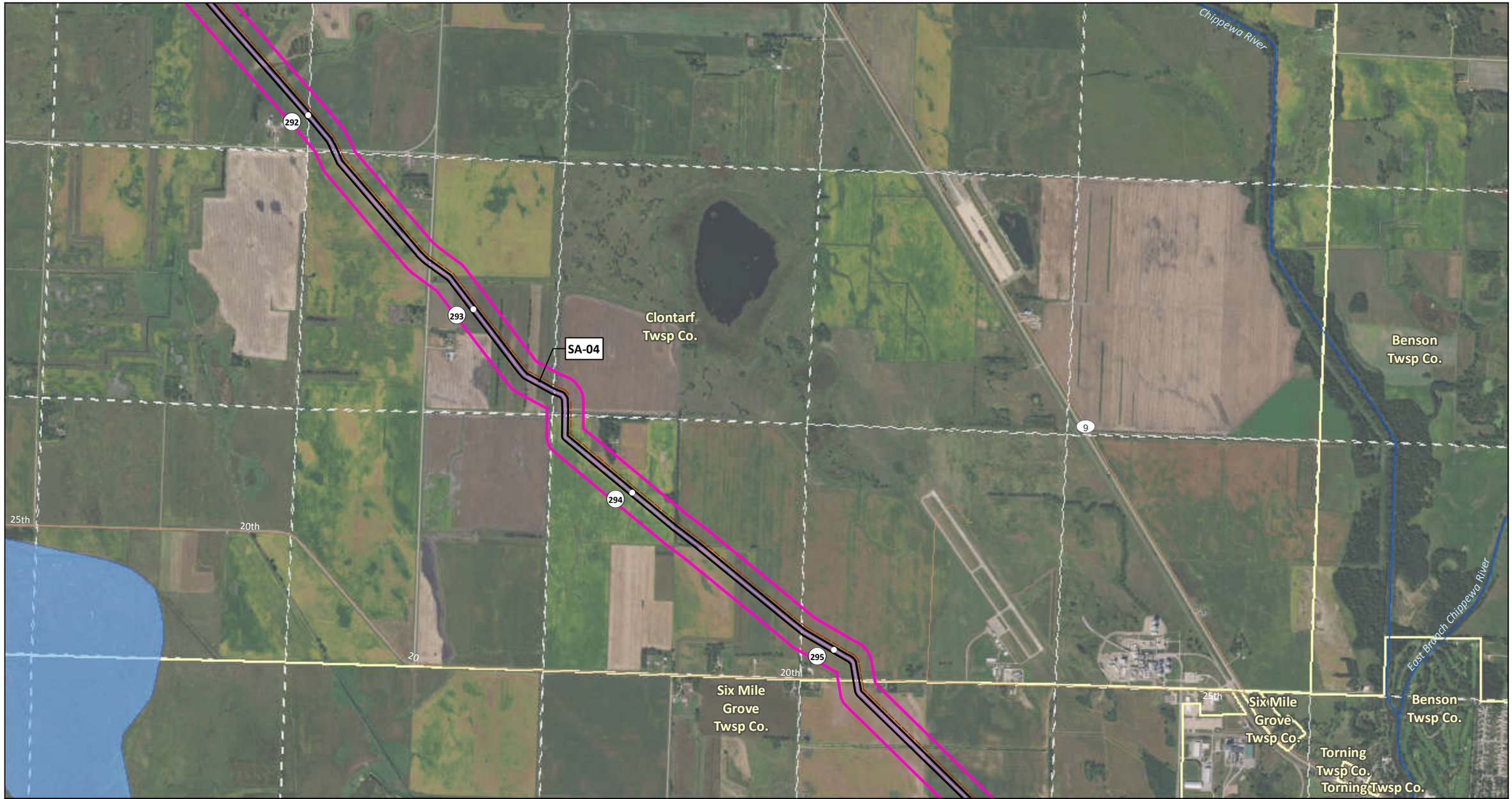
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

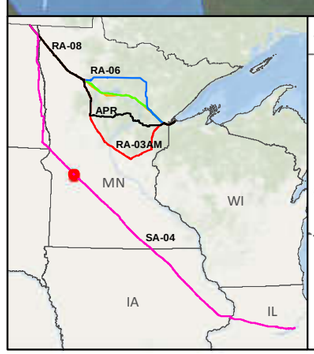
SA-04

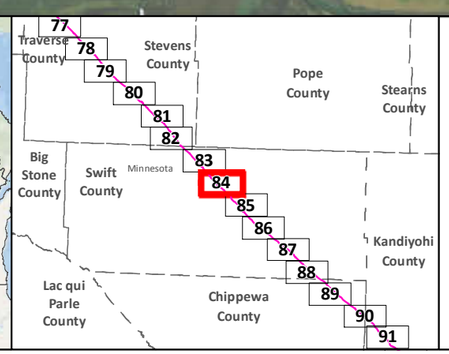
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 83B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 84A of 188

T122 R40W S19
T122 R40W S20
T122 R40W S21
T122 R40W S22
T122 R40W S23
T122 R40W S24
T122 R39W S19
T122 R40W S30
T122 R40W S29
T122 R40W S28
T122 R40W S27
T122 R40W S26
T122 R40W S25
T122 R39W S30
T122 R40W S31
T122 R40W S32
T122 R40W S33
T122 R40W S34
T122 R40W S35
T122 R40W S36
T122 R39W S31
T121 R40W S6
T121 R40W S5
T121 R40W S4
T121 R40W S3
T121 R40W S2
T121 R40W S1
T121 R39W S6

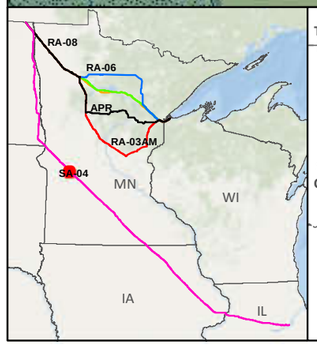
County Ditch 23
County Ditch 3
Chippewa River
Chippewa River
Chippewa River, East Branch
East Branch Chippewa River

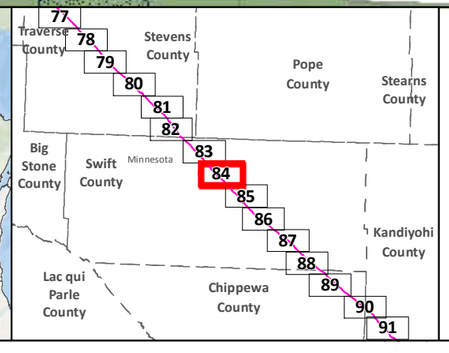
292
293
294
295
9

SA-04

Clontarf Twsp Co.
Benson Twsp Co.
Six Mile Grove Twsp Co.
Torning Twsp Co.

Danvers WMA





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

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Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
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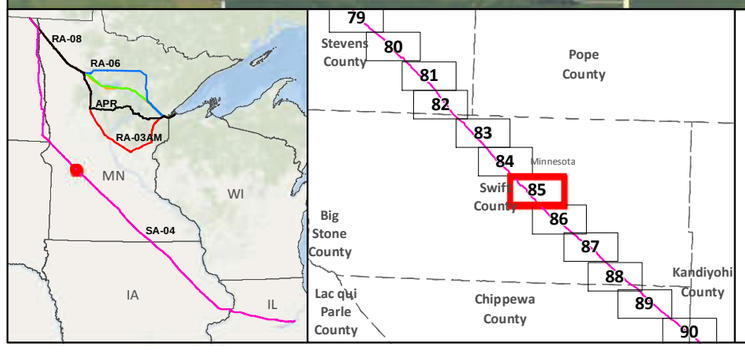
Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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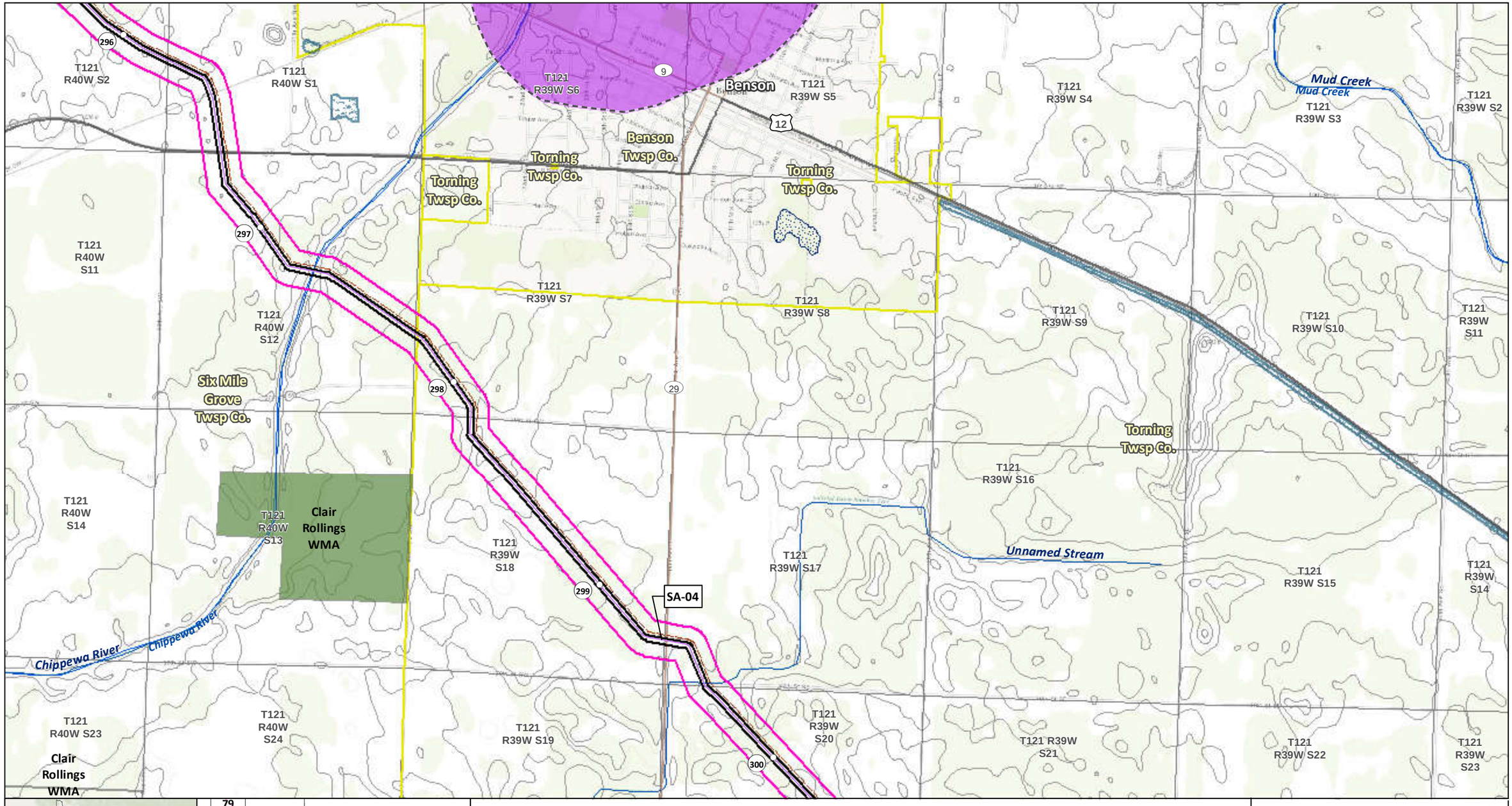
Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

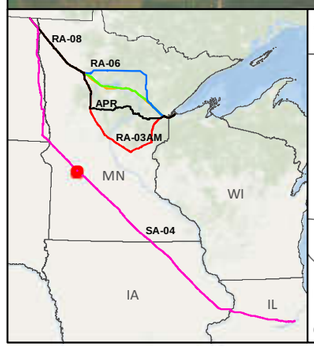
Data Sources: MNDNR, USGS, NHD, Enbridge

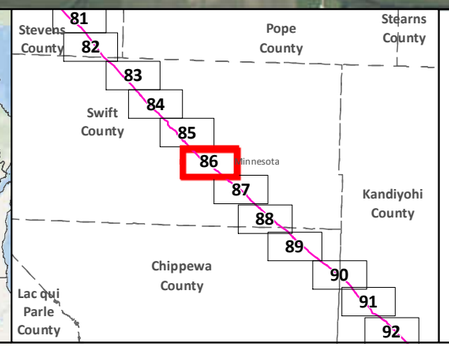
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

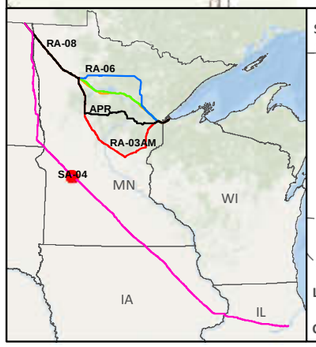
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

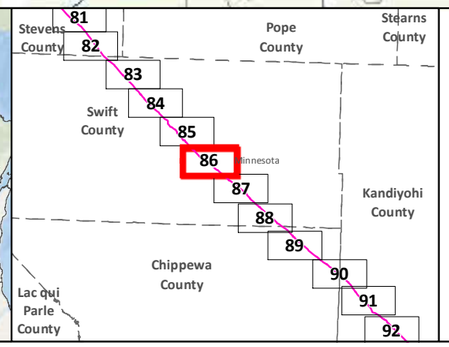
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 86A of 188

T121 R39W S19
T121 R39W S20
T121 R39W S21
T121 R39W S22
T121 R39W S23
T121 R39W S24
12
T121 R38W S19
301
T121 R39W S30
T121 R39W S29
T121 R39W S28
T121 R39W S27
Torning Twsp Co.
T121 R39W S26
T121 R39W S25
T121 R38W S30
Kildare Twsp Co.
302
T121 R39W S31
29
Unnamed Stream
303
SA-04
T121 R39W S32
T121 R39W S33
T121 R39W S34
T121 R39W S35
T121 R39W S36
T121 R38W S31
304
T120 R39W S6
T120 R39W S5
T120 R39W S4
T120 R39W S3
Cashel Twsp Co.
T120 R39W S2
T120 R39W S1
T120 R38W S6
Dublin Twsp Co.
305





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

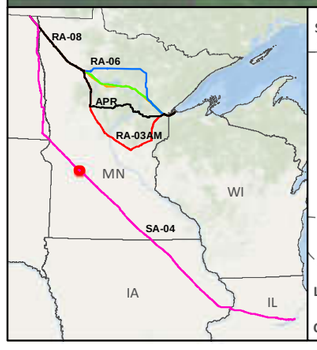
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

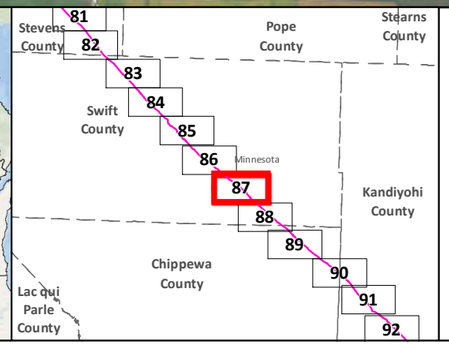
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

306
307
308
309
SA-04
Cashel
Twsp Co.
Dublin
Twsp Co.





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

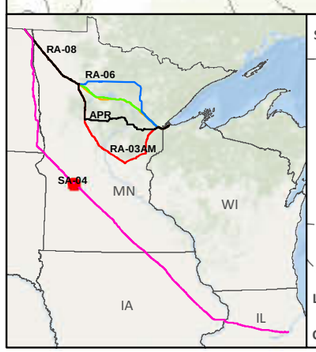
T120 R39W S3
T120 R39W S2
T120 R39W S1
T120 R38W S6
T120 R38W S5
T120 R38W S4
T120 R38W S3
T120 R39W S10
T120 R39W S11
T120 R39W S12
T120 R38W S7
T120 R38W S8
T120 R38W S9
T120 R38W S10
T120 R39W S15
T120 R39W S14
T120 R38W S18
T120 R38W S16
T120 R38W S15
T120 R38W S17
T120 R39W S23
T120 R39W S24
T120 R38W S19
T120 R38W S20
T120 R38W S21
T120 R38W S22

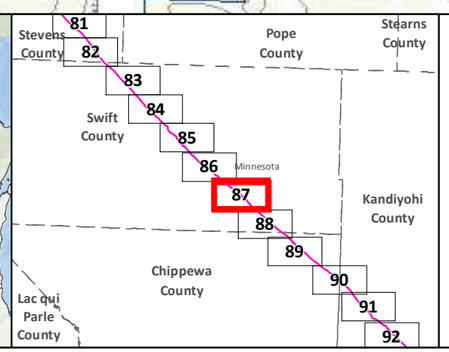
306
307
308
309

SA-04

Cashel Twsp Co.
Dublin Twsp Co.

Unnamed Stream





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
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Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 87B of 188

SA-04

310

311

312

313

314

Dublin
Twsp Co.

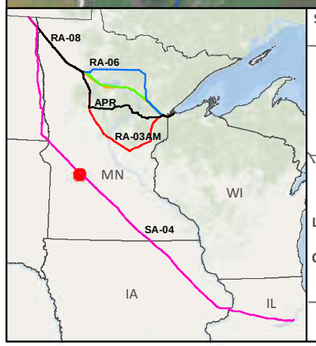
Louriston
Twsp Co.

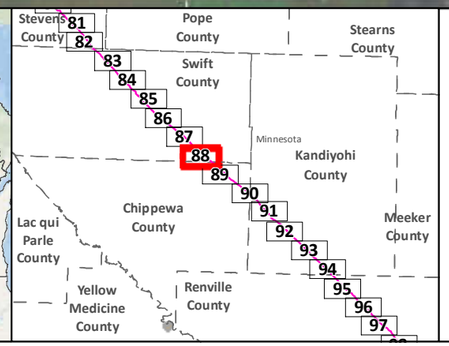
Pillsbury
Twsp Co.

Woods
Twsp Co.

Shakopee Creek

Shakopee Creek





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

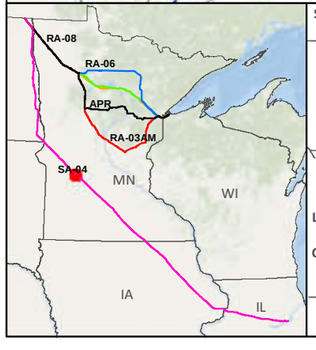
Data Sources:
MNDNR, NHD,USGS, Enbridge

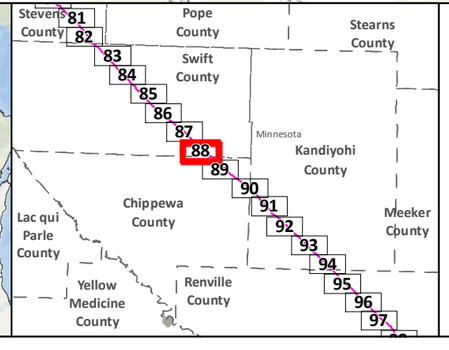
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T120 R38W S19
T120 R38W S20
T120 R38W S21
T120 R38W S22
T120 R38W S23
T120 R38W S24
T120 R37W S19
T120 R38W S30
T120 R38W S29
T120 R38W S28
Dublin Twsp Co.
T120 R38W S27
T120 R38W S26
T120 R38W S25
T120 R37W S30
Pillsbury Twsp Co.
Unnamed Stream
SA-04
T120 R38W S31
T120 R38W S32
T120 R38W S33
T120 R38W S34
T120 R38W S35
T120 R38W S36
T120 R37W S31
Louriston Twsp Co.
T119 R38W S6
T119 R38W S5
T119 R38W S4
T119 R38W S3
T119 R38W S2
T119 R38W S1
Woods Twsp Co.
T119 R37W S6
Shakopee Creek
Shakopee Creek
Shakopee Creek





- SA-04
- Applicant's Preferred Route (APR)

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Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Shakopee Creek

315

316

317

318

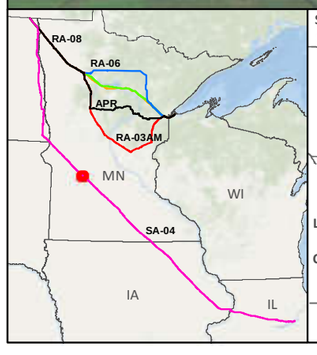
319

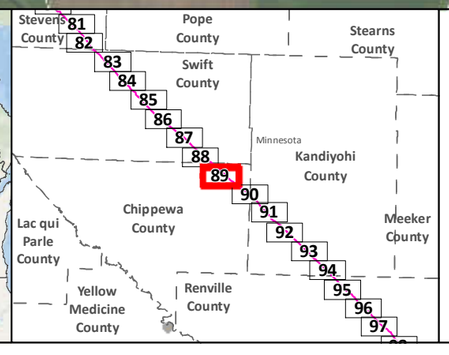
SA-04

40

Louriston
Twsp Co.

Woods
Twsp Co.





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

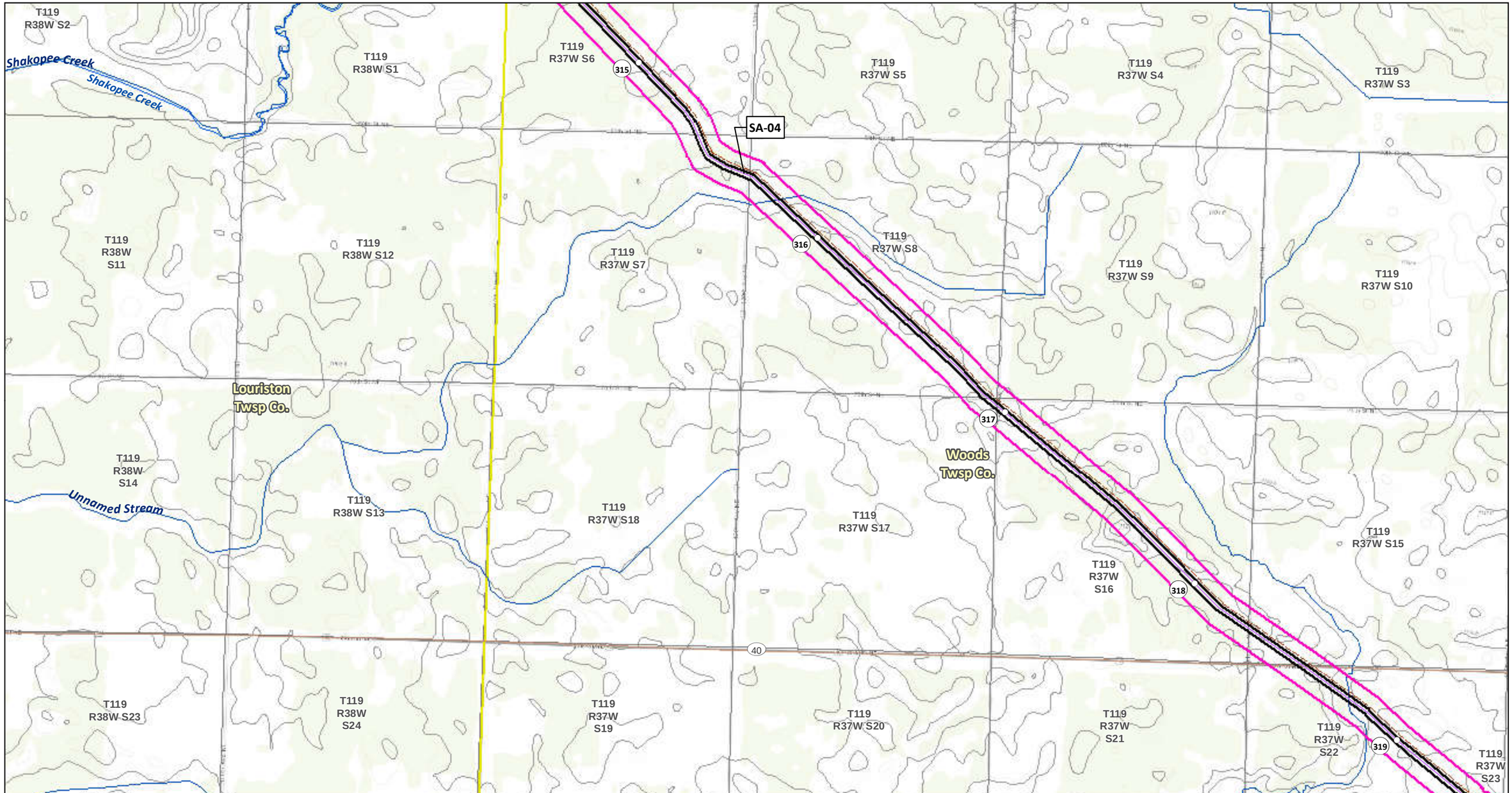
Water Resources
Lake
River

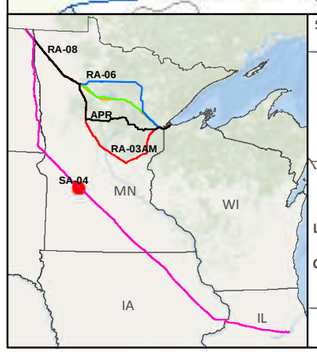
Data Sources:
MNDNR, NHD,USGS, Enbridge

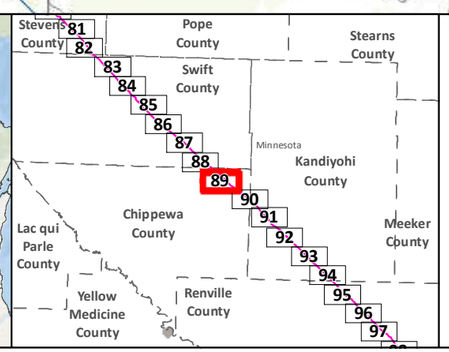
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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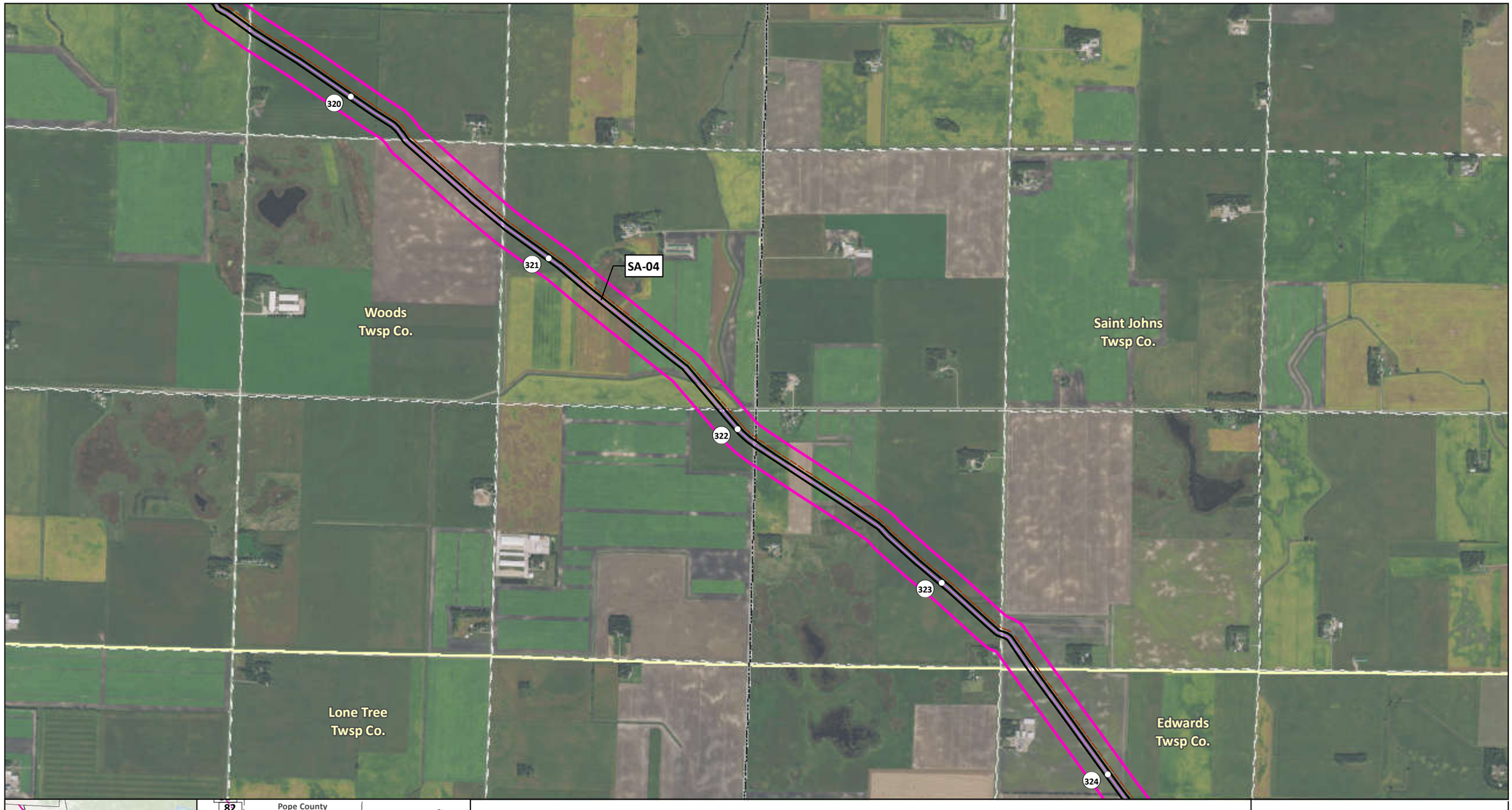
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

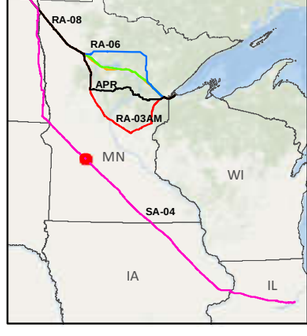
SA-04

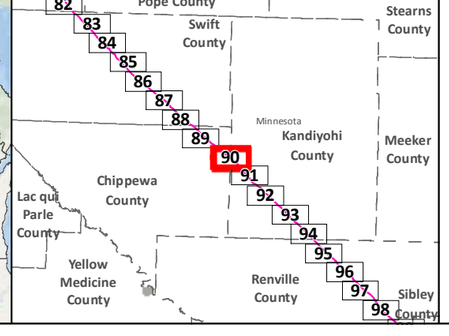
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 89B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
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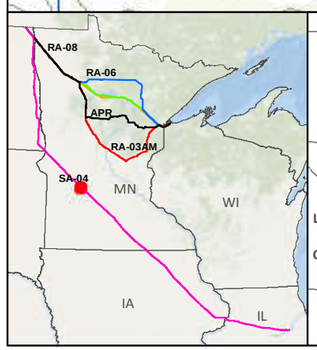
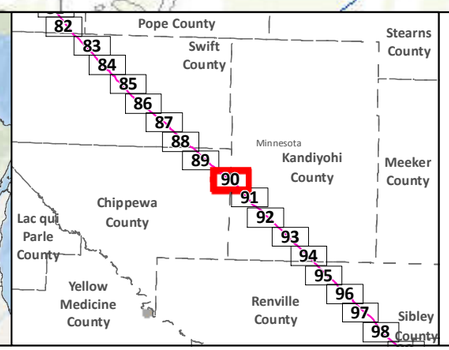
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T119 R37W S22
T119 R37W S23
T119 R37W S24
T119 R36W S19
T119 R36W S20
T119 R36W S21
320
Sena WMA
T119 R37W S27
T119 R37W S26
321
T119 R37W S25
T119 R36W S30
T119 R36W S29
T119 R36W S28
Woods Twsp Co.
Saint Johns Twsp Co.
Unnamed Stream
SA-04
322
Cuka WMA
T119 R37W S34
T119 R37W S35
T119 R37W S36
T119 R36W S32
T119 R36W S33
T119 R36W S31
323
T118 R37W S3
Lone Tree Twsp Co.
T118 R37W S2
T118 R37W S1
Edwards Twsp Co.
T118 R36W S6
T118 R36W S5
T118 R36W S4
324





SA-04
Applicant's Preferred Route (APR)

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Mile Post
Anticipated 120' Construction ROW
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High
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

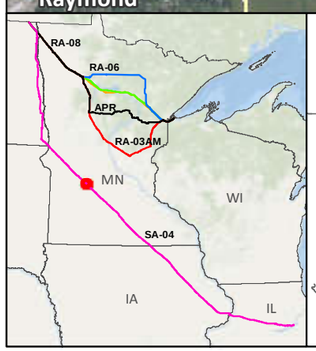
SA-04

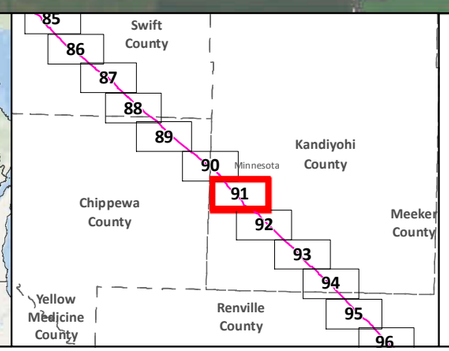
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 90B of 188







SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

Data Sources:
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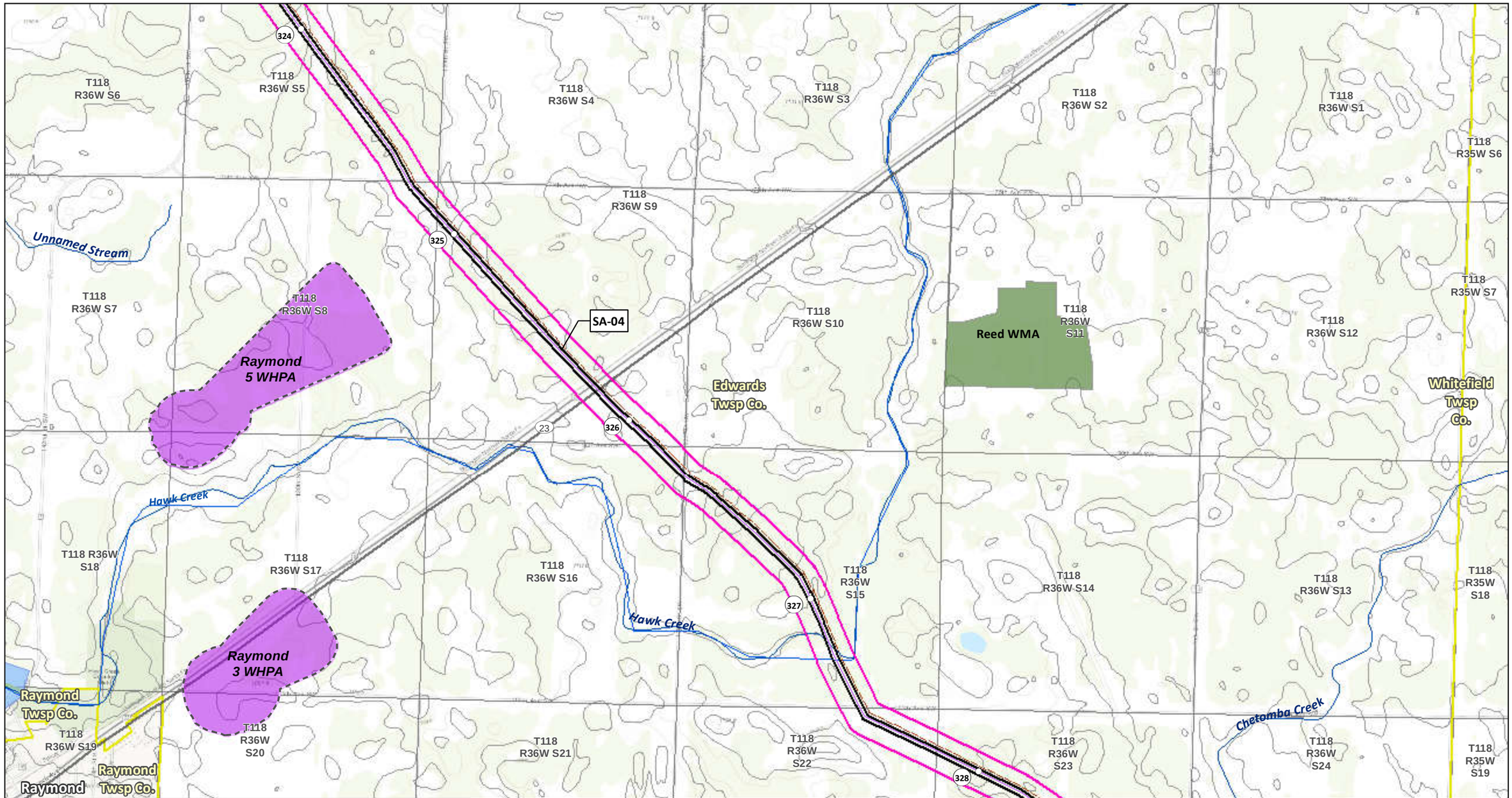
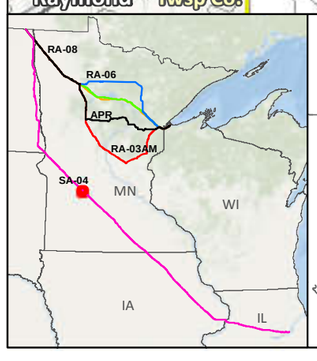
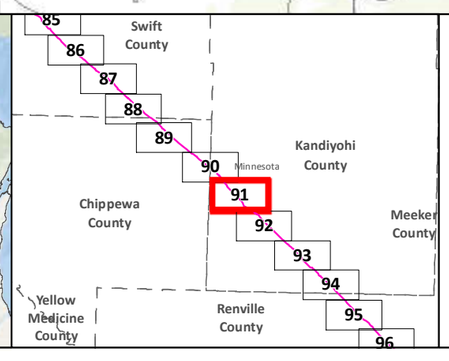
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 91A of 188







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands

WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance

Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 91B of 188

Edwards Twsp Co.

Whitefield Twsp Co.

Holland Twsp Co.

Roseland Twsp Co.

329

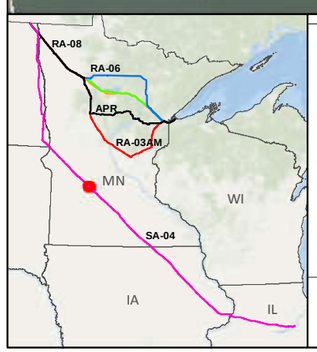
330

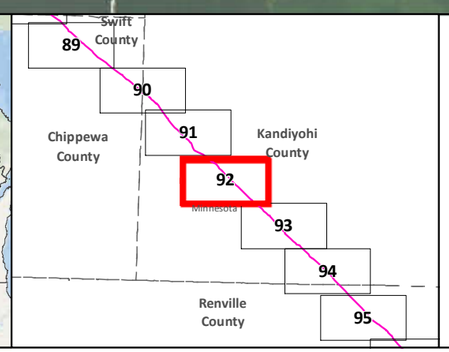
331

332

333

SA-04





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 92A of 188

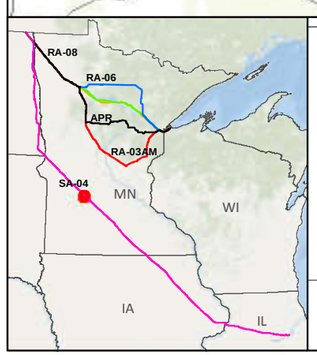
T118 R36W S21
T118 R36W S22
T118 R36W S23
T118 R36W S24
T118 R35W S19
T118 R35W S20
T118 R35W S21
T118 R36W S28
T118 R36W S27
T118 R36W S26
T118 R36W S25
T118 R35W S30
T118 R35W S29
T118 R35W S28
T118 R36W S33
T118 R36W S34
T118 R36W S35
T118 R36W S36
T118 R35W S31
T118 R35W S32
T118 R35W S33
T117 R36W S3
T117 R36W S2
T117 R36W S1
T117 R35W S6
T117 R35W S5
T117 R35W S4

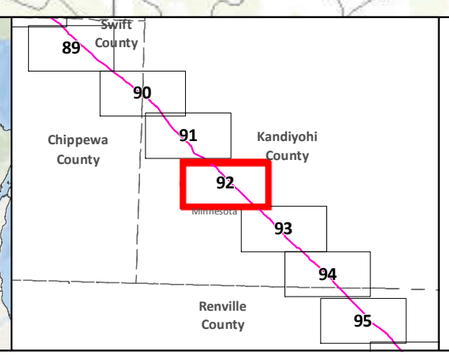
329
330
331
332
333

SA-04

Edwards Twsp Co.
Whitefield Twsp Co.
Holland Twsp Co.
Roseland Twsp Co.

Chetomba Creek





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 92B of 188

Roseland
Twsp Co.

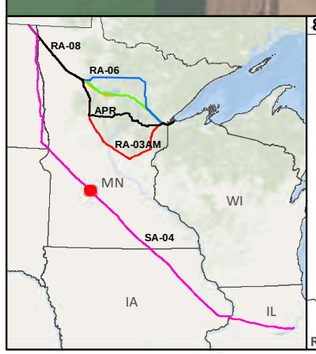
Blomkest
Twsp Co.

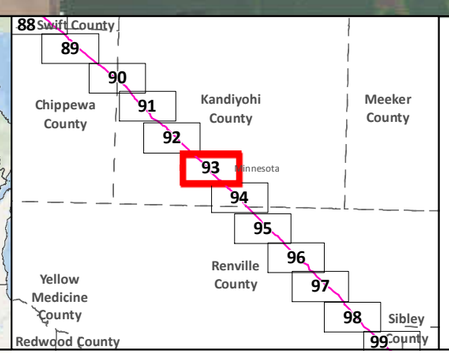
Blomkest

Lake
Lillian
Twsp Co.

334
335
71
336
7
337

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

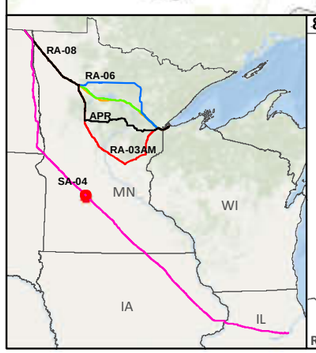
SA-04

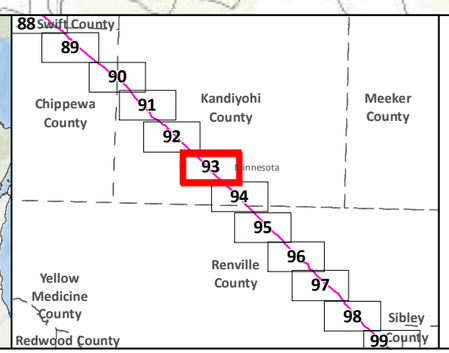
Map 93A of 188

T117 R35W S5
T117 R35W S4
T117 R35W S3
T117 R35W S2
T117 R35W S1
T117 R34W S6
T117 R35W S8
T117 R35W S9
T117 R35W S10
T117 R35W S11
T117 R35W S12
T117 R34W S7
T117 R35W S17
T117 R35W S16
T117 R35W S15
T117 R35W S14
T117 R35W S13
T117 R34W S18
T117 R35W S20
T117 R35W S21
T117 R35W S22
T117 R35W S23
T117 R35W S24
T117 R34W S19

Roseland Twsp Co.
Blomkest Twsp Co.
Lake Lillian Twsp Co.
Blomkest WHPA
Blomkest
SA-04

334
335
71
336
7
337





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

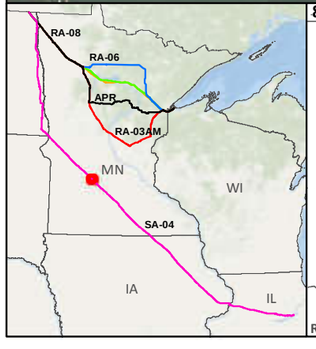
SA-04

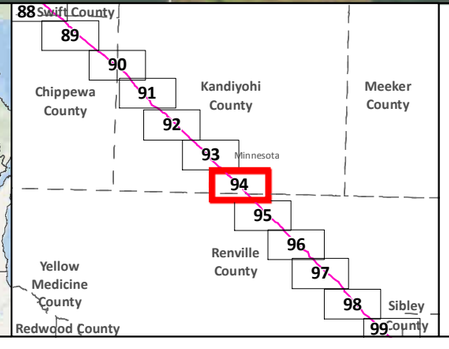
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 93B of 188

338
339
340
341
342
71
SA-04
Roseland Twsp Co.
Lake Lillian Twsp Co.
Winfield Twsp Co.
Kingman Twsp Co.
Buffalo Creek





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T117 R35W S23
T117 R35W S24
T117 R34W S19
T117 R34W S20
T117 R34W S21
T117 R34W S22
T117 R35W S26
T117 R35W S25
T117 R34W S30
T117 R34W S29
T117 R34W S28
T117 R34W S27
Roseland Twsp Co.
Lake Lillian Twsp Co.
T117 R34W S26
T117 R35W S35
T117 R35W S36
T117 R34W S31
T117 R34W S32
T117 R34W S33
T117 R34W S34
T117 R34W S35
338
339
340
341
342
SA-04
71
T116 R35W S2
Winfield Twsp Co.
T116 R35W S1
T116 R34W S6
T116 R34W S5
Kingman Twsp Co.
T116 R34W S4
T116 R34W S3
T116 R35W S3
Beaver Creek
Buffalo Creek

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

88 Swift County
89
90
91
92
93
94
95
96
97
98
99
Chippewa County
Kandiyohi County
Meeker County
Minnesota
Renville County
Yellow Medicine County
Redwood County
Sibley County

- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

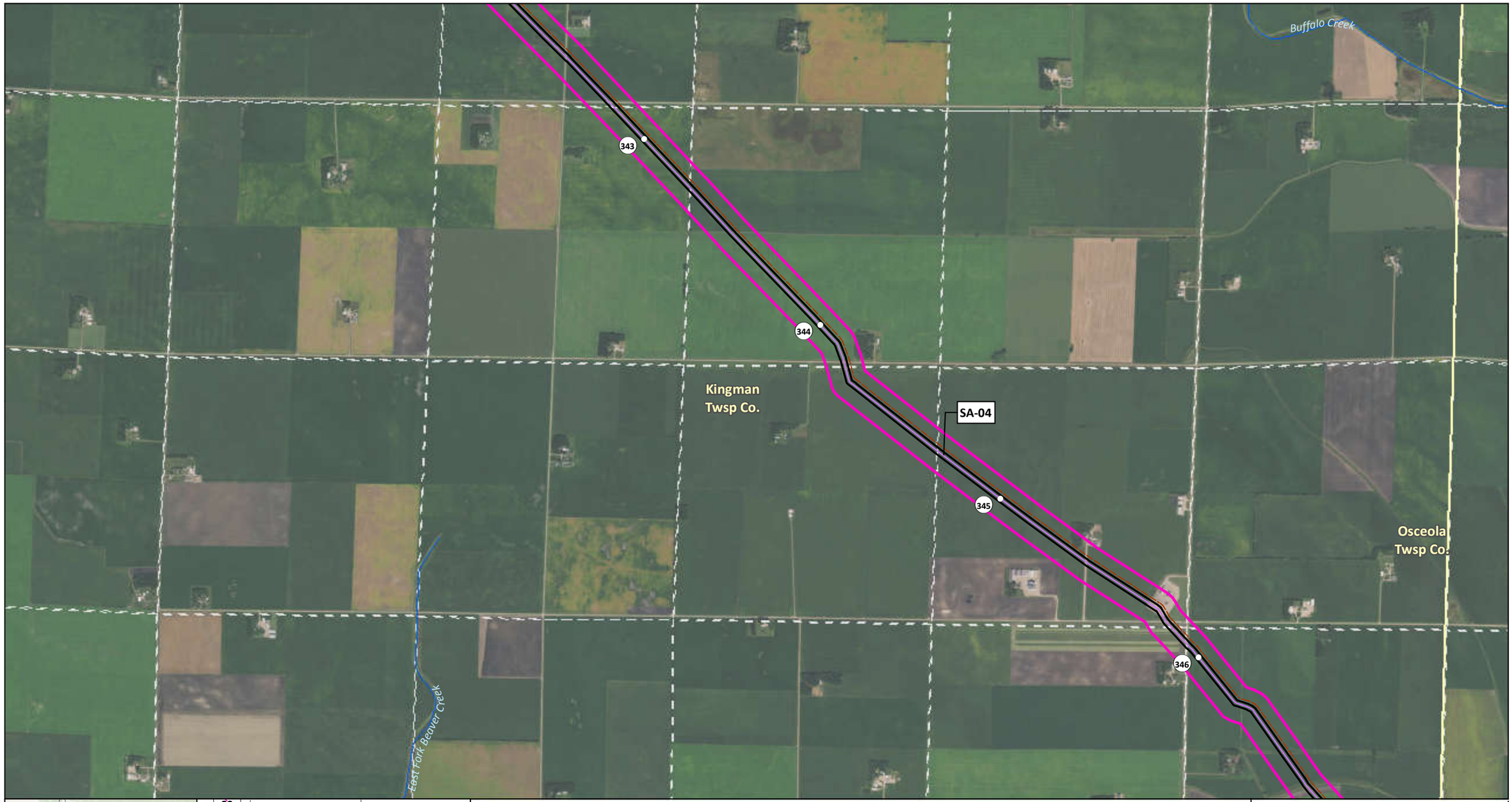
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

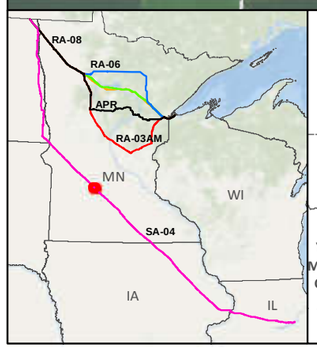
SA-04

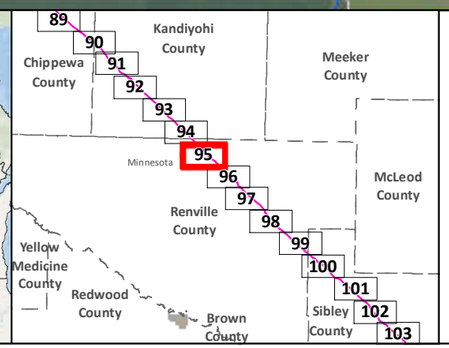
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 94B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

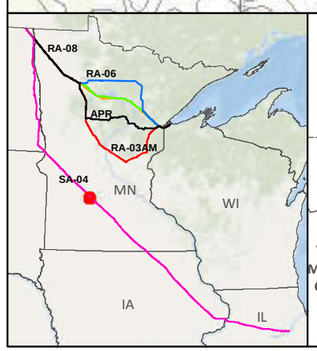
Data Sources:
MNDNR, NHD,USGS, Enbridge

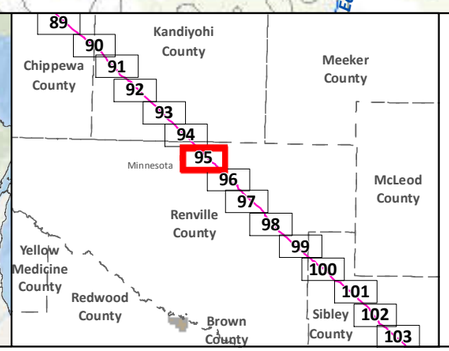
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T116 R34W S6
T116 R34W S5
T116 R34W S4
T116 R34W S3
T116 R34W S2
T116 R34W S1
T116 R33W S6
Buffalo Creek
343
T116 R34W S7
T116 R34W S8
T116 R34W S9
T116 R34W S10
T116 R34W S11
T116 R34W S12
T116 R33W S7
County Ditch 67
344
SA-04
Kingman Twsp Co.
T116 R34W S18
T116 R34W S17
T116 R34W S16
T116 R34W S15
T116 R34W S14
T116 R34W S13
T116 R33W S18
345
Osceola Twsp Co.
346
T116 R34W S19
T116 R34W S20
T116 R34W S21
T116 R34W S22
T116 R34W S23
T116 R34W S24
T116 R33W S19
East Fork Beaver Creek





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
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- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

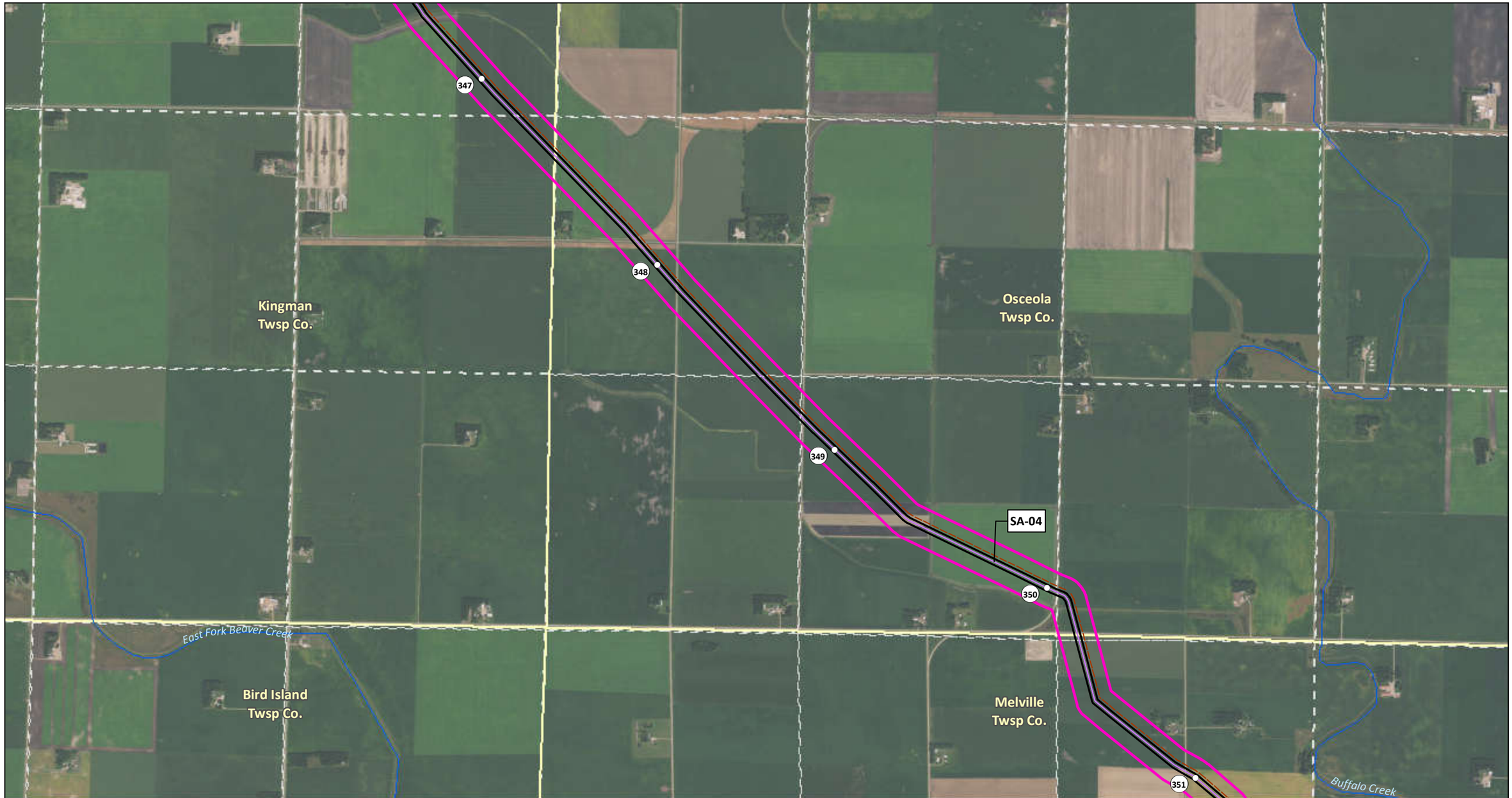
Data Sources: MNDNR, USGS, NHD, Enbridge

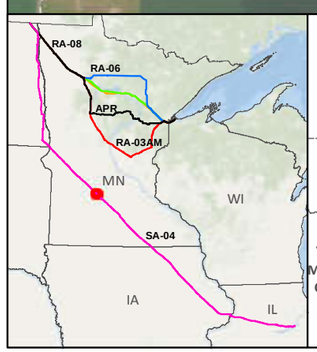
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

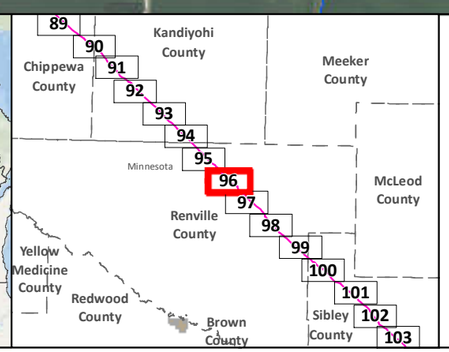
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

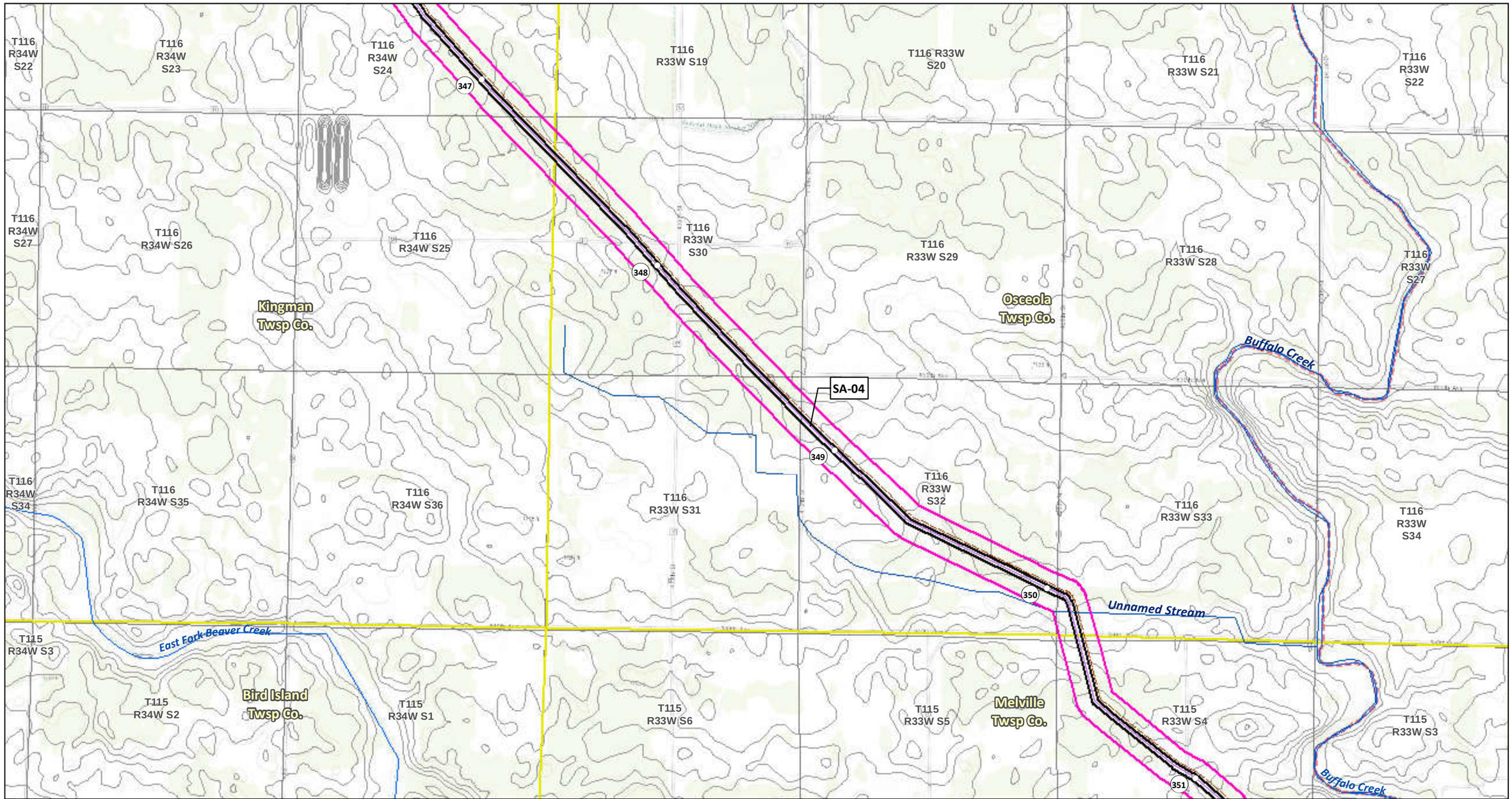
Data Sources:
MNDNR, NHD,USGS, Enbridge

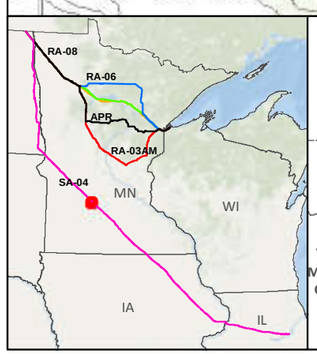
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

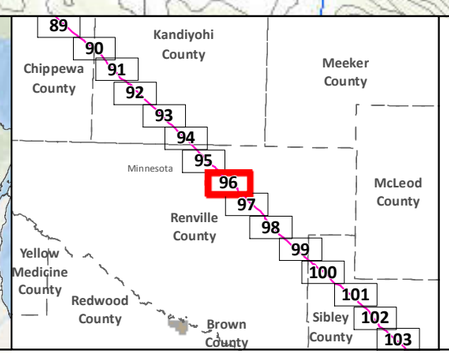
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 96A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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- Route Width (750')
- Existing Pipelines
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

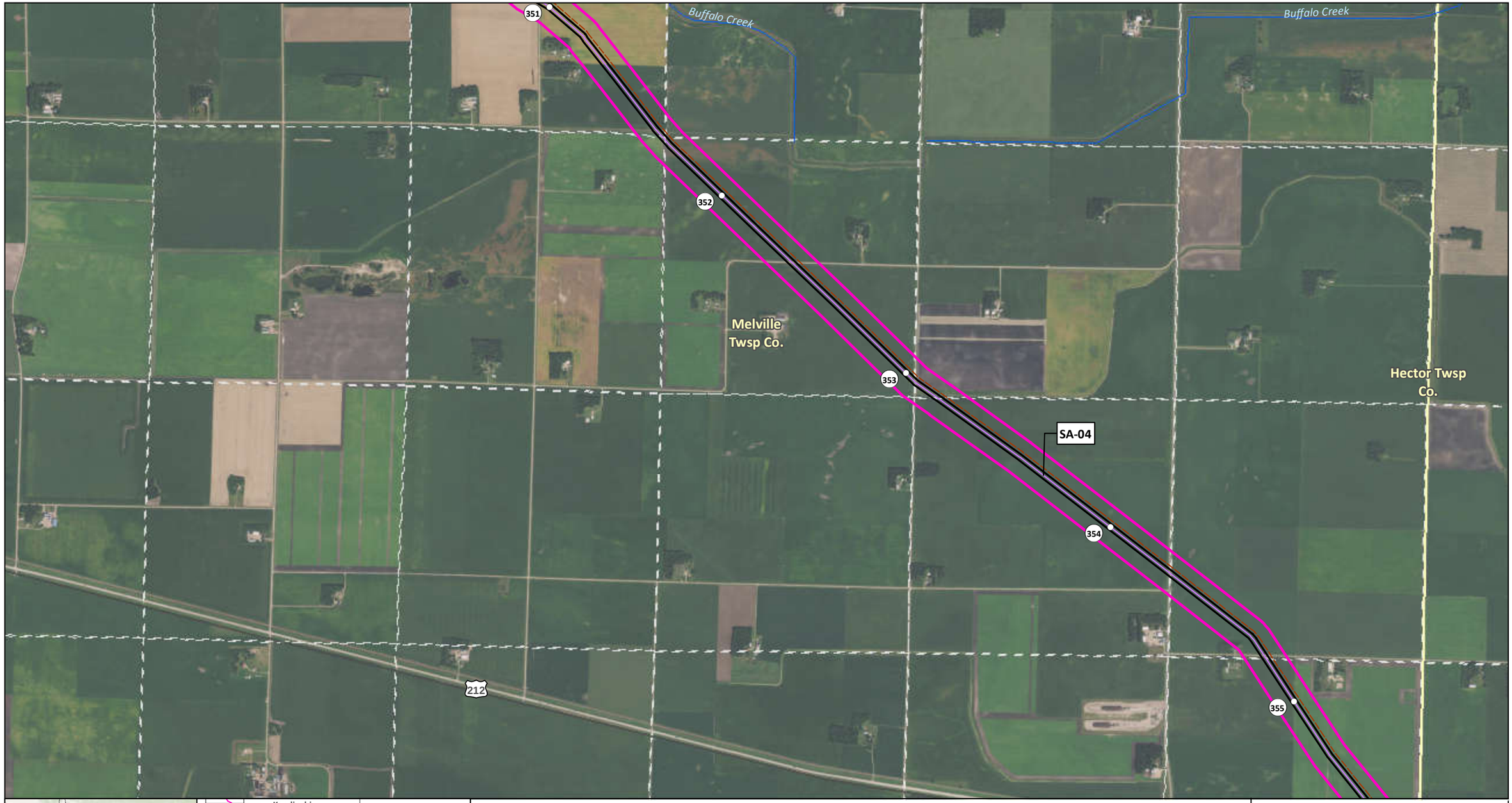
Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

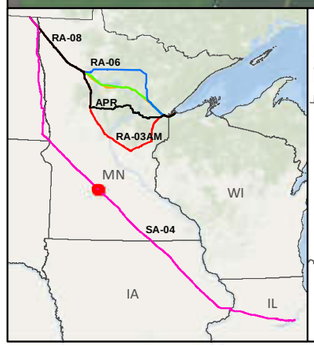
Data Sources: MNDNR, USGS, NHD, Enbridge

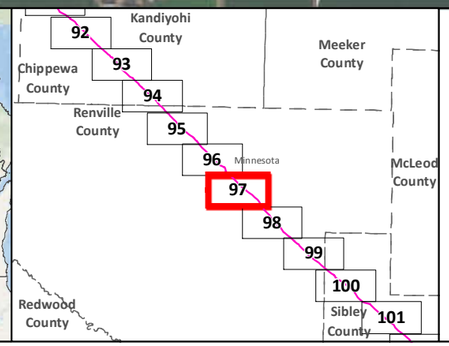
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

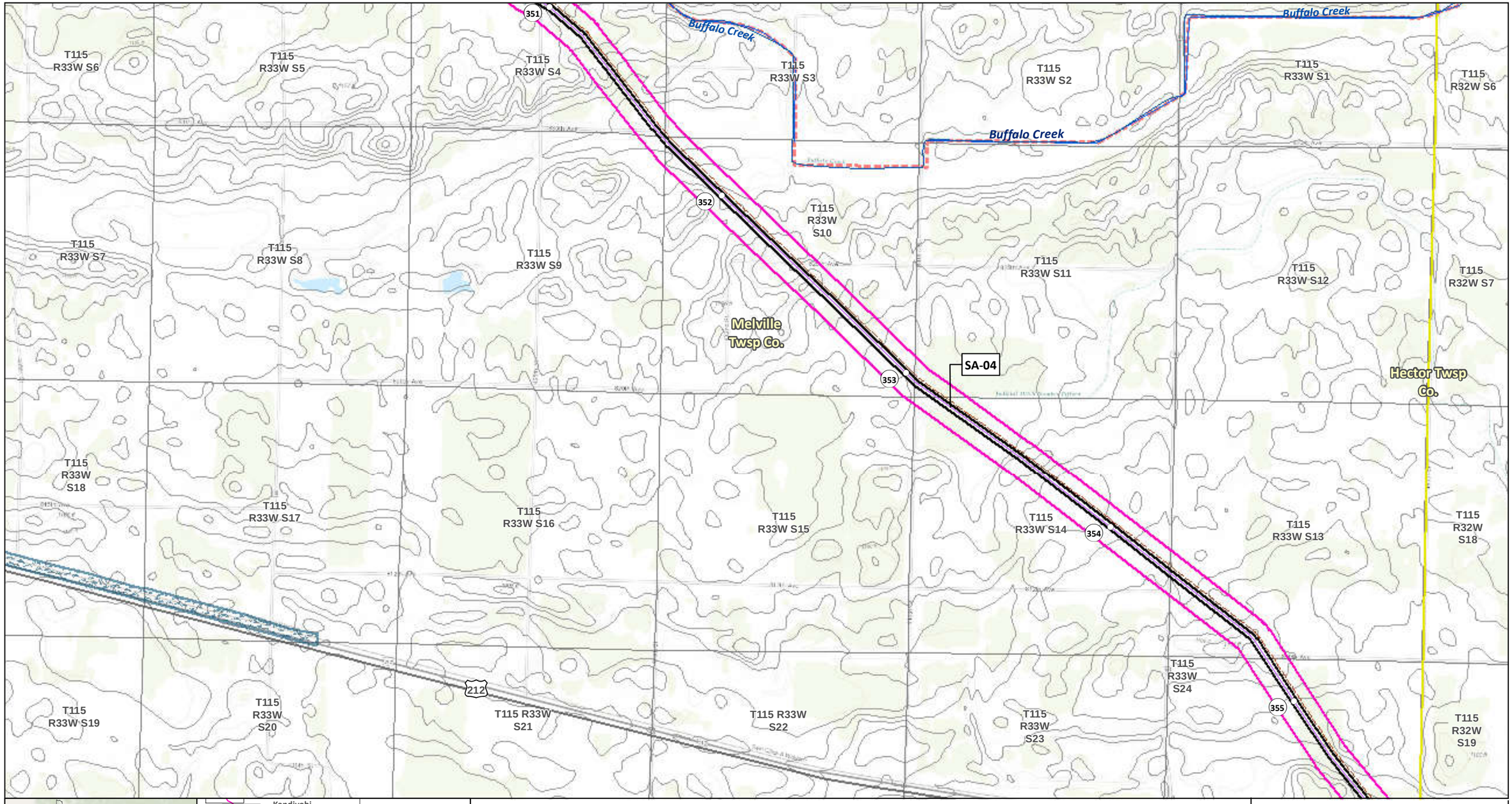
Data Sources:
MNDNR, NHD,USGS, Enbridge

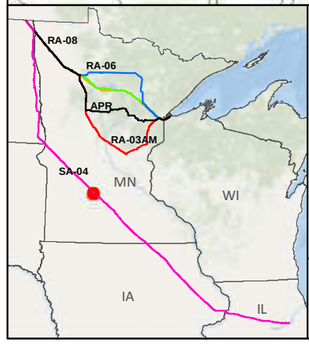
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

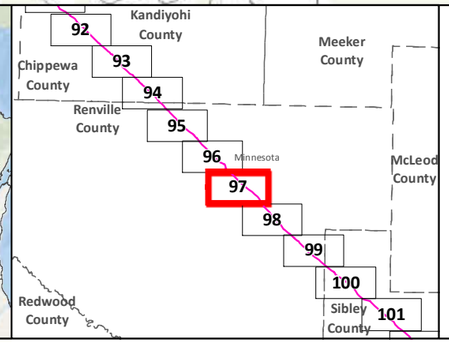
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 97A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

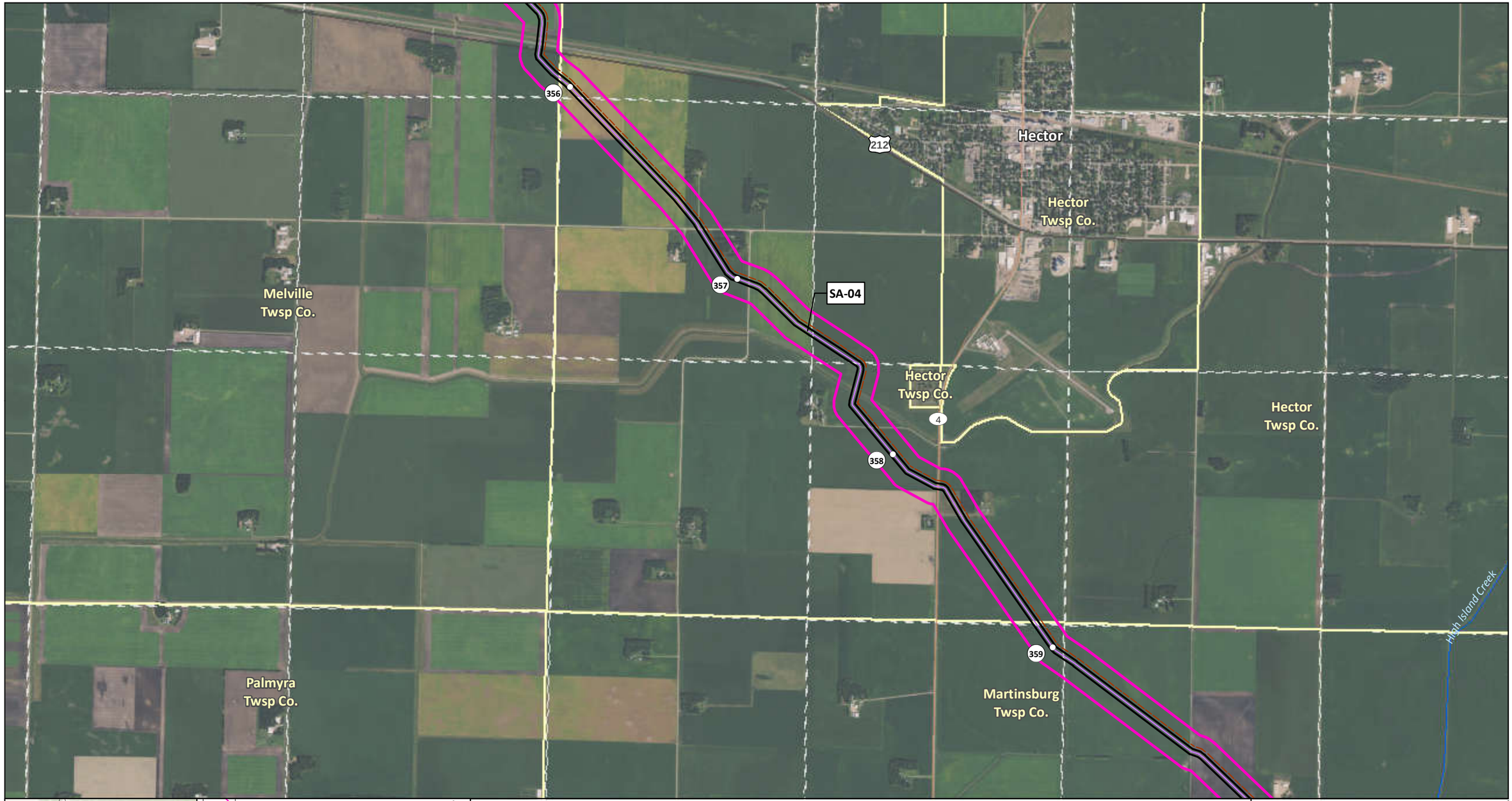
Data Sources: MNDNR, USGS, NHD, Enbridge

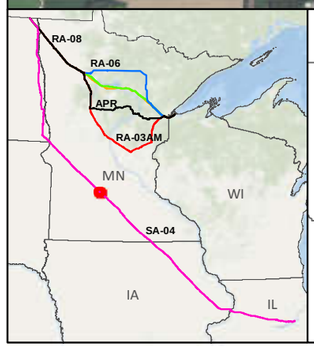
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

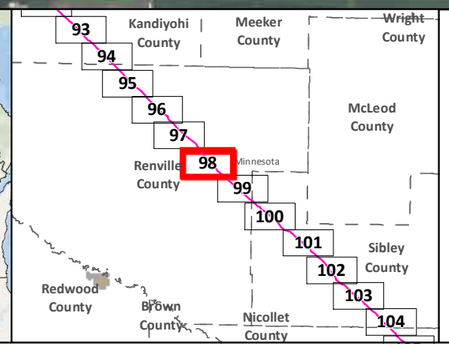
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 97B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 98A of 188

T115 R33W S22
T115 R33W S23
T115 R33W S24
T115 R32W S19
T115 R32W S20
T115 R32W S21
T115 R32W S22
T115 R33W S27
T115 R33W S26
T115 R33W S25
T115 R32W S29
T115 R32W S28
T115 R32W S27
T115 R32W S30
T115 R33W S35
T115 R33W S36
T115 R32W S31
T115 R32W S32
T115 R32W S33
T115 R32W S34
T115 R33W S34
T114 R33W S3
T114 R33W S2
T114 R33W S1
T114 R32W S6
T114 R32W S5
T114 R32W S4
T114 R32W S3

Hector
Hector Twsp Co.
Melville Twsp Co.
Palmyra Twsp Co.
Martinsburg Twsp Co.

356
212
357
4
358
359

SA-04

High Island Creek

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

93
94
95
96
97
98
99
100
101
102
103
104
Kandiyohi County
Meeker County
Wright County
McLeod County
Renville County
Minnesota
Sibley County
Redwood County
Brown County
Nicollet County

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

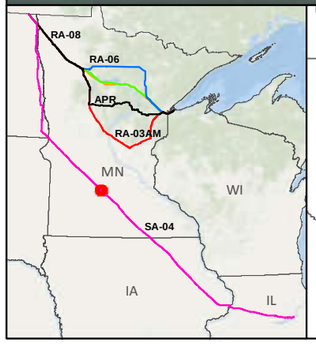
SA-04

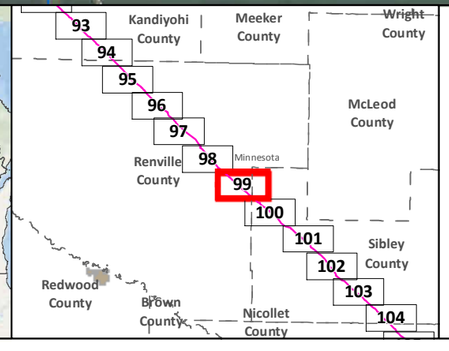
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 98B of 188

360
361
362
363
364
SA-04
Martinsburg
Twsp Co.
Grafton
Twsp Co.
High Island Creek
High Island Creek





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

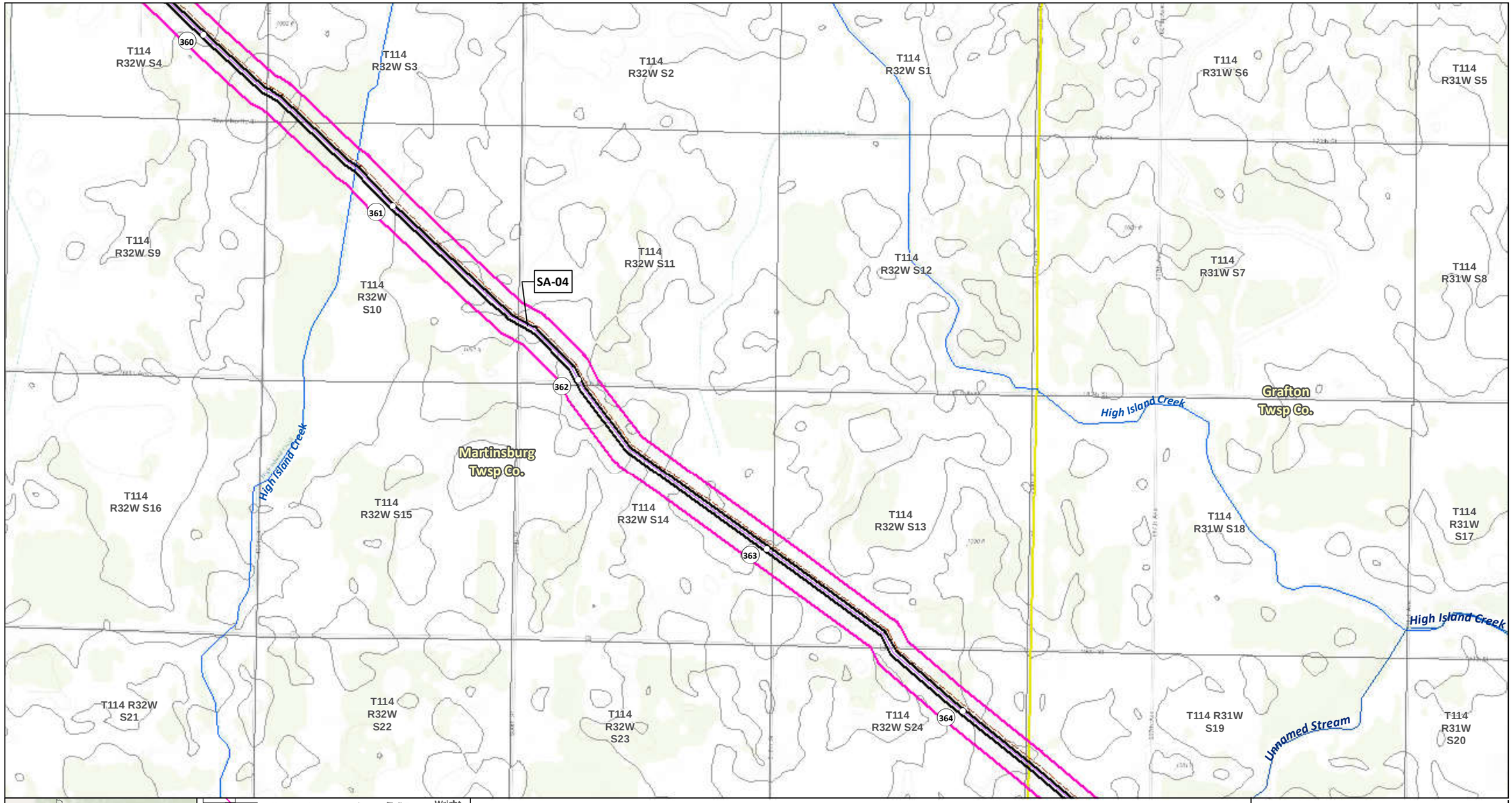
Water Resources
Lake
River

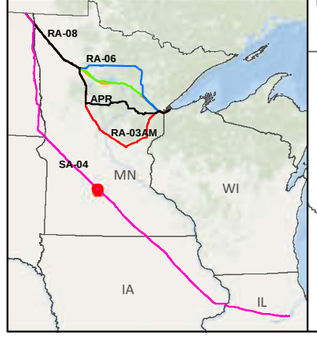
Data Sources:
MNDNR, NHD,USGS, Enbridge

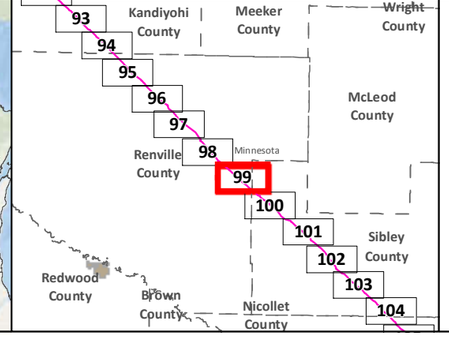
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

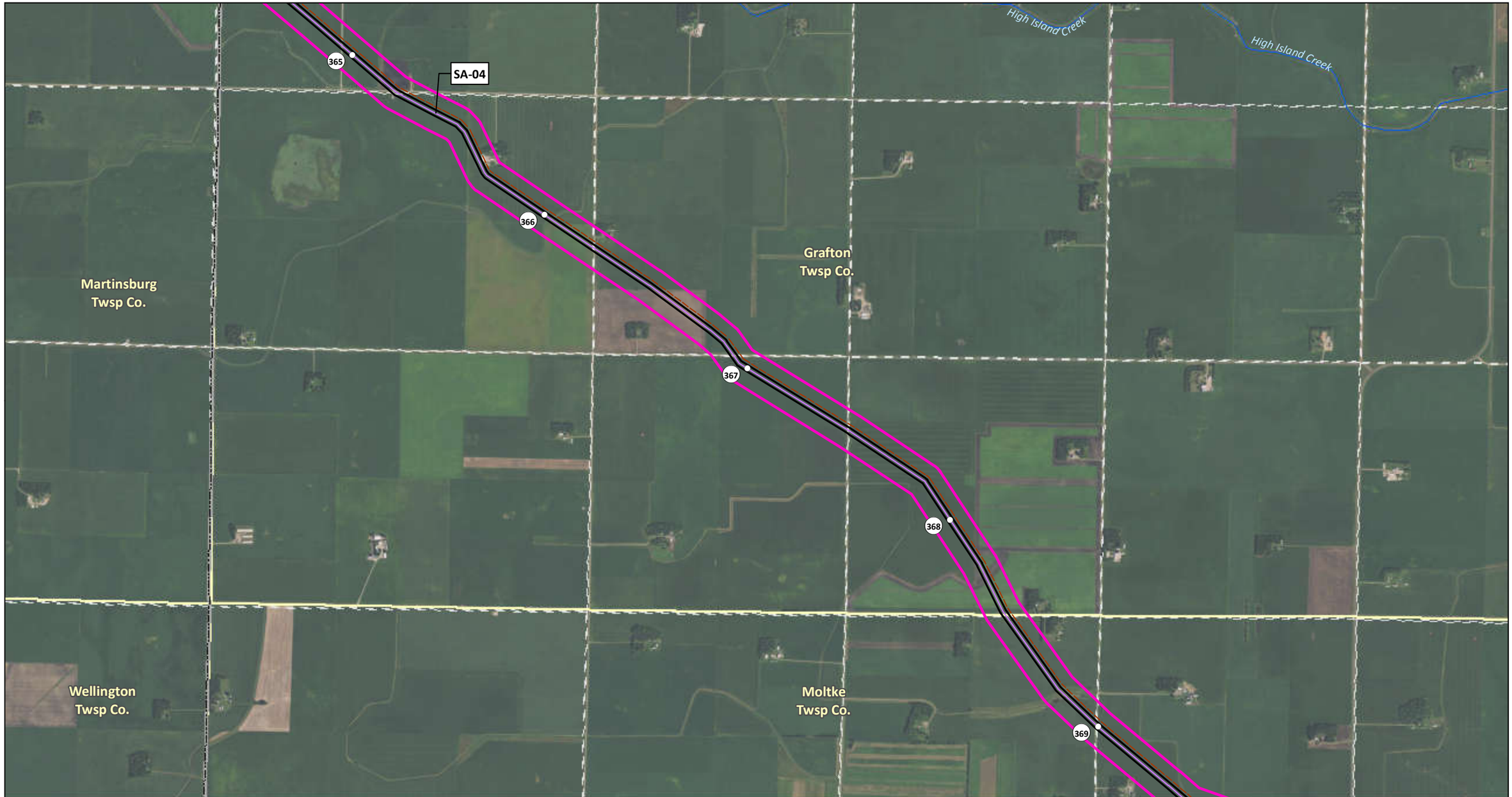
SA-04

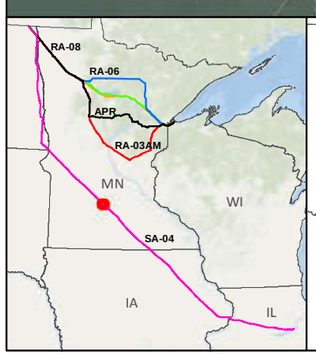
0 0.125 0.25 0.5 Miles

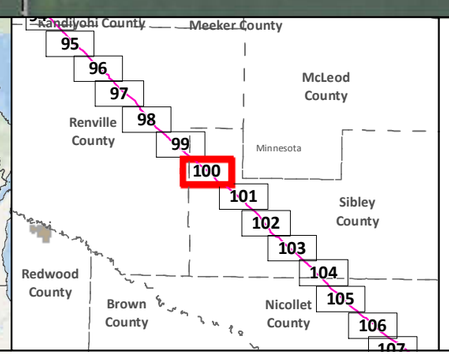
0 125 250 500 Meters

1:24,000

10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

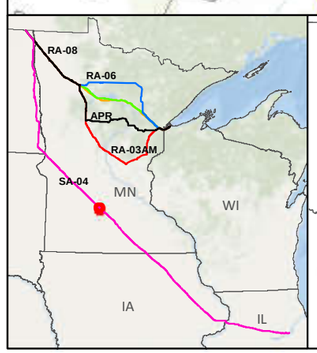
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

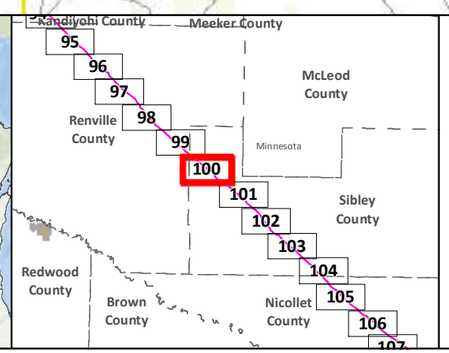
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 100A of 188

T114 R32W S24
T114 R31W S19
T114 R31W S20
T114 R31W S21
T114 R31W S22
T114 R31W S23
High Island Creek
Unnamed Stream
T114 R32W S25
T114 R31W S30
T114 R31W S29
T114 R31W S28
T114 R31W S27
T114 R31W S26
Martinsburg Twsp Co.
Grafton Twsp Co.
SA-04
365
366
367
368
369
T114 R32W S36
T114 R31W S31
T114 R31W S32
T114 R31W S33
T114 R31W S34
T114 R31W S35
T113 R32W S1
T113 R31W S6
T113 R31W S5
T113 R31W S4
T113 R31W S3
T113 R31W S2
Wellington Twsp Co.
Moltke Twsp Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

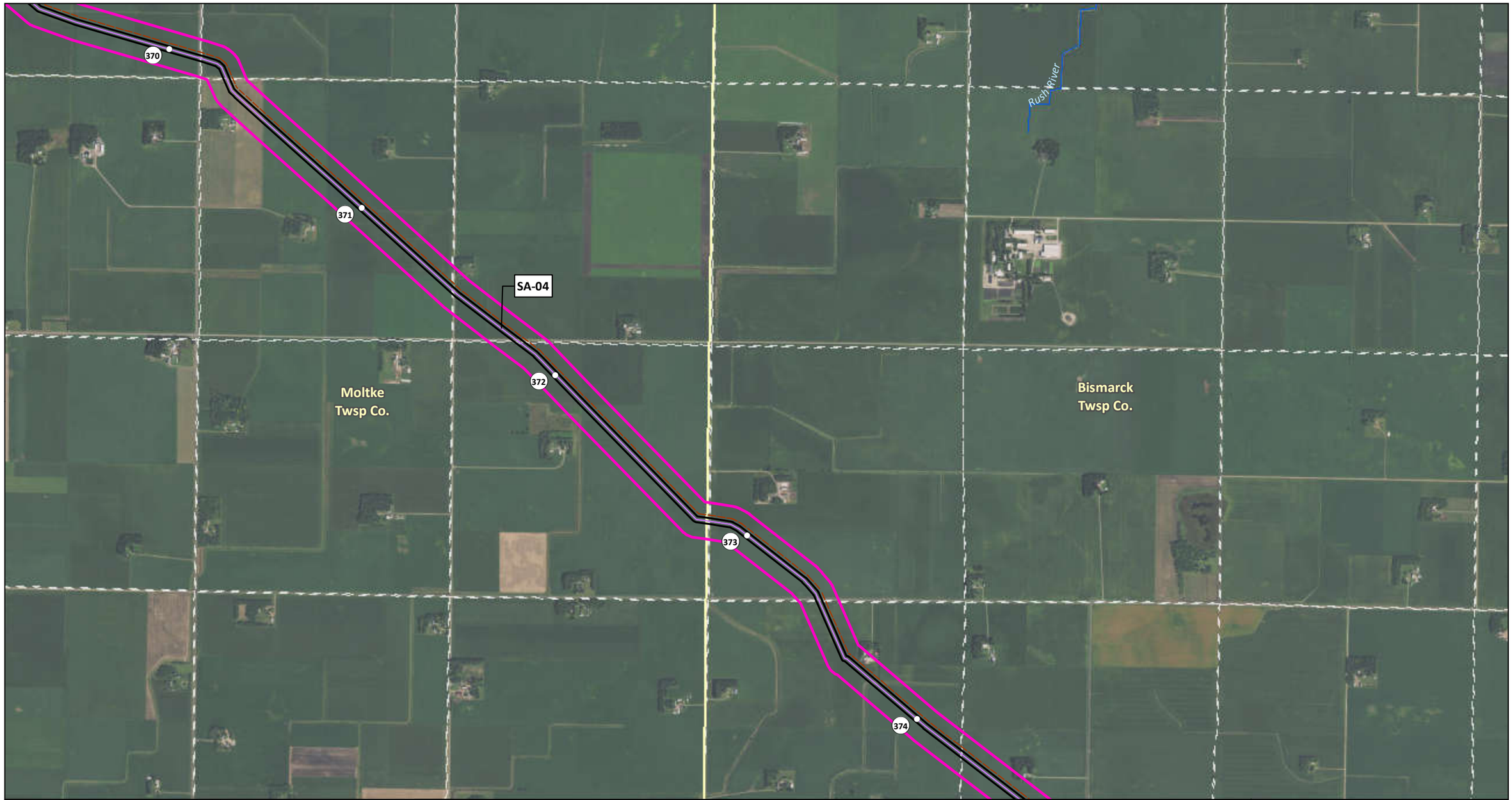
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

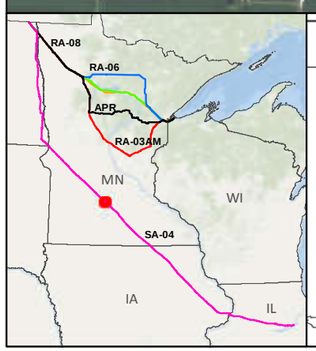
SA-04

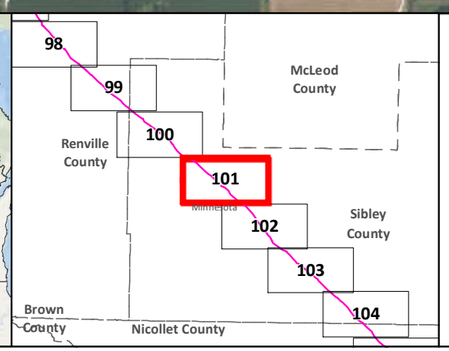
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 100B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources:
MNDNR, NHD,USGS, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 101A of 188

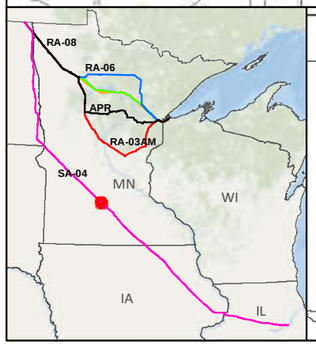
T113 R31W S3
T113 R31W S2
T113 R31W S1
T113 R30W S6
T113 R30W S5
T113 R30W S4
T113 R30W S3
T113 R31W S10
T113 R31W S11
T113 R31W S12
T113 R30W S7
T113 R30W S8
T113 R30W S9
T113 R30W S10
T113 R31W S15
T113 R31W S14
T113 R31W S13
T113 R30W S18
T113 R30W S17
T113 R30W S16
T113 R30W S15
T113 R31W S22
T113 R31W S23
T113 R31W S24
T113 R30W S19
T113 R30W S20
T113 R30W S21
T113 R30W S22

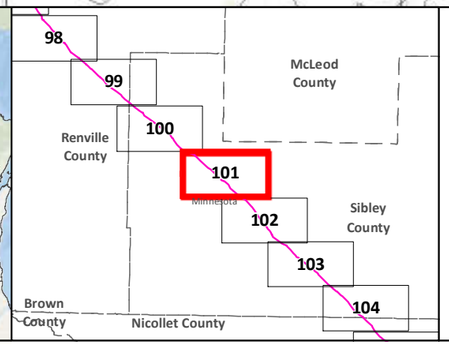
370
371
372
373
374

SA-04

Rush River
Rush River

Moltke Twsp Co.
Bismarck Twsp Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

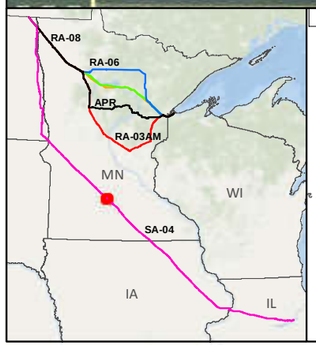
SA-04

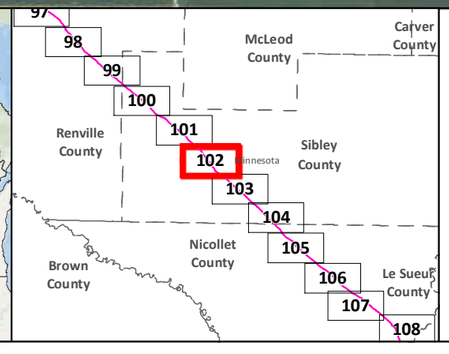
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 101B of 188

375
376
377
378
19
SA-04
Bismarck
Twsp Co.
Severance
Twsp Co.
Cornish
Twsp Co.
Middle Branch Rush River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

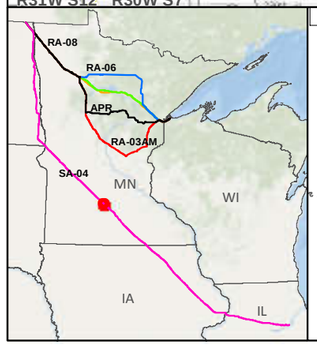
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

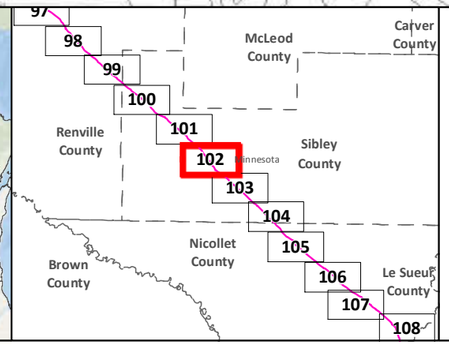
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 102A of 188

T113 R30W S19
T113 R30W S20
T113 R30W S21
T113 R30W S22
T113 R30W S23
T113 R30W S24
T113 R30W S30
T113 R30W S29
T113 R30W S28
T113 R30W S27
T113 R30W S26
T113 R30W S25
375
376
377
Bismarck Twsp Co.
Middle Branch Rush River
Rush River, Middle Branch
T113 R30W S31
T113 R30W S32
T113 R30W S33
T113 R30W S34
T113 R30W S35
T113 R30W S36
19
Severance Twsp Co.
Cornish Twsp Co.
378
SA-04
T112 R31W S1
T112 R30W S6
T112 R30W S5
T112 R30W S4
T112 R30W S3
T112 R30W S2
T112 R30W S1
T112 R31W S12
T112 R30W S7





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

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- WMA - Wildlife Management Areas
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- Navigable Waterway Crossings
- National River Inventory Crossing
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- 303d Imparied Waters
- Designated Trout Stream
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 102B of 188

Winthrop Twsp Co.

379

380

381

382

383

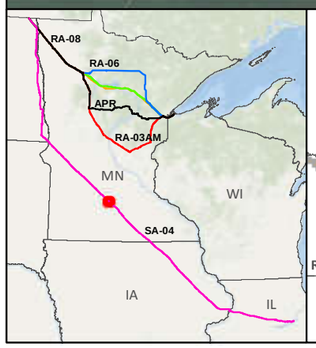
15

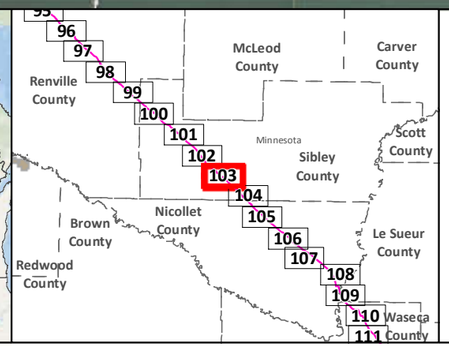
Middle Branch Rush River

Cornish Twsp Co.

Alfsborg Twsp Co.

SA-04





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

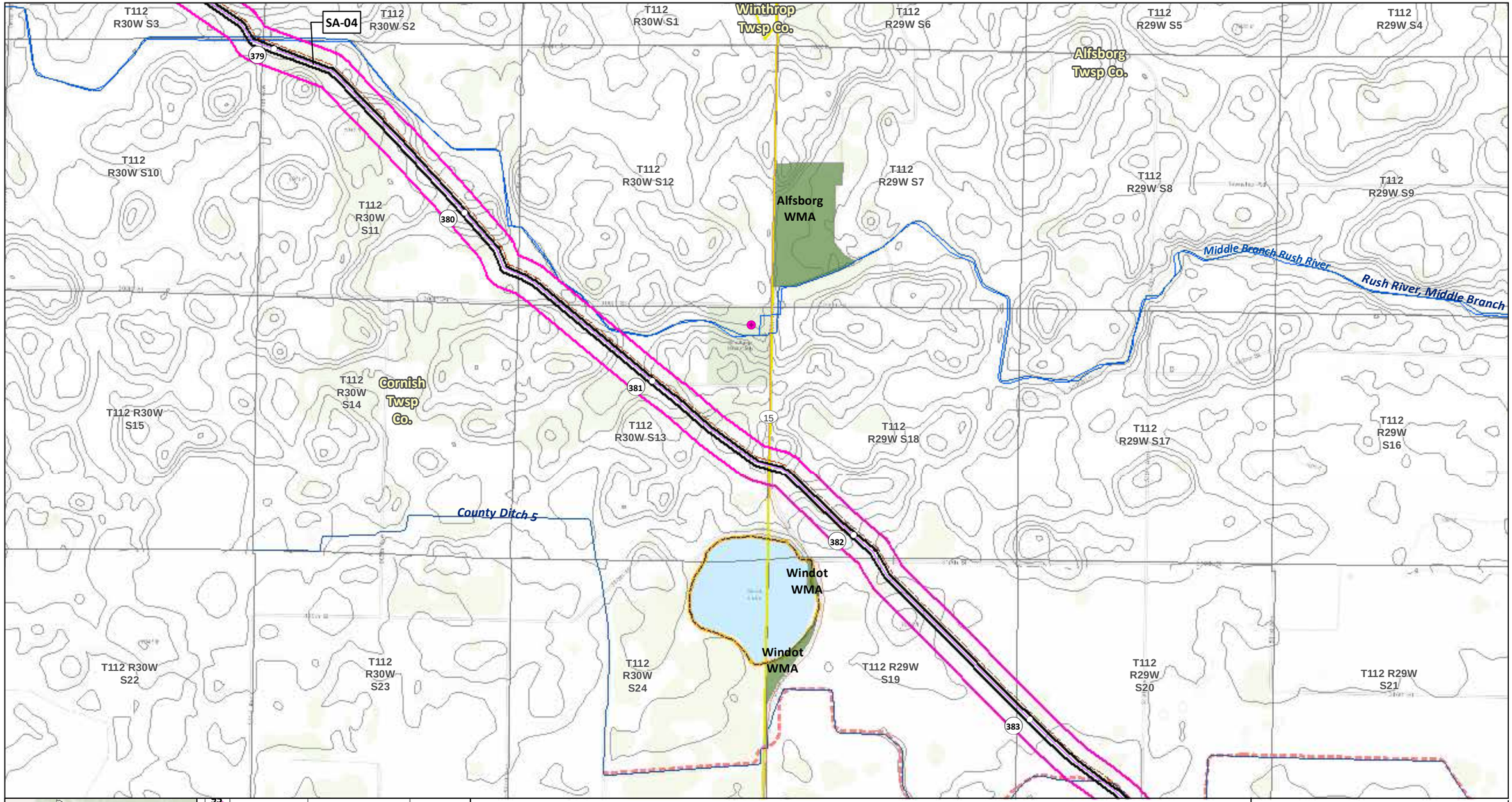
Water Resources
- Lake
- River

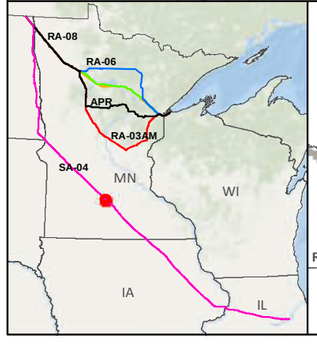
Data Sources: MNDNR, NHD,USGS, Enbridge

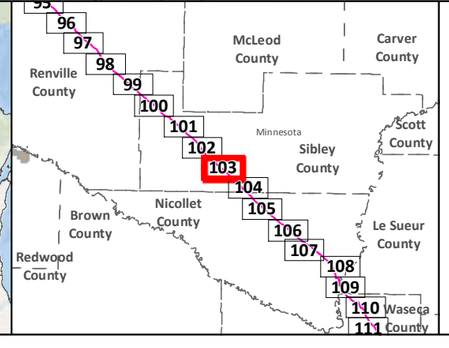
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

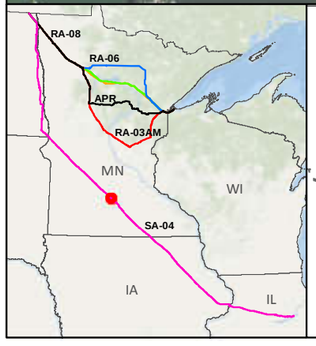
1:24,000

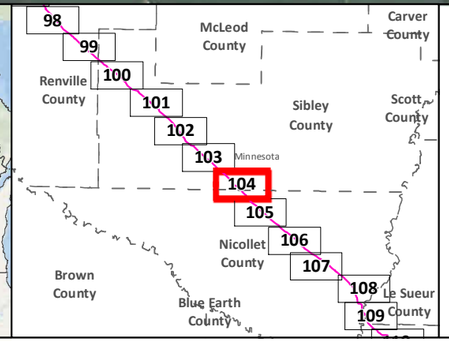
10ft Contours

N

Map 103B of 188

384
385
386
387
SA-04
Alfsborg
Twsp Co.
Sibley
Twsp Co.
Bernadotte
Twsp Co.
New Sweden
Twsp Co.
South Branch Rush River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

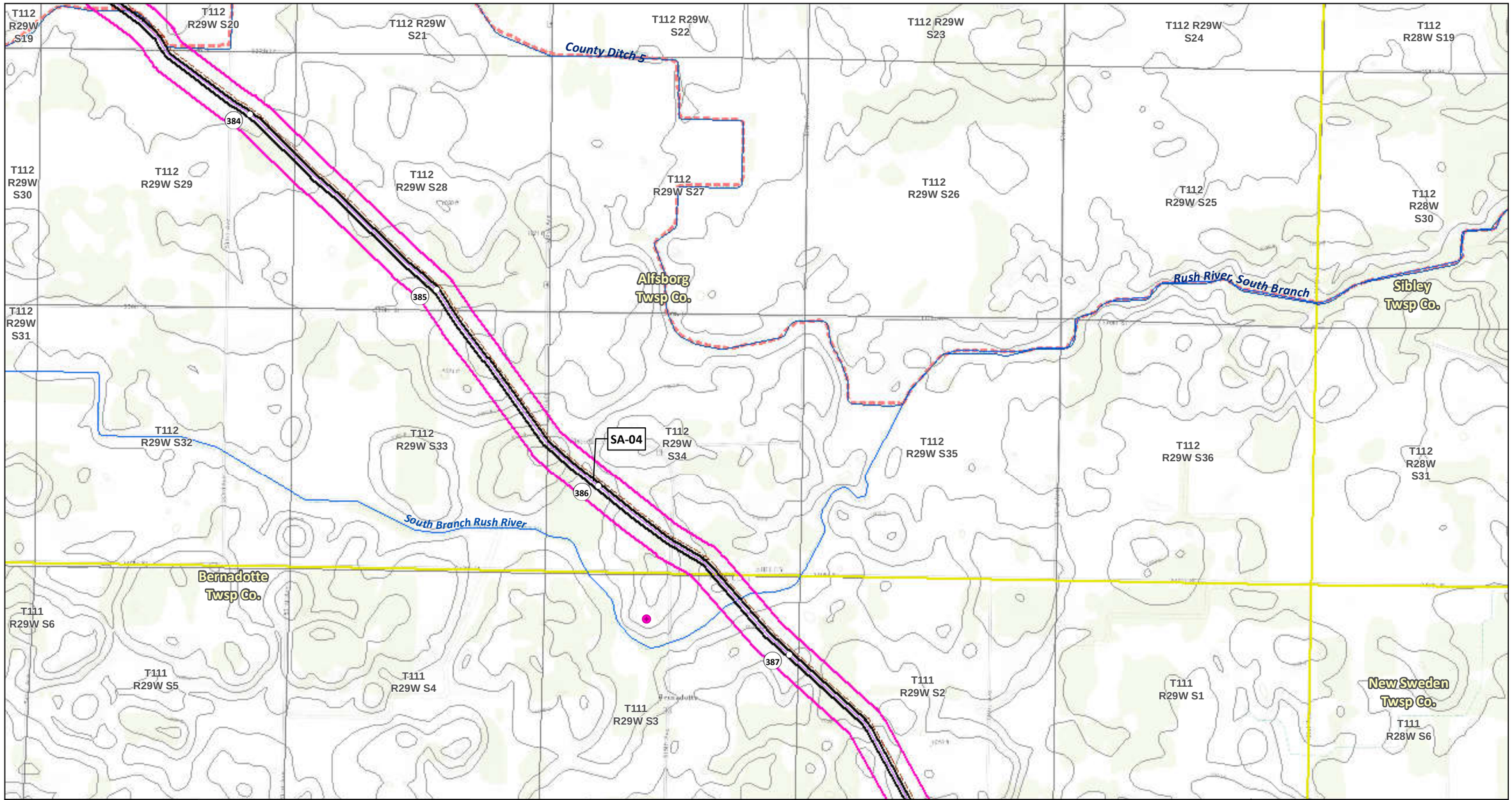
Data Sources:
MNDNR, NHD,USGS, Enbridge

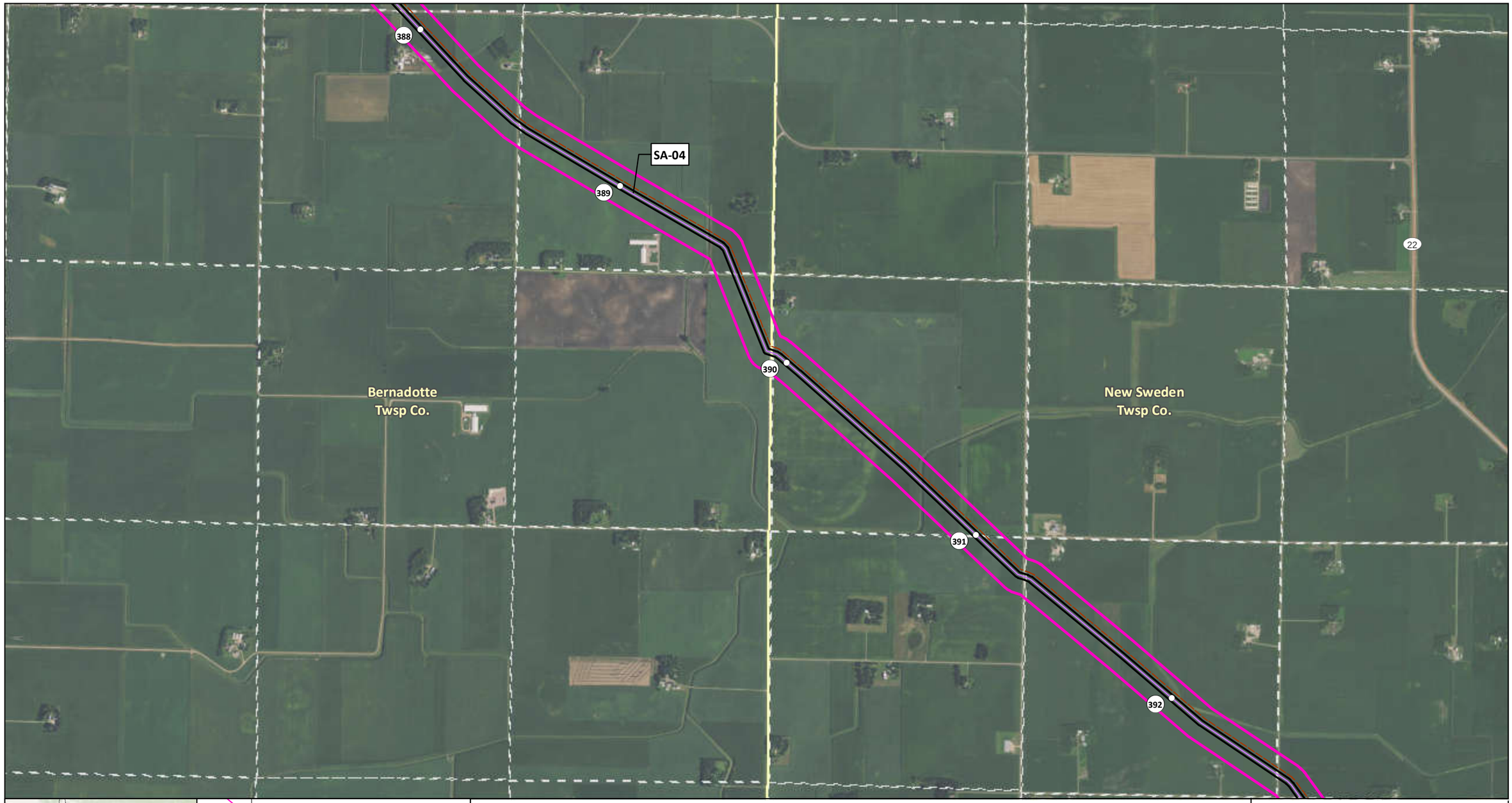
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

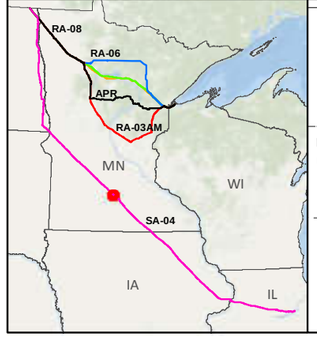
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

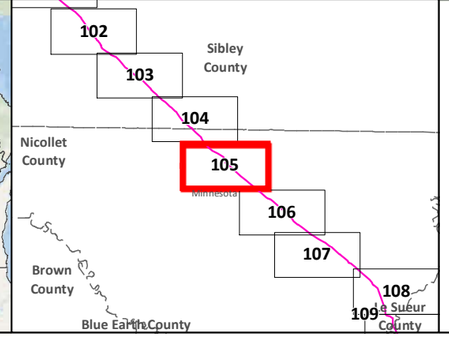
SA-04

Map 104A of 188


T112 R29W S19
T112 R29W S20
T112 R29W S21
T112 R29W S22
T112 R29W S23
T112 R29W S24
T112 R28W S19
County Ditch 5
384
T112 R29W S30
T112 R29W S29
T112 R29W S28
T112 R29W S27
T112 R29W S26
T112 R29W S25
T112 R28W S30
Alfsborg Twsp Co.
Rush River, South Branch
Sibley Twsp Co.
385
T112 R29W S31
T112 R29W S32
T112 R29W S33
SA-04
T112 R29W S34
T112 R29W S35
T112 R29W S36
T112 R28W S31
386
South Branch Rush River
Bernadotte Twsp Co.
T111 R29W S6
387
T111 R29W S5
T111 R29W S4
T111 R29W S3
T111 R29W S2
T111 R29W S1
New Sweden Twsp Co.
T111 R28W S6
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
98
99
100
101
102
103
104
105
106
107
108
109
Minnesota
McLeod County
Carver County
Renville County
Sibley County
Scott County
Nicollet County
Brown County
Blue Earth County
Le Sueur County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Data Sources: MNDNR, USGS, NHD, Enbridge
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC
SA-04
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 104B of 188
N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 105A of 188

T111 R29W S3
T111 R29W S2
T111 R29W S1
T111 R28W S6
T111 R28W S5
T111 R28W S4
Bernadotte Twsp Co.
SA-04
T111 R29W S10
T111 R29W S11
T111 R29W S12
T111 R28W S7
T111 R28W S8
T111 R28W S9
388
389
390
391
392
22
T111 R29W S14
T111 R29W S15
T111 R29W S13
T111 R28W S18
New Sweden Twsp Co.
T111 R28W S16
T111 R28W S17
T111 R29W S22
T111 R29W S23
T111 R29W S24
T111 R28W S19
T111 R28W S20
T111 R28W S21
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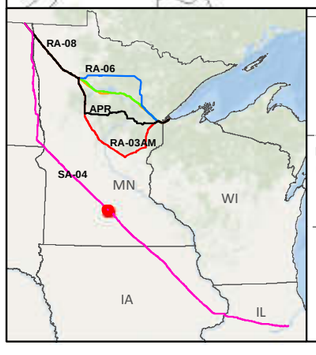
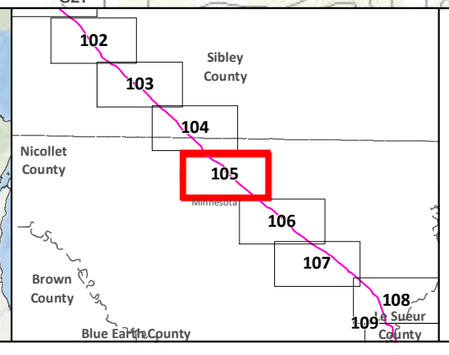
T111 R29W S26
T111 R29W S25
T111 R28W S30
T111 R28W S29
T111 R28W S28





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 105B of 188

SA-04

393

394

395

396

397

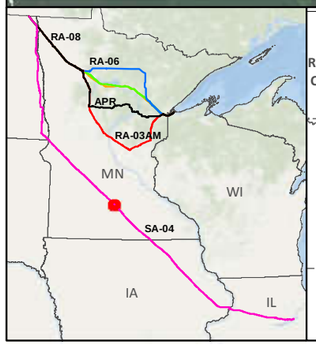
111

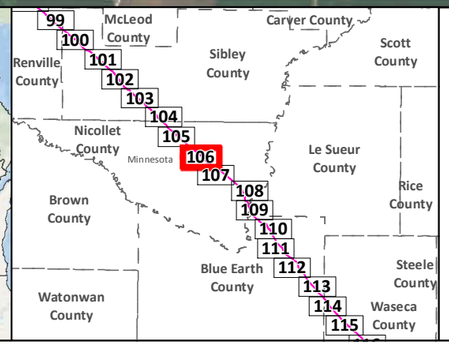
New Sweden Twsp Co.

Lake Prairie Twsp Co.

Granby Twsp Co.

Traverse Twsp Co.





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary

- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

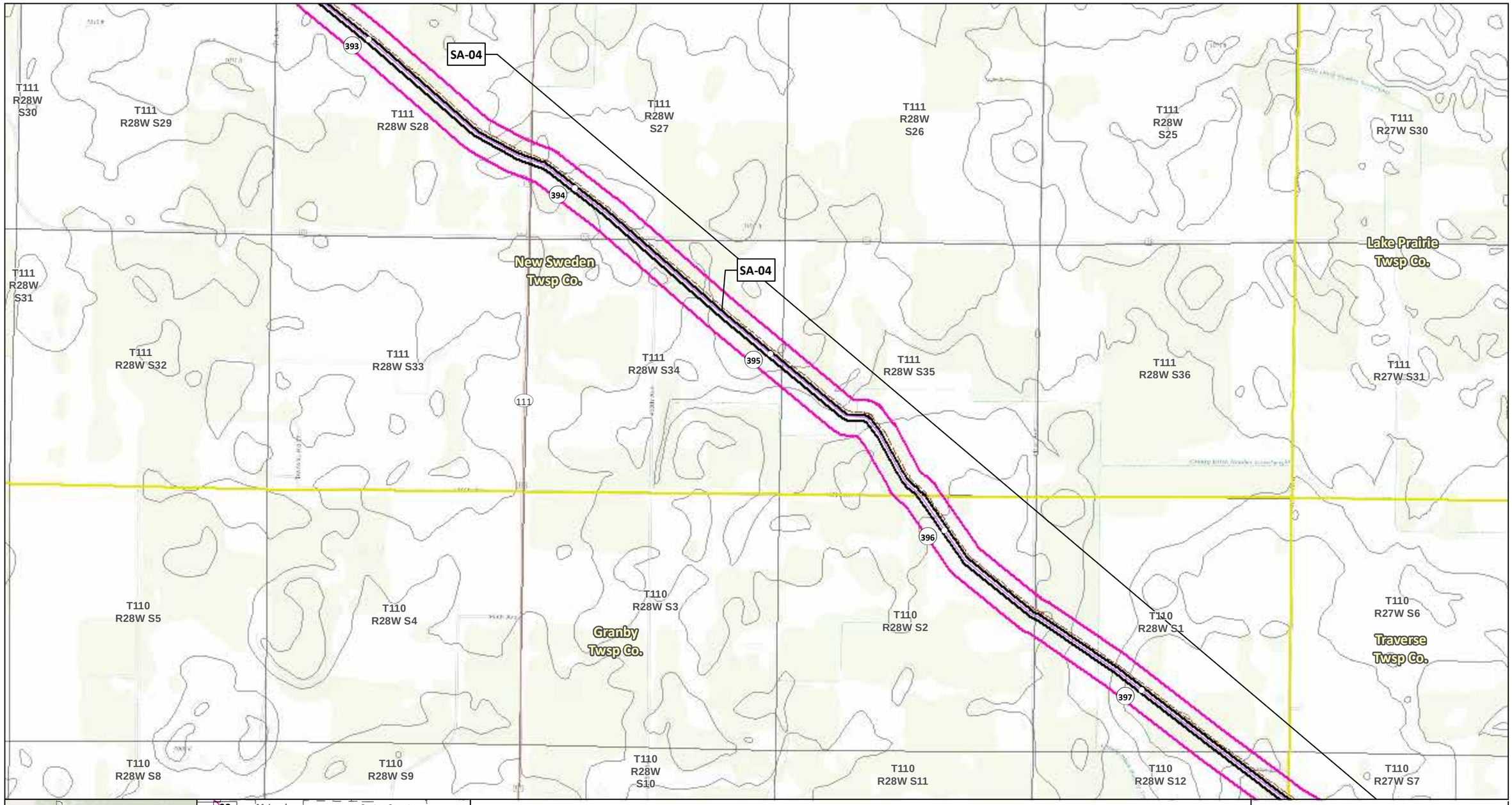
Water Resources
- Lake
- River

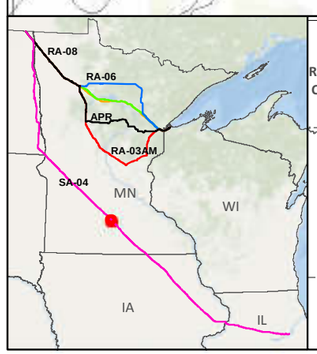
Data Sources:
MNDNR, NHD,USGS, Enbridge

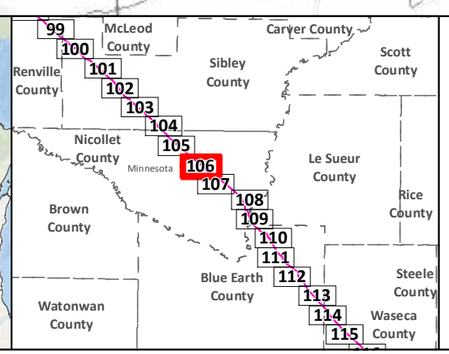
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

10ft Contours

N

Map 106B of 188

Granby
Twsp Co.

Traverse
Twsp Co.

Middle
Lake

Wiwi Bay

Oshawa
Twsp Co.

398

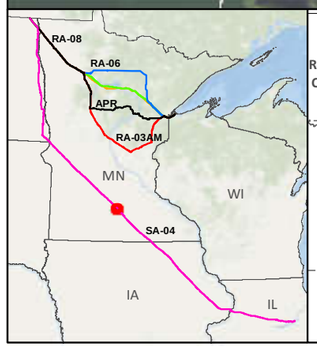
399

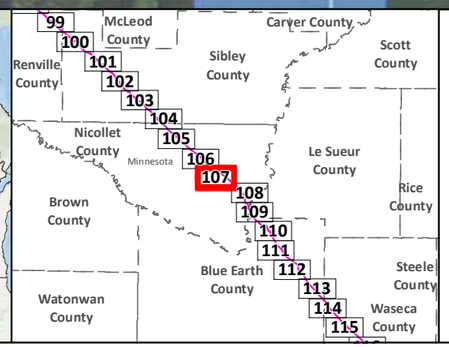
400

401

SA-04

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

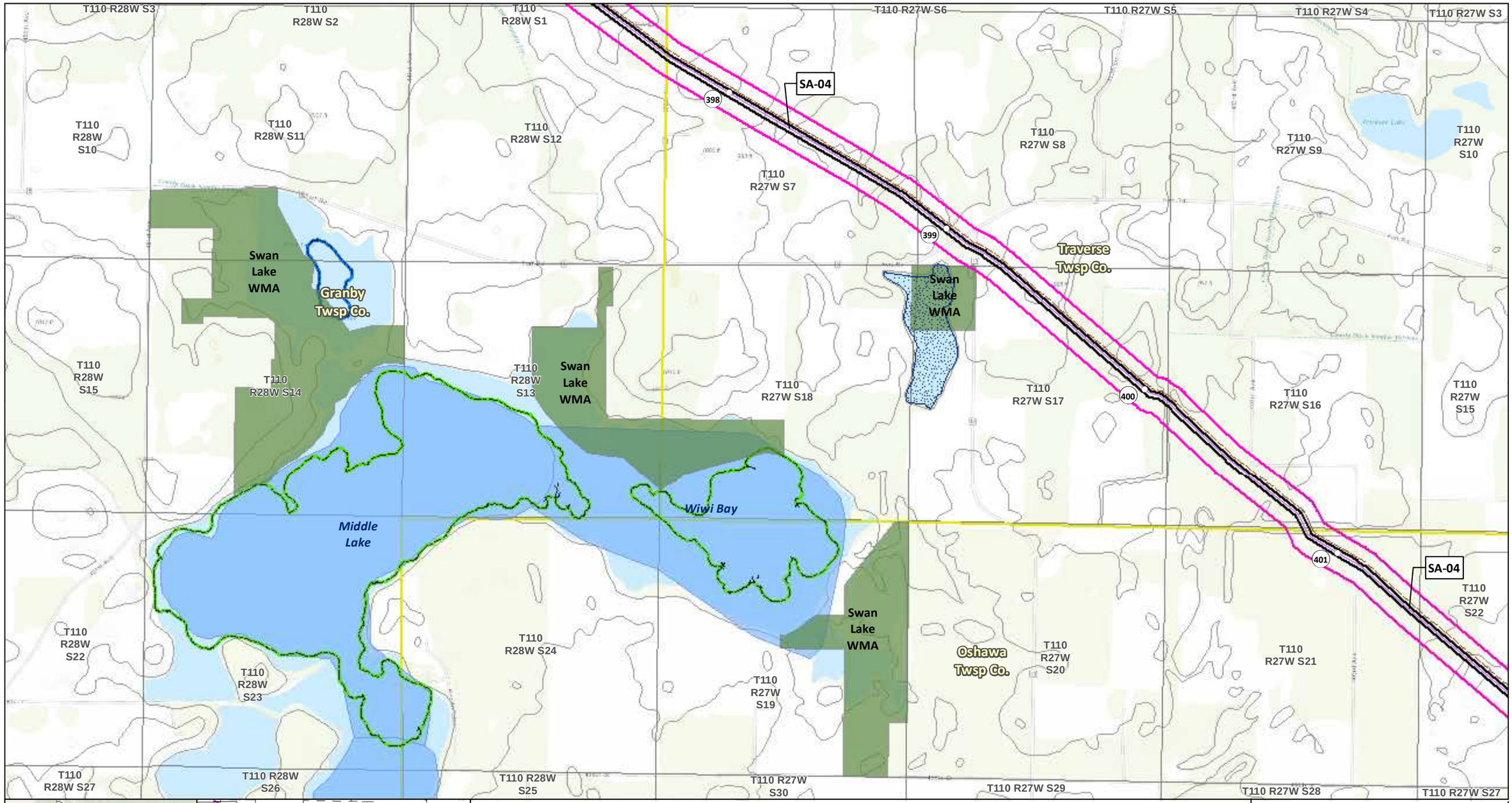
Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 107A of 188


T110 R28W S3
T110 R28W S2
T110 R28W S1
T110 R27W S6
T110 R27W S5
T110 R27W S4
T110 R27W S3
SA-04
398
T110 R28W S10
T110 R28W S11
T110 R28W S12
T110 R27W S7
T110 R27W S8
T110 R27W S9
T110 R27W S10
399
Swan Lake WMA
Granby Twsp Co.
Traverse Twsp Co.
Swan Lake WMA
T110 R28W S15
T110 R28W S14
T110 R28W S13
Swan Lake WMA
T110 R27W S18
T110 R27W S17
400
T110 R27W S16
T110 R27W S15
Wiwi Bay
Middle Lake
401
SA-04
T110 R27W S22
T110 R28W S22
T110 R28W S24
Swan Lake WMA
Oshawa Twsp Co.
T110 R27W S20
T110 R27W S21
T110 R28W S23
T110 R27W S19
T110 R28W S27
T110 R28W S26
T110 R28W S25
T110 R27W S30
T110 R27W S29
T110 R27W S28
T110 R27W S27
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
McLeod County
Carver County
Scott County
Renville County
Sibley County
Nicollet County
Minnesota
Le Sueur County
Rice County
Brown County
Blue Earth County
Steele County
Waseca County
Watonwan County
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
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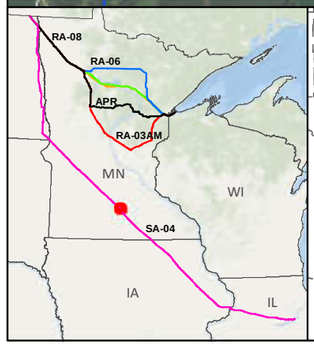
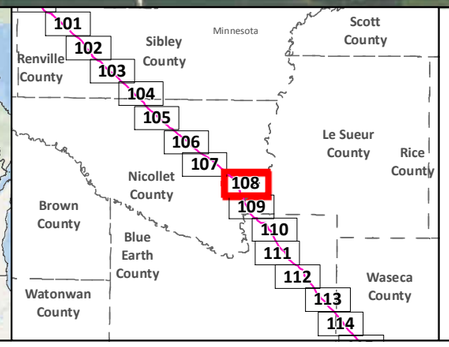
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
SA-04
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 107B of 188
N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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Water Resources
Lake
River

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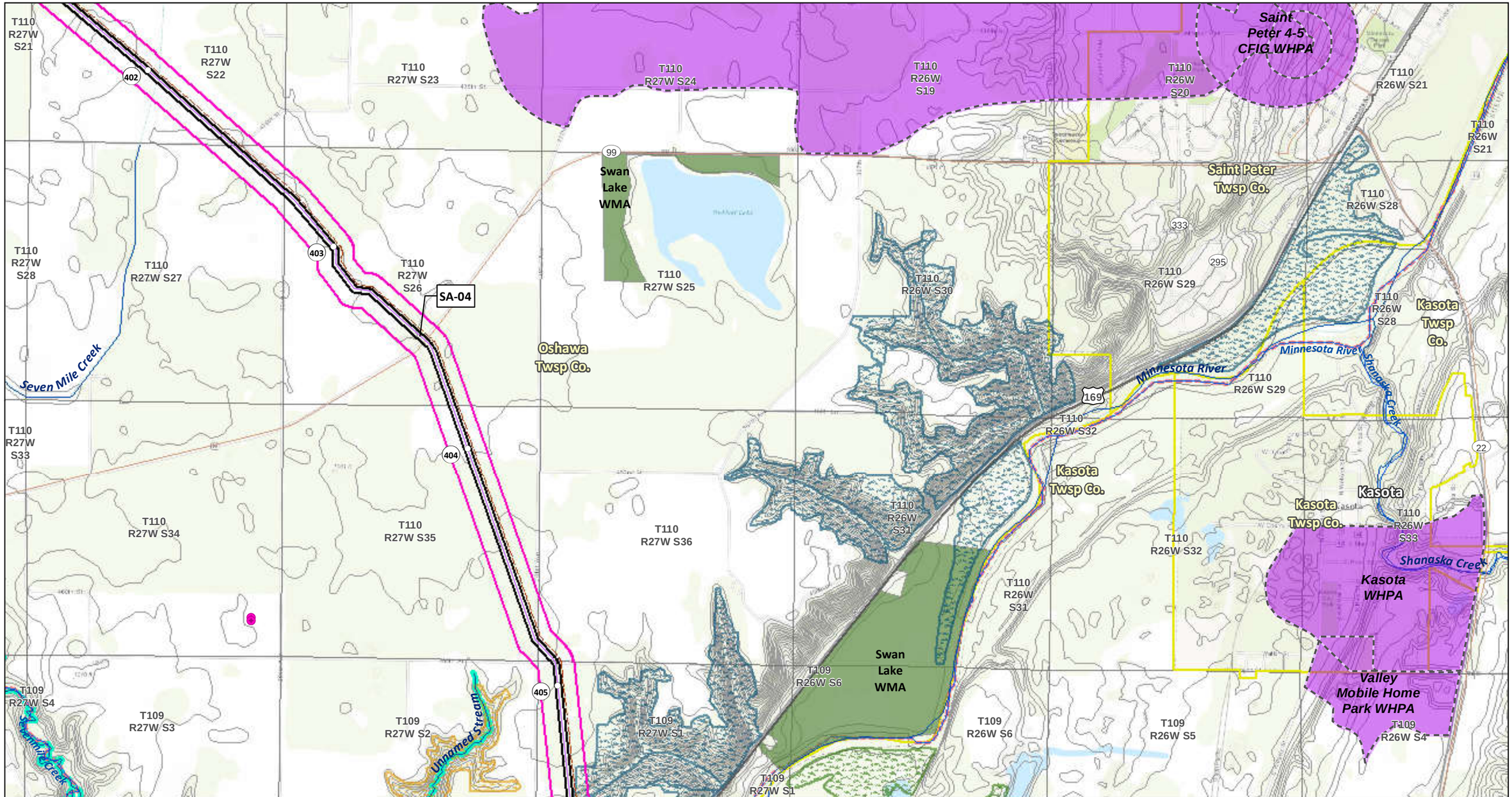
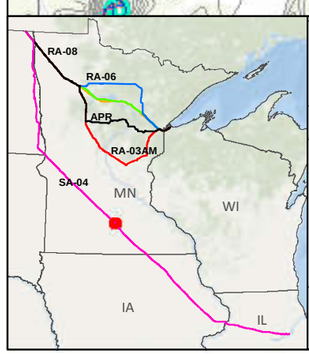
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

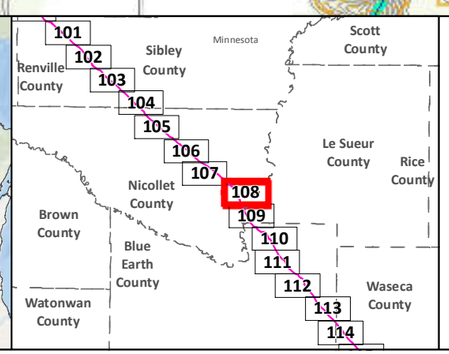
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 108A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Oshawa Twsp Co.

406

Sevenmile Creek

407

169

Belgrade Twsp Co.

Kasota Twsp Co.

22

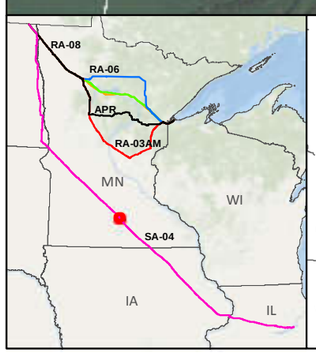
408

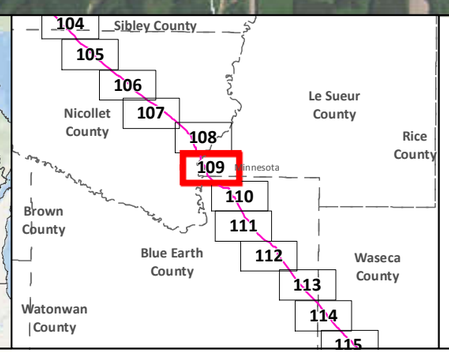
Minnesota River

409

SA-04

Lime Twsp Co.





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

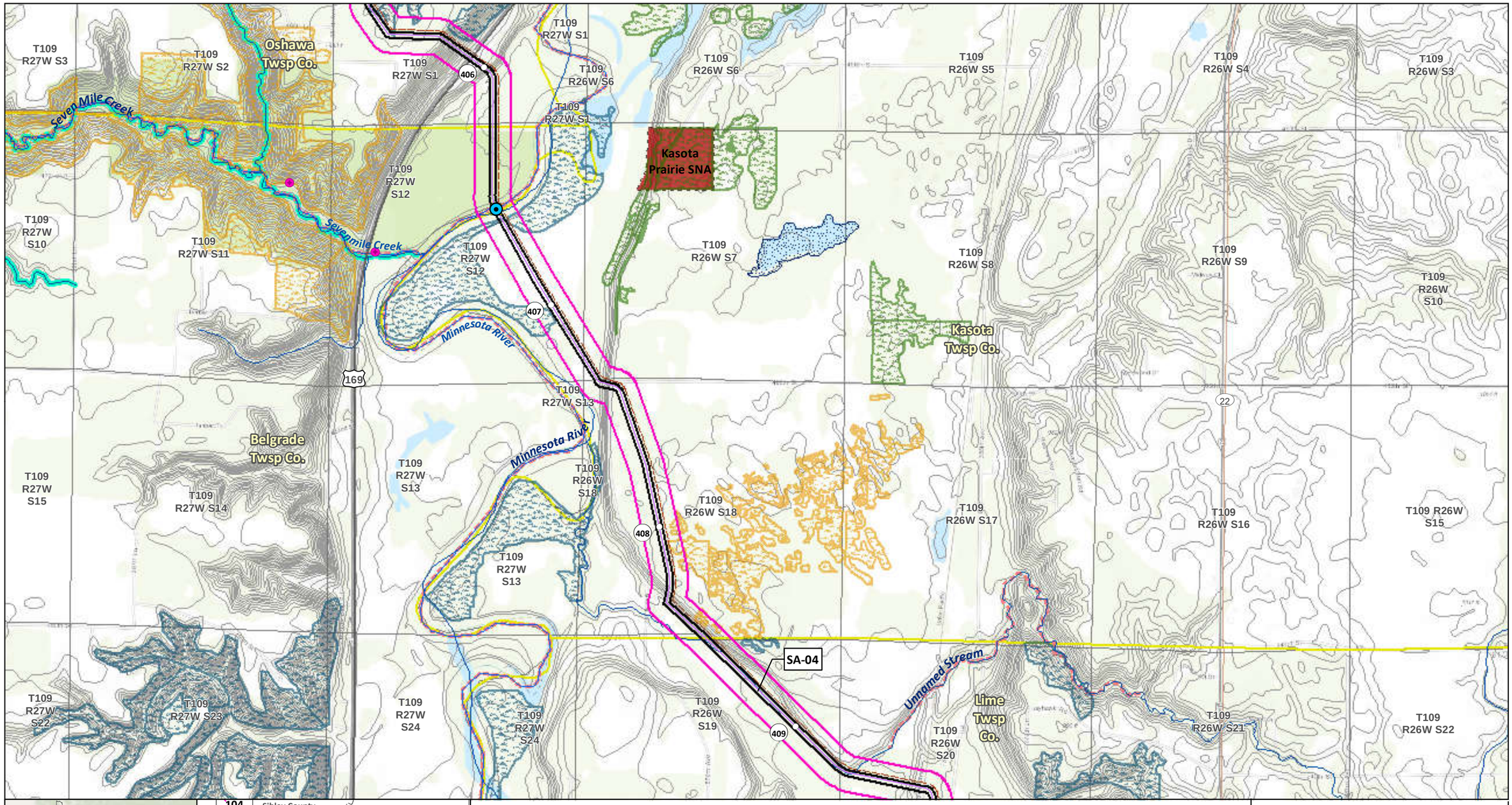
1:24,000

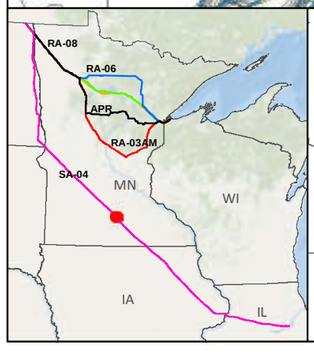
0 125 250 500 Meters

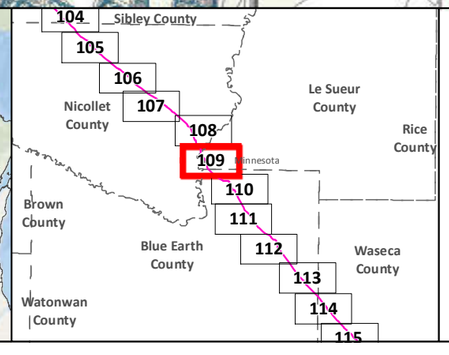
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 109A of 188







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

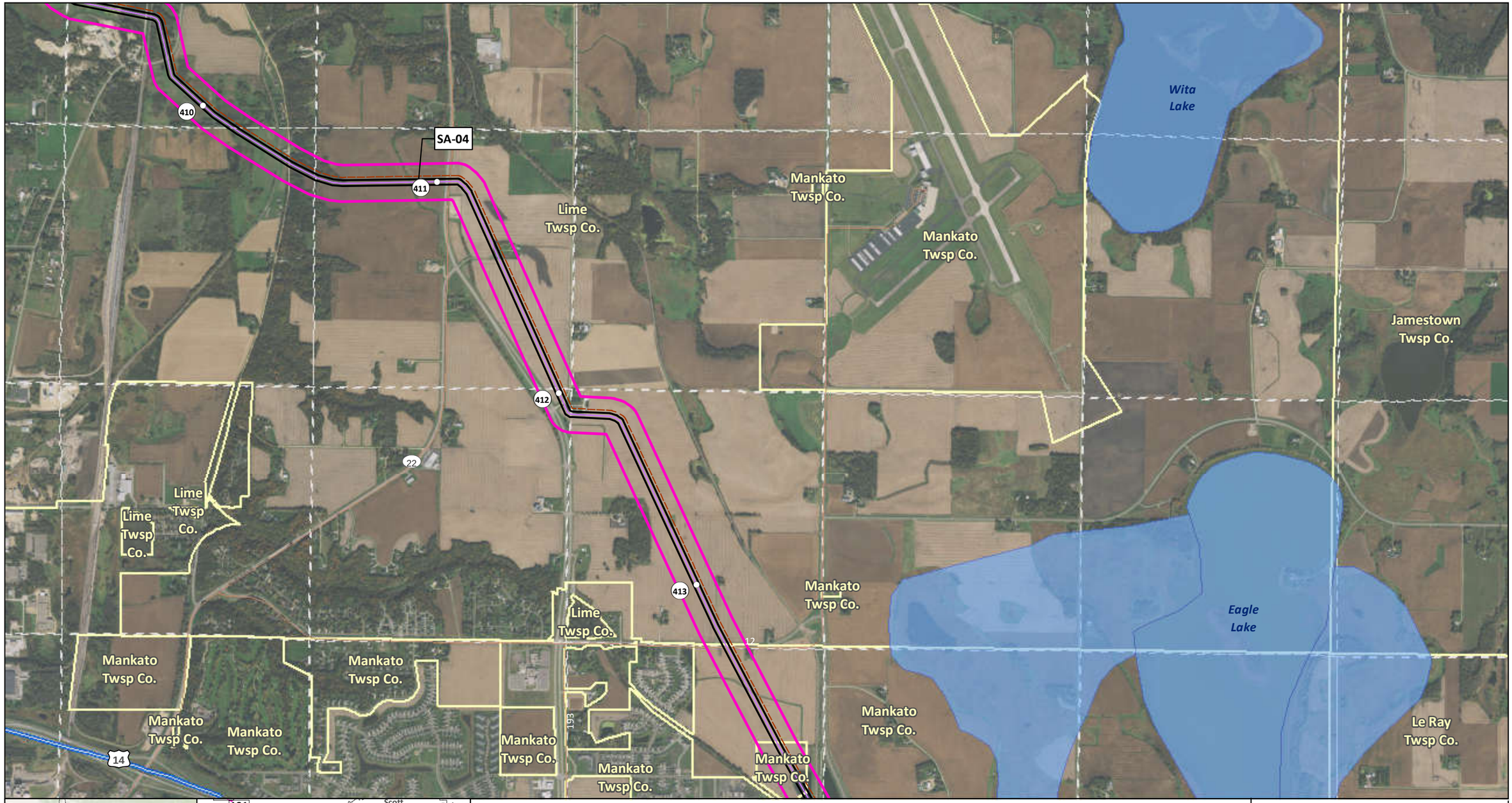
0 125 250 500 Meters

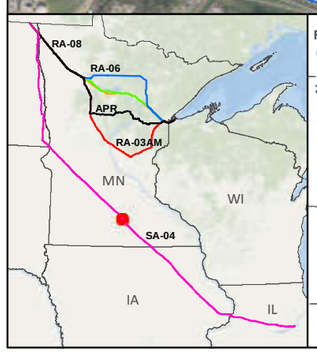
1:24,000

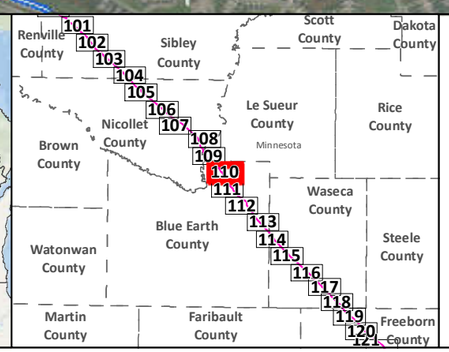
10ft Contours

N

Map 109B of 188







SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

0 0.125 0.25 0.5 Miles

1:24,000

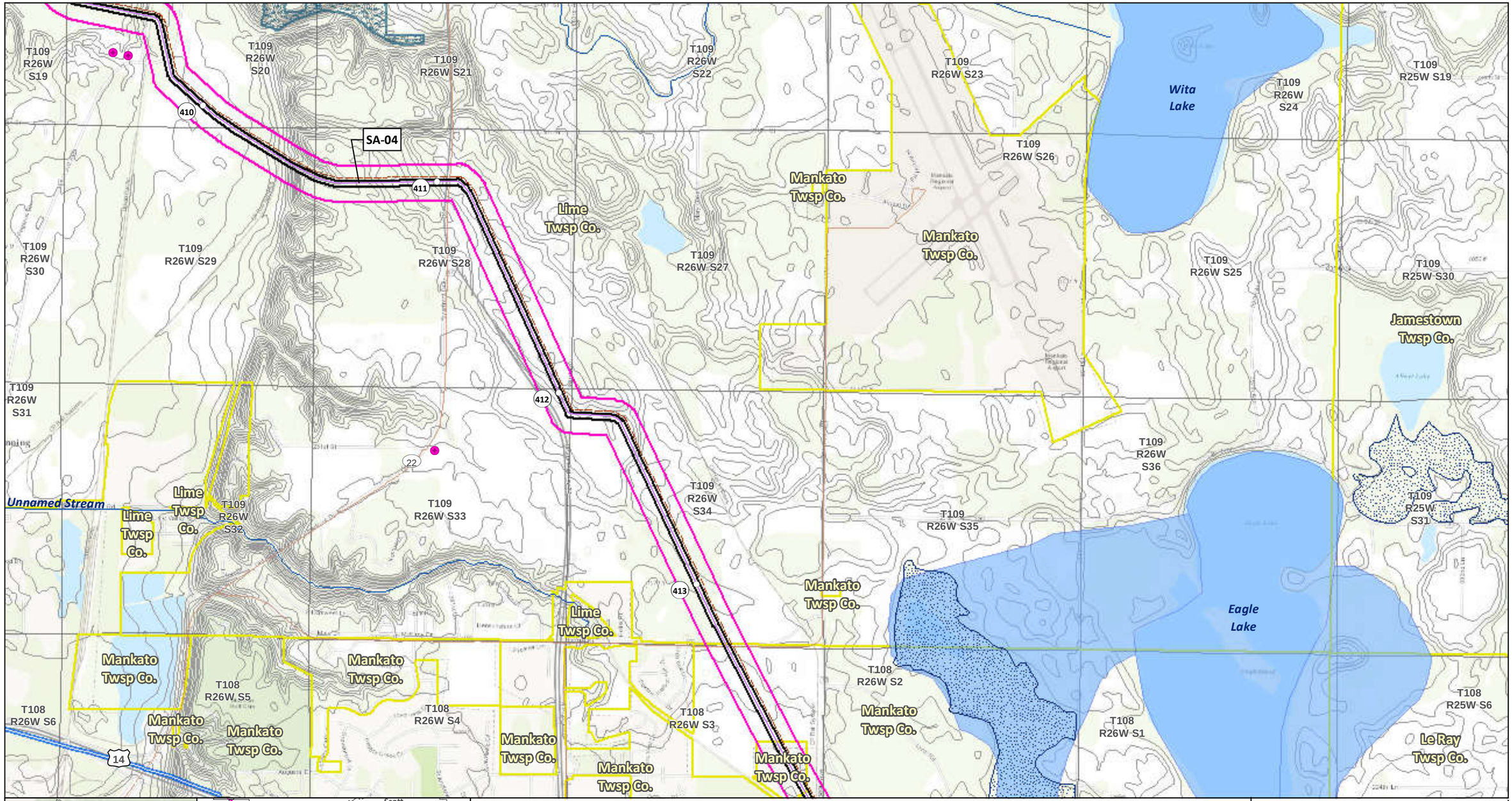
0 125 250 500 Meters

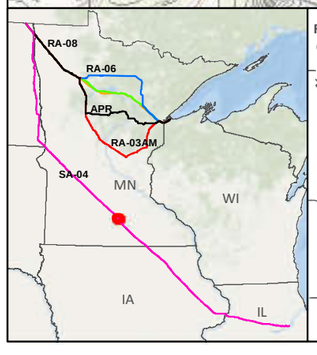
Data Sources:
MNDNR, NHD,USGS, Enbridge

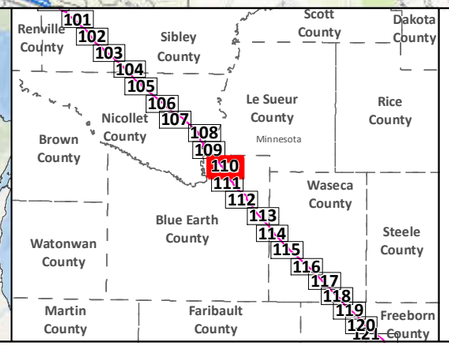
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 110A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

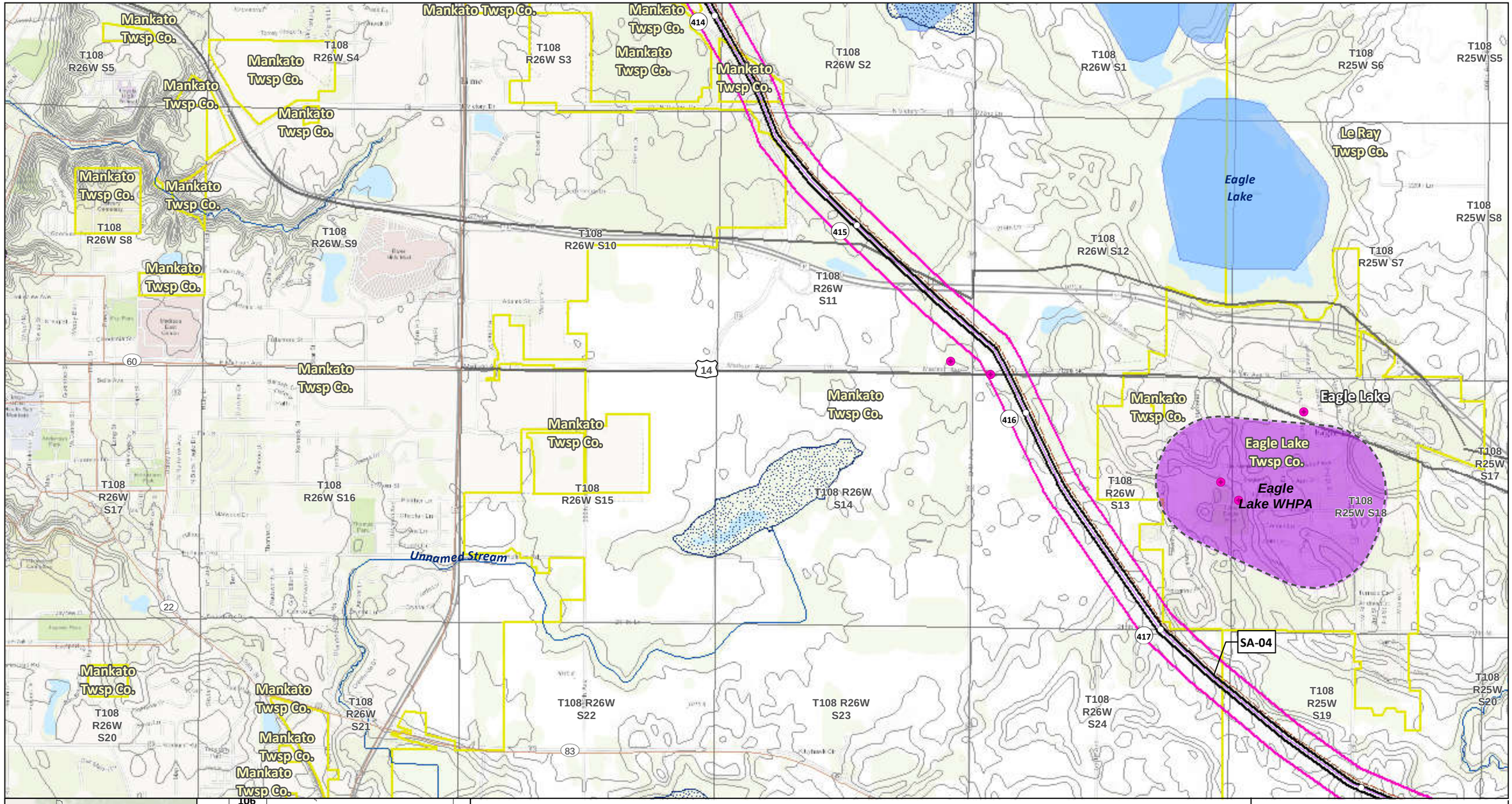
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

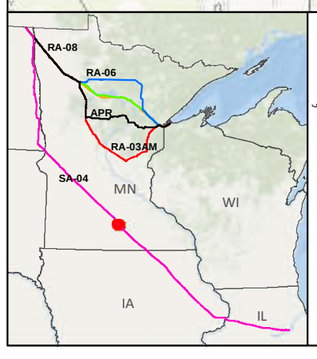
SA-04

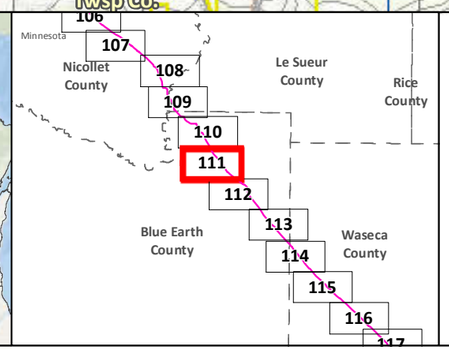
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 110B of 188

Mankato Twsp Co.
Mankato Twsp Co.
Mankato Twsp Co.







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 111B of 188

SA-04

419

420

421

422

83

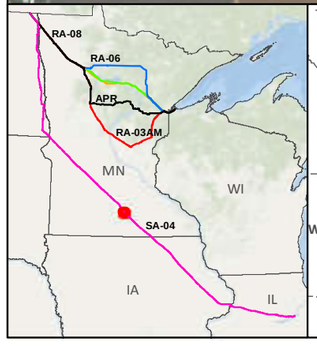
Mankato
Twsp Co.

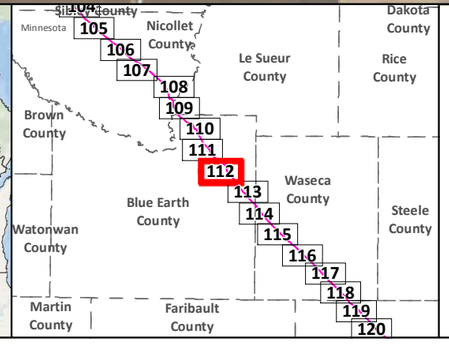
Le Ray
Twsp Co.

Decoria
Twsp Co.

McPherson
Twsp Co.

Le Sueur River





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership

- State Forest
- National Forest
- Tribal Reservation

Water Resources

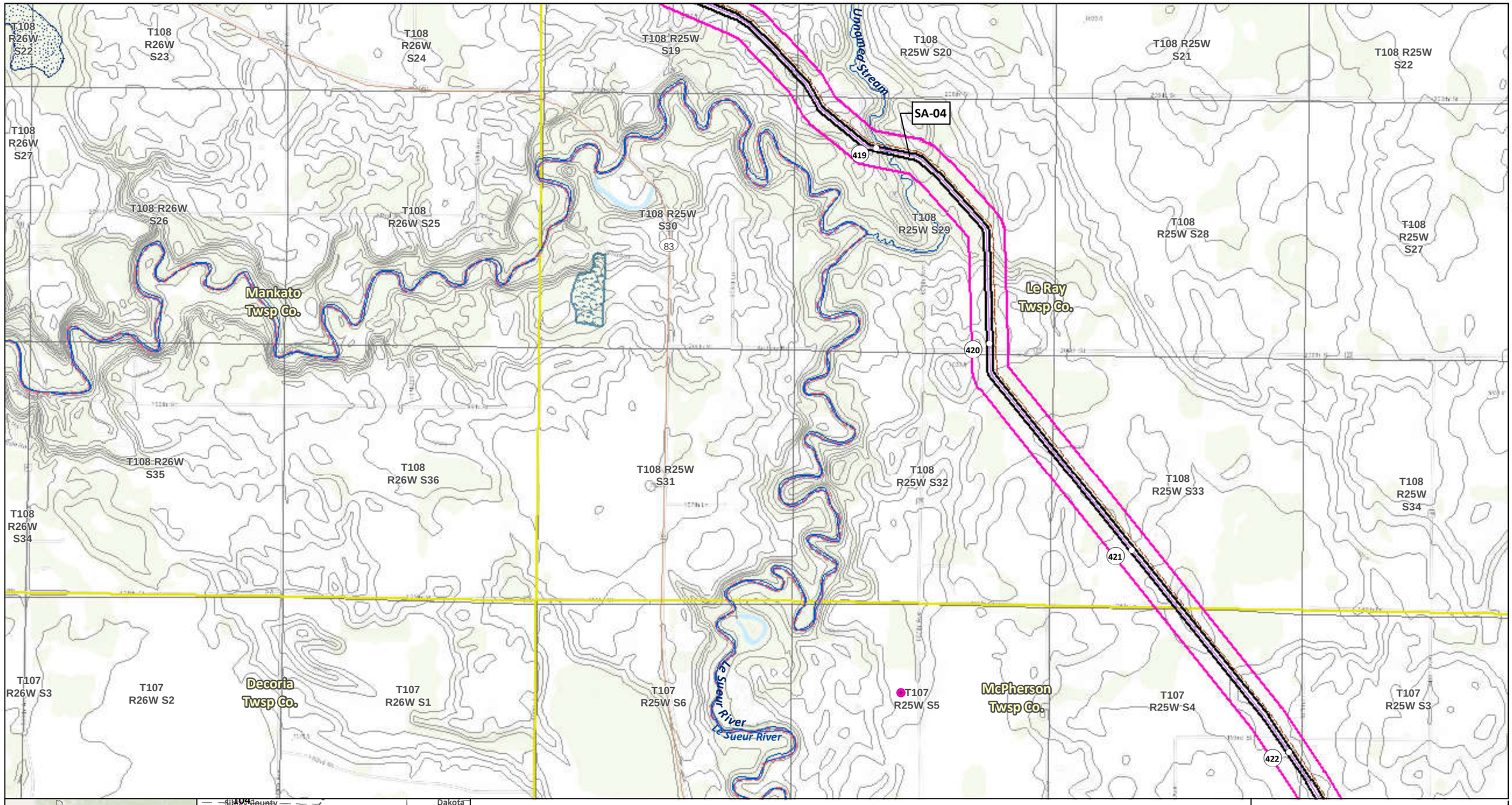
- Lake
- River

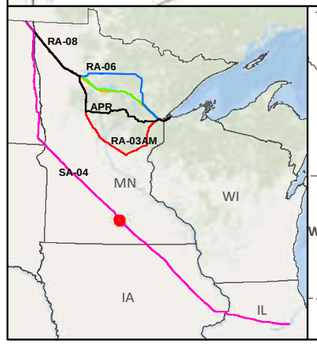
Data Sources:
MNDNR, NHD,USGS, Enbridge

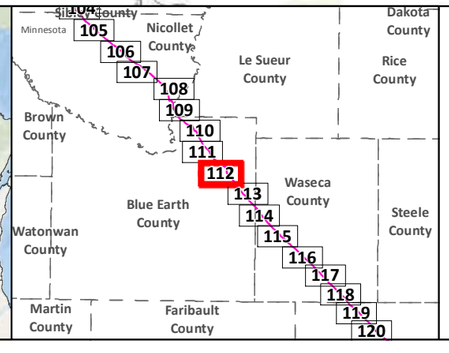
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 112B of 188

Saint Clair Twsp Co.

McPherson Twsp Co.

Alton Twsp Co.

Buffalo Lake

Le Sueur River

423

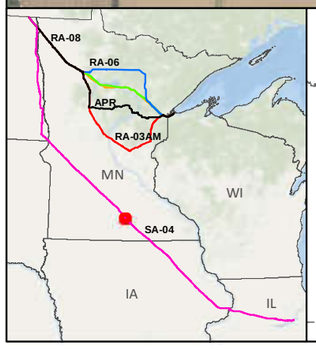
424

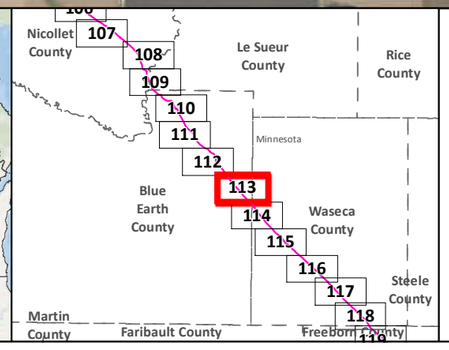
425

426

83

SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

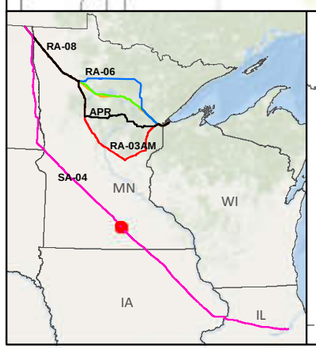
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

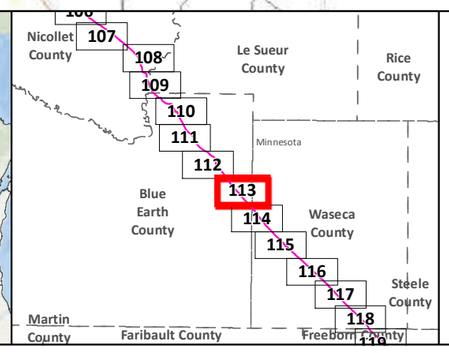
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 113A of 188

T107 R25W S5
T107 R25W S4
T107 R25W S3
T107 R25W S2
T107 R25W S1
T107 R24W S6
T107 R24W S5
T107 R25W S8
T107 R25W S9
Unnamed Stream
423
T107 R25W S11
T107 R25W S12
T107 R24W S7
T107 R24W S8
T107 R25W S10
Saint Clair Twsp Co.
SA-04
424
Alton Twsp Co.
T107 R25W S14
McPherson Twsp Co.
Mayhew Creek
T107 R25W S17
T107 R25W S16
T107 R25W S15
T107 R25W S13
T107 R24W S18
T107 R24W S17
425
T107 R25W S20
83
T107 R25W S21
T107 R25W S22
Le Sueur River
Le Sueur River
T107 R25W S23
T107 R25W S24
T107 R24W S19
Buffalo Lake
T107 R24W S20
426





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

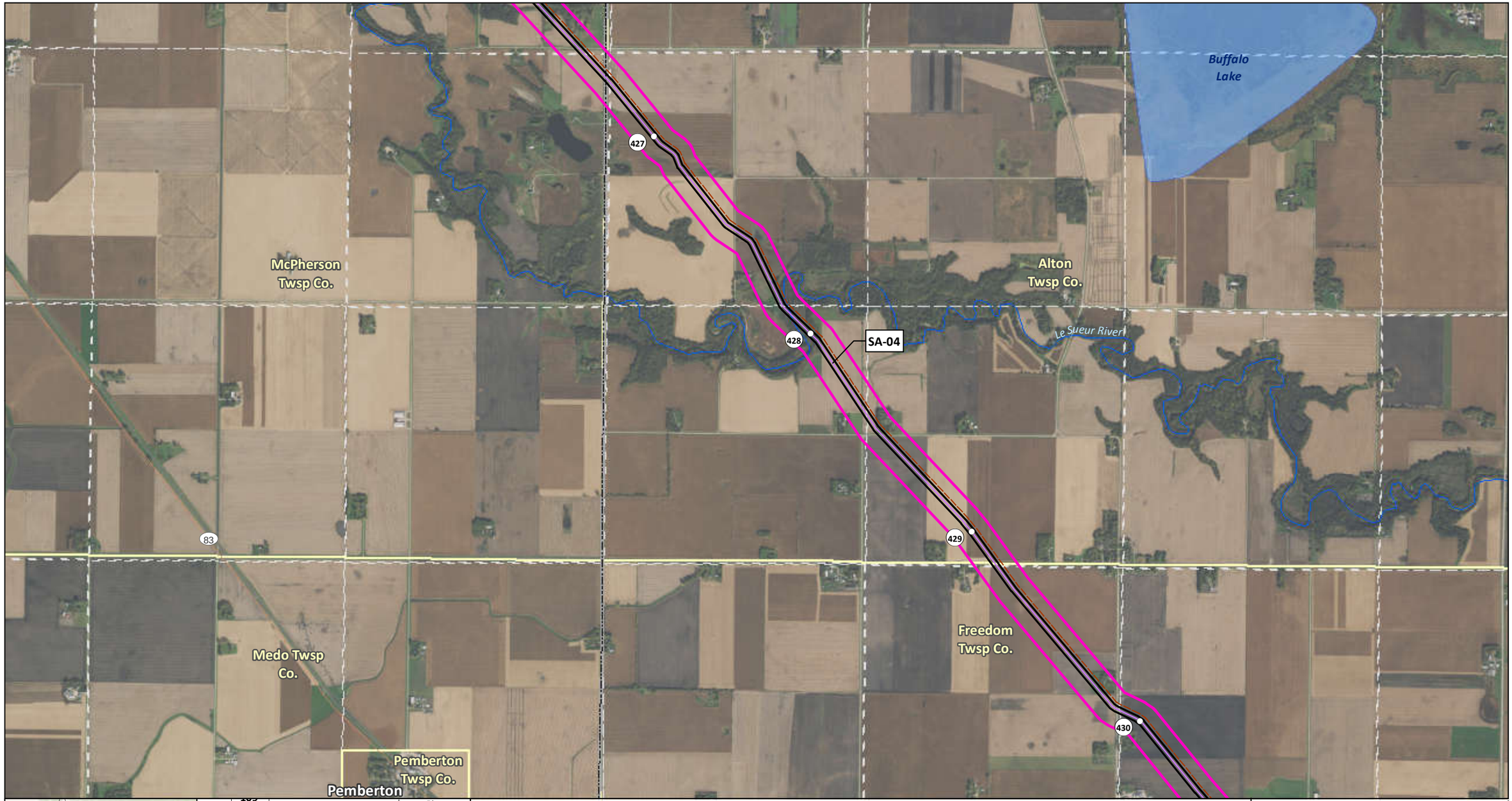
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

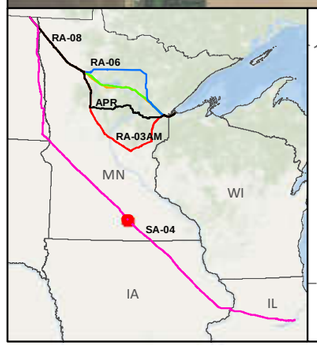
SA-04

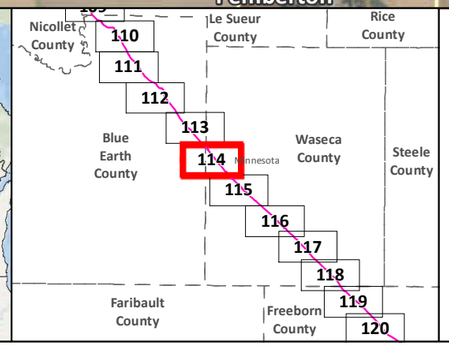
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 113B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

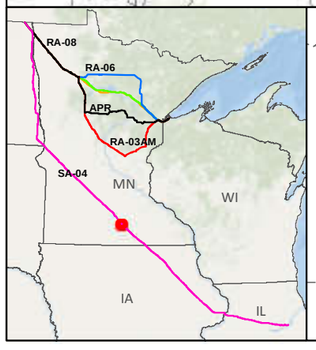
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

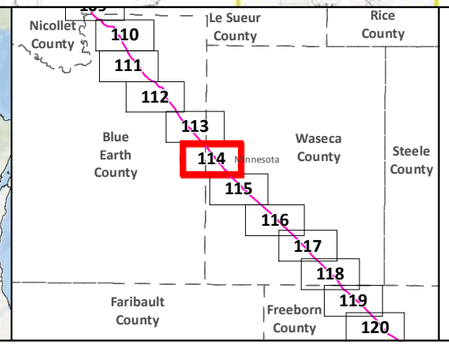
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 114A of 188

T107 R25W S22
T107 R25W S23
T107 R25W S24
T107 R24W S19
T107 R24W S20
T107 R24W S21
T107 R24W S22
Buffalo Lake
T107 R25W S27
T107 R25W S26
T107 R25W S25
T107 R24W S30
T107 R24W S29
T107 R24W S28
T107 R24W S27
McPherson Twsp Co.
Alton Twsp Co.
Le Sueur River
Le Sueur River
427
428
429
430
83
T107 R25W S34
T107 R25W S35
T107 R25W S36
T107 R24W S31
T107 R24W S32
T107 R24W S33
T107 R24W S34
Alma City
Freedom Twsp Co.
T106 R25W S3
T106 R25W S2
Medo Twsp Co.
T106 R25W S1
T106 R24W S6
T106 R24W S5
SA-04
T106 R24W S4
T106 R24W S3
Pemberton Twsp Co.





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

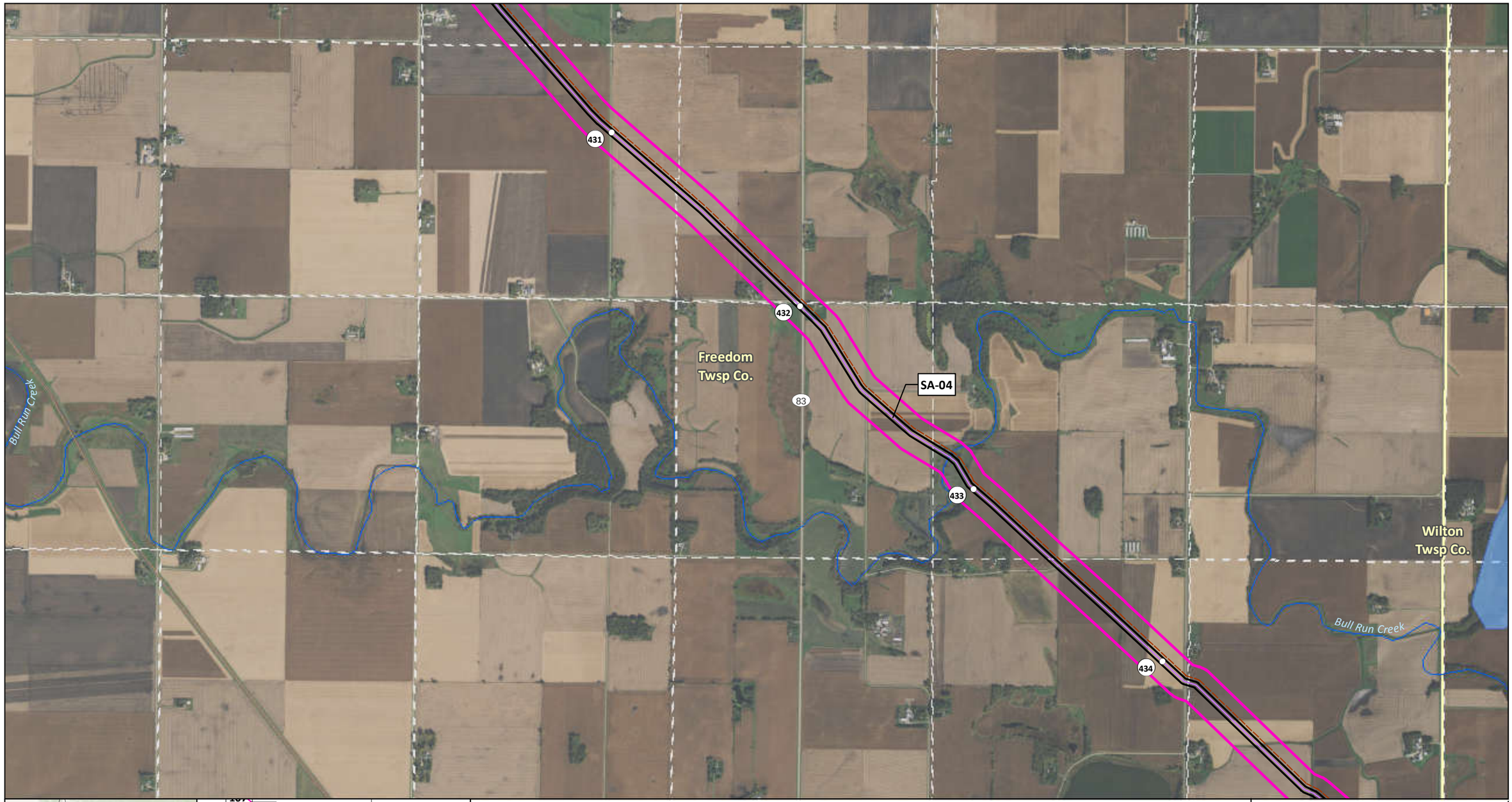
Data Sources: MNDNR, USGS, NHD, Enbridge

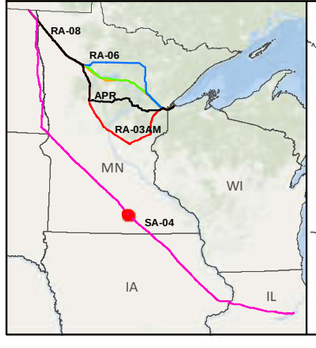
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

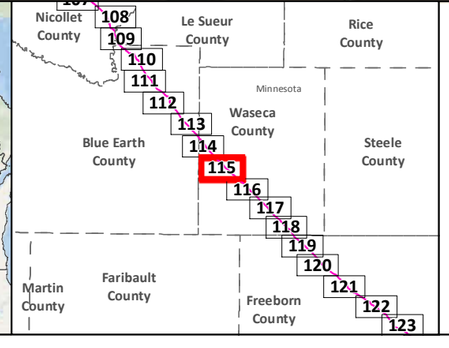
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 114B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

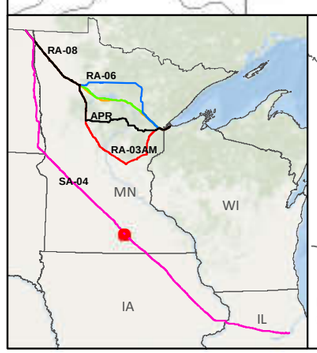
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

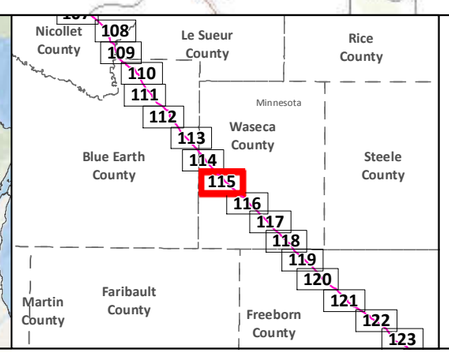
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 115A of 188

T106 R24W S6
T106 R24W S5
T106 R24W S4
T106 R24W S3
T106 R24W S2
T106 R24W S1
T106 R23W S6
T106 R24W S7
T106 R24W S8
T106 R24W S9
T106 R24W S10
T106 R24W S11
T106 R24W S12
T106 R23W S7
431
432
433
434
83
Freedom Twsp Co.
Bull Run Creek
T106 R24W S17
T106 R24W S16
T106 R24W S15
T106 R24W S14
T106 R24W S13
T106 R23W S18
T106 R24W S18
Unnamed Stream
Wilton Twsp Co.
T106 R24W S20
T106 R24W S21
T106 R24W S22
T106 R24W S23
T106 R24W S24
T106 R23W S19
T106 R24W S19
SA-04
Mueller WMA





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

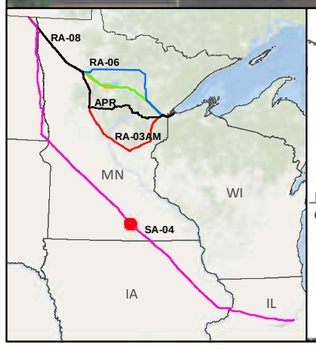
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

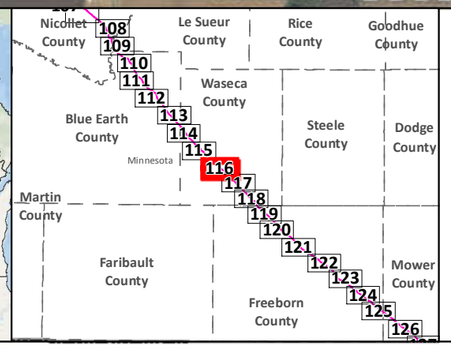
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

435
436
437
438
439
SA-04
Freedom Twsp Co.
Wilton Twsp Co.
Vivian Twsp Co.
Byron Twsp Co.





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources: MNDNR, NHD,USGS, Enbridge

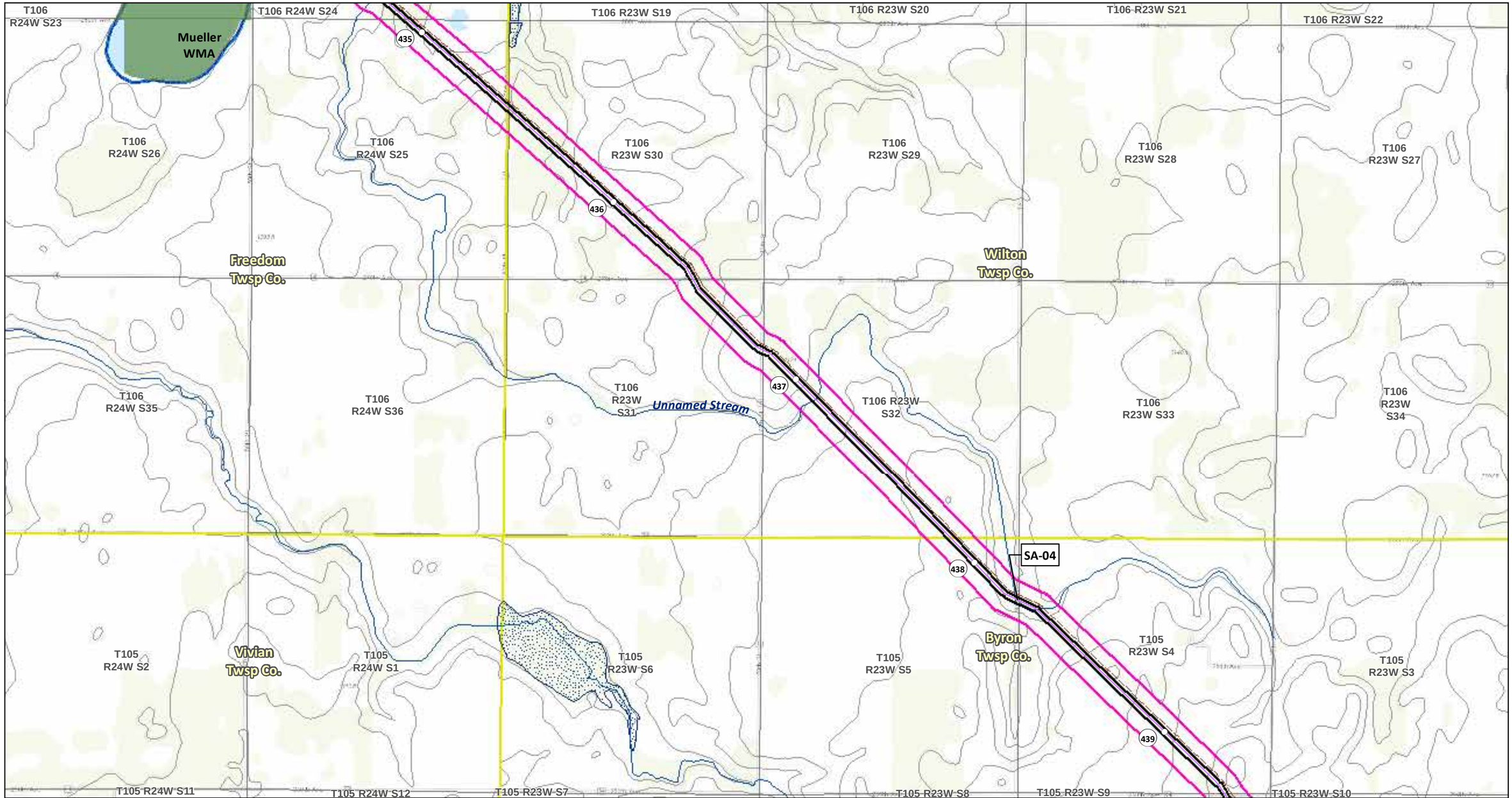
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 116A of 188

N


T106 R24W S23
T106 R24W S24
T106 R23W S19
T106 R23W S20
T106 R23W S21
T106 R23W S22
Mueller WMA
435
T106 R24W S26
T106 R24W S25
T106 R23W S30
T106 R23W S29
T106 R23W S28
T106 R23W S27
436
Freedom Twsp Co.
Wilton Twsp Co.
T106 R24W S35
T106 R24W S36
T106 R23W S31
Unnamed Stream
437
T106 R23W S32
T106 R23W S33
T106 R23W S34
SA-04
438
T105 R24W S2
Vivian Twsp Co.
T105 R24W S1
T105 R23W S6
T105 R23W S5
Byron Twsp Co.
T105 R23W S4
T105 R23W S3
439
T105 R24W S11
T105 R24W S12
T105 R23W S7
T105 R23W S8
T105 R23W S9
T105 R23W S10
RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL
Nicollet County
Le Sueur County
Rice County
Goodhue County
Waseca County
Blue Earth County
Steele County
Dodge County
Minnesota
Martin County
Faribault County
Freeborn County
Mower County
108
109
110
111
112
113
114
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116
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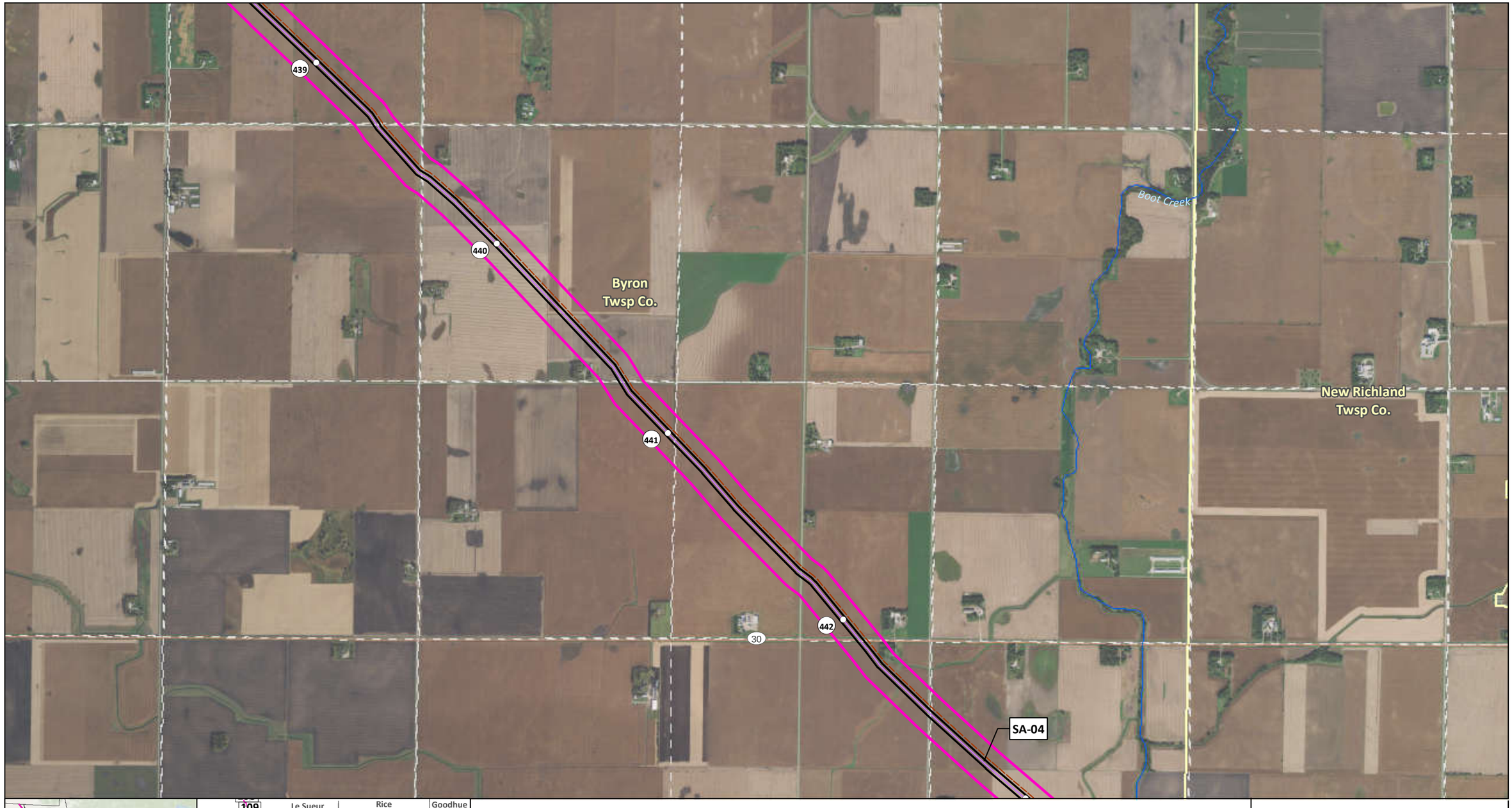
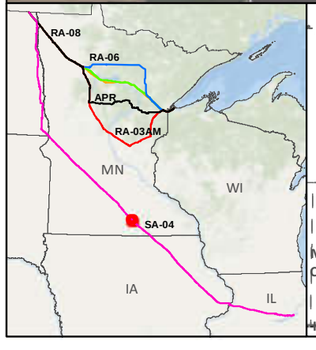
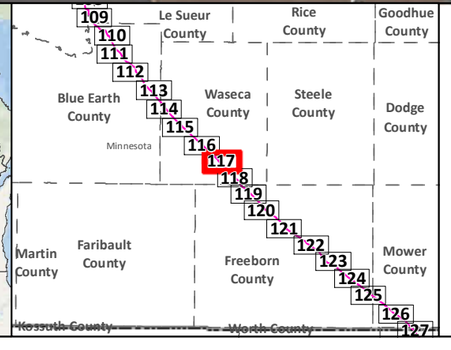
SA-04
Applicant's Preferred Route (APR)
Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')
Existing Pipelines
Township Boundary
State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area
Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)
Lakes of Biological Significance
Outstanding
High
Moderate
Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate
Data Sources:
MNDNR, USGS, NHD, Enbridge
LINE 3
REPLACEMENT PROJECT
DETAILED MAP SET
TOPOGRAPHIC
SA-04
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours
Map 116B of 188
N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

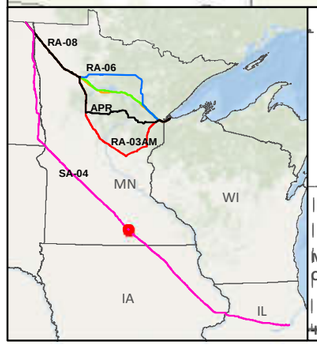
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

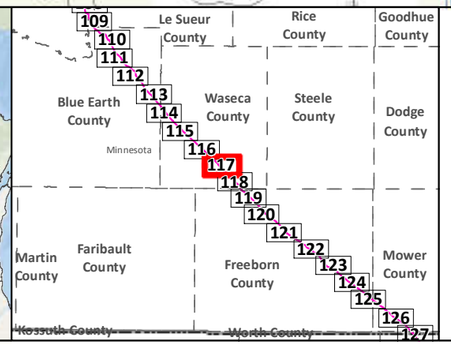
SA-04

Map 117A of 188

T105 R23W S5
T105 R23W S4
T105 R23W S3
T105 R23W S2
T105 R23W S1
T105 R22W S6
T105 R22W S5
T105 R23W S8
T105 R23W S9
T105 R23W S10
T105 R23W S11
T105 R23W S12
T105 R22W S7
T105 R22W S8
T105 R23W S17
T105 R23W S16
T105 R23W S15
T105 R23W S14
T105 R23W S13
T105 R22W S18
T105 R22W S17
T105 R23W S20
T105 R23W S21
T105 R23W S22
T105 R23W S23
T105 R23W S24
T105 R22W S19
T105 R22W S20

Byron Twsp Co.
New Richland Twsp Co.
Boot Creek
Unnamed Stream
439
440
441
442
30
SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
- RA-07
- RA-08
- Mile Post
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- Route Width (750')

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- WMA - Wildlife Management Areas
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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 117B of 188

New Richland
Twsp.Co.

443

SA-04

444

Byron
Twsp Co.

Boot Creek

New Richland
Twsp Co.

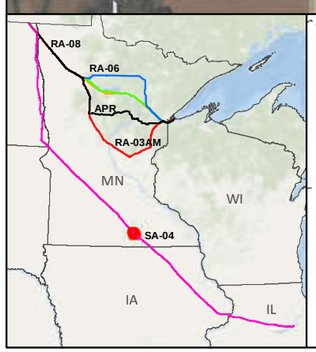
13

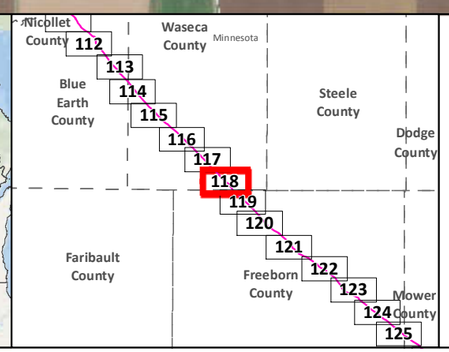
445

446

Freeborn
Twsp Co.

Hartland
Twsp Co.





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

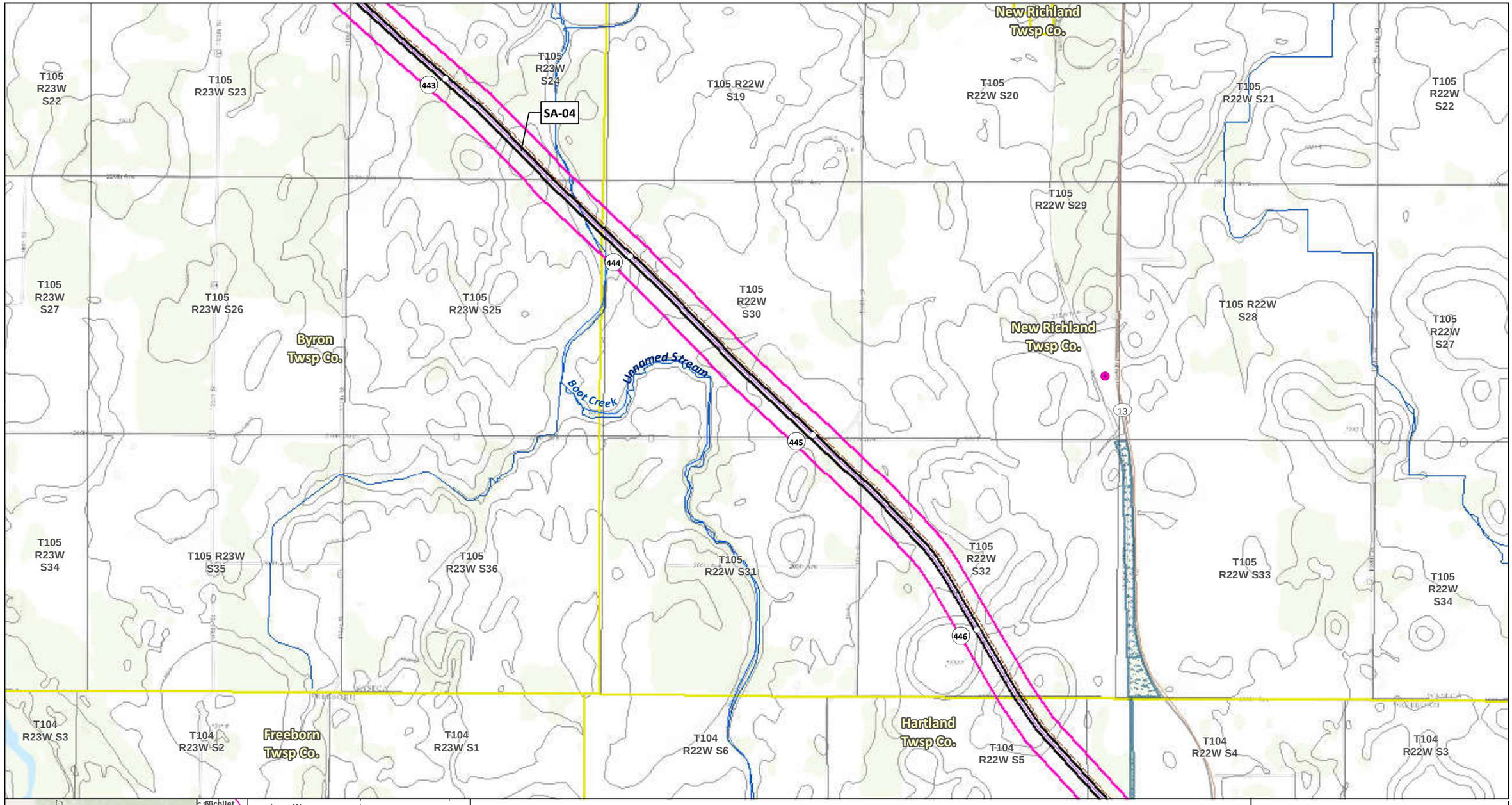
Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

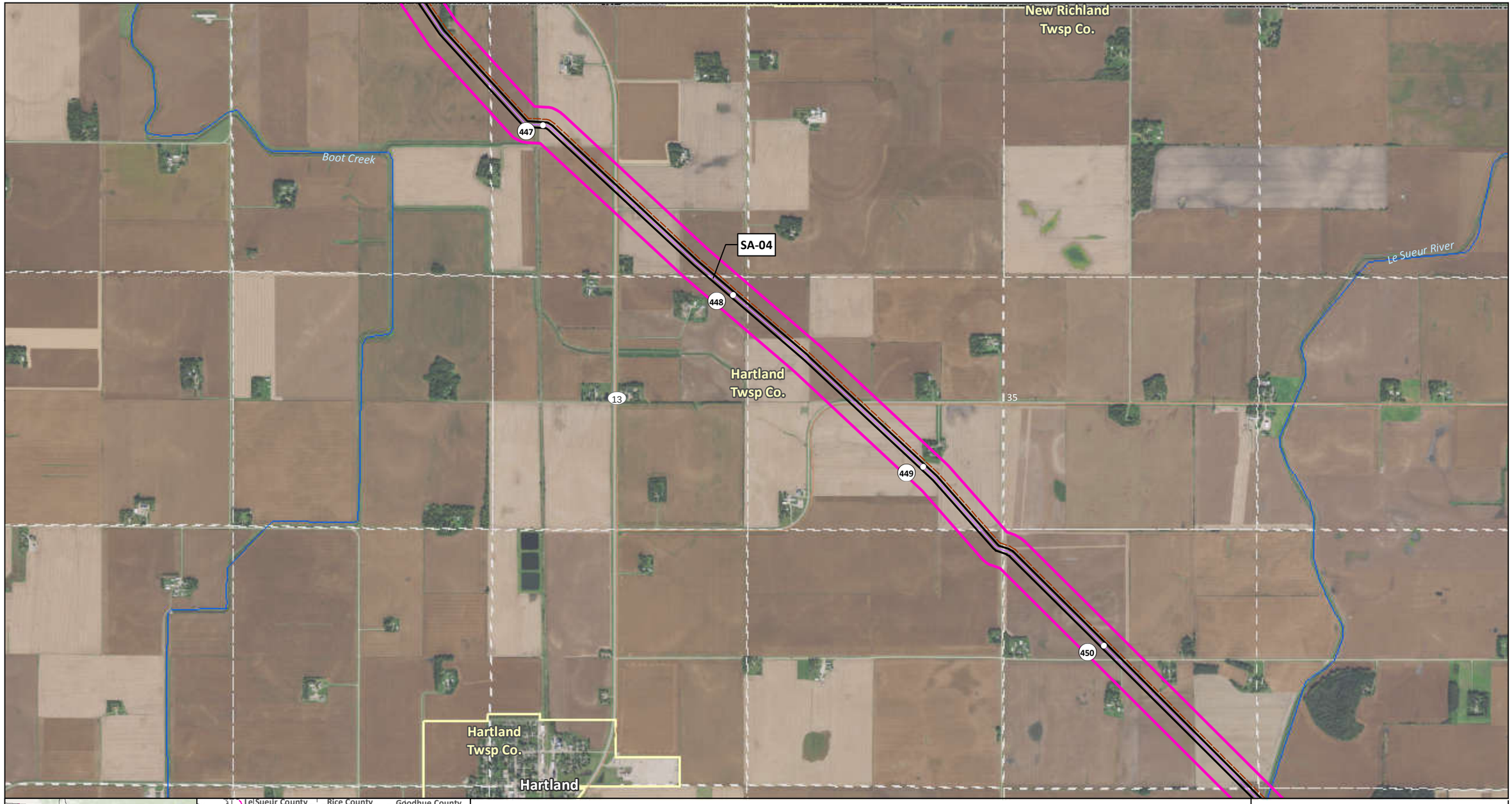
Map 118A of 188

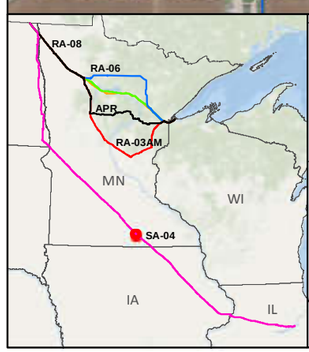


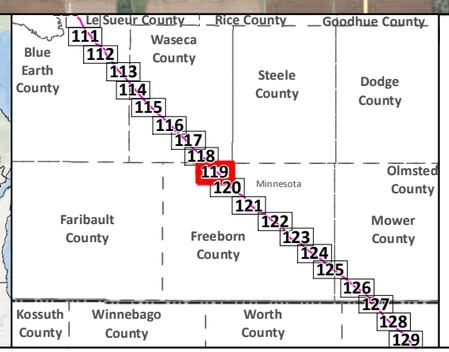
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

Map 118B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

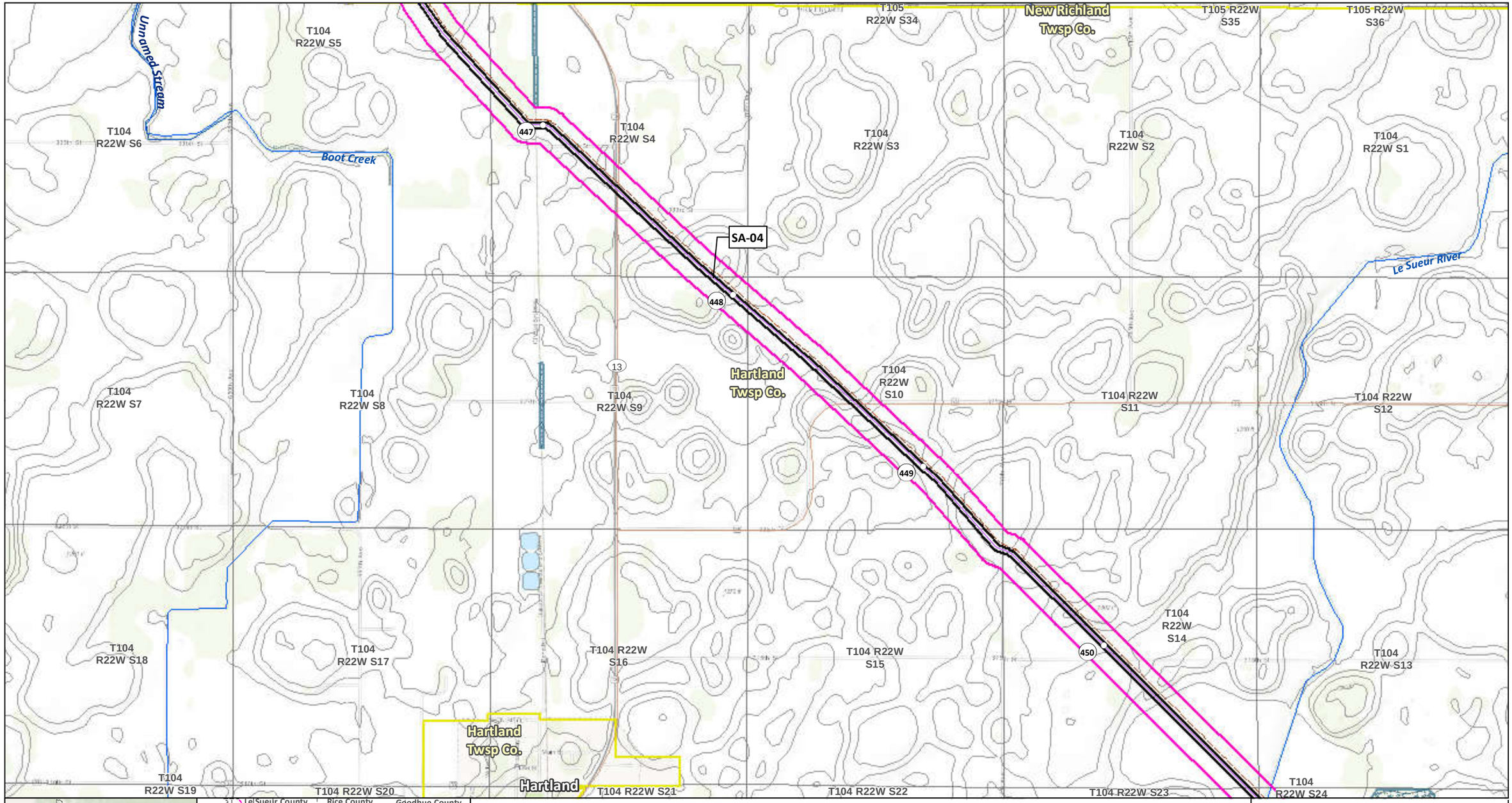
Data Sources:
MNDNR, NHD,USGS, Enbridge

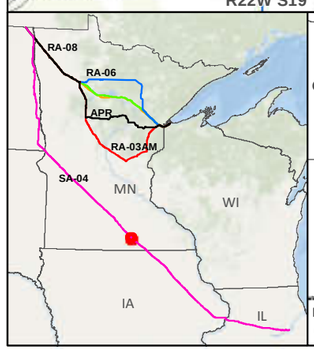
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

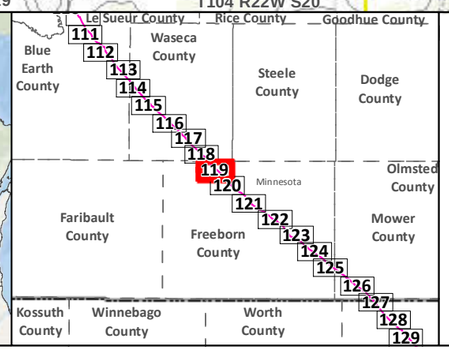
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 119A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 119B of 188

Hartland Twsp Co.

Hartland Twsp Co.

Bath Twsp Co.

Hartland Twsp Co.

451

452

453

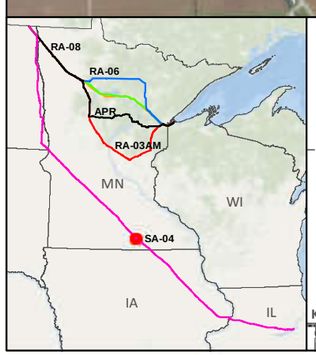
454

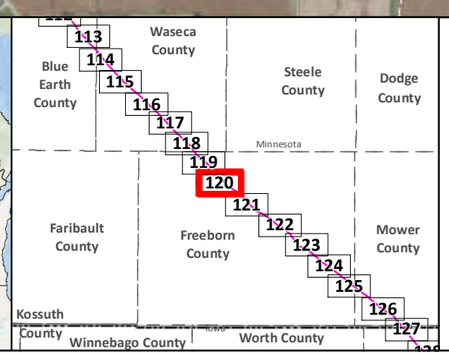
SA-04

13

20

Le Sueur River





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

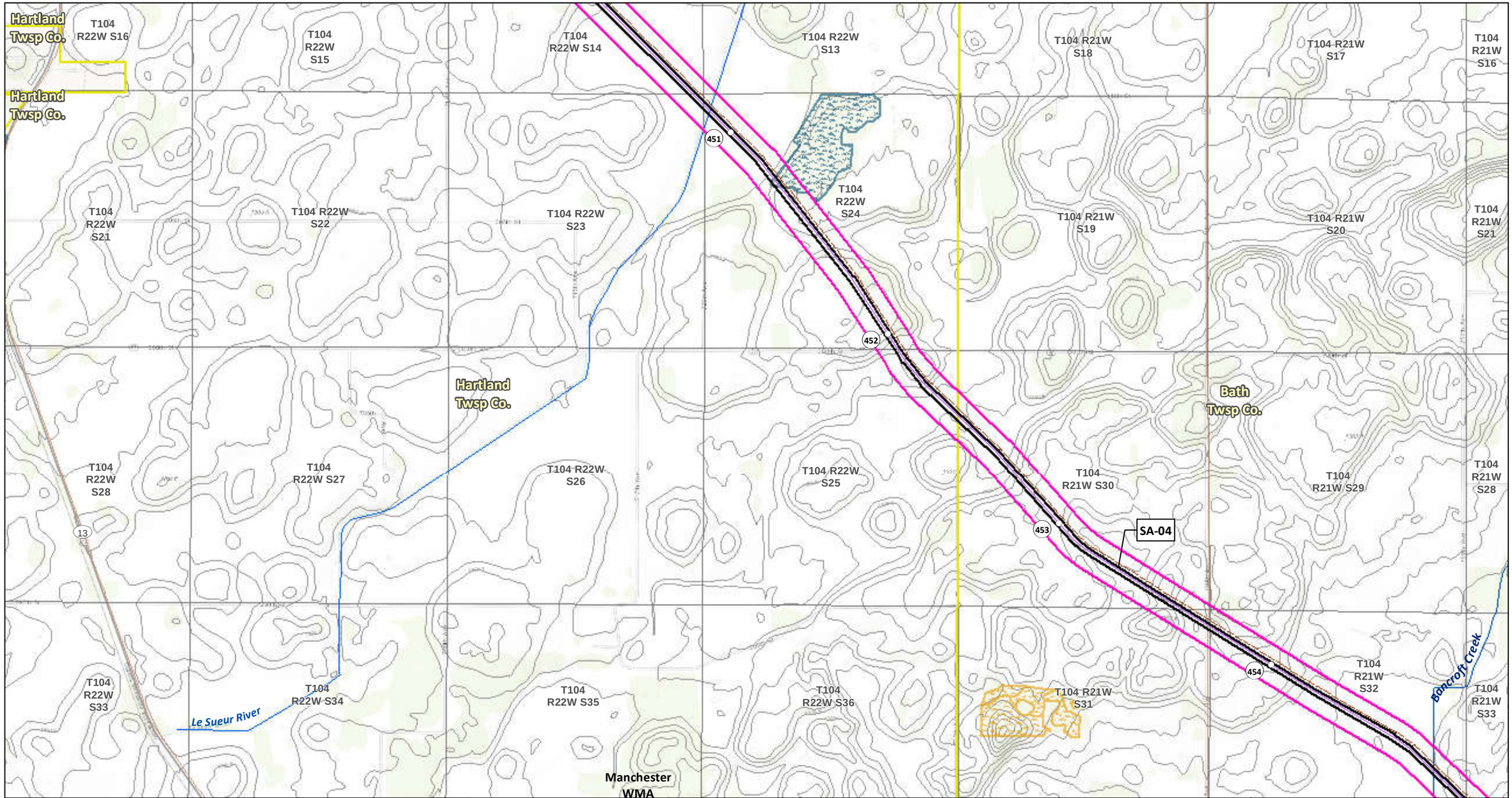
1:24,000

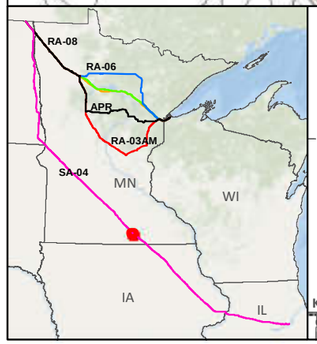
0 125 250 500 Meters

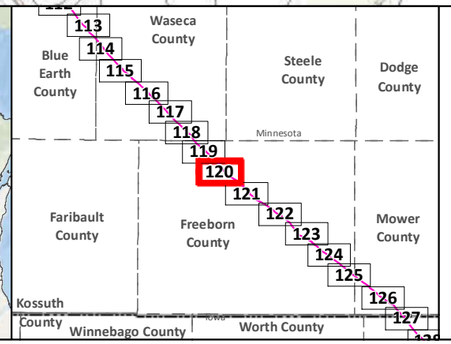
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 120A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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Native Plant Communities with Biodiversity Significance
- Outstanding
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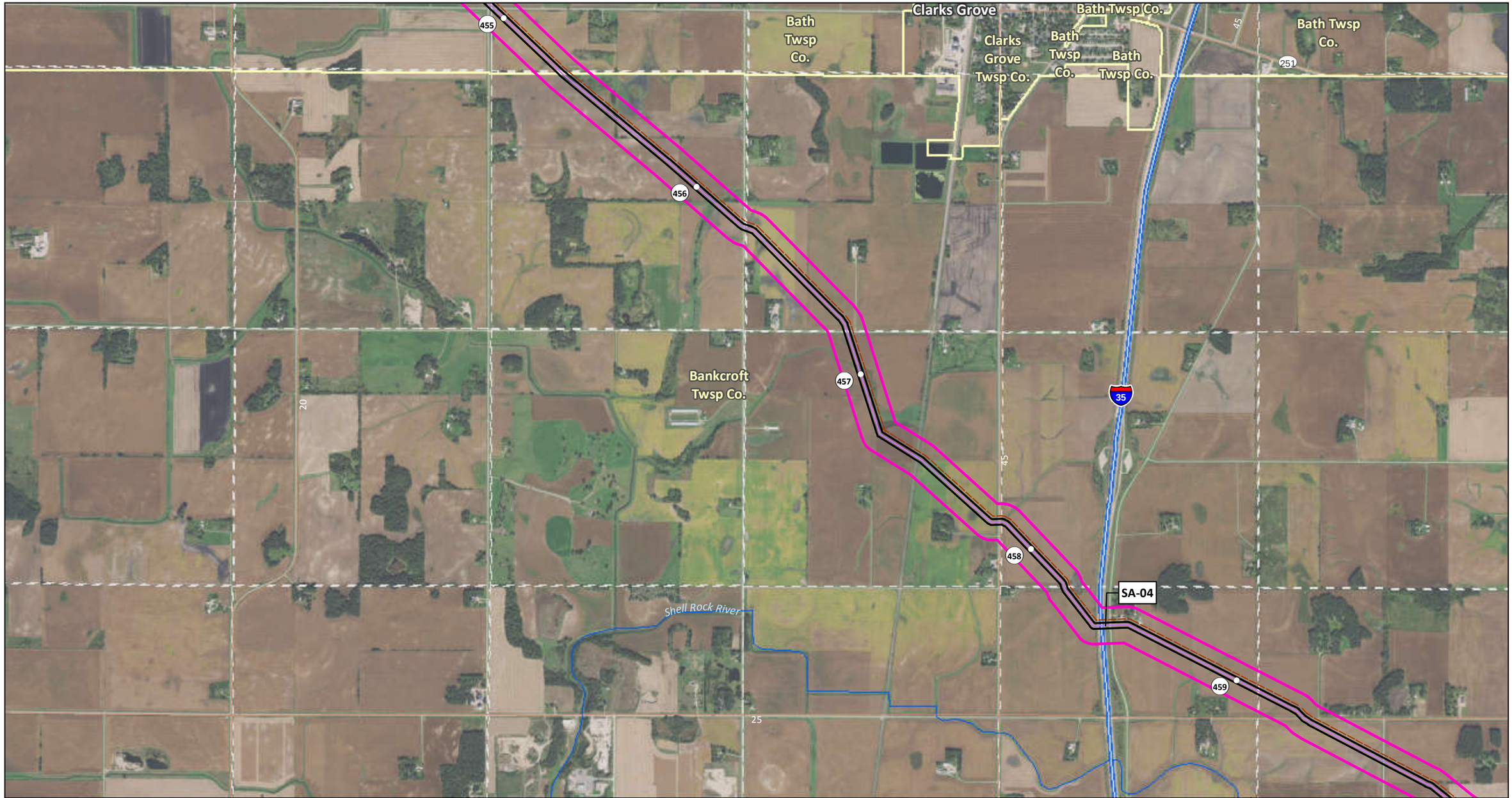
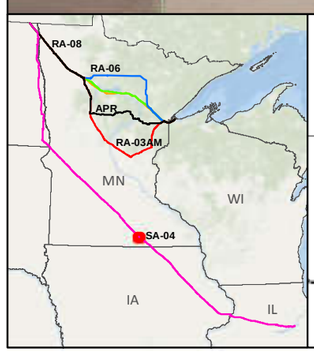
Data Sources: MNDNR, USGS, NHD, Enbridge

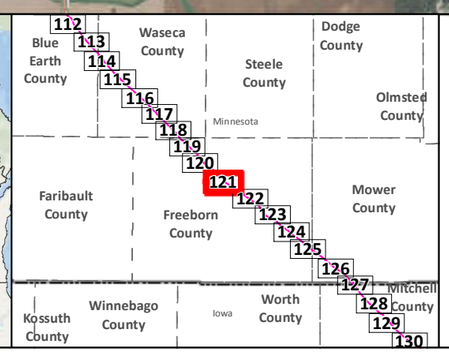
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

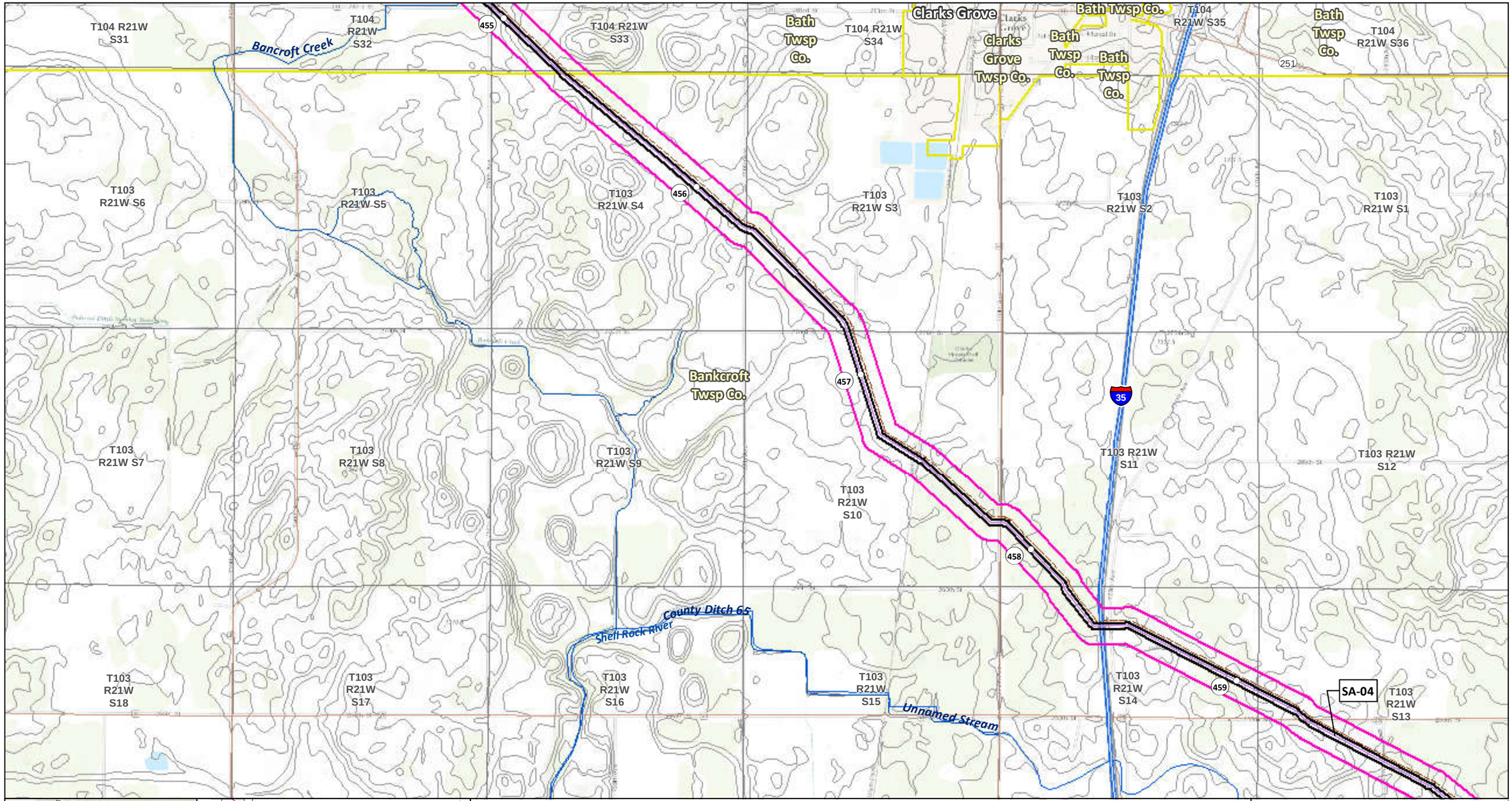
Data Sources:
MNDNR, NHD,USGS, Enbridge

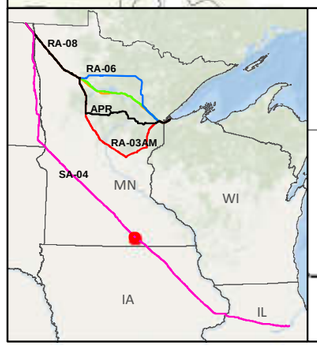
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

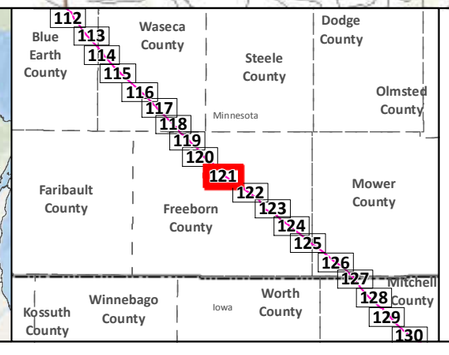
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 121A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

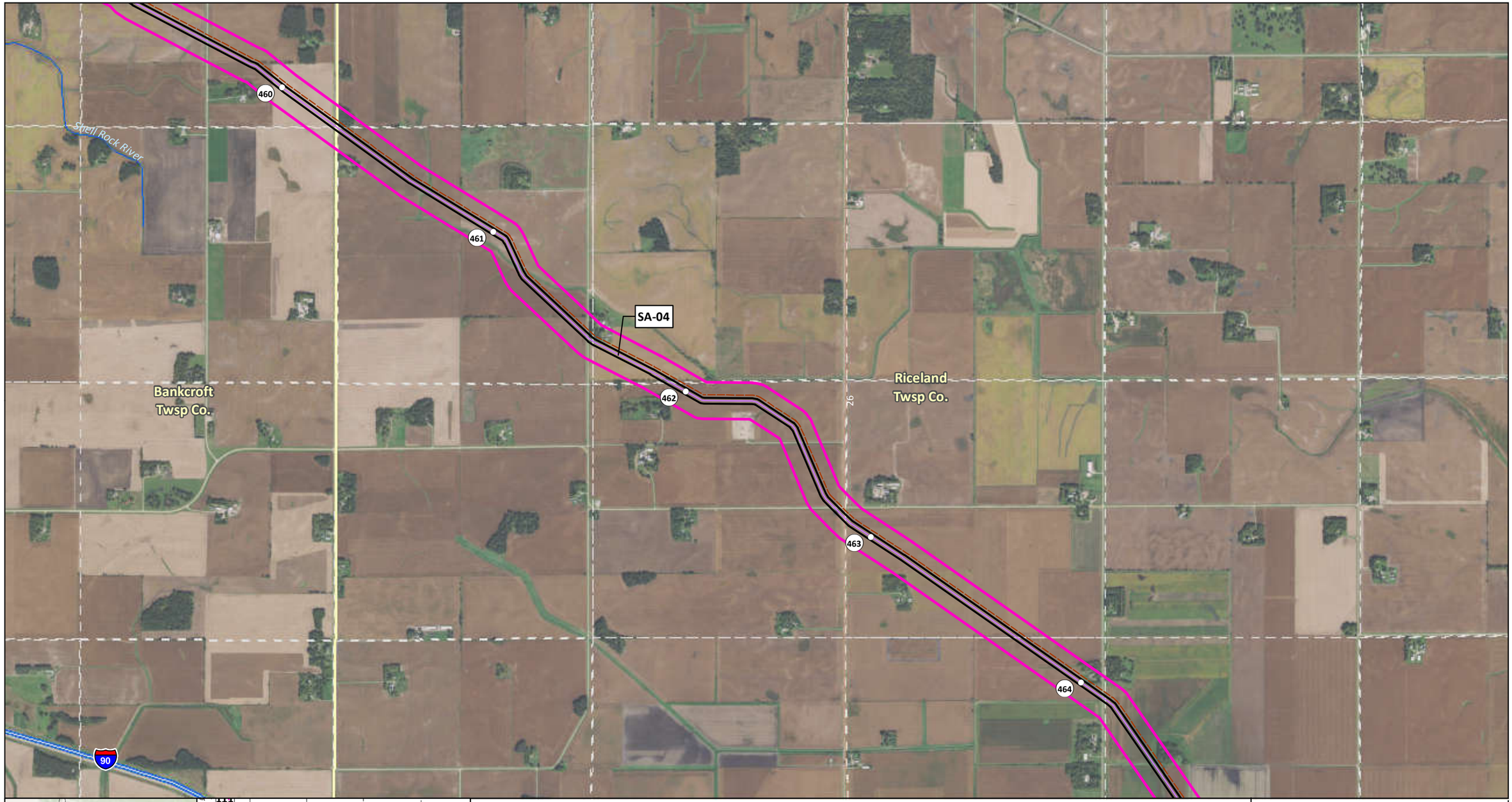
Data Sources: MNDNR, USGS, NHD, Enbridge

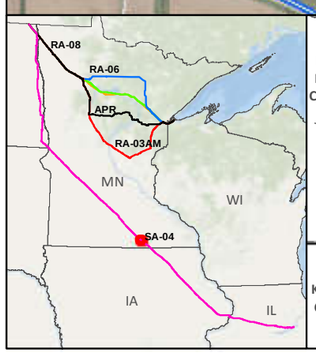
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

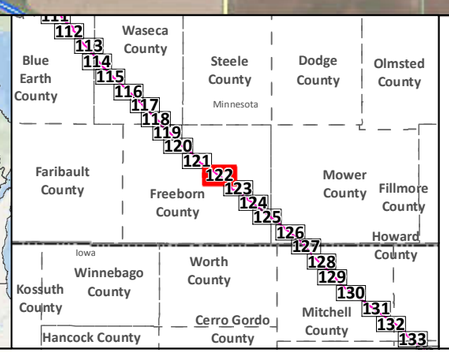
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 121B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

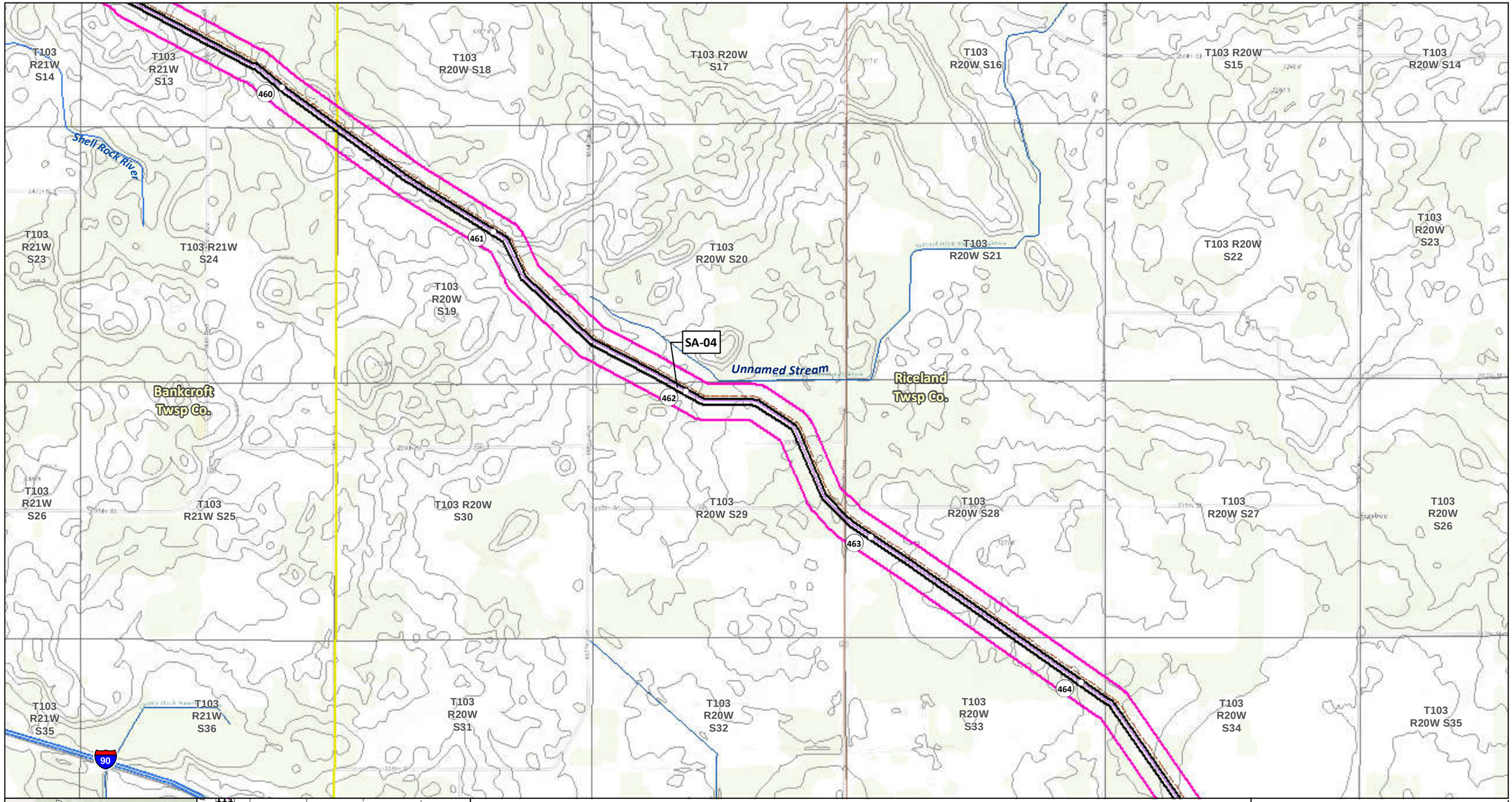
Data Sources:
MNDNR, NHD,USGS, Enbridge

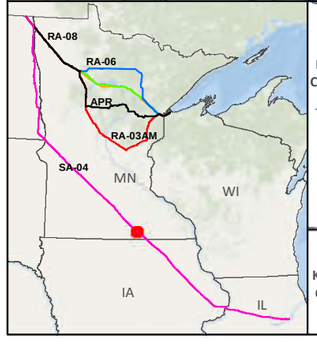
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

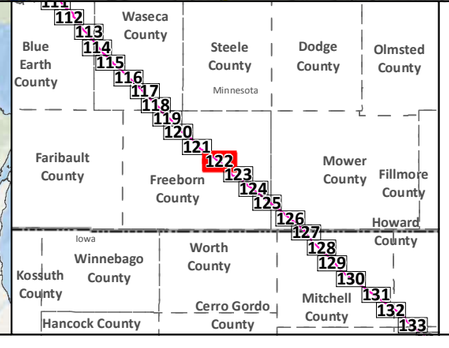
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 122A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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- National River Inventory Crossing
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Riceland Twsp Co.

Moscow Twsp Co.

Hayward Twsp Co.

Oakland Twsp Co.

Hayward Twsp Co.

465

466

467

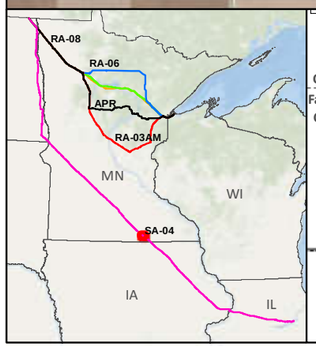
468

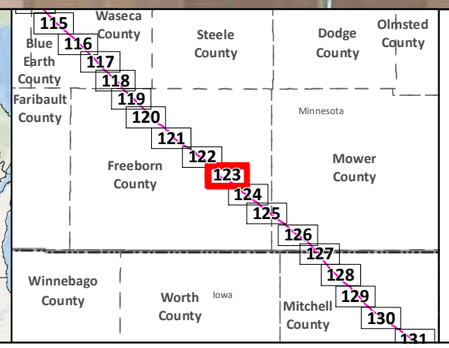
SA-04

90

46

Woodbury Creek





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

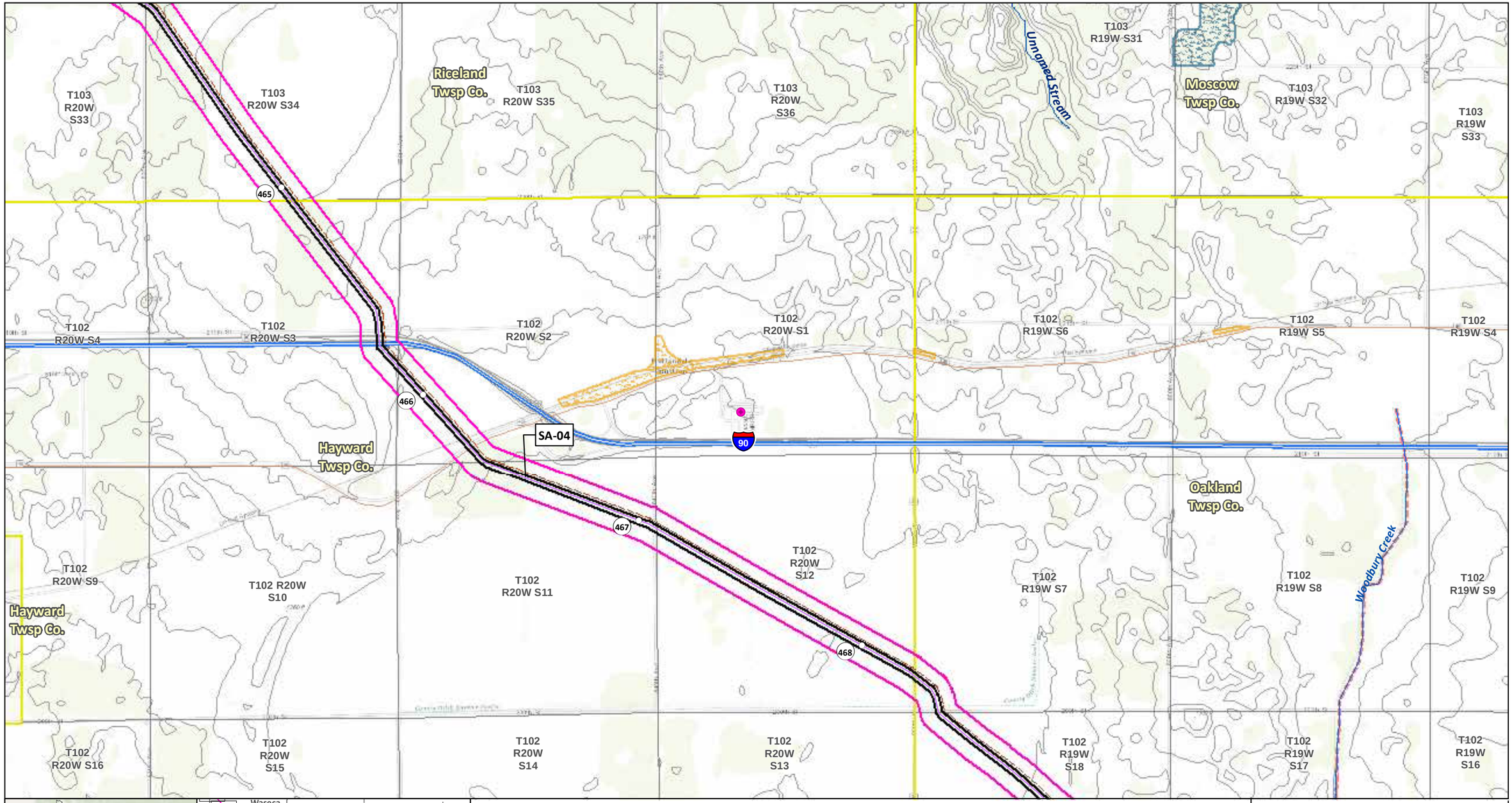
1:24,000

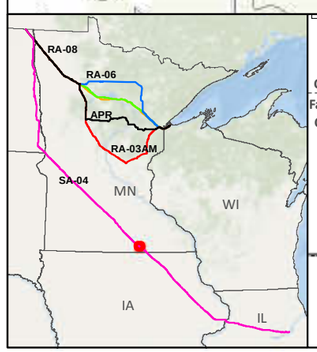
0 125 250 500 Meters

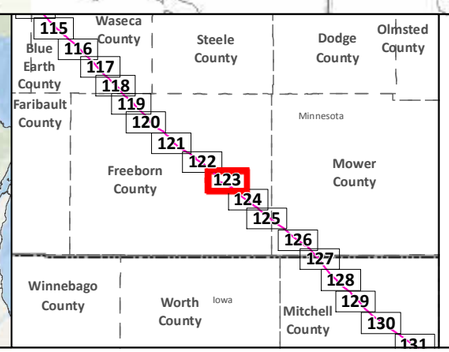
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 123A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
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- RA-08
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- High
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Native Plant Communities with Biodiversity Significance
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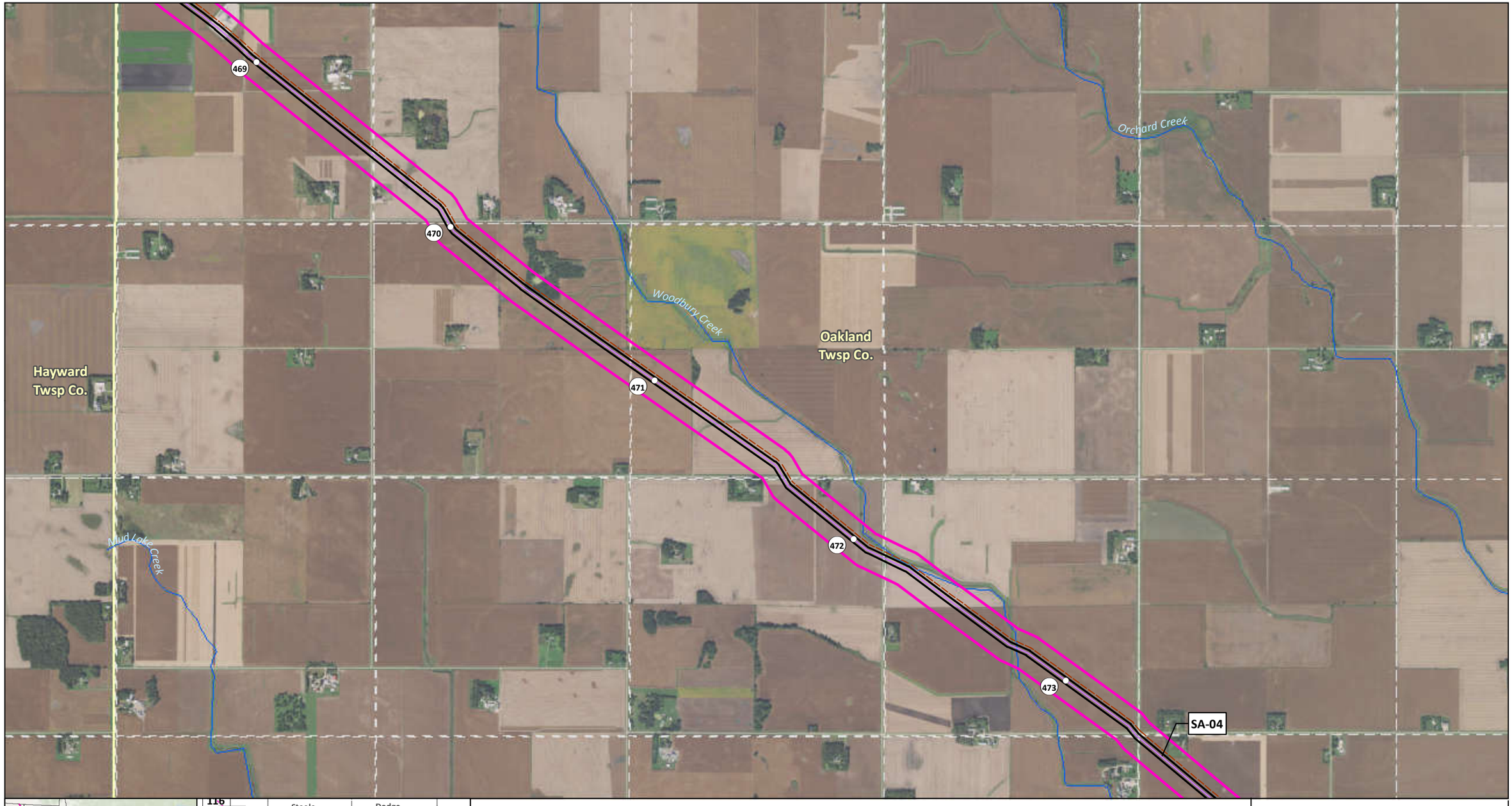
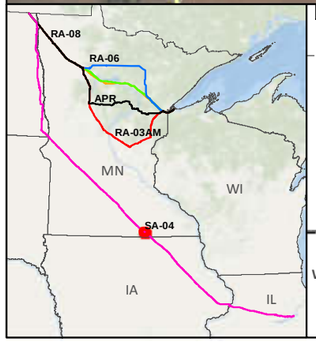
Data Sources: MNDNR, USGS, NHD, Enbridge

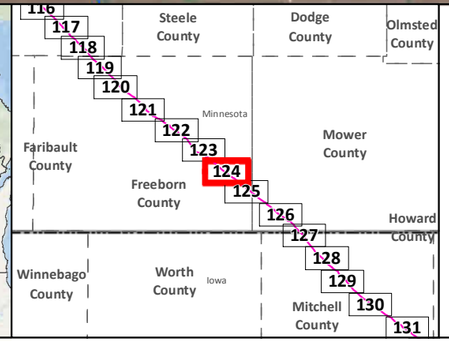
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

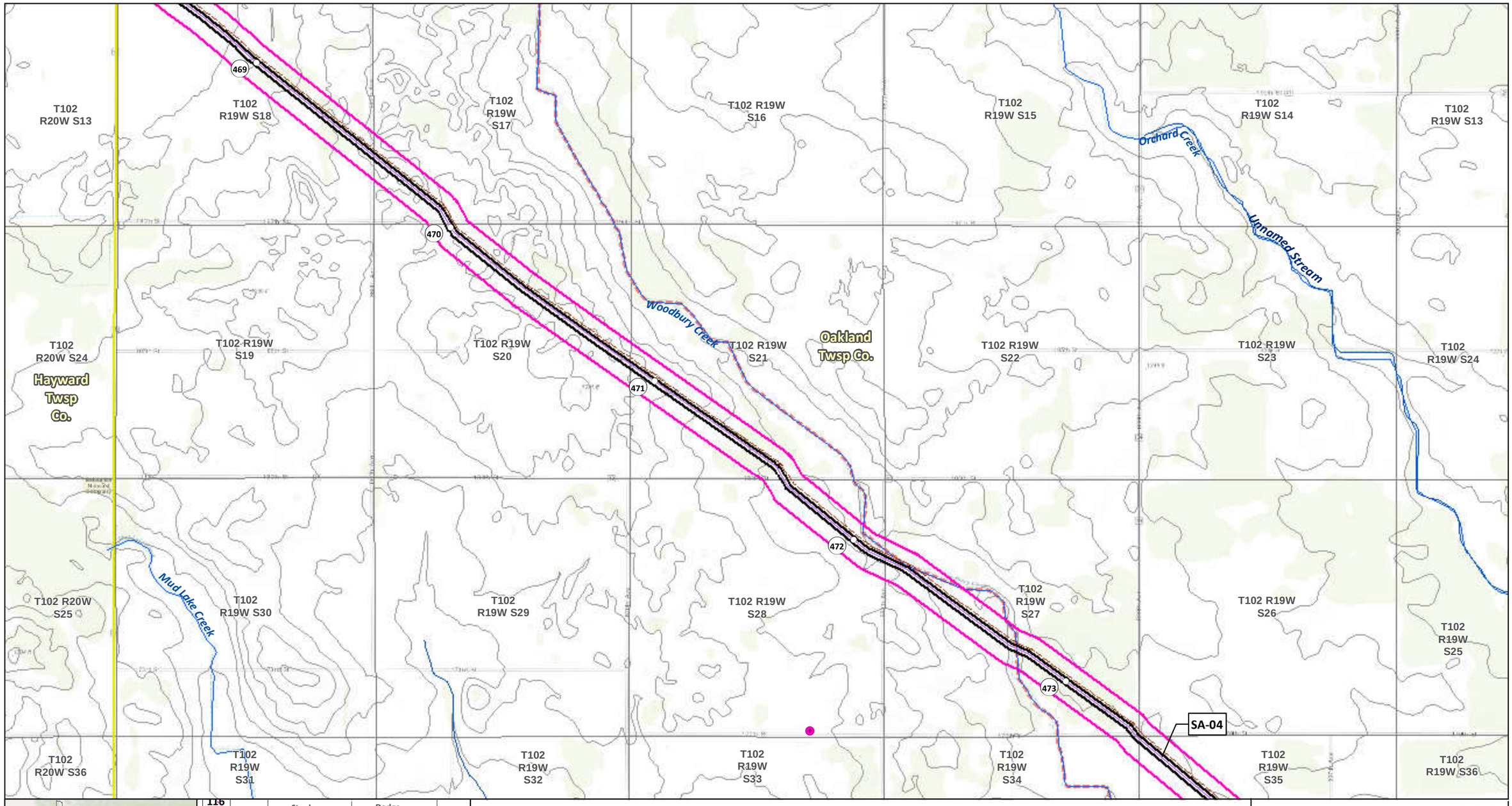
Data Sources:
MNDNR, NHD,USGS, Enbridge

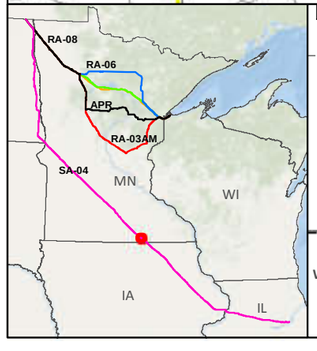
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

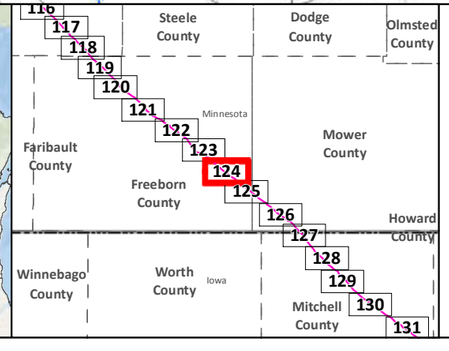
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 124A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
- RA-07
- RA-08
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- National River Inventory Crossing
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- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Oakland Twsp Co.

Austin Twsp Co.

London Twsp Co.

Lyle Twsp Co.

Mud Lake Creek

Woodbury Creek

Orchard Creek

474

475

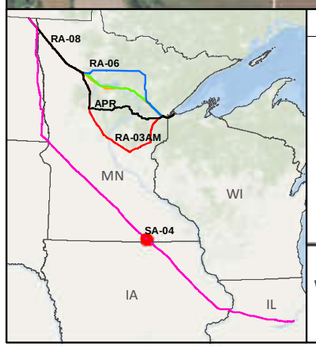
476

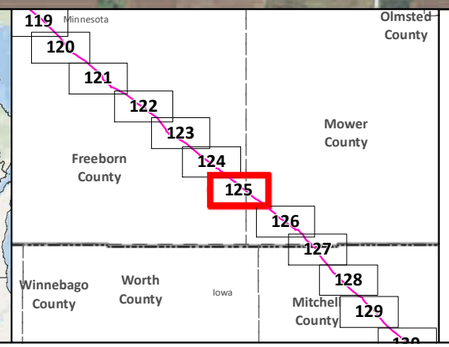
477

478

105

SA-04





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

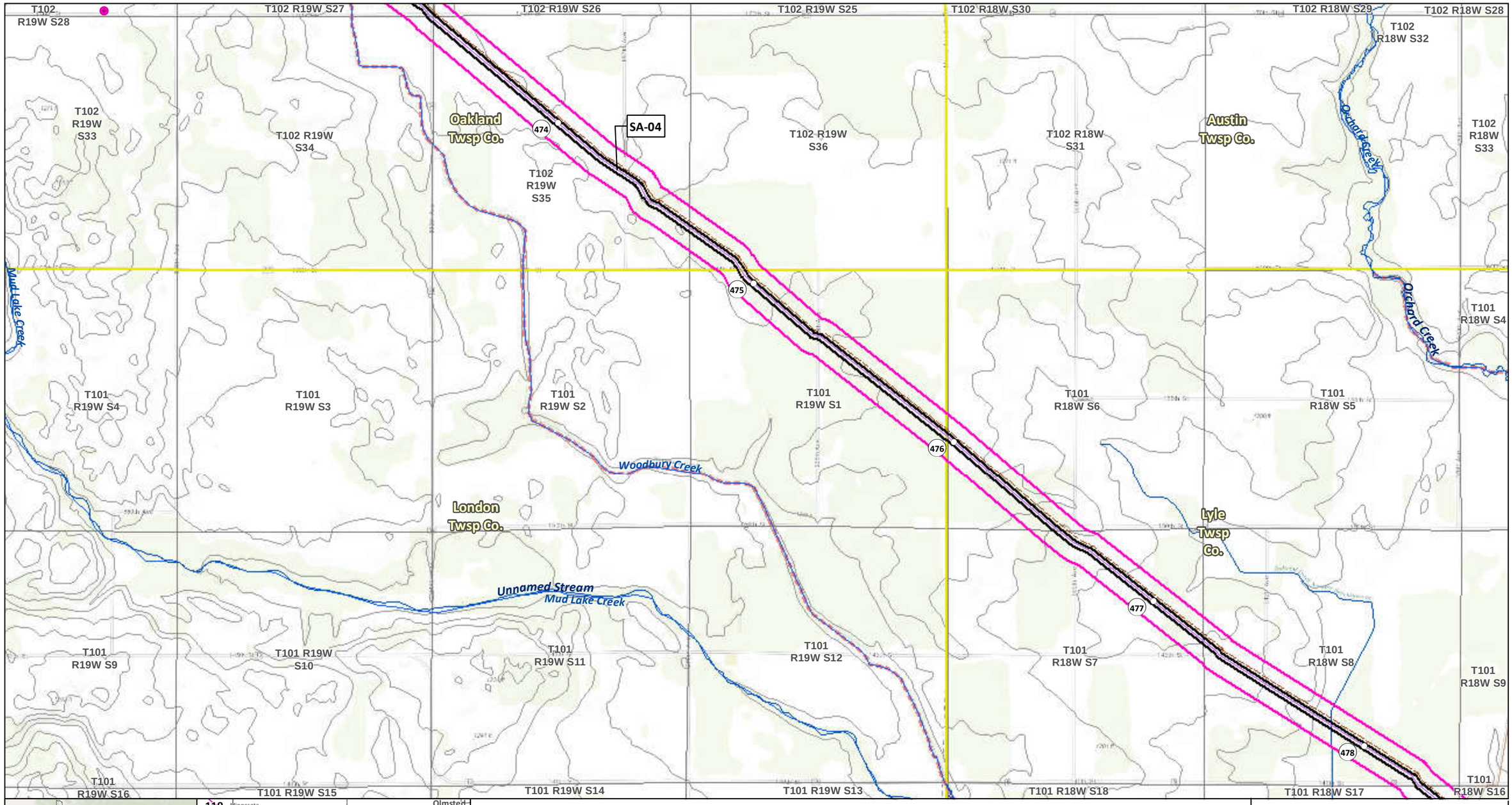
Data Sources: MNDNR, NHD,USGS, Enbridge

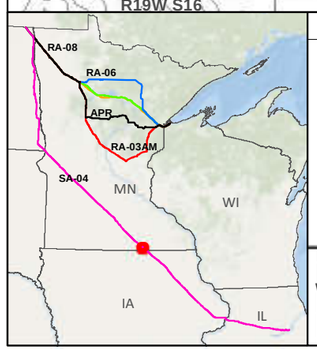
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

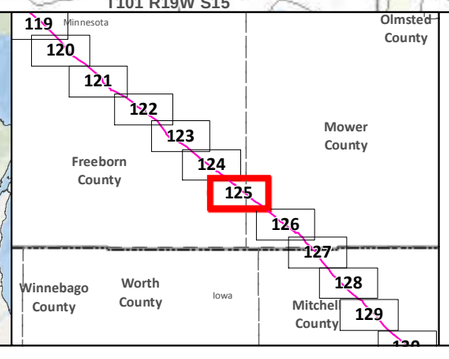
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 125A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

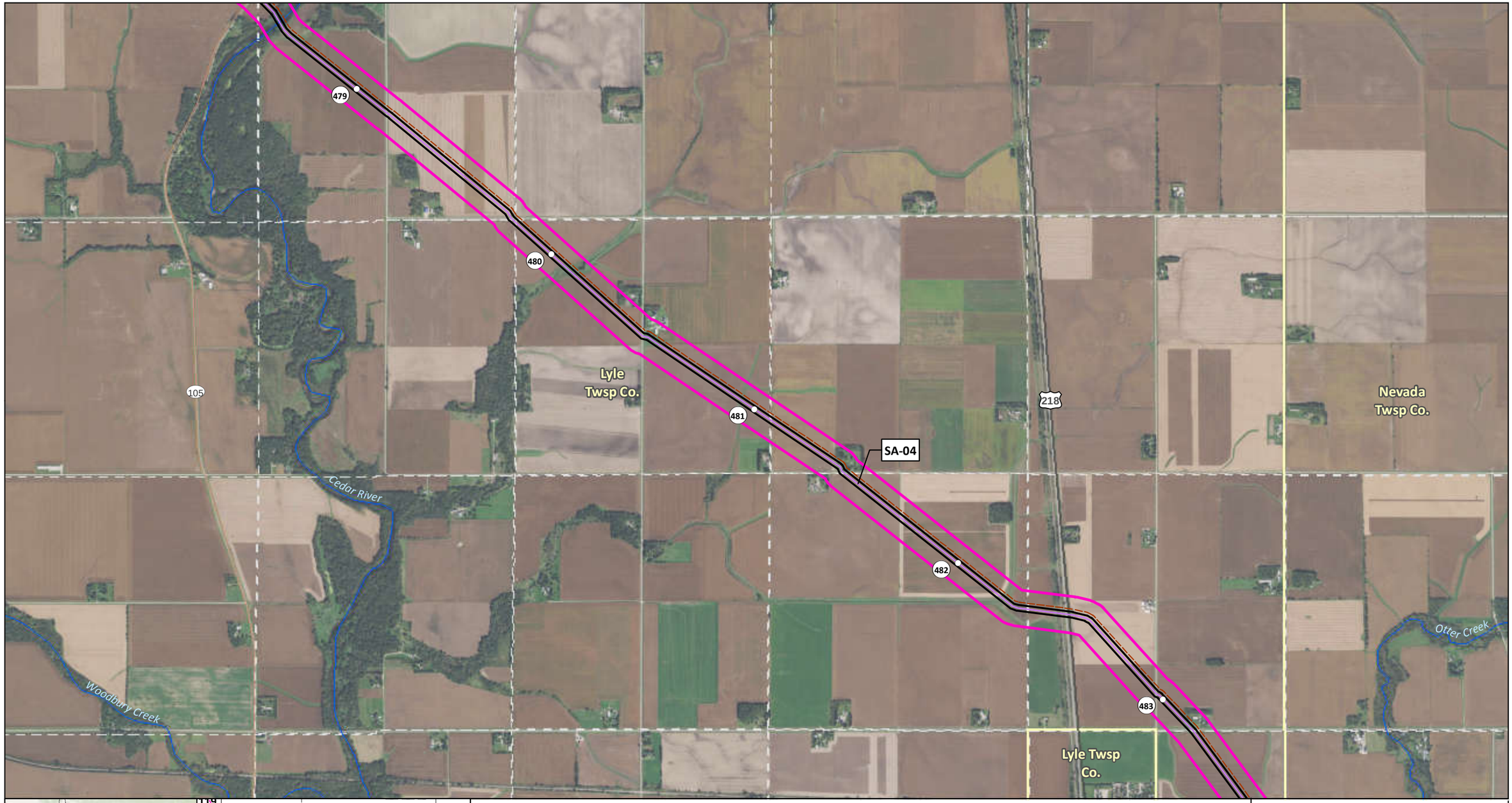
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

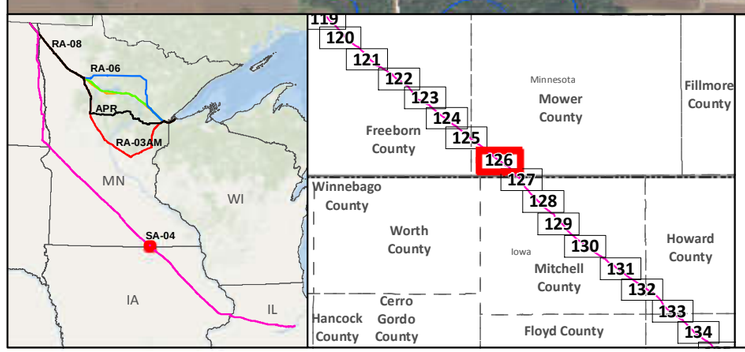
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 125B of 188





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
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Interstate
Highway
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Water Resources
Lake
River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources:
MNDNR, NHD,USGS, Enbridge

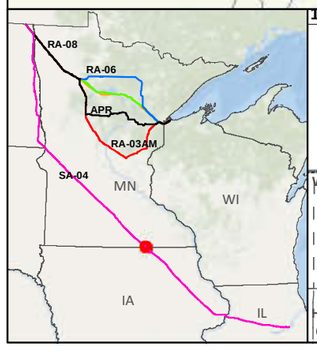
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

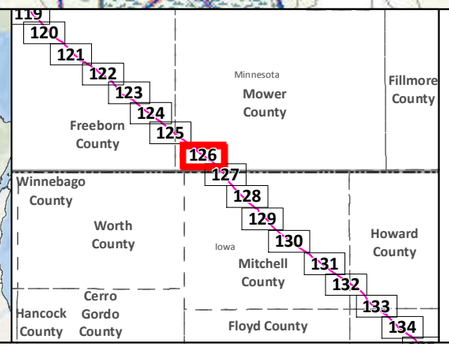
SA-04

Map 126A of 188

N

T101 R18W S17
T101 R18W S16
T101 R18W S15
T101 R18W S14
T101 R18W S13
T101 R17W S18
Red Cedar River WMA
479
480
481
482
483
T101 R18W S20
T101 R18W S21
T101 R18W S22
T101 R18W S23
T101 R18W S24
T101 R17W S19
105
218
Lyle Twsp Co.
Lyle-austin WMA
Nevada Twsp Co.
Cedar River
Unnamed Creek
T101 R18W S29
T101 R18W S28
T101 R18W S27
T101 R18W S26
T101 R18W S25
T101 R17W S30
Unnamed Stream
SA-04
Woodbury Creek
Otter Creek
T101 R18W S32
T101 R18W S33
T101 R18W S34
T101 R18W S35
T101 R18W S36
T101 R17W S31
Lyle Twsp Co.
Lyle WHPA





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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Township Boundary

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Native Plant Communities with Biodiversity Significance
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Data Sources: MNDNR, USGS, NHD, Enbridge

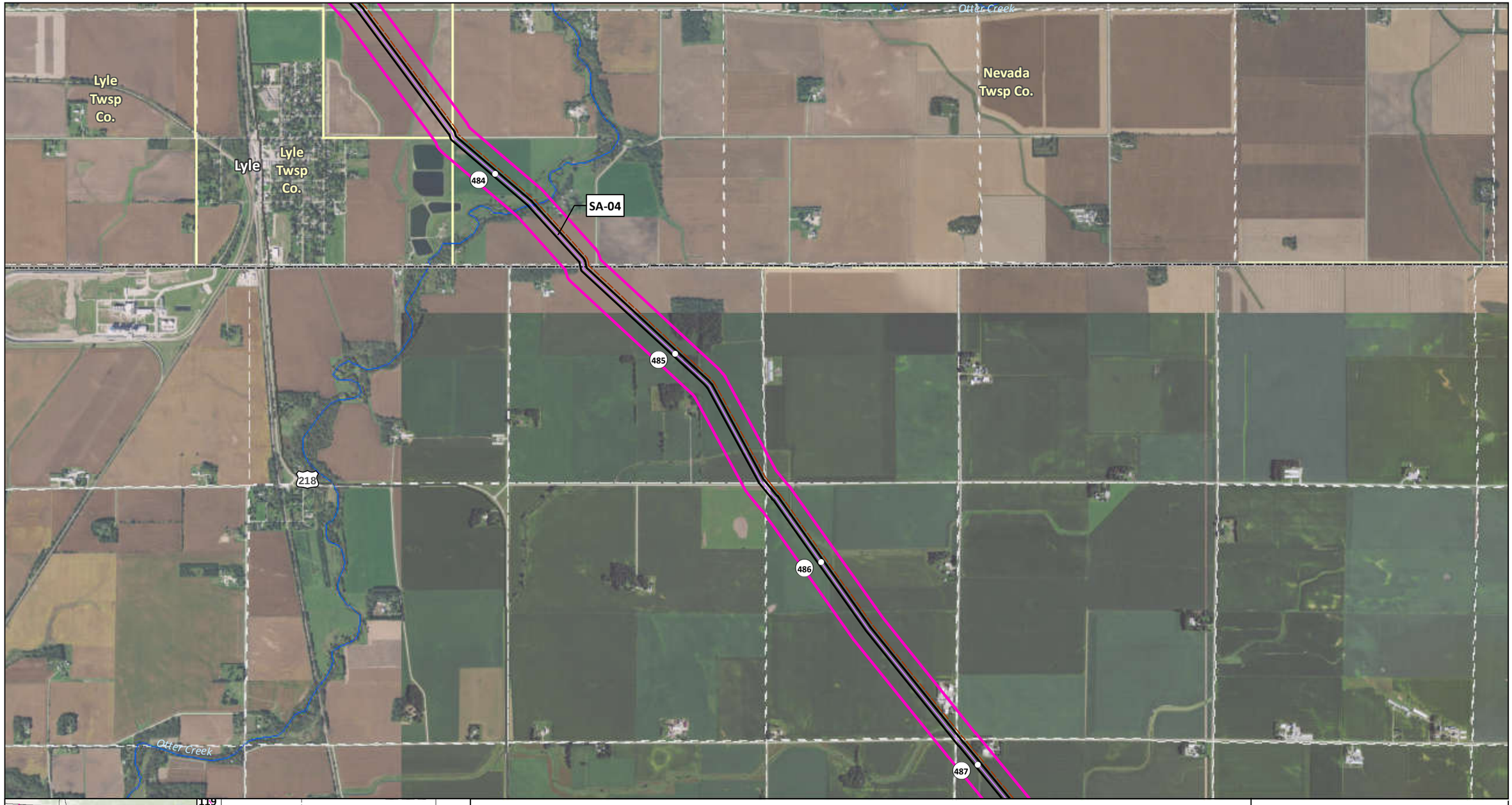
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

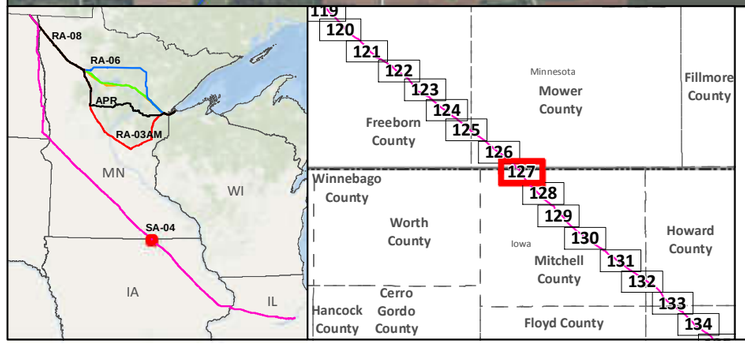
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 126B of 188





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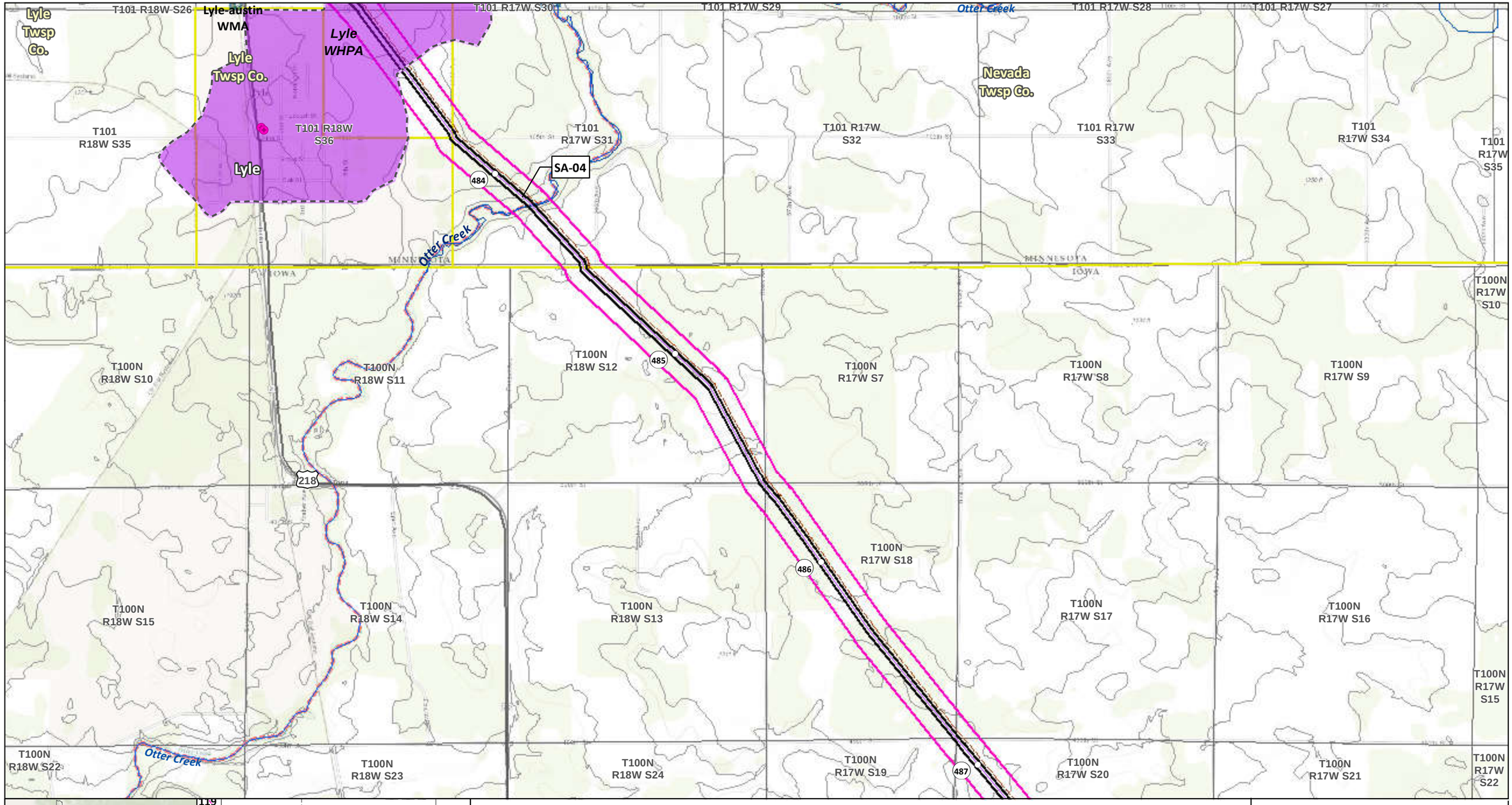
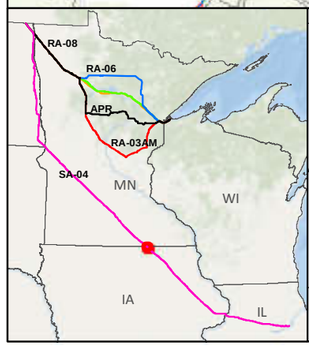
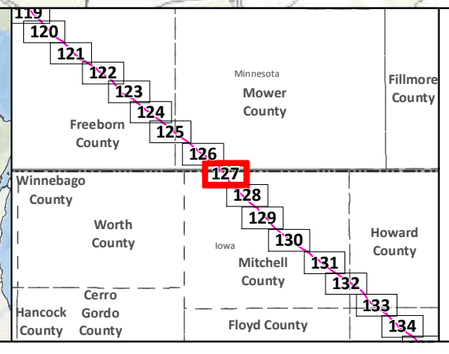
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

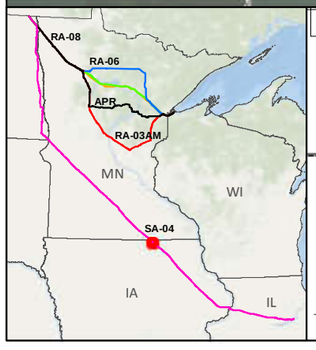
1:24,000

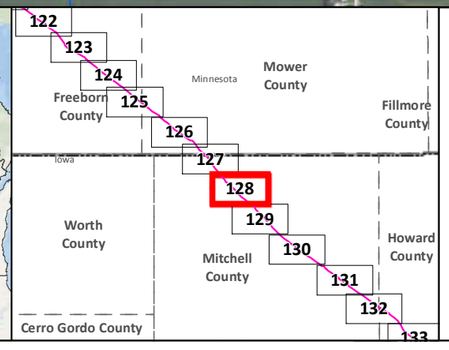
10ft Contours

N

Map 127B of 188

488
489
490
491
Turtle Creek
465th
Main
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

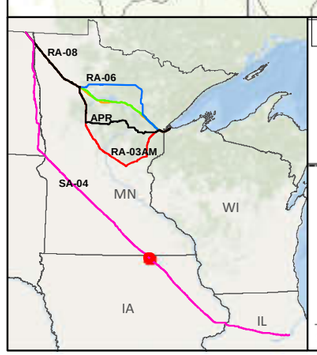
SA-04

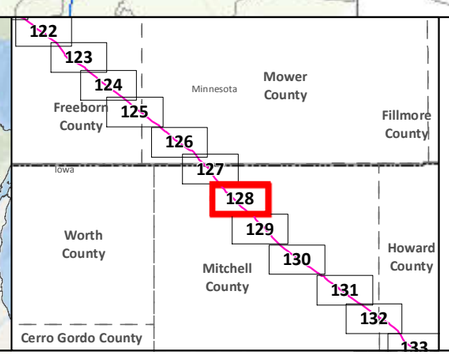
T100N R17W S19
T100N R17W S20
T100N R17W S21
T100N R17W S22
T100N R17W S23
T100N R17W S24
T100N R16W S19
T100N R17W S30
T100N R17W S29
T100N R17W S28
T100N R17W S27
T100N R17W S26
T100N R17W S25
T100N R16W S30
T100N R17W S31
T100N R17W S32
T100N R17W S33
T100N R17W S34
T100N R17W S35
T100N R17W S36
T100N R16W S31
T99N R17W S6
T99N R17W S5
T99N R17W S4
T99N R17W S3
T99N R17W S2
T99N R17W S1
T99N R16W S6

488
489
490
491

Turtle Creek

SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
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National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

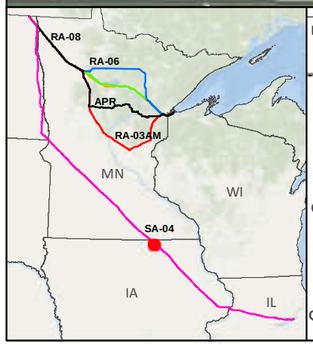
SA-04

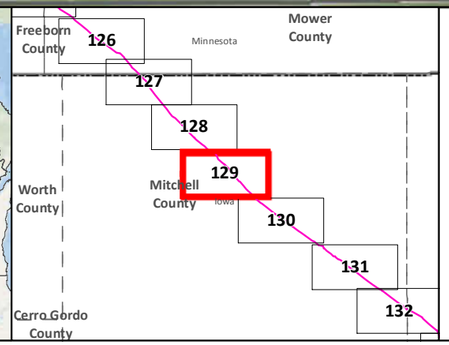
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 128B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

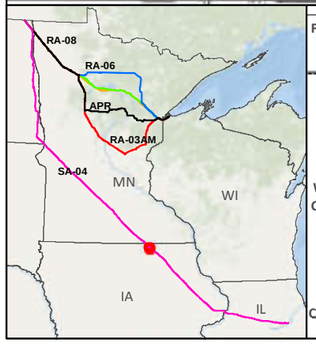
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

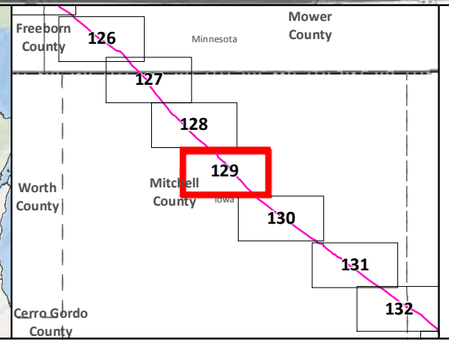
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 129A of 188

T99N R17W S4
T99N R17W S3
T99N R17W S2
T99N R17W S1
T99N R16W S6
T99N R16W S5
T99N R16W S4
T99N R17W S9
T99N R17W S10
T99N R17W S11
T99N R17W S12
T99N R16W S7
T99N R16W S8
T99N R16W S9
T99N R17W S16
T99N R17W S15
T99N R17W S14
T99N R17W S13
T99N R16W S18
T99N R16W S17
T99N R16W S16
T99N R17W S21
T99N R17W S22
T99N R17W S23
T99N R17W S24
T99N R16W S19
T99N R16W S20
T99N R16W S21
492
493
494
495
496
227
SA-04
Little Cedar River
Burr Oak Creek





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

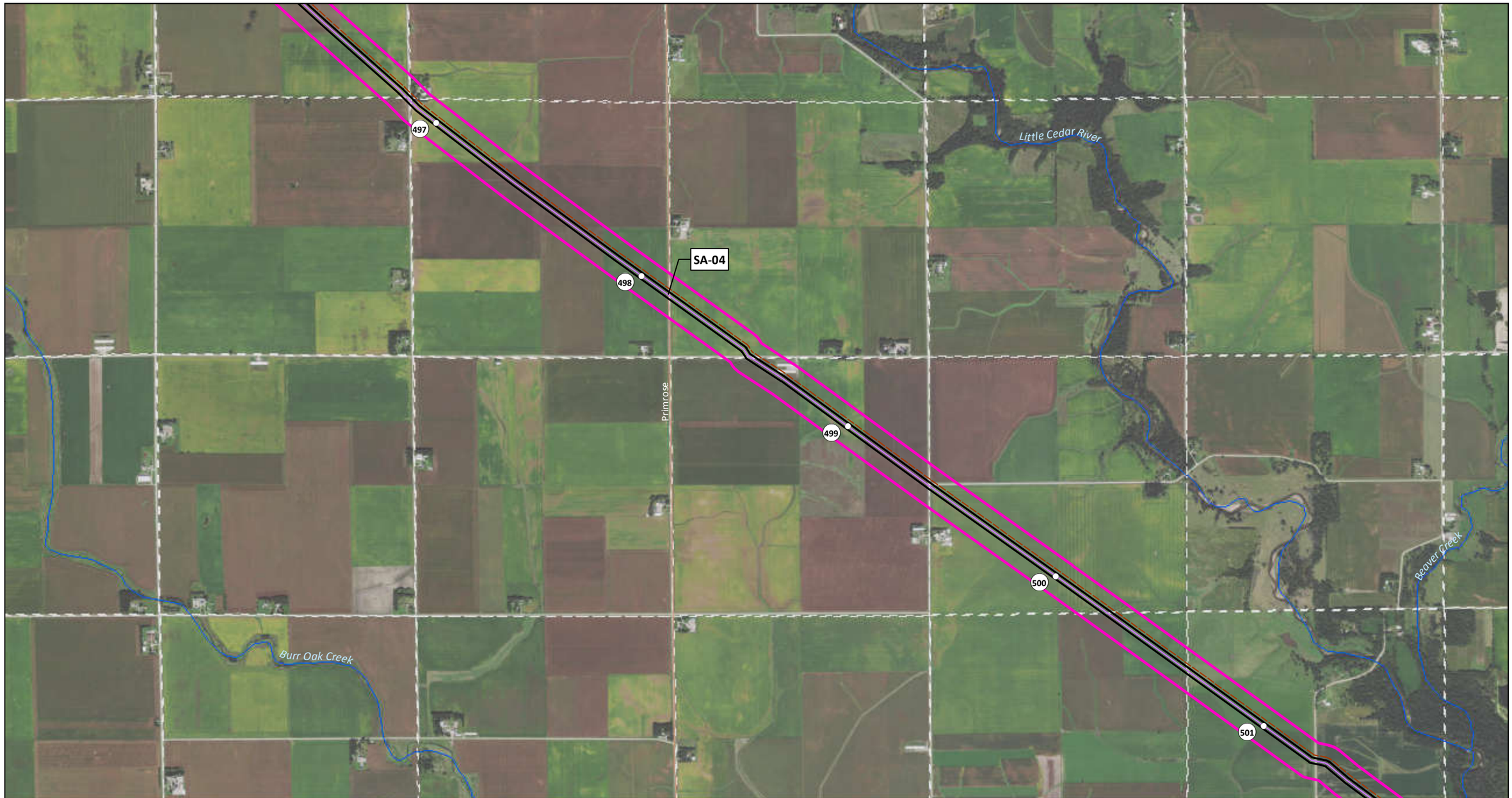
Data Sources: MNDNR, USGS, NHD, Enbridge

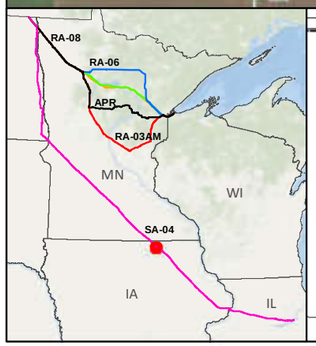
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

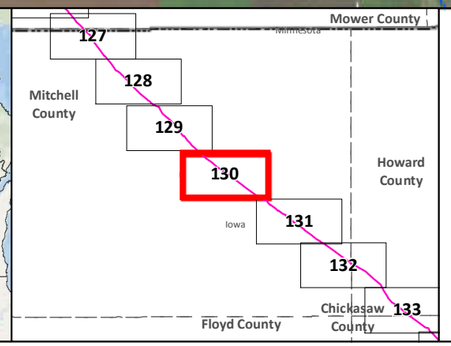
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

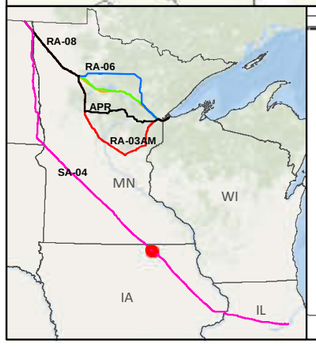
Map 130A of 188

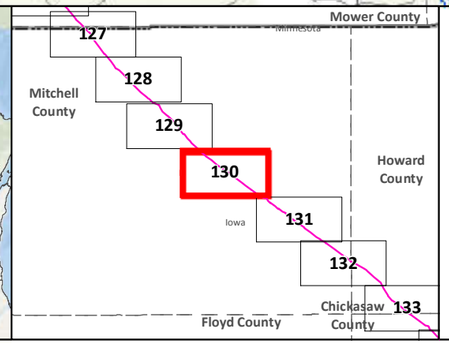
T99N R16W S19
T99N R16W S20
T99N R16W S21
T99N R16W S22
T99N R16W S23
T99N R16W S24
T99N R15W S19
T99N R16W S30
T99N R16W S29
T99N R16W S28
T99N R16W S27
T99N R16W S26
T99N R16W S25
T99N R15W S30
T99N R16W S31
T99N R16W S32
T99N R16W S33
T99N R16W S34
T99N R16W S35
T99N R16W S36
T99N R15W S31
T98N R16W S6
T98N R16W S5
T98N R16W S4
T98N R16W S3
T98N R16W S2
T98N R16W S1
T98N R15W S6

497
498
499
500
501

SA-04

Little Cedar River
Beaver Creek
Burr Oak Creek





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

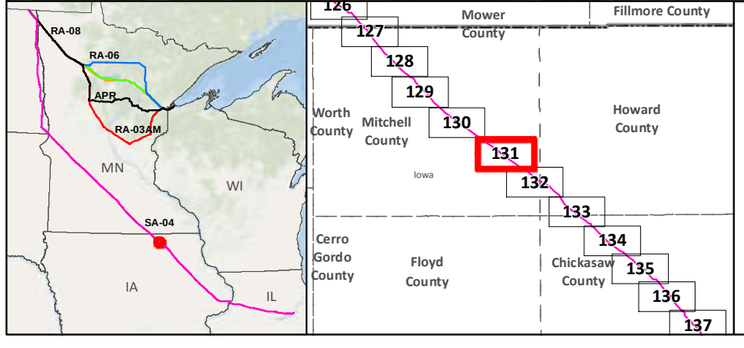
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 130B of 188





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

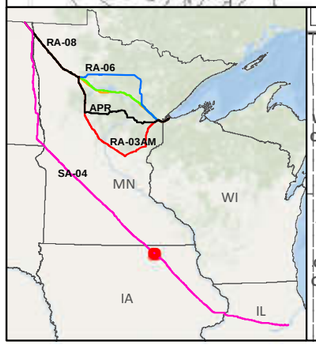
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

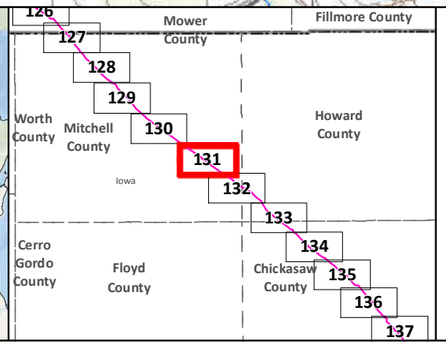
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 131A of 188

T98N R16W S1
T98N R15W S6
T98N R15W S5
T98N R15W S4
T98N R15W S3
T98N R15W S2
T98N R15W S1
T98N R16W S12
T98N R15W S7
T98N R15W S8
T98N R15W S9
T98N R15W S10
T98N R15W S11
T98N R15W S12
Burr Oak Creek
Little Cedar River
T98N R16W S13
T98N R15W S18
T98N R15W S17
T98N R15W S16
T98N R15W S15
T98N R15W S14
T98N R15W S13
T98N R16W S24
T98N R15W S19
T98N R15W S20
T98N R15W S21
T98N R15W S22
T98N R15W S23
T98N R15W S24
502
503
504
505
506
9
SA-04





SA-04
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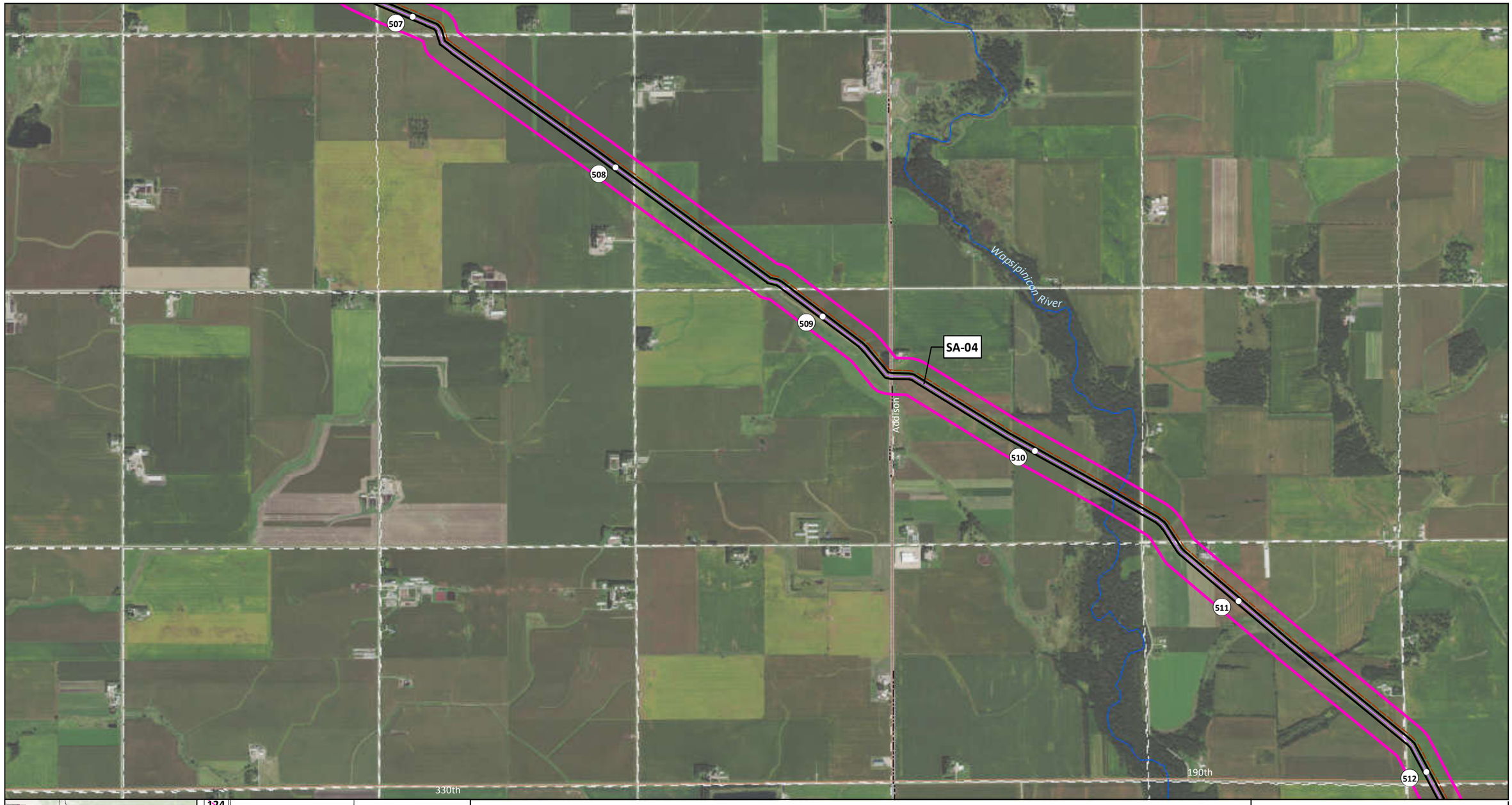
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

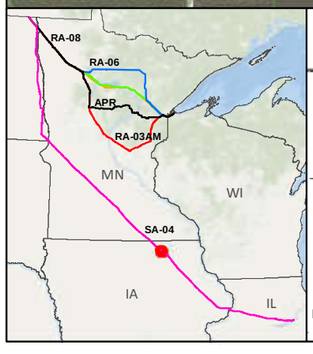
SA-04

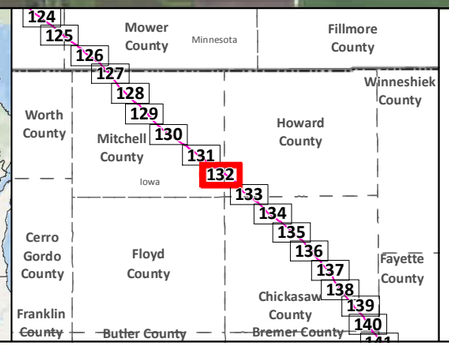
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 131B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

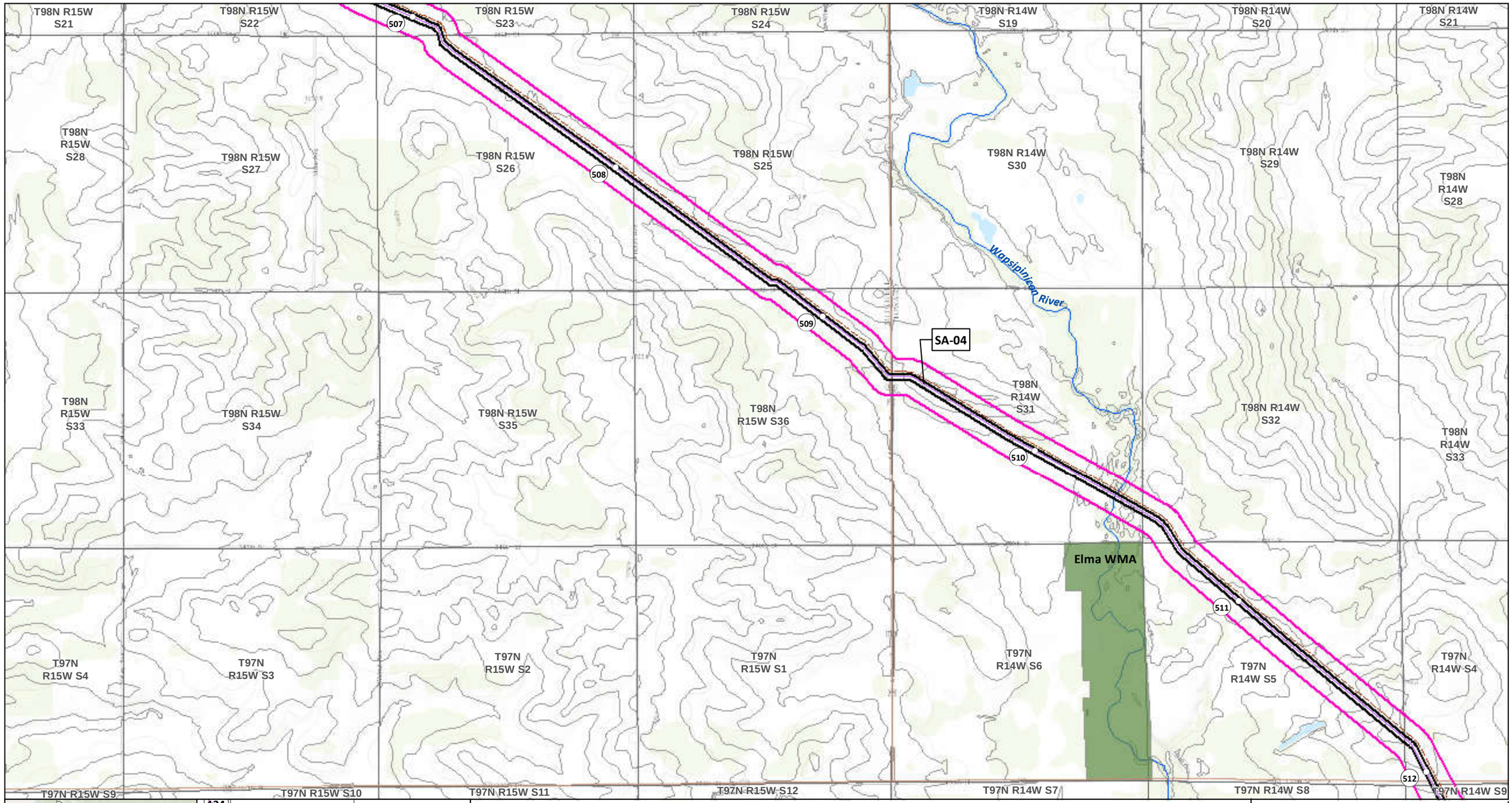
Data Sources:
MNDNR, NHD,USGS, Enbridge

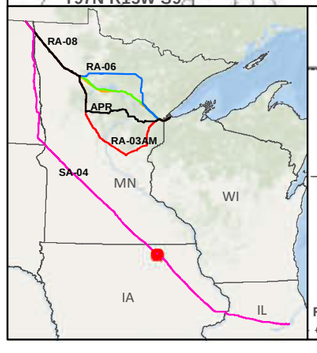
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

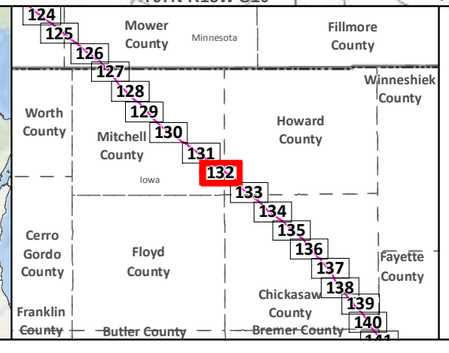
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 132A of 188







SA-04
Applicant's Preferred Route (APR)

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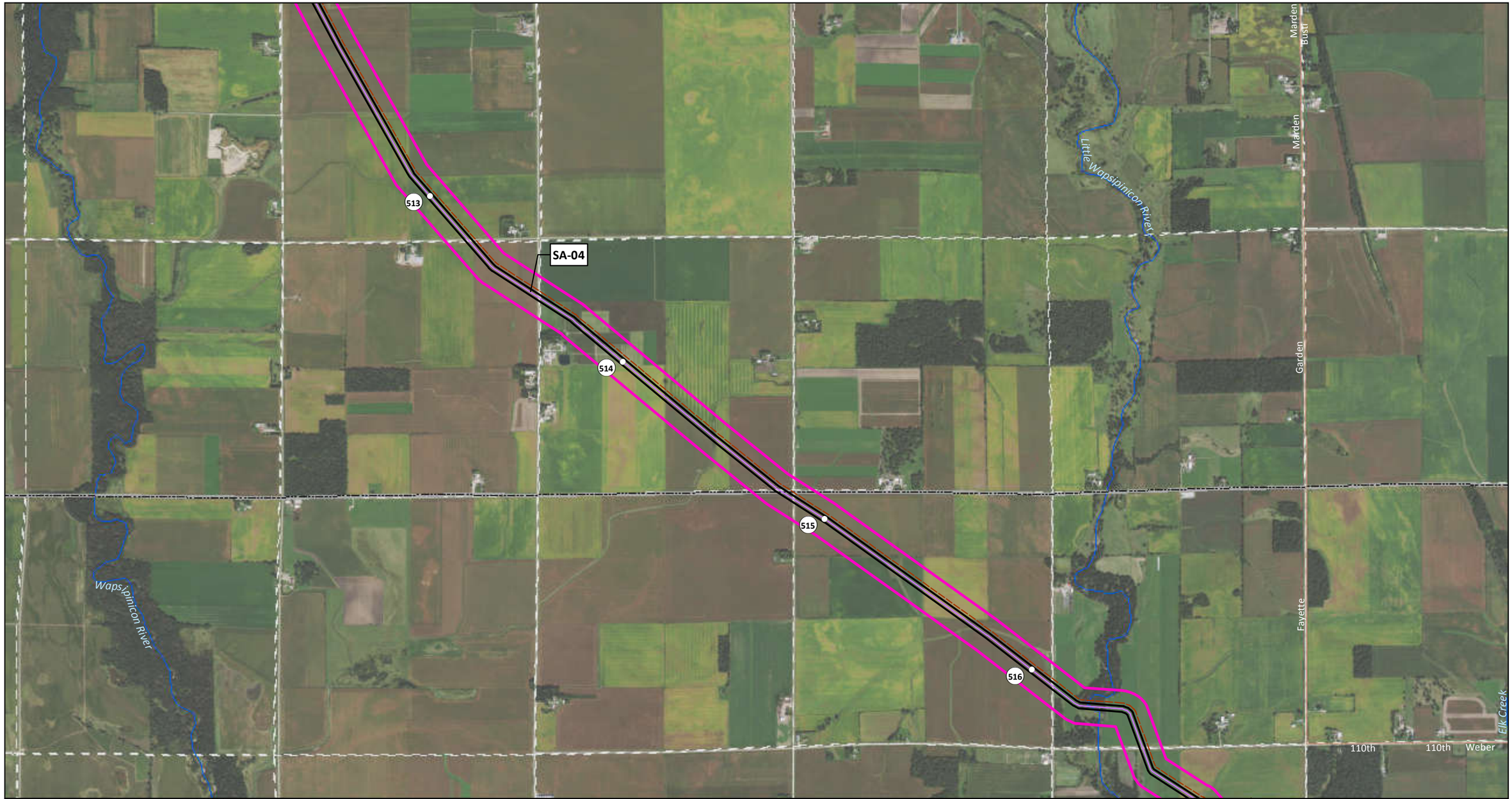
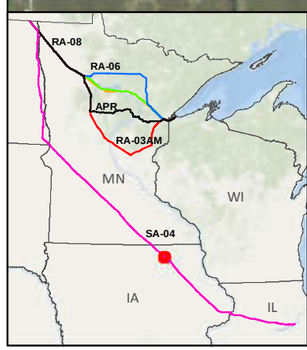
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

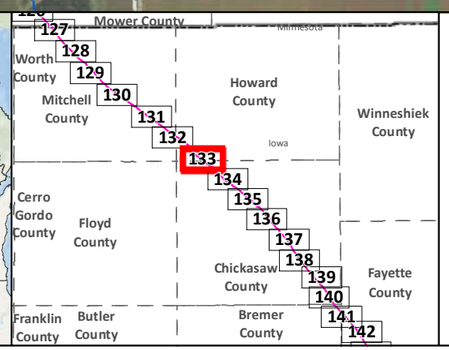
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 132B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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Lake
River

Data Sources:
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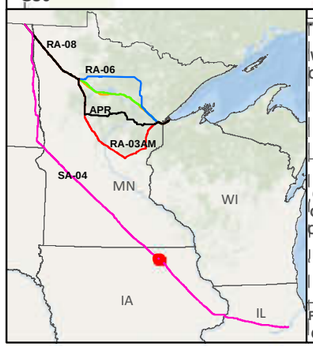
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

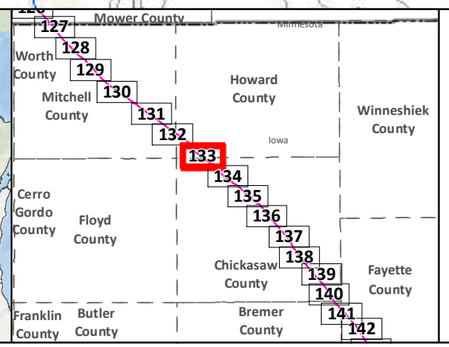
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 133A of 188

T97N R14W S8
T97N R14W S9
T97N R14W S10
T97N R14W S11
Little Wapsi River WMA
T97N R14W S12
T97N R13W S7
T97N R14W S7
Little Wapsipinicon River
513
T97N R14W S18
T97N R14W S17
T97N R14W S16
514
T97N R14W S15
T97N R14W S14
T97N R14W S13
T97N R13W S18
T97N R14W S19
515
SA-04
T97N R14W S20
Wapsipinicon River
T97N R14W S21
T97N R14W S22
T97N R14W S23
516
T97N R14W S24
T97N R13W S19
Elk Creek
T97N R14W S30
T97N R14W S29
T97N R14W S28
T97N R14W S27
T97N R14W S26
T97N R14W S25
T97N R13W S30





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

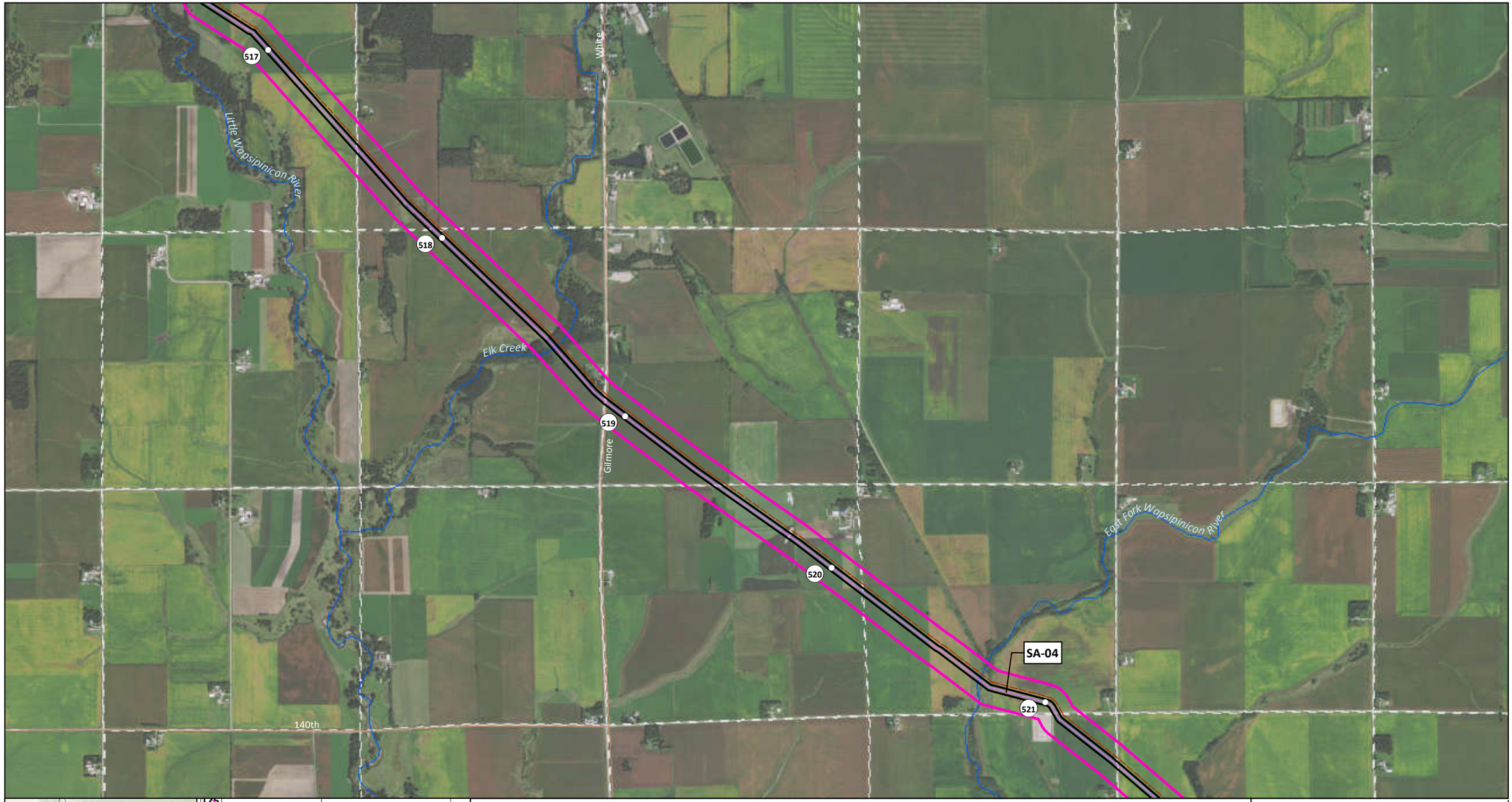
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

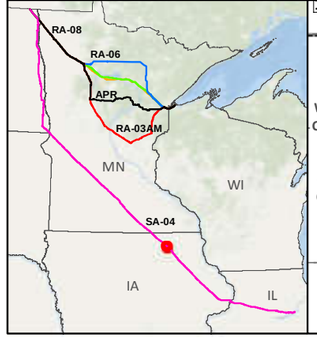
SA-04

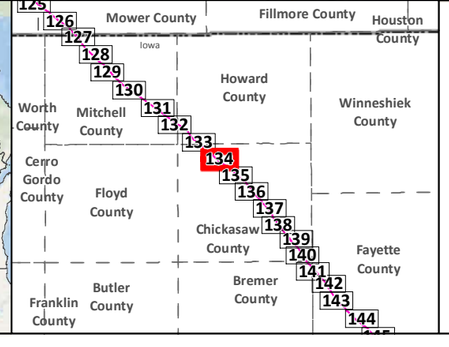
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 133B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

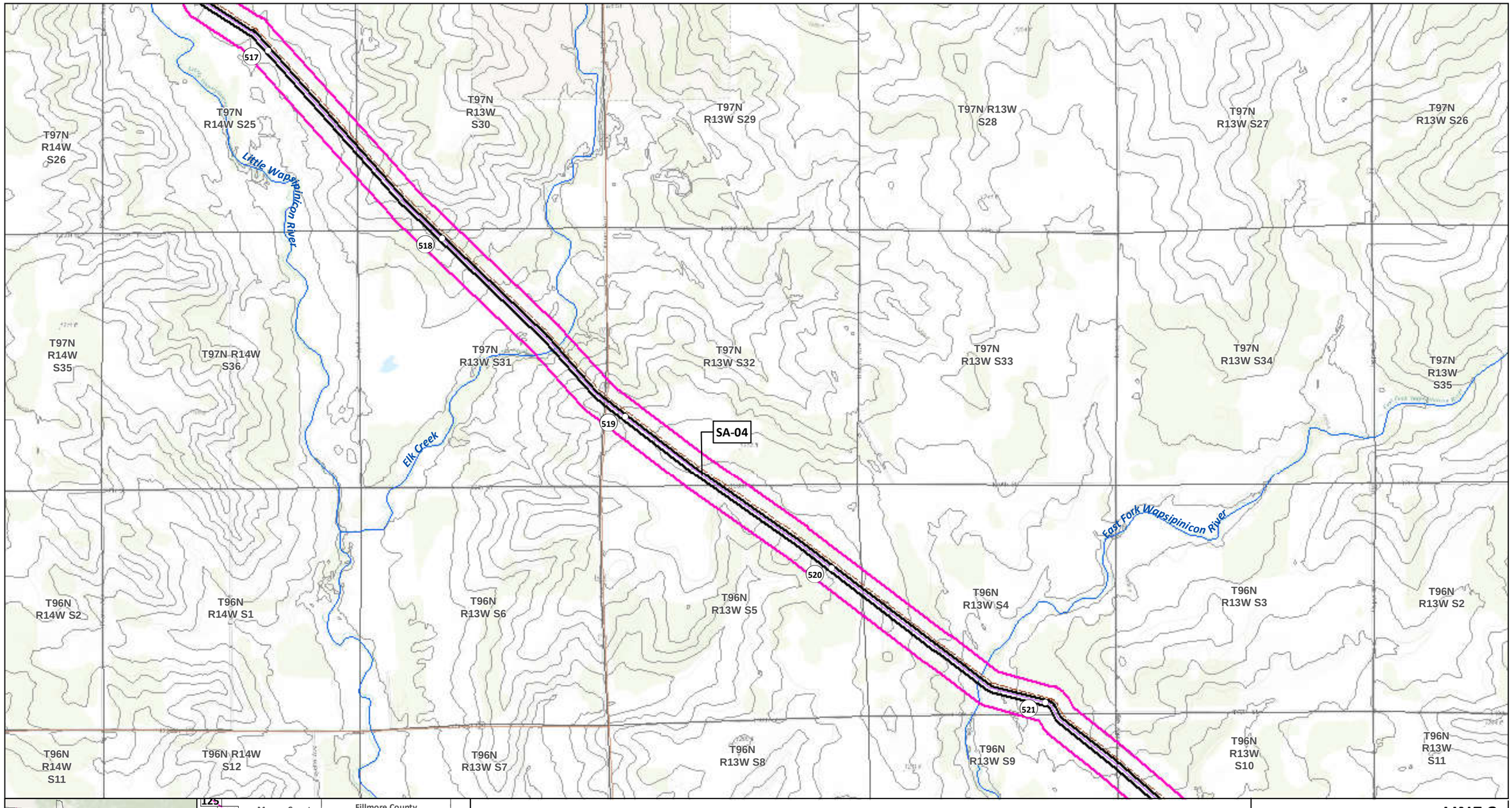
Water Resources
Lake
River

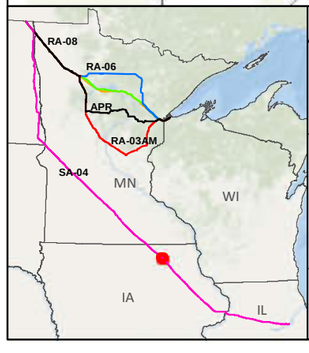
Data Sources:
MNDNR, NHD,USGS, Enbridge

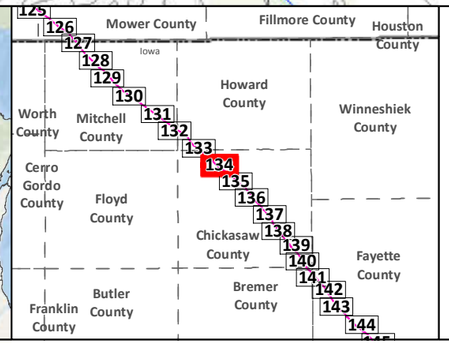
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

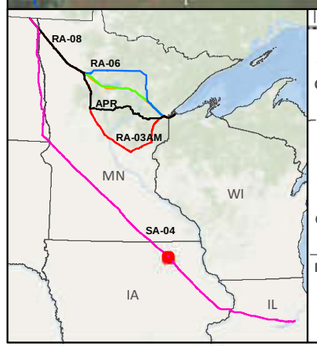
0 0.125 0.25 0.5 Miles

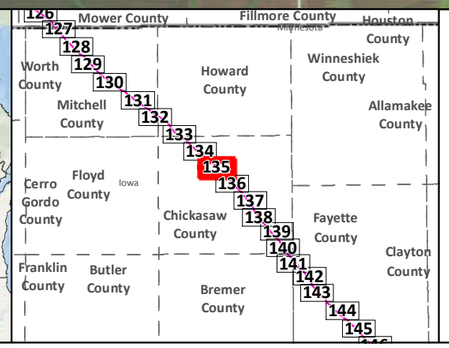
1:24,000

0 125 250 500 Meters

10ft Contours

522
523
524
525
526
63
SA-04
East Fork Wapsipinicon River





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

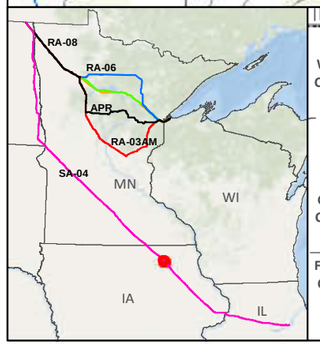
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

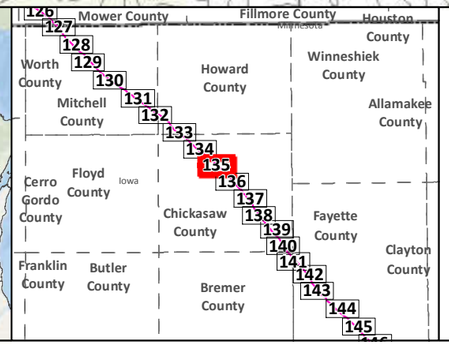
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 135A of 188

T96N R13W S8
T96N R13W S9
T96N R13W S10
T96N R13W S11
T96N R13W S12
T96N R12W S7
T96N R12W S8
522
523
524
525
526
63
T96N R13W S17
T96N R13W S16
T96N R13W S15
T96N R13W S14
T96N R13W S13
T96N R12W S18
T96N R12W S17
T96N R13W S20
T96N R13W S21
T96N R13W S22
T96N R13W S23
T96N R13W S24
T96N R12W S19
T96N R12W S20
T96N R13W S29
T96N R13W S28
T96N R13W S27
T96N R13W S26
T96N R13W S25
T96N R12W S30
T96N R12W S29
East Fork Wapsipinicon River
SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

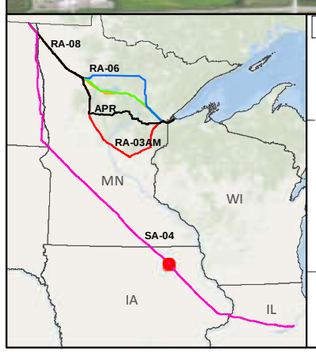
SA-04

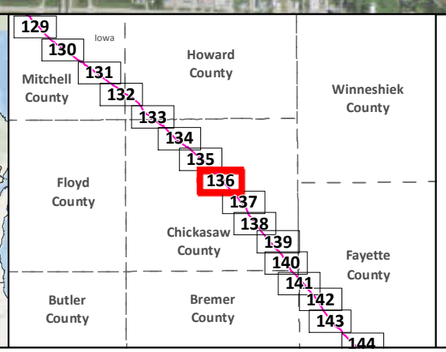
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 135B of 188

526
527
528
529
63
SA-04
East Fork Wapsipinicon River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 136A of 188

T96N R13W S26
T96N R13W S25
T96N R12W S30
T96N R12W S29
T96N R12W S28
T96N R12W S27
T96N R12W S26
T96N R13W S35
T96N R13W S36
T96N R12W S31
T96N R12W S32
T96N R12W S33
T96N R12W S34
T96N R12W S35
T95N R13W S2
T95N R13W S1
T95N R12W S6
T95N R12W S5
T95N R12W S4
T95N R12W S3
T95N R12W S2
T95N R13W S12
T95N R12W S7
T95N R12W S8
T95N R12W S9
T95N R12W S10
T95N R12W S11

526
527
528
529
63

East Fork Wapsipinicon River

SA-04

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

129
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132
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143
144

Iowa
Howard County
Winneshiek County
Mitchell County
Floyd County
Chickasaw County
Fayette County
Butler County
Bremer County

SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
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National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
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Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources:
MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

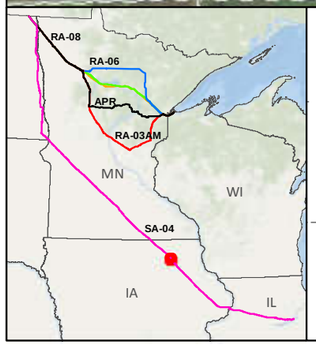
SA-04

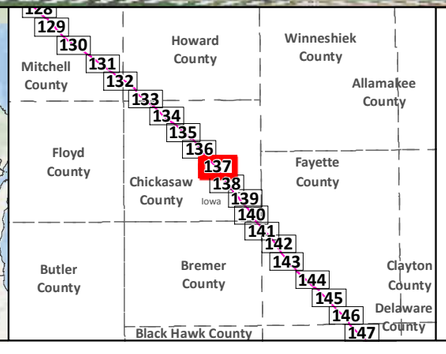
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 136B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 137A of 188

T95N R12W S5 | T95N R12W S4 | T95N R12W S3 | T95N R12W S2 | T95N R12W S1 | T95N R11W S6 | T95N R11W S5

T95N R12W S8 | T95N R12W S9 | T95N R12W S10 | T95N R12W S11 | T95N R12W S12 | T95N R11W S7 | T95N R11W S8

T95N R12W S17 | T95N R12W S16 | T95N R12W S15 | T95N R12W S14 | T95N R12W S13 | T95N R11W S18 | T95N R11W S17

T95N R12W S20 | T95N R12W S21 | T95N R12W S22 | T95N R12W S23 | T95N R12W S24 | T95N R11W S19 | T95N R11W S20

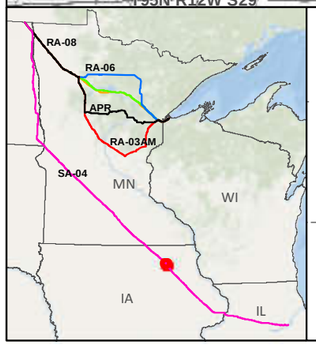
T95N R12W S29 | T95N R12W S28 | T95N R12W S27 | T95N R12W S26 | T95N R12W S25 | T95N R11W S30 | T95N R11W S29

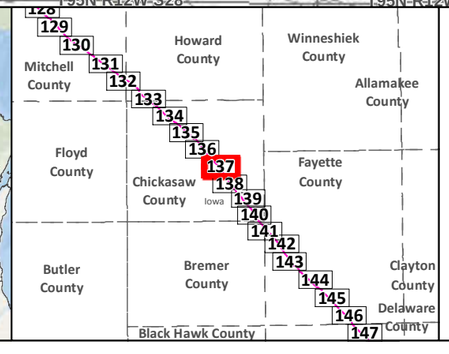
530 531 532 533 24

SA-04

Simpson Creek

East Fork Wapsipinicon River





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post

Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

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- Wildlife Refuge Inventory
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Water Resources

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- National River Inventory Crossing
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- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
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Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

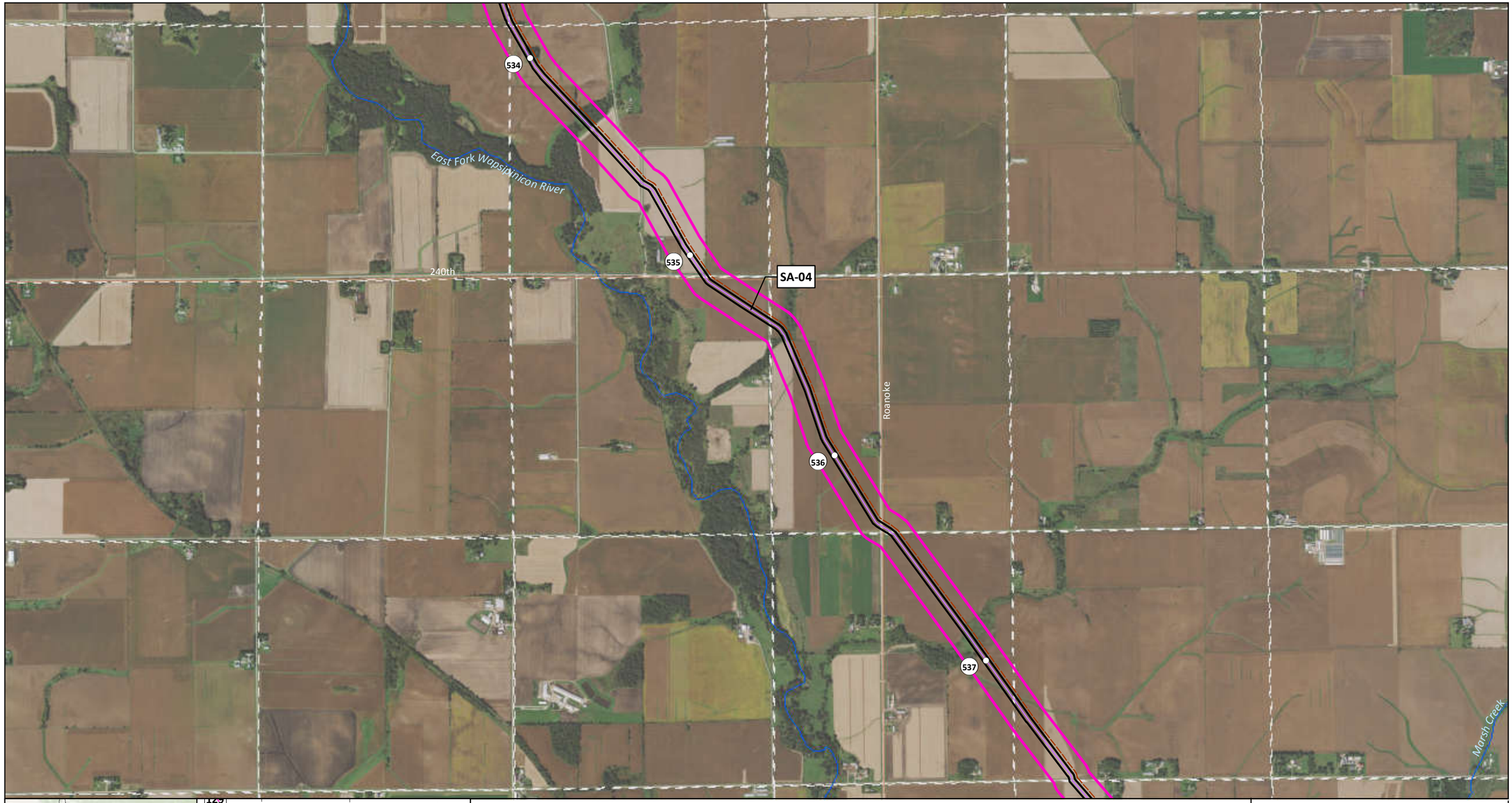
0 125 250 500 Meters

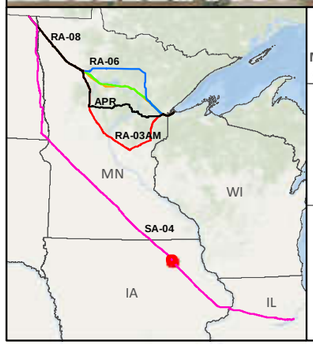
1:24,000

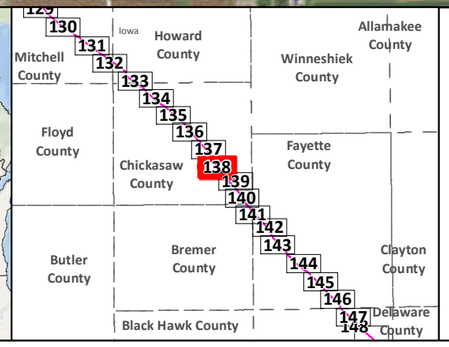
10ft Contours

N

Map 137B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

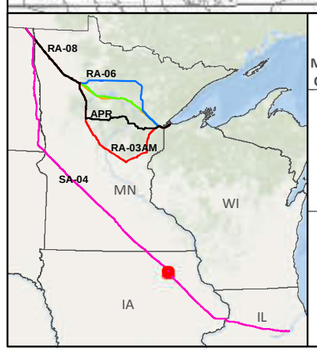
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

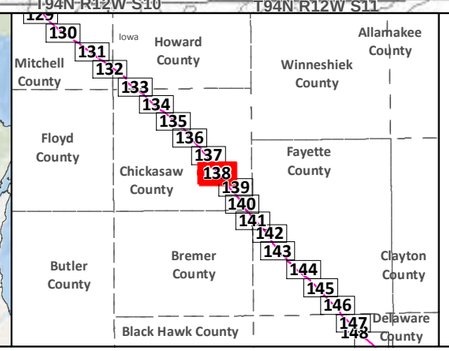
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 138A of 188

T95N R12W S22
T95N R12W S23
T95N R12W S24
T95N R11W S19
T95N R11W S20
T95N R11W S21
T95N R12W S27
T95N R12W S26
East Fork Wapsipinicon River
T95N R12W S25
T95N R11W S30
T95N R11W S29
T95N R11W S28
534
535
SA-04
536
T95N R12W S34
T95N R12W S35
T95N R12W S36
T95N R11W S31
T95N R11W S32
T95N R11W S33
537
T94N R12W S3
T94N R12W S2
T94N R12W S1
T94N R11W S6
T94N R11W S5
T94N R11W S4
Marsh Creek
T94N R12W S10
T94N R12W S11
T94N R12W S12
T94N R11W S7
T94N R11W S8
T94N R11W S9





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

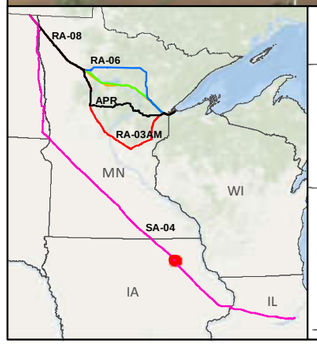
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

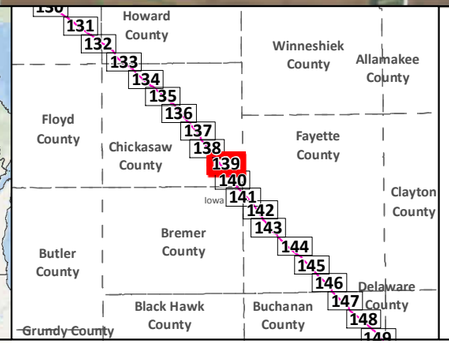
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 138B of 188







SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

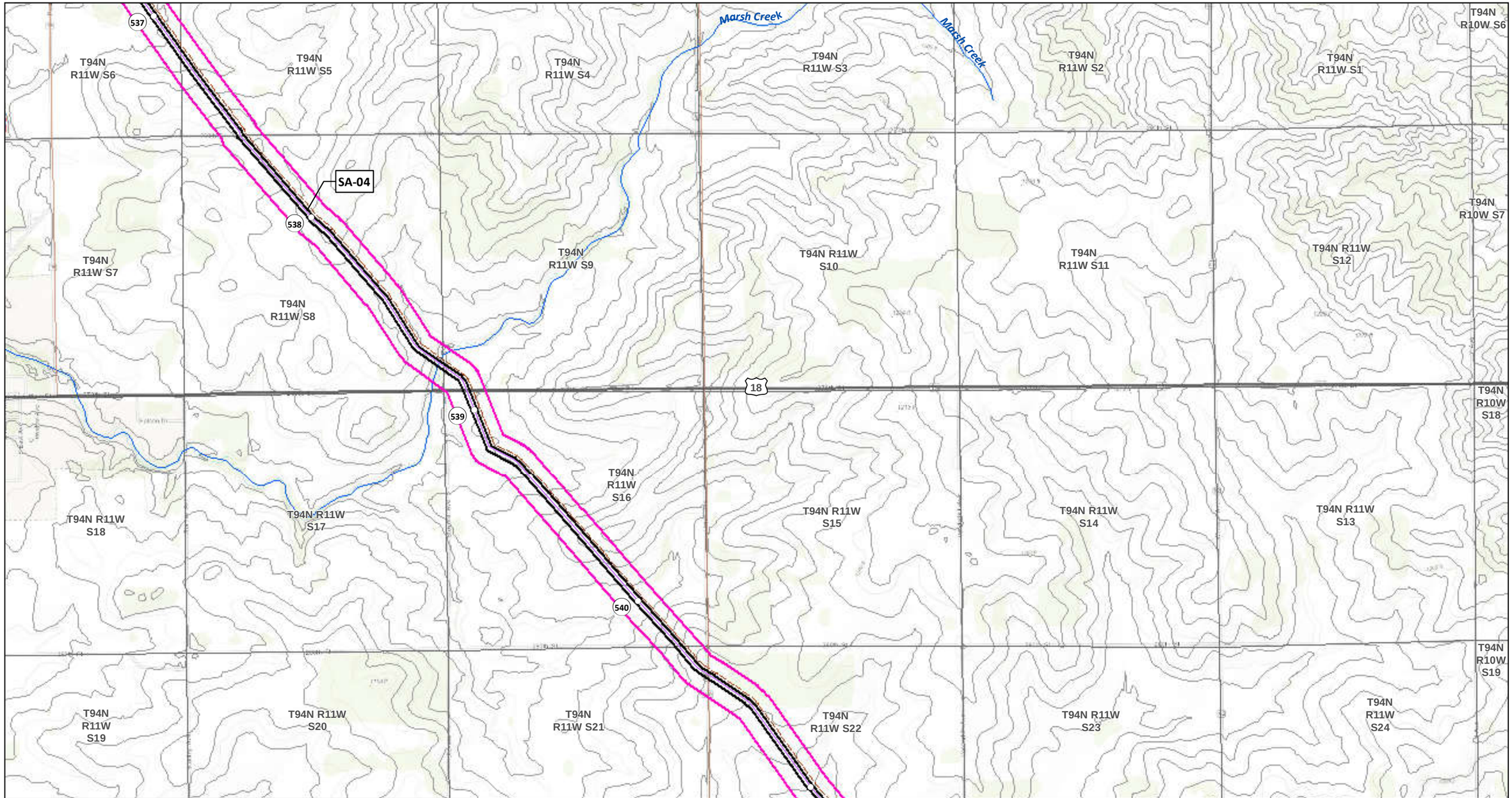
1:24,000

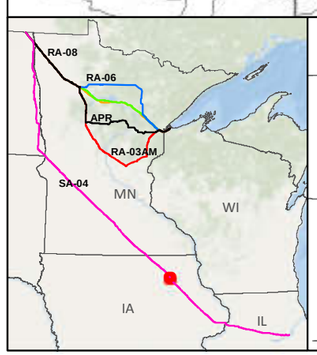
0 125 250 500 Meters

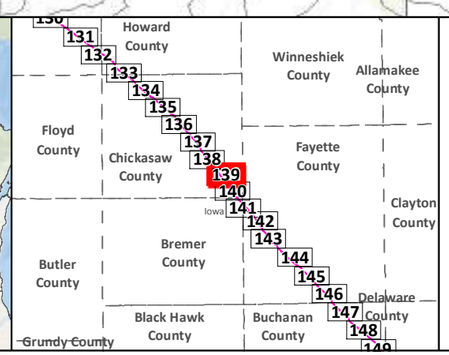
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 139A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

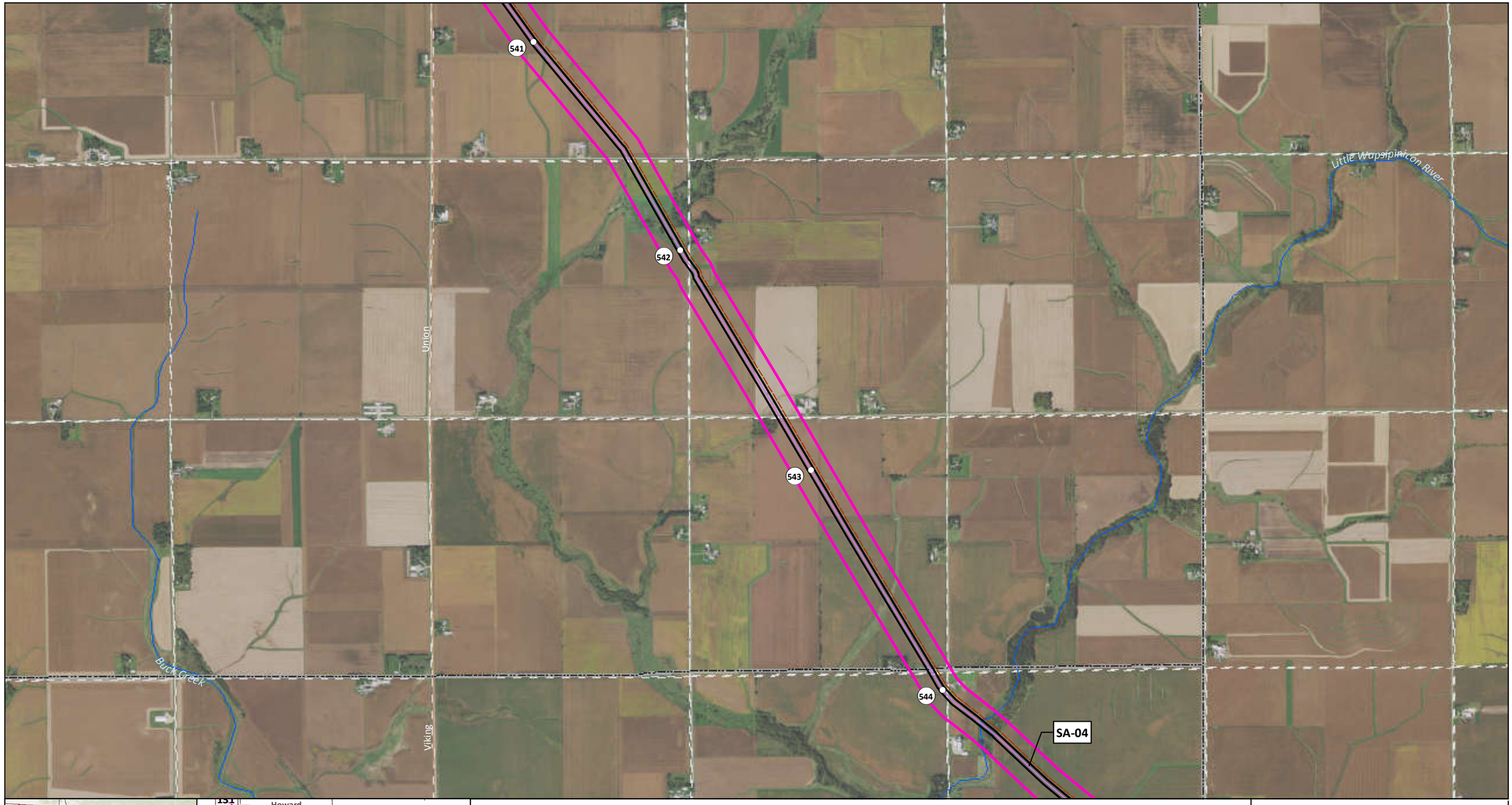
0 125 250 500 Meters

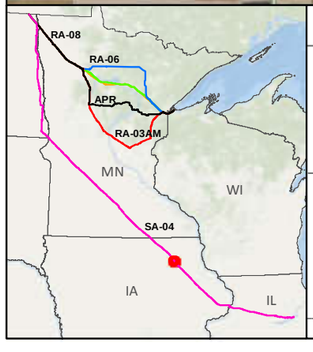
1:24,000

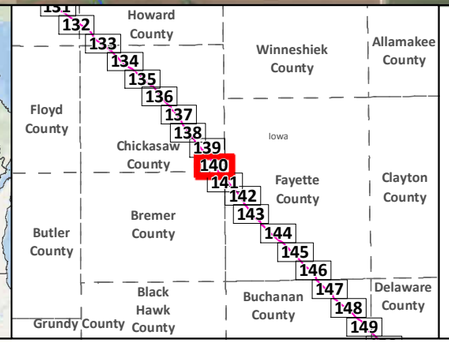
10ft Contours

N

Map 139B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

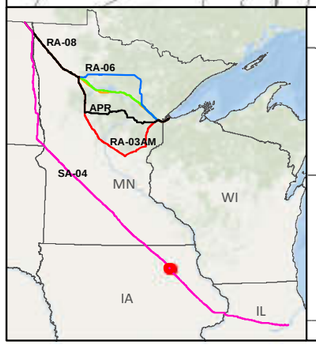
SA-04

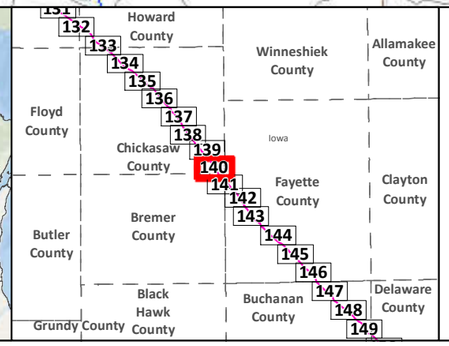
Map 140A of 188

T94N R11W S20
T94N R11W S21
T94N R11W S22
T94N R11W S23
T94N R11W S24
T94N R10W S19
T94N R10W S20
T94N R11W S28
T94N R11W S27
T94N R11W S26
T94N R11W S25
T94N R10W S30
T94N R10W S29
T94N R11W S29
T94N R11W S32
T94N R11W S33
T94N R11W S34
T94N R11W S35
T94N R11W S36
T94N R10W S31
T94N R10W S32
T93N R11W S5
T93N R11W S4
T93N R11W S3
T93N R11W S2
T93N R11W S1
T93N R10W S6
T93N R10W S5

Little Wapsipinicon River
Buck Creek

541
542
543
544
SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

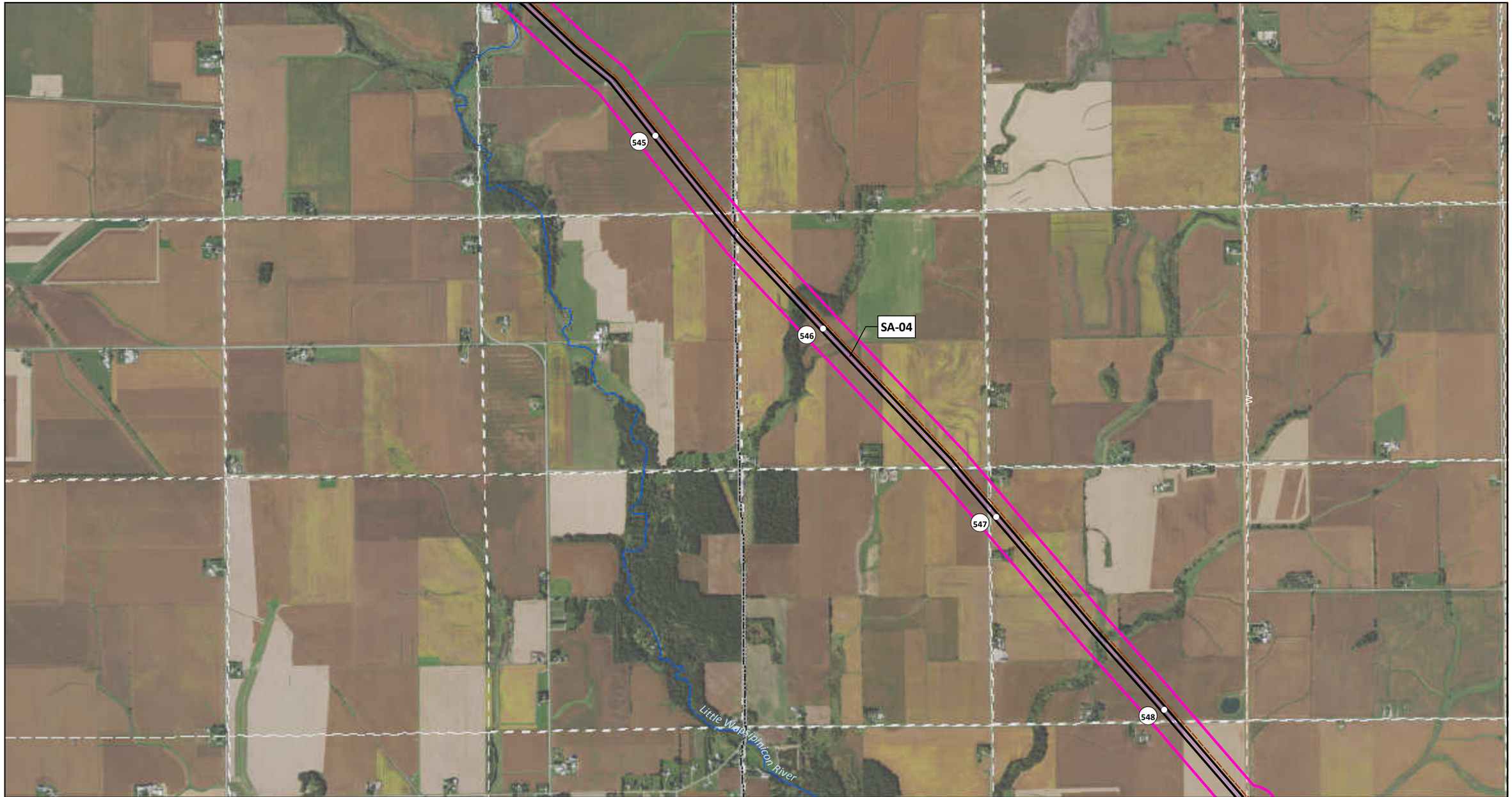
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

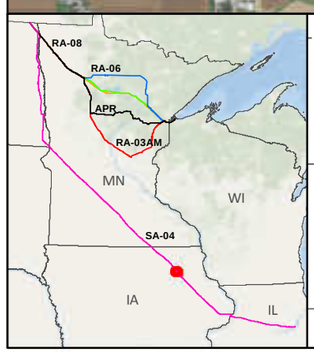
SA-04

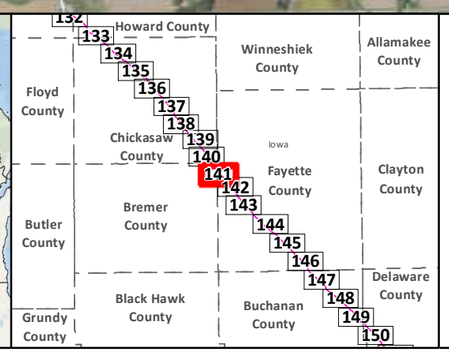
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 140B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

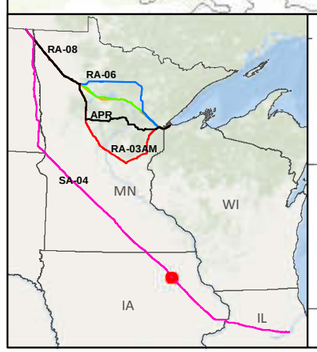
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

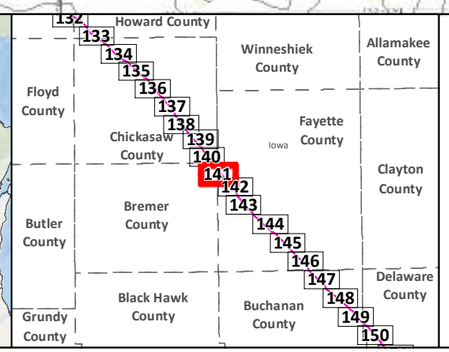
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 141A of 188

T93N R11W S3
T93N R11W S2
T93N R11W S1
T93N R10W S6
T93N R10W S5
T93N R10W S4
T93N R11W S10
T93N R11W S11
T93N R11W S12
T93N R10W S7
T93N R10W S8
T93N R10W S9
T93N R10W S10
T93N R11W S15
T93N R11W S14
T93N R11W S13
T93N R10W S18
T93N R10W S17
T93N R10W S16
T93N R10W S15
T93N R11W S22
T93N R11W S23
T93N R11W S24
T93N R10W S19
T93N R10W S20
T93N R10W S21
T93N R10W S22
545
546
547
548
SA-04
Little Wapsipinicon River





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 141B of 188

SA-04

548

549

550

551

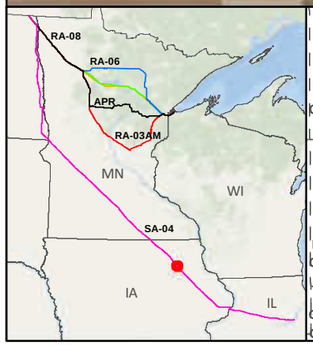
93

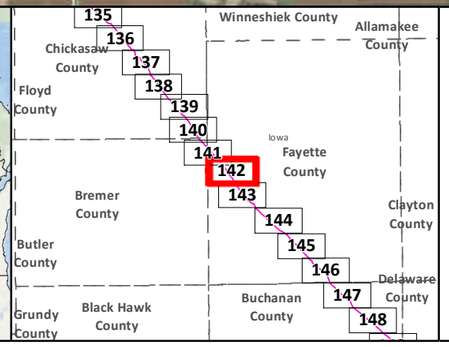
W

Volga River

Little Wapsipinicon River

Stoe Creek





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

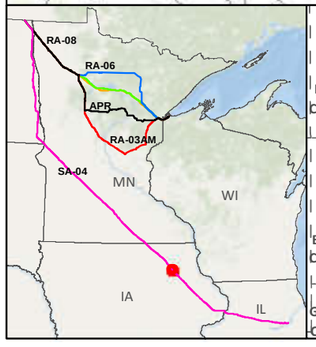
Map 142A of 188

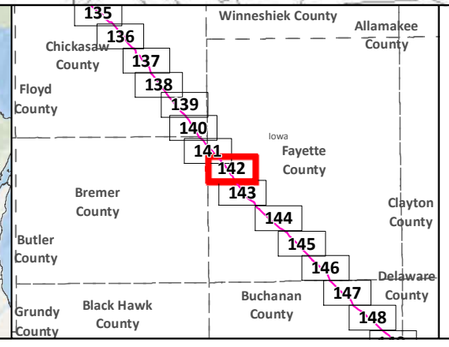
T93N R10W S18
T93N R10W S17
T93N R10W S16
T93N R10W S15
T93N R10W S14
T93N R10W S13
T93N R10W S19
T93N R10W S20
T93N R10W S21
T93N R10W S22
T93N R10W S23
T93N R10W S24
T93N R10W S30
T93N R10W S29
T93N R10W S28
T93N R10W S27
T93N R10W S26
T93N R10W S25
T93N R10W S31
T93N R10W S32
T93N R10W S33
T93N R10W S34
T93N R10W S35
T93N R10W S36

548
549
550
551
93

SA-04

Volga River
Little Wapsipinicon River
Sloe Creek





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

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- National River Inventory Crossing
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- 303d Imparied Waters
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- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

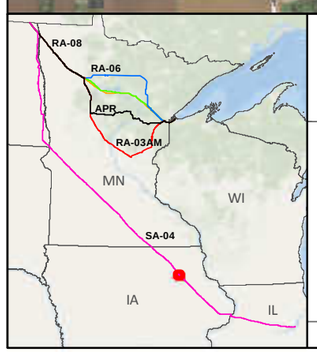
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

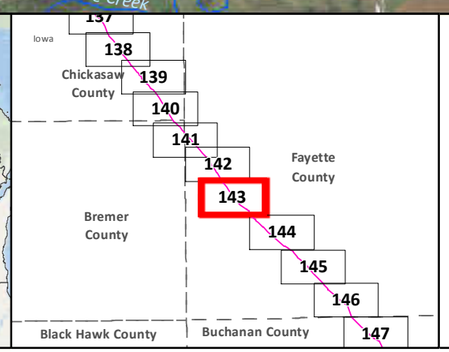
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

552
553
554
555
SA-04
Stoe Creek
Stoe Creek
W
R





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

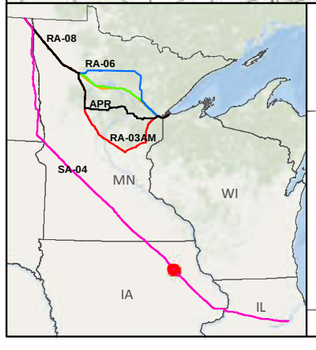
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

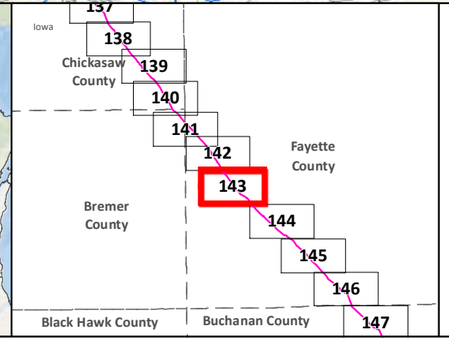
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 143A of 188

T93N R10W S32
T93N R10W S33
T93N R10W S34
T93N R10W S35
T93N R10W S36
T93N R09W S31
T93N R09W S32
T92N R10W S5
T92N R10W S4
T92N R10W S3
T92N R10W S2
T92N R10W S1
T92N R09W S6
T92N R09W S5
T92N R10W S8
T92N R10W S9
T92N R10W S10
T92N R10W S11
T92N R10W S12
T92N R09W S7
T92N R09W S8
T92N R10W S17
T92N R10W S16
T92N R10W S15
T92N R10W S14
T92N R10W S13
T92N R09W S18
T92N R09W S17
552
553
554
555
SA-04
Stoe Creek
Stoe Creek





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 143B of 188

SA-04

100th

150

Maynard

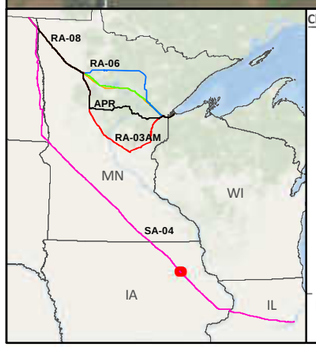
556

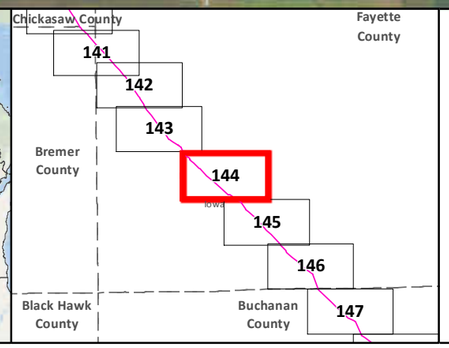
557

558

559

Little Volga River





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
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- Township Boundary

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- National Forest
- Tribal Reservation

Water Resources
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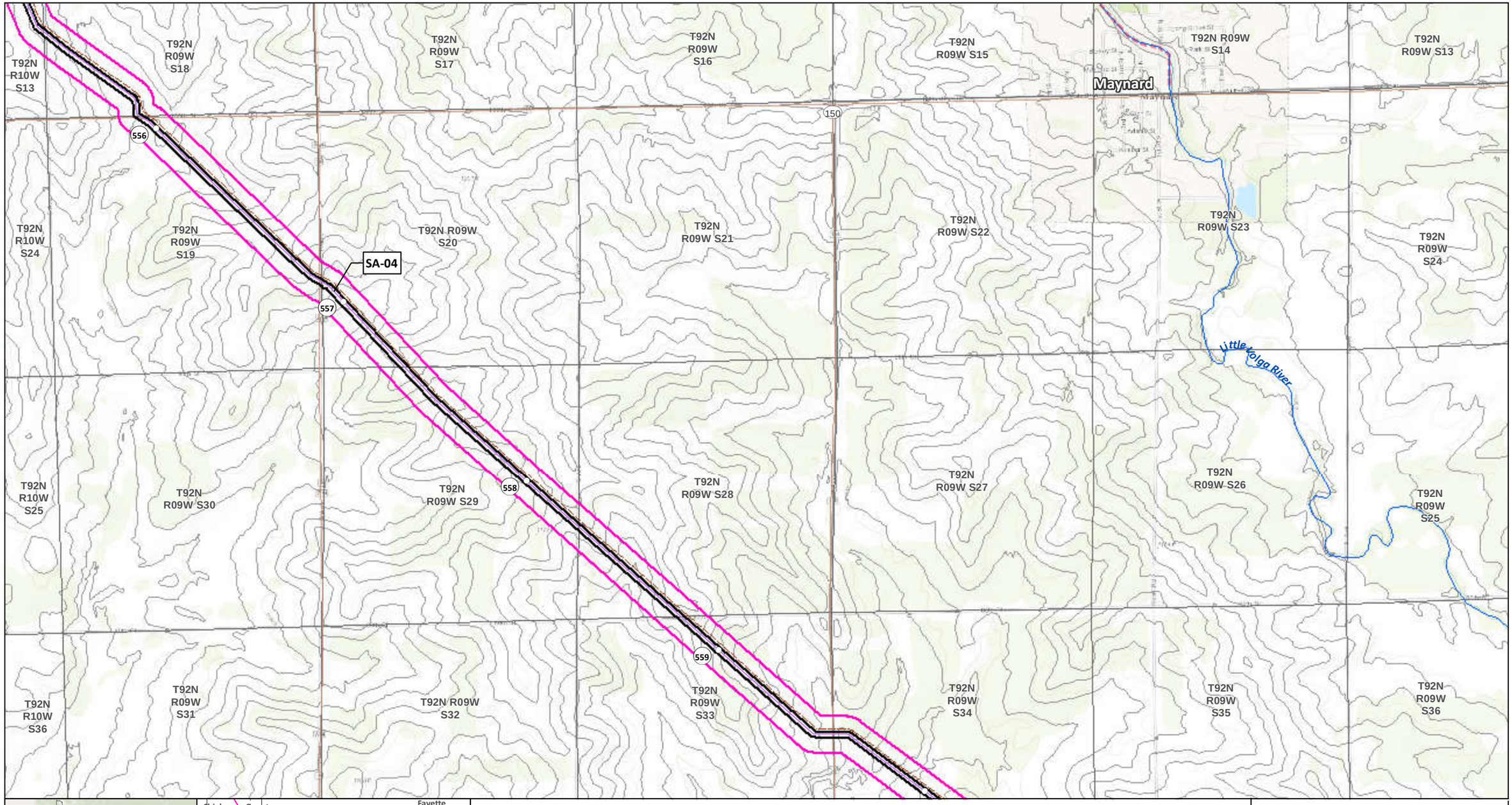
- River

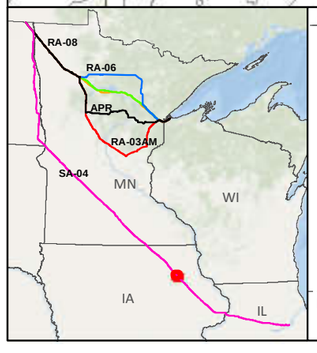
Data Sources: MNDNR, NHD,USGS, Enbridge

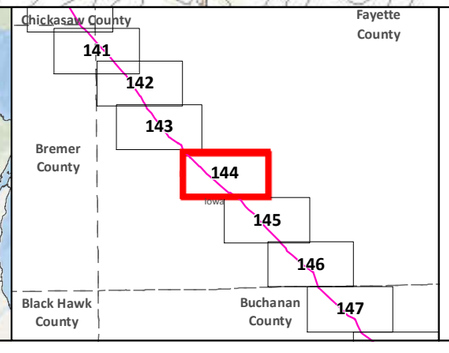
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

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Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

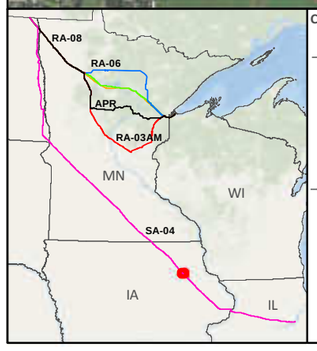
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

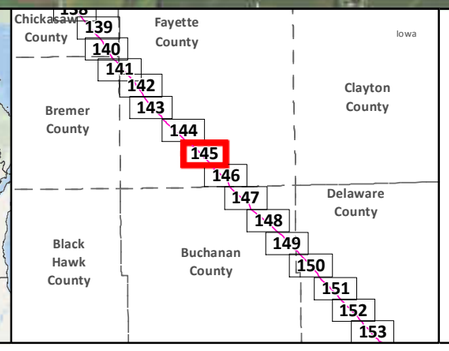
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 144B of 188

561
150
60th
562
SA-04
563
564
West Branch Buffalo Creek





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 145A of 188

T92N R09W S33
T92N R09W S34
T92N R09W S35
T92N R09W S36
T92N R08W S31
T92N R08W S32
T92N R08W S33
T91N R09W S4
T91N R09W S3
T91N R09W S2
T91N R09W S1
T91N R08W S6
T91N R08W S5
T91N R08W S4
T91N R09W S9
T91N R09W S10
T91N R09W S11
T91N R09W S12
T91N R08W S7
T91N R08W S8
T91N R08W S9
T91N R09W S16
T91N R09W S15
T91N R09W S14
T91N R09W S13
T91N R08W S18
T91N R08W S17
T91N R08W S16
T91N R08W S19
T91N R08W S20
T91N R08W S21
150
561
562
563
564
SA-04
West Branch Buffalo Creek

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Chickasaw County
Fayette County
Iowa
Clayton County
Bremer County
Delaware County
Black Hawk County
Buchanan County
138
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SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

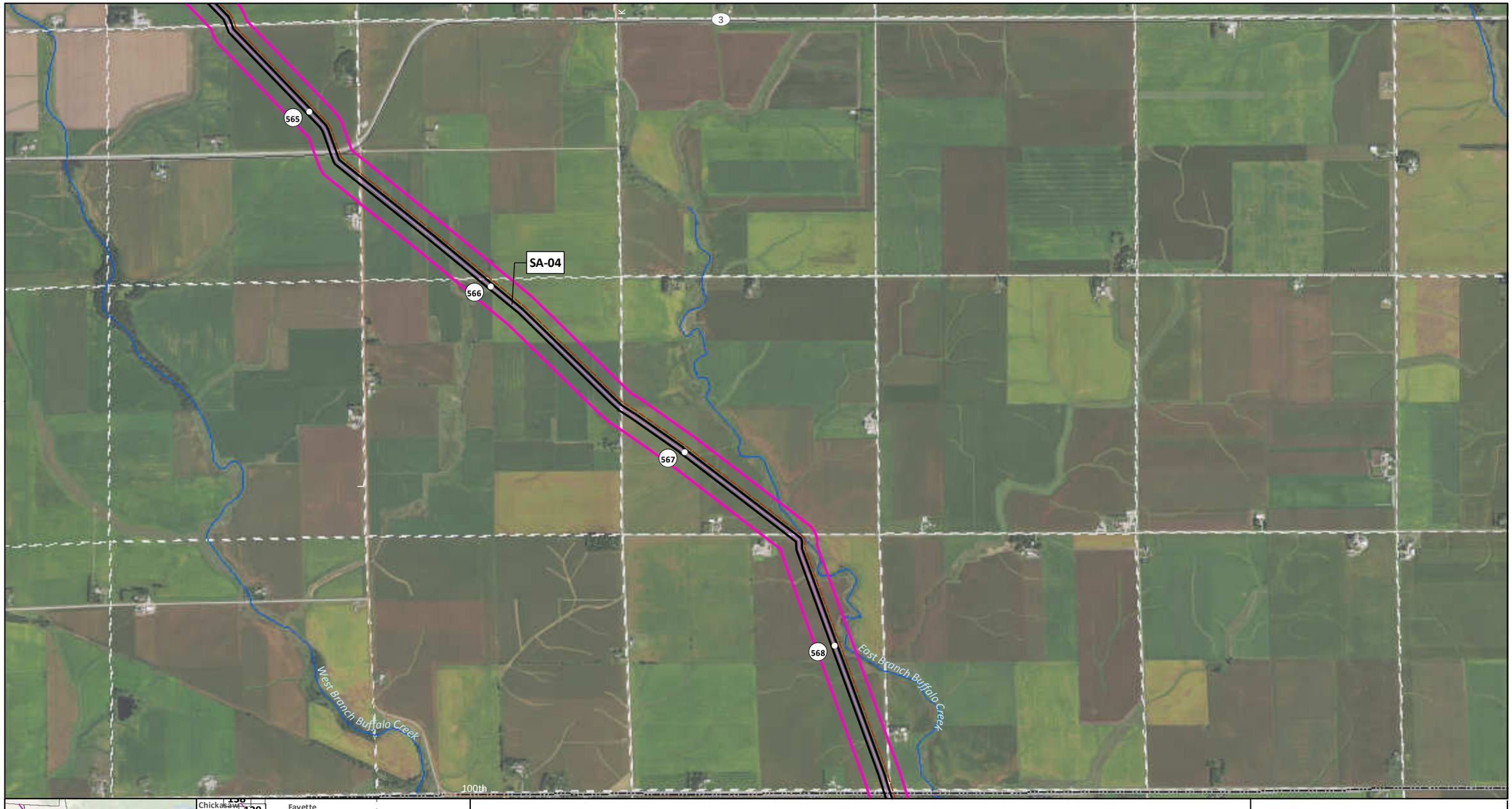
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

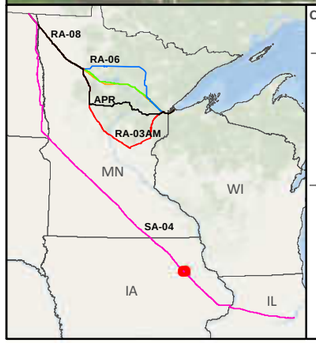
SA-04

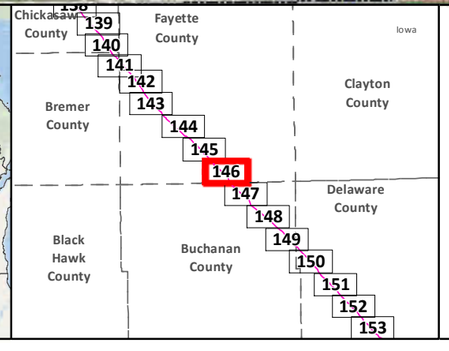
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 145B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T91N R09W S13
T91N R08W S18
T91N R08W S17
T91N R08W S16
T91N R08W S15
T91N R08W S14
T91N R08W S13
T91N R09W S24
T91N R08W S19
T91N R08W S20
T91N R08W S21
T91N R08W S22
T91N R08W S23
T91N R08W S24
T91N R09W S25
T91N R08W S30
T91N R08W S29
T91N R08W S28
T91N R08W S27
T91N R08W S26
T91N R08W S25
T91N R08W S31
T91N R08W S32
T91N R08W S33
T91N R08W S34
T91N R08W S35
T91N R09W S36
T91N R08W S36
T90N R09W S1
T90N R08W S6
T90N R08W S5
T90N R08W S4
T90N R08W S3
T90N R08W S2
T90N R08W S1
565
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3
SA-04
West Branch Buffalo Creek
East Branch Buffalo Creek

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Chickasaw County
Fayette County
Iowa
Bremer County
Clayton County
Delaware County
Black Hawk County
Buchanan County
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SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 146B of 188

East Branch Buffalo Creek

South Fork Maquoketa River

Lamont Creek

West Branch Buffalo Creek

569

570

571

572

SA-04

110th

115th

120th

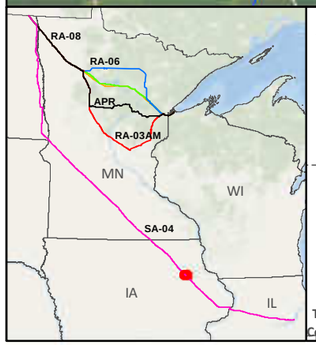
130th

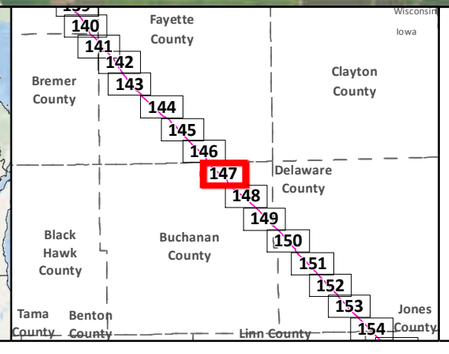
Union

Slater

York

Aurora





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
MNDNR, NHD,USGS, Enbridge

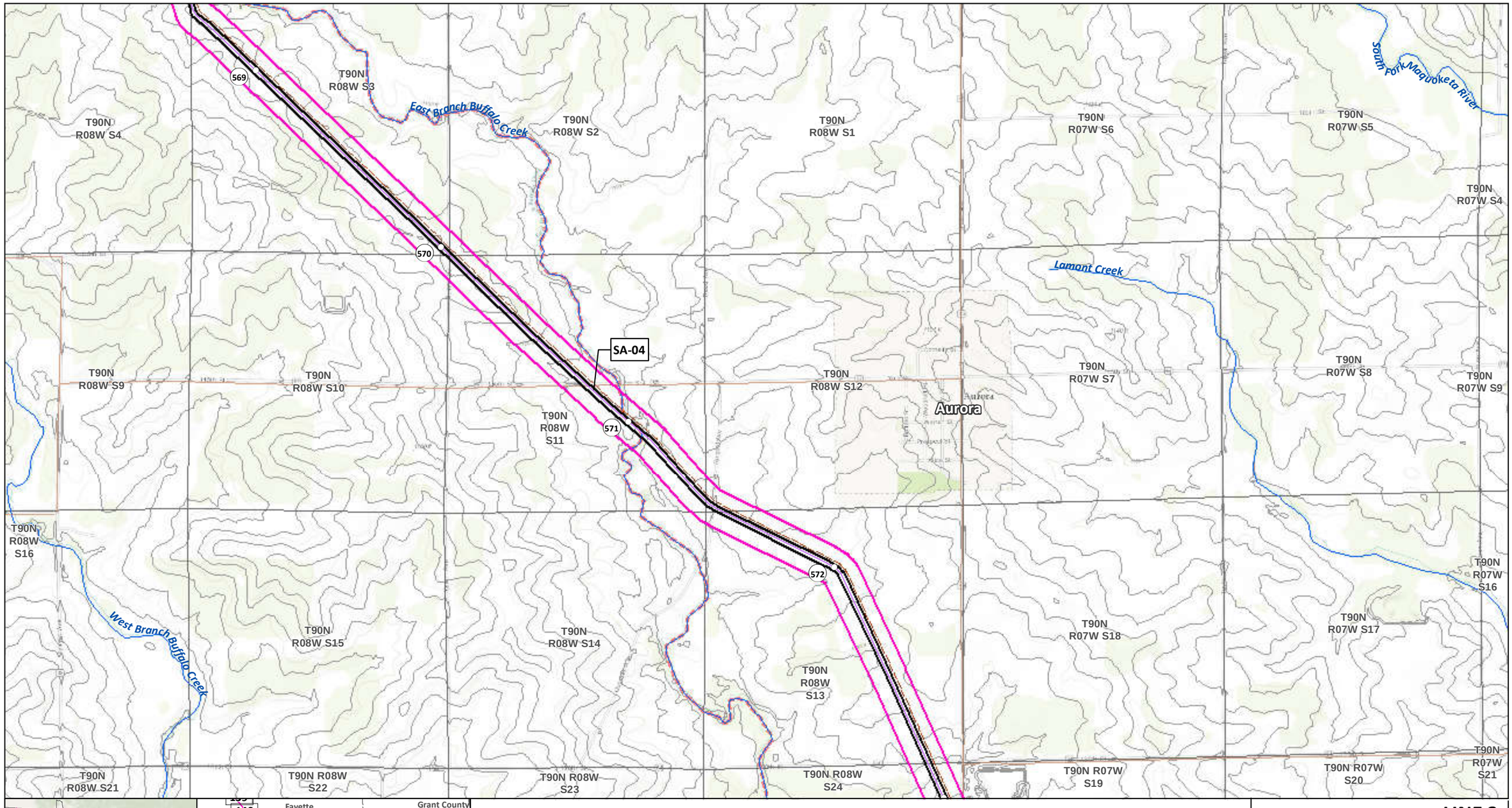
0 0.125 0.25 0.5 Miles

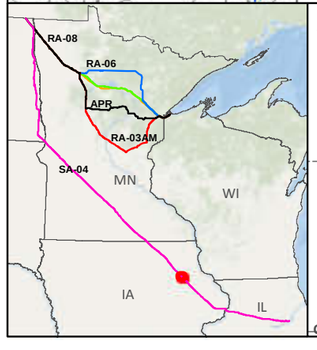
1:24,000

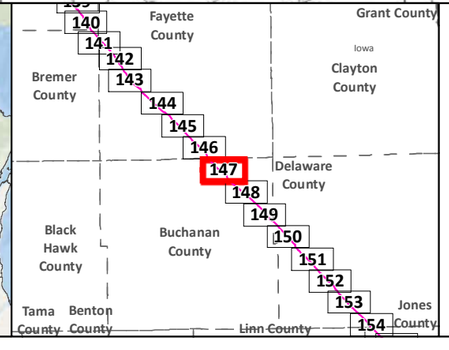
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

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- SNA - Scientific and Natural Area

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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

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- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

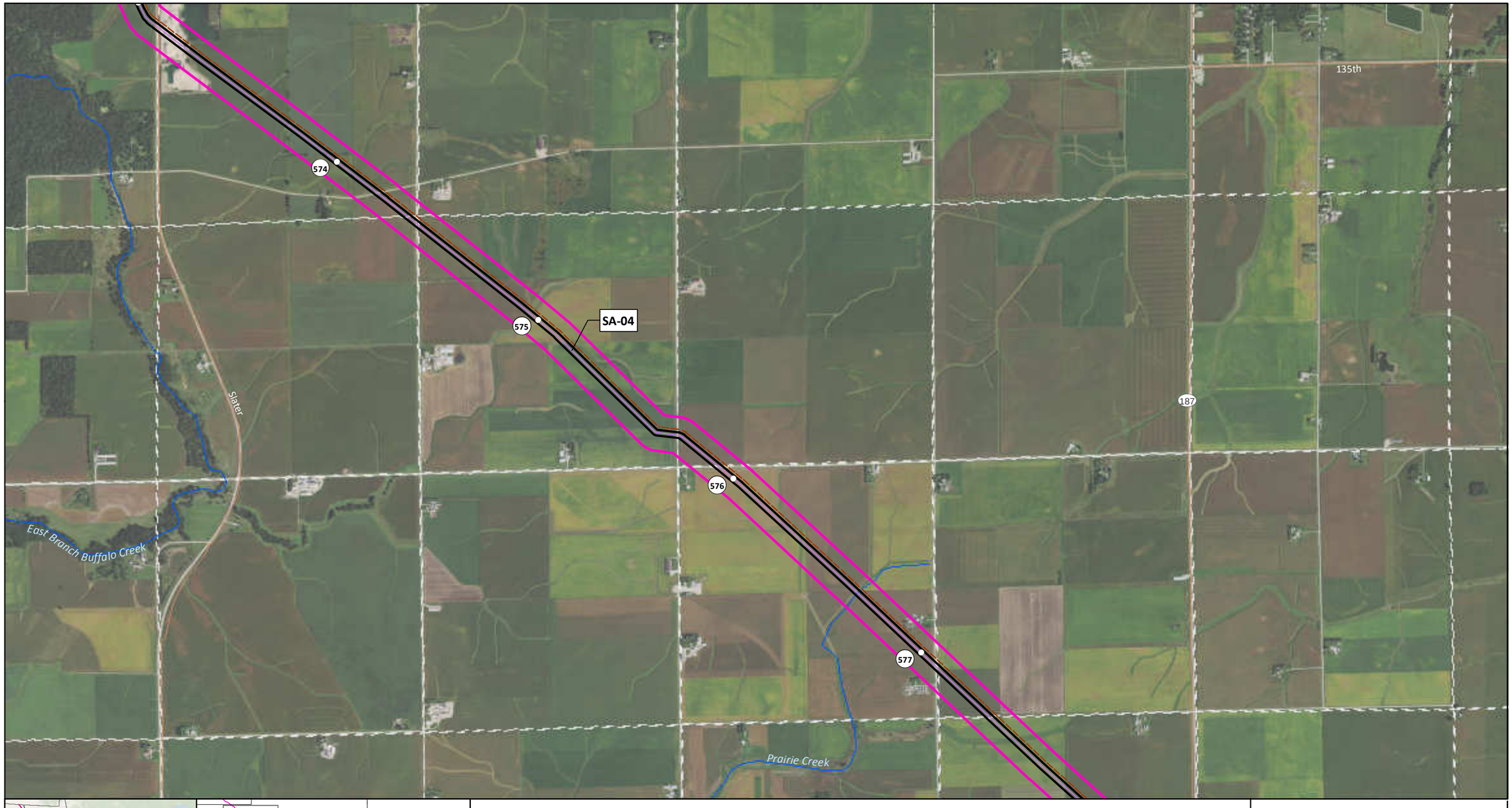
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

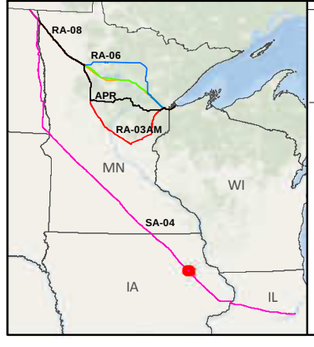
SA-04

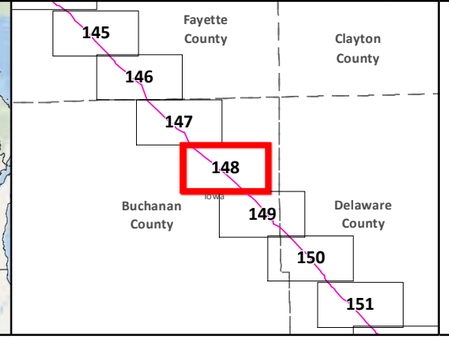
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 147B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
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Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
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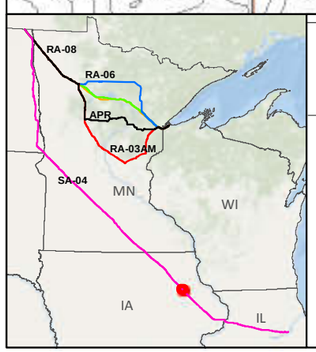
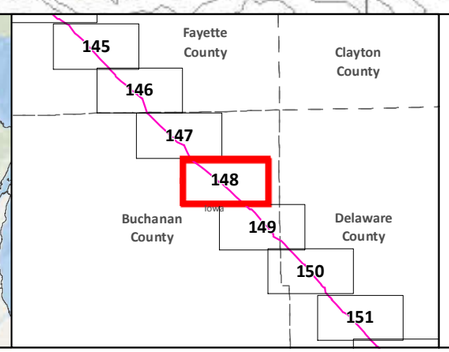
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T90N R07W S19
T90N R07W S20
T90N R07W S21
T90N R07W S22
T90N R07W S23
T90N R07W S24
T90N R08W S24
T90N R08W S25
T90N R07W S30
T90N R07W S29
T90N R07W S28
T90N R07W S27
T90N R07W S26
T90N R07W S25
T90N R08W S36
T90N R07W S31
T90N R07W S32
T90N R07W S33
T90N R07W S34
T90N R07W S35
T90N R07W S36
T89N R08W S1
T89N R07W S6
T89N R07W S5
T89N R07W S4
T89N R07W S3
T89N R07W S2
T89N R07W S1
East Branch Buffalo Creek
Prairie Creek
574
575
576
577
187
SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
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- 303d Imparied Waters
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- Calcareous Fens
- Wild Rice Lakes (DNR)
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- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

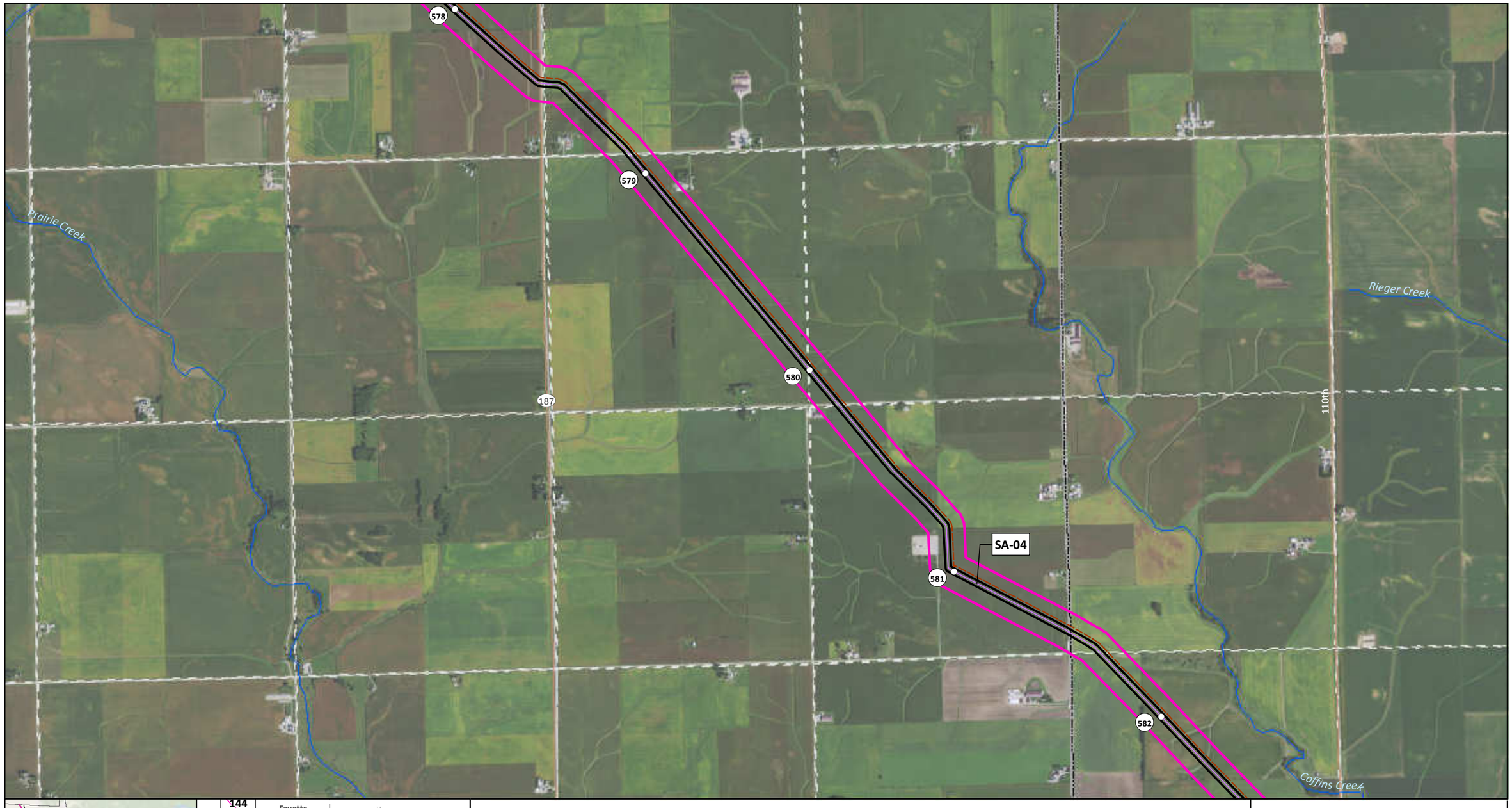
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

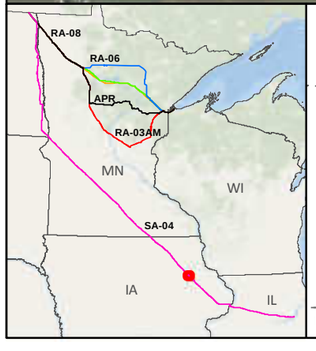
SA-04

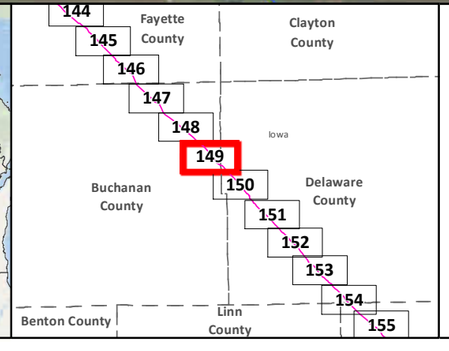
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 148B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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Tribal Reservation

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Lake
River

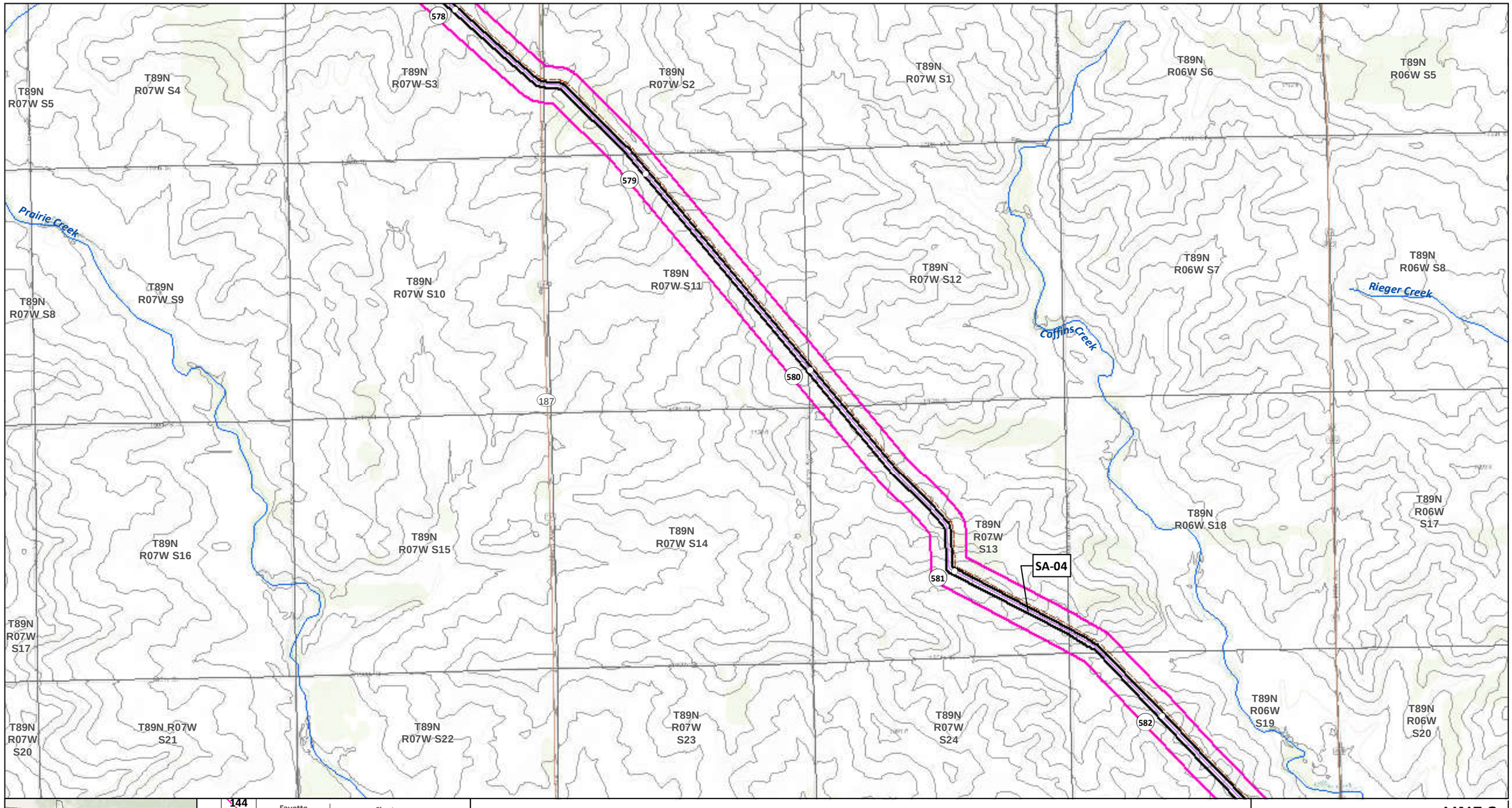
Data Sources:
MNDNR, NHD,USGS, Enbridge

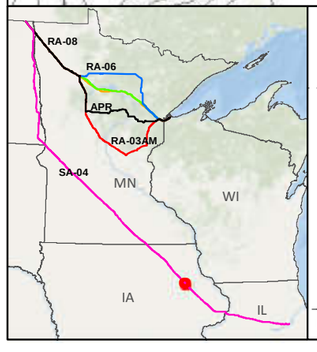
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

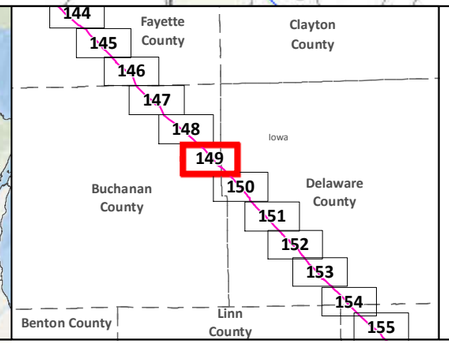
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 149A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

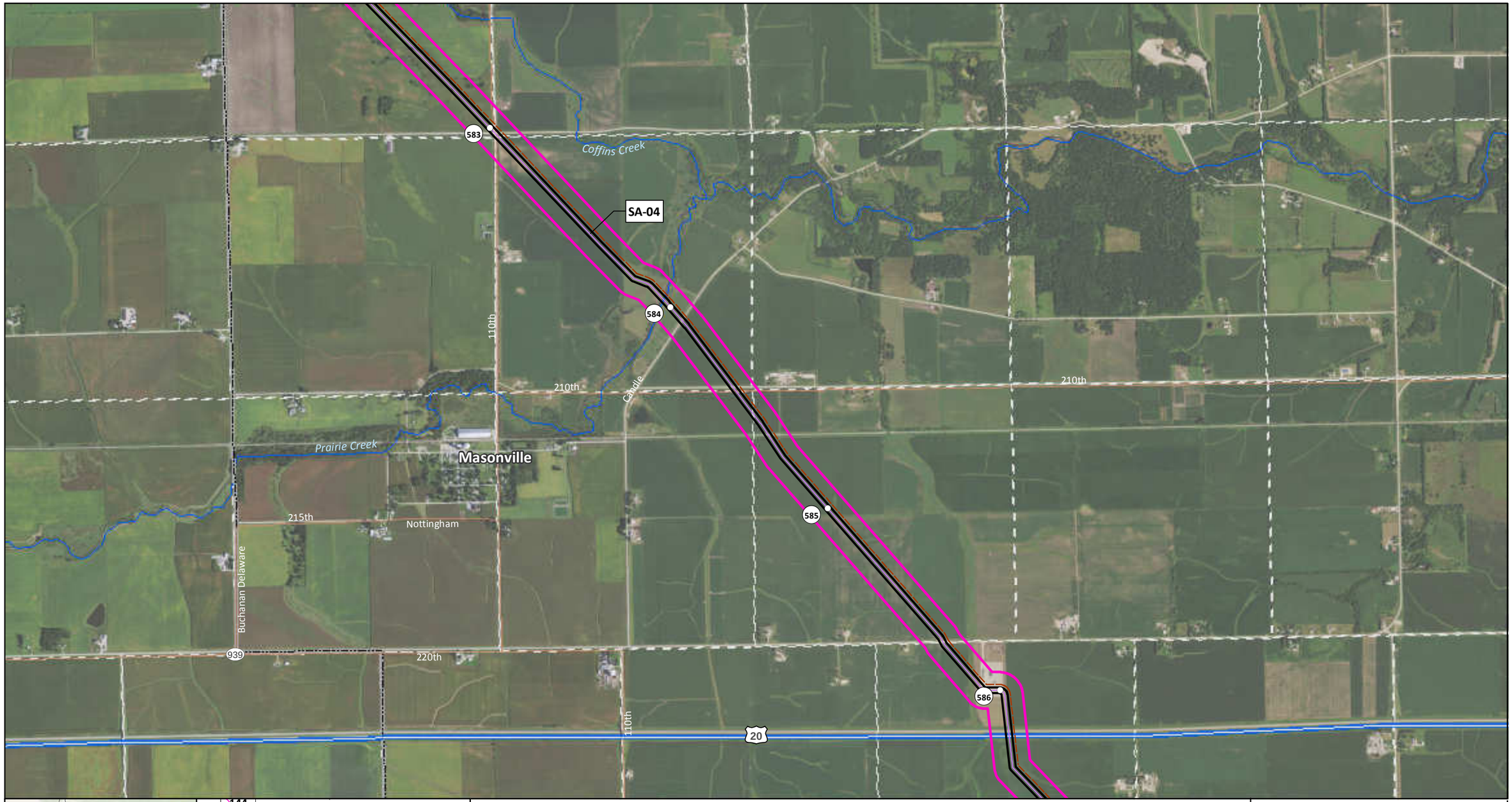
0 125 250 500 Meters

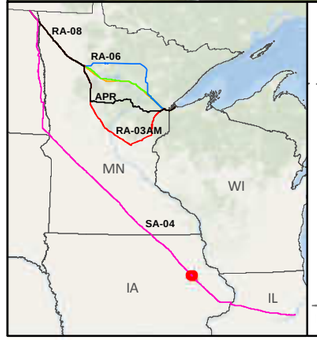
1:24,000

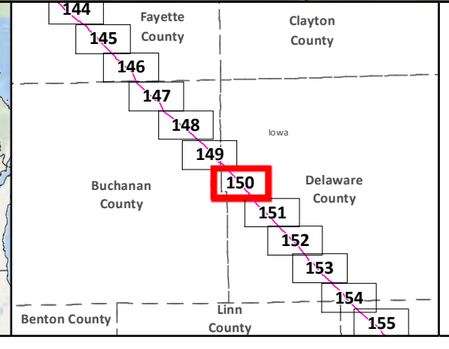
10ft Contours

N

Map 149B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

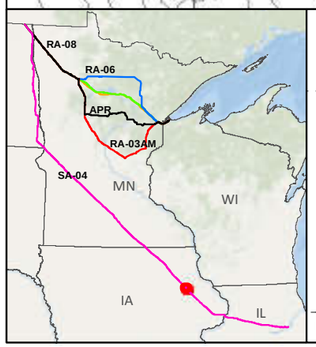
SA-04

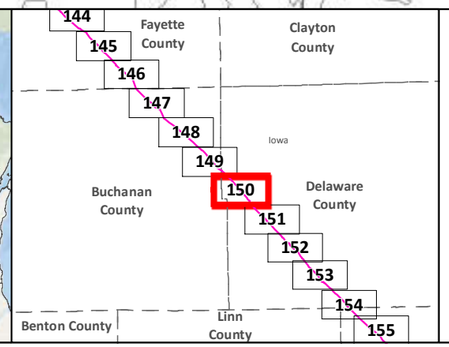
Map 150A of 188

T89N R07W S24
T89N R06W S19
T89N R06W S20
T89N R06W S21
T89N R06W S22
T89N R06W S23
T89N R07W S25
T89N R06W S30
T89N R06W S29
T89N R06W S28
T89N R06W S27
T89N R06W S26
T89N R07W S36
T89N R06W S31
T89N R06W S32
T89N R06W S33
T89N R06W S34
T89N R06W S35
T88N R07W S2
T88N R07W S1
T88N R06W S6
T88N R06W S5
T88N R06W S4
T88N R06W S3
T88N R06W S2

583
584
585
586
939
20

Coffins Creek
Prairie Creek
Masonville
SA-04





- SA-04
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- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

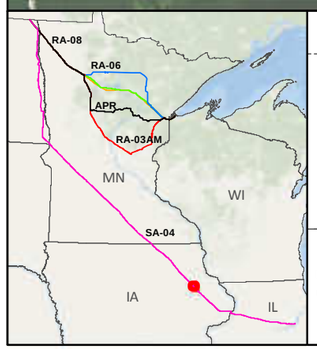
SA-04

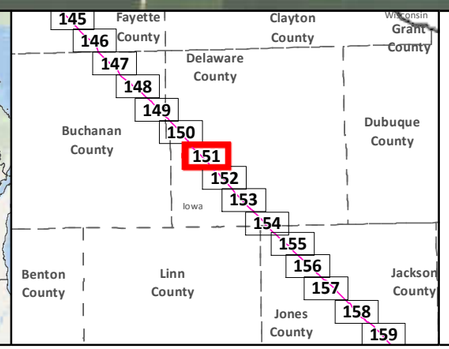
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 150B of 188

587
588
589
590
SA-04
Sand Creek
Todds Creek
13





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

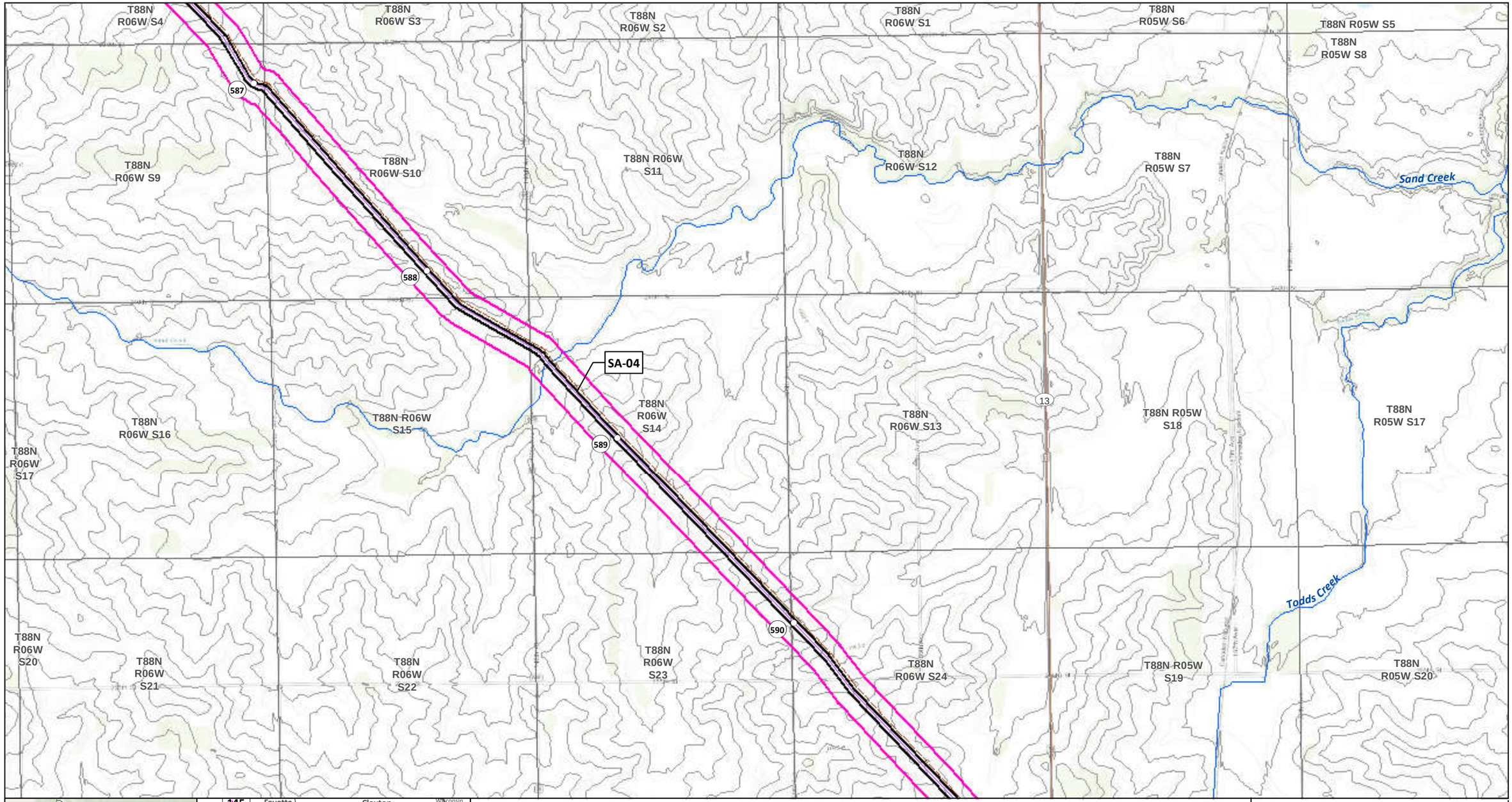
Data Sources:
MNDNR, NHD,USGS, Enbridge

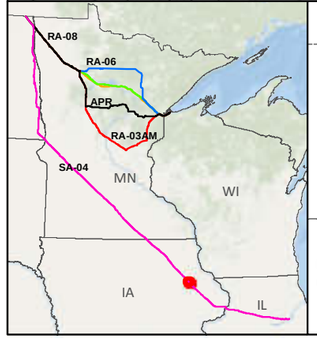
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

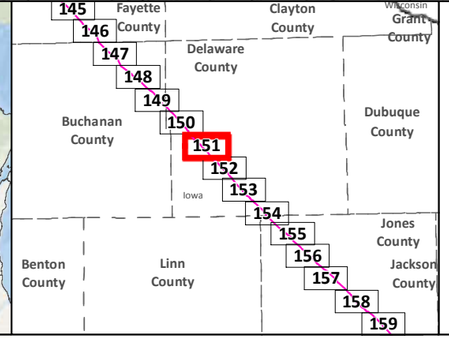
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 151A of 188







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
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Water Resources

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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
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- Public Drinking Water Supply
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Native Plant Communities with Biodiversity Significance

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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

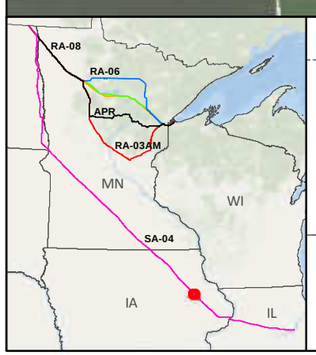
1:24,000

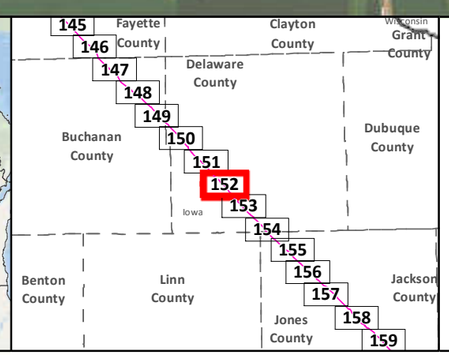
10ft Contours

N

Map 151B of 188

591
592
593
594
595
13
SA-04
Todds Creek
Golden Branch





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

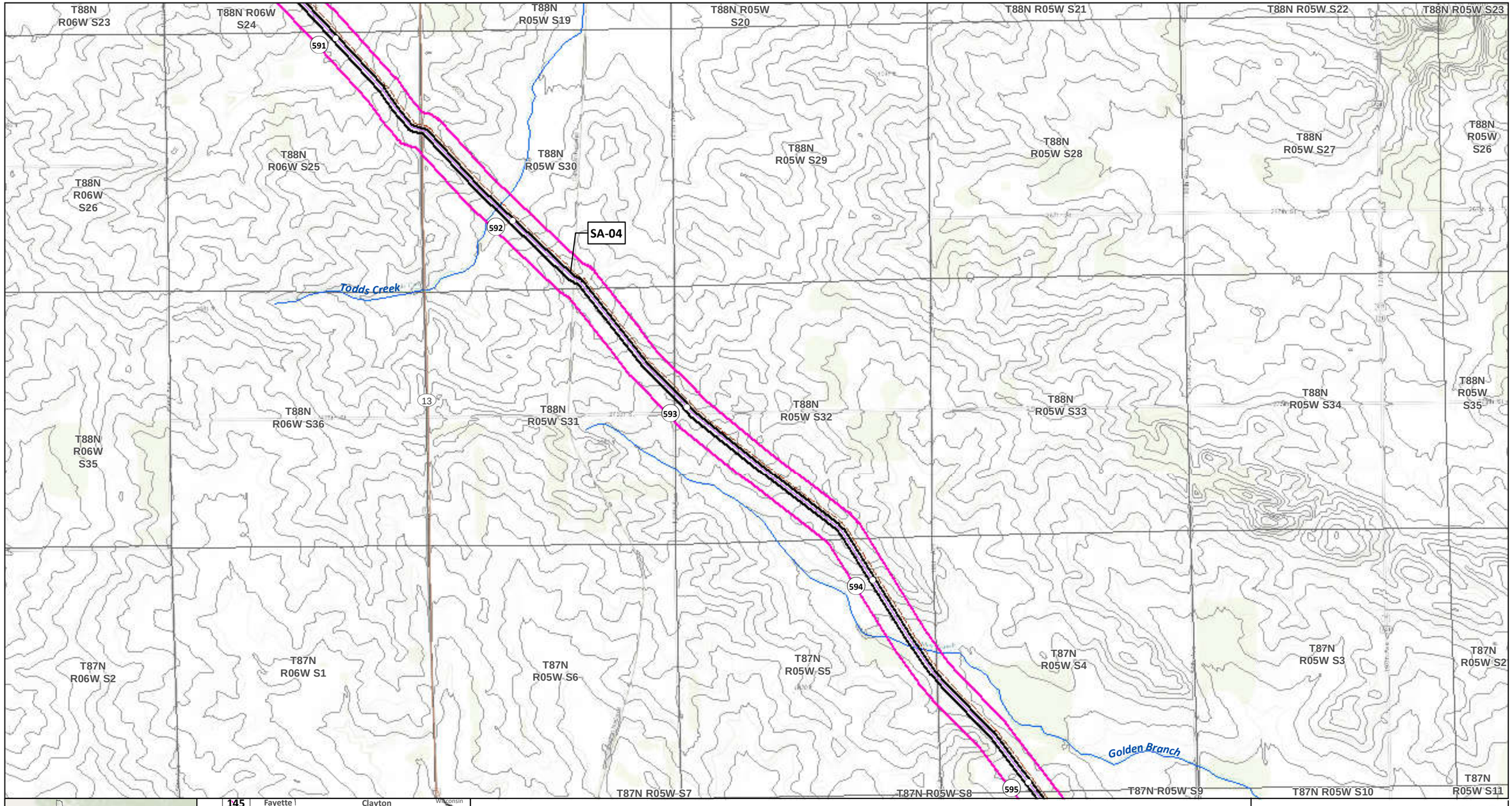
Data Sources:
MNDNR, NHD,USGS, Enbridge

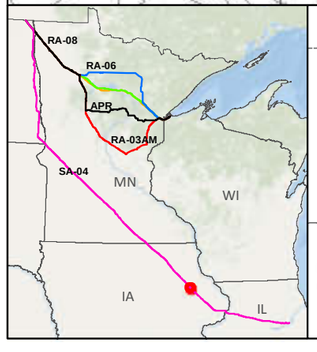
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

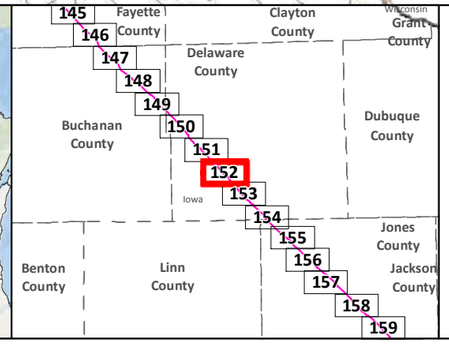
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 152A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
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- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

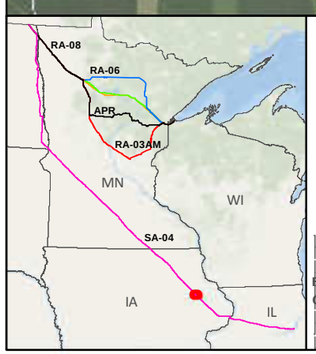
SA-04

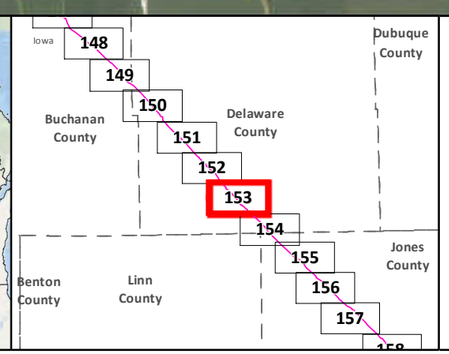
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 152B of 188

595
596
597
598
599
SA-04
Golden Branch
Buck Creek
Lime Creek
310th
220th
315th





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

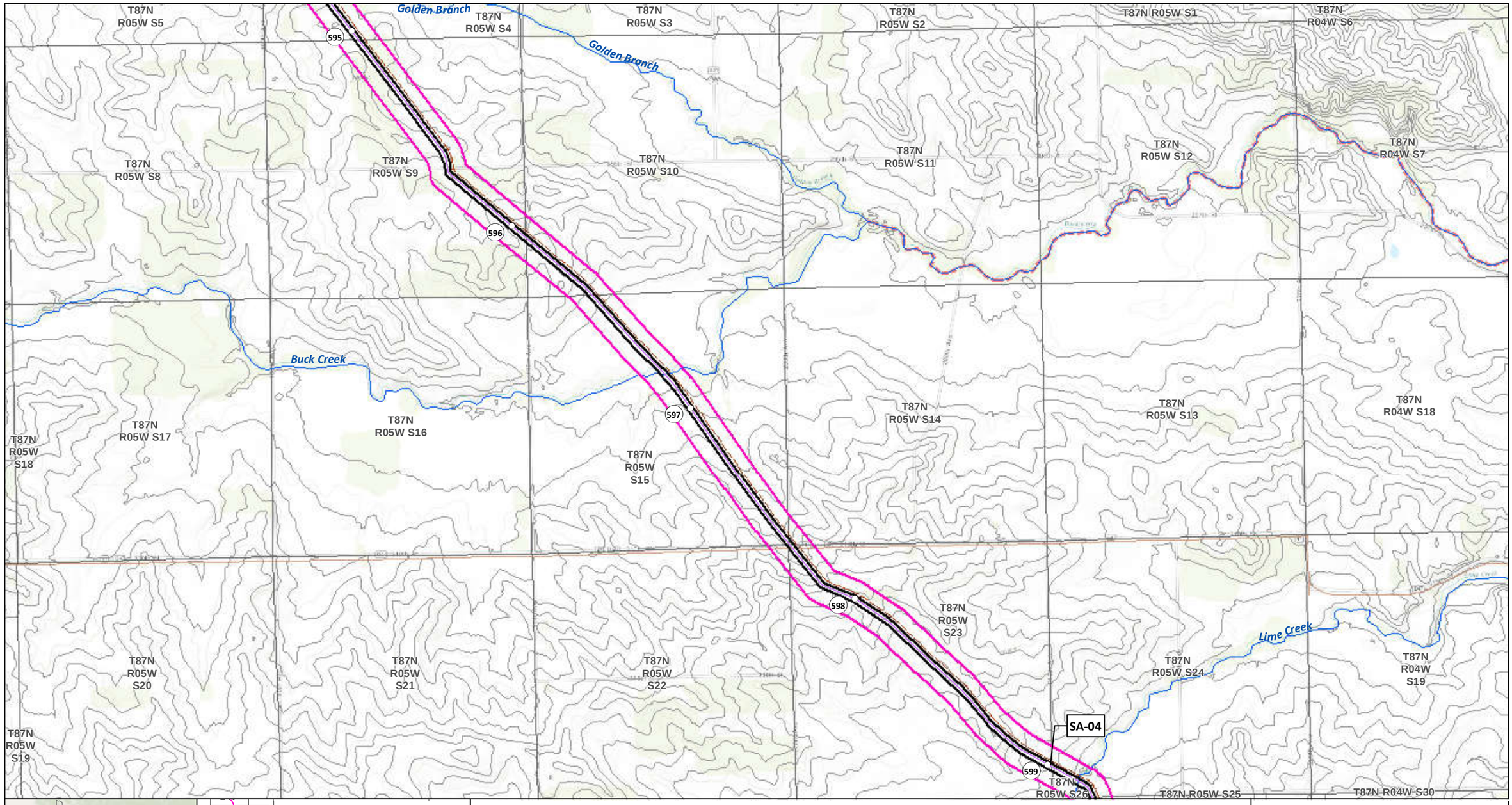
Data Sources:
MNDNR, NHD,USGS, Enbridge

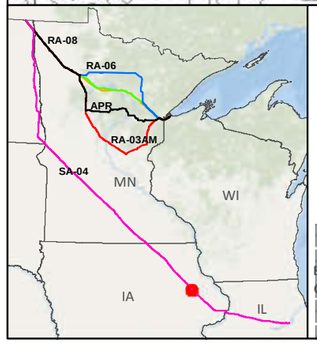
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

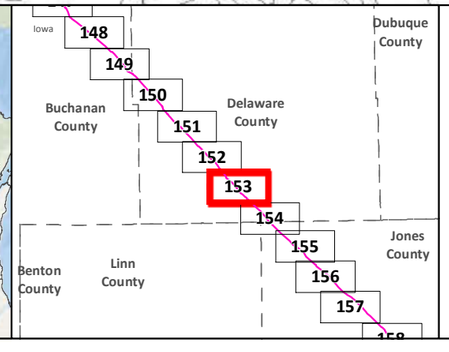
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 153A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

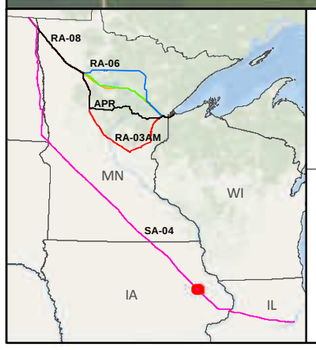
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

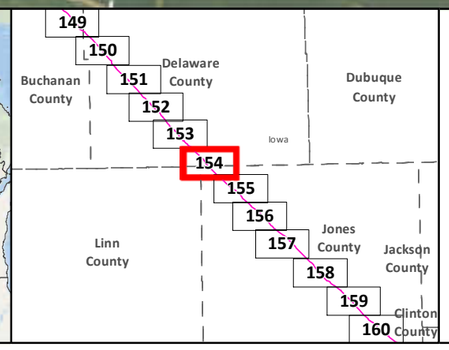
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 153B of 188

Lime Creek
Lime Creek
600
601
602
603
SA-04
245th
Grove Creek
X31
Grove Creek
D62
X31
Monticello





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

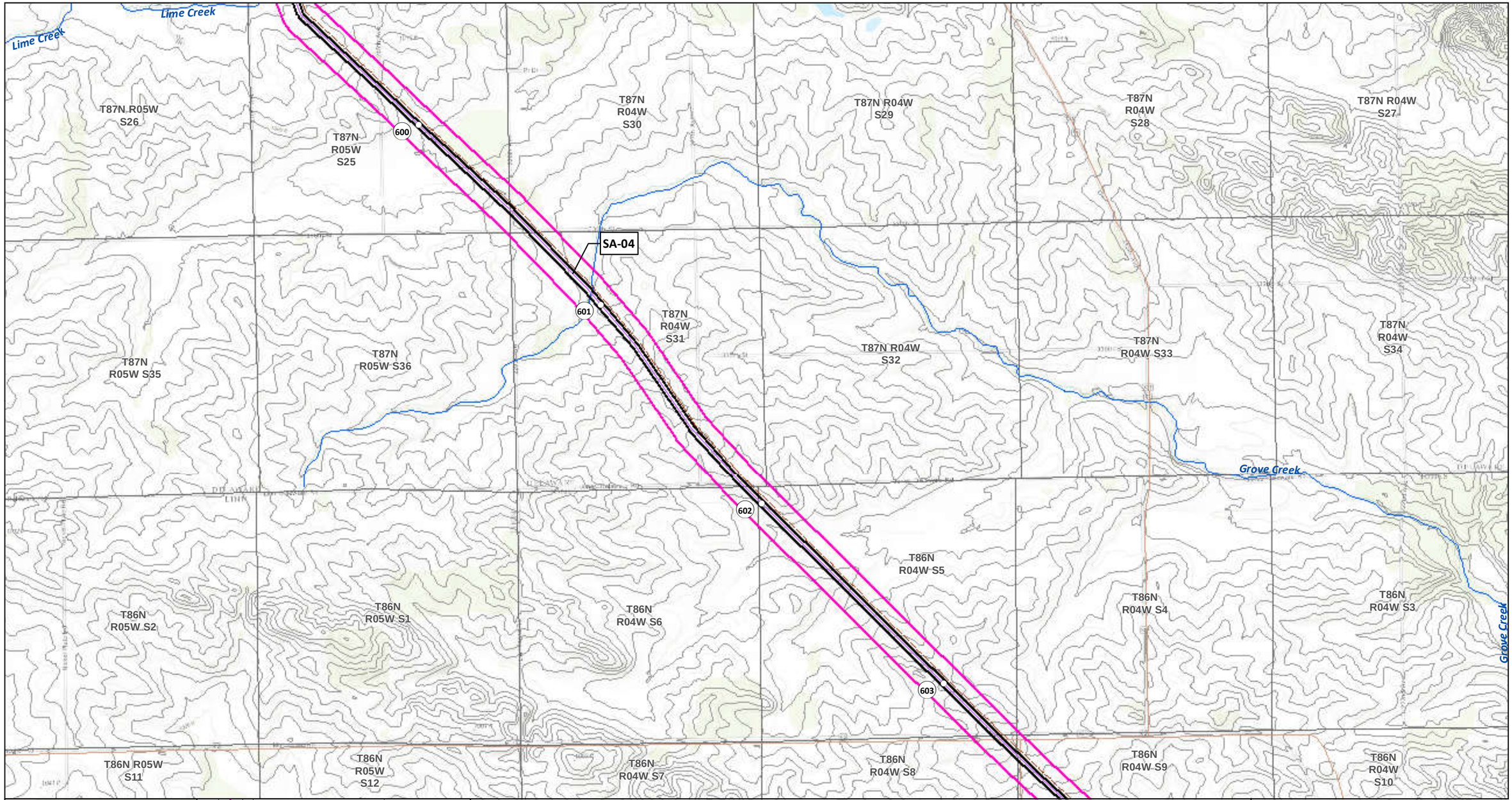
Data Sources:
MNDNR, NHD,USGS, Enbridge

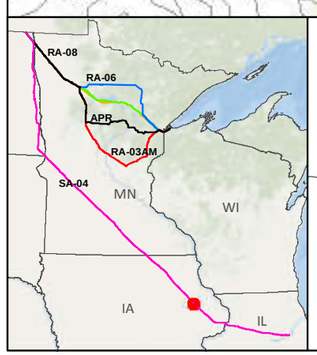
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

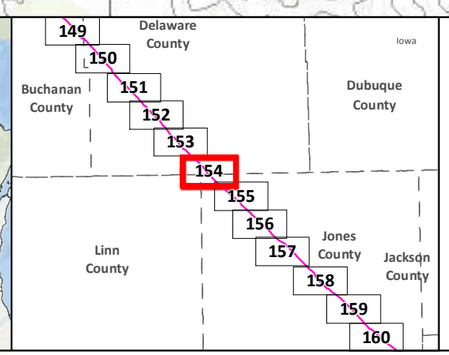
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 154A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
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Lakes of Biological Significance
- Outstanding
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Native Plant Communities with Biodiversity Significance
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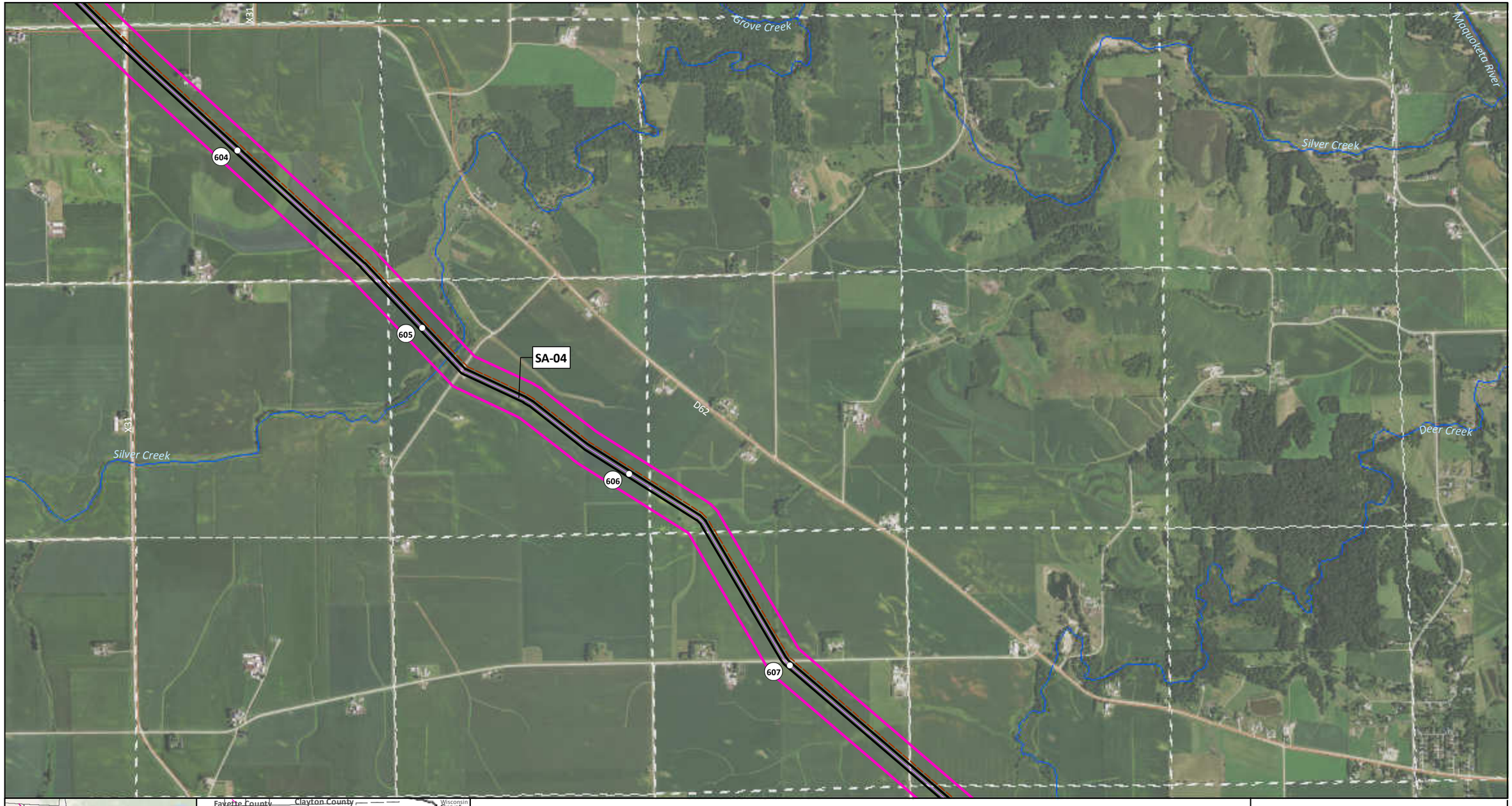
Data Sources: MNDNR, USGS, NHD, Enbridge

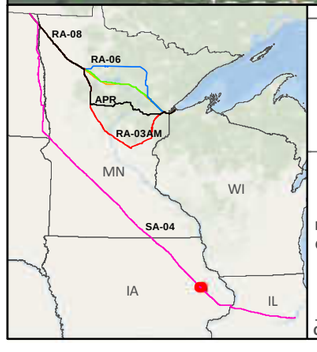
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

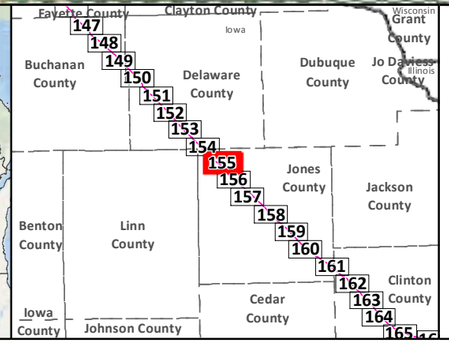
SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 154B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

T86N R04W S5
T86N R04W S4
T86N R04W S3
T86N R04W S2
T86N R04W S1
T86N R03W S6
T86N R03W S5
Grove Creek
Mequoketa River
T86N R04W S9
T86N R04W S8
T86N R04W S10
T86N R04W S11
T86N R04W S12
T86N R03W S7
Silver Creek
T86N R03W S8
604
605
606
607
SA-04
T86N R04W S17
T86N R04W S16
T86N R04W S15
T86N R04W S14
T86N R04W S13
T86N R03W S18
T86N R03W S17
Silver Creek
T86N R04W S23
T86N R04W S24
Deer Creek
T86N R03W S19
T86N R03W S20
T86N R04W S20
T86N R04W S21
T86N R04W S22
T86N R04W S29
T86N R04W S28
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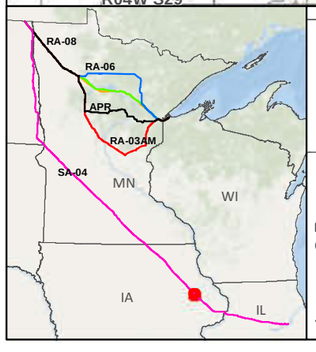
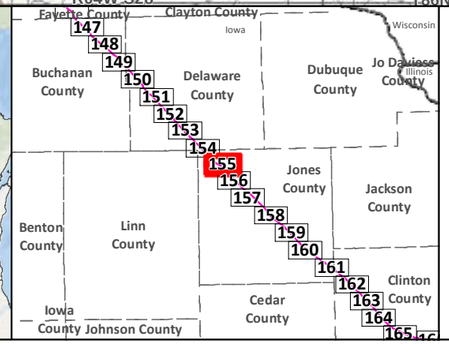
T86N R03W S30
T86N R03W S29





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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High
Moderate

Native Plant Communities with Biodiversity Significance
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Data Sources:
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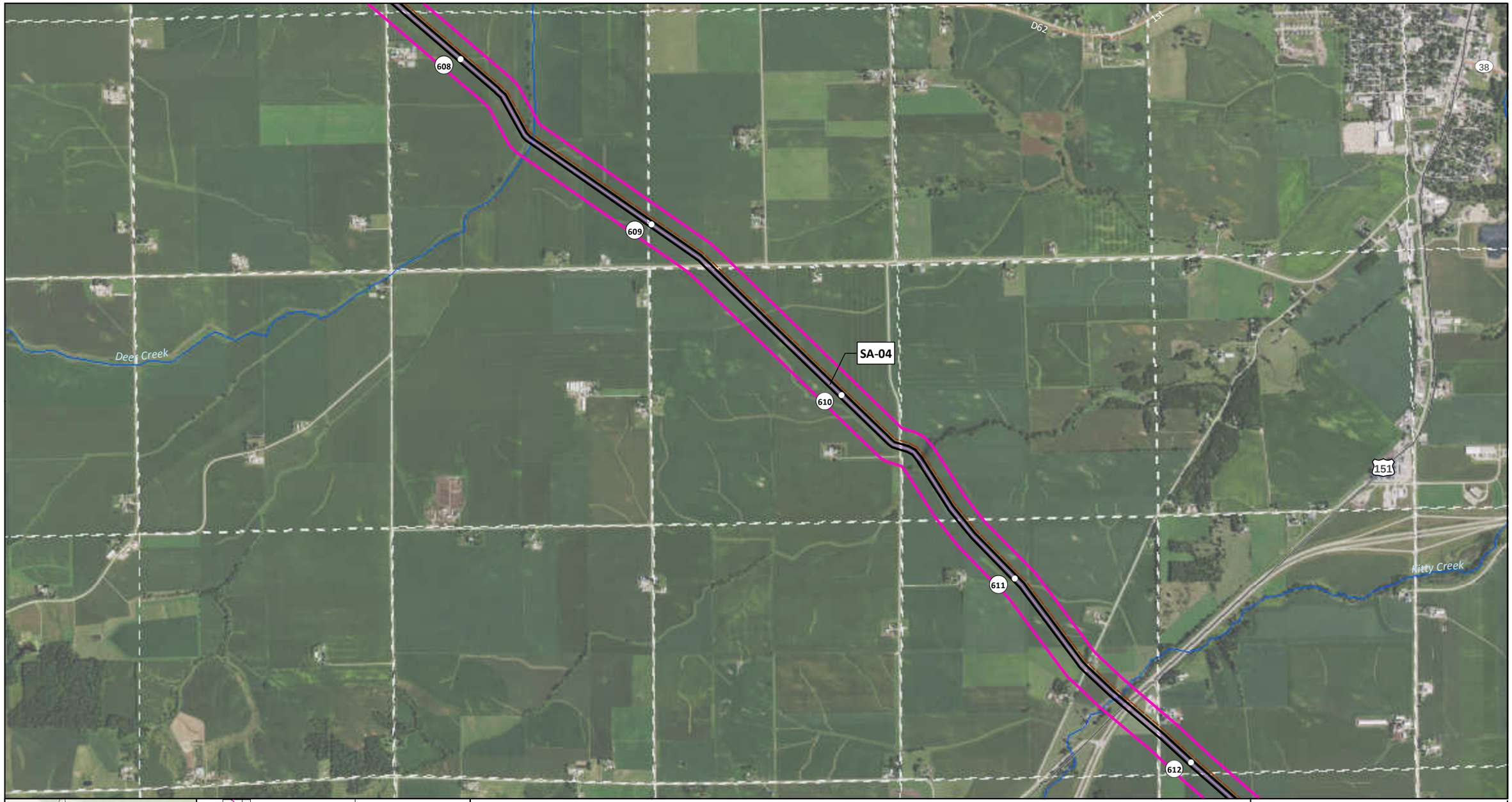
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

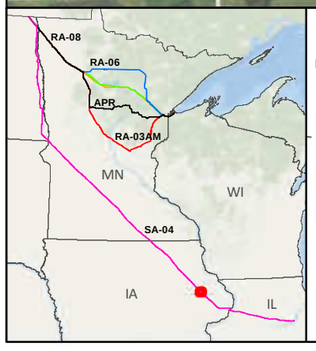
SA-04

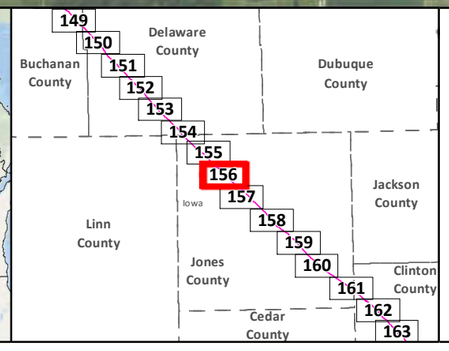
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 155B of 188







- SA-04
- Applicant's Preferred Route (APR)
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Data Sources:
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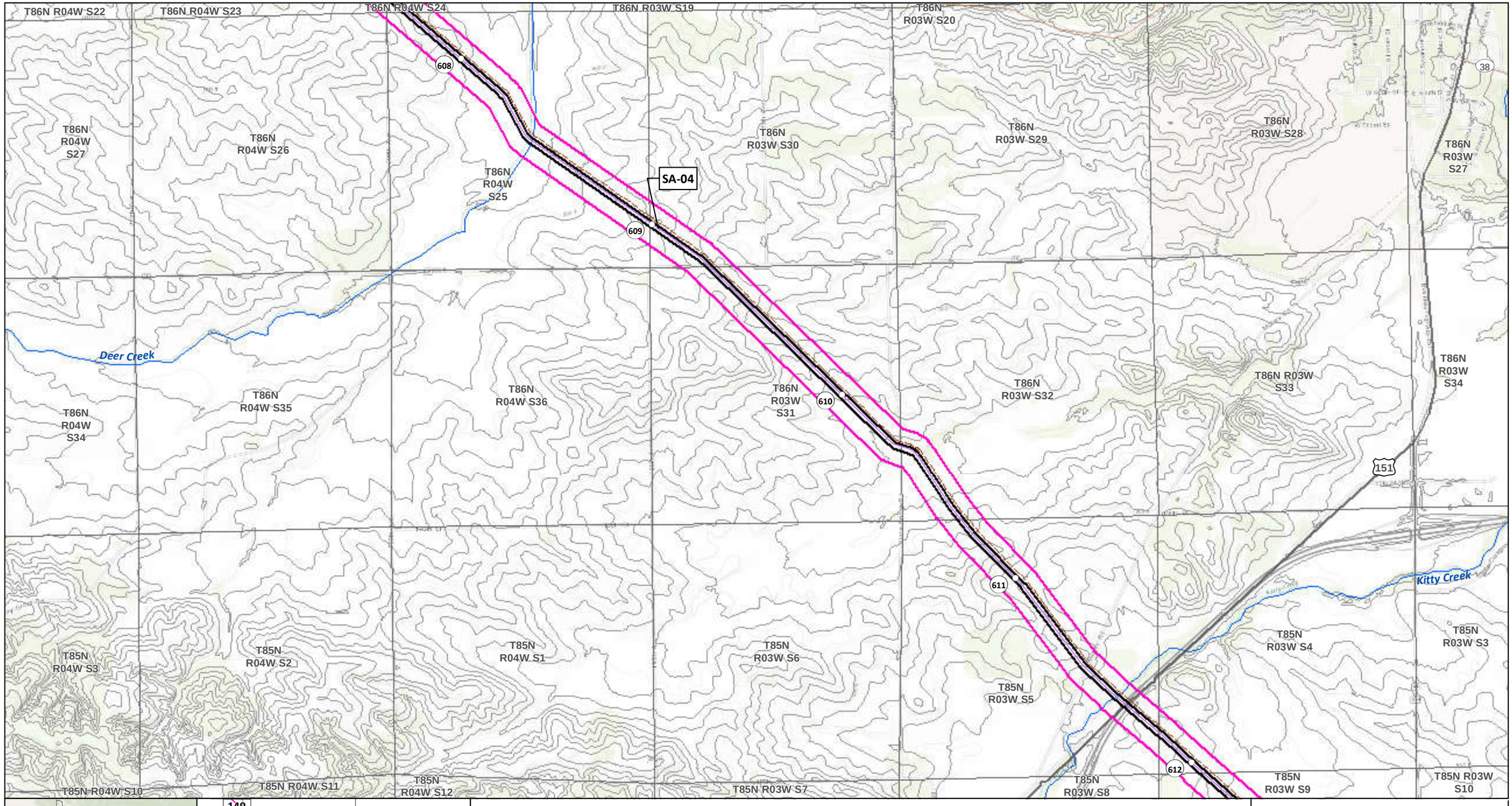
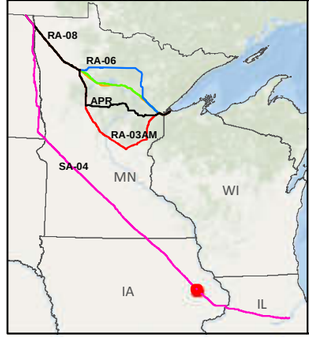
1:24,000
0 125 250 500 Meters

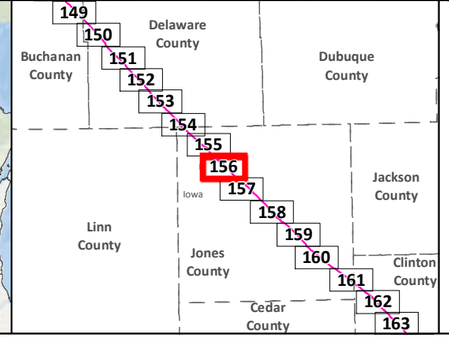
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 156A of 188







- SA-04
- Applicant's Preferred Route (APR)

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- RA-06
- RA-07
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- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 156B of 188

Langworthy

Kitty Creek

SA-04

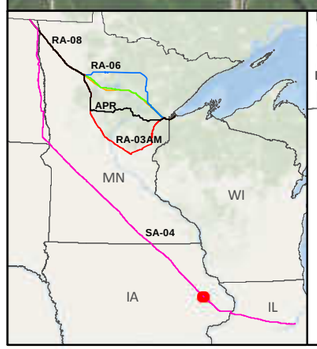
613

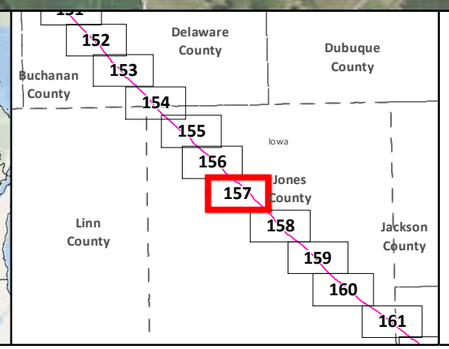
614

615

616

151





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

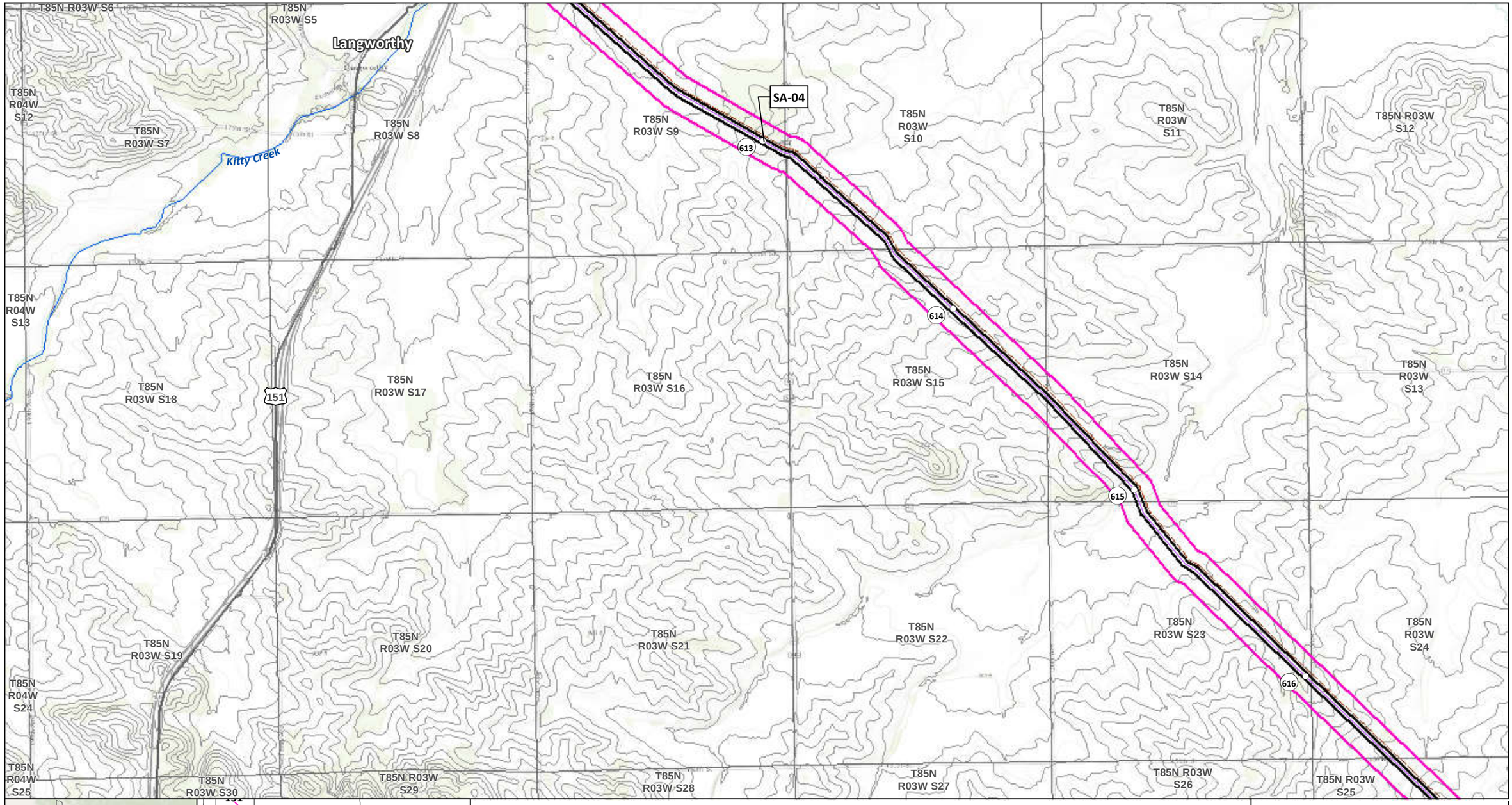
Data Sources:
MNDNR, NHD,USGS, Enbridge

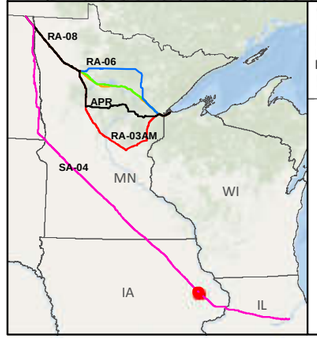
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

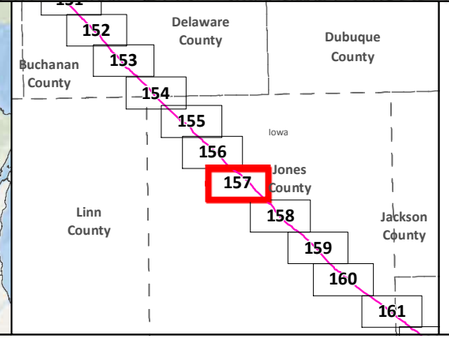
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 157A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
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- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

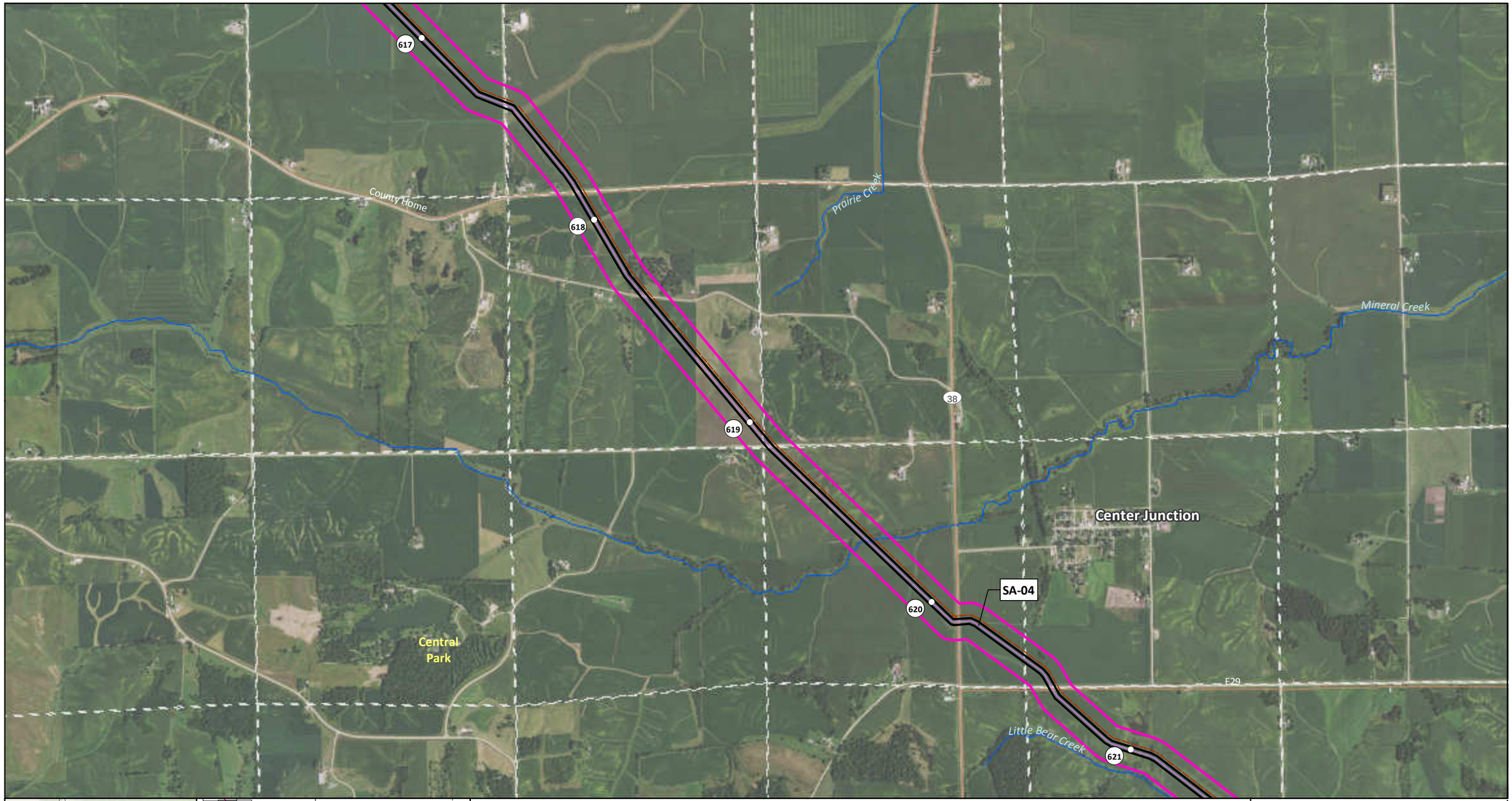
Data Sources: MNDNR, USGS, NHD, Enbridge

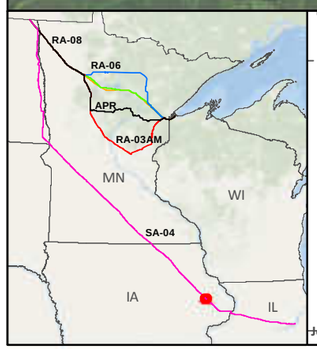
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

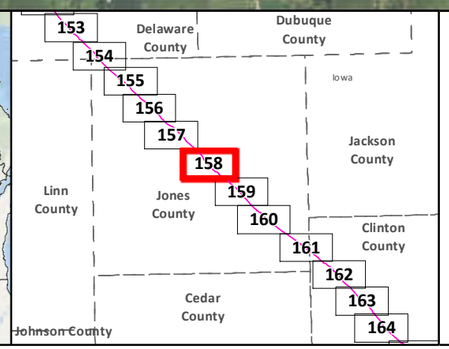
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 157B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

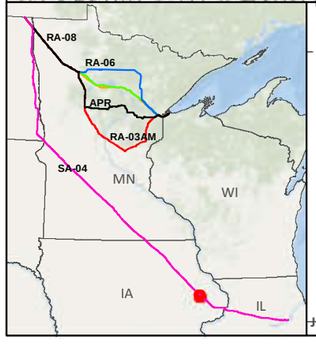
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

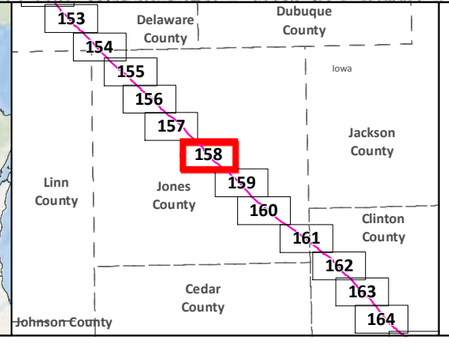
SA-04

T85N R03W S26
T85N R03W S25
T85N R02W S30
T85N R02W S29
T85N R02W S28
T85N R02W S27
T85N R02W S34
T85N R03W S35
T85N R03W S36
T85N R02W S31
T85N R02W S32
T85N R02W S33
T84N R03W S2
T84N R03W S1
T84N R02W S6
T84N R02W S5
T84N R02W S4
T84N R02W S3
T84N R03W S11
T84N R03W S12
T84N R02W S7
T84N R02W S8
T84N R02W S9
T84N R02W S10

617
618
619
620
621
38

Prairie Creek
Mineral Creek
Little Bear Creek
Center Junction
SA-04





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

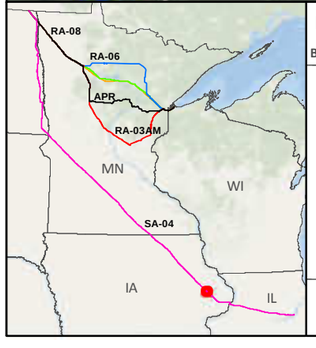
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

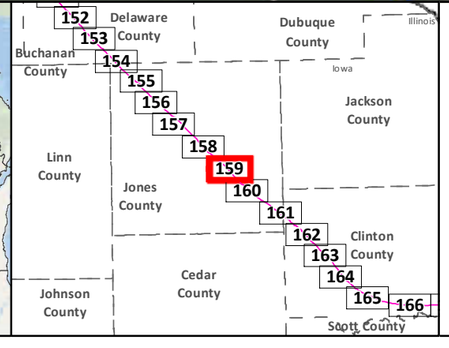
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

622
623
624
625
SA-04
38
136
64
Little Bear Creek
Beers Creek
Bear Creek
Bear Creek
Bear Creek
Bear Creek
Bear Creek
Wyoming
Green Isabel





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 159A of 188

N

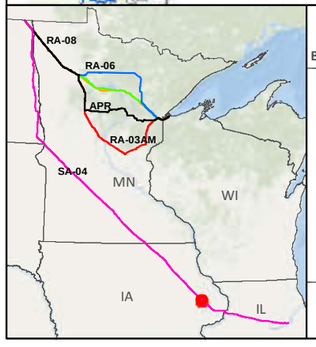
T84N R02W S8
T84N R02W S9
T84N R02W S10
T84N R02W S11
T84N R02W S12
T84N R01W S7
T84N R01W S8
T84N R02W S17
T84N R02W S16
T84N R02W S15
T84N R02W S14
T84N R02W S13
T84N R01W S18
T84N R01W S17
T84N R02W S20
T84N R02W S21
T84N R02W S22
T84N R02W S23
T84N R02W S24
T84N R01W S19
T84N R01W S20
T84N R02W S29
T84N R02W S28
T84N R02W S27
T84N R02W S26
T84N R02W S25
T84N R01W S30
T84N R01W S29

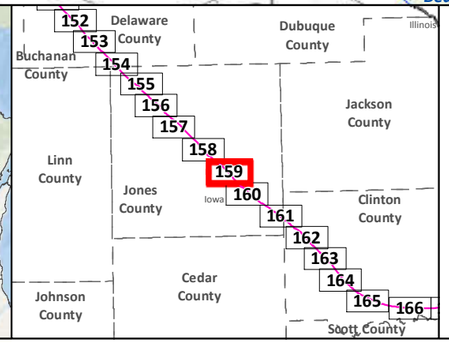
622
623
624
625
38
136
64

SA-04

Little Bear Creek
Beers Creek
Bear Creek
Bear Creek
Bear Creek

Wyoming





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

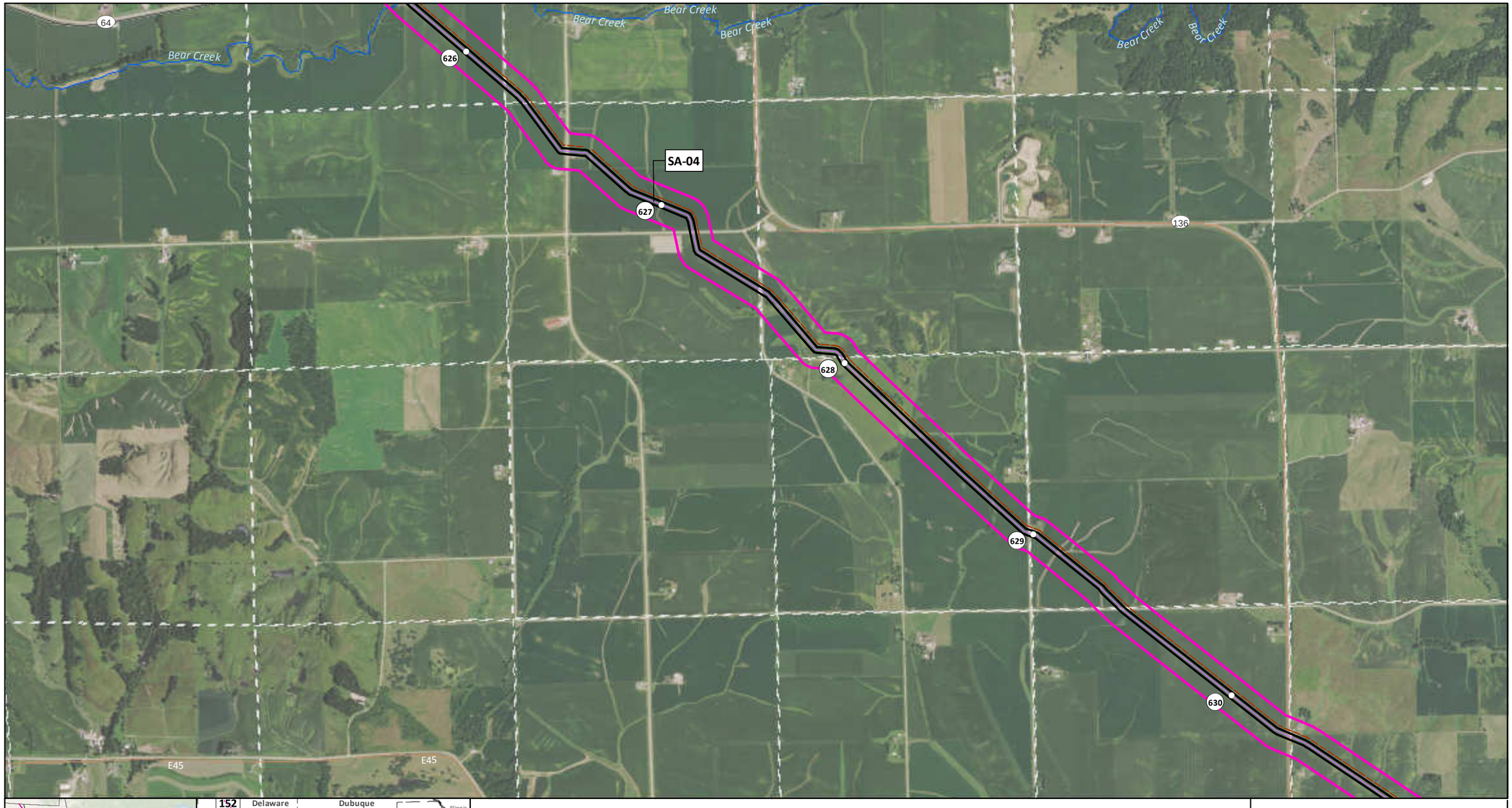
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

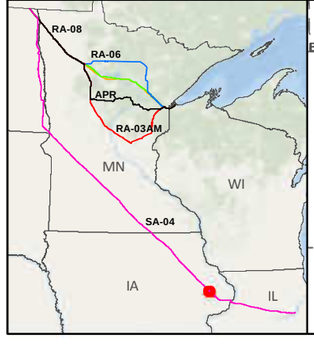
SA-04

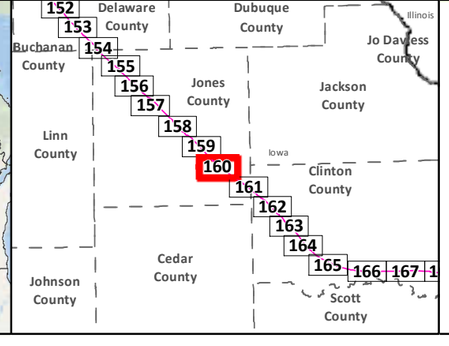
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 159B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

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State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

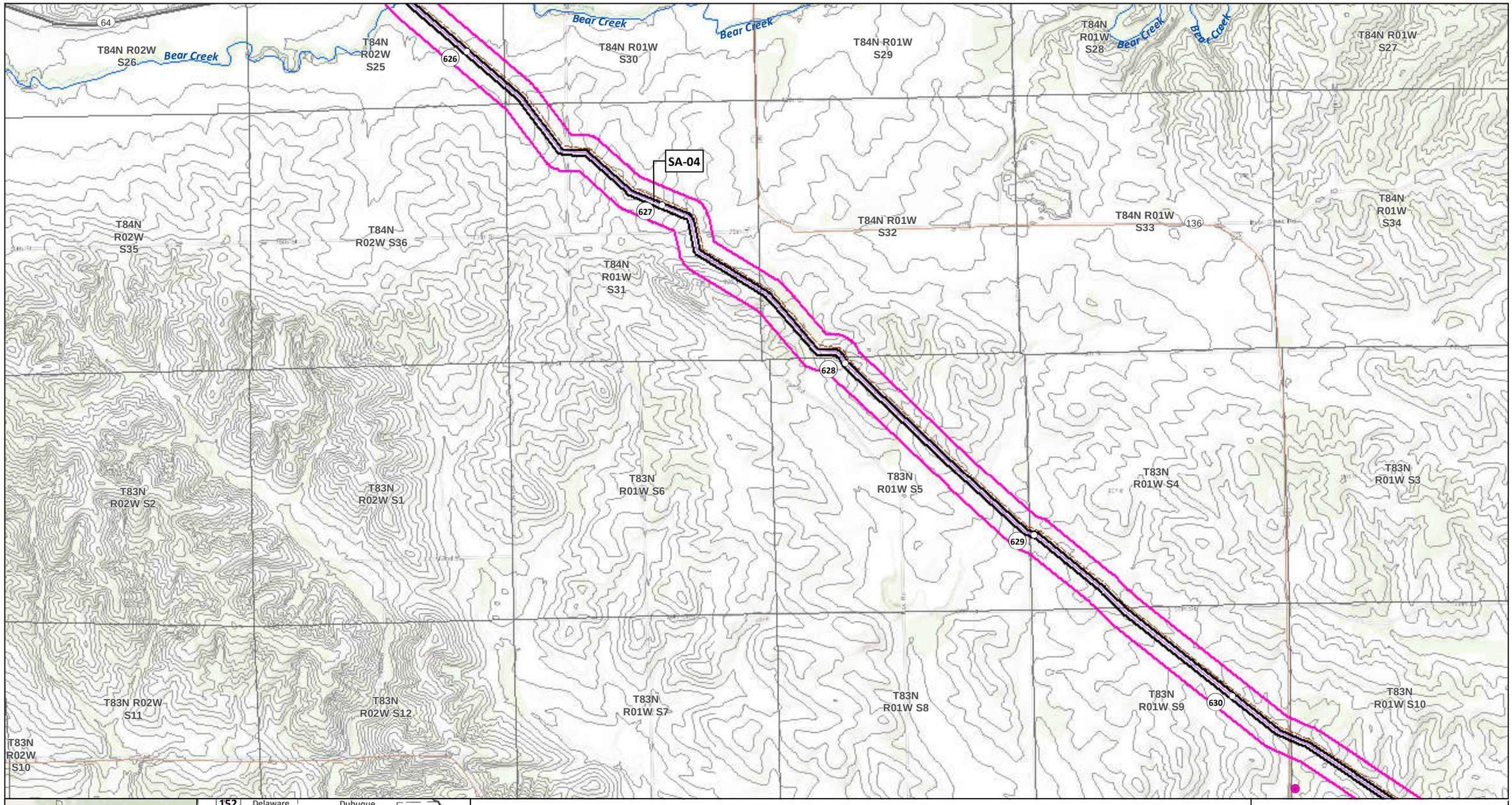
Data Sources:
MNDNR, NHD,USGS, Enbridge

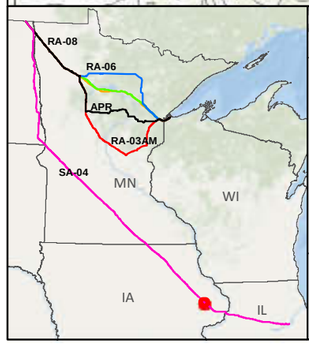
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

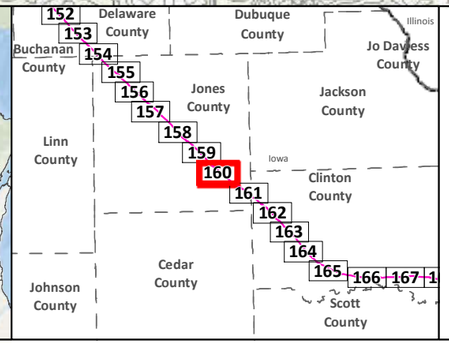
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 160A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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Native Plant Communities with Biodiversity Significance
- Outstanding
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

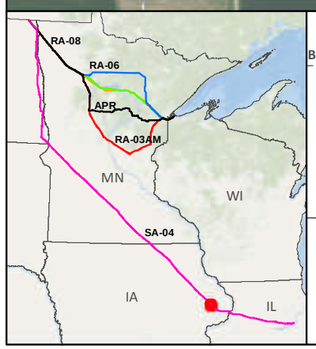
SA-04

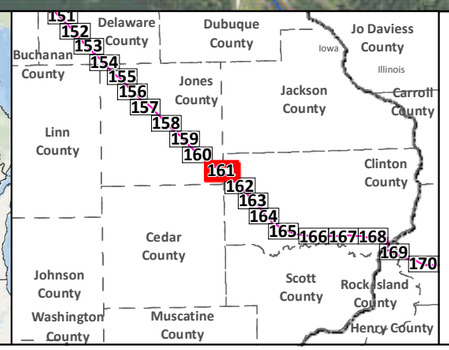
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 160B of 188

631
632
633
634
635
136
SA-04
E45
Oxford Junction
1st
X64
Wapsipinicon River





SA-04
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Route Width (750')
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0 0.125 0.25 0.5 Miles
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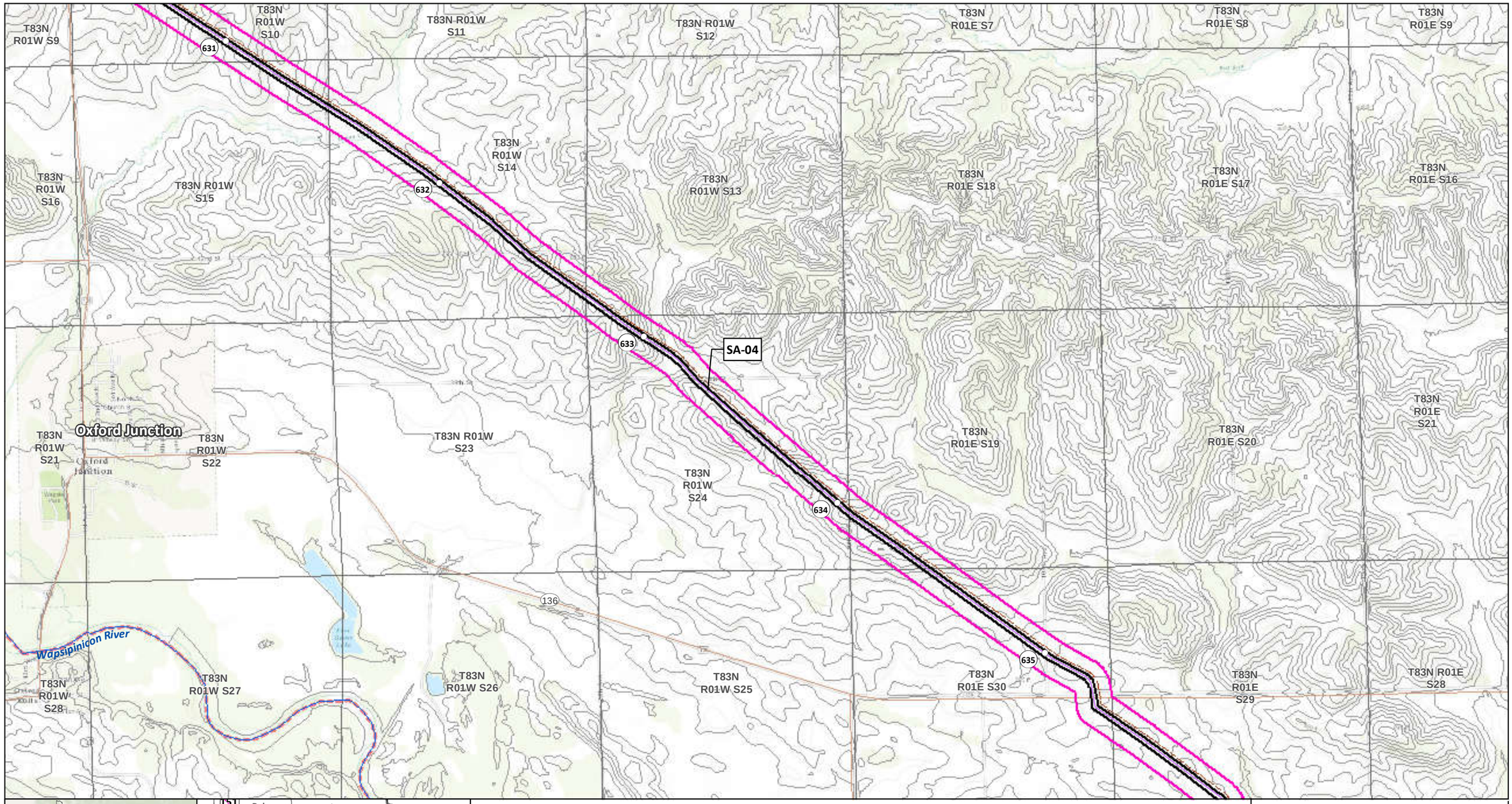
0 125 250 500 Meters

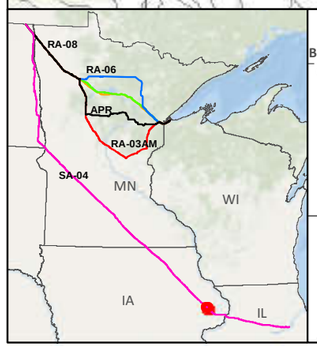
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

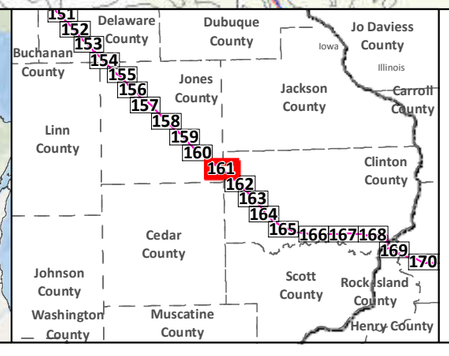
SA-04

Map 161A of 188

N







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

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- RA-06
- RA-07
- RA-08
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Township Boundary

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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

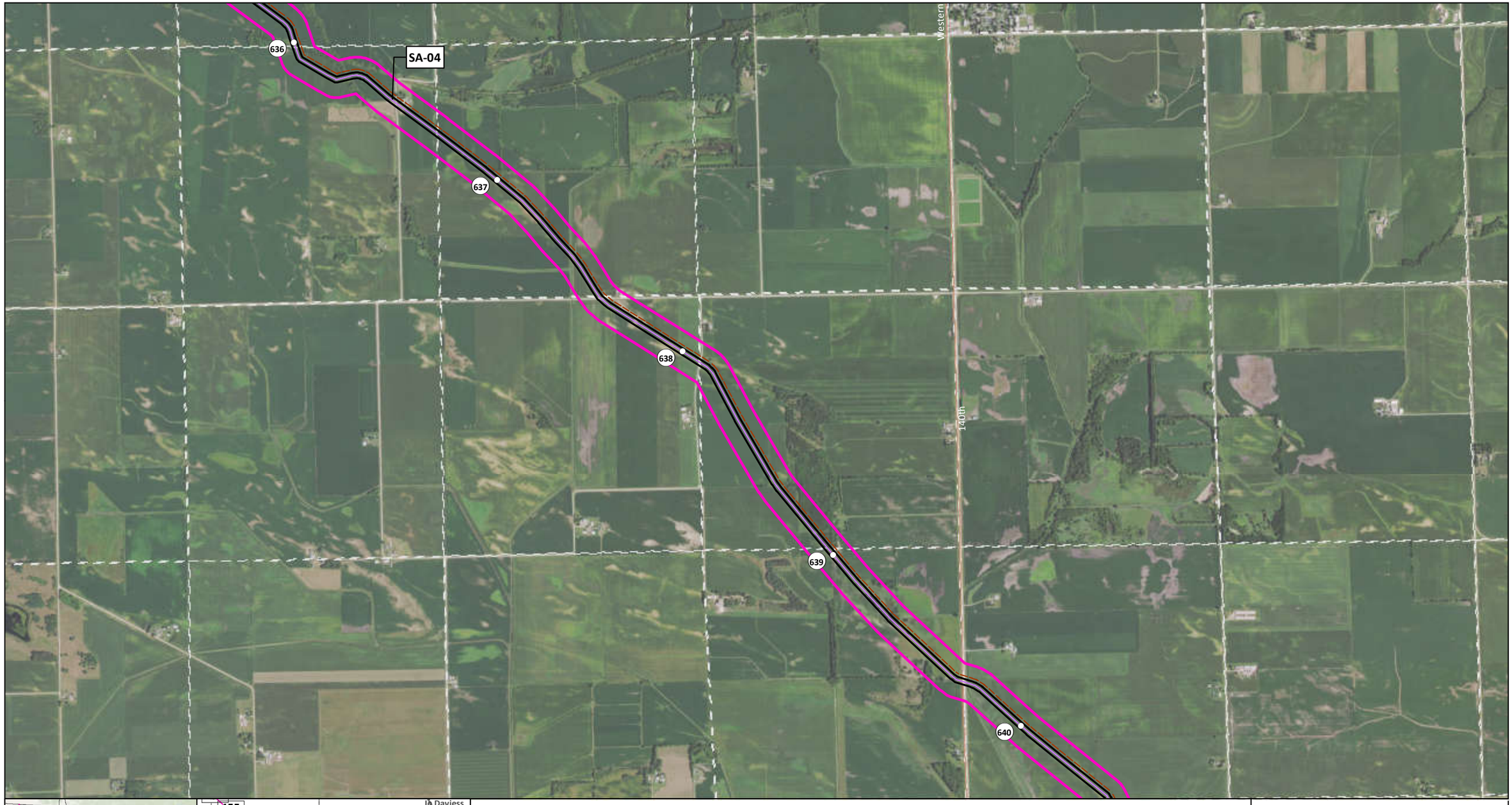
0 125 250 500 Meters

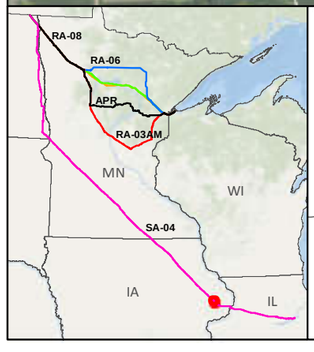
1:24,000

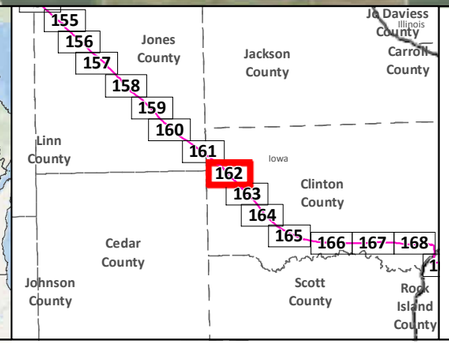
10ft Contours

N

Map 161B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary

- Mile Post
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- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
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- National Forest
- Tribal Reservation

Water Resources
- Lake
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Data Sources:
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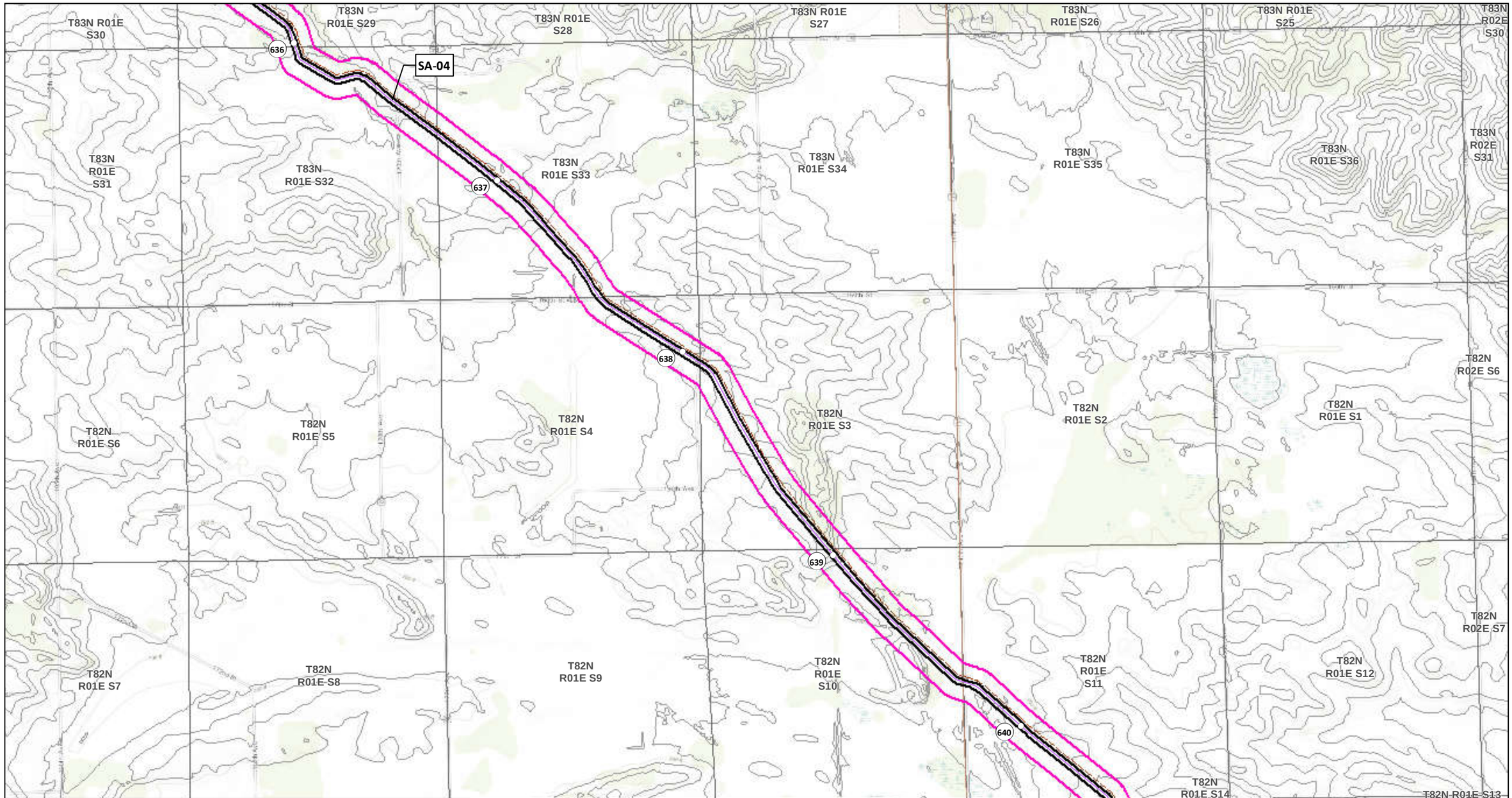
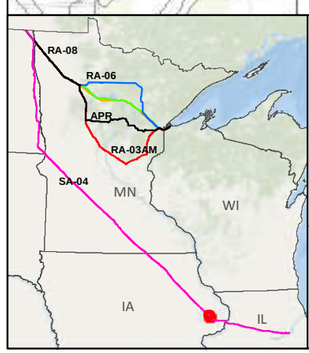
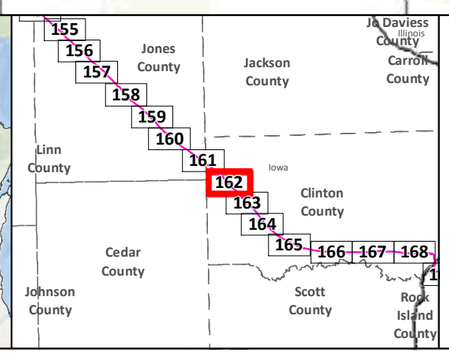
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







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- Applicant's Preferred Route (APR)

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- RA-06
- RA-07
- RA-08
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- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

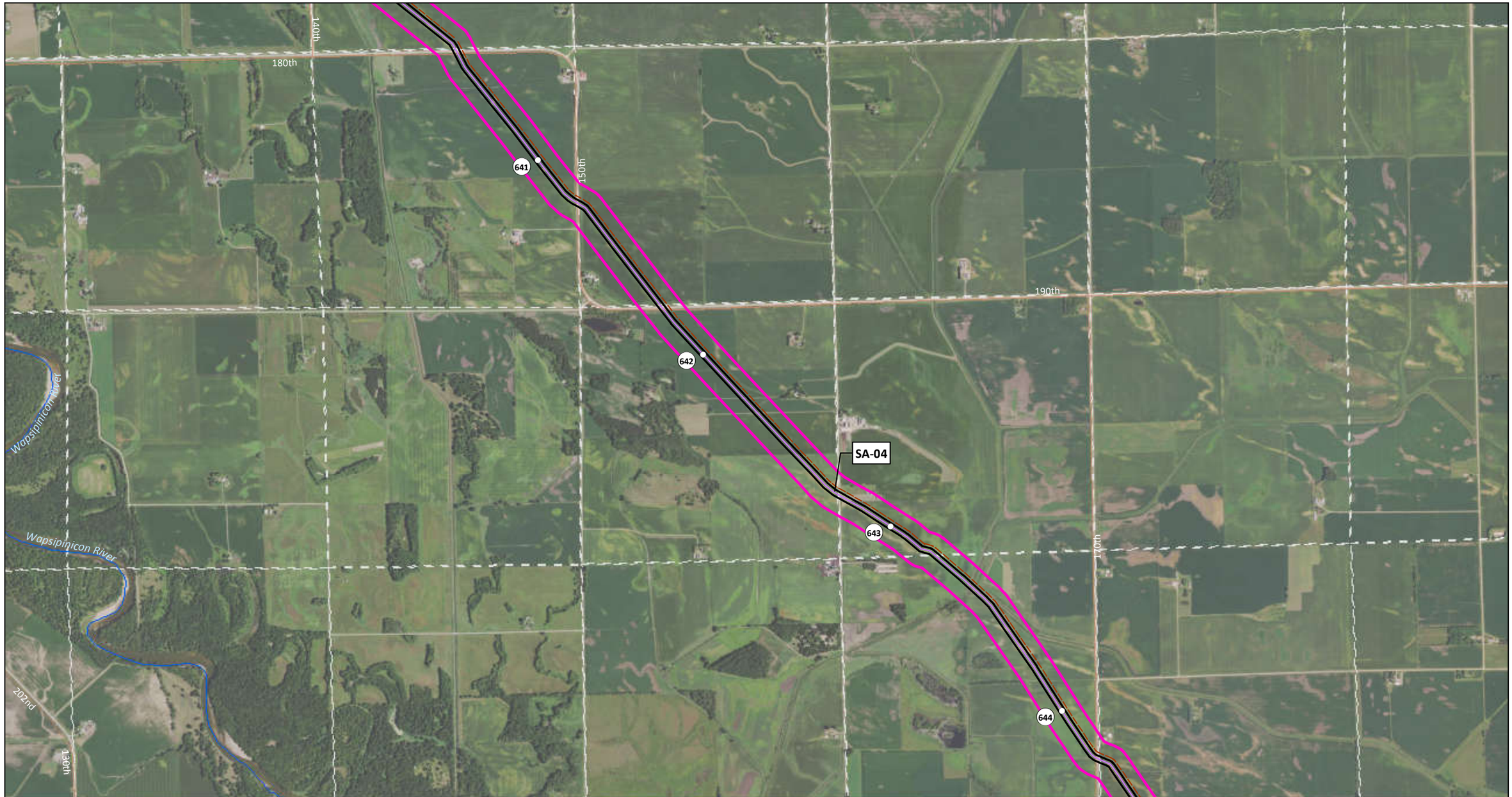
Data Sources: MNDNR, USGS, NHD, Enbridge

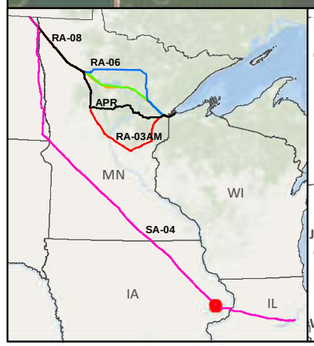
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

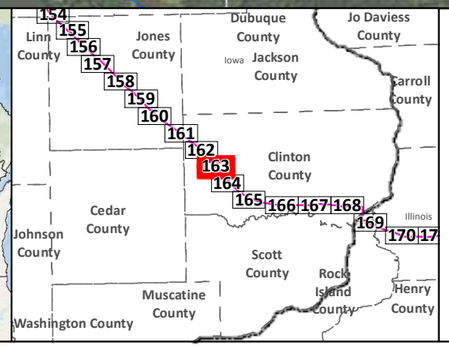
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 162B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

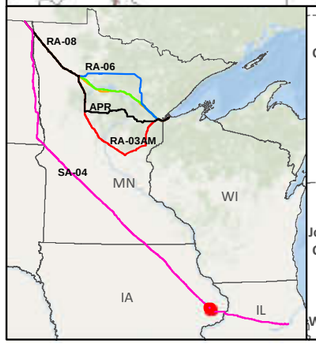
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

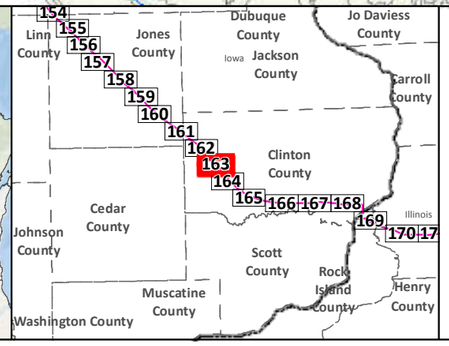
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 163A of 188

T82N R01E S9
T82N R01E S10
T82N R01E S11
T82N R01E S12
T82N R02E S7
T82N R02E S8
T82N R02E S9
T82N R01E S16
T82N R01E S15
T82N R01E S14
T82N R01E S13
T82N R02E S18
T82N R02E S17
T82N R02E S16
641
642
643
644
SA-04
Wapsipinicon River
T82N R01E S21
T82N R01E S22
T82N R01E S23
T82N R01E S24
T82N R02E S19
T82N R02E S20
T82N R02E S21
T82N R01E S28
T82N R01E S27
T82N R01E S26
T82N R01E S25
T82N R02E S30
T82N R02E S29
T82N R02E S28





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
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- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

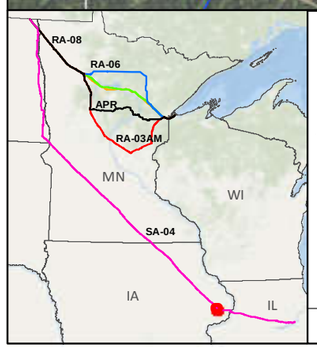
SA-04

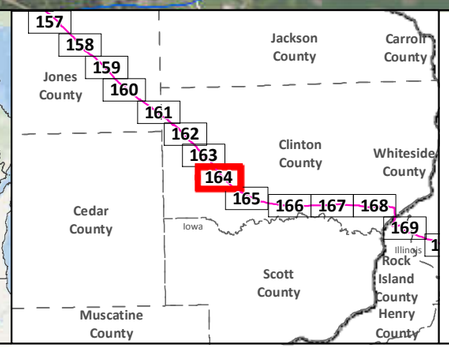
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 163B of 188

645
646
647
648
SA-04
170th
Wapsipinicon River
Calamus Creek
30





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

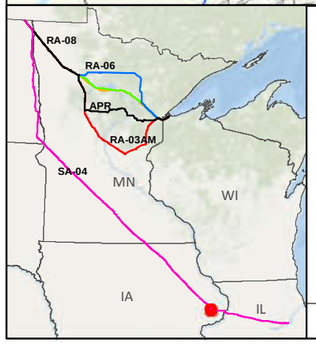
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

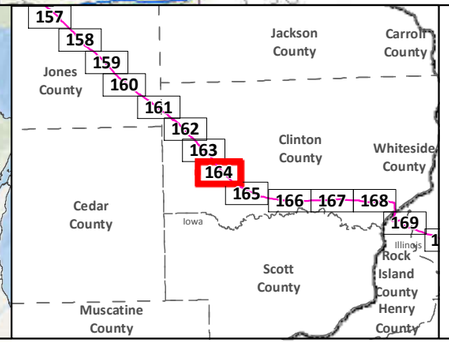
SA-04

Map 164A of 188

N

T82N R01E S26
T82N R01E S25
T82N R02E S30
T82N R02E S29
T82N R02E S28
T82N R02E S27
T82N R02E S26
T82N R01E S35
T82N R01E S36
T82N R02E S31
T82N R02E S32
T82N R02E S33
T82N R02E S34
T82N R02E S35
645
646
647
648
SA-04
Wapsipinicon River
T81N R01E S1
T81N R02E S6
T81N R02E S5
T81N R02E S4
T81N R02E S3
T81N R02E S2
T81N R01E S2
Syracuse WMA
T81N R01E S11
T81N R01E S12
T81N R02E S7
T81N R02E S8
T81N R02E S9
T81N R02E S10
T81N R02E S11
Calamus Creek
T81N R02E S16
T81N R02E S15
T81N R02E S14
30





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

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- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

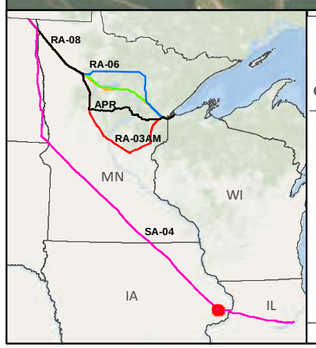
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

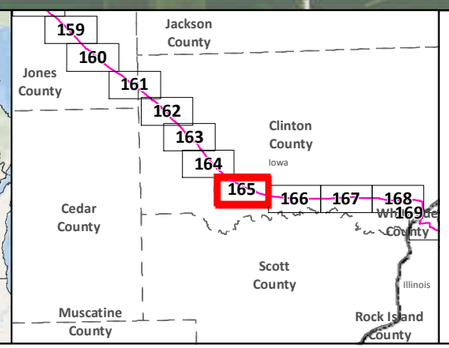
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

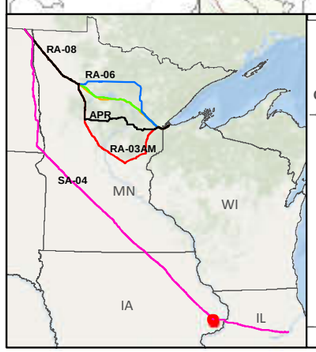
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

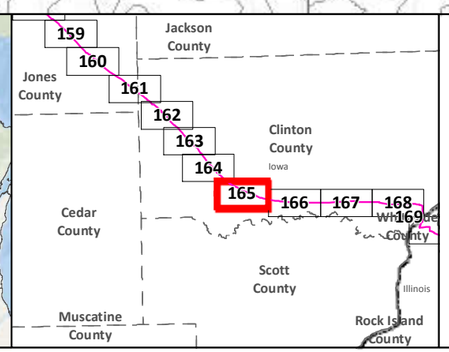
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 165A of 188

T81N R02E S9
T81N R02E S10
T81N R02E S11
T81N R02E S12
T81N R03E S7
T81N R03E S8
T81N R03E S9
30
649
650
651
652
653
Crystal Creek
Grand Mound
T81N R02E S16
T81N R02E S15
T81N R02E S14
T81N R02E S13
T81N R03E S18
T81N R03E S17
T81N R03E S16
T81N R02E S21
T81N R02E S22
T81N R02E S23
T81N R02E S24
T81N R03E S19
T81N R03E S20
T81N R03E S21
Barber Creek
SA-04
T81N R02E S27
T81N R02E S26
T81N R02E S25
T81N R03E S30
T81N R03E S29
T81N R03E S28
T81N R02E S28
T81N R02E S35
T81N R02E S36
T81N R03E S31
T81N R03E S32
T81N R03E S33





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
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- National River Inventory Crossing
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- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
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- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

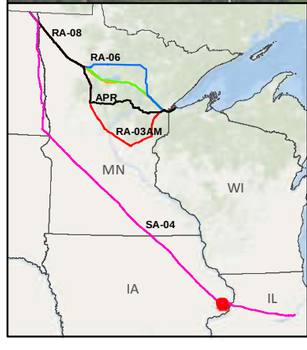
SA-04

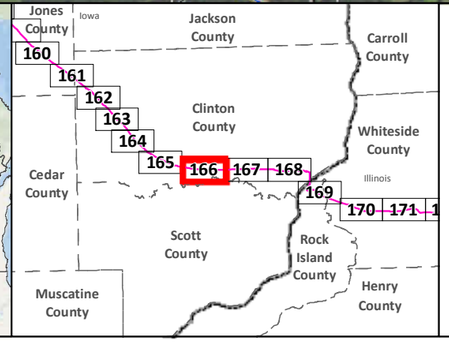
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 165B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

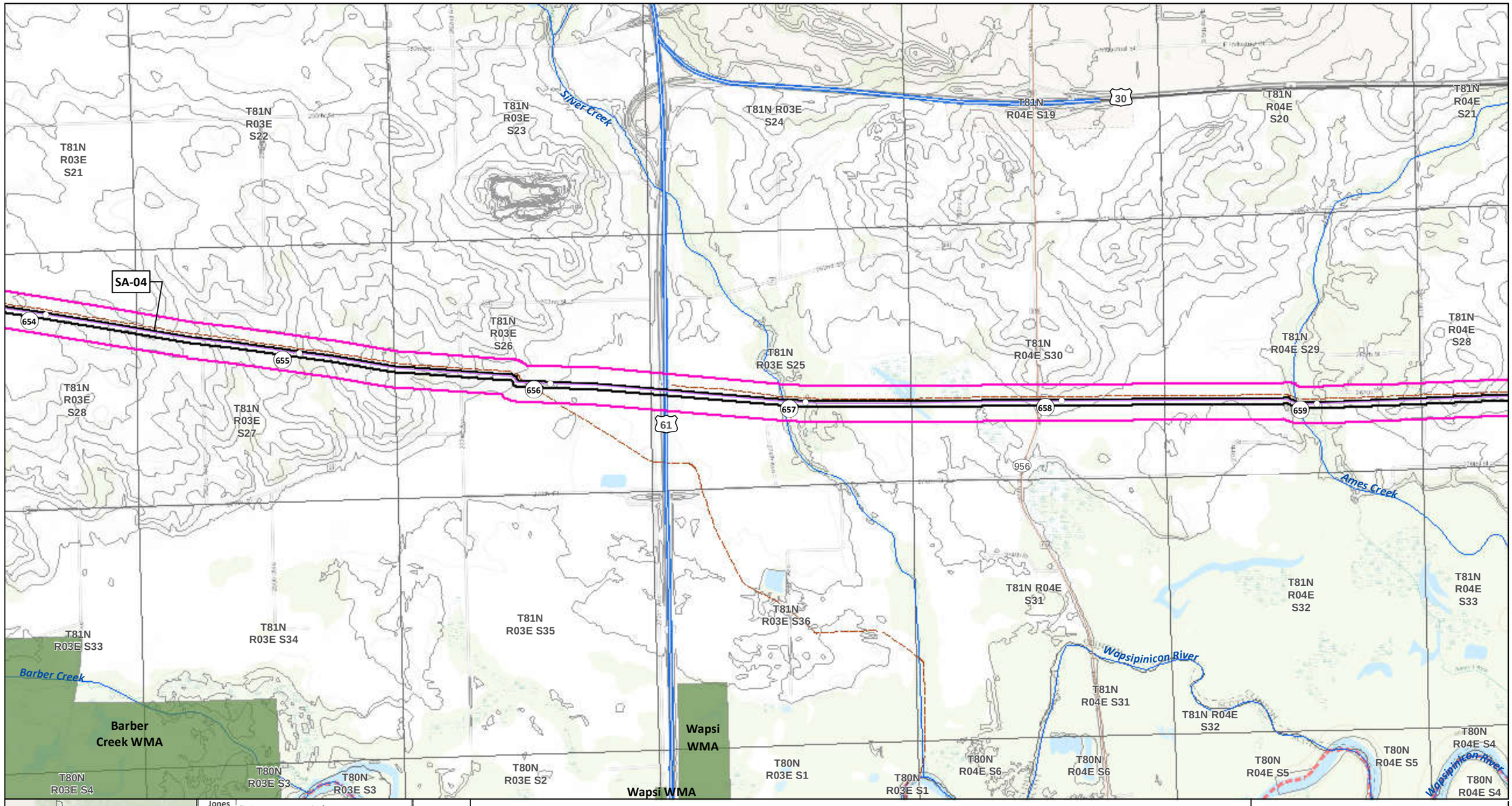
Data Sources:
MNDNR, NHD,USGS, Enbridge

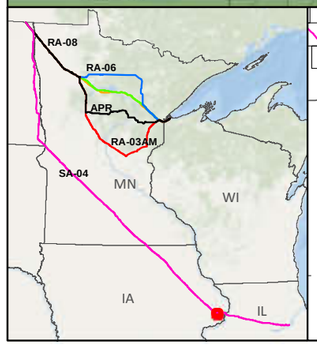
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

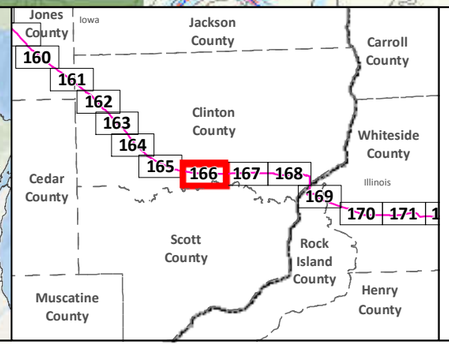
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 166A of 188







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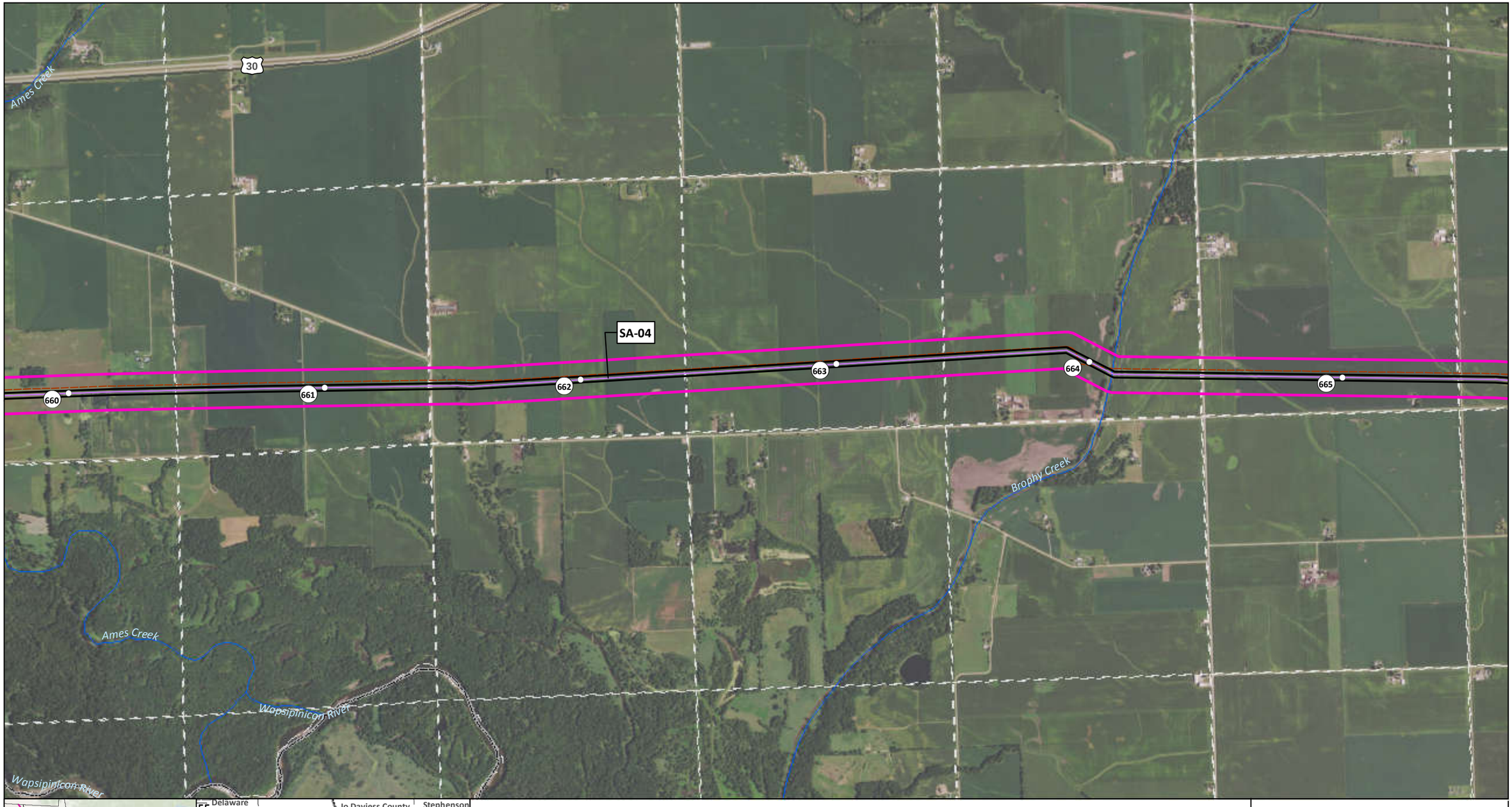
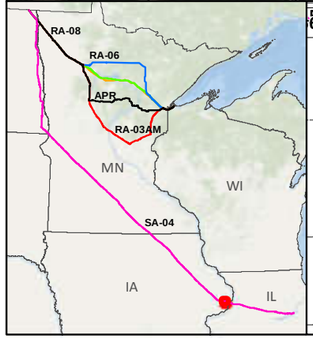
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

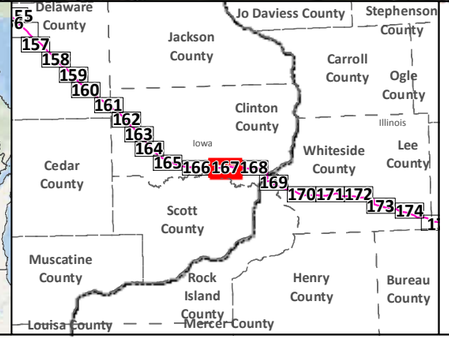
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 166B of 188







SA-04
Applicant's Preferred Route (APR)
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Route Width (750')
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Lake
River

Data Sources:
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0 0.125 0.25 0.5 Miles
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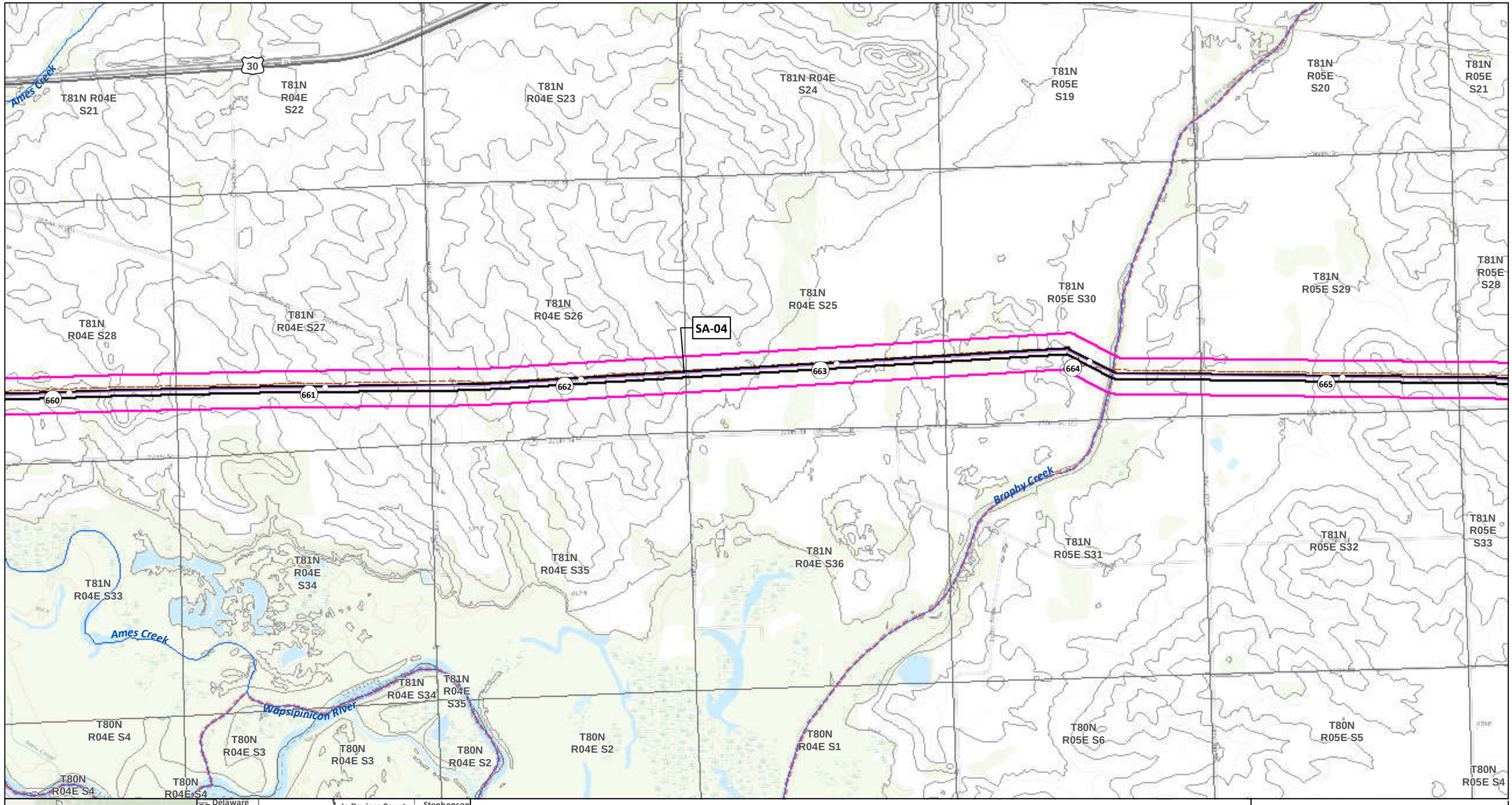
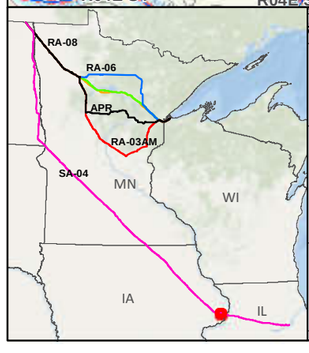
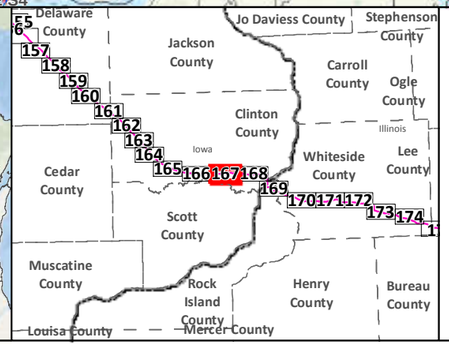
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

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- RA-06
- RA-07
- RA-08
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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 167B of 188

Low Moor

3rd

Rock Creek

SA-04

666

667

668

669

670

671

672

67

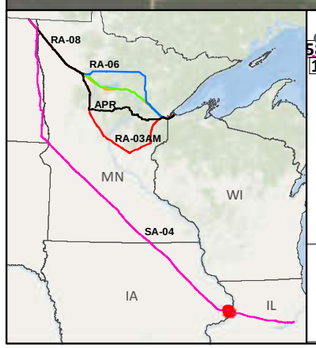
380th

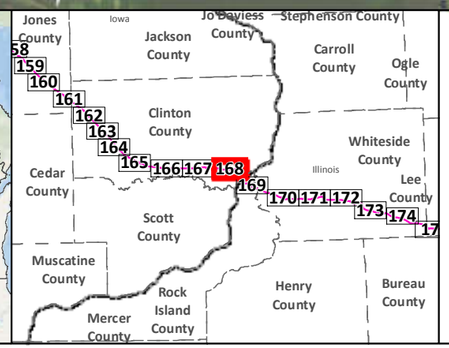
9th

Sodus Creek

Mississippi River

Mississippi River





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary

- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
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- Tribal Reservation

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- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

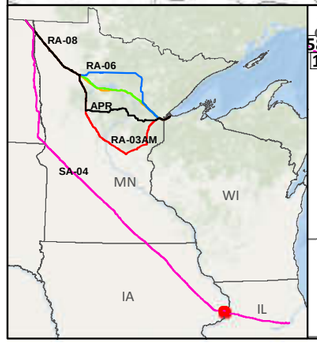
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

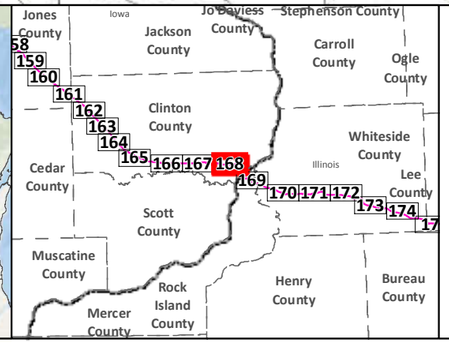
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 168A of 188

T81N R05E S21
T81N R05E S22
T81N R05E S23
T81N R05E S24
T81N R06E S19
T81N R06E S20
T81N R06E S21
Low Moor
Rock Creek
T81N R06E S28
T81N R05E S28
T81N R05E S27
T81N R05E S26
T81N R05E S25
T81N R06E S30
T81N R06E S29
666
667
668
669
670
671
SA-04
T81N R06E S33
T81N R05E S33
T81N R05E S34
T81N R05E S35
T81N R05E S36
T81N R06E S31
T81N R06E S32
67
672
Sodus Creek
Mississippi River
T80N R05E S4
T80N R05E S3
T80N R05E S2
T80N R05E S1
T80N R06E S6
T80N R06E S5
Upper Mississippi River Wildlife and Fish Refuge
Mississippi River
T21N R2E S33
T21N R2E S32





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

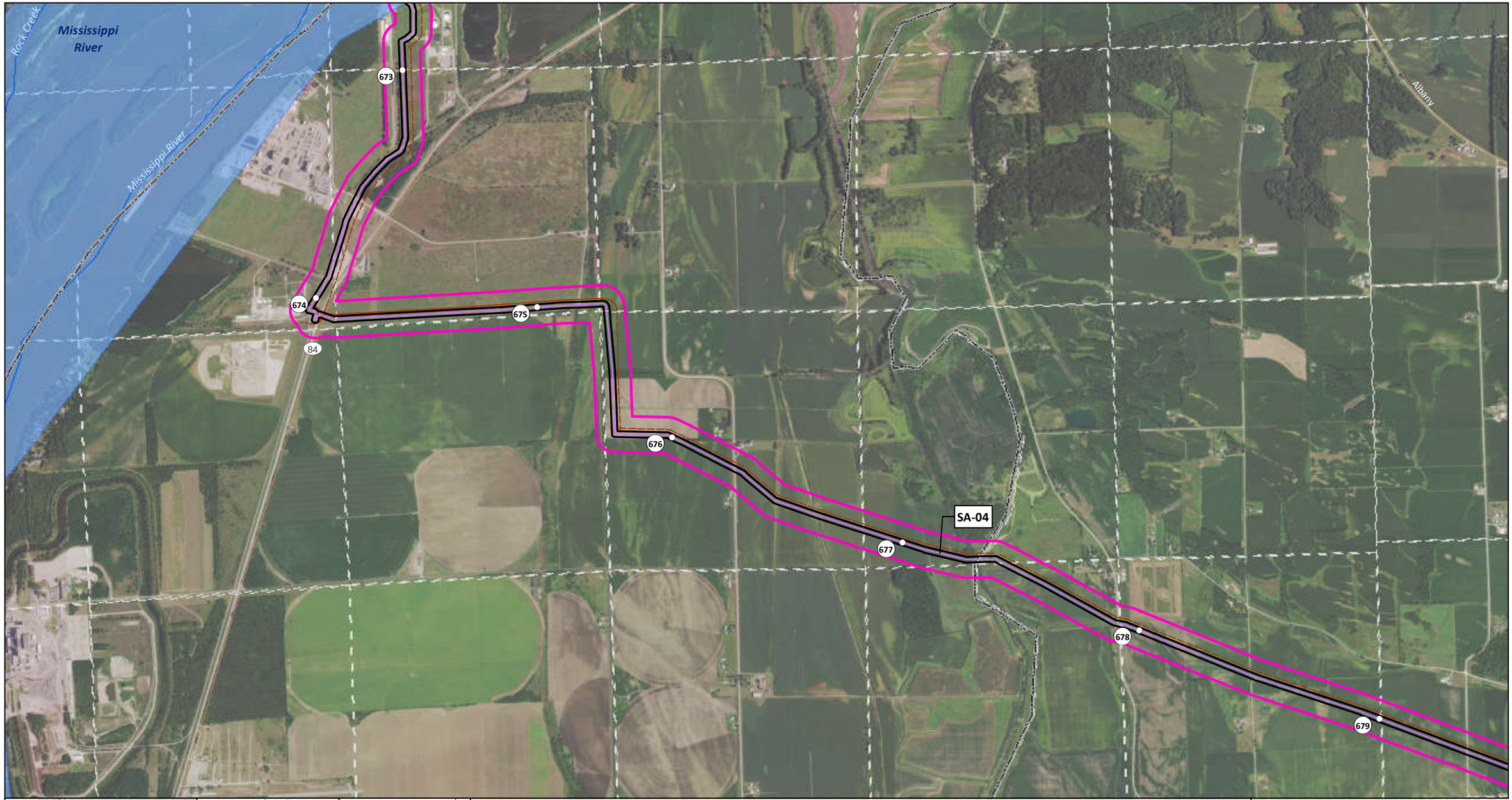
Data Sources: MNDNR, USGS, NHD, Enbridge

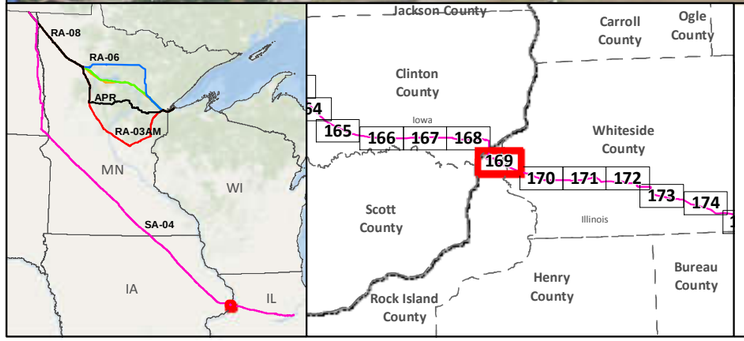
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

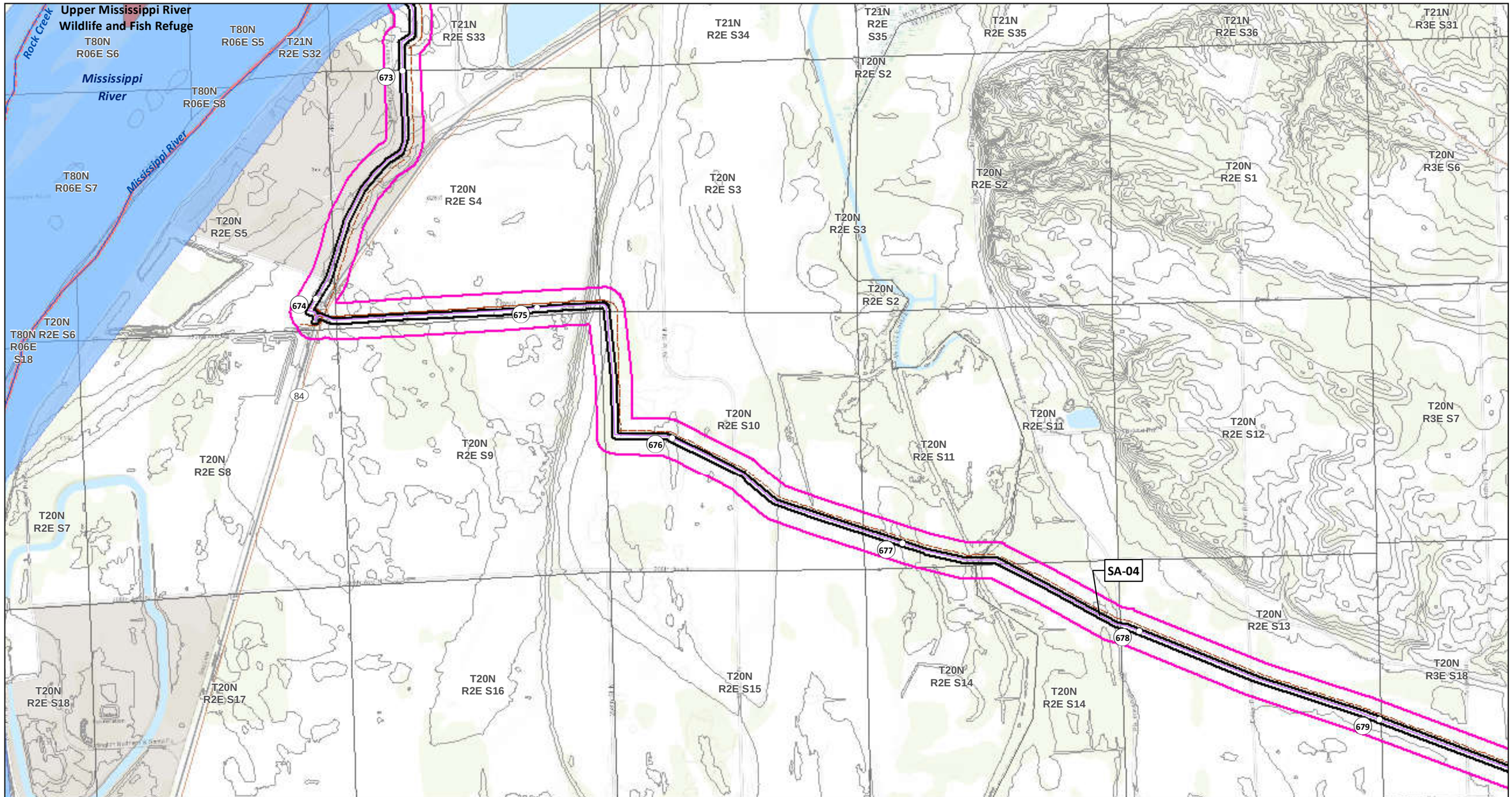
Data Sources:
MNDNR, NHD,USGS, Enbridge

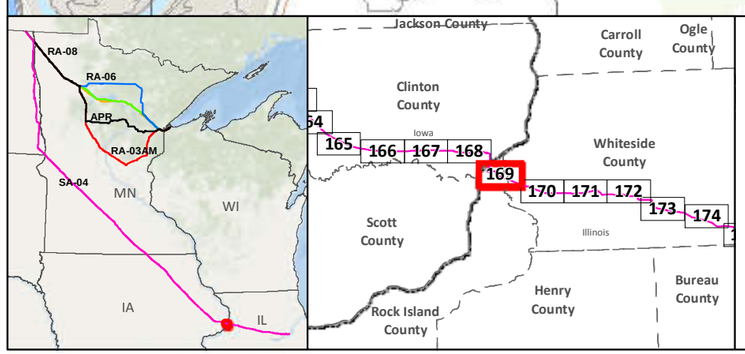
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 169A of 188





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08

Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

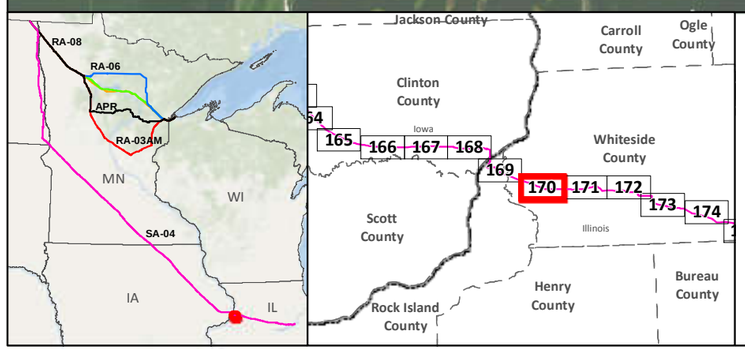
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 169B of 188





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

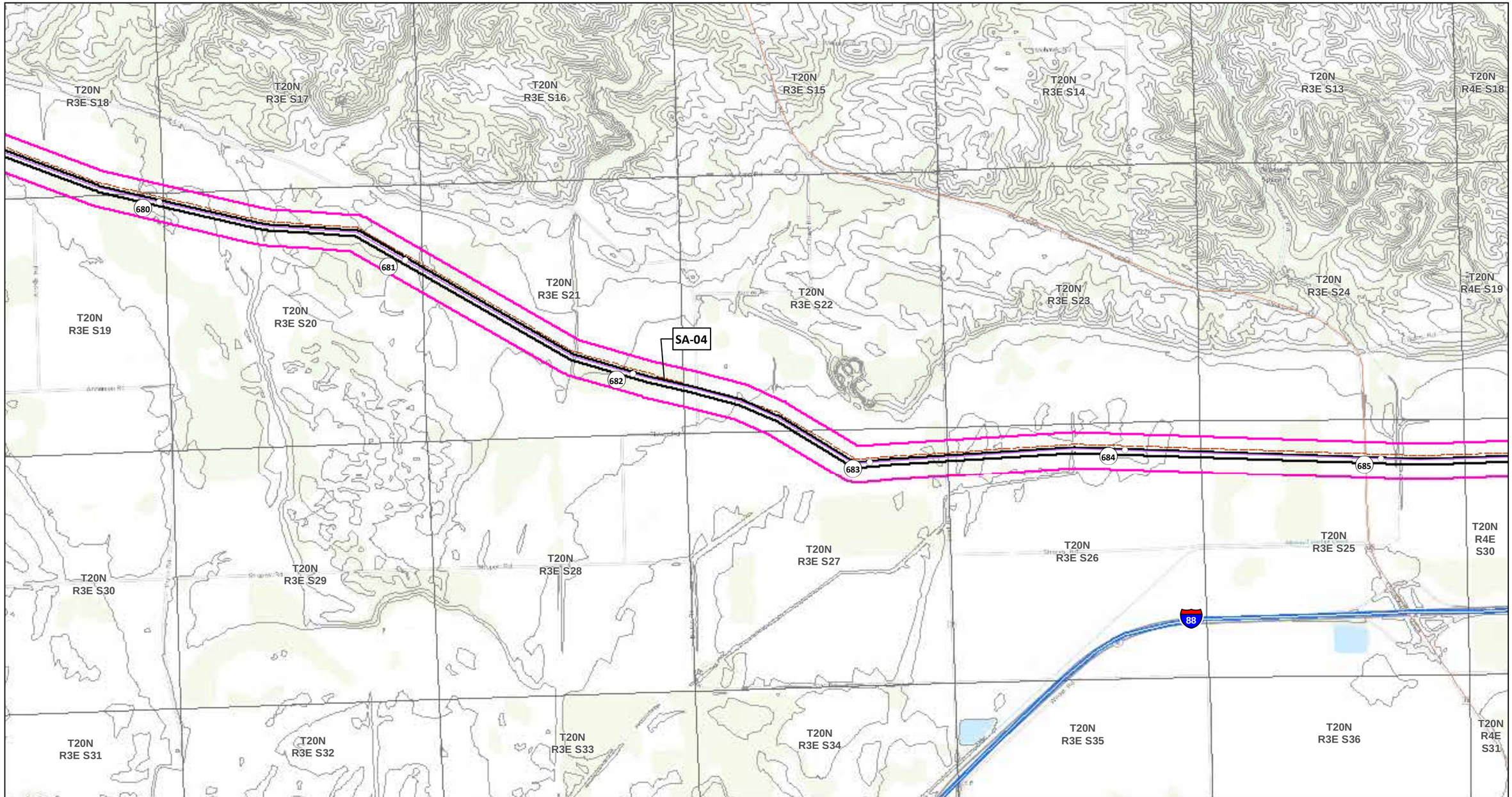
Data Sources:
MNDNR, NHD,USGS, Enbridge

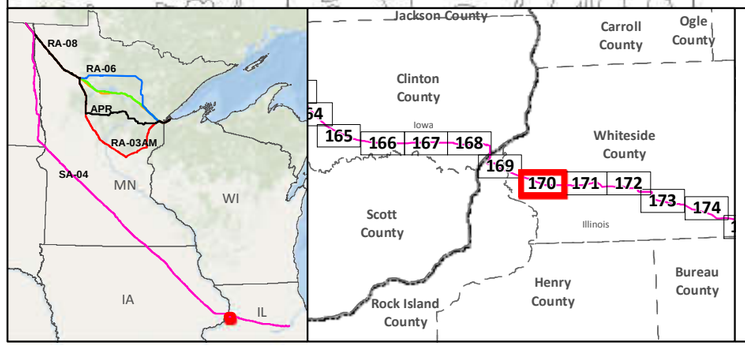
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 170A of 188





SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
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Lakes of Biological Significance

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- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

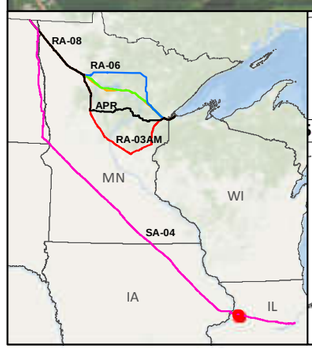
1:24,000

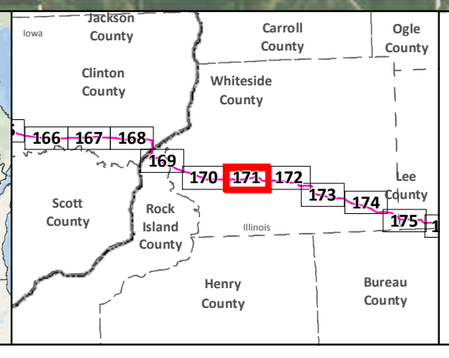
10ft Contours

N

Map 170B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources: MNDNR, NHD,USGS, Enbridge

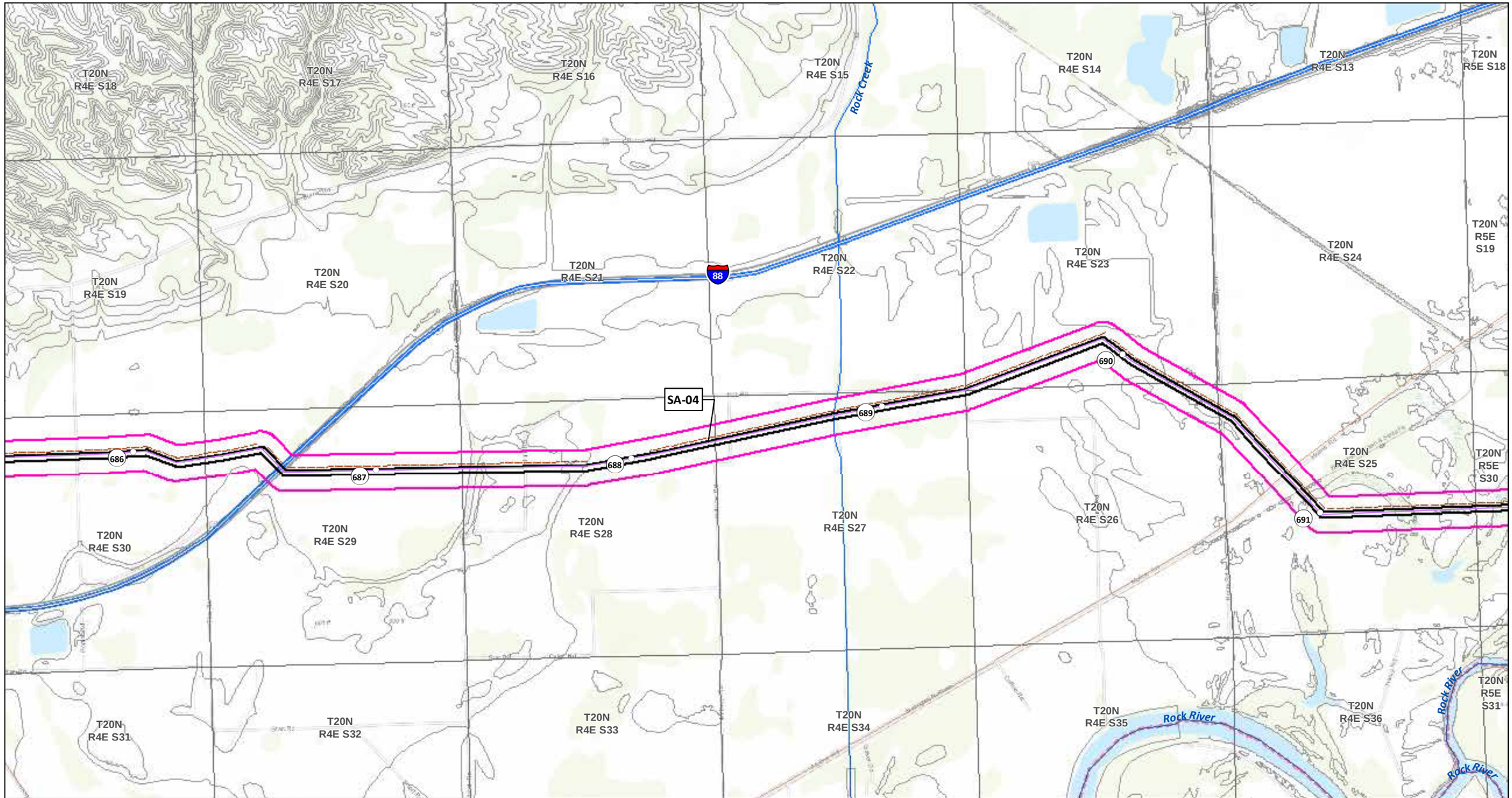
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

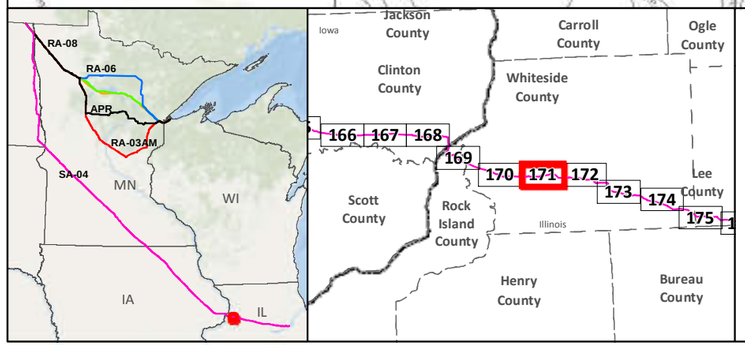
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 171A of 188

N





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

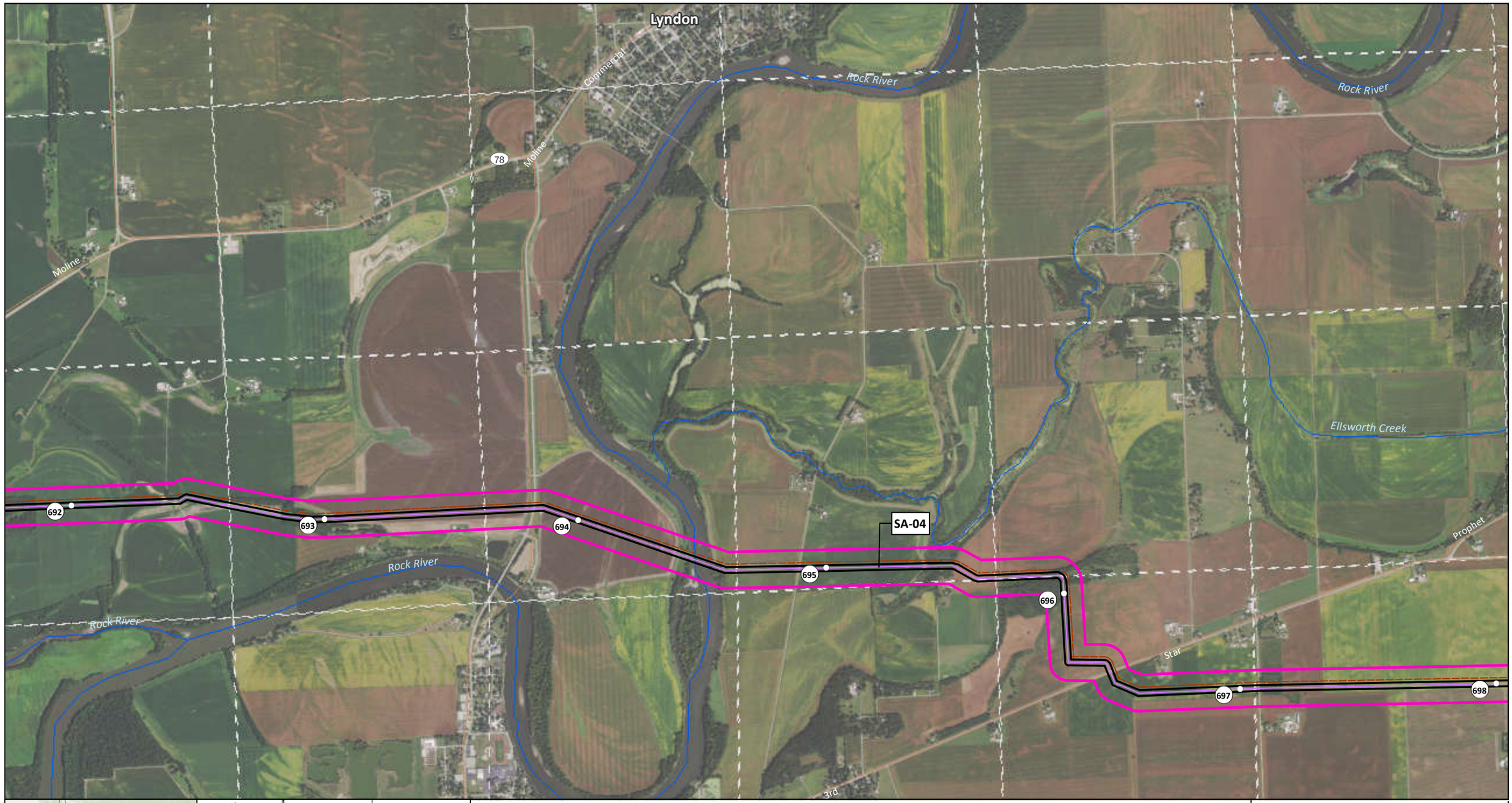
Data Sources: MNDNR, USGS, NHD, Enbridge

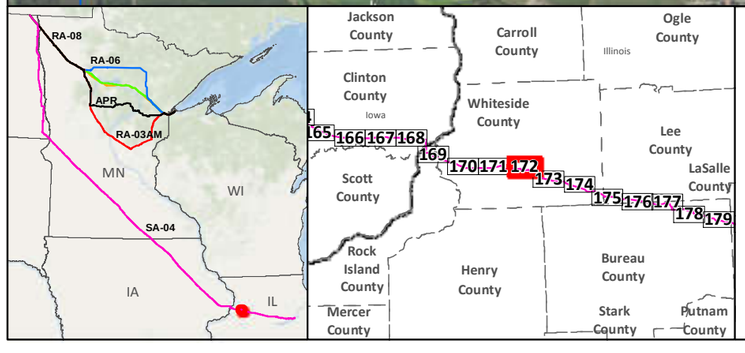
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 171B of 188





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 172A of 188

Lyndon

T20N R5E S18 | T20N R5E S17 | T20N R5E S16 | T20N R5E S15 | T20N R5E S14 | T20N R5E S13 | T20N R6E S18

T20N R6E S19

T20N R5E S19 | T20N R5E S20 | T20N R5E S21 | T20N R5E S22 | T20N R5E S23 | T20N R5E S24

T20N R6E S30

T20N R5E S25

T20N R5E S26

T20N R5E S27

T20N R5E S28

T20N R5E S29

T20N R5E S30

T20N R5E S31

T20N R5E S32

T20N R5E S33

T20N R5E S34

T20N R5E S35

T20N R5E S36

Rock River

Ellsworth Creek

78

692 | 693 | 694 | 695 | 696 | 697 | 698

SA-04

RA-08 | RA-06 | APR | RA-03AM | SA-04 | MN | WI | IA | IL

Jackson County | Carroll County | Ogle County | Illinois | Clinton County | Iowa | Whiteside County | Lee County | Scott County | LaSalle County | Rock Island County | Henry County | Bureau County | Stark County | Putnam County | Mercer County

165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179

SA-04

Applicant's Preferred Route (APR)

Route Alternatives

RA-03AM

RA-06

RA-07

RA-08

Mile Post

Anticipated 120' Construction ROW

Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

WMA - Wildlife Management Areas

Wildlife Refuge Inventory

SNA - Scientific and Natural Area

Water Resources

Navigable Waterway Crossings

National River Inventory Crossing

Public Waters Watercourse

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Public Waters Wetlands

Public Water Basin

Public Drinking Water Supply

Wellhead Protection Area (WHPA)

Lakes of Biological Significance

Outstanding

High

Moderate

Native Plant Communities with Biodiversity Significance

Outstanding

High

Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

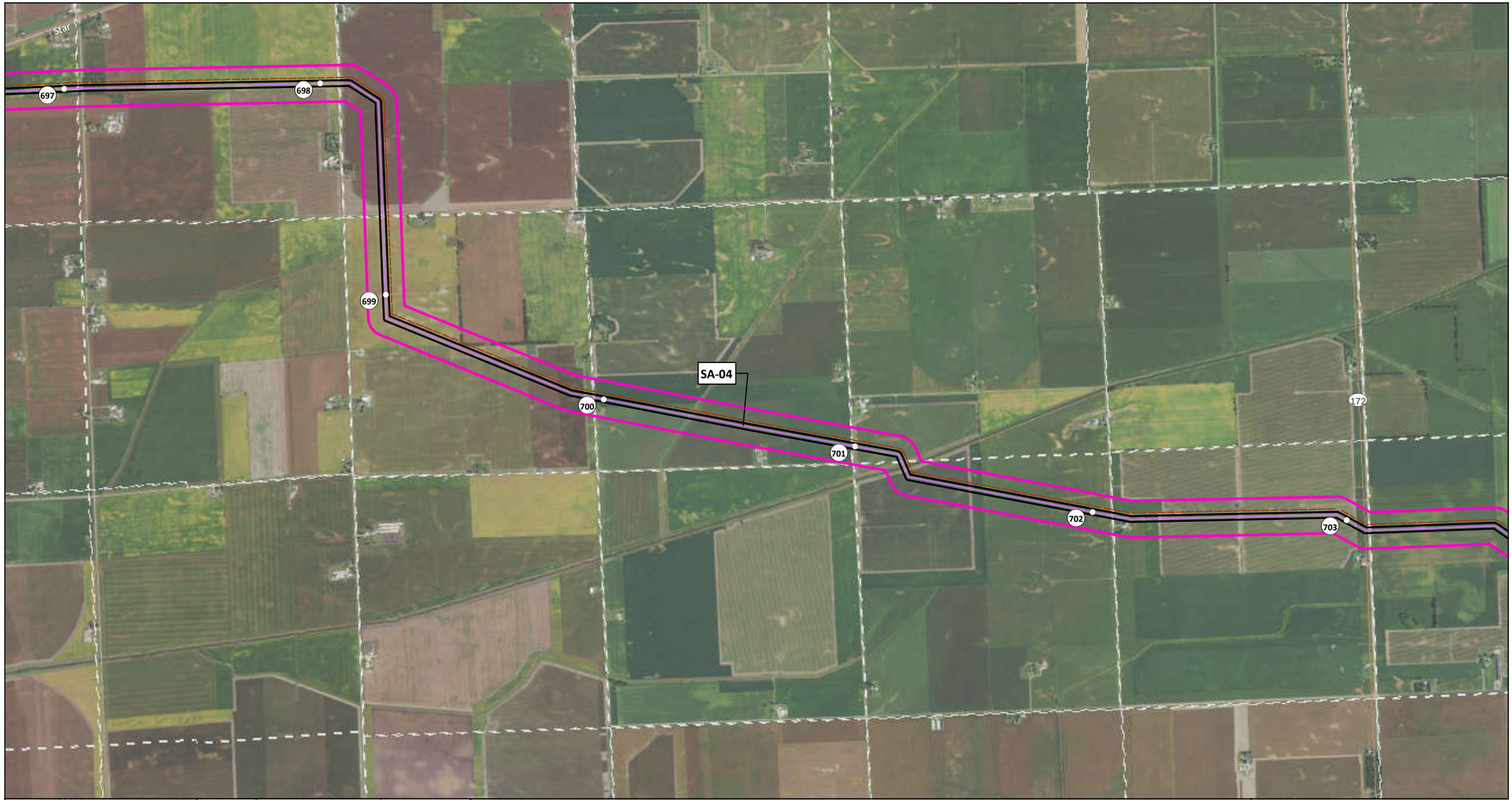
0 125 250 500 Meters

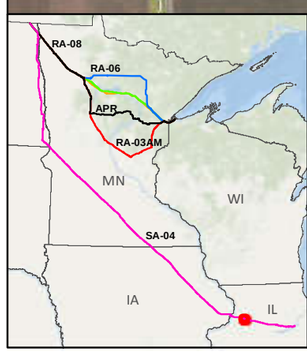
1:24,000

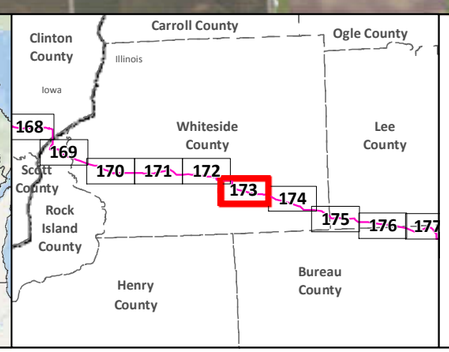
10ft Contours

N

Map 172B of 188







- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources:
MNDNR, NHD,USGS, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

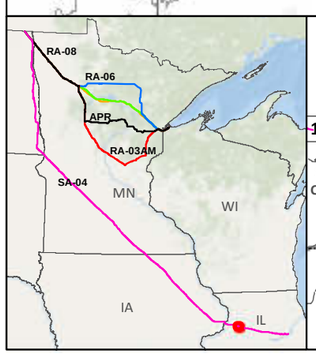
Map 173A of 188

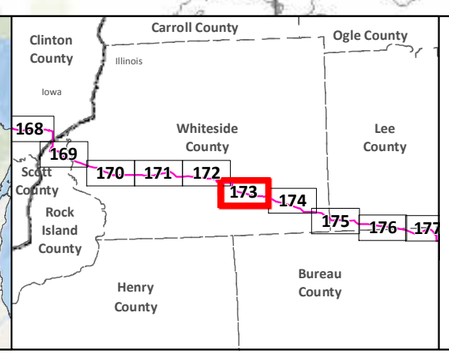
N

T20N R5E S35
T20N R5E S36
T20N R6E S31
T20N R6E S32
T20N R6E S33
T20N R6E S34
T20N R6E S35
T19N R5E S2
T19N R5E S1
T19N R6E S6
T19N R6E S5
T19N R6E S4
T19N R6E S3
T19N R6E S2
T19N R5E S11
T19N R5E S12
T19N R6E S7
T19N R6E S8
T19N R6E S9
T19N R6E S10
T19N R6E S11
T19N R5E S14
T19N R5E S13
T19N R6E S18
T19N R6E S17
T19N R6E S16
T19N R6E S15
T19N R6E S14

697 698 699 700 701 702 703 172

SA-04





SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

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Township Boundary

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WMA - Wildlife Management Areas
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Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

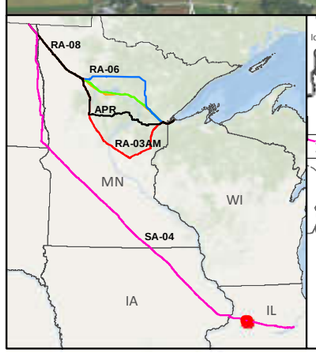
SA-04

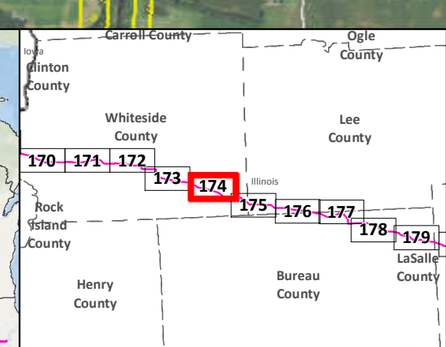
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 173B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

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Highway
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Township Boundary

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State Forest
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Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 174A of 188

T19N R6E S2
T19N R6E S1
T19N R7E S6
T19N R7E S5
T19N R7E S4
T19N R7E S3
T19N R7E S2
T19N R6E S11
T19N R6E S12
T19N R7E S7
T19N R7E S8
T19N R7E S9
T19N R7E S10
T19N R7E S11
704
705
SA-04
706
T19N R7E S18
T19N R7E S17
T19N R7E S16
T19N R7E S15
T19N R7E S14
T19N R6E S14
T19N R6E S13
707
708
T19N R7E S21
T19N R7E S22
T19N R7E S23
T19N R6E S23
T19N R6E S24
T19N R7E S19
T19N R7E S20
709
710
88

RA-08
RA-06
APR
RA-03AM
SA-04
MN
WI
IA
IL

Carroll County
Ogle County
Iowa
Clinton County
Whiteside County
Lee County
170 171 172 173 174 175 176 177 178 179
Illinois
Rock Island County
LaSalle County
Henry County
Bureau County
Putnam County

SA-04
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

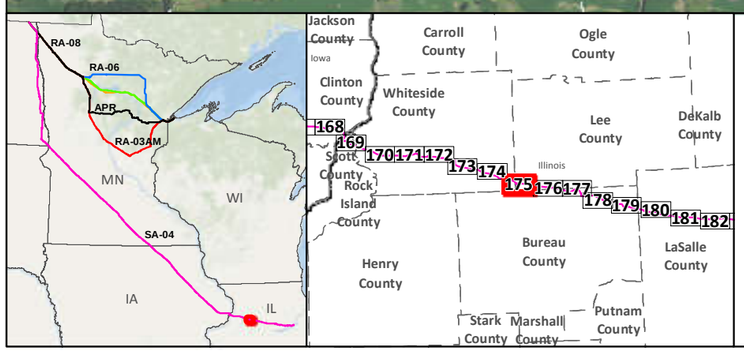
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 174B of 188

710
711
712
SA-04
713
714
715
Green River



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Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources:
MNDNR, NHD,USGS, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

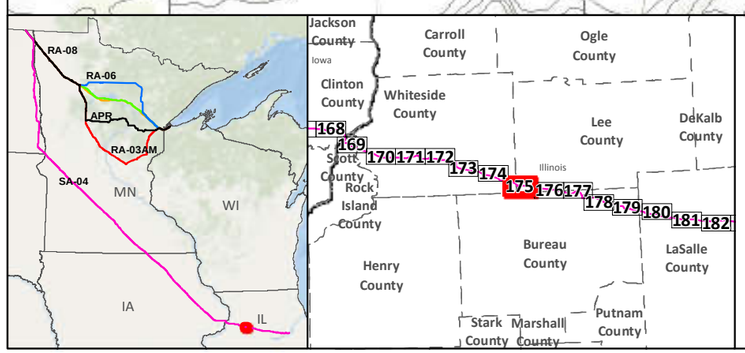
Map 175A of 188

T19N R7E S23
T19N R7E S24
T19N R8E S19
T19N R8E S20
T19N R8E S21
T19N R8E S22
T19N R7E S22
T19N R7E S25
T19N R7E S26
T19N R7E S27
T19N R8E S30
T19N R8E S29
T19N R8E S28
T19N R8E S27
T19N R7E S36
T19N R8E S31
T19N R8E S32
T19N R8E S33
T19N R8E S34
T19N R7E S35
T19N R7E S34
T18N R7E S1
T18N R8E S6
T18N R8E S5
T18N R8E S4
T18N R8E S3
T18N R7E S3
T18N R7E S2

Green River

SA-04

710 711 712 713 714 715



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing
Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

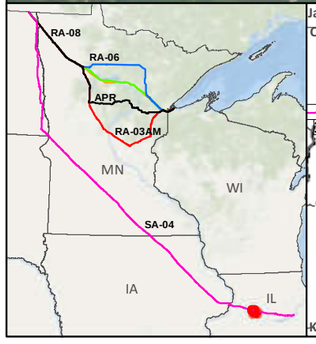
SA-04

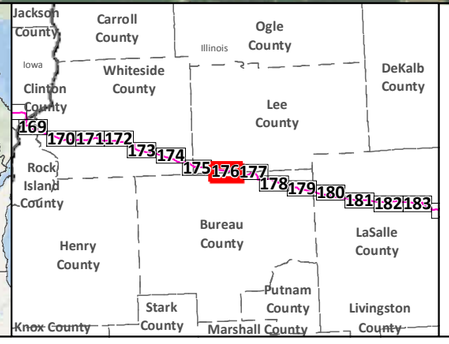
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 175B of 188

716
717
718
719
720
721
SA-04
26
Walnut Creek
Walnut Creek





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

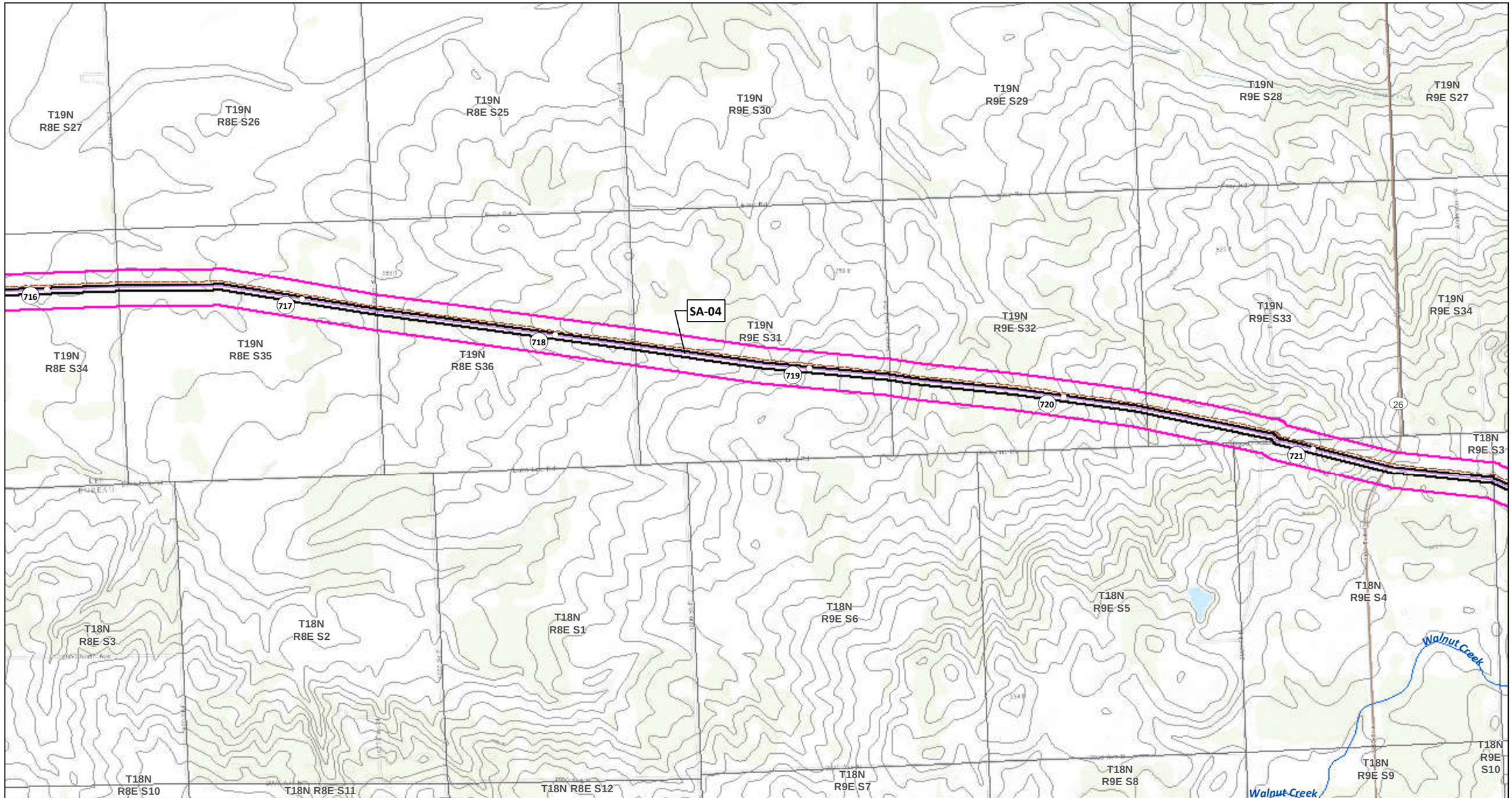
Data Sources:
MNDNR, NHD,USGS, Enbridge

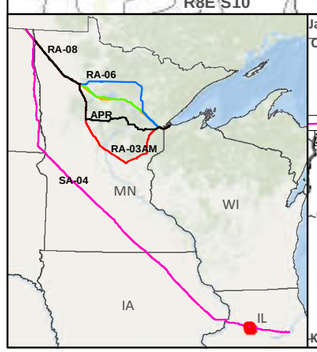
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

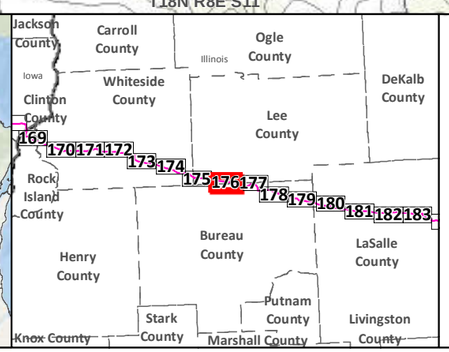
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 176A of 188







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

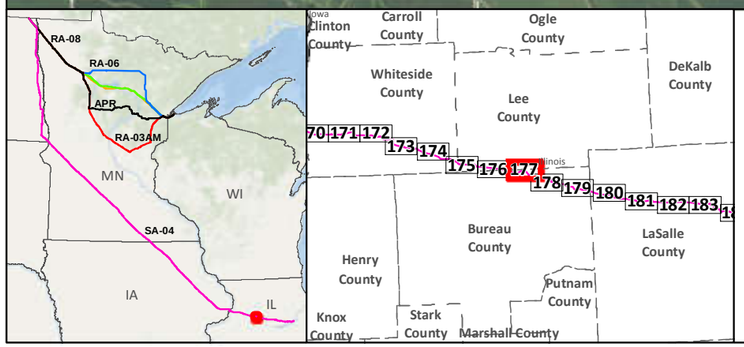
1:24,000

0 125 250 500 Meters

10ft Contours

Map 176B of 188

722
723
724
725
726
728
SA-04
Walnut Creek
Masters Fork



SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

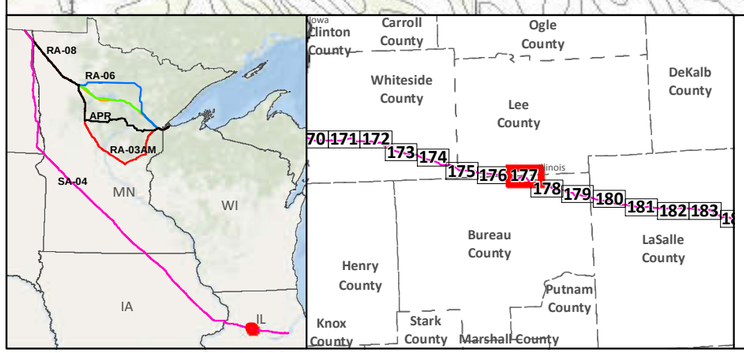
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 177A of 188

T19N R9E S27
T19N R9E S26
T19N R9E S25
T19N R10E S30
T19N R10E S29
T19N R10E S28
T19N R10E S27
T19N R9E S34
T19N R9E S35
T19N R9E S36
T19N R10E S31
T19N R10E S32
T19N R10E S33
T19N R10E S34
SA-04
722
723
724
725
726
728
T18N R9E S4
T18N R9E S3
T18N R9E S2
T18N R9E S1
T18N R10E S6
T18N R10E S5
T18N R10E S4
Walnut Creek
Masters Fork
T18N R9E S9
T18N R9E S10
T18N R9E S11
T18N R9E S12
T18N R10E S7
T18N R10E S8
T18N R10E S9



SA-04
Applicant's Preferred Route (APR)

Route Alternatives
RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

State Managed Lands
WMA - Wildlife Management Areas
Wildlife Refuge Inventory
SNA - Scientific and Natural Area

Water Resources
Navigable Waterway Crossings
National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
Designated Trout Stream
Calcareous Fens
Wild Rice Lakes (DNR)
Public Waters Wetlands
Public Water Basin
Public Drinking Water Supply
Wellhead Protection Area (WHPA)

Lakes of Biological Significance
Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 177B of 188

SA-04

727 728 729 730 731 732 733

92

34

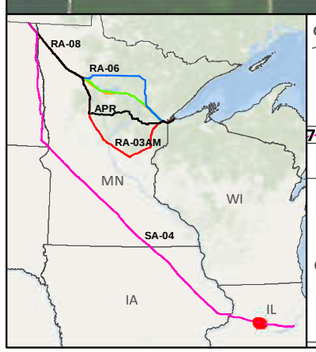
89

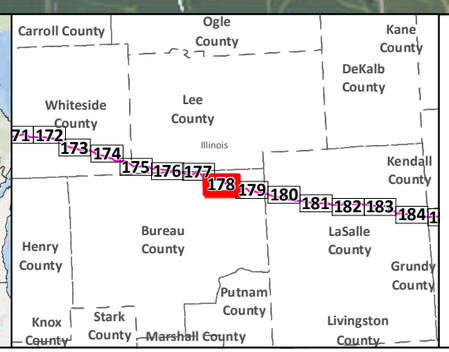
Big Bureau Creek

Masters Fork

Pike Creek

La Moille





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

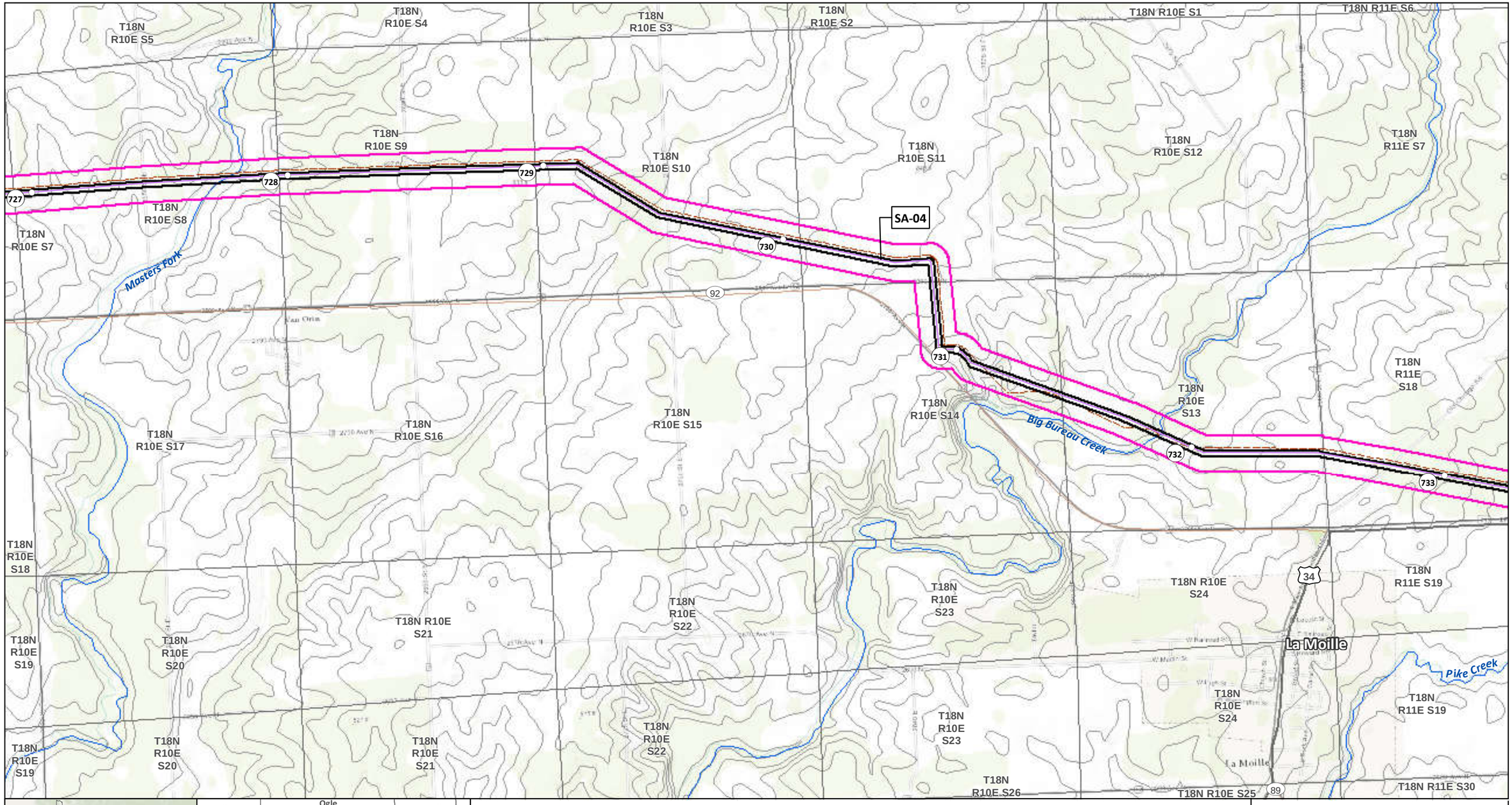
Data Sources:
MNDNR, NHD,USGS, Enbridge

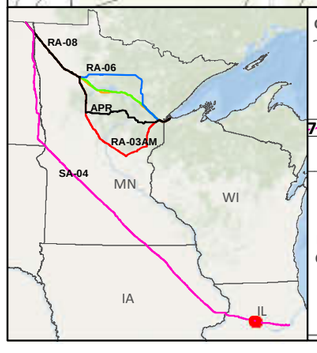
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

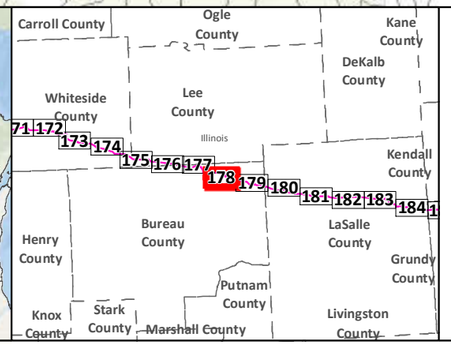
SA-04

Map 178A of 188

N







SA-04

Applicant's Preferred Route (APR)

Route Alternatives

- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

Existing Pipelines

Township Boundary

State Managed Lands

- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources

- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance

- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance

- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles

0 125 250 500 Meters

1:24,000

10ft Contours

N

Map 178B of 188

Pike Creek

34

Spring Creek

734

735

736

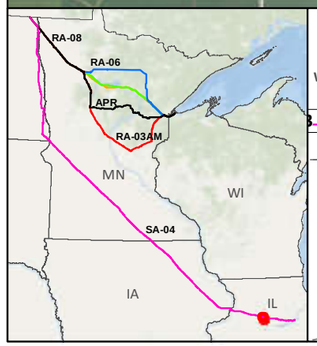
737

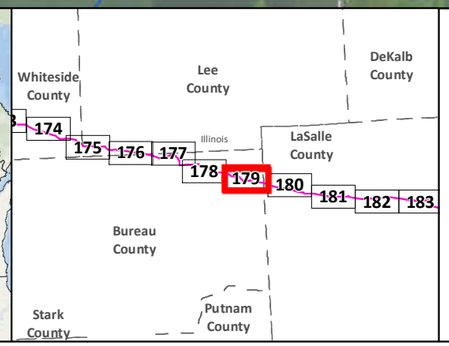
738

739

SA-04

East Bureau Creek





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

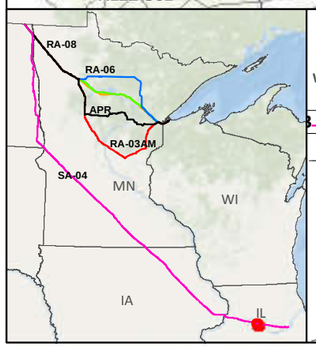
SA-04

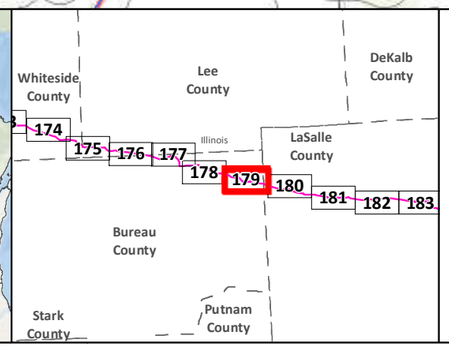
Map 179A of 188

T18N R11E S18
T18N R11E S17
T18N R11E S16
T18N R11E S15
T18N R11E S14
T18N R11E S13
T36N R1E S31
T35N R1E S6
T18N R11E S24
T18N R11E S23
T18N R11E S22
T18N R11E S21
T18N R11E S20
T18N R11E S19
T35N R1E S6
T18N R11E S24
T18N R11E S23
T18N R11E S22
T18N R11E S21
T18N R11E S20
T18N R11E S19
T35N R1E S7
T18N R11E S25
T18N R11E S26
T18N R11E S27
T18N R11E S28
T18N R11E S29
T18N R11E S30
T35N R1E S18
T18N R11E S36
T18N R11E S35
T18N R11E S34
T18N R11E S33
T18N R11E S32
T18N R11E S31

34
734
735
736
737
738
739
SA-04

Spring Creek
Pike Creek
East Bureau Creek





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
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- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

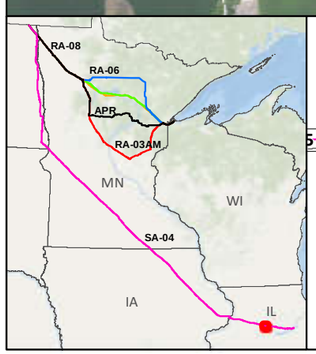
SA-04

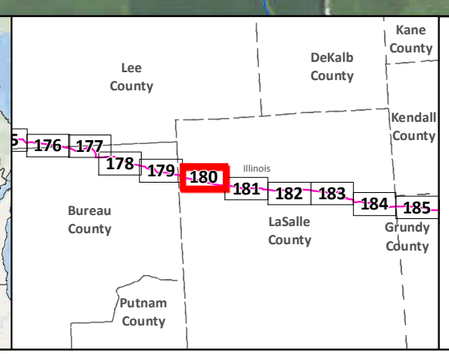
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 179B of 188

Mendota Creek
Spring Creek
Snyder
Grove Park
Little Vermilion River
Vermilion Creek
Vermilion Creek
Vermilion Creek
52
39
740
741
742
743
744
745
SA-04





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

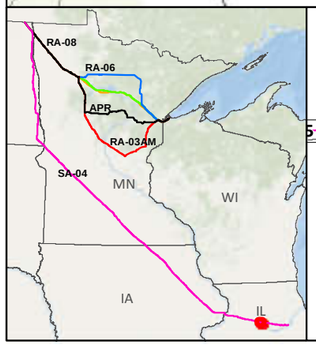
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

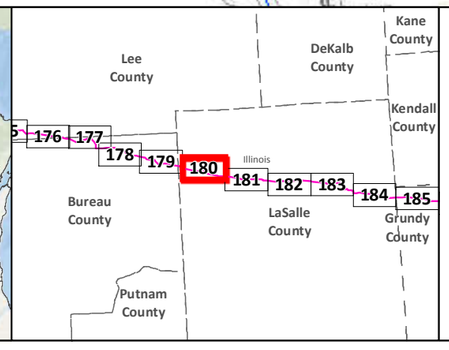
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 180A of 188

T35N R1E S6
T35N R1E S5
T35N R1E S4
T35N R1E S3
T35N R1E S2
T35N R1E S1
T35N R2E S6
T35N R1E S5
T35N R1E S6
Mendota Creek
Vermilion Creek
Spring Creek
T35N R1E S8
T35N R1E S9
T35N R1E S10
Little Vermilion River
T35N R1E S11
T35N R1E S12
T35N R2E S7
T35N R1E S7
52
39
740
741
742
743
744
745
SA-04
T35N R1E S15
T35N R1E S14
T35N R1E S13
T35N R2E S18
T35N R1E S18
T35N R1E S17
T35N R1E S16
T35N R1E S21
T35N R1E S22
T35N R1E S23
T35N R1E S24
T35N R2E S19
T35N R1E S19
T35N R1E S20
Vermilion Creek





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW Route Width (750')
- Existing Pipelines
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State Managed Lands
- WMA - Wildlife Management Areas
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Water Resources
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- National River Inventory Crossing
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Lakes of Biological Significance
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- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
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Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 180B of 188

Tomahawk Creek

Vermilion Creek

Triumph

746

747

748

SA-04

749

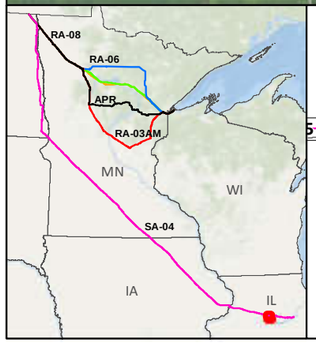
750

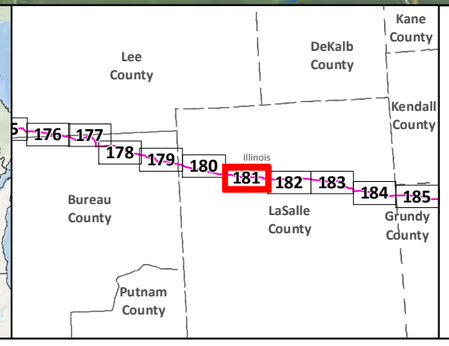
751

52

8th

Buck Creek





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

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- National Forest
- Tribal Reservation

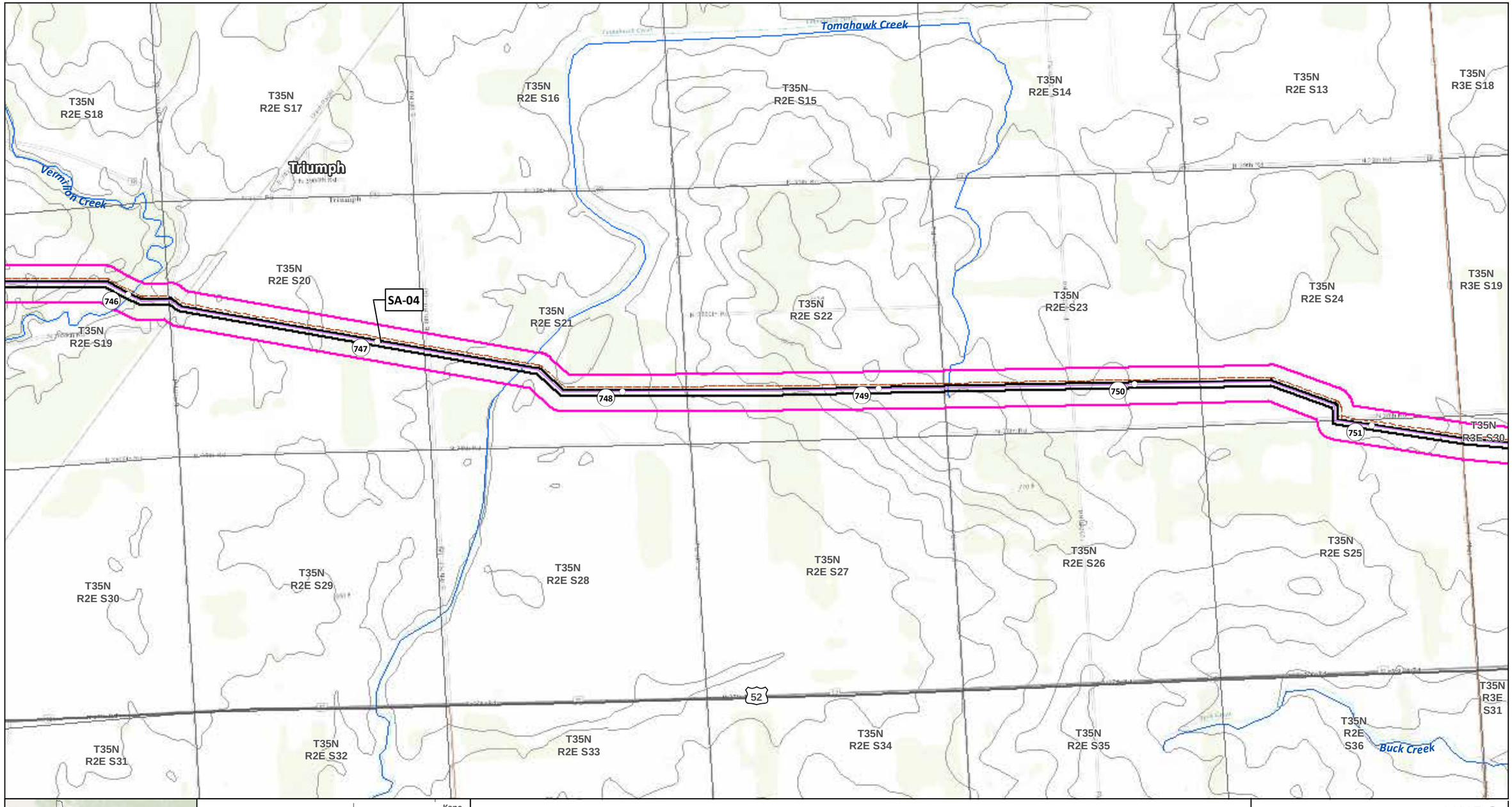
Water Resources
- Lake
- River

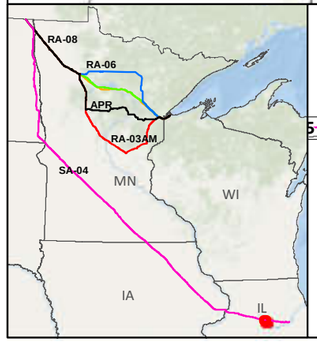
Data Sources:
MNDNR, NHD,USGS, Enbridge

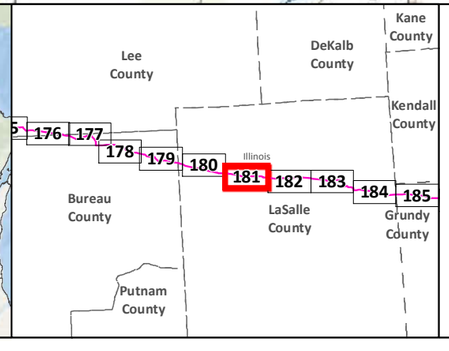
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04







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- Applicant's Preferred Route (APR)

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- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

N

Map 181B of 188

SA-04

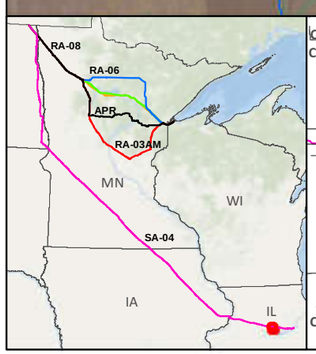
752 753 754 755 756 757

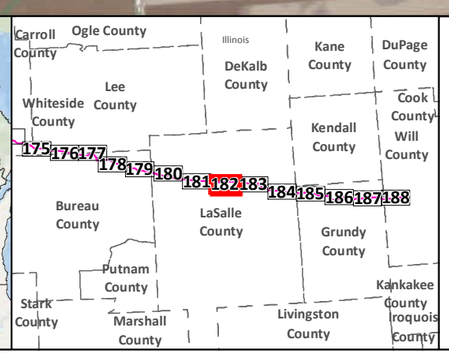
52

23

Crookedleg Creek

Buck Creek





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

Data Sources:
MNDNR, NHD,USGS, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 182A of 188

N

T35N R3E S19
T35N R3E S20
T35N R3E S21
T35N R3E S22
T35N R3E S23
T35N R3E S24
T35N R3E S25
T35N R3E S26
T35N R3E S27
T35N R3E S28
T35N R3E S29
T35N R3E S30
T35N R3E S31
T35N R3E S32
T35N R3E S33
T35N R3E S34
T35N R3E S35
T35N R3E S36
T34N R3E S1
T34N R3E S2
T34N R3E S3
T34N R3E S4
T34N R3E S5
T34N R3E S6

SA-04

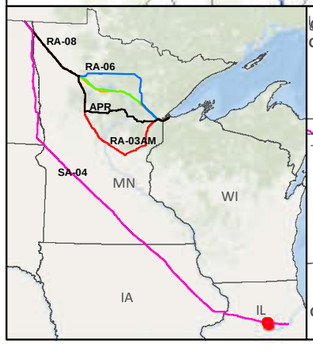
752 753 754 755 756 757

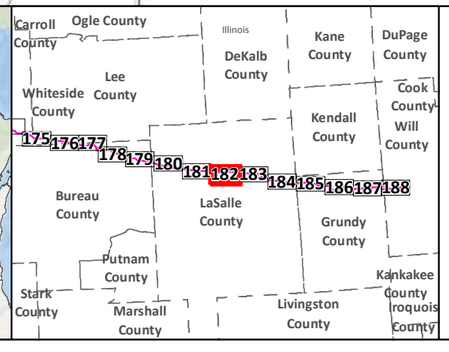
52

23

Buck Creek

Crookedleg Creek





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')
- Existing Pipelines
- Township Boundary

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- National River Inventory Crossing
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- 303d Imparied Waters
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- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

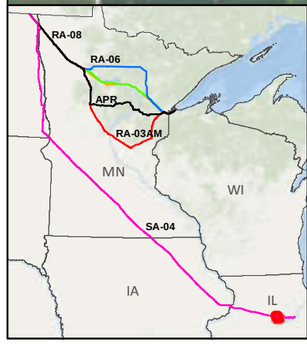
SA-04

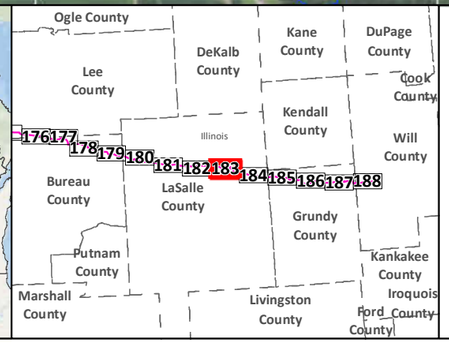
0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 182B of 188







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

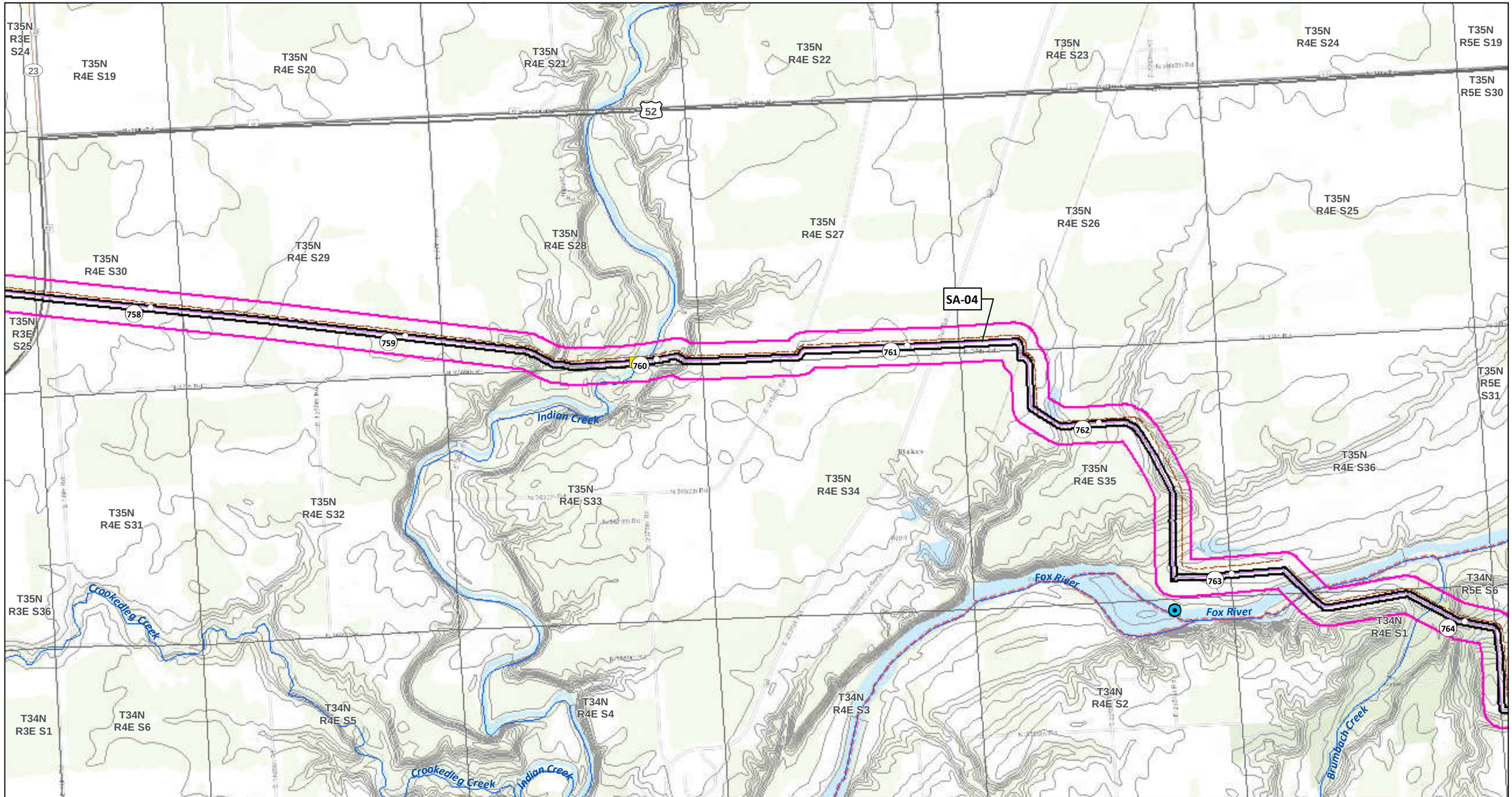
Data Sources:
MNDNR, NHD,USGS, Enbridge

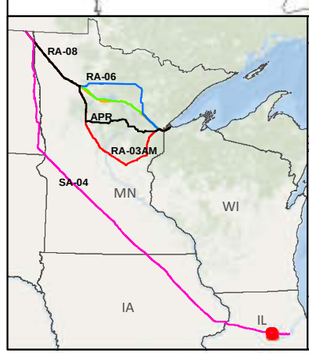
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

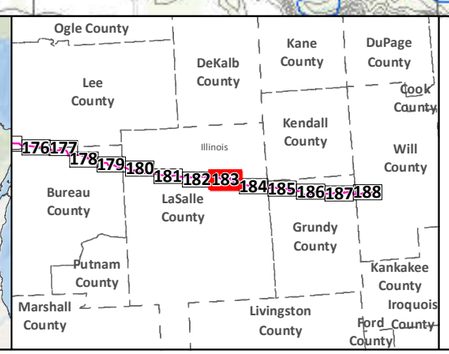
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 183A of 188







- SA-04
- Applicant's Preferred Route (APR)

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- RA-06
- RA-07
- RA-08
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- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 183B of 188

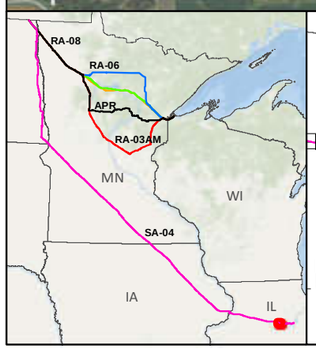
Fox River

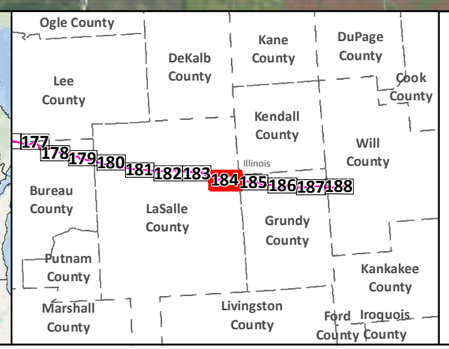
765 766 767 768 769 770

SA-04

71

Brumbach Creek





- SA-04
- Applicant's Preferred Route (APR)
- Anticipated 120' Construction ROW
- Route Width (750')
- County Boundary
- Mile Post
- Existing Pipeline
- Interstate
- Highway
- Major Road
- Township Boundary

Land Ownership
- State Forest
- National Forest
- Tribal Reservation

Water Resources
- Lake
- River

Data Sources:
MNDNR, NHD,USGS, Enbridge

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

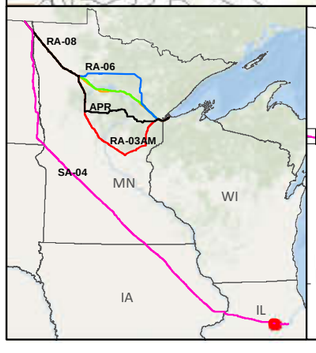
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

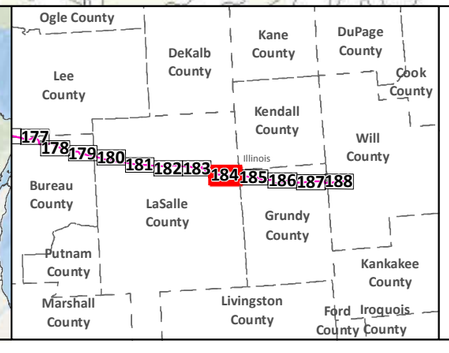
SA-04

Map 184A of 188

N

T35N R5E S31
T35N R5E S32
T35N R5E S33
T35N R5E S34
T35N R5E S35
T35N R5E S36
T35N R6E S31
Fox River
T34N R6E S6
T34N R5E S1
T34N R5E S2
T34N R5E S3
T34N R5E S4
T34N R5E S5
SA-04
765
766
767
768
769
770
71
T34N R5E S6
T34N R6E S7
T34N R4E S1
T34N R5E S7
T34N R5E S8
T34N R5E S9
T34N R5E S10
T34N R5E S11
T34N R5E S12
Brumbach Creek
T34N R4E S12
T34N R4E S13
T34N R5E S13
T34N R5E S14
T34N R5E S15
T34N R5E S16
T34N R5E S17
T34N R5E S18





- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
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- Township Boundary

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- National River Inventory Crossing
- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

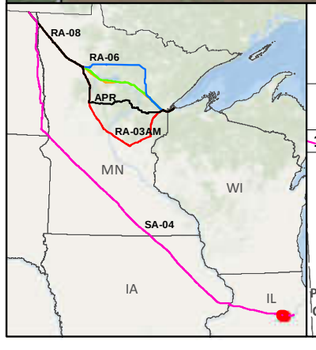
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

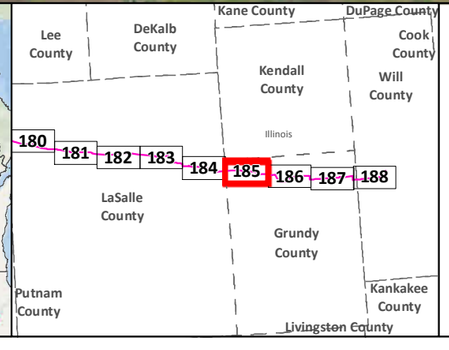
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N







SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

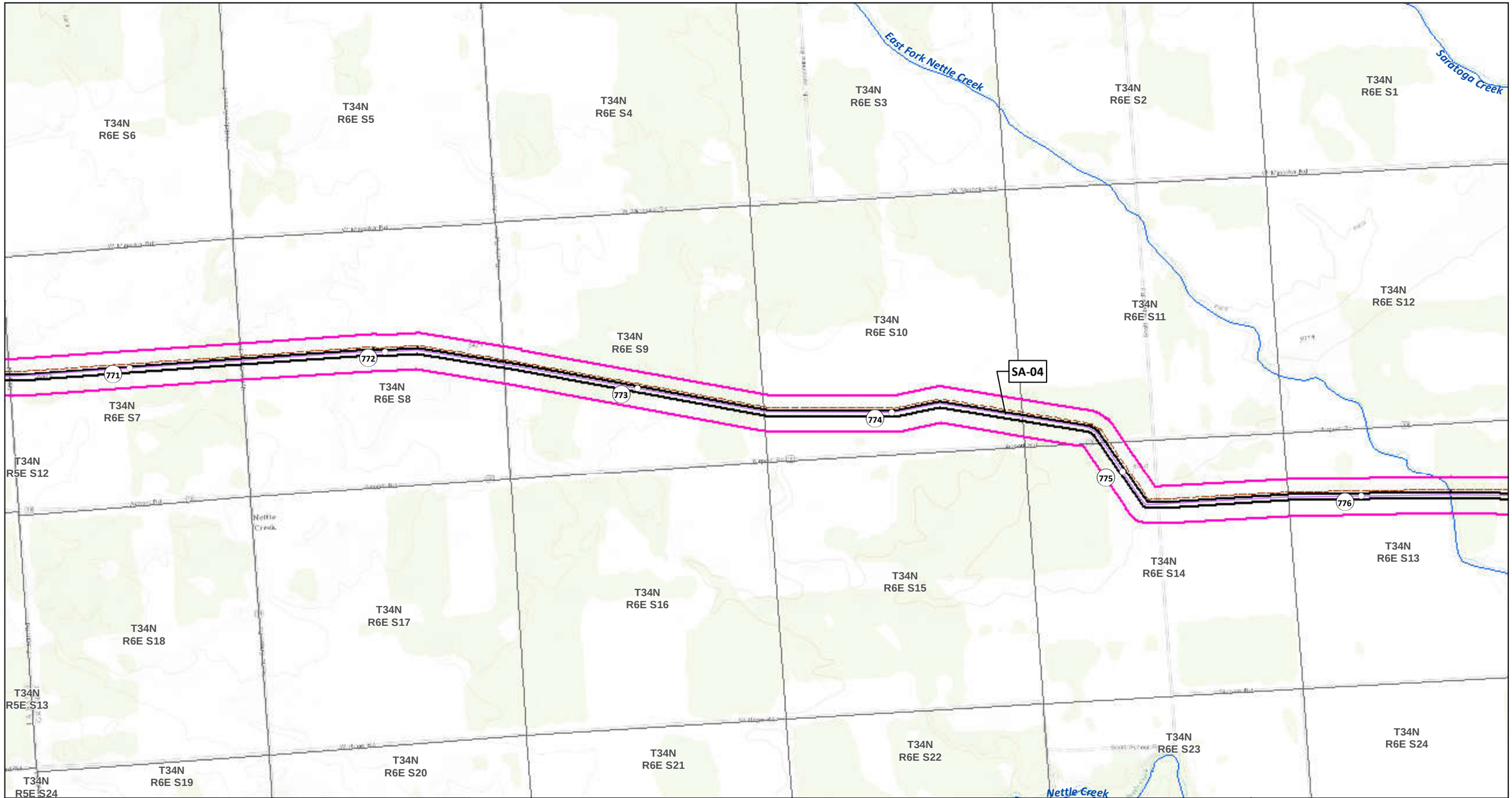
Data Sources:
MNDNR, NHD,USGS, Enbridge

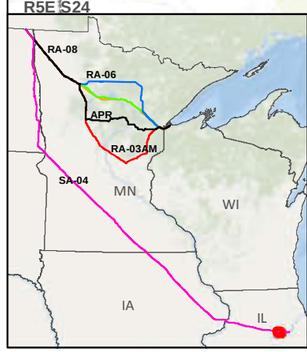
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

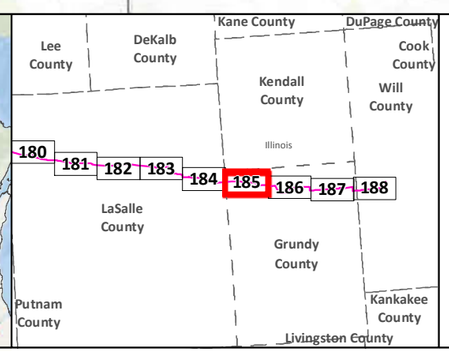
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 185A of 188







SA-04
Applicant's Preferred Route (APR)

Route Alternatives
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- RA-06
- RA-07
- RA-08
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Existing Pipelines
Township Boundary

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LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters
10ft Contours

Map 185B of 188

Saratoga Creek

Valley Run

Collins Run

East Fork Nettle Creek

Lisbon

Ashley

Granville

777

778

779

780

781

782

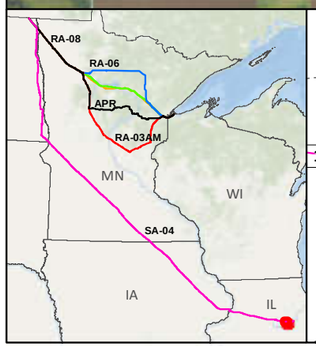
783

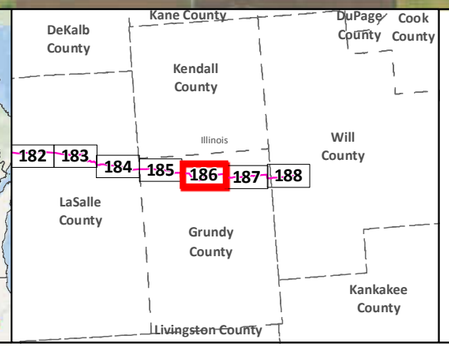
SA-04

47

80

6





SA-04

Applicant's Preferred Route (APR)

Anticipated 120' Construction ROW

Route Width (750')

County Boundary

Mile Post

Existing Pipeline

Interstate

Highway

Major Road

Township Boundary

Land Ownership

State Forest

National Forest

Tribal Reservation

Water Resources

Lake

River

Data Sources:
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0 0.125 0.25 0.5 Miles

1:24,000

0 125 250 500 Meters

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 186A of 188

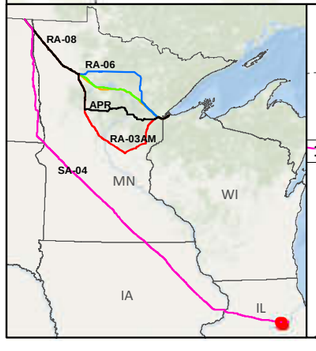
T34N R7E S7
T34N R7E S8
T34N R7E S9
T34N R7E S10
T34N R7E S11
T34N R7E S12
T34N R6E S12
T34N R7E S13
T34N R7E S14
T34N R7E S15
T34N R7E S16
T34N R7E S17
T34N R7E S18
T34N R6E S13
T34N R7E S19
T34N R7E S20
T34N R7E S21
T34N R7E S22
T34N R7E S23
T34N R7E S24
T34N R6E S24
T34N R7E S25
T34N R7E S26
T34N R7E S27
T34N R7E S28
T34N R7E S29
T34N R7E S30
T34N R6E S25

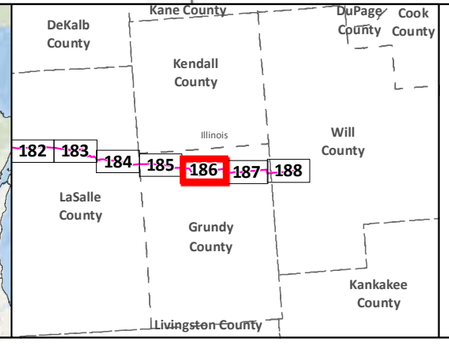
Saratoga Creek
Valley Run
Collins Run
East Fork Nettle Creek

SA-04

777 778 779 780 781 782 783

47 80 6





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- Applicant's Preferred Route (APR)

Route Alternatives
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Native Plant Communities with Biodiversity Significance
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Data Sources: MNDNR, USGS, NHD, Enbridge

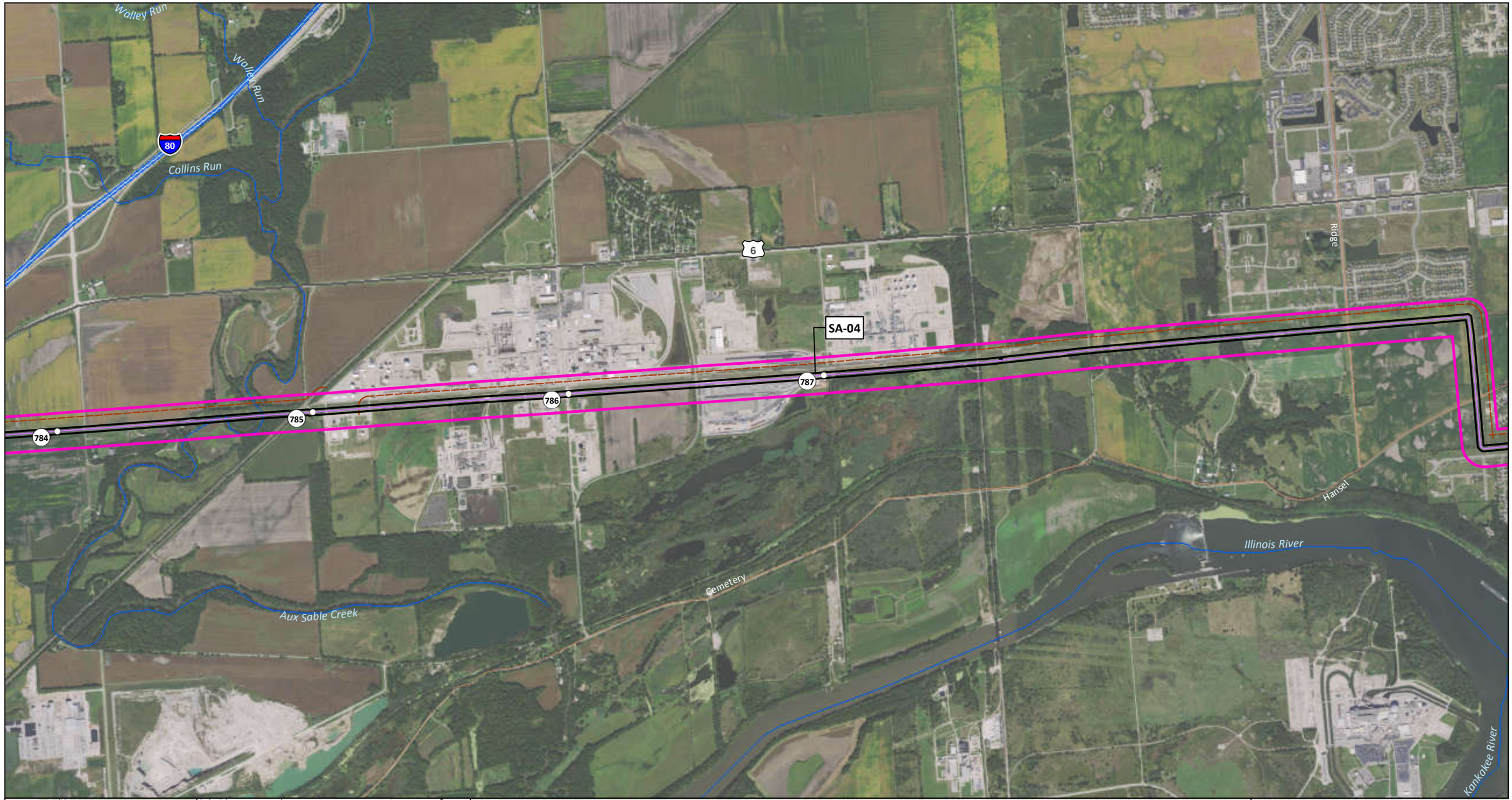
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

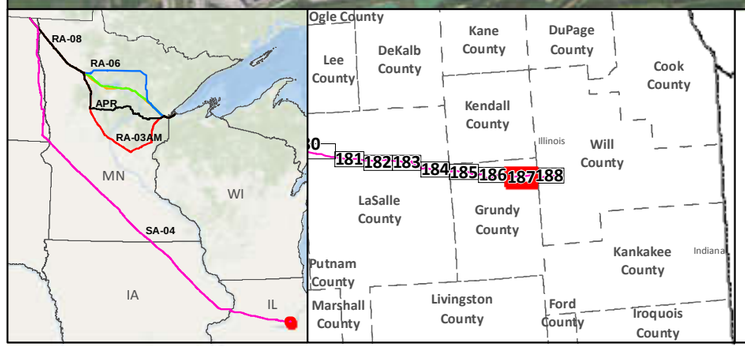
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

N

Map 186B of 188





- SA-04
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- Mile Post
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- Highway
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Water Resources
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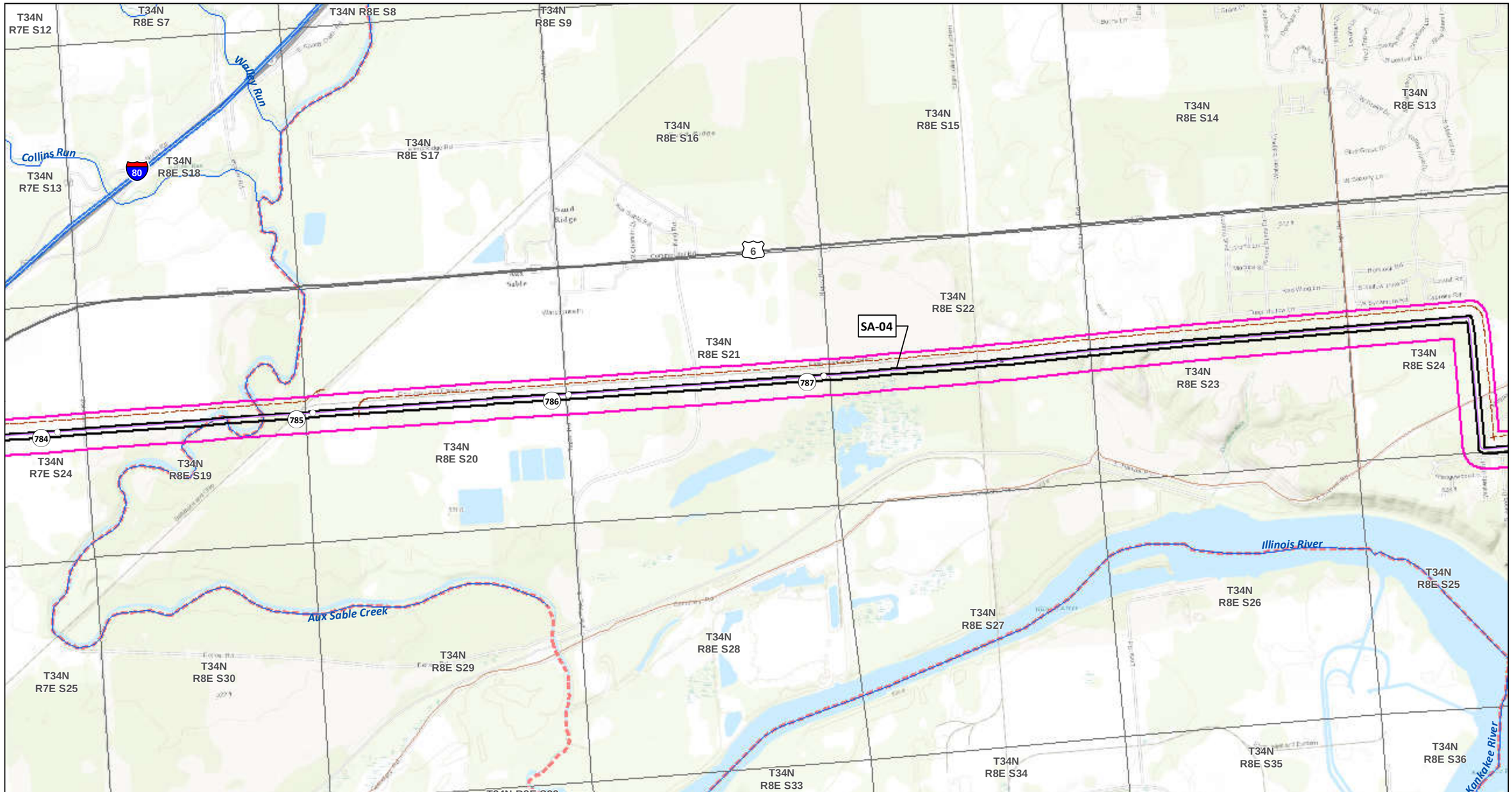
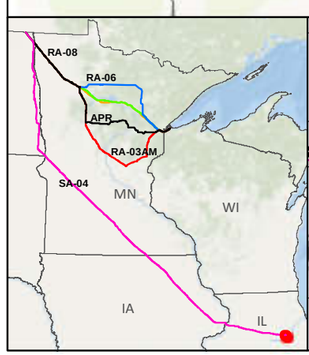
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

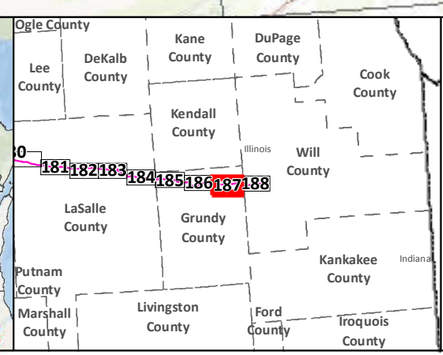
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

SA-04

Map 187A of 188







SA-04
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RA-03AM
RA-06
RA-07
RA-08
Mile Post
Anticipated 120' Construction ROW
Route Width (750')

Existing Pipelines
Township Boundary

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National River Inventory Crossing

Public Waters Watercourse
303d Imparied Waters
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Public Drinking Water Supply
Wellhead Protection Area (WHPA)

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Outstanding
High
Moderate

Native Plant Communities with Biodiversity Significance
Outstanding
High
Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

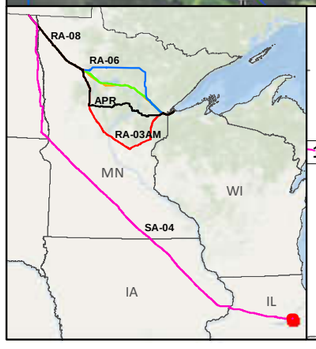
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

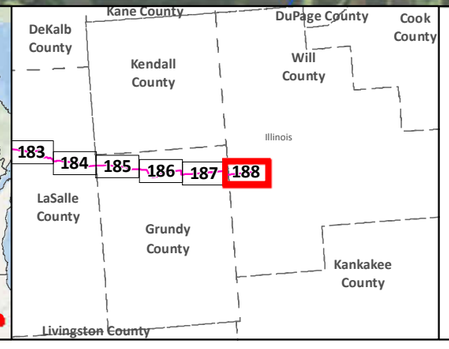
SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 187B of 188

Channahon
Center
Bridge
6
Hansel
Des Plaines River
Du Page River
Des Plaines River
Arsenal
Jackson Creek
55
SA-04
Des Plaines River
Kankakee River
Des Plaines River





SA-04
Applicant's Preferred Route (APR)
Anticipated 120' Construction ROW
Route Width (750')
County Boundary

Mile Post
Existing Pipeline
Interstate
Highway
Major Road
Township Boundary

Land Ownership
State Forest
National Forest
Tribal Reservation

Water Resources
Lake
River

Data Sources:
MNDNR, NHD,USGS, Enbridge

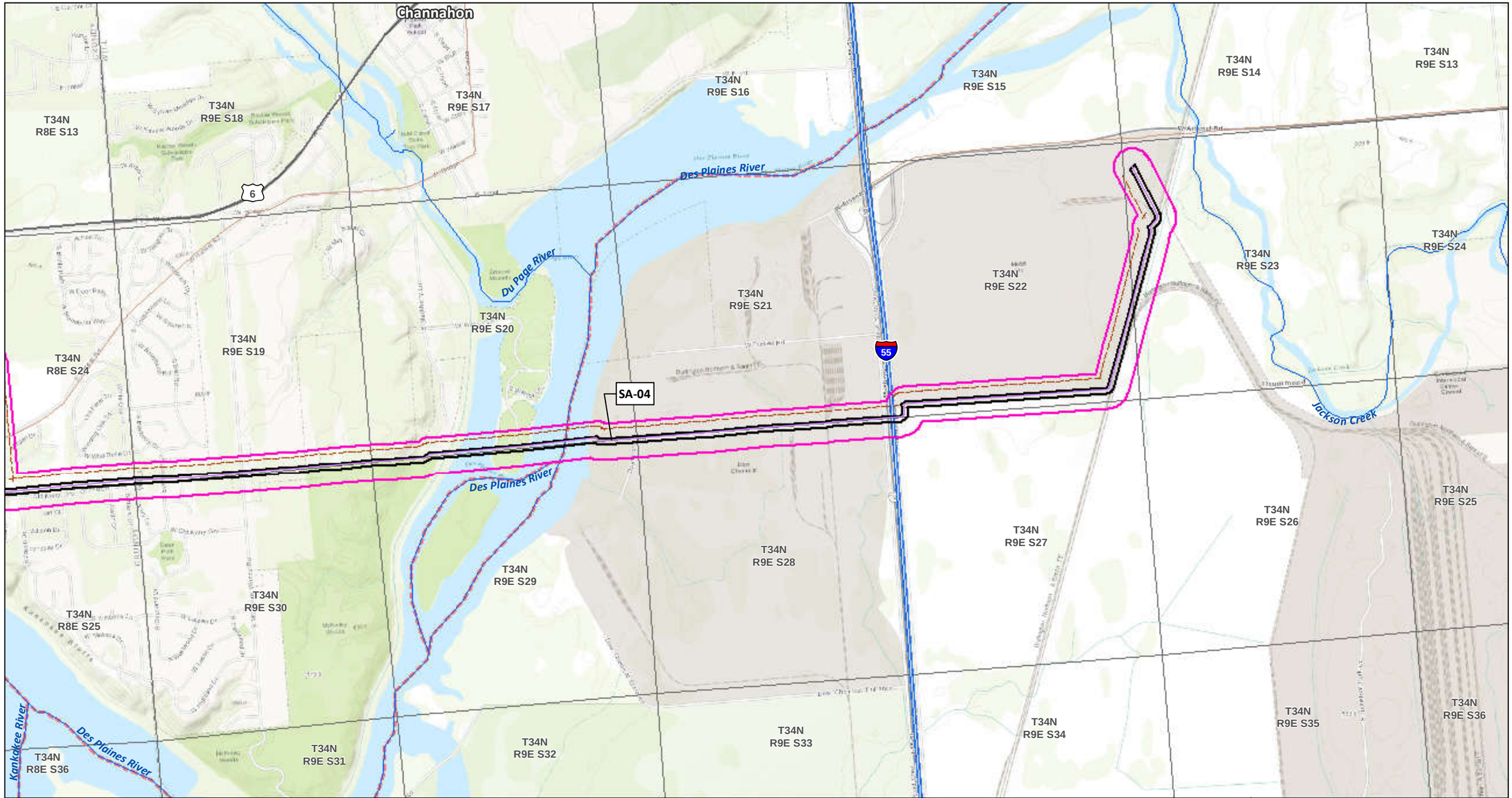
0 0.125 0.25 0.5 Miles
1:24,000
0 125 250 500 Meters

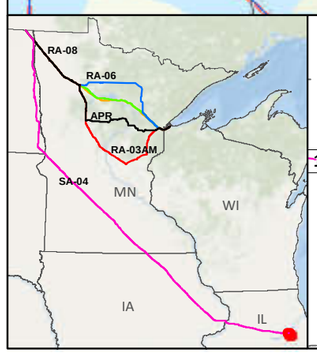
LINE 3 REPLACEMENT PROJECT DETAILED MAP SET AERIAL

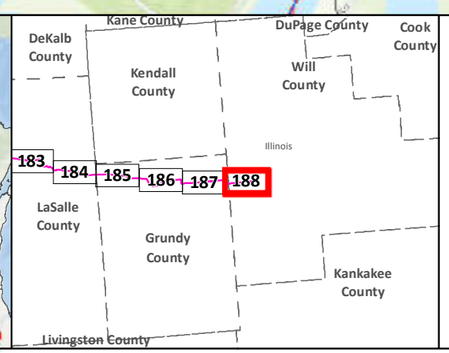
SA-04

Map 188A of 188

N







- SA-04
- Applicant's Preferred Route (APR)

Route Alternatives
- RA-03AM
- RA-06
- RA-07
- RA-08
- Mile Post
- Anticipated 120' Construction ROW
- Route Width (750')

- Existing Pipelines
- Township Boundary

State Managed Lands
- WMA - Wildlife Management Areas
- Wildlife Refuge Inventory
- SNA - Scientific and Natural Area

Water Resources
- Navigable Waterway Crossings
- National River Inventory Crossing

- Public Waters Watercourse
- 303d Imparied Waters
- Designated Trout Stream
- Calcareous Fens
- Wild Rice Lakes (DNR)
- Public Waters Wetlands
- Public Water Basin
- Public Drinking Water Supply
- Wellhead Protection Area (WHPA)

Lakes of Biological Significance
- Outstanding
- High
- Moderate

Native Plant Communities with Biodiversity Significance
- Outstanding
- High
- Moderate

Data Sources: MNDNR, USGS, NHD, Enbridge

LINE 3 REPLACEMENT PROJECT DETAILED MAP SET TOPOGRAPHIC

SA-04

0 0.125 0.25 0.5 Miles
0 125 250 500 Meters
1:24,000
10ft Contours

Map 188B of 188

Minnesota Department of Commerce
Energy Environmental Review and Analysis

Draft Environmental Impact Statement
Line 3 Project

Appendices

Docket Nos. PPL-15-137/CN-14-916

May 15, 2017

MINNESOTA

Appendix B

Line 3 Permanent Deactivation Plan

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Enbridge Energy, Limited Partnership

Line 3 Permanent Deactivation Plan (U.S.)

MPUC Docket Nos. PL-9/CN-14-916 and PPL-15-137
OAH Docket Nos. 65-2500-32764 and 65-2500-33377

January 2017

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DEFINITIONS AND ACRONYMS

Abandoned Pipeline: A pipeline permanently removed from service that has been physically separated from its source of gas or hazardous liquid and is no longer maintained under regulation 49 CFR Parts 192 or 195, as applicable. Source: PHMSA Operations & Maintenance Enforcement Guidance, Part 195 Subpart F.

ASME: American Society of Mechanical Engineers.

CEPA: Canadian Energy Pipeline Association – CEPA is an organization whose mission is to enable companies to advance operations and develop safety and environmental innovations for the transmission pipeline industry through leadership and credible engagement between member companies, governments, the public and stakeholders. CEPA works together with companies to define and implement leading practices to continuously improve industry performance in three key areas: pipeline safety, environmental protection and socio-economics.

CFR: Code of Federal Regulations.

Cathodic Protection (CP): A technique used to control the corrosion of a metal surface, in this case a pipeline, by making it the cathode of an electrochemical cell. Most often this involves the application of a low level electrical current to the pipeline. Source: National Association of Corrosion Engineers (NACE) standard SP0169.

DNV GL: An international certification body and classification society whose main expertise is in technical assessment, advisory, and risk management. It is the world's largest technical consultancy to onshore and offshore wind, wave, tidal, and solar industries, as well as the global oil & gas industry - 65% of the world's offshore pipelines are designed and installed to DNV GL's technical standards.

Grouting: The use of an injectable mortar mix to fill in voids in soils, pipes or other cavities.

Hydraulic Vacuum Excavation (Hydrovac): Using pressurized water and a vacuum system to quickly and safely expose underground infrastructure. Pressurized water is injected into the ground through a handheld wand and as soil is liquefied, the resulting slurry is removed by powerful truck-mounted vacuum systems.

ISD: In-service date.

Line 3 Replacement Project: The Line 3 Replacement Project is the Minnesota portion of Enbridge's Line 3 maintenance driven replacement program and includes the replacement of approximately 282 miles of the existing 34-inch diameter Line 3 pipeline with approximately 340 miles of 36-inch diameter pipeline and associated facilities between the North Dakota/Minnesota border and the Minnesota/Wisconsin border.

Mainline Valves (MLVs): Mainline valves are designed and installed to isolate sections of the pipeline for maintenance purposes or in the event of a release. Valves are also required to be installed per federal pipeline safety regulations (49 CFR Part 195). The valves are remotely controlled by the Control Center to limit the extent of a release.

MP: Mile Post.

NORM: Naturally Occurring Radioactive Materials.

NPMS: National Pipeline Mapping System.

PCB: Polychlorinated biphenyl; any of a class of toxic aromatic compounds, often formed as waste in industrial processes.

Permanent Deactivation: Permanent deactivation as used by Enbridge herein means a pipeline permanently removed from service that has been physically separated from its source of gas or hazardous liquid.

PHMSA: Pipeline Hazardous Materials Safety Administration

Pipeline Inspection Gauge (PIG): Pigs are used for hydrostatic testing and pipeline drying, internal cleaning, internal coating, liquid management, batching, and inspection.

Pipeline Isolation: The separation of a pipeline from existing stations, terminals, and crossover connections to prevent the reintroduction of product.

Pipeline Segmentation: Employing methods such as: installation of a plug, cutting, and capping of the pipeline or closing of valves to effectively take the pipeline and turn it into smaller, hydraulically-independent sections.

O&MMs: Operations and Maintenance Manuals.

ROW: Right-of-way.

Water Conduit: Any physical pathway which fosters the conveyance of water.

1 EXECUTIVE SUMMARY

Enbridge's Line 3 pipeline was put into service in 1968. Line 3 is a 34-inch diameter, 1,097 mile long pipeline, which extends from Alberta, Canada to Superior, Wisconsin. The Minnesota portion of Line 3 includes approximately 282 miles of 34-inch pipeline, associated mainline valve sites, piping, pumps and manifold connections at the seven pump stations, and two terminals which facilitate the operation of the existing Line 3. As part of Enbridge's maintenance driven Line 3 Replacement Project, a new 36-inch diameter pipeline will replace Line 3. Once the Line 3 Replacement Project is permitted, constructed and placed into service, the existing Line 3 pipeline will be Permanently Deactivated.

Enbridge's Line 3 Permanent Deactivation Plan is based upon engineering assessments which considers risks to the environment, public safety, industrial entities (e.g., railway companies and utilities), and current land use. These assessments included detailed literature review, internal stakeholder consultation, the application of mitigation strategies to those identified risks, and the validation of the Permanent Deactivation Plan by assessing current pipeline conditions and modeling expected future pipeline conditions.

Enbridge conducted a risk assessment to determine the technical risks associated with the Permanently Deactivated pipeline. As part of this assessment, Enbridge assessed the relative risks of removing the pipeline and Permanently Deactivating it in place. Removing the 282 miles of existing Line 3 would create a significant risk to other operating pipelines and additional impacts to the environment, land use, and public safety similar to and exceeding those related to constructing a new pipeline project. Based on the results of the risk assessment, Enbridge believes that deactivating a pipeline in place minimizes and/or eliminates unnecessary impacts to the environment, landowners, and the state of Minnesota..

This document describes the way in which Enbridge plans to Permanently Deactivate the existing Line 3 pipeline in the United States. This plan was designed to Permanently Deactivate the pipeline in a way that minimizes risks to public safety, the environment, and current land use. A brief summary of the Permanent Deactivation scope is as follows:

1. Purging the oil;
2. Cleaning of the pipeline;
3. Isolating the pipeline from specific infrastructure which is actively transporting oil;
4. Further segmentation of the pipeline, as needed, including completing all required remediation at roads, railroads, waterbodies, or any other permitted crossing in consultation and coordination with that crossing's authority; and
5. Continue to monitor the existing right-of-way (ROW) to identify, assess, and appropriately mitigate apparent or emerging risk to public safety, the environment, or current land use caused by the Permanently Deactivated pipeline. As part of the ongoing maintenance and monitoring, continue to apply cathodic protection (CP) until such time that it is ineffective or otherwise detrimental.

As discussed in this Plan, Enbridge's assessments identified the following risks are related to pipelines Permanently Deactivated in place:

- soil and water contamination;
- water conduits; and
- subsidence.

Enbridge analyzed these risks and developed mitigation plans, as necessary. Table 1-1 summarizes how Enbridge plans to minimize each of these risks on Line 3. Further details of these activities are presented in the body of this report.

Table 1-1: Summary of Risks and Mitigation

Hazard	Enbridge Analysis/Mitigation
Soil and Water Contamination	To prevent soil and water contamination, Enbridge will purge (i.e., remove) all crude oil from the pipeline and clean the pipe of remaining hydrocarbons. Based on the results of third party testing and validation, it is expected that the amount of hydrocarbons left in the pipe after cleaning would be de minimis. As a result, there will be no material risks to soil or water contamination from oil remaining in Line 3 after the line is purged and cleaned.
Water Conduits	Enbridge will segment the Permanently Deactivated pipeline to protect the water resources from the risk that the pipeline would act as a water conduit. The pipeline will be isolated at its 7 pump stations/terminals and further segmented at the 40 MLV locations which are located along Line 3 in Minnesota. Additional segmentation and/or grouting may be completed in consultation with the crossing authorities at roads, railroads, and other locations where public and environmental safety is a concern. Assessment of topography and existing water resources demonstrates that Enbridge's segmentation plan will prevent water from moving a material distance within the Permanently Deactivated pipeline.
Ground Subsidence	Enbridge conducted a series of assessments to predict the risk of ground subsidence over an extended time frame. Enbridge plans to continue applying cathodic protection (CP) to the Permanently Deactivated pipeline to address the risk of ground subsidence due to eventual pipeline collapse. With the application of CP, the first single points of through wall corrosion are not expected to occur for 25 to 50 years. Note that a single point of through wall corrosion would not cause the pipe to collapse. The structural integrity of the pipe is expected to remain intact for hundreds of years. Given these estimates, it is anticipated that the pipe will likely be filled with soil by the time it has corroded to a point of collapse, which will minimize subsidence. Further, Enbridge plans to continue to monitor the Permanently Deactivated Line 3 ROW, which is in the middle of a corridor of other operating pipelines. Additional grouting may be completed at roads and railroads after consultation with crossing authorities, in order to remove the risk of any subsidence at these locations. This ROW monitoring program will inspect for any signs of subsidence on the ROW and develop plans to address the issue if it arises.

2 GUIDING INDUSTRY REGULATIONS AND LITERATURE

While Enbridge has used the term “Permanently Deactivated” to refer to taking the existing Line 3 out of service permanently, industry terminology generally refers to pipeline “abandonment” rather than “Permanent Deactivation,” and the references and citations that follow use the terminology accordingly. Enbridge has relied on this literature because, from a physical perspective, the activities associated with abandonment and deactivation are the same.

2.1 FEDERAL

Line 3 is an interstate pipeline. As such, its operations are regulated by PHMSA under Title 49 of the CFR. Enbridge will comply with all applicable federal requirements within Title 49 of the CFR or those requirements included by reference. Additionally, Enbridge will follow the code guidance published by the ASME.

- **49 CFR § 195.59** – “For each abandoned offshore pipeline facility or each abandoned onshore pipeline facility that crosses over, under or through a commercially navigable waterway, the last operator of that facility must file a report upon abandonment of that facility.”

- **PHMSA’s NPMS Submission Guide** – “6I. Newly Abandoned Pipelines. Pipelines that were newly abandoned during the last calendar year should be included in your new NPMS data submission.”

- **PHMSA – 195.64** – “§ 195.64 National Registry of Pipeline and LNG Operators. (a) OPID Request. Effective January 1, 2012, each operator of a hazardous liquid pipeline or pipeline facility must obtain from PHMSA an Operator Identification Number (OPID). An OPID is assigned to an operator for the pipeline or pipeline system for which the operator has primary responsibility. To obtain an OPID or a change to an OPID, an operator must complete an OPID Assignment Request DOT Form PHMSA F 1000.1 through the National Registry of Pipeline and LNG Operators in accordance with §195.58….(c) Changes. Each operator must notify PHMSA electronically through the National Registry of Pipeline and LNG Operators at http://opsweb.phmsa.dot.gov, of certain events. (1) An operator must notify PHMSA of any of the following events not later than 60 days before the event occurs: (i) Construction or any planned rehabilitation, replacement, modification, upgrade, uprate, or update of a facility, other than a section of line pipe, that costs $10 million or more. If 60 day notice is not feasible because of an emergency, an operator must notify PHMSA as soon as practicable.”

- **49 CFR § 195.402** – “(a) General. Each operator shall prepare and follow for each pipeline system a manual of written procedures for conducting normal operations and maintenance activities and handling abnormal operations and emergencies. (c) Maintenance and normal operations. This manual shall be reviewed at intervals not exceeding 15 months, but at least once each calendar year, and appropriate changes

made as necessary to insure that the manual is effective. This manual shall be prepared before initial operations of a pipeline system commence, and appropriate parts shall be kept at locations where operations and maintenance activities are conducted. The manual required by paragraph (a) of this section must include procedures for the following to provide safety during maintenance and normal operations: "(10) Abandoning pipeline facilities, including safe disconnection from an operating pipeline system, purging of combustibles, and sealing abandoned facilities left in place to minimize safety and environmental hazards. For each abandoned offshore pipeline facility or each abandoned onshore pipeline facility that crosses over, under or through commercially navigable waterways the last operator of that facility must file a report upon abandonment of that facility in accordance with § 195.59 of this part."(13) Periodically reviewing the work done by operator personnel to determine the effectiveness of the procedures used in normal operation and maintenance and taking corrective action where deficiencies are found."

- **PHMSA – 645.211** - "The FHWA [U.S. Department of Transportation's Federal Highway Administration]> should use the current editions of the AASHTO [American Association of State Highway and Transportation Officials] publications, "A Guide for Accommodating Utilities Within Highway Right-of-Way" and "Roadside Design Guide" to assist in the evaluation of adequacy of STD utility accommodation policies….(a) Utilities must be accommodated and maintained in a manner which will not impair the highway or adversely affect highway or traffic safety. Uniform procedures controlling the manner, nature and extent of such utility use shall be established."

- **PHMSA's Operations & Maintenance Enforcement Guidance, Part 195 Subpart F** – "Only abandoned (permanently removed from service) pipelines are exempt from Part 195 regulations with exception of abandonment inventory reporting requirements….. Inactive pipeline, which may or may not contain liquids, must meet all applicable requirements of Part 195. Operators sometimes do not completely abandon a pipeline and may sometimes use terms such as "idle", "inactive", or "out of service" to describe this situation. The regulations do not define "idle" or "inactive" pipe. Pipe is either considered active or abandoned. If a pipeline has not been abandoned according to the guidance, then it is active and the operator must ensure that the pipeline complies with all requirements of Part 195."

- **The American Association of State Highway and Transportation Officials** (AASHTO) – A Guide on the Accommodation of Utilities Within Freeway Right-of-Way, – "Untrenched Construction - Methods may include directional drilling, micro tunneling, driving, coring, or boring….Grout backfill should be considered for carriers or casings more than 300 mm (12 in.) in diameter and for overbreaks, unused holes, or abandoned carriers or casings. Untrenched excavations 100 mm (4 in.) or less in diameter may be exempt from void filling requirements in accordance with the transportation agency's utility accommodation policy."

- **American Society of Mechanical Engineers (ASME) B31.4-2012** – 457 ABANDONING A PIPING SYSTEM – "In the event of abandoning a piping system, it is required that (a) facilities to be abandoned in place shall be disconnected from all sources of the transported liquid, such as other pipelines, meter stations, control lines, and other appurtenances; (b) facilities to be abandoned in place shall be purged of the transported liquid and vapor with an inert material and the ends sealed."

- **PHMSA Advisory Bulletin – Pipeline Safety: Clarification of Terms Relating to Pipeline Operational Status –** "SUMMARY: PHMSA is issuing this advisory bulletin to all owners and operators (operators) of hazardous liquid, carbon dioxide, and gas pipelines, as defined in 49 Code of Federal Regulations Parts 192 and 195, to clarify the regulatory requirements that may vary depending on the operational status of a pipeline. Further, this advisory bulletin identifies regulatory requirements operators must follow for the abandonment of pipelines. Pipeline owners and operators should verify their operations and procedures align with the regulatory intent of defined terms as described under this bulletin. Congress recognized the need for this clarification in its Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016."

2.2 ENBRIDGE STANDARDS

Enbridge has developed an internal standard titled "D06-201 – Pipeline and Facility Change in Operational Status" to ensure compliance with the applicable standards. This internal standard recommends the completion of several analyses, including:

- project-specific risk assessment;
- land use assessment;
- crossing assessment;
- depth of cover assessment;
- erosion and slope stability assessment;
- long-term monitoring and mitigation assessment;
- ground subsidence and soil mechanics/pipeline collapse assessment;
- environmental contaminant considerations assessments;
- coatings contamination assessment; and
- NORM and PCB review.

In addition to the aforementioned analyses, the standard provides guidance on:

- criteria for draining product from existing mainline and facilities;
- methods of purging product from the system;
- methods of cleaning pipeline and facilities; and
- methods to isolate the pipeline from operating infrastructure.

Enbridge has adhered to this internal standard in order to ensure the safest and most efficient practice when deactivating Line 3.

2.3 PIPELINE ABANDONMENT MATRIX

The Canadian Energy Pipeline Association (CEPA) developed a Pipeline Abandonment Matrix to provide general guidance for a company who has to decide whether to abandon a pipeline by removing it or abandoning it in place. The Pipeline Abandonment Matrix looks at both the diameter of the pipeline and existing and potential future land use considerations which are then broken down into usage categories. A summary of the Pipeline Abandonment Matrix for pipe diameters greater than 26 inches is provided in Table 2-1 below.

Table 2-1: CEPA Pipeline Abandonment Matrix

Land Use		Primary Option For Abandonment (Pipe Diameter > 26")
Agricultural	Cultivated	Abandon In Place
	Cultivated with special features* (depth of cover considerations)	Remove
	Non Cultivated (Native Prairie, Rangeland, Pasture)	Abandon In Place
Non-Agricultural	Existing Developed Lands (Commercial, Industrial, Residential)	Abandon In Place
	Prospective future development (Commercial, Industrial, Residential)	Remove
	No future development anticipated (e.g., Forest Areas)	Abandon In Place
Other Areas	Environmentally Sensitive Areas (including Wetlands)	Abandon In Place
	Roads & Railways	Abandon In Place (with special treatment to prevent potential ground subsidence)
	Water Crossings	Abandon In Place
	Other Crossings (Utilities)	Abandon In Place (with special treatment to prevent potential ground subsidence)

In the CEPA Pipeline Abandonment Matrix, there are only two land use situations in which removal is the recommended method to abandon a pipeline: (1) where the land is cultivated but has special features such as depth of cover considerations; or (2) when it is non-agricultural land and there is prospective future development contemplated. Neither of these two land use situations applies to Line 3 because it exists in a multi-pipeline corridor that contains active pipelines. In all other categories of land use, abandon in place is the recommended method to abandon a pipeline. Enbridge is proposing to Permanently Deactivate the existing Line 3 in place, and Enbridge's decision to deactivate in place is consistent with CEPA's recommendations.

3 RISK ASSESSMENT

Enbridge conducted a risk assessment to determine the technical risks associated with both removing the Line 3 from the ground and Permanently Deactivating Line 3 in place. As part of the assessment, Enbridge consulted with internal stakeholders, worked with external consultants to perform studies, and performed a literature review of industry studies. The risk assessment consisted of:

- collecting risk data during a risk identification workshop attended by representatives from Enbridge's various functional groups and subject matter experts;
- developing risk reduction and mitigation strategies for high risk scenarios; and
- committing to re-assessing the high risks (post-action) to assess the value of the reduction and mitigation strategies.

3.1 RISKS ASSOCIATED WITH PIPE REMOVAL

Pipeline removal would create impacts to the environment, land use, and public safety similar to a new pipeline project. Environmental hazards associated with pipe removal are related to the disturbance of the soil, potential impacts to the groundwater, and potential impacts to human activities, natural wildlife and vegetation. Reduced soil stability during and after excavation can also be a concern, as it can lead to increased localized erosion and destabilized slopes. These hazards may cause considerable disruption to ongoing and future land management activities. These risks increase significantly during a large scale removal project.

Excavation of the Permanently Deactivated Line 3 will cause significant disruption to landowners and the general public. Construction activities would restrict access to the ROW and adjacent works areas. Removal operations at crossings would not only cause traffic interruptions and restrictions, but soil stability issues caused by pipe removal could damage the roads, bridges and crossings. These issues introduce risk to existing infrastructure such as roadways, railways, and other utilities.

One of the greatest risks of removing a Permanently Deactivated pipeline is the risk of damaging adjacent pipelines or infrastructure, which can lead to significant public, environment, and operational impacts. The existing Line 3 currently shares a congested ROW with either five or six additional pipelines. Line 3 is located in the third position in roughly 75% of the mainline ROW corridor in Minnesota. In the U.S., the majority of Line 3 is within 7 to 18 feet edge-to-edge from the nearest adjacent, active pipeline. Given the proximity of Line 3 to other operating pipelines, removal increases the chance of a release from adjacent operational lines caused by either a line strike or by their fatigue due to the use of heavy equipment during removal activities.

In light of the significant construction-related risks, execution in the congested corridor would also be a significant challenge, especially as it relates to excavation. Unlike the installation of a new pipeline (i.e., a pipeline installed as the outside pipe in a multi-pipe corridor), where crews can work over areas where there aren't active pipes underneath, the removal of a pipeline within a multi-pipe corridor necessitates the placement of timber mats over the active pipelines. The placement of these mats creates a working and travelling surface for large equipment to use when excavating and pulling out the abandoned pipe. Enbridge estimates approximately 600,000 – 900,000 mats would be required to safely remove Line 3 from the ground. Securing this volume of mats at one time may not be feasible.

Additionally, in areas where pipelines are relatively close to each other or where there exists slope stability concerns due to either changes of ground elevation across the ROW or wet soil conditions, the installation of sheet piling may be required. Sheet piling will likely be required in all saturated wetlands. Removal of Line 3 would require over 235,000 tons of steel to sheet pile both sides of the pipe located in saturated wetlands along the ROW. Similar to mats, securing this volume of sheet piling at one time may not be feasible.

Due to restrictions on utilization machines to excavate within close proximity of active pipelines (minimum of 1 foot of clearance), Enbridge would likely use either hand dig or hydraulic vacuums to excavate the Permanently Deactivated Line 3 in order to meet Enbridge's Ground Disturbance Guideline (MP-HSMS-009) to reduce the likelihood of construction damage to existing infrastructure. Hydraulic vacuum excavation could present a challenge due to the large amount of water and associated slurry waste needed due to the size of the removal project. Enbridge estimates approximately 1.7 million gallons of slurry waste would be produced if the pipe were to be removed from the trench. This will also create disposal and erosion challenges. Notwithstanding Enbridge's robust construction specifications, proper planning and execution, the likelihood of a mechanical incident will be elevated due to the size of the removal project, irrespective of the party conducting the excavation.

In areas where the abandoned pipe is both (a) on the interior of a multi-pipeline corridor and (b) within a saturated wetland, mats and sheet piling will not provide the protections they would normally offer in a dry area based upon the lack of bearing capacity of the saturated wetland's soil. This lack of bearing capacity introduces the potential for the placed matting to *sink* when it is driven over by heavy equipment. This sinking could progress all the way unit the mats are resting upon those very same pipes they were once trying to protect. Again, because of the lack of bearing pressure, even when considering relatively long sheet piling, there exists risk that driven sheet pile will not "reach bottom" and, as such, will not serve as adequate soil stability or as the "foundation" for a temporary matting road and would prevent access to those areas. Due to the access issues identified in saturated wetlands, Enbridge anticipates there will be areas where pipe removal cannot be safely performed. Please see Figure 3-1 which shows the stages of pipeline removal.

Figure 3-1: Stages of Pipeline Removal



Line 3 is located within a multi-pipeline corridor.



To remove Line 3 would require additional temporary work space for equipment and topsoil storage.



Temporary mats would be placed over operating lines.



The mats protect the operating pipelines from heavy equipment.



Soil would be removed to expose the pipeline.



Heavy equipment would be brought in to remove the pipeline from its trench.



The pipeline would be cut into sections. Valves and buoyancy weights would be detached and removed.



The pipeline is further sectioned to fit onto trucks.



The pipeline sections would be hauled away by truck.



Additional trucks would bring in soil to fill the void from the removed pipeline.



The right-of-way would be restored.

3.2 Risks Associated with Deactivating a Pipe in Place

Permanently Deactivating Line 3 in place avoids the potential risks and impacts related to ground disturbance and active pipelines discussed for removal. Nonetheless, there are other risks related to abandoning a pipeline in place that need to be addressed. To further assess these risks, Enbridge reviewed industry literature related to the deactivation or abandonment of pipelines, including: CSA Z662[4], the 2007 CEPA Report[1], and the 2010 DNV GL Study[6]. The literature review identified that the following areas are the most critical to address for Permanently Deactivated pipelines:

- Soil and water contamination;
- Water conduits; and
- Subsidence.

As summarized in Table 1-1, Enbridge has studied each of these risks and determined a mitigation strategy to minimize each one. Each identified risk, Enbridge's engineering analyses, and mitigation strategies, is described in detail in the following sections of this Plan.

3.3 RECOMMENDED APPROACH

Based on the results of the risk assessment, Enbridge believes that deactivating a pipeline in place minimizes and/or eliminates unnecessary impacts to the environment, landowners, and the state of Minnesota. Removing the 282 miles of existing Line 3 would create a significant risk to other operating pipelines and additional impacts to the environment, land use, and public safety similar to and exceeding those related to constructing a new pipeline project. Permanently Deactivating Line 3 in place poses some risk of water and soil contamination, water conduit, and ground subsidence. However, based on Enbridge's engineering assessments, these risks can be adequately avoided, minimized, or mitigated through the cleaning program, isolation and segmentation, and ongoing monitoring and maintenance activities as described in this Plan.

It is unnecessary, therefore, to subject the environment, landowners, and the state of Minnesota to the additional removal impacts and risks when deactivating a pipeline in place can be done in a manner that minimizes known risks. Accordingly, deactivation in place is recommended for the following land uses because the disturbance caused by pipe removal would likely adversely affect landowners, sensitive areas or existing infrastructure:

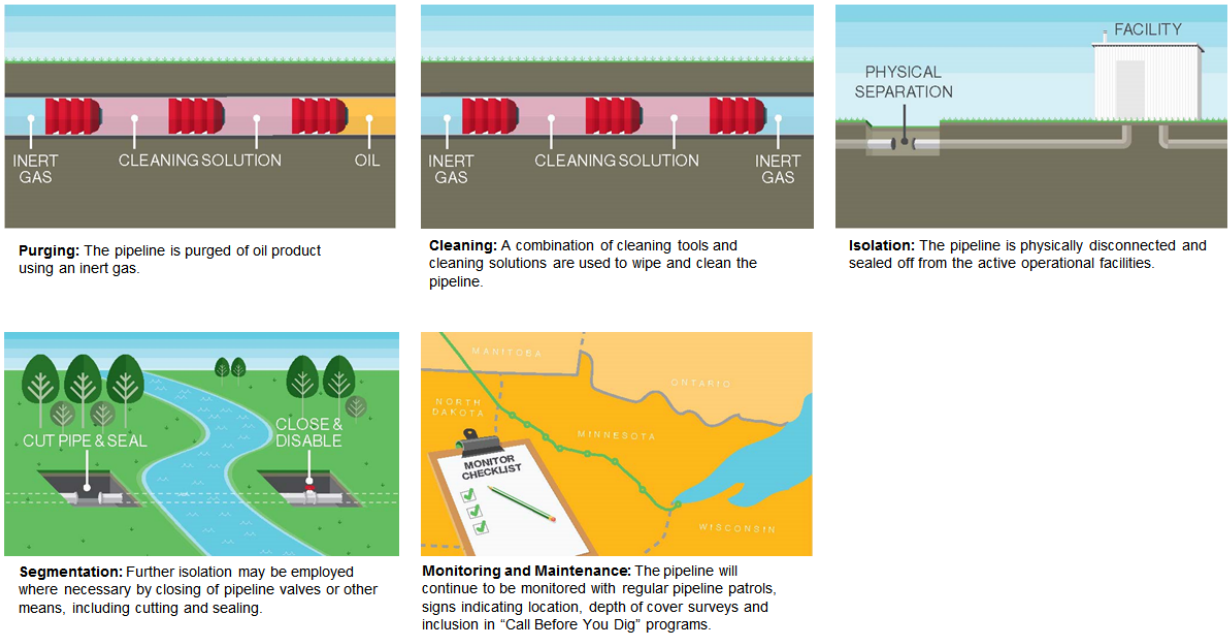
- environmentally sensitive areas (parks, wetlands, natural areas, species at risk habitat);
- water crossings (streams, rivers, lakes, canals);
- non-agricultural lands;
- forested lands;
- existing developed lands (commercial, industrial, residential);
- non-cultivated lands (native prairie, range land);
- roads and railways;
- other crossings (utilities, other pipelines); and
- cultivated (including those that are irrigated).

The remainder of this Permanent Deactivation Plan discusses minimize risks and impacts related to the pipeline remaining in the ground.

4 SCOPE OF WORK FOR DEACTIVATING IN PLACE

The Line 3 Permanent Deactivation Plan will comply with applicable regulations for abandoned pipelines and include execution of measures designed to minimize the risk of soil and water contamination, water conduits, and ground subsidence. The Permanent Deactivation Plan will follow the five main steps which are summarized in Figure 4-1 below.

Figure 4-1: Deactivation Process



Purging: The pipeline is purged of oil product using an inert gas.

Cleaning: A combination of cleaning tools and cleaning solutions are used to wipe and clean the pipeline.

Isolation: The pipeline is physically disconnected and sealed off from the active operational facilities.

Segmentation: Further isolation may be employed where necessary by closing of pipeline valves or other means, including cutting and sealing.

Monitoring and Maintenance: The pipeline will continue to be monitored with regular pipeline patrols, signs indicating location, depth of cover surveys and inclusion in "Call Before You Dig" programs.

4.1 MINIMIZING THE RISK OF SOIL AND WATER CONTAMINATION

4.1.1 Soil and Water Contamination Risk

One identified risk is that soil and water contamination could occur from hydrocarbons remaining in the pipeline after it is removed from service. In order to minimize this risk, Enbridge will purge the pipeline of crude oil and implement a cleaning program to remove remaining hydrocarbons from the pipeline.

4.1.2 Mitigation

4.1.2.1 Purging

Existing product within the pipe will be purged, or pushed through the pipeline, using pigs propelled with nitrogen gas. Enbridge will deactivate the existing Line 3 between MP 789 near Joliette, ND and MP 1098 near Superior, WI. Deactivation will proceed in two sections:

Section one will consist of a pipeline purge between the Gretna Station (MP 772) and the Clearbrook Terminal (MP 909) followed by pipeline cleaning and disconnecting the pipeline from the facilities along the Gretna to Clearbrook segment and at Clearbrook Terminal. See Figure 4-2.

Section two will consist of a pipeline purge, pipeline cleaning, and disconnecting the pipeline from the facilities at Clearbrook Terminal (MP 909) and along the pipeline to the Superior Terminal (MP 1097). See Figure 4-3.

Figure 4-2: Purge Diagram (Gretna to Clearbrook)

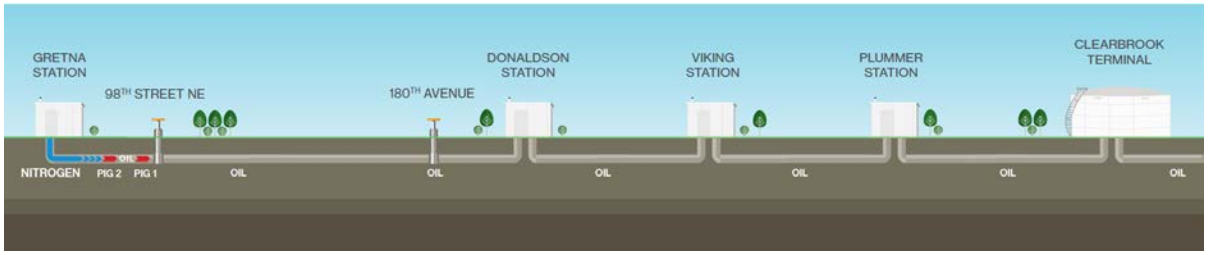
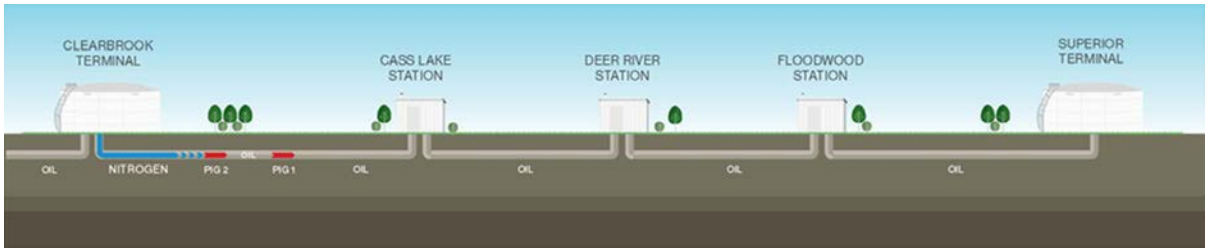


Figure 4-3: Purge Diagram (Clearbrook to Superior)



For each section, a batch of two (2) 34" pigs will be loaded and launched. The first pig will be a purge pig followed by a batch of oil and a tailing purge pig. Nitrogen injected at the beginning of the section is used to propel the pigs to the downstream side of the nearest intermediate station. This will "push" the oil along the pipeline. The purge operation will continue by injecting nitrogen at each of the intermediate stations until the pigs reach the end of the section; the Clearbrook Terminal (MP 909) or Superior Terminal (MP 1097), respectively. The oil that has been pushed to the terminus of the pipeline (i.e., purged oil) will be delivered to tankage at either the Clearbrook Terminal for section 1 or the Superior Terminal for section 2. All purging activities will be undertaken subject to any federal, state or local permitting requirements.

Once the purging operation is complete, the section of Line 3 will be prepared for cleaning.

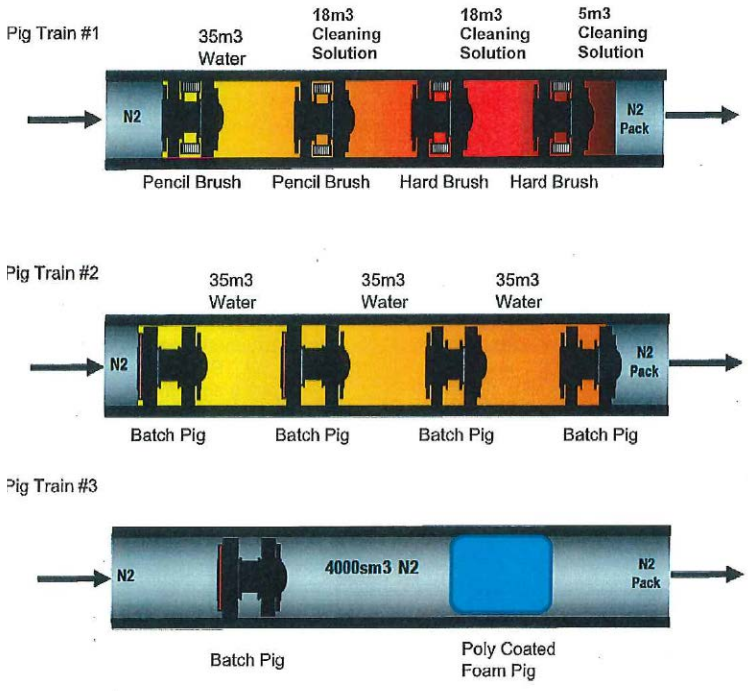
4.1.2.2 Cleaning

In order to minimize soil and water contamination risks, the existing Line 3 pipeline will be cleaned with the appropriate solvents to remove hydrocarbons from the pipe walls. The appropriate solvent is typically an engineered cleaning solution comprised of water and/or water and biodegradable cleaning agents. After purging is complete, cleaning runs will be completed in a sequence similar to that shown in Figure 4-4.

The cleaning program will be verified when Enbridge completes cleaning the first section and re-verified during cleaning of each subsequent section. Each cleaning stage will be sampled to confirm cleanliness.

All cleaning activities will be undertaken subject to any applicable federal, state or local permit requirements. All solid waste materials generated as a result of cleaning activities will be handled and disposed of in accordance with applicable federal and/or state requirements. All of the cleaning solution used during this process will be appropriated and disposed of in accordance with permit requirements.

Figure 4-4: Example Cleaning Sequence



Enbridge completed a two-phase verification to validate its proposed cleaning program (Appendix 7.1). The first phase consisted of laboratory testing of representative pipeline material, which determined the appropriate chemical selection for the cleaning material, as well as hydraulic modeling and cleaning train design. In the second phase, this cleaning program was then applied to a 12-mile deactivated section of Line 3 pipe after it was taken out of service

in 2014. All fluid samples collected during the cleaning process were submitted to an accredited laboratory for unbiased and independent chemical analysis of the samples taken. The laboratory analysis concluded that PCB and NORM concentrations were below detectable limits and, therefore, the Permanently Deactivated pipe did not pose a risk of contamination. Scientific analysis of the rinse water concluded that 99.9999987% of the product was removed from the pipeline after the cleaning regime was completed. If the results of this 12-mile section were extrapolated to the results expected from cleaning the entire 282 miles of Line 3 in Minnesota, this is equivalent to less than one gallon of hydrocarbons that would be left inside the pipeline. Therefore, the cleaned pipe would not pose a risk of contamination.

As mandated by the Department of Justice Consent Decree, cleaning and purging of the existing Line 3 must begin within three months of the in-service date (ISD) for the Line 3 Replacement Project.

4.2 MINIMIZING THE RISK OF WATER CONDUIT EFFECT

4.2.1 Water Conduit Risk

A Permanently Deactivated pipeline may function as a conduit to transport water or soil in a downslope direction if the pipeline has significantly degraded after being Permanently Deactivated. Pipeline corrosion and/or third party damage (e.g., a line strike which may affect coating quality and, in turn, accelerate localized corrosion) are the most likely events that cause the pipe to degrade over time. If the structural integrity of the pipeline is compromised, water and surrounding materials may infiltrate the pipe and have the potential of travelling downslope and exiting the pipe at another location. Water conduits may cause water migration to or from sensitive environmental features such as wetlands, watercourses, water supply areas such as aquifers, areas with sodic/saline or sandy soils, agricultural lands, and areas with a high water table.

Each of the following conditions is necessary for the formation of water conduits:

- Through-wall corrosion to allow water to enter the pipeline;
- The Permanently Deactivated pipeline must be in contact with water (that is, the pipeline is located at or below the water table);
- The portion of the pipeline that forms the conduit must be intact;
- There must be a preferential exit corrosion point that allows water to exit following movement within the pipeline;
- There must be sufficient elevation changes between the entry and exit points to allow for the movement of water; and
- The influx of soil must be of such type and occur in such a fashion that it does not effectively block the conduit.

The creation of water conduits along the outside of pipelines has not been identified as a risk. It is industry standard during pipeline construction and restoration that trench breakers are placed to prevent this occurrence, and it is assumed that given the vintage of Line 3, the likelihood of an external conduit occurring is minimal as the pipeline has been through numerous freeze/thaw cycles over its lifetime. In addition, the Permanently Deactivated pipeline will be monitored as part of the Enbridge Operations and Maintenance Manual, and if evidence of water conduit formation along the outside of the Permanently Deactivated pipeline is observed, similar mitigation measures to those used for operating pipelines will be implemented.

The key mitigation measures identified to reduce the potential effects of the formation of water conduits are:

- pipeline cleanliness (to address potential contamination from within the pipeline);
- isolation and pipeline segmentation;
- responding to one call requests for the Permanently Deactivated line;
- monitoring of the ROW; and
- maintaining CP.

Enbridge's planned cleaning program is described in Section 4.1.2.2. Enbridge's planned continued monitoring and maintenance, including One-call participation, are discussed in Section 4.3.2. The following section focuses on Enbridge's assessment and plans to isolate and segment existing Line 3.

4.2.2 Segmentation Assessments

Segmentation is conducted to avoid the potential for the Permanently Deactivated pipeline to act as a water conduit. To ensure protection of resources such as wetlands, streams and rivers, a detailed analysis has been completed to show the effectiveness of segmentation of the Permanently Deactivated pipeline at predetermined locations, including pump station and MLV locations. In addition to these existing segmentation locations, topography, hydrology and depth of cover have been reviewed in detail and taken into consideration in order to identify additional segmentation locations.

Enbridge conducted several segmentation assessments to identify segmentation locations for the Permanently Deactivated Line 3 pipeline and to mitigate the risk of water conduit via the pipeline. The following analyses were completed:

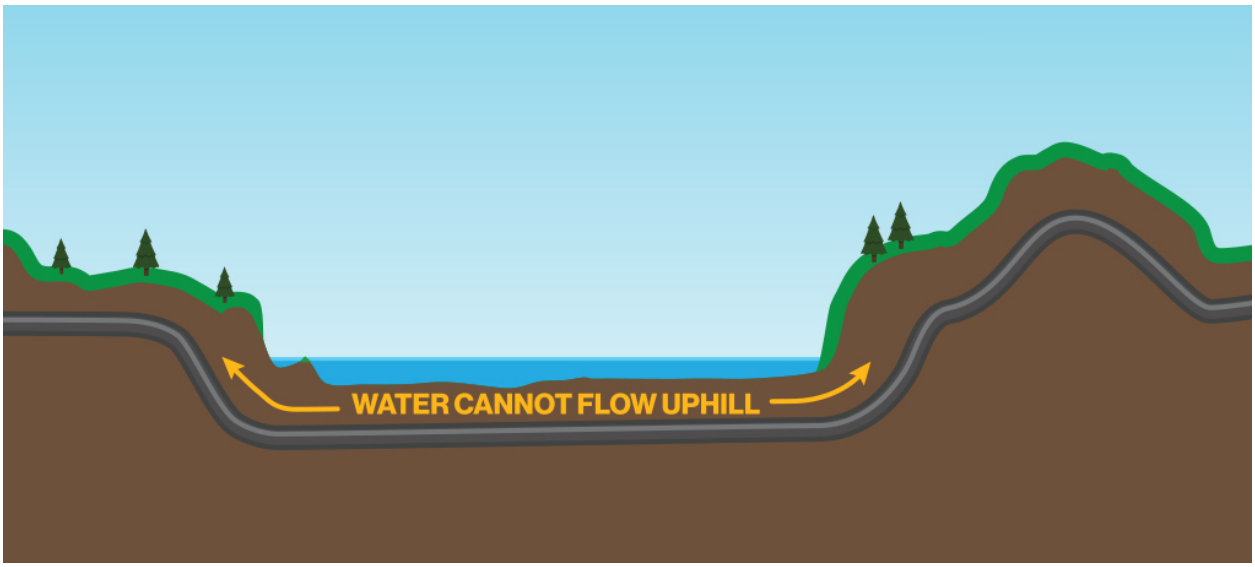
1. Desktop review of Enbridge data collected through years of operational history, including, but not limited to: wetland and waterbody delineations, cultural surveys, pipe depth of cover, ground profile information, and valve and station locations;
2. Desktop review of publicly available data including: water table elevation, soil types and ground profile information;
3. Computer-assisted iterative model to verify and confirm the results of the in-depth desktop analysis;

4. Using the results of the desktop analysis and computer model, provide a detailed listing of segmentation locations; and
5. Provide implementation strategy for in-field segmentation locations to ensure protection of all identified features, on a site-specific basis.

4.2.2.1 Topographical High Concept

The Topographical High Concept is an approach used to identify where the existing topography of the land acts as a physical barrier to the movement of water through a Permanently Deactivated pipeline. To accommodate local accumulation of seepage water at sag, or low points, a topographical high must be greater than one pipeline diameter above any adjacent lows. The Topographical High Concept was used to identify areas along the Line 3 pipeline that will act to hydraulically disconnect the pipeline and mitigate the water conduit effect. See Figure 4-5 for a representation of the Topographical High Concept.

Figure 4-5: Topographical High Concept



For the purpose of the Topographical High Concept used in the segmentation modeling, a topographical high is defined by:

A location along a pipeline that has an elevation sufficiently above:

- The predicted groundwater elevation, based on known ground surface elevations and regional characteristics, and
- The water level on both sides of a surface water or delineated wetland/waterbody feature that provides sufficient topographical relief to hydraulically isolate adjacent features or other upstream and downstream features outside a natural hydraulic connection. In addition to hydraulic disconnection, and in order to accommodate local

accumulation of fluid at sag points, a topographic high must also be a distance greater than one pipeline diameter (here, 34 inches) above any adjacent lows.

This definition will be used to identify areas along the existing Line 3 pipeline where the surface topography acts to hydraulically disconnect the pipeline and effectively mitigate the water conduit effect. To be effective, the topographic high must ensure that hydraulic disconnection is maintained in one or both directions from the topographic high to the next adjoining segmentation point in perpetuity. To prevent the pipeline from acting as a conduit, the elevation of the topographic high must be greater than the estimated highest annual surface/groundwater level.

The distance over which a topographical high will be applicable as an alternative to other segmentation methods will depend on factors such as hydrological and hydrostatic conditions, pipeline elevation, topography, local water accumulation, outflow zones, and both the distance to, and the elevation of, the next adjoining segmentation point specific to the lateral section of the pipeline being considered.

4.2.2.2 SEGMENTATION MODELING METHODS

4.2.2.2.1 Desktop Analysis

Using publicly available and additional Enbridge captured ground and pipeline profile data, a desktop analysis was performed to holistically review potential flow paths caused by elevation differences between known and delineated wetlands/waterbodies and ground water levels using the Topographical High Concept.

In many cases the wetlands and water bodies were found to be at naturally occurring local low points in the topography. In such cases, the pipe elevation coming into and exiting such features is greater than the elevation of the feature itself. This effectively eliminates the susceptibility for water to migrate out of the identified feature to any other feature. In addition to this naturally occurring segmentation, each delineated wetland was reviewed to determine if it is part of a larger wetland complex and/or combined wetland and stream/river crossing in order to identify locations of hydraulic connectivity and limit any potential exposure outside of the confines of the same complex.

Similar to the analysis performed for each individual wetland and waterbody feature, publicly available data in combination with field data obtained during the construction of Line 67 (Alberta Clipper) in 2009/2010 was used to analyze the possibility of a flow path within the water table that could create a water conduit risk.

4.2.2.2.2 Computer Assisted Model

To support the detailed desktop analysis, a segmentation model was developed using an iterative process to assess the potential effects of the water conduit effect. The model considers the topography of the land, the depth of cover of the pipeline, the location of

wetlands/waterbodies, and current proposed isolation/segmentation locations (that is, manual and automatic valves and facilities), and the groundwater elevation. The model uses an iterative process to determine and verify the results of the desktop analysis by doing a query that looks both upstream and downstream of known features to find the topographical high, and reports such areas that need to be investigated for potential segmentation points, if other factors do not mitigate such risk.

Data for topography, and the groundwater elevation was obtained from publically available sources. Isolation and segmentation locations (MLVs, stations and terminals) and pipeline depth-of-cover were obtained from Enbridge. In order to determine where additional segmentation of the pipeline is recommended, the segmentation model uses water table evaluation data, surface elevation data, pipeline elevation data, the location of existing isolation and segmentation points, and an iterative computer analysis. The segmentation model considers the regional movement of water when determining the placement of segmentation locations.

4.2.2.3 Refinement of the Segmentation Model Results

The model results were reviewed to determine whether or not the segmentation locations were optimally placed to mitigate the water conduit effect while reducing the amount of environmental disturbance associated with segmentation activities to the greatest extent practicable. As part of the desktop and iterative computer model reviews, all known features were given the same consideration for protection from a water conduit path.

4.2.2.4 Results and Recommended Segmentation Assessments

Based on the engineering assessment completed, 47 locations have been identified in the state of Minnesota for isolation (see Table 4-1). These 47 locations consist of the 40 mainline valves, 6 pump stations, and one co-located pump station/terminal within MN. There are three additional locations that have been identified as potential segmentation locations (items 8, 10 and 12 in Table 4-1) due to elevation changes and waterbody characteristics; these locations are currently being analyzed based on site specific factors (e.g., soil characteristics, topography, and hydraulic connectivity) and will be used as segmentation locations if determined that the water conduit effect poses a risk. Additionally, final isolation locations are subject to further refinement based upon the completion of the field assessment and detailed engineering and constructability review.

Table 4-1: Segmentation and Isolation Locations

Existing Line 3 Segmentation/Isolation Locations				
Number	ROW MP	Elevation (ft.)	Location	Action
1	803.25	792	MLV 803.25-3-V	Segment
2	805.55	795	MLV 805.55-3-MOV	Segment
3	814.01	820	MLV 814.01-3-V (Donaldson)	Station Isolation
	814.02	820	CHK 814.02-3-V (Donaldson)	
	814.11	820	MLV 814.11-3-MOV (Donaldson)	
4	829.16	877	MLV 829.16-3-V	Segment
5	834.51	929	MLV 834.51-3-V	Segment
6	838.36	964	MLV 838.36-3-V	Segment
7	840.77	984	MLV 840.77-3-V	Segment
8	844-848			Site Specific Analysis Underway
9	848.15	1049	MLV 848.15-3-MOV (Viking)	Station Isolation
10	850-854			Site Specific Analysis Underway
11	857.14	1133	MLV 857.14-3-V	Segment
12	860-864			Site Specific Analysis Underway
13	864.02	1100	MLV 864.02-3-MOV	Segment
14	865.06	1102	MLV 865.06-3-MOV	Segment
15	867.40	1101	MLV 867.40-3-V	Segment
16	873.43	1116	MLV 873.43-3-V	Segment
17	876.99	1142	MLV 876.99-3-MOV (Plummer)	Station Isolation
	877.05	1142	CHK 877.05-3-V (Plummer)	
18	885.65	1141	MLV 885.65-3-V	Segment
19	895.96	1240	MLV 895.96-3-V	Segment
20	899.31	1335	MLV 899.31-3-V	Segment
21	904.56	1292	MLV 904.56-3-V	Segment
22	909.15	1351	MLV 909.15-3-MOV (Clearbrook)	Terminal/Station Isolation
	909.17	1351	MLV 909.17-3-MOV (Clearbrook)	
	909.39	1351	MLV 909.39-3-MOV (Clearbrook)	
	909.43	1351	MLV 909.43-3-MOV (Clearbrook)	
23	916.52	1440	MLV 916.52-3-V	Segment

24	933.43	1383	MLV 933.43-3-V	Segment
25	939.45	1365	MLV 939.45-3-MOV	Segment
27	940.02	1362	MLV 940.02-3-MOV	Segment
27	943.69	1365	MLV 943.69-3-V	Segment
28	949.90	1358	MLV 949.90-3-V	Segment
29	953.02	1337	MLV 953.02-3-MOV (Cass Lake)	Station Isolation
	953.02	1337	CHK 953.02-3-V (Cass Lake)	
30	955.05	1312	MLV 955.05-3-V	Segment
31	957.91	1320	MLV 957.91-3-MOV	Segment
32	972.74	1314	MLV 972.74-3-V	Segment
33	973.70	1320	MLV 973.70-3-MOV	Segment
34	985.66	1307	MLV 985.66-3-MOV	Segment
35	986.40	1304	MLV 986.40-3-MOV	Segment
36	987.75	1293	MLV 987.75-3-V	Segment
37	989.71	1291	MLV 989.71-3-V	Segment
38	995.92	1292	MLV 995.92-3-V (Deer River)	Station Isolation
	996.03	1292	MLV 996.03-3-MOV (Deer River)	
39	1007.32	1327	MLV 1007.32-3-V	Segment
40	1010.57	1288	MLV 1010.57-3-MOV	Segment
41	1011.66	1292	MLV 1011.66-3-MOV	Segment
42	1017.99	1307	MLV 1017.99-3-MOV	Segment
43	1019.87	1302	MLV 1019.87-3-V	Segment
44	1025.85	1315	MLV 1025.85-3-V	Segment
45	1044.36	1253	MLV 1044.36-3-MOV (Floodwood)	Station Isolation
	1044.36	1253	CHK 1044.36-3-V (Floodwood)	
46	1046.94	1270	MLV 1046.94-3-V	Segment
47	1060.10	1320	MLV 1060.10-3-V	Segment
48	1062.51	1347	MLV 1062.51-3-V	Segment
49	1073.41	1212	MLV 1073.41-3-MOV	Segment
50	1079.91	1051	MLV 1079.91-3-MOV	Segment

4.2.3 Mitigation

To minimize the potential risk for existing Line 3 to act as a water conduit, Enbridge will isolate and segment the pipeline as described in this Plan.

4.2.3.1 Pipeline Isolation

In accordance with CFR Part 195, the Permanently Deactivated pipeline will be physically separated (or isolated) from in-service piping to prevent the reintroduction of oil into the pipeline. Additionally, equipment and instrumentation on the pipeline, with the exception of CP, will be disconnected from electrical sources. All applicable federal, state and local permitting approvals will be obtained prior to undertaking any pipeline isolation activities.

The following sections provide additional details regarding the activities undertaken to isolate Line 3 from other pipelines, pump stations, terminal, MLVs and other facilities.

4.2.3.1.1 Pump Stations and Terminals

The pipeline will be physically disconnected and isolated from pump stations and terminals by safely excavating down to the isolation location, mechanically cutting the pipeline, removing a small section of pipe, and welding a plate or weld cap to the pipe on each side of pipeline and facility left in the ground. This activity will occur both upstream of the station suction valve and downstream of the station discharge valve. It is anticipated that this activity will occur near the fenced boundaries of the stations and terminals to ensure all auxiliary piping is isolated within the pump station or terminal. The precise locations where these activities will occur will be evaluated on a site-specific basis to minimize disruption to any nearby infrastructure due to construction activities. The Superior Terminal will only be isolated on the upstream side of the facility, as it is the terminating facility for the existing Line 3. The pump station and facilities buildings will remain in place and be used for maintenance and storage.

4.2.3.1.2 Mainline Valves (MLVs)

All MLVs will be electrically disconnected as to discontinue operability of the electrical actuators and be closed as a method of segmentation.

4.2.3.1.3 Electrical and Instrumentation

Electrical connections will be de-energized and rendered safe as determined during detailed engineering. Any electrical or instrumentation infrastructure required for the ongoing application of the CP system will be maintained.

4.2.3.1.4 Facilities

The following facilities on the existing Line 3 are locations at which isolation will occur:

- the northern endpoint of the Project located in North Dakota (MLV-789.43-3-B);
- Donaldson Pump Station (MP 814.00);
- Viking Pump Station (MP 847.91);
- Plummer Pump Station (MP 876.97);
- Clearbrook Terminal/Pump Station (MP 909.10);
- Cass Lake Pump Station (MP 952.98);
- Deer River Pump Station (MP 995.83);
- Floodwood Pump Station (MP 1044.33); and
- Superior Terminal (MP 1096.95).

The deactivation process involving the removal of mechanical piping will start with a safety briefing with the staff working on this project to discuss any onsite hazards and mitigation activities. Upon completion, the purging process will begin at each of the stations identified above. All removed piping and equipment will be cleaned and disposed of per applicable regulations. Pipe, piping components, valves, pumps and pipe fittings that are no longer fit for service or reuse within the Enbridge system would be cleaned and disposed of through regional salvage or disposal companies. The removal of the suction and discharge valves and associated piping will isolate the pump stations from the Line 3 mainline, once sealed. Any pipe within each facility that cannot be removed safely will be cleaned and plated so that there is a barrier between the facility and the pipe. The Line 3 pumps will be permanently removed to allow for a safe working area. The sump tank and its associated piping will be cleaned and removed.

The process to disconnect the facilities' electrical systems will start with a safety briefing to discuss any onsite hazards and mitigation measures. A review of the electrical equipment to be disconnected will be performed and equipment identified as non-essential will be removed and salvaged. Items essential for the operations of the adjacent operating lines will be identified and kept in place. A Lock Out/Tag Out tally will be performed on all of the electrical equipment associated with Line 3. If required, a 480 volt pad mounted transformer would be installed to provide power to maintain the yard, building lights and any power needed for CP. All equipment that is no longer fit for service or reuse within the Enbridge system would be cleaned and disposed of through regional salvage or disposal companies in accordance with applicable codes, regulations, and ordinances.

4.2.3.2 Pipeline Segmentation

The Line 3 pipeline will be segmented via the permanent closure of existing mainline valves. In addition, and as required by CFR Part 195, the stations will be isolated from the pipeline and

serve as additional segmentation points. When Line 3 was constructed, the valves were strategically placed to prevent volumes of oil from entering sensitive areas in the event of an emergency release during operation and, as such, they will also prevent movement of water within the empty pipe from reaching these same resources.

At locations other than existing MLVs, which will be permanently closed, additional mainline segmentation will be achieved by mechanically cutting the pipeline, removing a short piece of pipe, and welding a plate or weld cap to the pipe on each side of the pipeline left in the ground similar to facility isolation (see Section 4.2.3.1), or by installing a plug of grout. Pipeline segmentation activities will be undertaken in accordance with all applicable federal, state, and local permits.

4.3 MINIMIZING THE RISK OF SUBSIDENCE

The risk of ground subsidence has been identified by CEPA, the Petroleum Technology Alliance of Canada ("PTAC"), and the NEB as a possible concern for permanent deactivation of a pipeline in-place.[1,3,13] The literature recognizes that the long-term degradation of a Permanently Deactivated pipeline may eventually lead to a measureable amount of ground subsidence; however, the extent of that subsidence is not well defined and must be assessed. In order to responsibly deactivate a pipeline, an operator must consider the risks of ground subsidence and develop a plan to address it. The decision to Permanently Deactivate in-place requires that potential ground subsidence levels are within tolerable limits for site-specific land use.[1,3] While guidance for establishing tolerable limits is not presently available in the industry, the information available instead defers to a risk-based decision-making process to support appropriate actions for a specific pipeline.[1]

4.3.1 Structural Integrity and Subsidence Risk Assessments

This section provides details of the assessments of subsidence and structural integrity performed as part of developing the Line 3 Deactivation Plan to predict the short and long-term risks of ground subsidence. It should be noted that subsidence as a general term is used in relation to both natural and artificial hazards, such as growth faults, flood or groundwater withdrawal, and mining operations. However, reference to ground subsidence within this Plan is used solely with respect to possible subsidence concerns related to pipeline deactivation.

Enbridge performed a thorough review of the possible risks associated with ground subsidence with respect to pipeline deactivation, considering industry guidance from the 2007 CEPA Report,[1] the NEB Background and Discussion Papers,[3,5] the PTAC Report,[13] the 2010 DNV GL Report,[6] and additional Enbridge work summarized in this plan. The review identified the following potential consequences related to ground subsidence with respect to pipeline deactivation.

- Public Safety:
    - hazards to agricultural equipment;
    - road subsidence at primary highways;
    - track bed subsidence at railway crossings; and
    - hazards to people, machinery, or livestock.
- Environmental Impact and Land Use:
    - water channeling and subsequent erosion;
    - loss of topsoil; and
      long-term impact on land use.

4.3.1.1 Subsidence Failure Modes

Ground subsidence can occur where a void is created within the ground, generally at the pipe depth, allowing the soil above to collapse into the void, and creating a disturbance at the surface. This may occur due to a combination of corrosion degradation and loss of structural integrity of the pipe wall. Subsidence due to corrosion can be either partial, considering soil infill into large localized perforations in a Permanently Deactivated pipe, or total, considering significant overall general wall loss and total infill of soil.

Structural integrity, in the case of a Permanently Deactivated pipeline, is defined by the ability of the pipeline to resist collapse due to external loading, rather than internal product and pressure containment. DNV GL recognized that an abandoned pipeline sufficiently degraded by corrosion such that structural integrity is compromised could, in theory, collapse due to the weight of the soil and any potential surface loads present.[6,13] The possibility for total subsidence of a large diameter pipeline, (defined by CEPA[1] as having an outer diameter of 24 to 48 inches) is of specific concern for the 34-inch Line 3 because of potential environmental and safety concerns, as mentioned above. While the magnitude of subsidence due to partial infill is generally considered minor,[3] it has nonetheless been assessed in the following sections for comparative purposes.

In 2013, the Petroleum Technology Alliance of Canada (PTAC) commissioned DNV GL to prepare a study entitled “Understanding the Mechanisms of Corrosion and their Effects on Abandoned Pipeline”. The PTAC report presents a conservative methodology proposed by DNV GL for estimating time to loss of structural support for an abandoned pipeline. This assessment considers a worst case condition, assuming no coating (or 100% loss of coating) and no CP applied. However, these assumptions are not applicable to Line 3 since CP will continue to be applied to the pipeline; thus, the corrosion progression is predicted to be localized perforations due to external corrosion and not general wall thinning. Similarly, the conditions for internal corrosion on Line 3 are not consistent with the conditions used in the corrosion aspect of the PTAC model.

4.3.1.2 Corrosion Degradation

The structural integrity of a pipeline in a load bearing capacity is subject to decrease with corrosion degradation. The specific rate of corrosion due to exposure to the environment depends on a number of factors, including the condition of the pipeline coating, soil aeration, types and homogeneity of soils, soil moisture, internal atmosphere, and electrical factors which create the potential differences for a corrosion cell to be established.

Line 3 has been in service since 1968. The types of environmental degradation normally affecting onshore pipelines of similar vintage are:

- localized corrosion;
- uniform corrosion;
- stress corrosion cracking (SCC);
- corrosion fatigue; and
- selective seam weld corrosion.

Localized pitting and uniform corrosion, both external and internal, are the only two forms of corrosion that are relevant with respect to pipeline deactivation and contribution to subsidence. SCC, corrosion fatigue, and selective seam weld corrosion are unlikely to affect the structural integrity of the pipeline because they have a crack-like morphology that can grow to failure under an applied high hoop stress from internal pressure. The Permanently Deactivated Line 3 will not be under hoop stress due to internal pressure. In the absence of internal pressure, the primary stresses in the circumferential (hoop) direction will be minimized. As such, the driving stresses for continued SCC or corrosion fatigue crack growth are expected to be negligible. Therefore, SCC, corrosion fatigue, and selective seam weld corrosion are not considered as contributing factors to the risk of pipe collapse and subsidence caused by Line 3.

4.3.1.3 Effects of Coating and Cathodic Protection on Corrosion

External corrosion control is generally achieved on underground pipelines by a combination of corrosion resistant coatings and CP systems. Corrosion resistant coatings are designed to provide high dielectric strength, and low moisture permeability. The coating, where intact, provides a barrier to moisture, which is necessary to support the corrosion reactions. However, coatings contain defects, or ‘holidays’ where corrosion can occur. Furthermore, coatings can degrade with time which increases the extent of bare pipe surface susceptible to corrosion.

Generally, pipeline corrosion on an externally coated pipeline will primarily progress as localized pitting with general corrosion occurring at coating holidays, or where coating is disbonded.[13, 37] Per historical industry experience and guidance from CEPA and the NEB, it is considered highly unlikely for corrosion to cover the entire circumference of a pipeline over a significant length.[1,3] Thus, it is correspondingly unlikely that a long segment of the pipeline will be potentially susceptible to sudden collapse and subsidence. It should be noted that the 2011GE UltraScan®

WM in-line inspection data collected on the most severely corroded section of Line 3 revealed that approximately 99% of the inspected pipe joints contained corrosion that was <10% of the pipe's total surface area. This data substantiates the guidance provided by CEPA and the NEB that it is considered highly unlikely for corrosion to cover the entire circumference of a pipeline over a significant length.[1,3]

Line 3 is externally coated with polyethylene tape. A Gas Research Institute (GRI) report published in 1992 provides information that the most common problems reported by pipeline operators who had used tape coating on their pipeline systems were: poor field application, failure of adhesive, poor resistance to soil stress, and high susceptibility to shielding the current of the CP system.

Data collected from the 1996 direct examinations conducted on Line 3 was reviewed to provide a baseline for historical metal loss on this line. There were 49 locations excavated between 1978 and 1982 based on the findings of the in-line inspection (ILI) tool. External metal loss was found at 15 of these locations, all under wrinkled and disbonded tape. Excavations conducted on Line 3 have provided confirmation that the polyethylene tape is experiencing disbonding due to soil stress promoting the formation of wrinkles (on the coating) at the point of maximum stress, typically at the 3 o'clock and 9 o'clock circumferential positions of the pipe. (For reference, circumferential positions are indicated in terms of clock divisions looking downstream, with 12 o'clock representing the top centerline of the pipe.) Once the wrinkles form, water is able to seep under the disbonded coating and is carried along the pipeline's steel surface by capillary action. Permeation of the CP current is limited due to high dielectric strength of the polyethylene tape shielding the current.

4.3.1.4 Estimate of Corrosion Rates

A review of historical and conservative theoretical external and internal corrosion rates was undertaken to help establish a predicted time to failure for possible pipeline collapse, and related ground subsidence.

4.3.1.5 External Corrosion Rates

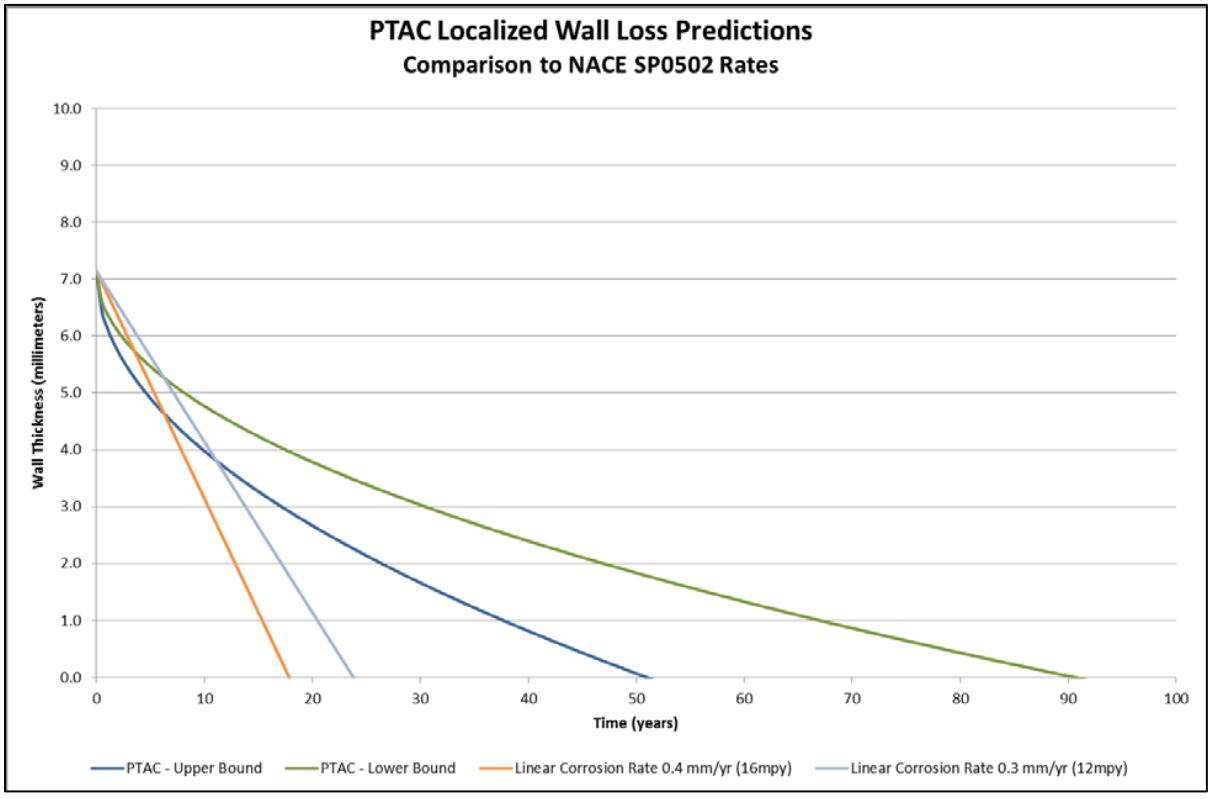
The U.S. National Bureau of Standards (NBS) initiated an extensive series of tests in 1922 to measure corrosion rates of various metals and alloys in a number of soil environments.[14] The soils studied were the native soils in over 150 test sites from around the United States. The soils were analyzed for pH, total acidity and the concentrations of sodium, potassium, calcium, magnesium, carbonate, bicarbonate, chloride and sulfate ions. The soil resistivity values were measured and the local climatic conditions were recorded.[14]

The numerical analysis provided in the PTAC report was used to calculate the localized corrosion rate and the uniform corrosion rate, as a function of soil drainage, assuming it was limited by ionic diffusion of oxygen through a surface oxide. The soil drainage was the only parameter that showed a weak but usable correlation between the mass loss (uniform corrosion) and the localized corrosion, with soils drainage. The wall thickness of the pipe was

calculated with respect to time for the two extreme soil drainage conditions: very poor and good. The results are presented in Figure 4-6.

A 0.4 mm/year (16 mils/year [mpy]) default corrosion rate for pipelines when other data are not available, is presented by ANSI/NACE SP0502-2010, "Pipeline External Corrosion Direct Assessment Methodology" (SP0502).[15] This corrosion growth rate was developed using an 80% probability bound (X80) value, established by the NBS study discussed above. SP0502 also provides a default pitting rate of 0.3 mm/year (12 mpy) for pipelines when other data was not available, provided that the piping has had at least 40 millivolts (mV) of polarization for a significant period of time since installation. This 0.4 mm/year growth rate was calculated from long-term underground corrosion tests of bare steel pipe coupons in a variety of soils, including native and non-native backfill, and is considered conservative for most transmission pipelines.[15] NACE guidance allows for a 24% reduction of this default rate, yielding the 0.3mm/year rate cited.[15]

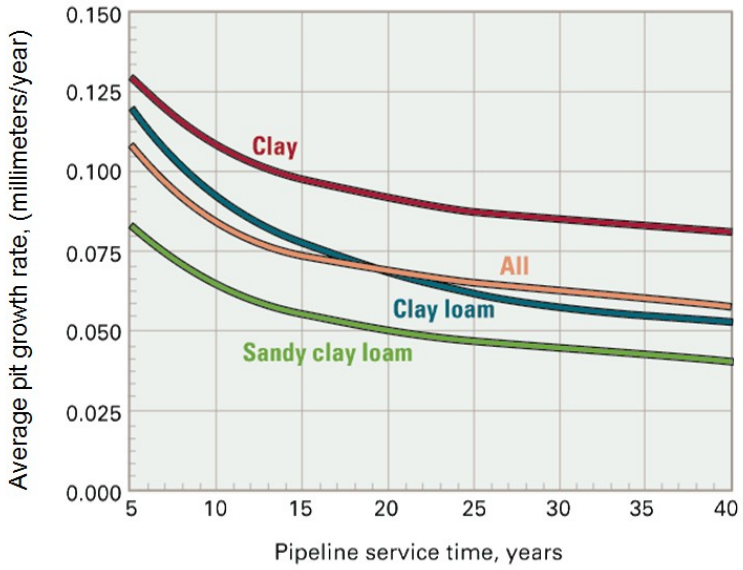
Figure 4-6: Upper and Lower Bound Wall loss progression due to corrosion as a function of soil drainage (PTAC). Applicable NACE SP0502 corrosion rates have been included for comparison.



These corrosion rates are generally considered conservative as presented below in Section 4.3.6, but are presented for comparison.

Both general and pitting corrosion rates have been shown to decline with age, as shown in Figure 4-7.[17] Velazquez presented a statistical analysis of over 250 excavations to predict the long term rates of pitting corrosion over a 40 year period.[17] For comparison, the worst case pitting growth rate (based on the X80 value) for the various soil types considered in this study was presented as 0.119 mm/year (4.7 mpy), or roughly a third of the 0.4 mm/year growth rate proposed by NACE.[15]

Figure 4-7: Average Corrosion Pitting Growth Rates as a Function of Time and Soil Classifications (Reproduced from Oil and Gas Journal – Corrosion)[17]



4.3.1.6 Historical Corrosion – Leaks and Ruptures

In an effort to better understand historical external corrosion performance for Line 3, the historical incidents along the entire length of Line 3 and the most recent integrity data for a representative section was reviewed. There have been five in-service incidents, the last of which was in 1997, in which external corrosion was either the cause or played a significant role in the cause of the incident; one was due to extensive general and pitting corrosion, three were due to cracks at the bottom of a deep pit, and the other was classified as narrow axial external corrosion. These incidents were caused by localized defects in the pipe wall and not general wall loss. From examination of the integrity data, there is no indication of significant areas of general wall loss and therefore the structural integrity of the pipe as a load bearing structure will not be significantly affected.

Data from the 2011 GE UltraScan® WM in-line inspection conducted on the most severely corroded section of Line 3 was reviewed to provide an assessment on the prevalence and severity of the metal loss on line. Table 4-2 summarizes the percentage of anomalies identified during inspection along this 255 km long section of Line 3. After approximately 60 years in service, over 50% of the anomalies identified were reported with an external metal loss less than 20% of the nominal wall thickness. Based on this 2011 data, less than 0.5% of the

anomalies were reported with an external metal loss greater than 50% of the nominal wall thickness.

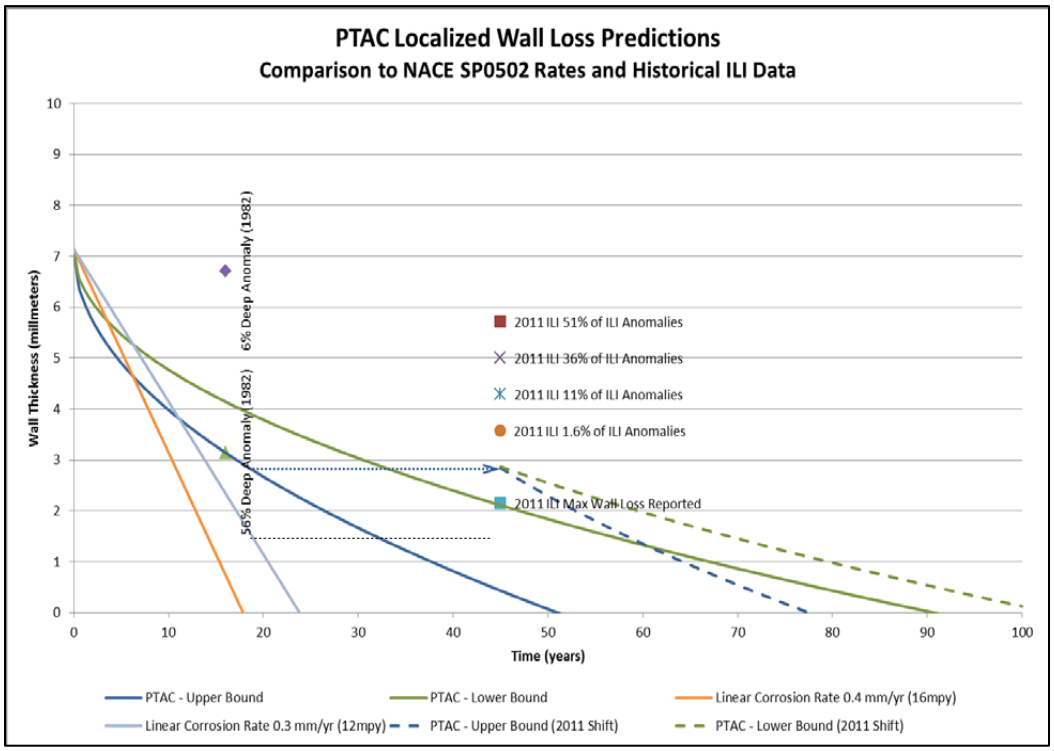
Table 4-2: Depth Distribution of External Metal Loss Anomalies Reported by 2011 WM Inspection for Line 3

Wall Loss as Percentage of Nominal Wall Thickness	Percentage of Total Anomalies (%)
≤ 20%	51.2
20 - 30%	36.4
30 - 40%	10.4
40 - 50%	1.6
≥ 50%	0.45

When comparing the 2011 ILI results to the localized corrosion data presented in the PTAC Report, a time to perforate the Permanently Deactivated Line 3 due to external corrosion may be estimated.[13] Figure 4-8 shows the wall thickness reduction with time due to localized external corrosion under two types of soils, one considering good drainage resulting in a lower bound corrosion rate (PTAC Lower Bound), and one with very poor drainage resulting in an upper bound corrosion rate (PTAC Upper Bound). The 1982 ILI data is also included in the plot for comparison. Reviewing the depth and time related to the worst case 56% deep through wall anomaly, identified in 1982, shows good comparison with the predicted curve for the worst case soil conditions. Based on the information presented in Figure 4-8, the worst case time to failure, from the original installation is estimated at 51 years. Based on this, it would be assumed that the pipeline is already penetrated or is likely to be within the next five years considering an in-service date of 1968. This demonstrates the over-conservative nature of the corrosion rates presented in the PTAC Model when compared to the corrosion rates experienced on Line 3. The time to penetration is linked to the time when internal metal loss due to corrosion could begin as a result of the ingress of ground water and soil to the internal surface of the pipe.

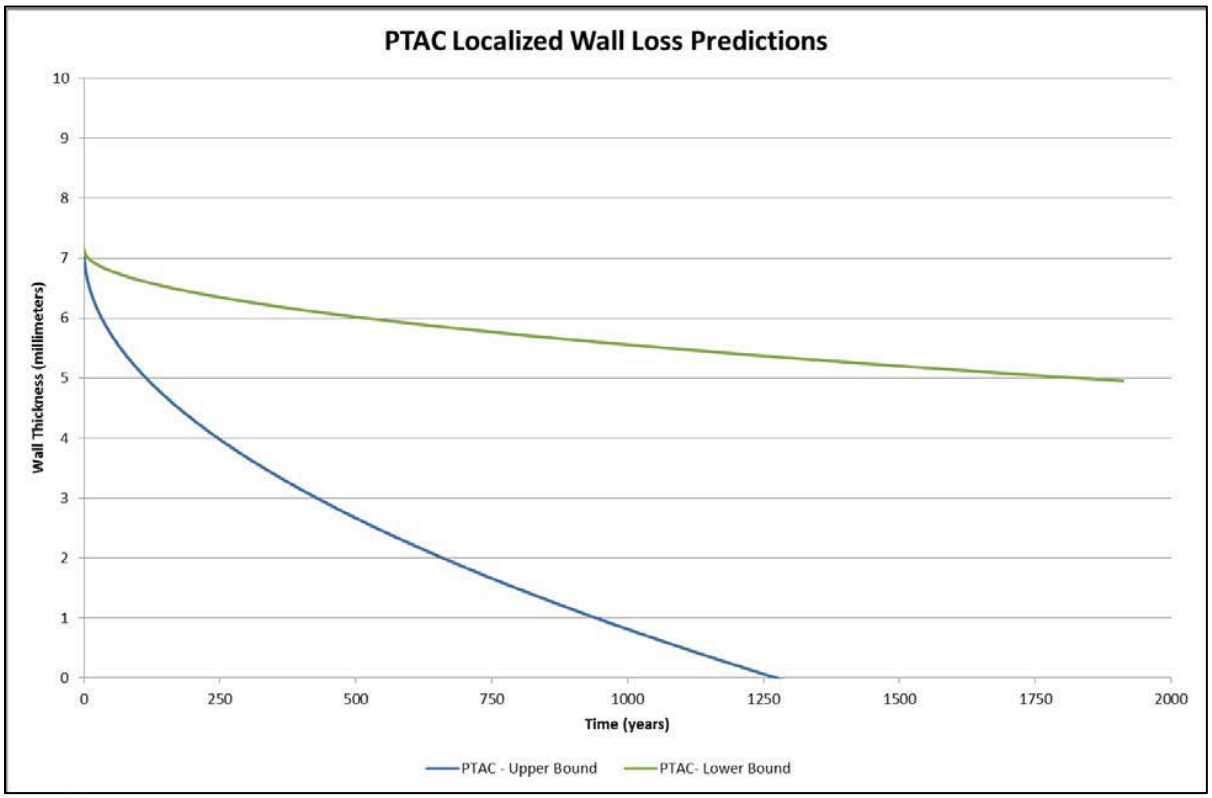
Reviewing the data from the 2011 ILI run, however, and assuming that the largest anomalies with external metal loss greater than 66% of the nominal wall thickness were repaired, it can be shown that the worst case anomaly is approximately 60% through wall as of 2011. Taking the degradation curve based on the PTAC Upper and Lower Bound corrosion rates and shifting those curves accordingly to represent a 60% through wall pit at 2011, as shown with the dashed curves in Figure 4-8, yields estimates of time to through wall penetration based on the PTAC model between 25 to 50 years from 2011. This only represents through-wall corrosion and not failure or collapse.

Figure 4-8: Upper and Lower Bound Wall loss progression due to corrosion as a function of soil drainage (PTAC). Historical metal loss inspection data collected on Line 3 has been included for comparative purposes.



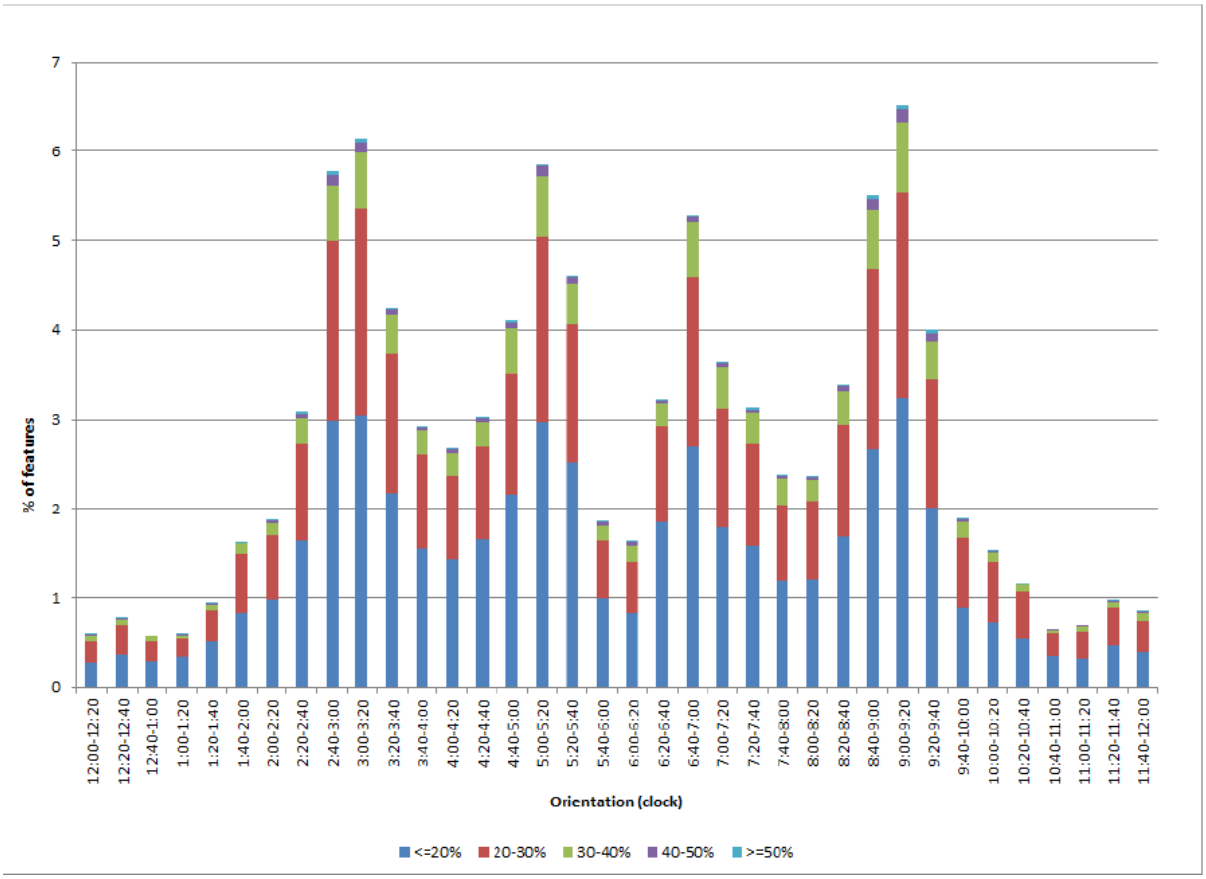
An analysis was conducted to evaluate the time it would take for the entire pipe wall thickness to corrode to zero due to uniform corrosion. Figure 4-9 shows the wall thickness reduction with time due to uniform external corrosion under types of soils, one considering good drainage resulting in a generally moderate corrosion rate (green curve), and one with very poor drainage resulting in a more aggressive corrosion rate (blue curve). The worst case estimates for time to total pipe degradation due to generalized corrosion, based on the PTAC model are greater than 1,250 years.

Figure 4-9: Pipe Wall Thickness Affected by Uniform Corrosion as a Function of Time and Drainage of the Soil (PTAC). Comparison to 2011 ILI Results.



The distribution of the external metal loss around the circumference of the pipe reported by the 2011 ILI run is presented in Figure 4-10. The sides of the pipe (2:40 to 3:40 o'clock and 8:40 to 9:40 o'clock) generally contained the highest percentage of external metal loss. This finding is most likely attributable to the fact that polyethylene tape coatings, such as that used on Line 3, are susceptible to soil stresses that result in wrinkling and disbondment along the sides of the pipe.[39] Due to the shielding characteristics of the coating, the CP system would not be able to adequately protect the pipe surface under the areas of disbondment.[18] The data presented in this figure does not suggest that the entire circumference of Line 3 is being corroded at a uniform rate and thus, there is no evidence to currently suggest that there are segments of Line 3 potentially susceptible to sudden collapse and abrupt subsidence.

Figure 4-10: Orientation of Metal Loss Features Reported by the 2011 GE UltraScan® WM In-Line Inspection of a Representative Section of Line 3



4.3.1.7 Predicted External Corrosion Progression

In its 1996 Report, the NEB presents a mechanism of corrosion leading to ultimate structural failure of a pipeline. Based on a review of the literature presented, industry guidance, and historical industry experience, a predicted external corrosion progression is proposed below to establish a relative understanding of the long term corrosion mechanisms.[1,3,6,13,14,17,19] The predicted external corrosion progression assumes Enbridge will continue the application of CP as part of its ongoing Operations and Maintenance programs as described in Section 4.3.2.1.

- After Permanently Deactivating Line 3, external corrosion is expected to progress in a similar manner with what has been historically observed.[1,3,6,13 12]
    - External corrosion is expected to grow at the locations of coating holidays, or disbonded coating, similar to the locations presented in Section 4.3.1.6.[3,13 14]
    - Pitting corrosion is expected to be the primary form of corrosion on Line 3 as opposed to large scale general corrosion; this assumption is consistent with the findings from the 2011 GE UltraScan® WM in-line inspection conducted in the most severely corroded section of Line 3 in which approximately 99% of the pipe

joints inspected contained corrosion that was <10% of the pipe's total surface area.

- The external corrosion is expected to continue being localized on the sides of the pipe, where the highest percentage of external metal loss has been measured, as discussed in Section 4.3.1.6.
- External corrosion is expected to be the dominate degradation rate until pits penetrate through wall, allowing moisture ingress into the pipeline.[3,13]

- Once external perforations have developed, water or soil may accumulate within the pipeline, and internal corrosion may progress as presented in Section 4.3.1.8.[13] This accumulation is expected to occur over hundreds of years.

- As the coating degrades and disbonds, more of the pipeline surface will be exposed. Areas where coating fails completely (i.e. exposing the external surface of the pipe to the surrounding soil), will be accessible to the CP system and thus, subsequent corrosion growth would be minimized. By contrast, locations where the coating is disbonded but remains intact will be shielded from the CP system and subject to continued corrosion as discussed in Section 4.3.1.3.[3,13]

The corrosion analyses presented in the NEB study indicated that due to the slow rates of pitting corrosion, and their localized nature, complete structural failure is not expected to occur for decades, or even centuries.[3] The findings from the NEB study are consistent with the type of corrosion present on Line 3 and the time estimates presented in Section 4.3.1.6, based on the PTAC Model. Furthermore, based on the random nature of pitting corrosion, it is considered unlikely that localized pits would coalesce to the point of significant pipe collapse.[3,13]

4.3.1.8 Predicted Internal Corrosion Progression

The predicted internal corrosion progression assumes the pipe has been cleaned, and residual moisture levels are as proposed in the cleaning program (Appendix 7.1). It is also assumed that corrosion due to microbially induced corrosion ("MIC") is negligible. Based on minimal amount of water, MIC results in insignificant degree of corrosion.

1. Internal corrosion is expected to be minimal until large enough external perforations occur to allow moisture or soil to enter.

   The findings from the 2011 GE UltraScan® WM in-line inspection conducted in the most severely corroded section of Line 3 revealed that only 0.4% of the pipe joints within the inspected section of line contained internal metal loss features. In total, only 122 internal metal loss features were detected in this section, and half of those had a reported length of ≤50 mm which would typically be indicative of pitting corrosion. With no product in the line and assuming the line is sufficiently cleaned and dried, the research performed by DNV GL and NGA/NYSEARCH related to casing corrosion is applicable for reference. In this study, 39 bench, small-scale, and field tests were performed for a variety of casing

environments. Field testing of a bare, cathodically-protected carrier pipe with a dry, vented environment showed no pitting on corrosion coupons and very low corrosion rates with a maximum of 0.002 mm/year (0.08 mpy) at all pipe positions except for the bottom of the line (6 o'clock). At the 6 o'clock position, an average corrosion rate of 0.05 mm/year (2.01 mpy) was observed. Although the annular environment was reportedly dry, the vent may have allowed for ingress of moisture and oxygen. Similarly, it is expected based on the cleaning program that any residual moisture will not have sufficient volume to pool, and the pipeline will have low oxygen content as nitrogen will be used to drive the cleaning pigs. However, it is considered that there may be a possibility of residual moisture in areas of existing internal pits, undercuts, or other defects that are not sufficiently dried during cleaning. Therefore, given lack of other specific data, it may be considered that an internal corrosion rate of 0.05 mm/year be used to provide a conservative estimate of the internal corrosion rates prior to perforation of the pipe wall.

Based on estimates above in Section 4.3.1.6, time to through-wall penetration is estimated to be between 25 to 50 years from 2011.

2. After the first perforations form, the rate of internal corrosion is expected to accelerate.

   Two scenarios were addressed, comparable to the scenarios presented in the DNV GL Scoping Study;[6] namely, considering complete fill of the pipeline where the water table is above the pipeline, and partial filling of the pipe due to moisture ingress where the water table is below.

   For the first case, a proposed progression is presented in the DNV GL Scoping Study, as follows.

   For Case 1, it was assumed that the pipe fills with aerated groundwater. Since the solubility of oxygen in water is low (< 8 ppm), the oxygen in a pipeline will be consumed rapidly for typical corrosion rates. For example, the oxygen in a 24-inch diameter pipeline will be consumed in around one week at a corrosion rate of about 0.1 mm/yr. After the oxygen is consumed, the corrosion rate will drop to negligibly low values. Anaerobic bacteria may accelerate the corrosion rate somewhat, but significant damage would not be expected based on measured corrosion rates for deep steel pilings (Beavers 1998), or buried subsea artifacts (J. A. Beavers, G. H. Koch, and W. E. Berry, "Corrosion of Metals in Marine Environments," Metals and Ceramics Information Center, MCIC Report 86-50, 1986). Furthermore, resupply of oxygen in the pipeline would be very limited unless there were a large number of large holes present in the pipeline.[6]

   For Case 2, considering a partial fill scenario, when the pipe has perforated, the internal surface will be exposed to moisture and possibly soil. In the DNV GL and NGA/NYSEARCH study, small-scale testing of bare carrier pipe exposed to air and a static level of brackish water (1/2-filled annular space) showed an average corrosion rate

of 0.22 mm/year (8.61 39 mpy) and an average pitting rate of 0.45 mm/year (18.1 mpy).[19] It should be noted that these rates were observed primarily at the water/air interface, which was located at the 3 o'clock and 9 o'clock positions in this experiment. Other locations around the pipe showed relatively low corrosion rates, with a maximum rate of 0.06 mm/year (2.20 mpy) and no appreciable pitting.

If soil enters the Permanently Deactivated pipeline, there is the possibility of these deposits causing localized areas of corrosion, which would be expected to occur along the bottom of the pipe at or near the 6 o'clock position where the soil is likely to settle. For this scenario, the internal surface would essentially act analogous to a bare external surface. ANSI/NACE SP0502-2010 provides a default pitting rate of 0.3 mm/year (12 mpy) for pipelines when other data are not available, provided CP level of the piping has had at least 40 mV of polarization for a significant fraction of time since installation.[16] This 12 mpy was calculated from long-term underground corrosion tests of bare steel pipe coupons in a variety of soils, including native and non-native backfill, and is considered conservative for most transmission pipelines.[16]

4.3.1.9 Effects of CP

It is expected that given sufficient time, a pipeline that is not maintained, has poor or no coating, and without CP, will eventually collapse due to corrosion. Estimates of this timeframe have been provided in Section 4.3.1.6, as well as from industry references to be decades at the low end, and thousands of years on the high end.[1,3,6,13] The NEB recognizes that maintaining abandoned pipelines while continuing CP cannot completely eliminate the risk of pipeline degradation or collapse. However, it can be expected to significantly slow the corrosion process, and thereby delay any potential subsidence.[5]

It is recognized, however, that polyethylene tape coatings are subject to disbondment, and locations where coating has disbonded will be dielectrically shielded from CP.[39] Enbridge will continue to monitor the Permanently Deactivated pipeline as part of its ongoing Operations and Maintenance programs as described in Section 4.3.2.1 and will continue the application of CP until which time it can be determined that it is ineffective or otherwise detrimental. Continuing the application and monitoring of CP will help to minimize the corrosion at coating holidays. However, corrosion may continue at locations of disbonded coating where water may come in contact with the pipe surface, and the coating dielectrically shields CP.

4.3.1.10 Structural Integrity and Subsidence Estimates

The PTAC model[13] for pipe collapse presents a conservative methodology for estimating time to collapse, defined as time to loss of structural integrity, of an abandoned pipeline. This assessment considers uniform wall loss scenarios, considering no coating (or 100% loss of coating) and no CP.

The primary loads that may contribute to structural collapse are loads imposed by soil cover, and any surface loads transferred to the pipe from forces acting at the ground surface. Surface

loads may refer to any loads acting at the ground surface, such as vehicular or equipment loads. The load acting directly at the pipe, or the “effective live load”, is generally much less than the loads at the surface, as the loads are dissipated through the soil as they are transferred to the pipe. The degree of this dissipation is dependent on the depth of soil cover. The PTAC report[13] provides calculations methods and summary tables of typical effective live loads for various American Society of Civil Engineers (“ASCE”) load and impact factors, which is reproduced in Appendix 7.2 (document titled Appendix 7-9.4 Structural Integrity and Subsidence, Section C-ASCE Loading Conditions). The effects of surface live loads on a Permanently Deactivated pipeline are considered more significant than the loads associated with depth of cover alone.[3,13] If sufficient enough to exceed the structural capacity of a Permanently Deactivated pipeline, the pressures transferred to the pipe will lead to ovalization, as depicted in Figure 4-11. If the loads are sufficient to progress, the pipe may fail through either plastic collapse or elastic buckling, as depicted in Figure 4-12 and as per the PTAC Report[13] and the American Life Alliance Guidelines for the Design of Buried Steel Pipe.[20]

Plastic collapse occurs when bending stress on the pipe walls exceeds the yield strength of the pipe steel. The wall plastically yields, and collapses under the loads on the pipe. Elastic collapse, or buckling, occurs when the elastic energy in the pipe wall exceeds the critical buckling limit. Both failure modes need to be considered in development of collapse assessments.[13] The critical load acting on the pipe to cause this collapse is considered the load bearing capacity of the pipeline.

Figure 4-11: Surface Load and Transmitted Pressured and Corresponding Ovality of Pipe Cross-Section (Reproduced from American Lifelines Alliance)[20]

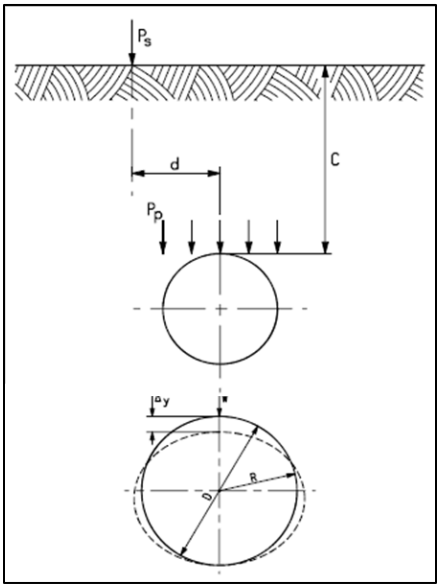
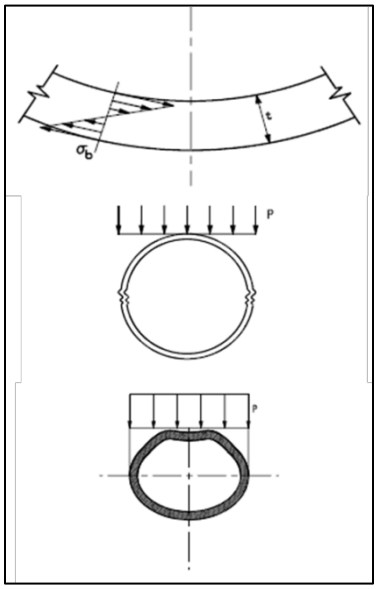


Figure 4-12: Through-Wall Bending Stress, Crushing of the Side-Wall, Elastic Buckling of Pipe Cross-Section (Reproduced from American Lifelines Alliance)[20]

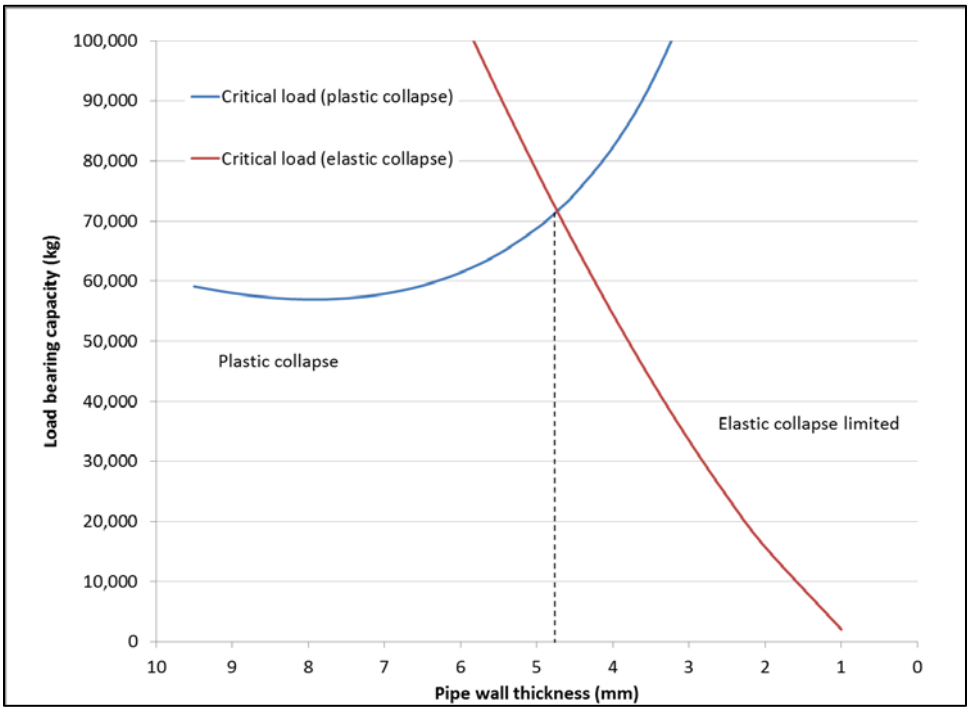


The PTAC model presents a methodology to assess the load bearing capacity of a pipeline as a function of wall thickness, considering both plastic and elastic collapse. An example plot is presented in Figure 4-13, where the blue curve represents the load bearing capacity as limited by plastic collapse, and the red curve represents the load bearing capacity as limited by elastic collapse. It should be noted that the load bearing capacity is not directly decreasing with the decrease in wall thickness. As the pipe wall becomes thinner, the stiffness of the pipe wall decreases. The decreased stiffness increases resistance to plastic collapse, until the point where elastic buckling is the controlling failure mode as described within the PTAC report.

As represented in Figure 4-13, the pipe can fail in two ways (elastic and plastic). As the pipe wall thins, the wall becomes more flexible being able to support greater loads following the blue curve. At the intersection of the curves, the pipe becomes weaker; following the red curve as the wall thickness decreases until failure results from a given load.

Figure 4-13: Example Plot of Load Bearing Capacity as a Function of Pipe Wall Thickness 2

(Reproduced from PTAC)[13]



4.3.1.11 Lapse Due to Generalized Corrosion

Structural integrity models presented by PTAC ("PTAC Model") were analyzed to assess the load bearing capacity of the Permanently Deactivated Line 3 as a function of corrosion damage. As the Permanently Deactivated pipeline corrodes, the load bearing capacity will be reduced. Analyses were performed to estimate the critical surface load necessary to cause pipe collapse, the corresponding soil subsidence geometry, and the pipe stresses associated with various surface loading scenarios.

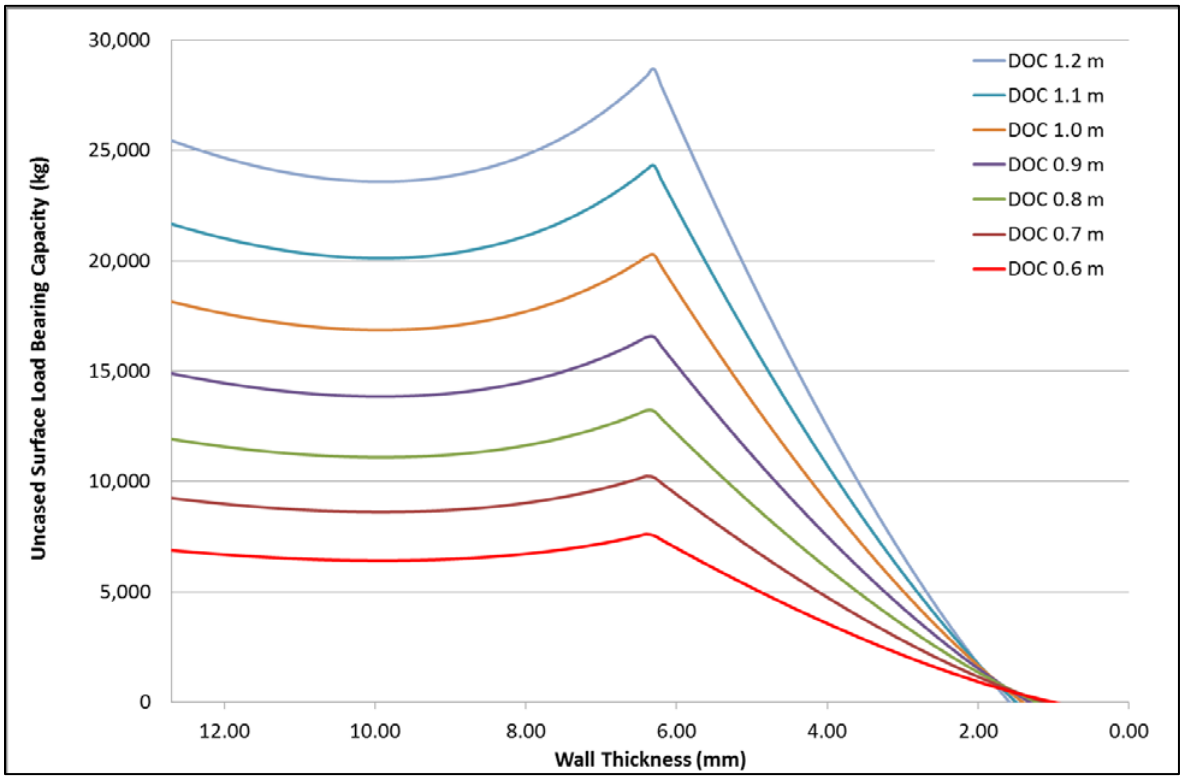
The load bearing capacity of a 34-inch pipeline comparable to the Permanently Deactivated Line 3 was analyzed using the combined PTAC model for plastic and elastic collapse. It should be noted that the PTAC model is considered a conservative estimate, as it assume generalized corrosion, no coating, and no CP, which are not representative of conditions on the Permanently Deactivated Line 3. However, it may be used to establish a conservative lower bound estimate. Input assumptions were used, as required, based on known or approximated conditions along Line 3. They are summarized below, and detailed in Appendix 7.2, Section B – PTAC Model Setup:

- Max Soil Density = 2000 kg/m3
- X52 Pipe (52,000 psi = 359 MPa)
- 34" Diameter (863.6mm)

- Young's Modulus (E = 205 GPa)
- Soil Modulus (E') = 6.9 MPa
- Bedding factor = 0.1
- Lag factor = 1.5
- Stress Intensity Factor = 3
- Impact factor = 1.75

Figure 4-14 presents the estimated surface load bearing capacity as calculated by the PTAC model for a 34-inch pipeline as a function of remaining or effective wall thickness. The surface load bearing capacity curve considers both plastic collapse and elastic buckling, as indicated on Figure 4-14. The surface loads represented in Figure 4-14 consider a point load acting at the ground surface in kilograms, and is generally conservative as surface loading will be distributed over a given area. The data is presented, however, to demonstrate the effect of depth of cover with respect to the surface load bearing capacity of a Permanently Deactivated pipeline.

Figure 4-14: Uncased Load Bearing Capacity Versus Wall Thickness as a Function of Depth of Cover



In order to allow for direct comparison with typical loading scenarios ASCE loads for known conditions, Enbridge considered the effective live load bearing capacity, or the load acting at the pipe as described in Section 4.3.1.10.

Figure 4-15 presents the effective live load capacity, for an uncased pipe, calculated as above. The effective live loads due to various surface load conditions are presented for comparison. An E80 load simulates an 80,000 lbs/ft. railway load, with impact loading considerations as defined by ASCE. An HS20 load simulates a 20-ton truck traffic load as defined by ASCE.[20] The personal truck load simulates a 5-ton vehicle traffic load. The minimum wall thickness necessary to resist collapse for a given load is found where the horizontal load lines intersect the corresponding DOC curve, as represented by the vertical dashed lines. For example, considering an HS20 load scenario at 0.6 m (2 ft.) DOC, the minimal wall thickness to resist collapse is found where the red curve representing the 0.6 m (2 ft.) DOC intersects the horizontal live load line for an HS20 load 0.6 m (2 ft.), at 2.6 mm for this example.

It should be noted that the effective live loads presented in Figure 4-15 represent the live load acting directly at the pipe, considering allowable contribution from surface loading. The live load capacity decreases slightly with depth of cover, as the contribution from soil loads will be greater at depth. The data presented in Figure 4-15 indicates that the added load from soil is minor in comparison to the benefits of depth of cover, however. For comparison, considering an HS20 load at the ground surface, the effective live load at the pipe for a relatively shallow depth of cover of 0.6 m (2 ft.) is two times greater than the effective live load considering a 1.2 m (3.9 ft) depth of cover, while the load capacity is only reduced approximately 6% due to soil loading.

Figure 4-15: Uncased Effective Load Bearing Capacity Versus Wall Thickness

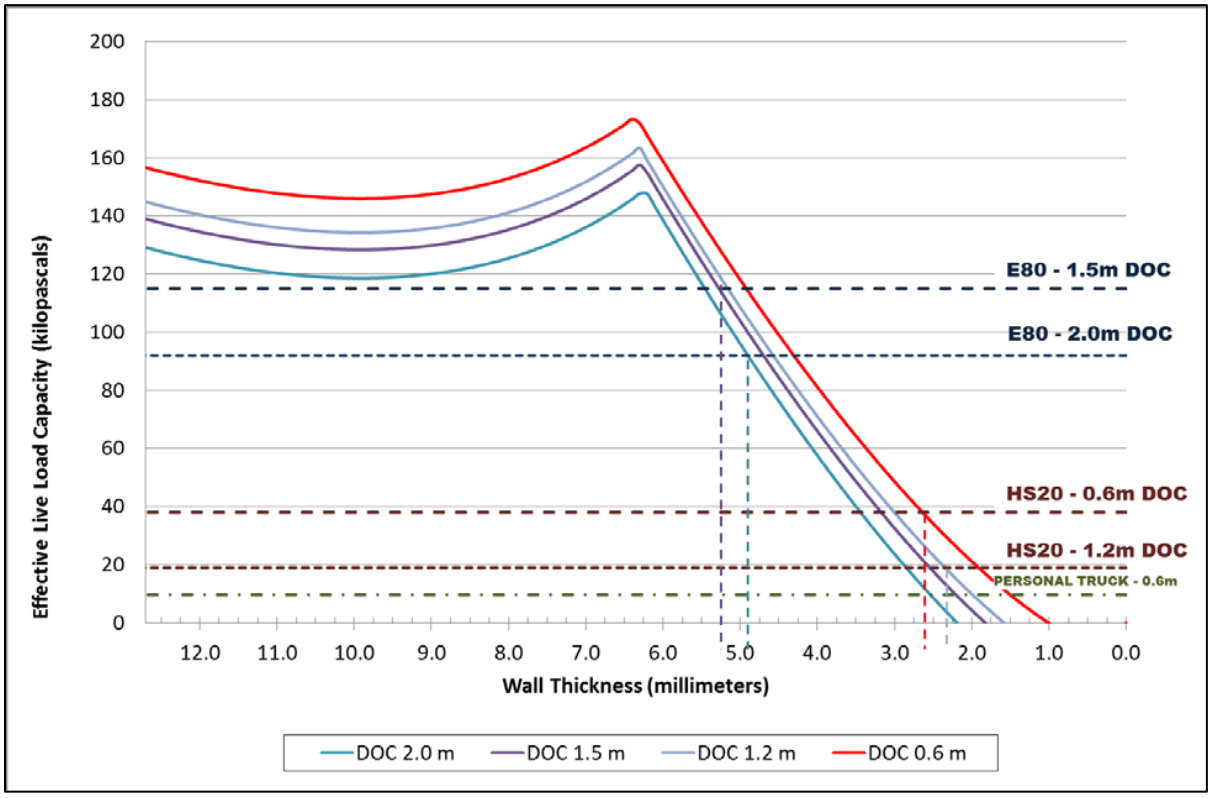


Table 4-3 summarizes the minimum effective wall thickness necessary for the Permanently Deactivated Line 3 to resist collapse considering the three loading scenarios (i.e., personal truck load, 20-ton truck load and 80,000 lbs/ft. railway load). The depths of cover in Table 4-3 are based on the following and are taken from the depth of cover measurements for Line 3 in Canada:

- 0.6 m (2 ft.) is the approximate minimum measured depth of cover in the 2008 depth of cover survey completed on Line 3;
- 1.2 m (3.9 ft.) is the typical depth of cover as measured in the 2008 depth of cover survey completed on Line 3;
- 2.0 m (6.6 ft.) is the minimum expected depth of cover for railway crossings (note: the depth of cover associated with each active railway crossing will be confirmed during detailed engineering); and
- 1.5 m (4.9 ft.) is a conservative estimated depth of cover for railway crossings.

Table 4-3: Minimum Effective Uncased Wall Thickness Capable of Withstanding Highway or Rail Loads

DOC		Minimum Allowable Wall Thickness (mm, in)		
(m)	(ft.)	Personal Truck	HS20	E80
0.6	2.0	1.5, 0.06	2.6. 0.10	N/A
1.2	3.9	1.8, 0.07	2.4, 0.09	N/A
1.5	4.9	1.9, 0.07	2.3, 0.09	5.3, 0.21
2.0	6.6	2.3, 0.09	2.5, 0.10	4.9, 0.19

The key findings from Table 4-3 are summarized below:

- At the minimum measured depth of cover of 0.6 m (2 ft.), the Permanently Deactivated Line 3 is capable of resisting collapse due to equivalent highway loads until sufficient corrosion degradation occurs such that the effective wall thickness is reduced to 1.5 mm, or approximately 78% uniform reduction of the nominal pipe wall thickness for Line 3.
- At a depth of cover of 1.5 m (4.9 ft.),. (expected depth of cover for a railway crossing) the Permanently Deactivated Line 3 is capable of resisting collapse due to equivalent railway loads until sufficient corrosion degradation occurs such that the effective wall thickness is reduced to 0.19 in., or approximately 30% uniform reduction of the nominal pipe wall thickness for Line 3.
- At a depth of cover of 2.0 m (6.6 ft.), (conservative depth of cover for a railway crossing) the Permanently Deactivated Line 3 is capable of resisting collapse due to equivalent railway loads until sufficient corrosion degradation occurs such that the effective wall thickness is reduced to 0.21 in., or approximately 25% uniform reduction of the nominal pipe wall thickness for Line 3.

The 2008 depth of cover survey completed on Line 3 indicates that less than 1% of the line has a depth of cover less than or equal to 0.9 m (3.0 ft,), and over 50% of the line has a depth of cover greater than 1.2 m (3.9 ft.).

It should be noted that these analyses were performed considering only the strength of the carrier pipe. All primary highway and railway crossings are expected to be cased as per original design recommendations. The nominal wall thickness of a casing for a 34-inch carrier varies, but is typically reported to be greater than 12 mm (0.5 in.).[21]

The estimated time required for Line 3 to undergo such environmental degradation that it would collapse was calculated with the assumption that no coating or CP is acting on the line. With active CP and intact coating, the general corrosion rate is expected to decrease, and subsequently the time to failure would be expected to increase.[5] As mentioned above, the nominal wall thickness of a casing for a 34-inch carrier pipe is typically 13-17 mm (0.5-0.7 in.) wall thickness. The 2011 GE MF ILI inspection conducted on Line 3 indicated that all active railway crossings on this line are cased.

Table 4-4 and Table 4-5 illustrate that the predicted time to failure under typical highway loads assuming uniform wall loss (i.e. the pipe wall has thinned to the extent that it can no longer support the live load under a highway or railway) varies from approximately 87 years to over 1000+ years depending upon the assumed wall thickness, soil classification and drainage.

Table 4-4: Time to Failure due to Critical Wall Loss - Highway

Time to Critical Uniform Wall Loss (Highway Load HS20) (years)				
	Soil Internal Drainage and Wall Thickness			
	PTAC Upper Bound Degradation Rates		PTAC Lower Bound Degradation Rates	
Depth of Cover	7.14 mm	12.1 mm	7.14 mm	12.1 mm
0.6 m	506	2237	8100	35797
0.9 m	536	2299	8575	36787
1.2 m	574	2377	9178	38025

Soil Type A: E'= 6.9 MPa, γs= 2000 kg/m3
kml PTAC upper bound degradation rate = 0.2
kml PTAC lower bound degradation rate = 0.05

Table 4-5: Time to Failure due to Critical Wall Loss - Railway

Time to Critical Uniform Wall Loss (Railway Load) (years)				
	Soil Internal Drainage and Wall Thickness			
	PTAC Upper Bound Degradation Rates		PTAC Lower Bound Degradation Rates	
Depth of Cover	7.14mm	12.1 mm	7.14 mm	12.1 mm
1.5 m	87	1166	1399	18660
2.0 m	125	1296	2007	20736

Soil Type A: E'= 6.9 MPa, γs= 2000 kg/m3
kml PTAC upper bound degradation rate = 0.2
kml PTAC lower bound degradation rate = 0.05

4.3.1.12 Pipe Collapse Due to Pitting Corrosion

In addition to the previously discussed model involving a uniform reduction in wall thickness, the PTAC "perforation" model was used to identify the percent of coating disbondment needed to create a pipe collapse scenario due to extensive perforations. The perforation calculations are built upon the plastic collapse model and the assumption that as the corrosion progresses, randomized pitting will be the predominant mechanism, and that there would still exist some amount of metal between the through-wall perforations.

To calculate the loss in load bearing capacity from a plastic collapse perspective, due to these randomized perforations, the PTAC model assumes that a 1% reduction in the wall thickness corresponds to a 1% loss in load bearing capacity, and a 10% reduction in wall thickness corresponds to a 10% loss in load bearing capacity.

Two perforation scenarios were investigated, one with the depth of cover of 2.0 ft. depth of cover, and another with 3.9 ft. depth of cover (this is the average depth of cover for Line 3 including topsoil cover) as illustrated in Figure 4-16 and Figure 4-17. In each of these scenarios the live loading capacity of pipe with a 7.1 mm and a 12.1 mm wall thickness, based on the range of nominal wall thicknesses for the Permanently Deactivated Line 3, was plotted. Additionally, the live loads transferred to the pipe from both a 5-ton personal truck and a 20-ton truck traffic highway are shown alongside the loading limits of the pipe.

Figure 4-16 and Figure 4-17 show the load bearing capacity of all graphed pipe is higher than the loads imposed by both the 5-ton personal truck and 20-ton truck traffic highway in all valid graphed areas. It is acknowledged within the PTAC report that as the perforation area increases from 20% to 50% or greater, the simple relationship breaks down, and it is not recommended this model be considered. As such, the plots are cutoff at 30% degradation, but demonstrate that the pipe wall will likely maintain a majority of its load bearing capacity until greater than 30% of the pipe's circumference is lost due to coalescing of perforations. The corrosion detected, to date, on Line 3 fits within the applicable portion of these figures based on the 2011 GE UltraScan® WM in-line inspection data, collected on the most severely corroded section of Line

3, that approximately 99% of the inspected pipe joints contained corrosion that was <10% of the pipe's total surface area. A time to collapse analysis could not be completed under this model, as the analysis does not extrapolate accurately past the 30% degradation, and the pipe was not predicted to collapse before that point.

Figure 4-16: Allowable surface loading per Pitting Corrosion Model, at 0.6m (2.0 ft.) DOC

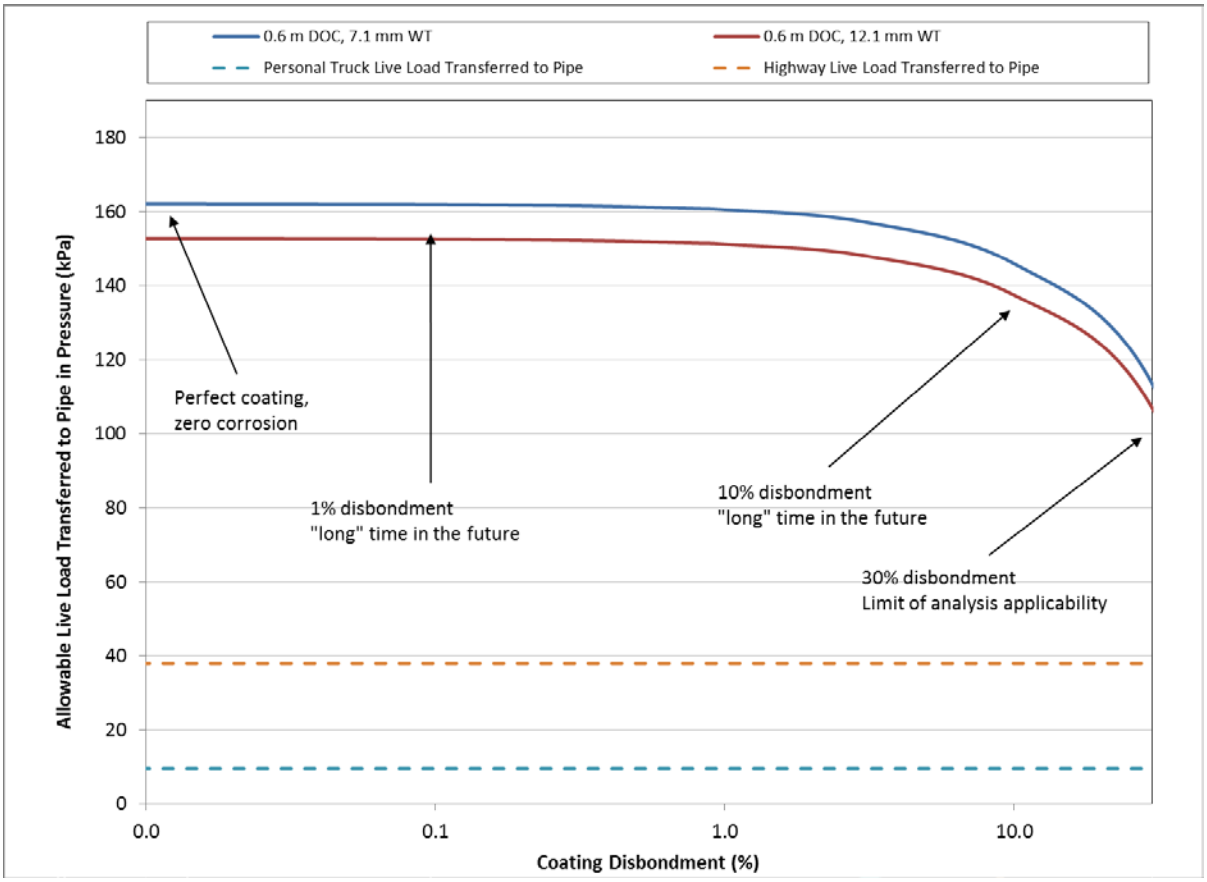
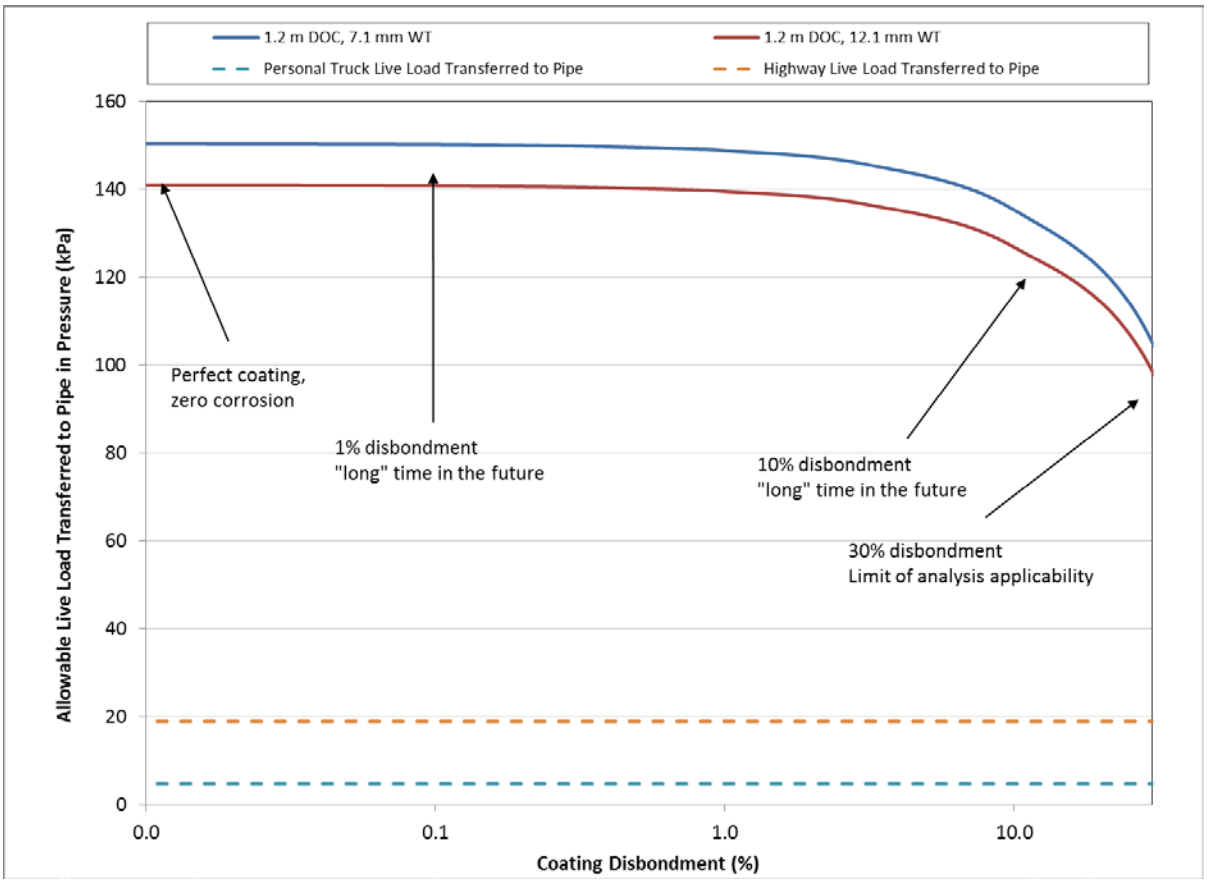


Figure 4-17: Allowable surface loading per Pitting Corrosion Model, at 1.2 m (3.9 ft.) DOC



4.3.1.13 Historical Ground Subsidence

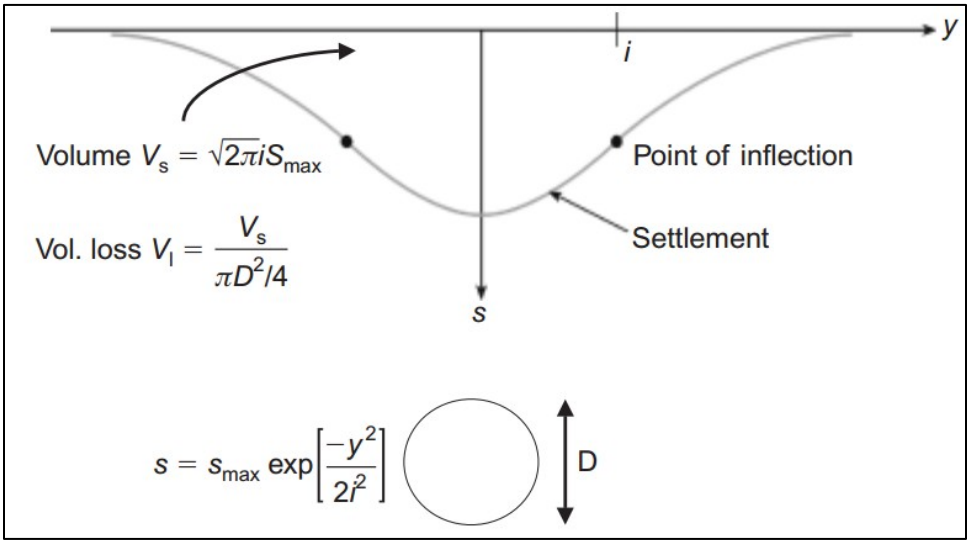
In 1996, the NEB commissioned a study on corrosion and soil mechanics in an attempt to better understand the connection between pipeline corrosion, structural integrity, and the possible ground subsidence that might be observed. The results of this study indicated that there had been no documented incidents of ground subsidence related to pipeline structural failure and this included the approximate 10,500 miles of abandoned or discontinued pipe, as of 1994, in Alberta.[3] The study further stated that ground subsidence associated with the collapse of pipelines is negligible for pipeline diameters up to 12 inches in diameter, at typical depths of cover. Additionally, while there is expected to be some measurable degree of subsidence associated with larger diameter pipelines, it may be small enough to be considered in the tolerable range.[3] The 1996 Discussion Paper concluded after significant study that even under the worst conditions of total structural collapse, ground subsidence would be negligible for pipelines with diameters of 12-inches and smaller. It went on to conclude that for pipelines with greater diameters, the degree of subsidence may be within tolerable ranges.[1] CEPA guidance recommends an assessment to determine the magnitude of subsidence possible for the Permanently Deactivated Line 3, which Enbridge undertook and provided below.

4.3.1.14 Predicted Subsidence Profiles

The rate and magnitude of ground subsidence are generally difficult to predict. Subsidence depends on a complex combination of site-specific parameters, pipe degradation, and soil mechanics properties near the pipeline. In 2014, as part of developing the Engineering Basis for the Line 3 Deactivation Program, Enbridge commissioned DNV GL to provide a geotechnical analysis to determine the possible subsidence levels, and corresponding trough profiles that could occur assuming various levels of pipe infill, up to and including full loss of pipe volume.

Ideally, ground subsidence estimations should consider both total subsidence from pipe collapse at shallow burial depth, and partial subsidence due to excessive ovalization and/or finite soil ingress. Prediction of ground subsidence in the absence of significant external loading can be predicted through analogy with tunneling construction. Extensive field measurements[40,41,42] have shown that the subsidence profile, or settlement trough, during open-face tunneling construction can be well characterized by the Gaussian distribution curve method. Figure 4-18 shows the generic settlement trough, where *i* describes the characteristic half-width of the trough and is a dependent on the depth of cover and soil type. For the scenarios presented for the Permanently Deactivated Line 3, the exact shape of the Gaussian distribution curve can be estimated based on the particular scenario: total pipeline collapse (Vl = 18 1), or partial collapse (i.e., excessive ovalization, or corrosion ingress, 0 < Vl < 1).

Figure 4-18: Generic Ground Settlement Trough Considering Gaussian Distribution Curve Method



A series of assessments were conducted to predict ground subsidence profiles considering 25%, 50% and 100% volume loss at various depths of cover. Note: 100% volume loss represents complete infill of the pipeline (i.e., at the time of collapse, the pipe is completely empty), while the 25% and 50% volume loss estimates represent a partial infill of the pipeline

(i.e., at the time of collapse, 75% and 50% of the pipe is filled with soil, respectively), see figure 4-19.

Figure 4-19: Pictorial Representation of Volume Loss for the 100%, 50%, and 25% Scenarios

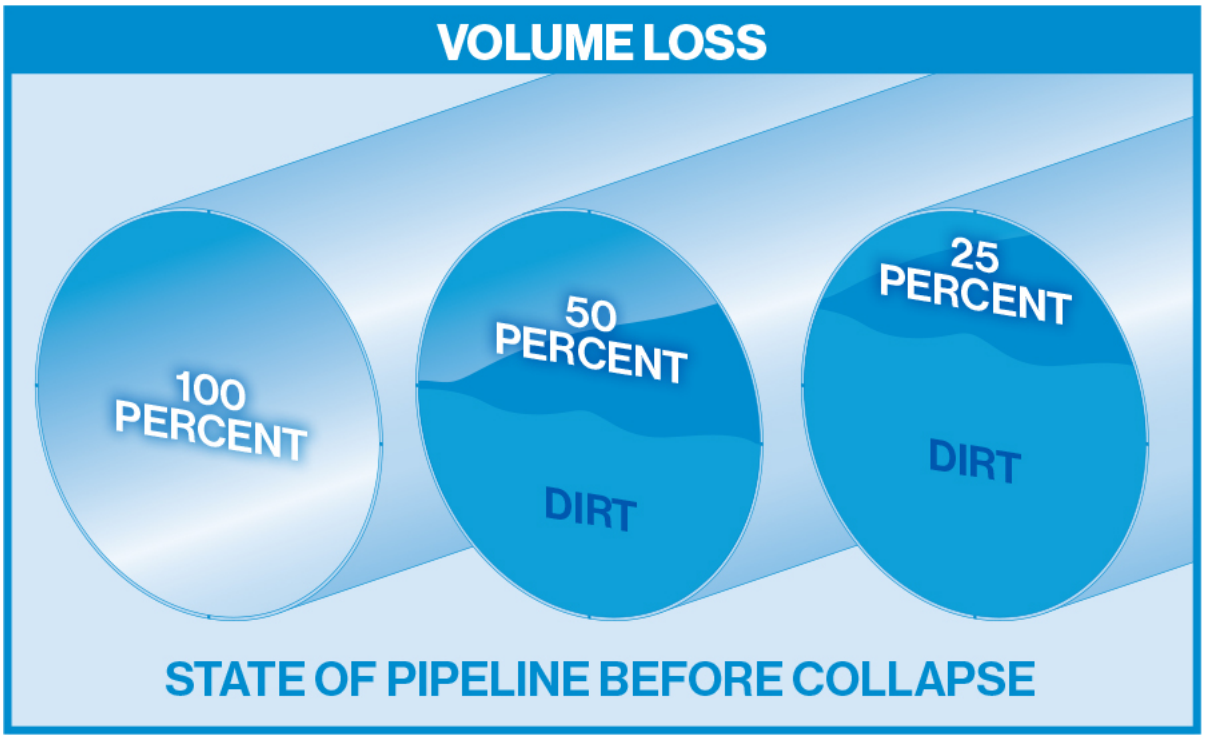


Table 4-6 through Table 4-8 summarize the maximum depth of the ground subsidence expected above the center line of the pipe and the half-width of the settlement trough (*i*) on both side of the pipe's center line at different volume loss values (100%, 50% and 25%) and depths of cover (assumed at 0.6m (2 ft.), 1.2m (3.9 ft.), 1.6m (5.2 ft.), 2.0m (6.6 ft.) and 4.0m (13.1 ft.)).

Figure 7A-2 through Figure 7A-4 found in Appendix 7.2, present the ground settlement profiles for the considered depths of cover and volume losses. Each figure consists of two graphs - one that shows the horizontal and vertical settlement in equal scales and a second which magnifies the vertical settlement by a factor of ten (10) for clarity.

The predicted trough profile presents a gradual non-linear profile that can be expected in the event of total subsidence of a Permanently Deactivated pipeline. The width of the subsidence trough is predicted to be significantly greater than the depth, as seen in the settlement profiles in the aforementioned Appendix 7.2. For example, considering the worst case subsidence profile for total subsidence of a 34-inch pipe, at 0.6 m (2.0 ft.) depth of cover, the peak depth is predicted to be 6.8 inches, whereas the full width of the profile spans nearly 27 feet. This would indicate that for a crossing where the Permanently Deactivated pipeline is perpendicular to a road crossing, for example, the trough width would be parallel to the direction of the road, and

the maximum predicted settlement of 6.8 inches would be distributed over approximately 27 feet of the road length in a gradual profile similar to that shown in Appendix 7.2.

The largest magnitude of subsidence predicted for a 34-inch pipeline at a depth of cover 0.6 m (2 ft.) was approximately 6.8 inches, decreasing to 4.7 inches of subsidence at 2 m (6.6 ft.) of cover, as shown in Tables 4-6 through 4-8. This analysis assumes a scenario where there is complete 100% soil infill of the pipe through either complete collapse of the pipe wall or total degradation of the pipe steel. Reviewing the Depth of Cover Survey from 2008, it can be seen that less than 1% of the line has a depth of cover equal to or less than 0.9 m (3.0 ft.), and over 50% of the line has a depth of cover greater than 1.2 m (3.9 ft.). This would indicate that the magnitude of subsidence considering complete loss of pipe volume and 100% infill is expected to be approximately 6 inches or less for the majority of the Permanently Deactivated Line 3.

In agricultural areas, the effect of subsidence due to the eventual decomposition of the pipeline will likely be minimized as a result of regular farming activity. Any cumulative low spots will be identified by Enbridge depth of cover surveys and mitigated.

Table 4-6: Settlement at 100% Volume Loss

Prediction with Assumed Volume Loss of 100%					
Depth of Cover		**Peak Subsidence**		**Half width of significant settlement trough**	
(m)	(ft.)	(m)	(in.)	(m)	(ft.)
0.6	2.0	0.1725	6.8	1.36	4.5
1.2	3.9	0.1450	5.7	1.62	5.3
1.6	5.2	0.1310	5.2	1.79	5.9
2	6.6	0.1195	4.7	1.96	6.4
4	13.1	0.0831	3.3	2.82	9.3

Table 4-7: Settlement at 50% Volume Loss

Prediction with Assumed Volume Loss of 50%					
Depth of Cover		**Peak Subsidence**		**Half width of significant settlement trough**	
(m)	(ft.)	(m)	(in.)	(m)	(ft.)
0.6	2.0	0.0863	3.4	1.36	4.5
1.2	3.9	0.0725	2.8	1.62	5.3
1.6	5.2	0.0655	2.9	1.79	5.9
2	6.6	0.0598	2.4	1.96	6.4
4	13.1	0.0415	1.6	2.82	9.3

Table 4-8: Settlement at 25% Volume Loss

Prediction with Assumed Volume Loss of 25%					
Depth of Cover		Peak Subsidence		Half width of significant settlement trough	
(m)	(ft.)	(m)	(in.)	(m)	(ft.)
0.6	2.0	0.0431	1.7	1.36	4.5
1.2	3.9	0.0362	1.4	1.62	5.3
1.6	5.2	0.0328	1.3	1.79	5.9
2	6.6	0.0299	1.2	1.96	6.4
4	13.1	0.0208	0.8	2.82	9.3

4.3.1.15 Crossings

The issue of subsidence at crossings is considered when identifying areas of potential risk. Subsidence and structural integrity are not easily predicted on a universal scale; rather, they are a function of site specific corrosion properties, soil mechanics and classification, loading impacts, pipeline depth and other factors. Of particular importance are the terms contained in agreements relating to the crossings of railways, primary and secondary highways, roads, other pipelines, power lines, and communication lines, and the conditions they may place on the deactivation process.

Predicted subsidence profiles have been introduced in section 4.3.1.14 based on assumed depths of cover (Table 4-6 through 4-8). However, with respect to crossings, it should be noted that the depth of cover will be generally greater than those presented in the subsidence profiles due to current installation practices and design criteria. It can therefore be presumed that the extent of subsidence will be less than that shown in Table 4-6 through 4-8.

While not applicable at the time of construction for Line 3, as a reference CFR Part 195.248 dictates depth of cover based on installation location, as seen in Table 4-9 below.

Table 4-9: Cover Over Buried Lines

Location	Cover (in)	
	Normal Excavation	Rock Excavation
Industrial, commercial, and residential areas	36	30
Crossing of inland bodies of water with a width of at least 100 feet (30 millimeters) from high water mark to high water mark	48	18
Drainage ditches at public roads and railroads	36	36
Deepwater port safety zones	48	24

Gulf of Mexico and its inlets in waters less than 15 feet (4.6 meters) deep as measured from mean low water	36	18
Other offshore areas under water less than 12 ft (3.7 meters) deep as measured from mean low water	36	18
Any other area	30	18

Unfortunately, guidance is not presently available in the industry for establishing tolerable subsidence limits; the information available instead defers to a risk=-based decision process to support appropriate actions for a specific pipeline.[1]

Table 4-10 is a preliminary summary of the Line 3 crossings identified, and details will be verified during detailed engineering.

Table 4-10: Preliminary Summary of Line 3 Crossings

Crossing Type	Number of crossing type
Roads	**297**
Highway	22
County, City, Township	275
Other (Trail)	**1**
Railroad	**17**
Active	15
Inactive	2

Ground-truthing will occur early during detailed engineering to identify and confirm the number and location of highway and railway crossings. Environmental impacts of treatment of specific crossing locations will be permitted with any applicable federal, state, and local permit requirements.

The crossing methods described below may be further refined upon completion of consultations and final agreements with third parties.

4.3.1.16 Railway

Though both corrosion degradation and structural integrity are believed to not be of concern for decades due to the higher loading produced by rail cars, the grouting of railroad crossings is being evaluated. Enbridge will consult with all railroad authorities in order to determine course of action for all active and inactive railroad crossings.

Ground subsidence due to corrosion and pipe collapse has been shown to be a time dependent failure mode. Specifically, this means that possible subsidence due to pipe or casing degradation would likely occur gradually with time, and therefore monitoring with appropriate intervals is considered an effective response to mitigating the risk. Detailed calculations and estimates of the proposed time to failure will be used as guidance for establishing the inspection intervals.

Based on current information, there are 15 active railway crossings, the majority of which are cased. Given the predicted corrosion rates on Line 3, the corrosion and the structural integrity model results shown in Figure 4-14 predict that the Permanently Deactivated Line 3 will maintain its load bearing capacity until significant general corrosion (approximately 37% equivalent general wall loss, for the full circumference of the pipe) has occurred for a depth of cover of approximately 3.9 feet. Based on the 2008 depth of cover survey, it is expected that all railway crossings will have depth of cover greater than 3.9 feet, but this will be verified during detailed engineering. As large scale general corrosion has not been identified, as addressed in Section 4.3.1.12, total subsidence is not expected to occur.

4.3.1.17 Roads

Due to lower loading considerations and continued third-party maintenance programs, grouting will not take place at road crossings. In an effort to minimize environmental impacts, Enbridge will monitor these crossings to ensure integrity is maintained and will consult with the appropriate road authorities as required.

4.3.1.17.1 Primary Highways

The pipe collapse model presented in Section 4.3.1.11 predicts that all depth of cover analyzed would have sufficient structural integrity to prevent collapse due to HS20 Highway loads, simulating a 20-ton truck traffic load, until significant general corrosion (at least 45% equivalent general wall loss, for the full circumference of the pipe) has occurred. As large scale general corrosion has not been identified, as addressed in Section 4.3.1.12, total subsidence is not expected to occur.

4.3.1.17.2 Secondary Highways, Rural Municipality, and Other Roads

The reduced traffic frequency for secondary highways and roadways further diminishes the likelihood of subsidence at road level caused by pipe collapse. The continued application of CP and standard monitoring practices are appropriate to manage these crossings.

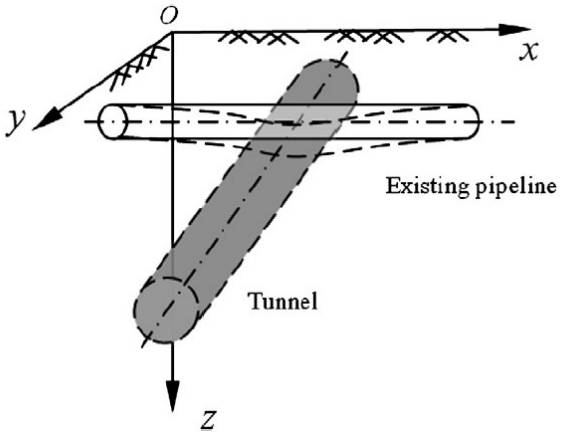
4.3.1.18 Utility Crossings

The CEPA Abandonment Matrix recommends abandonment in-place with special treatment for utility crossings when the pipe diameter is greater than 26 inches. The risks to utilities from pipe removal include the possible loss of support and/or interference with the operation of the utility (i.e., due to third party damage, restricted access, etc.).

Enbridge's proposal is to Permanently Deactivate these crossings in-place subject to a technical risk assessment of utility crossings. Depending upon the result of that assessment, Enbridge may apply special treatment on a case-by-case basis. The primary risk for utility crossings associated with a Permanently Deactivated in-place pipeline is the potential for void formation, which could lead to an unsupported length of pipeline or cable, or displacement due to ground subsidence, as illustrated in Figure 4-20.

Figure 4-20: Representation of Tunneling Possible for Crossing Utility

(Reproduced from *Boundary element model for analysis of the mechanical behavior of existing pipelines subjected to tunneling-induced deformations*)[22]



4.3.1.19 Casings

The benefits of casings with respect to structural integrity of the pipeline and any cased crossing locations should be noted. Presently, the structural integrity models presented were based solely on the capacity of the carrier pipe, and conservatively ignored any benefits of the casings.

The primary benefit of casings, with respect to structural integrity and loading capacity are that casing pipes, while intact, will provide additional structural support to the Permanently Deactivated carrier pipe. Secondly, from a risk perspective, casings will provide a secondary barrier to failure, either by corrosion or structural collapse, meaning that both the casing pipe and the Permanently Deactivated carrier pipe would have to fail prior to any substantial ground subsidence at a cased crossing. The nominal wall thicknesses for casings vary but are typically reported to be greater than ~.5 inches.[19]

It has been shown that subsidence due to pipe or casing corrosion and possible pipe collapse is a long-term time-dependent risk. Specifically, this means that possible subsidence due to pipe or casing degradation would occur gradually with time, and can be monitored or observed so that appropriate corrective action can be taken prior to significant subsidence.

Of primary concern for casings is that they are generally not coated, and therefore subject to general corrosion. Additionally, there is potential for shielding of CP from the carrier pipe if not properly maintained.

4.3.1.20 Summary and Conclusions – Structural Integrity and Subsidence

The primary conclusions of the analyses provided are as follows:

- Based on the PTAC corrosion rate curves presented, and comparison with historical ILI data for Line 3, the estimated time to through wall penetration was calculated to be between 25 to 50 years from 2011.
- The results of the PTAC model considering generalized wall loss for the Permanently Deactivated Line 3 indicate predicted minimum time to collapse as 87 years, with estimates well above 1,000 years based on the variety of soil conditions as described in Section 4.3.1.7.
- The results of the PTAC model considering pitting corrosion indicate the Permanently Deactivated Line 3 will maintain the majority of its structural strength until greater than 30% of the pipe's circumference is lost due to coalescing of perforations.
- The maximum subsidence predicted considering 100% volume loss of the pipe, complete infill, and 2.0 feet depth of cover was 6.8 inches.
- The maximum subsidence predicted considering 50% volume loss of the pipe, complete infill, and 2.0 feet depth of cover was 3.4 inches.
- Predicted subsidence profiles indicate a gradual sloping surface profile, which would create minimal disturbance to surface profile for the depths predicted.

4.3.2 Mitigation

As stated above, subsidence due to pipe or casing corrosion and possible pipe collapse is a long-term time-dependent failure mode. Numerous calculations are referenced estimating the time to collapse as being many decades, or more likely centuries.[1,3,6,13] Conservative calculations based on the PTAC collapse model for a 34-inch pipeline, similar to Line 3, predict the minimum time to collapse as 87 years at railway crossings, and with estimates significantly greater than 1,000 years based on the variety of soil conditions as described in Section 4.3.1.7.

To address the risks associated with long-term corrosion and possible ground subsidence, Enbridge will:

- continue to monitor the Permanently Deactivated pipeline as part of its ongoing Operations and Maintenance programs;

- survey, assess, and mitigate the depth of cover over the Permanently Deactivated pipeline in accordance with O&MM and Enbridge's PDMP;
- monitor and apply the CP in accordance with Enbridge O&MMs and CCG; and
- perform ground-truthing to identify and confirm the number and location of crossings.

4.3.2.1 Monitoring & Maintenance

Enbridge will continue to monitor the Permanently Deactivated pipeline as part of its ongoing Operations and Maintenance programs. Certain applicable monitoring procedures currently practiced on active pipelines will be extended to the Permanently Deactivated pipeline, in order to address the risks identified in Section 3. Operations and Maintenance activities include:

- completing pipeline inspections during patrols;
- assessing areas of potential geotechnical threats;
- maintaining pipeline signage;
- performing depth of cover surveys; and
- monitoring the CP system.

The Permanently Deactivated pipeline will also remain a part of Enbridge's programs for damage prevention and safe work practices, which include:

- continuing Enbridge's public awareness program; and
- ensuring ground disturbance activities by the Company or third parties in the vicinity of the pipeline in accordance with Enbridge construction specifications and O&MMs. Typical requirements are:
    - specifying safe work distances during excavation;
    - surface locating and identifying the pipeline;
    - ensuring pipeline is crossed in a safe manner and applying temporary ramps or matting when required; and
    - verifying that construction activities do not negatively impact the integrity of the pipeline or its CP system.

Enbridge periodically reviews and revises its standards and procedures to incorporate regulatory and legislative changes, updated safe work practices and industrial knowledge, and new technology. As such, the on-going monitoring of the Permanently Deactivated pipeline will progress in the same manner as Enbridge's active pipelines.

4.3.2.2 Right-Of-Way Patrols, Geotechnical Threat Assessments and Signage

To protect the public in proximity of the pipeline, the environment, and the integrity of the pipeline, the ROW is monitored by:

- patrolling the entire ROW plus the adjacent land;
- documenting and assessing abnormal conditions or activities on or adjacent to the ROW;
- assessing areas of potential geotechnical instability; and
- inspecting and maintaining ROW signs and markers.

ROW monitoring is completed in accordance with Enbridge O&MM.

ROW patrols are completed by qualified individuals to identify abnormal surface conditions or activities on or adjacent to the ROW using methods of walking, driving, flying or other appropriate means, periodically. Any abnormal condition or activity will be recorded. Enbridge will complete additional investigations when warranted. These investigations include documenting the location and condition of exposed pipe, and assessing the effects of unsupported spans, atmospheric corrosion, and third party damage on the pipeline. Remediation activities are planned based on the risk associated with the abnormality. Remediation options include, but are not limited to:

- on-going monitoring;
- improving community awareness; or
- providing additional depth of cover, buoyancy control, pipeline protection, cladding, matting, or drainage control.

The Enbridge mainline is assessed for geotechnical threats such as areas of potential slope stability or erosion concerns. These areas, when identified, undergo a site-specific assessment which may recommend more frequent or detailed on-site monitoring. Enbridge's plan to leave the Permanently Deactivated pipeline in-place will minimize the risk of erosion caused by construction activities because the vast majority of the ROW will remain undisturbed. With no disturbance, the permanently deactivated Line 3 ROW will have the same risk for erosion as the surrounding ROW for the active pipelines. In areas where excavation may occur, site-specific erosion plans will be developed, and all work will be performed in accordance with the Project's Environmental Protection Plan.

Warning signs and line markers are located in key areas to promote awareness in the vicinity of the pipeline. These signs will be visually inspected during regular patrols and, when required, the key information on the signs will be updated. Signage is also checked annually to ensure signs are not missing, vandalized, or damaged, and are visible from appropriate roadways and railways.

4.3.2.3 Pipeline Depth Monitoring Program

Depth-of-cover surveys utilize electromagnetic line locating equipment or equivalent technology to accurately locate and record the depths for each pipeline in the ROW. The depth of cover over the Permanently Deactivated pipeline will be surveyed, assessed, and mitigated in

accordance with the O&MM. The depth of cover survey program for the Permanently Deactivated pipeline will be completed at least once every ten years. The frequency for the depth of cover survey program may be reduced for portions of the pipeline based on internal risk assessments.

The depth of the pipe will be measured and recorded at predefined intervals down the ROW. Additional measurements will be taken on either side of a location with insufficient depth of cover. Physically probing for pipeline depth is used to validate non-intrusive depth measurements.

If the measured depth of cover of the Permanently Deactivated pipeline poses a risk to public safety or the environment, a risk analysis will be conducted to assess whether mitigative action is required. This risk analysis will consider land use, underground structures in close proximity, and/or adverse conditions that may prevent the maintenance of such cover. The risk assessment will determine if further action is required, such as:

- adding soil over the pipeline;
- lowering the pipeline;
- developing new agreements to restrict land use with the appropriate stakeholders; or
- installing mechanical protection over the pipeline.

4.3.2.3.1 Exposed Pipe

Currently, locations where pipe is exposed are identified through aerial patrol as well as by performing field depth of cover surveys. The areas of exposed pipe are reviewed by various internal stakeholders through a risk assessment, to identify priority and necessary remedial actions.

A review of the exposed pipe, depth of cover data and pipeline crossing features has been completed to identify areas that may be subject to loss of cover once the pipeline is purged.

Enbridge continues to monitor high risk areas and prescribes the appropriate course of action in the event additional pipe becomes exposed.

Following completion of deactivation activities on Line 3, if newly exposed pipe is discovered, each site will be reviewed by the following stakeholder representation: ROW/permitting agent(s), environmental lead and relevant agency, operations representative, and Enbridge Pipeline Integrity representative. Each will have a specific responsibility when considering the completion of site-specific mitigation efforts:

- The ROW agent will work with landowners or pertinent jurisdictional authorities impacted;

- The Environment Lead will need to complete a review with those agencies having jurisdiction;
- The Operations representatives will need to be engaged to review the workspace and any potential impacts to the operation of adjacent lines; and
- The Enbridge Pipeline Integrity representative should review and address risks brought from an Enbridge systems perspective.

The aforementioned stakeholder review will be used to identify inputs to a risk assessment matrix. Mitigation methods will be chosen upon completion of the risk review with the following potential actions:

- Pipe Removal: Removal of pipe will be dependent on site-specific conditions and will likely produce the highest environmental impacts, risk to adjacent lines and complications with regards to constructability.
- Grouting: grouting as a mitigation technique will have permanent results if the pipe re-settles and will have a lower environmental impact and lower risk to adjacent lines as compared to full pipe removal. Grouting lengths may be limited and therefore pose effective installation risk during construction. Grouting for buoyancy mitigation is meant to re-settle the pipeline, with the intent of eliminating positive buoyancy.
- Continued monitoring: with continued monitoring, there is no present impact to either Line 3 or the adjacent lines. The company will continue to monitor the high risk areas and mitigate as necessary.

4.3.2.4 Cathodic Protection

There are currently 82 Impressed Current CP (ICCP) Systems along the US portion of the route that actively function to mitigate threats of external corrosion on the entire mainline system. Additionally, there exists upwards of 90 bonds connecting Line 3 and adjacent pipelines, as well as an unknown number of below grade bonds, the locations of which may not be known.

In evaluating how to manage the existing cathodic protection (CP) system, the following were assessed: regulatory requirements and commitments, Enbridge's Operating and Maintenance Procedures, economic impact, and external corrosion risks associated with potential changes to the CP system. Based on this analysis, it was determined that the CP system will remain in place.

4.3.2.4.1 Maintaining the Active CP System

In keeping the existing CP system in place, there are effectively no changes from current CP work practices within the EEP corridor due to the operational status of Line 3. In any areas where Line 3 is segmented, new bonding cables will be installed to ensure electrical continuity remains across the pipeline, to maintain cathodic protection along the existing Line 3.

Environmental impacts of CP system maintenance will be permitted in accordance with any applicable federal, state, and local permit requirements.

In a multiple pipeline ROW, it is common to install bonds to maintain electrical continuity of the pipelines for CP operation. Bonds help to distribute CP current evenly through the pipeline ROW as well as mitigate stray current interference amongst neighboring pipelines. To ensure electrical continuity, bonds will be installed at locations where Line 3 is non-contiguous. The installation of bond cables will be completed in accordance with Enbridge D04-101 (2015), "Cathodic Protection – Mainline." Bond cable sizing will be determined based upon the current carrying capacity but will be no smaller than #4 AWG stranded copper cable. In addition to the bond cables installed, it is recommended that Test Lead cables are installed for future monitoring. The intention is to install bond cables on each Enbridge pipeline at segmentation locations. All cables will be terminated in an above grade junction box at a location that minimizes impacts to land use.

In some cases, it may be required to relocate a bond box to a suitable location for the above grade appurtenance. When able, these locations will remain within the existing Enbridge ROW, however they may be situated at the nearest tree line, fence line, or edge of a roadway ditch. As the project develops, site specific drawings may be required for cases where bond boxes cannot be placed at the segmentation location and will be addressed on a case-by-case basis.

4.3.2.4.2 Monitoring of CP System

In the short-term, Operations would continue to monitor and maintain the CP system to meet requirements for all pipelines along the EEP corridor. In the long-term, as CP systems become depleted and protective coatings deteriorate or change, new design and monitoring efforts will need to be implemented to maintain system integrity. As the coating quality on Line 3 degrades, an increased current requirement will be needed to mitigate external corrosion, ultimately increasing the costs associated with operating the CP system, both electrically and through the installation of new CP groundbeds.

The following programs or monitoring methods are currently undertaken by Enbridge to ensure the integrity of the CP systems:

- AC-DC Structure to Soil Potential Monitoring Program: Regularly scheduled monitoring to verify adequate cathodic protection levels on all pipelines and facilities through field surveys or remote monitoring;
- Bonding Inspection Program: Regularly scheduled monitoring of critical and non-critical bonds through field surveys or remote monitoring;
- Rectifier Operation Monitoring: Regularly scheduled monitoring of cathodic protection system rectifiers and related equipment to ensure correct operation of the cathodic protection system through field surveys or remote monitoring equipment;
- Close Interval Survey Program: Regular scheduled close interval surveys to provide a cathodic protection (CP) profile of the pipeline. An initial survey is completed when the

pipeline is put into operation and additional surveys are completed if operating conditions change;

- CP Coupon Monitoring Program: Regular inspection of CP coupons to obtain field or remote measurements to monitor current densities and induced resistance free reading; and
- Atmospheric Pipe Inspection Program: Regularly scheduled visual inspection of all above grade piping, including exposed piping, for atmospheric corrosion.

While the proposed Permanent Deactivation Plan involves maintaining CP as practical to extend the life as a load bearing structure, it is recognized that, "…in the long term, any pipeline left in-place would eventually degrade to the point that a void exists in the ground".[2] The terms, "long-term" and "eventually", cited here were intentionally vague, as they refer to site specific conditions. The analyses presented have shown that this "long-term" may be in the order of centuries or more. Specifically, this means that possible subsidence due to pipe or casing degradation or collapse would occur gradually with time, and therefore on-going monitoring with appropriate intervals is considered an effective response to mitigating the risk. Detailed calculations and estimates of the proposed time to failure will be used as guidance for establishing the inspection intervals during detailed engineering.

5 CONCLUSION

Enbridge's Line 3 Permanent Deactivation Plan is based upon engineering and risk assessments which identified the technical risks and mitigation measures associated with the Permanently Deactivated pipeline. As part of this assessment, Enbridge assessed the relative risks of removing the pipeline and Permanently Deactivating it in place. Removing the 282 miles of existing Line 3 would create a significant risk to other operating pipelines and additional impacts to the environment, land use, and public safety similar to and exceeding those related to constructing a new pipeline project. Based on the results of the risk assessment, Enbridge believes that deactivating a pipeline in place minimizes and/or eliminates unnecessary impacts to the environment, landowners, and the state of Minnesota.

Enbridge's Permanent Deactivation Plan was designed to Permanently Deactivate the pipeline in a way that minimizes risks to public safety, the environment, and current land use. In summary, the scope of the Plan includes:

1. Purging the oil;
2. Cleaning of the pipeline;
3. Isolating the pipeline from specific infrastructure which is actively transporting oil;
4. Further segmentation of the pipeline, as needed, including completing all required remediation at roads, railroads, waterbodies, or any other permitted crossing in consultation and coordination with that crossing's authority; and

5. Continue to monitor the existing right-of-way (ROW) to identify, assess, and appropriately mitigate apparent or emerging risk to public safety, the environment, or current land use caused by the Permanently Deactivated pipeline. As part of the ongoing maintenance and monitoring, continue to apply cathodic protection (CP) until such time that it is ineffective or otherwise detrimental.

These measures will protect the environment and human activity by minimizing risks related to soil and water contamination, water conduits, and subsidence. This Permanent Deactivation Plan will also avoid the unnecessary risks and impacts related to pipeline removal.

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7 APPENDICES

7.1 ENBRIDGE LINE 3 DECOMMISSIONING CLEANING VALIDATION PROGRAM REPORT

Appendix 7.1



Line 3 Decommissioning
Cleaning Validation Program Report

Enbridge Pipelines Inc.
September 4, 2015

Enbridge Pipelines Inc. (Enbridge) conducted a cleaning validation program on a 19.8 km section of the NPS 34 Line 3 that was recently deactivated near Cromer, Manitoba by Enbridge as part of National Energy Board (NEB) filing A50617. This validation program was completed in accordance with NEB filing A64166 as part of Enbridge's application to the NEB for the Line 3 Replacement Program (L3RP).

The cleaning validation program successfully accomplished the following objectives:

1. Develop and execute an economical, reliable, and repeatable cleaning program that could be implemented when decommissioning Line 3,

2. Demonstrate the effectiveness of the program by completing third party testing for residual hydrocarbons in fluid samples of the cleaning solution and water used to clean the pipeline, and

3. Validate that polychlorinated biphenyls (PCB) and naturally occurring radioactive materials (NORMs) are not a risk that requires modification to the decommissioning plan for Line 3 currently filed with the NEB.

The cleaning program consisted of one chemical train (comprised of two 18 m^3 batches of cleaning solution and one 35 m^3 water batch), one rinse train (comprised of three 35 m^3 water batches), and a third train (comprised of a foam pig and scraper pig) to remove residual bulk fluid remaining in the pipeline. Approximately 5 m^3 of cleaning solution was injected in front of the chemical train to lubricate the first pig in the train. A combination of hard brushes, pencil brushes, and scraper pigs were used to scrape the pipe walls and maximize cleaning effectiveness. The objectives each pig and train are outlined in table 1 below.

Table 2: PIG sequence and objectives for chemical train

Pig Train #	Pig Sequence #	Pig Type	Objective
1 - Chemical	1	Spring Loaded Hard Brush Pig	Initial brush pigs were used to scrape the pipe walls to maximum cleaning effectiveness. Aggressive brushes were installed on a spring to provide mechanical cleaning without damaging the pipe wall.
	2	Spring Loaded Hard Brush Pig	
	3	Spring Loaded Pencil Brush Pig	Slightly less aggressive brushes removed residual deposits remaining after the hard wired brushes. The pencil brushes were also spring loaded to avoid excessive scraping of the pipe wall.
	4	Spring Loaded Pencil Brush Pig	
2 - Rinse	5	Scraper Batch Pig	Scraper pigs were used for final scraping of the pipe walls with the polyurethane discs. These pigs removed any debris/contaminants dislodged by the brush pigs in pig train #1, and transported the material in the water batches. The combination of cups and discs provided effective isolation of the rinse batches to prevent bypass of material and, removed most of the fluid from the pipeline.
	6	Scraper Batch Pig	
	7	Scraper Batch Pig	
	8	Scraper Batch Pig	
3 - Foam	9	Foam Pig	Foam pig and Scraper pig used to remove residual free bulk fluid remaining in the pipeline after pig train #2.
	10	Scraper Batch Pig	

Engineering of the cleaning validation program was completed in two phases: laboratory testing of representative pipeline material to determine appropriate chemical selection for the cleaning solution, and hydraulic modeling and design of the cleaning train. Laboratory testing of potential cleaning chemistries was completed using hydrocarbon covered test coupons representative of the worst case scenario for potential pipe wall contamination based on the previous products transported on Line 3. These tests determined that a water-based cleaning formulation in combination with water rinses was most appropriate for cleaning the Line 3 pipeline. The volume of cleaning solution and water were sized based on specific parameters of the Line 3 pipeline segment (i.e. length and diameter). Engineering of the Line 3 cleaning program will consist of the same two phase approach, during which the batch sizes and cleaning chemistry may be subject to change. Figure 1 illustrates the three pig trains employed in the cleaning validation program.

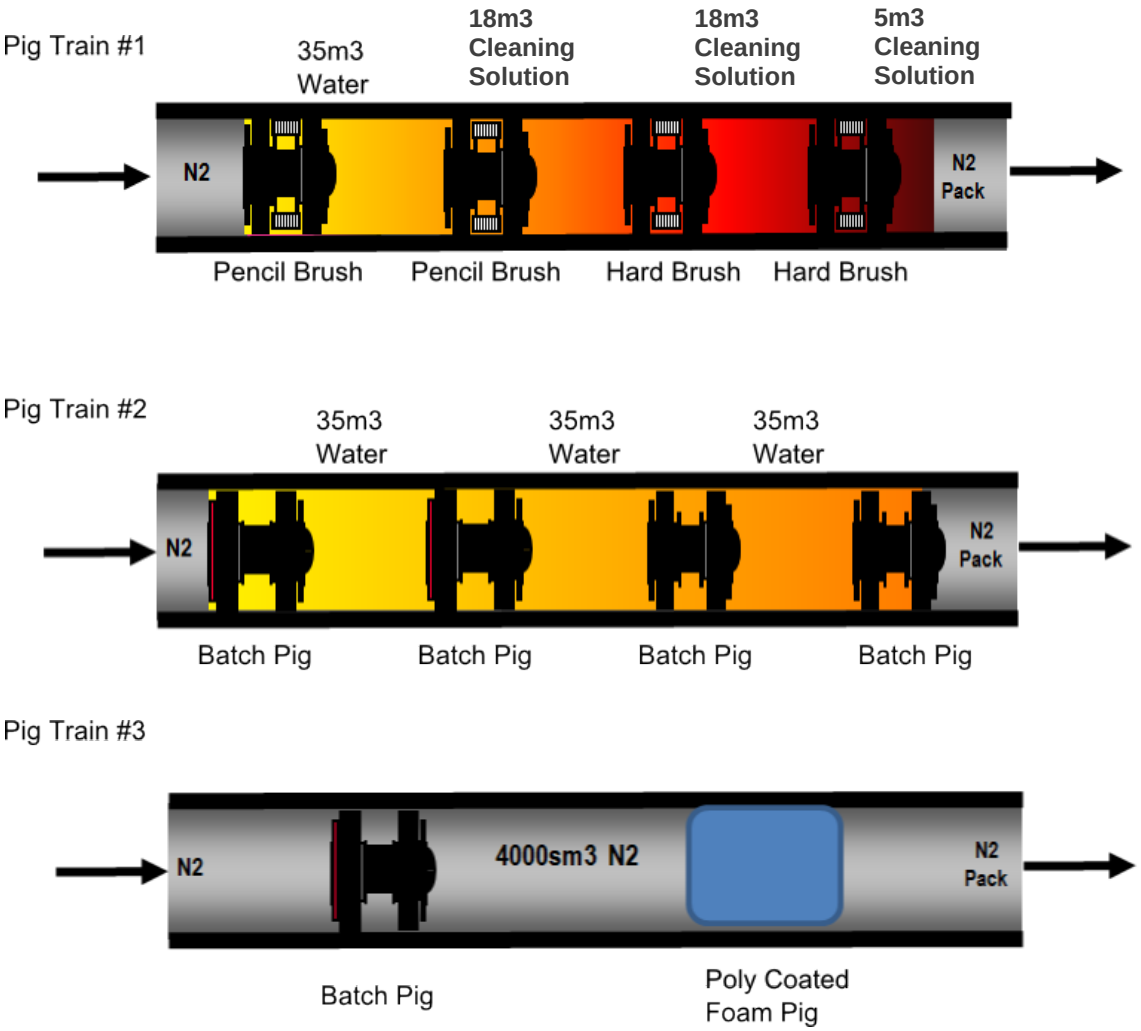


Figure 1: Cleaning validation program pig trains

The execution of the cleaning operation was split into three separate trains due to the size of receiving traps available for the cleaning validation program. The Contractor agreed that the resulting cleanliness for either a combined or split pig train was unchanged provided the fluid volumes, cleaning fluids, and fluid residence times are not altered. Enbridge intends to clean Line 3 in a single operation (one pig train) when decommissioning the remainder of the Line 3 pipeline.

Nitrogen (N_2) was used to propel all pig trains. Nitrogen was chosen as the propellant for this application as its inert properties allow for the safe propulsion of the cleaning train regardless of the residual vapours. Sampling of the lower explosive limit (LEL) completed during the cleaning operation confirmed that compressed air could be utilized safely as an alternative propellent when cleaning the remainder of Line 3 as part of L3RP. The propellant selection for the Line 3 cleaning program will be further evaluated as part of detailed engineering.

All samples collected during the cleaning validation program were submitted to a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited laboratory to provide an unbiased and independent chemical analysis of the effectiveness of the cleaning validation program. The laboratory analysis of the samples collected confirmed that PCB and NORM concentrations were below detectable limits and therefore are not a risk to the decommissioning of the remainder of the Line 3 pipeline..

Samples taken at the discharge of the pipeline demonstrated that the cleaning program developed was effective in removing residual hydrocarbons from the deactivated pipeline. The cleaning and rinse trains were designed to identify possible limitations in cleaning technologies when decommissioning Line 3. Sampling of the water rinse batches indicated a strong downward trend in the concentration of hydrocarbon constituents between rinse batches as shown by Figure 2. The remaining water flush sample concentrations ranged from 108.2 mg/L for the initial sample to 15.54 mg/L for last samples of the final rinse. As the total petroleum hydrocarbon (TPH) concentrations in the water samples produced a statistically significant exponential decay curve with a high degree of confidence, the measured decrease in the TPHs are expected to be repeatable when using similar cleaning methodology, cleaning equipment/materials, and initial conditions on Line 3.

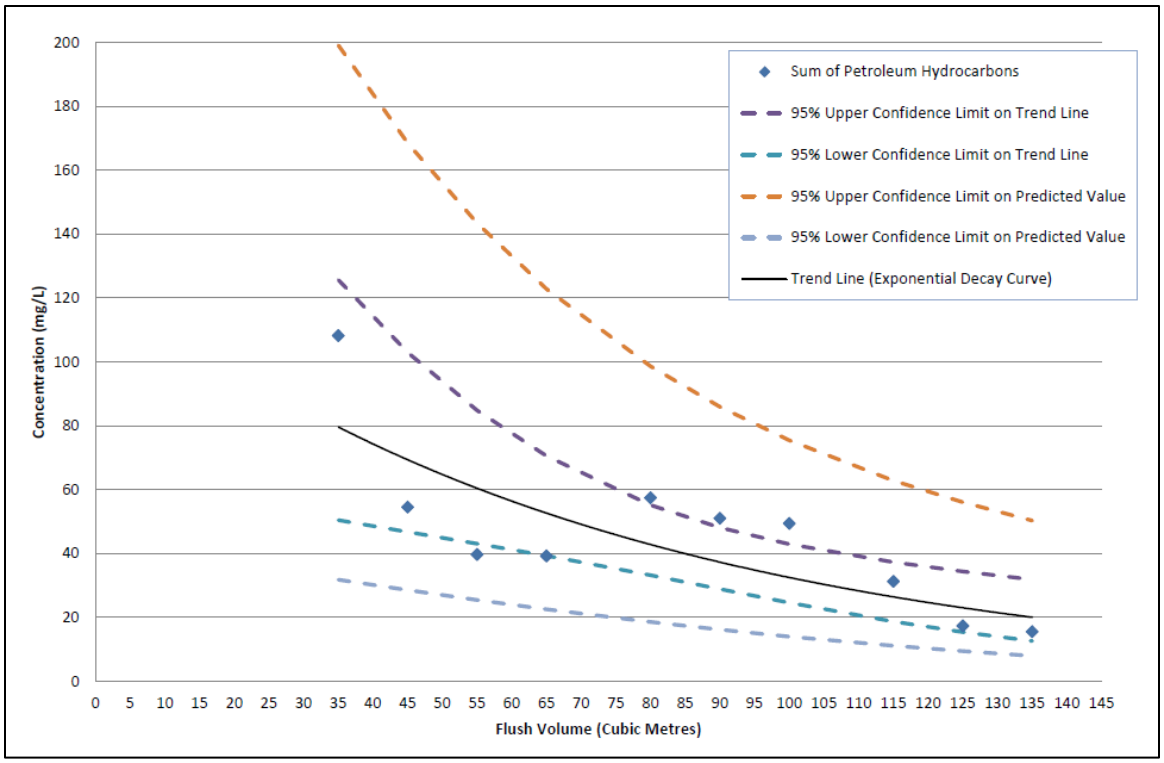


Figure 2: Rinse train sample TPH analysis based on flush volume

Based on the successful execution of the cleaning validation program, the same engineering approach utilized for the cleaning validation program will be implemented to develop the cleaning program to decommission the remainder of Line 3 as per Enbridge's current filing with the NEB for L3RP.

7.2 STRUCTURAL INTEGRITY AND SUBSIDENCE

APPENDIX 7.2
Structural Integrity and Subsidence

SECTION A – SOIL TROUGH SUBSIDENCE PROFILES

This section provides the results and discussions from studies conducted for a series of generalized soil subsidence scenarios. These generalized cases have been assumed to be imposed on the 34-inch OD pipeline. The scenarios considered predictions of settlement profiles (ground subsidence) under 25, 50 & 100% volume loss at various depths of cover (between ground level and crown of the pipe), in which 100% volume loss is the total collapse of the pipeline, with complete soil infill and 25% volume loss represents a partial infill scenario.

Ground subsidence estimations should take into account two different scenarios: following complete infill considering pipe collapse at shallow burial depth, and partial infill due to excessive ovalization and/or finite soil ingression.

Prediction of total ground subsidence, considering complete infill of the pipe volume can be predicted through analogy with tunneling construction. Extensive field measurements (Peck, 1969; Schmidt, 1969; Rankin, 1988; Mair, 2008) have shown that the settlement trough during open-face tunneling construction can be well characterized by the Gaussian distribution curve:

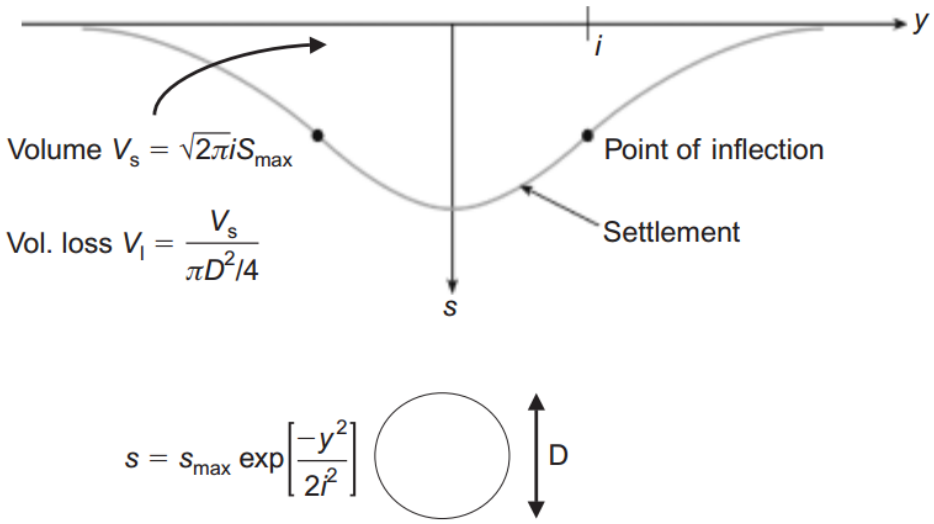
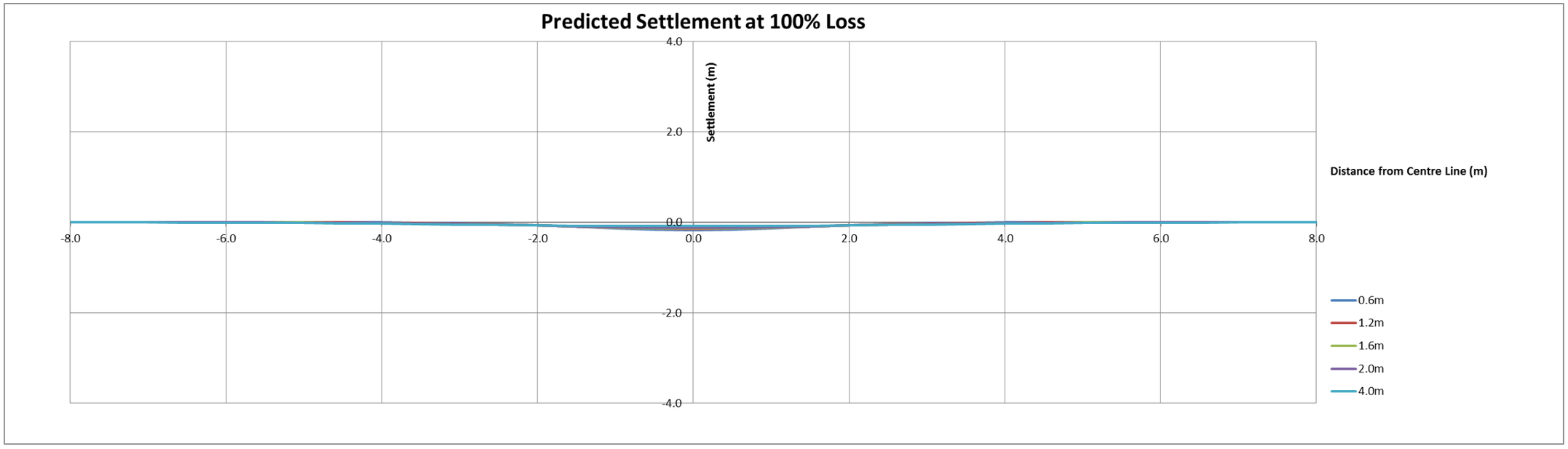


Figure 7A - 1: Generic ground settlement trough considering Gaussian Distribution Curve Method

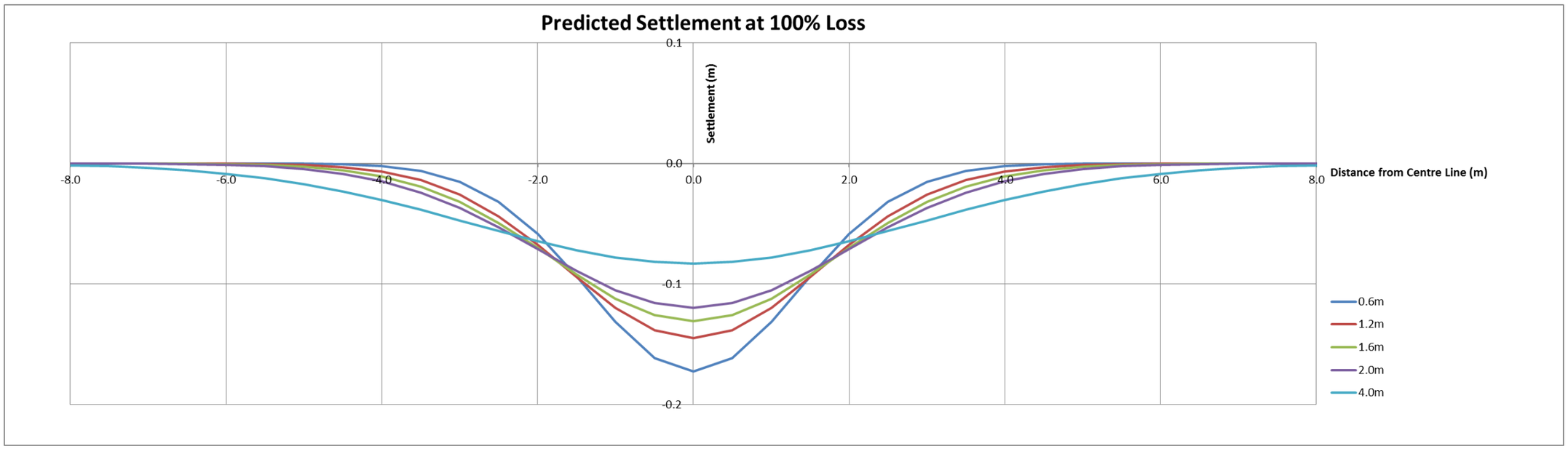
Where *i* describes the characteristic half-width of the settlement trough and is a dependent on the soil cover height and soil type. For this particular case, the exact shape of the Gaussian distribution curve can be estimated based on the particular scenario: total pipeline collapse (V_l = 1), or partial collapse (i.e. excessive ovalization, $0 < V_l < 1$).

Figure 7A - 1 through Figure 7A - 3 shows results from a number of preliminary settlement at different volume loss values (100%, 50% and 25%) and depths of cover to the pipe's crown (assumed at 0.6m, 1.2m, 1.6m, 2.0m and 4.0m). Each figure consists of two graphs - one that shows the horizontal and vertical settlement in equal scales and a second which magnifies the vertical settlement by a factor of ten (10) for clarity.

As expected, the peak subsidence increases with higher volume loss value and shallower depth of cover. The half-width of settlement trough is only dependent on the depth of cover though it is not as linearly increasing with depth of cover as assumed in geometric models presented in PTAC report. The reason is that for pipe embedded at shallower depths, the two models are similar in their predictions but at deeper covers the Gaussian distribution curve introduced in this analysis has been shown to offer a better match to the observed ground settlement data, particularly for tunnels.

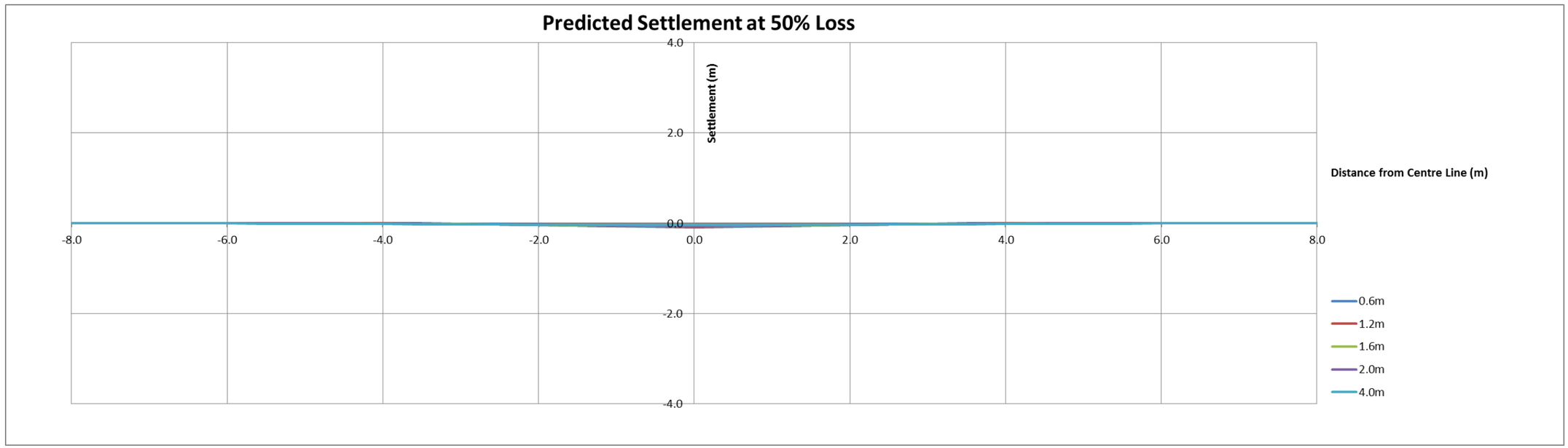


(a)

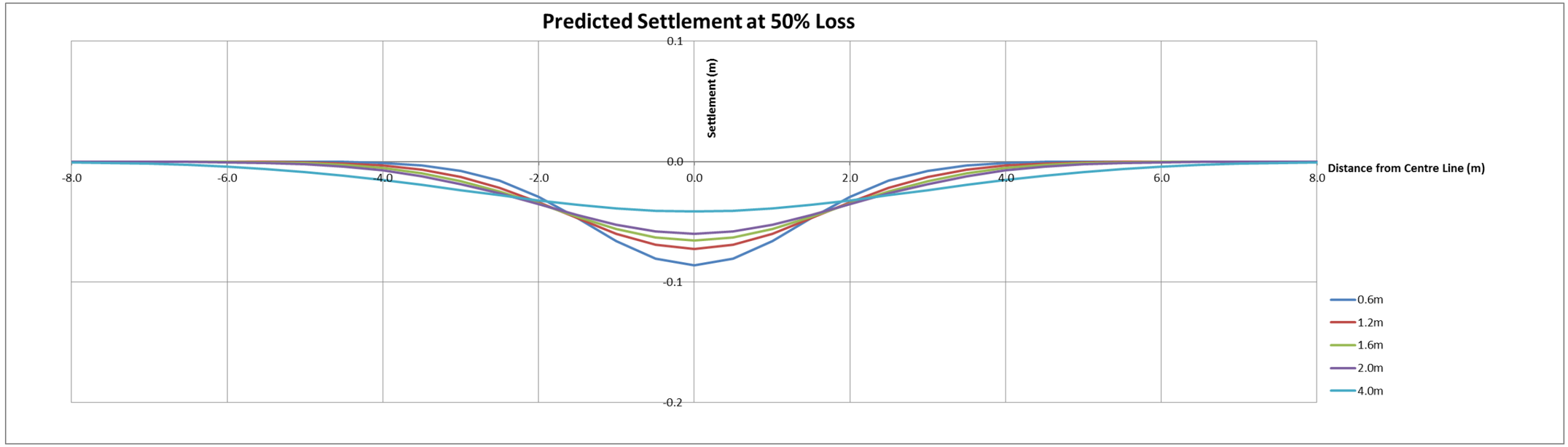


(b)

Figure 7A - 2: Predicted settlement profile at ground level for different depths of cover assuming 100% volume loss (a) equivalent horizontal and vertical scales (b) vertical scale magnified to ten times the horizontal scale

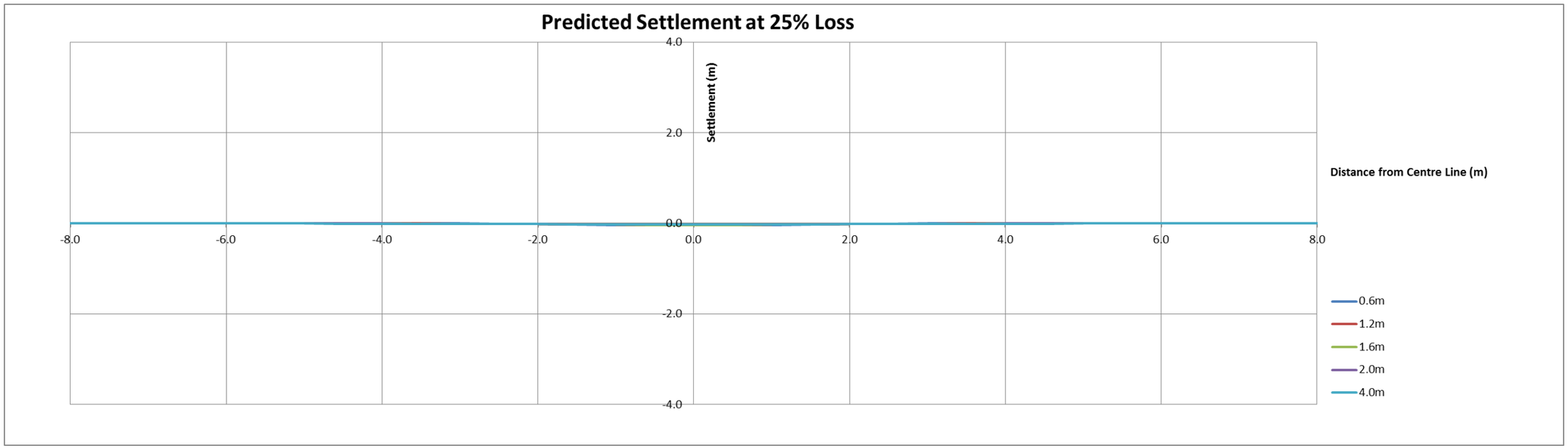


(a)

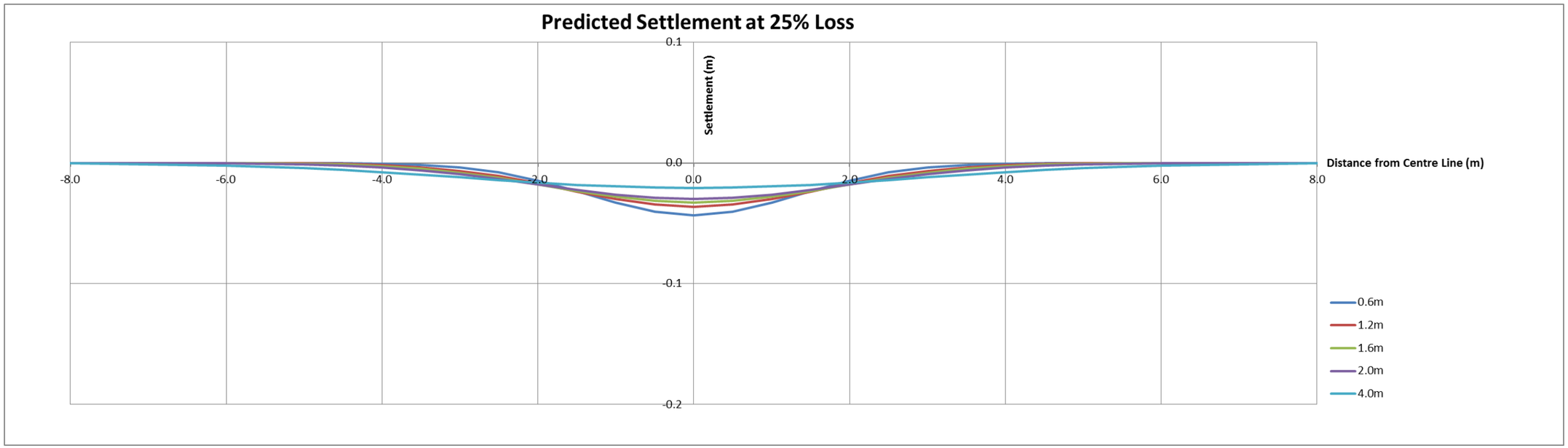


(b)

Figure 7A - 3: Predicted settlement profile at ground level for different depths of cover assuming 50% volume loss (a) equivalent horizontal and vertical scales (b) vertical scale magnified to ten times the horizontal scale



(a)



(b)

Figure 7A - 4: Predicted settlement profile at ground level for different depths of cover assuming 25% volume loss (a) equivalent horizontal and vertical scales (b) vertical scale magnified to ten times the horizontal scale

SECTION B – PTAC MODEL SETUP

Parameter	Symbol	Value	Comments
Max soil density	$\rho_{soil,max}$	2000 kg/m^3	The max soil density results in the lowest predicted load bearing capacity for the pipe, range indicated along pipeline from 990 kg/m^3 to 2000 kg/m^3
Yield strength of X52 pipe	$\sigma_{y,X52}$	359 MPa (52,000 psi)	
Pipe diameter	D	0.8636 m	
Young's Modulus	E	205 GPa	
Soil Modulus	E'	6.9 MPa	E' increases with increasing depth of cover and increased compaction [Hartley & Duncan]; the use of 6.9 MPa is recommended for coarse-grained soils with fines at 90% compaction and also for fine-grained soils with less than 25% sand content at 95% compaction at less than 1.5 m depth of cover, therefore this is conservative due to the compaction level assumed and especially with respect to the majority of crossings at deeper depths of cover
Bedding factor	K	0.1	Conservative for buried pipe that is in intimate contact with soils at the side wall, such as soil compacted over 60 years or constructed to CPCS-SPEC-PIPELINE-001: Specification for Pipeline Construction, 19.3.2: which states compaction to 98% of Standard Proctor Density
Lag factor	L	1.5	Values of 1.0 to 1.5 acceptable, 1.5 is most conservative and accounts for Spangler's observation that culvert ovality can increase over long periods of time, values closer to 1.3 have been suggested for pipe by Warman et al
Safety factor	FS	3	Applied to elastic collapse to account for stress concentrations due to perforations, see Section 7.4.6.3.2 for details
Impact factor	F'	1.75	Recommended for Railway by Warman et al, the impact factor also decreases with depth to a value of 1.0 at a depth of only 0.9m (3.0 ft) for traffic live loads, therefore this is conservative
Pipe diameter	D	0.864 m	
Pipe modulus of elasticity	E	2.05 x 10^{11} Pa	
Height of soil above pipe (DOC)	C	variable	
Modulus of soil reaction	E'	6.9 MPa	
Gravitational constant	g	9.81 m/s^2	
Yield strength of pipe	σ_{yield}	3.59 x 10^{8}Pa	
Dry density of soil	γ_S	2000 kg/m^3	
Bedding factor (for pipeline constructed by trenching)	K	0.1	
Density of water	γ_W	1000 kg/m^3	
Height of water table above pipe	h_W	0 (for pipe above water table)	
Lag factor (empirical)	L	1.5	
Effective load from traffic (from "Guidelines for the Design of Buried Steel Pipe," ASCE, July 2001)	P_{pipe}	variable (function of DOC, "C")	
Impact factor	F'	1.75 or 1.0 as stated	
Factor of safety	FS	3.0	

Assumptions and data inputs

Conservative assumptions were used in the model as necessary, and summarized below:

- The pipe is above the water table and there is no jacking of the pipe.
- The coating provides no significant stiffness.
- A conservative impact factor is used for all depths of cover.
- Soil behaves in the following way:
    - Soil will collapse along 45° planes as the shear stresses are highest along these planes.
    - When the pipeline collapses, soil flows efficiently and fills the empty void of the pipeline.
    - The volume of soil filling the pipeline can be calculated and used to estimate the depth of subsidence at the ground surface.
    - The prism of soil above the pipeline subsides by a depth of “S” after pipeline collapse.

SECTION C – ASCE LOADING CONDITIONS

TABLE 7A - 1: LIVE LOADS TRANSFERRED TO PIPE (KPA)

LIVE LOADS TRANSFERRED TO PIPE (kPa)				ADDENDUM	
Height of Cover (m)	Highway H20*	Railway E80**	Airport***	Personal Truck****	Person*****
0.3	86	–	–	21.6	5.0
0.6	38	182	91	9.6	1.3
0.9	29	163	85	7.2	0.6
1.2	19	127	78	4.8	0.3
1.5	12	115	70	3.0	0.2
1.8	10	108	61	2.4	0.1
2.1	8	84	54	2.1	0.1
2.4	5	77	48	1.2	0.1
3.0	–	53	42	–	–
3.7	–	38	33	–	–
4.3	–	29	21	–	–
4.9	–	24	16	–	–
5.5	–	19	13	–	–
6.1	–	14	11	–	–
6.7	–	13	8	–	–
7.3	–	12	7	–	–
7.9	–	10	–	–	–
8.5	–	7	–	–	–
9.1	–	5	–	–	–
10.7	–	–	–	–	–
12.2	–	–	–	–	–

* Simulates a 20-tonne truck traffic load, with impact.

** Simulates an 11 tonne / m railway load, with impact.

*** Simulates 82 tonne dual tandem gear assembly, 0.66 m spacing between tires and 1.68 m centre-to-centre spacing between fore and aft tires under a rigid pavement 30 cm inches thick, with impact.

**** Simulates a 5 tonne personal truck load, with impact

***** Assumes 100 kg person, no impact

SECTION D – HIGHWAY CLASSIFICATION

Alberta

In Alberta, “Primary Highways are divided into two series, the "1-216 Series" makes up Alberta's core highway network, has the highest traffic volume, and are mostly paved. The "500-986 Series", formerly known as the "Secondary Highways", provide more local access, and include a large number of gravel highways.”[1]

Saskatchewan

Saskatchewan highways can also be divided into seven classes.

Class 1 - serve major inter-provincial and international travel as well as regional service centres with 3,000 or more. These highways also link between regional and base hospitals.

Class 2 – serves population centres of 1,000 or more and provide a link between hospitals.

Class 3 – serve communities of 500 or greater and link health centres or special care homes to hospitals.

Class 4 – considered as primary inter-municipal roads that provide access to communities of more than 100 and large industrial sites.

Class 5 - considered as secondary inter-municipal roads that provide access to communities of less than 100 and medium industrial sites.

Class 6 – serves residences, school bus routes and small industrial sites.

Class 7 – provide access to land only.[2]

Manitoba

Manitoba’s highway classification system defines highways under control of MIT as

1. RTAC routes
2. Class “A1” highways – Provincial Truck Highways numbered from 1 to 110 that are not RTAC routes
3. Class “B1” highways – highways with a numeric designation above 110. Note that some B1 highways have been upgraded to RTAC or A1 loadings.[3]

[1] http://en.wikipedia.org/wiki/List_of_Alberta_provincial_highways
[2] Saskatchewan Highways and Infrastructure, “Design Manual”, Government of Saskatchewan,1992
[3] Manitoba Highway Classification System, Government of Manitoba website, http://www.gov.mb.ca/mit/mcd/mcpd/mhcs.html

Appendix C

Plot Plans for Expanded Clearbrook Terminal and Pump Stations

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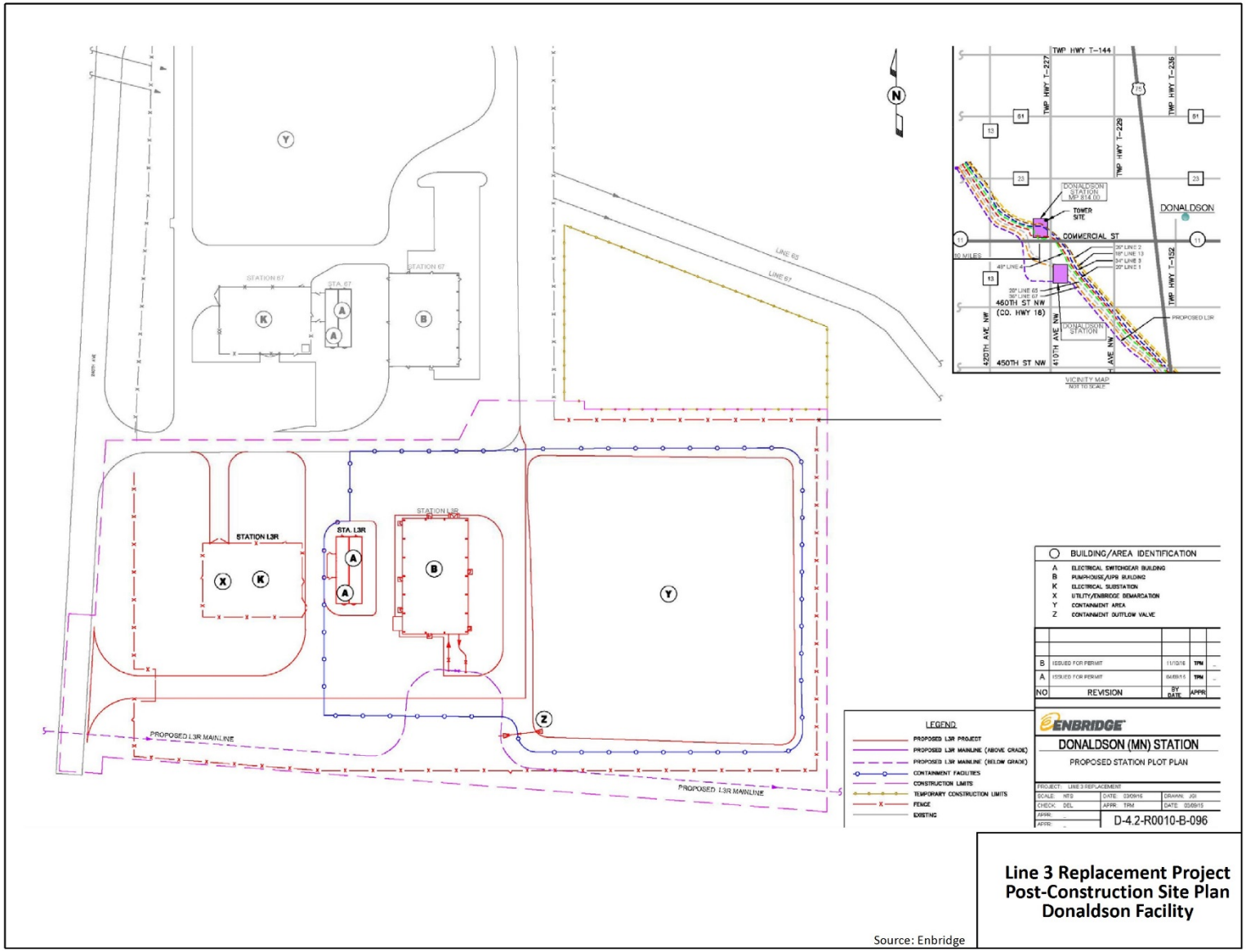
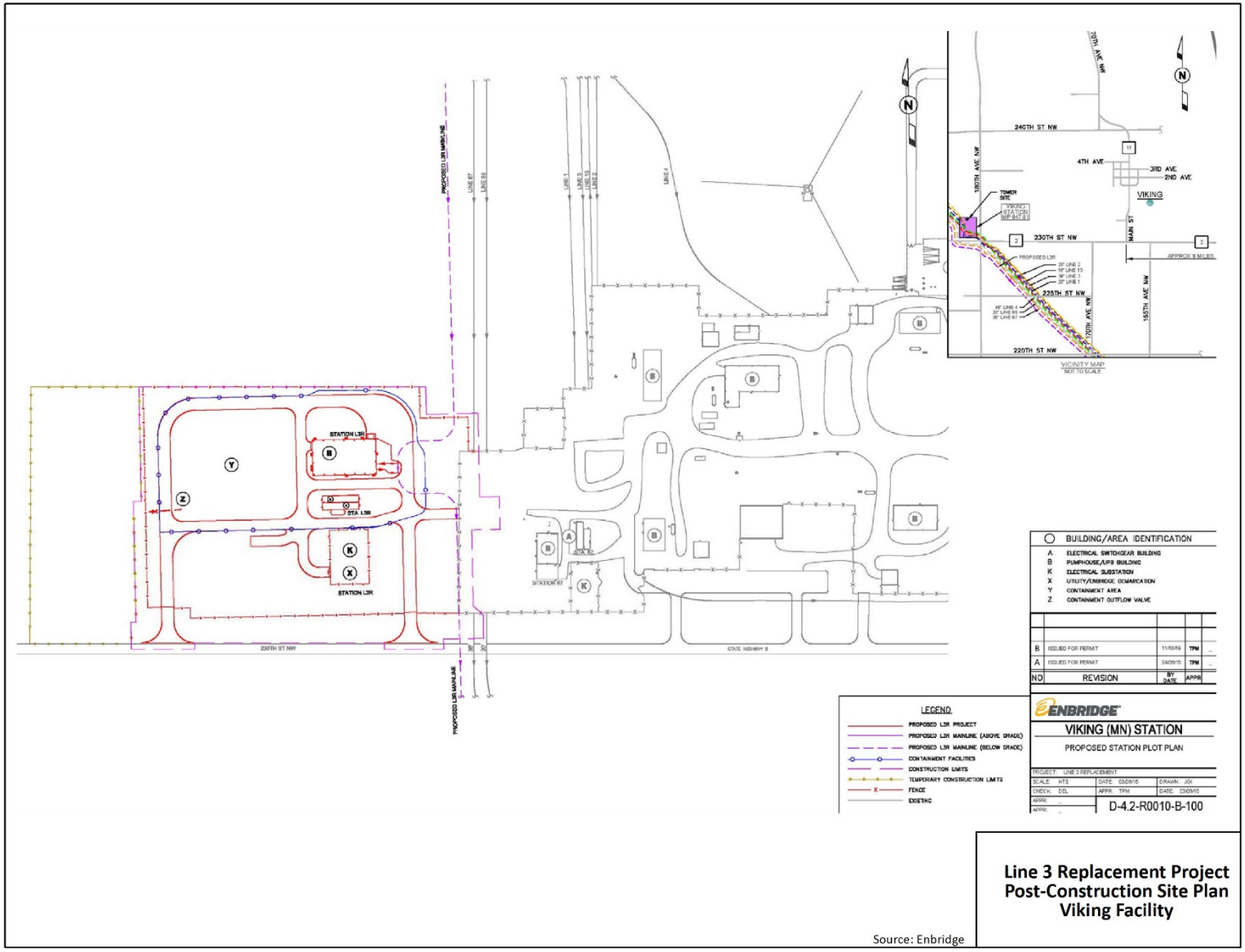


Source: Enbridge



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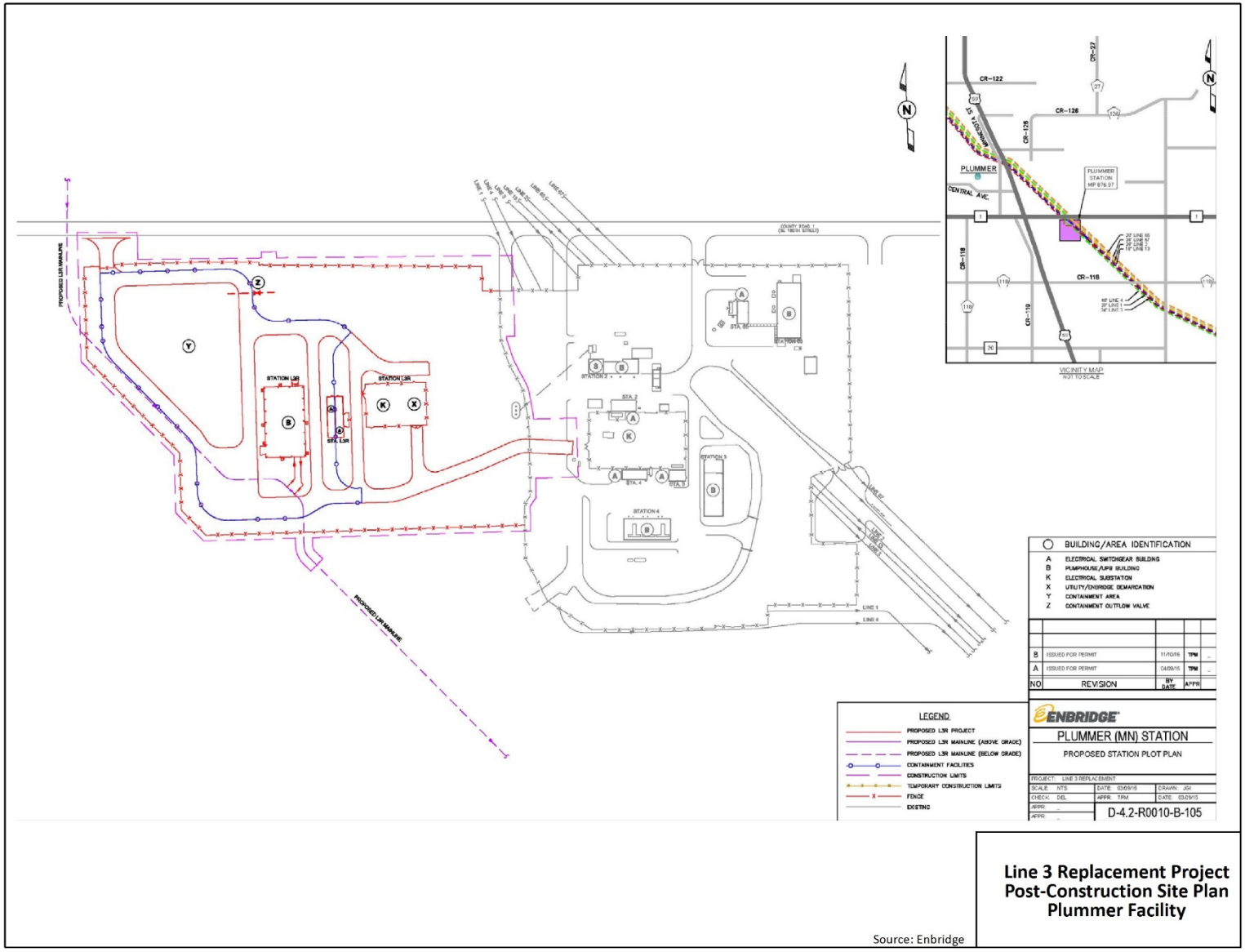
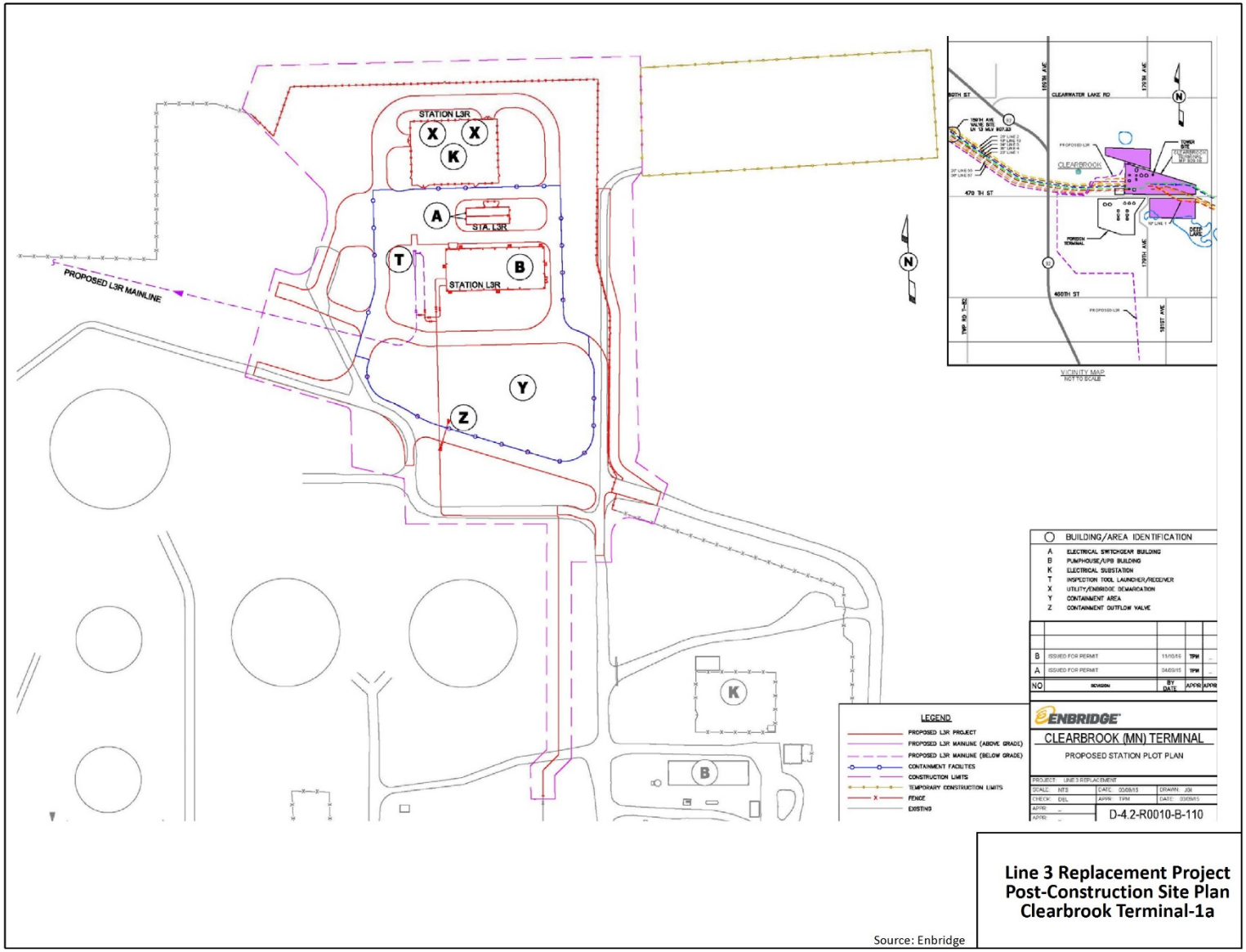
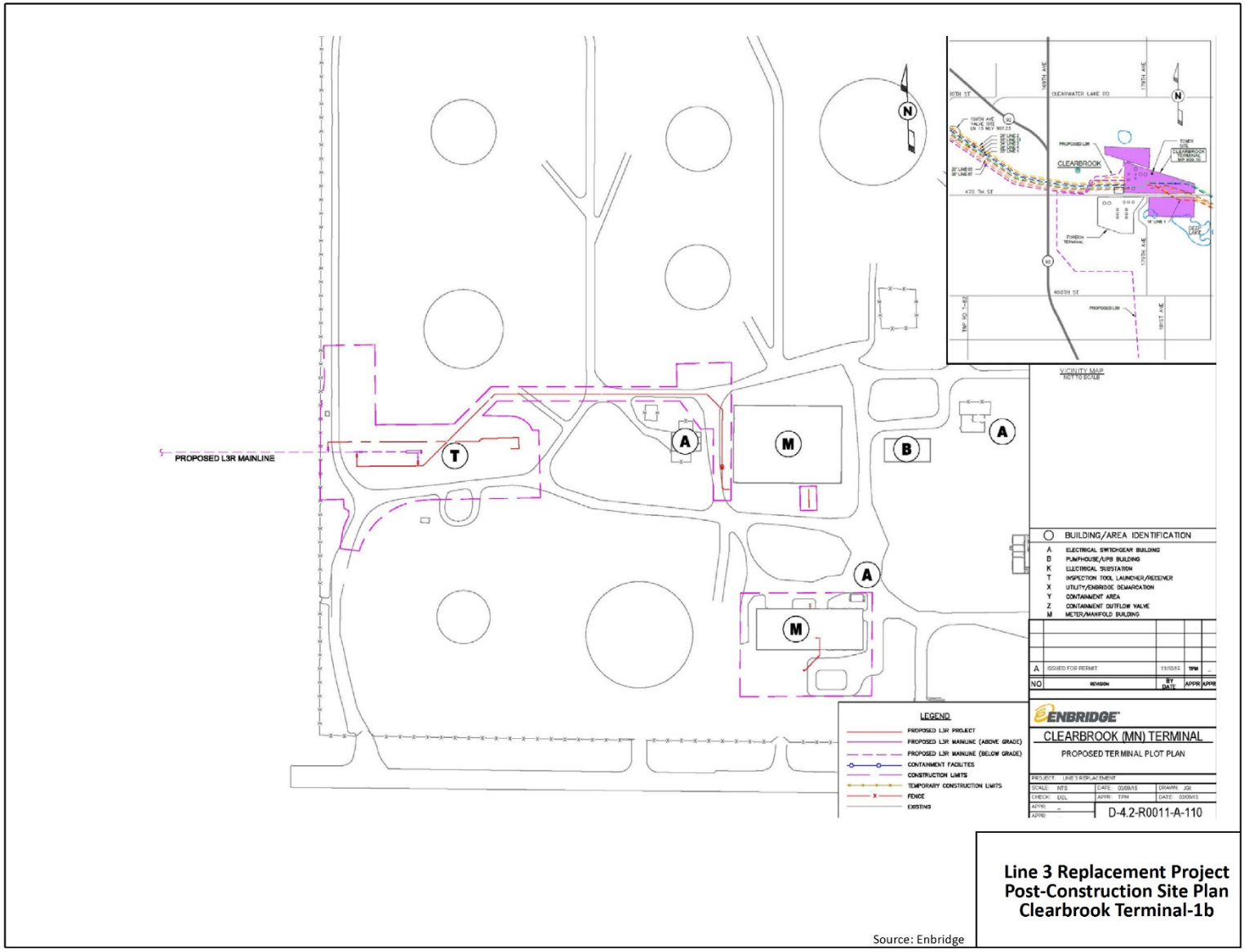


Line 3 Replacement Project Post-Construction Site Plan Plummer Facility

Source: Enbridge


STATION L3R
STA. L3R
STATION L3R
PROPOSED L3R MAINLINE
VICINITY MAP
NOT TO SCALE
BUILDING/AREA IDENTIFICATION
A ELECTRICAL SWITCHGEAR BUILDING
B PUMPHOUSE/UPS BUILDING
K ELECTRICAL SUBSTATION
T INSPECTION TOOL LAUNCHER/RECEIVER
X UTILITY/ENBRIDGE DEMARCATION
Y CONTAINMENT AREA
Z CONTAINMENT OUTFLOW VALVE
LEGEND
PROPOSED L3R PROJECT
PROPOSED L3R MAINLINE (ABOVE GRADE)
PROPOSED L3R MAINLINE (BELOW GRADE)
CONTAINMENT FACILITIES
CONSTRUCTION LIMITS
TEMPORARY CONSTRUCTION LIMITS
FENCE
EXISTING
ENBRIDGE
CLEARBROOK (MN) TERMINAL
PROPOSED STATION PLOT PLAN
D-4.2-R0010-B-110
Line 3 Replacement Project
Post-Construction Site Plan
Clearbrook Terminal-1a
Source: Enbridge



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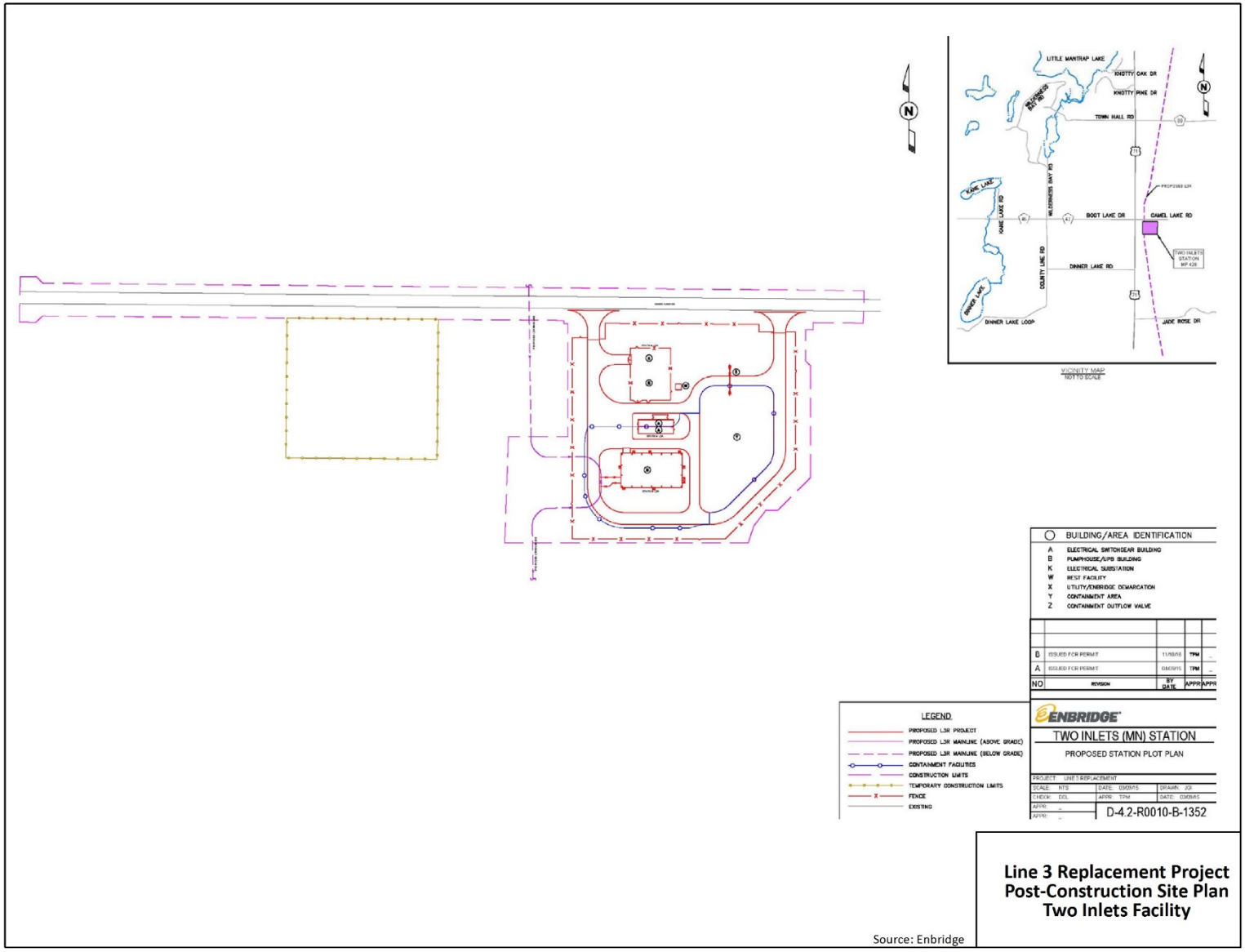

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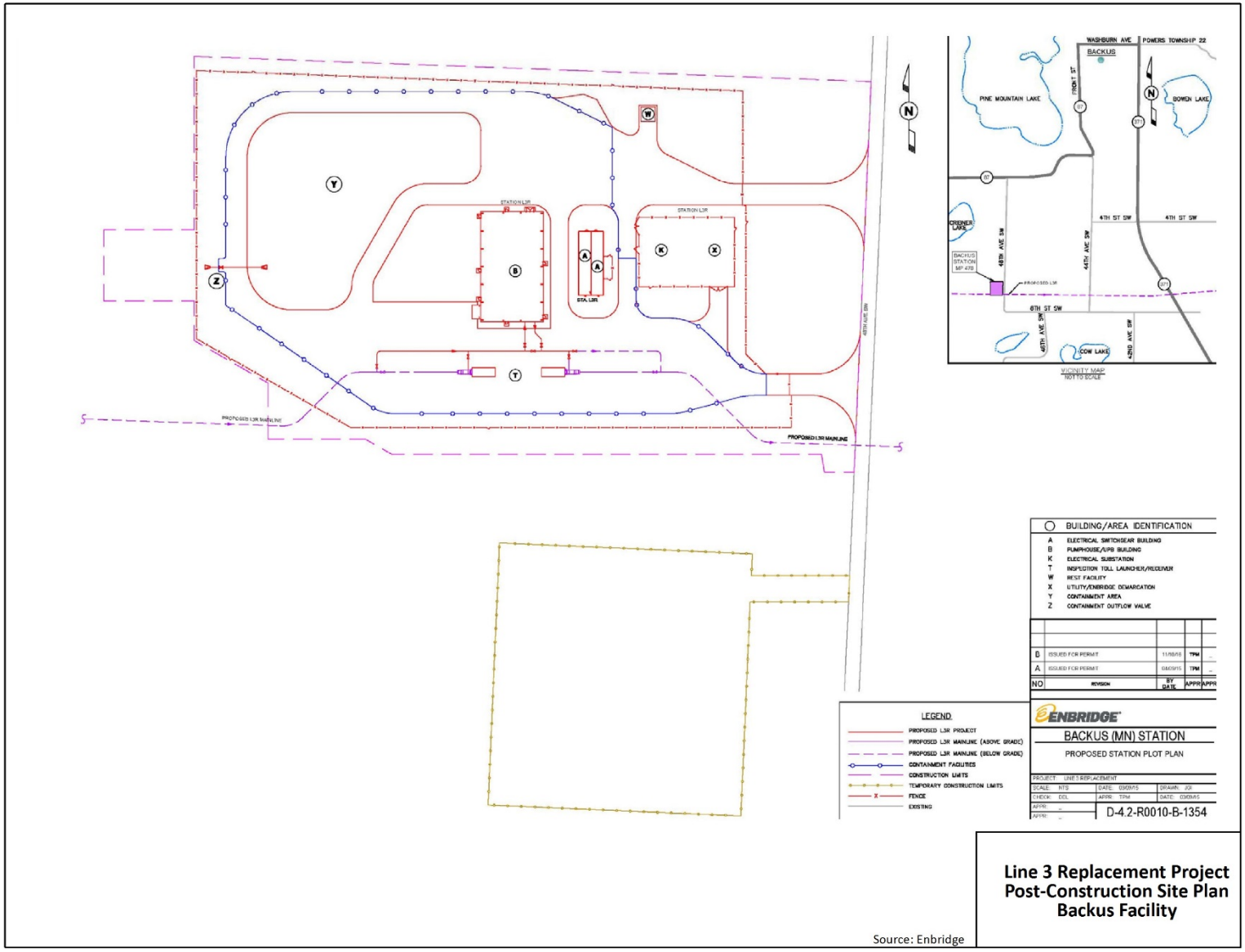

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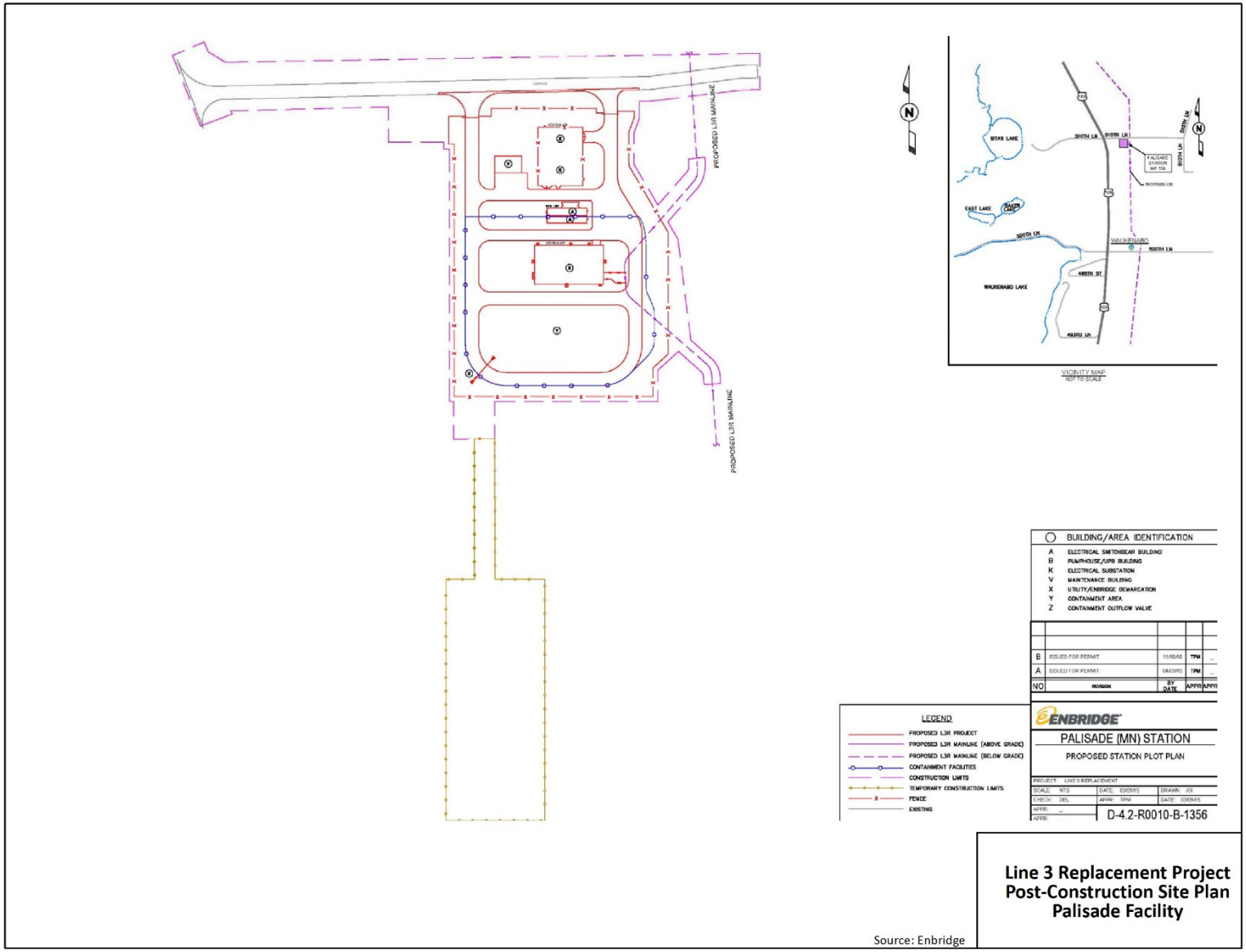

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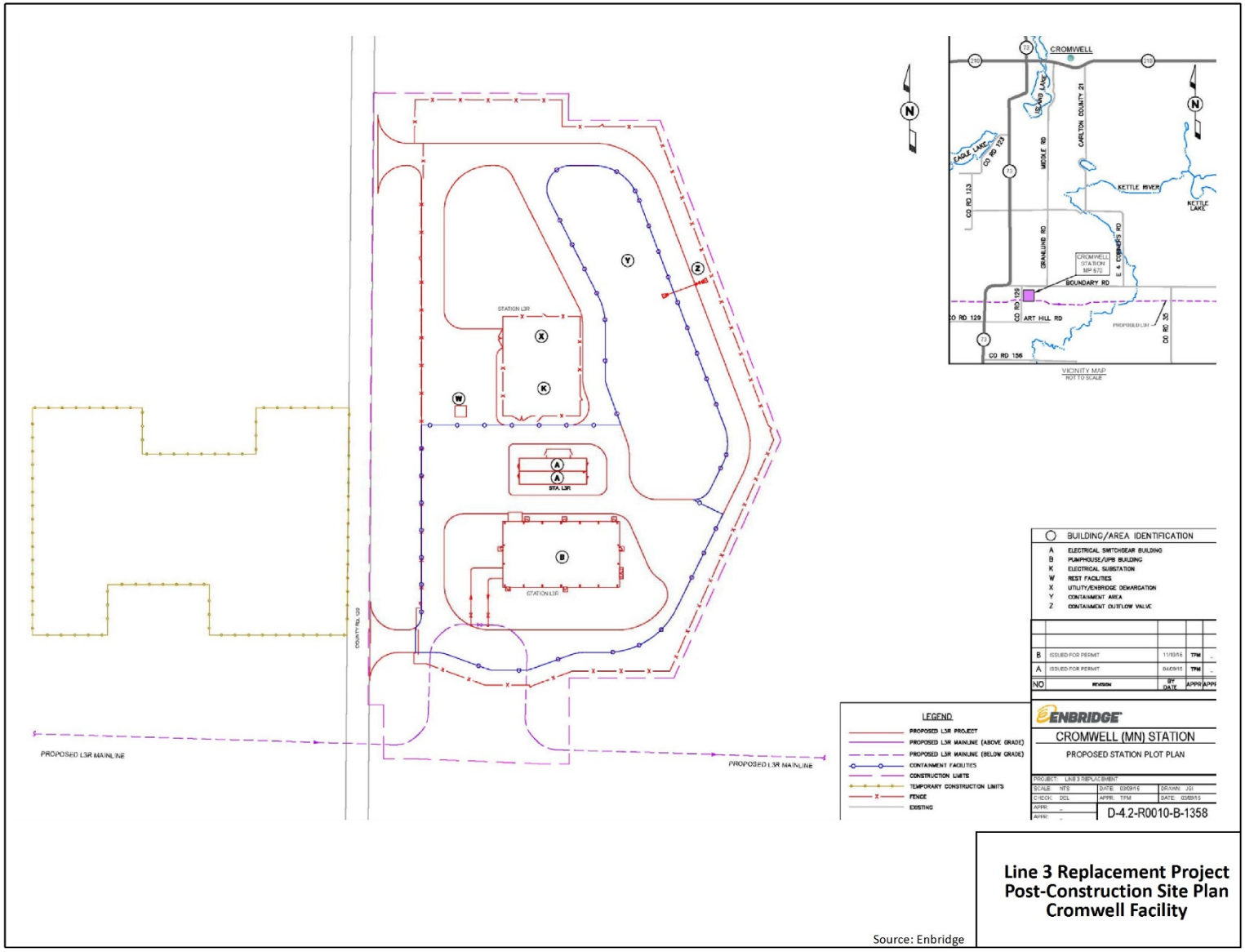

Source: Enbridge

Appendix D

Access Roads Table

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Appendix E
Access Roads Table

This information was not previously submitted as part of the Enbridge Energy, Limited Partnership Application for a Pipeline Routing Permit on April 24, 2015. The Access Roads Table was provided in April 2016 and was published as part of the Environmental Assessment Worksheet.

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Kittson	AR1005	802.0	field	new	no	TBD	Primary	TBD	MN-KI-23.0030220	0.0	0.0
Kittson	AR1005	802.0	field	new	no	TBD	Primary	Private	T-1028	1611.6	1.2
Kittson	AR1005	802.0	field	new	no	TBD	Primary	Private	T-1029	13.5	0.2
Kittson	AR1005	802.0	field	new	no	TBD	Primary	TBD	230100400	1.2	0.0
Kittson	AR1008	815.6	field	new	no	TBD	Primary	Private	T-993	0.0	0.0
Kittson	AR1008	815.6	field	new	no	TBD	Primary	County	T-993A	0.0	0.0
Kittson	AR1008	815.6	field	new	no	TBD	Primary	Private	T-994	264.7	0.1
Marshall	AR1009	817.8	gravel	existing	yes	TBD	Primary	Private	T-983	2496.5	1.7
Marshall	AR1011	828.1	gravel	existing	yes	TBD	Primary	Private	T-955	3457.3	2.4
Marshall	AR1012	828.3	field	new	no	TBD	Shoofly	Private	T-955	318.1	0.2
Marshall	AR1013	828.7	gravel/field	new/existing	partial	TBD	Primary	TBD	MN-MH-44-0094-000	326.9	0.2
Marshall	AR1013	828.7	gravel/field	new/existing	partial	TBD	Primary	TBD	MN-MH-44-0095-000	845.7	0.8
Marshall	AR1013	828.7	gravel/field	new/existing	partial	TBD	Primary	TBD	MN-MH-44-0102-000	1795.6	1.0
Marshall	AR1013	828.7	gravel/field	new/existing	partial	TBD	Primary	Private	T-952-1	2892.6	2.0
Marshall	AR1013	828.7	gravel/field	new/existing	partial	TBD	Primary	Private	T-954	0.0	0.0
Marshall	AR1014	828.8	field	new	no	TBD	Primary	Private	T-952-1	1033.9	0.7
Marshall	AR1015.7	835.8	Field	New	No	TBD	Primary	Private	T-932	425.4	0.3
Marshall	AR1016	835.8	gravel	existing	yes	TBD	Primary	Private	T-932	428.4	0.3
Marshall	AR1017	837.1	gravel/field	new/existing	no	TBD	Primary	Private	T-927	178.1	0.1
Marshall	AR1017	837.1	gravel/field	new/existing	no	TBD	Primary	Private	T-928	1361.9	0.9
Marshall	AR1017	837.1	gravel/field	new/existing	no	TBD	Primary	Private	T-929	1296.3	0.7
Marshall	AR1017	837.1	gravel/field	new/existing	no	TBD	Primary	TBD	MN-MH-17-0098-000	56.6	0.2
Marshall	AR1018	838.3	field	new	no	TBD	Primary	Private	T-925	307.1	0.2
Marshall	AR1019	838.5	field	new	no	TBD	Primary	Private	T-925	83.5	0.1
Marshall	AR1020	843.2	field	new	no	TBD	Primary	Private	T-909	1189.6	1.1
Marshall	AR1021	846.4	gravel/field	new/existing	partial	TBD	Primary	RR	T-0899-A	1052.5	0.7
Marshall	AR1021	846.4	gravel/field	new/existing	partial	TBD	Primary	Private	T-899	0.0	0.0
Marshall	AR1022	846.9	field	new	no	TBD	Primary	Private	T-896	84.8	0.1
Pennington	AR1023	853.9	field	new	no	TBD	Primary	Private	T-877	116.4	0.2
Pennington	AR1024	856.6	gravel	existing	yes	TBD	Primary	Private	T-864	464.4	0.3
Pennington	AR1024	856.6	gravel	existing	yes	TBD	Primary	Right of Way	ROW8055	63.3	0.1
Pennington	AR1025	856.8	gravel	existing	yes	TBD	Primary	Private	T-863A	348.0	0.2
Pennington	AR1025	856.8	gravel	existing	yes	TBD	Primary	Right of Way	ROW8055	56.3	0.0
Pennington	AR1026	858.7	field	new	no	TBD	Primary	Private	T-855	138.4	0.1
Pennington	AR1026	858.7	field	new	no	TBD	Primary	Private	T-856	0.0	0.0
Pennington	AR1027	859.3	gravel	existing	yes	TBD	Primary	Private	T-854	399.1	0.3
Pennington	AR1027.2	859.6	Gravel	Existing	No	TBD	Primary	Enbridge	T-852A	477.1	0.3
Pennington	AR1028	861.7	gravel	existing	yes	TBD	Primary	Private	T-846	0.0	0.0
Pennington	AR1028	861.7	gravel	existing	yes	TBD	Primary	Private	T-846A	335.8	0.2

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Pennington	AR1029	861.9	gravel	existing	yes	TBD	Primary	Private	T-845B	390.0	0.3
Pennington	AR1031	862.8	gravel	existing	yes	TBD	Primary	Private	T-844	0.0	0.0
Pennington	AR1031	862.8	gravel	existing	yes	TBD	Primary	Private	T-844A	1841.8	1.3
Pennington	AR1032	863.8	field	new	no	TBD	Primary	Private	T-840A	966.5	0.5
Pennington	AR1032	863.8	field	new	no	TBD	Primary	Private	T-841	0.0	0.2
Pennington	AR1033	864.1	gravel	existing	yes	TBD	Primary	Private	T-840	14.4	0.0
Pennington	AR1033	864.1	gravel	existing	yes	TBD	Primary	Right of Way	ROW8077	172.9	0.1
Pennington	AR1035	864.9	field	new	no	TBD	Primary	Private	T-838	8.2	0.0
Pennington	AR1035	864.9	field	new	no	TBD	Primary	Private	T-838A	1604.7	1.1
Red Lake	AR1035.4	872.1	Gravel	Existing	No	TBD	Primary	Private	T-818	349.7	0.2
Red Lake	AR1036	875.3	field	new	no	TBD	Primary	Private	T-810	1517.5	1.0
Red Lake	AR1037	877.2	field	new	no	TBD	Primary	Private	T-805	581.8	0.4
Red Lake	AR1037	877.2	field	new	no	TBD	Primary	TBD	TBD	536.7	0.4
Red Lake	AR1037	877.2	field	new	no	TBD	Primary	Enbridge	T-805B	0.0	0.0
Red Lake	AR1038	885.7	field	new	no	TBD	Primary	Private	T-780	215.1	0.2
Red Lake	AR1038.1	885.8	field	new	no	TBD	Primary	City	T-778	195.2	0.1
Red Lake	AR1038.1	885.8	field	new	no	TBD	Primary	Right of Way	ROW8061	14.6	0.0
Red Lake	AR1039	886.0	gravel/field	new/existing	partial	TBD	Primary	Private	T-776	945.0	0.7
Red Lake	AR1040	886.6	gravel	existing	yes	TBD	Primary	Private	T-774	245.7	0.2
Red Lake	AR1040	886.6	gravel	existing	yes	TBD	Primary	Private	T-774D	108.8	0.1
Polk	AR1041	886.8	gravel	existing	yes	TBD	Primary	Private	T-773	323.7	0.2
Polk	AR1042	889.7	gravel	existing	yes	TBD	Primary	Private	T-766	54.2	0.0
Polk	AR1043	891.3	gravel	existing	yes	TBD	Primary	Private	T-761	0.0	0.0
Polk	AR1043	891.3	gravel	existing	yes	TBD	Primary	Private	T-761A	1214.0	0.9
Polk	AR1044	892.5	field	new	no	TBD	Primary	Private	T-758-1	886.5	0.6
Polk	AR1045	894.7	gravel	existing	yes	TBD	Primary	Private	T-752	1013.9	0.7
Polk	AR1045	894.7	gravel	existing	yes	TBD	Primary	Private	T-753	343.1	0.2
Polk	AR1045	894.7	gravel	existing	yes	TBD	Primary	Private	T-753A	114.9	0.1
Polk	AR1045.8	895.9	Gravel and Field	Existing	No	TBD	Shoofly	Private	T-747A	40.9	0.1
Polk	AR1045.8	895.9	Gravel and Field	Existing	No	TBD	Shoofly	Private	T-748	181.4	0.1
Polk	AR1045.8	895.9	Gravel and Field	Existing	No	TBD	Shoofly	Right of Way	ROW8058	100.0	0.1
Polk	AR1046	896.1	gravel	existing	yes	TBD	Primary	Private	T-747	181.8	0.1
Polk	AR1047	896.9	gravel	existing	yes	TBD	Primary	Private	T-745	22.9	0.0
Polk	AR1047	896.9	gravel	existing	yes	TBD	Primary	Private	T-745-A	559.6	0.4
Polk	AR1047	896.9	gravel	existing	yes	TBD	Primary	Right of Way	ROW8060	81.1	0.1
Polk	AR1048	897.0	field	new	no	TBD	Primary	Private	T-744	25.6	0.1
Polk	AR1048	897.0	field	new	no	TBD	Primary	Private	T-745-A	383.8	0.2
Polk	AR1048	897.0	field	new	no	TBD	Primary	Right of Way	ROW8060	255.8	0.2
Polk	AR1049	897.2	field	new	no	TBD	Primary	Private	T-744	453.2	0.3

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Polk	AR1049	897.2	field	new	no	TBD	Primary	Right of Way	ROW8060	78.1	0.1
Polk	AR1050	898.5	field	new	no	TBD	Primary	Private	T-738	861.3	0.6
Clearwater	AR1051	900.6	field	new	no	TBD	Primary	Private	T-732	194.0	0.1
Clearwater	AR1051.2	900.9	Field	Existing	No	TBD	Primary	Private	T-731	863.1	0.6
Clearwater	AR1051.2	900.9	Field	Existing	No	TBD	Primary	Private	T-732	0.0	0.0
Clearwater	AR1052	902.8	field	new	no	TBD	Primary	Private	T-725	71.2	0.1
Clearwater	AR1053	903.0	field	new	no	TBD	Primary	Private	T-725	933.8	0.6
Clearwater	AR1054	903.9	field	new	no	TBD	Primary	Private	T-721	191.9	0.1
Clearwater	AR1055	903.9	gravel	existing	yes	TBD	Primary	Private	T-721	1161.0	0.8
Clearwater	AR292	906.1	Field	New	No	TBD	Primary	Private	MN-CL-015.300	1896.3	1.3
Clearwater	AR292	906.1	Field	New	No	TBD	Primary	Private	MN-CL-017.300	0.0	0.0
Clearwater	AR292	906.1	Field	New	No	TBD	Primary	Private	T-714A	118.9	0.1
Clearwater	AR292	906.1	Field	New	No	TBD	Primary	Private	T-716	527.4	0.4
Clearwater	AR292	906.1	Field	New	No	TBD	Primary	Private	T-716A	1829.0	1.3
Clearwater	AR292	906.1	Field	New	No	TBD	Primary	Private	T-717	0.0	0.0
Clearwater	AR293	906.8	Field	New	No	TBD	Primary	Private	T-712	2058.7	1.4
Clearwater	AR1058	908.1	field	new	no	TBD	Primary	Private	T-709	817.3	0.6
Clearwater	AR1060	910.1	field	new	no	TBD	Primary	Other Utility	T-708B	322.8	0.2
Clearwater	AR1059	910.3	field	new	no	TBD	Primary	Other Utility	T-708B	184.2	0.1
Clearwater	AR295	912.7	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-005.000	389.6	0.3
Clearwater	AR296	913.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-006.000	414.0	0.3
Clearwater	AR296.1	914.4	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-011.000	908.1	0.4
Clearwater	AR296.1	914.4	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-012.000	0.0	0.2
Clearwater	AR297	914.9	Field	New	No	TBD	Primary	Private	MN-CL-C5-013.000	1405.8	1.0
Clearwater	AR297.1	915.0	Field	New	No	TBD	Shoofly	Private	MN-CL-C5-013.000	178.4	0.1
Clearwater	AR298.1	916.0	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-015.000	2494.7	1.7
Clearwater	AR299.1	916.8	Field	New and Existing	No	TBD	Shoofly	Private	MN-CL-C5-018.000	1697.5	1.2
Clearwater	AR300	917.0	Field	New	No	TBD	Primary	Private	MN-CL-C5-018.000	63.0	0.0
Clearwater	AR300	917.0	Field	New	No	TBD	Primary	Private	MN-CL-C5-018.210	2642.8	1.8
Clearwater	AR301	919.2	Field	New	No	TBD	Primary	Private	MN-CL-C5-026.200	83.2	0.1
Clearwater	AR301	919.2	Field	New	No	TBD	Primary	Private	MN-CL-C5-024.200	914.2	0.6
Clearwater	AR301	919.2	Field	New	No	TBD	Primary	Private	MN-CL-C5-025.000	742.7	0.5
Clearwater	AR301	919.2	Field	New	No	TBD	Primary	Private	MN-CL-C5-026.300	314.0	0.2
Clearwater	AR302	920.4	Field	New	No	TBD	Primary	Private	MN-CL-C5-030.000	706.8	0.5
Clearwater	AR303	921.1	Field	New	No	TBD	Primary	Private	MN-CL-C5-031.000	2273.6	1.6
Clearwater	AR303.1	922.0	Field	New	No	TBD	Primary	Private	MN-CL-C5-036.000	118.8	0.1
Clearwater	AR303.2	922.1	Field	New	No	TBD	Primary	Private	MN-CL-C5-036.000	544.5	0.4
Clearwater	AR304	922.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-036.000	767.3	0.5
Clearwater	AR304	922.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-037.000	0.0	0.0

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Clearwater	AR305	925.3	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-051.000	2619.4	1.8
Clearwater	AR305	925.3	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-051.000	0.0	0.0
Clearwater	AR306	925.4	Field	New	No	TBD	Primary	Private	MN-CL-C5-051.000	2013.3	1.4
Clearwater	AR306	925.4	Field	New	No	TBD	Primary	Private	MN-CL-C5-051.000	0.0	0.0
Clearwater	AR306.1	927.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-059.000	88.9	0.1
Clearwater	AR306.2	927.5	Gravel	Existing	Yes	TBD	Shoofly	Private	MN-CL-C5-059.000	86.8	0.1
Clearwater	AR306.2	927.5	Gravel	Existing	Yes	TBD	Shoofly	Enbridge	MN-CL-C5-060.000	586.7	0.3
Clearwater	AR306.3	927.8	Field	New	No	TBD	Shoofly	Private	MN-CL-C5-061.000	393.1	0.3
Clearwater	AR306.4	927.9	Field	New	No	TBD	Shoofly	Private	MN-CL-C5-062.000	380.4	0.3
Clearwater	AR307	928.1	Field	New	No	TBD	Primary	Private	MN-CL-C5-062.000	3167.0	2.2
Clearwater	AR308	928.9	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-065.000	0.0	0.0
Clearwater	AR308	928.9	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-066.000	770.6	0.5
Clearwater	AR308	928.9	Gravel	Existing	Yes	TBD	Primary	Private	MN-CL-C5-066.300	36.9	0.0
Clearwater	AR308.1	929.7	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-069.000	2154.1	1.5
Clearwater	AR309	929.8	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-071.000	990.6	0.7
Clearwater	AR309	929.8	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-C5-069.000	1364.4	0.5
Clearwater	AR309	929.8	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CL-R14.029.0400	0.0	0.4
Clearwater	AR309.2	930.8	Gravel and Field	New and Existing	No	TBD	Primary	County	MN-CL-C5-074.000	1764.2	1.2
Clearwater	AR309.2	930.8	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-CL-C5-074.100	1948.7	1.4
Clearwater	AR309.2	930.8	Gravel and Field	New and Existing	No	TBD	Primary	State	MN-CL-C5-074.200	201.4	0.1
Clearwater	AR309.2	930.8	Gravel and Field	New and Existing	No	TBD	Primary	State	MN-CL-C5-074.300	16.0	0.0
Clearwater	AR309.2	930.8	Gravel and Field	New and Existing	No	TBD	Primary	County	MN-CL-C5-074.000	0.0	0.0
Clearwater	AR309.1	930.8	Field	New	No	TBD	Primary	County	MN-CL-C5-074.000	92.9	0.1
Clearwater	AR309.3	930.9	Gravel	New	No	TBD	Primary	County	MN-CL-C5-074.000	732.2	0.5
Clearwater	AR309.3	930.9	Gravel	New	No	TBD	Primary	County	MN-CL-C5-074.000	0.0	0.0
Clearwater	AR310	931.8	Gravel and Field	Existing	No	TBD	Primary	Private	MN-CL-C5-075.000	852.7	0.6
Clearwater	AR310.05	932.7	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-077.000	217.3	0.1
Clearwater	AR310.1	933.1	Field	New	No	TBD	Primary	Private	MN-CL-C5-078.000	578.8	0.4
Clearwater	AR311	934.7	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-085.000	1364.9	0.9
Clearwater	AR311.1	937.6	Field	New	No	TBD	Primary	Private	MN-CL-C5-097.000	108.4	0.1
Clearwater	AR311.2	937.7	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-097.000	76.1	0.1
Clearwater	AR312	938.2	Field	Existing	No	TBD	Primary	State	MN-CL-C5-100.000	3238.8	2.1
Clearwater	AR312	938.2	Field	Existing	No	TBD	Primary	County	MN-CL-C5-099.000	0.0	0.1
Clearwater	AR313	938.4	Field	Existing	No	TBD	Primary	State	MN-CL-C5-100.000	3120.4	2.1
Clearwater	AR313	938.4	Field	Existing	No	TBD	Primary	State	MN-CL-C5-100.000	0.0	0.0
Clearwater	AR314	938.7	Field	New and Existing	No	TBD	Primary	State	MN-CL-C5-100.000	1233.1	0.9
Clearwater	AR314	938.7	Field	New and Existing	No	TBD	Primary	State	MN-CL-C5-100.000	0.0	0.0
Clearwater	AR314.1	939.0	Field	New	No	TBD	Shoofly	Private	MN-CL-C5-102.000	233.2	0.2
Clearwater	AR315	940.2	Field	New and Existing	No	TBD	Primary	Private	MN-CL-C5-106.000	1666.2	1.1

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Clearwater	AR315	940.2	Field	New and Existing	No	TBD	Primary	Private	MN-CL-C5-107.000	148.4	0.1
Clearwater	AR316	940.5	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-111.000	0.0	0.0
Clearwater	AR316	940.5	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-108.300	25.4	0.0
Clearwater	AR316	940.5	Gravel	Existing	No	TBD	Primary	Other Utility	MN-CL-C5-109.000	478.6	0.3
Clearwater	AR317	942.1	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-119.300	0.0	0.3
Clearwater	AR317	942.1	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-119.301	675.2	0.5
Clearwater	AR317	942.1	Gravel	Existing	No	TBD	Primary	Private	MN-CL-C5-122.300	1824.4	0.9
Hubbard	AR319	944.0	Field	Existing	No	TBD	Primary	County	MN-HU-C5-006.000	1279.6	0.9
Hubbard	AR320	944.6	Gravel and Field	Existing	No	TBD	Primary	County	MN-HU-C5-009.000	328.5	0.2
Hubbard	AR321	945.0	Field	Existing	No	TBD	Primary	Private	MN-HU-C5-011.000	1344.5	0.9
Hubbard	AR321	945.0	Field	Existing	No	TBD	Primary	Private	MN-HU-C5-012.000	163.3	0.1
Hubbard	AR322	946.4	Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-016.000	24.1	0.0
Hubbard	AR322	946.4	Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-017.000	362.4	0.2
Hubbard	AR322	946.4	Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-017.200	564.9	0.4
Hubbard	AR323	947.4	Field	Existing	No	TBD	Primary	County	MN-HU-C5-023.000	833.3	0.6
Hubbard	AR324.1	950.3	Field	New	No	TBD	Shoofly	County	MN-HU-C5-037.000	443.1	0.3
Hubbard	AR324.11	950.4	Field	New	No	TBD	Primary	County	MN-HU-C5-037.000	316.4	0.2
Hubbard	AR324.2	950.4	Field	New	No	TBD	Shoofly	County	MN-HU-C5-037.000	445.9	0.3
Hubbard	AR324.2	950.4	Field	New	No	TBD	Shoofly	County	MN-HU-C5-037.000	94.5	0.1
Hubbard	AR324.3	950.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-037.000	287.6	0.2
Hubbard	AR324.3	950.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-037.000	94.6	0.1
Hubbard	AR324.31	950.6	Field	New	No	TBD	Primary	County	MN-HU-C5-038.000	577.8	0.4
Hubbard	AR324.4	950.8	Field	New	No	TBD	Shoofly	County	MN-HU-C5-038.000	480.6	0.3
Hubbard	AR325	950.9	Gravel and Field	New and Existing	No	TBD	Primary	County	MN-HU-C5-038.000	655.9	0.5
Hubbard	AR325.01	951.0	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	153.0	0.1
Hubbard	AR325.01	951.0	Field	New	No	TBD	Shoofly	County	MN-HU-C5-038.000	345.2	0.2
Hubbard	AR325.020	951.2	Gravel	New	No	TBD	Primary	County	MN-HU-C5-039.000	1411.2	1.0
Hubbard	AR325.020	951.2	Gravel	New	No	TBD	Primary	TBD	15.38.03300	511.3	0.4
Hubbard	AR325.020	951.2	Gravel	New	No	TBD	Primary	County	MN-HU-C5-039.000	30.9	0.0
Hubbard	AR325.02	951.3	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	383.6	0.3
Hubbard	AR325.0211	951.4	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	118.4	0.1
Hubbard	AR325.0211	951.4	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	0.0	0.0
Hubbard	AR325.03	951.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	502.3	0.3
Hubbard	AR325.03	951.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	9.0	0.0
Hubbard	AR325.021	951.5	Field	New	No	TBD	Primary	County	MN-HU-C5-039.000	1133.1	0.8
Hubbard	AR325.021	951.5	Field	New	No	TBD	Primary	County	MN-HU-C5-040.000	48.4	0.0
Hubbard	AR325.021	951.5	Field	New	No	TBD	Primary	County	MN-HU-C5-039.000	0.0	0.0
Hubbard	AR325.012	951.5	Gravel	New and Existing	Partial	TBD	Shoofly	County	MN-HU-C5-039.000	2226.4	1.5
Hubbard	AR325.012	951.5	Gravel	New and Existing	Partial	TBD	Shoofly	County	MN-HU-C5-040.000	139.4	0.1

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Hubbard	AR325.012	951.5	Gravel	New and Existing	Partial	TBD	Shoofly	County	MN-HU-C5-041.200	1098.8	0.8
Hubbard	AR325.012	951.5	Gravel	New and Existing	Partial	TBD	Shoofly	State	MN-HU-C5-040.200	2061.8	1.4
Hubbard	AR325.012	951.5	Gravel	New and Existing	Partial	TBD	Shoofly	State	MN-HU-C5-041.300	307.6	0.2
Hubbard	AR325.012	951.5	Gravel	New and Existing	Partial	TBD	Shoofly	County	MN-HU-C5-039.000	30.9	0.0
Hubbard	AR325.04	951.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	245.0	0.2
Hubbard	AR325.04	951.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-040.000	92.5	0.1
Hubbard	AR325.04	951.5	Field	New	No	TBD	Shoofly	County	MN-HU-C5-039.000	7.7	0.0
Hubbard	AR325.1	952.0	Gravel	Existing	No	TBD	Shoofly	State	MN-HU-C5-041.000	5.9	0.0
Hubbard	AR325.1	952.0	Gravel	Existing	No	TBD	Shoofly	County	MN-HU-C5-041.200	1344.5	0.9
Hubbard	AR325.1	952.0	Gravel	Existing	No	TBD	Shoofly	County	MN-HU-C5-042.000	304.3	0.2
Hubbard	AR325.1	952.0	Gravel	Existing	No	TBD	Shoofly	County	MN-HU-C5-042.200	776.9	0.5
Hubbard	AR325.2	952.0	Field	New	No	TBD	Shoofly	State	MN-HU-C5-041.000	308.7	0.2
Hubbard	AR325.2	952.0	Field	New	No	TBD	Shoofly	State	MN-HU-C5-041.000	0.0	0.0
Hubbard	AR325.3	952.1	Field	New	No	TBD	Shoofly	State	MN-HU-C5-041.000	161.0	0.1
Hubbard	AR325.3	952.1	Field	New	No	TBD	Shoofly	County	MN-HU-C5-042.000	342.0	0.2
Hubbard	AR325.3	952.1	Field	New	No	TBD	Shoofly	State	MN-HU-C5-041.000	3.1	0.0
Hubbard	AR326.1	952.3	Field	New	No	TBD	Shoofly	County	MN-HU-C5-043.000	354.5	0.2
Hubbard	AR326.10	952.3	Field	New	No	TBD	Shoofly	County	MN-HU-C5-043.000	650.8	0.4
Hubbard	AR328	955.7	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-058.000	1116.9	0.8
Hubbard	AR329	956.6	Field	New	No	TBD	Primary	Private	MN-HU-C5-062.000	1314.1	0.9
Hubbard	AR330	957.6	Gravel and Field	Existing	No	TBD	Primary	Private	MN-HU-C5-067.320	102.2	0.1
Hubbard	AR330	957.6	Gravel and Field	Existing	No	TBD	Primary	Private	MN-HU-C5-068.000	614.8	0.4
Hubbard	AR330	957.6	Gravel and Field	Existing	No	TBD	Primary	Private	MN-HU-C5-068.300	315.5	0.2
Hubbard	AR330	957.6	Gravel and Field	Existing	No	TBD	Primary	Private	MN-HU-C5-067.310	1269.7	0.9
Hubbard	AR330.1	959.0	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-073.000	816.0	0.6
Hubbard	AR330.1	959.0	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-074.000	87.6	0.1
Hubbard	AR330.1	959.0	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-074.000	0.0	0.0
Hubbard	AR330.4	959.1	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-073.310	194.1	0.1
Hubbard	AR330.4	959.1	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-073.000	34.4	0.0
Hubbard	AR330.4	959.1	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-074.000	336.9	0.2
Hubbard	AR330.4	959.1	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-074.300	20.4	0.0
Hubbard	AR330.4	959.1	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-074.000	0.0	0.0
Hubbard	AR331	959.2	Field	New	No	TBD	Primary	Private	MN-HU-C5-074.000	26.8	0.0
Hubbard	AR331	959.2	Field	New	No	TBD	Primary	Private	MN-HU-C5-074.300	0.1	0.0
Hubbard	AR332	959.4	Field	New	No	TBD	Primary	Private	MN-HU-C5-076.000	109.5	0.1
Hubbard	AR332.1	959.5	Field	Existing	No	TBD	Primary	Enbridge	MN-HU-C5-077.000	140.7	0.1
Hubbard	AR335	961.8	Gravel	Existing	No	TBD	Primary	Private	MN-HU-C5-086.000	934.6	0.6
Hubbard	AR335.1	962.6	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-089.000	300.3	0.2
Hubbard	AR335.4	964.2	Field	New	No	TBD	Shoofly	County	MN-HU-C5-095.210	604.5	0.4

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Hubbard	AR335.4	964.2	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-098.000	156.4	0.1
Hubbard	AR335.3	964.2	Field	New	No	TBD	Shoofly	County	MN-HU-C5-095.000	346.8	0.2
Hubbard	AR335.3	964.2	Field	New	No	TBD	Shoofly	County	MN-HU-C5-096.000	13.7	0.0
Hubbard	AR336	964.4	Gravel and Field	Existing	No	TBD	Primary	Private	MN-HU-C5-098.000	1259.9	0.9
Hubbard	AR337	966.7	Field	New and Existing	No	TBD	Primary	Private	MN-HU-C5-106.000	420.2	0.3
Hubbard	AR338.2	968.0	Field	Existing	No	TBD	Primary	Private	MN-HU-C5-112.000	0.0	0.1
Hubbard	AR338.2	968.0	Field	Existing	No	TBD	Primary	Private	MN-HU-C5-110.000	1325.3	0.8
Hubbard	AR338.2	968.0	Field	Existing	No	TBD	Primary	Private	MN-HU-C5-111.000	0.0	0.1
Hubbard	AR338.3	969.2	Field	Existing	No	TBD	Primary	Private	MN-HU-C5-117.000	553.3	0.4
Hubbard	AR339	969.9	Field	New	No	TBD	Primary	Private	MN-HU-C5-118.000	386.9	0.2
Hubbard	AR339	969.9	Field	New	No	TBD	Primary	Private	MN-HU-C5-119.000	0.0	0.1
Hubbard	AR339.01	972.2	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-126.000	374.6	0.3
Hubbard	AR341	974.2	Field	New	No	TBD	Primary	Commercial	MN-HU-C5-135.000	214.7	0.2
Hubbard	AR341	974.2	Field	New	No	TBD	Primary	Commercial	MN-HU-C5-136.000	628.2	0.4
Hubbard	AR342	974.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-140.000	0.0	0.0
Hubbard	AR342	974.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-139.000	921.1	0.5
Hubbard	AR342	974.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-140.300	0.0	0.1
Hubbard	AR343	976.4	Field	New	No	TBD	Shoofly	Commercial	MN-HU-C5-151.000	1000.2	0.7
Hubbard	AR343.1	976.5	Field	New	No	TBD	Primary	Commercial	MN-HU-C5-150.000	157.9	0.1
Hubbard	AR344	977.1	Gravel	Existing	Yes	TBD	Primary	Private	MN-HU-C5-157.000	1199.4	0.8
Hubbard	AR345	977.9	Field	New	No	TBD	Primary	Private	MN-HU-C5-160.300	982.5	0.8
Hubbard	AR345	977.9	Field	New	No	TBD	Primary	Commercial	MN-HU-C5-160.000	299.8	0.2
Hubbard	AR345	977.9	Field	New	No	TBD	Primary	Private	MN-HU-C5-160.310	337.9	0.2
Hubbard	AR345.1	978.2	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-161.000	398.4	0.3
Hubbard	AR345.2	978.7	Field	New	No	TBD	Primary	State	MN-HU-C5-165.000	22.4	0.0
Hubbard	AR345.2	978.7	Field	New	No	TBD	Primary	RR	MN-HU-C5-167.000	337.7	0.2
Hubbard	AR345.2	978.7	Field	New	No	TBD	Primary	County	MN-HU-C5-165.300	32.2	0.0
Hubbard	AR345.2	978.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-166.000	0.0	0.0
Hubbard	AR345.2	978.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-168.000	108.0	0.1
Hubbard	AR346	979.6	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-172.000	807.3	0.6
Hubbard	AR346	979.6	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-172.210	0.0	0.0
Hubbard	AR346	979.6	Gravel and Field	New and Existing	Partial	TBD	Primary	County	MN-HU-C5-173.000	1832.4	1.3
Hubbard	AR347	980.3	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-174.000	521.8	0.4
Hubbard	AR347	980.3	Gravel and Field	New and Existing	Partial	TBD	Primary	State	MN-HU-C5-175.100	1422.5	1.0
Hubbard	AR347	980.3	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-175.300	46.1	0.0
Hubbard	AR348.1	981.6	Gravel and Field	New and Existing	Partial	TBD	Primary	State	MN-HU-C5-178.000	427.5	0.2
Hubbard	AR348.1	981.6	Gravel and Field	New and Existing	Partial	TBD	Primary	County	MN-HU-C5-178.200	45.3	0.1
Hubbard	AR348.1	981.6	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-179.000	165.6	0.1
Hubbard	AR348.1	981.6	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-HU-C5-179.200	0.0	0.0

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Hubbard	AR348.12	981.8	Gravel	Existing	No	TBD	Primary	Private	MN-HU-C5-179.000	96.3	0.1
Hubbard	AR348.12	981.8	Gravel	Existing	No	TBD	Primary	Private	MN-HU-C5-179.220	31.3	0.0
Hubbard	AR348.2	984.0	Field	New	No	TBD	Shoofly	Private	MN-HU-C5-184.000	901.0	0.6
Hubbard	AR349	984.3	Field	New	No	TBD	Primary	Private	MN-HU-C5-185.000	21.7	0.2
Hubbard	AR349	984.3	Field	New	No	TBD	Primary	Private	MN-HU-C5-185.100	1306.5	0.8
Hubbard	AR349	984.3	Field	New	No	TBD	Primary	Private	MN-HU-C5-186.000	1140.5	0.7
Hubbard	AR350	985.3	Field	New	No	TBD	Primary	Private	MN-HU-C5-189.000	0.0	0.1
Hubbard	AR350	985.3	Field	New	No	TBD	Primary	Private	MN-HU-C5-190.000	2581.9	1.7
Hubbard	AR350.21	986.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-193.200	507.9	0.4
Hubbard	AR350.21	986.7	Field	New	No	TBD	Primary	Private	MN-HU-C5-193.000	502.8	0.3
Hubbard	AR350.3	986.8	Field	New	No	TBD	Primary	Private	MN-HU-C5-193.000	513.3	0.2
Hubbard	AR350.3	986.8	Field	New	No	TBD	Primary	Private	MN-HU-C5-193.300	0.0	0.1
Wadena	AR350.5	990.4	Field	New	No	TBD	Primary	County	MN-WA-009.000	40.8	0.1
Wadena	AR350.5	990.4	Field	New	No	TBD	Primary	Commercial	MN-WA-010.000	1290.4	0.9
Wadena	AR351.1	990.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Commercial	MN-WA-010.000	116.4	0.2
Wadena	AR351.1	990.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Commercial	MN-WA-011.000	1073.7	0.6
Wadena	AR351.3	991.4	Gravel and Field	New and Existing	Partial	TBD	Primary	State	MN-WA-010.100	0.0	0.1
Wadena	AR351.3	991.4	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-WA-013.000	214.7	0.1
Wadena	AR351.3	991.4	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-WA-014.000	738.0	0.4
Wadena	AR351.3	991.4	Gravel and Field	New and Existing	Partial	TBD	Primary	County	MN-WA-015.000	1418.3	0.9
Wadena	AR351.3	991.4	Gravel and Field	New and Existing	Partial	TBD	Primary	County	MN-WA-015.000	0.0	0.0
Wadena	AR351.4	991.6	Gravel and Field	New and Existing	Partial	TBD	Primary	County	MN-WA-015.000	1664.4	1.1
Wadena	AR351.4	991.6	Gravel and Field	New and Existing	Partial	TBD	Primary	County	MN-WA-015.000	0.0	0.0
Wadena	AR353.3	992.5	Field	New	No	TBD	Primary	County	MN-WA-017.000	350.7	0.3
Wadena	AR353.3	992.5	Field	New	No	TBD	Primary	Private	MN-WA-017.300	429.8	0.2
Hubbard	AR353.4	993.6	Gravel and Field	New and Existing	No	TBD	Shoofly	County	MN-WA-017.000	44.3	0.0
Hubbard	AR353.4	993.6	Gravel and Field	New and Existing	No	TBD	Shoofly	County	MN-WA-019.300	3234.3	2.2
Hubbard	AR353.4	993.6	Gravel and Field	New and Existing	No	TBD	Shoofly	Private	MN-WA-020.000	157.6	0.1
Hubbard	AR353.4	993.6	Gravel and Field	New and Existing	No	TBD	Shoofly	Private	MN-WA-020.300	66.9	0.0
Hubbard	AR353.4	993.6	Gravel and Field	New and Existing	No	TBD	Shoofly	County	MN-WA-018.000	2180.7	1.5
Wadena	AR354.3	994.2	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-WA-020.000	3370.8	2.2
Wadena	AR354.3	994.2	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-WA-020.200	0.0	0.1
Cass	AR355.2	995.5	Field	New	No	TBD	Primary	Private	MN-CA-C5-001.520	846.2	0.5
Cass	AR355.2	995.5	Field	New	No	TBD	Primary	Private	MN-CA-C5-001.520.300	0.0	0.0
Cass	AR357	997.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-007.200	97.3	0.1
Cass	AR357	997.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-009.200	0.0	0.1
Cass	AR357	997.3	Gravel	Existing	Yes	TBD	Primary	State	MN-HU-C5-225.200	870.7	0.5
Cass	AR357	997.3	Gravel	Existing	Yes	TBD	Primary	County	MN-CA-C5-006.000	6562.9	4.3
Cass	AR357	997.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-009.300	35.3	0.3

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County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Cass	AR357	997.3	Gravel	Existing	Yes	TBD	Primary	County	MN-HU-C5-225.100	0.0	0.0
Cass	AR358	998.1	Field	New	No	TBD	Shoofly	Private	MN-CA-C5-010.000	719.9	0.5
Cass	AR358.1	998.3	Field	New	No	TBD	Primary	Private	MN-CA-C5-010.000	1718.0	1.2
Cass	AR358.2	998.5	Field	New	No	TBD	Primary	Private	MN-CA-C5-010.000	125.6	0.1
Cass	AR359	999.0	Field	New	No	TBD	Primary	Commercial	MN-CA-C5-011.000	1189.7	0.8
Cass	AR360	1000.0	Field	New	No	TBD	Primary	Private	MN-CA-C5-013.000	110.1	0.2
Cass	AR360	1000.0	Field	New	No	TBD	Primary	Private	MN-CA-C5-014.000	835.0	0.4
Cass	AR361	1002.2	Gravel	Existing	Yes	TBD	Primary	County	MN-CA-C5-018.000	6224.1	4.3
Cass	AR361	1002.2	Gravel	Existing	Yes	TBD	Primary	County	MN-CA-C5-019.000	1263.6	0.9
Cass	AR361	1002.2	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-020.000	1674.7	1.2
Cass	AR360.1	1002.2	Gravel and Field	New and Existing	No	TBD	Shoofly	County	MN-CA-C5-019.000	837.3	0.6
Cass	AR361.01	1003.5	Field	New	No	TBD	Shoofly	State	MN-CA-C5-020.000	503.1	0.3
Cass	AR361.001	1003.5	Field	New	No	TBD	Shoofly	State	MN-CA-C5-020.000	357.3	0.2
Cass	AR361.1	1004.4	Field	New	No	TBD	Shoofly	State	MN-CA-C5-021.000	3116.3	2.1
Cass	AR361.3	1007.1	Field	New	No	TBD	Primary	Private	MN-CA-C5-027.000	1225.9	0.8
Cass	AR361.4	1008.9	Field	New	No	TBD	Primary	Private	MN-CA-C5-039.000	1295.1	0.9
Cass	AR362.1	1013.6	Gravel and Field	New	No	TBD	Primary	Private	MN-CA-C5-059.310	0.0	0.0
Cass	AR362.1	1013.6	Gravel and Field	New	No	TBD	Primary	Private	MN-CA-C5-059.320	0.0	0.1
Cass	AR362.1	1013.6	Gravel and Field	New	No	TBD	Primary	County	MN-CA-C5-060.000	623.9	0.4
Cass	AR362.1	1013.6	Gravel and Field	New	No	TBD	Primary	Private	MN-CA-C5-060.100	941.4	0.5
Cass	AR362.1	1013.6	Gravel and Field	New	No	TBD	Primary	County	MN-CA-C5-060.200	150.7	0.1
Cass	AR362.1	1013.6	Gravel and Field	New	No	TBD	Primary	State	MN-CA-C5-060.300	1385.4	1.0
Cass	AR362.12	1014.8	Gravel	Existing	No	TBD	Primary	Private	MN-CA-C5-066.200	149.7	0.1
Cass	AR362.12	1014.8	Gravel	Existing	No	TBD	Primary	Private	MN-CA-C5-066.000	156.2	0.1
Crow Wing	AR364	1016.6	Field	New	No	TBD	Primary	Private	MN-CW-C5-005.000	1069.2	0.7
Crow Wing	AR364	1016.6	Field	New	No	TBD	Primary	Private	MN-CW-C5-005.000	0.0	0.0
Crow Wing	AR364.1	1016.6	Field	New	No	TBD	Primary	Private	MN-CW-C5-005.000	122.9	0.1
Crow Wing	AR364.1	1016.6	Field	New	No	TBD	Primary	Private	MN-CW-C5-005.000	0.0	0.0
Crow Wing	AR364.11	1016.7	Field	New	No	TBD	Shoofly	Private	MN-CW-C5-005.000	799.5	0.6
Crow Wing	AR364.11	1016.7	Field	New	No	TBD	Shoofly	Private	MN-CW-C5-006.000	293.5	0.2
Crow Wing	AR364.11	1016.7	Field	New	No	TBD	Shoofly	Private	MN-CW-C5-005.300	522.8	0.4
Crow Wing	AR365	1017.2	Gravel	Existing	Yes	TBD	Primary	Private	MN-CW-C5-009.000	1062.7	0.7
Crow Wing	AR366	1017.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CW-C5-012.000	804.8	0.6
Crow Wing	AR366	1017.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CW-C5-013.000	0.0	0.0
Crow Wing	AR366	1017.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CW-C5-011.000	44.1	0.0
Crow Wing	AR366	1017.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CW-C5-011.210	24.9	0.0
Crow Wing	AR366.1	1019.6	Field	New	No	TBD	Shoofly	County	MN-CW-C5-021.000	299.9	0.2
Crow Wing	AR366.1	1019.6	Field	New	No	TBD	Shoofly	County	MN-CW-C5-023.000	245.8	0.2
Crow Wing	AR366.1	1019.6	Field	New	No	TBD	Shoofly	State	MN-CW-C5-021.200	298.3	0.2

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County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Cass	AR367	1020.5	Field	New	No	TBD	Primary	Private	MN-CA-C5-072.100	1397.2	1.0
Cass	AR367	1020.5	Field	New	No	TBD	Primary	Private	MN-CA-C5-072.200	1067.4	0.7
Cass	AR367	1020.5	Field	New	No	TBD	Primary	Private	MN-CA-C5-072.300	204.5	0.1
Cass	AR367	1020.5	Field	New	No	TBD	Primary	County	MN-CA-C5-073.000	94.6	0.1
Cass	AR367	1020.5	Field	New	No	TBD	Primary	County	MN-CA-C5-072.000	1435.3	1.0
Cass	AR368	1021.7	Field	New	No	TBD	Primary	County	MN-CA-C5-077.000	203.5	0.1
Cass	AR368	1021.7	Field	New	No	TBD	Primary	County	MN-CA-C5-078.000	1594.4	1.1
Cass	AR368.01	1023.0	Field	New	No	TBD	Primary	Private	MN-CA-C5-085.000	1084.8	0.7
Cass	AR368.01	1023.0	Field	New	No	TBD	Primary	Private	MN-CA-C5-085.100	371.7	0.3
Cass	AR368.01	1023.0	Field	New	No	TBD	Primary	Private	MN-CA-C5-084.504	9.9	0.0
Cass	AR372	1024.7	Field	New	No	TBD	Primary	Private	MN-CA-C5-091.000	1479.1	1.0
Cass	AR372	1024.7	Field	New	No	TBD	Primary	Private	MN-CA-C5-091.300	126.5	0.1
Cass	AR373	1024.9	Field	New	No	TBD	Primary	Private	MN-CA-C5-093.000	621.4	0.4
Cass	AR373	1024.9	Field	New	No	TBD	Primary	Private	MN-CA-C5-092.000	1005.0	0.7
Cass	AR374	1025.6	Field	New	No	TBD	Primary	County	MN-CA-C5-095.000	1056.6	0.7
Cass	AR375	1026.3	Field	New	No	TBD	Primary	County	MN-CA-C5-097.000	626.3	0.4
Cass	AR376	1026.4	Field	New	No	TBD	Primary	County	MN-CA-C5-099.000	94.5	0.1
Cass	AR376.1	1027.1	Field	New	No	TBD	Primary	County	MN-CA-C5-104.000	124.1	0.1
Cass	AR376.1	1027.1	Field	New	No	TBD	Primary	County	MN-CA-C5-101.200	216.3	0.1
Cass	AR378	1027.7	Field	New	No	TBD	Primary	County	MN-CA-C5-106.000	0.0	0.0
Cass	AR378	1027.7	Field	New	No	TBD	Primary	County	MN-CA-C5-105.000	0.0	0.0
Cass	AR378	1027.7	Field	New	No	TBD	Primary	County	MN-CA-C5-107.000	47.4	0.0
Cass	AR378	1027.7	Field	New	No	TBD	Primary	State	MN-CA-C5-107.300	2.4	0.0
Cass	AR379	1028.2	Field	New	No	TBD	Primary	County	MN-CA-C5-108.000	123.4	0.1
Cass	AR379	1028.2	Field	New	No	TBD	Primary	County	MN-CA-C5-109.000	141.7	0.1
Cass	AR380	1028.6	Field	New	No	TBD	Primary	County	MN-CA-C5-110.000	290.8	0.2
Cass	AR381	1029.4	Field	New	No	TBD	Primary	County	MN-CA-C5-113.000	540.7	0.4
Cass	AR382	1030.0	Field	New	No	TBD	Primary	County	MN-CA-C5-116.000	260.8	0.2
Cass	AR383	1030.9	Field	New	No	TBD	Primary	County	MN-CA-C5-119.200	143.5	0.1
Cass	AR384	1031.3	Field	New	No	TBD	Shoofly	County	MN-CA-C5-121.200	113.7	0.1
Cass	AR385	1032.6	Field	New	No	TBD	Primary	County	MN-CA-C5-126.000	16.2	0.0
Cass	AR385	1032.6	Field	New	No	TBD	Primary	County	MN-CA-C5-126.200	145.5	0.1
Cass	AR386	1032.9	Field	New	No	TBD	Primary	County	MN-CA-C5-127.000	372.3	0.3
Cass	AR388	1034.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-12-446-0102	0.0	0.0
Cass	AR388	1034.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-133.100	614.3	0.4
Cass	AR388	1034.3	Gravel	Existing	Yes	TBD	Primary	County	MN-CA-C5-133.000	29.5	0.0
Cass	AR388	1034.3	Gravel	Existing	Yes	TBD	Primary	County	MN-CA-C5-134.000	1452.2	1.0
Cass	AR388	1034.3	Gravel	Existing	Yes	TBD	Primary	County	MN-CA-C5-135.000	12.6	0.0

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County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Cass	AR387.1	1034.5	Field	New	No	TBD	Primary	County	MN-CA-C5-134.000	245.0	0.2
Cass	AR387.1	1034.5	Field	New	No	TBD	Primary	County	MN-CA-C5-135.000	29.5	0.0
Cass	AR389	1035.3	Gravel and Field	New and Existing	Partial	TBD	Shoofly	County	MN-CA-C5-138.000	1043.3	0.7
Cass	AR389.2	1035.8	Gravel and Field	New and Existing	Partial	TBD	Shoofly	County	MN-CA-C5-139.000	665.2	0.5
Cass	AR389.2	1035.8	Gravel and Field	New and Existing	Partial	TBD	Shoofly	County	MN-CA-C5-140.000	1294.6	0.9
Cass	AR389.2	1035.8	Gravel and Field	New and Existing	Partial	TBD	Shoofly	Private	MN-CA-C5-141.000	51.9	0.0
Cass	AR391	1036.4	Gravel	New and Existing	Partial	TBD	Primary	County	MN-CA-C5-143.000	838.5	0.6
Cass	AR391	1036.4	Gravel	New and Existing	Partial	TBD	Primary	County	MN-CA-C5-142.000	167.0	0.1
Cass	AR391.1	1039.3	Field	New	No	TBD	Shoofly	State	MN-CA-C5-155.000	967.8	0.7
Cass	AR391.1	1039.3	Field	New	No	TBD	Shoofly	State	MN-CA-C5-153.000	134.9	0.1
Cass	AR391.2	1039.5	Field	New	No	TBD	Shoofly	State	MN-CA-C5-155.000	503.1	0.3
Cass	AR391.3	1039.7	Field	New	No	TBD	Shoofly	State	MN-CA-C5-155.000	1822.6	1.2
Cass	AR391.4	1040.1	Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-155.000	1403.3	1.0
Cass	AR391.4	1040.1	Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-156.000	838.2	0.6
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-156.000	1519.7	1.0
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-156.100	1359.1	0.9
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-156.400	1408.2	1.0
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-156.500	193.5	0.1
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-156.200	1454.3	1.0
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-156.300	1071.1	0.7
Cass	AR392	1040.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-156.600	67.1	0.0
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.300	386.9	0.2
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.800	1096.9	0.5
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.810	0.0	0.0
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.910	103.4	0.1
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	State	MN-CA-C5-158.100	1343.0	0.9
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.400	634.3	0.5
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.500	338.2	0.2
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.600	1380.3	0.9
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.700	0.0	0.1
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-156.600	1377.7	0.9
Cass	AR393	1040.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CA-C5-158.900	223.8	0.4
Cass	AR393.2	1040.9	Field	New	No	TBD	Primary	State	MN-CA-C5-156.000	263.9	0.2
Cass	AR393.1	1041.0	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-156.000	2641.7	1.8
Cass	AR393.1	1041.0	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-157.000	178.8	0.1
Cass	AR394	1041.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.000	1875.2	1.3
Cass	AR394	1041.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.100	772.1	0.5
Cass	AR394	1041.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.200	483.6	0.4
Cass	AR394	1041.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.400	1809.8	1.2

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Cass	AR394	1041.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.500	564.5	0.4
Cass	AR394	1041.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.600	1664.6	1.1
Cass	AR394	1041.1	Field	New	No	TBD	Primary	Private	MN-CA-C5-156.600	139.4	0.1
Cass	AR394.2	1042.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.000	470.0	0.3
Cass	AR394.2	1042.1	Field	New	No	TBD	Primary	State	MN-CA-C5-157.000	0.0	0.0
Cass	AR394.1	1042.2	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-157.000	6903.7	4.7
Cass	AR394.1	1042.2	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-158.000	601.5	0.4
Cass	AR394.1	1042.2	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-158.200	1468.9	1.0
Cass	AR394.1	1042.2	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-161.000	480.0	0.3
Cass	AR394.1	1042.2	Gravel and Field	Existing	No	TBD	Shoofly	State	MN-CA-C5-157.000	0.0	0.0
Cass	AR394.6	1043.4	Field	New	No	TBD	Shoofly	State	MN-CA-C5-162.000	783.6	0.5
Cass	AR394.6	1043.4	Field	New	No	TBD	Shoofly	State	MN-CA-C5-161.000	873.2	0.6
Aitkin	AR397	1047.8	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-004.000	2245.4	1.5
Aitkin	AR397.1	1048.6	Field	New	No	TBD	Primary	Private	MN-AI-C5-006.000	1302.7	0.9
Aitkin	AR398	1048.8	Field	New	No	TBD	Primary	Private	MN-AI-C5-007.000	779.7	0.5
Aitkin	AR398	1048.8	Field	New	No	TBD	Primary	Private	MN-AI-C5-008.000	53.1	0.1
Aitkin	AR399	1049.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-AI-C5-008.000	582.1	0.4
Aitkin	AR400	1051.2	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-025.200	1457.9	1.0
Aitkin	AR400	1051.2	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-023.000	1235.3	0.8
Aitkin	AR401.1	1052.1	Field	New	No	TBD	Primary	Private	MN-AI-2C5-028.000	180.1	0.1
Aitkin	AR402	1052.3	Field	New	No	TBD	Primary	Private	MN-AI-2C5-029.000	626.2	0.4
Aitkin	AR403	1053.0	Field	New	No	TBD	Primary	State	MN-AI-2C5-032.000	1191.8	0.8
Aitkin	AR404	1054.4	Field	New	No	TBD	Primary	State	MN-AI-2C5-036.000	941.8	0.6
Aitkin	AR406	1055.0	Field	New	No	TBD	Primary	State	MN-AI-2C5-036.000	295.7	0.2
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	State	MN-AI-2C5-037.000	0.0	0.0
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	State	MN-AI-2C5-038.000	192.3	0.1
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-039.000	1515.6	1.0
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-041.300	1287.4	0.9
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-041.400	351.8	0.2
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	State	MN-AI-2C5-041.500	33.4	0.0
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	State	MN-AI-2C5-041.600	20.6	0.0
Aitkin	AR408	1056.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-041.200	812.1	0.6
Aitkin	AR408.1	1058.3	Field	New	No	TBD	Primary	Private	MN-AI-2C5-050.000	39.3	0.0
Aitkin	AR410	1058.7	Field	New	No	TBD	Primary	Private	MN-AI-2C5-053.000	1167.2	0.8
Aitkin	AR411	1061.5	Field	New	No	TBD	Primary	Private	MN-AI-2C5-069.000	754.0	0.5
Aitkin	AR412	1062.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-075.000	164.2	0.1
Aitkin	AR412	1062.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-075.300	1059.4	0.7
Aitkin	AR412.1	1064.2	Field	New	No	TBD	Primary	Private	MN-AI-2C5-084.000	495.2	0.3
Aitkin	AR412.2	1064.2	Field	New	No	TBD	Primary	Private	MN-AI-2C5-085.000	1089.6	0.8

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Aitkin	AR413	1064.6	Field	New	No	TBD	Primary	State	MN-AI-2C5-087.500	340.2	0.2
Aitkin	AR413	1064.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-087.000	1329.2	1.0
Aitkin	AR414	1064.7	Field	New	No	TBD	Primary	State	MN-AI-2C5-087.502	909.2	0.6
Aitkin	AR414	1064.7	Field	New	No	TBD	Primary	Private	MN-AI-2C5-087.000	263.2	0.2
Aitkin	AR414	1064.7	Field	New	No	TBD	Primary	Private	MN-AI-2C5-088.000	1784.6	1.2
Aitkin	AR414.2	1065.9	Field	New	No	TBD	Primary	Private	MN-AI-2C5-087.506	559.6	0.4
Aitkin	AR415	1067.1	Field	New	No	TBD	Primary	Private	MN-AI-2C5-102.000	1736.0	1.2
Aitkin	AR415	1067.1	Field	New	No	TBD	Primary	Private	MN-AI-2C5-102.000	0.0	0.0
Aitkin	AR415.1	1067.2	Gravel	Existing	No	TBD	Primary	Private	MN-AI-2C5-102.000	177.3	0.1
Aitkin	AR415.1	1067.2	Gravel	Existing	No	TBD	Primary	Private	MN-AI-2C5-102.000	0.0	0.0
Aitkin	AR416	1068.4	Field	New	No	TBD	Primary	Private	MN-AI-2C5-106.300	1279.2	0.9
Aitkin	AR417	1070.6	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-163.100	587.0	0.4
Aitkin	AR417	1070.6	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-163.200	621.2	0.4
Aitkin	AR417	1070.6	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-164.000	1259.5	0.9
Aitkin	AR417	1070.6	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-166.200	732.0	0.5
Aitkin	AR417	1070.6	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-167.200	1001.8	0.7
Aitkin	AR417	1070.6	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-168.200	602.4	0.4
Aitkin	AR417.01	1074.0	Field	New	No	TBD	Primary	Private	MN-AI-2C5-121.200	1373.7	0.9
Aitkin	AR417.1	1074.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-121.200.515	1284.0	0.9
Aitkin	AR418	1075.5	Field	New	No	TBD	Primary	Private	MN-AI-2C5-121.200.540	1900.5	1.4
Aitkin	AR418	1075.5	Field	New	No	TBD	Primary	Private	MN-AI-2C5-121.200.545	0.0	0.0
Aitkin	AR418	1075.5	Field	New	No	TBD	Primary	TBD	MN-AI-C5-121.200.550	1325.7	0.7
Aitkin	AR418	1075.5	Field	New	No	TBD	Primary	TBD	MN-AI-C5-121.200.555	277.2	0.4
Aitkin	AR419	1080.2	Field	New	No	TBD	Primary	Private	MN-AI-2C5-137.000	276.2	0.2
Aitkin	AR420	1082.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-2C5-147.000	2290.5	1.6
Aitkin	AR420	1082.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-2C5-146.000	804.1	0.6
Aitkin	AR421	1085.7	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-2C5-156.000	136.6	0.1
Aitkin	AR422	1086.2	Field	New	No	TBD	Primary	Private	MN-AI-2C5-159.000	0.0	0.0
Aitkin	AR422	1086.2	Field	New	No	TBD	Primary	Private	MN-AI-2C5-160.000	25.1	0.0
Aitkin	AR423	1086.6	Field	New	No	TBD	Primary	Private	MN-AI-2C5-161.000	28.4	0.0
Aitkin	AR424	1086.8	Field	New	No	TBD	Primary	Private	MN-AI-2C5-162.000	32.6	0.0
Aitkin	AR425	1087.0	Field	New	No	TBD	Primary	Private	MN-AI-2C5-162.000	20.7	0.0
Aitkin	AR425	1087.0	Field	New	No	TBD	Primary	State	MN-AI-2C5-163.000	2.2	0.0
Aitkin	AR426	1087.3	Field	New	No	TBD	Primary	State	MN-AI-2C5-163.000	24.5	0.0
Aitkin	AR427	1090.3	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-290.000	1127.7	0.5
Aitkin	AR427	1090.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-290.100	1340.2	0.6

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Aitkin	AR427	1090.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-290.200	22.2	0.0
Aitkin	AR427	1090.3	Gravel	Existing	Yes	TBD	Primary	County	MN-AI-C5-294.000	0.0	0.3
Aitkin	AR427	1090.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-294.100	0.0	0.3
Aitkin	AR427	1090.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-294.200	0.0	0.0
Aitkin	AR428	1091.4	Field	New	No	TBD	Primary	Private	MN-AI-C5-300.000	0.0	0.1
Aitkin	AR428	1091.4	Field	New	No	TBD	Primary	Private	MN-AI-C5-298.300	986.7	0.6
Aitkin	AR429	1092.8	Field	New	No	TBD	Primary	Private	MN-AI-C5-306.300	735.3	0.5
Aitkin	AR429	1092.8	Field	New	No	TBD	Primary	Private	MN-AI-C5-307.300	664.2	0.5
Aitkin	AR429	1092.8	Field	New	No	TBD	Primary	Private	MN-AI-C5-306.000	4.2	0.0
Aitkin	AR431	1093.7	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-310.000	335.3	0.2
Aitkin	AR431	1093.7	Gravel	Existing	Yes	TBD	Primary	Private	MN-AI-C5-310.300	277.1	0.2
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	County	MN-AI-C5-321.300	3272.9	2.3
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	State	MN-AI-C5-321.400	7806.6	5.4
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	State	MN-AI-C5-321.600	3597.3	2.5
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	State	MN-AI-C5-321.500	4234.9	2.9
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	Private	MN-AI-C5-321.800	0.0	0.0
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	State	MN-AI-C5-321.601	13.8	0.0
Aitkin	AR431.41	1097.4	Gravel and Field	New	No	TBD	Primary	State	MN-AI-C5-321.801	0.0	0.0
Carlton	AR431.6	1099.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.700	655.5	0.5
Carlton	AR431.6	1099.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.800	351.9	0.2
Carlton	AR431.6	1099.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.700	488.3	0.3
Carlton	AR431.6	1099.9	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.800	1164.9	0.8
Carlton	AR431.61	1100.0	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.700	915.3	0.6
Carlton	AR431.61	1100.0	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.800	124.5	0.1
Carlton	AR431.61	1100.0	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.700	488.3	0.3
Carlton	AR431.61	1100.0	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C6-006.800	1166.4	0.8
Carlton	AR433.1	1102.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C6-011.100	109.3	0.1
Carlton	AR433.1	1102.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C6-011.200	0.0	0.0
Carlton	AR433.2	1102.3	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C5-001.510.300	863.5	0.6
Carlton	AR434	1103.0	Gravel	Existing	Yes	TBD	Primary	County	MN-CR-C5-001.514	5.7	0.0
Carlton	AR434	1103.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-015.300	0.0	0.0
Carlton	AR434	1103.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-016.300	1539.3	1.1
Carlton	AR434	1103.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-001.512	1317.2	0.9
Carlton	AR434	1103.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-014.310	1385.1	1.0
Carlton	AR434	1103.0	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-017.300	1118.2	0.8
Carlton	AR434.1	1103.6	Gravel	Existing	Yes	TBD	Shoofly	State	MN-CR-C5-019.300	800.4	0.6
Carlton	AR434.1	1103.6	Gravel	Existing	Yes	TBD	Shoofly	Private	MN-CR-C5-017.300	449.0	0.3
Carlton	AR434.1	1103.6	Gravel	Existing	Yes	TBD	Shoofly	Private	MN-CR-C5-018.300	1590.4	1.1
Carlton	AR434.1	1103.6	Gravel	Existing	Yes	TBD	Shoofly	County	MN-CR-C5-019.000	80.6	0.1

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Carlton	AR435	1105.7	Field	New	No	TBD	Primary	County	MN-CR-C5-026.000	1064.7	0.7
Carlton	AR435	1105.7	Field	New	No	TBD	Primary	Private	90-010-5650	0.9	0.0
Carlton	AR436.05	1107.1	Gravel and Field	New and Existing	Partial	TBD	Primary	State	MN-CR-C5-037.000	381.1	0.3
Carlton	AR436.05	1107.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C5-038.000	666.4	0.5
Carlton	AR436.05	1107.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C5-039.000	33.2	0.0
Carlton	AR436.1	1108.8	Field	New	No	TBD	Primary	Private	MN-CR-C5-047.000	268.6	0.2
Carlton	AR436.1	1108.8	Field	New	No	TBD	Primary	Private	MN-CR-C5-046.000	61.0	0.0
Carlton	AR436.1	1108.8	Field	New	No	TBD	Primary	Private	MN-CR-C5-047.200	1404.7	1.0
Carlton	AR436.2	1109.4	Field	New	No	TBD	Primary	County	MN-CR-C5-049.000	0.0	0.0
Carlton	AR436.2	1109.4	Field	New	No	TBD	Primary	Private	MN-CR-C5-049.200	1009.3	0.7
Carlton	AR436.2	1109.4	Field	New	No	TBD	Primary	Private	MN-CR-C5-049.210	917.5	0.6
Carlton	AR436.2	1109.4	Field	New	No	TBD	Primary	County	MN-CR-C5-050.000	25.7	0.0
Carlton	AR436.2	1109.4	Field	New	No	TBD	Primary	State	MN-CR-C5-050.200	28.0	0.0
Carlton	AR438	1110.5	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-054.000	0.0	0.2
Carlton	AR438	1110.5	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-056.000	1242.7	0.6
Carlton	AR439	1113.0	Field	New	No	TBD	Primary	Private	MN-CR-C5-068.000	973.2	0.5
Carlton	AR439	1113.0	Field	New	No	TBD	Primary	Private	MN-CR-C5-069.000	0.0	0.2
Carlton	AR440	1113.5	Field	New	No	TBD	Primary	Private	MN-CR-C5-071.000	959.2	0.7
Carlton	AR441	1114.2	Field	New	No	TBD	Primary	Private	MN-CR-C5-075.000	944.1	0.6
Carlton	AR441	1114.2	Field	New	No	TBD	Primary	Private	MN-CR-C5-075.000	0.1	0.0
Carlton	AR441.1	1114.2	Field	New	No	TBD	Primary	Private	MN-CR-C5-075.000	478.3	0.3
Carlton	AR441.1	1114.2	Field	New	No	TBD	Primary	Private	MN-CR-C5-075.000	0.1	0.0
Carlton	AR441.2	1114.7	Field	New	No	TBD	Primary	Private	MN-CR-C5-077.000	976.2	0.7
Carlton	AR443	1116.3	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-088.000	938.5	0.6
Carlton	AR444	1116.8	Field	New	No	TBD	Primary	Private	MN-CR-C5-089.000	171.3	0.1
Carlton	AR444	1116.8	Field	New	No	TBD	Primary	Private	MN-CR-C5-090.000	1483.3	1.0
Carlton	AR445	1117.4	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-C5-092.000	1362.6	0.9
Carlton	AR446	1118.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-098.200	426.3	0.3
Carlton	AR446	1118.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-098.000	664.1	0.3
Carlton	AR446	1118.8	Gravel	Existing	Yes	TBD	Primary	Private	MN-CR-C5-099.000	16.0	0.2
Carlton	AR447	1122.6	Field	New	No	TBD	Primary	Private	MN-CR-R51-012.300	1489.7	1.0
Carlton	AR447	1122.6	Field	New	No	TBD	Primary	Private	MN-CR-R51-012.000	981.6	0.7
Carlton	AR449.2	1123.8	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-CR-R51-010.603.300	351.5	0.2
Carlton	AR449.2	1123.8	Gravel and Field	New and Existing	No	TBD	Primary	Private	MN-CR-R51-010.603.400	216.5	0.1
Carlton	AR450	1125.5	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-R51-010.615	260.9	0.2
Carlton	AR450	1125.5	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-R51-010.613.300	1063.6	0.7

Line 3 Replacement Project
Access Roads Table

County	Access Road ID	MP	Surface Type	Road Status	Permanent	Improvements	Road Class	Ownership	Tract Number	Length (feet)	Acres
Carlton	AR450	1125.5	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-R51-010.613.400	1819.2	1.3
Carlton	AR452.1	1128.4	Field	New	No	TBD	Primary	Private	MN-CR-C5-161.200	1927.2	1.3
Carlton	AR452.1	1128.4	Field	New	No	TBD	Primary	Private	MN-CR-R51-010.633	972.7	0.7
Carlton	AR453	1129.1	Field	New	No	TBD	Primary	Private	MN-CR-C5-167.000	654.8	0.4
Carlton	AR453	1129.1	Field	New	No	TBD	Primary	Private	MN-CR-C5-167.300	437.1	0.4
Carlton	AR453	1129.1	Field	New	No	TBD	Primary	Private	MN-CR-C5-168.000	1140.1	0.7
Carlton	AR453	1129.1	Field	New	No	TBD	Primary	Other Utility	MN-CR-C5-169.000	0.0	0.1
Carlton	AR453.1	1138.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-159.000	346.7	0.2
Carlton	AR453.1	1138.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Private	MN-CR-159.200	17.3	0.0
Carlton	AR453.1	1138.1	Gravel and Field	New and Existing	Partial	TBD	Primary	Enbridge	MN-CR-158.000	628.3	0.4
Carlton	AR453.2	1138.9	Gravel	Existing	Yes	TBD	Primary	Enbridge	MN-CR-162.000	490.3	0.3
Carlton	AR454	1139.3	Gravel	Existing	Yes	TBD	Primary	RR	MN-CR-164.900RR	531.4	0.4
Cass	AR394.1	TBD	TBD	TBD	TBD	TBD	Shoofly	TBD	TBD	0.0	1.0
Hubbard	AR325.020	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.0
Aitkin	AR398	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.0
Aitkin	AR417	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.0
Polk	AR1043	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.0
Red Lake	AR1039	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.0
Pennington	AR1032	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.1
Cass	AR388	TBD	TBD	TBD	TBD	TBD	Primary	TBD	TBD	0.0	0.5

Appendix E

Enbridge Environmental Protection Plan

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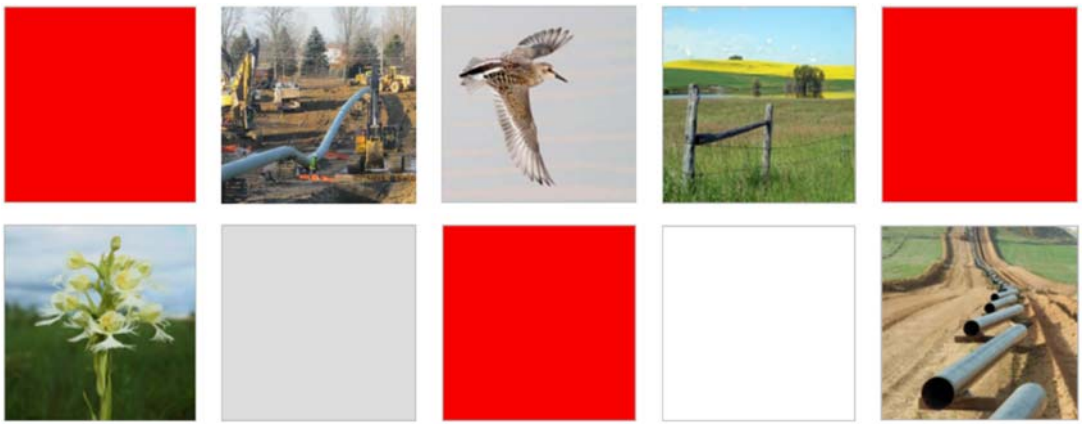
Appendix F
Environmental Protection Plan

This EPP updates the EPP submitted as Appendix E of the Enbridge Energy, Limited Partnership's Application for a Pipeline Routing Permit on April 24, 2015.



Enbridge

ENVIRONMENTAL PROTECTION PLAN

September 2015

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INTRODUCTION

This Environmental Protection Plan ("EPP") outlines construction-related environmental policies, procedures, and protection measures Enbridge developed as a baseline for construction. This EPP was developed based on Enbridge's experience implementing Best Management Practices ("BMPs") during construction as well as the Federal Energy Regulatory Commission's ("FERC's") Upland Erosion Control, Revegetation, and Maintenance Plan (May 2013 Version) and Wetland and Waterbody Construction and Mitigation Procedures (May 2013 Version). It is intended to meet or exceed federal, state, tribal, and local environmental protection and erosion control requirements, specifications and practices. The EPP is designed to address typical circumstances that may be encountered along the Project. Project-specific permit conditions and/or landowner agreements may supersede the general practices described in this document.

This document includes the following sections:

- Section 1.0 describes general mitigation measures, including soil erosion and sedimentation control procedures, to be implemented during upland construction and upland restoration;
- Section 2.0 describes stream and river construction, crossing, and restoration;
- Section 3.0 describes practices for wetland construction, crossings, and restoration;
- Section 4.0 describes highway, road, and rail crossings;
- Section 5.0 describes construction dewatering;
- Section 6.0 outlines water appropriation practices;
- Section 7.0 addresses revegetation measures;
- Section 8.0 addresses winter construction issues;
- Section 9.0 addresses waste management issues;
- Section 10.0 addresses construction equipment-related spill prevention, containment and controls; and
- Section 11.0 addresses containment, response, and notification procedures for inadvertent releases of drilling fluid.

Alternative construction procedures implemented in lieu of this EPP will provide an equal or greater level of protection to the environment, and will be approved in writing by Enbridge.

Unless otherwise specified, the construction Contractor ("Contractor") is responsible for implementing the requirements of this EPP.

Enbridge will provide appropriate construction oversight to confirm and document compliance with the measures of this EPP and requirements of applicable federal, state, tribal, and local permits. Enbridge's Environmental Inspectors ("EIs") will assist the Contractor in interpreting and implementing the requirements of the EPP, and verify compliance with these procedures for Enbridge. Enbridge will employ experienced EIs to manage unforeseen situations that are not directly addressed by project documents. Enbridge relies on the experience and judgment of the EIs, through coordination and consultations with project management staff, to address unforeseen situations should they occur in the field. The EIs will be expected to use judgment in the field to

interpret environmental conditions and requirements, but will not be authorized to make major modifications or changes without the prior written approval of Enbridge. The EI, in consultation with Enbridge Environment staff, will have the authority to stop activities and order corrective mitigation for actions that are not in compliance with the measures in this EPP, landowner agreements, or environmental permit requirements. The EI will maintain appropriate records to document compliance with these and other applicable environmental permit conditions.

Enbridge has also committed to applicable agencies to fund a comprehensive third-party monitoring program to be deployed during Project construction. Enbridge has constructed numerous projects with the oversight of third-party monitors and accepts the recommendation by state agencies regarding their use. Enbridge will work with the agencies to define the role and qualifications of proposed third-party monitors to ensure they are experienced in the type of construction they will be observing and knowledgeable regarding the resources that may be impacted.

1.0 GENERAL MITIGATION MEASURES

1.1 IDENTIFICATION OF AVOIDANCE AREAS

The EI will post signs for environmental features such as wetlands, waterbodies, drainages/drain tiles, buffer zones, rare plant or ecological community sites, invasive species and noxious weed locations, regulated wildlife habitat, cultural resources, and erosion-prone or steep slopes.

1.2 CONSTRUCTION LINE LIST AND PERMITS

Enbridge will provide the Contractor with a Construction Line List ("CLL") that describes special requirements (e.g., timber salvage, topsoil segregation, restoration measures, fencing requirements, etc.) as agreed upon with landowners provided the special requirements conform to project permits. The Contractor will comply with these special requirements and/or permit conditions.

The CLL identifies requirements and comments provided by landowners; however it is not a comprehensive list of construction requirements. The CLL will be considered in conjunction with other project documents and permits.

1.3 WET WEATHER SHUTDOWN

During construction, certain activities may be suspended in wet soil conditions, based on consideration of the following factors:

- extent of surface ponding;
- extent and depth of rutting and mixing of soil horizons;
- areal extent and location of potential rutting and compaction (i.e., can traffic be rerouted around wet area); and
- type of equipment and nature of the construction operations proposed for that day.

The Contractor will cease work in the applicable area until Enbridge determines that site conditions are such that work may continue. The EIs, in collaboration with Enbridge construction management, will ultimately decide if wet weather shutdown is necessary in a given location.

1.4 RIGHT-OF-WAY ACCESS

Access to the right-of-way ("ROW") will be from public roadways and Enbridge-approved private access roads only. Enbridge is responsible for posting signs or other methods to identify approved access roads in the field and to ensure that access is confined to only the approved roads. Vehicle tracking of soil from the construction site will be minimized by installation and implementation of best management practices ("BMPs") such as stone pads, timber mats, reducing equipment/vehicle access to the construction ROW where practicable (off-ROW parking), or equivalent. Installation of stone or timber mat access pads will be in accordance with applicable permits and state/federal specifications. If such BMPs are not adequately preventing sediment from being tracked onto public roads, street sweeping, or other equivalent means of collecting sediment, will be used. If soil is tracked onto a roadway, the contractor will remove accumulated material from the road and return it to the construction ROW within an upland area as soon as possible, but in no circumstances more than 24 hours after discovery. In addition, soil on roadways cannot be broomed, washed, and/or graded into the road ditch or onto the shoulder.

1.5 RIGHT-OF-WAY REQUIREMENTS

All construction equipment and vehicles will be confined to the approved construction ROW and additional temporary workspace. Prior to commencement of clearing operations, the outer limits of the construction ROW and additional temporary workspace areas will be marked with distinctive stakes and flagging by Enbridge. Construction activities are restricted to the approved designated areas.

The construction ROW (i.e., construction workspace) for the Project will vary and may include a portion of Enbridge's existing corridor, new permanent corridor, permitted temporary workspace, and site-specific extra workspaces as defined below and shown in Figures 1 through 3. The construction ROW width will be reduced in selected locations (e.g., wetlands, waterbodies, and forested shelterbelts), in accordance with applicable permit conditions, as indicated on the Project construction alignment sheets and in the field by the use of staking.

(a) ROW (Permanent)

Enbridge's existing permanent ROW varies in width. Additional footage may be added, depending on the location of the new pipeline(s) in relation to the existing pipelines. The permanent ROW is maintained to facilitate access and aerial inspection of the pipeline system.

(b) Temporary Workspace

In addition to the ROW/permanent corridor, construction will require Temporary Workspaces ("TWS"). The TWS will be located adjacent to and contiguous with the proposed ROW/permanent corridor and will be identified on the construction alignment sheets and by distinctive staking of construction limits prior to clearing.

(c) Additional Temporary Workspace

Site-specific additional temporary workspace ("ATWS") locations, (construction work areas beyond the permanent corridor and TWS previously described), will be required at select locations such as steep slopes, road, waterbody, railroad, some wetland crossings, and where it is necessary to cross under the existing pipelines or foreign utilities. ATWS will typically be located in uplands adjacent to the construction ROW and set at least 50-feet back from sensitive resource boundaries where site-specific field conditions allow. However, to complete work safely, Enbridge may need to locate ATWS within a wetland or within the 50-foot setback from a wetland or waterbody based on site-specific conditions. ATWS adjacent to waterbodies and/or wetlands is addressed further in Sections 2.0 and 3.0, respectively.

1.6 CONTROLLING SPREAD OF UNDESIRABLE SPECIES

It is Enbridge's intent to minimize the potential introduction and/or spread of undesirable species (i.e., invasive species, noxious weeds, or crop diseases) along the construction ROW due to pipeline construction activities. However, it is not practicable for Enbridge to eradicate undesirable species that are adjacent to the construction ROW. Enbridge will minimize the potential for the establishment of undesirable species by minimizing the time duration between final grading and permanent seeding.

In consultation with the applicable agencies, Enbridge will identify plant species that are considered noxious weeds and/or invasive plants that may occur within the counties being crossed by the pipeline corridor (refer to Appendix A).

1.6.1 Prevention and Control Measures

To prevent the introduction of identified noxious weeds and invasive species into the Project areas from other construction sites, construction equipment will be cleaned prior to arriving on site. This cleaning consists of removing visible dirt from the equipment and blowing loose material from equipment using compressed air. Equipment designated for use within waterbodies will be washed and dried prior to use. Purge and clean all pumps before proceeding from one location to the next if designated noxious weeds or invasive species (e.g. zebra mussels, Eurasian milfoil, etc.) are known to be present in the area. The Contractor(s) will keep logs documenting the cleaning history of each piece of equipment and make the logs available to the EI upon request. Contractors may use the equipment cleaning log provided in Appendix A or an equivalent form approved by Enbridge. Equipment found to be in non-compliance with the cleaning requirement will not be allowed on the Project sites until it has been adequately cleaned.

Prior to clearing and grading of the construction right-of-way and pending landowner permission, major infestation areas identified during surveys or by Enbridge's EIs may be treated with the recommended herbicides or their equivalents as identified through consultation with local authorities. All proposed herbicides will be reviewed and approved by Enbridge's Environment Department prior to use. Alternatively, full construction ROW topsoil segregation may be implemented for weed control to allow equipment to work through the area after topsoil has been stripped, as long as equipment stays on the subsoil (clearing, grading, and restoration equipment will still be cleaned). The Contractor(s) will obtain necessary permits and/or certifications for the use of the applicable herbicides, is responsible to limit off-ROW overspray, and will comply with state laws regarding the use of those herbicides. Contractor(s) will keep proper documentation of the locations where the herbicides have been used and provide such documentation to Enbridge within 3 days of completing the work. Weed control spraying will be restricted near certified organic farms and prohibited on certified organic farms.

Treatment of known infestation areas will be completed in accordance with applicable chemical contact times (as specified by the manufacturer) in advance of clearing and grading within the construction ROW. Treatment may be restricted in areas that are not readily accessible, such as areas where access is limited by topography or other site conditions such as saturated/inundated soils. In the event that an area is determined to be inaccessible, the EI will be notified and a site-specific alternative treatment method will be developed.

If additional noxious weed infestations are identified subsequent to herbicide applications, mechanical means (scrape down/blow down) may be used to remove weeds from tracked equipment prior to leaving the infested area. High pressure water wash stations may be established in select areas if the above measures do not adequately remove soil and vegetation debris from construction equipment. Enbridge will determine where this practice will be implemented. The Contractor(s) will keep logs documenting the cleaning history of each piece of equipment and make the logs available to the EI or other Enbridge Representative upon request. Any equipment found to be in noncompliance with the cleaning requirement will be removed from the Project sites until it has been adequately cleaned.

To prevent the spread of noxious weeds and invasive species during construction, mulch used on the Project will be composed of weed-free material. Certified weed-free mulch may also be

required at site-specific locations. The Contractor(s) will be responsible for identifying and acquiring sources of weed-free and certified weed-free mulch. Sources will be approved by Enbridge prior to purchase.

1.7 POTHOLING/HYDROVAC SLURRY

Hydrovac excavation is used to positively identify pipelines and other buried utilities. The Contractor will construct an unlined but bermed containment area or identify comparable containment (e.g., open top tank) to hold the hydrovac slurry in an Enbridge and landowner-approved upland area within the construction workspace or dispose of the material off-site at a licensed disposal facility. Once the slurry is drained and dry, it may be incorporated with the subsoil in an Enbridge and landowner-approved upland area within the construction workspace. Discharging hydrovac slurry on to topsoil is not permitted as the material will degrade the quality of the topsoil and potentially affect revegetation.

1.8 UPLAND CLEARING

The initial stage of construction involves the clearing of brush, trees, and tall herbaceous vegetation from the ROW. Clearing may be accomplished with chain saws, mowers, and hydraulic tree-cutting equipment.

1.8.1 Disposal of Non-Merchantable Timber

Unless otherwise directed by Enbridge, non-merchantable timber and slash will be disposed of by mowing, chipping, grinding, and/or hauling off site to an approved disposal facility or used in stabilizing erodible slopes or construction entrances. In non-agricultural, non-wetland areas, chips, mulch, or mechanically cut woody debris may be uniformly broadcast across the ROW where the material would ultimately be incorporated into the topsoil layer during grading activities, with landowner approval (coordinated through Enbridge ROW agents). Burning of non-merchantable wood may be allowed only where the Contractor has acquired all applicable permits and approvals (e.g. agency, tribal, and landowner) and in accordance with all tribal, state, and local regulations. The Contractor will provide Enbridge with copies of these permits and/or approvals prior to initiating burning.

1.8.2 Disposal of Merchantable Timber

All merchantable timber will be managed in accordance with Enbridge contract specifications.

1.8.3 Upland Grading and Stump Removal

To facilitate proper cleanup and restoration in upland areas, tree stumps outside the ditch line will be ground below normal ground surface or completely removed and hauled off to an approved disposal facility. Stumps in the ditch line will be completely removed, ground, and/or hauled off to an approved disposal facility.

1.9 TEMPORARY EROSION AND SEDIMENT CONTROLS

Temporary erosion and sediment controls (“ECDs”) include, but are not limited to, slope breakers, sediment barriers (i.e. silt fence, straw bales, bio-logs, etc.), stormwater diversions, trench breakers, mulch, and revegetation subsequent to seeding of exposed soils (refer to Figures 4 through 11). The Contractor will maintain erosion and sediment control structures as required in the Project construction documents and as required by all applicable permits. Non-functional erosion and sediment controls will be repaired, replaced, or supplemented with functional materials within 24 hours after discovery, or as otherwise specified in project permits. ECDs will

be installed after initial clearing but before grading activities, and will be replaced by permanent erosion controls as restoration is completed.

Temporary ECDs will be installed after clearing and prior to grubbing and grading activities at the base of sloped approaches to streams, wetlands, and roads. Temporary ECDs will also be installed at the edge of the construction ROW as needed, and/or in other areas determined by the EI to slow water leaving the site and prevent siltation of waterbodies and wetlands down slope or outside of the construction ROW (e.g., swales and side slopes). Temporary ECDs will be placed across the entire construction ROW at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from tile line inlets, drainage ways, wetlands, and/or waterbodies until the area is revegetated and there is no potential scouring or sediment transport to surface waters. Adequate room will be available between the base of the slope and the sediment barrier to accommodate ponding of water and sediment deposition.

If silt fence is used, when the depth of sediment reaches about one-third of the height, the sediment will be removed. Non-functional ECDs will be repaired, replaced, or supplemented with functional structures within 24 hours after discovery, or as otherwise specified in project permits.

Temporary ECDs installed across the travel lane may be removed during active daytime construction; however, ECDs will be properly reinstalled after equipment passage, or activities in the area are completed for the day. These ECDs will also be repaired and/or replaced prior to inclement weather when forecasted.

1.9.1 Temporary Stabilization

Installation of temporary seeding, mulch (straw or hydromulch), and erosion control mats may be required by Enbridge in certain locations (including topsoil piles) if there are construction delays within a spread of at least 14 days. The Contractor may be required by Enbridge to install temporary stabilization materials sooner based on site conditions, or as required in project permits.

1.9.2 Erosion Control Blanket

The appropriate class of erosion control blanket will be installed in accordance with manufacture recommendations and/or state Department of Transportation (“DOT”) specifications on slopes greater than 5 percent that would be exposed over the winter and drain to surface waters (refer to Figures 8 and 9). The Contractor will attempt to install erosion control blankets on the exposed slopes prior to snowfall; however, construction progress and/or seasonal weather variations may prevent installation prior to the first snowfall. Installation of erosion control blankets and additional BMPs, as applicable based on site conditions, is required after the first snowfall to protect slopes prior to spring melt and runoff. Erosion control blankets will be installed running parallel (up and down) with the direction of the slope (not perpendicular).

1.9.3 Mulch

Mulch (weed-free straw, wood fiber hydromulch, or a functional equivalent) will be applied to disturbed areas (except for actively cultivated land and wetlands) if requested by the landowner or land managing agency, if specified by the applicable permits or licenses, or as required by Enbridge. Mulch will specifically be required on:

- Slopes greater than 5 percent; and
- Dry, sandy areas that can blow or wash away (field decision).

Mulch will be free of noxious weeds as listed in applicable state laws. Certified weed-free mulch may also be required at site-specific locations. The Contractor will be responsible for identifying and acquiring sources of weed-free and certified weed-free mulch. Sources will be approved by Enbridge prior to purchase.

Mulch will be applied at a rate of 2 tons per acre to cover at least 75 percent of the ground surface unless otherwise stipulated by permit conditions. Mulch will be uniformly distributed by a mechanical mulch blower, or by hand in areas not accessible to the mulch blower. Mulch will be anchored/crimped using a mulch-anchoring tool or disc set in the straight position to minimize loss by wind and water, as site conditions allow. In areas not accessible to a mulch-anchoring tool or too steep for safe operation, the mulch may be anchored by liquid tackifiers, with advance written approval from Enbridge. The manufacturer's recommended method and rate of application will be followed.

Hydro-mulch and liquid tackifier can be used in place of straw or weed-free hay mulch with prior approval from Enbridge. All hydromulch and liquid tackifier products used will be on the applicable state DOT product list. Application rates will be at the manufacturer's recommended rate, equal to or greater than 2 tons per acre of straw mulch.

1.9.4 Cat Tracking

Cat tracking, also known as horizontal slope grading, may be implemented based on site conditions (sandy or silt soils) to reduce erosion potential. Cat tracking is achieved by driving a bulldozer vertically up and down the slope which results in the tracks being oriented horizontally; creating small speed bumps for water (refer to Figure 11).

1.9.5 Temporary Slope Breakers

Temporary slope breakers will be installed to minimize concentrated or sheet flow runoff in disturbed areas in accordance with the following maximum allowable spacing unless otherwise specified in permit conditions.

Slope (%)	Approximate Spacing (ft)
3-5	250
5-15	200
15-25	150
>25	<100

If the length of the slope is less than the distance of the required spacing, slope breakers are not required unless a sensitive resource area (e.g., wetland or public roadway) is located immediately down slope, or as requested by the EI. Temporary slope breakers may be constructed using earthen subsoil material, silt fence, straw bales, or in non-agricultural land, rocked trenches may be used. On highly erodible slopes, slope breakers in the form of earthen berms will be used whenever possible.

Temporary slope breakers will be constructed according to the following specifications (refer to Figures 4 and 5):

- straw bales used as slope breakers will be trenched in and staked so as to not allow spacing between bales or allow flow underneath the bales;

- the outfall of temporary slope breakers will be directed off the construction ROW into a stable well-vegetated upland area or into an appropriate energy-dissipating sediment control device (e.g., silt fence, straw bales, rock aprons) to prevent the discharge of sediments (refer to Figure 4);

- proper slope breaker outfalls will be established where topsoil segregation and/or grading has created a barrier at the edge of the construction workspace; and

- gaps will be created through spoil piles where necessary to allow proper out letting of temporary berms.

1.10 UPLAND TOPSOIL SEGREGATION

Upland areas where topsoil will be stripped includes cropland, hay fields, pasture, residential areas, and other areas as requested by the landowner or as specified in the project plans, commitments, and/or permits. Topsoil will not be used to construct berms, trench breakers, temporary slope breakers, improving or maintaining roads, or to pad the pipe. Berms used for stacking pipe in pipe yards may be constructed using topsoil if landowner permission and necessary approvals are obtained. Gaps will be left and ECDs installed where stockpiled topsoil and spoil piles intersect with water conveyances (i.e., ditches, swales, and waterways) to maintain natural drainage.

Topsoil Segregation Methods

The following topsoil segregation methods may be employed during construction:

- Full Construction ROW (refer to Figure 1)

- Trench-Line-Only (refer to Figure 2)

- Modified Ditch-Plus-Spoil Side (refer to Figure 3)

The Full Construction ROW topsoil segregation technique will typically be used in active cropland, which will consist of stripping topsoil from the spoil storage area, ditch line, and the primary travel lane. The Trench-Line-Only topsoil segregation method may be used where Enbridge determines that the width of the construction ROW is insufficient for other methods to be used. Enbridge may also use the Trench-Line-Only topsoil segregation method in areas where there is a thick sod layer such as in hay fields, pastures, golf courses, and residential areas, unless otherwise requested by the landowner. Alternative topsoil segregation methods, such as Modified Ditch-Plus-Spoil Side, may be used on a site-specific basis or as requested by the landowner. Topsoil is not typically segregated in standing water wetlands unless specifically requested by the landowner and/or managing land agency in accordance with applicable permit conditions.

Depth of Upland Topsoil Stripping

In deep soils (more than 12 inches of topsoil), topsoil will be stripped to a minimum depth of 12 inches, unless otherwise specified/requested by other plans, permit conditions, or the landowner. Additional space may be needed for spoil storage if more than 12 inches of topsoil are segregated. If less than 12 inches of topsoil are present, the Contractor will attempt to segregate to the depth that is present.

1.11 UPLAND TRENCHING

Trenching in uplands is typically accomplished with a backhoe excavator or a rotary wheel ditching machine. Excavated material will be side cast (stockpiled) within the approved construction ROW separate from topsoil, and stored such that the area subject to erosion is minimized. Enbridge will coordinate with landowners to minimize disruption of access caused by the trench during construction. Where deemed appropriate by Enbridge, the Contractor will leave plugs of subsoil in the ditch or will construct temporary access bridges across the trench for the landowner to move livestock or equipment. Trenches may also be sloped where started and ended to allow ramps for wildlife to escape. Spacing of plugs and ramps will be determined in the field.

1.11.1 Timing

The length of time a trench is left open will be minimized to ensure that installation of the pipe and restoration of the construction ROW occurs in a timely fashion. Therefore, unless otherwise specified by project permits or Enbridge, the Contractor will limit the amount of excavated open trench to a maximum of 3 days of anticipated welding production per spread, per pipe. This timeframe may be decreased at the discretion of Enbridge based on site conditions. Site-specific activities such as horizontal directional drilling, guided bores, road bores, tie-in points, and valve work may be performed independent of a spread.

1.12 FOAM PILLOW INSTALLATION

Use of foam pillows for pipe protection in the trench will be approved by Enbridge in advance and installed in accordance with applicable project permits, local/state/federal regulations, and manufacturer's recommendations.

1.13 TRENCH BREAKERS

Trench breakers will be installed as deemed necessary by Enbridge in sloped areas after the pipe has been lowered into the trench. Trench breakers protect against subsurface water flow along the pipe after the trench is backfilled. Trench breakers will be constructed with bags filled with rock-free subsoil or sand. Use of foam trench breakers will be approved by Enbridge in advance and installed in accordance with applicable project permits, local/state/federal regulations, and manufacturer's recommendations. Trench breakers will be placed from the bottom of the trench to near the top of the trench, completely surrounding the pipe and will be properly keyed into the undisturbed trench walls (refer to Figures 12 and 13). The location for trench breakers will be based on field conditions including the degree and length of slope, presence of down slope sensitive resource areas such as wetland and waterbodies, and proximity to other features such as roads and/or railroads. The following conditions apply to the placement and installation of trench breakers unless otherwise directed by Enbridge:

- Trench breakers will be installed on slopes greater than 5 percent adjacent to streams, wetlands, or other waterbodies.
- Topsoil cannot be used to construct trench breakers.
- Where the pipeline exits a wetland towards areas of lower relief, trench breakers will be installed (within the upland) where there is a potential for underground drainage along the pipe in order to prevent wetland or waterbody drainage.

- At all waterbody crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep accumulated trench water out of the waterbody.

The actual location of each trench breaker will be selected through coordination between Enbridge's EIs, Enbridge's Craft Inspectors, and the Contractor's Foreman for backfilling activities.

1.14 DRAIN TILE INLET PROTECTION AND TILE REPAIRS

Enbridge will attempt to locate existing drain tile inlets that are located near the construction work area prior to construction. Drain tile inlets will be marked using flags. The Contractor will protect located drain tile inlets with the potential to receive stormwater from construction of the Project using the appropriate ECDs until sources with the potential to discharge have been stabilized. The determination of the specific ECD will be made based on the location of an inlet with respect to the project area, drainage area from the construction work area to the inlet, topography, vegetation, soils, and accessibility to the inlet. Where drain tile inlets are located off of Enbridge's construction ROW, Enbridge may not have authorization to install ECDs at the inlet site. In these cases, sediment control measures (typically silt fence) will be installed along the edge of the construction work area that drains to the inlet structure to minimize sedimentation.

If underground drainage tile is damaged by pipeline construction, it will be repaired in a manner that assures proper tile line operation at the point of repair in accordance with the Agricultural Protection Plan.

1.15 UPLAND BACKFILLING

Backfilling follows pipe installation and consists of replacing the material excavated from the trench. In areas where topsoil has been segregated, the subsoil will be replaced first, and the topsoil will be spread uniformly over the area from which it was removed. Prior to backfilling, the trench will be dewatered in accordance with the methods discussed in Section 5.0 if water obscures the trench bottom.

1.16 CLEANUP AND ROUGH/FINAL GRADING

All waste materials, including litter generated by construction crews, will be disposed of daily by the Contractor. Initial cleanup and rough grading activities may take place simultaneously. Cleanup involves removing construction debris (including litter generated by construction crews and excess rock) and large woody debris. Rough and final grading includes restoring disturbed areas as near as practicable to preconstruction conditions, returning the topsoil where topsoil has been stripped, preparing a seedbed and de-compacting subsoil (where applicable) for permanent seeding, installing or repairing temporary erosion control measures, repairing/replacing fences, and installing permanent erosion controls.

1.16.1 Timing

The Contractor will begin cleanup and rough grading (including installation of temporary erosion and sediment control measures) within 72 hours after backfilling the trench. The Contractor will attempt to complete this rough cleanup within one week. The Contractor will initiate final grading, topsoil replacement, seeding, and installation of permanent erosion control structures within 14 days after backfilling the trench. If seasonal or other weather conditions prevent compliance with these timeframes, temporary erosion controls will be maintained until conditions allow completion of cleanup.

1.17 PERMANENT EROSION AND SEDIMENT CONTROLS

During final grading, slopes in areas other than cropland will be stabilized with erosion control structures. With exception for actively cultivated areas, permanent berms (diversion dikes or slope breakers) will be installed on all slopes, according to the following maximum spacing requirements unless otherwise specified in permit conditions:

Slope (%)	Approximate Spacing (ft)
3-5	250
5-15	200
15-25	150
>25	<100

Permanent berms will be constructed according to the following specifications:

- Permanent berms will be constructed of compacted earth, stone, or functional equivalent as approved in advance by Enbridge.
- The outfall of berms will be directed toward appropriate energy-dissipating devices, and off the construction ROW if possible.
- Permanent berms will be inspected and repaired as deemed necessary by Enbridge to maintain function and prevent erosion.
- Erosion control blankets (curlex, jute, or equivalent) will be placed on slopes over 30 percent or that are a continuous slope to a sensitive resource area (e.g., wetland or waterway).

1.18 SOIL COMPACTION TREATMENT

Cultivated fields and compacted or rutted areas will be tilled prior to topsoil replacement with a deep tillage device or chisel plowed to loosen compacted subsoils. If subsequent construction and cleanup activities result in further compaction, additional measures will be undertaken to alleviate the soil compaction.

1.19 STONE REMOVAL

A diligent effort will be made to remove excess stones equal to or larger than 4 inches in diameter from the upper 8 inches of subsoil or as specified in permit conditions, contract documents, or landowner agreements. After the topsoil is replaced, stone removal efforts will cease when the size and density of stones on the construction ROW are similar to undisturbed areas adjacent to the construction ROW as determined by the EI. Excess rock will be piled in upland areas where landowner permission has been obtained, or will be hauled off-site to an Enbridge approved disposal site.

1.20 REPAIR OF DAMAGED CONSERVATION PRACTICES

The Contractor will restore all soil conservation practices (such as terraces, grassed waterways, etc.) that are damaged by the pipeline construction to preconstruction conditions to the extent practicable.

1.21 LAND LEVELING FOLLOWING CONSTRUCTION

Following the completion of the pipeline, the construction ROW will be restored to its pre-construction conditions as practical. Should uneven settling or documented surface drainage problems occur following the completion of pipeline construction and restoration, Enbridge will take appropriate steps to remedy the issue.

2.0 STREAM AND RIVER CROSSING GENERAL REQUIREMENTS

The procedures in this section apply to streams, rivers, and other waterbodies such as jurisdictional ditches, ponds, and lakes. These procedures require that judgment be applied in the field and will be implemented under the supervision of Enbridge.

Stream crossing requirements, including construction methods, timing, erosion control, and restoration are described in this section and in the stream crossing permits issued by state and federal agencies and by tribal authorities (as applicable). If the contractor considers certain parts of these procedures to be technically impractical due to site-specific engineering constraints, they may submit an on-site modification request to Enbridge for consideration of alternative measures that would provide an equal or greater level of protection to the stream and river ecosystems. Enbridge will review the contractor's alternatives and consult with appropriate regulatory agencies and tribal resource specialists (as applicable). The contractor will receive written approval from Enbridge prior to implementing the alternatives. During wet and high runoff conditions, the EI will determine whether conditions warrant additional considerations for construction activities.

2.1 TIME WINDOW FOR CONSTRUCTION

All in-stream work activities (installation of dams, sheet piling, etc.) will be minimized to the extent practicable on an area and time duration basis. In-stream trenching will be conducted during periods permitted by the appropriate regulatory agencies and applicable permits. Unless otherwise specified in applicable permits and with exception to blasting and other rock breaking measures and directional drill, in-stream construction activities (specifically trenching, pipeline installation, backfill, and restoration of the streambed contours) for wet crossing methods will occur within the following timeframes:

- Minor Waterbodies (all waterbodies less than or equal to 10 feet wide at the water's edge at the time of crossing): 24 hours

- Intermediate Waterbodies (all waterbodies greater than 10 feet wide but less than 100 feet wide at the water's edge at the time of crossing): 48 hours

- Major Waterbodies (all waterbodies greater than 100 feet wide at the time of crossing): As specified by Enbridge or in the applicable permits.

These timeframes apply regardless of the presence or absence of flow. These timeframes also apply to dry crossing methods as a guideline and can be extended based on site-specific conditions with approval from Enbridge Environment staff, Construction Management, and the EI.

Stream crossings will be designed as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow, creating the shortest crossing length.

2.2 CLEARING AND GRADING

The construction ROW width will consist of a 25-foot-wide neck down beginning 20 feet from the ordinary high water mark ("OHWM") / ordinary high water level ("OHWL") on the working side of the right-of-way (refer to Figures 15 through 17).

2.2.1 Beaver Dam Removal and Prevention of Dam Rebuilding

With landowner approval and in accordance with necessary permits obtained, the Contractor may trap beavers, alter or remove beaver dams in order to attempt to lower the water level prior to construction. For alterations, the Contractor will insert a 12-inch minimum diameter, 20-foot long minimum perforated steel culvert, or an equivalent device, through the dam to allow the water to continually drain. The perforations should be a minimum of 1.5-inch diameter, encompassing the entire circumference and extend for the full length of the culvert.

2.2.2 Impaired Waters

Where discharges of stormwater may occur to waters designated under Section 303(d) of the Clean Water Act as Impaired Waters, additional BMPs will be implemented as specified in the applicable project permits.

2.3 ADDITIONAL TEMPORARY WORKSPACE

ATWS includes work areas outside the boundary of the typical construction ROW. These spaces are typically used to assemble pipe segments and for temporary spoil storage. Clearing of forested and brushy areas for ATWS will be avoided as much as possible. Woody vegetation in wetlands and riparian areas will typically not be cleared for the purpose of ATWS unless approved by appropriate regulatory agencies as stipulated in permits issued for the Project. ATWS will be constructed as follows:

- ATWS will be located at least 50 feet away from the OHWM/OHWL if topographic or other physical conditions such as stream channel meanders allow, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land (refer to Figures 15 through 17).

- If safe work practices or site conditions do not allow for a 50-foot setback, ATWS should be located no closer than 20 feet from the OHWM/OHWL, subject to site-specific approval by Enbridge.

- ATWS will be limited to the minimum size needed to construct the stream crossing.

2.4 BRIDGES

Temporary equipment bridges will be used on most waterways (upon approval by the appropriate agency), including small waterways such as ditches and intermittent streams, where there is a potential for stormwater runoff or rain events to transport sediment downstream from equipment crossing the waterway. Bridges will be constructed as described below and will be removed as soon as possible during final restoration. Bridges will not typically be installed at directionally drilled waterbodies, unless there is no reasonable alternative that provides an efficient, economical way to transport heavy construction equipment around the waterbody by truck.

With exception to clearing-related equipment, fording of waterways is prohibited (i.e. civil survey, potholing, or other equipment are not permitted to ford waterways prior to bridge placement). Clearing equipment and equipment necessary for installation of equipment bridges will be allowed a single pass across waterbodies prior to bridge installation, unless restricted by applicable permits.

2.4.1 Types of Bridges

Equipment bridges will be constructed using one of the following techniques:

- Typical Span Type Bridge (timber mats - refer to Figure 19)
- Rock Flume (refer to Figure 20)
- Railroad flat cars
- Flexi-float or other pre-fabricated portable bridges
- Other methods as approved by Enbridge and appropriate agencies

2.4.2 Bridge Design and Maintenance

Bridges will be designed as close to perpendicular to the axis of the stream channel, creating the shortest crossing length and will be built and maintained in accordance with applicable permits. Equipment bridges will be designed to withstand the maximum foreseeable flow of the stream with headers and support structures being placed above the ordinary high water mark (OHWM) of the feature. In the event that local jurisdictions require stricter guidelines associated with bridge placement, Enbridge will design the bridge to comply with these requirements. Bridges will not restrict flow or pool water while the bridge is in place, and will be constructed with clean materials. Bridges will be designed and maintained to prevent soil from entering the waterbody. Soil that accumulates on the bridge decking will be removed as needed, or as deemed necessary by the EI.

2.5 STREAM AND RIVER CROSSING CONSTRUCTION METHODS

The following stream and river crossing methods are typically used, subject to further restrictions by Enbridge and applicable permits and subject to modifications as approved by appropriate regulatory agencies and tribal resource specialists (as applicable) during construction.

2.5.1 Wet Trench Method

Installation

The wet trench method will be used to cross streams and rivers not permitted to be flumed, dam and pumped, or directionally drilled (refer to Figure 15). The following procedures will be used during wet trench crossings:

- Sediment control measures will be installed before grading from the 20-foot vegetative buffer left on each stream bank. Spoil containment structures will be installed back from the stream bank so that spoil does not migrate into the stream.

- Grading will be directed away from the waterbody to minimize the potential for sediment to enter the stream. Grading of stream banks will be restricted to the trench line and areas necessary for safe bridge installation.

- After grading, backhoes or draglines will be used to excavate the trench. Where possible, excavating equipment will operate from one or both banks, without entering the stream. If equipment must encroach into the stream, it will operate on clean construction mats. Streambed material will be segregated (e.g., upper one foot and the remaining trench spoil will be stored separately) and placed within a spoil containment structure in approved

construction work area limits. Storage of streambed spoil within the stream will only be allowed if expressly approved in the applicable permits.

- Earthen trench plugs (hard plugs) between the stream and the upland trench will be left undisturbed during excavation of the in-stream trench to prevent diversion of the stream flow into the open trench and to prevent water that may have accumulated in the adjacent upland trench from entering the waterbody. Trench plugs will be removed immediately prior to pipe placement, and then replaced when the pipe is in place. Trench water accumulated upslope of trench plugs will be dewatered appropriately prior to trench plug removal.

- Water within the trench will be managed in accordance with Section 5.0

- Backfilling will begin after the pipe is positioned in the trench at the desired depth. Backfill material will consist of the spoil material excavated from the trench and parent streambed unless otherwise specified in state or federal permits. The in-stream trench will be backfilled so that the stream bottom is as near as practicable to its pre-construction condition, with no impediments to normal water flow.

Temporary Stabilization

The Contractor will restore the stream banks as near as practicable to pre-construction conditions unless that slope is determined to be unstable. If Enbridge determines the slope is considered unstable, the Contractor will reshape the banks to prevent slumping. Once the banks have been reshaped, ECDs will be installed within 24 hours of backfilling the crossing. Temporary slope breakers will be installed on all sloped approaches to streams in accordance with the spacing requirements previously specified.

A temporary seed mix (e.g., annual rye or annual oats) and mulch and/or erosion control blankets will be installed within a 50-foot buffer on either side of the stream, with exception to actively cultivated land. Silt fence or functional equivalent as approved in advance by Enbridge will be installed upslope of the temporary seeding area.

2.5.2 Dam and Pump Method

Installation

The dam and pump method is a dry crossing technique that is suitable for low flow streams and is generally preferred for crossing meandering channels. The dam and pump method involves damming of the stream upstream and downstream of the proposed trench before excavation (refer to Figure 16) and pumping water around the construction area. The following procedures will be used for dam and pump crossings:

- Dams may be constructed of sandbags, inflatable dams, aqua-dams, sheet piling, and/or steel plates. The dams will prevent the stream from flowing into the construction area. The dams will be continuously monitored for a proper seal. Additional sandbags, plastic sheeting, steel plating, or similar materials will be used where necessary to minimize the amount of water seeping around the dams and into the construction work area. The dam will not be removed until after the pipeline has been installed, the trench has been backfilled, and the banks have been stabilized.

- Pumping of the stream across the ROW will commence simultaneously with dam construction to prevent interruption of downstream flow. Stream flow will be pumped across the construction area through a hose and will be discharged to an energy-dissipation device, such as plywood boards, to prevent scouring of the streambed.

- The pumps and fuel containers will be located on the upstream side of the crossing and will be placed in impermeable, sided structures which will act as containment units (refer to Section 10.0). The pumps used for this crossing method will not be placed directly in the stream or on the streambed. Pumps will have a capacity greater than the anticipated stream flow. The pumping operation will be staffed 24 hours a day and pumping will be monitored and adjusted as necessary to maintain an even flow of water across the work area and near-normal water levels upstream and downstream from the crossing. .

The pump intake will be suspended to prevent sediment from being sucked from the bottom of stream and will be equipped with a screen, or equivalent device, to prevent fish uptake.

- Where possible, excavating equipment will operate from one or both banks, without entering the stream. If equipment must encroach into the stream, it will operate on clean construction mats (free of soil and plant material prior to being transported onto the construction ROW). Streambed material will be segregated as stated in the wet trench method and will be placed within a spoil containment structure in approved construction work area limits. Storage of streambed spoil within the stream will only be allowed if expressly approved in the applicable permits.

- Earthen trench plugs (hard plugs) between the stream and the upland trench will be left undisturbed during excavation of the in-stream trench to prevent diversion of the stream flow into the open trench and to prevent water that may have accumulated in the adjacent upland trench from entering the waterbody. Trench plugs will be removed immediately prior to pipe placement, and then replaced when the pipe is in place. Trench water accumulated upslope of trench plugs will be dewatered appropriately prior to trench plug removal.

- Standing water that is isolated in the construction area by the dams will be managed in accordance with Section 5.0

- Backfilling will begin after the pipe is positioned in the trench to the desired depth. Backfill material will consist of the spoil material and parent streambed excavated from the trench unless otherwise specified in state or federal permits. The in-stream trench will be backfilled so that the stream bottom is similar to its pre-construction condition, with no impediments to normal water flow.

Temporary Stabilization

Restoration of the stream banks and the installation of temporary erosion controls will be similar to that described for the wet trench method above but will occur immediately following installation of the pipeline. Once the stream banks have been stabilized, the dams and pump will be removed.

2.5.3 Flume Method

Installation

The flume method is a dry crossing technique that is suitable for crossing relatively narrow streams that have straight channels and are relatively free of large rocks and bedrock at the point of crossing (refer to Figure 17). This method involves placement of flume pipe(s) in the stream bed to convey stream flow across the construction area without introducing sediment to the water. The procedures for using the flume method are described below.

- The flume(s) will be of sufficient diameter to transport the maximum flows anticipated to be generated from the watershed. The flume(s), typically 40 to 60 feet in length, will be installed before trenching and will be aligned so as not to impound water upstream of the flume(s) or cause downstream bank erosion. The flumes will not be removed until after the pipeline has been installed, trench has been backfilled, and the stream banks have been stabilized.

- The upstream and downstream ends of the flume(s) will be incorporated into dams made of sand bags and plastic sheeting (or equivalent). The upstream dam will be constructed first and will funnel stream flow into the flume(s). The downstream dam will prevent backwash of water into the trench and construction work area. The dams will be continuously monitored for a proper seal. Adjustments to the dams will be made where necessary to prevent large volumes of water from seeping around the dams and into the trench and construction work area.

- Where possible, excavating equipment will operate from one or both banks, without entering the stream. If equipment must encroach into the stream, it will operate on clean construction mats. Streambed material will be segregated and placed within a spoil containment structure in approved construction work area limits. Storage of streambed spoil within the stream will only be allowed if expressly approved in the applicable permits.

- Earthen trench plugs (hard plugs) between the stream and the upland trench will be left undisturbed during excavation of the in-stream trench to prevent diversion of the stream flow into the open trench and to prevent water that may have accumulated in the adjacent upland trench from entering the waterbody. Trench plugs will be removed immediately prior to pipe placement, and then replaced when the pipe is in place. Trench water accumulated upslope of trench plugs will be dewatered appropriately prior to trench plug removal.

- If additional trench dewatering is necessary to complete the installation of the pipe, the discharge will be managed in accordance with Section 5.0.

- Backfilling will begin after the pipe is positioned in the trench to the desired depth. Backfill material will consist of the spoil material excavated from the trench and parent streambed unless otherwise specified in state or federal permits. The in-stream trench will be backfilled so that the stream bottom is similar to its pre-construction condition, with no impediments to normal water flow.

Temporary Stabilization

Restoration of the ROW and the installation of temporary erosion controls will be similar to that described for the wet trench method above but will occur immediately following installation of the

pipeline. After the stream banks have been stabilized, the dams and flume will be removed from the stream bed allowing water to resume its flow in the channel.

2.5.4 Directional Drill and/or Guided Bore Method

Installation

Installing the pipe underneath a stream will involve placing a drill unit on one side of the stream (refer to Figure 18). A small-diameter pilot hole will be drilled under the stream along a prescribed profile. After the pilot hole has been completed, barrel reams will be used to enlarge the pilot hole to accommodate the desired pipeline diameter. Drilling mud will be necessary to remove cuttings and maintain the integrity of the hole. Water from an Enbridge-approved source will be used to prepare the slurry of drilling mud, and will be appropriated according to applicable permits. The pipe section will be pulled through the hole by the drilling rig and welded to the adjoining sections of pipe on each side of the river.

Drilling Mud

During drilling operations, drilling mud and slurry will be stored back from the waterbody in an earthen berm sediment control structure, in tanks, or by other methods so that it does not flow into the waterbody, adjacent wetlands or off the workspace (refer to Section 11.0 for additional details).

After the pipe is in place, excess drilling mud will be hauled off-site to an Enbridge-approved disposal location or licensed disposal facility.

Temporary Stabilization

The directional drilling/guided bore method normally does not result in the disturbance of the stream banks or riparian vegetation (with exception of extremely limited hand clearing of woody required to facilitate guide wire placement), which reduces the potential for erosion and sedimentation at the stream crossing. Consequently, temporary erosion control measures that are installed at open-cut crossings typically are not necessary for drilled/bored crossings.

2.6 PERMANENT RESTORATION

Stream/channel banks disturbed during installation of the pipelines will be stabilized with erosion control materials such as an erosion control blanket and seeded in accordance with Section 7.0. Permanent stabilization will be initiated within 24 hours after installation of the crossing using the wet trench method and prior to restoring flow using the dam and pump or flume method, unless site and permit conditions delay permanent installation. Where the banks have been disturbed, the Contractor will restore the slopes as near as practicable to pre-construction conditions unless that slope is determined by Enbridge to be unstable. Where the slope of the banks is determined to be unstable or has the potential to erode or fail, the banks will be reshaped to transition the disturbed areas into the natural stream bank with the intent to stabilize the bank and create a blended, natural appearance.

Berms or other sediment filter devices will be installed at the base of sloped approaches to streams greater than five percent and the outlet of the berm will be directed away from the stream into a well vegetated area. Temporary sediment control devices will remain in place until the area has stabilized and adequate revegetation has established.

2.6.1 Vegetative Bank Restoration

Typically, waterbody banks will be restored as near as practicable to preconstruction conditions after backfilling is complete and will be seeded with an appropriate seed mix as specified in Section 7.0 and covered with an erosion control blanket. Erosion controls, (e.g. straw bales, bio-logs, silt fences, etc.) will be installed as necessary based on site-specific conditions.

2.6.2 Supplemental Bank Stabilization

Unstable soils and/or site-specific factors such as stream velocity and flow direction may require additional restoration efforts, such as installation of rock rip-rap, to stabilize disturbed stream banks. Rock rip-rap will be used only where site-specific conditions require and where applicable permits or approvals have been acquired. Geotextile fabric and rock riprap will be placed according to site and permit conditions (refer to Figure 23). Disturbed soils upslope and on either side of the riprap will be prepared for seeding according to Section 7.0 and other stream bank protection requirements. Bioengineering techniques may also be implemented as determined by Enbridge (refer to Figures 26 through 28).

2.6.3 Bridge Removal

Equipment bridges will be removed during final cleanup or, if access is needed, after final cleanup and permanent seeding. Restoration of the bridge area will be completed upon bridge removal.

2.6.4 Swales

Swales will be restored as near as practicable to original conditions. Swales will be seeded and either mulched with straw or erosion control blankets will be installed to the perceivable top of bank for the width of the construction ROW.

3.0 WETLAND CROSSING GENERAL REQUIREMENTS

The procedures in this section apply to all wetlands that will be affected by the Project. These procedures require that judgment be applied in the field and will be implemented under the supervision of Enbridge and the EI. The intent of these procedures is to minimize construction-related disturbance and sedimentation of wetlands and to restore wetlands as nearly as possible to pre-existing conditions. Additionally, in wetlands that are being farmed at the time of construction, Enbridge will construct the pipeline using standard upland methods. Most seasonally saturated farmed wetlands are used for crop production and topsoil will be segregated in the same manner as topsoil in upland agricultural lands. Pipe stringing and fabrication may occur within the farmed wetland adjacent to the trench, or adjacent to the farmed wetland in a designated ATWS.

Wetland crossing requirements, including construction methods, timing, erosion control, and restoration, are described in this section and in the wetland crossing permits issued by state, federal and/or tribal agencies as applicable. If the contractor considers certain parts of these procedures to be technically impractical due to site-specific engineering constraints, they may submit an on-site modification request to Enbridge for approval of alternative measures. Enbridge will review the contractor's alternatives and consult with appropriate regulatory agencies. The contractor must receive approval from Enbridge prior to implementing the alternatives.

3.1 WETLAND ACCESS

The Contractor will use the construction ROW and only approved roads to access wetland areas.

3.2 CLEARING

Clearing the construction ROW in wetlands will be similar to clearing in uplands. For construction to proceed, obstructions (e.g., trees, brush, and logs) need to be removed. Typically, low ground pressure equipment will be used, limiting disturbance to the wetland. Vegetation and trees within wetlands will be cut off at ground level, leaving existing root systems intact; clearing debris will generally be removed from the wetland for disposal. Hydro-axe debris, or similar can be left in the wetland if spread evenly in the construction ROW to a depth which will allow for normal revegetation, as determined by the EI.

3.3 ADDITIONAL TEMPORARY WORKSPACE IN WETLANDS

In general, Enbridge attempts to locate ATWS outside of wetlands wherever practicable; however, ATWS may be sited in select wetlands where the wetland is adjacent to a waterbody, road, railroads, foreign utility crossings, and/or pipeline cross-over with prior approval from the applicable regulatory agencies. Clearing of forested wetlands for ATWS will be avoided as much as possible.

- Staging areas, additional spoil storage areas, and other ATWS will be located in upland areas at least 50 feet away from wetland boundaries (refer to Figures 24), where safe work practices or site conditions permit, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. If site conditions do not permit a 50-foot setback, then these areas will be located as far away from the wetland as is practicable. Vegetation will not be cleared between these areas and the wetland in any event. No construction activities including vegetation clearing or earthwork will occur between the ATWS and the wetland.

- The size of the ATWS areas will be limited to the minimum needed to construct the wetland crossing.

3.4 GRADING IN A WETLAND

Grading activities will be confined to the area of the trench and will be minimized to the extent practicable. Grading outside the trench will only be allowed where required to ensure safety and restore the construction ROW after backfilling the trench with prior approval from Enbridge.

ECDs will be installed:

- across the entire construction ROW upslope of the wetland boundary, where necessary, to prevent sediment flow into the wetland;
- along the edge of the construction ROW as necessary to prevent sediment flow into off-ROW wetlands; and
- Along the edge of the construction ROW as necessary to contain spoil and sediment within the construction ROW through wetlands.

ECDs will be maintained in proper working order to prevent the flow of sediment into wetlands from spoil piles or sloped approaches that are adjacent to the wetlands. .

3.5 RIGHT-OF-WAY STABILIZATION

Tree stumps, brush riprap, imported soil, and rock fill will not be brought in to stabilize the right-of-way in wetlands. Where low ground pressure equipment is not used, construction equipment will operate from timber construction mats or equivalent means with prior approval from Enbridge (refer to Figure 24). To prevent the spread of noxious and invasive plant species, timber mats will be free of soil and plant material prior to being transported onto the construction ROW and/or moved from one area of the construction ROW to another area. Timber riprap (also known as corduroy road) will not be used without prior written approval from Enbridge and the appropriate regulatory agencies. Pre-existing corduroy roads in wetlands may be used but may not be improved, maintained, restored, or replaced without site-specific authorization from applicable agencies.

Subsoil from the pipeline trench within the immediate wetland may be placed on top of equipment mats for additional stabilization. Timber mats may be placed over the ditch line or on the working side to facilitate trench excavation. All timber mats, construction debris, and larger woody vegetative debris will be removed during cleanup of wetlands.

3.6 TRENCHING

Excavation of the pipeline trench in wetlands typically will be accomplished using backhoe excavators. The Contractor will take reasonable steps to insure that the duration of open trench in wetlands, including tie-ins, is minimized to the fullest extent possible.

3.6.1 Topsoil Segregation

When constructing in wetland areas without standing water, up to one foot of topsoil (organic layer) will be stripped from the trench line and stockpiled separate from trench spoil to preserve the native seed stock. In standing water wetlands, organic soil segregation is not typically practical; however, the Contractor will attempt to segregate as much of the organic layer as possible based on site/saturation conditions. If normally unsaturated wetlands are saturated at

the time of construction, topsoil segregation will be attempted according to Figure 2 and based on recommendations from the EI and appropriate regulatory agencies.

3.6.2 Trench Breakers

Where the EI determines that the pipeline trench has the potential to drain or partially drain a wetland, trench breakers will be installed as necessary to maintain the original wetland hydrology.

3.7 PIPELINE INSTALLATION

The following procedures are intended to minimize siltation and disturbance to wetlands during installation.

3.7.1 Push/Pull Method

Large wetlands with standing water can generally not be crossed with typical crossing methods. In these areas, the pipeline will be assembled in an upland area and positioned in the trench using the “push-pull" and/or "float" techniques.

Usually this fabrication requires use of ATWS adjacent to the construction ROW. A backhoe (or equivalent) supported on timber mats or equivalent low ground pressure equipment will be used to dig the trench. The prefabricated section of pipeline will then be pushed-pulled into position or floated across the wetland. When the pipeline is in position, floats, if used, will be removed and the pipeline will sink into position. The trench will then be backfilled and a backhoe or similar equipment working from construction mats or by low ground pressure equipment will be used restore the wetland.

3.7.2 Temporary Erosion and Sediment Controls

ECDs at approaches to wetlands will be installed as previously described and in accordance with Section 1.0.

3.7.3 Concrete Coating

Concrete will generally be mixed off-site, and concrete coated pipe will be transported to the construction ROW on trucks. If required, pre-fabricated concrete weights and/or saddlebag weights will also be used to provide negative buoyancy. Concrete weights will be manufactured off-site and transported to the ROW. Weights will be strung along the construction ROW, where necessary, until they are placed over the pipe within the excavated ditch. Limited mixing and coating activities may occur on the construction ROW for coating pipe joints and concrete weight repairs according to the concrete usage specifications in Section 10.0. Washing equipment used for mixing, pouring, casting, or coating will not be within 100 feet of any wetland and will be conducted and contained in a leak-proof containment facility or impermeable liner. The EI will determine where ECDs will be installed down slope of equipment wash areas to capture sediments and minimize erosion from runoff.

3.8 BACKFILLING

Subsequent to pipe installation, backfilling of wetland trenches will take place immediately, or as approved by EI. The Contractor will restore wetlands as near as practicable to pre-construction conditions and will make a reasonable attempt to return the subsoil to its pre-construction density. During backfilling of wetland areas, subsoil material removed from the trench during construction will be replaced so that the material is not mounded above the adjacent ground surface (undisturbed trench wall). Subsoil that exceeds the elevation of the ground adjacent to the trench

will be removed from the wetland and disposed of in an upland area or an Enbridge-approved disposal site. After the trench has been backfilled with subsoil, previously segregated topsoil will be spread over the trench area and mounded.

3.9 ROUGH GRADING, CLEANUP, AND TEMPORARY RESTORATION

Cleanup and rough grading activities may take place simultaneously. Cleanup typically involves removing construction debris and replacing fences removed during construction. Rough grading includes restoring original conditions within the disturbed areas (i.e., ditch line, spoil storage areas, and equipment travel lane) and installing or repairing temporary ECDs. Temporary slope breakers will be installed near the boundary between the wetland and adjacent sloped approaches, to prevent sediment flow into the wetland.

3.9.1 Timing

Cleanup and rough grading (including installation of temporary erosion control measures) will begin as soon as practical after the trench is backfilled, weather permitting.

3.9.2 Temporary Stabilization

Where necessary, disturbed wetland areas will be seeded with oats (40 lbs/acre) and/or a temporary seed mix, unless standing water is prevalent or unless permanent planting or seeding with native wetland vegetation is required by applicable permits. No fertilizer, lime, or mulch will be applied in wetlands.

4.0 HIGHWAY, ROAD AND RAIL CROSSINGS

4.1 ADDITIONAL WORKSPACE

Additional workspaces for bored road and railroad crossings and open-cut road crossings will be determined on a site-specific basis. These workspaces will be adjacent to the road or railroad and limited to the size needed to contain spoil from the crossing.

4.2 MAINTENANCE

Roadway crossings will be maintained in a condition that will prevent tracking of mud onto the roadway.

Rock tracking pads, constructed of stone as required by the applicable permits, will be installed adjacent to paved public roads to prevent or minimize the tracking of soil onto the roadway. If the roadside ditch is part of a jurisdictional waterway, a permit will be obtained prior to installing the tracking pad or culvert. If permitted in wetlands, tracking pads will be limited in size to reduce impacts. Tracking pads installed in wetlands will be constructed with clean rock placed on geotextile fabric, as approved by an EI and with approval from applicable regulatory agencies. All rock and fabric will be removed from the wetland during cleanup.

4.3 TEMPORARY EROSION AND SEDIMENT CONTROLS

Temporary ECDs (e.g., silt fence and/or double-staked straw bales) will be installed on sloped approaches to road crossings where vegetation has been disturbed (refer to Figure 25).

5.0 CONSTRUCTION DEWATERING

5.1 TRENCH DEWATERING

Prior to initiating dewatering activities, the EI will approve the water discharge plan to ensure that the best management practices are applied in such a way as to minimize the potential for scour and water containing sediment from reaching a wetland or waterbody. Furthermore, landowner approval is required in advance of placement of dewatering structures outside of the approved construction ROW. The Contractor will assess each water discharge situation to include:

- **Water Discharge Setting** - This includes:
    - Soil Type - The soil type the discharged water would flow over. The management of discharged water traveling over sandy soil is more likely to soak into the ground as compared to clay soils.
    - Ground Surface - The topography in the area that would influence the surface flow of the discharged water.
    - Adjustable Discharge rate - The flow rate of the discharged water (which may need to vary) can be managed based on the site conditions to minimize instances of water from reaching a sensitive resource area such as a wetland or waterbody. (Example - Water discharged at 500 gallons per minute may soak into the ground while if discharged at a higher flow rate would cause water to flow via overland runoff into a sensitive resource area)
    - Discharge Outfall - The amount of hose and number/size of pumps needed to attempt to discharge water at a location which drains away from waterbodies or wetlands.

- **Pump Intake** - Use floating suction hose or other similar measures to prevent sediment from being sucked from bottom of trench.

- **Overwhelming Existing Drainage** - If the discharge (assumed to be clean) enters a stream, the flow added to the stream will not exceed 50 percent of the peak storm event flow (to prevent adding high water volumes to a small stream channel that causes erosion due to imposing high flow conditions on the stream.

- **Filtering Mechanism –** All dewatering discharges will be directed through a filtering device as indicated below.
    - Well-Vegetated Upland Area – Water can be directed to a well-vegetated upland area through a geotextile filter bag. Geotextile bags need to be sized appropriately for the discharge flow and suspended sediment particle size.
    - Straw Bale Dewatering Structure – Where the dewatering discharge point cannot be located in an upland area due to site conditions and/or distance, the discharge should be directed into a straw bale dewatering structure. The size of the straw bale dewatering structure is dependent on the maximum water discharge rate (refer to Figure 21). A straw bale dewatering structure should be used in conjunction with a geotextile filter bag to provide additional filtration near sensitive resource areas.
    - Alternative dewatering methods - Alternative methods may be approved by Enbridge on a site-specific basis.

5.1.1 Flow Measurement and Water Sampling

The volume of water discharged from the trench will be recorded as required by the applicable permits. The volume may be determined using a flow meter, or equivalent method, as approved by Enbridge or specified by applicable permit conditions.

Samples of the water discharged will be sampled if required by tribal permits and/or state-issued discharge permits.

5.1.2 Regulatory Notification and Reporting

Enbridge will notify and submit reports to appropriate tribal, state and federal agencies as required by all permits/authorizations.

5.2 HYDROSTATIC TEST DISCHARGES

Hydrostatic testing involves filling the new pipeline segments with water acquired in accordance with applicable permits (refer to Section 6.0), raising the internal pressure level, and holding that pressure for a specific period of time per federal DOT specifications. Hydrostatic testing will be done to verify that there are no flaws in the pipe or welds. Pre-built sections may be hydrostatically tested prior to installation using horizontal directional drilling ("HDD") and/or guided bore techniques. Hydrostatic testing will be conducted in accordance with applicable appropriation and discharge permits obtained by Enbridge. Hydrostatic test waters will not be transferred from one waterbody to another. Chlorinated source water will be used and treated as specified in applicable permits. After the hydrostatic test is complete, the line will be depressurized and the water discharged.

5.2.1 Refueling

The operation and refueling of hydrostatic test equipment will be in accordance with the conditions outlined in Section 10.0.

5.2.2 Siting of Test Manifolds

Hydrostatic test manifolds will be installed where necessary to ensure proper test pressures and incorporates changes due to topography. Where feasible, Enbridge will incorporate minor adjustments to the test manifold locations to avoid placement in wetlands and riparian areas. However, completely avoiding the placement of a test manifold in a wetland may not always be possible. The Contractor will install appropriate erosion control measures where the EI determines they are necessary.

5.2.3 Water Sampling

Water discharged from hydrostatic tests will be sampled as required by state-issued appropriation or discharge permits. Water volumes and flow rates will be recorded using the form provided in Appendix D.

5.2.4 Best Management Practices

Prior to hydrostatic testing the pipeline, Enbridge will prepare the pipe by removing accumulated construction debris, mill scale, dirt, and dust using a cleaning pig. The debris will be collected in a temporary receiver and will be properly disposed off-site of by the Contractor. Upon completion of the cleaning operation, the pipeline will be sealed with the test headers.

Test headers and pigs will be arranged to allow for rinse water to be installed ahead of the fill pigs. Rinse water will be treated and disposed of in accordance with applicable permit conditions.

Following testing, the test section will be depressurized and the water will be discharged to a well-vegetated, upland area with an appropriate dewatering structure such as a geotextile filter bag and/or a hay bale structure that will be lined with geotextile fabric. Direct discharges to surface waters, if allowed by permit, will be directed into an energy dissipation device such as a splash pup.

At no time will the discharge rate exceed the applicable discharge rates specified in state-issued or other discharge permits. In the event no maximum discharge rate is identified, discharges will be monitored and adjusted as necessary to avoid scouring, erosion, or sediment transport from the discharge location.

To minimize the potential for introduction and/or spread of invasive species due to hydrostatic testing activities, Enbridge will discharge water to the same source location from which it was appropriated. If water is used to test multiple test sections, it will be relayed back to the source water through the pipeline for final discharge. Test water will not be discharged to a waterbody other than the appropriation source, unless coordinated and permitted through the applicable agencies.

5.2.5 Flow Measurement

The total volume of water discharged will be determined with a flow meter (or equivalent), or as required by the applicable state permit. The total volume of water discharged will not exceed the volume specified in the applicable permit.

6.0 WATER APPROPRIATION

6.1 GENERAL

Water may be drawn from local sources, such as lakes, streams, and private or municipal wells for construction activities such as dust control, horizontal directional drilling/guided boring, trench dewatering, and hydrostatic testing. The Project will follow applicable permit conditions for the appropriation of water.

The intake hose will be suspended off of the stream or lake bottom and equipped with a screen, or equivalent device, to prevent fish uptake. During withdrawal, adequate waterbody flow rates and volumes will be maintained to protect aquatic life and allow for downstream uses. The volume and rate of withdrawal will be monitoring to comply with applicable permit conditions.

6.2 WATER SOURCES

Water will only be withdrawn from sources approved by Enbridge and in accordance with applicable permits. No additives to the water are permitted unless written approval is received from Enbridge and applicable permits authorize such additives.

If appropriation is scheduled to occur during possible periods of low flow, including frozen conditions, a backup source will be identified.

6.3 FLOW MEASUREMENT

At no time will the withdrawal rate for the water source exceed the rate specified in the applicable permits.

The Contractor will measure the withdrawal rate and total volumes of water appropriated with a flow meter (or equivalent) and provide the data to Enbridge, as required by the applicable permits.

6.4 WATER SAMPLING

Where required by permit conditions, Enbridge will sample the water during appropriation. The Contractor will assist Enbridge in obtaining these samples.

6.5 REGULATORY NOTIFICATION AND REPORTING

Enbridge will notify appropriate agencies of the time of appropriations if required by the state appropriations permits. Enbridge will submit reports regarding the volume and quality of the water withdrawn if required by the applicable permits.

7.0 REVEGETATION & MONITORING

This section was developed in conjunction with Natural Resources Conservation Service ("NRCS") guidelines. Project-specific permit conditions and landowner requests (with exception to wetlands) for specific seed mixes (as indicated in the Project CLL) take precedence over this section.

7.1 PROJECT SEED SPECIFICATIONS

Seed used will be purchased on a "Pure Live Seed" ("PLS") basis for seeding (both temporary and permanent) revegetation areas. Seed tags will identify:

- purity;
- germination;
- date tested;
- total weight and PLS weight;
- weed seed content; and
- seed supplier's name and business information.

Seed will be used within 12 months of testing as required by applicable state rules and regulations. The seed tags on the seed sacks will also certify that the seed is "Noxious Weed Free". Seed rates used on the Project will be based on PLS rate, not actual weight basis. Therefore, to determine the correct application rate if not indicated on the seed tag, a correction calculation will be performed based the purity and germination. For example, a seed mix that has a specified 10 pounds PLS per acre, 95 percent germination rate, and is 80 percent pure needs to be applied at the following rate:

(95% germination × 80% purity)/100 = 76% PLS
10 pounds PLS per acre/.76% PLS = 13.2 pounds per acre actual seeding rate

The species components of individual mixes are subject to availability at the time of purchase. Grass species may be substituted with alternative native or non-invasive species that are included in the NRCS guidelines and subject to approval by Enbridge.

Seed tags will be collected by the contractor and provided to Enbridge during seeding activities. The tags will be reviewed by the EI prior to installation to ensure that the seed mix complies with Enbridge's specifications and that it is being applied to the correct location. If bulk delivery of seed is made, the above information will still be made available to Enbridge. Off-loading/on-loading of seed will not be performed in a designated wetland area.

Legume seed (if used) will be treated with an inoculant specific to the species and in accordance with the manufacturer's recommended rate of inoculant appropriate for the seeding method (broadcast, drill, or hydroseeding). When hydroseeding, four times the manufacturer's recommended rate of inoculant will be used.

7.2 TEMPORARY REVEGETATION

Enbridge's temporary seed mix (refer to Appendix C) was developed based on recommendations from the NRCS. Unless specifically requested by landowners or land managing agencies, Enbridge does not intend to establish temporary vegetation in actively cultivated land, standing water wetlands, and/or other standing water areas.

7.3 TIMING FOR TEMPORARY VEGETATION

Temporary revegetation will be established in construction work areas where 14 days or more will elapse between:

- the installation of the first pipeline and the second line where two pipelines will be co-constructed and active construction is ongoing;
- the completion of final grading at a site and the establishment of permanent vegetation; and/or,
- where there is a high risk of erosion due to site-specific soil conditions and topography.

Enbridge may require the Contractor(s) to conduct temporary seeding sooner than 14 days at site-specific locations near sensitive resource areas and/or areas prone to wind/water erosion.

Temporary vegetation should be established at any time between **April 1 and September 1**. Attempts at temporary revegetation after this date should be assessed on a site-specific basis and with approval from Enbridge.

7.4 MULCH

Mulch (weed-free straw, wood fiber hydromulch, or a functional equivalent) will be applied to disturbed areas (except for actively cultivated land and wetlands) if requested by the landowner or land managing agency, if specified by the applicable permits or licenses, or as required by Enbridge. Mulch will specifically be required on:

- Slopes greater than 5 percent; and
- Dry, sandy areas that can blow or wash away (field decision).

Mulch will be free of noxious weeds as listed in applicable state laws. Certified weed-free mulch may also be required at site-specific locations. The Contractor will be responsible for identifying and acquiring sources of weed-free and certified weed-free mulch. Sources will be approved by Enbridge prior to purchase.

Mulch will be applied at a rate of 2 tons per acre to cover at least 75 percent of the ground surface unless otherwise stipulated by permit conditions. Mulch will be uniformly distributed by a mechanical mulch blower, or by hand in areas not accessible to the mulch blower. Mulch will be anchored/crimped using a mulch-anchoring tool or disc set in the straight position to minimize loss by wind and water, as site conditions allow. In areas not accessible to a mulch-anchoring tool or too steep for safe operation, the mulch may be anchored by liquid tackifiers, with advance written approval from Enbridge. The manufacturer's recommended method and rate of application will be followed.

Hydro-mulch and liquid tackifier can be used in place of straw or weed-free hay mulch with prior approval from Enbridge. All hydromulch and liquid tackifier products used will be on the applicable state DOT product list. Application rates will be at the manufacturer's recommended rate, equal to or greater than 2 tons per acre of straw mulch.

7.5 PERMANENT REVEGETATION

Permanent vegetation will be established in areas disturbed within the construction work area (permanent easement, TWS, and ATWS) except in actively cultivated areas and standing water wetlands. The seed mixes for permanent seeding include native seed varieties commonly found and/or available from local seed distributors. Enbridge's seed mixes (refer to Appendix C) were

selected to augment revegetation via natural recruitment from native seed stock in the topsoil and are not intended to change the natural species composition. Rates provided are assumed for a drill application and will be adjusted as discussed in Section 7.1.

7.6 UPLAND CONSTRUCTION AREAS

In consulting with the NRCS and other agencies, Enbridge developed standard upland seed mixes for restoring disturbed areas affected by the Project (Appendix C, Tables 1-23). These mixes include species that will provide for effective erosion control and revegetation of the project area. These seed mixes will be used by Enbridge as the standard upland mixes unless an alternate seed mix is specified by a landowner or land managing agency.

7.7 PERMANENT SEEDING OF WETLAND AREAS

7.7.1 Unsaturated Wetland Areas

Non-standing water wetlands in Minnesota and Wisconsin will be seeded with the mix provided in Appendix C, Table 17 (MN Seed Mix 3) to provide temporary cover and allowed to revegetate naturally. No unsaturated wetlands will be seeded in North Dakota. The natural revegetation process will be encouraged by the seeds and rhizomes in the topsoil spread back over the right-of-way after pipe installation. No fertilizer, lime, or mulch will be applied in wetlands.

7.7.2 Saturated/Standing Water Wetlands

Enbridge does not propose to seed saturated or standing water wetland areas. It is widely accepted that the reestablishment of vegetation within standing water wetlands occurs best through natural process without supplemental seeding.

7.7.3 Forested Wetland Restoration

Enbridge proposes to allow natural reforestation of the temporary workspace area within forested wetlands via stump sprouting, root sprouting, and natural recruitment. Specific forested wetland restoration provisions will be followed as indicated in applicable permits issued for the Project.

7.8 PERMANENT SEEDING OF WATERBODY BANKS

Enbridge will reestablish stream bank vegetation in North Dakota using ND Seed Mix 2 (Table 2, Appendix C), and in Minnesota and Wisconsin using MN Seed Mix 2 (Table 16 Appendix C) unless an alternate seed mix is requested by applicable agencies. Additional vegetation requirements may also be contained within project-specific permits. Where a waterbody is located within a wetland, the Contractor will re-seed the banks with the applicable wetland seed mix.

7.9 SPECIALIZED SEED MIXES

Enbridge developed specialized seed mixes for restoring these areas:

- Native prairie in North Dakota and Minnesota;
- Openings in forested areas in Minnesota and Wisconsin;
- Mixed native prairie/tamed hayland areas and road ditches in North Dakota, Minnesota, and Wisconsin;
- Tame pasture and Conservation Reserve Program (“CRP”) lands;
- North Dakota State School land; and
- Protected waterbody banks and wetland fringes in Minnesota;

Enbridge will provide other specialized seed mixes upon landowner request on a site-specific basis for:

- Residential Areas: This seed mix will be used to reestablish residential lawns or other types of "turf-type" land cover.
- Wildlife Areas: This seed mix will be used to provide a desirable food source for wildlife, specifically deer.

7.10 CONSERVATION RESERVE PROGRAM PROPERTIES

Enbridge's Land Agents will contact landowners where the construction ROW crosses land enrolled in CRP. Enbridge will work with the respective landowners to identify the parcel-specific CRP seed mixes. CRP lands will be seeded at the direction of the landowner per the site-specific landowner CRP requirements for that parcel and no non-CRP approved seed mix will be planted on CRP lands. CRP parcels will also be seeded with Enbridge's temporary cover seed mix. Seed for CRP seeding will meet the same criteria as other seed described in Section 7.1

7.11 SEED BED PREPARATION AND SEEDING PROCEDURES

After final grading, deep tillage will be performed in actively cultivated areas and in non-agricultural areas (as directed by Enbridge) to relieve soil compaction and promote root penetration. Deep tillage will not be conducted in non-farmed wetlands. The soil will then be tilled with a disc, field cultivator, or chisel plow (or equivalent) to prepare a seedbed, breaking up large clods and firm the soil surface.

Tillage and equipment operations related to seeding and mulching will be performed parallel to ground contours as much as practicable. Fertilizer and other soil amendments will be incorporated into the soil during seedbed preparation as specified by Enbridge in the project-specific CLL requirements and permits. No soil amendments will be applied in wetlands unless directed by the appropriate agencies.

7.12 SEEDING METHODS

Seed will be applied uniformly at specified rates across the prepared construction ROW by drilling, broadcasting, hydroseeding, or air seeding. The EI will suspend seeding activities if conditions are such that equipment will cause rutting of the surface in the designated seeding areas. Enbridge will continue to monitor ROW conditions to resume seeding activities as site conditions improve and according to the general seeding timing restrictions listed in Section 7.15.

7.12.1 Drill Seeding

Seeding equipment will be capable of uniformly distributing the seed and sowing it at the required depth. Drills will be equipped with a feeding mechanism that will provide a uniform flow of seed at the desired application rate. Double-disc furrow openers equipped with depth bands and packer wheels to firm the soil over the seed will be used where practicable.

7.12.2 Broadcast Seeding

Broadcast seeding rate will be double the drill-seeding rate. Seed will be uniformly distributed by a mechanical or hand operated seeder. Following seeding, a cultipacker, harrow, or hand rake will be used to cover the seeds and firm the seedbed as is appropriate for the area.

7.12.3 Hydroseeding

Hydroseeding rate will be double the drill seeding rate, or the same as broadcast seeding rate. Seed will be applied alone or in a seed, fertilizer, and/or hydromulch slurry. If seeding is applied alone, the amount of hydromulch material will be adjusted to the seed slurry to show where seeding has taken place, providing a means to identify uniform cover of the construction ROW. Hydroseeders will provide continuous agitation and be capable of supplying a continuous, non-fluctuating flow of slurry. Enbridge will pre-approve all hydromulch products, which must be on the applicable state DOT product list.

7.13 COMPANION CROPS

A companion crop is an annual that can be planted with the perennial species where soil erosion is a severe hazard. A companion crop may be used for all seed mixes.

Seeding rates for companion crops are lower than normal seeding rates for those crops to reduce competition with the seeded perennial species.

Table 7.13-1
Companion Crops

Seed	Planting Rate
Barley	10 lbs/acre
Oats	10 lbs/acre
Spring wheat	15 lbs/acre
Flax	7 lbs/acre

7.14 SOIL AMENDMENTS

Enbridge will consult with NRCS representatives and review county soil survey information to assess where soil amendments, specifically the application of fertilizer or lime are needed to promote successful revegetation. No fertilizer or lime will be added with native seed mixes. When using non-native species on dry, dry-mesic and mesic sites for permanent seeding a minimum of 150 pounds of 20-10-10, and 2 tons of 80-85 lime or equivalent will be applied, unless otherwise specified or restricted by the landowner, NRCS, or land-managing agency. Soil amendments may be applied to agricultural, pasture, and/or residential lands if requested by landowners and/or land managing agencies. Enbridge will apply phosphate free fertilizers to areas within 100 feet of a waterway if soil amendments are required.

7.15 SEEDING PERIODS

Recommended seeding dates in Table 7.15-1 are based on climatic records, research, and experience; and they also represent optimum periods for the germination of grass and legumes. The dates below provide adequate development of adventurous roots prior to stressful periods.

Table 7.15-1 Recommended Seeding Dates	
Species Type and Season of Planting	**Recommended Dates**
Cool Season Species Spring Late Summer Late fall dormant seeding	Prior to May 20 August 10 to September 1 Typically November 1 and later
Warm Season Species Spring	May 10 to June 25
Warm/Cool Season Mix Spring	May 1 to June 14

Enbridge will delay seeding during frozen ground conditions until the applicable spring seeding period or will complete dormant seeding where conditions allow (i.e., no snow cover). Enbridge will install temporary erosion controls during frozen conditions.

7.16 TIMING OF FINAL SEEDING

Upon final grading of the construction ROW, and upon the restoration of wetland and waterways, seeding and restoration/stabilization will occur within 48 hours if weather and soils conditionals allow. Other methods of stabilization will be used if temporary seeding is not appropriate due to seasonal conditions (e.g., mulch, erosion control matting).

7.17 EROSION & SEDIMENT CONTROL

Erosion control blankets, such as sewn straw mats, jute mats, coconut erosion control blankets, or biodegradable synthetic erosion control blankets, as approved by Enbridge, will be used on slopes over 30 percent, on stream banks and ditch banks and as directed by Enbridge.

7.18 DORMANT SEEDING

Dormant seeding is a method used after soil temperatures have cooled to 55 degrees Fahrenheit or cooler to prevent seed germination. Dormant seeding is only practicable if the soil is not frozen and snow is not present. Procedures for applying soil amendments, seedbed preparation, seeding, and mulching are the same as outlined for permanent revegetation in this section.

Where dormant seeding is conducted, one or more of the following temporary erosion and sediment controls will be put in place over the freshly seeded area unless the local soil conservation authority, landowner, or land managing agency specifies otherwise. The temporary measures will be in place within 48 hours of seeding, and are as follows:

- noxious weed-free straw mulch, at not more than 2 tons/acre, anchored;
- hydromulch, at 2 tons/acre, anchored; and/or
- erosion control blanket.

Additional erosion control measures will be applied as requested by the EI.

7.19 MANAGEMENT AND MONITORING

Enbridge will monitor and address all areas where stabilization techniques have been implemented in accordance with conditions identified in the applicable project permits and/or licenses.

8.0 WINTER CONSTRUCTION

Frozen conditions can preclude effective topsoil segregation. When soil is frozen to a depth greater than the depth of topsoil, the soil will come off in thick slabs that contain both topsoil and subsoil, and mixing can result. If top soiling will proceed under these conditions, it should be done at the excavation only. A ripper should be used to break up the frozen topsoil over the trench line only. Care should be taken to only rip to the actual depth of topsoil or to a maximum depth of 12 inches, whichever is less. Topsoil in the spoil storage area should be graded smooth to minimize mixing during backfilling. Sufficient time is needed to allow the newly graded topsoil to freeze in place prior to trenching.

Summer construction of large diameter pipelines in saturated/standing water wetlands with unconsolidated soils can be difficult and potentially result in greater wetland disturbance including wider trench widths and extensive rutting/surface disturbance. Constructing across these types of wetlands in the winter can result in fewer impacts. Heavy construction equipment use and travel along the construction ROW, which may not be possible in summer conditions due to saturated, unstable soil conditions, can be accomplished in the winter by establishing temporary winter frost/ice roads. These frost/ice roads protect underlying vegetation and upper layers of wetland surfaces from disturbance potentially created during summer construction.

The area of open excavation will be minimized during winter construction to reduce amount of frozen backfill, and facilitate restoration to pre-construction contours. If winter conditions preclude final grading and cleanup, the Contractor will stabilize the area and temporary erosion control measures will remain in place until permanent erosion control measures are installed. Depending on site and weather conditions, Enbridge may require the Contractor to install dormant seeding, mulching, and/or installation of erosion control blanket on stream banks or other sensitive locations.

9.0 WASTE MANAGEMENT

The Contractor will properly handle, store, and dispose of all solid and hazardous materials and wastes that are used or generated by the Contractor as a result of the Project. The Contractor will determine if the materials and wastes associated with the Project classify as hazardous materials and/or wastes in accordance with applicable federal and/or state criteria. Upon request by Enbridge, the Contractor will provide documentation to Enbridge to substantiate findings of the regulatory status of materials and/or wastes used and/or generated as a result of the Project.

The Contractor will collect all waste materials, including oil or other waste liquids generated as a result of equipment maintenance, daily in suitable or approved containers (i.e., labeled and meeting any relevant regulatory requirements). On a routine basis, the Contractor will remove the containers of waste from the site and properly dispose of them. Throughout the duration of the Project, the Contractor will cleanup areas to the satisfaction of Enbridge. The Contractor is responsible for proper off-site disposal of all wastes generated during the Project. No wastes are to be left on Enbridge property, along the ROW, or buried in an excavation or otherwise disposed of on Enbridge property or ROW.

9.1 HAZARDOUS WASTES

If a Contractor generates a hazardous waste from materials they have brought on-site (e.g., paint clean-up solvents, waste paints, etc.), then the Contractor is responsible for proper waste collection, storage and disposal in accordance with all applicable regulations. The Contractor remains responsible for the proper handling, storage and disposal of the hazardous waste. Any release of the hazardous waste as a result of the improper handling, storage or disposal by the Contractor in this instance is the responsibility of the Contractor to rectify to the satisfaction of Enbridge and all applicable regulatory agencies.

9.2 ABRASIVE BLAST DEBRIS

The Contractor will contain and collect spent abrasive blast materials and place it into appropriate containers. The Contractor is responsible for covering the containers with appropriate means of rainwater and stormwater control to prevent said waters from entering or exiting the container. The Contractor is responsible for disposal of the spent abrasive in accordance with applicable federal, state and local regulatory requirements. The Contractor is responsible for determining if the spent abrasive is classified as a “hazardous” or “special” waste as defined by applicable federal and state regulations. If the spent abrasive is determined to be hazardous waste as a direct result of constituents of an Enbridge facility or equipment, Enbridge will coordinate proper disposal with the Contractor as previously discussed.

10.0 SPILL PREVENTION, CONTAINMENT, AND CONTROL MEASURES

This section describes planning, prevention and control measures to minimize impacts resulting from spills of fuels, petroleum products, or other regulated substances as a result of construction. These measures will be implemented by the Contractor, unless otherwise indicated by Enbridge.

10.1 PLANNING AND PREVENTION

Enbridge requires its Contractors to implement proper planning and preventative measures to minimize the likelihood of spills, and to quickly and successfully clean up a spill should one occur. This section sets forth minimum standards for handling and storing regulated substances and cleaning up spills. Potential sources of construction-related spills include machinery and equipment failure, fuel handling, transfer accidents and storage tank leaks. The Contractor will be responsible for implementing, at a minimum, the following planning and prevention measures.

10.2 ROLES AND RESPONSIBILITIES

10.2.1 Spill Coordinator

A Spill Coordinator will be designated by the Contractor, subject to approval by Enbridge. For all construction related spills, the Spill Coordinator will:

- report all spills to the Enbridge Representative immediately;
- report spills to appropriate federal, state and local agencies as soon as possible (subject to EI verification);
- mobilize on-site personnel, equipment, and materials for containment and/or cleanup commensurate with the extent of the spill;
- assist the Emergency Response Contractor (refer to a list of potential contractors provided in Appendix E) and monitor containment procedures to ensure that the actions are consistent with the requirements of this section;
- in consultation with Enbridge and appropriate agencies, determine when it is necessary to evacuate spill sites to safeguard human health;
- in consultation with Enbridge, coordinate with appropriate agencies the need to contact additional parties or agencies; and
- complete a Spill Report Form (refer to Appendix F) within 24-hours of the occurrence of a spill, regardless of the size of the spill.

10.2.2 Environmental Inspector

The EI will monitor the Contractor's compliance with the provisions of this section to ensure that appropriate agency notifications are made, spill resources are allocated, and clean-up is accomplished in accordance with applicable agency requirements

10.2.3 Authorized Personnel

Authorized Personnel are representatives of the Contractor who are designated to handle fuel, lubricants or other regulated substances. Authorized Personnel will be familiar with the requirements of this section and the consequences of non-compliance.

10.2.4 Construction Superintendent

The Contractor's Construction Superintendent or representative will notify the EI immediately of any spill of a petroleum product or hazardous liquid, regardless of volume.

10.2.5 Construction Personnel

Construction Personnel are representatives of the Contractor involved with the installation of the pipeline. Construction Personnel will notify the crew foreman or Spill Coordinator immediately of any spill of a petroleum product or hazardous liquid, regardless of volume.

10.3 TRAINING

The Contractor will train all employees handling fuels and other regulated substances to follow spill prevention procedures. The Contractor will train all employees who handle fuels and other regulated substances to prevent spills and to quickly and effectively contain and clean up spills that may occur in accordance with applicable regulations. .

10.4 EQUIPMENT

- Each construction crew will have adequate absorbent materials and containment booms on hand, to enable the rapid cleanup of any spill which may occur.

- The Contractor will maintain spill kits containing a sufficient quantity of absorbent and barrier materials to adequately contain and recover foreseeable spills. These kits may include, but are not limited to absorbent pads, straw bales, absorbent clay, sawdust, floor-drying agents, spill containment barriers, plastic sheeting, skimmer pumps, and holding tanks. This equipment will be located near fuel storage areas and other locations as necessary to be readily available to control foreseeable spills.

- Suitable plastic lining materials will be available for placement below and on top of temporarily-stored contaminated soils and materials.

- All fueling vehicles, and where necessary, service vehicles, will carry materials adequate to control foreseeable spills. Such material may include but not be limited to absorbent pads, commercial absorbent material, plastic bags with ties, and shovels.

- The Spill Coordinator will inform the Authorized Personnel, Construction Personnel, and the EIs of the locations of spill control equipment and materials, and have them readily accessible during construction activity. Spill kits should be clearly labeled for quick and easy identification in the field.

- All fuel nozzles will be equipped with functional automatic shut-offs.

- Fuel trucks transporting fuel to on-site construction equipment will travel only on approved access roads.

10.5 SUPERVISION AND INSPECTION

The Contractor will perform a pre-construction inspection and test of all equipment to ensure that it is in good repair. During construction, the Contractor will regularly inspect hoses, pipes, valves, and tanks to ensure equipment is free of leaks. Any equipment that found to be is leaking or in need of repair will be immediately removed from service by Contractor and repaired, prior to resuming work.

10.6 STORAGE AND HANDLING OF FUELS/HAZARDOUS LIQUIDS

10.6.1 Fuel Storage - General

The Contractor will follow proper fuel storage practices, including, but not limited to the following:

- Fuel storage will be at Contractor yards only or as approved by Enbridge.
- Proper signage at and adjacent to fuel storage areas to include “Fuel Storage Area – No smoking within 50 feet.”
- Tools and materials to stop the flow of leaking will be kept on-site. Such equipment may include, but not be limited to, plugs of various sizes, 3M tank patches, a hammer, assorted sizes of metal screws with rubber washers, a screwdriver, and plastic tape.
- Fuels, lubricants, waste oil, and any other regulated substances will be stored in aboveground tanks only.
- Storage tanks and containers will conform to all applicable industry codes (e.g., NFPA, UFC).
- A suitable secondary containment structure will be utilized at each fuel storage site. These structures will be lined with suitable plastic sheeting; provide a minimum containment volume equal to 150 percent of the volume of the largest storage vessel.
- Secondary containment areas will not have drains. Precipitation may be drawn off as necessary. If visual inspection indicates that no spillage has occurred in the secondary containment structure, accumulated water may be drawn off and discharged in accordance with Section 5.0. If spillage has occurred in the structure, accumulated waste will be drawn off and pumped into drum storage for disposal.

10.6.2 Refueling

Contractor will make all efforts to dispense fuel by Authorized Personnel during daylight hours. Fuel dispensing operations will be attended by Authorized Personnel at all times. Personnel will be stationed at both ends of the hose during fueling unless both ends are visible and are readily accessible by one person.

10.6.3 Refueling, Maintenance, and Fuel Storage Near Wetlands and Waterbodies

Enbridge requires that the storage of petroleum products, refueling, maintenance, and lubricating operations take place in upland areas that are more than 100 feet from wetlands, streams, and waterbodies (including drainage ditches), and water supply wells. In addition, the Contractor will store hazardous materials, chemicals, fuel and lubricating oils, and perform concrete coating activities outside these areas.

In certain instances, refueling or fuel storage may be unavoidable due to site-specific conditions or unique construction requirements (e.g., continuously operating pumps or equipment on barges). These locations will be approved in advance by the EI. Site-specific precautions, in addition to those practices described above, will be taken when refueling or maintenance activities are required within 100 feet of streams, wetlands or other waterbodies. These precautions include, but are not limited to:

- Adequate amounts of absorbent materials and containment booms will be kept on hand by each construction crew to enable the rapid cleanup of any spill which may occur;
- If fuel will be stored within wetlands or near streams for refueling of continuously operating pumps, secondary containment will be used;
- Secondary containment structures will be lined with suitable plastic sheeting, provide a containment volume of at least 150 percent of the storage vessel, and allow for at least one foot of freeboard; and
- Provide adequate lighting for these locations and activities.

10.6.4 Overnight parking

Overnight parking of equipment (including but not limited to light plants, generators, pumps, and machinery) is not allowed within 100 feet of a wetland or waterbody unless special containment provisions have been implemented and approved by the EI in advance.

10.6.5 Concrete Washout Handling

Concrete wash water, grindings and slurry, will not be discharged to wetlands, waterbodies, and storm sewer systems or allowed to drain onto adjacent properties. Wash water disposal will be limited to a defined area of the site or to an area designated for cement washout. The area(s) will be sufficient to contain the wash water and residual cement. Contractors hired to provide concrete products will provide equipment capable of reclaiming wash water during wash out.

10.7 INITIAL SPILL MANAGEMENT

10.7.1 Immediate Response

Immediately upon learning of any fuel, oil, hazardous material or other regulated substance spill, or upon learning of conditions that will lead to an imminent spill, the person discovering the situation will:

- Initiate actions to contain the fluid that has spilled or is about to spill, and initiate action to eliminate the source of the spill to the maximum extent that is safely possible.
- Notify the crew foreman and/or the Spill Coordinator and provide them with the following information:
    - Location and cause of the spill;
    - The type of material that has spilled; and
    - Whether the spill has reached or is likely to reach any surface water.

Upon learning of a spill or a potential spill the Spill Coordinator will:

- Assess the situation and determine the need for further action;
- Direct subsequent activities and/or further assign responsibilities to other personnel; and
- Notify the EI.

10.7.2 Mobilization

The Spill Coordinator will mobilize on-site personnel, equipment, and materials for containment and/or cleanup commensurate with the extent of the spill. If the Spill Coordinator feels that a spill is beyond the scope of on-site equipment and personnel, the Spill Coordinator will immediately notify the Construction Superintendent that an Emergency Response Contractor is needed to contain and/or clean up the spill. Appendix E contains a list of potential Emergency Response Contractors. The Spill Coordinator will assist the Emergency Response Contractor and monitor containment procedures to ensure that the actions are consistent with the requirements of this Section.

In the event of a suspected Enbridge pipeline spill (or from an adjacent pipeline), Enbridge's Emergency Pipeline Control Center will be notified at 1-800-858-5253 (24-hours/day), as well as the Enbridge EI. Actions requiring emergency response will be coordinated by Enbridge.

10.8 SPILL NOTIFICATION RESPONSIBILITIES

10.8.1 Notification Volumes

The Contractor's Construction Superintendent or representative will notify the Enbridge Representative and the EI immediately of any spill of a petroleum product or hazardous liquid, regardless of volume.

10.8.2 Spill Report Form

The Spill Coordinator will complete a Spill Report Form (Appendix F) for each release of a regulated substance, regardless of volume. The Spill Report Form will be submitted to the EI within 24 hours of the occurrence of a spill. Follow-up written reports, associated laboratory analyses, and other documentation may also be required separately on a site-specific basis as directed by the EI. Documentation is the responsibility of the Contractor.

10.8.3 Agency Notification

The Contractor will report spills to appropriate federal, state and local agencies as soon as possible. A listing of federal, state, and local agencies including reporting thresholds and timeframes is provided in Appendix G.

The Contractor, in coordination with Enbridge and the appropriate federal, state and local agencies will ensure that additional parties or agencies are properly notified. Additionally, the Contractor is responsible for ensuring that all cleanup activities required by a jurisdictional agency are satisfactorily met and provide documentation to Enbridge demonstrating this compliance.

10.9 SPILL CONTAINMENT AND CLEANUP

In the event of a spill, the Contractor will abide by all applicable federal, state and local regulations with respect to cleaning up the spill. All clean-up and other construction related spill

activities will be completed by, and costs assumed by the Contractor. Specific cleanup measures for both upland and wetland/waterbody spills are described below.

10.9.1 Spill Control - Upland Areas

- If a spill should occur during refueling operations, **STOP** the operation until the spill can be controlled and the situation corrected.
- The source of the spill will be identified and contained immediately.
- For large spills on land, the spill will be contained and pumped immediately into tank trucks. The Contractor or, if necessary, an Emergency Response Contractor, will excavate contaminated soil.
- The spilled material and the contaminated soil will be treated and/or disposed of in accordance with all applicable federal, state, and local agency requirements.
- Smaller spills on land will be cleaned up with absorbent materials. Contaminated soil or other materials associated with these releases will also be collected and disposed of in accordance with applicable regulations.
- Flowing spills will be contained and/or absorbed before reaching surface waters or wetlands.
- Absorbent material(s) will be placed over spills to minimize spreading and to reduce its penetration into the soil.
- The Spill Coordinator, in consultation with the EI and appropriate agencies, determine when spill sites will be evacuated as necessary to safeguard human health. Evacuation parameters will include consideration for the potential of fire, explosion, and hazardous gases.

10.10 SPILL CONTROL - WETLANDS AND WATERBODIES

In addition to the above measures, the following conditions apply if a spill occurs near or into a wetland or waterbody, regardless of size:

- If a spill occurs during refueling operations, **STOP** the operation until the spill can be controlled and the situation corrected.
- The Contractor will use absorbent booms and pads to contain and recover released materials in standing water.
- If necessary, for large spills in waterbodies, The Contractor will secure an Emergency Response Contractor to further contain and clean up the spill.
- The Contractor will excavate contaminated soils in wetlands and temporarily place them on plastic sheeting in a bermed area, a minimum of 100 feet away from the wetland. Contaminated soils will be covered with plastic sheeting while being stored temporarily and properly disposed of as soon as possible, in accordance with Section 10.11.

10.11 STORAGE AND DISPOSAL OF CONTAMINATED MATERIALS

- Appendix E lists potential treatment and disposal facilities for contaminated materials, petroleum products, and other construction-related wastes. The Contractor should recycle those wastes, such as motor oil, where there is an established recycling program available. Wastes such as grease or oily rags shall be disposed of in accordance with state requirements.

- The Contractor will store and dispose of all contaminated soils, absorbent materials, and other wastes in accordance with all applicable state and federal regulations.

- Only licensed carriers may be used to transport contaminated material from the site to a disposal facility.

- If it is necessary to temporarily store excavated soils on site, these materials will be placed on, and covered by, plastic sheeting, and the storage area bermed to prevent and contain runoff.

11.0 DRILLING FLUID RESPONSE, CONTAINMENT, AND NOTIFICATION PROCEDURES

Construction of a pipeline may include the use of trenchless methods known as the HDD and guided/road bore methods. Throughout this section, both methods are referred to collectively as "drilling". While the HDD method always includes the use of drilling fluid, the guided or road bore method might use drilling fluid or only use water to power and lubricate the bore. The HDD drilling fluids/mud consists primarily of water mixed with inert bentonite clay. Under certain conditions an additive may need to be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only non-hazardous additives will be used and a Material Safety Data Sheet for the drilling fluid will be maintained on-site.

This section elaborates on measures to be implemented by the Contractor if an inadvertent release of drilling fluid occurs despite prevention efforts. Prior to the commencement of drilling operations, the Contractor will inform construction personnel involved as to the responsible party(ies) for release containment and response. The Contractor will ensure that the appropriate response personnel and containment equipment are on site for each drill/bore.

11.1 ON-SITE OBSERVATION DURING CONSTRUCTION

During construction of a drilled crossing, Contractor personnel will monitor the pipeline route throughout the process, as follows:

The Contractor will inform construction observers on what to watch for and will make them aware of the importance of timely detection and response actions to any release of drilling fluid.

- Construction observers will have appropriate, operational communication equipment (e.g., radio and cell phones) available at all times during installation of the directionally drilled crossing, with the ability to communicate directly with the HDD operator.
- The HDD operator will monitor the annular drilling fluid pressures during pilot hole operations.
- If the HDD operator identifies a sustained loss in fluid pressure or loss of circulation:
    - The operator will immediately notify the construction observers of the assumed position of the drill tool; and
    - The Contractor will visually monitor the appropriate portion of the drill path where the drill tool is located to determine if an inadvertent return occurred. The Contractor may perform this monitoring by walking or by using a boat, as appropriate.
- Construction observers, EI(s), or the Enbridge HDD craft inspector have the authority to order installation of containment structures, if needed, and to require additional response measures if deemed appropriate.

11.2 CONTAINMENT, RESPONSE, AND CLEAN-UP EQUIPMENT

Containment, response and clean-up equipment will be available at both sides of an HDD crossing location and one side of a guided or road bore prior to the commencement to assure a

timely response in the event of an inadvertent release of drilling fluid. Containment and response equipment includes but is not limited to:

- straw bales and staking
- pre-filled sandbags
- turbidity curtain (not necessary for guided or road bores that do not involve a waterbody)
- silt fence
- plastic sheeting and/or geotextile fabric
- shovels, brooms, buckets, and other appropriate hand tools
- pumps and sufficient hose
- fluid storage tanks (may not be necessary for guided or road bores)
- vacuum truck on 24-hour call
- one small boat (for larger rivers and open water wetlands)
- light plant/generator (only necessary where operations are conducted outside of daylight hours)

11.3 RESPONSE

In the event an inadvertent drilling fluid release is observed, the EI and the Contractor will assess to determine the amount of fluid being released and potential for the release to reach sensitive resource areas (e.g., wetlands and waterbodies). Response measures will vary based on location of inadvertent release as discussed below.

11.3.1 Upland Locations

Response measures include:

- The EI will evaluate the release to determine if containment structures are warranted and if they will effectively contain the release.
- If the amount of the surface release is not great enough to allow the practical physical collection from the affected area, it will be diluted with clean water and/or the fluid will be allowed to dry and dissipate naturally.
- Earthen or sandbag berms, silt fence, and/or hay bales will be installed to contain small releases and prevent migration of drilling fluid.
- The Contractor will remove excess fluid at a rate sufficient to prevent an uncontrolled release.
- If the amount of the surface release exceeds that which can be completely contained with hand-placed barriers, small collection sumps (less than 5 cubic yards) may be used (with approval from Enbridge) to remove released drilling fluid by the use of portable pumps and hoses.
- The EI will inform the Contractor to initiate immediate suspension of drilling operations if the fluid release cannot be effectively contained.

11.3.2 Wetland and Waterbody Locations

This section also applies to areas immediately adjacent to wetlands and waterbodies, such as stream banks or steep slopes, where drilling fluid releases could quickly reach surface waters.

- In the event of a drilling fluid release in wetlands, waterbodies, or adjacent areas:
  - The EI will evaluate the release, and the Contractor will implement appropriate containment measures.
  - The EI and the Contractor will evaluate the recovery measures to determine the most effective collection method.
  - Enbridge Engineering and the Contractor will review and consider adjusting drill pressures, pump volume rates, and drill profile, based on best management practices, to minimize the extent of the release.
  - Enbridge will suspend drilling operations if containment measures do not effectively control the release.
- If the amount of the surface release exceeds that which can be contained with hand-placed barriers, small collection sumps (less than 5 cubic yards) may be utilized to collect released drilling fluid for removal by the use of portable pumps and hoses.
- If the amount of the surface release is not great enough to allow the practical physical collection from the affected area without causing additional impacts, with approval from both Enbridge Environmental and Construction Management, the drilling fluid may be diluted with clean water and/or the fluid will be allowed to dry and dissipate naturally.
- Excess fluid will be held within the containment area and removed using pumps or other appropriate measures at a rate sufficient to maintain secure containment.
- Recovered fluid will be stored in a temporary holding tank or other suitable structure out of the floodplain and/or wetland for reuse or eventual disposal in an approved disposal facility
- Enbridge will consult with the appropriate regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions the HDD may proceed.

11.4 NOTIFICATION AND RESUMPTION OF SUSPENDED HDD OPERATIONS

The Contractor will immediately notify the EI of all drilling fluid releases. If the EI determines the release affects wetland or waterbody areas, he or she will immediately notify Enbridge Environment and Construction Management and the appropriate regulatory agencies.

If notifications are necessary during non-business hours they will be done according to prior arrangements made between Enbridge and the regulatory agencies. Follow-up notifications will be made as necessary and practicable.

The conditions under which drilling/boring operations can resume will be discussed with appropriate regulatory agencies and/or field representatives. If containment measures are functioning, and the circumstances and potential impacts of the release are understood, drilling/boring operations will resume.

11.5 CLEAN-UP

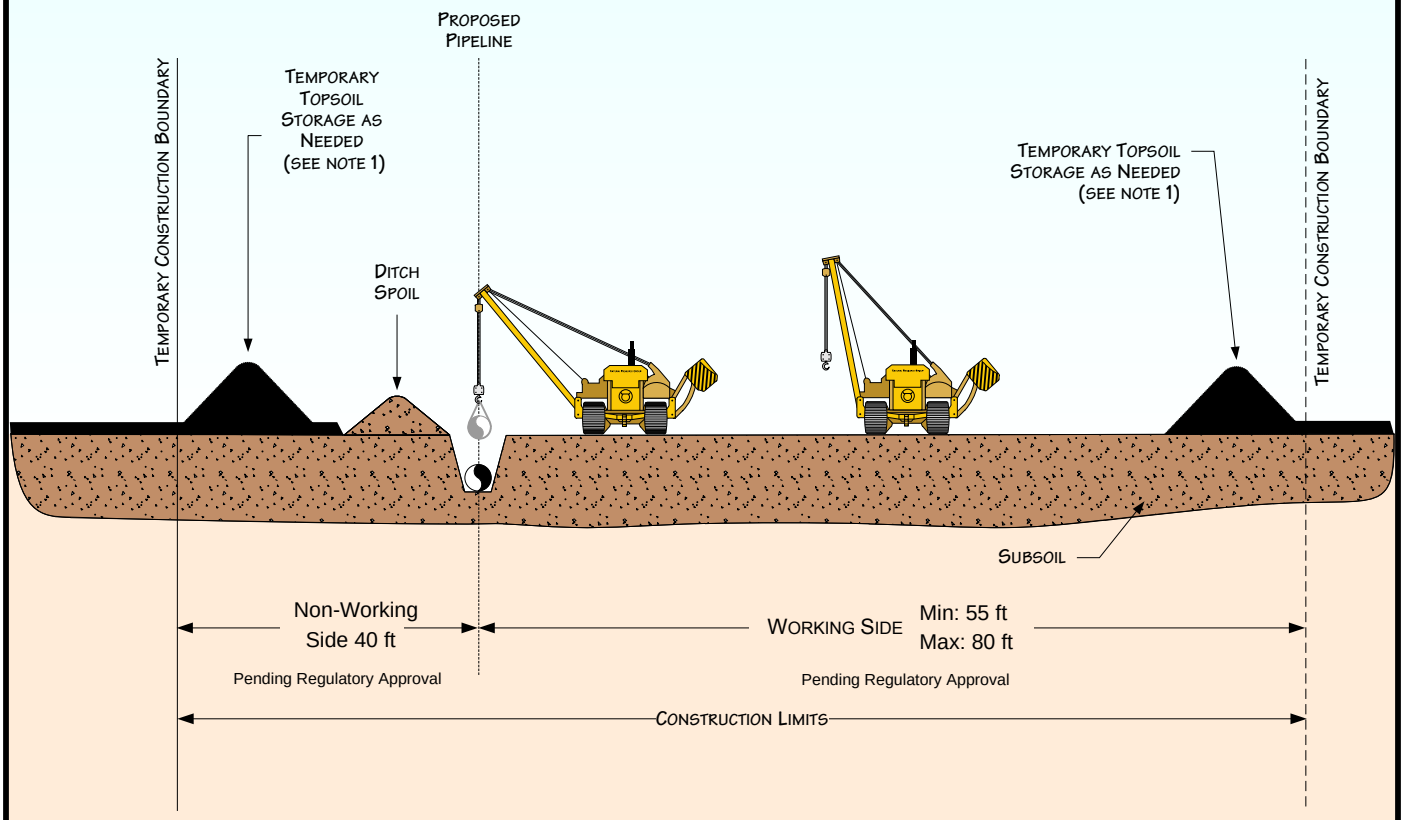
The following measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using hand shovels, buckets and soft-bristled brooms as possible without causing extensive ancillary damage to existing vegetation. Clean water washes may also be employed if deemed beneficial and feasible.
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or ancillary damage to existing and adjacent vegetation.
- Material will be collected in containers for temporary storage prior to removal from the site.
- The EI will regularly evaluate the potential for secondary impact from the clean-up process and clean-up activities terminated if physical damage to the site is deemed to exceed the benefits of removal activities. This decision will be made in consultation with the appropriate regulatory agencies and/or Enbridge.

11.6 RESTORATION AND POST-CONSTRUCTION MONITORING

Following cleanup activities, restoration and revegetation of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to Enbridge's EPP. Enbridge will monitor the release site as appropriate to assure adequate restoration.

Figures



PROFILE

NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATIONS APPROVED BY THE COMPANY.

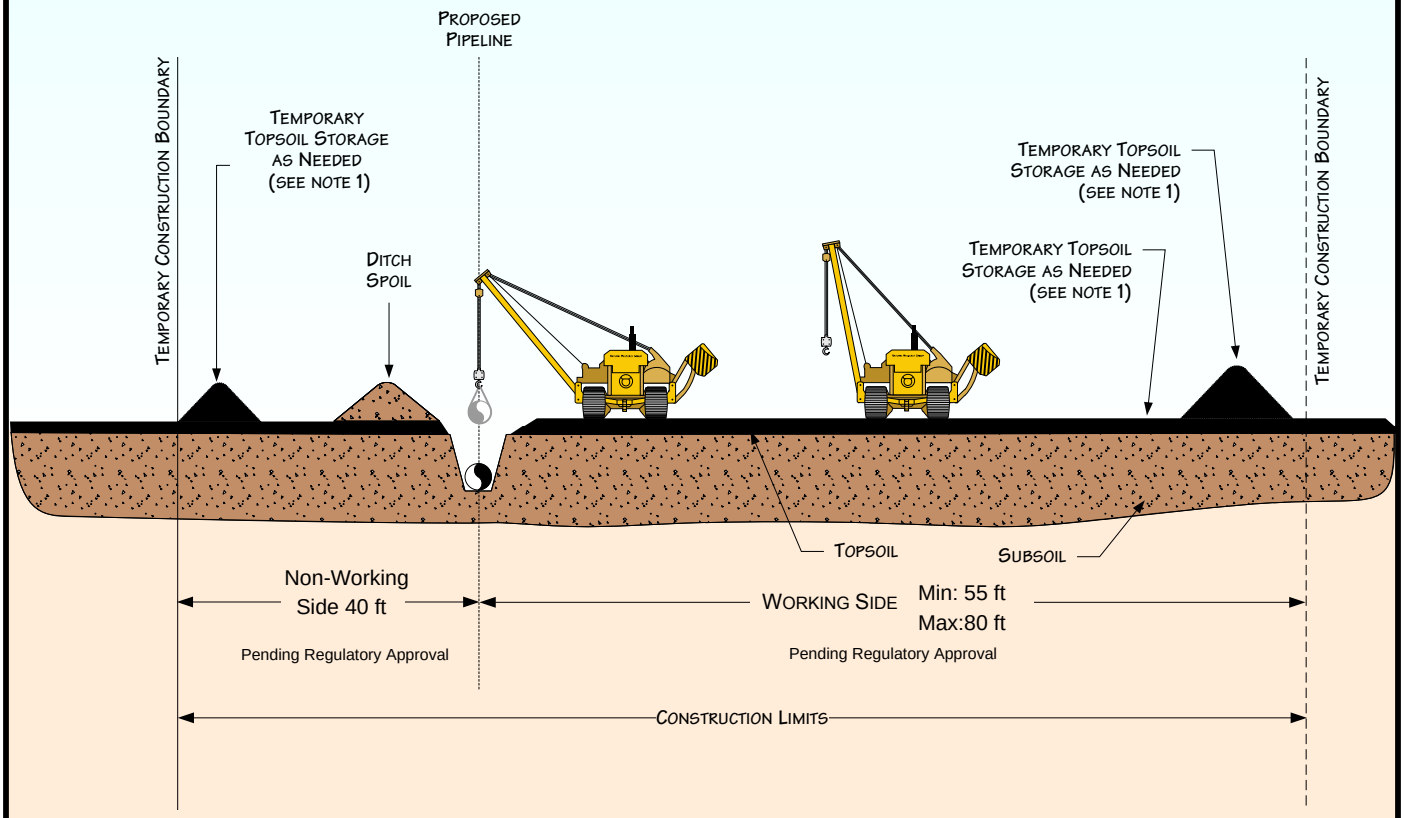
ENBRIDGE

Figure 1

Environmental Protection Plan

Typical Topsoil Segregation - Full Right-of-Way

DATE:	7/9/2001
REVISED:	3/11/2011
SCALE:	NTS
DRAWN BY:	JPBOENTJE
K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_1-3_TYPICAL_TOPSOIL_SEGREGATION.VSD	



PROFILE

NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATIONS APPROVED BY THE COMPANY.

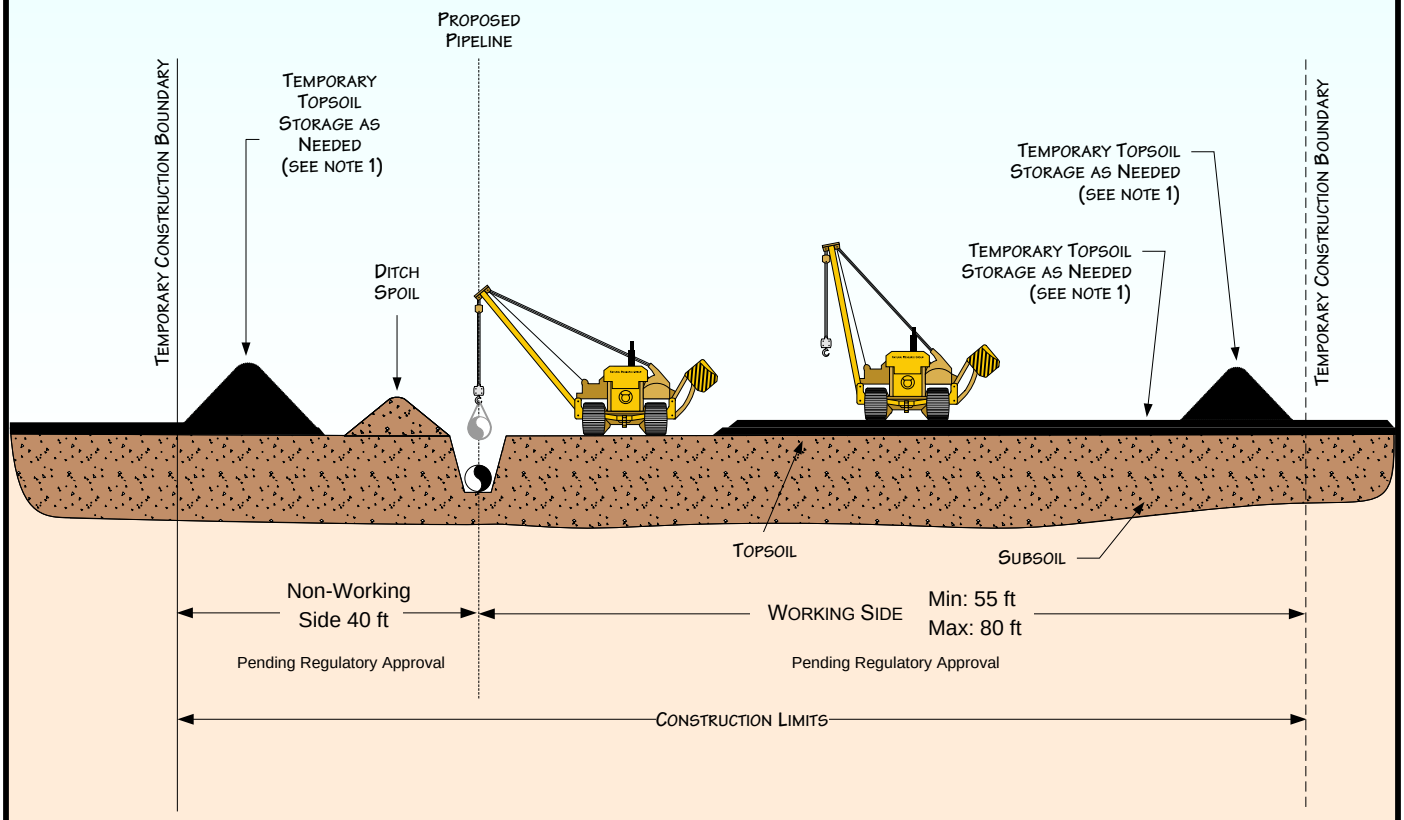
ENBRIDGE

Figure 2

Environmental Protection Plan

Typical Topsoil Segregation – Trench Line Only

DATE:	7/9/2001
REVISED:	3/11/2011
SCALE:	NTS
DRAWN BY:	JPBOENTJE
K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_1-3_TYPICAL_TOPSOIL_SEGREGATION.VSD	



PROFILE

NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATIONS APPROVED BY THE COMPANY.

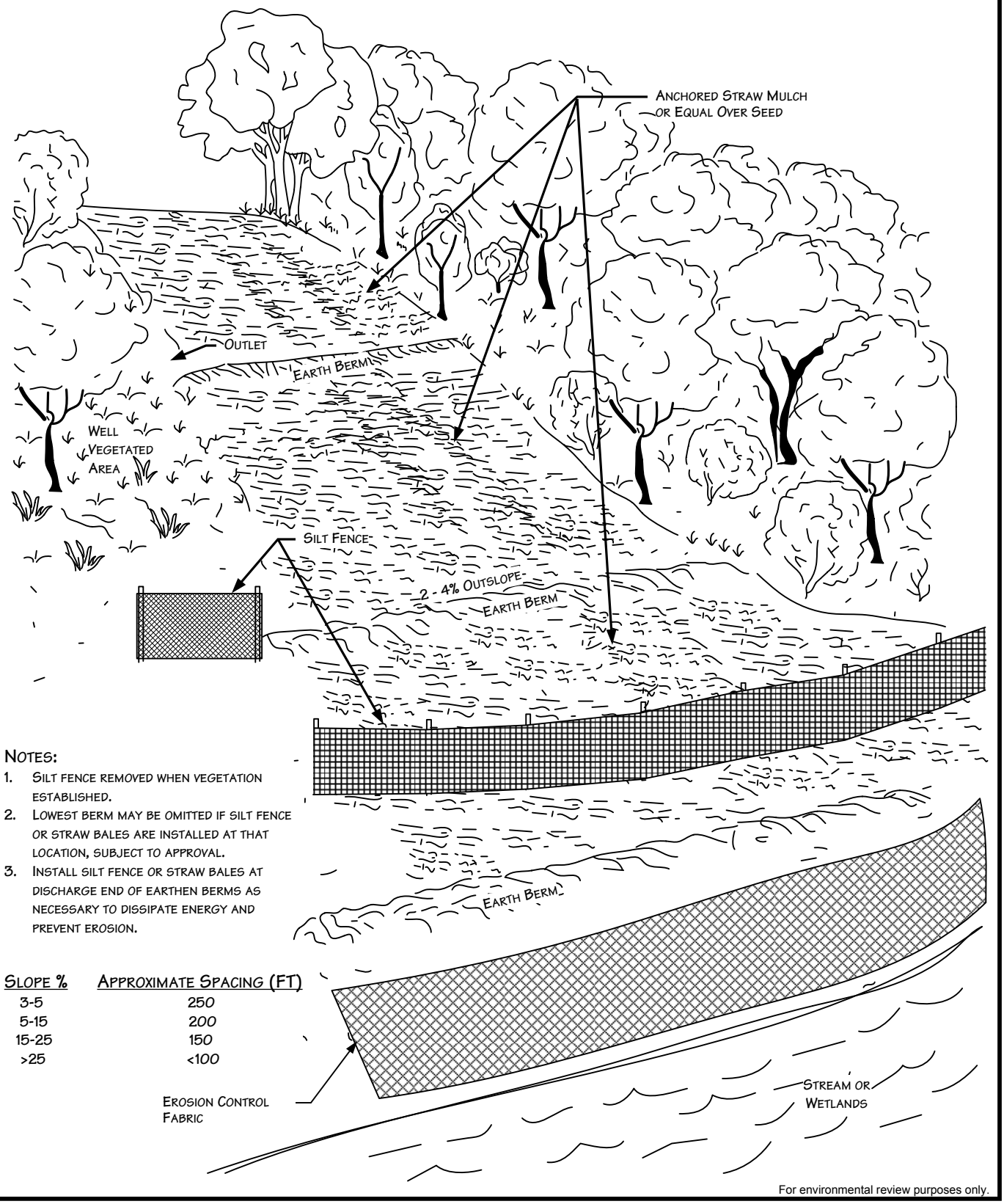
ENBRIDGE

Figure 3

Environmental Protection Plan

Typical Topsoil Segregation –
Modified Ditch Plus Spoil Side

DATE:	7/9/2001
REVISED:	3/11/2011
SCALE:	NTS
DRAWN BY:	JPBOENTJE
K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_1-3_TYPICAL_TOPSOIL_SEGREGATION.VSD	



Notes:

1. Silt fence removed when vegetation established.
2. Lowest berm may be omitted if silt fence or straw bales are installed at that location, subject to approval.
3. Install silt fence or straw bales at discharge end of earthen berms as necessary to dissipate energy and prevent erosion.

Slope %	Approximate Spacing (ft)
3-5	250
5-15	200
15-25	150
>25	<100

For environmental review purposes only.

ENBRIDGE

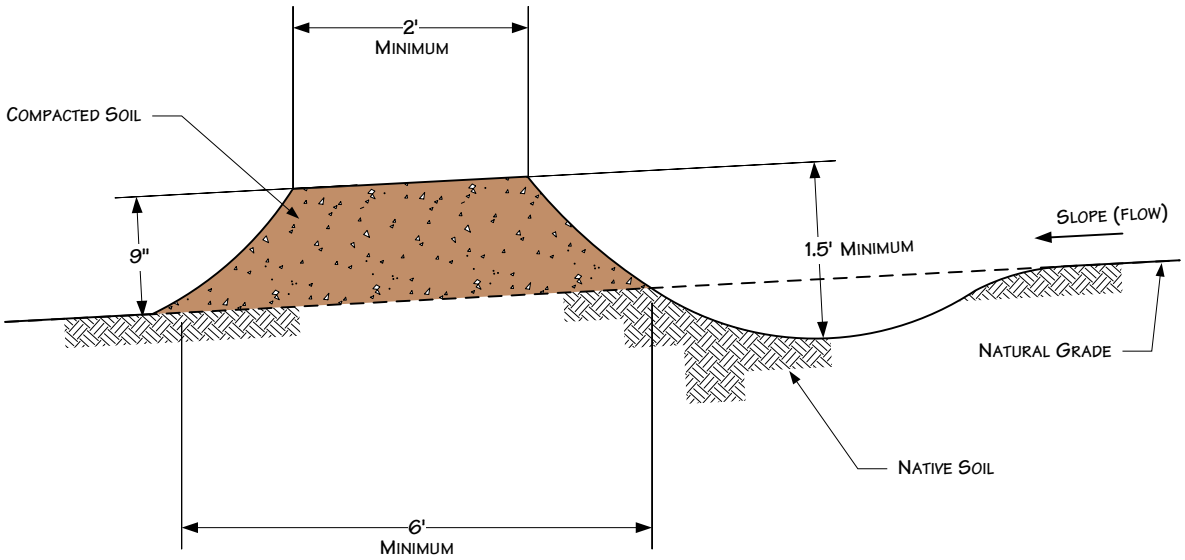
Figure 4

Environmental Protection Plan

Typical Temporary or Permanent Berms
Perspective View

DATE: 11/14/2000
REVISED: 3/11/2011
SCALE: NTS
DRAWN BY: KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_4_BERMS_PERSPECTIVE_VIEW.VSD



NOTES

1. BERMS SHALL BE CONSTRUCTED WITH 2 TO 4 PERCENT OUTSLOPE.
2. BERMS SHALL BE OUTLETED TO WELL VEGETATED STABLE AREAS, SILT FENCES, STRAW BALES OR ROCK APRONS.
3. BERMS SHALL BE SPACED AS DESCRIBED IN CONSTRUCTION SPECIFICATIONS.
4. ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS.

For environmental review purposes only.

ENBRIDGE

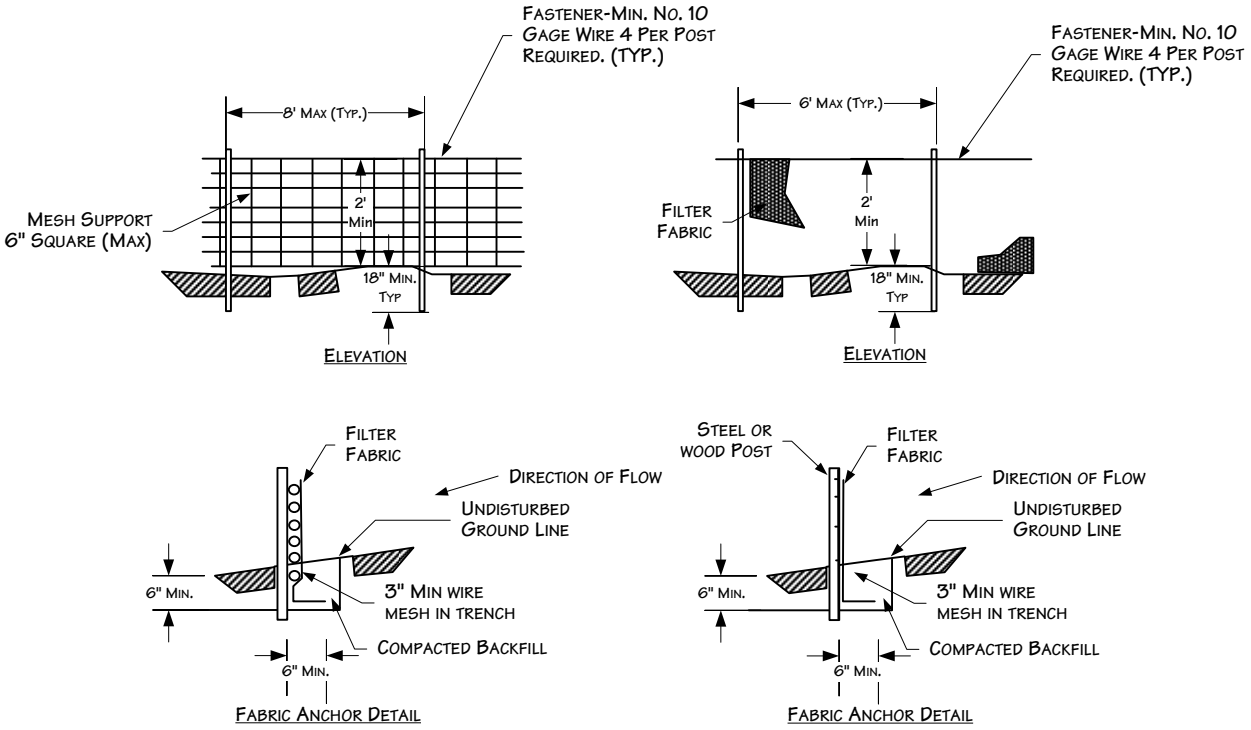
Figure 5

Environmental Protection Plan

Typical Temporary or Permanent Berms
Elevation View

DATE:	5/25/2001
REVISED:	3/11/2011
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_5_BERMS_ELEVATION_VIEW.VSD



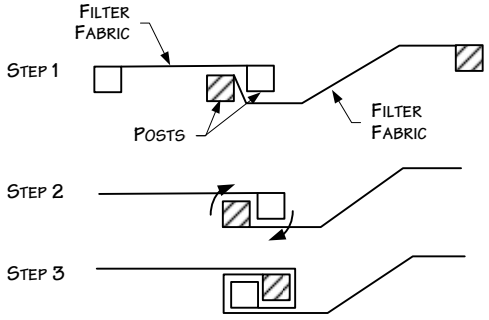
Silt Fence with wire support plan

Silt Fence Plan

NTS

Notes:

1. Wires of mesh support shall be min. gage no. 12.
2. Filter fabric shall meet the requirements of the specification with equivalent opening size of at least 30 for nonwoven and 50 for woven. (Sieve No.)
3. The posts used to support the silt fence should be hardwood material with a minimum cross sectional area of 4 inches square and 4 feet long. Metal posts should be used in areas that pond water.



Attaching two silt fences

Notes:

1. Place the end post of the second fence inside the end post of the first fence.
2. Rotate both posts at least 180 degrees in a clockwise direction to create a tight seal with the fabric material.
3. Drive both posts a minimum of 18 inches in the ground and bury the flap.

For environmental review purposes only.

ENBRIDGE

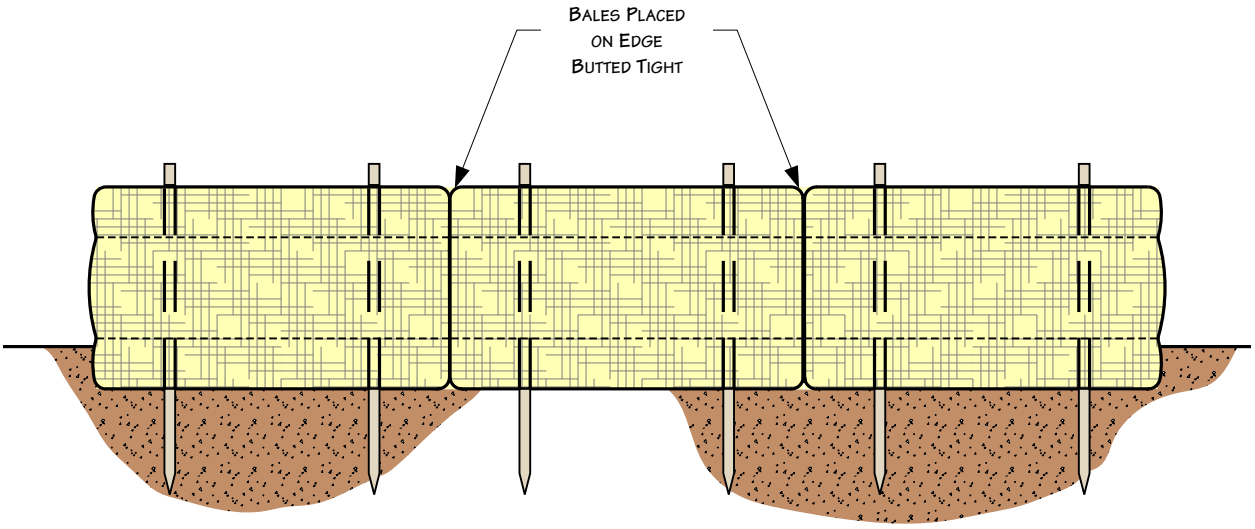
Figure 6

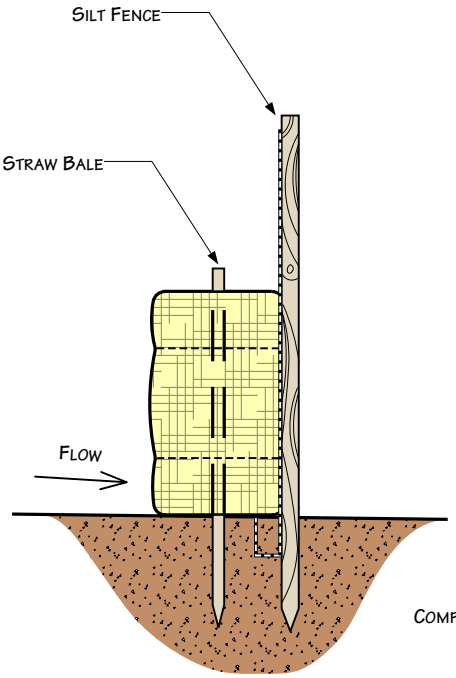
Environmental Protection Plan

Typical Silt Fence Installation

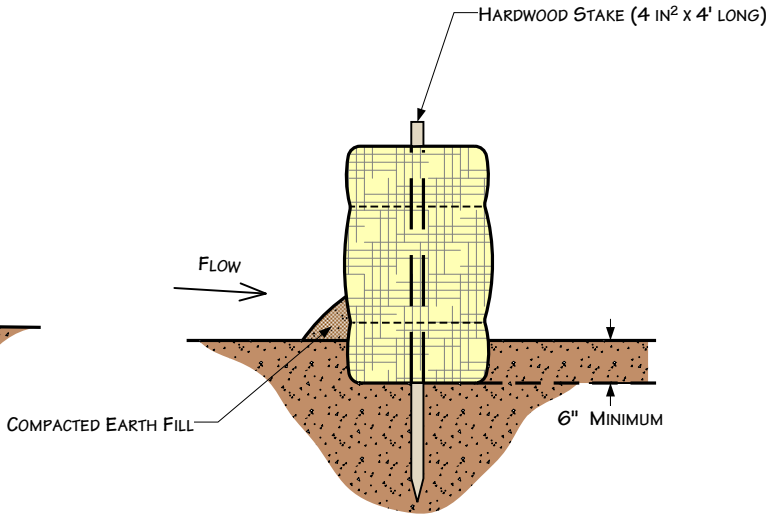
DATE:	5/25/2001
REVISED:	3/23/2011
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_6_SILT_FENCE_INSTALL.VSD





Straw Bales & Silt Fence



Straw Bales Only

For environmental review purposes only.

ENBRIDGE

Figure 7
Environmental Protection Plan
Typical Straw Bale Installation

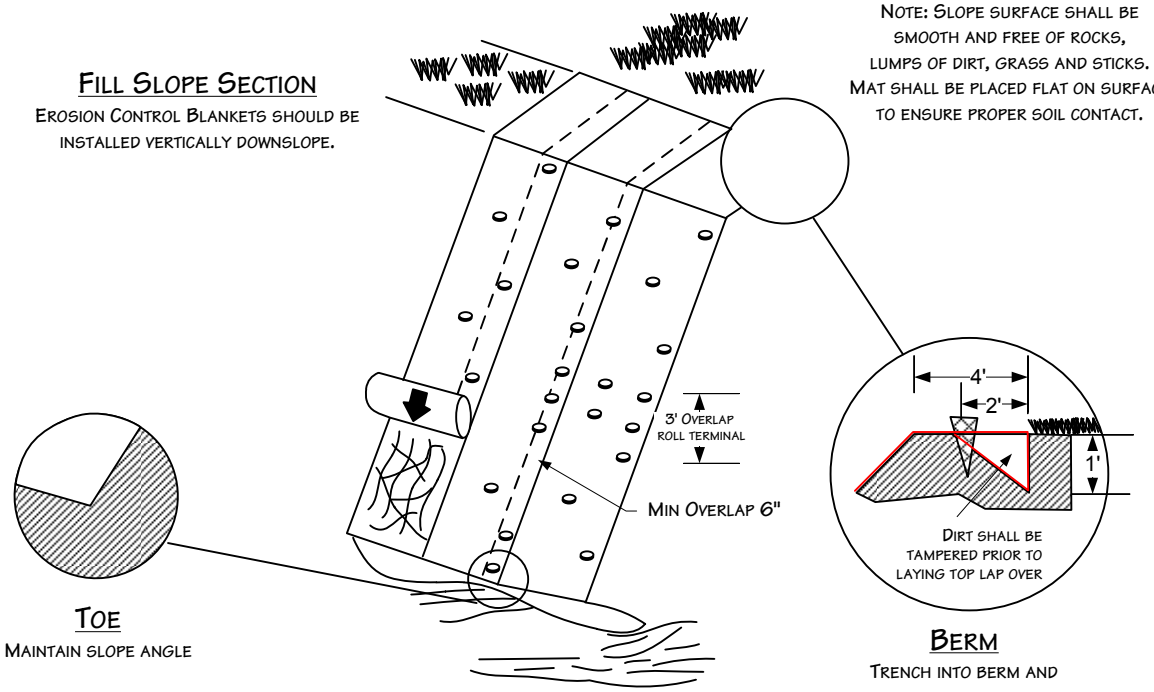
DATE:	5/25/01
REVISED:	3/11/11
SCALE:	Not to Scale
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_7_STRAW_BALE_INSTALL.VSD

Fill Slope Section

Erosion Control Blankets should be installed vertically downslope.

Note: Slope surface shall be smooth and free of rocks, lumps of dirt, grass and sticks. Mat shall be placed flat on surface to ensure proper soil contact.



Toe

Maintain slope angle

Berm

Trench into berm and progress downslope

Stream Channel

Erosion Control Blankets should be installed Horizontally with Stream Flow.

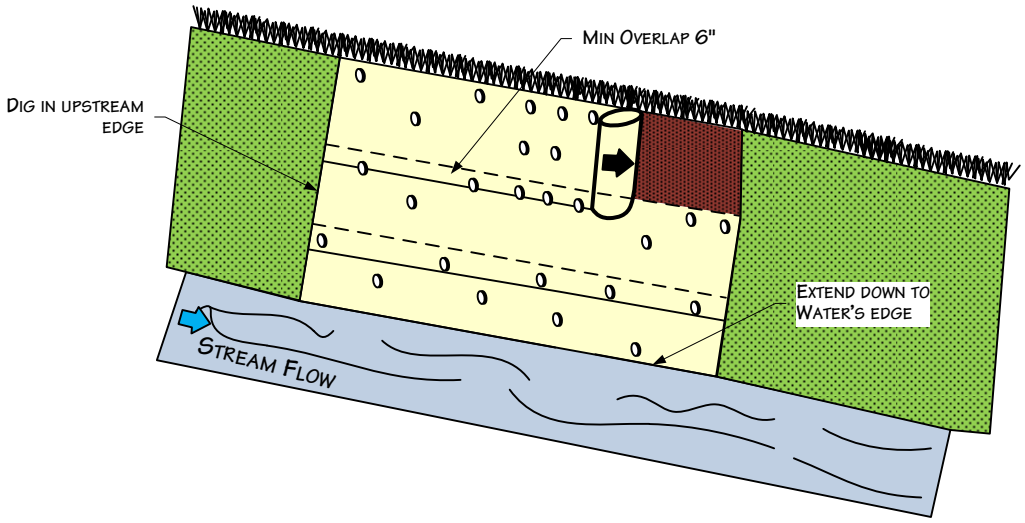


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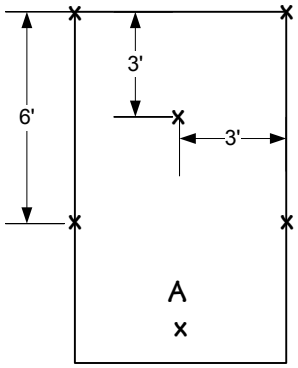
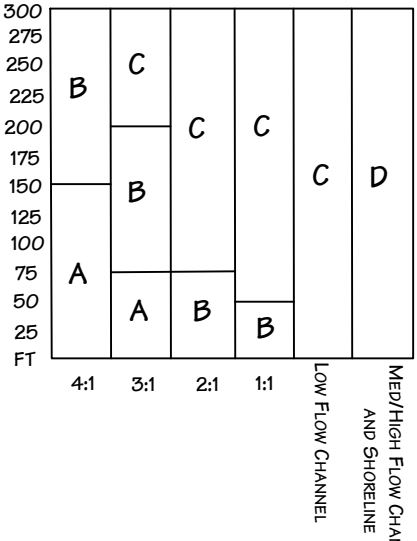
Figure 8
Environmental Protection Plan
Typical Erosion Control Blanket Installation

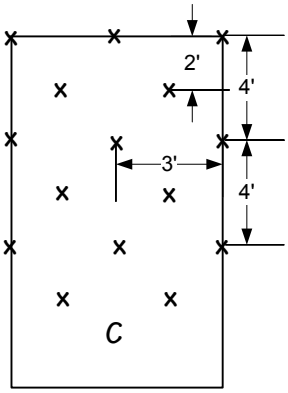
DATE:	5/25/2001
REVISED:	3/23/2011
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_8_EROSION_CONTROL_BLANKET_INSTALL.VSD

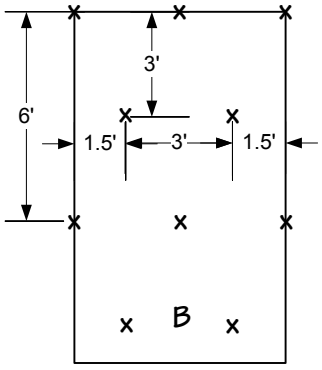


1 Staple Per Sq. Yd



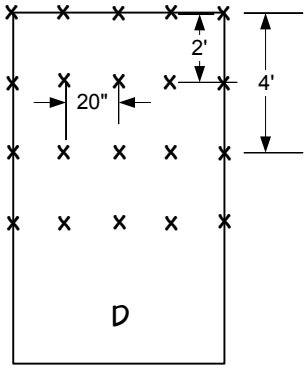


2 Staples Per Sq. Yd



1 ½ Staples Per Sq. Yd

For optimum results, these recommended staple pattern guides must be followed. Suggested anchoring methods vary according to the manufacturer. This chart shows how to slope lengths and how gradients affect sampling patterns.



3 1/2 Staples Per Sq. Yd

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Figure 9
Environmental Protection Plan
Typical Staple Pattern for Erosion Control Fabric

DATE:	5/25/2001
REVISED:	3/24/2011
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_9_STAPLE_PATTERN_EROSION_CONTROL_FABRIC.VSD

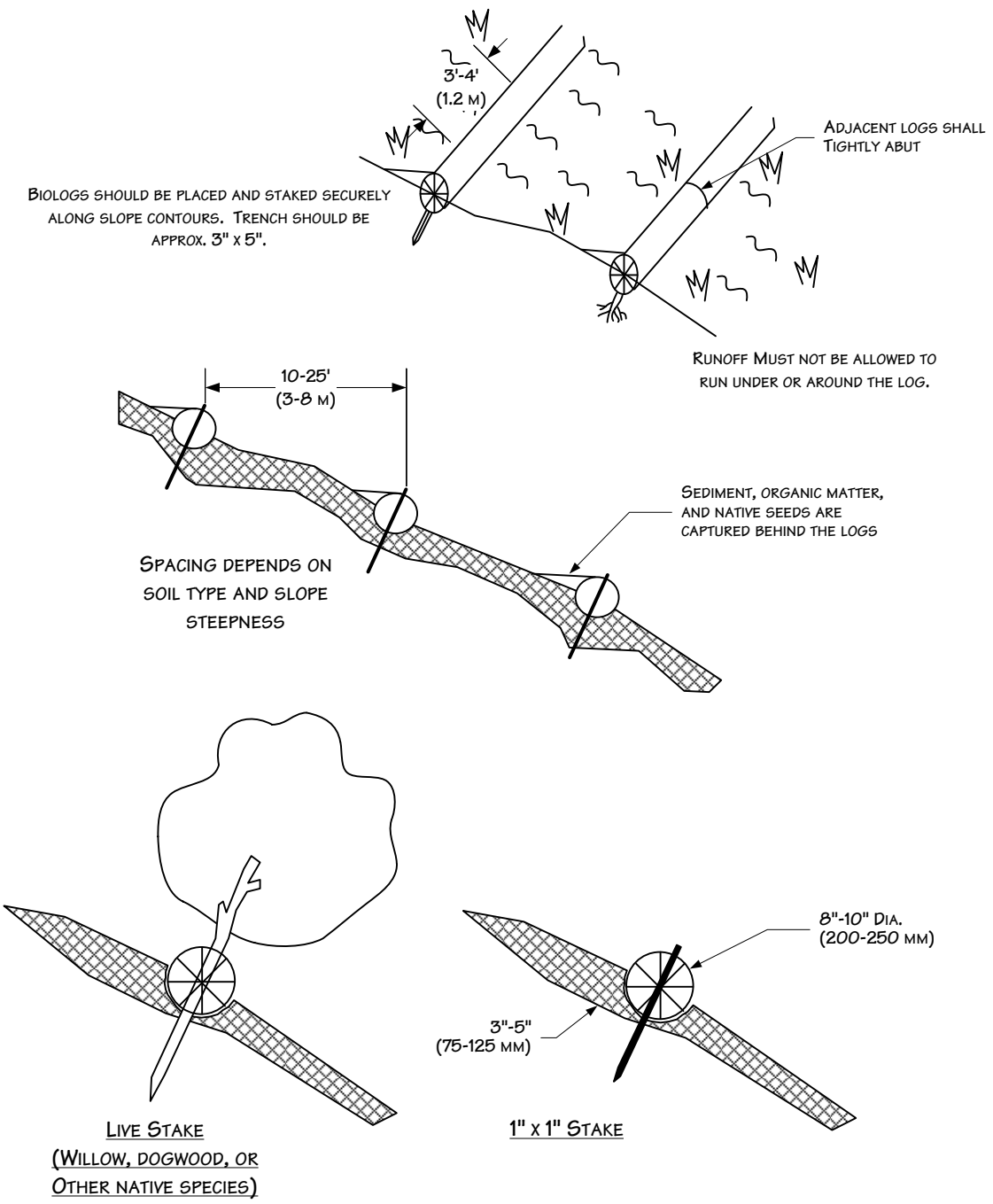

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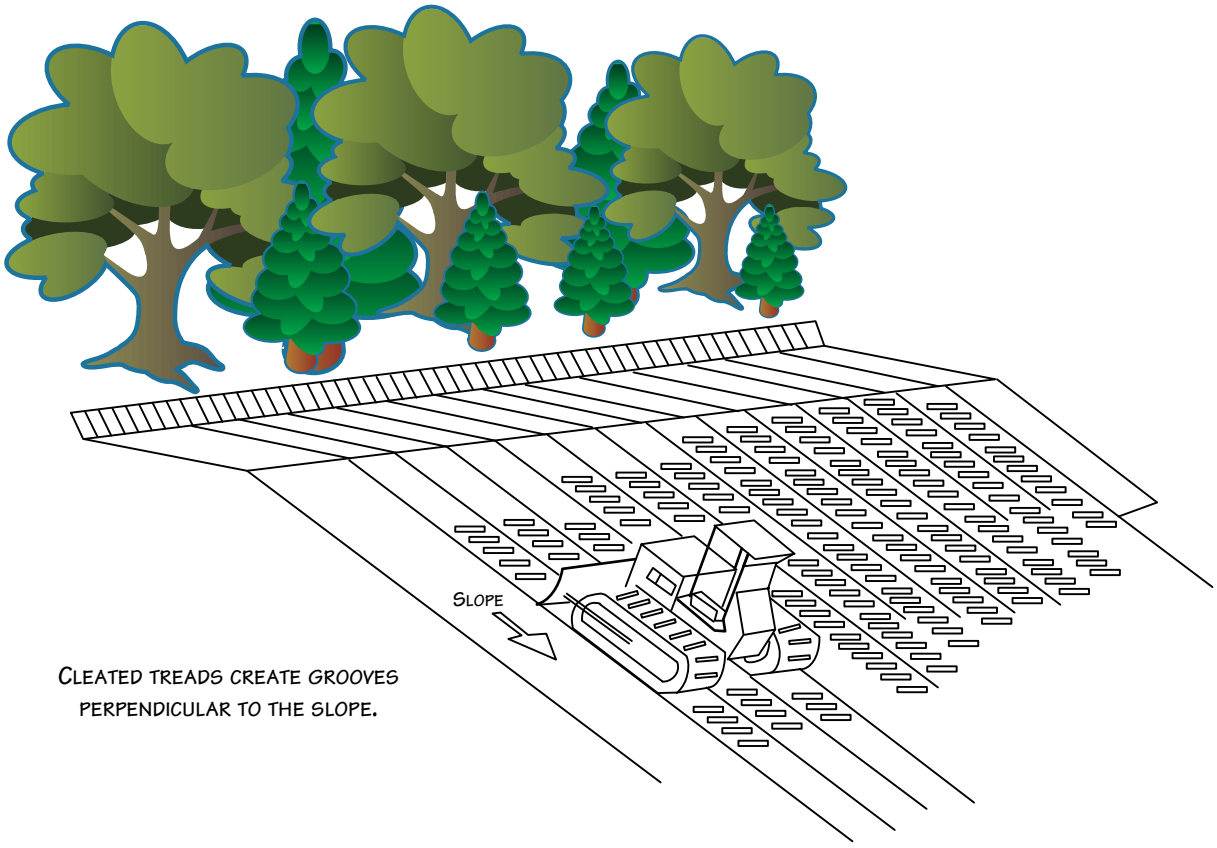
Figure 10
Environmental Protection Plan
Typical Biolog Installation

DATE:	5/25/2001
REVISED:	3/24/2011
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_10_BIOLOG INSTALL.VSD



CLEATED TREADS CREATE GROOVES PERPENDICULAR TO THE SLOPE.

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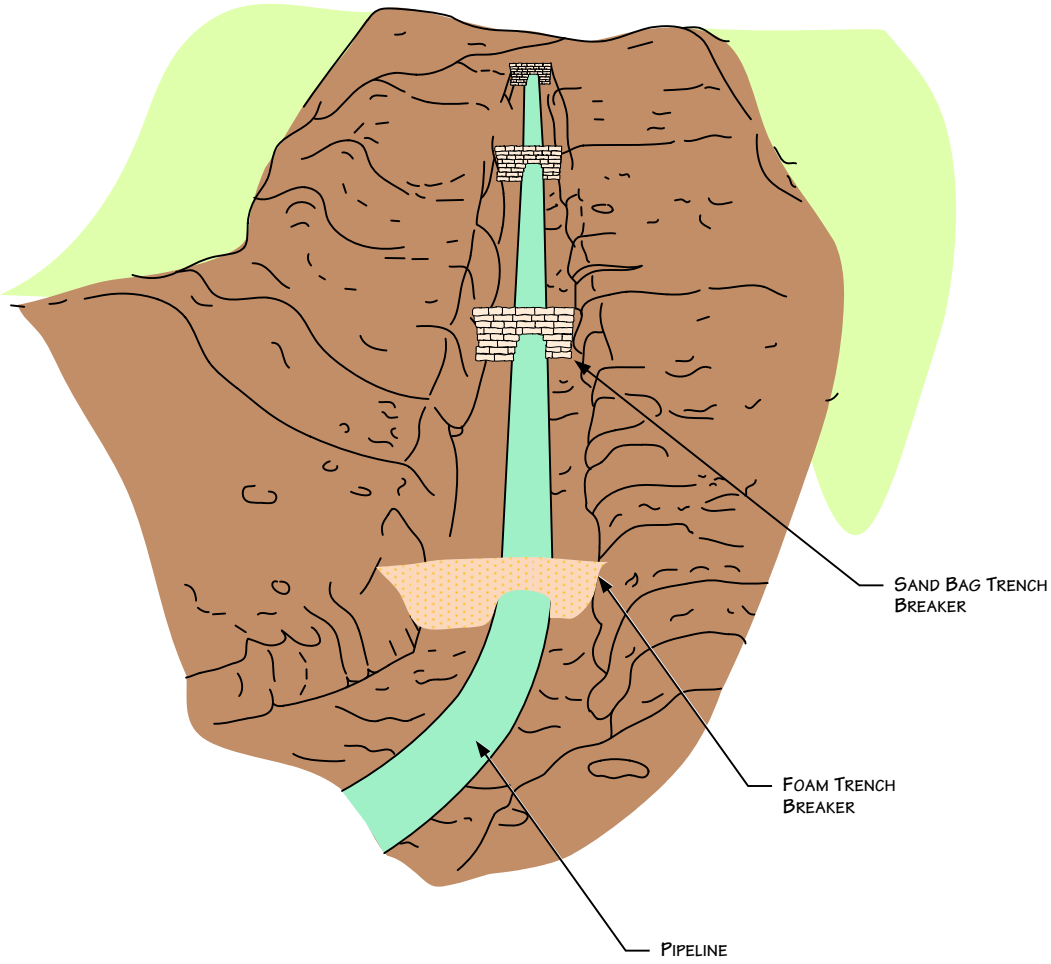
Figure 11
Environmental Protection Plan
Typical Cat Tracking

DATE:	5/25/2001
REVISED:	3/24/2011
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_11_CAT_TRACKING.VSD



NOTES

1. BAGS WILL NOT BE FILLED WITH TOPSOIL.
2. ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS.

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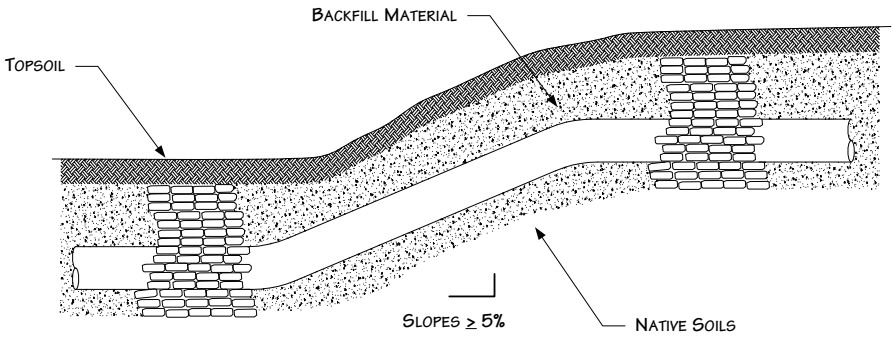
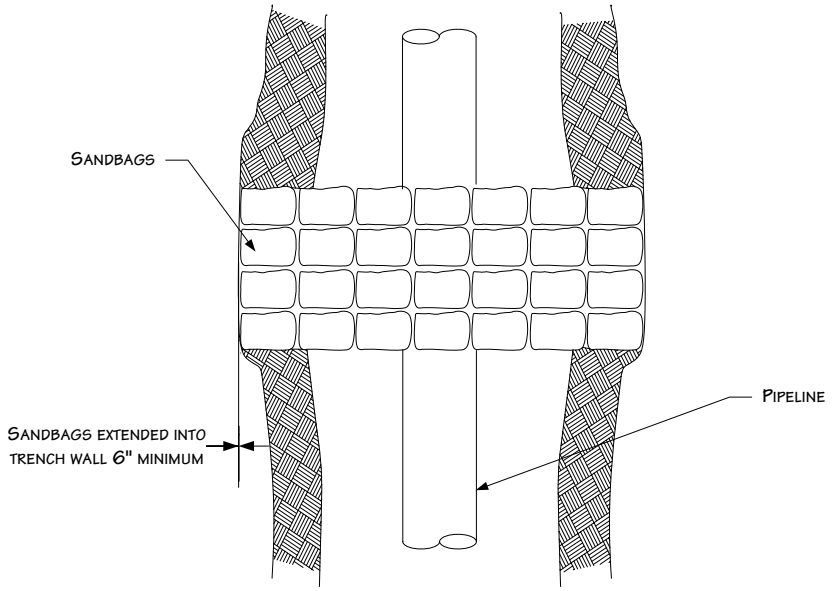
Figure 12
Environmental Protection Plan
Typical Trench Breakers - Perspective View

DATE:	5/25/2001
REVISED:	3/11/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

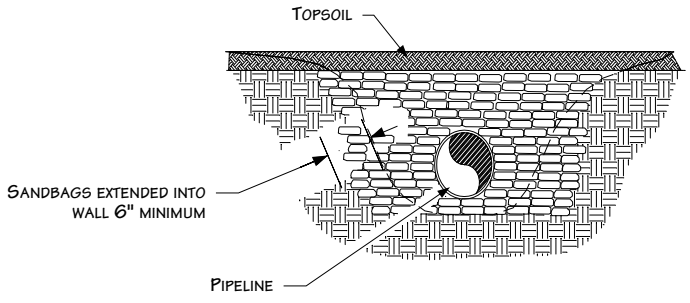
K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_12_TRENCH_BREAKER_PERSPECTIVE_VIEW.VSD



PROFILE VIEW
(NOT TO SCALE)



PLAN VIEW
(NOT TO SCALE)



FACE VIEW
(NOT TO SCALE)

NOTES

1. BAGS WILL NOT BE FILLED WITH TOPSOIL
2. ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS

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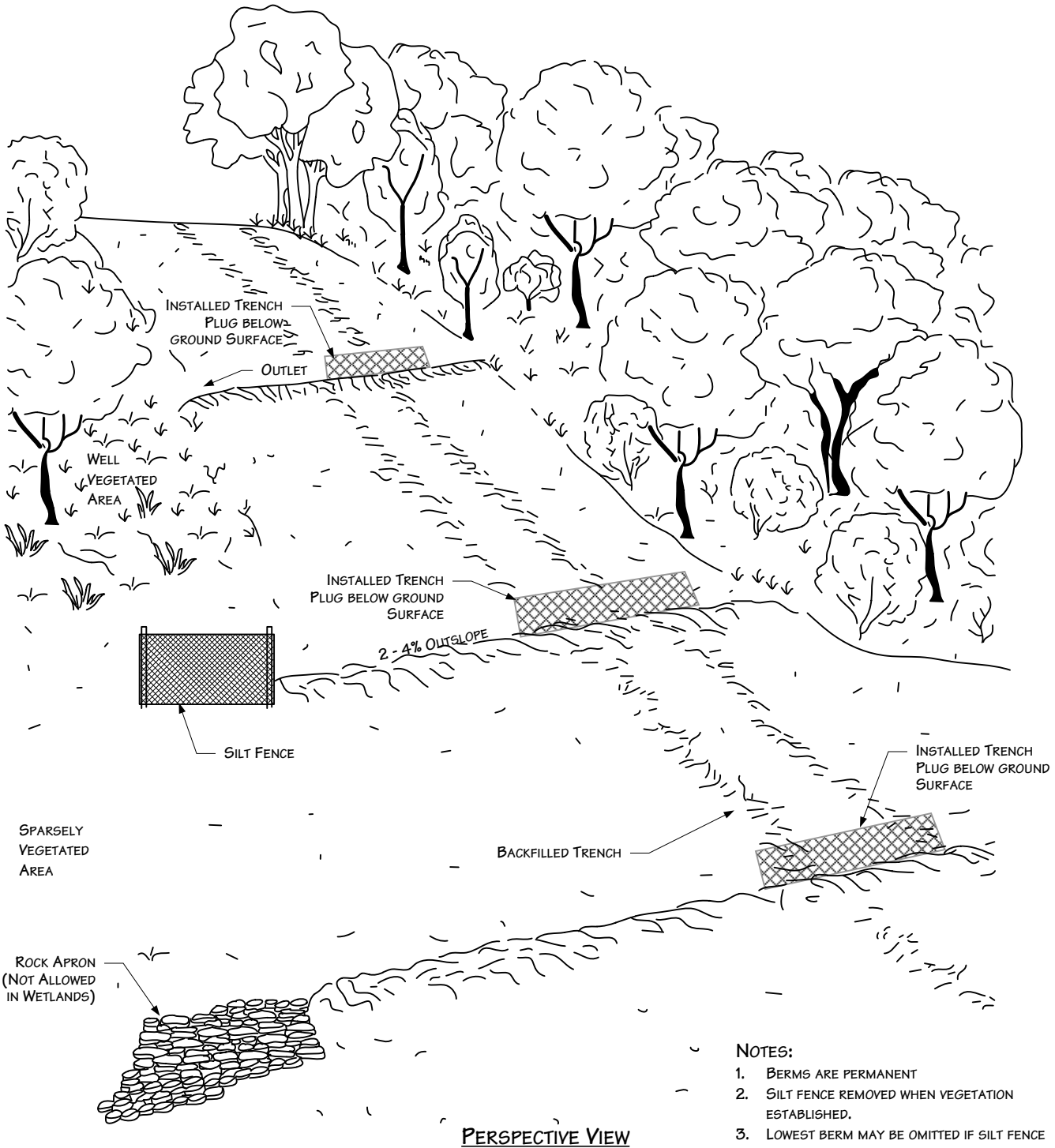
ENBRIDGE

Figure 13
Environmental Protection Plan
Typical Trench Breakers – Plan & Profile View

DATE:	11/15/2000
REVISED:	3/11/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_13_TRENCH_BREAKER_PLAN_PROFILE_VIEW.VSD



Perspective View
(not to scale)

Slope %	Approximate Spacing (FT)
3-5	250
5-15	200
15-25	150
>25	<100

Notes:

1. Berms are permanent
2. Silt fence removed when vegetation established.
3. Lowest berm may be omitted if silt fence or straw bales are installed at that location, subject to approval.
4. Install silt fence or straw bales at discharge end of earthen berms as necessary to dissipate energy and prevent erosion.

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Figure 14

Environmental Protection Plan

Permanent Slope Breakers - Perspective View

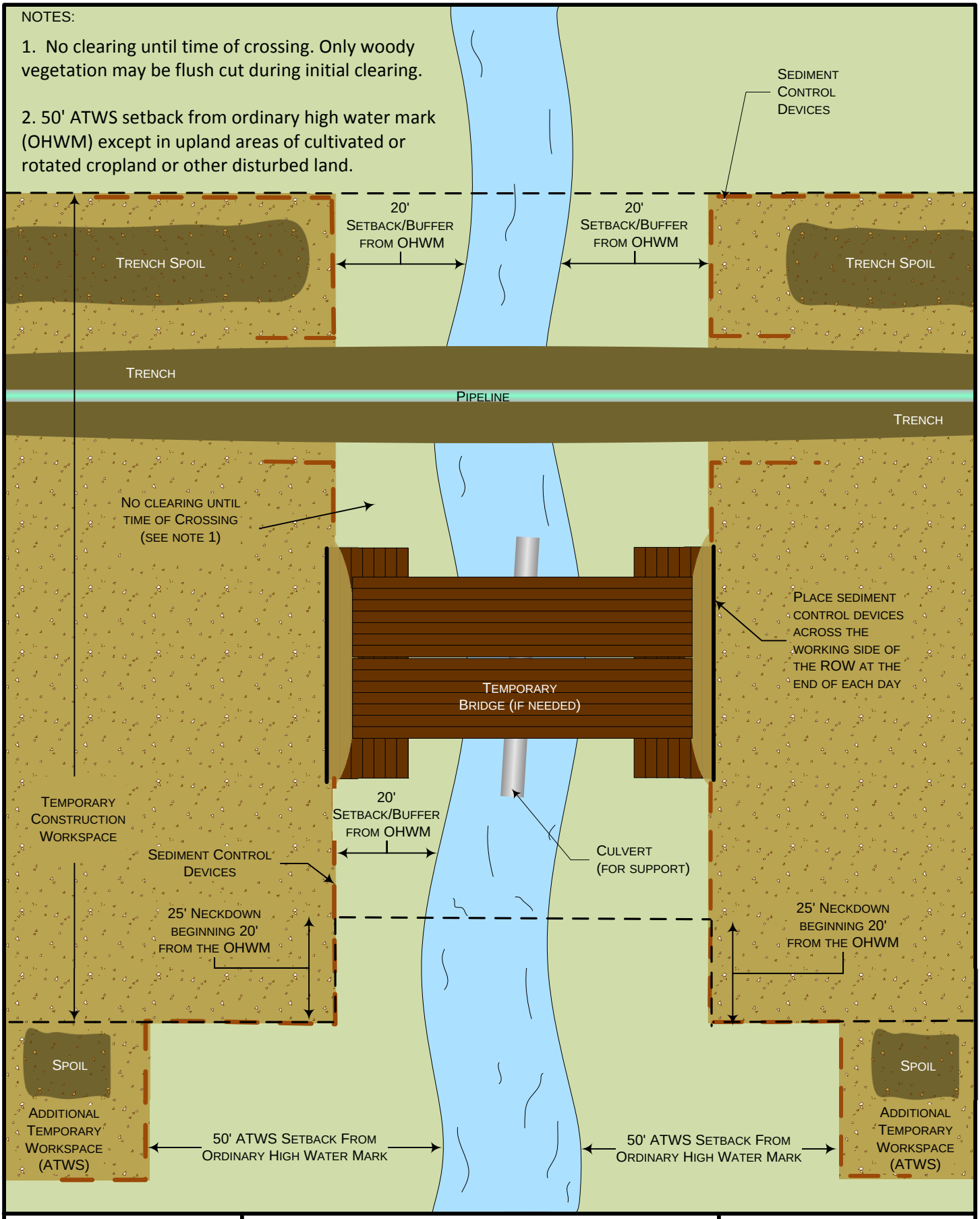
DATE:	5/25/2001
REVISED:	3/11/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_14_SLOPE_BREAKERS_PERSPECTIVE_VIEW.VSD

NOTES:

1. No clearing until time of crossing. Only woody vegetation may be flush cut during initial clearing.

2. 50' ATWS setback from ordinary high water mark (OHWM) except in upland areas of cultivated or rotated cropland or other disturbed land.

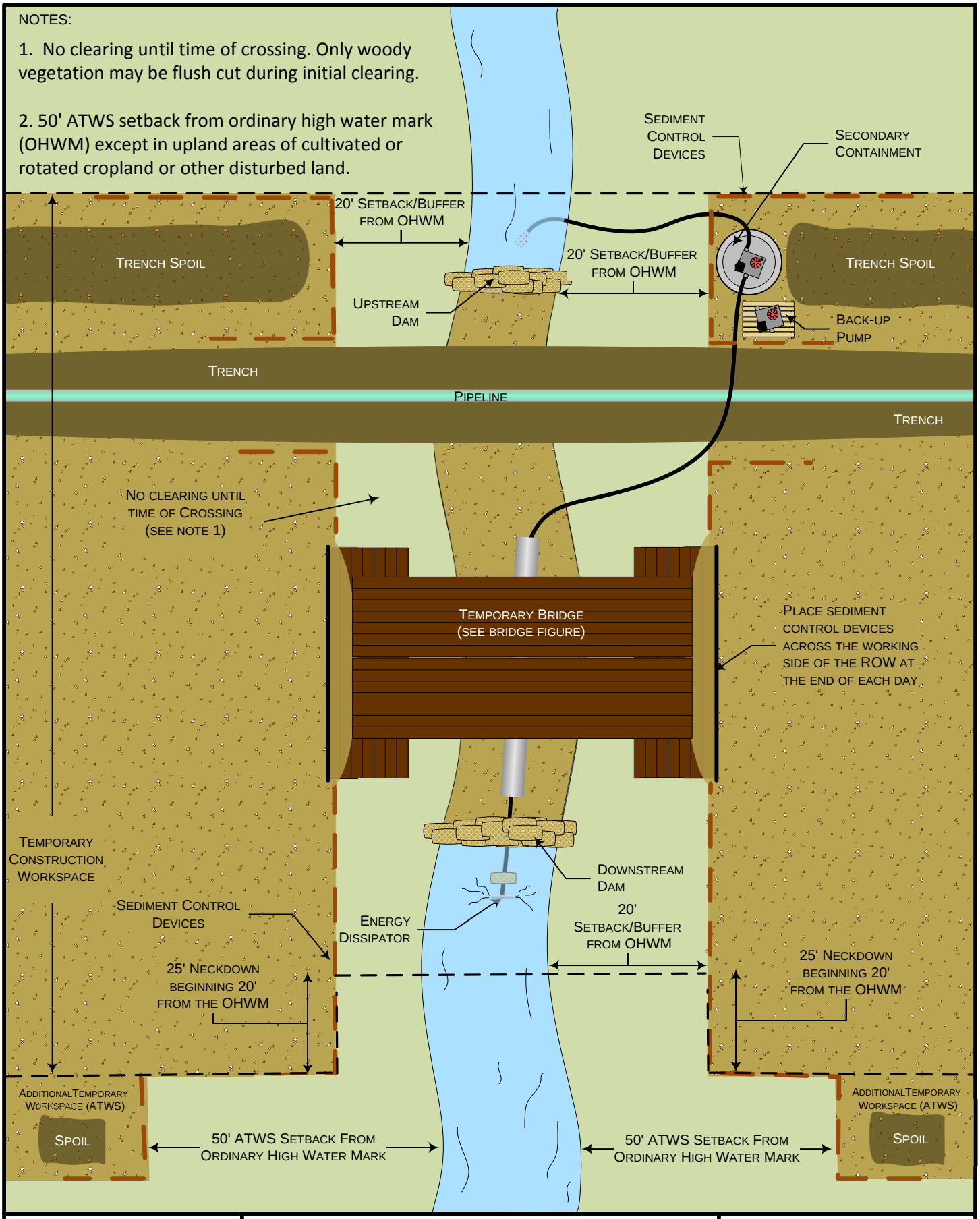


ENBRIDGE

Figure 15
Typical Waterbody Crossing
Open-Cut Wet Trench Method

Environmental Protection Plan

Drawn by: merjent 9/17/2015



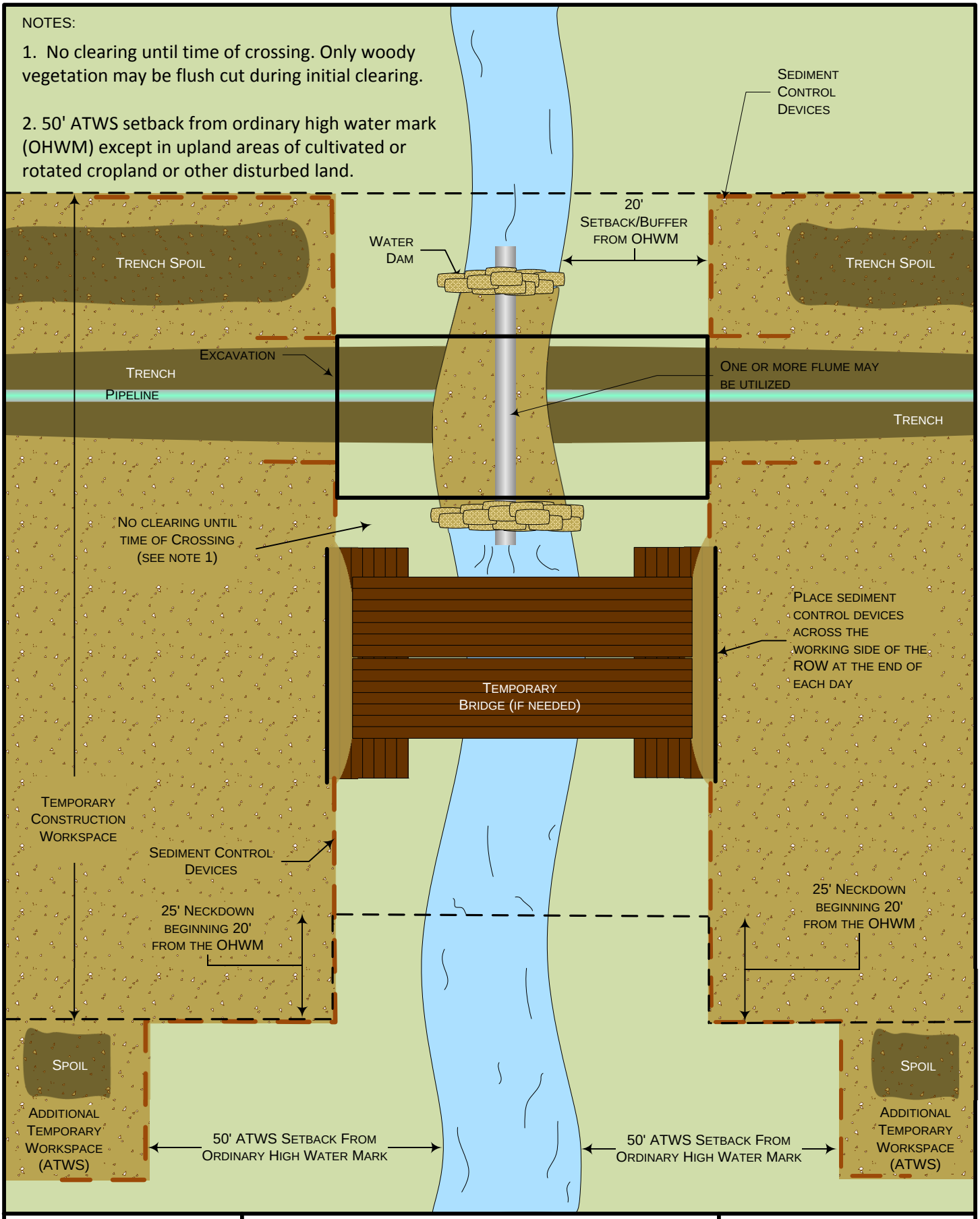
ENBRIDGE

Figure 16
Typical Waterbody Crossing
Dam and Pump Method

Environmental Protection Plan

Drawn by: merjent

9/14/2015



ENBRIDGE

Figure 17
Typical Waterbody Crossing
Flume Method

Environmental Protection Plan

Drawn by: merjent 9/14/2015

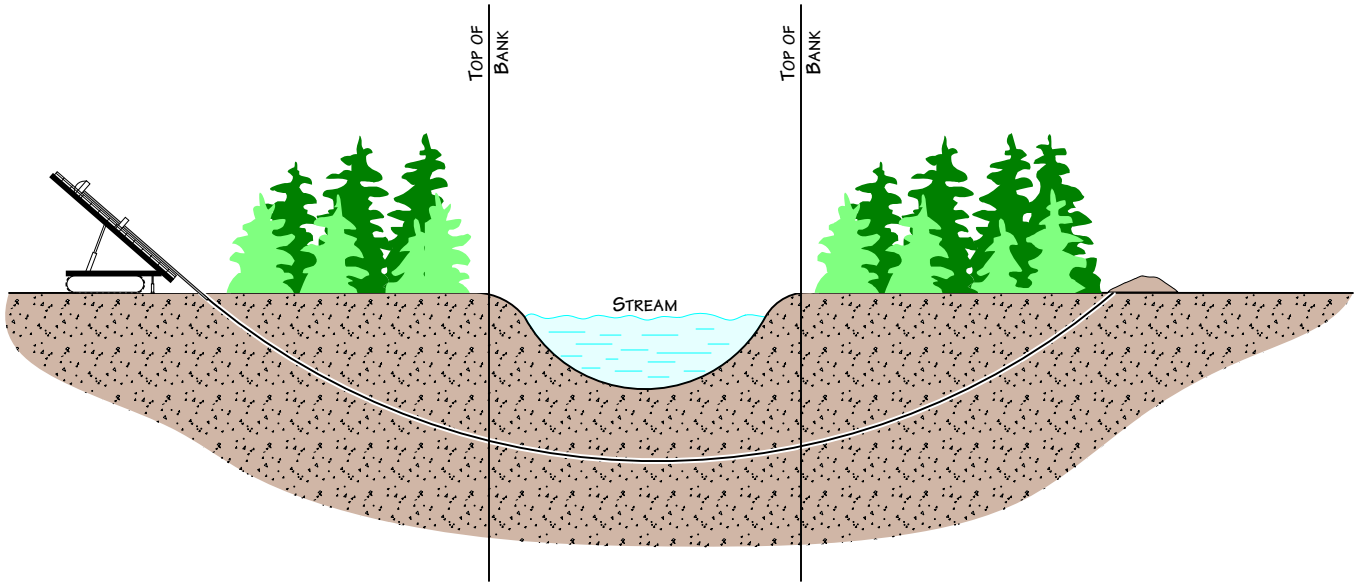


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Figure 18

Environmental Protection Plan

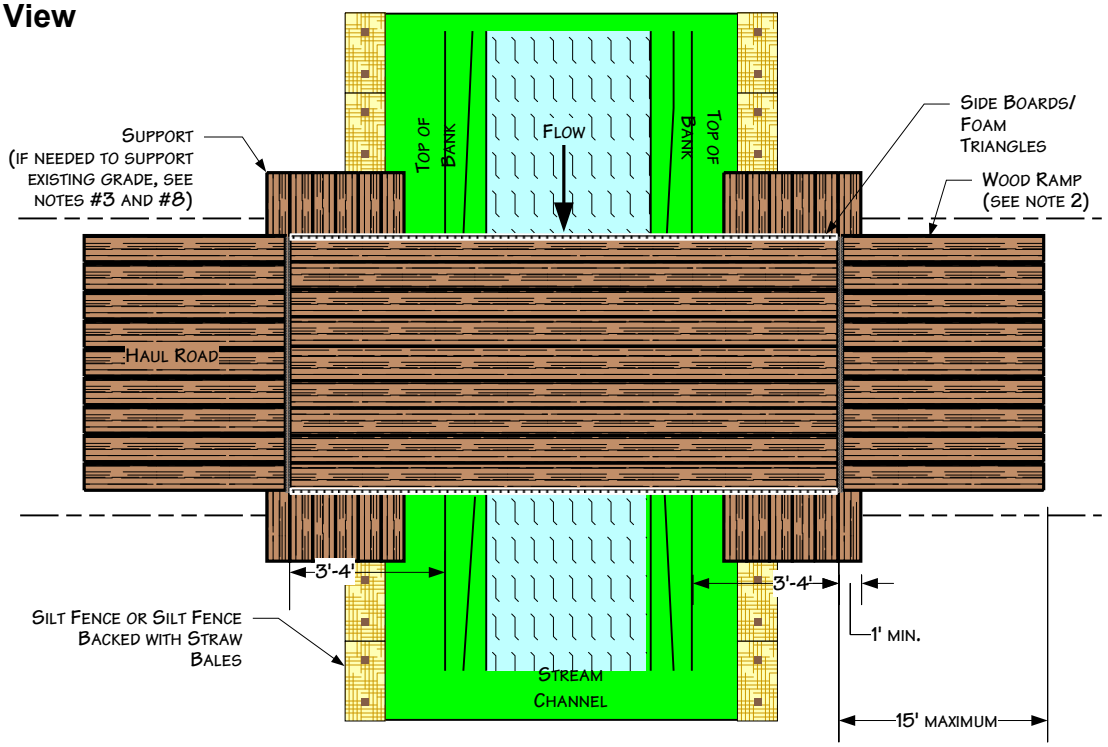
Typical Waterbody Crossing
Directional Drill Method

DATE:	7/14/2000
REVISED:	3/11/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

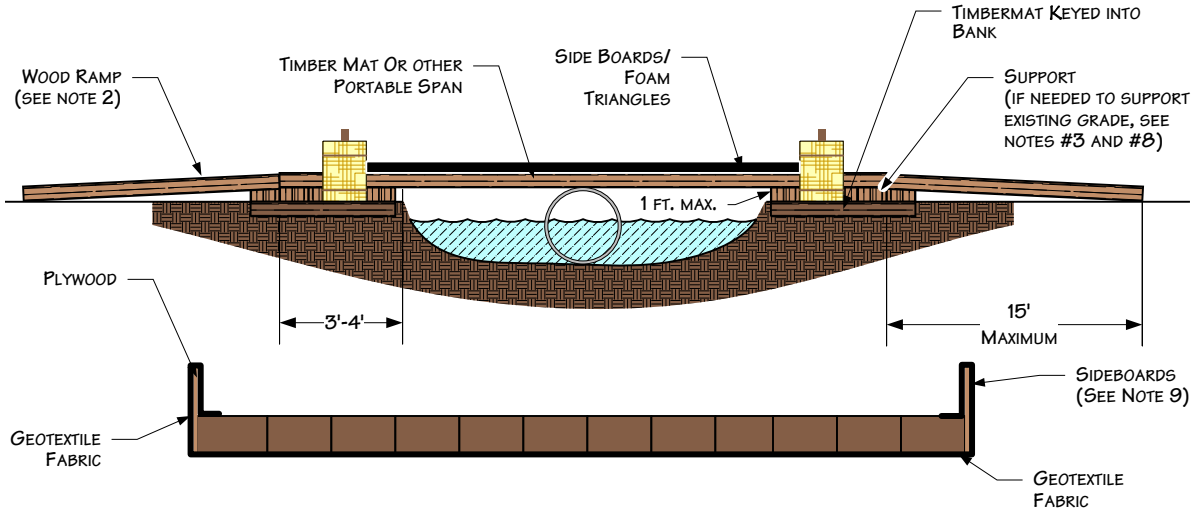
NATURAL RESOURCE GROUP

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_18_WATERBODY_DIRECTIONAL_DRILL.VSD

Plan View



Profile View



Notes:

1. Inspect bridge opening periodically and following rainfalls of over ½". Remove any debris restricting flow and deposit it at an upland site outside of floodplain.
2. If physical circumstances prohibit wood or metal ramps, earthen ramps may be used as approved.
3. Inspect bridge elevation so bridge remains supported above OHWM.
4. The culvert support must be anchored to the stream bottom and may not be supported with fill.
5. Earthen ramp cannot be taller than 1' and cannot extend for more than 15' on either side of the crossing.
6. The bridge must span above OHWM to OHWM.
7. Additional support must be added on top of bank and under span if initial support starts to settle.
8. Erosion and sedimentation control measures shall be inspected and maintained in accordance with the company's Environmental Protection Plan
9. Sideboards will be installed on temporary bridges to minimize the potential for sediment transport. Sideboards may be constructed out of plywood, or equivalent, and affixed to the outer sides of the bridge. Geo-textile fabric, or equivalent, must also be adequately secured to the underside of the bridge to prevent material from falling through the bridge deck. The geo-textile fabric or an equivalent should be secured to the bottom of the bridge and wrapped around the sideboards in a continuous fashion.

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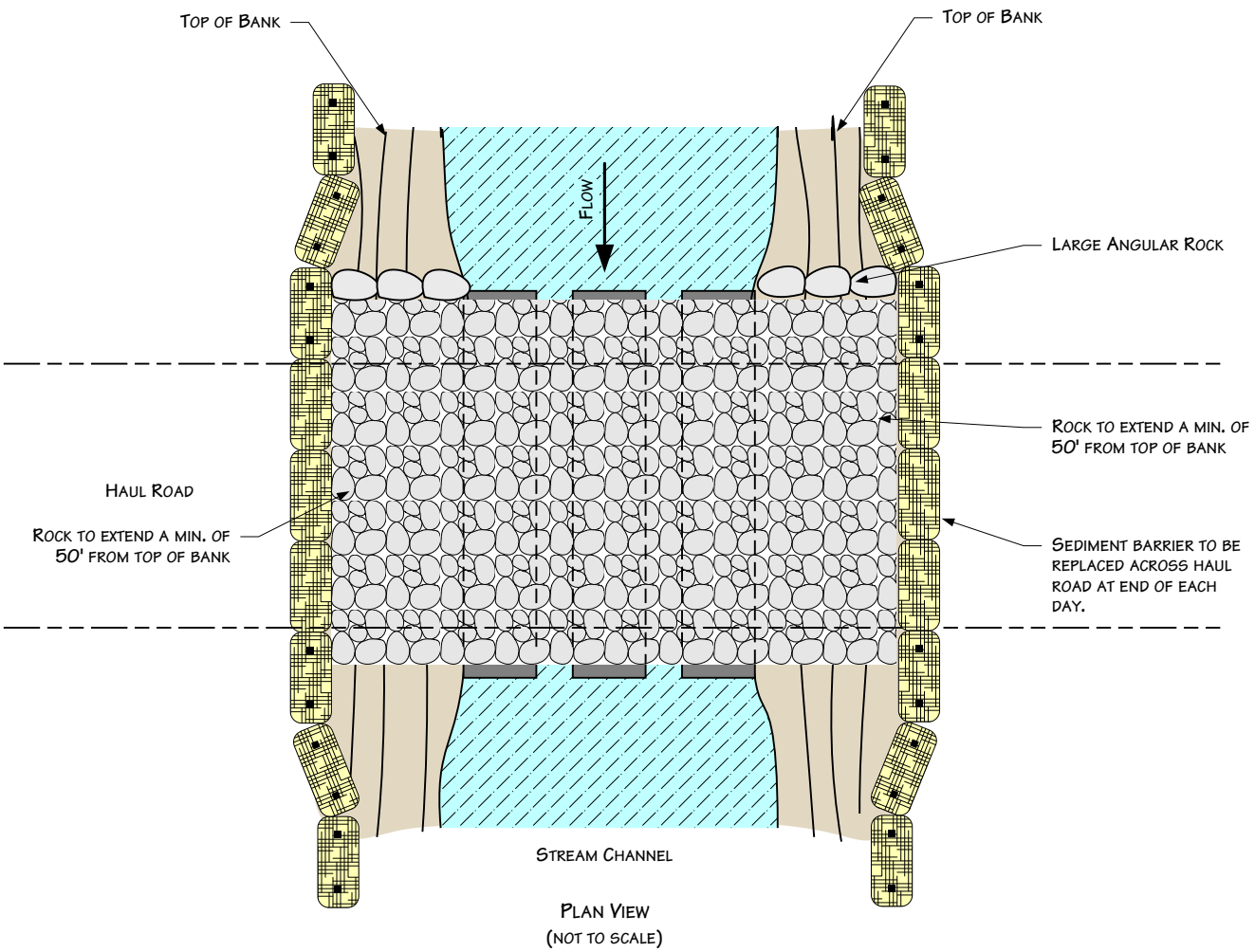
Figure 19

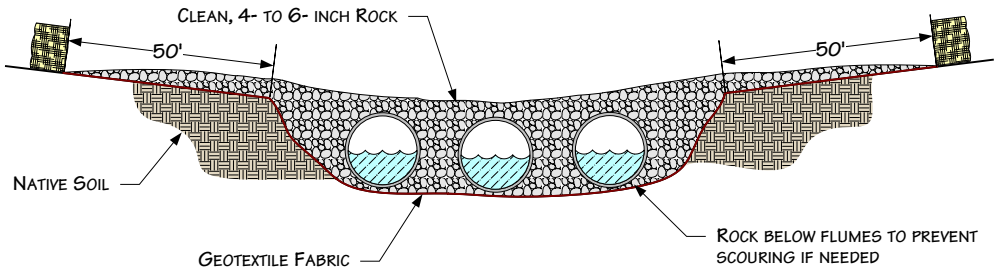
Environmental Protection Plan

Typical Span Type Bridge
With or Without Instream Support

DATE:	3/11/2003
REVISED:	3/25/2011
SCALE:	NTS
DRAWN BY:	KMK6792

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_19_BRIDGE_SPAN.VSD





NOTES:

1. STEEL FLUME PIPE(S) SIZED TO ALLOW FOR STREAM FLOW AND EQUIPMENT LOAD.
2. STRAW BALES SHALL BE PLACED ACROSS BRIDGE ENTRANCE EVERY NIGHT.
3. ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS.

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Figure 20

Environmental Protection Plan

Typical Rock Flume Bridge

DATE:	5/25/2001
REVISED:	3/15/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

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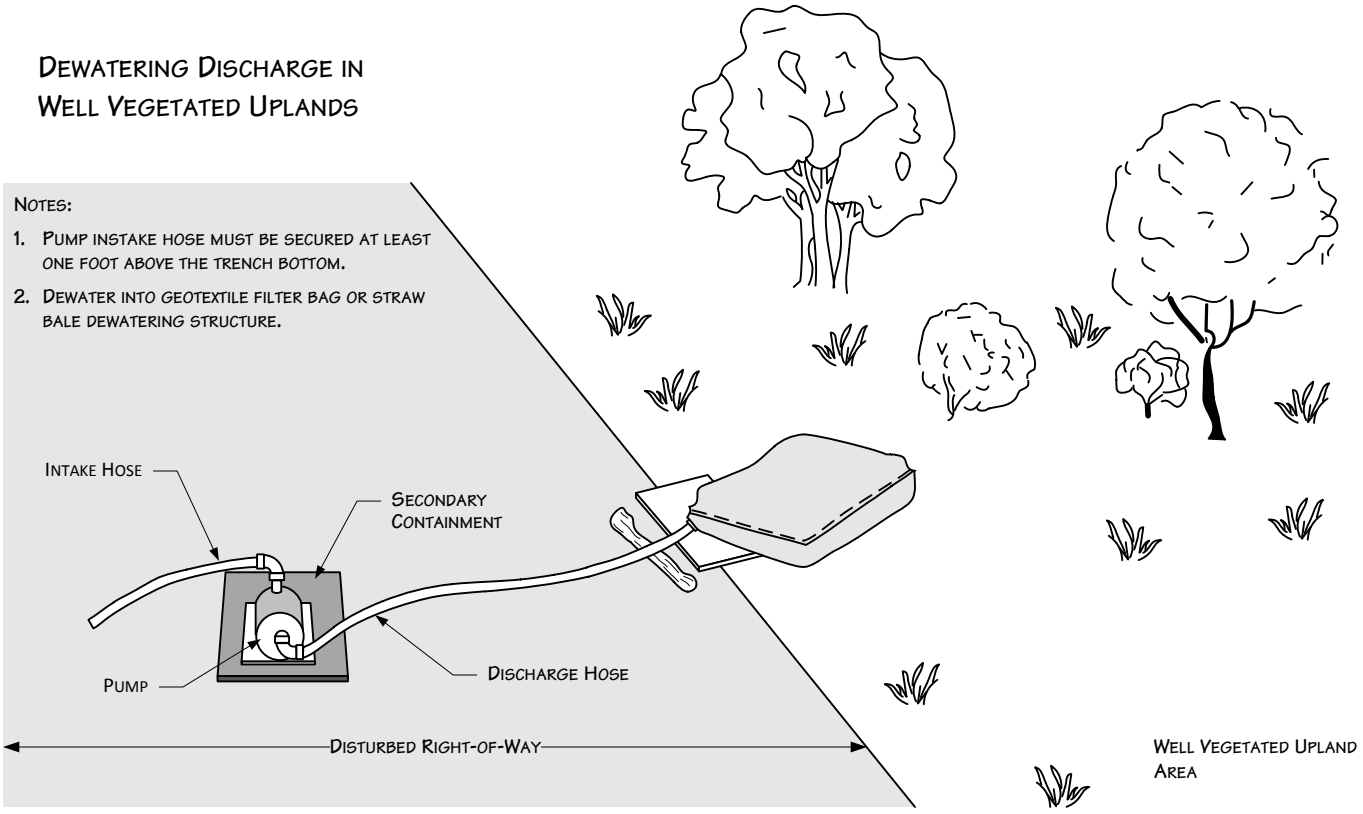
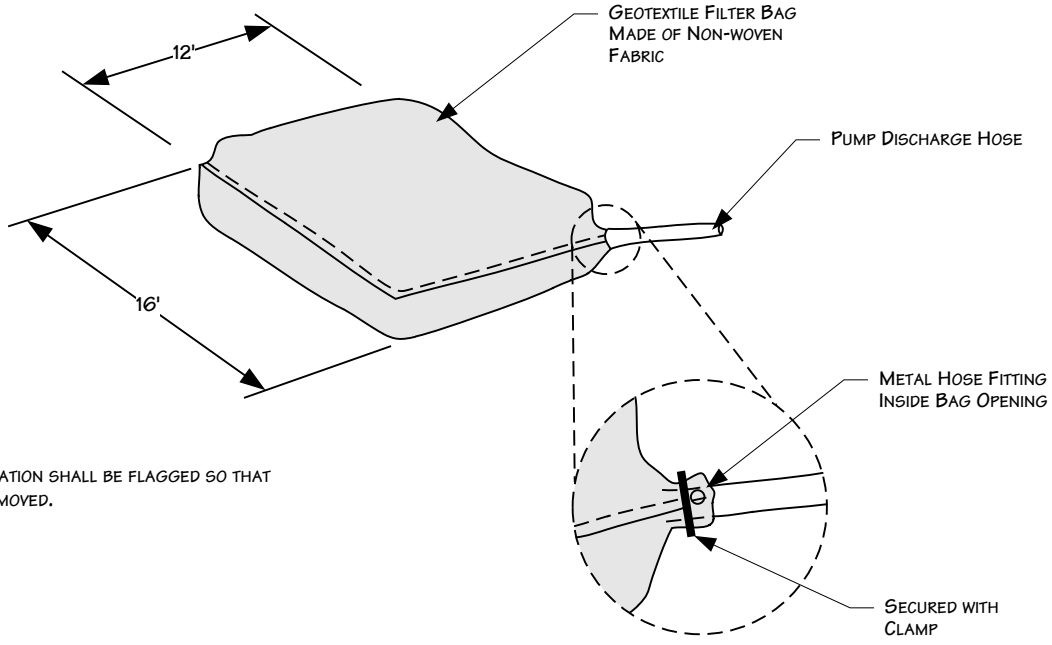
K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_20_ROCK_FLUME_BRIDGE.VSD

Dewatering Discharge in Well Vegetated Uplands



Geotextile Filter Bag



Note:

1. Filter bag location shall be flagged so that bag can be removed.

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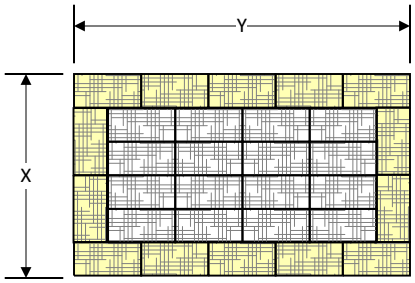
Figure 21
Environmental Protection Plan
Typical Dewatering Measures

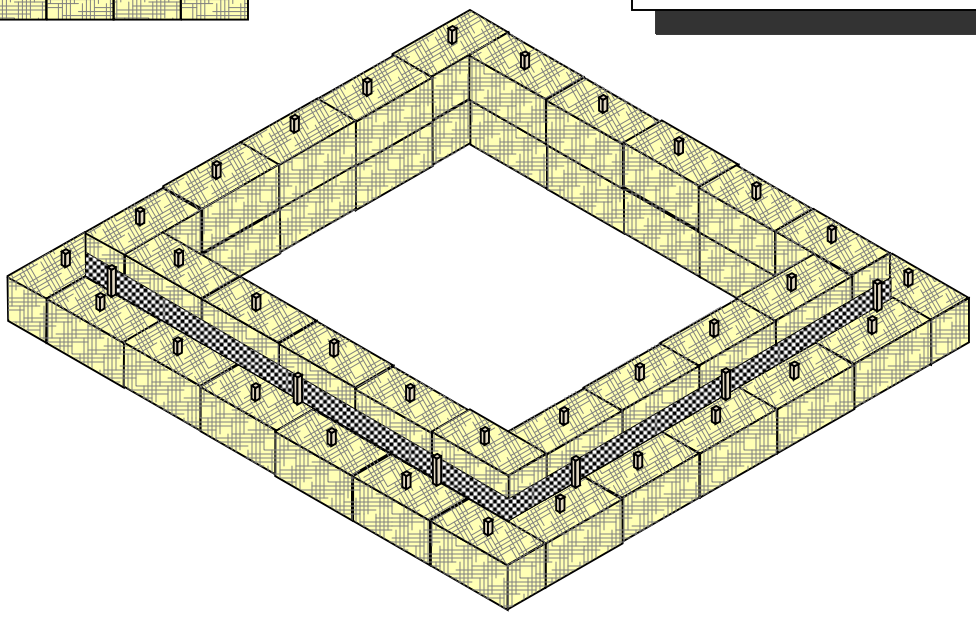
DATE:	5/25/2001
REVISED:	3/15/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_21_DEWATERING_MEASURES.VSD

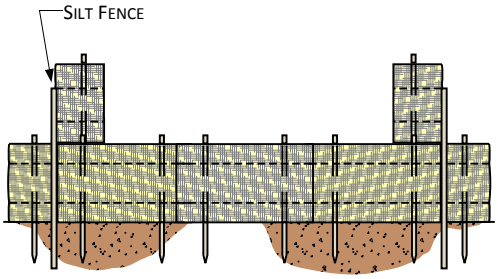


NOTES

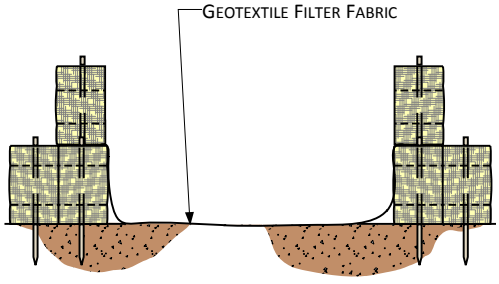
1. ARRANGE THE STRAW BALES TO THE X AND Y DIMENSIONS AS SPECIFICIED BELOW.
2. IF BOTTOM OF STRUCTURE IS NOT LINED WITH STRAW BALES (OPTION 1), LINE ENTIRE STRUCTURE WITH GEOTEXTILE FILTER FABRIC.



PERSPECTIVE VIEW



OPTION 1



OPTION 2

TYPICAL MINIMUM SUMP DIMENSIONS (FEET)		MAXIMUM PUMPING RATE
X	Y	GALLONS PER MINUTE
10	20	300
15	20	350
20	20	400
20	25	450
25	25	500
25	30	550
30	30	660

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Figure 22A
Environmental Protection Plan
Straw Bale Dewatering Structure

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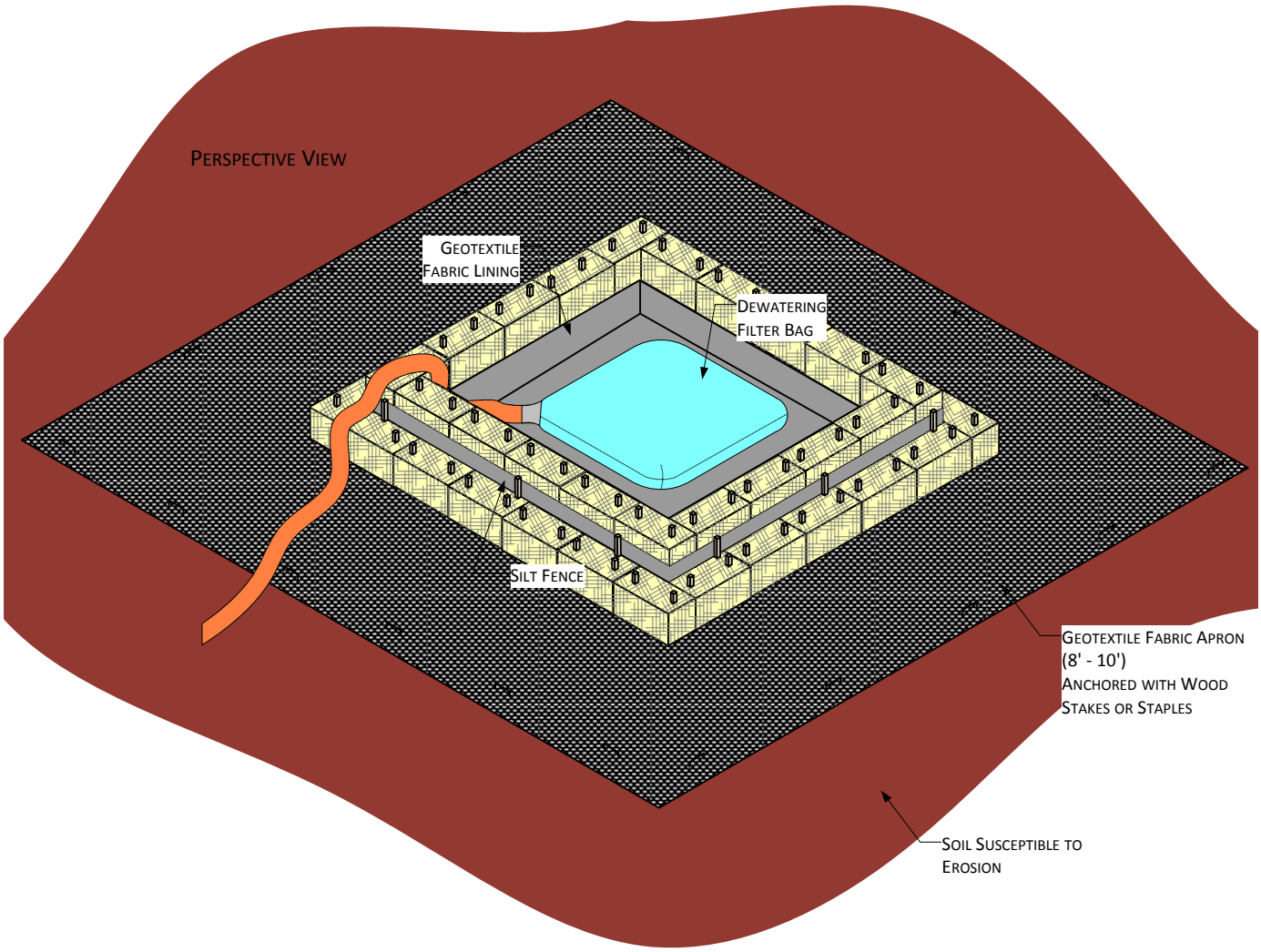
K:_CLIENT_PROJECTS\D-FEEL\2011-019\FIG_22_STRAW_BALE_DEWATERING_STRUCTURE_C.VSD	SCALE: NTS	DATE: 3/11/2003	REVISED: 3/25/2011	DRAWN BY: KJANDERSON



Construct Dewatering Structure to accommodate anticipated pumping rates. See example below.

Example Pumping rate = 200 g.p.m.
Storage volume (c.f.) = 16 x 200 g.p.m. = 3200 c.f.
Height of straw bale structure = 3 feet (2 bales stacked) (based on height of bales, not silt fence)
Inside dimensions of structure = 33 x 33 feet square

Notes:

1. Silt fence ends must be wrapped to join two sections.
2. Install silt fence 2 inches above top of straw bales, and anchor a minimum of 8 inches straight down.
3. Silt fence post staking must be 4 feet or less.
4. Dewatering intake hose supported at least 1 foot from bottom of trench being dewatered.
5. Erosion and sedimentation control measures shall be inspected and maintained in accordance with the company's upland erosion control, revegetation, and maintenance plan.

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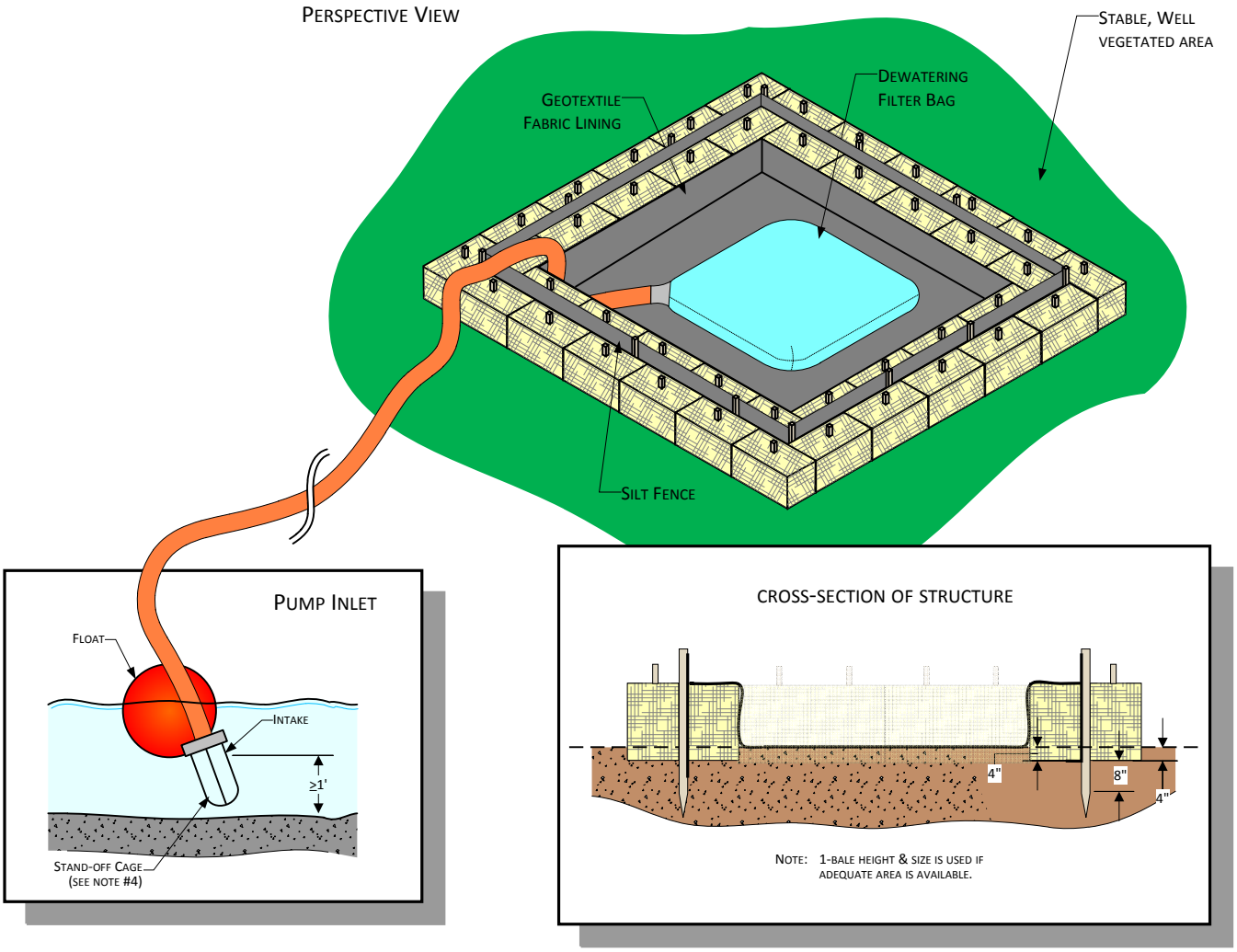
Figure 22B
Environmental Protection Plan
Straw Bale Dewatering Structure

NATURAL RESOURCE GROUP

K:_CLIENT_PROJECTS\D-FEEL\2011-019\FIG_22_STRAW_BALE_DEWATERING_STRUCTURE_C.VSD	SCALE: NTS	DATE: 3/11/2003	REVISED: 3/25/2011	DRAWN BY: KJANDERSON



CONSTRUCT DEWATERING STRUCTURE TO ACCOMMODATE ANTICIPATED PUMPING RATES. SEE EXAMPLE BELOW.

EXAMPLE PUMPING RATE = 200 G.P.M.
STORAGE VOLUME (C.F.) = 16 X 200 G.P.M. = 3200 C.F.
HEIGHT OF STRAW BALE STRUCTURE = 1.5 FEET (1 BALE) (BASED ON HEIGHT OF BALES, NOT SILT FENCE)
INSIDE DIMENSIONS OF STRUCTURE = 46 X 46 FEET SQUARE

NOTES:

1. SILT FENCE ENDS MUST BE WRAPPED TO JOIN TWO SECTIONS.
2. INSTALL SILT FENCE 2 INCHES ABOVE TOP OF STRAW BALE, AND ANCHOR A MINIMUM OF 8 INCHES STRAIGHT DOWN.
3. SILT FENCE POST STAKING MUST BE 4 FEET OR LESS.
4. DEWATERING INTAKE HOSE SUPPORTED AT LEAST 1 FOOT FROM BOTTOM OF TRENCH BEING DEWATERED.
5. USE A FILTER BAG AT THE DISCHARGE HOSE END.
6. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE COMPANY'S UPLAND EROSION CONTROL, REVEGETATION, AND MAINTENANCE PLAN.

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Figure 22C
Environmental Protection Plan
Straw Bale Dewatering Structure

NATURAL RESOURCE GROUP

NOTE: PLACE JUTE BLANKET A MINIMUM OF ONE (1) FOOT UNDER RIP RAP. EXTEND JUTE BLANKET FROM MEAN HIGH WATER LEVEL TO SEVERAL FEET BEHIND HIGH BANK.

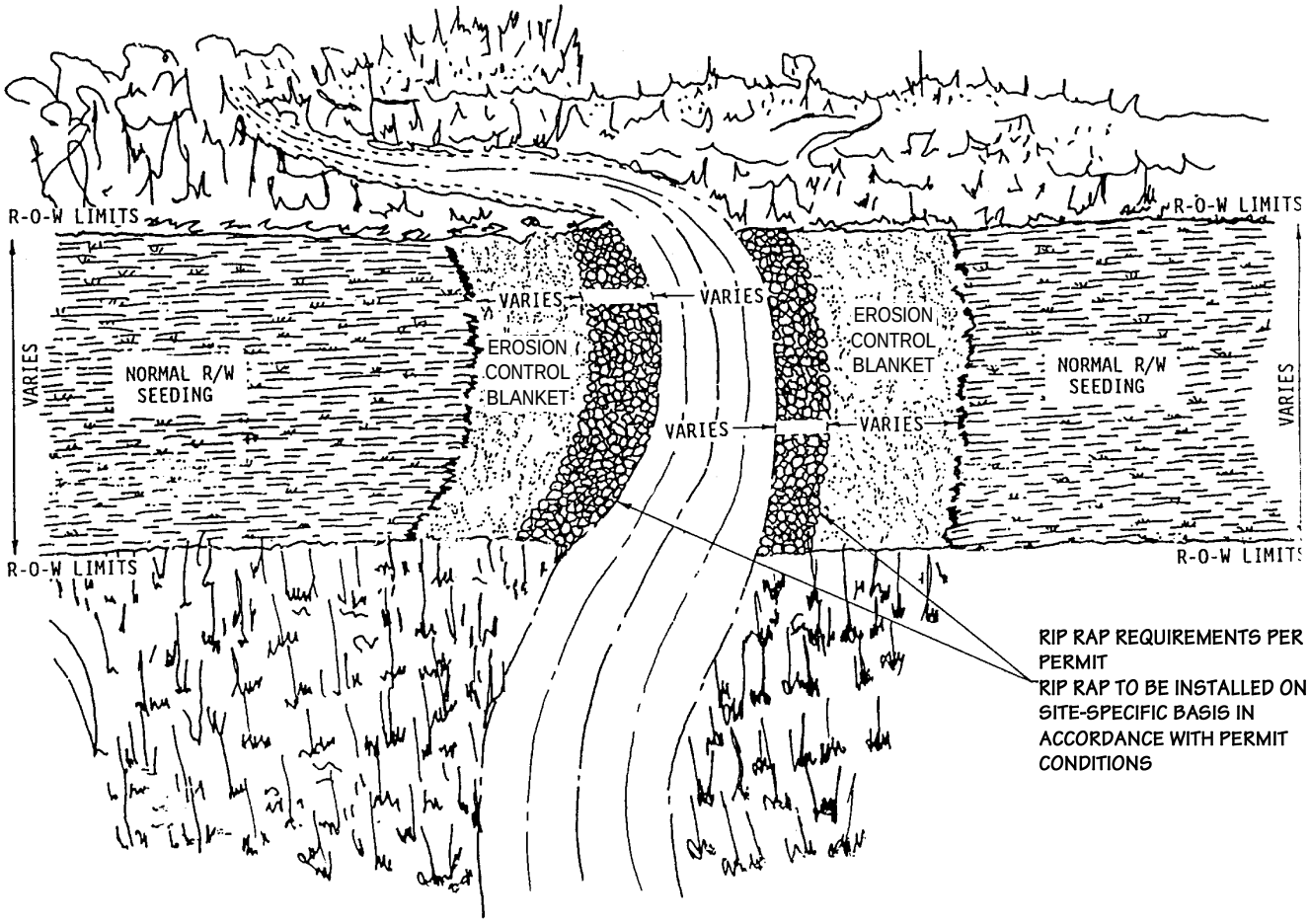

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Figure 23

Environmental Protection Plan

Typical Final Stream Bank Stabilization
Rip Rap & Erosion Control

DATE:	7/19/2000
REVISED:	3/14/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_23_STREAM_BANK_STABILIZATION.VSD

NATURAL RESOURCE GROUP

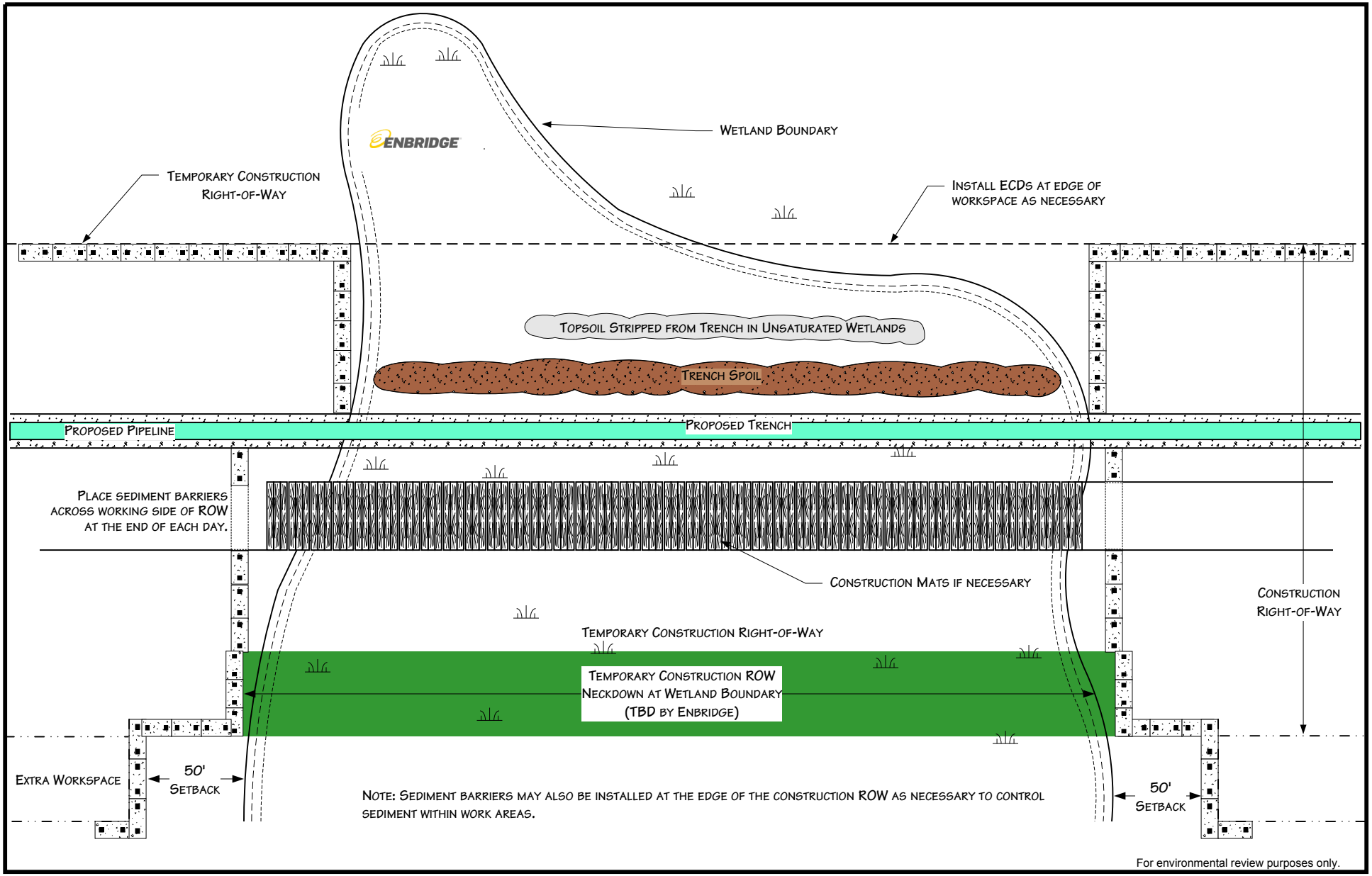

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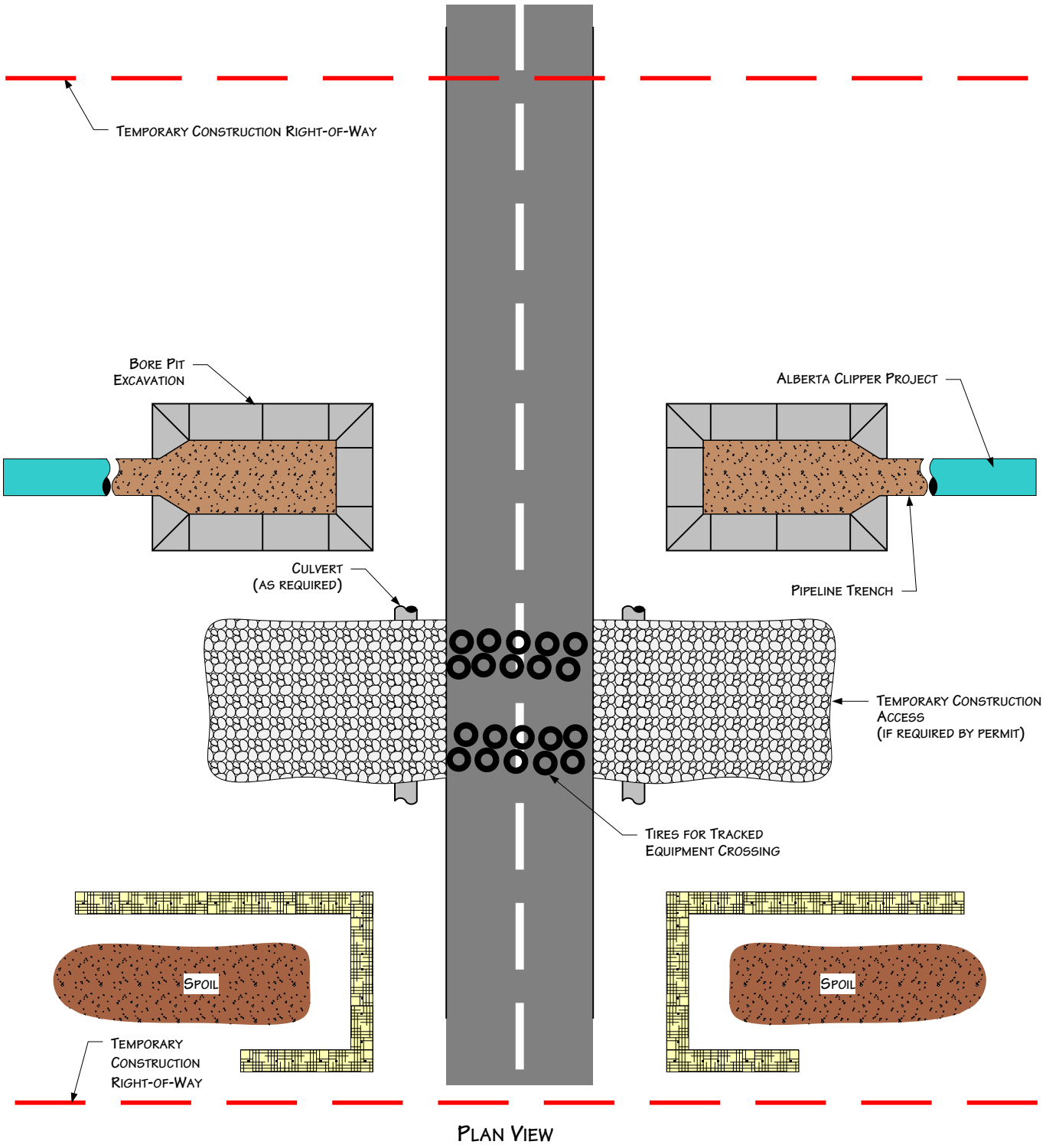
Figure 24
Environmental Protection Plan
Typical Wetland Crossing Method

DATE:	5/25/2001
REVISED:	3/14/11
SCALE:	NTS
DRAWN BY:	KMKENDALL

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_24_WETLAND_CROSSING_METHOD.VSD



Plan View

Notes

1. Procedures shown in this drawing apply to improved roads.
2. Roads must be cleaned after equipment crosses and dirt placed in spoil containment areas.
3. Temporary access materials must be removed upon project completion.
4. Additional information included on other drawings or permits.
5. Construction areas located outside road ROW.

For environmental review purposes only.

ENBRIDGE

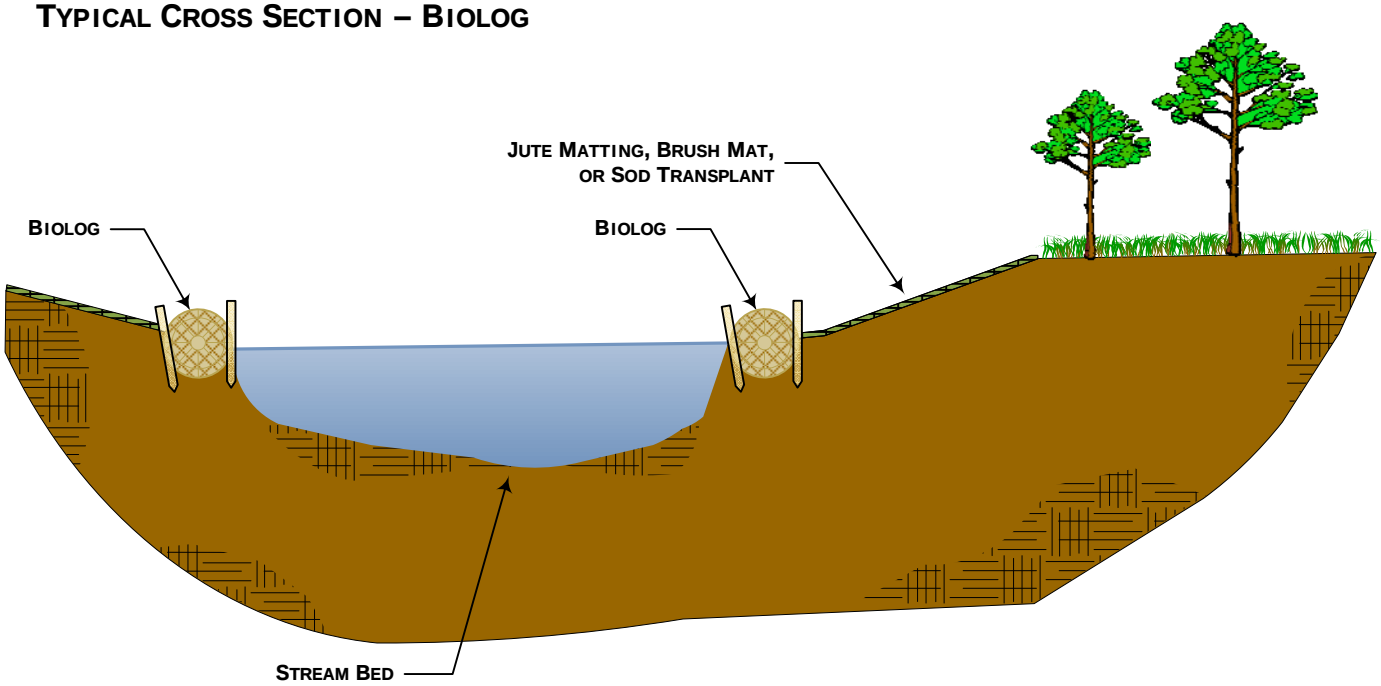
Figure 25
Environmental Protection Plan
Typical Improved Road Crossing
Directional Bore Method

DATE: 7/13/1999
REVISED: 3/14/11
SCALE: NTS
DRAWN BY: KMKENDALL

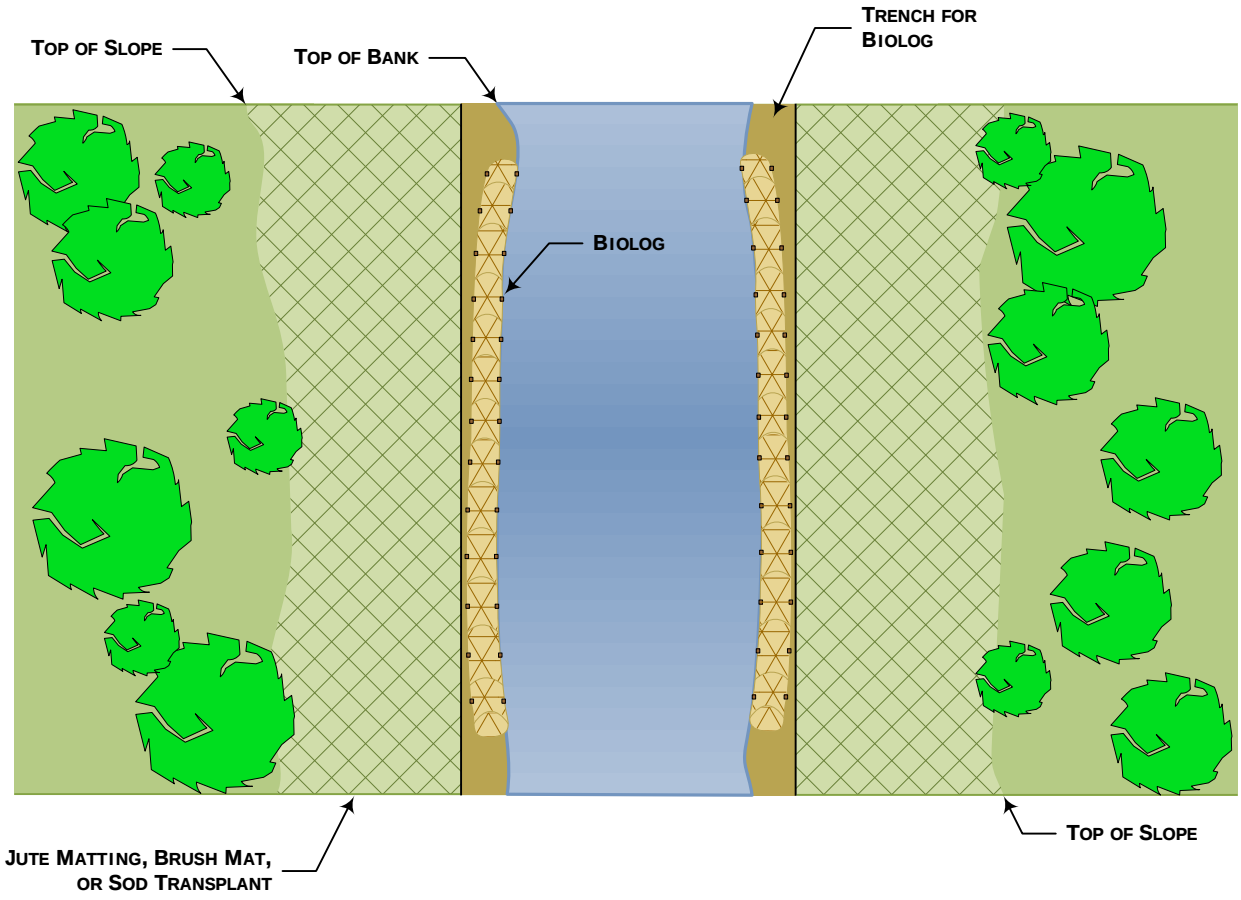
NATURAL RESOURCE GROUP

K:_CLIENT_PROJECTS\D-F\EEL\2011-019\FIG_25_IMPROVED_ROAD_BORE_CROSSING.VSD

Typical Cross Section – Biolog



Typical Plan View – Biolog

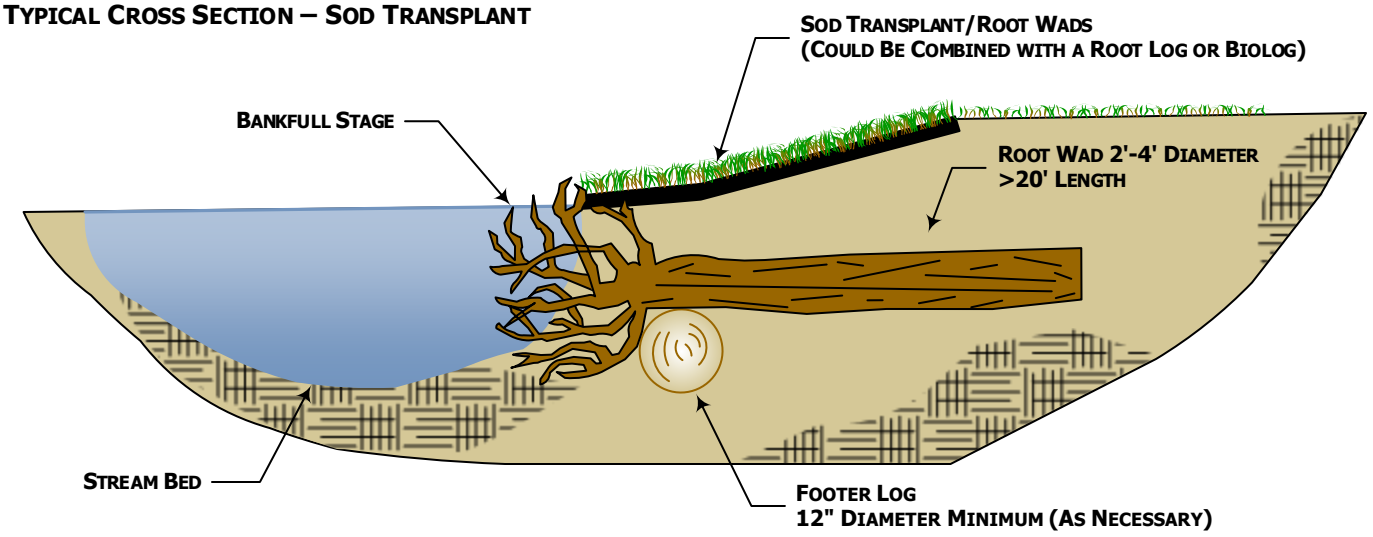


ENBRIDGE

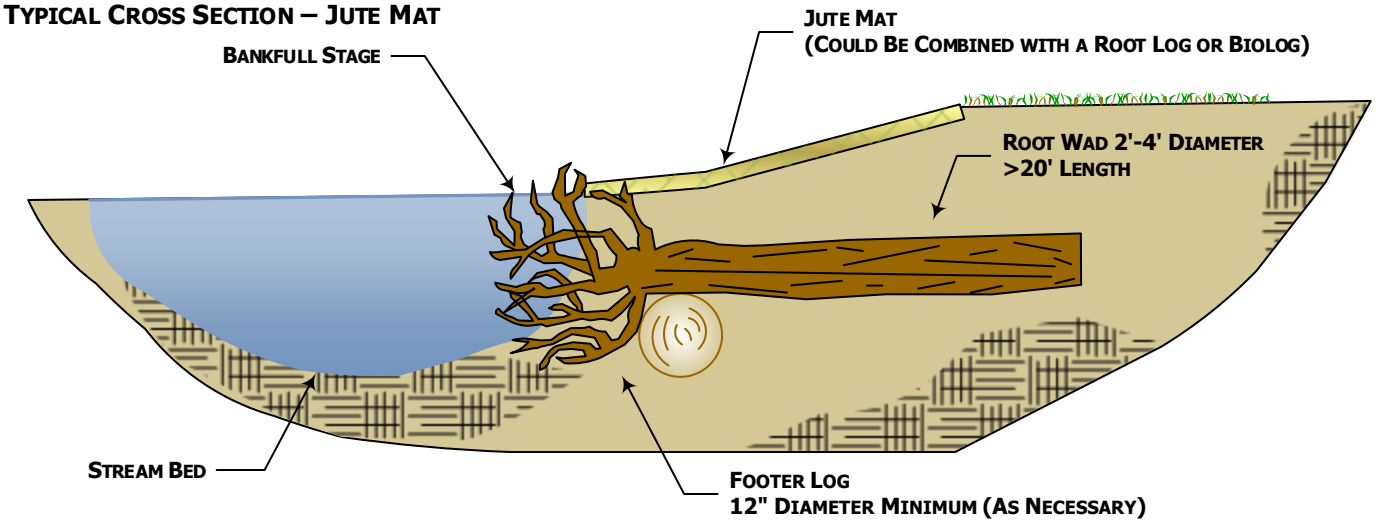
Figure 26
Typical Stream Bank Stabilization
Biolog

04/17/2013

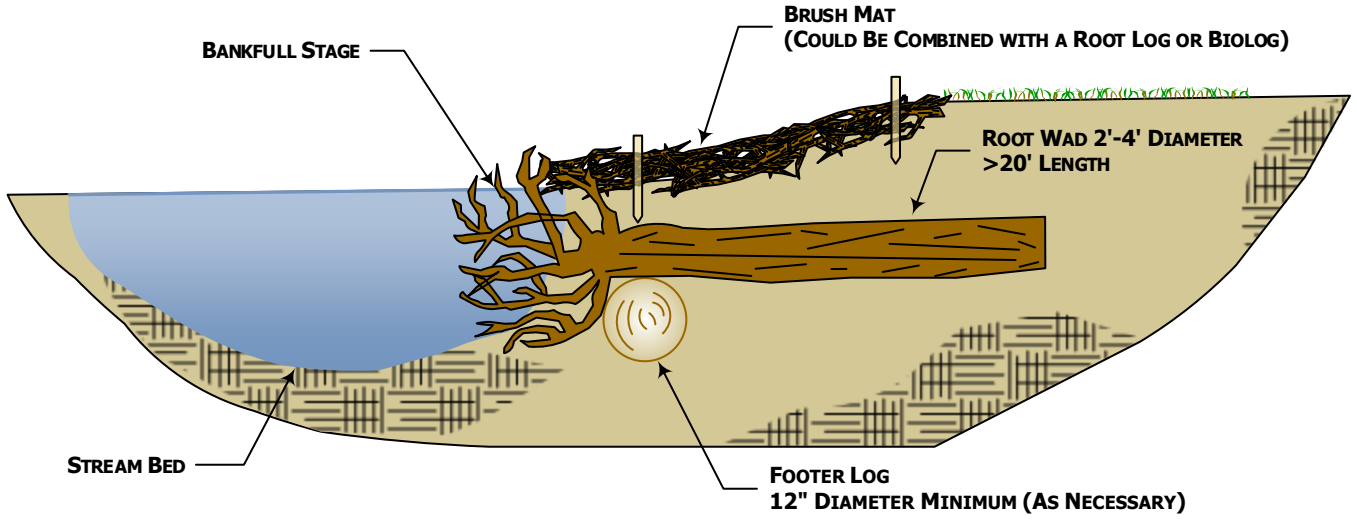
Typical Cross Section – Sod Transplant



Typical Cross Section – Jute Mat



Typical Cross Section – Brush Mat

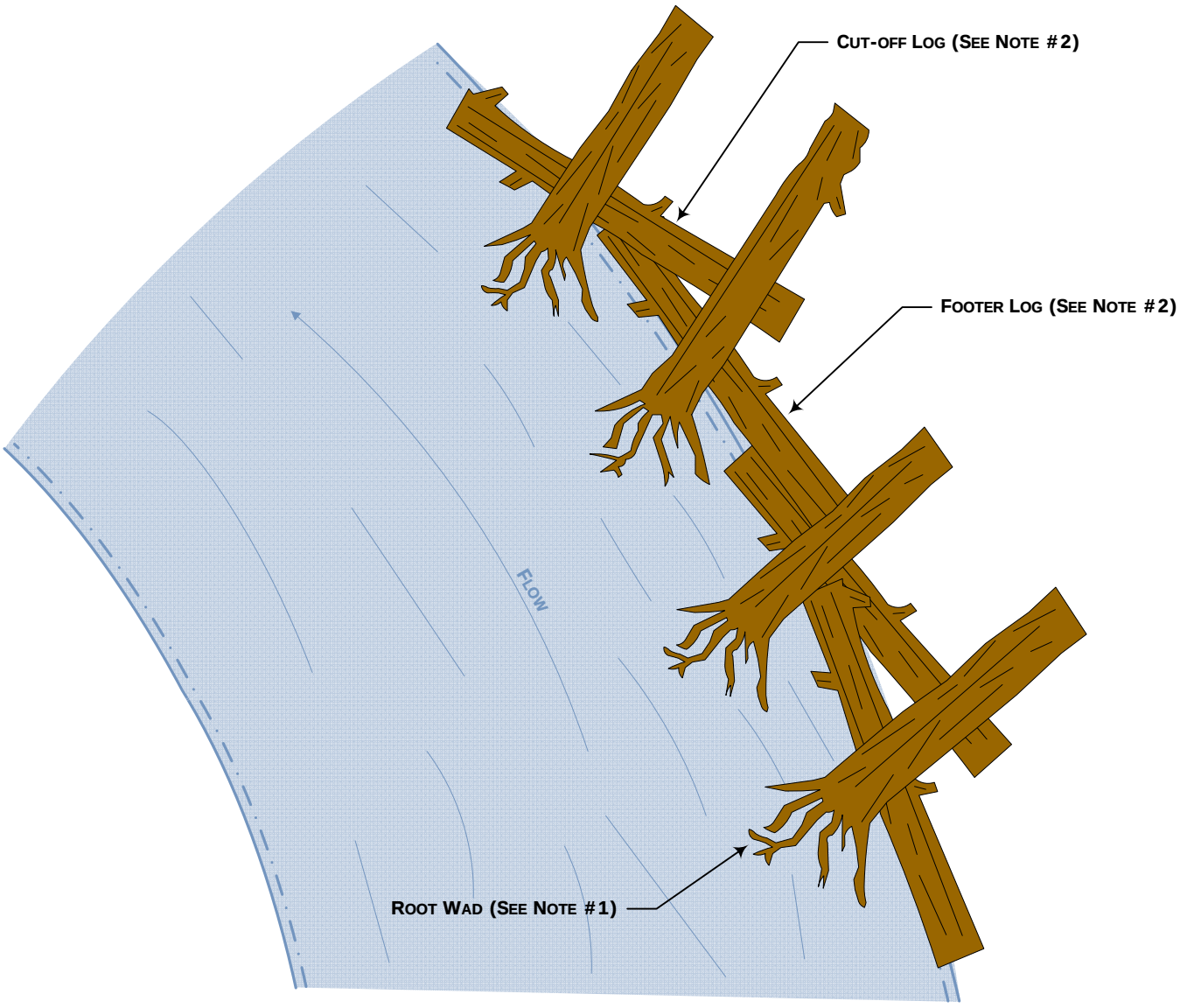


ENBRIDGE

Figure 27
Typical Root Wad

8/25/2015

TYPICAL PLAN VIEW – NATURAL MATERIAL REVETMENT



Notes:

#1 – Root wad logs to be used on steep banks or based on agency recommendations.
#2 - Root wad logs to be anchored appropriately based on site-specific conditions or agency recommendations.

ENBRIDGE

Figure 28
Typical Natural Material Revetment

04/17/2013

Appendix A
Noxious and Invasive Weed Species

Appendix A

Enbridge
Noxious and Invasive Weed Species

State/Weed Type	Common Name	Scientific Name	Regulatory Classification
NORTH DAKOTA			
Terrestrial Weeds	Russian knapweed	*Acroptilon repens*	NW [a]
	absinth wormwood	*Artemisia absinthium*	NW [a]
	musk thistle	*Carduus nutans*	NW [a]
	diffuse knapweed	*Centaurea diffusa*	NW [a]
	yellow starthistle	*Centaurea solstitialis*	NW [a]
	spotted knapweed	*Centaurea stoebe; Centaurea maculosa*	NW [a]
	Canada thistle	*Cirsium arvense*	NW [a]
	field bindweed	*Convolvulus arvensis*	NW [a]
	leafy spurge	*Euphorbia esula*	NW [a]
	Dalmatian toadflax	*Linaria dalmatica; Linaria genistifolia*	NW [a]
	purple loosestrife	*Lythrum salicaria; Lythrum virgatum*	NW [a]
	saltcedar	*Tamarix chinensis; Tamarix parviflora; Tamarix ramosissima*	NW [a]
Mountrail County	common tansy	*Tanacetum vulgare*	CONW [a]
	houndstounge	*Cynoglossum officinale*	CONW [a]
Ward County	scentless chamomile	*Anthemis arvensis*	CONW [a]
	yellow toadflax	*Linaria vulgaris*	CONW [a]
	houndstounge	*Cynoglossum officinale*	CONW [a]
Ramsey County	annual sowthistle	*Sonchus oleraceus*	CONW [a]
	scentless chamomile	*Anthemis arvensis*	CONW [a]
	common milkeed	*Asclepias syriaca*	CONW [a]
Nelson County	perennial sowthistle	*Sonchus arvensis*	CONW [a]
Grand Forks County	kochia	*Bassia scoparia*	CONW [a]
Pembina County	kochia	*Bassia scoparia*	CONW [a]
	common tansy	*Tanacetum vulgare*	CONW [a]
Aquatic Weeds	curly leaf pondweed	*Potamogeton crispus*	Regulated
	Eurasian watermilfoil	*Myriophyllum spicatum*	Regulated
	didymo or rock snot	*Didymosphenia geminata*	Prohibited
Aquatic Invertebrate Invasives (Bivalves)	Asian clam	*Corbicula fluminea*	Prohibited
	Zebra mussel	*Dreissena polymorpha*	Prohibited
	Quagga mussel	*Dreissena bugensis*	Prohibited
	New Zealand mudsnail	*Potamopyrgus antipodarum*	Prohibited
Aquatic Invertebrate Invasives	Rusty crayfish	*Orconectes rusticus*	Prohibited
	Scud	*Echinogammarus ischnus*	Prohibited
	Fishhook water flea	*Cercopagis pengoi*	Prohibited
	Spiny water flea	*Bythotrephes cederstroemi*	Prohibited
MINNESOTA			
Terrestrial Weeds	black swallow-wort	*Cynanchum louiseae*	SN [b]

Enbridge Noxious and Invasive Weed Species			
State/Weed Type	Common Name	Scientific Name	Regulatory Classification
	brown knapweed	*Centaurea jacea*	SN [b]
	Canada thistle	*Cirsium arvense*	SN, PS [c]
	common or European buckthorn	*Rhamnus cathartica*	RN [d]
	common reed – non-native subspecies	*Phragmites australis*	RN [d]
	common teasel	*Dipsacus fullonum*	SN [b]
	cut-leaved teasel	*Dipsacus laciniatus*	SN [b]
	Dalmatian toadflax	*Linaria dalmatica*	SN [b]
	garlic mustard	*Alliaria petiolata*	SN [c]
	giant hogweed	*Heracleum mantegazzianum*	FN [b]
	glossy buckthorn, including all cultivars	*Frangula alnus*	RN [d]
	Grecian foxglove	*Digitalis lanata*	PS [b]
	Japanese hops	*Humulus japnicus*	SN [b]
	leafy spurge	*Euphorbia esula*	SN, PS [c]
	meadow knapweed	*Centaurea x moncktonii*	FN [b]
	multiflora rose	*Rosa multiflora*	RN [d]
	musk thistle	*Carduus nutans*	SN, PS [c]
	narrowleaf bittercress	*Cardamine impatiens*	SN [c]
	Oriental bittersweet	*Celastrus orbiculatus*	SN [b]
	plumeless thistle	*Carduus acanthoides*	SN, PS [c]
	poison ivy	*Toxicodendron radicans*	SR; Specially Regulated
	purple loosestrife	*Lythrum salicaria, virgatum*	SN [c]
	spotted knapweed	*Centaurea stoebe*	SN [c]
	common tansy	*Tanacetum vulgare*	SN [c]
	wild parsnip	*Pastinaca sativa*	SN [c]
	yellow starthistle	*Centaurea solstitialis*	PI [b]
Aquatic Weeds	African oxygen weed	*Lagarosiphon major*	FN, PI; Prohibited Species
	ambulia	*Limnophila sessiliflora*	FN
	anchored or rooted water hyacinth	*Eichornia azurea*	FN
	aquarium watermoss, giant salvinia	*Salvinia molesta*	FN; Prohibited Species
	arrowhead	*Sagittaria sagittifolia*	FN
	arrowleaf false pickerelweed	*Monochoria hastata*	FN
	Australian stonecrop	*Crassula helmsii*	PI; Prohibited Species
	brittle naiad	*Najas minor*	PI; Prohibited Species
	broadleaf paper bark tree	*Melaleuca quenquinervia*	FN
	curly-leaf pondweed	*Potamogeton crispus*	PI; Prohibited Species
	European frog-bit	*Hydrocharis morsus-ranae*	PI; Prohibited Species

Enbridge Noxious and Invasive Weed Species			
State/Weed Type	Common Name	Scientific Name	Regulatory Classification
	Eurasian watermilfoil	*Myriophyllum spicatum*	PI; Prohibited Species
	exotic bur-reed	*Sparganium erectum*	FN
	ducklettuce	*Ottelia alismoides*	FN
	flowering rush	*Butomus umbellatus*	PE; Prohibited Species
	giant salvinia	*Salvinia auriculata*	FN
	giant salvinia	*Salvinia biloba*	FN
	giant salvinia	*Salvinia herzogii*	FN
	heart-shaped false pickerelweed	*Monochoria vaginalis*	FN
	hydrilla	*Hydrilla verticillata*	FN, PI; Prohibited Species
	Indian swampweed, Miramar weed	*Hygrophila polysperma*	FN; Prohibited Species
	Mediterranean strain (killer algae)	*Caulerpa taxifolia*	FN
	mosquito fern, water velvet	*Azolla pinnata*	FN
	purple loosestrife	*Lythrum salicaria, Lythrum virgatum*	PI, SN; Prohibited Species
	water aloe or water soldiers	*Stratioles aloides*	PI; Prohibited Species
	water chestnut	*Trapa natans*	PI; Prohibited Species
	water-spinach, swamp morning-glory	*Ipomoea aquatica*	FN
	wetland nightshade	*Solanum tampicense*	FN
	Brazilian waterweed	*Egeria densa*	Regulated Species
	Carolina fanwort or fanwort	*Cabomba caroliniana*	Regulated Species
	Chinese water spinach	*Ipomoea aquatica*	Regulated Species
	nonnative waterlilies	*Nymphaea spp.*	Regulated Species
	parrot's feather	*Myriophyllum aquaticum*	Regulated Species
	yellow iris or yellow flag	*Iris pseudacoris*	Regulated Species
Aquatic Invertibrate Invasives	faucet snail	*Bithynia tentaculata*	Prohibited Species
	New Zealand mud snail	*Potamopyrgus antipodarum*	Prohibited Species
	quagga mussel	*Dreissena bugensis*	Prohibited Species
	red swamp crayfish	*Procambarus clarkii*	Prohibited Species
	zebra mussel	*Dreissena spp.*	Prohibited Species
	Banded mystery snail	*Viviparus georgianus*	Regulated Species
	Chinese mystery snail, Japanese trap door snail	*Cipangopaludina spp.*	Regulated Species
	rusty crayfish	*Orconectes rusticus*	Regulated Species
	spiny water flea	*Bythotrephes longimanus*	Regulated Species
WISCONSIN			
Terrestrial Weeds	Amur honeysuckle	*Lonicera maackii*	Prohibited/Restricted
	Autumn olive	*Elaeagnus umbellata*	Restricted

Enbridge Noxious and Invasive Weed Species			
State/Weed Type	Common Name	Scientific Name	Regulatory Classification
	Bells honeysuckle	*Lonicera x bella*	Restricted
	Black swallow-wort	*Vincetoxicum nigrum*	Prohibited/Restricted
	Canada thistle	*Cirsium arvense*	Restricted
	Cattail hybrid	*Typha x glauca*	Restricted
	Celandine	*Chelidonium majus*	Prohibited/Restricted
	Chinese yam	*Dioscorea oppositifolia*	Prohibited
	Common buckthorn	*Rhamnus cathartica*	Restricted
	Common teasel	*Dipsacus fullonum subsp. sylvestris*	Restricted
	Creeping bellflower	*Campanula rapunculoides*	Restricted
	Cut-leaved teasel	*Dipsacus laciniatus*	Restricted
	Cypress spurge	*Euphorbia cyparissias*	Restricted
	Cypress spurge	*Euphorbia cyparissias*	Restricted
	European marsh thistle	*Cirsium palustre*	Prohibited/Restricted
	Garlic mustard	*Alliaria petiolata*	Restricted
	Giant hogweed	*Heracleum mantegazzianum*	Prohibited
	Giant knotweed	*Polygonum sachalinense*	Prohibited
	Glossy buckthorn	*Frangula alnus*	Restricted
	Hairy willow herb	*Epilobium hirsutum*	Prohibited/Restricted
	Helleborine orchid	*Epipactis helleborine*	Restricted
	Hemp nettle, brittlestem hemp nettle	*Galeopsis tetrahit*	Restricted
	Hill mustard	*Bunias orientalis*	Prohibited/Restricted
	Hound's tongue	*Cynoglossum officinale*	Restricted
	Japanese hedge-parsley	*Torilis japonica*	Prohibited/Restricted
	Japanese honeysuckle	*Lonicera japonica*	Prohibited
	Japanese hops	*Humulus japonicus*	Prohibited/Restricted
	Japanese knotweed	*Polygonum cuspidatum*	Restricted
	Japanese stilt grass	*Microstegium vimineum*	Prohibited
	Kudzu	*Pueraria lobata*	Prohibited
	Leafy spurge	*Euphorbia esula*	Restricted
	Lyme grass or sand ryegrass	*Leymus arenarius*	Prohibited/Restricted
	Mile-a-minute vine	*Polygonum perfoliatum*	Prohibited
	Morrow's honeysuckle	*Lonicera morrowii*	Restricted
	Multiflora rose	*Rosa multiflora*	Restricted
	Musk thistle	*Carduus nutans*	Restricted
	Narrow-leaf cattail	*Typha angustifolia*	Restricted
	Oriental bittersweet	*Celastrus orbiculatus*	Restricted
	Pale swallow-wort	*Vincetoxicum rossicum*	Prohibited
	Perennial pepperweed	*Lepidium latifolium*	Prohibited
	Phragmites, Common reed	*Phragmites australis*	Restricted
	Plumeless thistle	*Carduus acanthoides*	Restricted
	Poison hemlock	*Conium maculatum*	Prohibited/Restricted

Enbridge Noxious and Invasive Weed Species			
State/Weed Type	Common Name	Scientific Name	Regulatory Classification
	Porcelain berry	*Ampelopsis brevipedunculata*	Prohibited
	Princess tree	*Paulownia tomentosa*	Prohibited
	Purple loosestrife	*Lythrum salicaria*	Restricted
	Russian olive	*Elaeagnus angustifolia*	Restricted
	Sawtooth oak	*Quercus acutissima*	Prohibited
	Scotch broom	*Cytisus scoparius*	Prohibited
	Sericea lespedeza	*Lespedeza cuneata*	Prohibited
	Spotted knapweed	*Centaurea biebersteinii, c. stoebe*	Restricted
	Spreading hedge parsley	*Torilis arvensis*	Prohibited
	Tall or Reed manna grass	*Glyceria maxima*	Prohibited/Restricted
	Tansy	*Tanacetum vulgare*	Restricted
	Tartarian honeysuckle	*Lonicera tatarica*	Restricted
	Tree-of-heaven	*Ailanthus altissima*	Restricted
	Wild chervil	*Anthriscus sylvestris*	Prohibited/Restricted
	Wild parsnip	*Pastinaca sativa*	Restricted
	Wineberry	*Rubus phoenicolasius*	Prohibited
	Yellow star thistle	*Centaurea solstitialis*	Prohibited
Wetland Weeds	Dame's rocket	*Hesperis matronalis*	Restricted
	European marsh thistle	*Cirsium palustre*	Prohibited/Restricted
	Flowering rush	*Butomus umbellatus*	Restricted
Aquatic Weeds	Australian swamp crop	*Crassula helmsii*	Prohibited
	Brazilian waterweed	*Egeria densa*	Prohibited
	Brittle waternymph	*Najas minor*	Prohibited
	Curly-leaf pondweed	*Potamogeton crispus*	Restricted
	Eurasian water milfoil	*Myriophyllum spicatum*	Restricted
	European frog-bit	*Hydrocharis morsus-ranae*	Prohibited
	Fanwort, Carolina Fanwort	*Cabomba caroliniana*	Prohibited
	Flowering rush	*Butomus umbellatus*	Restricted
	Hydrilla	*Hydrilla verticillata*	Prohibited
	Oxygen-weed, African elodea	*Lagarosiphon major*	Prohibited
	Parrot feather	*Myriophyllum aquaticum*	Prohibited
	Water chestnut	*Trapa natans*	Prohibited
	Yellow floating heart	*Nymphoides peltata*	Prohibited
	N/A	*Ulva (Enteromorpha) spp.*	Prohibited
Aquatic Fish and Invertebrate Invasives	Asian clam	*Corbicula fluminea*	Prohibited
	Bloody shrimp	*Hemimysis anomala*	Prohibited
	Chinese mitten crabs	*Eriocheir sinensi*	Prohibited
	Chinese mystery snail	*Cipangopaludina chinensis*	Restricted

Enbridge
Noxious and Invasive Weed Species

State/Weed Type	Common Name	Scientific Name	Regulatory Classification
	Cylindro (cyanobacteria)	*Cylindrospermopsis raciborskii*	Prohibited
	Didymo or rock snot	*Didymoshpenia geminata*	Prohibited
	Faucet snail	*Bithynia tentaculata*	Prohibited
	Fishhook waterflea	*Cercopagis pengoi*	Prohibited
	Golden alga	*Prymneisum parvum*	Prohibited
	New Zealand mudsnail	*Potamopyrgus antipodarum*	Prohibited
	Novel cyanobacterial epiphyte of order Stigonematales	*Stigonematales spp.*	Prohibited
	Quagga mussels	*Dreissena bugensis*	Prohibited
	Red swamp crayfish	*Procambarus clarkii*	Prohibited
	Rusty crayfish	*Orconectes rusticus*	Restricted
	Spiny waterflea	*Bythotrephes cederstroemi*	Prohibited
	Starry stonewort (alga)	*Nitellopsis obtusa*	Prohibited
	Water flea	*Daphnia lumholtzi*	Prohibited
	Zebra mussel	*Dreissena polymorpha*	Restricted

_____

North Dakota:

[a] Listed Regulated Species

Minnesota Control Status:

[b] Eradicate

[c] Control

[d] Restricted

Abbreviations:

NW = Noxious Weed
CONW = County Noxious Weed
SN = State noxious weed (Minnesota Department of Agriculture)
PS = State prohibited weed seed (Minnesota Department of Agriculture)
SR= Specially regulated (Minnesota Department of Agriculture)
RN = Restricted noxious weed (Minnesota Department of Agriculture)
FN = Federal noxious weed (USDA-Animal Plant Health Inspection Service)
PI = Prohibited exotic species (Minnesota Department of Natural Resources)

Appendix B
Equipment Cleaning Log

Equipment Cleaning Log

Form Completed By: _____

Date: _____ Time: _____

Location of Equipment (tract & milepost): _____

Equipment Type: _____

Equipment ID (e.g., company, unique ID number): _____

Cleaning Method: (check all that apply)

- □ Scrape Down
- □ Steam Wash Blow Down (compressed air)
- □ Power/Pressure Wash (water)
- □ Other (Describe): _____

Comments: _____

_____

_____

_____

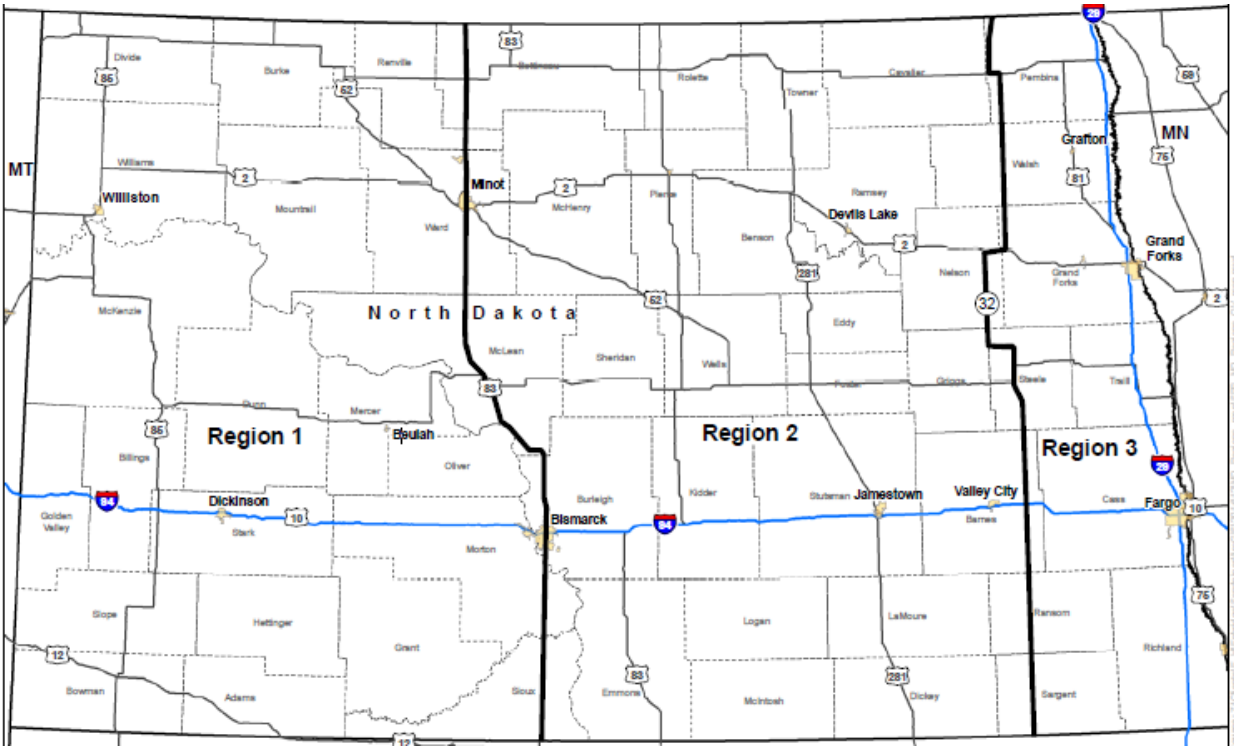
_____

Appendix C
Seed Mixes

NORTH DAKOTA SEED MIXES

Upon recommendations of the North Dakota Natural Resources Conservation Service, Enbridge divided regional seeding in North Dakota into three regions based on precipitation and general soil types as follows:

- Region 1 is between the Montana state line and Highway 83;
- Region 2 is between Highway 83 and Highway 32; and
- Region 3 is between Highway 32 and the Minnesota state line.



NORTH DAKOTA STATE-WIDE SEED MIXES

Table 1
ND Seed Mix 1 – State-Wide Temporary Cover Crop

Use: Where agency, landowner, or Enbridge requests a cover crop
Seeding rate: 80.0 pounds/acre Pure Live Seed ("PLS") drilled or 160.0 pounds /acre PLS broadcast
Notes: *No species substitutions allowed*

Species: Preferred Varieties (if available)	Pounds/Acre Pure Live Seed (PLS)	Percent of Mix
Oats *if spring or summer seeding,* **OR** Winter Wheat *if dormant (late fall) seeding*	40.0	50.0
Annual Ryegrass or Slender Wheat Grass	40.0	50.0
Total Seed	**80.0**	**100.0**

Table 2
ND Seed Mix 2 – North Dakota State-Wide State School Lands Seed Mix

Use: School Trust Lands and reestablishing stream bank vegetation where the waterbodies are open cut
Seeding Rate: 19.0 pounds/acre PLS drilled or 38.0 pounds/acre PLS broadcast without the companion crop. Double the rate of the companion crop when broadcast seeding
Notes: *No species substitutions allowed*

Species: Preferred Variety (if available)	Pounds/Acre PLS	Percent of Mix
Western wheatgrass: Rodan, Walsh, Flintlock, Rosana, Recovery	8.0	42.1
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	5.0	26.3
Green needlegrass: Lodorn, AC Mallard, Fowler	4.0	21.1
Side-oats grama: Killdeer, Pierre, Butte	2.0	10.5
Total	**19.0**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**29.0**	**100.0[1]**

[1] May not equal 100 percent due to rounding

NORTH DAKOTA REGION 1 SEED MIXES

Table 3
ND Seed Mix 3 – Region 1 Native Prairie Seed Mix

Use: North Dakota Region 1 on private and state lands (non-school trust) where native and degraded prairie are currently managed as range or hay land
Seeding rate: 11.90 pounds/acre PLS drilled or 23.80 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve substitutions in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Western wheatgrass: Rodan, Walsh, Flintlock, Rosana, Recovery	2.50	21.0
Green needlegrass: Lodorn, AC Mallard, Fowler	2.00	16.8
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	1.50	12.6
Little bluestem: Badlands, Itasca	1.00	8.4
Prairie sandreed: Goshen, Bowman, Koch	1.00	8.4
Side oats grama: Killdeer, Pierre, Butte	2.00	16.8
Blue grama: Bad River	0.50	4.2
Prairie cordgrass: Red River	0.50	4.2
Purple prairieclover: Common	0.10	0.8
White prairieclover: Antelope	0.10	0.8
Maximilian sunflower: Medicine Creek	0.10	0.8
Blanket flower: Common	0.20	1.7
Black-eyed Susan: Common	0.05	0.4
Stiff sunflower: Common	0.10	0.8
Canada goldenrod or Missouri goldenrod: Common	0.05	0.4
Lewis flax: Appar, Maple Grove	0.10	0.8
Prairie coneflower: Stillwater	0.10	0.8
Total	**11.90**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**21.90**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 4
ND Seed Mix 4 – Mixed Hay Land (Converted Prairie) and Open-Cut Road Ditch Seed Mix

Use: North Dakota Region 1 for private land hay land planting and re-establishing road bank/ditch vegetation
Seeding Rate: 11.4 pounds/acre PLS drilled or 22.8 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species/Preferred Varieties (if available)	Pounds/ Acre PLS	Percent of Mix
Crested wheatgrass: Nordan, RoadCrest, Summit	3.0	26.3
Pubescent: Manska, Greenleaf; **OR** Intermediate wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	4.0	35.1
Alfalfa: Vernal, Ladak	4.0	35.1
Purple prairieclover: Bismarck	0.1	0.9
White prairieclover: Antelope	0.1	0.9
Narrow leaf purple coneflower: Bismarck	0.1	0.9
Stiff sunflower: Bismarck	0.1	0.9
Total	**11.4**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**21.4**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 5
ND Seed Mix 5 – Tame Pasture Reclamation Seed Mix

Use: North Dakota Region 1 on private tame (improved) pasture planting
Seeding Rate: 14.0 pounds/acre PLS drilled or 28.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Crested wheatgrass: Nordan, RoadCrest, Summit	4.0	28.6
Pubescent: Manska, Greenleaf; **OR** Intermediate wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	5.0	35.7
Western wheatgrass: Rodan, Walsh, Flintlock, Rosana, Recovery	5.0	35.7
Total	**14.0**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**24.0**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 6
ND Seed Mix 6– North Dakota Default Conservation Reserve Program (CRP) Seed Mix

Use: North Dakota Region 1 on tracts enrolled in CRP
Seeding Rate: 8.0 pounds/acre PLS drilled or 16.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *No species substitutions allowed*

Species: Preferred Variety (if available)	Pounds/Acre PLS	Percent of Mix
Tall Wheatgrass: Platt, Orbit	4.4	55.0
Intermediate Wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	1.7	21.3
Slender Wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	0.5	6.3
Alfalfa: Vernal, Ladak or any with Zone 2 winter hardiness	1.1	13.8
Sweetclover: Common	0.3	3.8
Total	**8.0**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**18.0**	**100.0[1]**

[1] May not equal 100 percent due to rounding

NORTH DAKOTA REGION 2 SEED MIXES

Table 7
ND Seed Mix 7 – Native Prairie Seed Mix

Use: North Dakota Region 2 on private and state lands (non-school trust) where native and degraded prairie are currently managed as range or hay land
Seeding Rate: 11.9 pounds/acre PLS drilled or 23.8 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve* substitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Western wheatgrass: Rodan, Walsh, Flintlock, Rosana, Recovery	2.50	21.0
Green needlegrass: Lodorn, AC Mallard, Fowler	1.50	12.6
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	1.50	12.6
Little bluestem: Badlands, Itasca	1.00	8.4
Big Bluestem: Sunnyview, Bison, Bonilla, Bounty	1.00	8.4
Prairie sandreed: Goshen, Bowman, Koch	1.00	8.4
Side oats grama: Killdeer, Pierre, Butte	2.00	16.8
Blue grama: Bad River	0.25	2.1
Switch grass: Dacotah, Forestburg, Sunburst, Summer	0.25	2.1
Purple prairieclover: Common	0.10	0.8
White prairieclover: Antelope	0.10	0.8
Maximilian sunflower: Medicine Creek	0.10	0.8
Blanket flower: Common	0.20	1.7
Black-eyed Susan: Common	0.05	0.4
Stiff sunflower: Common	0.10	0.8
Canada goldenrod or Missouri goldenrod: Common	0.05	0.4
Lewis flax: Appar, Maple Grove	0.10	0.8
Prairie coneflower: Stillwater	0.10	0.8
Total	**11.90**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**21.90**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 8
ND Seed Mix 8 – Mixed Hay Land (Converted Prairie) and Open-Cut Road Ditch Seed Mix

Use: North Dakota Region 2 on private land mixed hay land planting and re-establishing road bank/ditch vegetation
Seeding Rate: 13.4 pounds/acre PLS drilled or 26.8 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Pubescent: Manska, Greenleaf; **OR** Intermediate wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	3.0	22.4
Meadow Bromegrass: Fleet, Paddock, Regar, Montana, MacBeth, Cache	7.0	52.2
Alfalfa: Vernal, Ladak	3.0	22.4
Purple prairieclover: Bismarck	0.1	0.7
White prairieclover: Antelope	0.1	0.7
Narrow leaf purple coneflower: Bismarck	0.1	0.7
Stiff sunflower: Bismarck	0.1	0.7
Total	**13.4**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**23.4**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 9
ND Seed Mix 9 – Tame Pasture Reclamation Seed Mix

Use: North Dakota Region 2 on private tame (improved) pasture planting
Seeding Rate: 21.0 pounds/acre PLS drilled or 42.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Pubescent: Manska, Greenleaf; **OR** Intermediate wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	6.0	28.6
Meadow bromegrass: Fleet, Paddock, Regar, Montana, MacBeth, Cache	15.0	71.4
Total	**21.0**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**31.0**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 10
ND Seed Mix 10– North Dakota Default Conservation Reserve Program (CRP) Seed Mix

Use: North Dakota Region 2 on tracts enrolled in CRP
Seeding Rate: 8.0 pounds/acre PLS drilled or 16.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *No species substitutions allowed*

Species: Preferred Variety (if available)	Pounds/Acre PLS	Percent of Mix
Tall Wheatgrass: Platt, Orbit	4.4	55.0
Intermediate Wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	1.7	21.3
Slender Wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	0.5	6.3
Alfalfa: Vernal, Ladak or any with Zone 2 winter hardiness	1.1	13.8
Sweetclover: Common	0.3	3.8
Total	**8.0**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**18.0**	**100.0[1]**

[1] May not equal 100 percent due to rounding

NORTH DAKOTA REGION 3 SEED MIXES

Table 11
ND Seed Mix 11 – Native Prairie Seed Mix

Use: North Dakota Region 3 on private and state lands (non-school trust) where native or degraded prairie currently managed as range or hay land

Seeding Rate: 12.15 pounds/acre PLS drilled or 24.30 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding

Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties	Pounds/Acre PLS	Percent of Mix
Western wheatgrass: Rodan, Walsh, Flintlock, Rosana, Recovery	2.00	16.5
Green needlegrass: Lodorn, AC Mallard, Fowler	2.00	16.5
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	1.00	8.2
Canada wildrye: Mandan	1.00	8.2
Big Bluestem: Sunnyview, Bison, Bonilla, Bounty	1.50	12.3
Side oats grama: Killdeer, Pierre, Butte	2.00	16.5
Blue grama: Bad River	0.25	2.1
Switch grass: Dacotah, Forestburg, Sunburst, Summer	0.50	4.1
Indiangrass: Tomahawk	1.00	8.2
Purple prairieclover: Common	0.10	0.8
White prairieclover: Antelope	0.10	0.8
Maximilian sunflower: Medicine Creek	0.10	0.8
Blanket flower: Common	0.20	1.6
Black-eyed Susan: Common	0.05	0.4
Stiff sunflower: Common	0.10	0.8
Canada goldenrod or Missouri goldenrod: Common	0.05	0.4
Lewis flax: Appar, Maple Grove	0.10	0.8
Prairie coneflower: Stillwater	0.10	0.8
Total	**12.15**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**22.15**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table 12
ND Seed Mix 12 –Mixed Hay Land (Converted Prairie) and Open-Cut Road Ditch Seed Mix

Use: North Dakota Region 3 on private land mixed hay land planting and re-establishing road bank/ditch vegetation
Seeding Rate: 15.3 pounds/acre PLS drilled or 30.6 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Meadow Bromegrass: Fleet, Paddock, Regar, Montana, MacBeth, Cache	10.0	65.4
Alfalfa: Vernal, Ladak	5.0	32.7
Purple prairieclover: Bismarck	0.1	0.7
White prairieclover: Antelope	0.1	0.7
Narrow leaf purple coneflower: Bismarck	0.1	0.7
Total	**15.3**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**25.3**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 13
ND Seed Mix 13 – Tame Pasture Reclamation Seed Mix

Use: North Dakota Region 3 on private tame (improved) pasture planting
Seeding Rate: 21.0 pounds/acre PLS drilled or 42.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Pubescent: Manska, Greenleaf; **OR** Intermediate wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	6.0	28.6
Meadow bromegrass: Fleet, Paddock, Regar, Montana, MacBeth, Cache	15.0	71.4
Total	**21.0**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**31.0**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 14
ND Seed Mix 14 – North Dakota Default CRP Seed Mix

Use: North Dakota Region 3 on tracts enrolled in CRP
Seeding Rate: 10.0 pounds/acre PLS drilled or 20.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *No species substitutions allowed*

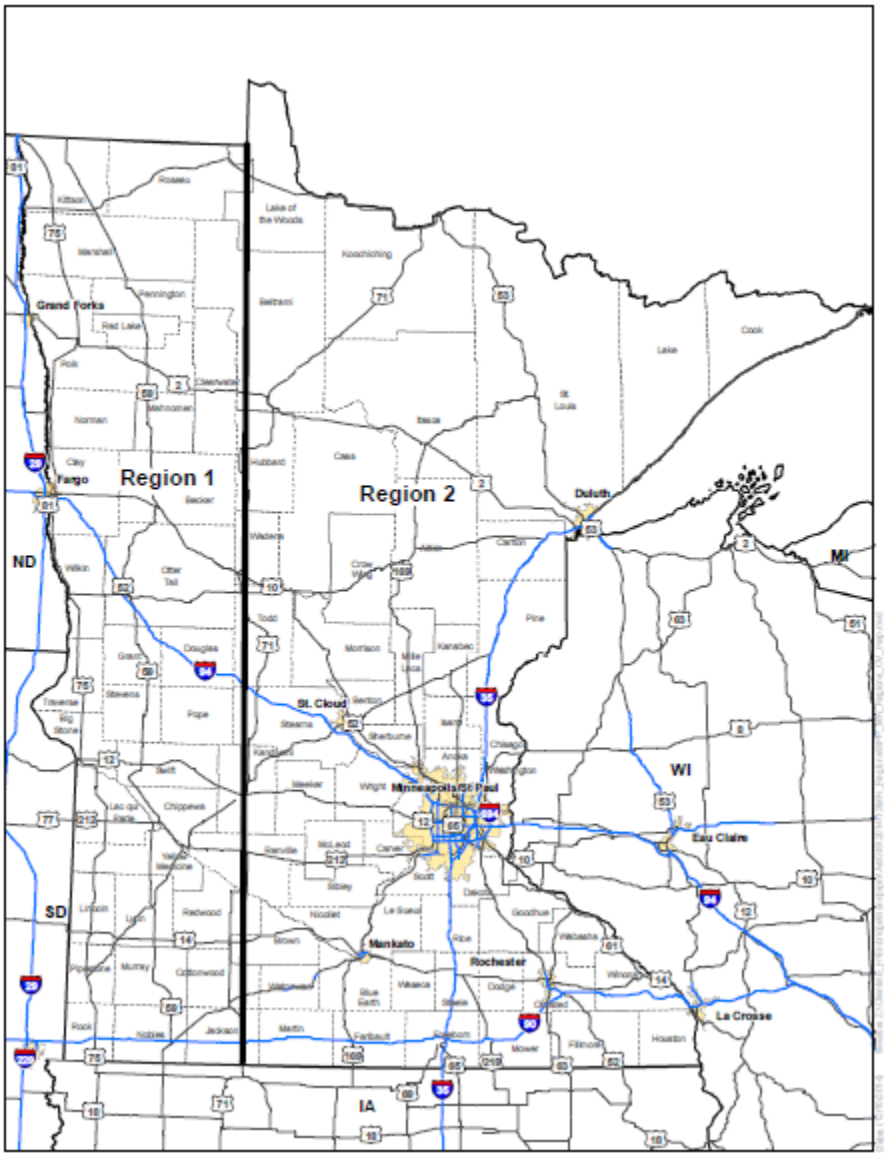
Species: Preferred Variety (if available)	Pounds/Acre PLS	Percent of Mix
Western Wheatgrass: Rodan, Walsh, Flintlock, Rosana, Recovery	2.0	20.0
Intermediate Wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	5.0	50.0
Alfalfa: Any with Zone 2 winter hardiness	2.0	20.0
Sweetclover: Common	1.0	10.0
Total	**10.0**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**20.0**	**100.0**[1]

[1] May not equal 100 percent due to rounding

MINNESOTA SEED MIXES

Based on average annual precipitation and temperatures and soil types, Enbridge divided seeding in Minnesota into two regions. These regions have different seed mixes for specific areas.

- Region 1 is between the North Dakota state line and approximately Highway 71; and
- Region 2 is between Highway 71 and the Wisconsin state line.



MINNESOTA STATEWIDE SEED MIXES

Table 15
MN Seed Mix 1 – Minnesota Default CRP Seed Mix

Use: Minnesota state-wide on tracts enrolled in the CRP
Seeding Rate: 12.0 pounds/acre PLS drilled or 24.0 PLS pounds/acre broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *No species substitutions allowed*

Species: Preferred Variety (if available)	Pounds/Acre PLS	Percent of Mix
Big Bluestem: Bison, Bonilla	4.0	33.3
Western Wheatgrass: Rodan	0.5	4.2
Slender Wheatgrass; Revenue	0.9	7.5
Sideoats Grama: Bad River	1.6	13.3
Switchgrass:Dacotah, Forestburg, Sunburst, Nebraska	0.2	1.7
Indiangrass: Tomahawk, Holte	0.5	4.2
Rough Dropseed: Common	0.3	2.5
Yarrow: Common	0.1	0.8
Purple Prairie Clover: Common	2.0	16.7
Ox-eye Sunflower: Common	1.0	8.3
Prairie Cinquefoil: Common	0.1	0.8
Black-eyed Susan Common	0.8	6.7
Total	**12.0**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**22.0**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table 16
MN Seed Mix 2 – Minnesota Protected and Other Waters Seed Mix

Use: Minnesota state-wide on the outer fringe of Public Water Inventory ("PWI") waterbodies and wetlands and all other waterbody banks
Seeding Rate: 8.255 pounds/acre PLS drilled or 16.510 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
American slough grass: Common	1.500	18.2
Blue-joint grass: Common	0.100	1.2
Reed manna grass: Common	0.200	2.4
Fowl manna grass: Common	0.100	1.2
Fowl bluegrass: Common	1.800	21.8
Rice cut-grass: Common	0.250	3.0
Annual ryegrass: Common	0.900	10.9
Tussock sedge: Common	0.100	1.2
Fox sedge: Common	0.300	3.6
Green bulrush: Common	0.100	1.2
Wool grass: Common	0.005	0.1
River bulrush: Common	0.250	3.0
Soft-stem bulrush: Common	0.100	1.2
March milkweed: Common	0.100	1.2
Flat-topped aster: Common	0.300	3.6
Joe-pye weed: Common	0.300	3.6
Boneset: Common	0.250	3.0
Sneezeweed: Common	0.250	3.0
Spotted touch-me-not: Common	0.100	1.2
Great blue lobelia: Common	0.100	1.2
Monkey flower: Common	0.100	1.2
Mountain mint: Common	0.100	1.2
Giant goldenrod: Common	0.250	3.0
Blue vervain: Common	0.350	4.2
Ironweed: Common	0.350	4.2
Total	**8.255**	**100.0**[1]
Companion Crop		
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	3.000	100.0
Total Seed	**11.255**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 17
MN Seed Mix 3 – Minnesota Unsaturated Wetlands Seed Mix

Use: Minnesota state-wide in unsaturated wetland areas
Seeding Rate: 17.0 pounds/acre PLS drilled or 34.0 pounds/acre PLS broadcast
Notes: *No species substitutions allowed*

Species: Preferred Variety (if available)	Pounds/Acre PLS	Percent of Mix
American slough grass: Common	6.0	35.3
Annual ryegrass: Common	8.0	47.1
Flow bluegrass: Common	3.0	17.6
Total Seed	**17.0**	**100.0[1]**

[1] May not equal 100 percent due to rounding

MINNESOTA REGION 1 SEED MIXES

Table 18
MN Seed Mix 4 – Native Prairie Seed Mix

Use: Minnesota Region 1 on private and public land where native or degraded prairie are currently managed as range or hay land
Seeding Rate: 13.0 pounds/acre PLS drilled or 26.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Big bluestem: Sunnyview, Bison, Bonilla, Bounty	1.25	9.6
Side-oats grama: Killdeer, Pierre, Butte	1.00	7.7
Fringed bromegrass: Common	1.40	10.8
Canadian wild rye: Mandan	2.00	15.4
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	2.50	19.2
Virginia wild rye: Common	2.00	15.4
Switchgrass: Dacotah, Forestburg, Sunburst, Summer	0.75	5.8
Fowl bluegrass: Common	0.60	4.6
Indian grass: Tomahawk	1.00	7.7
Black-eyed Susan: Common	0.10	0.8
Wild bergamont: Common	0.05	0.4
Hoary vervain: Common	0.05	0.4
Partridge pea: Common	0.30	2.3
Total	**13.00**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**23.00**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table 19
MN Seed Mix 5 – Mixed Hay Land (Converted Prairie) and Open-Cut Road Ditches Seed Mix

Use: Minnesota Region 1 on private mixed hay land and for re-establishing road bank/ditch vegetation
Seeding Rate: 15.0 pounds/acre PLS drilled or 30.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Meadow bromegrass: Fleet, Paddock, Regar, Montana, MacBeth, Cache	3.75	25.0
Intermediate wheatgrass: Reliant, Clarke, Slate, Chief, Oahe, Haymaker, Beefmaker, Manifest	3.75	25.0
Crested wheatgrass: Nordan, RoadCrest, Summit	3.75	25.0
Tetraploid ryegrass: Common	1.50	10.0
Alfalfa: Any with Zone 2 hardiness	2.25	15.0
Total	**15.00**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**25.00**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table 20
MN Seed Mix 6 – Tame Pasture Reclamation Seed Mix

Use: Minnesota Region 1 on private land tame (improved) pasture planting
Seeding Rate: 20.0 pounds/acre PLS drilled or 40.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Alfalfa: Any with Zone 2 hardiness	6.0	30.0
Red clover: Arlington, Astred, Cinnamon , Concord or Marathon	4.0	20.0
Timothy: Climax or Claire	2.0	10.0
Orchard grass: Orion, Hawkeye, Duke, Condor, Albert	3.0	15.0
Smooth bromegrass: Alpha, Badger, Bounty , York	5.0	25.0
Total	**20.0**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**30.0**	**100.0**[1]

[1] May not equal 100 percent due to rounding

MINNESOTA REGION 2 SEED MIXES

Table 21
MN Seed Mix 7 – Native Prairie Seed Mix

Use: Minnesota Region 2 on private and public land where native or degraded prairie are currently managed as range or hay land
Seeding Rate: 8.20 pounds/acre PLS drilled or 16.40 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Fringed brome grass: Common	2.00	24.4
Bluejoint grass: Common	0.15	1.8
Poverty grass: Common	0.50	6.1
Canadian (Nodding) wild rye: Manda	1.25	15.2
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	2.00	24.4
Fowl Bluegrass: Common	0.85	10.4
False melic grass: Common	0.25	3.0
Stiff golden rod: Common	0.15	1.8
Smooth wild rose: Common	0.15	1.8
Black-eyed susan: Common	0.25	3.0
Smooth aster: Common	0.15	1.8
American vetch: Common	0.50	6.1
Total	**8.20**	**100.0[1]**
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**18.20**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table 22
MN Seed Mix 8 – Mixed Hay Land and Open-Cut Road Ditches Seed Mix

Use: Minnesota Region 2 on private mixed hay land and for re-establishing road bank/ditch vegetation
Seeding Rate: 45.00 pounds/acre PLS drilled or 90.00 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Fowl Bluegrass: Common	6.00	13.3
Smooth Bromegrass: Alpha, Badger, Bounty , York	7.75	17.2
Slender Wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	2.00	4.4
Perennial Rye: Citadel, Mongita, Madera, Pagent, Achiever, SR-4000, Vivid, Linn Perennial Ryegrass, Windstar, and Festulolium hybrid	13.50	30.0
Switchgrass: Kanlow, Blackwell, Shelter, Carthage	1.50	3.3
Timothy: Climax or Claire	1.75	3.9
Alfalfa: Any with Zone 2 hardiness	12.50	27.8
Total	**45.00**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.00	100.0
Total Seed	**55.00**	**100.0**[1]

[1] May not equal 100 percent due to rounding

Table 23
MN Seed Mix 9 – Tame Pasture Reclamation Seed Mix

Use: Minnesota Region 2 on private land tame (improved) pasture planting
Seeding Rate: 20.0 pounds/acre PLS drilled or 40.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Alfalfa: Any with Zone 2 hardiness	6.0	30.0
Red clover: Arlington, Astred, Cinnamon , Concord or Marathon	4.0	20.0
Timothy: Climax or Claire	2.0	10.0
Orchard grass: Orion, Hawkeye, Duke, Condor, Albert	3.0	15.0
Smooth bromegrass: Alpha, Badger, Bounty , York	5.0	25.0
Total	**20.0**	**100.0**[1]
Companion Crop		
Oats (or see Table 4 in Seed Standards and Specifications)	10.0	100.0
Total Seed	**30.0**	**100.0**[1]

[1] May not equal 100 percent due to rounding

WISCONSIN SEED MIXES

Based on precipitation and general soil types the following seed mixes will be used in Wisconsin:

Table 24
WI Seed Mix 1 – Standard Upland Seed Mix

Use: Wisconsin state-wide in upland areas
Seeding Rate: 15.0 pounds/acre PLS drilled or 30.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve* substitutions *in advance*

Species: Preferred Varieties (if available)	**Pounds/Acre PLS**	**Percent of Mix**
Perennial Ryegrass	2	17.0
Canada Wild-rye	4	33.0
Switchgrass: unimproved native variety	4	33.0
Timothy	2	17.0
Subtotal	12	100.0[1]
Associated Companion Crop Mix		
Oats for summer seeding; or Winter Wheat for seeding in late fall (dormant) or spring	16	80.0
Annual Ryegrass or Slender Wheat Grass	4	20.0
Companion/Cover Crop Subtotal	20	100.0
GRAND TOTAL (pounds)	**32**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table 25
WI Seed Mix 2 – Native Sedge/Wet Meadow Mixture (W2)

Use: Wisconsin state-wide in unsaturated Wet Meadow wetland areas
Seeding Rate: See below summary.
Notes: *Enbridge Environment must approve* substitutions *in advance*

Common Name	Botanical Name	Indicator Status	Seeds/oz.	Seeds/ft^2	% of Mix
Brome, fringed	*Bromus ciliata*	*FACW*	10,000	1.5	8.1
Blue-joint grass	*Calamagrostis canadensis*	*OBL*	280,000	8.2	1.6
Wild-rye, Virginia	*Elymus virginicus*	*FACW-*	4,200	3.2	42.3
Manna grass, reed	*Glyceria grandis*	*OBL*	80,000	4.7	3.2
Manna grass, fowl	*Glyceria striata*	*OBL*	160,000	4.7	1.6
Bluegrass, fowl	*Poa palustris*	*FACW+*	118,000	16.7	7.1
Sedge, bottlebrush	*Carex comosa*	*OBL*	30,000	2.2	4.3
Sedge, pointed- broom	*Carex scoparia*	*FACW*	84,000	1.5	1.0
Sedge, tussock	*Carex stricta*	*OBL*	53,000	0.8	0.8
Sedge, Common fox	*Carex stipata*	*OBL*	34,000	2.0	3.2
Sedge, fox	*Carex vulpinoidea*	*OBL*	100,000	5.9	3.2
Rush, slender	*Juncus tenuis*	*FAC*	1,000,000	11.0	0.2
Torry's Rush	*Juncus toryi*	*OBL*	1,600,000	5.9	0.6
Bulrush, green	*Scirpus atrovirens*	*OBL*	460,000	16.9	2.0
Wool grass	*Scirpus cyperinus*	*OBL*	1,700,000	6.2	0.2
Milkweed, marsh	*Asclepias incarnata*	*OBL*	4,800	0.4	5.0
Aster, swamp	*Aster puniceus*	*OBL*	80,000	5.9	4.0
Aster, flat-topped	*Aster umbellatus*	*FACW*	67,000	1.5	1.2
Joe-pye weed	*Eupatorium maculatum*	*OBL*	95,000	0.7	0.4
Boneset	*Eupatorium perfoliatum*	*FACW+*	160,000	1.2	0.4
Goldenrod, grass- leaved	*Euthamia graminifolia*	*FACW-*	350,000	1.0	0.2
Sneezeweed	*Helenium autumnale*	*FACW+*	130,000	0.8	0.3
Sunflower, serrated	*Helianthus grosseserratus*	*FACW-*	15,000	0.2	0.6
Lobelia, great-blue	*Lobelia siphilitica*	*FACW+*	500,000	2.9	0.3
Monkey flower	*Mimulus ringens*	*OBL*	2,300,000	6.8	0.2
Mint, mountain	*Pycnanthemum virginianum*	*FACW+*	220,000	1.3	0.3
Meadow-rue, purple	*Thalicturm dasycarpum*	*FACW*	11,000	0.1	0.4
Vervain, blue	*Verbena hastata*	*FACW+*	93,000	2.2	1.3
Alexanders, Golden	*Zizea aurea*	*FACW*	11,000	1.0	5.0

Recommended Rate: 5.0 (PLS lbs/acre)

SUMMARY

Mix Seeds Per Square Foot	Mix Seeds Per Square Yard	Mix Seeds Per Acre
121	1,093	5,290,320
% by wt. Grasses	**% by wt. Graminoids**	**% by wt. Forbs**
64.0	15.0	21.0
% by Seed Count Grasses	**% by Seed Count Graminoids**	**% by Seed Count Forbs**
32.1	43.2	24.7

Table 26
WI Seed Mix 3 –Native Wet Prairie Mixture (W3)

Use: Wisconsin state-wide in unsaturated Wet Prairie wetland areas
Seeding Rate: See below summary.
Notes: *Enbridge Environment must approve* substitutions *in advance*

Common Name	Botanical Name	Indicator Status	Seeds/oz.	Seeds/ft^2	% of Mix
Bluestem, big	*Andropogon gerardi*	*FAC-*	10,000	3.7	15.3
Brome, fringed	*Bromus ciliata*	*FACW*	10,000	1.8	7.7
Blue-joint grass	*Calamagrostis canadensis*	*OBL*	280,000	6.2	0.9
Wild-rye, Virginia	*Elymus virginicus*	*FACW-*	4,200	2.0	19.9
Manna grass, reed	*Glyceria grandis*	*OBL*	80,000	2.9	1.5
Manna grass, fowl	*Glyceria striata*	*OBL*	160,000	3.5	0.9
Switchgrass	*Panicum virgatum*	*FAC+*	14,000	3.1	9.2
Bluegrass, fowl	*Poa palustris*	*FACW+*	118,000	9.6	3.0
Indian grass	*Sorghastrum nutans*	*FACU+*	12,000	2.0	6.7
Cord grass, prairie	*Spartina pecinata*	*FACW+*	6,600	1.1	6.9
Sedge, tussock	*Carex stricta*	*OBL*	53,000	0.7	0.5
Sedge, fox	*Carex vulpinoidea*	*OBL*	100,000	3.7	1.5
Bulrush, green	*Scirpus atrovirens*	*OBL*	460,000	7.7	0.7
Wool grass	*Scirpus cyperinus*	*OBL*	1,700,000	18.7	0.5
Anemone, Canada	*Anemone canadensis*	*FACW*	8,000	0.09	0.5
Milkweed, marsh	*Asclepias incarnata*	*OBL*	4,800	0.1	1.4
Aster, swamp	*Aster puniceus*	*OBL*	80,000	2.4	1.2
Aster, flat-topped	*Aster umbellatus*	*FACW*	67,000	1.5	0.9
Tic-trefoil, showy	*Desmodium canadense*	*FAC-*	5,500	0.8	6.1
Joe-pye weed	*Eupatorium maculatum*	*OBL*	95,000	1.7	0.8
Boneset	*Eupatorium perfoliatum*	*FACW+*	160,000	2.4	0.6
Goldenrod, grass- leaved	*Euthamia graminifolia*	*FACW-*	350,000	2.0	0.3
Sneezeweed	*Helenium autumnale*	*FACW+*	130,000	2.39	0.8
Sunflower, serrated	*Helianthus grosseserratus*	*FACW-*	15,000	0.3	0.7
Blazingstar, tall	*Liatris pycnostachya*	*FAC-*	11,000	0.1	0.5
Lobelia, great-blue	*Lobelia siphilitica*	*FACW+*	500,000	1.4	0.1
Monkey flower	*Mimulus ringens*	*OBL*	2,300,000	6.4	0.1
Mint, mountain	*Pycnanthemum virginianum*	*FACW+*	220,000	1.2	0.3
Vervain, blue	*Verbena hastate*	*FACW+*	93,000	1.0	0.5
Ironweed	*Veronia fasciculate*	*FACW*	24,000	0.1	0.3
Culver's root	*Veronicastrum virginicum*	*FAC*	800,000	8.8	0.5
Alexander's, golden	*Zizea aurea*	*FAC+*	11,000	2.4	9.2

Recommended Rate: 5.0 (PLS lbs/acre)

SUMMARY

Mix Seeds Per Square Foot	Mix Seeds Per Square Yard	Mix Seeds Per Acre
102	884	4,436,283
% by wt. Grasses	**% by wt. Graminoids**	**% by wt. Forbs**
72.0	3.0	24.0
% by Seed Count Grasses	**% by Seed Count Graminoids**	**% by Seed Count Forbs**
35.0	30.0	35.0

Appendix D
Enbridge Environment Hydrotest Discharge Authorization and Documentation

Enbridge Environment Hydrotest Discharge Authorization & Documentation - *Instructions*

The purpose of this form is to document and insure that appropriate planning occurs prior to hydrostatic test discharge activities as well as the proper recording of necessary information during the actual discharge event. If the discharge permit specifies the need for a Certified Operator, he/she is responsible for the final section of the form. Otherwise, an Environmental Inspector will be responsible for completion of this form.

Part 1: Basic Discharge Information: All information must be completed. Coordination with Enbridge Engineering is necessary to obtain the exact test section length and volume of water to be discharged. The estimated duration of the discharge must be calculated using the maximum permitted rate (or the anticipated rate, if lower than the permitted rate) and the total volume of water to be discharged. This is critical information and will ensure that any required sampling is conducted at the appropriate frequency specified in the permit.

Part 2: Pre-Discharge Planning Checklist: A pre-discharge planning meeting must be held with the Certified Operator (if required), Contractor, Craft Inspection, Environmental Inspection, and Construction Management staff to review items included in the checklist and any other pertinent information deemed necessary. A full copy of the permit and discharge plan must be provided to all participants. Upon completion of this meeting, all participants must sign the form to indicate that they understand all steps of the discharge process. ***Note: In order to proceed with discharge activities, the Enbridge Construction Manager and Environment Staff assigned to the project, or their designees, must review the information and provide their authorization by signing and dating the form.***

Part 3: Discharge Monitoring: A copy of the permit, discharge plan, and parts one and two of the form must be on-site at all times during the discharge event. In addition to the items specified on the form, the following photographs are required:

- Receiving water before, during, and after the discharge (minimum 3 photos/day)
- Discharge structure/device before and during the discharge (minimum 3 photos/day)

As noted, upon completion of the discharge event, the Certified Operator or Environmental Inspector, Craft Inspector, Contractor Foreman, and Enbridge Construction Manager must sign and date the form. ***The completed form, along with the supplemental photographs, and a copy of the chain of custody for any samples submitted for laboratory analysis must be submitted to the Enbridge Environment Project Manager/Lead within 12 hours of ending the discharge. Any permit violations will be reported to the applicable agencies by the Enbridge Environment Project Manager/Lead within the timeframes specified in the discharge permit.***

Enbridge Environment Hydrotest Discharge Authorization & Documentation

Part 1: Basic Discharge Information

Date: _____

Project Name: _____ Spread: _____ Tract #: _____

Test Section Identification: _____

Pipe Diameter (inches): _____ Test Section Length (feet): _____

Volume to be discharged (gallons): _____

Permitted Discharge Rate (gpm): _____ Est. Duration of Discharge (hours): _____

Receiving Waterbody Name/Nearest Surface Waterbody: _____

Certified Operator Name and Number (if applicable): _____

Part 2: Pre-Discharge Planning Checklist

Note: All items must be complete prior to initiating discharge activities

☐ Notification to agency(ies) provided (if applicable - attach copy of notification documentation)

☐ Flow meter installed and functional in accordance with manufacturers recommendations

☐ Sample collection port/tap installed or other positive means of direct sampline of discharge water (only necessary if sampling is required)

☐ Review of discharge permit and site-specific plan complete (attach a copy of the permit and approved site specific plan)

☐ Discharge structure/BMPs installed according to approved plan

☐ Complete the table below, including quantity of samples required in accordance with the permit based on anticipated discharge duration. Add other parameters as specified in the permit:

Parameter	Analytical Method Number	Container type	Container Volume	Preservation	Maximum Holding Times	Permit Limit	Sample Type	Frequency of Analysis Specified in Permit	Number of Samples Required
pH	NA	Polyethylene / Glass	NA	None required	Analyze immediately		Field measurement		
Dissolved Oxygen	NA	Glass bottle and top	NA	None required	Analyze immediately		Field measurement		
TSS	106.2	Polyethylene	500 ml	Cool to 4° C	7 days				
Oil & Grease	1664	Amber Glass	1 liter	Cool to 4° C, HCL or H_2SO_4 to pH <2	28 days				

☐ Indicate responsible party for emergency/upset/spill notifications in accordance with the permit:_____

☐ Indicate responsible party for to begin flow diversion when change in coloration observed: _____

All staff involved in hydrostatic test discharge activities must review the above information and print and sign their name below indicating their participation in a pre-job planning meeting and that they understand the discharge plan, permit, and procedures and are prepared to properly implement them. Attach additional sheets as necessary.

Name (print and sign):

Certified Operator or Environmental Inspector Signature: _____

Enbridge Environment and Construction Management staff reviewed the pre-planning information provided and approve the initiation of discharge activities.

Enbridge Environment Staff Signature and Date: _____

Enbridge Construction Manager Signature and Date: _____

Part 3: Discharge Monitoring - attach additional sheets as necessary
Note: Flow rate must be recorded hourly, sample frequency must be in accordance with the permit specifications

Date	Time	Recorded/Sampled By	Flow Rate (gpm)	pH	Dissolved Oxygen (mg/l)	TSS Sample Collected?	Oil & Grease Sample Collected?	Other (indicate)

Appendix E
Emergency Response Contractors/Disposal and Treatment Facilities

Emergency Response Contractors/Disposal and Treatment Facilities

The Contractor will dispose of all wastes according to applicable federal, state, and local requirements. A listing of potential Emergency Spill Response Contractors and waste disposal facilities is provided below. This list was developed from state-wide data bases. This list represents firms operating at the time the data base was produced. The Contractor is responsible for verifying if a contractor or facility is currently operating under appropriate permits or licenses. The Contractor is responsible for ensuring wastes are disposed of properly.

Spill Response Contractors		
Company	**City/State**	**Phone Number**
North Dakota		
Clean Harbors Environmental	Williston, ND	(701) 774-2201 (800) 645-8265
Garner Environmental Services	Williston, ND	(701) 577-1200 (855) 774-1200
Absorbent & Safety Solutions	Watford City, ND	(701) 838-4558
Minnesota Limited	Berthold, ND	(701) 453-3700
Bobs Oilfield Service Inc	Belfield, ND	(701) 575-4666
Keitu Engineers & Consultants, Inc.	Mandan, ND	(701) 667-1800
Minnesota		
Bay West Environmental	St. Paul, MN	(800) 279-0456 (651) 291-0456
West Central Environmental Consultants Inc.	Morris, MN	(800) 422-8356 (888) 923-2778
Minnesota Limited	Bemidji, MN	(218) 755-9595
OSI Environmental	Bemidji, MN	(800) 585-8838
OSI Environmental	Eveleth, MN	(800) 777-8542
Bay West Environmental	Duluth, MN	(800) 279-0456 (218) 740-0110
Wisconsin - *The Contractor should consult with the WDNR Northern Regional Spill Coordinator (John Sager: phone (715) 365-8959) for assistance when selecting a spill response contractor.*		

Waste Disposal/Treatment Facilities		
Facility	**City/State**	**Telephone**
North Dakota		
Gascoyne Materials Handling & Recycling LLC	Dickinson, ND	701.225.0061
Sawyer Disposal Services LLC*	Sawyer, ND	701.624.5622
Dishon Disposal Inc*	Williston, ND	701.572.3223
Prairie Disposal Inc*	Tioga, ND	800.490.2106
Minnesota		
Pope-Douglas Solid Waste	Alexandria, MN	(320) 762-2381
Northstar Reclamation	Fosston, MN	(800) 422-0817
Polk County Incinerator	Fosston, MN	(218) 435-6501
Wisconsin		
Lake Area Landfill (BFI)	Sarona, WI	(612) 457-2778
Timberline Trail (Waste Mgmt.)	Weyerhaueser, WI	(800) 504-1067 ext. 7

Please note: Some facilities may have limitations on amounts, types of materials, etc.
*May accept crude oil-impacted soils and/or wastes from oil field exploration and production activities.

Appendix F
Spill Report Form

Spill Report Form

(The Contractor Spill Coordinator must complete this for any spill, regardless of size, and submit the form to the Enbridge Representative within 24 hours of the occurrence)

Date of Spill:_____ Date of Spill Discovery:_____

Time of Spill:_____ Time of Spill Discovery:_____

Name and Title of Discoverer:_____

Type of material spilled and manufacturer's name:_____

Legal Description of spill location to the quarter section:_____

Directions from nearest community:_____

Estimated volume of spill:_____

Weather conditions:_____

Topography and surface conditions of spill site:_____

Spill medium (pavement, sandy soil, water, etc.):_____

Proximity of spill to surface waters: _____

Did the spill reach a waterbody? _____Yes _____No

If so, was a sheen present? _____Yes _____No

Describe the causes and circumstances resulting in the spill:_____

_____

_____

_____

Describe the extent of observed contamination, both horizontal and vertical (i.e., spill-stained soil in a 5-foot radius to a depth of 1 inch): _____

_____

_____

Describe immediate spill control and/or cleanup methods used and implementation schedule: _____

_____

_____

_____

Current status of cleanup actions:_____

Name and Company for the following:

Construction Superintendent:_____

Spill Coordinator:_____

Enbridge Representative:_____

Person Who Reported the Spill:_____

Environmental Inspector:_____

Form completed by:_____Date:_____

Appendix G
Spill Reporting-Agency Contacts

Spill Reporting Contacts			
Agency	**Reporting Criteria**	**When**	**Phone Number**
Federal Contacts			
National Response Center	Release of a hazardous substance in an amount equal to or greater than its reportable quantity under CERCLA Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on the water's surface, or leaves sludge or emulsion beneath the surface	Immediately	(800) 424-8802
Environmental Protection Agency (EPA) Region V (MN&WI)	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on the water's surface, or leaves sludge or emulsion beneath the surface	Immediately	1 (312) 353-2000
Environmental Protection Agency (EPA) Region VIII (ND)	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on the water's surface, or leaves sludge or emulsion beneath the surface	Immediately	1 (303) 312-6312
State Contacts			
North Dakota Industrial Commission, Oil and Gas Division	Must be a leak, spill or other release of fluid that is less than one barrel total volume and remains onsite of a facility.	Immediately	(701) 328-8020
North Dakota Department of Health	Any Amount	Immediately	(701) 328-5210 or 5166
North Dakota Department of Emergency Services (NDDES)	As Needed	Immediately	NDDES Duty Officer System (701) 328-9921 (24 hour, request the Duty Officer be paged) ND Regional Hazardous Materials Teams (800) 472-2121 (Teams requested through State Radio)

Spill Reporting Contacts			
Agency	**Reporting Criteria**	**When**	**Phone Number**
Minnesota Duty Officer Program	Minnesota has a reporting threshold of greater than five-gallons for petroleum spills. Spills of any quantity of all other chemicals or materials should be reported. If in doubt, report.	Immediately	Duty Officer (651) 649-5451 1 (800) 422-0798
Wisconsin Department of Natural Resources	>one gallon of gasoline on a pervious surface	Immediately	24-hour Toll Free Hotline for Reporting Spills 1 (800) 943-0003
County Contacts – North Dakota			
Williams County Emergency Services County Law Enforcement Center	As Needed		Mike Hallesy (701) 577-7707
Mountrail County Emergency Management Resources	As Needed		Don Longmuir (701) 628-2909
Ward County Emergency Management	As Needed	8:00 a.m.–4:30 p.m. Monday-Friday	Amanda Schooling, Director (701) 857 6560
McHenry County Emergency Management	As Needed		Marvin Sola (815) 338-6400
Pierce County Emergency Management	As Needed	7:30 a.m.-4:30 p.m. Monday-Friday	Kelsey Siegler (253) 798-6595
Benson County Emergency Management	As Needed		Scott Todahl (701) 473-5320
Ramsey County Emergency Management	As Needed		Kristen Nelsen, Local Emergency Manager (701) 662-7001
Nelson County Emergency Management	As Needed		Sharon Young, Local Emergency Manager (701) 247-2472
Grand Forks County Emergency Services	As Needed		Jim Campbell (701) 780-8213
City of Grand Forks Emergency Services	As Needed		John Bernstrom (701) 746-4636
Pembina County Emergency Management	As Needed		Andrew Kirking (701)265-4849
County Contacts – Minnesota			

Spill Reporting Contacts			
Agency	**Reporting Criteria**	**When**	**Phone Number**
Kittson County Emergency Management	Kittson, Marshall, Pennington, Polk, Clearwater, Hubbard, Wadena, Cass, Crow Wing, Aitkin, and Carlton counties		Barb O'Hara (218) 843-2113
Marshall County Emergency Services	As Needed		Josh Johnston (218) 745-5841
Pennington County Emergency Management	As Needed		Erik Beitel (218)683-7087
Wadena County Emergency Management	As Needed		Luke Manderschied (218)631-7795
Polk County Emergency Management	As Needed		Barb Erdman, Director (218) 281-0437
Red Lake County Emergency Management	As Needed		Mitch Bernstein (218) 253-2996
Clearwater County Emergency Management	As Needed	8:00 a.m.–4:30 p.m. Monday-Friday	(218) 694-6183
Hubbard County Emergency Management	As Needed		Brian Halbasch (218) 732-2588
Cass County Emergency Management	As Needed		Kerry Swenson, Dispatcher (218) 547-7437
Crow Wing County Emergency Management	As Needed		John Bowen, Director (218) 829-4749
Aitkin County Emergency Management	As Needed		Dispatch (non-emergency) (218) 927-7400
Carlton County Emergency Management	As Needed		Brian Belich, Manager (218) 384-3236
County Contacts – Wisconsin			
Douglas County Emergency Management	As Needed	8:00 a.m.-4:30 p.m. Monday-Friday	Keith Kesler, Director (715) 395-1636

Appendix F

Enbridge Agricultural Protection Plan

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Appendix G
Agricultural Protection Plan

This APP is the same APP that was submitted as Appendix H of the Enbridge Energy, Limited Partnership Application for a Pipeline Routing Permit on April 24, 2015.



Enbridge

AGRICULTURAL PROTECTION PLAN

April 2015

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APPENDICES

Appendix A Mitigation Measures for Organic Agricultural Land
Appendix B Management of Change Onsite Modification Request Form

DEFINITIONS

Agricultural Inspector	On-site inspector retained by Enbridge to verify compliance with requirements of this Plan during construction.
Agricultural Land	Land that is actively managed for agricultural purposes, including: cropland, hayland, or pasture; silvicultural activities (i.e., tree farms); and land in government set-aside programs such as Conservation Reserve Program and Conservation Reserve Enhancement Program. Agricultural Land may also include land that is otherwise fallow but would likely be cultivated within 5 years of construction completion.
Agricultural Monitor	On-site third-party monitor retained and funded by Enbridge, but providing direct reports to the Minnesota Department of Agriculture and/or Wisconsin Department of Agricultural, Trade, and Consumer Protection and responsible for auditing Enbridge's compliance with provisions of this Plan.
APP	Agricultural Protection Plan.
ATWS	Additional Temporary Workspace.
BMP	Best Management Practices.
CFR	Code of Federal Regulations.
Cropland	Land actively managed for growing row crops, small grains, or hay.
Easement	The agreement(s) and/or interest in privately owned Agricultural Land held by Enbridge by virtue of which it has the right to construct and operate together with such other rights and obligations as may be set forth in such agreement.
EPP	Environmental Protection Plan
Final Cleanup	Pipeline construction activity that occurs after backfill but before restoration of fences and required reseeding. Final Cleanup activities include: replacing Topsoil, removal of construction debris, removal of excess rock, decompaction of soil as required, final grading, and installation of permanent erosion control structures.
Landowner	Person(s) holding legal title to Agricultural Land from whom Enbridge is seeking, or has obtained, a temporary or permanent Easement. The term "Landowner" shall include any person(s) authorized in writing by the actual Landowner to make decisions regarding the mitigation or restoration of agricultural impacts to such Landowner's property.
MDA	Minnesota Department of Agriculture
MOC	Management of Change procedure.
MN PUC	Minnesota Public Utilities Commission
Non-Agricultural Land	Any land that is not "Agricultural Land" as defined above.
NDA	North Dakota Department of Agriculture
ND PSC	North Dakota Public Service Commission

Person	An individual or entity, including any partnership, corporation, association, joint stock company, trust, joint venture, limited liability company, unincorporated organization, or governmental entity (or any department, agency, or political subdivision thereof).
Planned Tile	Locations where the proposed Tile installation is made known in writing to Enbridge by the Landowner either: 1) within 60 days after the signing of an Easement; or 2) before the issuance of a Routing Permit to Enbridge; whichever is sooner.
PSCW	Wisconsin Public Service Commission
Right-of-way	The land included in permanent and temporary Easements that Enbridge possess for the purpose of construction and operation.
Routing Permits	Routing permits issued by the ND PSC, MN PUC, and PSCW.
Spoil Storage Side	Non-working side of the construction Right-of-way where ditch spoil and temporary Topsoil are stored (as needed).
Tenant	Any person, other than the Landowner, lawfully residing on or in possession or control of the land that makes up the "right-of-way" as defined in this Plan.
Tile	Subsurface drainage systems and their aboveground appurtenances.
Topsoil	The uppermost horizon (layer) of the soil, typically with the darkest color and highest content of organic matter and nutrients.
Trench Crown	The placement of subsoil and Topsoil in the trench to a finished elevation somewhat above the surrounding ground surface to account for post-construction settling of soil returned to the trench.
TWS	Temporary Workspace
USC	United States Code
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
WDATCP	Wisconsin Department of Agricultural, Trade, and Consumer Protection

PURPOSE AND APPLICABILITY

This Agricultural Protection Plan (”Plan”) was developed by Enbridge in consultation with the Minnesota Department of Agriculture (“MDA”) and the Wisconsin Department of Agricultural, Trade, and Consumer Protection (“WDATCP”)[1]. Enbridge will include the Plan as part of applications for a Pipeline Routing Permit (“PRP”) from the Minnesota Public Utilities Commission (“MN PUC”) and a Public Interest Determination (“PID”) from the Wisconsin Public Service Commission (“PSCW”). Through the MN PUC and PSCW public notice and review processes associated with the applications, other agencies (including the MDA and WDATCP), local authorities, Landowners, Tenants, and other stakeholders are able to review and provide comments on the Plan. This Plan will be incorporated by reference into the Routing Permits issued by the MN PUC and the Public Interest Determination issued by the PSCW. Once finalized, this Plan may also be incorporated by reference into other federal, state, and local permits.

The objective of the Plan is to identify measures that Enbridge will implement to avoid, mitigate, or provide compensation for negative agricultural impacts that may result from pipeline construction. The construction standards described in this document apply only to construction activities occurring partially or wholly on privately owned Agricultural Land. Furthermore, Best Management Practices (“BMPs”) identified in the Enbridge’s Environmental Protection Plan (“EPP”) may be installed on Agricultural Land in conjunction with mitigation measures outlined in this Plan.

Unless the easement or other agreement, regardless of nature, between Enbridge and the Landowner specifically requires the contrary, the mitigation measures specified in this Plan will be implemented in accordance with the conditions discussed below.

Appendix A sets forth the specific additional mitigation measures that will be applied specifically to Organic Agricultural Lands, such as Certified Organic farms or farms that are in active transition to become Certified Organic. Organic Agricultural Land is defined as farms or portions thereof, as described in the National Organic Program, Title 7 Code of Federal Regulations (“CFR”) § 205.

GENERAL PROVISIONS

All mitigation measures are subject to change by Landowners, provided such changes are negotiated in advance of construction and acceptable to Enbridge. If any provision of this Plan is held to be unenforceable, no other provision will be affected by that holding, and the remainder of the Plan will be interpreted as if it did not contain the unenforceable provision.

Enbridge will consider any federal, state, and local permit, including Routing Permits, to be the controlling authority. To the extent a mitigation measure contemplated by this Plan is determined to be unenforceable in the future due to requirements of other permits issued, Enbridge will inform the regulatory authority and will develop reasonable alternative measures. Enbridge will implement the mitigation measures and BMPs described in this Plan to the extent they do not conflict with the requirements of federal and state rules and regulations, and permits and approvals obtained by Enbridge. Certain provisions of this Plan require Enbridge to consult and/or reach agreement with the Landowner of a property. Enbridge will engage in a good faith effort to

[1] Enbridge also attempted to engage the North Dakota Department of Agriculture (“NDA”) for purposes of Plan development. The NDA has not replied to-date. Nonetheless, Enbridge will apply this Plan to the entire project (including North Dakota Agricultural Lands). State-specific requirements may be referenced within this Plan.

secure the agreement. Tenants will not be consulted except where a Landowner has designated in writing that a Tenant has decision making authority on their behalf.

Enbridge will retain qualified contractors to perform mitigation measures; however, Enbridge may negotiate with Landowners to implement the mitigation measures that Landowners wish to perform themselves.

Enbridge will employ an Agricultural Inspector whose role is to verify compliance with the requirements of this Plan during construction of the pipeline. The Agricultural Inspector will be employed by and report to Enbridge, and will be a part of Enbridge's environmental inspection team.

The Agricultural Inspector will:

- Be a full-time member of Enbridge's environmental inspection team
- Provide construction personnel with training on provisions of this Plan before construction begins;
- Provide construction personnel with field training on specific topics, such as protocols for Topsoil stripping;
- Observe construction activities on Agricultural Land on a continual basis;
- Be responsible for verifying Enbridge's compliance with provisions of this Plan during construction;
- Work collaboratively with other Enbridge inspectors, right-of-way agents, and the Agricultural Monitor in achieving compliance with this Plan;
- Document instances of noncompliance and work with construction personnel to identify and implement appropriate corrective actions as needed; and
- Have the authority to stop construction activities that are determined to be out of compliance with the provisions of this Plan.

In addition to the Agricultural Inspector, an Agricultural Monitor will also inspect construction work on Agricultural Lands in Minnesota and Wisconsin. The Agricultural Monitor will be retained and funded by Enbridge, but will function as an independent third-party inspector providing direct reports to the MDA and WDATCP, and will be responsible for auditing Enbridge's compliance with the provisions of this Plan in Minnesota and Wisconsin, respectively. Enbridge will provide resumes of candidates who meet the qualifications of an Agricultural Monitor for review and final selection by the MDA and WDATCP.

The Agricultural Monitor will not be a member of Enbridge's environmental inspection team. The Agricultural Monitor will not have the authority to direct construction activities or manage Enbridge employees or contractors. The Agricultural Monitor will work through Enbridge's Agricultural Inspector and the MDA and WDATCP if compliance issues are identified. The Agricultural Monitor will have full access to Agricultural Land crossed in Minnesota and Wisconsin and will have the option to attend meetings where construction on Agricultural Land is discussed. Specific duties of the Agricultural Monitor will include:

- Participate in preconstruction training activities sponsored by Enbridge;
- Monitor construction and restoration activities on Agricultural Land for compliance with provisions of this Plan;
- Review Management of Change ("MOC") requests;
- Approve MOC Level 1 requests as appropriate;

- Report instances of noncompliance to Enbridge's Agricultural Inspector;
- Prepare regular compliance reports and submit them to the MDA and WDATCP;
- Act as a liaison between Landowners and the MDA and WDATCP when necessary and requested by the Landowner;
- Serve as a resource to investigate complaints at the direction of the MDA and WDATCP and to explain any proposed changes to this Plan during construction; and
- Maintain a written log of communications from Landowners regarding compliance with this Plan as well as report Landowner complaints to Enbridge's Agricultural Inspector or right-of-way representative.

Both the Agricultural Inspector and Monitor will have a bachelor's degree in agronomy, soil science, or equivalent work experience. In addition, the Agricultural inspectors and Agricultural Monitors will have demonstrated practical experience with pipeline construction and restoration on Agricultural Land.

Enbridge will provide each Landowner with a telephone number and address that can be used to contact Enbridge, during and following the completion of construction, regarding the agricultural mitigation work that is performed on their property or other construction-related matters. If the contact information changes following construction, Enbridge will provide the Landowner with updated contact information. Enbridge will respond to Landowner telephone calls and correspondence within a reasonable time.

Mitigation measures identified by Enbridge pursuant to this Plan, unless otherwise specified in this Plan or in an Easement or other agreement with an individual Landowner, will be initiated within forty-five (45) days following completion of Final Cleanup on an affected property, weather permitting or unless otherwise delayed at the request of the Landowner. If implementation of mitigation measures requires additional time, Enbridge will make temporary repairs, as needed, to minimize the risk of additional property damage or interference with the Landowner's access to or use of the property.

MITIGATION MEASURES

1. Right-of-Way Width

Prior to construction, Enbridge will establish the right-of-way width for construction and temporary workspace ("TWS") in Agricultural Lands based on prior project experience, engineering and construction requirements or best practices, and safety needs. The construction limits will be shown on alignment sheet drawings provided to the construction contractor, Environmental Inspector, Agricultural Inspector, Agricultural Monitor, and regulatory authorities.

A. The typical construction workspace will be governed by the Routing Permits and other permits, but may be up to 120 feet wide in uplands, of which 50 feet will typically be retained in a permanent Easement, and 70 feet, respectively, will typically be TWS. The TWS will be used during construction for soil storage and operation of equipment and vehicles along the entire length of the pipeline. At certain select areas where the pipeline crosses natural geographic or larger man-made features such as roads, railroads, streams, or wetland crossings, a defined area of additional temporary workspace ("ATWS") will be required on each side of the feature.
B. The construction boundaries of ATWS will be staked prior to the work at each location.

C. If the area of the ATWS is not sufficient to perform the work and implement BMPs, Enbridge will refrain from construction in that area until an adequate work area is available and approved. Enbridge will discuss the need for ATWS with the construction contractor, construction inspection team, Agricultural Inspector, Agricultural Monitor, and the Landowner, and will not use any additional workspace until approved by the Landowner, Agricultural Monitor, and regulatory authorities, as applicable.

2. Pipeline Depth of Cover

A. Except for aboveground facilities, such as mainline block valves, and except as otherwise stated in this Plan, the pipeline will be buried with the following depths of cover on Agricultural Land:

1) The pipeline will be constructed with a minimum depth of cover of 30 inches as required by U.S. Department of Transportation ("USDOT") regulations in 49 CFR §195.248. Section 216G.07 of the Minnesota Statutes further requires a minimum depth of cover of 54 inches unless waived by the Landowner. As a result, Enbridge will ask Landowners to waive the 54-inch-deep minimum cover requirement, as allowed by Minn. Stat. § 216G.07 and consistent with Enbridge's expansion projects in 1994, 1998, 2002, 2008, and 2009-2010.

2) Where existing or planned Tile systems are present, the pipeline will be installed at a depth that will achieve at least a 12-inch-wide separation between the pipeline and overlying Tiles as described in Section 2.C. of this Plan.

B. Enbridge will construct the pipeline under existing non-abandoned Tile and Planned Tile within six (6) feet of the surface, unless the Landowner determines otherwise in writing. Enbridge may install the pipeline over Tile that is buried deeper than six (6) feet. If, prior to construction, the Landowner plans to install a new Tile system, the Landowner must provide to Enbridge plans drawn by a qualified professional with experience in Tile design and installation. In determining the proper depth of the pipeline, Enbridge will accommodate the depth and grade needed for both existing and Planned Tile to function properly. Enbridge will not change the grade of existing Tile to accommodate the pipeline without the Landowner's advance written consent.

C. A minimum of twelve (12) inches of separation will be maintained between the pipeline and Tile unless the Landowner agrees in writing to a lesser separation. If unforeseen physical conditions are discovered during construction that prevents minimum separation, the Landowner will be informed of the situation prior to the installation of the pipeline over the Tile. If a good faith effort is made and the Landowner is unavailable, the Agricultural Monitor will be informed and construction will continue.

3. Winter Construction

Enbridge intends on avoiding construction in Agricultural Lands in the winter season. However, to protect the productivity of Agricultural Lands in the event that winter construction is unavoidable as a result of weather, permit acquisition, or any other unforeseen delays, the following mitigation measures are proposed:

A. *Minimize Topsoil Stripping in frozen conditions.* Frozen conditions can preclude effective Topsoil stripping. When soil is frozen to a depth greater than the depth of the Topsoil, Topsoil cannot be efficiently stripped from the subsoil. If Topsoil stripping must proceed under these conditions, it will only be removed from the area of the trench. A ripper will be used to break up the frozen Topsoil over the trenchline and a backhoe will remove the Topsoil layer and store the material in a separate pile. The ripper will extend to the depth of Topsoil or to a maximum depth of eighteen (18) inches in the Red River Valley (In Minnesota) and twelve (12) inches elsewhere, whichever is less.

B. *Minimize Final Clean-up activities in frozen conditions*. Frozen conditions can preclude effective Topsoil replacement, removal of construction debris, removal of excess rock, decompaction of soil as required, final grading, and installation of permanent erosion control structures. If seasonal or other weather conditions preclude Final Clean-up activities, the trench and temporary workspace areas will be backfilled, stabilized, and temporary erosion control measures will be installed until restoration can be completed. If Topsoil/spoil piles remain throughout the winter, the Topsoil/spoil piles will be stabilized by an application of mulch and a tackifier or other methods approved by the regulatory authority. To prevent subsidence, backfill operations will resume when the ground is thawed and the subsoil will be compacted (as needed) prior to Final Clean-up activities. The construction contractor must monitor these areas until final restoration is complete.

C. Topsoil Stripping and Final Clean-up activities proposed in Agricultural Lands in frozen conditions in Minnesota and Wisconsin will be discussed with the MDA and WDATCP, respectively prior to commencement of these activities.

4. Temporary Erosion and Sediment Control

Temporary erosion and sediment controls will be implemented as required and are described in the EPP.

5. Topsoil Stripping, Trenching, Soil Storage, and Replacement

A. Full and partial Topsoil stripping methods are similar except for the area where the Topsoil is removed. With full Topsoil stripping, the Topsoil is removed from the entire working side (traffic lane, trench spoil storage, Topsoil storage piles, and trench area) of the right-of-way. Under partial Topsoil stripping, the Topsoil will not be removed from under the Topsoil storage piles. Topsoil will also be removed and segregated in other areas, such as bore pits at road and railroad crossings, where the footprint may be larger and/or irregularly shaped. Topsoil is typically stored on the outer most edge of the working side of the construction right-of-way, however, Enbridge may also store Topsoil on the spoil storage side of the construction workspace where there are workspace constraints. Typical details for each Topsoil stripping method are presented in the EPP.

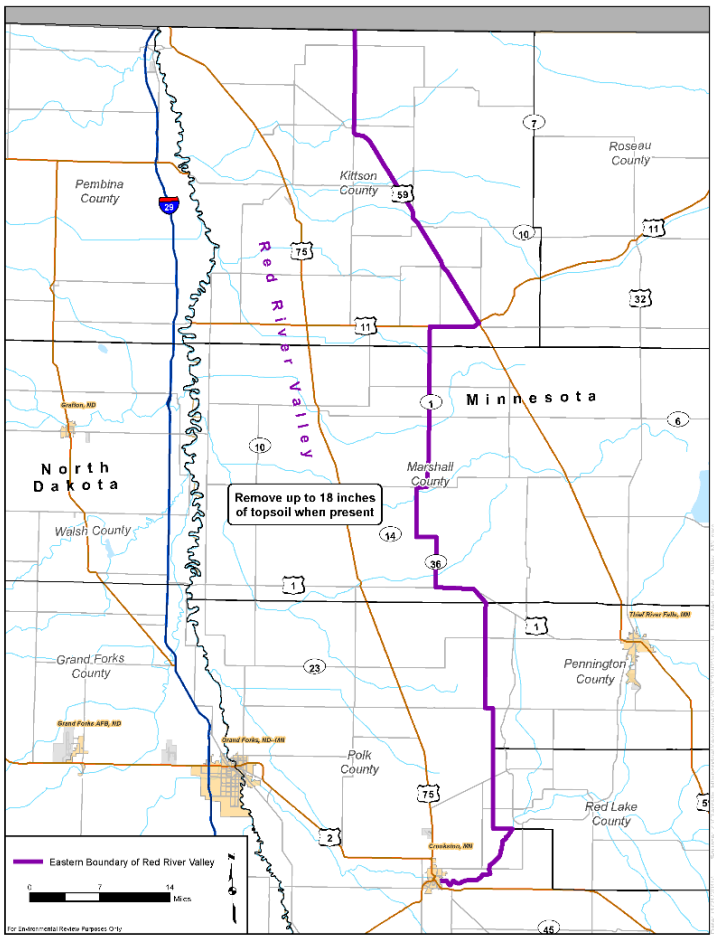
Enbridge will use the following Topsoil segregation methods during construction on Agricultural lands. The method selected will be dependent on specific Landowner approvals or agreements, field conditions, regulatory authority or permit requirements and/or other factors.

- Modified Ditch-Plus-Spoil-Side Method – This method involves stripping Topsoil horizon from the spoil storage area, the pipeline trench, and the primary portion of the travel lane. The modified ditch-plus-spoil-side method would typically be used in active cropland in the Red River Valley (in Minnesota).

- Full Right-of-Way Method – This method involves stripping Topsoil from the entire width of the construction right-of-way. On most Agricultural Land located outside of the Red River Valley (in Minnesota), Topsoil will be removed from the full right-of-way because this method typically results in less soil mixing between Topsoil and subsoil caused by equipment rutting over areas where Topsoil was not stripped. A larger volume of Topsoil will be generated using this method and, consequently, may warrant the need for Topsoil to also be stored on both sides of the construction right-of-way.

- Trenchline-Only Method – This method involves removing Topsoil from over the proposed trench only, and may be used where Enbridge determines that the width of the construction right-of-way is insufficient for storing Topsoil and maintaining a sufficient width to perform construction activities and allow equipment to pass.

B. The maximum depth of Topsoil stripping will be twelve (12) inches, except in the Red River Valley in Minnesota (see Figure below).



In the Red Lake Valley up to eighteen (18) inches of Topsoil may be stripped when present, unless otherwise agreed to with MDA. In this area, Enbridge will work with MDA to identify a suitable protocol for communicating the appropriate depth of Topsoil stripping to construction personnel. The Agricultural Inspector or the designated Enbridge inspector will observe Topsoil operations so that appropriate depths are removed.

C. Equipment operators will be trained to discriminate between Topsoil and subsoil based on obvious color changes. In locations where the Topsoil/subsoil color changes are not easily distinguishable or variable, the Agricultural Inspector will determine the depth.

D. Before removing Topsoil during wet soil conditions, the Agricultural Inspector will assess whether the moisture content in the surface horizon is suitable for grading. If the soil is considered too wet to segregate, stripping may be postponed. Based on the Agricultural Inspector's recommendation, Enbridge may allow Topsoil removal in areas where soils are persistently wet.

E. Enbridge may also remove Topsoil from ATWS as dictated by site-specific conditions and Landowner agreements. Topsoil will be removed in all "cut and fill" areas prior to grading.

F. In specific areas of deep Topsoil and as determined in consultation with the Agricultural Inspector and/or the Agricultural Monitor, the modified ditch-plus-spoil method will be used. However, the area requiring Topsoil stripping may be adjusted from the modified ditch-plus-spoil method where the Agricultural Inspector determines that such modification is necessary for safety or would be more protective of the soil resource. The adjusted method may include trenchline-only Topsoil segregation, such as in instances where Topsoil is removed under frozen conditions (i.e., winter construction). In all cases where modifications are proposed, approval from Enbridge, the MDA, the WDATCP, or other regulatory authority is required.

G. If the Agricultural Monitor and the Agricultural Inspector cannot agree on the proposed adjustment in the Topsoil segregation method, the Agricultural Monitor will document the objection and provide documentation to the MDA and/or WDATCP and Enbridge.

H. Trench spoil will be placed in a stockpile that is separate from Topsoil. Enbridge will maintain a minimum one (1)-foot-wide separation or place a barrier between Topsoil and subsoil piles to avoid mixing. In areas where the Topsoil has not been stripped from the subsoil storage area, subsoil can be stored on a thick layer of mulch or another physical barrier that identifies and protects the unstripped Topsoil.

J. Backfilling will follow lowering the pipe into the trench. During trench backfilling, subsoil material will be replaced first, followed by Topsoil. To prevent subsidence, subsoil will be backfilled and compacted. Compaction by operating construction equipment along the trench is acceptable.

K. Rock excavated from the trench may be included with backfill provided the rock content of the pre-construction soils is not significantly increased. In the event excess rock cannot be returned to the trench without substantially increasing pre-existing rock

content, rocks will be considered construction debris and removed (see Section 8 of this Plan).

L. Replacing Topsoil will be initiated within fourteen (14) days after backfilling the trench. If seasonal or other weather conditions prevent compliance with this timeframe, temporary erosion control measures must be implemented and maintained until conditions allow completion of cleanup. Topsoil will be replaced across the stripped area as near as practicable to its original depth. A Trench Crown over the trenchline is permissible to offset potential settling. Following placement of the subsoil crown, Topsoil would be uniformly returned across the stripped area. The height of the crown will generally be equal to, or less than, twelve (12) inches at the center. Breaks in the crown may be cut to accommodate overland water flow across the right-of-way.

6. Repair of Damaged and Adversely Affected Tile

If Tile is damaged during installation of the pipeline, the Tile will be repaired in a manner that restores operating condition. If Tile lines immediately adjacent to the construction area are adversely affected by the pipeline installation, Enbridge will restore the Tile, including the relocation, reconfiguration, or replacement of the Tile. The affected Landowner may settle with Enbridge for payment to repair, relocate, reconfigure, or replace the damaged Tile. In the event the Landowner chooses to perform the repair, relocation, reconfiguration, or replacement of the damaged Tile, Enbridge will not be responsible for correcting Tile repairs after completion of the pipeline and the Landowner's repairs. Enbridge is only responsible for correcting Tile repairs if the repairs were made by Enbridge or its agents or designees.

Prior to pipeline installation, Enbridge will contact Landowners to determine if Tile systems will be affected. Tile systems that will be damaged, cut, or removed during construction will be marked by placing a highly visible flag at the edge of the construction right-of-way directly over the Tile lines. These markers will not be removed until the Tile has been permanently repaired and approved and accepted by the Landowner, or the Agricultural Monitor.

The pipeline trench shall provide a minimum of twelve (12) inches of clearance, where practicable, between the pipe and drainage Tiles. In most situations, the pipe will be installed under the drainage Tile; however, where drain Tiles are deeper than six (6) feet Enbridge may elect to install the pipe above the Tile lines.

Enbridge will ensure that the construction contractor repairs damaged Tile in a manner consistent with industry-accepted methods. At the Landowner's request and with Enbridge's approval, local contractors may perform the repair, replacement, or reconfiguration of the Tiles damaged or cut during pipeline construction.

Where damaged Tile is repaired by Enbridge, the following procedures will apply:

A. Before completing permanent repairs, Tiles will be examined on both sides of the trench for their entire length within the work area to check for damage by construction equipment. If Tiles are found to be damaged, they will be repaired to preconstruction conditions.

B. Tiles will be repaired with material of the same or better quality as that which was damaged.

C. Filter-covered drain Tiles will be replaced with filter-covered drain Tiles.

D. If the Tile is clay, ceramic, or concrete, any connection made with new material must be made with commercially available connectors, wrapped in plastic, or sealed with Sakrete to prevent soil intrusion.

E. If water is flowing through a damaged Tile, temporary repairs will be promptly completed and maintained until permanent repairs can be made.

F. Where Tiles are damaged or severed by the pipeline trench, repairs will be made according to the following procedures:

   1) Where Tiles are severed by the pipeline trench, double-walled drain Tile pipe, or its equivalent material, will be used for Tile repairs.

   2) Within the trench, one and one-half (1.5) inch river gravel, four (4) inch crushed stone, sandbags, bags of Sakrete (or an equivalent), or poured concrete will be backfilled under Tiles, as needed, to provide support and prevent settling. Concrete blocks are also acceptable forms of support as are protective pads on the pipeline.

   3) The support member will be of sufficient strength to support loads expected from normal farming practices (i.e., loads up to a ten (10) ton point load) on the surface directly above the repaired Tile.

   4) The support member will extend a minimum of two (2) feet into the soil on both sides of the trench and will be installed in a manner that will prevent it from overturning. If the repairs involve clay Tile, the support member will extend to the first Tile joint beyond the minimum two (2) -foot-wide distance.

   5) There will be a minimum clearance as required by Section 2.C. of this APP.

   6) The grade of the Tile will not be changed.

G. Enbridge will initiate efforts to complete permanent Tile repairs within a reasonable timeframe after Final Cleanup, weather and soil conditions permitting.

H. Following completion of the Final Cleanup, Enbridge will be responsible for correcting repairs to Tile that fail, but only if Enbridge or its agents or designees made the initial repairs. Enbridge will not be responsible for Tile repairs that Enbridge has paid the Landowner to perform.

I. Any necessary modifications to the configuration of existing Tile systems must be consistent with the U.S. Department of Agriculture (“USDA”), Natural Resources Conservation Service, and Minnesota Wetland Conservation Act restrictions, and other regulatory authorities on wetland drainage.

7. Agricultural Drainage Ditches

Where the pipeline route crosses agricultural drainage ditches that are operated by the Landowner, the pipeline will be installed at a depth that is sufficient to allow for ongoing maintenance of the ditch. After the pipeline is installed, the ditch will be restored to its preconstruction contours with erosion controls as needed. Ditches that are operated and maintained by a public entity will be crossed in accordance with applicable permits.

8. Rock Removal

The following conditions will apply on Agricultural Land:

A. If trenching, blasting, or boring operations are required in bedrock, suitable precautions will be taken to minimize the potential for rocks to become mixed with the backfill.

B. After the construction right-of-way has been decompacted as required in Section 10 of this Plan and the Topsoil replaced, Enbridge will remove rocks from the surface of the entire construction area so that the size, density, and distribution of rock on the right-of-way is similar to that on adjacent off-right-of-way areas. Enbridge will consult with the Landowner to identify suitable rock disposal locations on the construction right-of-way, or the rocks will be removed for disposal at another approved disposal location. Written authorization from the Landowner is required for disposal on the Landowner's property. Rock disposal will comply with any federal, state, or local regulations involving fill and disposal of construction debris.

9. Removal of Construction Debris

Construction-related debris, material, and litter will be removed from the Landowner's property at Enbridge's expense. The Landowner or land-managing agency may approve leaving specific materials onsite that may provide for beneficial uses for stabilization or habitat restoration.

10. Compaction, Rutting, and Soil Restoration

A. In an effort to minimize soil compaction prior to trenching activities, Enbridge will, where practical, transport pipe joints (i.e., "stringing trucks") as closely as possible along the pipeline centerline.

B. After construction, compaction of the subsoil will be alleviated on Cropland using deep-tillage equipment, as needed. Decompaction of the topsoil, if necessary, will be performed during favorable soil conditions. If the Agricultural Inspector and/or Agricultural Monitor determine that the soil is too wet, decompaction will be delayed until the subsoil is friable/tillable in the top eighteen (18) inches.

C. Deep subsoil ripping in cropland will occur in all traffic and work areas of the pipeline right-of-way where there was full right-of-way Topsoil stripping, unless the Agricultural Inspector determines compaction has not occurred. This includes ATWS.

D. Subsoil ripping equipment may include v-rippers, chisel plows, or equivalents.

E. If the Landowner makes a written claim for damages related to soil compaction greater than that of immediately adjacent Agricultural Land owned by the Landowner but unaffected by pipeline construction, Enbridge will retain a Professional Licensed Soil Scientist, or an appropriately qualified professional engineer. The Professional Soil Scientist or engineer will perform a survey of the construction right-of-way, ATWS, and adjacent unaffected land owned by the Landowner for soil compaction using field equipment such as a soil penetrometer. In addition, where there are row crops, samples will be taken in the middle of the row, but not in rows where the drive wheels of farm equipment normally travel. Copies of the results of the survey will be provided to the Landowners making such claim within thirty (30) days of completion of the soil survey. These surveys for soil compaction will be completed at Enbridge's expense.

F. Enbridge will restore rutted land as near as practical to its preconstruction condition.

G. Enbridge will compensate Landowners, as appropriate, for damages caused by Enbridge during construction. Damages will be paid for the cost of soil restoration on the construction right-of-way and ATWS to the extent such restoration work is not performed by Enbridge.

H. In the event of a dispute between the Landowner and Enbridge regarding what areas need to be deep tilled (i.e., “ripped”) or chiseled, or the depth at which compacted areas should be ripped or chiseled, Enbridge will determine the appropriate actions based on the Agricultural Monitor’s opinion.

11. Fertilization and Liming

Fertilizers and lime will be applied based on Landowner requirements.

12. Land Leveling

Following completion of the construction, Enbridge will restore the construction work areas as practicable to the original preconstruction contours. If uneven settling occurs or surface drainage problems develop as a result of pipeline construction, Enbridge will provide additional land leveling services within forty-five (45) days of receiving a Landowner's written notice, weather and soil conditions permitting. Alternatively, Enbridge will negotiate with the Landowner for reasonable compensation in lieu of restoration.

13. Prevention of Soil Erosion

Enbridge will install permanent erosion control devices during restoration to prevent erosion as described in Enbridge’s EPP.

14. Repair of Damaged Soil Conservation Practices

Soil conservation practices (e.g., terraces, grassed waterways) that are damaged by pipeline construction will be restored to their preconstruction condition.

15. Interference with Irrigation Systems

A. If it is feasible and mutually acceptable to Enbridge and the Landowner, temporary measures will be implemented to allow an irrigation system to continue to operate across land on which the pipeline is being constructed.

B. If the pipeline right-of-way and/or ATWS interfere with an operational (or soon-to-be operational) spray irrigation system, Enbridge will inform the Landowner of the need to take the Irrigation system out of service. Enbridge and the Landowner will agree upon an acceptable amount of time the irrigation system may be out of service. If Enbridge and the Landowner are unable to agree on the amount of time within ten (10) days of Enbridge informing the Landowner of the need to take the irrigation system out of service, construction will proceed and the Landowner will be asked to take the irrigation system out of service.

C. If, as a result of pipeline construction, interruption of an irrigation system results in crop damages, either on the right-of-way or off-right-of-way, compensation of Landowners will be determined as described in Section 21 of this Plan.

16. Ingress and Egress

Prior to pipeline construction, Enbridge will identify the means of entering and exiting the right-of-way should access to the right-of-way not be practical or feasible from adjacent tracts or from public highway or railroad rights-of-way, consistent with Enbridge's Easement rights. Temporary access ramps may be constructed using locally obtained Topsoil as needed to facilitate the movement of equipment between public highways and the right-of-way.

17. Temporary Roads

A. If public roads do not provide sufficient access, Enbridge will attempt to use existing farms roads for access to and from the right-of-way, subject to approval from the Landowner or Enbridge's Easement rights. If Enbridge needs to construct a new temporary access road across Agricultural Land, the location will be made in collaboration with the Landowner. Temporary roads that are needed during construction will be located to minimize impacts on the landowner's or tenant's use of the agricultural land. If temporary roads in Agricultural Lands require gravel stabilization, geotextile construction fabric will be placed beneath the rock to add stability and to provide a distinctive barrier between the rock and soil surface. During restoration of the right-of-way, temporary access roads will be removed or restored to preconstruction conditions, except as described in Section 17C of this Plan.

B. Temporary roads will be designed so as not to impede drainage and will be constructed to minimize soil erosion.

C. Following construction, new temporary roads may be left intact through mutual agreement of the Landowner and Enbridge unless otherwise restricted by federal, state, or local regulations.

D. If the temporary roads are to be removed, the Agricultural Land on which the temporary roads are constructed will be returned to its previous use and restored to a condition

equivalent to what existed prior to construction. Restoration techniques for temporary roads will be similar to those used in restoring the construction right-of-way (e.g., decompaction).

18. Weed Control

Enbridge has identified and will implement weed control measures as described in the EPP.

Enbridge will provide weed control at its aboveground facility sites (e.g., mainline block valve sites, pump stations) to avoid the spread of weeds onto adjacent Agricultural Land during operation activities. Weed control spraying, will be conducted in accordance with applicable regulatory authorities.

19. Pumping of Water from Open Trenches

A. Enbridge will identify locations for discharging water pumped out of trenches in consultation with the Agricultural Inspector and Landowner, to the extent practicable.

B. When dewatering trenches, Enbridge will discharge the water in a manner that will minimize damaging adjacent Agricultural Land, crops, and/or pasture. Such damages may include, but are not limited to, inundation of crops for more than twenty-four (24) hours and deposition of sediment in cropland and drainage ditches. If water-related damage during discharge from trenches results in a loss of yield, compensation of Landowners will be determined as described in Section 21 of this Plan.

C. Discharge of water will be conducted in accordance with the EPP, federal and state regulations, and permit conditions.

20. Construction in Wet Conditions

A. Should the Agricultural Monitor determine that continued construction in wet conditions could result in damage to soil structure and compromise future cropland productivity, the Agricultural Monitor may request Enbridge's Agricultural Inspector to temporarily halt the activity on a Landowner's property until the Agricultural Monitor consults with Enbridge's Environmental Inspector and Construction Manager. Should Enbridge elect to continue construction activities over the objection of the Agricultural Monitor, Enbridge will retain a Professional Licensed Soil Scientist or an appropriately qualified professional engineer, at its own expense, to perform a survey of the construction right-of-way, ATWS, and adjacent unaffected land owned by the Landowner for soil compaction, prior to final restoration and using the procedures described above.

21. Procedures for Determining Construction-Related Damages

A. Enbridge will negotiate in good faith with Landowners who assert claims for construction-related damages. The procedure for resolution of these claims will be in accordance with the terms of the Easements.

B. Negotiations between Enbridge and any affected Landowner will be voluntary in nature and no party is obligated to follow a specific procedure or method for computing the amount of loss for which compensation is sought or paid, except as otherwise

specifically provided in the Easements. In the event a Landowner should decide not to accept compensation offered by Enbridge, the compensation offered is only an offer to settle, and the offer shall not be introduced in any proceeding brought by the Landowner to establish the amount of damages Enbridge must pay. In the event that Enbridge and a Landowner are unable to reach an agreement on the amount of compensation, any such Landowner may seek further recourse as provided in the Easement.

22. Advance Notice of Access to Private Property

A. Enbridge or its agents will provide the Landowner with a minimum of twenty-four (24) hours' notice before accessing his/her property for construction, in addition to any regulatory notifications.

B. Prior notice will consist of a personal or telephone contact, whereby the Landowner is informed of Enbridge's intent to access the land. If the Landowner cannot be reached in person or by telephone, Enbridge will mail or hand-deliver to the Landowner's home a dated, written notice of Enbridge's intent. The Landowner need not acknowledge receipt of the written notice before Enbridge enters the property.

23. Indemnification

Indemnification obligations relating to the pipeline installation covered by this Plan shall be determined in accordance with the terms of the Easements and applicable law.

24. Tile Repair Following Pipeline Installation

A. If, after pipeline installation, the Landowner must make repairs to the Tile system within the right-of-way, or plans to install a new Tile system, the Landowner must obtain Enbridge approval of the work plan prior to commencing any activities within the right-of-way. Enbridge may impose such requirements and limitations on the work as necessary to protect the safety and integrity of Enbridge's facilities. The Landowner will be responsible for contacting 811 or the local one call center prior to any excavation near the pipeline and complying with all necessary requirements imposed by Enbridge to protect the safety and integrity of Enbridge's facilities.

Enbridge will, at its own expense, follow the procedures below.

B. An Enbridge representative will be present while the excavation work is being performed, but will not perform the excavation work. If the pipeline is above the Tile system, Enbridge will be responsible for reasonable extra costs incurred by the Landowner to excavate and expose the pipeline in accordance with Enbridge's requirements for protection of the pipeline.

MANAGEMENT OF CHANGE PROCEDURE

As a result of variable field conditions during construction, Enbridge established a MOC procedure to allow this Plan to be modified as needed during construction. The MOC procedure allows for modifications to mitigation measures, construction alignments, plans, designs, methods, and construction work areas governed by this Plan. These modifications will involve discussions amongst representatives of Enbridge, the Agricultural Inspector, the Agricultural Monitor, and the

MDA and/or WDATCP, or other regulatory authorities. Some authority for approval/denial may be delegated to the Agricultural Monitor by the MDA and/or WDATCP, or other regulatory authorities. The MOC process can also be used to clarify discrepancies discovered in project documents and/or to distribute information to team members. Three MOC levels (Levels 1, 2, and 3) will be used to categorize and process requests. Enbridge will not conduct activities that deviate from approved activities without prior authorization by the MDA and/or WDATCP, or other regulatory authorities.

Enbridge anticipates that two types of minor route field realignments/modifications may be required after issuance of the routing permits that would not require approval of the Agricultural Monitor, the MDA and/or WDATCP, or other regulatory authorities: 1) minor realignments that are requested by the Landowner; and 2) minor realignments required due to site-specific conditions (e.g., steep slopes and other constructability concerns).

When these modifications are requested by Landowners or determined necessary for constructability and they do not affect other Landowners or sensitive environmental areas, such as wetlands, Enbridge will review all of the preconstruction surveys, documentation/collection, and mitigation, but will not request written approval of the Agricultural Monitor, MDA and/or WDATCP, or other regulatory authorities unless required by the terms of applicable permit(s). However, the Agricultural Inspector will inform the Agricultural Monitor of these minor adjustments.

Enbridge will request written approval from the Agricultural Monitor for all other modifications that would affect additional Landowners, or change construction procedures or methods, before commencing construction in or near any of these areas.

Level 1 Modification

Level 1 modifications are site-specific, minor changes to project specifications or mitigation measures that provide equal or better protection to environmental and agricultural resources. These minor modification requests can be reviewed and either approved or denied by the Agricultural Monitor in the field during normal construction operations.

Examples of Level 1 modifications include:

- Modifying the Topsoil segregation methods based on site-specific conditions;
- Using alternative soil stockpile locations (i.e., along the non-working (spoil) side of the right-of-way);
- Allowing the use of existing access roads that have not been previously approved, provided adequate cultural, wetland, and biological survey coverage is documented, if the use would be considered “like-use;” and
- Shifting extra workspace along the right-of-way a short distance where the overall disturbance remains the same, surveys have been completed, no sensitive resources would be affected, the workspace remains within the area permitted by the routing permits, and property access is available.

A Level 1 modification may also be used to document and disseminate agency-directed changes to mitigation measures. To initiate a Level 1 modification request, the Agricultural Inspector or other designated Enbridge representative will complete a modification request form (see Appendix B) and obtain the appropriate signatures (to be determined by Enbridge). Landowner approval will be obtained by Enbridge for those modifications requiring such approval. The

Agricultural Inspector will contact the Agricultural Monitor to review the proposed change. The Agricultural Inspector and the Agricultural Monitor will collaborate to evaluate the site-specific situation and determine if the modification is appropriate, feasible, and justified.

The Agricultural Monitor may approve a reasonable Level 1 modification request if, in the Agricultural Monitor's opinion, the results of implementing the change will provide equal or better protection for the resource than the original mitigation measure or if the original mitigation measure is not applicable to that specific site. If a Level 1 modification request is approved in the field, the Agricultural Monitor will sign the modification form.

The Agricultural Monitor will document the modification approval and transmit the approved form to the MDA and/or WDATCP, or other regulatory authority. If the modification exceeds the Agricultural Monitor's authority level, the Agricultural Monitor will inform the Agricultural Inspector that a Level 2 or Level 3 modification request is required.

Level 2 Modification

A Level 2 modification request exceeds the field decision authority of the Agricultural Monitor and requires review and final approval by the MDA and/or WDATCP, or other regulatory authority. Level 2 modification requests generally involve project changes that would affect an area outside of the previously approved work area, but are still within the corridor previously surveyed for cultural, wetland, and biological resources. Level 2 modification requests typically require the review of supplemental documents, correspondence, and records, and may require applicable agency approval.

Examples of Level 2 modifications include:

- Reducing the width or depth of Topsoil segregation in agricultural fields;
- Reducing the area to be decompacted or using an alternative method to decompact subsoil;
- Use of ATWS outside of the previously approved work area but within the previously surveyed corridor;
- The use of existing access roads that have not been previously approved if the use would not be considered "like-use" that could be approved as a Level 1 modification;
- Modifying a previously approved access road in ways not previously identified; and
- Increasing the width of the construction right-of-way at locations other than those allowed by Routing Permits, Enbridge Construction Alignment Sheets, and Enbridge's EPP.

To initiate a Level 2 modification request with the MDA and/or WDATCP, and other regulatory authority, the Agricultural Inspector or other designated Enbridge representative will fill out a modification request form, prepare the appropriate supporting documentation, and obtain the required signatures. The designated Enbridge representative will complete and submit the modification request form and supporting documentation by e-mail (scanned copy) or fax to the regulatory authority. The regulatory authority will review the request and supporting documentation. Landowner approval will be obtained by Enbridge for those modifications requiring approval. The regulatory authority will also discuss the request with the Agricultural Monitor.

If the Level 2 modification request is approved, the regulatory authority will sign the modification request and e-mail the approved form (scanned copy) to the designated Enbridge representatives and the Agricultural Monitor. The modification may be implemented in the field as soon as the regulatory authority and all other applicable agencies have approved the modification.

Level 3 Modification

Level 3 modification requests generally involve project changes that would affect an area outside of the previously approved work area, and that are outside corridor previously surveyed for cultural resources, wetlands, and biological resources.

Examples of Level 3 modifications include:

- Extra workspaces, access roads, or route realignments for which landowner approval has not been obtained (i.e., condemnation tracks);
- Certain changes to mitigation measures or construction/restoration procedures; and
- Extra workspaces, access roads, or route realignments outside the previously surveyed corridor that require additional surveys and agency approvals that affect resources of sufficient sensitivity to require a formal letter approval from other regulatory authorities.

To initiate a Level 3 modification request, the Agricultural Inspector or other designated Enbridge representative will fill out a modification request form, prepare the appropriate supporting documentation, ensure the required environmental surveys have been completed, and obtain the required signatures. The designated Enbridge representative will submit the modification request form and supporting documentation by e-mail (scanned copy) or fax to the all applicable regulatory authorities. The regulatory authorities will review the request and supporting documentation and consult with other agencies as necessary. The MDA and/or WDATCP may also discuss the request with the Agricultural Monitor. If sensitive biological species and/or habitat are encountered during the additional surveys, documentation of consultation with applicable agencies will be provided with the modification request. The MDA and/or WDATCP will consult with the regulatory authorities and receive appropriate agency approvals before authorizing the modification.

If the Level 3 modification request is approved, the MDA and/or WDATCP will sign the modification request and e-mail the approved form (scanned copy) to the designated Enbridge representatives and the Agricultural Monitor. The modification may be implemented in the field as soon as the approved modification is received. All agency-approved mitigation measures will adhere to the modification if it is approved by the MDA and/or WDATCP.

Appendix A
Mitigation Measures for Organic Agricultural Land

INTRODUCTION

This appendix identifies mitigation measures that apply specifically to farms that are Certified Organic or farms in Minnesota that are in active transition to become Certified Organic, and is intended to address the unique management and certification requirements of these operations. All protections provided in the Plan must also be applied to Organic Agricultural Land in addition to the provisions of this appendix.

The provisions of this appendix will apply to Organic Agricultural Land for which the Landowner has provided to Enbridge a true, correct, and current version of the Organic System Plan within sixty (60) days after the signing of the Easement for such land or sixty (60) days after the issuance of a PRP to Enbridge by the MN PUC, whichever is sooner. In the event the Easement is signed later than sixty (60) days after the issuance of the PRP, the provisions of this appendix are applicable when the Organic System Plan is provided to Enbridge at the time of the signing of the Easement. In instances where Enbridge is in possession of the Easement prior to submitting its MN PUC application, the Landowner must provide the Organic System Plan to Enbridge no later than sixty (60) days after the issuance of the PRP. Enbridge recognizes that Organic Agricultural Land is a unique feature of the landscape and will treat this land with the same level of care as other sensitive environmental features.

DEFINITIONS

Unless otherwise provided to the contrary in this appendix, capitalized terms used in this appendix shall have the meanings provided below and in the Plan. In the event of a conflict between this appendix and the Plan with respect to definitions, the definition provided in this appendix will prevail but only to the extent such conflicting terms are used in this appendix. The definition provided for the defined words used herein shall apply to all forms of the words.

Apply	To intentionally or inadvertently spread or distribute any substance onto the exposed surface of the soil.
Certifying Agent	As defined by the National Organic Program Standards, 7 CFR § 205.2.
Decertified or Decertification	Loss of Organic Certification.
Organic Agricultural Land	Farms, or portions thereof, that have been Certified Organic.
Certified Organic	"Certified" as defined in 7 CFR § 205.2.
Organic System Plan	As defined by the National Organic Program Standards, 7 CFR § 205.2.
Prohibited Substance	As defined in 7 CFR § 205.2. Prohibited Substances are further described in 7 CFR §§ 205.600-607.

ORGANIC SYSTEM PLAN

Enbridge recognizes the importance of the individualized Organic System Plan to the Organic Certification process. Enbridge will work with the Landowner, the Landowner's Certifying Agent, and/or a USDA-approved organic consultant to identify site-specific construction practices and develop an organic construction plan that will minimize the potential for Decertification as a result of construction activities. Enbridge also recognizes that Organic System Plans are proprietary in nature and confidentiality will be respected.

PROHIBITED SUBSTANCES

Enbridge will avoid the application of Prohibited Substances onto Organic Agricultural Land. No herbicides, pesticides, fertilizers, or seed will be applied unless requested and approved by the Landowner. Likewise, no refueling, fuel, or lubricant storage or routine equipment maintenance will be allowed on Organic Agricultural Land. Equipment will be checked prior to entry to make sure that fuel, hydraulic, and lubrication systems are in good working order before working on Organic Agricultural Land. If Prohibited Substances are used on land adjacent to Organic Agricultural Land, these substances will be used in such a way as to prevent them from entering Organic Agricultural Land.

SOIL HANDLING

Topsoil and subsoil layers that are removed during construction will be stored separately and replaced in the proper sequence after the pipeline is installed. Unless otherwise specified in the site-specific plan described above, Enbridge will not use this soil for other purposes, including creating access ramps at road crossings. No Topsoil or subsoil (other than incidental amounts) may be removed from Organic Agricultural Land. Likewise, Organic Agricultural Land will not be used for storage of soil from non-Organic Agricultural Land.

EROSION CONTROL

On Organic Agricultural Land, Enbridge will, to the extent feasible, implement erosion control methods consistent with the Landowner's Organic System Plan. On land adjacent to Organic Agricultural Land, Enbridge's erosion control procedures will be designed so that sediment from adjacent non-Organic Agricultural Land will not flow along the right-of-way and be deposited on Organic Agricultural Land. Treated lumber will not be used in erosion control measures on Organic Agricultural Land.

WATER IN TRENCHES

During construction, Enbridge will leave an earthen plug in the trench at the boundary of Organic Agricultural Land to prevent trench water from adjacent land from flowing into the trench on Organic Agricultural Land. Likewise, Enbridge will not allow trench water from adjacent land to be pumped onto Organic Agricultural Land.

WEED CONTROL

On Organic Agricultural Land, Enbridge will, to the extent feasible, implement weed control methods consistent with the Landowner's Organic System Plan. Prohibited Substances will not be used for weed control on Organic Agricultural Land. In addition, Enbridge will not use

Prohibited Substances for weed control on land adjacent to Organic Agricultural Land in such a way as to allow these materials to drift onto Organic Agricultural Land.

MITIGATION OF NATURAL RESOURCE IMPACTS

Enbridge will not use Organic Agricultural Land for the purpose of required compensatory mitigation of impacts on natural resources such as wetlands or woodlands unless approved by the Landowner.

MONITORING

In addition to the responsibilities of the Agricultural Monitor described in the Plan, the following will apply:

- The Agricultural Monitor or a trained Organic Inspector (trained through a USDA-approved Organic Inspection Program and retained by Enbridge) will routinely monitor construction and restoration activities on Organic Agricultural Land for compliance with the provisions of this appendix and will document activities that could result in Decertification; and

- Instances of noncompliance will be documented according to International Organic Inspectors Association protocol consistent with the Landowner's Organic System Plan, and will be made available to the MDA, the Landowner, the Landowner's Certifying Agent, and to Enbridge.

If the Agricultural Monitor is responsible for routinely monitoring activities on Organic Agricultural Land, he or she will have been trained in such activities by the International Organic Inspectors Association, at Enbridge's expense if necessary.

COMPENSATION FOR CONSTRUCTION DAMAGES

The settlement of damages will be based on crop yield and/or crop quality determination and the need for additional restoration measures, and will proceed in accordance with the terms of the Easement. Unless the Landowner of Organic Agricultural Land and Enbridge agree otherwise, at Enbridge's expense, a mutually agreed upon professional agronomist will make crop yield determinations, and the MDA Fruit and Vegetable Inspection Unit will make crop quality determinations. If the crop yield and/or crop quality determinations indicate the need for soil testing, the testing will be conducted by a commercial laboratory that is properly certified to conduct the necessary tests and is mutually agreeable to Enbridge and the Landowner. Fieldwork for soil testing will be conducted by a Professional Soil Scientist or Professional Engineer licensed by the State of Minnesota. Enbridge will be responsible for the cost of sampling, testing, and additional restoration activities, if needed. Landowners may elect to settle damages with Enbridge in advance of construction on a mutually acceptable basis or to settle after construction based on a mutually agreeable determination of actual damages.

COMPENSATION FOR DAMAGES DUE TO DECERTIFICATION

Should any portion of Organic Agricultural Land be Decertified as a result of construction activities, the settlement of damages will be based on the difference between revenue generated from the land affected before Decertification and after Decertification, for the entire period of time the land is Decertified, so long as a good faith effort is made by the Landowner to regain certification.

Appendix B
Management of Change Onsite Modification Request Form

ON-SITE MODIFICATION REQUEST FORM

Change Request No.: _____ Approval Reference No.: _____

Date Approval Required: _____ Date Submitted: _____

Spread/Location: _____ Time Submitted: _____

Land Owner: _____ Current Land Use: _____

Alignment Sheet Station No.: _____ Tract No.: _____

Change From (check one): ☐ Permit ☐ Plan/Procedure ☐ Drawing ☐ Specification ☐ Other

Specify Source (e.g., Detail Drawing 1): _____

Detailed Description of Change: Attachments? ☐ Yes ☐ No Photos? ☐ Yes ☐ No

Change Justification:

Environmental Review – Describe Potential to Affect Each of the Following (including area and agency consultation as appropriate):

Wetlands:

Endangered and Threatened Species:

Archeological Sites:

Closest Residence:

Closest Drinking Water Supply Well:

Other Conditions:

Prepared by: _____ Date: _____

Reviewed by: _____ Date: _____

Attachment

☐ Yes ☐ No

For Agency or Enbridge Environment Management Use Only

Check one:

☐ Modification Approved ☐ Modification Denied ☐ Point of Contact

Signature: _____ Date: _____

CONDITIONAL APPROVAL

☐ Yes ☐ No

(If yes, list conditions below)

Conditions:

Distribution (note all that apply):

Appendix G

Waterbody Crossings

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Appendix G1 Waterbody Crossing Trenching and Installation Methods

Construction at waterbodies requires clearing and grading; installing erosion control measures; possibly removing beavers and removing or altering beaver dams; and constructing temporary equipment bridges. After initial clearing and grading is completed, Enbridge would install the pipeline across the waterbody using one of the following crossing methods: wet trench, dam and pump, flume, or horizontal directional drill (HDD) or guided bore. Each of these waterbody crossing trenching and installation methods are detailed below.

Wet Trench Method

The open-cut method (also known as the "wet open-cut" method) is a waterbody crossing technique that often minimizes the total duration of instream disturbance. The wet trench method is typically used to cross waterbodies for which dam and pump, flume, and HDD are not permitted. This method is illustrated in Figure H-1.

Enbridge would excavate the trench using draglines or backhoes operating from one or both streambanks. If equipment is required to enter the stream to excavate the trench, the equipment would conduct the excavation on clean construction mats. Enbridge would place excavated material on the upland construction work area at least 20 feet from the water's edge or in an ATWS. The upper 1 foot of the trench spoil would be stored separately from the remaining spoil. The ATWS would be set back 50 feet from the water's edge, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land. Sediment containment devices, such as silt fences and straw bales, would be installed to contain the excavated material and to minimize the potential for sediment to migrate into the waterbody. Enbridge would only store trench spoil within the stream if doing so is expressly approved by regulatory agencies.

During excavation of the instream trench, Enbridge would leave earthen trench plugs at each end of the excavation to prevent the waterbody from flowing into the adjacent excavated pipeline trench and to prevent water accumulated in the upland trench from running into the waterbody. When excavation of the trench is complete, the trench plugs would be removed, and a prefabricated section of pipe would be positioned and lowered into the trench.

Enbridge would backfill the trench with the excavated material, unless otherwise specified in stream crossing permits. Enbridge would attempt to return the bed of the waterbody as near as practicable to its preconstruction condition with no impediments to normal waterbody flow.

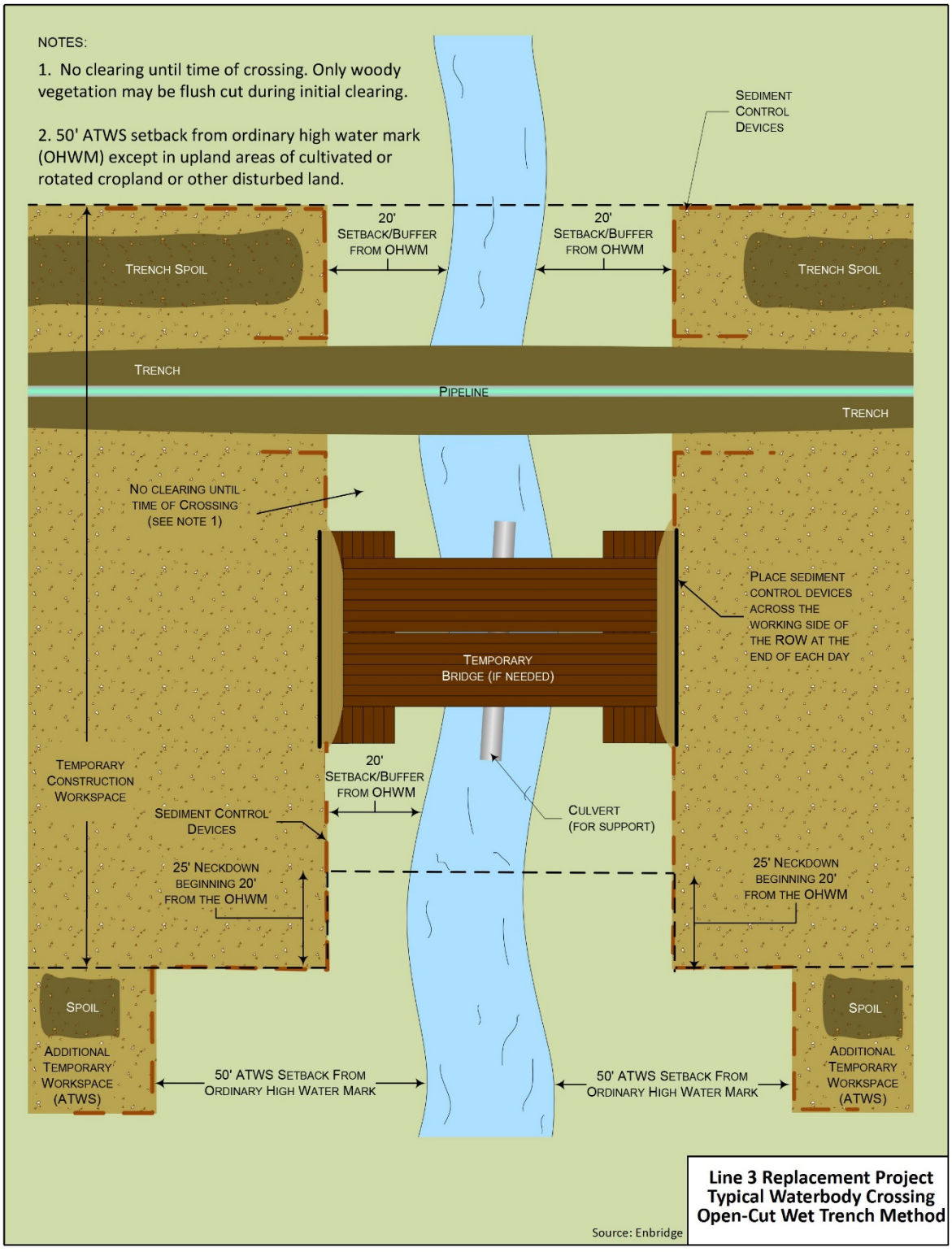

Figure G-1. Wet Open Cut Waterbody Crossing Technique

Dry Crossing Methods

Dam-and-Pump Method

The dam-and-pump method is a dry crossing method that is typically used for waterbodies with low gradients and flow or waterbodies with meandering channels. This method involves constructing temporary dams across the waterbody, both upstream and downstream of the crossing, prior to excavation. Dams generally would be installed using sandbags, plastic sheeting, sheet piling, or steel plates. Pumps and piping would be used to transport the stream flow around the construction area for the duration of the process. This method is illustrated in Figure H-2.

When using this method, Enbridge would begin pumping the upstream flow while the dams are being installed to prevent interruption of stream flows. The downstream flow would be discharged into an energy-dissipation device to prevent scouring of the waterbody bed or adjacent banks. The capacity of the pumps and piping would be greater than the anticipated flow of the waterbody being crossed but would be adjusted to maintain the flow of water downstream and prevent excessive drawdown of the waterbody upstream of the construction area. Pumps and fuel for the pumps would be installed in impermeable, sided containment structures in the upland on the upstream side of the waterbody crossings. Enbridge would cover the pump intake with a screen and suspend it above the waterbody bed to prevent sediment uptake and entrainment of aquatic organisms.

Once stream flow is routed around the construction area, water from the area between the dams would be pumped, via separate pumps, into a straw bale structure or similar dewatering discharge device. These devices would be located in well-vegetated upland areas, if present, and would be designed in a manner to prevent the flow of heavily silt-laden water into waterbodies or wetlands. Backhoes would excavate the trench from one or both banks or on clean construction mats within the isolated waterbody bed. Enbridge would place excavated material on the upland construction work area at least 20 feet from the water's edge or in an ATWS. The upper 1 foot of the trench spoil would be stored separately from the remaining spoil. The ATWS would be set back 50 feet from the water's edge, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land. Sediment containment devices, such as silt fences and straw bales, would be installed to contain the excavated material and to minimize the potential for sediment to migrate into the waterbody.

During excavation of the instream trench, Enbridge would leave earthen trench plugs at each end of the excavation to prevent water accumulated in the upland trench from running into the isolated waterbody bed. After the trench is excavated to the proper depth, the trench plugs would be removed, and a prefabricated section of pipe would be positioned and lowered into it. Enbridge would then backfill the trench with the material excavated from the bed of the waterbody, unless otherwise specified in stream crossing permits. Prior to removing the dams and restoring stream flow, Enbridge would pump water that accumulated in the construction area into a straw bale structure or similar dewatering device and restore the bottom contours of the streambed and the streambanks as closely as practical to preconstruction contours with no impediment to waterbody flow.

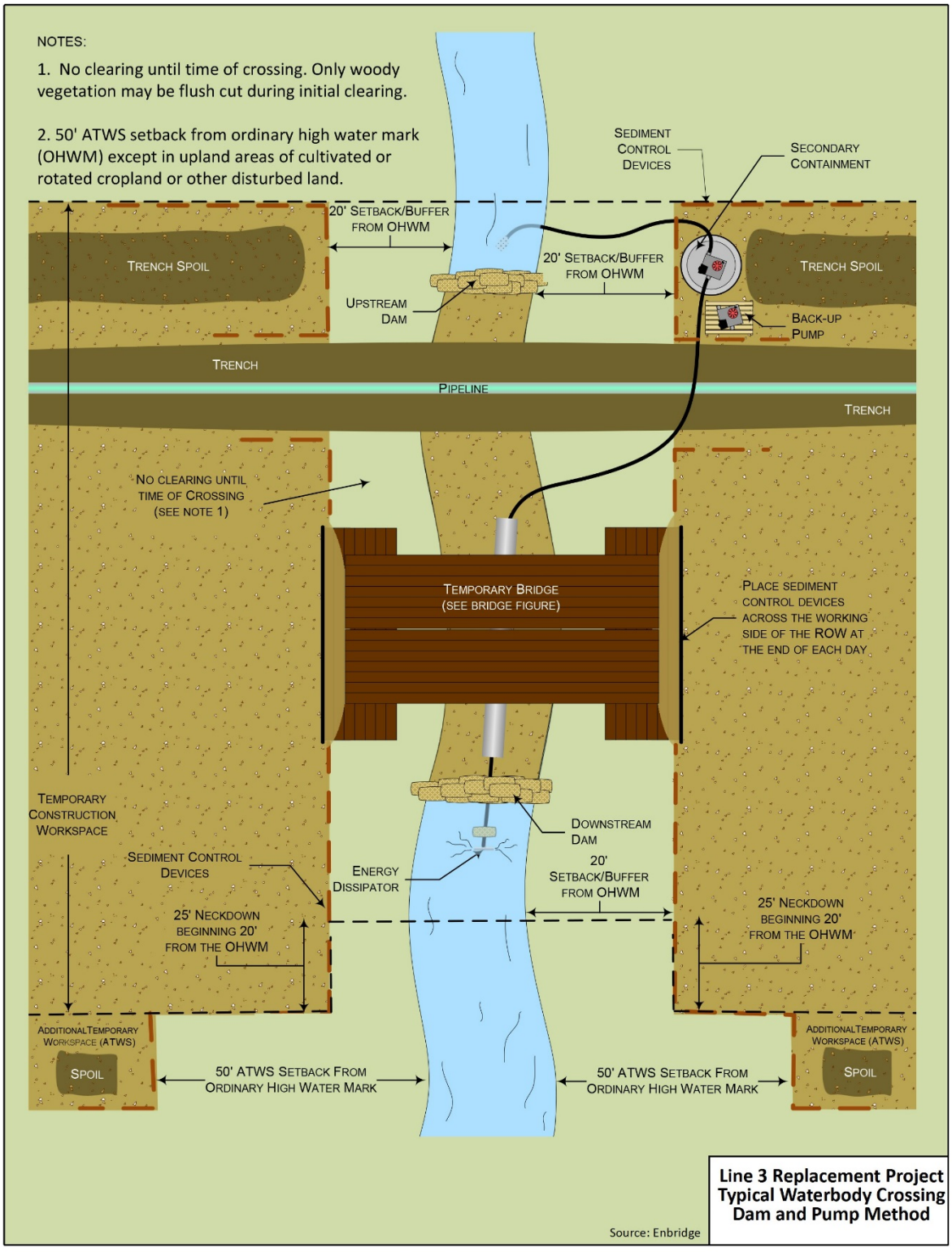

Figure G-2. Dam-and-Pump Waterbody Crossing Technique

Flume Method

The flume method is a dry crossing method used for relatively narrow waterbodies free of large rocks and bedrock at the trench line and with a relatively straight channel across the construction work area. The flume method generally is not appropriate for wide, deep, or heavily flowing waterbodies. Use of this method involves installing dams upstream and downstream of the construction area and installing one or more pipes (flumes) that would extend along the course of the waterbody and through both dams. Streamflow would be carried through the construction area by the flume pipe(s). The flume method is illustrated in Figure H-3.

Flumes would be installed with sufficient capacity to transport the maximum flows that could be generated seasonally within the waterbody. The flumes, typically 40 to 60 feet long, would be installed before trenching and aligned to prevent impounding of water upstream of the construction area or to cause back-erosion downstream.

The upstream and downstream ends of the flumes would be incorporated into dams made of sandbags and plastic sheeting (or equivalent material). Upstream dams would be installed first and would funnel stream flow into the flumes. Downstream dams then would be constructed to prevent water from flowing back into the area to be trenched. Enbridge would monitor the dams and adjust them as necessary to minimize leakage. The flumes would remain in place during pipeline installation, backfilling, and streambank restoration.

Prior to trenching, the area between the dams typically would be dewatered. Backhoes working from one or both banks, or from clean construction mats within the isolated waterbody bed, would excavate the trench across the waterbody and under the flume pipes. Excavated material would be placed on the upland construction work area at least 20 feet from the water's edge or in an ATWS. The upper 1 foot of the trench spoil would be stored separately from the remaining spoil. The ATWS would be set back 50 feet from the water's edge, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land. Sediment containment devices, such as silt fences and straw bales, would be installed to contain the excavated material and to minimize the potential for sediment to migrate into the waterbody.

During excavation of the instream trench, Enbridge would leave earthen trench plugs at each end of the excavation to prevent water accumulated in the upland trench from running into the isolated waterbody bed. After the trench is excavated to the proper depth, the trench plugs would be removed, and a prefabricated section of pipe would be positioned and lowered into the trench. The trench then would be backfilled with the excavated material from the stream unless otherwise specified in stream crossing permits. Prior to removing the dams and flume pipes and restoring stream flow, Enbridge would pump water that accumulated in the construction area into a straw bale structure or similar dewatering device and restore the bottom contours of the streambed and the streambanks as closely as practical to preconstruction contours with no impediment to waterbody flow.

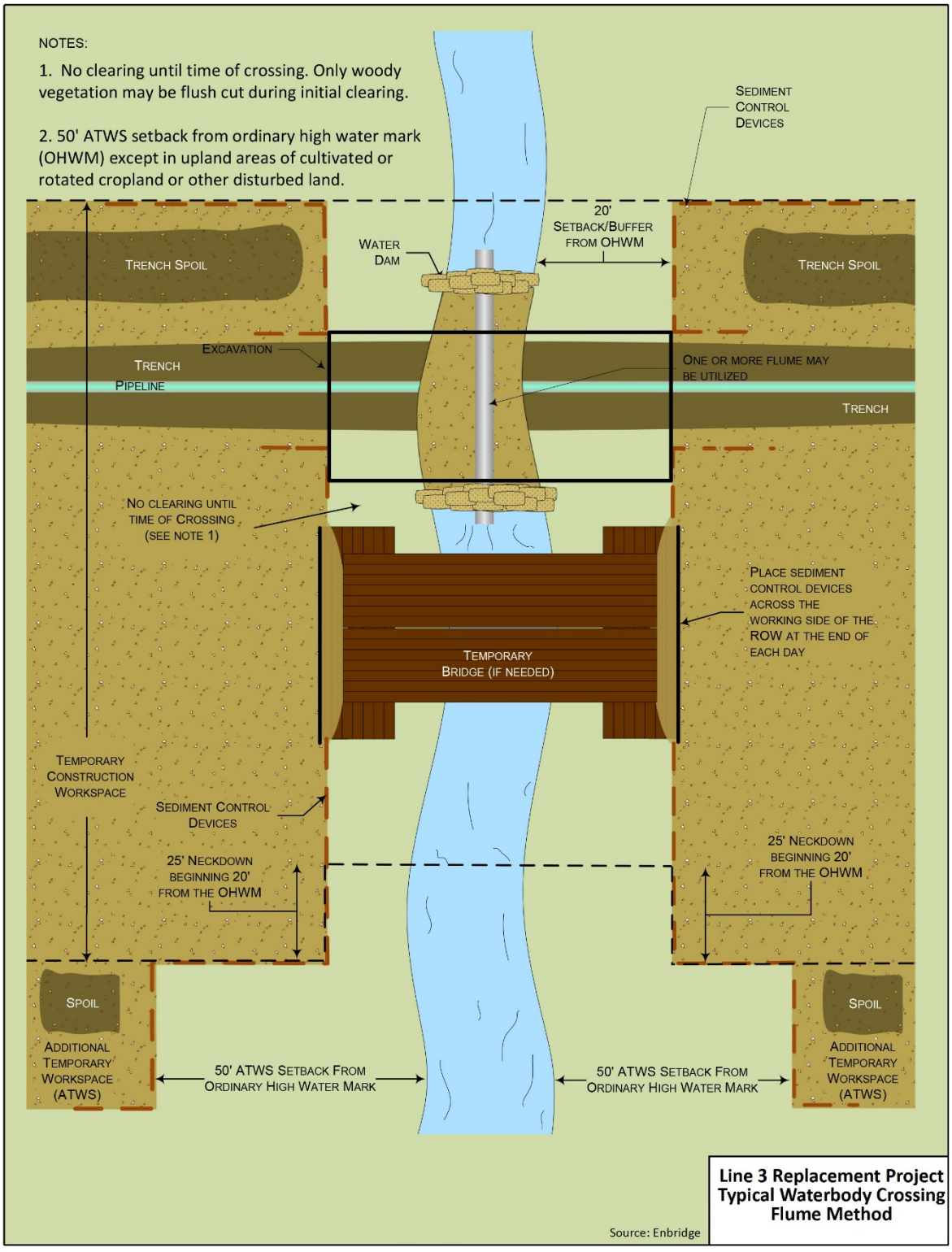

Figure G-3. Flume Waterbody Crossing Technique

Horizontal Directional Drilling and Guided Bore Method

Horizontal Directional Drilling (HDD) involves drilling under a wetland or waterbody and installing the pipeline without physical disturbance of the wetland or waterbody feature. These methods could be used to cross environmentally sensitive areas identified by permitting agencies including the Minnesota Department of Natural Resources and the Army Corps of Engineers such as riparian forested wetlands, sensitive fishery resources, and impaired waters.

The feasibility of using HDD depends on subsurface substrate conditions and the length of the drill path. Portions of the pipeline route might cross regions with soils that are not conducive to HDD technology, including soils containing cobbles, boulders, layers of gravel, or non-cohesive sands. To determine the feasibility of using HDD at a specific crossing, Enbridge would undertake preliminary geotechnical investigations.

The HDD process is accomplished in three stages:

- A small-diameter pilot hole is drilled along a predetermined path under the waterbody.
- The pilot hole is incrementally enlarged or reamed out to a diameter that would accommodate the pipeline.
- Prefabricated segments of the pipe are pulled through the enlarged hole and welded to adjoining sections at the beginning and end of the crossing.

During drilling, construction personnel would monitor the crossing to detect unanticipated releases of drilling mud to the surface (termed “frac-outs”). The Environmental Protection Plan includes planned response actions if releases of drilling mud were to occur in wetlands, waterbodies, or upland areas. The plan identifies containment, clean-up, and notification procedures, the steps to be taken to restore affected areas and the equipment to be used.

Guided Bore

The guided bore method is typiccally used at crossings of narrow wetlands and ditches adjacent to roads or railroads. It is not suitable adjacent to steep slopes, where water tables are near the surface, or where substrates consist of loose sand and gravel.

The guided bore method consists of boring an auger from an entrance hole on one side of the wetland to a corresponding hole on the other side of the wetland. The bore may or may not include a casing. An advantage of the guided bore is that there is no concern for a sediment release.

The holes on each side of the water, however, typically require large excavations and could consequently require dewatering and sheet-piling to maintain their structure. Pumps could be required to drain seepage within the holes onto adjacent land, which includes the risk of releasing sediment into the adjacent wetland. The guided bore method may also risk some subsidence along the bore alignment.

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Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	ND	Pembina	ND Section	Pembina River	Artificial Path	ND 1.4	IA	303d-Listed Impaired, NRI-listed, USACE Navigable	NA	NA
APR	ND	Pembina	ND Section	Pembina River	Artificial Path	ND 1.7	IA	303d-Listed Impaired, NRI-listed, USACE Navigable	NA	NA
APR	ND	Pembina	ND Section	Tongue River	Stream/River - Perennial	ND 12.1	II	None	NA	NA
APR	ND	Pembina	ND Section	Tongue River Cutoff	Stream/River - Intermittent	ND 9.2	II	303d-Listed Impaired	NA	NA
APR	ND	Pembina	ND Section	County Drain Number 33	Stream/River - Perennial	ND 8.5	III	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Canal Ditch	Canal Ditch	ND 21.7	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Canal Ditch	Canal Ditch	ND 24.4	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Canal Ditch	Canal Ditch	ND 23	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Canal Ditch	Canal Ditch	ND 25.8	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 23.7	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 24.4	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 13.6	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 4.8	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 14.8	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 16.3	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 7.5	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 7.2	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 15.7	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 11.3	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 11.7	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Waterbody	Swamp/Marsh	ND 17.2	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	ND	Pembina	ND Section	Unnamed Waterbody	Lake/Pond - Perennial	ND 17.1	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Waterbody	Lake/Pond - Perennial	ND 18.3	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Waterbody	Lake/Pond - Perennial	ND 8.8	None	None	NA	NA
APR	ND	Pembina	ND Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 26.6	None	None	NA	NA
APR	MN	Marshall	ND Border to Clearbrook	Tamarac River	Stream/River - Perennial	MN 54.4	1C, 2Bd, 3C	303d-Listed Impaired, MN Public Water	HDD	Dry Crossing
APR	MN	Pennington	ND Border to Clearbrook	Red Lake River	Artificial Path	MN 91.9	1C, 2Bd, 3C	NRI-listed, USACE Navigable, MN Public Water	HDD	None
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 44.9	1C, 2Bd, 3C	None	NA	NA
APR	MN	Kittson	ND Border to Clearbrook	Red River of the North	Artificial Path	MN 27.6	1C, 2Bd,3C	303d-Listed Impaired, USACE Navigable, MN Public Water	HDD	None
APR	MN	Clearwater	ND Border to Clearbrook	Silver Creek	Stream/River - Perennial	MN 135.9	2B, 3C	303d-Listed Impaired, MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Lost River	Stream/River - Perennial	MN 132.2	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Marshall	ND Border to Clearbrook	Middle River	Stream/River - Perennial	MN 62.3	2B, 3C	303d-Listed Impaired, NRI-listed, MN Public Water	HDD	None
APR	MN	Marshall	ND Border to Clearbrook	South Branch Snake River	Stream/River - Intermittent	MN 74.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Snake River	Stream/River - Perennial	MN 70.5	2B, 3C	MN Public Water	HDD	Dry Crossing
APR	MN	Red Lake	ND Border to Clearbrook	Clearwater River	Artificial Path	MN 103	2B, 3C	303d-Listed Impaired, MN Public Water	HDD	None
APR	MN	Red Lake	ND Border to Clearbrook	Lost River	Artificial Path	MN 113.5	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Silver Creek	Stream/River - Perennial	MN 135.3	2B, 3C	303d-Listed Impaired, MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Silver Creek	Stream/River - Perennial	MN 135.6	2B, 3C	303d-Listed Impaired, MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137.4	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 131.1	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 131.7	None	None	NA	NA
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Connector	Connector	MN 133.9	None	None	NA	NA
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 64.5	None	None	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 98.9	None	None	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129	None	None	Dry Crossing	Wet Open Cut
APR	MN	Polk	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 121.2	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 75.2	None	None	Bore	Dry Crossing
APR	MN	Polk	ND Border to Clearbrook	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 122.3	None	None	Dry Crossing	Wet Open Cut
APR	MN	Polk	ND Border to Clearbrook	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 117.9	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 43	None	None	Bore	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 69.1	None	None	Dry Crossing	Wet Open Cut
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 38.7	None	None	Dry Crossing	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 95.6	None	None	NA	NA
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129.5	None	None	NA	NA
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 99.6	None	None	Dry Crossing	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 93.8	None	MN Public Water	NA	NA
APR	MN	Polk	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 128.4	None	None	NA	NA
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 31.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 107.9	None	None	NA	NA
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 84.8	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 41.7	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129.9	None	None	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 114.3	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 52.1	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 60.4	None	None	Dry Crossing	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 86.3	None	None	Bore	Dry Crossing
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 97.3	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.4	None	None	Dry Crossing	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 91.1	None	None	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 101.4	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 35.8	None	None	Bore	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 94.9	None	None	Dry Crossing	Wet Open Cut
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 37.3	None	None	Bore	Dry Crossing
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 80.5	None	None	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129.3	None	None	NA	NA
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 92.3	None	None	HDD	None
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 97.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 112.3	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 49.6	None	None	NA	NA
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 39.9	None	None	Bore	Dry Crossing

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Polk	ND Border to Clearbrook	State Ditch Number Sixty-one	Canal Ditch	MN 117.4	None	None	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 109	None	None	NA	NA
APR	MN	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 35.9	None	None	Bore	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 87.7	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 47	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 51.8	None	None	Dry Crossing	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 82.6	None	303d-Listed Impaired	Wet open cut	Dry Crossing
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 99.8	None	None	Dry Crossing	Wet Open Cut
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 89.3	None	None	Bore	Dry Crossing
APR	MN	Polk	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 118.5	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 130.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.8	None	None	NA	NA
APR	MN	Polk	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 115.7	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 59.4	None	None	Dry Crossing	Wet Open Cut
APR	MN	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 100	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 65.6	None	None	NA	NA
APR	MN	Polk	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 123	None	None	NA	NA
APR	MN	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.6	None	None	Dry Crossing	Wet Open Cut
APR	MN	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.7	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Polk	ND Border to Clearbrook	Unnamed Waterbody	Lake/Pond - Perennial	MN 127.4	None	None	NA	NA
APR	MN	Pennington	ND Border to Clearbrook	Unnamed Waterbody	Lake/Pond - Perennial	MN 88.2	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Spring Branch	Stream/River - Perennial	MN 265.3	1B, 2A, 3B	Trout stream, MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	King Creek	Stream/River - Intermittent	MN 344.2	1B, 2A, 3B	Trout stream, MN Public Water	Wet Open Cut	Dry Crossing
APR	MN	Hubbard	Clearbrook to Carlton	Straight River	Artificial Path	MN 198.3	1B, 2A, 3B	Trout stream, MN Public Water	HDD	Open cut
APR	MN	Carlton	Clearbrook to Carlton	Blackhoof River	Stream/River - Perennial	MN 352.1	1B, 2A, 3B	Trout stream	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	Moose River	Stream/River - Perennial	MN 272.1	1B, 2Bd, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	Big Swamp Creek	Canal Ditch	MN 224.6	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Moose Horn River	Stream/River - Perennial	MN 347.6	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Mississippi River	Artificial Path	MN 296.7	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	HDD	Open cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Carlton	Clearbrook to Carlton	West Branch Kettle River	Stream/River - Perennial	MN 328.4	2B, 3C	MN Public Water	NA	NA
APR	MN	Wadena	Clearbrook to Carlton	Shell River	Artificial Path	MN 215.3	2B, 3C	NRI-listed, MN Public Water	HDD	Open cut
APR	MN	Aitkin	Clearbrook to Carlton	Sandy River	Canal Ditch	MN 312.8	2B, 3C	MN Public Water	HDD	Open cut
APR	MN	Cass	Clearbrook to Carlton	Daggett Brook	Stream/River - Perennial	MN 261.4	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Kettle River	Canal Ditch	MN 338.2	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Wadena	Clearbrook to Carlton	Crow Wing River	Artificial Path	MN 217.4	2B, 3C	NRI-listed, MN Public Water	HDD	Wet Open Cut
APR	MN	Hubbard	Clearbrook to Carlton	Shell River	Stream/River - Perennial	MN 205.5	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Sandy River	Artificial Path	MN 305.9	2B, 3C	USACE Navigable, MN Public Water	HDD	Open Cut
APR	MN	Hubbard	Clearbrook to Carlton	Shell River	Artificial Path	MN 207.8	2B, 3C	MN Public Water	HDD	Open cut
APR	MN	Carlton	Clearbrook to Carlton	West Fork Moose Horn River	Stream/River - Perennial	MN 342.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	South Fork Pine River	Stream/River - Perennial	MN 232.6	2B, 3C	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Pine River	Artificial Path	MN 241.4	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Clearwater	Clearbrook to Carlton	Clearwater River	Artificial Path	MN 149.5	2B, 3C	303d-Listed Impaired, NRI-listed, MN Public Water	HDD	Open cut
APR	MN	Hubbard	Clearbrook to Carlton	Shell River	Stream/River - Perennial	MN 200.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Hubbard	Clearbrook to Carlton	Hay Creek	Artificial Path	MN 187.8	2B, 3C	MN Public Water	HDD	Open cut
APR	MN	Clearwater	Clearbrook to Carlton	Mississippi River	Stream/River - Perennial	MN 165.1	2B, 3C	303d-Listed Impaired, MN Public Water	HDD	Dry Crossing
APR	MN	Aitkin	Clearbrook to Carlton	Willow River	Stream/River - Perennial	MN 292.8	2C	NRI-listed, MN Public Water	HDD	Open cut
APR	MN	Hubbard	Clearbrook to Carlton	LaSalle Creek	Stream/River - Perennial	MN 170.1	2C	Trout stream, MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 286.2	None	None	NA	NA
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 302.3	None	None	Wet Open Cut	Dry Crossing
APR	MN	Crow Wing	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 245.5	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 308	None	None	Wet Open Cut	Dry Crossing
APR	MN	Wadena	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 220.2	None	None	Wet Open Cut	Dry Crossing

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 303.6	None	None	Wet Open Cut	Dry Crossing
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 347.1	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 308.2	None	None	Wet Open Cut	Dry Crossing
APR	MN	Aitkin	Clearbrook to Carlton	White Elk Creek	Stream/River - Intermittent	MN 291.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 309.5	None	None	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	Unnamed Connector	Connector	MN 269.8	None	None	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Park Lake Creek	Stream/River - Perennial	MN 346.7	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Heikkila Creek	Stream/River - Perennial	MN 334.5	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 341.1	None	None	Wet Open Cut	Dry Crossing
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 277.4	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 225.3	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 279.2	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 298.3	None	None	Wet Open Cut	Dry Crossing
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 301.9	None	None	Wet Open Cut	Dry Crossing
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 314.1	None	None	NA	NA
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 310.1	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 318.9	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 290.7	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 257.9	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Connector	Connector	MN 275.5	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 209.5	None	None	HDD	Open cut
APR	MN	Cass	Clearbrook to Carlton	Blind Lake Creek	Stream/River - Perennial	MN 250.5	None	MN Public Water	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 138.2	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Shell River	Artificial Path	MN 209.5	None	NRI-listed, MN Public Water	NA	NA
APR	MN	Aitkin	Clearbrook to Carlton	White Elk Creek	Stream/River - Perennial	MN 283.5	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Wadena	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 220.2	None	None	Wet Open Cut	Dry Crossing
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 335.3	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 223.7	None	None	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 226.9	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 138.1	None	MN Public Water	NA	NA
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 299	None	None	Wet Open Cut	Dry Crossing
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 343.5	None	None	Dry Crossing	Wet Open Cut
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 320.8	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 185.5	None	None	Dry Crossing	Wet Open Cut
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed artificial Path	Artificial Path	MN 209.2	None	None	NA	NA
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 337.7	None	None	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 333.8	None	None	NA	NA
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 295.1	None	None	Dry Crossing	Wet Open Cut
APR	MN	Cass	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 270.6	None	None	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 333.7	None	None	NA	NA
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 333.7	None	None	NA	NA
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 333.8	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137.2	None	None	Dry Crossing	Wet Open Cut

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137.2	None	None	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 138.8	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 253.1	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 229.5	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 230.7	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Walker Brook	Stream/River - Perennial	MN 151.4	None	303d-Listed Impaired, MN Public Water	Wet Open Cut	None
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 169.9	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Bear Creek	Stream/River - Perennial	MN 164.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 349	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 146.9	None	None	NA	NA
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Connector	Connector	MN 354.4	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 352.3	None	Trout stream	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 144.3	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 146.3	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 189.4	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 152.6	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 353.7	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.2	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 154.4	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 163.5	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 227	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Crow Wing	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 246.6	None	None	NA	NA
APR	MN	Aitkin	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 299.1	None	None	NA	NA
APR	MN	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 231.7	None	None	NA	NA
APR	MN	Crow Wing	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 244.3	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 186.4	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 147.9	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 148.9	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 191.2	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 155.1	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 186.3	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 154.7	None	None	NA	NA
APR	MN	Hubbard	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 177.6	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	MN	Carlton	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 356.6	None	None	NA	NA
APR	MN	Clearwater	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 156.4	None	None	NA	NA
APR	MN	Carlton	Carlton to WI Border	Unnamed Waterbody	Lake/Pond - Perennial	MN 359.5	None	None	NA	NA
APR	MN	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 365.4	None	None	Wet Open Cut	Dry Crossing
APR	MN	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 364.7	None	None	Wet Open Cut	Dry Crossing
APR	MN	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 365.1	None	None	Wet Open Cut	Dry Crossing
APR	MN	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 362.3	None	None	NA	NA
APR	MN	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 363.3	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	WI	Douglas	WI Section	Unnamed Stream/River Perennial	Stream/River - Perennial	WI 369	None	None	NA	NA
APR	WI	Douglas	WI Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	WI 368.5	None	None	NA	NA

Table G-2. Certificate of Need - Waterbodies crossed by the Applicant's Preferred Route

Route	State	County	Section	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	WI	Douglas	WI Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	WI 367.6	None	None	NA	NA
APR	WI	Douglas	WI Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	WI 369.9	None	None	NA	NA
APR	WI	Douglas	WI Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent	WI 375.7	None	None	NA	NA
APR	WI	Douglas	WI Section	Pokegama River	Stream/River - Perennial	WI 366.5	LFF	None	NA	NA
APR	WI	Douglas	WI Section	Pokegama River	Stream/River - Perennial	WI 376	LFF	USACE Navigable	NA	NA
APR	WI	Douglas	WI Section	Unnamed Stream/River Intermittent	Stream/River - Intermittent		None	None	NA	NA
APR	WI	Douglas	WI Section	Unnamed Stream/River Perennial	Stream/River - Perennial		None	None	NA	NA
APR	WI	Douglas	WI Section	Unnamed Stream/River Perennial	Stream/River - Perennial		None	None	NA	NA

Notes: Waterbody crossings determined using NHD GIS layers.

State-designated Use.

North Dakota (ND) (Chapter 33-16-02.1):

- Class I: suitable for the propagation or protection, or both, of resident fish species and other aquatic biota and for swimming, boating, and other water recreation; suitable for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use.
- Class 1A: The quality of the waters in this class shall be the same as the quality of class I streams, except that where natural conditions exceed class I criteria for municipal and domestic use, the availability of softening or other treatment methods may be considered in determining whether ambient water quality meets the drinking water requirements

of the department.

- Class II: The quality of the waters in this class shall be the same as the quality of class I streams, except that additional treatment may be required to meet the drinking water requirements of the department. Streams in this classification may be intermittent in nature which would make these waters of limited value for beneficial uses such as municipal water, fish life, irrigation, bathing, or swimming.
- Class III: suitable for agricultural and industrial uses. Streams in this class generally have low average flows with prolonged periods of no flow. During periods of no flow, they are of limited value for recreation and fish and aquatic biota. The quality of these waters must be maintained to protect secondary contact recreation uses (e.g., wading), fish and aquatic biota, and wildlife uses.

Minnesota (MN): Minnesota Rule 7050.0470 lists the classifications of major waterbodies in the state. If a waterbody is not listed under 7050.0470 and is not a wetland, it is classified as a Class 2B, 3C, 4A, 4B, 5, and 6 water per Minnesota Rule 7050.0430.

- Class 1 – domestic consumption (i.e., drinking water);
- Class 2 – aquatic life and recreation;
- Class 3 – industrial or commercial use;
- Class 4 – agricultural use, irrigation (4A) and livestock and wildlife watering (4B);
- Class 5 – aesthetics and navigation;
- Class 6 – other uses and protection of border waters; and
- Class 7 – limited resource value waters.

- Minnesota Rule 7050.0222 further defines the water quality standards for the following subclasses of Class 2 waters:
  - Class 2A – Coldwater fisheries, trout waters, suitable for all aquatic recreation and protected as a source of drinking water;
  - Class 2Bd – Cold and warm water fisheries, suitable for all aquatic recreation and protected as a source of drinking water;
  - Class 2B – Cold and warm water fisheries, suitable for all aquatic recreation but not protected for drinking water;
  - Class 2C – Indigenous fish and associated aquatic community, suitable for boating but not protected for drinking water.

Wisconsin (WI): LFF –Limited forage fish communities. (Intermediate surface waters). This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life (Chapter NR 102.04).

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Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	ND	Pembina	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 13.6	None	None
SA-04	ND	Pembina	Tongue River	Stream/River - Perennial	ND 12.1	II	None
SA-04	ND	Pembina	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 4.8	None	None
SA-04	ND	Pembina	Tongue River Cutoff	Stream/River - Intermittent	ND 9.2	II	303d-Listed Impaired
SA-04	ND	Pembina	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 14.8	None	None
SA-04	ND	Pembina	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 16.3	None	None
SA-04	ND	Pembina	County Drain Number 33	Stream/River - Perennial	ND 8.5	None	None
SA-04	ND	Pembina	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 7.5	None	None
SA-04	ND	Pembina	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 7.2	None	None
SA-04	ND	Pembina	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 15.7	None	None
SA-04	ND	Pembina	Pembina River	Artificial Path	ND 1.4	IA	303d-Listed Impaired, NRI-listed, USACE Navigable
SA-04	ND	Pembina	Pembina River	Artificial Path	ND 1.7	IA	303d-Listed Impaired, NRI-listed, USACE Navigable
SA-04	ND	Pembina	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 11.3	None	None
SA-04	ND	Pembina	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 11.7	None	None
SA-04	ND	Pembina	Unnamed Waterbody	Swamp/Marsh	ND 17.2	None	None
SA-04	ND	Pembina	Unnamed Waterbody	Lake/Pond - Perennial	ND 17.1	None	None
SA-04	ND	Pembina	Unnamed Waterbody	Lake/Pond - Perennial	ND 18.3	None	None
SA-04	ND	Pembina	Unnamed Waterbody	Lake/Pond - Perennial	ND 8.8	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 21.4	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 22.5	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 228.5	None	None
SA-04	ND	Richland	Wild Rice River	Artificial Path	ND 213	II	303d-Listed Impaired
SA-04	ND	Richland	Unnamed Waterbody	Swamp/Marsh	ND 194.4	None	None
SA-04	ND	Pembina	Unnamed Waterbody	Lake/Pond - Perennial	ND 28.1	None	None
SA-04	ND	Pembina	Unnamed Waterbody	Lake/Pond - Perennial	ND 29.2	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 23.6	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 23.6	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 231.6	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 227.9	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 214.4	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 232.9	None	None
SA-04	ND	Richland	Unnamed Canal Ditch	Canal Ditch	ND 223.9	None	None
SA-04	ND	Richland	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 213.7	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 228.3	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 230.3	None	None
SA-04	ND	Richland	Unnamed Canal Ditch	Canal Ditch	ND 225.6	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 219.5	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 189.2	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 184.4	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 197.3	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 208	None	None
SA-04	ND	Richland	South Branch Antelope Creek	Stream/River - Intermittent	ND 205.5	III	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 199.2	None	None
SA-04	ND	Richland	Pitcairn Creek	Stream/River - Intermittent	ND 192.9	None	None
SA-04	ND	Richland	Antelope Creek	Stream/River - Intermittent	ND 203.9	III	303d-Listed Impaired
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 185.2	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 205.4	None	None
SA-04	ND	Richland	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 183.6	None	None
SA-04	ND	Richland	Wild Rice River	Artificial Path	ND 185.6	II	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 160.9	None	None
SA-04	ND	Cass	Wild Rice River	Stream/River - Perennial	ND 173.3	II	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 147.7	None	None
SA-04	ND	Cass	Unnamed Artificial Path	Artificial Path	ND 167.5	None	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 169	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 145.2	None	None
SA-04	ND	Cass	Lower Branch Rush River	Stream/River - Intermittent	ND 151.3	III	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 163.5	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 143.2	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 147.2	None	None
SA-04	ND	Cass	Maple River	Stream/River - Perennial	ND 154.7	II	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 172.1	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 175	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	ND	Cass	Rush River	Stream/River - Perennial	ND 149.8	III	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 150.8	None	None
SA-04	ND	Cass	Unnamed Stream/River Perennial	Stream/River - Perennial	ND 155.4	None	None
SA-04	ND	Traill	North Branch Elm River	Stream/River - Perennial	ND 126.2	II	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 136.9	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 134.8	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 137.9	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 132.6	None	None
SA-04	ND	Traill	Goose River	Artificial Path	ND 120	IA	303d-Listed Impaired
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 140.1	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 129.5	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 135.8	None	None
SA-04	ND	Traill	Elm River	Artificial Path	ND 132.1	II	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 108.2	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 107.6	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 109.4	None	None
SA-04	ND	Traill	Buffalo Coulee	Stream/River - Intermittent	ND 109.6	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 100	None	None
SA-04	ND	Grand Forks	Drain Number 4	Canal Ditch	ND 89.5	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 108.1	None	None
SA-04	ND	Grand Forks	Cole Creek	Stream/River - Intermittent	ND 96.9	None	303d-Listed Impaired

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 107.9	None	None
SA-04	ND	Grand Forks	Elm Coulee	Stream/River - Intermittent	ND 94.3	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 75.1	None	None
SA-04	ND	Grand Forks	English Coulee	Stream/River - Intermittent	ND 84.5	None	None
SA-04	ND	Grand Forks	County Ditch Number 3	Canal Ditch	ND 65.9	None	None
SA-04	ND	Grand Forks	Unnamed Canal Ditch	Canal Ditch	ND 67.1	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 73	None	None
SA-04	ND	Grand Forks	County Ditch Number 13	Canal Ditch	ND 64.1	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 78.7	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 82.5	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 74.7	None	None
SA-04	ND	Grand Forks	Turtle River	Artificial Path	ND 69.1	II	303d-Listed Impaired
SA-04	ND	Walsh	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 40.4	None	None
SA-04	ND	Walsh	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 57.8	None	None
SA-04	ND	Walsh	Park River	Artificial Path	ND 43.3	II	303d-Listed Impaired
SA-04	ND	Walsh	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 39.4	None	None
SA-04	ND	Walsh	Forest River	Stream/River - Perennial	ND 53.9	II	303d-Listed Impaired
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 37.4	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 24.6	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 27.7	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 28.7	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 25.7	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 26.7	None	None
SA-04	ND	Pembina	Unnamed Canal Ditch	Canal Ditch	ND 32.8	None	None
SA-04	ND	Richland	Unnamed Artificial Path	Artificial Path	ND 213.1	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 159.2	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 159.3	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 159.7	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 155.6	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 155.6	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 161.7	None	None
SA-04	ND	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 162	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 104.7	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 104.7	None	None
SA-04	ND	Traill	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 104.8	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 100.3	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 100.4	None	None
SA-04	ND	Grand Forks	Unnamed Stream/River Intermittent	Stream/River - Intermittent	ND 100.4	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 329.8	None	MN Public Water
SA-04	MN	Kandiyohi	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 334.4	None	None
SA-04	MN	Nicollet	Unnamed Canal Ditch	Canal Ditch	MN 400.1	None	None
SA-04	MN	Waseca	Bull Run Creek	Stream/River - Intermittent	MN 432.8	2C	MN Public Water
SA-04	MN	Freeborn	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 457	None	None
SA-04	MN	Renville	Judicial Ditch Number Fifteen	Canal Ditch	MN 353.1	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 335.4	None	None
SA-04	MN	Nicollet	Unnamed Connector	Connector	MN 406.1	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 262.9	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 252.4	None	None
SA-04	MN	Chippewa	Shakopee Creek	Stream/River - Perennial	MN 314.5	2C	MN Public Water
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 377.9	None	None
SA-04	MN	Traverse	County Ditch Number Four	Canal Ditch	MN 242.8	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 287.5	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 279	None	MN Public Water
SA-04	MN	Freeborn	County Ditch Number Twelve	Canal Ditch	MN 468.4	None	None
SA-04	MN	Stevens	Muddy Creek	Stream/River - Intermittent	MN 268.2	7	MN Public Water
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 250.2	None	None
SA-04	MN	Nicollet	Judicial Ditch Number Six	Canal Ditch	MN 386.7	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 311.8	None	None
SA-04	MN	Le Sueur	Minnesota River	Artificial Path	MN 406.6	2B, 2C	303d-Listed Impaired, NRI-listed, USACE Navigable, MN Public Water
SA-04	MN	Renville	Unnamed Canal Ditch	Canal Ditch	MN 346.7	None	None
SA-04	MN	Sibley	Middle Branch Rush River	Canal Ditch	MN 378.9	7	MN Public Water
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 314.8	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 325	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 286.8	None	None
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 320.8	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Waseca	Boot Creek	Stream/River - Perennial	MN 443.7	2C	MN Public Water
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 307.4	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 288.9	None	MN Public Water
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 340.6	None	None
SA-04	MN	Nicollet	Unnamed Canal Ditch	Canal Ditch	MN 400.8	None	None
SA-04	MN	Mower	Cedar River	Artificial Path	MN 478.6	2C, 3C	303d-Listed Impaired, MN Public Water
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 442.3	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 271.1	None	MN Public Water
SA-04	MN	Freeborn	Unnamed Canal Ditch	Canal Ditch	MN 467.5	None	None
SA-04	MN	Swift	Judicial Ditch Number Five	Stream/River - Intermittent	MN 299.6	None	MN Public Water
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 318.7	None	MN Public Water
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 243.2	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 295.1	None	None
SA-04	MN	Le Sueur	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 407.3	None	None
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 440.7	None	None
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 315.7	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 247.8	None	MN Public Water
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 279.4	None	None
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 380.2	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 310.1	None	None
SA-04	MN	Freeborn	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 461.2	None	None
SA-04	MN	Freeborn	County Ditch Number Sixtythree	Canal Ditch	MN 454.8	None	MN Public Water

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 410.9	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 256.7	None	None
SA-04	MN	Renville	High Island Creek	Canal Ditch	MN 360.8	7	None
SA-04	MN	Renville	Unnamed Canal Ditch	Canal Ditch	MN 351.7	None	None
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 434.5	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 309.4	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 290.7	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 293.2	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 274	None	MN Public Water
SA-04	MN	Nicollet	County Ditch Number Seventyeight	Canal Ditch	MN 395.4	None	None
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 366	None	None
SA-04	MN	Waseca	Le Sueur River	Stream/River - Perennial	MN 427.9	2C	MN Public Water
SA-04	MN	Sibley	County Ditch Number Thirtyone	Canal Ditch	MN 368.8	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 341.3	None	None
SA-04	MN	Renville	Unnamed Canal Ditch	Canal Ditch	MN 349.5	None	None
SA-04	MN	Blue Earth	Unnamed Canal Ditch	Canal Ditch	MN 421.5	None	None
SA-04	MN	Kandiyohi	County Ditch Number Eight A	Canal Ditch	MN 335.1	None	None
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 372.8	None	None
SA-04	MN	Swift	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 305.7	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 333.7	None	None
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 243.8	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 261.7	None	None
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 443.2	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Renville	Unnamed Canal Ditch	Canal Ditch	MN 357.7	None	None
SA-04	MN	Swift	Chippewa River	Artificial Path	MN 297.3	2B	MN Public Water
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 309.1	None	None
SA-04	MN	Freeborn	Unnamed Canal Ditch	Canal Ditch	MN 468.3	None	None
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 315.8	None	MN Public Water
SA-04	MN	Mower	Unnamed Canal Ditch	Canal Ditch	MN 482.2	None	MN Public Water
SA-04	MN	Mower	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 480.1	None	MN Public Water
SA-04	MN	Renville	Unnamed Canal Ditch	Canal Ditch	MN 346.3	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 331.2	None	None
SA-04	MN	Nicollet	Judicial Ditch Number One A	Canal Ditch	MN 390.7	None	None
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 319.9	None	MN Public Water
SA-04	MN	Blue Earth	Unnamed Canal Ditch	Canal Ditch	MN 423.1	None	MN Public Water
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 376.4	None	None
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 248.6	None	None
SA-04	MN	Nicollet	County Ditch Number Five	Canal Ditch	MN 396.8	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 248.9	None	MN Public Water
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 263.5	None	MN Public Water
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 291.8	None	None
SA-04	MN	Traverse	Mustinka River	Artificial Path	MN 241.9	2C	MN Public Water
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 435.7	None	None
SA-04	MN	Swift	County Ditch Number Twentythree	Stream/River - Intermittent	MN 291.2	None	MN Public Water
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 280.2	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 264	None	MN Public Water

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 308.2	None	None
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 251.4	None	None
SA-04	MN	Stevens	Pomme de Terre River	Artificial Path	MN 277.5	None	303d-Listed Impaired, MN Public Water
SA-04	MN	Mower	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 480.9	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 337.5	None	None
SA-04	MN	Sibley	County Ditch Number Thirtyone	Canal Ditch	MN 369.5	None	None
SA-04	MN	Nicollet	Unnamed Canal Ditch	Canal Ditch	MN 388.2	None	None
SA-04	MN	Freeborn	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 452.3	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 331.9	None	None
SA-04	MN	Sibley	South Branch Rush River	Canal Ditch	MN 383.4	None	303d-Listed Impaired, MN Public Water
SA-04	MN	Blue Earth	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 424.7	None	MN Public Water
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 311.4	None	MN Public Water
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 413.5	None	None
SA-04	MN	Traverse	County Drain Number Twentyseven	Canal Ditch	MN 240.1	None	None
SA-04	MN	Freeborn	Unnamed Canal Ditch	Canal Ditch	MN 467.1	None	None
SA-04	MN	Freeborn	Woodbury Creek	Canal Ditch	MN 472.7	2C	303d-Listed Impaired
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 321.4	None	None
SA-04	MN	Mower	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 483.6	None	None
SA-04	MN	Stevens	Twelvemile Creek	Stream/River - Intermittent	MN 258.4	2C	MN Public Water
SA-04	MN	Kandiyohi	Hawk Creek	Canal Ditch	MN 327.2	7	MN Public Water

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Nicollet	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 406.3	None	None
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 426.4	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 296.9	None	None
SA-04	MN	Chippewa	Unnamed Canal Ditch	Canal Ditch	MN 321.8	None	MN Public Water
SA-04	MN	Chippewa	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 319	None	None
SA-04	MN	Renville	Unnamed Canal Ditch	Canal Ditch	MN 350.1	None	MN Public Water
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 327.8	None	None
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 365.1	None	MN Public Water
SA-04	MN	Mower	Judicial Ditch Number Seventyseven	Canal Ditch	MN 477.8	None	MN Public Water
SA-04	MN	Sibley	Unnamed Canal Ditch	Canal Ditch	MN 373.8	None	None
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 430.8	None	None
SA-04	MN	Swift	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 302.2	None	None
SA-04	MN	Freeborn	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 457.8	None	None
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 245.3	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 260.7	None	None
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 431.9	None	None
SA-04	MN	Renville	County Ditch Number Thirtythree	Canal Ditch	MN 359	None	None
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 415.4	None	None
SA-04	MN	Kandiyohi	Unnamed Canal Ditch	Canal Ditch	MN 332.7	None	None
SA-04	MN	Sibley	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 368.3	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 287.1	None	MN Public Water
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 246.9	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Mower	Otter Creek	Stream/River - Perennial	MN 484.2	2B, 3C	303d-Listed Impaired, MN Public Water
SA-04	MN	Nicollet	Unnamed Canal Ditch	Canal Ditch	MN 399	None	None
SA-04	MN	Stevens	Unnamed Canal Ditch	Canal Ditch	MN 263.1	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 244.4	None	None
SA-04	MN	Nicollet	Unnamed Canal Ditch	Canal Ditch	MN 389.4	None	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 287	None	None
SA-04	MN	Freeborn	Le Sueur River	Canal Ditch	MN 450.9	2C	None
SA-04	MN	Swift	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 293.6	None	None
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 252.7	None	None
SA-04	MN	Traverse	Twelvemile Creek	Stream/River - Perennial	MN 247.5	2C	303d-Listed Impaired, MN Public Water
SA-04	MN	Nicollet	County Ditch Number Thirteen A	Canal Ditch	MN 402.1	None	None
SA-04	MN	Swift	County Ditch Number Seven	Stream/River - Intermittent	MN 293.5	None	None
SA-04	MN	Sibley	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 384.8	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 234.5	None	MN Public Water
SA-04	MN	Traverse	Bois de Sioux River	Artificial Path	MN 233.6	2C	303d-Listed Impaired, USACE Navigable, MN Public Water
SA-04	MN	Freeborn	Unnamed Canal Ditch	Canal Ditch	MN 467.9	None	None
SA-04	MN	Freeborn	Unnamed Canal Ditch	Canal Ditch	MN 468	None	None
SA-04	MN	Freeborn	Unnamed Canal Ditch	Canal Ditch	MN 468.2	None	None
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 408.9	None	MN Public Water

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	MN	Blue Earth	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 419	None	MN Public Water
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 434.8	None	MN Public Water
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 437.1	None	MN Public Water
SA-04	MN	Waseca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 438.2	None	MN Public Water
SA-04	MN	Traverse	Unnamed Canal Ditch	Canal Ditch	MN 254.8	None	None
SA-04	MN	Stevens	Unnamed Canal Ditch	Canal Ditch	MN 255.6	None	None
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 419.7	None	None
SA-04	MN	Blue Earth	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 420.3	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 282.2	None	None
SA-04	MN	Stevens	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 285.5	None	MN Public Water
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 249.3	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 249.3	None	None
SA-04	MN	Traverse	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 249.5	None	None
SA-04	MN	Traverse	Unnamed Waterbody	Lake/Pond - Perennial	MN 239.7	None	None
SA-04	MN	Swift	Unnamed Waterbody	Lake/Pond - Perennial	MN 298.3	None	None
SA-04	MN	Le Sueur	Unnamed Waterbody	Lake/Pond - Perennial	MN 407.9	None	None
SA-04	IA	Howard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 514.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 627.6	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 627.8	None	None
SA-04	IA	Howard	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 511.1	None	None
SA-04	IA	Howard	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 511.3	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 582.6	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 582.7	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 582.7	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 555.9	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 646.3	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 646.5	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 646.6	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 485.5	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 485.8	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 486.8	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 487	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 487.4	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 664.3	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 664.6	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 633.2	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 633.7	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 587	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 587.3	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 515.7	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 516.1	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 615.4	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 615.8	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 670.7	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 527	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 590.2	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 572	None	None
SA-04	IA	Jones	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 602.2	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 622.4	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 527.4	None	None
SA-04	IA	Chickasaw	Elk Creek	Stream/River - Perennial	IA 518.6	A1, B (WW-2)	None
SA-04	IA	Jones	West Kitty Creek	Stream/River - Intermittent	IA 617.5	A1, B (WW-2)	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 488.4	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 506.7	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 489.7	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 578.4	None	None
SA-04	IA	Delaware	Todds Creek	Stream/River - Intermittent	IA 591.9	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 623.4	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 572.9	None	None
SA-04	IA	Delaware	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 585.9	None	None
SA-04	IA	Jones	Mineral Creek	Stream/River - Perennial	IA 619.7	A3, B (WW-2)	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 576.4	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 551.5	None	None
SA-04	IA	Chickasaw	Marsh Creek	Stream/River - Perennial	IA 538.8	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 523.8	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 547.6	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 557.6	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 533.9	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 589.3	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 629.1	None	None
SA-04	IA	Jones	Bryan Creek	Stream/River - Perennial	IA 631.7	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 607.2	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 563.4	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 643.4	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 591	None	None
SA-04	IA	Fayette	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 545.8	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 507.6	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 630.7	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 602.5	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 652.1	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 651.2	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 575.1	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 600.1	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 549.3	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 515.3	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 559.6	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 557.1	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 656.2	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 654.7	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 583.7	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 580.4	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 536.9	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 491.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 607.4	None	None
SA-04	IA	Clinton	Calamus Creek	Stream/River - Perennial	IA 647.9	A1, B (WW-2)	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 535.5	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 543.6	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 548.5	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 618	None	None
SA-04	IA	Jones	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 610.4	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 524.3	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 595	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 551.5	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 665.4	None	None
SA-04	IA	Jones	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 615	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 539.3	None	None
SA-04	IA	Bremer	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 544.8	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 655.4	None	None
SA-04	IA	Delaware	Sand Creek	Stream/River - Perennial	IA 588.6	A1, B (WW-2)	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 517.6	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 503.9	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 636.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 613.2	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 504.5	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 644.2	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 523.3	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 516.9	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 612.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 630.1	None	None
SA-04	IA	Clinton	Brophy Creek	Stream/River - Perennial	IA 664.1	A1, B (WW-2)	303d-Listed Impaired
SA-04	IA	Jones	Deer Creek	Stream/River - Perennial	IA 608.4	A1, B (WW-2)	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 527.8	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 556.3	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 525.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 633.1	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 646.6	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 660.7	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 603.4	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 530.3	None	None
SA-04	IA	Howard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 512.2	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 574.1	None	None
SA-04	IA	Bremer	Little Wapsipinicon River	Stream/River - Perennial	IA 544.2	A1, B (WW-2)	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 609.5	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 547.6	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 548.7	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 541.1	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 540	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 541.9	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 596.5	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 537.2	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 564.3	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 531.8	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 533	None	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 502.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 626.7	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 550.8	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 663.3	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 570.7	None	None
SA-04	IA	Chickasaw	Plum Creek	Stream/River - Perennial	IA 531.1	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 602.2	None	None
SA-04	IA	Howard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 514.7	None	None
SA-04	IA	Fayette	Stoe Creek	Stream/River - Perennial	IA 553.5	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 587.5	None	None
SA-04	IA	Fayette	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 559.7	None	None
SA-04	IA	Delaware	Unnamed Artificial Path	Artificial Path	IA 583.9	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 604.5	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 528.4	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 563.8	None	None
SA-04	IA	Chickasaw	Little Wapsipinicon River	Stream/River - Perennial	IA 516.3	A2, B (WW-2)	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 614.3	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 628.3	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 517.2	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 571.4	None	None
SA-04	IA	Fayette	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 550.3	None	None
SA-04	IA	Mitchell	Little Cedar River	Artificial Path	IA 501.9	A1, B (WW-1)	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 517.8	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 654.3	None	None
SA-04	IA	Buchanan	Prairie Creek	Stream/River - Intermittent	IA 576.6	A1, B (WW-2)	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 577.5	None	None
SA-04	IA	Howard	Wapsipinicon River	Artificial Path	IA 510.4	A1, B (WW-1)	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 616.6	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 558.6	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 534.3	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 662.7	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 622	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 661.5	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 591.9	None	None
SA-04	IA	Delaware	Prairie Creek	Artificial Path	IA 584	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 524.5	None	None
SA-04	IA	Howard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 512.6	None	None
SA-04	IA	Jones	Kitty Creek	Stream/River - Perennial	IA 611.6	A1, B (WW-2)	None
SA-04	IA	Clinton	Ames Creek	Stream/River - Perennial	IA 658.9	A1, B (WW-2)	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 640.6	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 595.3	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 565.8	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 637.4	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 526.8	None	None
SA-04	IA	Buchanan	East Branch Buffalo Creek	Stream/River - Perennial	IA 571.1	A1, B(WW-2)	303d-Listed Impaired
SA-04	IA	Jones	Bear Creek	Stream/River - Perennial	IA 625.7	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 542.7	None	None
SA-04	IA	Delaware	Grove Creek	Stream/River - Intermittent	IA 600.9	None	None
SA-04	IA	Clinton	Silver Creek	Stream/River - Perennial	IA 656.9	A2, B (WW-2)	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 629.5	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 581.7	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 619.9	None	None
SA-04	IA	Jones	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 628.8	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 581.7	None	None
SA-04	IA	Delaware	Lime Creek	Stream/River - Perennial	IA 599.1	A2, B(WW-2)	None
SA-04	IA	Mitchell	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 493	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 522.4	None	None
SA-04	IA	Chickasaw	East Fork Wapsipinicon River	Stream/River - Perennial	IA 520.7	A1, B (WW-1)	None
SA-04	IA	Chickasaw	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 526.2	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 618.8	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 624.9	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 573.6	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 521.8	None	None
SA-04	IA	Buchanan	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 575	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 608.1	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 603.8	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 556.1	None	None
SA-04	IA	Chickasaw	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 529.5	None	None
SA-04	IA	Howard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 514.5	None	None
SA-04	IA	Fayette	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 551.9	None	None
SA-04	IA	Delaware	Golden Branch	Stream/River - Intermittent	IA 594.3	None	None
SA-04	IA	Fayette	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 559.9	None	None
SA-04	IA	Delaware	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 585.8	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 639.7	None	None
SA-04	IA	Jones	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 606.3	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 644.5	None	None
SA-04	IA	Clinton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IA 655	None	None
SA-04	IA	Mitchell	Turtle Creek	Stream/River - Intermittent	IA 490.1	A1, A2, B(CW1), HH	None
SA-04	IA	Jones	Little Bear Creek	Stream/River - Intermittent	IA 622.1	None	None
SA-04	IA	Jones	Silver Creek	Stream/River - Perennial	IA 605.1	None	None
SA-04	IA	Delaware	Buck Creek	Stream/River - Perennial	IA 596.8	A1, B (WW-2)	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 649.5	None	None
SA-04	IA	Clinton	Unnamed Stream/River Perennial	Stream/River - Perennial	IA 643.4	None	None
SA-04	IA	Clinton	Rock Creek	Artificial Path	IA 670.9	None	None
SA-04	IA	Jones	Unnamed Waterbody	Lake/Pond - Intermittent	IA 631	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Lake/Pond - Perennial	IA 657.4	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Swamp/Marsh	IA 657.4	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IA	Clinton	Unnamed Waterbody	Swamp/Marsh	IA 657.4	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Swamp/Marsh	IA 657.6	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Swamp/Marsh	IA 659	None	None
SA-04	IA	Jones	Unnamed Waterbody	Lake/Pond - Intermittent	IA 605.1	None	None
SA-04	IA	Jones	Unnamed Waterbody	Lake/Pond - Perennial	IA 602.2	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Lake/Pond - Intermittent	IA 647.2	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Lake/Pond - Intermittent	IA 671.8	None	None
SA-04	IA	Delaware	Unnamed Waterbody	Lake/Pond - Perennial	IA 583.9	None	None
SA-04	IA	Clinton	Unnamed Waterbody	Lake/Pond - Perennial	IA 671.1	None	None
SA-04	IL	Clinton	Mississippi River	Artificial Path	IA 672.3	None	303d-listed Impaired, USACE Navigable
SA-04	IL	Rock Island	Unnamed Artificial Path	Artificial Path	IL 672.5	None	None
SA-04	IL	Rock Island	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 676.6	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 677.3	None	None
SA-04	IL	Rock Island	Unnamed Artificial Path	Artificial Path	IL 677.3	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 677.4	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 677.9	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 678.1	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 678.4	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 679.5	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 679.9	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 680.3	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 681.8	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 682.6	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 683.8	None	None
SA-04	IL	Whiteside	Mineral Spring Creek	Stream/River - Intermittent	IL 685.1	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 686.5	None	None
SA-04	IL	Whiteside	Rock Creek	Artificial Path	IL 688.8	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 690.1	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 690.4	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 690.9	None	None
SA-04	IL	Whiteside	Unnamed Waterbody	Swamp/Marsh	IL 691.3	None	None
SA-04	IL	Whiteside	Unnamed Artificial Path	Artificial Path	IL 691.7	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 692.4	None	None
SA-04	IL	Whiteside	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 692.6	None	None
SA-04	IL	Whiteside	Rock River	Artificial Path	IL 694.5	None	303d-listed Impaired, USACE Navigable, NRI-listed
SA-04	IL	Whiteside	Unnamed Canal Ditch	Canal Ditch	IL 700.4	None	None
SA-04	IL	Whiteside	Coon Creek	Artificial Path	IL 701.2	None	None
SA-04	IL	Whiteside	Unnamed Artificial Path	Artificial Path	IL 704.8	None	None
SA-04	IL	Whiteside	Main Ditch	Canal Ditch	IL 708.3	None	None
SA-04	IL	Lee	Green River	Artificial Path	IL 712.3	None	303d-listed Impaired, USACE Navigable
SA-04	IL	Lee	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 715.1	None	None
SA-04	IL	Lee	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 715.1	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IL	Lee	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 716.6	None	None
SA-04	IL	Lee	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 717.1	None	None
SA-04	IL	Lee	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 719.4	None	None
SA-04	IL	Lee	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 719.8	None	None
SA-04	IL	Lee	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 720.3	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 721	None	None
SA-04	IL	Bureau	Walnut Creek	Stream/River - Intermittent	IL 721.8	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 723	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 723.3	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 723.7	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 724	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 724.3	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 724.4	None	None
SA-04	IL	Bureau	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 725.9	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 726.9	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 727.1	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 727.4	None	None
SA-04	IL	Bureau	Masters Fork	Stream/River - Perennial	IL 727.7	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 727.9	None	None
SA-04	IL	Bureau	Unnamed Stream/River Perennial	Stream/River - Perennial	IL 729.5	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 731.2	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 731.5	None	None
SA-04	IL	Bureau	Big Bureau Creek	Stream/River - Perennial	IL 731.9	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 733.2	None	None
SA-04	IL	Bureau	Pike Creek	Stream/River - Perennial	IL 733.5	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 734.4	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 736.7	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 736.9	None	None
SA-04	IL	Bureau	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 737.8	None	None
SA-04	IL	Bureau	Brush Creek	Stream/River - Intermittent	IL 738.4	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 739.8	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 739.8	None	None
SA-04	IL	LaSalle	Spring Creek	Stream/River - Perennial	IL 740.5	None	None
SA-04	IL	LaSalle	Little Vermilion River	Stream/River - Perennial	IL 744.5	None	None
SA-04	IL	LaSalle	Unnamed Waterbody	Swamp/Marsh	IL 745.8	None	None
SA-04	IL	LaSalle	Unnamed Waterbody	Swamp/Marsh	IL 745.9	None	None
SA-04	IL	LaSalle	Vermilion Creek	Stream/River - Perennial	IL 746	None	None
SA-04	IL	LaSalle	Tomahawk Creek	Canal Ditch	IL 747.6	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 749.3	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 753.1	None	None
SA-04	IL	LaSalle	Crookedleg Creek	Stream/River - Perennial	IL 756.3	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 758.4	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 759.6	None	None
SA-04	IL	LaSalle	Indian Creek	Artificial Path	IL 759.9	None	NRI
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 761.8	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 762.4	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 762.7	None	None
SA-04	IL	LaSalle	Fox River	Artificial Path	IL 763.3	None	303d-listed Impaired, USACE Navigable
SA-04	IL	LaSalle	Brumbach Creek	Stream/River - Intermittent	IL 763.8	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Lake/Pond - Perennial	IL 763.8	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 763.9	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 764.7	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 765.2	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 765.8	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 766	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 766.4	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 766.7	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 767.4	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 767.4	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 769.1	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 769.8	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 770.2	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 770.3	None	None
SA-04	IL	LaSalle	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 770.5	None	None
SA-04	IL	Gundy	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 771.5	None	None
SA-04	IL	Gundy	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 773.3	None	None
SA-04	IL	Gundy	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 773.5	None	None
SA-04	IL	Gundy	East Fork Nettle Creek	Stream/River - Intermittent	IL 776.3	None	None

Table G-3. Certificate of Need - Waterbodies Crossed by the SA-04 System Alternative Route

Name	State	County	Waterbody Name	Waterbody Type/Flow	State MilePost	State-Designated Use	Agency Classification
SA-04	IL	Gundy	East Fork Nettle Creek	Stream/River - Intermittent	IL 778.5	None	None
SA-04	IL	Gundy	East Fork Nettle Creek	Stream/River - Intermittent	IL 778.5	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 781.3	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 781.3	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 781.3	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 781.6	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 781.7	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 781.9	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 782	None	None
SA-04	IL	Gundy	Saratoga Creek	Stream/River - Intermittent	IL 782	None	None
SA-04	IL	Gundy	Aux Sable Creek	Artificial Path	IL 784.6	None	303d-listed Impaired
SA-04	IL	Gundy	Aux Sable Creek	Artificial Path	IL 784.7	None	303d-listed Impaired
SA-04	IL	Gundy	Aux Sable Creek	Artificial Path	IL 784.8	None	303d-listed Impaired
SA-04	IL	Gundy	Unnamed Stream/River Intermittent	Swamp/Marsh	IL 787.4	None	None
SA-04	IL	Gundy	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 787.5	None	None
SA-04	IL	Gundy	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 788.3	None	None
SA-04	IL	Will	Des Plaines River	Artificial Path	IL 792.2	None	303d-listed Impaired, USACE Navigable
SA-04	IL	Will	Unnamed Stream/River Intermittent	Artificial Path	IL 792.8	None	None
SA-04	IL	Will	Unnamed Stream/River Intermittent	Stream/River - Intermittent	IL 793.1	None	None

Waterbody crossing methods for the SA-04 route have not been determined.
State Designated Use:

North Dakota (ND) (Century Code 33.16.02.1):

- Class I: suitable for the propagation or protection, or both, of resident fish species and other aquatic biota and for swimming, boating, and other water recreation; suitable for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use.
- Class 1A: The quality of the waters in this class shall be the same as the quality of class I streams, except that where natural conditions exceed class I criteria for municipal and domestic use, the availability of softening or other treatment methods may be considered in determining whether ambient water quality meets the drinking water requirements of the department.
- Class II: The quality of the waters in this class shall be the same as the quality of class I streams, except that additional treatment may be required to meet the drinking water requirements of the department. Streams in this classification may be intermittent in nature which would make these waters of limited value for beneficial uses such as municipal water, fish life, irrigation, bathing, or swimming.
- Class III: suitable for agricultural and industrial uses. Streams in this class generally have low average flows with prolonged periods of no flow. During periods of no flow, they are of limited value for recreation and fish and aquatic biota. The quality of these waters must be maintained to protect secondary contact recreation uses (e.g., wading), fish and aquatic biota, and wildlife uses.

Minnesota (MN): Minnesota Rule 7050.0470 lists the classifications of major waterbodies in the state. If a waterbody is not listed under 7050.0470 and is not a wetland, it is classified as a Class 2B, 3C, 4A, 4B, 5, and 6 water per Minnesota Rule 7050.0430.

- Class 1 – domestic consumption (i.e., drinking water);
- Class 2 – aquatic life and recreation;
- Class 3 – industrial or commercial use;
- Class 4 – agricultural use, irrigation (4A) and livestock and wildlife watering (4B);
- Class 5 – aesthetics and navigation;
- Class 6 – other uses and protection of border waters; and
- Class 7 – limited resource value waters.

- Minnesota Rule 7050.0222 further defines the water quality standards for the following subclasses of Class 2 waters:
  - Class 2A – Coldwater fisheries, trout waters, suitable for all aquatic recreation and protected as a source of drinking water;
  - Class 2Bd – Cold and warm water fisheries, suitable for all aquatic recreation and protected as a source of drinking water;
  - Class 2B – Cold and warm water fisheries, suitable for all aquatic recreation but not protected for drinking water;
  - Class 2C – Indigenous fish and associated aquatic community, suitable for boating but not protected for drinking water.

Iowa (IA) (Administrative Code 61.3(455B):

- Primary contact recreational use (Class “A1”). Waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.
- Secondary contact recreational use (Class “A2”). Waters in which recreational or other uses may result in contact with the water that is either incidental or accidental. During the recreational use, the probability of ingesting appreciable quantities of water is minimal. Class A2 uses include fishing, commercial and recreational boating, any limited contact incidental to shoreline activities and activities in which users do not swim or float in the water body while on a boating activity.
- Children’s recreational use (Class “A3”). Waters in which recreational uses by children are common. Class A3 waters are water bodies having definite banks and bed with visible evidence of the flow or occurrence of water. This type of use would primarily occur in urban or residential areas.
- Cold water aquatic life—Type 1 (Class “B(CW1)”). Waters in which the temperature and flow are suitable for the maintenance of a variety of cold water species, including reproducing and nonreproducing populations of trout (Salmonidae family) and associated aquatic communities.
- Cold water aquatic life—Type 2 (Class “B(CW2)”). Waters that include small, channeled streams, headwaters, and spring runs that possess natural cold water attributes of temperature and flow. These waters usually do not support consistent populations of trout (Salmonidae family), but may support associated vertebrate and invertebrate

organisms.

- Warm water—Type 1 (Class “B(WW-1)”). Waters in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrate species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.
- Warm water—Type 2 (Class “B(WW-2)”). Waters in which flow or other physical characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations. These waters generally consist of small perennially flowing streams.
- Human health (Class “HH”). Waters in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

IL (IL): No waterbodies crossed by the SA-04 route are designated per IL Administrative Code Par 303.

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Kittson	ND Border to Clearbrook	Red River of the North	Artificial Path	MN 27.6	1C, 2Bd,3C	303d-Listed Impaired, USACE Navigable, MN Public Water	HDD	None
APR	Kittson	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 31.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 35.8	None	None	Bore	Wet Open Cut
APR	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 35.9	None	None	Bore	Wet Open Cut
APR	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 37.3	None	None	Bore	Dry Crossing
APR	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 38.7	None	None	Dry Crossing	Wet Open Cut
APR	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 39.9	None	None	Bore	Dry Crossing
APR	Kittson	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 41.7	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 43	None	None	Bore	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 44.9	1C, 2Bd, 3C	None	NA	NA
APR	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 47	None	None	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 49.6	None	None	NA	NA
APR	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 51.8	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 52.1	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Tamarac River	Stream/River - Perennial	MN 54.4	1C, 2Bd, 3C	303d-Listed Impaired	HDD	Dry Crossing
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.4	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.6	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.7	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 57.8	None	None	NA	NA
APR	Marshall	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 59.4	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 60.4	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Middle River	Stream/River - Perennial	MN 62.3	2B, 3C	303d-Listed Impaired, NRI-	HDD	None

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
							listed, MN Public Water		
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 64.5	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 65.6	None	None	NA	NA
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 69.1	None	None	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Snake River	Stream/River - Perennial	MN 70.5	2B, 3C	MN Public Water	HDD	Dry Crossing
APR	Marshall	ND Border to Clearbrook	South Branch Snake River	Stream/River - Intermittent	MN 74.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Marshall	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 75.2	None	None	Bore	Dry Crossing
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 80.5	None	None	Dry Crossing	Wet Open Cut
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 82.6	None	303d-Listed Impaired	Wet open cut	Dry Crossing
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 84.8	None	None	NA	NA
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 86.3	None	None	Bore	Dry Crossing

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 87.7	None	None	Dry Crossing	Wet Open Cut
APR	Pennington	ND Border to Clearbrook	Unnamed Waterbody	Lake/Pond - Perennial	MN 88.2	None	None	NA	NA
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 89.3	None	None	Bore	Dry Crossing
APR	Pennington	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 91.1	None	None	Dry Crossing	Wet Open Cut
APR	Pennington	ND Border to Clearbrook	Red Lake River	Artificial Path	MN 91.9	1C, 2Bd, 3C	NRI-listed, USACE Navigable, MN Public Water	HDD	None
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 92.3	None	None	HDD	None
APR	Pennington	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 93.8	None	None	NA	NA
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 94.9	None	None	Dry Crossing	Wet Open Cut
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 95.6	None	None	NA	NA
APR	Pennington	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 97.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Pennington	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 97.3	None	None	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 98.9	None	None	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 99.6	None	None	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 99.8	None	None	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 100	None	None	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 101.4	None	None	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Clearwater River	Artificial Path	MN 103	2B, 3C	303d-Listed Impaired	HDD	None
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 107.9	None	None	NA	NA
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 109	None	None	NA	NA
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 112.3	None	None	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Lost River	Artificial Path	MN 113.5	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Red Lake	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 114.3	None	None	Dry Crossing	Wet Open Cut
APR	Polk	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 115.7	None	None	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Polk	ND Border to Clearbrook	State Ditch Number Sixtyone	Canal Ditch	MN 117.4	None	None	Dry Crossing	Wet Open Cut
APR	Polk	ND Border to Clearbrook	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 117.9	None	None	Dry Crossing	Wet Open Cut
APR	Polk	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 118.5	None	None	Dry Crossing	Wet Open Cut
APR	Polk	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 121.2	None	None	Dry Crossing	Wet Open Cut
APR	Polk	ND Border to Clearbrook	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 122.3	None	None	Dry Crossing	Wet Open Cut
APR	Polk	ND Border to Clearbrook	Unnamed Canal Ditch	Canal Ditch	MN 123	None	None	NA	NA
APR	Polk	ND Border to Clearbrook	Unnamed Waterbody	Lake/Pond - Perennial	MN 127.4	None	None	NA	NA
APR	Polk	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 128.4	None	None	NA	NA
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129	None	None	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129.3	None	None	NA	NA

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129.5	None	None	NA	NA
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 129.9	None	None	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 130.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 131.1	None	None	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 131.7	None	None	NA	NA
APR	Clearwater	ND Border to Clearbrook	Lost River	Stream/River - Perennial	MN 132.2	2B, 3C	None	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Unnamed Connector	Connector	MN 133.9	None	None	NA	NA
APR	Clearwater	ND Border to Clearbrook	Silver Creek	Stream/River - Perennial	MN 135.3	2B, 3C	303d-Listed Impaired, MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Silver Creek	Stream/River - Perennial	MN 135.6	2B, 3C	303d-Listed Impaired, MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Silver Creek	Stream/River - Perennial	MN 135.9	2B, 3C	303d-Listed Impaired	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137.2	None	None	Dry Crossing	Wet Open Cut
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137.2	None	None	Dry Crossing	Wet Open Cut
APR	Clearwater	ND Border to Clearbrook	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 137.4	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 138.1	None	MN Public Water	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 138.2	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 138.8	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.2	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 144.3	None	None	NA	NA

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 146.3	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 146.9	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 147.9	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 148.9	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Clearwater River	Artificial Path	MN 149.5	2B, 3C	303d-Listed Impaired, NRI-listed, MN Public Water	HDD	Open cut
APR	Clearwater	Clearbrook to Carlton	Walker Brook	Stream/River - Perennial	MN 151.4	None	303d-Listed Impaired, MN Public Water	Wet Open Cut	None
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 152.6	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 154.4	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 154.7	None	None	NA	NA

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Clearwater	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 155.1	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 156.4	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 163.5	None	None	NA	NA
APR	Clearwater	Clearbrook to Carlton	Bear Creek	Stream/River - Perennial	MN 164.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Clearwater	Clearbrook to Carlton	Mississippi River	Stream/River - Perennial	MN 165.1	2B, 3C	303d-Listed Impaired, MN Public Water	HDD	Dry Crossing
APR	Clearwater	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 169.9	None	None	NA	NA
APR	Hubbard	Clearbrook to Carlton	LaSalle Creek	Stream/River - Perennial	MN 170.1	2C	Trout stream, MN Public Water	Dry Crossing	Wet Open Cut
APR	Hubbard	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 177.6	None	None	NA	NA
APR	Hubbard	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 185.5	None	None	Dry Crossing	Wet Open Cut
APR	Hubbard	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 186.3	None	None	NA	NA

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Hubbard	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 186.4	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Hubbard	Clearbrook to Carlton	Hay Creek	Artificial Path	MN 187.8	2B, 3C	MN Public Water	HDD	Open cut
APR	Hubbard	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 189.4	None	None	NA	NA
APR	Hubbard	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 191.2	None	None	NA	NA
APR	Hubbard	Clearbrook to Carlton	Straight River	Artificial Path	MN 198.3	1B, 2A, 3B	Trout stream, MN Public Water	HDD	Open cut
APR	Hubbard	Clearbrook to Carlton	Shell River	Stream/River - Perennial	MN 200.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Hubbard	Clearbrook to Carlton	Shell River	Stream/River - Perennial	MN 205.5	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Hubbard	Clearbrook to Carlton	Shell River	Artificial Path	MN 207.8	2B, 3C	MN Public Water	HDD	Open cut
APR	Hubbard	Clearbrook to Carlton	Unnamed artificial Path	Artificial Path	MN 209.2	None	None	NA	NA
APR	Hubbard	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 209.5	None	None	HDD	Open cut
APR	Hubbard	Clearbrook to Carlton	Shell River	Artificial Path	MN 209.5	None	NRI-listed, MN Public Water	NA	NA
APR	Wadena	Clearbrook to Carlton	Shell River	Artificial Path	MN 215.3	2B, 3C	NRI-listed, MN Public Water	HDD	Open cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Wadena	Clearbrook to Carlton	Crow Wing River	Artificial Path	MN 217.4	2B, 3C	NRI-listed, MN Public Water	HDD	Wet Open Cut
APR	Wadena	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 220.2	None	None	Wet Open Cut	Dry Crossing
APR	Wadena	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 220.2	None	None	Wet Open Cut	Dry Crossing
APR	Cass	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 223.7	None	None	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Big Swamp Creek	Canal Ditch	MN 224.6	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 225.3	None	None	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 226.9	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 227	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 229.5	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 230.7	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 231.7	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	South Fork Pine River	Stream/River - Perennial	MN 232.6	2B, 3C	None	NA	NA

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Cass	Clearbrook to Carlton	Pine River	Artificial Path	MN 241.4	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Crow Wing	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 244.3	None	None	NA	NA
APR	Crow Wing	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 245.5	None	None	Dry Crossing	Wet Open Cut
APR	Crow Wing	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 246.6	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	Blind Lake Creek	Stream/River - Perennial	MN 250.5	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 253.1	None	None	NA	NA
APR	Cass	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 257.9	None	None	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Daggett Brook	Stream/River - Perennial	MN 261.4	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Spring Branch	Stream/River - Perennial	MN 265.3	1B, 2A, 3B	Trout stream, MN Public Water	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Unnamed Connector	Connector	MN 269.8	None	None	Dry Crossing	Wet Open Cut
APR	Cass	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 270.6	None	None	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Cass	Clearbrook to Carlton	Moose River	Stream/River - Perennial	MN 272.1	1B, 2Bd, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Connector	Connector	MN 275.5	None	None	NA	NA
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 277.4	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 279.2	None	None	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	White Elk Creek	Stream/River - Perennial	MN 283.5	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 286.2	None	None	NA	NA
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 290.7	None	None	NA	NA
APR	Aitkin	Clearbrook to Carlton	White Elk Creek	Stream/River - Intermittent	MN 291.2	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Willow River	Stream/River - Perennial	MN 292.8	2C	NRI-listed, MN Public Water	HDD	Open cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 295.1	None	None	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Mississippi River	Artificial Path	MN 296.7	2B, 3C	303d-Listed Impaired, USACE	HDD	Open cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
							Navigable, MN Public Water		
APR	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 298.3	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 299	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 299.1	None	None	NA	NA
APR	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 301.9	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 302.3	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 303.6	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Sandy River	Artificial Path	MN 305.9	2B, 3C	USACE Navigable, MN Public Water	HDD	Open Cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 308	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 308.2	None	None	Wet Open Cut	Dry Crossing
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 309.5	None	None	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 310.1	None	None	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Sandy River	Canal Ditch	MN 312.8	2B, 3C	MN Public Water	HDD	Open cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 314.1	None	None	NA	NA
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 318.9	None	None	Dry Crossing	Wet Open Cut
APR	Aitkin	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 320.8	None	None	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	West Branch Kettle River	Stream/River - Perennial	MN 328.4	2B, 3C	MN Public Water	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 333.7	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 333.7	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 333.8	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 333.8	None	None	NA	NA

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Carlton	Clearbrook to Carlton	Heikkila Creek	Stream/River - Perennial	MN 334.5	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 335.3	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Canal Ditch	Canal Ditch	MN 337.7	None	None	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Kettle River	Canal Ditch	MN 338.2	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 341.1	None	None	Wet Open Cut	Dry Crossing
APR	Carlton	Clearbrook to Carlton	West Fork Moose Horn River	Stream/River - Perennial	MN 342.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 343.5	None	None	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	King Creek	Stream/River - Intermittent	MN 344.2	1B, 2A, 3B	Trout stream, MN Public Water	Wet Open Cut	Dry Crossing
APR	Carlton	Clearbrook to Carlton	Park Lake Creek	Stream/River - Perennial	MN 346.7	None	MN Public Water	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 347.1	None	None	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Carlton	Clearbrook to Carlton	Moose Horn River	Stream/River - Perennial	MN 347.6	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 349	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Blackhoof River	Stream/River - Perennial	MN 352.1	1B, 2A, 3B	Trout stream	Dry Crossing	Wet Open Cut
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 352.3	None	Trout stream	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 353.7	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Connector	Connector	MN 354.4	None	None	NA	NA
APR	Carlton	Clearbrook to Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 356.6	None	None	NA	NA
APR	Carlton	Carlton to WI Border	Unnamed Waterbody	Lake/Pond - Perennial	MN 359.5	None	None	NA	NA
APR	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 362.3	None	None	NA	NA
APR	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 363.3	None	MN Public Water	Dry Crossing	Wet Open Cut

Table G-4. Route Permit - Waterbodies crossed by the Applicant's Preferred Route (in Minnesota)

Route	County	Section	Waterbody Name	Waterbody type/flow	MN Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
APR	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 364.7	None	None	Wet Open Cut	Dry Crossing
APR	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 365.1	None	None	Wet Open Cut	Dry Crossing
APR	Carlton	Carlton to WI Border	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 365.4	None	None	Wet Open Cut	Dry Crossing

Notes: Waterbody crossings determined using NHD GIS layers.

State-designated Use:

Minnesota Rule 7050.0470 lists the classifications of major waterbodies in the state. If a waterbody is not listed under 7050.0470 and is not a wetland, it is classified as a Class 2B, 3C, 4A, 4B, 5, and 6 water per Minnesota Rule 7050.0430.

- Class 1 – domestic consumption (i.e., drinking water);
- Class 2 – aquatic life and recreation;
- Class 3 – industrial or commercial use;
- Class 4 – agricultural use, irrigation (4A) and livestock and wildlife watering (4B);
- Class 5 – aesthetics and navigation;
- Class 6 – other uses and protection of border waters; and
- Class 7 – limited resource value waters.

Minnesota Rule 7050.0222 further defines the water quality standards for the following subclasses of Class 2 waters:

- Class 2A – Coldwater fisheries, trout waters, suitable for all aquatic recreation and protected as a source of drinking water;
- Class 2Bd – Cold and warm water fisheries, suitable for all aquatic recreation and protected as a source of drinking water;
- Class 2B – Cold and warm water fisheries, suitable for all aquatic recreation but not protected for drinking water;
- Class 2C – Indigenous fish and associated aquatic community, suitable for boating but not protected for drinking water.

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
Route Alternative RA-03AM								
RA-03AM	Clearwater	Unnamed Waterbody	Lake/Pond - Perennial	MN 139.6	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.2	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 144.3	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 146.3	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 146.9	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 147.9	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 148.9	None	None	NA	NA
RA-03AM	Clearwater	Clearwater River	Artificial Path	MN 149.5	2B, 3C	303d-Listed Impaired, NRI-listed, MN Public Water	HDD	Open cut
RA-03AM	Clearwater	Walker Brook	Stream/River - Perennial	MN 151.4	None	303d-Listed Impaired, MN Public Water	Wet Open Cut	None
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 152.6	None	MN Public Water	Dry Crossing	Wet Open Cut
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 154.4	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Clearwater	Unnamed Waterbody	Lake/Pond - Perennial	MN 154.7	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Waterbody	Lake/Pond - Perennial	MN 155.1	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Waterbody	Lake/Pond - Perennial	MN 156.4	None	None	NA	NA
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 163.5	None	None	NA	NA
RA-03AM	Clearwater	Bear Creek	Stream/River - Perennial	MN 164.2	2C, 3C	MN Public Water	Dry Crossing	Wet Open Cut
RA-03AM	Clearwater	Mississippi River	Stream/River - Perennial	MN 165.1	2B, 3C	303d-Listed Impaired, MN Public Water	HDD	Dry Crossing
RA-03AM	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 169.9	None	None	NA	NA
RA-03AM	Hubbard	LaSalle Creek	Stream/River - Perennial	MN 170.1	2C	Trout Stream, MN Public Water	Dry Crossing	Wet Open Cut
RA-03AM	Hubbard	Unnamed Waterbody	Lake/Pond - Perennial	MN 177.6	None	None	NA	NA
RA-03AM	Hubbard	Unnamed Waterbody	Lake/Pond - Perennial	MN 186.3	None	None	NA	NA
RA-03AM	Hubbard	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 186.4	None	MN Public Water	Dry Crossing	Wet Open Cut
RA-03AM	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 187.1	None	None	Dry Crossing	Wet Open Cut

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Hubbard	Hay Creek	Artificial Path	MN 187.8	2B, 3C	MN Public Water	HDD	Open cut
RA-03AM	Hubbard	Unnamed Canal Ditch	Canal Ditch	MN 189.4	None	None	NA	NA
RA-03AM	Hubbard	Unnamed Waterbody	Lake/Pond - Perennial	MN 191.2	None	None	NA	NA
RA-03AM	Hubbard	Straight River	Artificial Path	MN 198.3	1B, 2A, 3B	Trout Stream, MN Public Water	HDD	Open cut
RA-03AM	Hubbard	Shell River	Stream/River - Perennial	MN 200.7	2B, 3C	MN Public Water	Dry Crossing	Wet Open Cut
RA-03AM	Wadena	Blueberry River	Stream/River - Perennial	MN 207.5	2C, 3C	MN Public Water	NA	NA
RA-03AM	Wadena	Kettle River	Stream/River - Perennial	MN 208.2	2C	MN Public Water	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 210.2	None	None	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 210.5	None	None	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 210.9	None	None	NA	NA
RA-03AM	Wadena	Cat River	Canal Ditch	MN 212	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-03AM	Wadena	Cat River	Stream/River - Perennial	MN 213.2	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-03AM	Wadena	Kitten Creek	Stream/River - Perennial	MN 215	2C, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Wadena	Unnamed Canal Ditch	Canal Ditch	MN 217.7	None	None	NA	NA
RA-03AM	Wadena	Redeye River	Stream/River - Perennial	MN 218.3	2B, 3C	MN Public Water	NA	NA
RA-03AM	Wadena	Unnamed Canal Ditch	Canal Ditch	MN 224.5	None	None	NA	NA
RA-03AM	Wadena	Hay Creek	Stream/River - Perennial	MN 225.8	2B, 3C	MN Public Water	NA	NA
RA-03AM	Wadena	Unnamed Canal Ditch	Canal Ditch	MN 227.4	None	None	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 229.2	None	None	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 230.1	None	None	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 230.2	None	None	NA	NA
RA-03AM	Wadena	Leaf River	Stream/River - Perennial	MN 230.8	2B, 3C	MN Public Water	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 231.7	None	None	NA	NA
RA-03AM	Wadena	Unnamed Canal Ditch	Canal Ditch	MN 231.9	None	None	NA	NA
RA-03AM	Wadena	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 235	None	Trout Stream, MN Public Water	NA	NA
RA-03AM	Wadena	Partridge River	Stream/River - Perennial	MN 236.7	None	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Wadena	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 236.7	None	None	NA	NA
RA-03AM	Wadena	Unnamed Canal Ditch	Canal Ditch	MN 238.2	None	Trout Stream, MN Public Water	NA	NA
RA-03AM	Wadena	Unnamed Connector	Connector	MN 240.9	None	None	NA	NA
RA-03AM	Todd	Hayden Creek	Stream/River - Perennial	MN 241.6	None	MN Public Water	NA	NA
RA-03AM	Todd	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 242.9	None	MN Public Water	NA	NA
RA-03AM	Todd	Unnamed Canal Ditch	Canal Ditch	MN 244.4	None	None	NA	NA
RA-03AM	Todd	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 247	None	None	NA	NA
RA-03AM	Todd	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 247.2	None	None	NA	NA
RA-03AM	Todd	Long Prairie River	Artificial Path	MN 247.4	2B, 3C	MN Public Water	NA	NA
RA-03AM	Todd	Unnamed Canal Ditch	Canal Ditch	MN 249.2	None	None	NA	NA
RA-03AM	Todd	Unnamed Canal Ditch	Canal Ditch	MN 249.6	None	None	NA	NA
RA-03AM	Todd	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 252.2	None	None	NA	NA
RA-03AM	Todd	Fish Trap Creek	Stream/River - Perennial	MN 253.2	2B, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Morrison	Unnamed Waterbody	Lake/Pond - Perennial	MN 255.2	None	None	NA	NA
RA-03AM	Morrison	Corner Lake	Lake/Pond - Perennial	MN 256.4	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 259.2	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 261.1	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 262.2	None	None	NA	NA
RA-03AM	Morrison	Hay Creek	Stream/River - Perennial	MN 264.2	None	MN Public Water	NA	NA
RA-03AM	Morrison	Little Elk River	Stream/River - Perennial	MN 267.4	2C, 3C	MN Public Water	NA	NA
RA-03AM	Morrison	Little Elk River	Stream/River - Perennial	MN 268.6	2C, 3C	MN Public Water	NA	NA
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 271.7	None	None	NA	NA
RA-03AM	Morrison	Mississippi River	Artificial Path	MN 273.3	2B, 3C	USACE Navigable waterway, MN Public Water	NA	NA
RA-03AM	Morrison	Rice Creek	Canal Ditch	MN 276	2B, 3C	None	NA	NA
RA-03AM	Morrison	Rice Creek	Canal Ditch	MN 277.9	2B, 3C	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Morrison	Rice Creek	Stream/River - Perennial	MN 280	2B, 3C	MN Public Water	NA	NA
RA-03AM	Morrison	Platte River	Stream/River - Perennial	MN 282.6	2B, 3C	MN Public Water	NA	NA
RA-03AM	Morrison	Skunk River	Stream/River - Perennial	MN 286.8	2C, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 287.3	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 288.2	None	None	NA	NA
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 288.8	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 288.9	None	None	NA	NA
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 290.3	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 290.8	None	None	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 290.9	None	None	NA	NA
RA-03AM	Morrison	Mischke Creek	Stream/River - Intermittent	MN 292.3	None	None	NA	NA
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 292.7	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 294.5	None	None	NA	NA
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 298	None	None	NA	NA
RA-03AM	Morrison	Unnamed Canal Ditch	Canal Ditch	MN 299	None	None	NA	NA
RA-03AM	Morrison	Unnamed Artificial Path	Artificial Path	MN 300.8	None	MN Public Water	NA	NA
RA-03AM	Morrison	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 301.2	None	None	NA	NA
RA-03AM	Benton	West Branch Rum River	Stream/River - Perennial	MN 303.3	2B, 3C	MN Public Water	NA	NA
RA-03AM	Benton	Unnamed Waterbody	Lake/Pond - Perennial	MN 305.1	None	None	NA	NA
RA-03AM	Benton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 305.5	None	None	NA	NA
RA-03AM	Benton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 306	None	None	NA	NA
RA-03AM	Benton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 306.4	None	MN Public Water	NA	NA
RA-03AM	Benton	Stony Brook	Stream/River - Perennial	MN 306.8	None	MN Public Water	NA	NA
RA-03AM	Mille Lacs	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 307.7	None	None	NA	NA
RA-03AM	Mille Lacs	West Branch Rum River	Stream/River - Perennial	MN 308.3	2B, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Mille Lacs	West Branch Rum River	Stream/River - Perennial	MN 308.5	2B, 3C	MN Public Water	NA	NA
RA-03AM	Mille Lacs	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 311.6	None	None	NA	NA
RA-03AM	Mille Lacs	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 312.2	None	None	NA	NA
RA-03AM	Mille Lacs	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 313.4	None	None	NA	NA
RA-03AM	Mille Lacs	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 314.2	None	None	NA	NA
RA-03AM	Mille Lacs	Rum River	Artificial Path	MN 314.3	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-03AM	Mille Lacs	Unnamed Waterbody	Lake/Pond - Perennial	MN 315.8	None	None	NA	NA
RA-03AM	Mille Lacs	Unnamed Canal Ditch	Canal Ditch	MN 316.7	None	None	NA	NA
RA-03AM	Mille Lacs	Vondell Brook	Canal Ditch	MN 317.3	2C, 3C	MN Public Water	NA	NA
RA-03AM	Mille Lacs	Unnamed Canal Ditch	Canal Ditch	MN 320	None	None	NA	NA
RA-03AM	Mille Lacs	Bogus Brook	Stream/River - Perennial	MN 321	7	MN Public Water	NA	NA
RA-03AM	Mille Lacs	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 322	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Kanabec	South Fork Groundhouse River	Stream/River - Perennial	MN 323.3	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-03AM	Kanabec	Unnamed Canal Ditch	Canal Ditch	MN 325.3	None	None	NA	NA
RA-03AM	Kanabec	Groundhouse River	Stream/River - Perennial	MN 328.5	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	NA	NA
RA-03AM	Kanabec	Unnamed Canal Ditch	Canal Ditch	MN 329.2	None	None	NA	NA
RA-03AM	Kanabec	Ann River	Artificial Path	MN 332.7	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	NA	NA
RA-03AM	Kanabec	Snake River	Artificial Path	MN 334.9	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	NA	NA
RA-03AM	Kanabec	Spring Brook	Artificial Path	MN 335.2	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-03AM	Kanabec	Spring Brook	Stream/River - Perennial	MN 337	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-03AM	Kanabec	Spring Brook	Stream/River - Intermittent	MN 338	2B, 3C	303d-Listed Impaired	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Kanabec	Unnamed Canal Ditch	Canal Ditch	MN 341.5	None	MN Public Water	NA	NA
RA-03AM	Kanabec	Unnamed Canal Ditch	Canal Ditch	MN 342.6	None	None	NA	NA
RA-03AM	Kanabec	Mud Creek	Stream/River - Perennial	MN 343.5	None	303d-Listed Impaired, MN Public Water	NA	NA
RA-03AM	Pine	Unnamed Canal Ditch	Canal Ditch	MN 346.4	None	None	NA	NA
RA-03AM	Pine	Pokegama Creek	Stream/River - Perennial	MN 348.4	2B, 3C	MN Public Water	NA	NA
RA-03AM	Pine	Unnamed Canal Ditch	Canal Ditch	MN 348.5	None	None	NA	NA
RA-03AM	Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 349	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 349.6	None	MN Public Water	NA	NA
RA-03AM	Pine	East Pokegama Creek	Stream/River - Perennial	MN 351.7	2B, 3C	MN Public Water	NA	NA
RA-03AM	Carlton	Blackhoof River	Stream/River - Perennial	MN 352.1	1B, 2A, 3B	Trout Stream	Dry Crossing	Wet Open Cut
RA-03AM	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 352.3	None	Trout Stream	NA	NA
RA-03AM	Pine	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 352.7	None	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 353.7	2B, 3C	None	NA	NA
RA-03AM	Carlton	Unnamed Connector	Connector	MN 354.4	None	None	NA	NA
RA-03AM	Pine	Mission Creek	Stream/River - Perennial	MN 355.9	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-03AM	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 356.6	None	None	NA	NA
RA-03AM	Pine	Grindstone River	Artificial Path	MN 359.1	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	NA	NA
RA-03AM	Pine	Unnamed Canal Ditch	Canal Ditch	MN 362.6	None	None	NA	NA
RA-03AM	Pine	Friesland Ditch	Canal Ditch	MN 364.9	None	None	NA	NA
RA-03AM	Pine	Skunk Creek	Stream/River - Intermittent	MN 367.9	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 368.7	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 369	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 369.3	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 370.4	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Pine	Medicine Creek	Canal Ditch	MN 372.1	2B, 3C	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 373.5	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 373.7	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 374	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 374.4	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 375.2	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 375.5	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 375.6	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 375.8	None	None	NA	NA
RA-03AM	Pine	Pine River	Artificial Path	MN 377.2	None	MN Public Water	NA	NA
RA-03AM	Pine	Unnamed Connector	Connector	MN 379.1	None	None	NA	NA
RA-03AM	Pine	Unnamed Connector	Connector	MN 379.3	None	None	NA	NA
RA-03AM	Polk	Unnamed Waterbody	Lake/Pond - Perennial	MN 379.9	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-03AM	Polk	Fox Lake	Lake/Pond - Perennial	MN 380	None	MN Public Water	NA	NA
RA-03AM	Pine	Unnamed Connector	Connector	MN 382.6	None	None	NA	NA
RA-03AM	Pine	Kettle River	Artificial Path	MN 384.6	2B, 3C	303d-Listed Impaired, USACE Navigable, MN Public Water	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 387.1	None	None	NA	NA
RA-03AM	Pine	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 387.9	None	None	NA	NA
RA-03AM	Carlton	West Fork Moose Horn River	Stream/River - Perennial	MN 397.8	2B, 3C	MN Public Water	NA	NA
RA-03AM	Carlton	Moose Horn River	Stream/River - Perennial	MN 400.2	2B, 3C	MN Public Water	NA	NA
RA-03AM	Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 401.3	None	None	NA	NA
RA-03AM	Carlton	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 401.8	None	None	NA	NA
RA-03AM	Carlton	Unnamed Connector	Connector	MN 403	None	None	NA	NA
Route Alternative RA-06								
RA-06	Clearwater	Ruffy Brook	Stream/River - Perennial	MN 140.5	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.9	None	MN Public Water	NA	NA
RA-06	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 144.7	None	None	NA	NA
RA-06	Beltrami	Clearwater River	Stream/River - Perennial	MN 149.2	1B, 2A, 3B	Trout Stream, NRI-listed, MN Public Water	NA	NA
RA-06	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 143.5	None	MN Public Water	NA	NA
RA-06	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 145.6	None	None	NA	NA
RA-06	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 145.7	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 152.7	None	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Waterbody	Lake/Pond - Perennial	MN 153.6	None	MN Public Water	NA	NA
RA-06	Beltrami	Sandy River	Stream/River - Perennial	MN 153.9	2B, 3C	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 156.3	None	MN Public Water	NA	NA
RA-06	Beltrami	Rice Lake	Lake/Pond - Perennial	MN 159.6	2B	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 160.3	None	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Artificial Path	Artificial Path	MN 161.1	None	MN Public Water	NA	NA
RA-06	Beltrami	Pike Creek	Stream/River - Perennial	MN 161.5	2B, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Beltrami	Mud River	Stream/River - Perennial	MN 162.7	2B, 3C	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 162.9	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 166.1	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 166.2	None	None	NA	NA
RA-06	Beltrami	Hay Creek	Connector	MN 167.5	None	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 169.6	None	None	NA	NA
RA-06	Beltrami	Darrigans Creek	Stream/River - Perennial	MN 170.7	2B, 3C	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 171.7	None	None	NA	NA
RA-06	Beltrami	O'Brien Creek	Stream/River - Perennial	MN 172.4	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-06	Beltrami	O'Brien Creek	Stream/River - Perennial	MN 172.6	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-06	Beltrami	O'Brien Creek	Stream/River - Perennial	MN 172.7	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 173.8	None	None	NA	NA
RA-06	Beltrami	Unnamed Waterbody	Lake/Pond - Perennial	MN 173.9	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 174.4	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 174.9	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 175	None	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Waterbody	Lake/Pond - Perennial	MN 175.4	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 177	None	None	NA	NA
RA-06	Beltrami	Blackduck River	Stream/River - Perennial	MN 177.7	2B, 3C	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 178.5	None	None	NA	NA
RA-06	Beltrami	Unnamed Connector	Connector	MN 180.5	None	None	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 180.8	None	None	NA	NA
RA-06	Beltrami	Spring Creek	Artificial Path	MN 181.7	2B, 3C	MN Public Water	NA	NA
RA-06	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 183.7	None	MN Public Water	NA	NA
RA-06	Beltrami	South Cormorant River	Stream/River - Intermittent	MN 185.7	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 186.7	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 190.7	None	None	NA	NA
RA-06	Itasca	Popple River	Stream/River - Perennial	MN 191.8	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 193.5	None	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 194.3	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 196.2	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 199.6	None	None	NA	NA
RA-06	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 200.2	None	None	NA	NA
RA-06	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 200.6	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 201.7	None	MN Public Water	NA	NA
RA-06	Itasca	Moose Brook	Stream/River - Perennial	MN 203.4	2B, 3C	None	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 203.9	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 204.2	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 205.6	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Hay Creek	Stream/River - Perennial	MN 205.8	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Connector	Connector	MN 207.1	None	None	NA	NA
RA-06	Itasca	Harrison Creek	Stream/River - Perennial	MN 209.9	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 210	2B, 3C	USACE Navigable, MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Itasca	Unnamed Artificial Path	Artificial Path	MN 211.8	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Artificial Path	Artificial Path	MN 212	None	MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 212.6	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 213	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 213.2	None	None	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 214.5	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 215.2	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 215.9	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 216.8	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 221	None	MN Public Water	NA	NA
RA-06	Itasca	Big Fork River	Artificial Path	MN 223.4	2B, 3C	NRI-listed, USACE Navigable, MN Public Water	NA	NA
RA-06	Itasca	Rice Creek	Stream/River - Perennial	MN 224.4	2B, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Itasca	Coon Creek	Artificial Path	MN 226.9	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Coon Creek	Stream/River - Perennial	MN 227.9	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Coon Creek	Stream/River - Perennial	MN 232	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Larson Lake	Lake/Pond - Perennial	MN 233.2	1B, 2A, 3B	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 237.1	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 240.5	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 241.5	None	MN Public Water	NA	NA
RA-06	Itasca	Bear River	Stream/River - Perennial	MN 241.7	None	MN Public Water	NA	NA
RA-06	Itasca	Venning Creek	Stream/River - Perennial	MN 242.7	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 243.6	None	Trout Stream, MN Public Water	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 244.1	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 246.4	None	None	NA	NA
RA-06	Itasca	Unnamed Connector	Connector	MN 248.1	None	None	NA	NA
RA-06	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 249.1	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 249.2	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 250.9	None	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Itasca	Prairie River	Stream/River - Intermittent	MN 254	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 254.8	None	None	NA	NA
RA-06	Itasca	Day Brook	Stream/River - Perennial	MN 255.9	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	East River	Stream/River - Perennial	MN 259.9	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 261.3	None	None	NA	NA
RA-06	Itasca	Rock Creek	Stream/River - Perennial	MN 262.3	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 263	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 263.4	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 266.8	None	MN Public Water	NA	NA
RA-06	Itasca	O'Brien Creek	Stream/River - Perennial	MN 267.8	None	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 267.9	None	None	NA	NA
RA-06	Itasca	O'Brien Creek	Stream/River - Perennial	MN 268.4	None	MN Public Water	NA	NA
RA-06	Itasca	Welcome Creek	Artificial Path	MN 271.5	2C	None	NA	NA
RA-06	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 274	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 274.4	None	None	NA	NA
RA-06	St. Louis	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 274.7	None	MN Public Water	NA	NA
RA-06	Itasca	Hay Creek	Stream/River - Perennial	MN 275.6	2B, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	St. Louis	East Savanna River	Canal Ditch	MN 275.7	2B, 3C	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 277.3	None	None	NA	NA
RA-06	Itasca	Coons Creek	Artificial Path	MN 278.1	None	MN Public Water	NA	NA
RA-06	Itasca	Tank Creek	Connector	MN 278.8	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Artificial Path	Artificial Path	MN 279.1	None	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 279.8	None	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 280.1	None	None	NA	NA
RA-06	Itasca	Beauty Lake	Lake/Pond - Perennial	MN 280.8	None	MN Public Water	NA	NA
RA-06	Itasca	Mary Lake	Lake/Pond - Perennial	MN 281.4	None	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 281.8	None	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 281.8	None	None	NA	NA
RA-06	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 282.5	None	None	NA	NA
RA-06	St. Louis	Ahmik River	Stream/River - Perennial	MN 282.5	2B, 3C	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 283.6	None	Trout Stream, MN Public Water	NA	NA
RA-06	Itasca	Unnamed Artificial Path	Artificial Path	MN 284.2	None	MN Public Water	NA	NA
RA-06	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 285.5	None	MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 288.4	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-06	Carlton	Stoney Brook	Canal Ditch	MN 292.3	2B, 3C	MN Public Water	NA	NA
RA-06	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 292.3	None	None	NA	NA
RA-06	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 292.4	None	None	NA	NA
RA-06	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 292.5	None	None	NA	NA
RA-06	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 293.5	None	None	NA	NA
RA-06	Carlton	Unnamed Canal Ditch	Canal Ditch	MN 294.1	None	None	NA	NA
RA-06	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 294.5	None	None	NA	NA
RA-06	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 294.7	None	None	NA	NA
RA-06	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 294.7	None	None	NA	NA
RA-06	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 295.1	None	None	NA	NA
RA-06	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 295.2	None	None	NA	NA
RA-06	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 300	None	None	NA	NA
RA-06	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 301.4	None	MN Public Water	NA	NA
RA-06	Carlton	Little Otter Creek	Stream/River - Perennial	MN 304.2	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-06	St. Louis	Unnamed Waterbody	Lake/Pond - Perennial	MN 307	None	None	NA	NA
RA-06	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 326.9	None	None	NA	NA
RA-06	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 334.3	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
Route Alternative RA-07								
RA-07	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.5	None	MN Public Water	NA	NA
RA-07	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.8	None	None	NA	NA
RA-07	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 142.8	None	None	NA	NA
RA-07	Clearwater	Ruffy Brook	Stream/River - Perennial	MN 143.1	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-07	Clearwater	Unnamed Waterbody	Lake/Pond - Perennial	MN 145.3	None	None	NA	NA
RA-07	Clearwater	West Four Legged Lake	Lake/Pond - Perennial	MN 145.5	None	MN Public Water	NA	NA
RA-07	Clearwater	Unnamed Connector	Connector	MN 145.7	None	MN Public Water	NA	NA
RA-07	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 151.1	None	Trout Stream, MN Public Water	NA	NA
RA-07	Beltrami	Clearwater River	Stream/River - Perennial	MN 151.2	1B, 2A, 3B	Trout Stream, NRI-listed, MN Public Water	NA	NA
RA-07	Beltrami	Grant Creek	Stream/River - Perennial	MN 156.1	2B, 3C	MN Public Water	NA	NA
RA-07	Beltrami	Grant Creek	Stream/River - Perennial	MN 158.5	2B, 3C	MN Public Water	NA	NA
RA-07	Beltrami	Grant Creek	Stream/River - Perennial	MN 161.6	2B, 3C	MN Public Water	NA	NA
RA-07	Beltrami	Grant Creek	Stream/River - Perennial	MN 162.5	2B, 3C	MN Public Water	NA	NA
RA-07	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 163.6	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-07	Beltrami	Mississippi River	Artificial Path	MN 168.7	2B, 3C	MN Public Water	NA	NA
RA-07	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 170.8	None	None	NA	NA
RA-07	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 171.4	None	None	NA	NA
RA-07	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 172.4	None	None	NA	NA
RA-07	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 172.8	None	None	NA	NA
RA-07	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 173.3	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-07	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 174.5	None	Trout Stream, MN Public Water	NA	NA
RA-07	Hubbard	Necktie River	Stream/River - Intermittent	MN 176.4	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-07	Cass	Fox Creek	Artificial Path	MN 184.7	2B, 3C	MN Public Water	NA	NA
RA-07	Cass	Unnamed Connector	Connector	MN 192.4	None	None	NA	NA
RA-07	Cass	Unnamed Artificial Path	Artificial Path	MN 193.1	None	MN Public Water	NA	NA
RA-07	Cass	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 196.6	None	None	NA	NA
RA-07	Cass	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 196.9	None	None	NA	NA
RA-07	Cass	Unnamed Waterbody	Swamp/Marsh - Intermittent	MN 202.3	None	MN Public Water	NA	NA
RA-07	Cass	Sixmile Brook	Canal Ditch	MN 203.9	2C, 3C	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-07	Cass	Unnamed Canal Ditch	Canal Ditch	MN 208.2	None	None	NA	NA
RA-07	Cass	Unnamed Canal Ditch	Canal Ditch	MN 211	None	None	NA	NA
RA-07	Cass	Mississippi River	Artificial Path	MN 214.8	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-07	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 214.8	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 215	None	None	NA	NA
RA-07	Cass	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 215	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 216.9	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 218.3	None	MN Public Water	NA	NA
RA-07	Itasca	Ball Club River	Stream/River - Perennial	MN 218.4	2B, 3C	MN Public Water	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 220.5	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 221.8	None	None	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 222.8	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 223	None	None	NA	NA
RA-07	Itasca	Deer River	Stream/River - Perennial	MN 224.2	2B, 3C	MN Public Water	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 224.9	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-07	Itasca	Bass Brook	Stream/River - Perennial	MN 233	None	MN Public Water	NA	NA
RA-07	Itasca	Prairie River	Artificial Path	MN 239.3	None	MN Public Water	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 245.7	None	MN Public Water	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 249.2	None	None	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 249.8	None	None	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 250.2	None	None	NA	NA
RA-07	Itasca	Swan River	Stream/River - Perennial	MN 253.9	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 254.4	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 255.8	None	None	NA	NA
RA-07	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 257.3	None	None	NA	NA
RA-07	Itasca	Bruce Creek	Canal Ditch	MN 257.9	2B, 3C	MN Public Water	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 263.6	None	None	NA	NA
RA-07	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 264.9	None	None	NA	NA
RA-07	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 265.2	None	None	NA	NA
RA-07	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 265.9	None	None	NA	NA
RA-07	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 267.9	None	None	NA	NA
RA-07	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 274	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-07	St. Louis	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 274.7	None	MN Public Water	NA	NA
RA-07	St. Louis	East Savanna River	Canal Ditch	MN 275.7	2B, 3C	MN Public Water	NA	NA
RA-07	St. Louis	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 277.3	None	None	NA	NA
RA-07	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 279.8	None	MN Public Water	NA	NA
RA-07	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 280.1	None	None	NA	NA
RA-07	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 281.8	None	MN Public Water	NA	NA
RA-07	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 281.8	None	None	NA	NA
RA-07	St. Louis	Ahmik River	Stream/River - Perennial	MN 282.5	2B, 3C	MN Public Water	NA	NA
RA-07	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 288.4	None	None	NA	NA
RA-07	Carlton	Stoney Brook	Canal Ditch	MN 292.3	2B, 3C	MN Public Water	NA	NA
RA-07	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 292.3	None	None	NA	NA
RA-07	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 292.4	None	None	NA	NA
RA-07	Carlton	Unnamed Canal Ditch	Canal Ditch	MN 294.1	None	None	NA	NA
RA-07	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 294.7	None	None	NA	NA
RA-07	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 300	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-07	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 301.4	None	MN Public Water	NA	NA
RA-07	Carlton	Little Otter Creek	Stream/River - Perennial	MN 304.2	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-07	St. Louis	Unnamed Waterbody	Lake/Pond - Perennial	MN 307	None	None	NA	NA
RA-07	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 326.9	None	None	NA	NA
RA-07	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 334.3	None	None	NA	NA
Route Alternative RA-08								
RA-08	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.4	None	None	NA	NA
RA-08	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 141.8	None	None	NA	NA
RA-08	Clearwater	Unnamed Waterbody	Lake/Pond - Perennial	MN 142	None	None	NA	NA
RA-08	Clearwater	Ruffy Brook	Connector	MN 144.1	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-08	Clearwater	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 144.3	None	MN Public Water	NA	NA
RA-08	Clearwater	Ruffy Brook	Stream/River - Perennial	MN 144.3	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-08	Clearwater	Clearwater River	Stream/River - Perennial	MN 148.8	2B, 3C location	303d-Listed Impaired, NRI-listed, MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-08	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 149.9	None	None	NA	NA
RA-08	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 150.7	None	None	NA	NA
RA-08	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 151.1	None	None	NA	NA
RA-08	Clearwater	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 151.3	None	None	NA	NA
RA-08	Beltrami	Unnamed Waterbody	Lake/Pond - Perennial	MN 152.1	None	None	NA	NA
RA-08	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 155.1	None	None	NA	NA
RA-08	Beltrami	Unnamed Canal Ditch	Canal Ditch	MN 155.1	None	None	NA	NA
RA-08	Beltrami	Unnamed Connector	Connector	MN 155.6	None	None	NA	NA
RA-08	Beltrami	Unnamed Waterbody	Lake/Pond - Perennial	MN 156.6	None	None	NA	NA
RA-08	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 157.8	None	None	NA	NA
RA-08	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 157.9	None	MN Public Water	NA	NA
RA-08	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 159.4	None	None	NA	NA
RA-08	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 159.5	None	MN Public Water	NA	NA
RA-08	Beltrami	Grant Creek	Stream/River - Perennial	MN 161.9	2B, 3C	MN Public Water	NA	NA
RA-08	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 164.2	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-08	Beltrami	Mississippi River	Stream/River - Perennial	MN 165.8	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-08	Beltrami	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 165.9	None	None	NA	NA
RA-08	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 167.2	None	None	NA	NA
RA-08	Beltrami	Schoolcraft River	Artificial Path	MN 168.3	2B, 3C	MN Public Water	NA	NA
RA-08	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 170.9	None	None	NA	NA
RA-08	Beltrami	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 171.7	None	None	NA	NA
RA-08	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 172.1	None	None	NA	NA
RA-08	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 172.7	None	Trout Stream, MN Public Water	NA	NA
RA-08	Hubbard	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 173.9	None	Trout Stream, MN Public Water	NA	NA
RA-08	Hubbard	Necktie River	Stream/River - Perennial	MN 177	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-08	Hubbard	Unnamed Canal Ditch	Canal Ditch	MN 177.1	None	None	NA	NA
RA-08	Hubbard	Unnamed Connector	Connector	MN 179.5	None	None	NA	NA
RA-08	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 180.4	None	None	NA	NA
RA-08	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 182.3	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-08	Cass	Unnamed Artificial Path	Artificial Path	MN 185.3	None	MN Public Water	NA	NA
RA-08	Cass	Unnamed Artificial Path	Artificial Path	MN 186.4	None	MN Public Water	NA	NA
RA-08	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 191.2	None	None	NA	NA
RA-08	Cass	Sucker Creek	Stream/River - Perennial	MN 192.5	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-08	Cass	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 193	None	None	NA	NA
RA-08	Cass	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 194.4	None	None	NA	NA
RA-08	Cass	Portage Creek	Stream/River - Perennial	MN 198.3	2B, 3C	None, MN Public Water	NA	NA
RA-08	Cass	Sixmile Brook	Canal Ditch	MN 204.2	2C, 3C	None	NA	NA
RA-08	Cass	Unnamed Canal Ditch	Canal Ditch	MN 208	None	MN Public Water	NA	NA
RA-08	Cass	Unnamed Canal Ditch	Canal Ditch	MN 209.4	None	None	NA	NA
RA-08	Cass	Unnamed Canal Ditch	Canal Ditch	MN 210.6	None	None	NA	NA
RA-08	Cass	Unnamed Waterbody	Lake/Pond - Perennial	MN 212.8	None	None	NA	NA
RA-08	Cass	Unnamed Artificial Path	Artificial Path	MN 214.5	None	None	NA	NA
RA-08	Cass	Mississippi River	Artificial Path	MN 214.6	2B, 3C	USACE Navigable, MN Public Water	NA	NA
RA-08	Itasca	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 215	None	None	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-08	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 215	None	None	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 216.4	None	None	NA	NA
RA-08	Itasca	Ball Club River	Stream/River - Perennial	MN 218.1	2B, 3C	MN Public Water	NA	NA
RA-08	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 219.9	None	None	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 221.2	None	None	NA	NA
RA-08	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 221.9	None	None	NA	NA
RA-08	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 222.2	None	None	NA	NA
RA-08	Itasca	Deer River	Stream/River - Perennial	MN 223.5	2B, 3C	MN Public Water	NA	NA
RA-08	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 223.6	None	None	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 224.5	None	None	NA	NA
RA-08	Itasca	Unnamed Connector	Connector	MN 225.9	None	None	NA	NA
RA-08	Itasca	Blackwater Creek	Stream/River - Perennial	MN 230.1	2C	MN Public Water	NA	NA
RA-08	Itasca	Bass Brook	Stream/River - Perennial	MN 232.1	None	MN Public Water	NA	NA
RA-08	Itasca	Unnamed Waterbody	Lake/Pond - Perennial	MN 232.3	None	None	NA	NA
RA-08	Itasca	Forsythe Lake	Lake/Pond - Perennial	MN 232.4	None	None	NA	NA
RA-08	Itasca	Prairie River	Artificial Path	MN 239	None	MN Public Water	NA	NA
RA-08	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 247.6	None	None	NA	NA
RA-08	Itasca	Unnamed Canal Ditch	Canal Ditch	MN 247.7	None	None	NA	NA
RA-08	Itasca	Shallow Lake	Lake/Pond - Perennial	MN 250.9	None	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-08	Itasca	Swan River	Stream/River - Perennial	MN 252.3	2B, 3C	303d-Listed Impaired, MN Public Water	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 252.4	None	None	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 253.6	None	None	NA	NA
RA-08	Itasca	Spot Lake	Lake/Pond - Perennial	MN 254.9	None	None	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 255.8	None	None	NA	NA
RA-08	Itasca	Unnamed Stream/River Intermittent	Stream/River - Intermittent	MN 256	None	MN Public Water	NA	NA
RA-08	Itasca	Bruce Creek	Canal Ditch	MN 256.1	2B, 3C	MN Public Water	NA	NA
RA-08	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 261.7	None	None	NA	NA
RA-08	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 262.6	None	None	NA	NA
RA-08	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 263	None	None	NA	NA
RA-08	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 264.3	None	None	NA	NA
RA-08	Aitkin	Unnamed Canal Ditch	Canal Ditch	MN 265.7	None	None	NA	NA
RA-08	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 267.1	None	None	NA	NA
RA-08	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 268.2	None	None	NA	NA
RA-08	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 269.5	None	None	NA	NA
RA-08	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 270.2	None	None	NA	NA
RA-08	St. Louis	East Savanna River	Canal Ditch	MN 273.1	2B, 3C	MN Public Water	NA	NA

Table G-5. Route Permit - Waterbodies crossed by the Route Alternatives (Clearbrook to Carlton)

Route	County	Waterbody Name	Waterbody type/flow	State Mile Post	State-Designated Use	Agency Classification	Applicant-proposed Crossing Method	Applicant-proposed Alternative Crossing Method
RA-08	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 273.3	None	None	NA	NA
RA-08	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 276.8	None	MN Public Water	NA	NA
RA-08	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 279.1	None	MN Public Water	NA	NA
RA-08	St. Louis	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 279.2	None	None	NA	NA
RA-08	St. Louis	Ahmik River	Stream/River - Perennial	MN 279.9	2B, 3C	MN Public Water	NA	NA
RA-08	St. Louis	Ahmik River	Stream/River - Perennial	MN 280	2B, 3C	MN Public Water	NA	NA
RA-08	St. Louis	Unnamed Canal Ditch	Canal Ditch	MN 285.8	None	None	NA	NA
RA-08	Carlton	Stoney Brook	Canal Ditch	MN 289.6	2B, 3C	MN Public Water	NA	NA
RA-08	Carlton	Unnamed Canal Ditch	Canal Ditch	MN 291.4	None	None	NA	NA
RA-08	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 292	None	None	NA	NA
RA-08	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 295.1	None	None	NA	NA
RA-08	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 297.2	None	None	NA	NA
RA-08	Carlton	Unnamed Stream/River Perennial	Stream/River - Perennial	MN 298.6	None	MN Public Water	NA	NA
RA-08	Carlton	Little Otter Creek	Stream/River - Perennial	MN 301.4	1B, 2A, 3B	Trout Stream, MN Public Water	NA	NA
RA-08	Carlton	Unnamed Waterbody	Lake/Pond - Perennial	MN 302.4	None	None	NA	NA

Notes: Waterbody crossings determined using NHD GIS layers.
State-designated Use:

Minnesota Rule 7050.0470 lists the classifications of major waterbodies in the state. If a waterbody is not listed under 7050.0470 and is not a wetland, it is classified as a Class 2B, 3C, 4A, 4B, 5, and 6 water per Minnesota Rule 7050.0430.

- Class 1 – domestic consumption (i.e., drinking water);
- Class 2 – aquatic life and recreation;
- Class 3 – industrial or commercial use;
- Class 4 – agricultural use, irrigation (4A) and livestock and wildlife watering (4B);
- Class 5 – aesthetics and navigation;
- Class 6 – other uses and protection of border waters; and
- Class 7 – limited resource value waters.

Minnesota Rule 7050.0222 further defines the water quality standards for the following subclasses of Class 2 waters:

- Class 2A – Coldwater fisheries, trout waters, suitable for all aquatic recreation and protected as a source of drinking water;
- Class 2Bd – Cold and warm water fisheries, suitable for all aquatic recreation and protected as a source of drinking water;
- Class 2B – Cold and warm water fisheries, suitable for all aquatic recreation but not protected for drinking water;
- Class 2C – Indigenous fish and associated aquatic community, suitable for boating but not protected for drinking water.

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Appendix H

Locations and Methods of Road and Railroad Crossings

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Appendix O
Road and Railroad Crossings

This table updates the information submitted as Appendix L of the Enbridge Energy, Limited Partnership Application for a Pipeline Routing Permit on April 24, 2015. The Road and Railroad Crossing Table was provided in April 2016 and was published as part of the Environmental Assessment Worksheet.

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
802	Kittson	Road	160th Avenue	Open-cut
803	Kittson	Road	200th Street	Open-cut
804	Kittson	Road	170th Avenue	Open-cut
805	Kittson	Road	190th Street	Open-cut
806	Kittson	Road	180th Street	Open-cut
806	Kittson	Road	180th Avenue	Open-cut
807	Kittson	Road	CSAH #7	Bore
807	Kittson	Road	CSAH #1	Bore
808	Kittson	Road	200th Avenue	Open-cut
809	Kittson	Road	160th Street	Open-cut
810	Kittson	Road	150th Street	Bore
810	Kittson	Road	210th Avenue	Open-cut
811	Kittson	Road	CSAH #23	Bore
811	Kittson	Road	CSAH #13	Open-cut
813	Kittson	Road	130th Street	Open-cut
813	Kittson	Road	CSAH #13	Open-cut
814	Kittson	Road	240th Ave	Open-cut
814	Kittson	Road	State Highway 11	Bore
816	Kittson	Road	110th Street	Open-cut
816	Kittson	Road	250th Avenue	Open-cut
817	Kittson	Railroad	Burlington Northern Santa Fe Railway	Bore
817	Kittson	Road	100th St/460th St NW	Bore
817	Kittson	Road	US Highway 75	Bore
818	Marshall	Road	450th Street NW	Open-cut
819	Marshall	Road	380th Avenue NW	Open-cut
819	Marshall	Ditch	Jurisdiction Ditch Number 8	Open-cut
820	Marshall	Road	370th Avenue NW	Open-cut
820	Marshall	Road	CSAH #24	Bore
821	Marshall	Road	430th Street NW	Open-cut
822	Marshall	Road	420th Street NW	Open-cut
822	Marshall	Road	CSAH #23	Bore
823	Marshall	Road	415th Street NW	Open-cut
824	Marshall	Road	350th Avenue NW	Bore
824	Marshall	Road	410th Street NW	Bore
824	Marshall	Ditch	County Ditch #45-BR3	Bore
825	Marshall	Road	340th Avenue NW	Open-cut
825	Marshall	Road	CSAH #5	Bore
826	Marshall	Road	CSAH #6	Bore
826	Pennington	Ditch	Jurisdiction Ditch Number 16	Open-cut
827	Marshall	Road	330th Avenue NW	Open-cut
828	Marshall	Road	380th Street NW	Open-cut
829	Marshall	Road	CSAH #34	Bore
830	Marshall	Road	CSAH #30	Open-cut
831	Marshall	Road	300th Avenue NW	Open-cut
831	Marshall	Ditch	Name Not Confirmed	Open-cut
832	Marshall	Road	290th Avenue NW	Open-cut

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
832	Marshall	Road	350th Street NW	Open-cut
833	Marshall	Road	County Road 110	Open-cut
833	Marshall	Ditch		Open-cut
834	Marshall	Road	280th Avenue NW	Open-cut
835	Marshall	Road	CSAH #1	Bore
835	Marshall	Road	330th Street NW	Open-cut
836	Marshall	Road	County Road 111	Open-cut
836	Marshall	Road	CSAH #4	HDD
838	Marshall	Road	CSAH #3	Bore
838	Marshall	Road	250th Avenue NW	Open-cut
839	Marshall	Road	240th Avenue NW	Open-cut
839	Marshall	Road	County Road 37	Open-cut
840	Marshall	Road	290th Street NW	Open-cut
841	Marshall	Road	230th Avenue NW	Open-cut
842	Marshall	Road	220th Avenue NW	Open-cut
842	Marshall	Road	280th Street NW	Open-cut
843	Marshall	Road	CSAH #14	Bore
844	Marshall	Road	210th Avenue NW	Open-cut
845	Marshall	Road	200th Avenue NW	Bore
846	Marshall	Railroad	Northern Plains	Bore
846	Marshall	Road	CSAH #38	Bore
846	Marshall	Road	250th Street NW	Bore
847	Marshall	Road	240th Street NW	Open-cut
848	Marshall	Road	180th Avenue NW	Bore
848	Marshall	Road	CSAH #2	Bore
849	Marshall	Road	225th Street NW	Open-cut
850	Marshall	Road	160th Avenue NW	Open-cut
850	Marshall	Road	220th Street NW	Bore
850	Marshall	Road	County Road 107	Bore
851	Marshall	Road	160th Avenue NW	Bore
851	Marshall	Road	215th Street NW	Bore
851	Marshall	Road	165th Avenue NW	Open-cut
852	Pennington	Road	200th Street NW	Open-cut
853	Pennington	Road	147th Avenue NW	Open-cut
853	Pennington	Road	150th Avenue NW	Open-cut
855	Pennington	Road	County Highway 63/180th St NW	Bore
855	Pennington	Ditch	Jurisdiction Ditch Number 25-BR-3	Bore
856	Pennington	Road	130th Avenue NW	Open-cut
857	Pennington	Road	County Highway 71	Open-cut
857	Pennington	Road	State Highway 1	Bore
858	Pennington	Road	160th Street NW	Open-cut
858	Pennington	Ditch	County Ditch #96-BR-4	Open-cut
859	Pennington	Road	County Highway 61	Open-cut
859	Pennington	Road	CSAH #15	Bore
860	Pennington	Road	County Highway 72	Open-cut
861	Pennington	Road	CSAH #7	Bore

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
862	Pennington	Road	County Highway 59	Open-cut
862	Pennington	Road	County Highway 73	Bore
863	Pennington	Road	120th Street NE	Open-cut
863	Pennington	Road	County Highway 74	Open-cut
864	Pennington	Railroad	Minnesota Northern Railroad	Bore
864	Pennington	Road	State Highway 32	Bore
865	Pennington	Road	County Highway 75	Open-cut
866	Pennington	Road	CSAH #17	Bore
866	Pennington	Road	CSAH #3	Bore
867	Pennington	Road	County Highway 55	Open-cut
868	Pennington	Road	150th Avenue SE	Bore
869	Pennington	Road	160th Avenue SE	Open-cut
870	Pennington	Road	County Highway 79	Open-cut
870	Pennington	Road	CSAH #2	Open-cut
871	Pennington	Road	County Highway 52	Open-cut
871	Pennington	Road	175th Avenue SE	Open-cut
873	Red Lake	Road	CSAH #26	Open-cut
874	Red Lake	Road	160th Street SE	Open-cut
874	Red Lake	Road	190th Avenue SE	Open-cut
875	Red Lake	Road	Township #107	Open-cut
876	Red Lake	Railroad	Canadian Pacific Railway	HDD
876	Red Lake	Road	U.S Highway 59	HDD
876	Red Lake	Road	County Road 126	HDD
877	Red Lake	Road	CSAH #1	Bore
877	Red Lake	Ditch	County Ditch #22	Bore
878	Red Lake	Road	190th Street SE	Open-cut
879	Red Lake	Road	230th Avenue SE	Open-cut
880	Red Lake	Road	County Road 129	Open-cut
880	Red Lake	Ditch	BR-6	Open-cut
881	Red Lake	Road	250th Avenue SE	Open-cut
881	Red Lake	Ditch	County Ditch #67	Open-cut
883	Red Lake	Road	CSAH #21	Open-cut
884	Red Lake	Road	270th Avenue SE	Open-cut
885	Red Lake	Road	220th Street SE	Open-cut
885	Red Lake	Road	280th Avenue SE	Open-cut
886	Red Lake	Road	CSAH #5	Bore
887	Polk	Road	CSAH #33	Open-cut
888	Polk	Road	310th Avenue SE	Open-cut
890	Polk	Road	240th Street SE	Open-cut
891	Polk	Road	340th Avenue SE	Open-cut
892	Polk	Road	CSAH #6	Bore
893	Polk	Road	360th Ave SE	Open-cut
894	Polk	Road	Stine Road	Bore
894	Polk	Ditch	State Ditch 61 B.1.L.1	Open-cut
895	Polk	Road	CSAH #28	Open-cut
895	Polk	Ditch	State Ditch 61 B.1.L.1	Open-cut

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
896	Polk	Railroad	Canadian Pacific Railway	Bore
896	Polk	Road	State Highway 92	Bore
896	Polk	Road	380th Avenue SE	Bore
898	Polk	Road	CSAH #2	Bore
899	Polk	Road	410th Avenue SE	Open-cut
900	Polk	Road	420th Avenue SE	Bore
901	Clearwater	Road	101st St SE (Pine Lake T-131)	Bore
902	Clearwater	Road	113th Avenue	Open-cut
903	Clearwater	Road	CSAH #8	Bore
904	Clearwater	Road	CSAH #7	Bore
905	Clearwater	Road	County Road 73	Bore
905	Clearwater	Road	490th Street	Open-cut
907	Clearwater	Road	159th Avenue	Open-cut
908	Clearwater	Road	State Highway 92	Bore
912	Clearwater	Road	CR-3	Bore
913	Clearwater	Road	450TH ST	Open-cut
914	Clearwater	Road	181ST Avenue	Open-cut
914	Clearwater	Road	446TH ST	Open-cut
914	Clearwater	Road	MN Highway 223/Leonard Road	Bore
916	Clearwater	Road	418TH ST	Open-cut
918	Clearwater	Road	CR-1	Bore
920	Clearwater	Road	380th ST	Bore
920	Clearwater	Road	Fairground Road/CR-24	Bore
922	Clearwater	Road	US Highway 2	HDD
922	Clearwater	Railroad	Burlington Northern Santa Fe Railway	HDD
922	Clearwater	Road	Airport Drive	HDD
924	Clearwater	Road	CR-19	Bore
925	Clearwater	Road	340TH ST/CR-26	Bore
927	Clearwater	Road	CR-30/221ST Avenue	Bore
927	Clearwater	Road	320TH ST/CR-13	Bore
930	Clearwater	Road	300TH ST/Township Road 150	Open-cut
933	Clearwater	Road	CR-84/Pioneer Road	Bore
933	Clearwater	Road	270TH ST	Open-cut
934	Clearwater	Road	CR-36/Upper Rice Lake	Bore
935	Clearwater	Road	Mallard Grade Trail	Open-cut
936	Clearwater	Road	250TH ST	Open-cut
936	Clearwater	Road	CR-2	Bore
937	Clearwater	Road	240TH ST	Open-cut
938	Clearwater	Road	230TH ST/CR-40	HDD
939	Clearwater	Road	Clearline Road/220TH ST	Open-cut
941	Clearwater	Road	200TH ST	Open-cut
942	Clearwater	Road	190TH ST	Open-cut
946	Hubbard	Road	400TH ST	Open-cut
947	Hubbard	Road	390TH ST	Open-cut
948	Hubbard	Road	CR-95	Open-cut
950	Hubbard	Road	US Highway 71	Bore

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
950	Hubbard	Road	Norway Drive	Open-cut
954	Hubbard	Road	320th St/Wabisish Lake Road	Open-cut
955	Hubbard	Road	CR-89	Open-cut
956	Hubbard	Road	300TH ST	Open-cut
957	Hubbard	Road	Jade Rose Drive	Open-cut
959	Hubbard	Road	Inland Drive	Open-cut
959	Hubbard	Road	US Highway 71	Bore
960	Hubbard	Road	260TH ST	Open-cut
963	Hubbard	Road	CR-32	Open-cut
965	Hubbard	Road	CR-48	Bore
966	Hubbard	Road	200TH ST/Township Road 8	Open-cut
967	Hubbard	Road	190TH ST	Bore
967	Hubbard	Road	109TH Avenue	Bore
968	Hubbard	Road	MN Highway 34	Bore
969	Hubbard	Road	170TH ST	Open-cut
970	Hubbard	Road	160TH ST	Open-cut
971	Hubbard	Road	150TH ST	Open-cut
972	Hubbard	Road	CR-14	Bore
974	Hubbard	Road	109TH Avenue/CR-111	HDD
975	Hubbard	Road	114TH ST/Township Road 15	Open-cut
976	Hubbard	Road	110TH ST/CR-111	Open-cut
977	Hubbard	Road	109TH Avenue- Section Line	Open-cut
978	Hubbard	Road	119TH Avenue	Open-cut
979	Hubbard	Road	129TH Avenue	Open-cut
979	Hubbard	Road	US Highway 71	Bore
982	Hubbard	Road	159TH Avenue/Township Road 24	Bore
983	Hubbard	Road	CR-6	Bore
984	Hubbard	Road	179TH Avenue/CR-108	Open-cut
986	Hubbard	Road	CR-11	Bore
989	Wadena	Road	CR-25	Bore
992	Wadena	Road	CR-153	Open-cut
995	Cass	Road	96th Ave. SW	Open-cut
995	Cass	Road	94th Ave SW	Open-cut
995	Cass	Road	92nd Ave SW	Open-cut
997	Cass	Road	Mckinley Road # 2	Open-cut
997	Cass	Ditch	JD-2 Main	Open-cut
998	Cass	Ditch	JD-2 Lateral #1	Open-cut
999	Cass	Road	MN Highway 64	Bore
1000	Cass	Road	76TH Avenue SW	Open-cut
1001	Cass	Road	CR 112/72ND Avenue SW	Open-cut
1002	Cass	Road	68TH Avenue SW	Open-cut
1003	Cass	Trail	Bull Moose Trail	Bore
1007	Cass	Road	CR 27/48TH Avenue SW	Bore
1008	Cass	Road	44TH Avenue SW	Open-cut
1009	Cass	Trail	Paul Bunyan State Trail	Bore
1009	Cass	Road	MN Highway 371	Bore

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
1011	Cass	Road	32ND Avenue SW/Mildread Chapel Road	Open-cut
1012	Cass	Road	CR 42/28TH Avenue SW	Open-cut
1013	Cass	Road	24TH Avenue SW	Open-cut
1015	Cass	Road	MN Highway 84	Bore
1016	Cass	Road	CR 43/12TH Avenue SW	Bore
1016	Crow Wing	Road	CR 56	Bore
1017	Crow Wing	Road	Bulldozed Road	Open-cut
1022	Cass	Road	4TH ST NE	Open-cut
1027	Cass	Road	County Forest Road	Open-cut
1027	Cass	Road	CR 160/12TH ST NE	Open-cut
1029	Cass	Road	CR 160/12TH ST NE	Open-cut
1030	Cass	Road	CR 160/12TH ST NE	Open-cut
1032	Cass	Road	CR-55 NE	Open-cut
1033	Cass	Road	Lake Washburn Road NE/CR 48	Open-cut
1034	Cass	Road	CR 155 NE	Bore
1037	Cass	Road	Lake Washburn Road NE/CR 48	Bore
1038	Cass	Road	MN 6	Bore
1045	Cass	Road	Pikus Forest Road NE	Open-cut
1049	Aitkin	Road	CR-19	Open-cut
1052	Aitkin	Road	Osprey Avenue - CR 29	Open-cut
1056	Aitkin	Ditch	CD-30	Open-cut
1058	Aitkin	Road	CR-68	Open-cut
1059	Aitkin	Road	525TH Lane / UT-437	Open-cut
1060	Aitkin	Road	US Highway 169	Bore
1061	Aitkin	Road	510TH Lane	Open-cut
1062	Aitkin	Road	500TH Lane	Open-cut
1064	Aitkin	Road	480th St / CR-3	Bore
1066	Aitkin	Road	340TH Place	HDD
1067	Aitkin	Road	330TH Avenue	Open-cut
1069	Aitkin	Road	CR-10/Great River Road	HDD
1070	Aitkin	Road	CR-5	Bore
1071	Aitkin	Trail	Soo Line Recreational Trail	Open-cut
1071	Aitkin	Ditch	State Ditch-66	Open-cut
1072	Aitkin	Ditch	CD-38	Open-cut
1073	Aitkin	Ditch	Fire Relief Commission Ditch	Open-cut
1073	Aitkin	Road	270th Place	Open-cut
1073	Aitkin	Ditch	Fire Relief Commission Ditch	Open-cut
1074	Aitkin	Ditch	CD-4	Bore
1074	Aitkin	Road	Township Road 552	Open-cut
1074	Aitkin	Ditch	CD-4	Open-cut
1075	Aitkin	Ditch	CD-4	Open-cut
1075	Aitkin	Road	Township Road 550	Open-cut
1077	Aitkin	Road	240th Ave / CR-62	Open-cut
1077	Aitkin	Ditch	CD-4	Open-cut
1078	Aitkin	Road	240th Ave / CR-62	Open-cut
1080	Aitkin	Road	230th Ave / CR-62	Open-cut

Line 3 Replacement Project
Road and Railroad Crossing Table

MP	County	Crossing Type	Name	Crossing Method
1080	Aitkin	Road	440th Street	Open-cut
1082	Aitkin	Road	MN Highway 65	Bore
1082	Aitkin	Road	430th LANE	Open-cut
1083	Aitkin	Ditch	CD-42	Open-cut
1084	Aitkin	Road	Simpson Road/CR 73	Open-cut
1084	Aitkin	Ditch	CD-42	Open-cut
1086	Aitkin	Ditch	CD-42	HDD
1086	Aitkin	Railroad	Burlington Northern Santa Fe Railway	HDD
1086	Aitkin	Road	185TH Place	HDD
1086	Aitkin	Road	MN Highway 210	Bore
1087	Aitkin	Ditch	CD-29/42	Bore
1092	Aitkin	Ditch	CD-29	Open-cut
1092	Aitkin	Road	CR-16	Bore
1094	Aitkin	Road	395TH LANE	Open-cut
1102	Carlton	Road	CR 22	Bore
1107	Carlton	Road	Highway 73	Bore
1108	Carlton	Road	CR 129	Open-cut
1111	Carlton	Road	Heikkila Road	Open-cut
1112	Carlton	Road	CR-135	Bore
1115	Carlton	Road	CR-157	Open-cut
1116	Carlton	Road	Aho Road	Open-cut
1119	Carlton	Road	Strandberg Road	Open-cut
1120	Carlton	Road	CR-4	Bore
1121	Carlton	Road	CR-144 / Brandt Rd	Bore
1121	Carlton	Road	CR-61	Bore
1121	Carlton	Trail	Willard Munger State Trail	Bore
1124	Carlton	Road	Interstate 35	Bore
1126	Carlton	Road	CR-5	Bore
1127	Carlton	Road	Nendick Road	Open-cut
1128	Carlton	Road	Gillogly Road	Bore
1130	Carlton	Road	West Chub Lake Road	Bore
1131	Carlton	Road	East Chub Lake Road	Bore
1132	Carlton	Road	CR-3	Bore
1133	Carlton	Road	Alcohol Road/CR-101	Bore
1134	Carlton	Road	Thell Road/ UT-356	Bore
1135	Carlton	Road	CR-1	Bore
1135	Carlton	Road	Matten Road	Open-cut
1136	Carlton	Road	MAERE RD/T-373	Bore
1136	Carlton	Road	Cemetery Road/ T-94	Bore
1137	Carlton	Road	Cemetery Road / T-94	Bore
1137	Carlton	Road	MN 23	Bore

Appendix I

Sample Route Permit

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STATE OF MINNESOTA PUBLIC UTILITIES COMMISSION

PIPELINE ROUTING PERMIT
FOR CONSTRUCTION OF A LARGE [*PIPELINE TYPE*] PIPELINE
AND ASSOCIATED FACILITIES

IN
[*COUNTY*]

ISSUED TO
[*PERMITTEE*]

PUC DOCKET NO. [*DOCKET NUMBER*]

In accordance with the requirements of Minnesota Statutes Chapter 216G and Minnesota Rules Chapter 7852 this route permit is hereby issued to:

ENBRIDGE ENERGY LIMITED PARTNERSHIP

[*Permittee*] is authorized by this route permit to construct [*provide a description of the project authorized by the Minnesota Public Utilities Commission*].

The pipeline and associated facilities shall be built within the route identified in this permit and as portrayed on the aerial photos attached to this permit and in compliance with the conditions specified in this permit.

Approved and adopted this _____ day of [*Month, Year*]

By Order of the Commission

_____
Daniel P. Wolf,
Executive Secretary

This document can be made available in alternative formats (i.e., large print or audio) by calling 651-296-0406 (voice). Persons with hearing or speech disabilities may call us through their preferred Telecommunications Relay Service.

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1.0 ROUTE PERMIT

The Minnesota Public Utilities Commission (Commission) hereby issues this pipeline routing permit to [*Permittee*] (herein after Permittee or [*Accepted Abbreviation*]) pursuant to Minnesota Statutes Chapter 216G and Minnesota Rules Chapter 7852. This pipeline routing permit authorizes the Permittee to construct [*provide brief description of the project as authorized by the Commission*], and as identified in the attached route permit maps, hereby incorporated into this document.

1.1 Pre-emption

Pursuant to Minn. Stat. § 216G.02, Subd. 4, this permit shall be the sole route approval required to be obtained by the Permittee for construction of the pipeline and associated facilities and this permit shall supersede and preempt all zoning, building, or land use rules, regulations, or ordinances promulgated by regional, county, local and special purpose government.

1.2 Definitions

"Construction," as defined in Minn. R. 7852.0100 Subp. 11 "means any clearing of land, excavation, or other action for the purpose of constructing new pipeline that would adversely affect the natural environment of a pipeline route. Construction does not include changes needed for use of a route for purposes of maintenance, or replacement of an existing pipeline and associated facilities within existing rights-of-way, or for the minor relocation of less than three-quarters of a mile of an existing pipeline or for securing survey or geological data, including necessary borings to ascertain soil conditions."

"Associated facilities," as defined in Minn. R. 7852.0100 Subp. 7" means all parts of those physical facilities through which hazardous liquids or gas moves in transportation, including but not limited to pipe, valves, and other appurtenances connected or attached to pipe, plumbing and compressor units, fabricated assemblies associated with pumping and compressor units, metering and delivery stations, regulations stations, holders, breakout tanks, fabricated assemblies, cathodic protection equipment, telemetering equipment, and communication instrumentation located on the right-of-way."

2.0 PROJECT DESCRIPTION

[*Provide a detailed description of the project as authorized by the Commission.*]

2.1 Associated Facilities

[*Provide a detailed description of the Associated Facilities as authorized by the Commission.*]

2.2 Design Pressure

[*Provide the maximum allowable operating pressure – both design and operating pressure.*]

2.3 Timing of Project Construction

[*As applicable, should the project be phased, describe the distinct phases.*]

2.4 Project Location

[*Describe the location of the project including appropriate details, such as county, township, range, and section. Also include a reference to the relevant route map to be attached to the permit.*]

3.0 DESIGNATED ROUTE

The route designated by the Commission in this permit is the route described below and as shown on the route maps attached to this permit. The route is generally described as follows:

[*Provide a detailed description of the authorized route including the route widths and any other specifics relevant to each segment. Also include a reference to the relevant route map to be attached to the permit.*]

The identified route widths on the attached route maps provide the Permittee with flexibility for minor adjustments of the anticipated alignment or right-of-way to accommodate landowner requests and unforeseen conditions. The final alignment (i.e., permanent and maintained rights-of-way and temporary workspace) will be located within this designated route unless otherwise authorized by this permit or the Commission.

3.1 Permanent Right-of-Way

This Permit authorizes the Permittee to obtain a new permanent right-of-way for the pipeline up to [x]-feet in width [*describe any right-of-way width variations along the route, as necessary, including that needed for associated facilities*].

3.2 Temporary Right-of-Way/Workspace

[*Describe temporary right-of-way widths authorized by this permit.*]

3.3 Extra Temporary Right-of-Way/Workspace

[*As applicable, describe extra temporary right-of-way widths authorized by this permit.*]

3.4 Right-of-Way Conformance

This permit identifies an anticipated alignment within the designated route that minimizes potential impacts to the criteria identified in Minn. R. 7852.1900, and, as such, this permit anticipates that the actual right-of-way will generally conform to this anticipated alignment, except as otherwise provided by this permit. Any alignment modification within this designated

route shall be located to have the same or less impacts relative to the criteria in Minn. R. 7852.1900 as the alignment identified in this permit.

3.5 Right Width Variations

Route width variations may be allowed for the Permittee to overcome potential site specific constraints. These constraints may arise from any of the following:

1. Unforeseen circumstances encountered during the detailed engineering and design process.

2. Federal or state agency requirements.

3. Existing infrastructure within the pipeline route, including but not limited to railroads, natural gas and liquid pipelines, high voltage electric transmission lines, or sewer and water lines.

Any alignment modifications arising from these site specific constraints that would result in right-of-way placement outside of this designated route shall be located to have the same or less impacts relative to the criteria in Minn. R. 7852.1900 as the alignment identified in this permit and be specifically identified in and approved as part of the Plan and Profile submitted pursuant to this permit.

3.6 State and Federal Minimum Depth of Cover Requirements

Minn. Stat. § 216G.07, Subd. 1, requires the pipeline trench to be excavated to a depth that sufficiently allows for at least 54 inches (4.5 feet) of backfill from ground surface to the top of pipeline in all areas where the pipeline crosses the right-of-way of any public drainage facility or any county, town, or municipal street or highway and where the pipeline crosses agricultural land. Where the pipeline crosses the right-of-way of any drainage ditch the pipeline shall be installed with a minimum level cover of not less than 54 inches (4.5 feet) below the authorized depth of the ditch, unless waived in the manner provided in Minn. Stat. § 216G.07, Subd. 2 and 3. In agricultural land, the Permittee may seek a depth requirement waiver from the affected landowners to install the pipeline at the same depth required by 49 CFR 195.248.

In all cases, the pipeline trench shall be excavated to a depth that sufficiently allows for at least 36 inches (3 feet) of backfill from ground surface to the top of pipeline in accordance with U.S. Department of Transportation regulations (49 CFR 195.248).

4.0 ADMINISTRATIVE COMPLIANCE

The following administrative compliance procedures require submissions to the Commission. Submissions must be made by electronic filing (eFiling).

4.1 Permit Distribution to Local Governments and Residents

The Permittee shall, within 10 days of receipt of the pipeline routing permit from the Commission, send a copy of the permit to the office of each regional development commission

of a development region, soil and water conservation district, watershed district, watershed management district, office of the county auditor, and the clerk of each city and township crossed by the designated route.

Within 30 days of permit issuance, the Permittee shall send a printed copy of the permit and the complaint procedures to all affected landowners. In no case shall the affected landowner receive this route permit and complaint procedures less than five days prior to the start of construction on their property. An affected landowner is any landowner or designee that is within or adjacent to the designated pipeline route authorized by this permit.

The Permittee shall provide all affected landowners with information concerning, at a minimum, the initial survey, right-of-way acquisition, right-of-way preparation, construction, and restoration.

As provided by applicable laws and regulations the Permittee shall provide educational materials about the project and any restrictions or dangers associated with the project to affected landowners within the route whose land is crossed by the pipeline and, upon request, to any interested persons.

4.2 Notification

The Permittee shall notify landowners or their designee at least 14 days in advance but not greater than 60 days in advance of entering the property.

4.3 Field Representative

At least 14 days prior to the start of construction and continuously throughout construction and completion of restoration of the areas affected by construction, the Permittee shall designate a field representative responsible for overseeing compliance with the conditions of this Permit during construction of the project. This person (or a designee) shall be accessible by telephone or other means during normal business hours throughout site preparation, construction, cleanup, and restoration.

The Permittee shall file with the Commission the name, address, email, phone number, and emergency phone number of the field representative 14 days prior to commencing construction. The Permittee shall provide the field representative's contact information to affected landowners, residents, local government units and other interested persons 14 days prior to commencing construction. The Permittee may change the field representative at any time upon notice to the Commission by eFiling as well as posting to a project website maintained by the Permittee and by providing a telephone number to affected landowners, residents, local government units and other interested persons that provides current contact information for the field representative.

4.4 Agricultural Monitor and County Inspector Notification Requirements

The Permittee shall at least 14 days prior to the start of construction provide notice to all landowners affected by construction with the name, telephone number and email address of the Agricultural Monitor and County inspector designated by the County, if appointed.

4.5 Employee Training and Education of permit Terms and Conditions

Prior to any construction, the Permittee shall file an affirmative statement with the Commission, certified by a senior company official, that all Permittee personnel, environmental inspectors, and contractor personnel will be informed of the environmental inspector's authority and have been or will be trained on the implementation of environmental mitigation measures in this permit that are appropriate to their jobs before becoming involved with construction and restoration activities associated with the project.

5.0 GENERAL CONDITIONS

The Permittee shall comply with the following conditions during pipeline right-of-way preparation, construction, cleanup, and restoration over the life of this permit.

5.1 Environmental Mitigation Plan

The Permittee must develop and file with the Commission and Environmental Mitigation Plan, [*as applicable, in consultation with EERA staff*].

The Environmental Mitigation Plan shall include all environmental control plans and special conditions imposed by permits or licenses issued by federal, state, and local agencies or units of government, and a list of permits required for the construction of the Project. Plans within the Environmental Mitigation Plan shall include an Agricultural Mitigation Plan (AMP), a Vegetation Management Plan (VMP), and a Stormwater Pollution Prevention Plan (SWPPP). The Environmental Mitigation Plan shall be filed with the Commission with the first Plan and Profile Submission. The Environmental Mitigation Plan shall include the following:

1. Identification of and contact information for an Environmental Monitor to oversee the construction process and monitor compliance with the Environmental Mitigation Plan and all plans therein.

2. A process for reporting construction status to the Commission.

3. A process for internal tracking of construction management, including required plan or permit inspection forms.

4. Appropriate mitigation [*as discussed in the applicable environmental documents*].

5.2 Agricultural Mitigation Plan

The Permittee shall comply with the Agricultural Mitigation Plan (AMP) attached to this permit and incorporated herein. The obligation to comply with the AMP as a condition of this permit shall expire with the termination of Commission jurisdiction over this permit as prescribed by Minn. R. 7852.3900, unless otherwise specified in the AMP. The Minnesota Department of Agriculture must approve of any amendments to the AMP. The Permittee shall file an amended AMP with the Commission within 10 days of Minnesota Department of Agriculture approval.

5.3 Construction Practices

The Permittee shall follow those specific construction practices and material specifications described in the Permittee's Application to the Commission for a route permit for the [*Project Application Name and Environmental Information Report*], dated [*Date*], and the record of the proceedings unless this permit establishes a different requirement in which case this permit shall prevail. The Permittee shall comply with the conditions for right-of-way preparation, construction, cleanup, and restoration contained in Minn. R. 7852.3600.

5.3.1 Public Services, Public Utilities, and Existing Easements

During construction, the Permittee shall minimize any disruption to public services or public utilities. To the extent disruptions to public services or public utilities occur these would be temporary and the Permittee will restore service promptly. Where any impacts to utilities have the potential to occur the Permittee will work with both landowners and local agencies to determine the most appropriate mitigation measures if not already considered as part of this permit.

5.3.2 Access to Property for Construction

The Permittee shall obtain all necessary permits authorizing access to public rights-of-way prior to any construction. The Permittee shall obtain approval of the landowners for access to private property prior to any construction. The Permittee shall consult with property owners to identify and address any special problems the landowners may have that are associated with the pipeline prior to any construction.

The Permittee shall work with landowners to provide access to their property, to locate the pipeline on their property to minimize the loss of agricultural land, forest, and wetlands, with due regard for proximity to homes and water supplies, even if the deviations will increase the cost of the pipeline, so long as the landowner's requested relocation does not adversely affect environmentally sensitive areas.

The Permittee shall negotiate agreements with landowners that will give the landowners access to their property; minimize the impact on planned future development of the property; and to assume any additional costs for such development that may be the result of installing roads, driveways and utilities that must cross the right-of-way. The Permittee shall not unreasonably deny a landowner's request to cross the easement to access the landowner's property.

5.3.3 Noise

The Permittee shall comply with noise standards established under Minn. R. 7030.0010 to 7030.0080. Construction and maintenance activities shall be limited to daytime working hours to the extent practicable to ensure noise level standards will not be exceeded.

5.3.4 Site Sediment and Erosion Control

The Permittee shall develop a Soil Erosion and Sediment Control Plan prior to construction and submit the Plan to the Commission at least 14 days prior to the start of construction. This Plan may be the same as the SWPP submitted to the MPCA as part of the National Pollutant Discharge Elimination System (NPDES) permit application provided it identifies the information in the following paragraph.

The Soil Erosion and Sediment Control Plan shall address what types of erosion control measures will be implemented during each Project phase and shall at a minimum identify: plans for grading, construction, and restoration of the areas affected by construction activities; necessary soil information; detailed design features to maintain downstream water quality; a comprehensive revegetation plan to maintain and ensure adequate erosion control and slope stability and to restore the site after temporary activities; and measures to minimize the area of surface disturbance. Other practices shall include containing excavated material, protecting exposed soil, and stabilizing restored material and removal of silt fences or barriers when the area is stabilized. The plan shall identify methods for disposal or storage of excavated material. Erosion and sedimentation control measures shall be implemented prior to construction and maintained until restoration activities are completed for each phase of the Project.

5.3.5 Topsoil Protection

The Permittee shall take precautions to minimize mixing of topsoil and subsoil during excavation of the trench for the pipe unless otherwise negotiated with the affected landowner.

5.3.6 Soil Compaction

Compaction of agricultural lands by the Permittee must be kept to a minimum and mitigated in accordance with its AMP [*as applicable*].

5.3.7 Landscape Protection

Care shall be used to preserve the natural landscape, minimize tree removal and prevent any unnecessary destruction of the natural surroundings in the vicinity of all pipeline construction and restoration activities.

5.3.8 Sensitive Areas

The Permittee shall stabilize stream banks and other sensitive areas disturbed by pipeline construction in accordance with the requirements of applicable state or federal permits.

5.3.9 Wetlands and Water Resources

Wetlands and riparian areas shall be accessed using the shortest route possible in order to minimize travel through wetland areas and prevent unnecessary impacts. No temporary workspace areas shall be placed within or adjacent to wetlands or water resources, as practicable. To minimize impacts, construction in wetland areas shall occur during frozen ground conditions where practicable and shall be according to permit requirements by the applicable permitting authority. When construction during winter is not possible, wooden or composite mats shall be used to protect wetland vegetation. Soil excavated from the wetlands and riparian areas shall be handled in compliance with the permit from the appropriate regulatory agency. Should a permit not be required, excavated soils shall be contained and not placed back into the wetland or riparian area.

Dewatering during periods of excessive precipitation or in areas where the natural groundwater table intersects the pipeline trench will not be directed into wetlands or water bodies. Dewatering discharges will be directed toward well vegetated upland areas. Should discharge activities need to be directed off the right-of-way landowner consent will be obtained and locations will be chosen to minimize impacts. All discharge activities will comply with applicable agency permits or approvals.

Areas disturbed by construction activities shall be restored to preconstruction conditions. Restoration of the wetlands will be performed by Permittee in accordance with the requirements of applicable state and federal permits or laws and landowner agreements.

All requirements of the U.S. Army Corps of Engineers (wetlands under federal jurisdiction), Minnesota Department of Natural Resources (DNR) (Public Waters/wetlands), and County (wetlands under the jurisdiction of the Minnesota Wetland Conservation Act) shall be met.

As part of the preconstruction reports, the Permittee will include a section evaluating the potential for the occurrence of aquatic invasive species in the project area and describing, if any, the best management practices that apply.

The Permittee should identify any infested waters or otherwise indicate that aquatic invasive species are not anticipated Aquatic Invasive Species. The DNR must be provided an opportunity to review and comment on the plan. The DNR must be notified if any aquatic invasive species are identified in an area not previously identified as infested water.

5.3.10 Vegetation Removal and Protection

The Permittee shall clear the permanent right-of-way and temporary right-of-way preserving to the maximum extent practicable windbreaks, shelterbelts, living snow fences, and vegetation in

areas such as trail and stream crossings where vegetative screening may minimize aesthetic impacts, to the extent that such actions do not impact the safe operation, maintenance, and inspection of the pipeline and are in compliance with all applicable laws and regulations.

Tree stumps will be removed at the landowner's request or when necessitated due to trench location. Cleared vegetation may be disposed of in a manner authorized by the responsible governmental unit or as agreed to with the landowner, provided disposal complies with local regulations.

5.3.11 Application of Pesticides

The Permittee shall restrict pesticide use to those pesticides and methods of application approved by the Minnesota Department of Agriculture, DNR, and the U.S. Environmental Protection Agency. Selective foliage or basal application shall be used when practicable. The Permittee shall contact the landowner or his designee to obtain approval for the use of pesticide prior to any application on their property. The landowner may request that there be no application of pesticides on any part of the right-of-way within the landowner's property. All pesticides shall be applied in a safe and cautious manner so as not to damage crops, orchards, tree farms, or gardens. The Permittee shall provide notice of pesticide application to affected landowners and known beekeepers operating apiaries within three miles of the project site at least 14 days prior to such application.

5.3.12 Invasive Species

The Permittee shall develop and Invasive Species Plan to prevent the introduction of invasive species on lands disturbed by Project construction activities. This requirement may be included as an element of the Soil Erosion and Sediment Control Plan.

5.3.13 Noxious Weeds

The Permittee shall take all reasonable precautions against the spread of noxious weeds during all phases of pipeline construction and restoration of all areas affected by construction. When utilizing seed to establish temporary and permanent vegetative cover on exposed soil the Permittee shall select site appropriate seed certified to be free of noxious weeds. To the extent possible, the Permittee shall use native seed mixes. The Permittee shall consult with landowners on the selection and use of seed for replanting.

5.3.14 Roads (Public and Private)

Prior to commencement of construction, the Permittee shall identify all state, county, city or and township roads that will be used for the project and shall notify the state, county, city or township governing body having jurisdiction over the roads to determine if the governmental body needs to inspect the roads prior to use of these roads. The Permittee is responsible for maintenance and repair of roads that will be subject to extra wear and tear due to transportation of equipment and project related materials. The Permittee shall cooperate with state, county, city

and township road authorities to develop appropriate signage and traffic management during construction.

Equipment involved in pipeline construction shall be moved into the right-of-way using existing public or private roads unless a temporary access road is negotiated with the landowner and approved by the [*appropriate Monitor*].

The Permittee shall promptly repair private roads or lanes damaged when moving equipment or when accessing construction workspace, unless otherwise negotiated with the affected landowner.

5.3.15 Archaeological and Historic Resources

The Permittee shall work with the State Historic Preservation Office (SHPO) and the State Archaeologist prior to commencing construction to determine whether any additional archaeological survey work will be necessary for any part of the proposed Project. The Permittee shall contract with a qualified archaeologist to complete such surveys, and shall submit the results to SHPO, the State Archaeologist and the Commission.

The SHPO and the State Archaeologist will make recommendations for the treatment of any significant archaeological sites which are identified. Any issue in the implementation of these recommendations will be resolved by the Commission in consultation with SHPO and the State Archaeologist.

Prior to construction, workers shall be trained about the need to avoid cultural properties, how to identify cultural properties, and procedures to follow if undocumented cultural properties, including gravesites, are found during construction. If any previously unrecorded archaeological sites are found during construction, the Permittee shall mark and preserve the sites and promptly notify the SHPO, the State Archaeologist, and the Commission of such discovery. The Permittee shall not excavate at such locations until so authorized by the Commission in consultation with the SHPO and the State Archeologist.

If human remains are encountered during construction, the Permittee shall immediately halt construction at that location and promptly notify local law enforcement authorities and the State Archaeologist. Construction at the human remains location shall not proceed until authorized by local law Enforcement authorities or the State Archaeologist.

If any federal funding, permit, or license is involved or required, the Permittee shall complete any Section 106 (36 C.F.R. part 800) review that is necessary by coordinating with the federal agency or federal authority and SHPO as deemed necessary by the federal agency or federal authority.

5.3.16 Livestock Protection

The Permittee shall take precautions to protect livestock during all phases of construction and restoration of the areas affected by construction.

5.3.17 Security

The Permittee will install temporary gates or similar barriers, as needed, to prohibit public access to the right-of-way during construction.

5.3.18 Restoration

The Permittee shall restore the right-of-way, temporary work spaces, access roads, and other public or private lands affected by construction of the pipeline to the natural conditions that existed immediately before construction of the pipeline and as required by other federal and state agency permits. Restoration must be compatible with the safe operation, maintenance, and inspection of the pipeline. Within 60 days after completion of all restoration activities the Permittee shall advise the Commission in writing of the completion of such activities.

5.3.19 Cleanup

All waste and scrap that is the product of construction shall be removed from the right-of-way and all premises on which construction activities were conducted and properly disposed of upon completion of each task. Personal litter, including bottles, cans, and paper from construction activities shall be removed on a daily basis.

5.3.20 Pollution and Hazardous Wastes

All appropriate precautions to protect against pollution of the environment must be taken by the Permittee. The Permittee shall be responsible for compliance with all laws applicable to the generation, storage, transportation, clean up and disposal of all wastes generated during pipeline construction and restoration of the right-of-way.

5.3.21 Damages

The Permittee shall fairly restore or compensate landowners for damage to crops, fences, private roads and lanes, landscaping, drain tile, or other damages sustained during construction.

5.4 Other Requirements

The Permittee shall comply with all applicable state rules and statutes. The Permittee shall obtain all required permits for the project and comply with the conditions of those permits unless those permits conflict with or are preempted by federal or state permits and regulations. A list of the permits known to be required is included in the permit application. The Permittee shall file a listing of all permits with the Commission and submit a copy of any requested permit to the Commission.

6.0 SPECIAL CONDITIONS

Special conditions shall take precedence over other conditions of this permit should there be a conflict.

[*Describe any Special Conditions; see example language below.*]

6.1 Wildlife Friendly Erosion Control Materials

The Permittee, in cooperation with the DNR, shall use wildlife-friendly erosion control materials in areas known to be inhabited by wildlife species (birds, small mammals, reptiles, and amphibians) susceptible to entanglement in plastic netting.

6.2 Rare Species Surveys

The Permittee, in consultation with the U.S. Fish and Wildlife Service and the DNR, will determine the need for rare species surveys (pre-construction) within the designated route. In the areas where these species are known to exist or where the right-of-way passes through habitats where the species are likely to exist, field surveys may be required. In the event impacts cannot be avoided, the Permittee may need to obtain a take permit from the U.S Fish and Wildlife Service and the DNR for the species of concern. The Permittee shall submit the results of these efforts to the Commission with its Plan and Profile filing.

Construction and maintenance personnel will be made aware of rare resources and plant communities during preconstruction meetings to minimize potential disturbance. The Permittee shall avoid impacts to state-listed endangered, threatened, and special concern species in all areas of the project including temporary workspaces associated with the project.

6.3 Contamination Survey

The Permittee, in consultation with the MPCA, shall identify any contaminated sites as it performs its detailed survey and acquisition work prior to the submittal of the final plan and profile to the Commission.

6.4 Vegetation Management Plan

Permittee shall submit a VMP with the Environmental Mitigation Plan. The purpose of the VMP shall be to identify measures to minimize the disturbance and removal of vegetation for the Project, prevent the introduction of noxious weeds and invasive species, and re-vegetate disturbed non-cropland area with appropriate native species in cooperation with landowner and state, federal, and local resource agencies, such that such re-vegetation does not negatively impact safe and reliable operation of the Project.

6.5 Specific Landowner Requests

[*Describe any Special Conditions relating to a specific landowner.*]

7.0 DELAY IN CONSTRUCTION

If the Permittee has not commenced construction or improvement of the designated route within four years after the date of issuance of this permit the Commission shall suspend the permit in accordance with Minn. R. 7852.3300. If at the time of suspension, or at a later time, the Permittee decides to construct the pipeline, it shall certify to the Commission that there have been no significant changes in any material aspects of the conditions or circumstances existing when the permit was issued. If the Commission determines that there are no significant changes, it shall reinstate the permit. If the Commission determines that there is a significant change, it may order public information meetings or a new hearing and consider the matter further, or it may require the Permittee to submit a new application.

8.0 COMPLAINT PROCEDURES

Prior to the start of construction, the Permittee shall submit to the Commission the procedures that will be used to receive and respond to complaints. The procedures shall be in accordance with the requirements of Minn. R. 7852.3700, and as set forth in the complaint procedures attached to this permit.

The Permittee shall advise the Commission when such procedure has been established. The Permittee shall notify the Commission of any complaints received during the course of construction pertaining to Minn. R. 7852.3600 that are not resolved within 30 days of the complaint.

Upon request, the Permittee shall assist the Commission with the disposition of unresolved or longstanding complaints. This assistance shall include, but is not limited to, the submittal of complaint correspondence and complaint resolution efforts.

9.0 PIPELINE SAFETY

In an emergency situation, responders will take appropriate actions necessary to address the emergency. Pursuant to Minn. Stat. § 216G.02, Subd. 3(a) the pipeline routing permit may not set safety standards for the construction of pipeline. This would also apply to operation and maintenance. Therefore, this Pipeline Routing Permit does not address pipeline safety related issues.

10.0 COMPLIANCE REQUIREMENTS

Failure to timely and properly make compliance filings required by this permit is a failure to comply with the conditions of this permit. Compliance filings must be electronically filed with the Commission.

10.1 Plan and Profile

At least 30 days before right-of-way preparation for construction begins on any phase or portion of the project, the Permittee shall provide the Commission with a plan and profile of the right-of-way and the specifications and drawings for right-of-way preparation, construction, cleanup, and restoration for each phase of the project for which construction is scheduled. The documentation shall include maps depicting the plan and profile including the designated route, right-of-way, and pipeline alignment approved per this permit.

The Permittee may not commence construction until the 30 days has expired or until the Commission has advised the Permittee in writing that it has completed its review of the plan and profile documents and determined that the planned construction is consistent with this permit. If the Permittee intends to make any significant changes in its plan and profile or the specifications and drawings after submission to the Commission the Permittee shall notify the Commission at least five days before implementing the changes. No changes shall be made that would be in violation of any of the terms of this permit.

The Permittee shall also provide the Minnesota Office of Pipeline Safety with the same information provided to the Commission. The Permittee's plan and profile and specifications and drawings, shall become a condition of this permit and shall be complied with by the Permittee in accordance with Minn. R. 7852.3500.

10.2 Status Reports

In the event the Permittee proceeds with phased construction of the Project, such weekly reports shall be filed beginning with the submittal of the plan and profile for that phase and continue until completion of restoration of that phase. If there is any period of time where no construction activity is occurring, restoration of the prior phase of the Project has been completed, and the overall Project is not yet completed, Permittee need only provide status reports monthly.

10.3 Notification to Commission

At least three days before the pipeline is to be placed into service, the Permittee shall notify the Commission of the date on which the pipeline will be placed into service and the date on which construction was complete.

10.4 As-Builts

Within 90 days after completion of each phase of construction, the Permittee shall submit copies of all final as-built plans and specifications developed for each project phase.

10.5 GPS Data

Within 90 days after completion of each phase of construction the Permittee shall submit to the Commission, in the format requested by the Commission, geospatial information (e.g., ArcGIS

geodatabase or shapefiles, GPS coordinates, associated database of characteristics) for the pipeline and associated facilities.

11.0 RIGHT OF ENTRY

The Permittee shall allow Commission designated representatives to perform the following, upon reasonable notice, upon presentation of credentials and at all times in compliance with the Permittee's site safety standards:

a. To enter upon the facilities easement of the property for the purpose of obtaining information, examining records, and conducting surveys or investigations.

b. To bring such equipment upon the facilities easement of the property as is necessary to conduct such surveys and investigations.

c. To sample and monitor upon the facilities easement of the property.

d. To examine and copy any documents pertaining to compliance with the conditions of this permit.

12.0 PERMIT AMENDMENT

The Permittee may apply to the Commission for an amendment of the route designation or to conditions specified in the permit in accordance with the requirements and procedures of Minn. R. 7852.3400.

13.0 PERMIT MODIFICATION OR SUSPENSION

If the Commission determines that substantial evidence supports a finding that a violation of the terms or conditions of this pipeline routing permit has occurred or is likely to occur, it may take action to modify or suspend this permit in accordance with Minn. R. 7852.3800. The Commission may at any time re-consider modification or suspension of this permit if the Permittee has undertaken effective measures to correct the violations.

14.0 PIPELINE CONSTRUCTION COMPLETION CERTIFICATE

In accordance with Minn. R. 7852.3900, the Permittee shall file with the Commission a written certification that the construction and remediation of the permitted pipeline has been completed in compliance with all permit conditions and landowner agreements. The certification shall be considered by the Commission within 60 days of its filing. The Commission shall accept or reject the certification of completion and make a final determination regarding cost or reimbursements due. If the certification is rejected, the Commission shall inform the Permittee in writing which deficiencies, if corrected, will allow the certification to be accepted. When corrections to the deficiencies are completed, the Permittee shall notify the Commission, and the certification shall be reconsidered as soon as possible. After acceptance of the certification, the Commission's jurisdiction over the Permittee's pipeline routing permit shall be terminated.

Appendix J

Quality of Existing Surface Water Conditions

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Watershed Health Assessment Framework

"Managing for System Health"

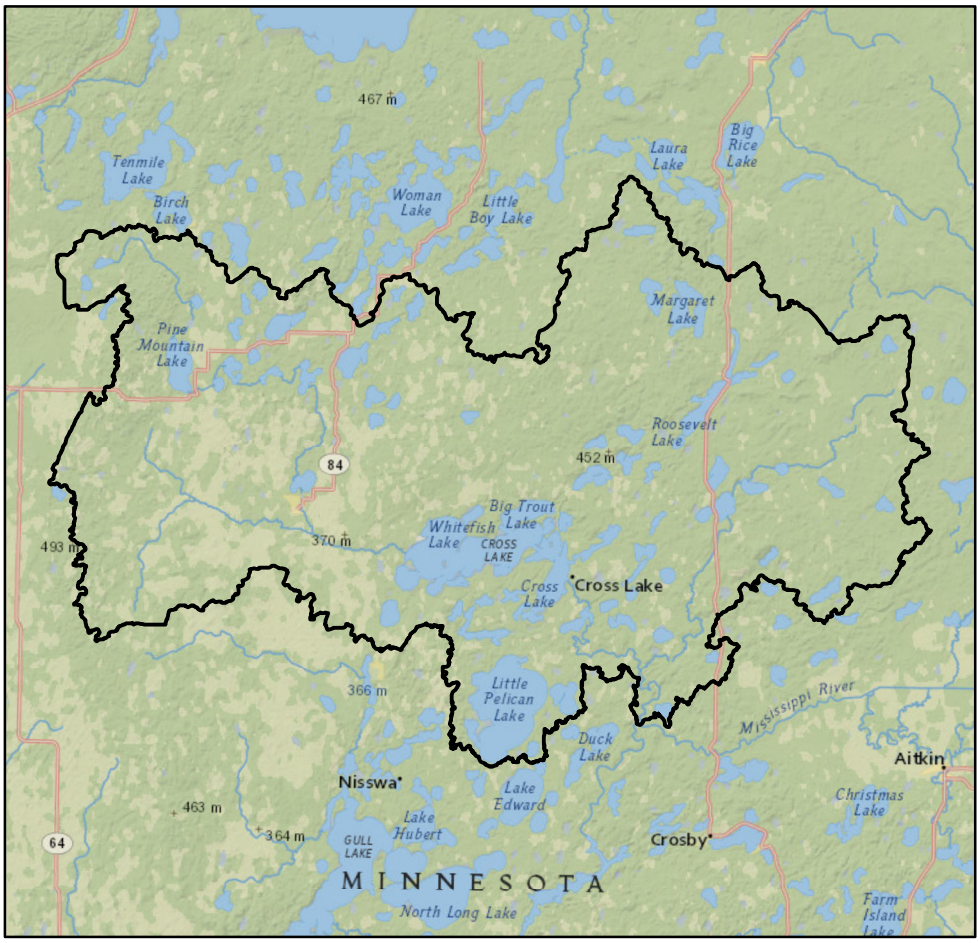
MNDNR

CLEAN WATER LAND & LEGACY AMENDMENT

Watershed Report Card:

Pine River





People and Places:

Watershed Population:

2000 census - 13,589
2010 census - 15,170

Largest Cities - Population:

Breezy Point - 2,346
Pine River - 944
Emily - 813
Jenkins - 430
Fifty Lakes - 387

Counties - % of watershed:

Cass - 50 %
Crow Wing - 47 %
Aitkin - 2 %
Hubbard - 0 %

Watershed Area:

Watershed size:

500,887 acres
783 square miles

Watershed Surface Area:

Percent Land - 88 %
Percent Water - 12 %

HUC8 ID:

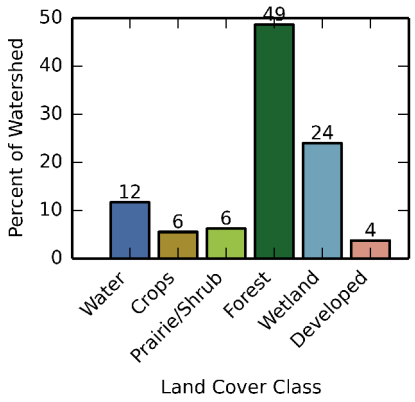
07010105

Basin Name:

Mississippi Headwaters (0701)

Land Use:

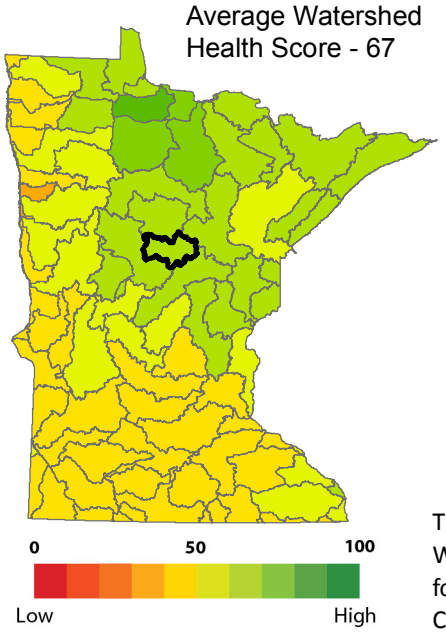
Percent of watershed area by land cover type:

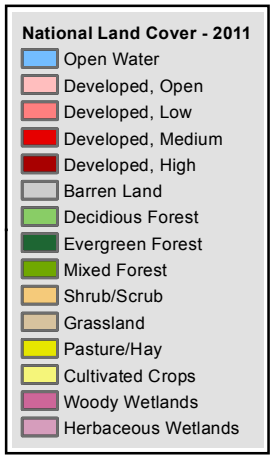


September, 2015

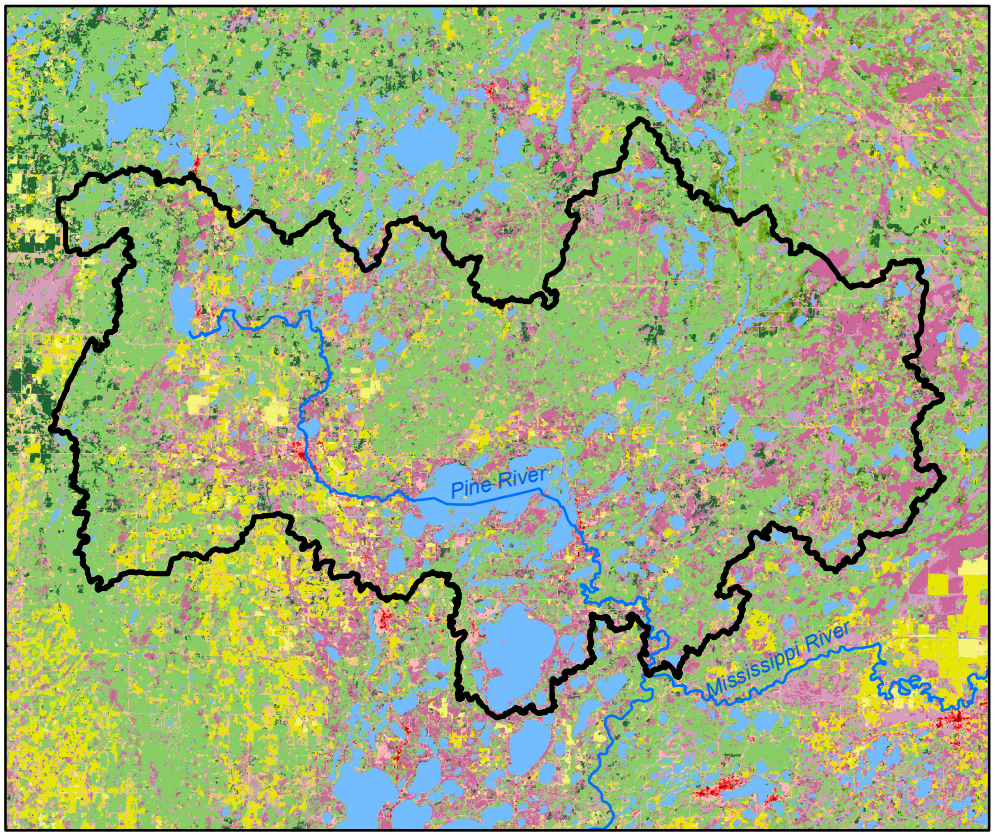
Watershed Health Report - Major Watershed

Pine River





These health scores are calculated at the Major Watershed (HUC8) scale. Health score names followed by (*) are also calculated at the DNR Catchment scale (subdivided HUC12). Those results are reported on the following pages.



Hydrology

Component Health Score (index average) 91

Index Scores

Perennial Cover*	94
Impervious Cover*	86
Water Withdrawal*	99
Flow Variability	68
Hydrologic Storage	94
Sub-Scores	
Altered Streams*	91
Surface Storage	98

Geomorphology

Component Health Score (index average) 59

Index Scores

Soil Erosion Potential*	75
Groundwater Susceptibility	31
Climate Vulnerability	70

Biology

Component Health Score (index average) 43

Index Scores

Terrestrial Habitat Quality*	21
Stream Species Quality*	58
Species Richness	54
At-Risk Species Richness	38

Connectivity

Component Health Score (index average) 46

Index Scores

Terrestrial Habitat Connectivity	30
Aquatic Connectivity*	72
Riparian Connectivity*	97

Water Quality

Component Health Score (index average) 95

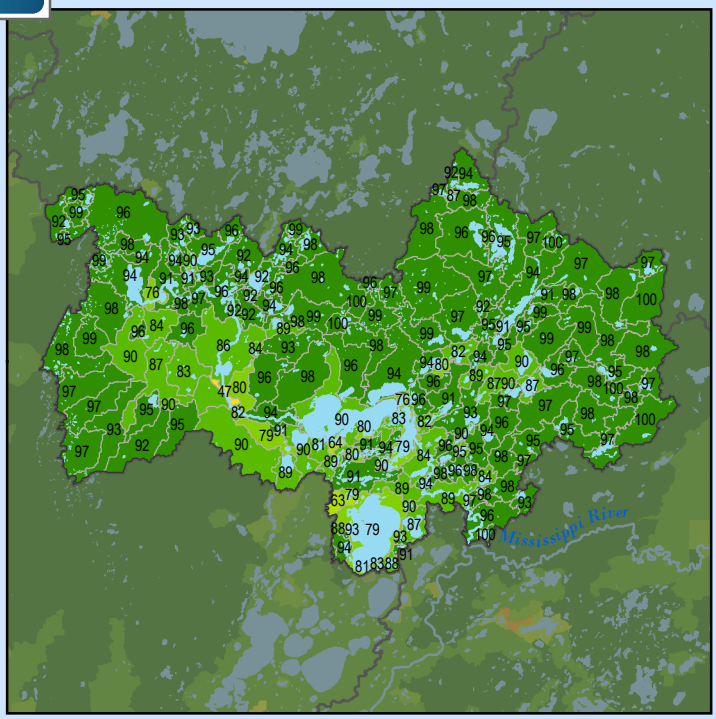
Index Scores

Non-Point Pollution Sources	90
Sub-Score Phosphorus Risk*	87
Localized Pollution Sources*	89
Assessments	95

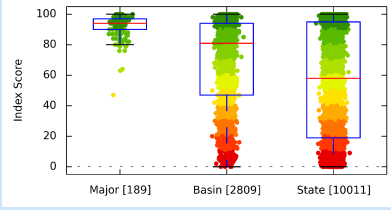
Watershed Health Assessment Framework
Health score methodology - **www.dnr.state.mn.us/whaf/about/scores**

September, 2015

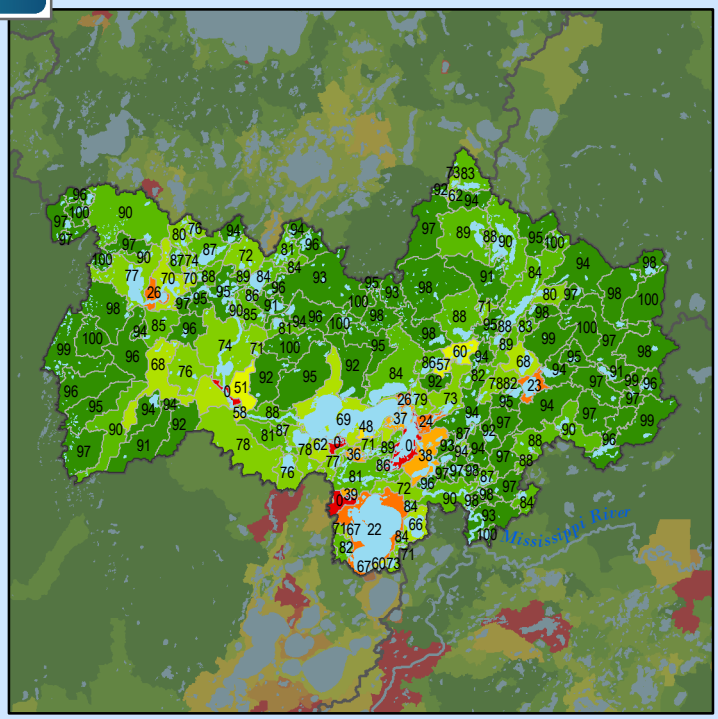
Perennial Cover (2011)



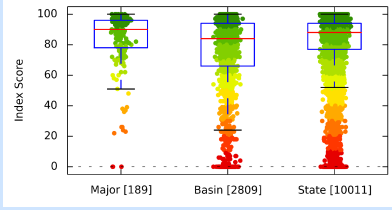
Health Score Distributions:
Pine River
- Min: 47
- Max: 100
- Median: 94.0
- Mean: 92.44
- Standard Dev: 7.11



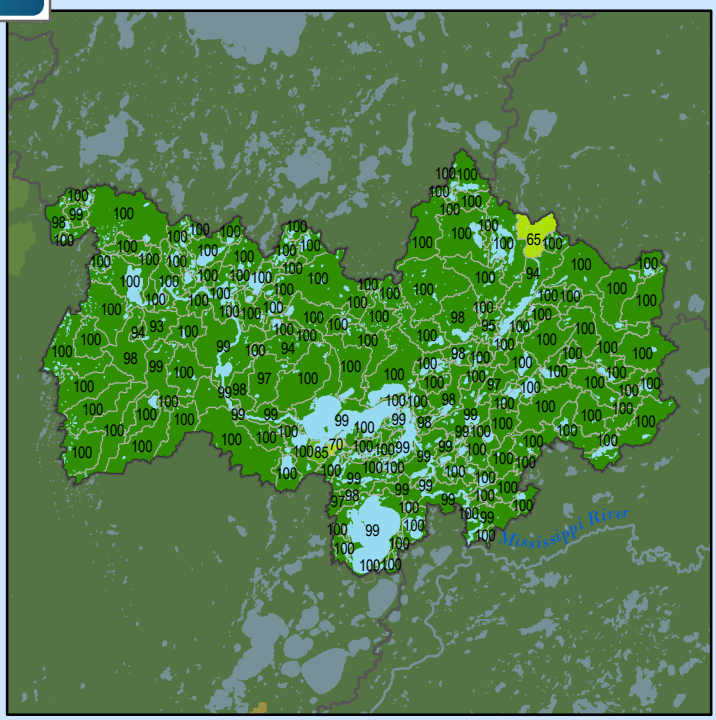
Impervious Cover (2011)



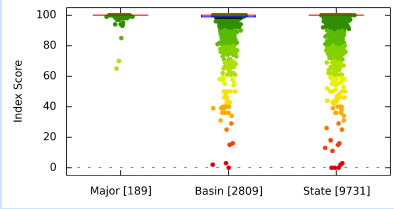
Health Score Distributions:
Pine River
- Min: 0
- Max: 100
- Median: 90.0
- Mean: 82.89
- Standard Dev: 20.41



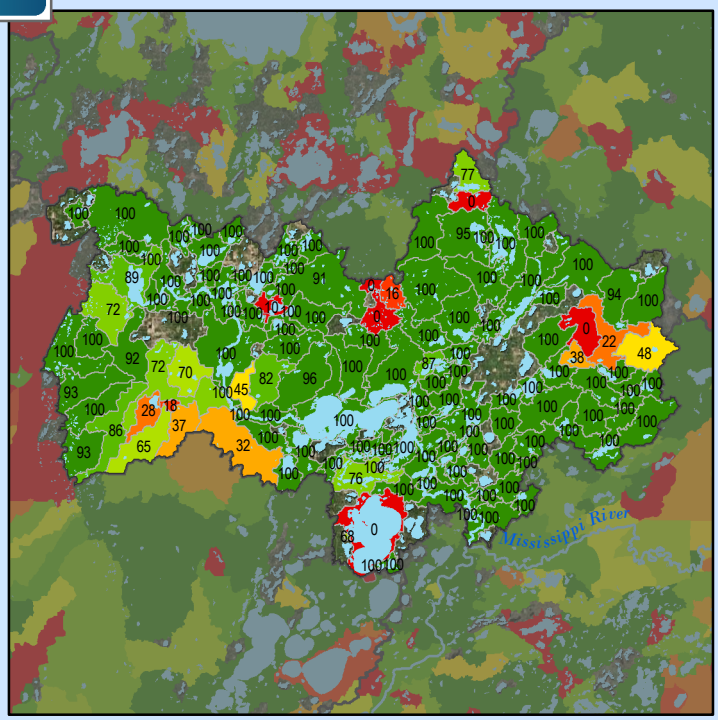
Water Withdrawal Index



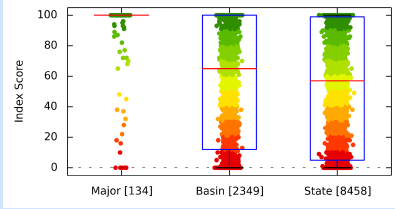
Health Score Distributions:
Pine River
- Min: 65
- Max: 100
- Median: 100.0
- Mean: 99.19
- Standard Dev: 3.63



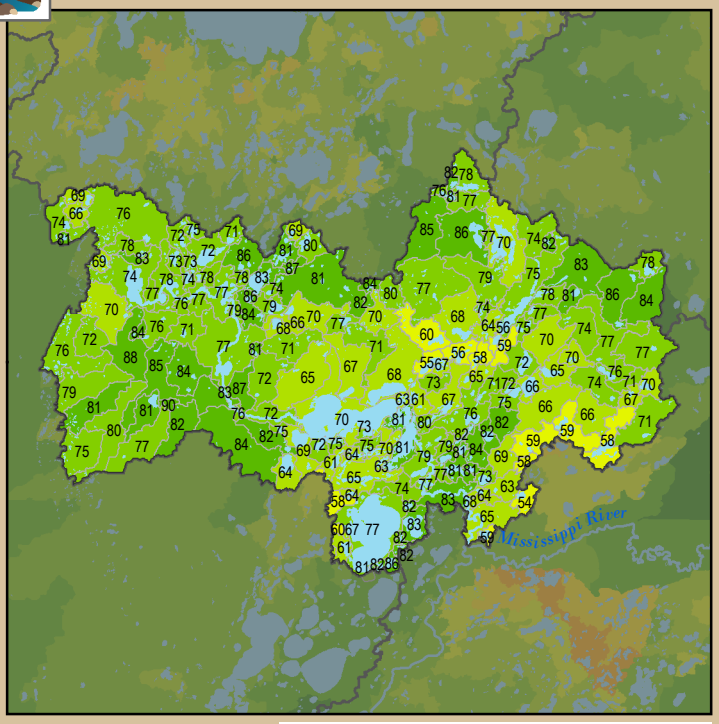
Altered Streams



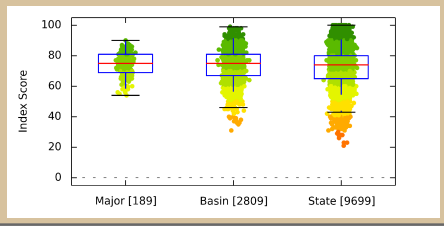
Health Score Distributions:
Pine River
- Min: 0
- Max: 100
- Median: 100.0
- Mean: 88.75
- Standard Dev: 26.1



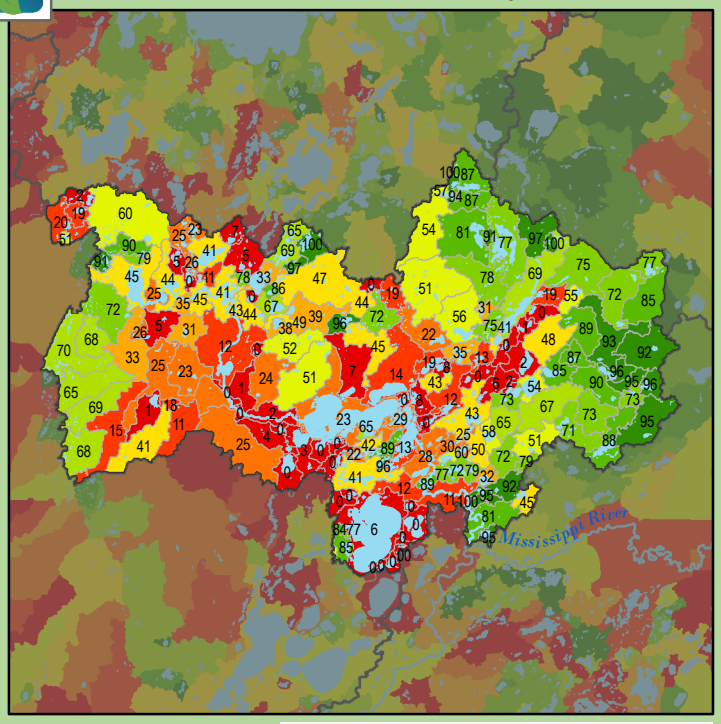
Soil Erosion Potential



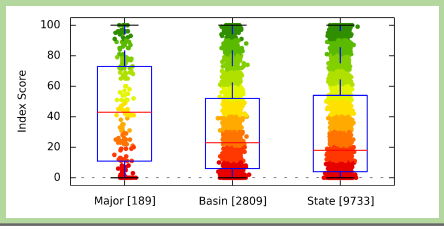
Health Score Distributions:
Pine River
- Min: 54
- Max: 90
- Median: 75.0
- Mean: 74.27
- Standard Dev: 7.95



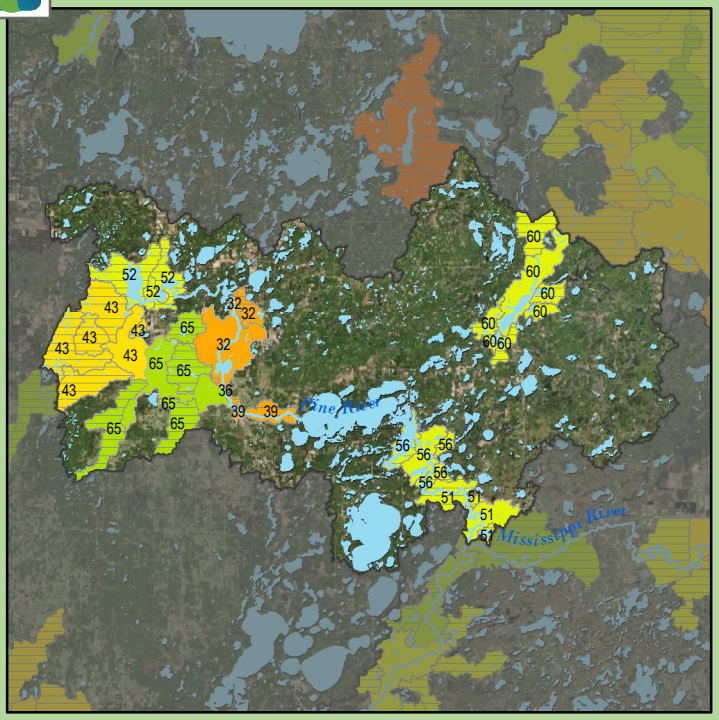
Terrestrial Habitat Quality



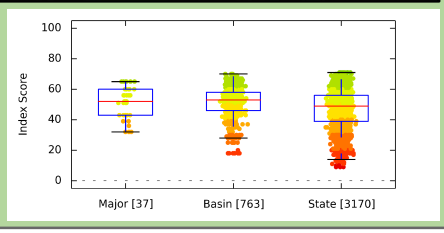
Health Score Distributions:
Pine River
- Min: 0
- Max: 100
- Median: 43.0
- Mean: 43.58
- Standard Dev: 33.64



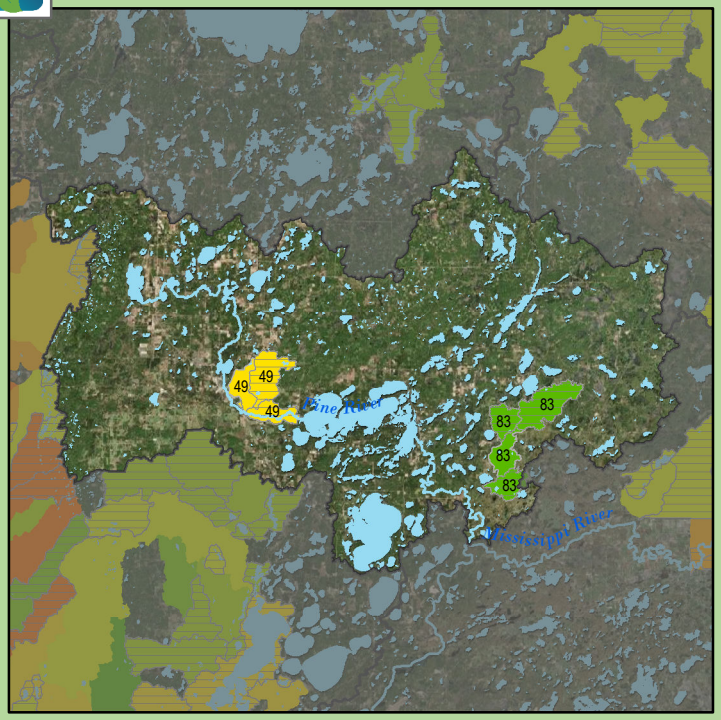
Stream Species Quality - Mussel Score



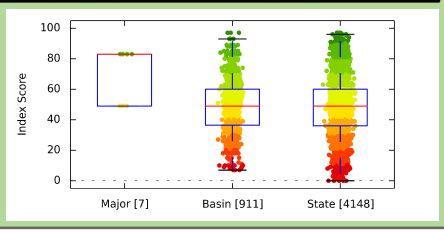
Health Score Distributions:
Pine River
- Min: 32
- Max: 65
- Median: 52.0
- Mean: 51.84
- Standard Dev: 10.17



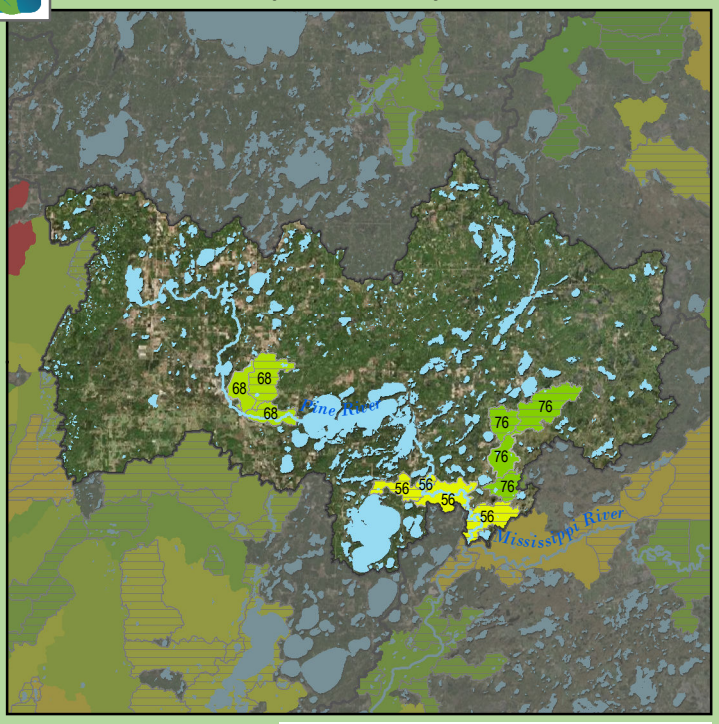
Stream Species Quality - Aquatic Invertebrate IBI



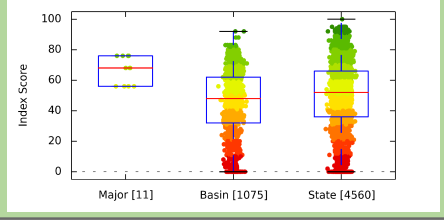
Health Score Distributions:
Pine River
- Min: 49
- Max: 83
- Median: 83.0
- Mean: 68.43
- Standard Dev: 16.83



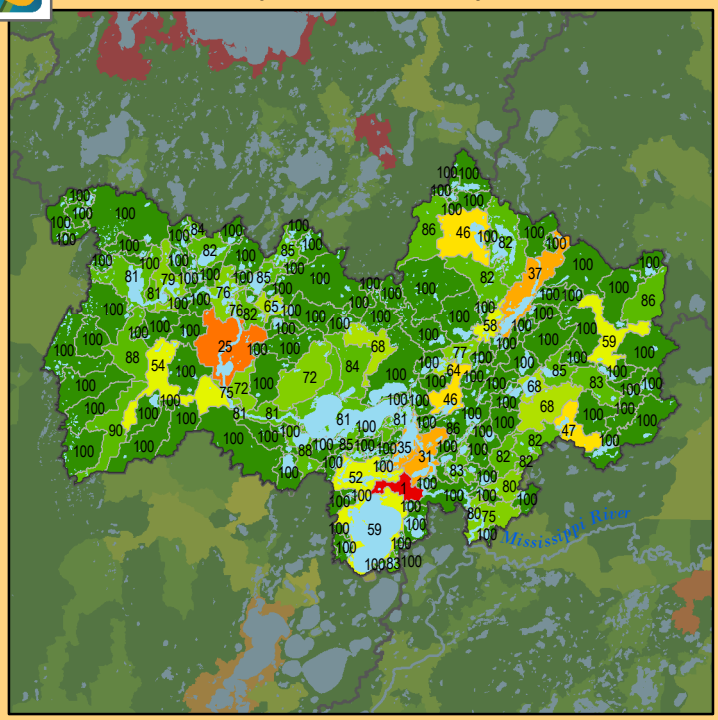
Stream Species Quality - Fish IBI



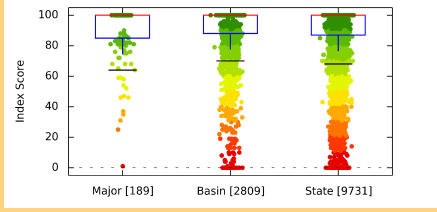
Health Score Distributions:
Pine River
- Min: 56
- Max: 76
- Median: 68.0
- Mean: 66.55
- Standard Dev: 8.57



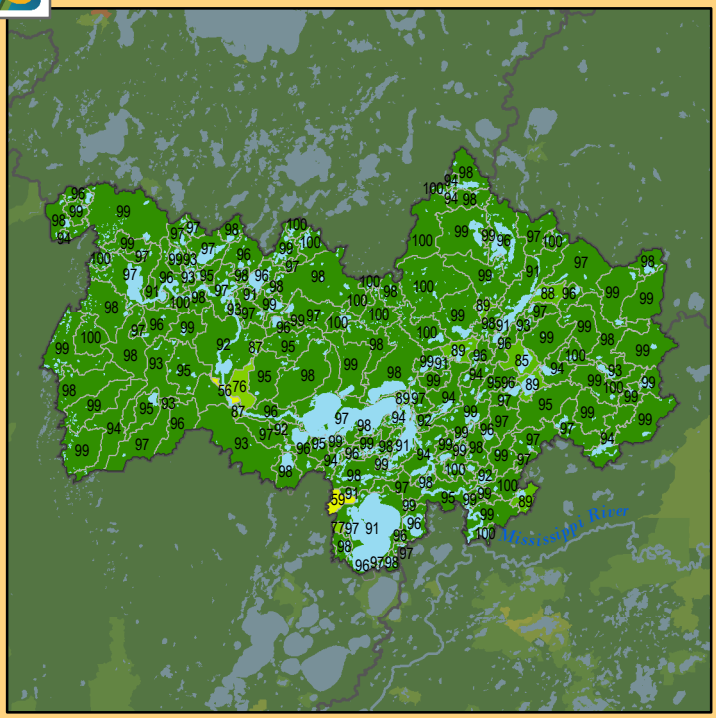
Aquatic Connectivity



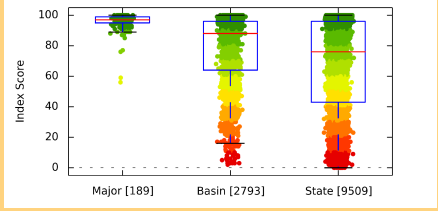
Health Score Distributions:
Pine River
- Min: 1
- Max: 100
- Median: 100.0
- Mean: 91.4
- Standard Dev: 16.55



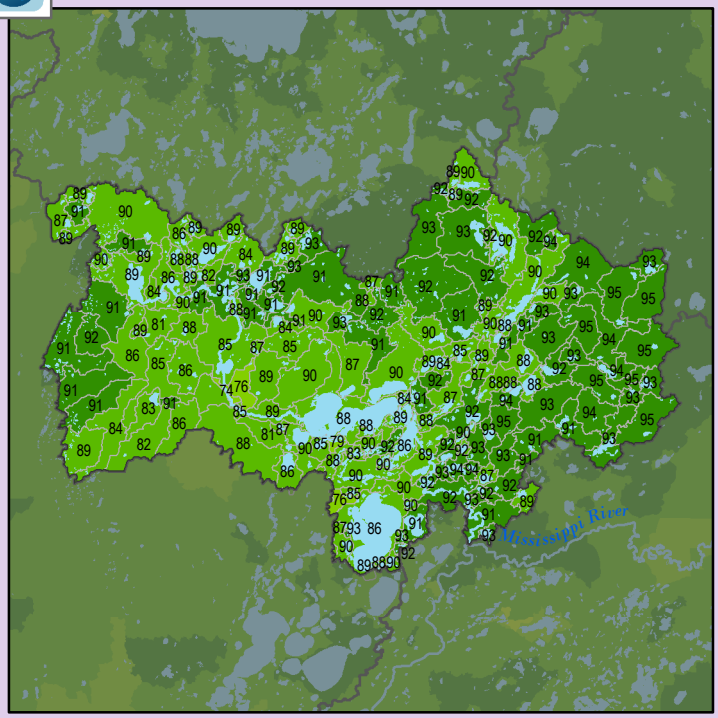
Riparian Connectivity



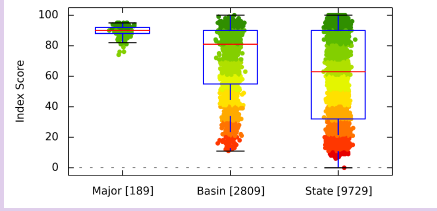
Health Score Distributions:
Pine River
- Min: 56
- Max: 100
- Median: 97.0
- Mean: 95.98
- Standard Dev: 5.44



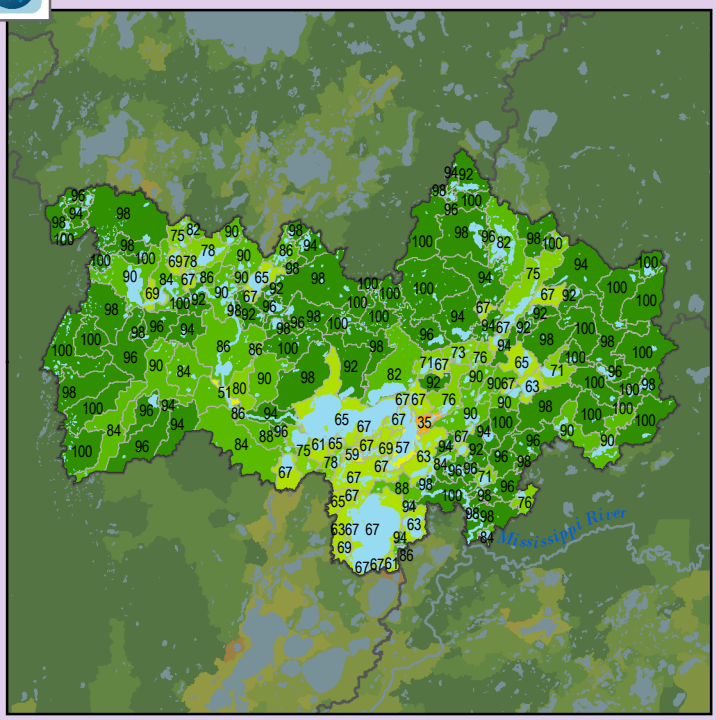
Non-Point Source - Phosphorus Risk



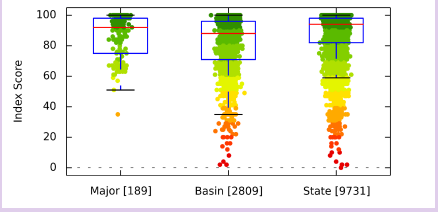
Health Score Distributions:
Pine River
- Min: 74
- Max: 95
- Median: 90.0
- Mean: 89.6
- Standard Dev: 3.61



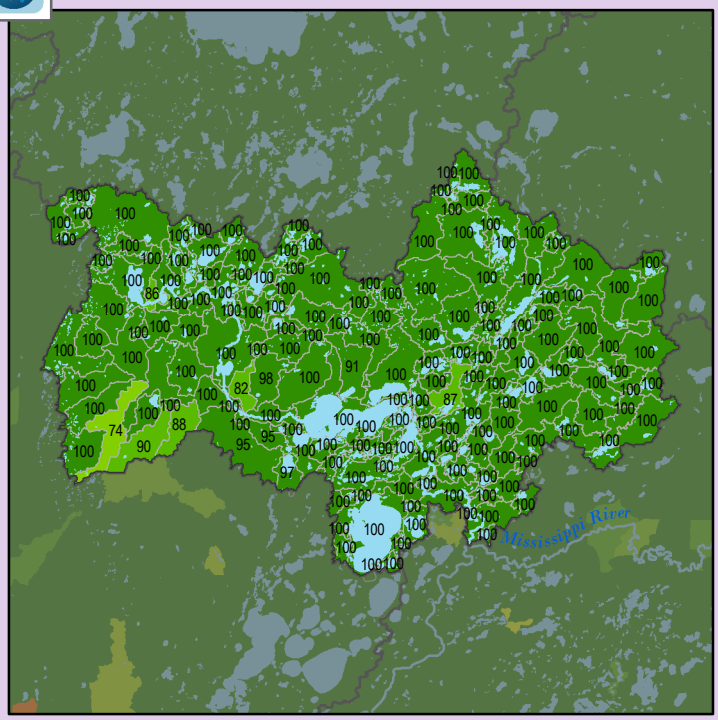
Localized Pollution Sources



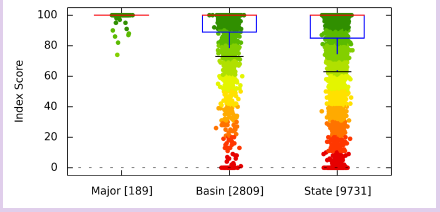
Health Score Distributions:
Pine River
- Min: 35
- Max: 100
- Median: 92.0
- Mean: 86.74
- Standard Dev: 13.68



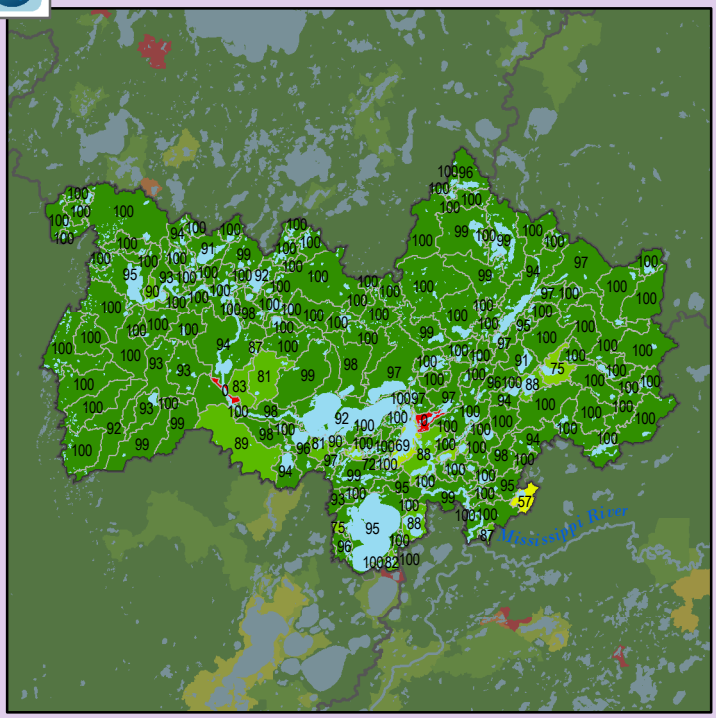
Localized Pollution Sources - Animal Units



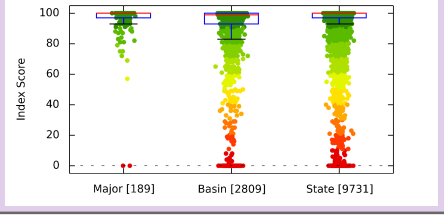
Health Score Distributions:
Pine River
- Min: 74
- Max: 100
- Median: 100.0
- Mean: 99.38
- Standard Dev: 2.98



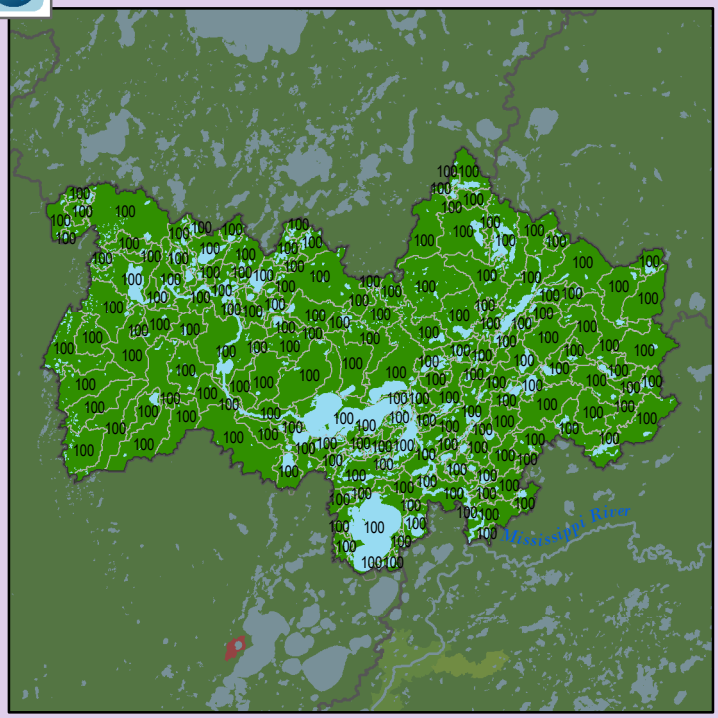
Localized Pollution Sources - Potential Contaminants



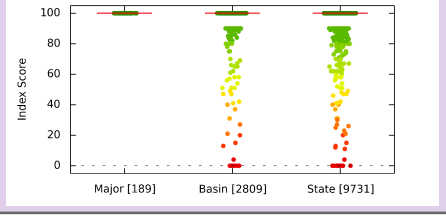
Health Score Distributions:
Pine River
- Min: 0
- Max: 100
- Median: 100.0
- Mean: 96.03
- Standard Dev: 11.75



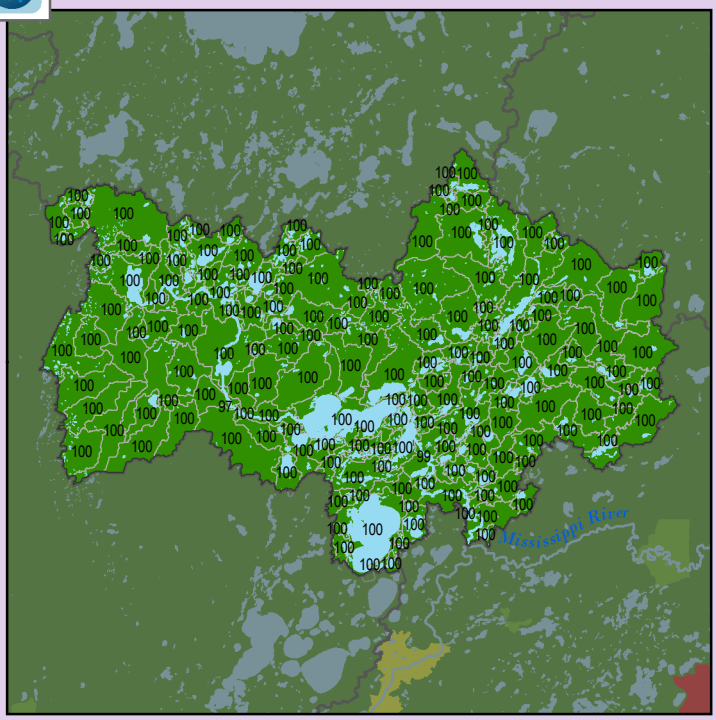
Localized Pollution Sources - Superfund Sites



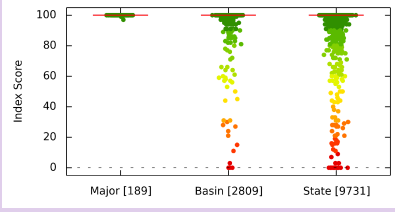
Health Score Distributions:
Pine River
- Min: 100
- Max: 100
- Median: 100.0
- Mean: 100.0
- Standard Dev: 0.0



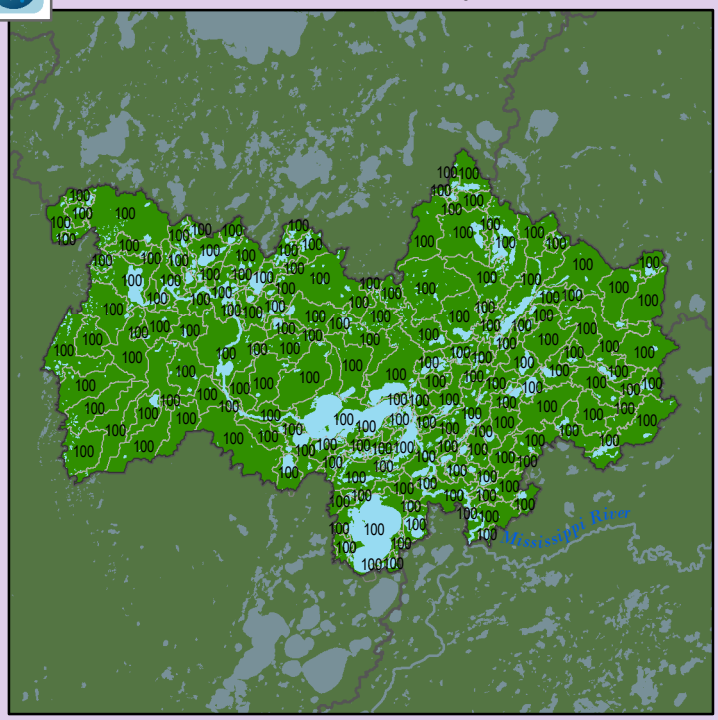
Localized Pollution Sources - Wastewater Treatment



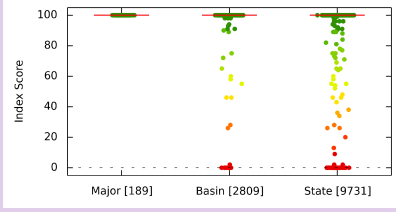
Health Score Distributions:
Pine River
- Min: 97
- Max: 100
- Median: 100.0
- Mean: 99.98
- Standard Dev: 0.23



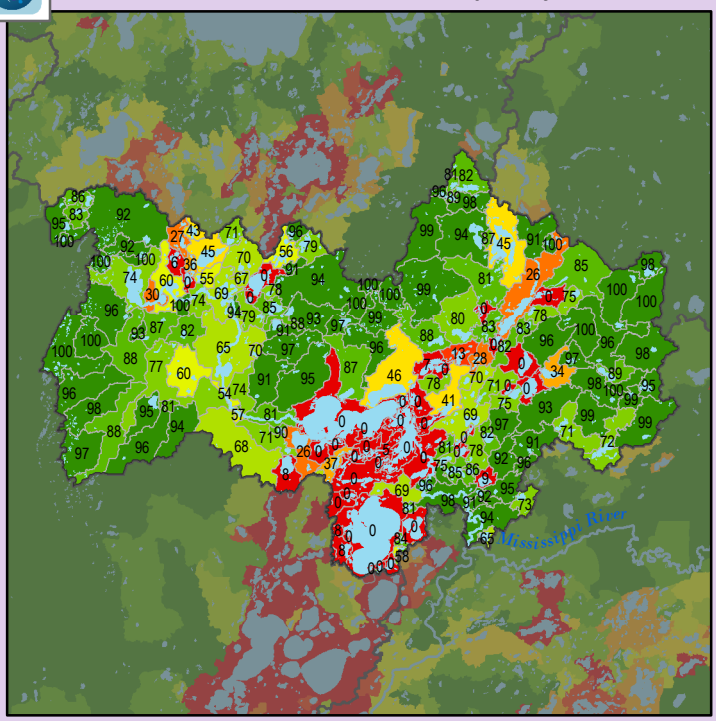
Localized Pollution Sources - Open Pit Mines



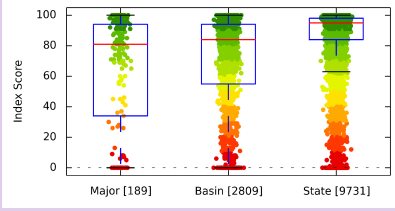
Health Score Distributions:
Pine River
- Min: 100
- Max: 100
- Median: 100.0
- Mean: 100.0
- Standard Dev: 0.0



Localized Pollution Sources - Septic Systems



Health Score Distributions:
Pine River
- Min: 0
- Max: 100
- Median: 81.0
- Mean: 63.82
- Standard Dev: 37.13



Watershed Health Assessment Framework

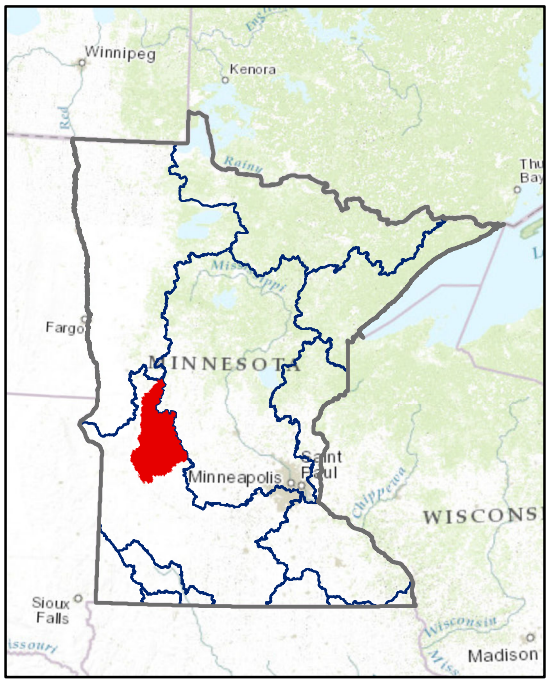
"Managing for System Health"

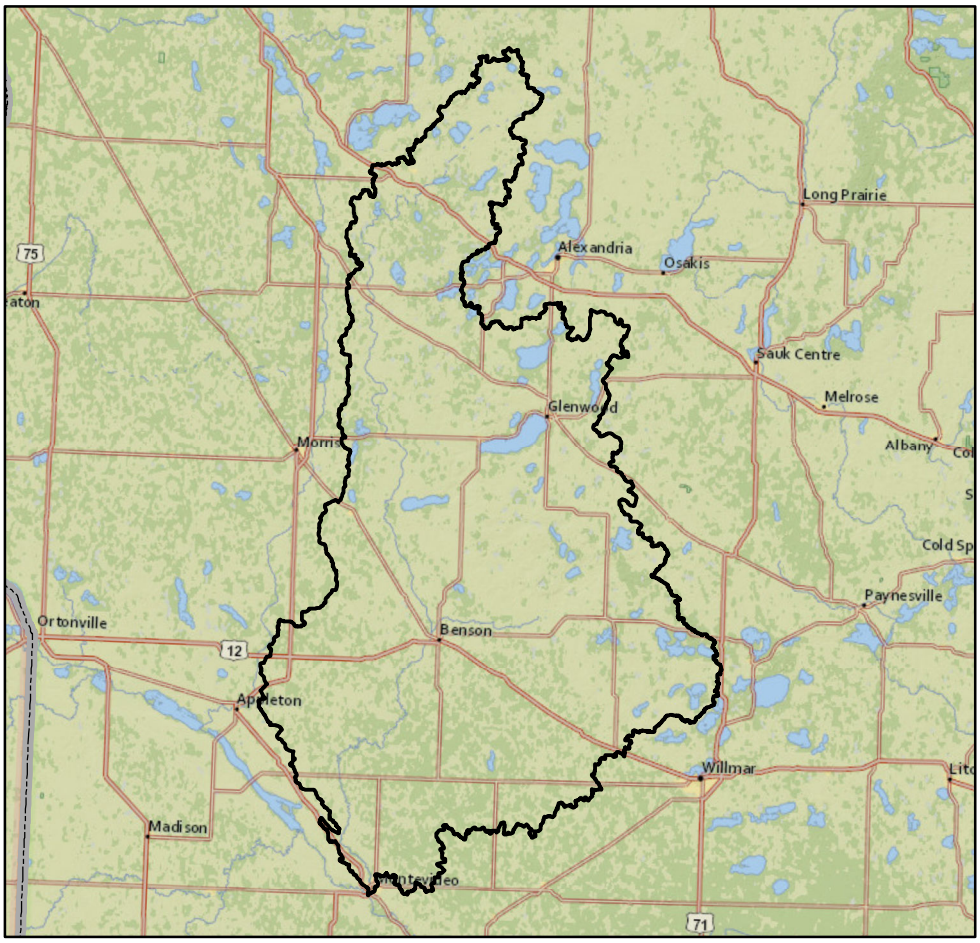
MNDNR

CLEAN WATER LAND & LEGACY AMENDMENT

Watershed Report Card:

Chippewa River





People and Places:

Watershed Population:

2000 census - 33,653
2010 census - 32,465

Largest Cities - Population:

Montevideo - 5,383
Benson - 3,240
Glenwood - 2,564
Starbuck - 1,302
Hancock - 765

Counties - % of watershed:

Pope - 30 %
Swift - 28 %
Douglas - 14 %
Chippewa - 13 %
Kandiyohi - 7 %
Stevens - 4 %
Grant - 2 %
Otter Tail - 1 %
Stearns - 0 %

Watershed Area:

Watershed size:

1,330,152 acres
2,078 square miles

Watershed Surface Area:

Percent Land - 94 %
Percent Water - 6 %

HUC8 ID:

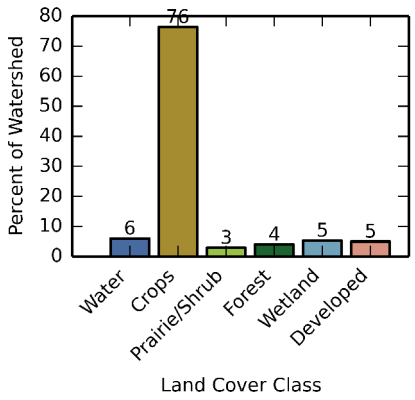
07020005

Basin Name:

Minnesota (0702)

Land Use:

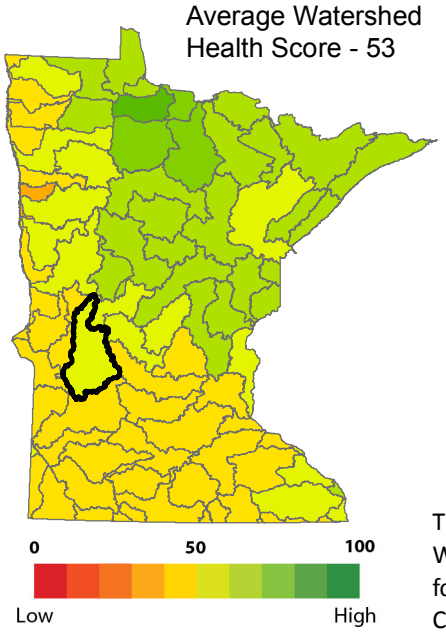
Percent of watershed area by land cover type:

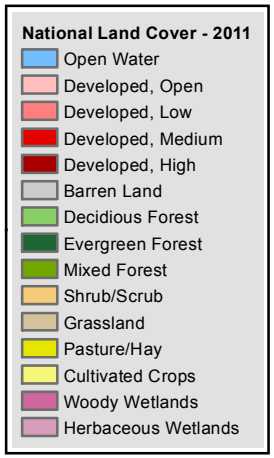


September, 2015

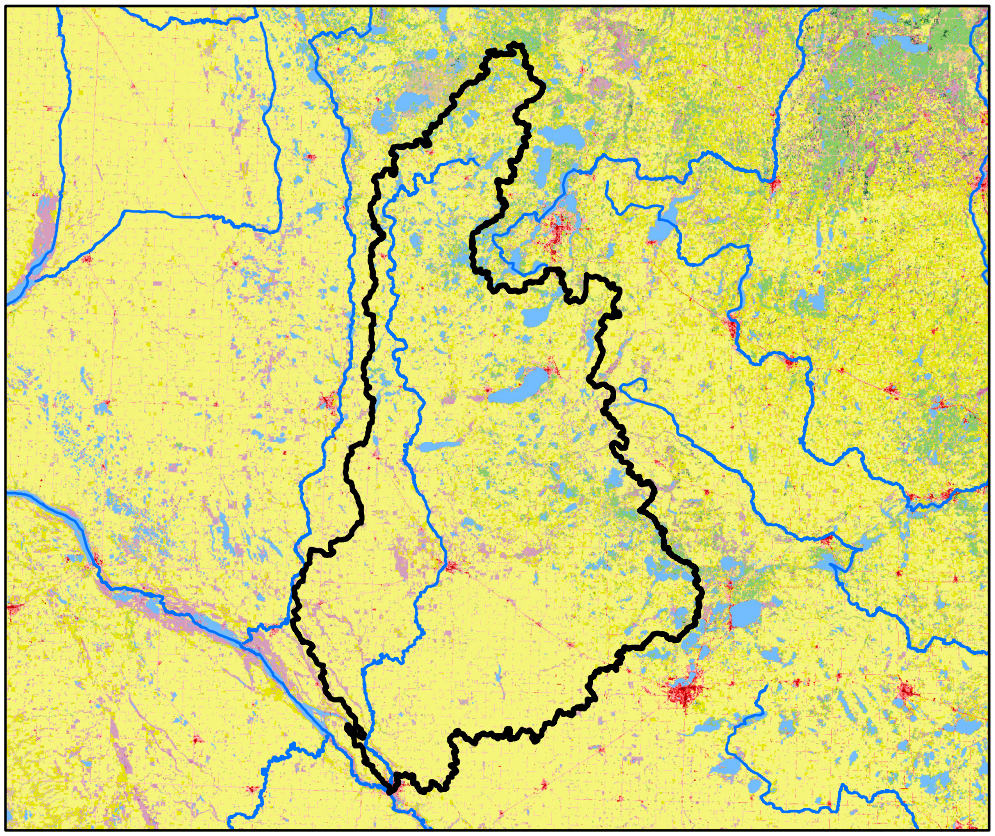
Watershed Health Report - Major Watershed

Chippewa River





These health scores are calculated at the Major Watershed (HUC8) scale. Health score names followed by (*) are also calculated at the DNR Catchment scale (subdivided HUC12). Those results are reported on the following pages.



Hydrology

Component Health Score (index average) 69

Index Scores

Perennial Cover*	22
Impervious Cover*	83
Water Withdrawal*	93
Flow Variability	66
Hydrologic Storage	69
Sub-Scores	
Altered Streams*	100
Surface Storage	39

Geomorphology

Component Health Score (index average) 62

Index Scores

Soil Erosion Potential*	71
Groundwater Susceptibility	51
Climate Vulnerability	63

Biology

Component Health Score (index average) 42

Index Scores

Terrestrial Habitat Quality*	4
Stream Species Quality*	69
Species Richness	63
At-Risk Species Richness	34

Connectivity

Component Health Score (index average) 27

Index Scores

Terrestrial Habitat Connectivity	6
Aquatic Connectivity*	37
Riparian Connectivity*	61

Water Quality

Component Health Score (index average) 64

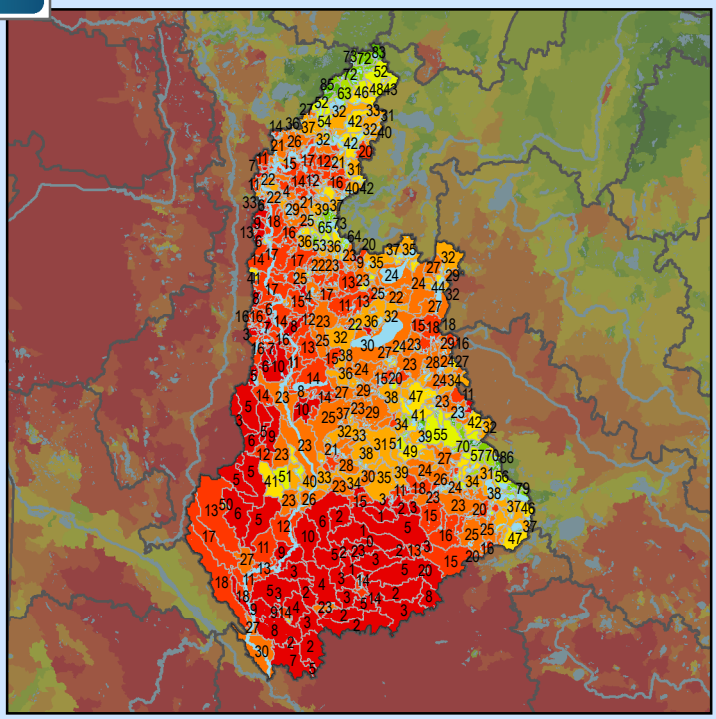
Index Scores

Non-Point Pollution Sources	45
Sub-Score Phosphorus Risk*	19
Localized Pollution Sources*	89
Assessments	56

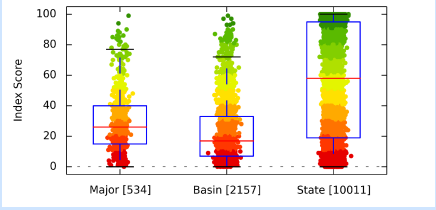
Watershed Health Assessment Framework
Health score methodology - **www.dnr.state.mn.us/whaf/about/scores**

September, 2015

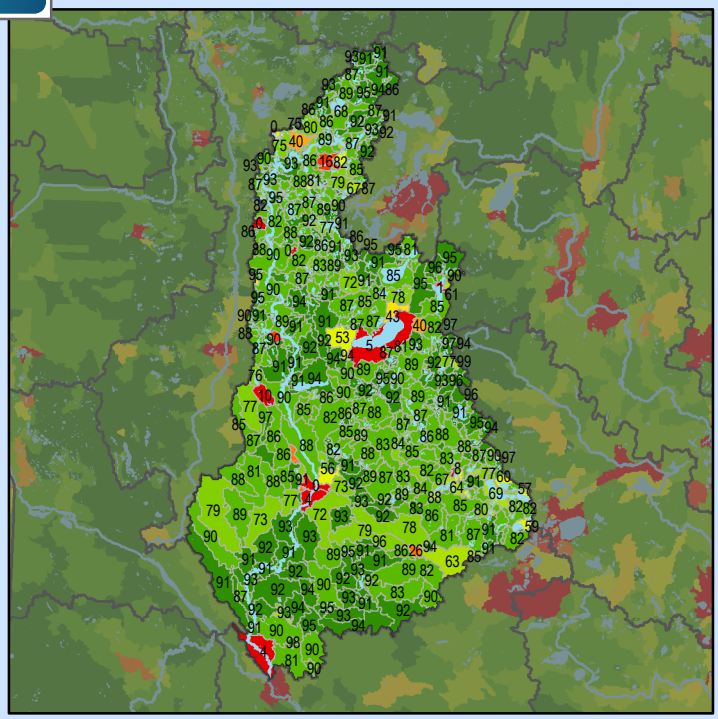
Perennial Cover (2011)



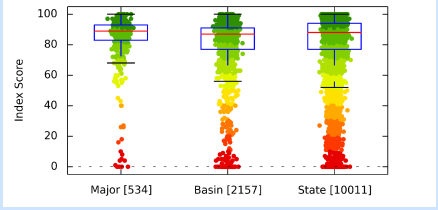
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 99
- Median: 26.0
- Mean: 29.95
- Standard Dev: 20.18



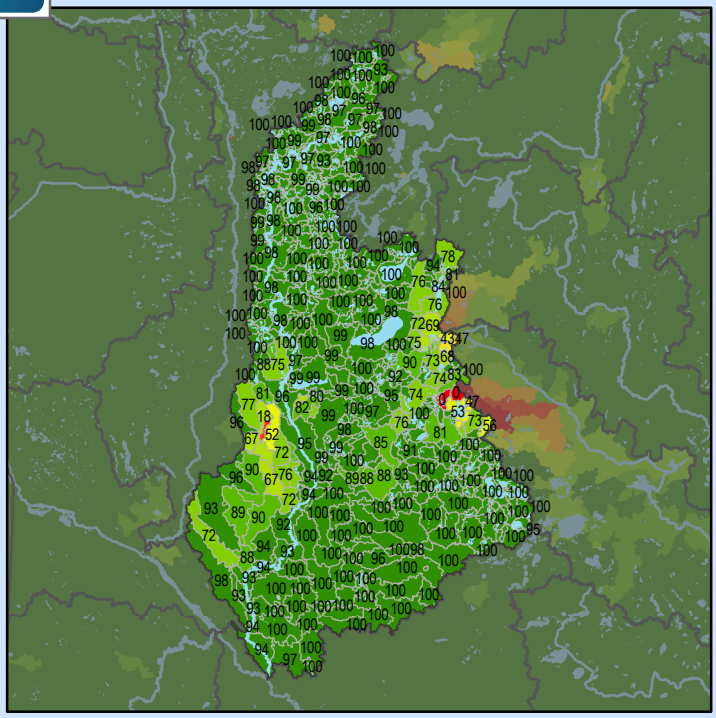
Impervious Cover (2011)



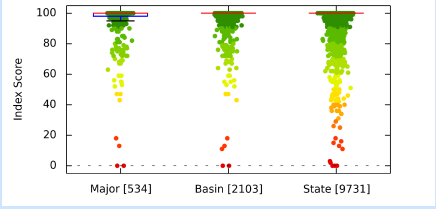
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 89.0
- Mean: 84.78
- Standard Dev: 15.88



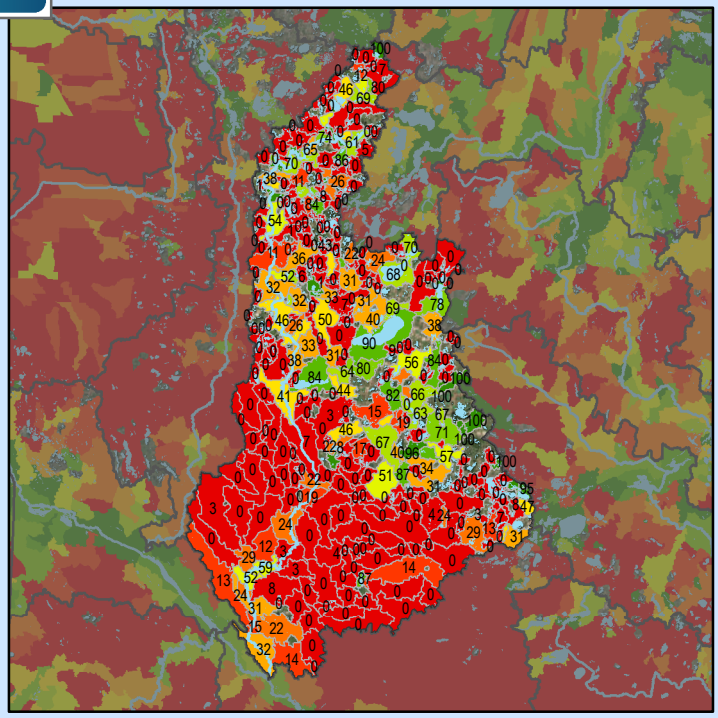
Water Withdrawal Index



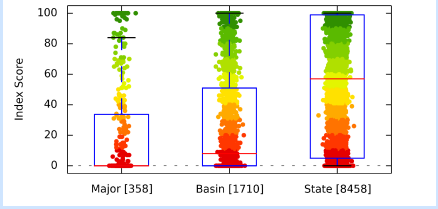
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 100.0
- Mean: 95.75
- Standard Dev: 11.86



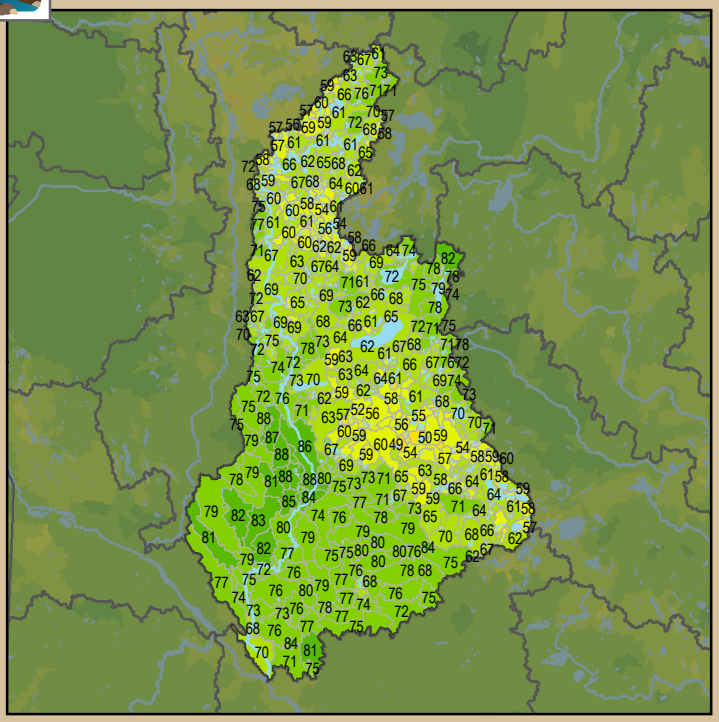
Altered Streams



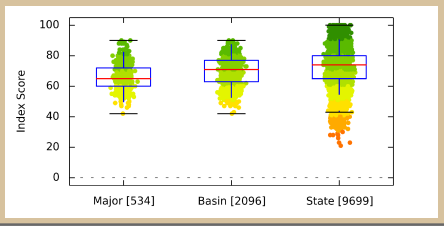
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 0.0
- Mean: 21.15
- Standard Dev: 32.33



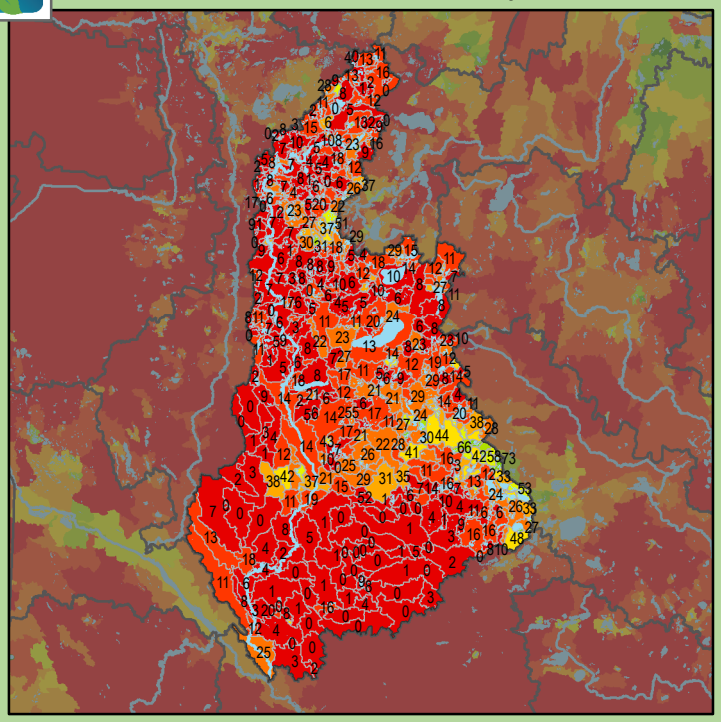
Soil Erosion Potential



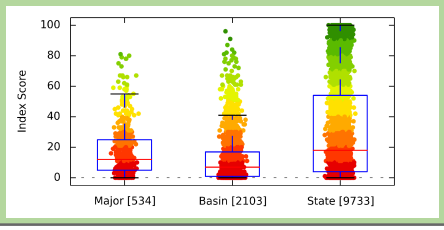
Health Score Distributions:
Chippewa River
- Min: 42
- Max: 90
- Median: 65.0
- Mean: 66.02
- Standard Dev: 8.44



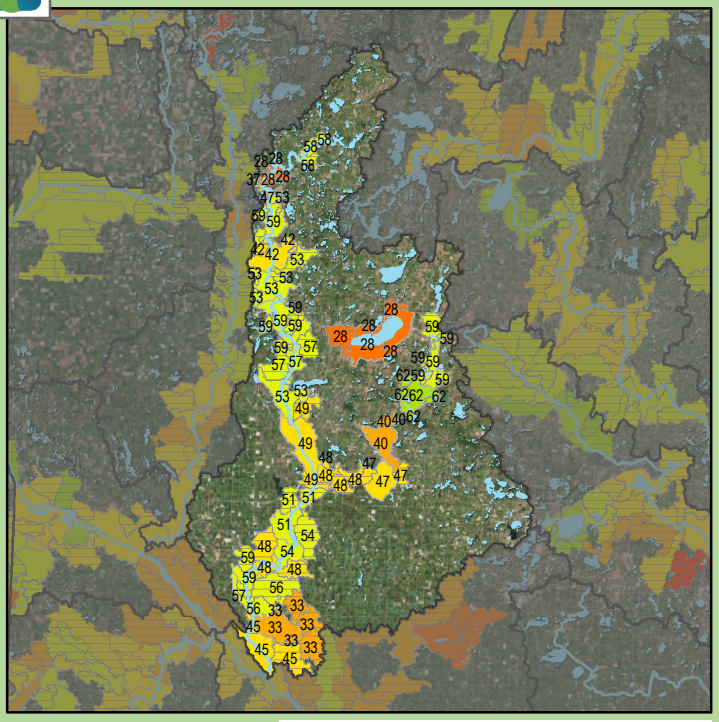
Terrestrial Habitat Quality



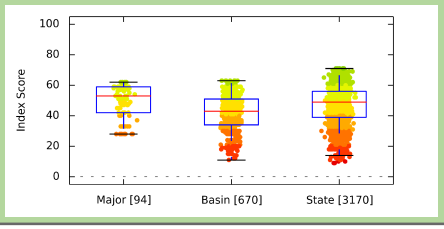
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 81
- Median: 12.0
- Mean: 17.09
- Standard Dev: 16.61



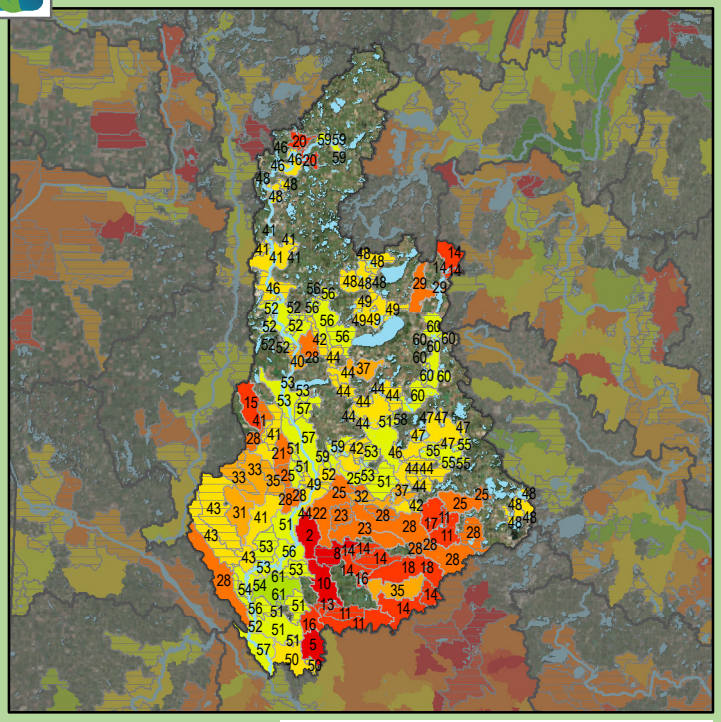
Stream Species Quality - Mussel Score



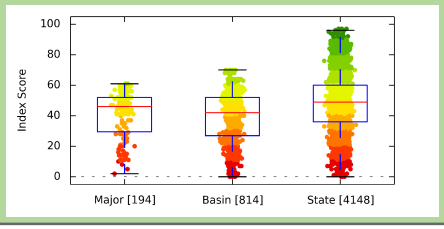
Health Score Distributions:
Chippewa River
- Min: 28
- Max: 62
- Median: 53.0
- Mean: 49.18
- Standard Dev: 10.66



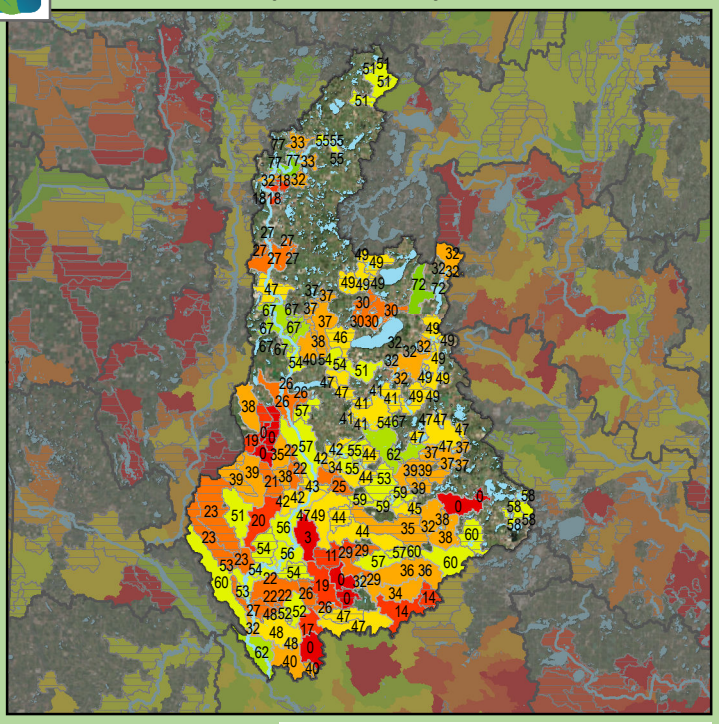
Stream Species Quality - Aquatic Invertebrate IBI



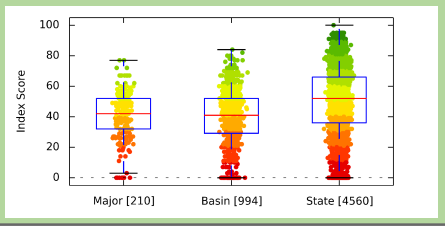
Health Score Distributions:
Chippewa River
- Min: 2
- Max: 61
- Median: 46.0
- Mean: 41.52
- Standard Dev: 14.66



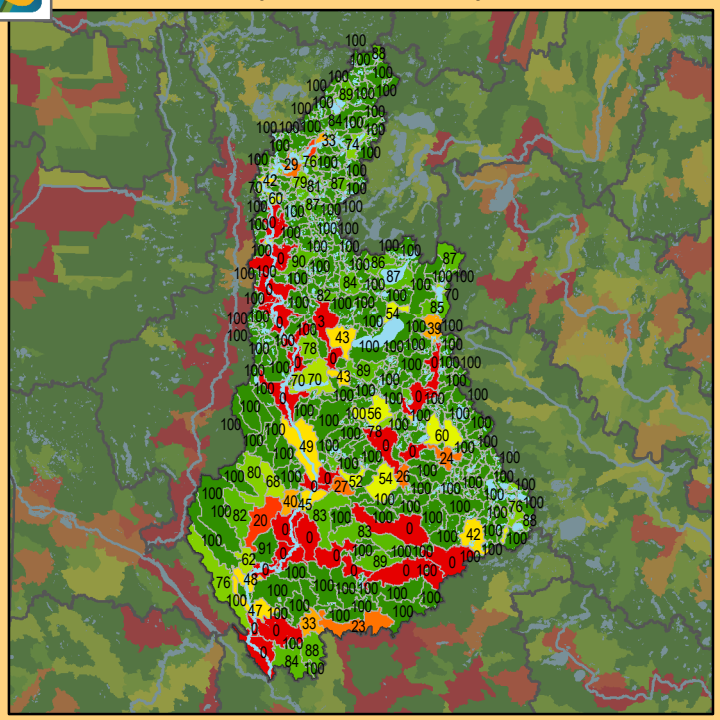
Stream Species Quality - Fish IBI



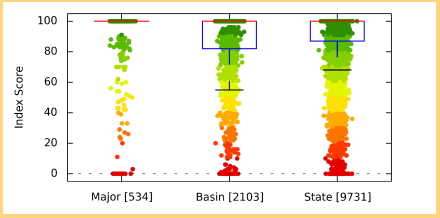
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 77
- Median: 42.0
- Mean: 40.9
- Standard Dev: 16.09



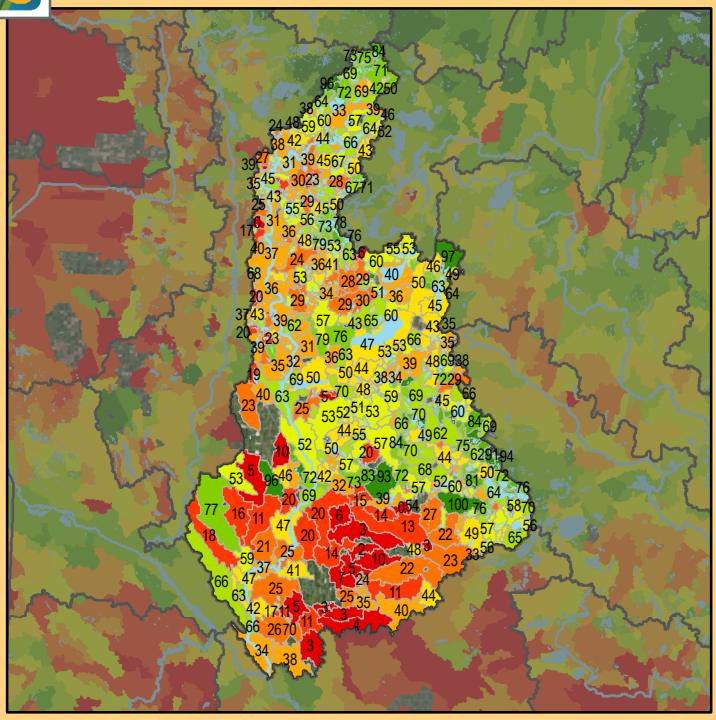
Aquatic Connectivity



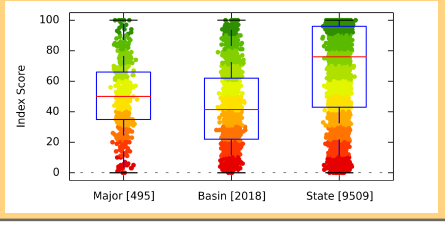
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 100.0
- Mean: 90.37
- Standard Dev: 24.86



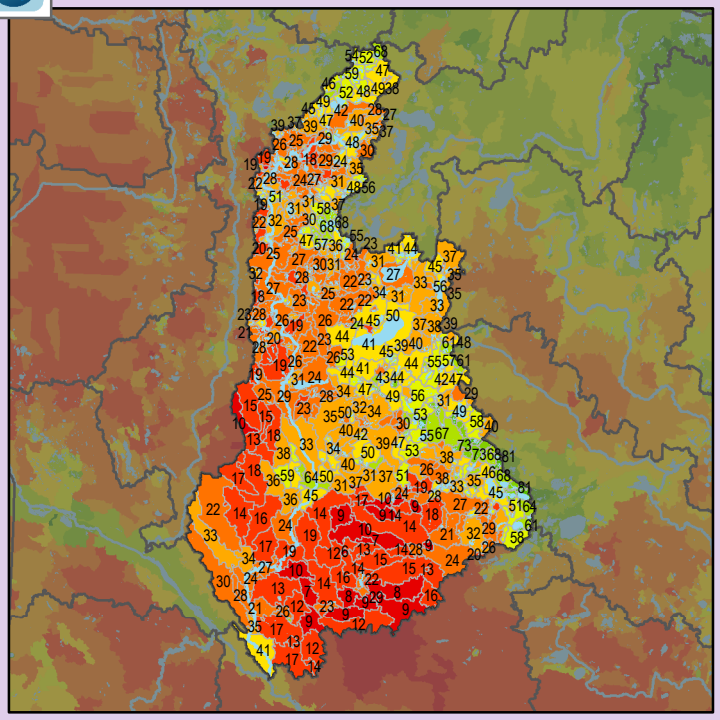
Riparian Connectivity



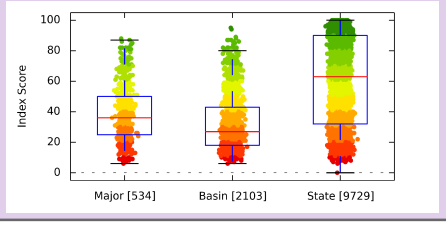
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 50.0
- Mean: 49.97
- Standard Dev: 22.32



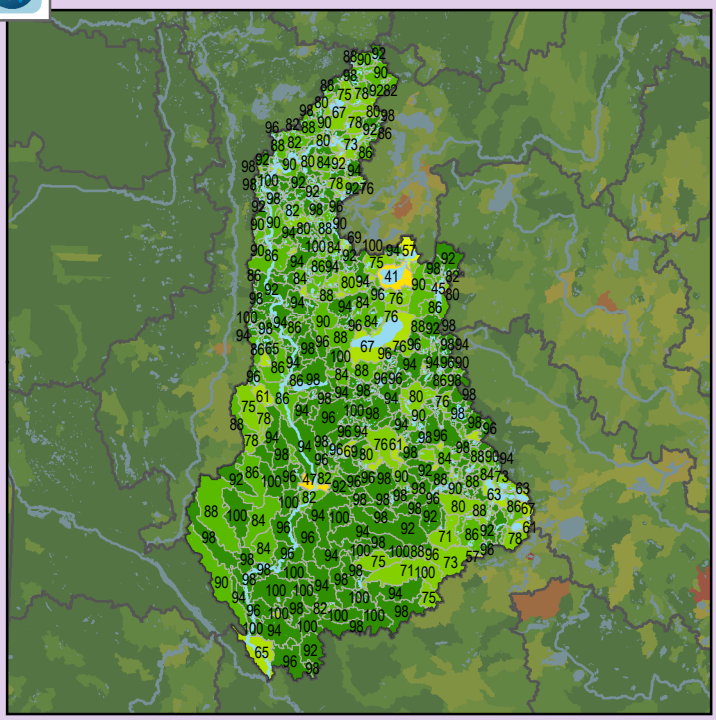
Non-Point Source - Phosphorus Risk



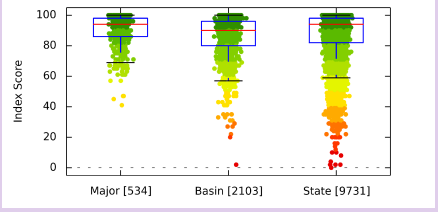
Health Score Distributions:
Chippewa River
- Min: 6
- Max: 88
- Median: 36.0
- Mean: 38.31
- Standard Dev: 17.94



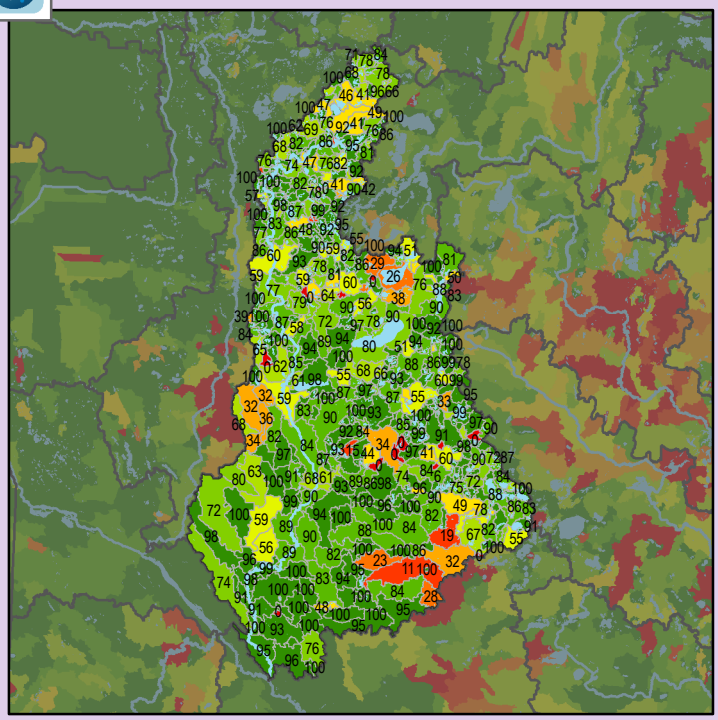
Localized Pollution Sources



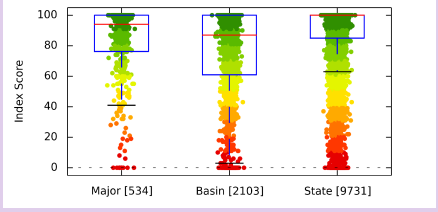
Health Score Distributions:
Chippewa River
- Min: 41
- Max: 100
- Median: 94.0
- Mean: 90.41
- Standard Dev: 10.65



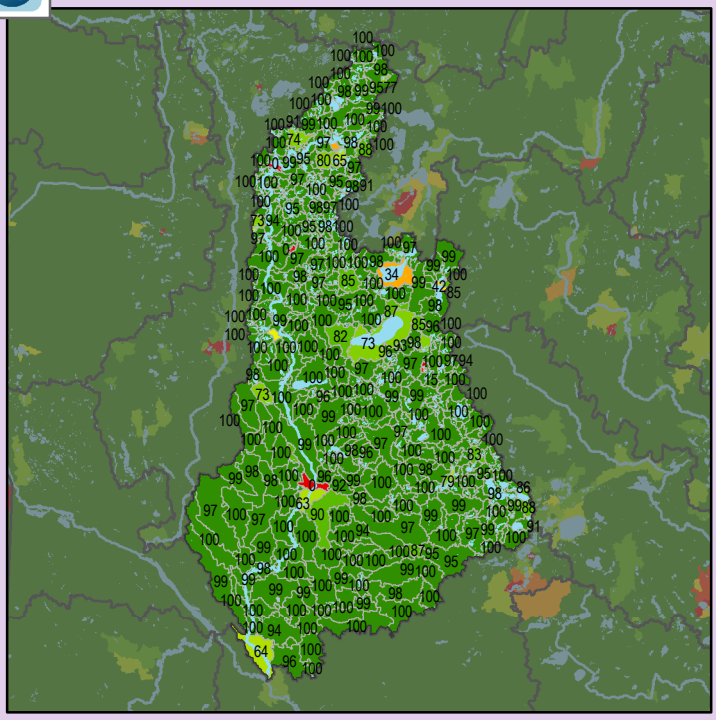
Localized Pollution Sources - Animal Units



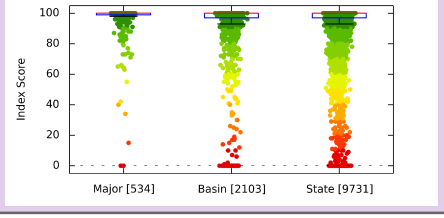
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 94.0
- Mean: 83.4
- Standard Dev: 23.56



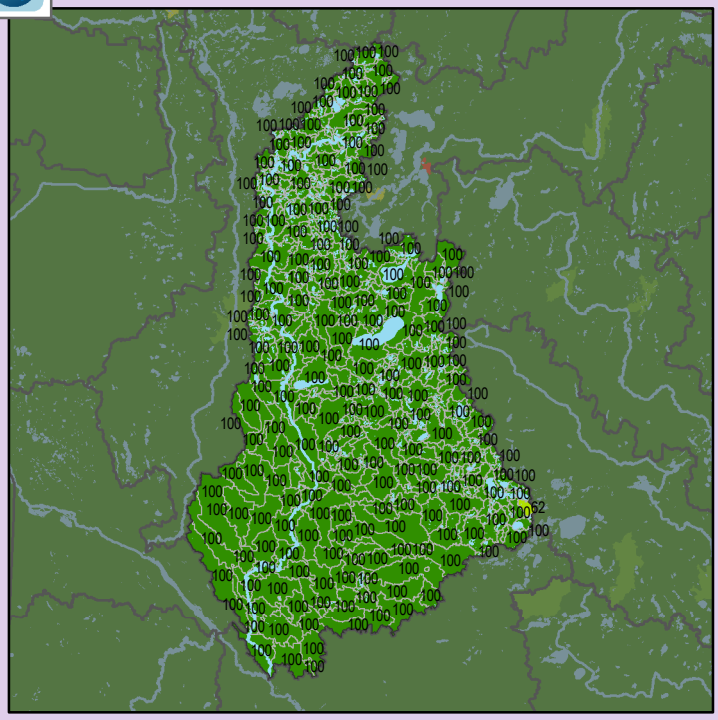
Localized Pollution Sources - Potential Contaminants



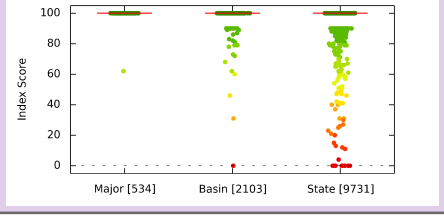
Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 100.0
- Mean: 96.9
- Standard Dev: 11.59



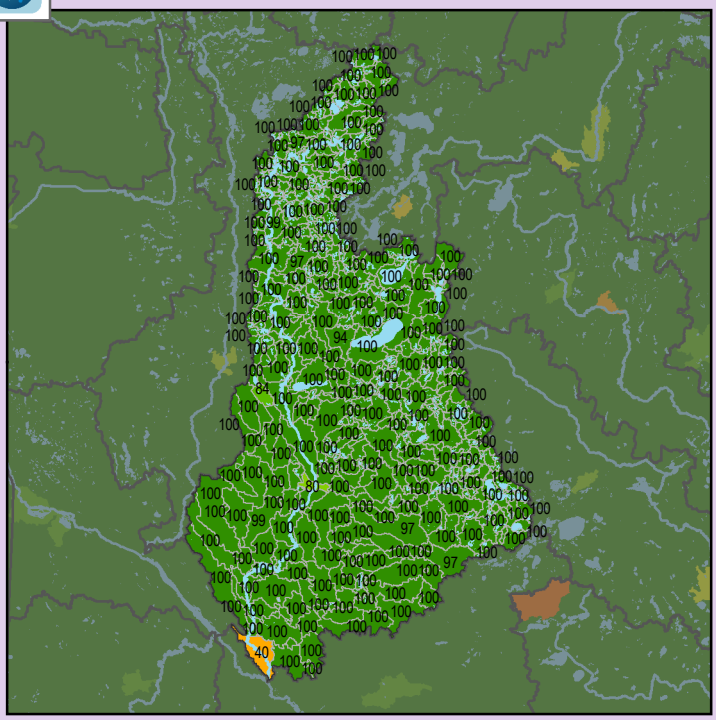
Localized Pollution Sources - Superfund Sites



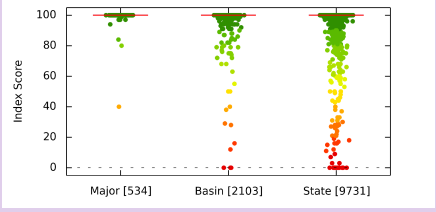
Health Score Distributions:
Chippewa River
- Min: 62
- Max: 100
- Median: 100.0
- Mean: 99.93
- Standard Dev: 1.64



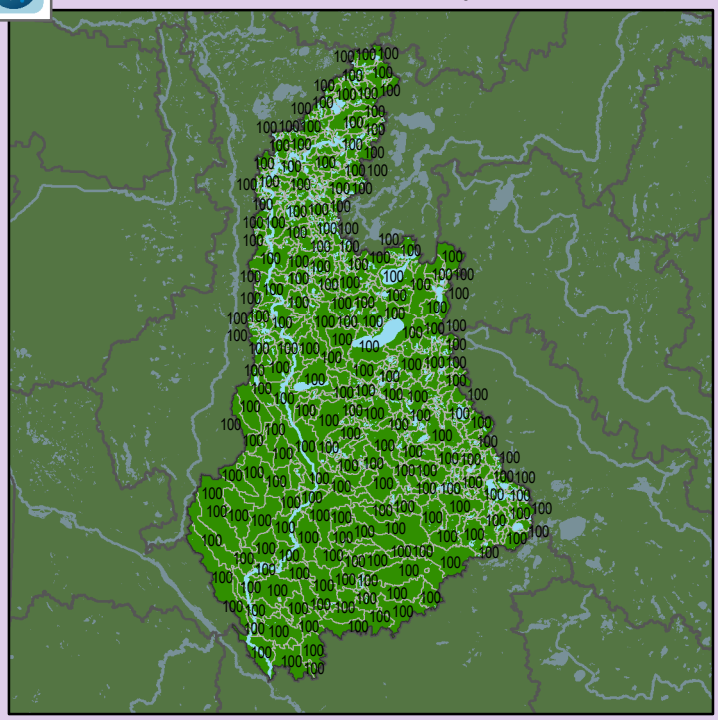
Localized Pollution Sources - Wastewater Treatment



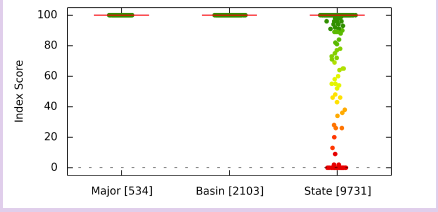
Health Score Distributions:
Chippewa River
- Min: 40
- Max: 100
- Median: 100.0
- Mean: 99.78
- Standard Dev: 2.84



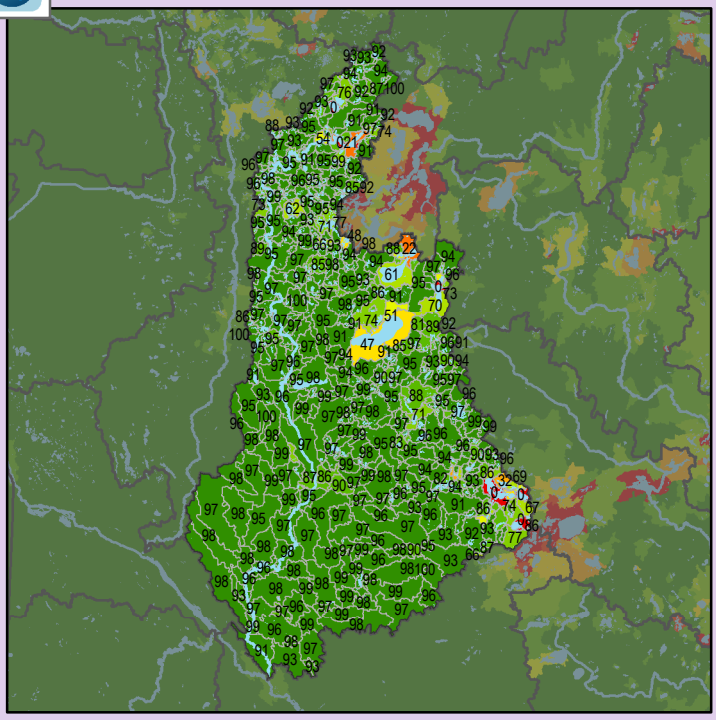
Localized Pollution Sources - Open Pit Mines



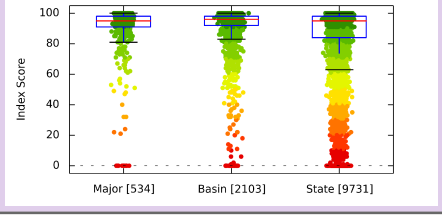
Health Score Distributions:
Chippewa River
- Min: 100
- Max: 100
- Median: 100.0
- Mean: 100.0
- Standard Dev: 0.0



Localized Pollution Sources - Septic Systems



Health Score Distributions:
Chippewa River
- Min: 0
- Max: 100
- Median: 95.0
- Mean: 90.38
- Standard Dev: 16.28



Watershed Health Assessment Framework

"Managing for System Health"

MNDNR

CLEAN WATER LAND & LEGACY AMENDMENT

Watershed Report Card:

Le Sueur River





People and Places:

Watershed Population:

2000 census - 33,099
2010 census - 34,412

Largest Cities - Population:

Eagle Lake - 2,422
Wells - 2,343
Janesville - 2,256
Mapleton - 1,756
New Richland - 1,203

Counties - % of watershed:

Blue Earth - 33 %
Waseca - 32 %
Faribault - 22 %
Freeborn - 10 %
Steele - 3 %
Le Sueur - 0 %

Watershed Area:

Watershed size:

711,115 acres
1,111 square miles

Watershed Surface Area:

Percent Land - 98 %
Percent Water - 2 %

HUC8 ID:

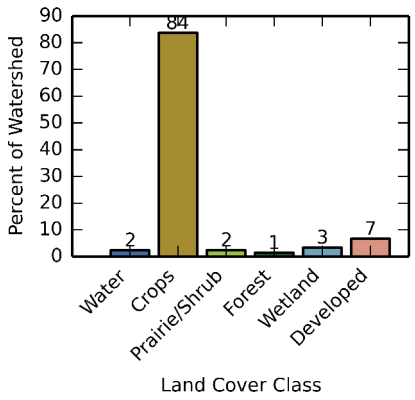
07020011

Basin Name:

Minnesota (0702)

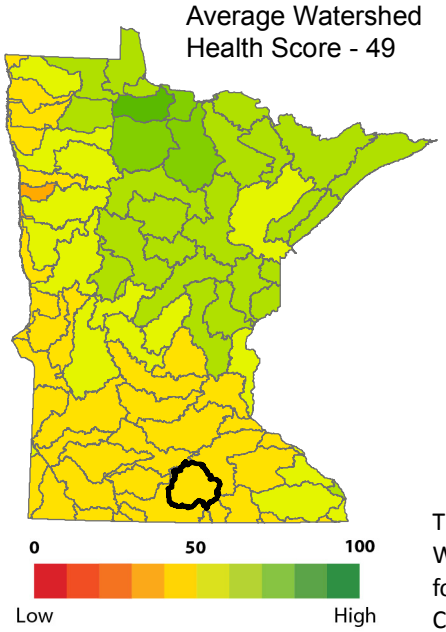
Land Use:

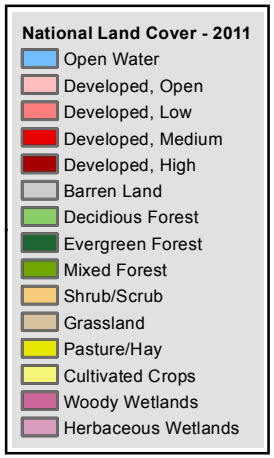
Percent of watershed area by land cover type:



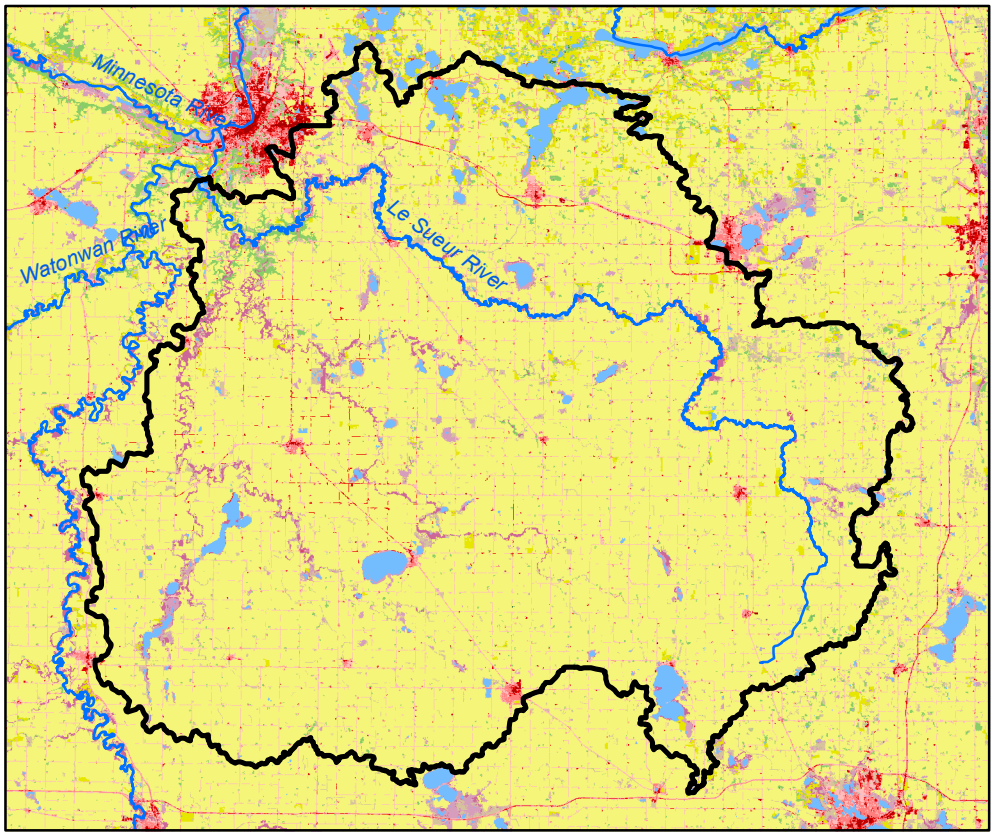
Watershed Health Report - Major Watershed

Le Sueur River





These health scores are calculated at the Major Watershed (HUC8) scale. Health score names followed by (*) are also calculated at the DNR Catchment scale (subdivided HUC12). Those results are reported on the following pages.



Hydrology

Component Health Score (index average) 60

Index Scores

Perennial Cover*	9
Impervious Cover*	71
Water Withdrawal*	99
Flow Variability	65
Hydrologic Storage	35
Sub-Scores	
Altered Streams*	53
Surface Storage	18

Geomorphology

Component Health Score (index average) 74

Index Scores

Soil Erosion Potential*	76
Groundwater Susceptibility	55
Climate Vulnerability	92

Biology

Component Health Score (index average) 38

Index Scores

Terrestrial Habitat Quality*	1
Stream Species Quality*	76
Species Richness	56
At-Risk Species Richness	18

Connectivity

Component Health Score (index average) 19

Index Scores

Terrestrial Habitat Connectivity	2
Aquatic Connectivity*	45
Riparian Connectivity*	44

Water Quality

Component Health Score (index average) 52

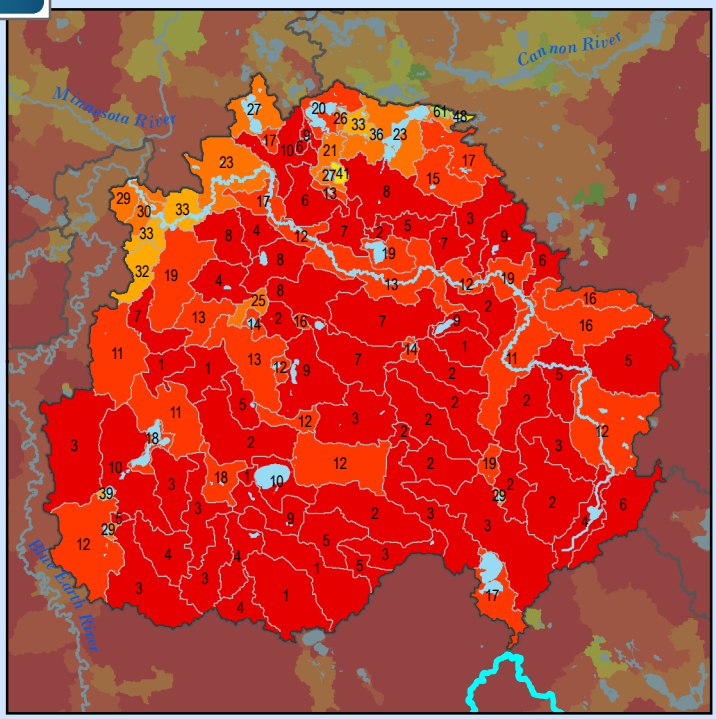
Index Scores

Non-Point Pollution Sources	31
Sub-Score Phosphorus Risk*	5
Localized Pollution Sources*	81
Assessments	39

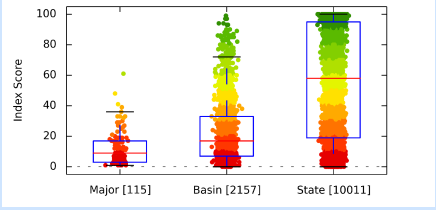
Watershed Health Assessment Framework
Health score methodology - **www.dnr.state.mn.us/whaf/about/scores**

September, 2015

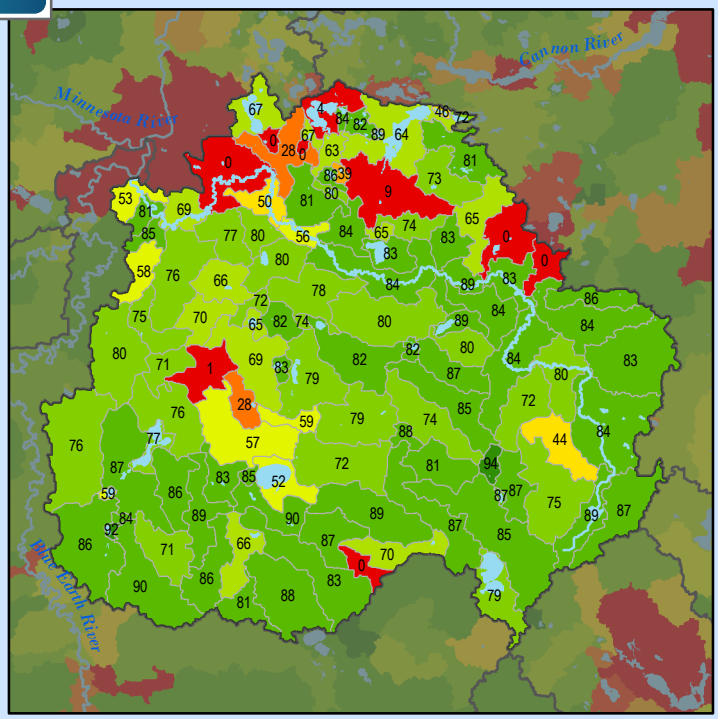
Perennial Cover (2011)



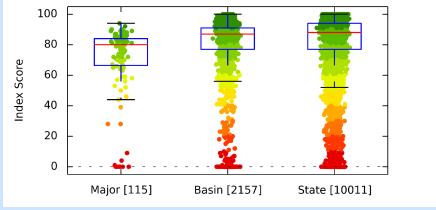
Health Score Distributions:
Le Sueur River
- Min: 1
- Max: 61
- Median: 9.0
- Mean: 12.13
- Standard Dev: 11.2



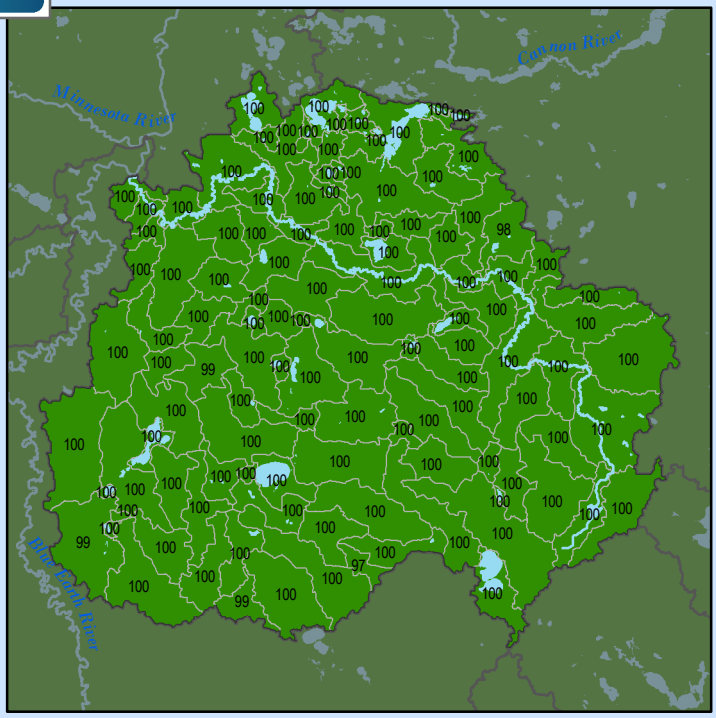
Impervious Cover (2011)



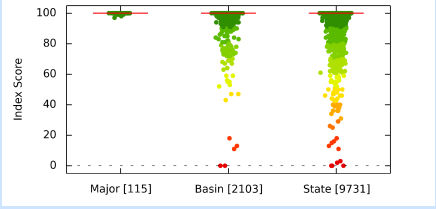
Health Score Distributions:
Le Sueur River
- Min: 0
- Max: 94
- Median: 80.0
- Mean: 70.28
- Standard Dev: 23.61



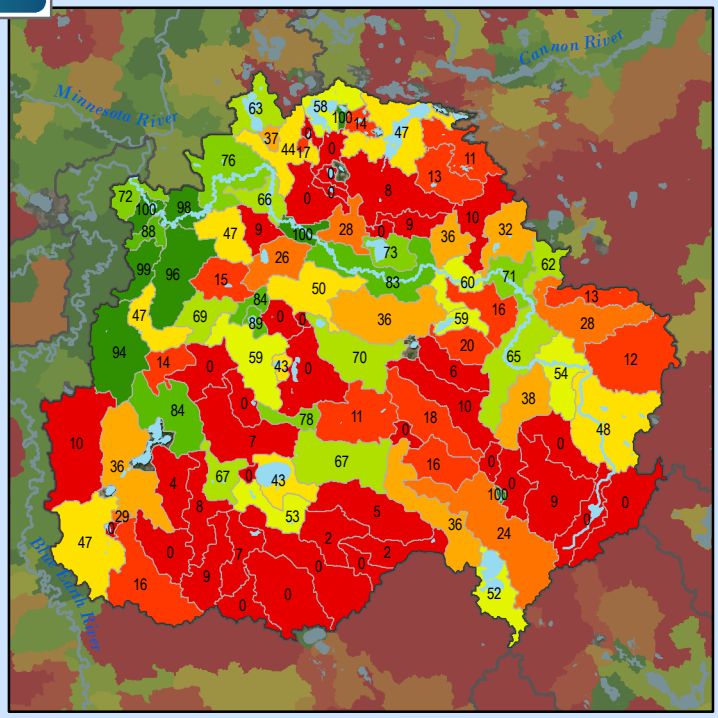
Water Withdrawal Index



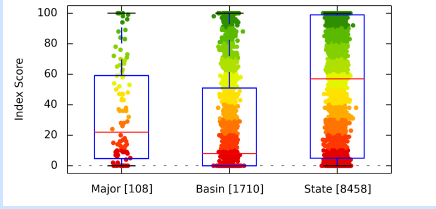
Health Score Distributions:
Le Sueur River
- Min: 97
- Max: 100
- Median: 100.0
- Mean: 99.93
- Standard Dev: 0.37



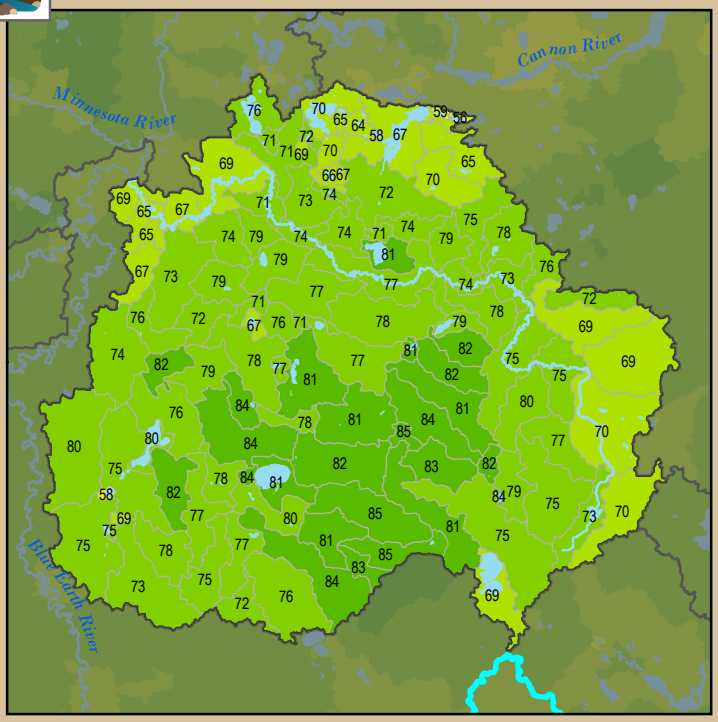
Altered Streams



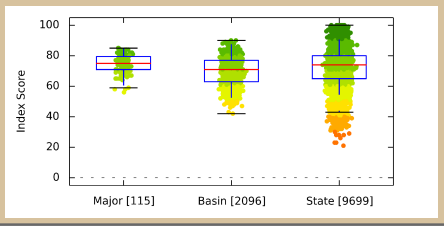
Health Score Distributions:
Le Sueur River
- Min: 0
- Max: 100
- Median: 22.0
- Mean: 33.63
- Standard Dev: 32.32



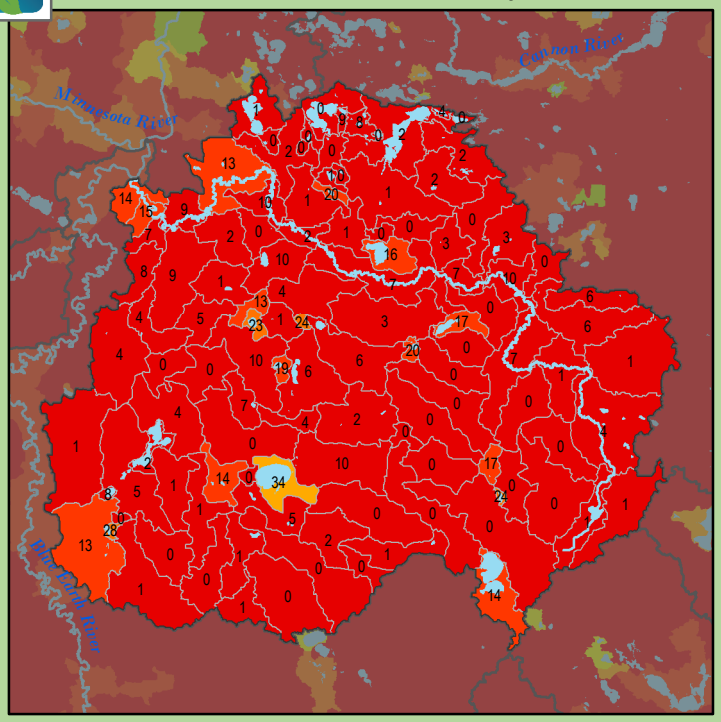
Soil Erosion Potential



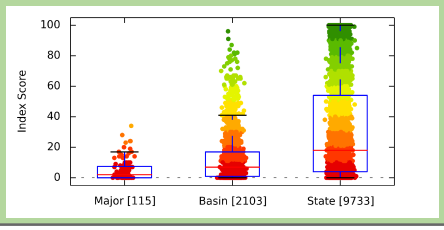
Health Score Distributions:
Le Sueur River
- Min: 56
- Max: 85
- Median: 75.0
- Mean: 74.89
- Standard Dev: 6.23



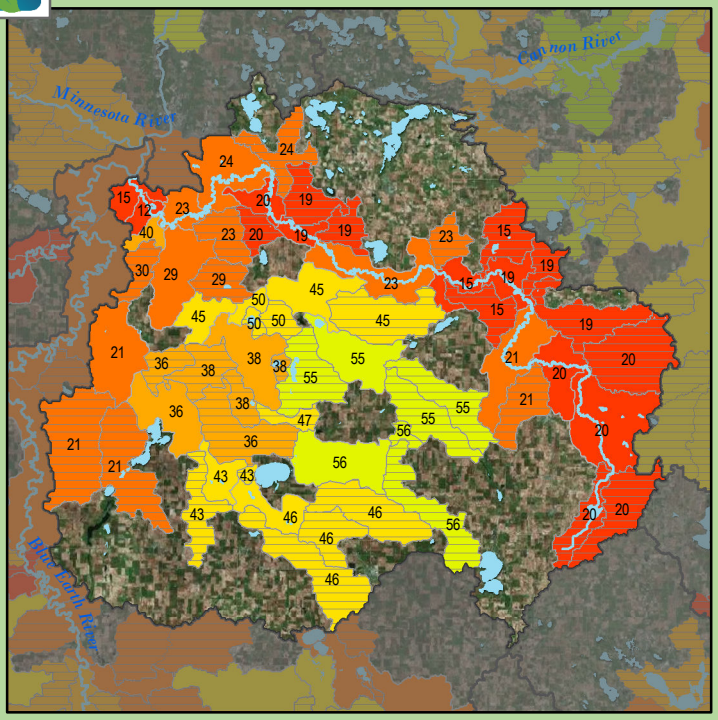
Terrestrial Habitat Quality



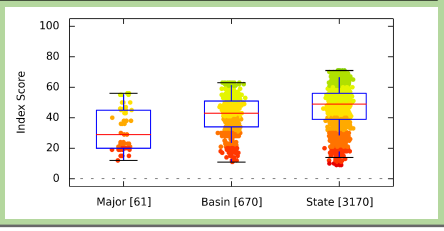
Health Score Distributions:
Le Sueur River
- Min: 0
- Max: 34
- Median: 2.0
- Mean: 5.1
- Standard Dev: 6.94



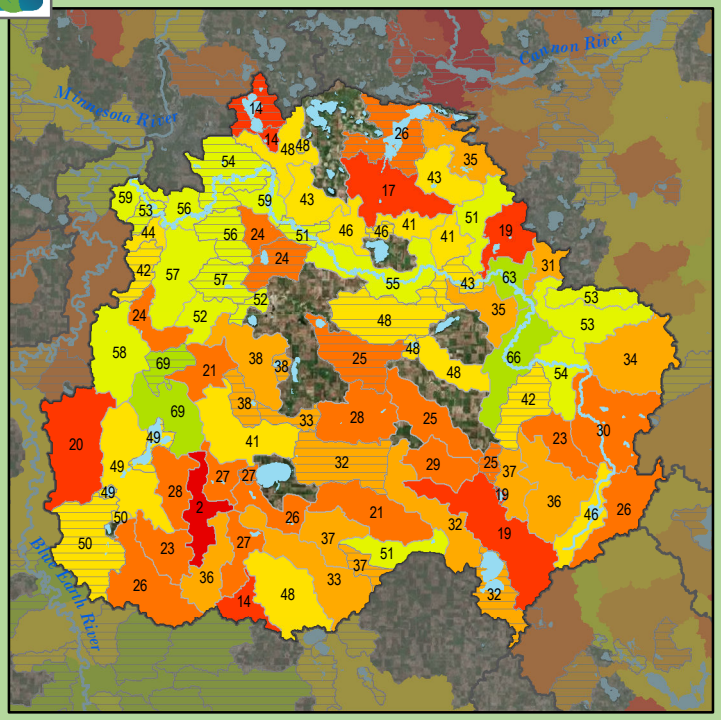
Stream Species Quality - Mussel Score



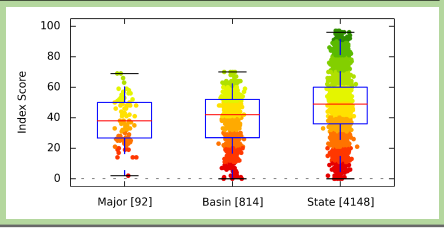
Health Score Distributions:
Le Sueur River
- Min: 12
- Max: 56
- Median: 29.0
- Mean: 32.66
- Standard Dev: 13.78



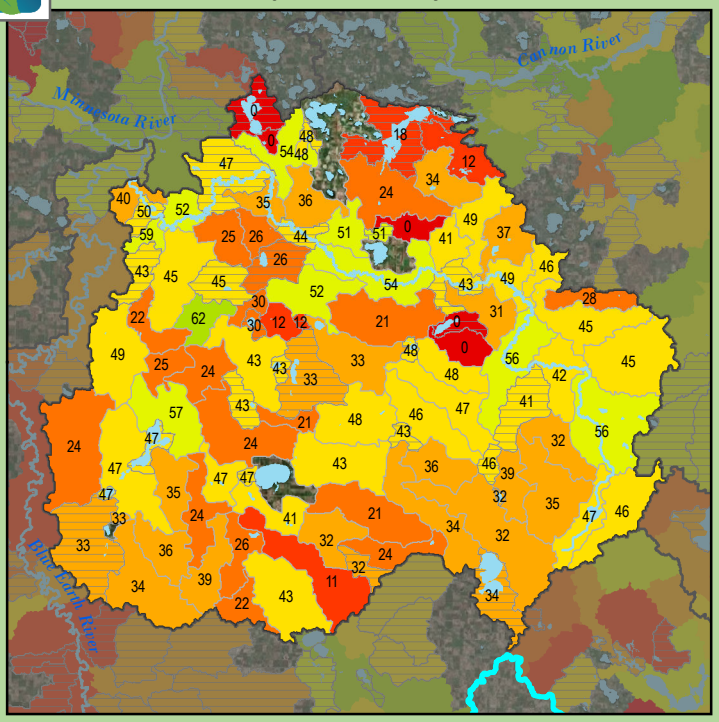
Stream Species Quality - Aquatic Invertebrate IBI



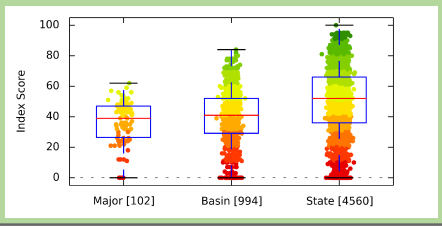
Health Score Distributions:
Le Sueur River
- Min: 2
- Max: 69
- Median: 38.0
- Mean: 38.78
- Standard Dev: 14.16



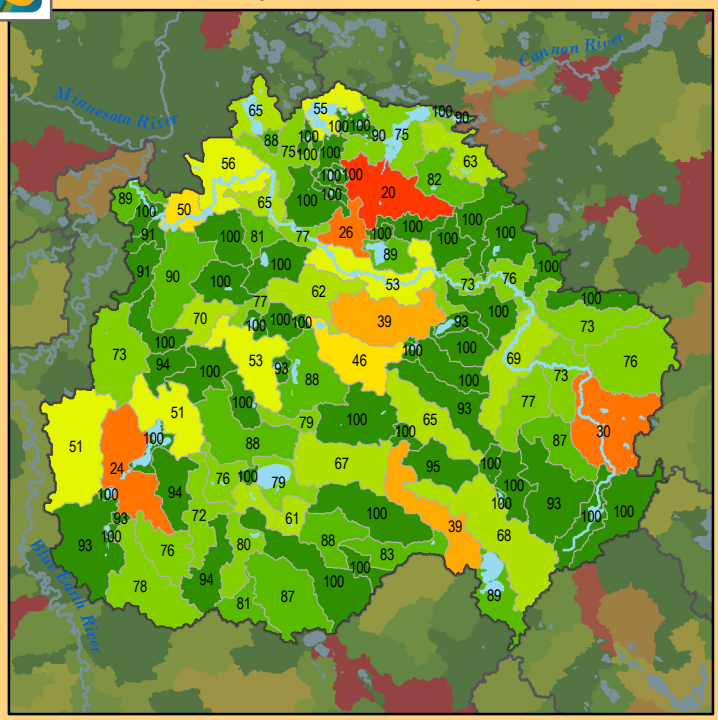
Stream Species Quality - Fish IBI



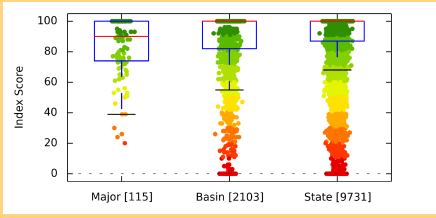
Health Score Distributions:
Le Sueur River
- Min: 0
- Max: 62
- Median: 39.0
- Mean: 36.21
- Standard Dev: 13.9



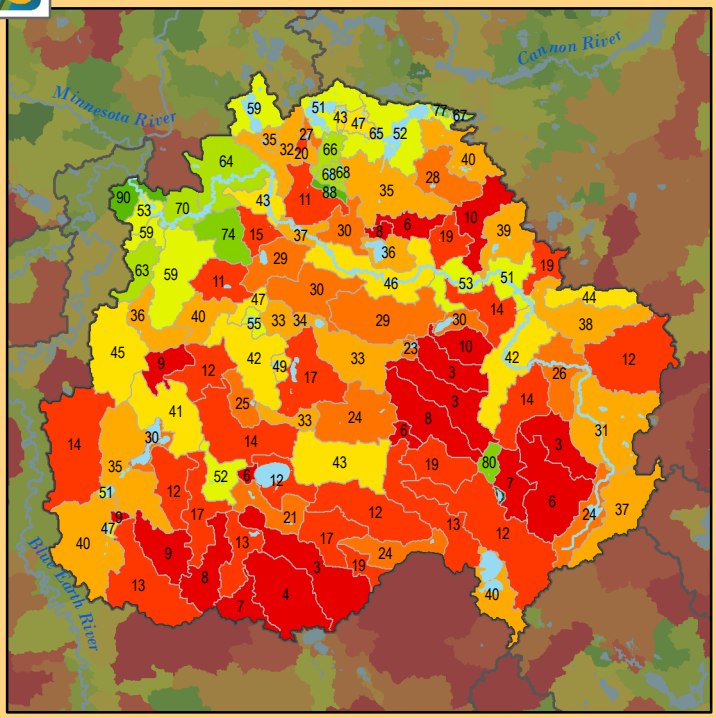
Aquatic Connectivity



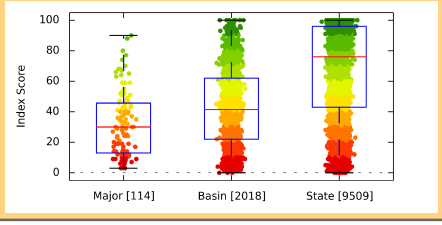
Health Score Distributions:
Le Sueur River
- Min: 20
- Max: 100
- Median: 90.0
- Mean: 83.65
- Standard Dev: 19.55



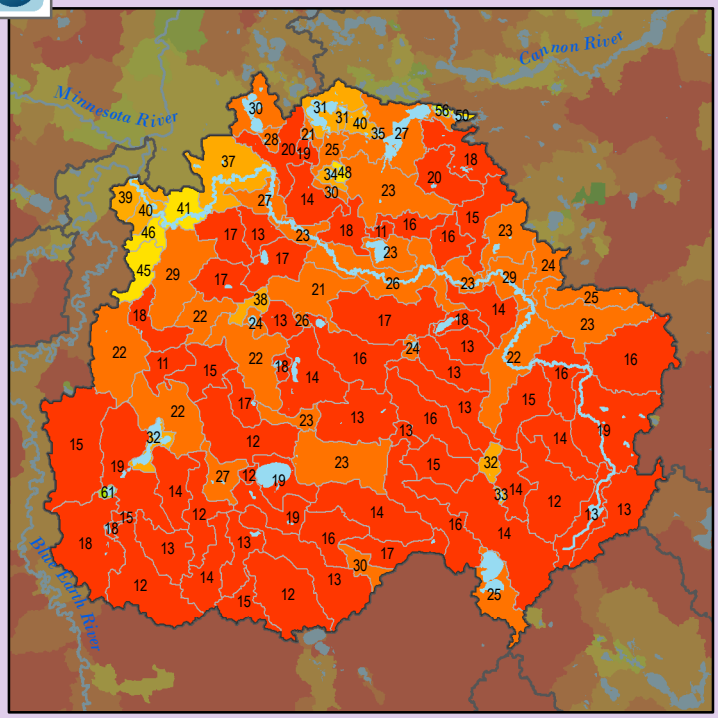
Riparian Connectivity



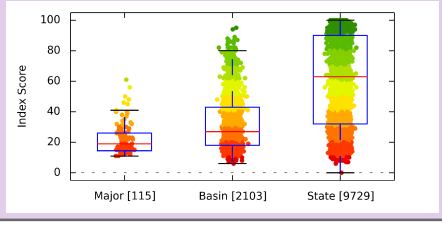
Health Score Distributions:
Le Sueur River
- Min: 3
- Max: 90
- Median: 30.0
- Mean: 32.23
- Standard Dev: 21.05



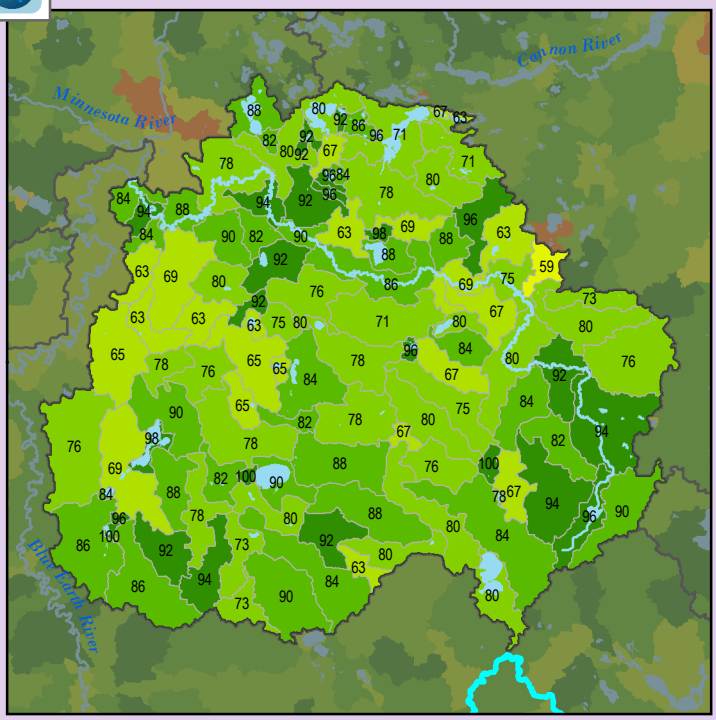
Non-Point Source - Phosphorus Risk



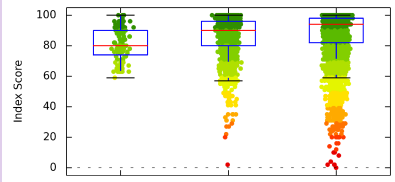
Health Score Distributions:
Le Sueur River
- Min: 11
- Max: 61
- Median: 19.0
- Mean: 22.03
- Standard Dev: 10.06



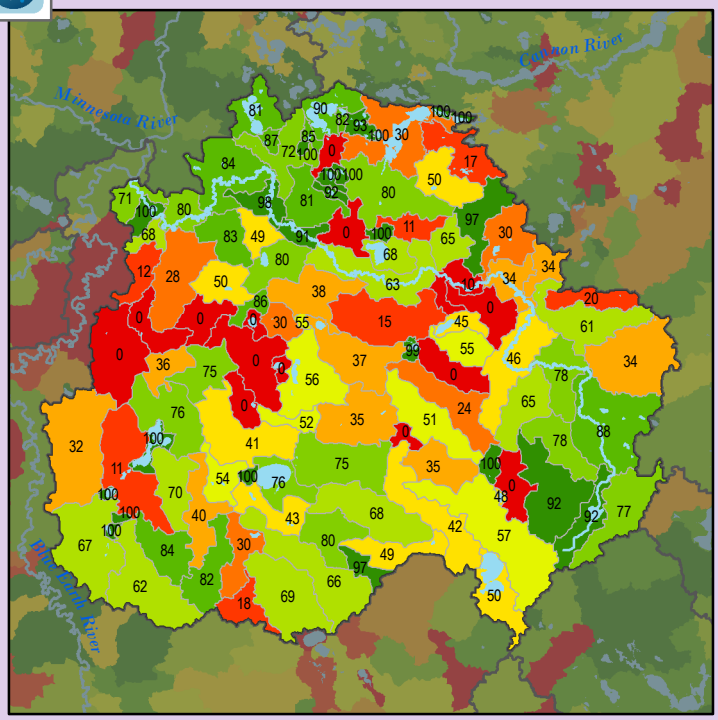
Localized Pollution Sources



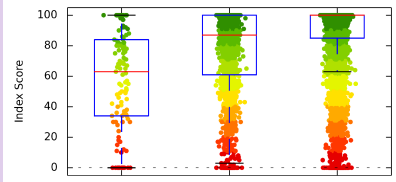
Health Score Distributions:
Le Sueur River
- Min: 59
- Max: 100
- Median: 80.0
- Mean: 81.17
- Standard Dev: 10.57



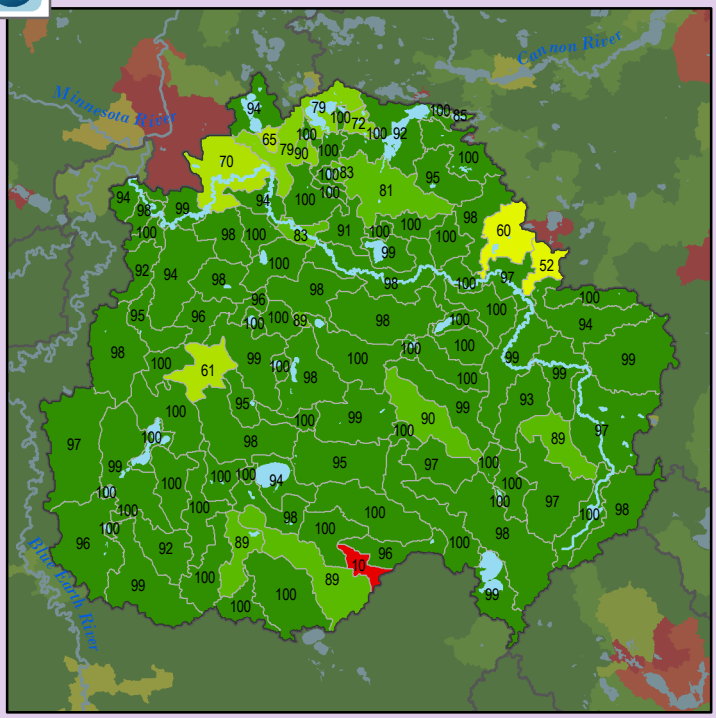
Localized Pollution Sources - Animal Units



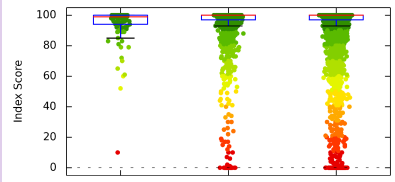
Health Score Distributions:
Le Sueur River
- Min: 0
- Max: 100
- Median: 63.0
- Mean: 57.29
- Standard Dev: 32.55



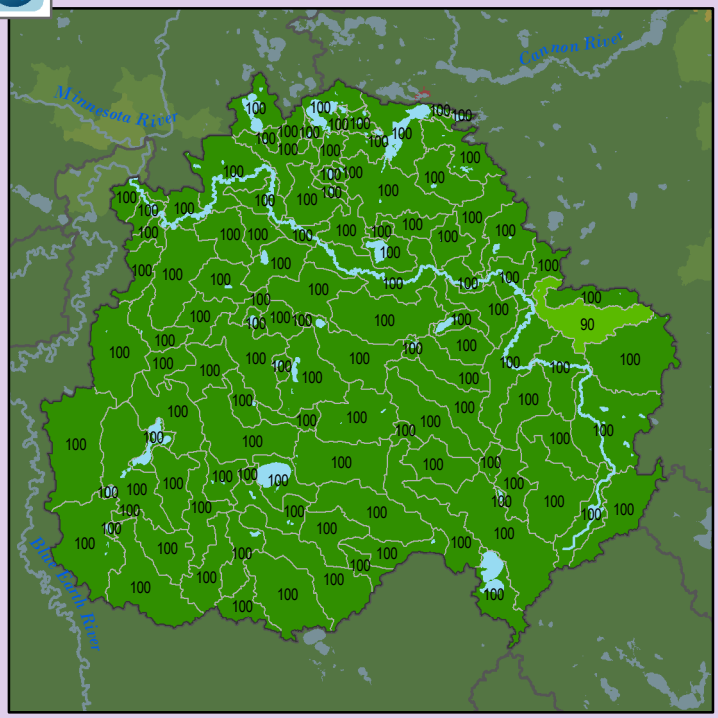
Localized Pollution Sources - Potential Contaminants



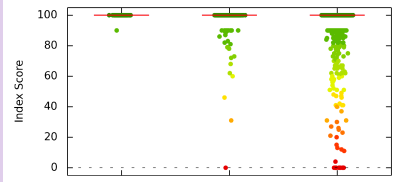
Health Score Distributions:
Le Sueur River
- Min: 10
- Max: 100
- Median: 99.0
- Mean: 94.37
- Standard Dev: 11.91



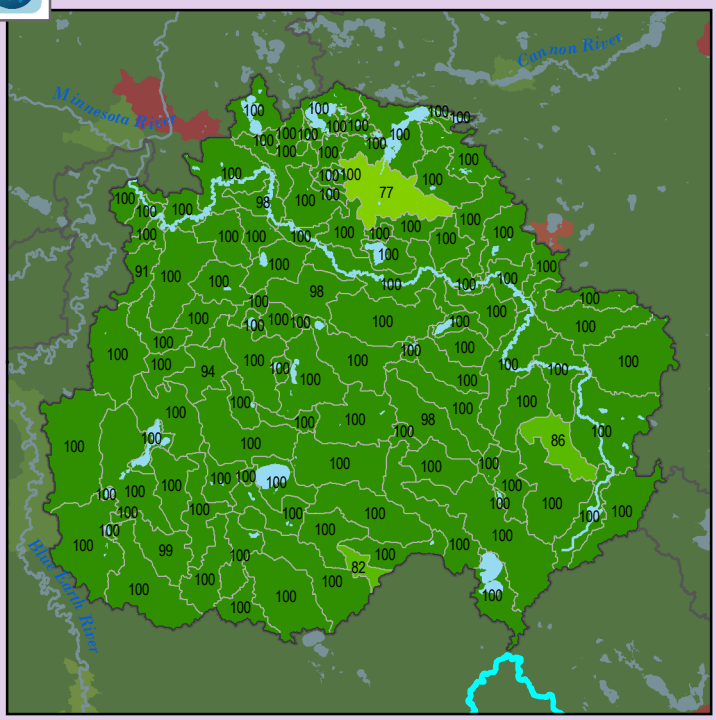
Localized Pollution Sources - Superfund Sites



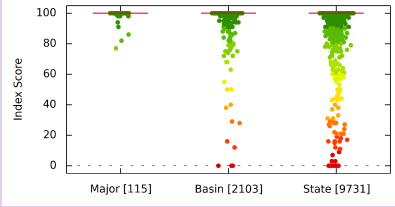
Health Score Distributions:
Le Sueur River
- Min: 90
- Max: 100
- Median: 100.0
- Mean: 99.91
- Standard Dev: 0.93



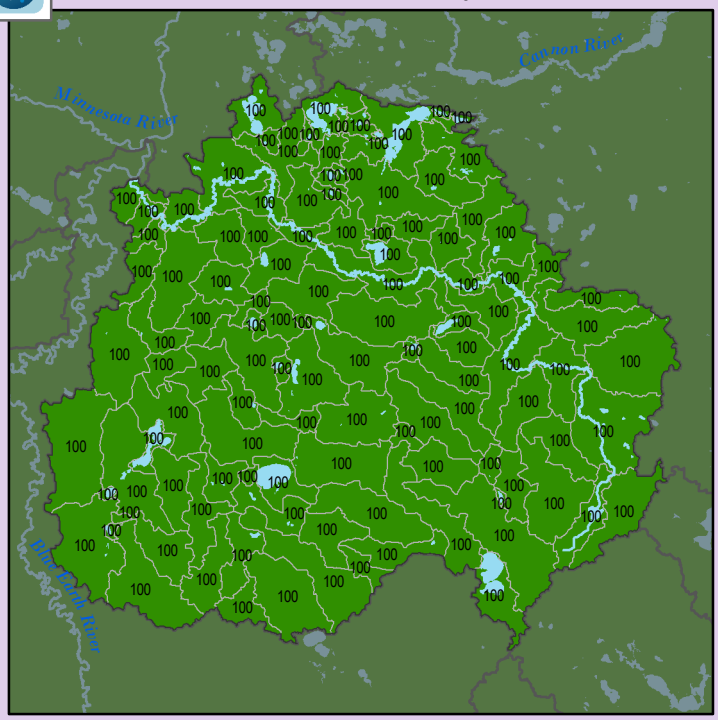
Localized Pollution Sources - Wastewater Treatment



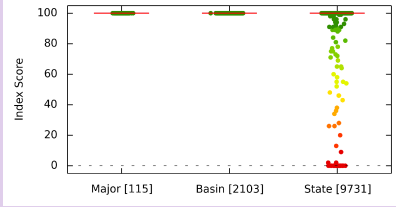
Health Score Distributions:
Le Sueur River
- Min: 77
- Max: 100
- Median: 100.0
- Mean: 99.33
- Standard Dev: 3.13



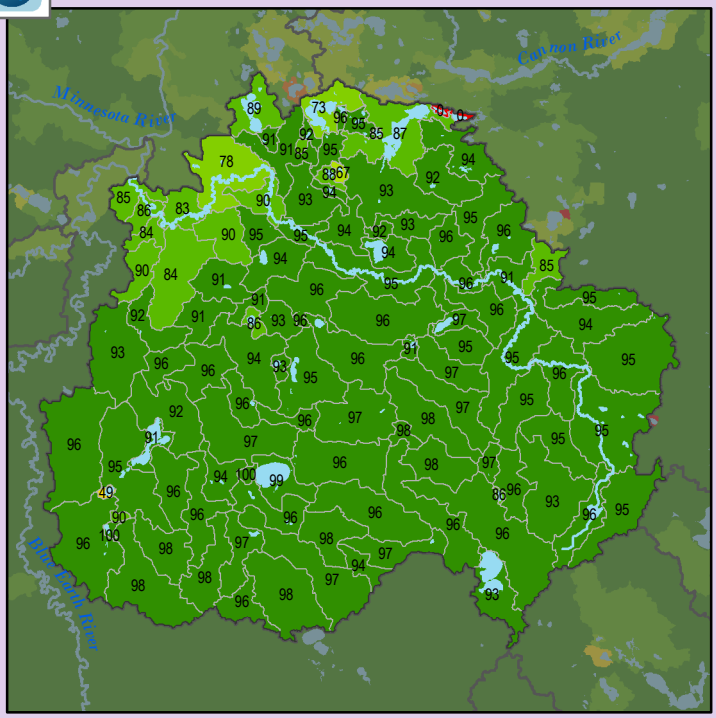
Localized Pollution Sources - Open Pit Mines



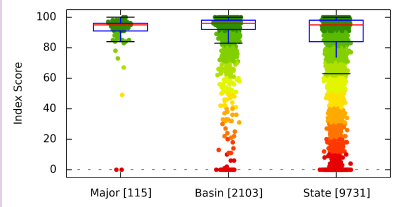
Health Score Distributions:
Le Sueur River
- Min: 100
- Max: 100
- Median: 100.0
- Mean: 100.0
- Standard Dev: 0.0



Localized Pollution Sources - Septic Systems

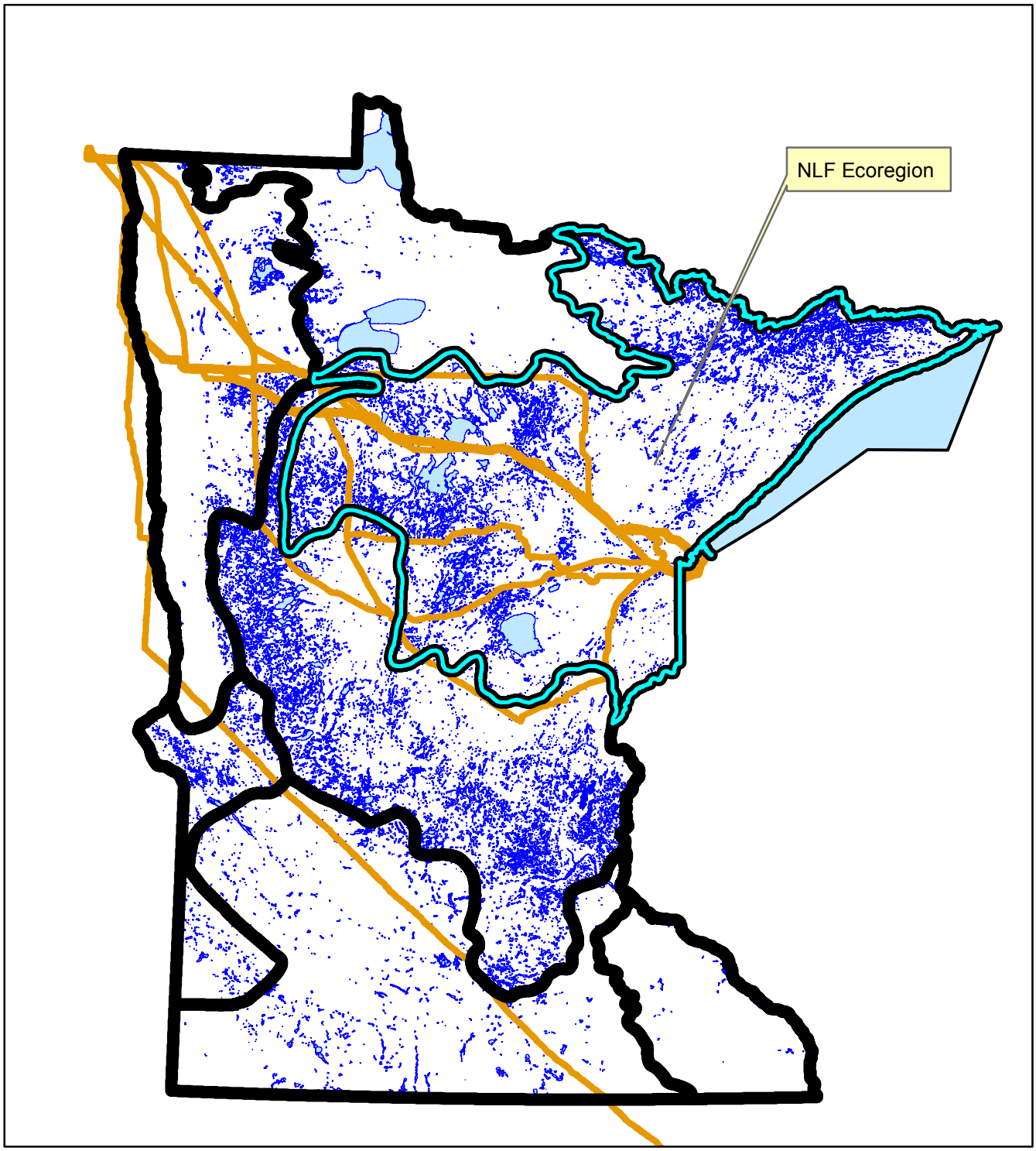


Health Score Distributions:
Le Sueur River
- Min: 0
- Max: 100
- Median: 95.0
- Mean: 91.22
- Standard Dev: 13.76



Appendix J-2

Lake Distribution Among Ecoregions-Routes



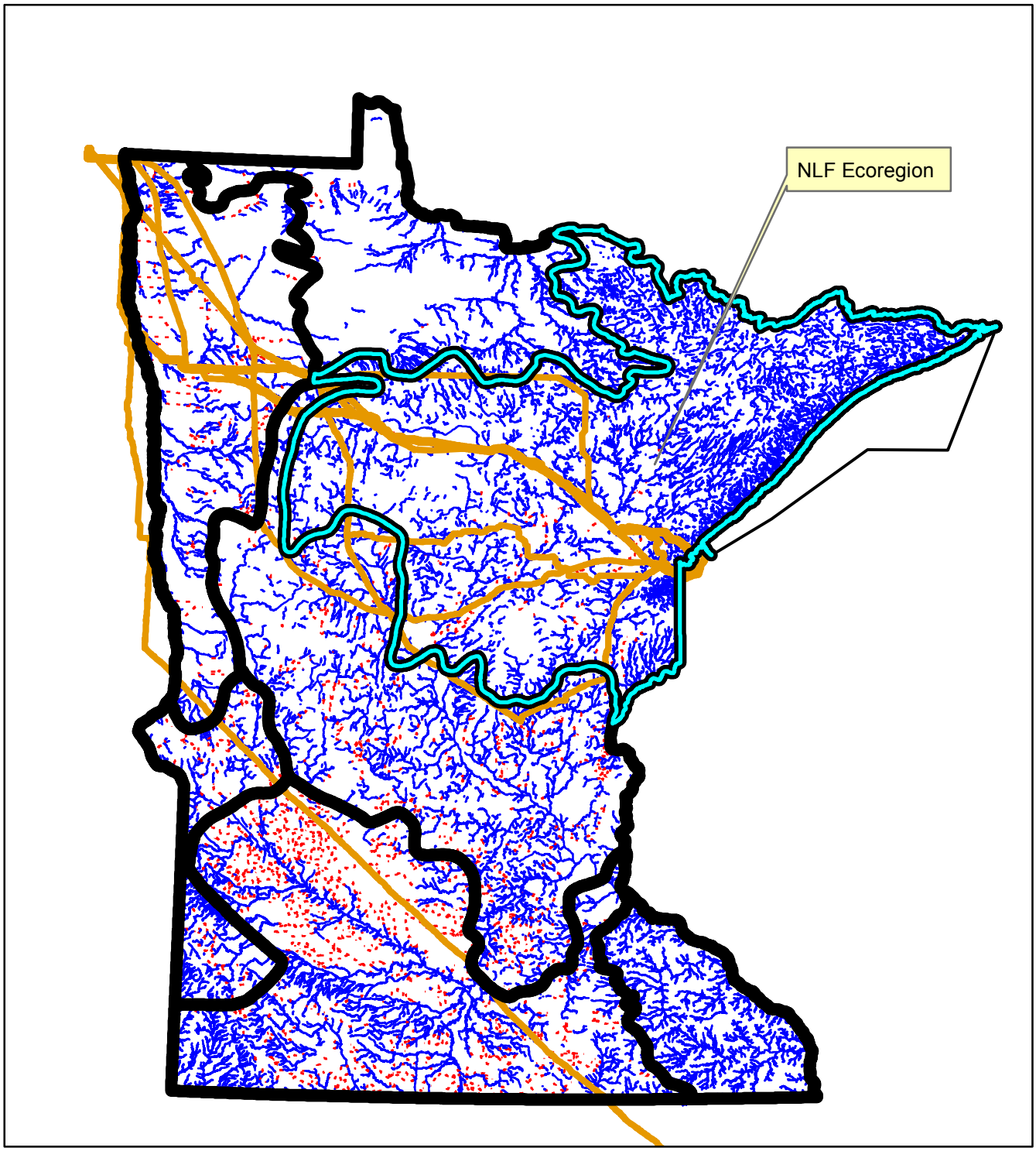
Legend

- mn_eco_l3
- Final_Rail_Routes_Buffer
- Final_Truck_Routes_Buffer
- RA
- Public Waters Basins

MNDNR

Appendix J-3

Stream Distribution Among Ecoregions-Routes



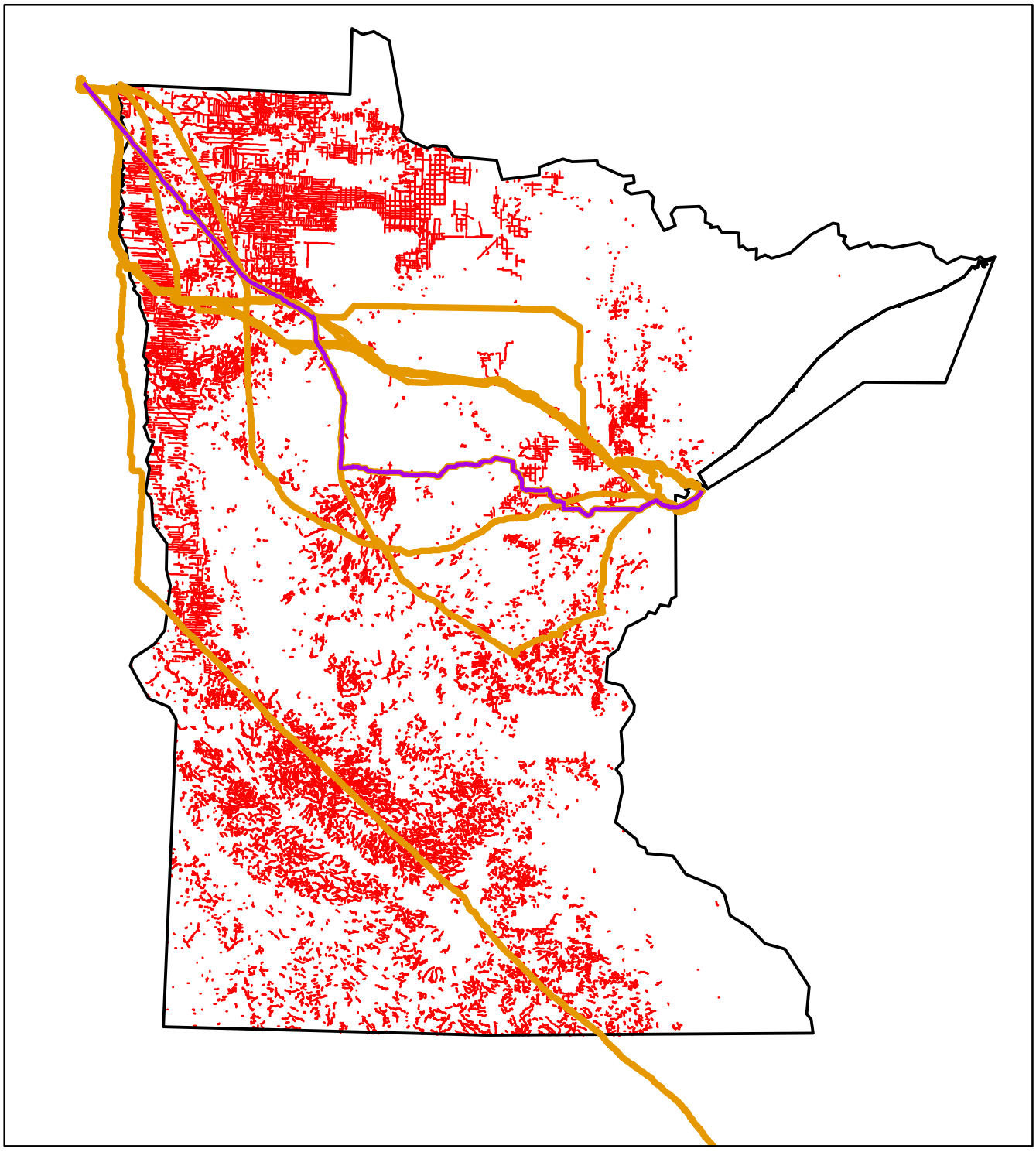
Legend

- mn_eco_l3
- Final_Rail_Routes_Buffer
- Final_Truck_Routes_Buffer
- RA
- Public Water Watercourse
- Public Ditch/Altered Natural Watercourse

MNDNR

Appendix J-4

Distribution of MN Ditches (Source DOT)



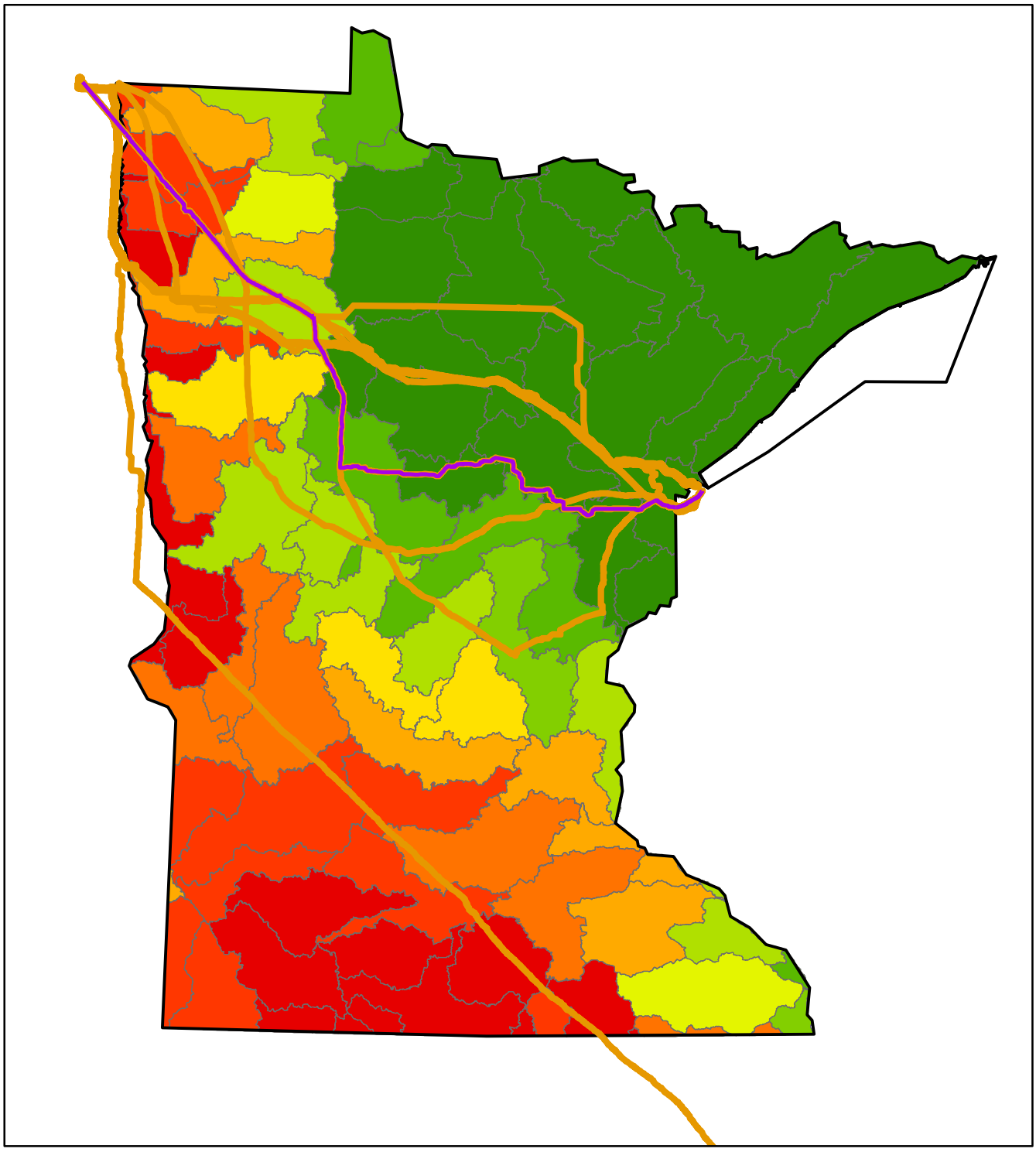
Legend

- Applicants_Preferred_Route
- Final_Rail_Routes_Buffer
- Final_Truck_Routes_Buffer
- RA
- Reduced Resolution Boundary > 1:3,000,000
- Drainage Ditches

MNDNR

Appendix J-5

Distribution of MN Ditches (Source DOT)



Legend

- Applicants_Preferred_Route
- Final_Rail_Routes_Buffer
- Final_Truck_Routes_Buffer
- RA
- Reduced Resolution Boundary > 1:3,000,000

Legend

Hyd Index - Perennial Cover, 2011

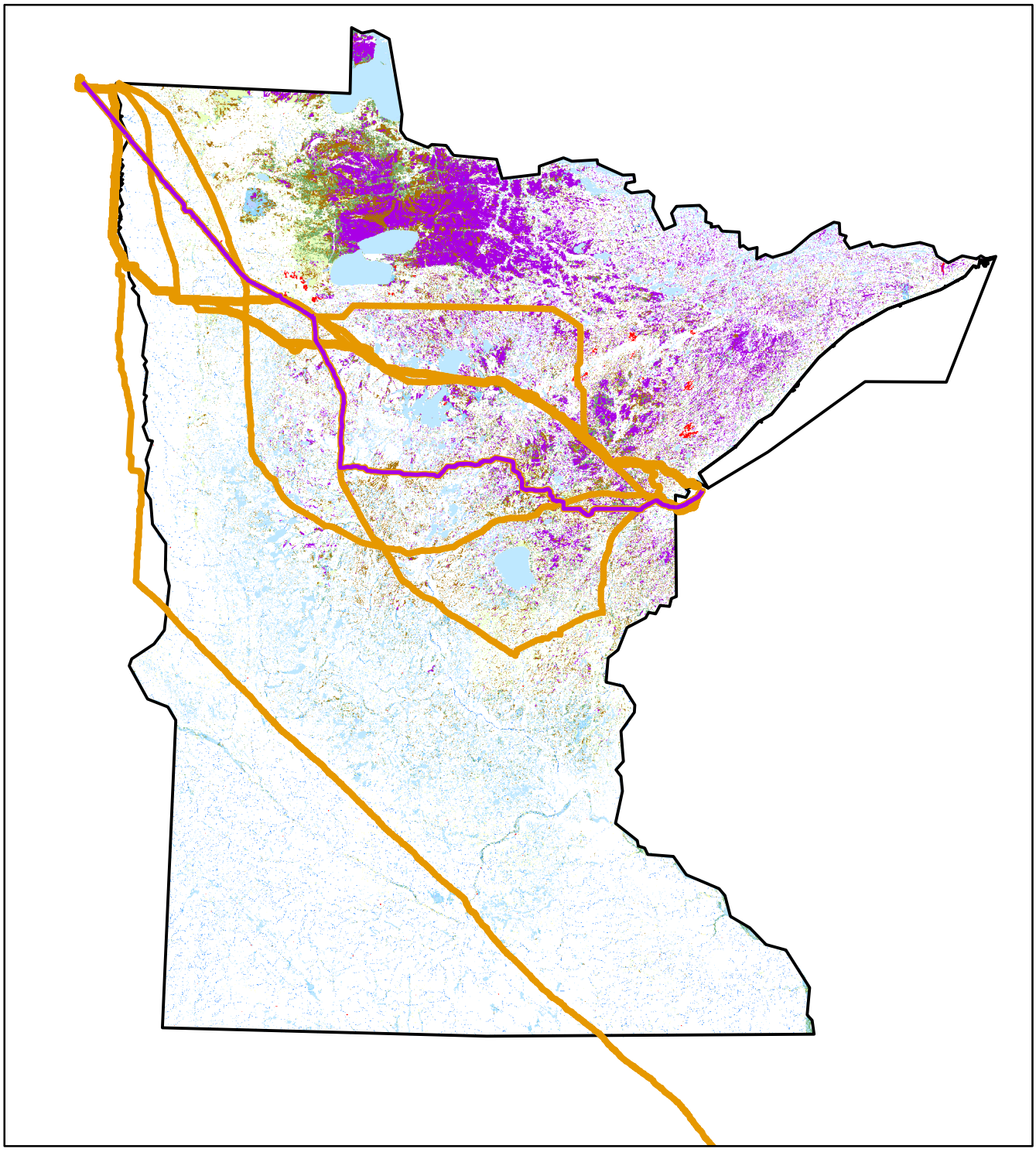
Major_Scores.H_I_PC

- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100

MNDNR

Appendix J-6

Wetland Distribution Circular 39



Legend

- Applicants_Preferred_Route
- Final_Rail_Routes_Buffer
- Final_Truck_Routes_Buffer
- RA
- Reduced Resolution Boundary > 1:3,000,000

Legend

National Wetlands Inventory Raster

NWI Circular 39 Classification

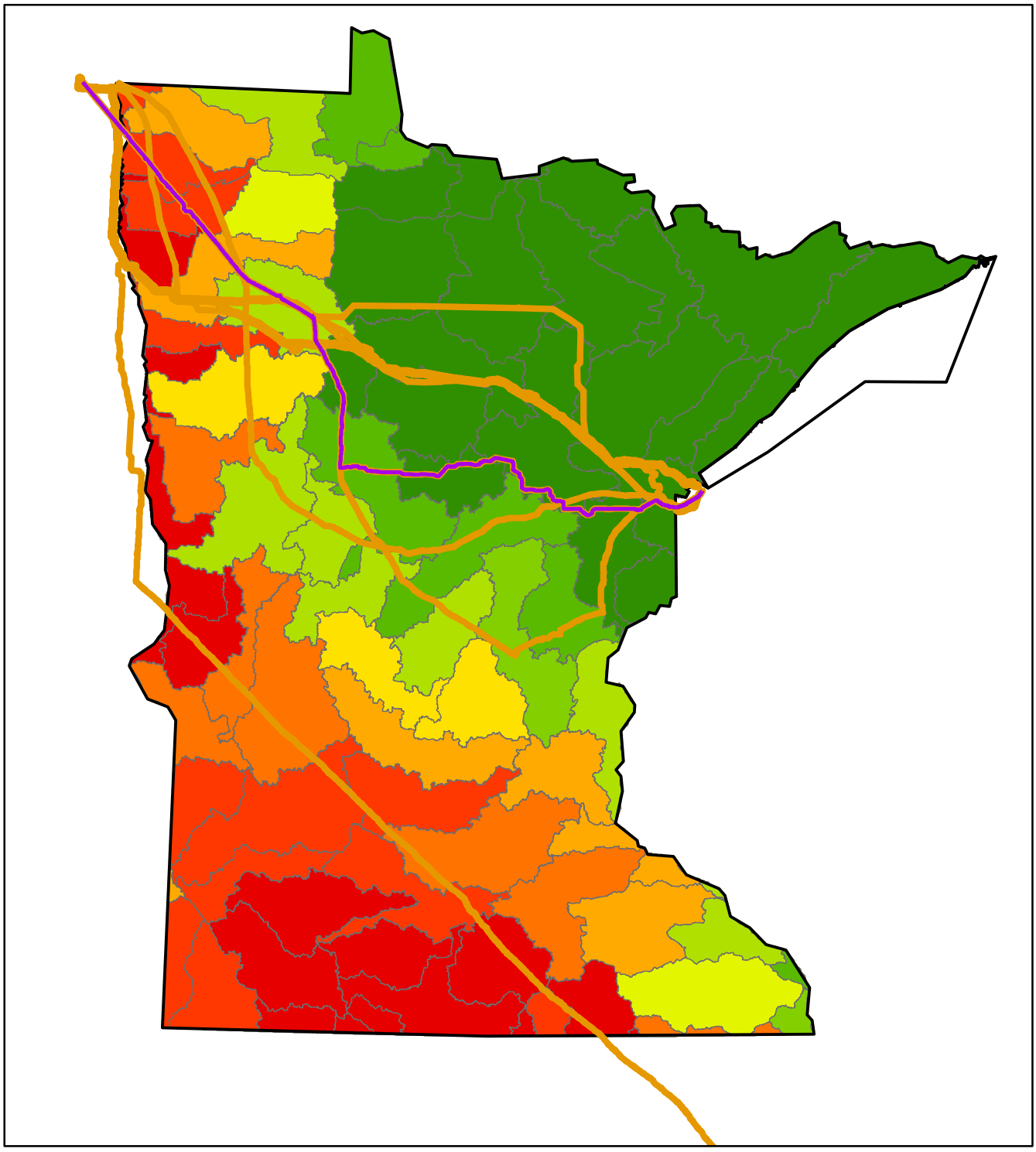
- Seasonally Flooded Basin or Flat
- Wet Meadow
- Shallow Marsh
- Deep Marsh
- Shallow Open Water
- Shrub Swamp
- Wooded Swamp
- Bog
- Municipal and Industrial
- Riverine System

Legend

MNDNR

Appendix J-7

Loss of Hydrologic Storage, Wetland Loss



Legend

- Applicants_Preferred_Route
- Final_Rail_Routes_Buffer
- Final_Truck_Routes_Buffer
- RA
- Reduced Resolution Boundary > 1:3,000,000

Legend

Hyd Index - Perennial Cover, 2011

Major_Scores.H_I_PC

- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100

Legend

MNDNR

Appendix K

Vegetation Tables

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Table K-1. Minnesota Ecological Sections Crossed by the Applicant's Preferred Route and Route Alternatives (miles)

Province	Section	Subsection	Applicant's Preferred Route		Route Alternatives[a]			
			Total within Minnesota	Between Clearbrook and Carlton	RA-03AM	RA-06	RA-07	RA-08
Prairie Parklands	Red River Valley	Red River Prairie	35.1					
Prairie Parklands subtotal								
Tallgrass Aspen Parklands	Lake Agassiz, Aspen Parklands	Aspen Parklands	61.6					
Tallgrass Aspen Parklands subtotal								
Eastern Broadleaf Forest	Minnesota & NE Iowa Morainal	Anoka Sand Plain			10.7			
		Hardwood Hills	20.9	8.5	24.0	9.6	6.2	6.4
Eastern Broadleaf Forest subtotal			***20.9***	***8.5***	***34.7***	***9.6***	***6.2***	***6.4***
Laurentian Mixed Forest	N. Minnesota & Ontario Peatlands	Littlefork-Vermillion Uplands				21.2		
	N. Minnesota Drift & Lake Plains	Chippewa Plains	31.5	31.5	31.5	54.9	87.3	87.9
		Pine Moraines & Outwash Plains	94.7	94.7	78.3			
		St. Louis Moraines	36.6	36.6		29.2	16.0	13.2
		Tamarack Lowlands	31.3	31.3		29.4	37.6	37.0
	Northern Superior Uplands	Nashwauk Uplands				30.9		
		North Shore Highlands				17.0	17.0	16.9
	Southern Superior Uplands	Glacial Lake Superior Plain	7.1					
	Western Superior Uplands	Mille Lacs Uplands	20.8	18.2	130.2	3.7	3.7	3.6
Laurentian Mixed Forest subtotal			***222.1***	***212.4***	***240.0***	***186.3***	***161.6***	***158.5***
TOTAL			**339.6**	**220.9**	**274.7**	**195.9**	**167.7**	**164.8**

Source: Minnesota DNR 2016a.

Notes: Blank = no occurrence.

[a] Route alternatives between Clearbrook and Carlton, Minnesota.

"-" = no occurrence

Table K-2. Noxious Weeds and Invasive Plants near the Applicant's Preferred Route and Route Alternatives

Common Name	Scientific Name	Minnesota Status[d]	Applicant's Preferred Route[a]		Route Alternatives[c]			
			Total within Minnesota	Between Clearbrook and Carlton[b]	RA-03AM	RA-06	RA-07	RA-08
Alyssum, Hoary	*Berteroa incana*		1	1	1			7
Buckthorn, Common	*Rhamnus cathartica*	RNW			18			
Creeping Charlie	*Glechoma hederacea*				1			
Daisy, Oxeye	*Leucanthemum vulgare*		5	5	5	5	26	12
Elm, Siberian	*Ulmus pumila*				1			4
Grass, Amur silver	*Miscanthus sacchariflorus*						1	
Grass, Reed canary	*Phalaris arundinacea*		66	65	14	106	316	208
Grass, Smooth brome	*Bromus inermis*		14	14	14	1		9
Hawkweed, Orange	*Hieracium aurantiacum*		3	3	7		1	
Honeysuckle, Exotic	*Lonicera* spp.		1	1	2		1	
Knapweed, Spotted	*Centaurea stoebe*	PNW	48	47	53	21	110	56
Knotweed, Giant	*Polygonum sachalinense*	SRP						1
Locust, Black	*Robinia pseudoacacia*						4	
Loosestrife, Purple	*Lythrum salicaria*	PNW					4	2
Maple, Amur	*Acer ginnala*				1		4	1
Mullein, Common	*Verbascum thapsus*				1			
Parsnip, Wild	*Pastinaca sativa*	PNW				6	128	50
Peashrub, Siberian	*Caragana arborescens*		1	1	4	2	5	4
Rose, Multi-Flora	*Rosa multiflora*	RNW					2	2
Spurge, Leafy	*Euphorbia esula*	PNW	1				4	
Sweetclover, White	*Melilotus alba*		7	7	9	12	43	37

Table K-2. Noxious Weeds and Invasive Plants near the Applicant's Preferred Route and Route Alternatives

Common Name	Scientific Name	Minnesota Status[d]	Applicant's Preferred Route[a]		Route Alternatives[c]			
			Total within Minnesota	Between Clearbrook and Carlton[b]	RA-03AM	RA-06	RA-07	RA-08
Sweetclover, Yellow	*Melilotus officinalis*		5	5	5	2		2
Tansy	*Tanacetum vulgare*	PNW	115	107	76	108	150	152
Thistle	*Various*		92	92	34	117	117	60
Thistle, Bull	*Cirsium vulgare*		14	14	23	1	1	2
Thistle, Canada	*Cirsium arvense*	PNW	18	18	29	17	34	29
Thistle, Plumeless	*Carduus acanthoides*	PNW	1	1				
Thistle, Sow	*Sonchus arvensis*		9	9	1			
Trefoil, Birdsfoot	*Lotus corniculatus*		12	11	11	10	50	27
Vetch, Cow	*Vicia cracca*				1			
Vetch, Crown	*Coronilla varia*				3		1	
Number of Taxa			18	17	23	13	20	19
Total Number of Occurrences			**413**	**401**	**314**	**408**	**1,002**	**665**

Sources: Minnesota DNR 2016d; Minnesota DA 2016.

Notes: Blank = no occurrence.

[a] Number of occurrences of infestations within 0.5 mile from the Applicant's preferred route within Minnesota.

[b] Number of occurrences of infestations within 0.5 mile from the Applicant's preferred route between Clearbrook and Carlton, Minnesota.

[c] Number of occurrences of infestations within 0.5 mile from the route alternatives between Clearbrook and Carlton, Minnesota.

[d] PNW – prohibited noxious weed; RNW – regulated noxious weed; SRP – specially regulated plants

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Table K-3. Estimated Impacts on Vegetation Cover for the Applicant's Preferred Route in Minnesota(acres)

Vegetation Cover Class	Con[a]	Op[a]	ATWS	Access Roads	Pump Stations	Valves	Total[b]	
							Con	Op
Minnesota								
Evergreen Forest	175.8	70.7	18.2	18.6	0.5	0.5	197.9	86.4
Deciduous Forest	1,349.2	594.0	96.8	102.6	2.4	2.1	1,477.1	670.0
Mixed Forest	18.2	7.8	1.4	2.3			19.7	10.0
Scrub/Shrub	225.8	111.5	15.2	13.1	2.1		242.5	125.3
Grassland/Herbaceous	129.8	62.1	32.4	8.7	3.5	0.2	164.1	72.5
Hay/Pasture	577.2	258.7	120.7	45.4	15.7	1.2	698.7	320.2
Cultivated Crops	1,335.5	574.6	326.9	22.3	20.1	1.8	1,664.5	616.8
Woody Wetlands	336.0	169.6	17.7	13.0	3.0	0.5	355.3	184.6
Emergent Herbaceous Wetlands	229.2	122.4	18.9	7.1	3.0	0.1	249.2	131.5
Barren Land	3.6	1.7	8.1	0.6			11.7	2.4
TOTAL	**4,380.3**	**1,973.2**	**656.2**	**233.8**	**50.2**	**6.6**	**5,080.8**	**2,219.5**

Source: Homer et al. 2015.

Notes:

Values in table may not sum to subtotals and totals due to rounding. Blank = no occurrence.

[a] Con = Enbridge-provided construction work area, which includes 50-foot-wide permanent right-of-way; Op = operations right-of-way

[b] Total: Con = sum of Enbridge-provided construction work area, ATWS (additional temporary workspace including pipe yards), and temporary access roads; Op = sum of Enbridge-provided pipeline permanent right-of-way, permanent access roads, pump stations, and valves

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Table K-4. Minnesota Native Plant Community Systems for the Applicant's Preferred Route

Native Plant Community System	MBS Site Biodiversity Significance Rank[a]	Con[b]		Op[b]		Facilities				Totals[c]				Within 0.5 Mile[d]	
						Con		Op		Con		Op			
		Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Acid Peatland System	High	2.4	3	1.2	3					2.4	3	1.2	3	339.5	23
Complex community	Moderate	5.8	2	3.1	2					5.8	2	3.1	2	288.4	5
	High													135.2	7
Fire-Dependent Forest/Woodland System	Moderate	28.7	9	13.7	9	3.5	19	3.5	6	32.2	28	17.2	15	1,817.4	59
	High					0.3	1			0.3	1			276.5	24
	Outstanding							1.5	2			1.5	2	267.3	32
Forested Rich Peatland System	Moderate	4.9	5	4.6	5	0.1	1			5.0	6	4.6	5	442.1	19
	High	17.6	6	9.0	6			0.7	2	17.6	6	9.7	8	650.1	32
	Outstanding	3.5	2	1.8	2					3.5	2	1.8	2	27.0	1
Marsh System	Moderate													0.0	1
	Outstanding													197.2	29
Mesic Hardwood Forest System	Moderate	42.7	7	19.0	7	12.0	37	2.1	5	54.7	44	21.1	12	1,393.5	28
	High	9.0	7	4.0	7	0.2	2			9.2	9	4.0	7	565.7	30
	Outstanding													128.9	30
Open Rich Peatland System	Moderate	5.5	7	4.3	7	0.0	3			5.5	10	4.3	7	514.5	16
	High													7.1	1
	Outstanding													49.5	3
Upland Prairie System	Moderate	1.7	1	0.7	1	0.3	1			2.0	2	0.7	1	43.9	1
	High													92.5	3
	Outstanding													37.1	6

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Table K-4. Minnesota Native Plant Community Systems for the Applicant's Preferred Route

Native Plant Community System	MBS Site Biodiversity Significance Rank[a]	Con[b]		Op[b]		Facilities				Totals[c]				Within 0.5 Mile[d]	
						Con		Op		Con		Op			
		Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Wet Forest System	Moderate	2.8	3	1.9	3	0.1	1			2.9	4	1.9	3	207.2	8
	High	6.2	4	2.8	4	0.6	3			6.8	7	2.8	4	206.2	18
	Outstanding													51.6	11
Wet Meadow/Carr System	Moderate	4.7	16	4.1	11					4.7	16	4.1	11	765.2	106
	High	0.5	1	0.3	1	10.5	11			11.0	12	0.3	1	177.3	19
	Outstanding							0.0	1			0.0	1	35.4	35
Wetland Prairie System	High													164.5	8
Total		**135.9**	**73**	**70.5**	**68**	**27.7**	**79**	**7.9**	**16**	**163.6**	**152**	**78.4**	**84**	**8,880.9**	**555**

Sources: Minnesota DNR 2016b, Minnesota DNR 2016e.

Notes:

Values in table may not sum to subtotals and totals due to rounding. Blank = no occurrence, 0.0 = <0.1.

[a] Systems occurring within Minnesota Biological Survey (MBS) Sites of Biodiversity Significance are given these ranks:
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for Outstanding, High, or Moderate rank.

[b] Con = Enbridge-provided construction work area, which includes 50-foot-wide permanent right-of-way; Op = operations right-of-way

[c] Totals: Con = sum of Enbridge-provided construction work area, ATWS (additional temporary workspace including pipe yards), and temporary access roads; Op = sum of Enbridge-provided pipeline permanent right-of-way, permanent access roads, pump stations, and valves

[d] Within 0.5 mile = Minnesota native plant community systems within 0.5-mile buffer centered on the route

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Table K-5. Rare Native Plant Communities for the Applicant's Preferred Route

Native Plant Community	MBS Site Biodiversity Significance Rank[a]	Conser-vation Rank[b]	Con[c]		Op[c]		Additional Impacts[d]				Total Impacts[e]				Within 0.5 Mile[f]	
							Con		Op		Con		Op			
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Alder – (Red Currant – Meadow-Rue) Swamp	Outstanding	S3													1.9	2
	(blank)	S3													0.0	1
Black Ash – (Red Maple) Seepage Swamp	High	S1S2	5.1	2	2.4	2	0.6	3			5.7	5	2.4	2	65.5	5
Calcareous Fen (Northwestern)	High	S2													7.1	1
Graminoid Poor Fen (Basin)	High	S3													11.5	3
Jack Pine – (Bush Honeysuckle) Woodland	Moderate	S1/S2/S3	10.3	5	5.4	5	1.4	5	2.3	4	11.7	10	7.7	9	714.5	22
Jack Pine – (Bush Honeysuckle) Woodland, Bracken Subtype	High	S1					0.3	1			0.3	1			68.2	2
Jack Pine – (Yarrow) Woodland	High	S1S2													30.4	1
Mesic Brush-Prairie (Northern)	High	S2													92.5	3
	Outstanding	S2													33.1	4
Mesic Prairie (Northern)	Moderate	S2	1.7	1	0.7	1	0.3	1			2.0	2	0.7	1	43.9	1
	Outstanding	S2													4.1	2
Oak – Aspen Forest	Below	S3	6.3	1	2.6	1	0.9	4	0.0	1	7.2	5	2.6	2	60.2	1
	Moderate	S3	16.4	3	7.2	3	2.1	13	1.2	2	18.0	12	8.4	5	1,024.4	34
	High	S3													87.8	2
	Outstanding	S3							0.8	1			0.8	1	128.1	15
	(blank)	S3													0.1	2
Red Pine – White Pine Forest	Moderate	S2													43.9	1
	High	S2													49.8	13
	Outstanding	S2							0.7	1			0.7	1	5.1	1
Red Pine – White Pine Woodland, Balsam Fir Subtype	High	S3													22.9	3

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Table K-5. Rare Native Plant Communities for the Applicant's Preferred Route

Native Plant Community	MBS Site Biodiversity Significance Rank[a]	Conser-vation Rank[b]	Con[c]		Op[c]		Additional Impacts[d]				Total Impacts[e]				Within 0.5 Mile[f]	
							Con		Op		Con		Op			
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Red Pine – White Pine Woodland, Mountain Maple Subtype	High	S3													10.2	2
Spikerush – Bur Reed Marsh (Northern)	Moderate	S2													0.0	1
	Outstanding	S2													12.5	23
	(blank)	S2													0.4	7
Sugar Maple – Basswood – (Bluebead Lily) Forest	High	S3													97.9	2
Tamarack Seepage Swamp (Aspen Parkland)	Moderate	S3													10.1	1
	Outstanding	S3													27.0	1
Wet Brush-Prairie (Northern)	High	S3													64.5	5
Wet Prairie (Northern)	High	S3													100.0	3

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Table K-5. Rare Native Plant Communities for the Applicant's Preferred Route

Native Plant Community	MBS Site Biodiversity Significance Rank[a]	Conser-vation Rank[b]	Con[c]		Op[c]		Additional Impacts[d]				Total Impacts[e]				Within 0.5 Mile[f]	
							Con		Op		Con		Op			
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
White Pine – White Spruce – Paper Birch Forest	High	S2	0.6	3	0.3	3	0.0	1			0.6	4	0.3	3	59.9	9
Total			**40.4**	**15**	**18.6**	**15**	**5.6**	**28**	**5.1**	**9**	**45.5**	**39**	**23.6**	**24**	**2,877.6**	**173**

Sources: Minnesota DNR 2016b, 2016d, 2016e.

Notes:

Values in table may not sum to subtotals and totals due to rounding. Blank = no occurrence, 0.0 = <0.1.

[a] Native plant communities occurring within Minnesota Biological Survey (MBS) Sites of Biodiversity Significance are given these ranks:
Outstanding = Sites containing the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes.
High = Sites containing very good quality occurrences of the rarest species, high quality examples of rare native plant communities, and/or important functional landscapes.
Moderate = Sites containing occurrences of rare species and/or moderately disturbed native plant communities, and/or landscapes that have a strong potential for recovery.
Below = Sites below minimum biodiversity threshold for statewide significance. These sites lack occurrences of rare species or natural features or do not meet Minnesota Biological Survey standards for Outstanding, High, or Moderate rank.

[b] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation

[c] Con = Enbridge provided construction work area, which includes 50-foot-wide permanent right-of-way; Op = operations right-of-way.

[d] Additional Impacts = footprints for additional temporary workspace (ATWS), pipe yards, access roads, valve pads and driveways, and pump stations

[e] Total Impacts = Con = sum of Enbridge-provided construction work area, ATWS (including pipe yards), and temporary access roads; Op = sum of Enbridge-provided pipeline permanent right-of-way, permanent access roads, pump stations, and valves

[f] Within 0.5 mile = rare native plant communities within 0.5-mile buffer centered on the route

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Table K-6. Estimated Impacts on Vegetation Cover for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota

Vegetation Cover	Applicant's Preferred Route[a]		Route Alternatives							
			RA-03AM[b]		RA-06[b]		RA-07[c]		RA-08[b]	
	Con	Op	Con	Op	Con	Op	Con	Op	Con	Op
Evergreen Forest	173.4	69.6	145.4	60.1	102.6	42.6	234.5	37.0	106.4	43.7
Deciduous Forest	1,255.5	554.0	975.1	403.1	797.7	332.9	772.6	177.1	591.8	245.5
Mixed Forest	17.5	7.4	13.5	5.7	164.2	68.3	139.4	27.9	74.6	30.5
Scrub/Shrub	210.6	104.3	190.5	80.2	251.4	104.2	276.9	83.4	123.8	51.8
Grassland/Herbaceous	93.5	45.0	142.8	60.6	115.5	49.2	404.8	107.0	81.3	34.5
Hay/Pasture	388.1	175.2	1,030.6	432.9	213.2	89.2	325.5	88.4	303.9	128.2
Cultivated Crops	173.4	76.4	565.2	237.7	43.0	18.0	76.3	23.1	31.7	13.2
Woody Wetlands	316.6	158.8	194.7	78.1	732.2	304.2	1,055.9	236.1	651.1	270.2
Emergent Herbaceous Wetlands	174.0	95.3	315.1	133.5	223.3	94.0	536.1	154.2	318.6	134.7
Barren Land	3.6	1.7	5.1	2.2	30.5	12.8	10.4	3.2	2.8	1.1
Total	**2,806.4**	**1,287.8**	**3,578.0**	**1,494.1**	**2,673.6**	**1,115.4**	**3,832.3**	**937.4**	**2,286.0**	**953.5**

Source: Homer et al. 2015

Notes:

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way

[b] Con = estimated 120-foot-wide construction work area centered on route, includes the 50-foot-wide permanent right-of-way; Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

[c] Con = estimated 205-foot-wide construction work area with 10-feet-wide on the north side of Line 3 and 195-feet-wide on the south side of Line 3; Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

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Table K-7. Estimated Impacts on Native Plant Community Systems for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota

Native Plant Community System	MBS Site Biodiversity Significance Rating	Applicant's Preferred Route[a]						Route Alternative RA-03AM[b]						Route Alternative RA-06[b]						Route Alternative RA-07[c]						Route Alternative RA-08[b]					
		Con		Op		0.5 mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 mile		Con		Op		Within 0.5 Mile	
		Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Acid Peatland System	Moderate											76.6	15																		
	High	2.4	3	1.2	3	339.5	23					1.1	1	8.6	2	3.7	2	290.1	8	27.3	2	3.4	1	493.7	14	37.2	9	15.9	8	2,580.0	42
Complex community	Moderate							0.0	1			68.5	12																		
	High					24.1	3																								
Fire-Dependent Forest/ Woodland System	Moderate	26.7	8	12.6	8	1,785.6	58	20.2	14	8.1	10	1,777.7	66							2.7	1			217.0	4					148.2	4
	High					269.3	23					255.9	22					9.5	1					9.5	1					9.5	1
	Outstanding					133.2	16					133.3	17																		
Floodplain Forest System	High											0.1	1																		
Forested Rich Peatland System	Moderate	4.9	5	4.6	5	432.0	18	2.2	8	0.6	4	531.9	36							8.4	1			264.2	4	2.3	1	0.4	1	412.9	9
	High	17.6	6	9.1	6	650.1	32	2.5	2	1.0	1	33.1	5	9.9	4	3.5	3	429.0	19	14.3	3	0.3	1	436.1	18	2.0	2	0.6	1	330.4	14
Marsh System	Moderate					0.0	1					40.7	3																		
	High											3.2	1																		
	Outstanding					12.5	23					12.5	23																		
Mesic Hardwood Forest System	Moderate	42.7	7	19.0	7	1,393.5	28	32.7	7	15.7	5	2,331.9	34																	3.5	1
	High	9.0	7	4.0	7	565.7	30	0.9	4	0.3	3	403.2	20	0.4	2	0.0	1	62.9	9	2.5	3	0.0	1	62.9	9	3.9	3	1.6	2	229.1	26
	Outstanding					128.9	30					128.9	30																		
Open Rich Peatland System	Moderate	5.5	7	4.3	7	514.5	16	8.4	10	3.3	7	648.5	27											48.4	2	2.9	2	1.2	2	168.2	4
	Outstanding					1.3	1					1.3	1																		
Upland Prairie System	High											3.7	1																		
Wet Forest System	Moderate	2.8	3	1.9	3	164.7	7	5.3	5	2.2	5	199.7	14																		
	High	6.2	4	2.8	4	190.9	17	5.6	2	2.4	2	128.4	8	0.6	2			233.0	10	9.0	3			233.0	11	1.3	1	0.6	1	301.2	10
	Outstanding					4.6	10					4.6	10																		
Wet Meadow/Carr System	Moderate	4.7	16	4.1	11	765.2	106	6.1	11	1.8	9	664.4	109							0.7	1			39.2	3					39.2	3
	High	0.5	1	0.3	1	177.3	19	2.6	2	1.1	2	247.1	21					3.3	1					3.3	1	0.4	1	0.2	1	11.7	2
	Outstanding					35.4	35					35.5	37																		
TOTAL		**122.9**	**67**	**63.8**	**62**	**7,588.4**	**496**	**86.5**	**66**	**36.4**	**48**	**7,732.1**	**514**	**19.5**	**10**	**7.3**	**6**	**1,027.7**	**48**	**64.9**	**14**	**3.8**	**3**	**1,807.2**	**67**	**50.1**	**19**	**20.6**	**16**	**4,233.9**	**116**

Sources: Minnesota DNR 2016b, 2016e

Notes:

Totals may not sum exactly due to rounding. Blank = no occurrence, 0.0 = < 0.1.

[a] Con = Enbridge-provided footprint for construction work area, Op = Enbridge-provided footprint for permanent right-of-way

[b] Con = estimated 120-foot-wide construction work area centered on route, includes the 50-foot-wide permanent right-of-way,
Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

[c] Con = estimated 205-foot-wide construction work area with 10-feet-wide on the north side of Line 3 and 195-feet-wide on the south side of Line 3,
Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

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Table K-8. Estimated Impacts on Rare Native Plant Communities for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota

Native Plant Communities	MBS Site Biodiversity Significance Rating	Conservation Rank[x]	Applicant's Preferred Route[a]						Route Alternative RA-03AM[b]						Route Alternative RA-06						Route Alternative RA-07[c]						Route Alternative RA-08[b]					
			Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile	
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Alder – (Red Currant – Meadow-Rue) Swamp	Outstanding	S3					1.9	2					1.9	2																		
	(blank)	S3					0.0	1					0.0	1																		
Aspen – Birch – Fir Forest	Moderate	S3																													3.5	1
Basswood – Black Ash Forest	Moderate	S3											85.2	2																		
	High	S3											41.8	1																		
Black Ash – (Red Maple) Seepage Swamp	High	S1S2	5.1	2	2.4	2	65.5	5	5.6	2	2.4	2	65.5	5																		
Black Ash – Silver Maple Terrace Forest	High	S3											0.1	1																		
Black Ash – Yellow Birch – Red Maple – Basswood Swamp (Eastcentral)	Moderate	S3							0.2	1	0.0	1	65.4	6																		
Dry Sand – Gravel Oak Savanna (Southern)	High	S1S2											3.7	1																		
Graminoid Poor Fen (Basin)	High	S3					11.5	3																								
Jack Pine – (Bush Honeysuckle) Woodland	Moderate	S1/S2/S3	10.3	5	5.4	5	714.5	22					48.6	3																		
Jack Pine – (Bush Honeysuckle) Woodland, Bracken Subtype	High	S1					68.2	2					68.2	2																		
Jack Pine – (Yarrow) Woodland	Moderate	S1S2																			2.7	1			160.7	2					100.7	2
	High	S1S2					30.4	1					30.4	1																		
Oak – Aspen Forest	Below	S3	6.3	1	2.6	1	60.2	1																								
	Moderate	S3	16.4	3	7.2	3	1,024.4	34	13.7	3	7.2	3	1,019.6	33											56.3	2					47.5	2
	High	S3					87.8	2					70.3	1																		
	Outstanding	S3					128.1	15					128.2	16																		
	(blank)	S3					0.1	2					0.1	2																		
Pin Oak – Bur Oak Woodland	Moderate	S3											40.3	1																		
	High	S3											14.0	1																		
Red Pine – White Pine Forest	Moderate	S2					43.9	1					43.9	1																		
	High	S2					49.8	13					49.8	13							-	-	-	-	-	-	-	-	-	-	-	-
	Outstanding	S2					5.1	1					5.1	1							-	-	-	-	-	-	-	-	-	-	-	-
Red Pine – White Pine Woodland, Balsam Fir Subtype	High	S3					22.9	3					22.9	3							-	-	-	-	-	-	-	-	-	-	-	-
Red Pine – White Pine Woodland, Mountain Maple Subtype	High	S3					10.2	2					0.3	1							-	-	-	-	-	-	-	-	-	-	-	-
Spikerush – Bur Reed Marsh (Northern)	Moderate	S2					0.0	1					0.0	1							-	-	-	-	-	-	-	-	-	-	-	-
	Outstanding	S2					12.5	23					12.5	23							-	-	-	-	-	-	-	-	-	-	-	-
	(blank)	S2					0.4	7					0.4	7							-	-	-	-	-	-	-	-	-	-	-	-
Sugar Maple – Basswood – (Bluebead Lily) Forest	High	S3					97.9	2																								
White Pine – White Spruce – Paper Birch Forest	High	S2	0.6	3	0.3	3	59.9	9	0.7	3	0.3	3	59.9	9																		
TOTAL			**38.7**	**14**	**17.9**	**14**	**2,495.3**	**152**	**20.3**	**9**	**9.9**	**9**	**1,878.3**	**138**							**2.7**	**1**			**217.0**	**4**					**151.8**	**5**

Table K-8. Estimated Impacts on Rare Native Plant Communities for the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota

Native Plant Communities	MBS Site Biodiversity Significance Rating	Conservation Rank[x]	Applicant's Preferred Route[a]						Route Alternative RA-03AM[b]						Route Alternative RA-06						Route Alternative RA-07[c]						Route Alternative RA-08[b]					
			Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile		Con		Op		Within 0.5 Mile	
			Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.

Sources: Minnesota DNR 2016b, 2016e

Notes:

RA-06 contains no rare native plant communities. Totals may not sum exactly due to rounding. Blank = no occurrence, 0.0 = < 0.1.

[x] S1 = critically imperiled, S2 = imperiled, S3 = vulnerable to extirpation

[a] Con = Enbridge-provided footprint for construction work area, Op = Enbridge-provided footprint for permanent right-of-way

[b] Con = estimated 120-foot-wide construction work area centered on route, includes the 50-foot-wide permanent right-of-way
Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

[c] Con = estimated 205-foot-wide construction work area with 10-feet-wide on the north side of Line 3 and 195-feet-wide on the south side of Line 3
Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

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Table K-9. Occurrence of Old-Growth Forests along the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (acres and number)

Main Cover Type	Applicant's Preferred Route[a]			Route Alternatives											
				RA-03AM[b]			RA-06[b]			RA-07[c]			RA-08[b]		
	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile	Con	Op	Within 0.5 Mile
Ash			13.0 (2)												
Aspen									24.7 (1)			16.8 (1)			23.3 (2)
Birch									23.1 (1)						3.1 (1)
Northern Hardwoods															11.5 (2)
White Pine															22.0 (3)
Norway Pine			0.4 (1)			0.4 (1)			34.3 (2)	0.1 (1)	-	43.5 (3)			
White Cedar												28.3 (1)	2.1 (1)	0.9 (1)	28.6 (2)
TOTAL			**13.4 (3)**			**0.4 (1)**			**82.1 (4)**	**0.1 (1)**		**88.5 (5)**	**2.1 (1)**	**0.9 (1)**	**88.4 (10)**

Source: Minnesota DNR 2016c.

Notes:

Old-growth forest as identified by Timber Status = 5 (designated old growth) and 7 (potential or future old growth); area in acres is followed by the number of stands in parentheses; blank = no occurrence.

[a] Con = Enbridge-provided footprint for construction work area; Op = Enbridge-provided footprint for permanent right-of-way

[b] Con = estimated 120-foot-wide construction work area centered on route, includes the 50-foot-wide permanent right-of-way; Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

[c] Con = estimated 205-foot-wide construction work area with 10-feet-wide on the north side of Line 3 and 195-feet-wide on the south side of Line 3; Op = estimated operations area based on 50-foot-wide permanent right-of-way centered on route

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Appendix L

Fish and Wildlife Tables

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Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Blackhoof River (S-001-003)	MN 408.1	RA-03AM	1	1	1	1	1	1									
Cat River (M-096-028)	MN 211.9	RA-03AM				1		1									
Cat River (M-096-028)	MN 213.2	RA-03AM					1										
Clearwater River (H-026-030-019)	MN 149.2	RA-06							1	1	1						
Clearwater River (H-026-030-019)	MN 151.2	RA-07										1	1	1			
Fawn Creek (M-096-018)	MN 238.2	RA-03AM				1	1	1									
Hay Creek (M-096-020-001)	MN 235	RA-03AM				1	1	1									
King Creek (M-050-046-029-023)	MN 344.2	Applicant's preferred route	1	1	1												
King Creek (M-050-046-029-023)	MN 400.4	RA-03AM						1									
LaSalle Creek (M-163)	MN 171.4	RA-03AM			1			1									
LaSalle Creek (M-163)	MN 171.7	RA-03AM	1	1	1	1	1	1									
Little Otter Creek (S-002-009-001)	MN 301.5	RA-08															1

Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Little Otter Creek (S-002-009-001)	MN 332.3	RA-06									1			1			
Little Otter Creek (S-002-009-001)	MN 333.3	RA-06							2	1	1	2	1	1	2	1	1
Mission Creek (M-050-044-006)	MN 355.9	RA-03AM				1	1	1									
Necktie River (M-146-017-001)	MN 173.3	RA-07												1			1
Necktie River (M-146-017-001)	MN 176.4	RA-07										1	1	1			1
Necktie River (M-146-017-001)	MN 177	RA-08													1	1	1
Necktie River (M-146-017-001-B010)	MN 173.7	RA-07												1			1
O'Brien Creek (H-026-030-069-004)	MN 172.6	RA-06							1	1	1						
Otter Creek (S-002-009)	MN 295	RA-08									1			1			1
Otter Creek (S-002-009)	MN 298.5	RA-07									1			1			
Pine River, South Fork (M-106-013)	MN 232.7	Applicant's preferred route			1												

Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Spring Brook (M-106-004-002-001)	MN 265.3	Applicant's preferred route	1	1	2												
Spring Creek (H-026-030-069-003-004)	MN 182.1	RA-06									1						
Spring Creek (M-050-046-010-001)	MN 360.7	RA-03AM						1									
Straight River (M-096-035-002-002)	MN 198.3	Applicant's preferred route	1	1	1	1	1	1									
Unnamed Creek (H-026-030-019-024.35)	MN 150.4	RA-06									1						
Unnamed Creek (H-026-030-019-024.4)	MN 149.1	RA-06									1						
Unnamed Creek (H-026-030-019-024.45)	MN 148.5	RA-06									1						
Unnamed Creek (H-026-030-019-024.5)	MN 148.2	RA-06									1						
Unnamed Creek (H-026-030-019-025.1)	MN 151.1	RA-07										1	1	1			

Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Unnamed Creek (H-026-030-069-004-007)	MN 173.1	RA-06									1						
Unnamed Stream (H-001-030-023-002-010-001)	MN 243.6	RA-06									1						
Unnamed Stream (H-001-030-023-002-010-001-001)	MN 243.6	RA-06							1	1	1						
Unnamed Stream (H-001-030-023-002-010-001-001-001)	MN 243.7	RA-06									1						
Unnamed Stream (H-001-030-023-002-010-002)	MN 243.2	RA-06									1						
Unnamed Stream (H-001-030-023-002-010-003)	MN 243.3	RA-06									1						
Unnamed Stream (M-050-046-029-023-002)	MN 344.8	Applicant's preferred route			1												
Unnamed Stream (M-050-046-029-029)	MN 406.3	RA-03AM			1			1									
Unnamed Stream (M-096-020-001-002)	MN 234.9	RA-03AM						1									

Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Unnamed Stream (M-096-020-001-003)	MN 233.6	RA-03AM						1									
Unnamed Stream (M-106-013-008)	MN 232.4	Applicant's preferred route			1												
Unnamed Stream (M-146-017-001-001)	MN 173.9	RA-08										2	1	1	2	1	1
Unnamed Stream (M-146-017-001-002)	MN 172.7	RA-08													1	1	
Unnamed Stream (M-146-017-001-002)	MN 173	RA-08															1
Unnamed Stream (M-146-017-001-002)	MN 173.3	RA-07										1	1	1			1
Unnamed Stream (M-146-017-001-003)	MN 172.9	RA-07												1			1
Unnamed Stream (S-001-003-027.8)	MN 408.1	RA-03AM			1			1									
Unnamed Stream (S-001-003-028)	MN 352.1	Applicant's preferred route			1			1									

Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Unnamed Stream (S-001-003-029)	MN 352.3	Applicant's preferred route	1	1	1	1	1	1									
Unnamed Stream (S-001-003-030)	MN 352.7	Applicant's preferred route			1			1									
Unnamed Stream (S-001-003-030-001)	MN 408.7	RA-03AM			1			1									
Unnamed Stream (S-001-003-030-001-B001)	MN 408.8	RA-03AM			1			1									
Unnamed Stream (S-002-009-001-000.4)	MN 301.3	RA-08									1			1	1		1
Unnamed Stream (S-002-009-001-000.5)	MN 333.3	RA-06									1			1			1
Unnamed Stream (S-002-009-001-001)	MN 332.3	RA-06									2			2			1
Unnamed Stream (S-002-009-001-002)	MN 330.4	RA-06									1			1			1
Unnamed Stream (S-002-009-001-002-001)	MN 298.5	RA-08									1			1			1

Table L-1. Trout Streams Potentially Affected by the Applicant's Preferred Route and Route Alternatives between Clearbrook and Carlton, Minnesota (number)

Trout Streams – Kittle Name (Kittle Number)	Near Milepost	Near Route	Applicant's Preferred Route			Route Alternative RA-03AM			Route Alternative RA-06			Route Alternative RA-07			Route Alternative RA-08		
			Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile	Con	Op	0.5 mile
Unnamed Stream (S-002-009-001-003)	MN 298.3	RA-08									1			1			2
Unnamed Stream (S-002-032-011)	MN 283.6	RA-06							1	1	1						
Venning Creek (H-001-030-023-002-010)	MN 242.7	RA-06							1	1	1						
Venning Creek (H-001-030-023-002-010-B001)	MN 243.5	RA-06									1						
Venning Creek (H-001-030-023-002-010-B002)	MN 243.6	RA-06									1						
TOTAL			**6**	**6**	**17**	**8**	**8**	**19**	**7**	**6**	**28**	**8**	**6**	**19**	**7**	**4**	**18**

Source: Minnesota DNR 2015a.

Notes:

Con = construction; Op = operations; SA = study area number of occurrences (potential crossings) based on 1 mile wide corridor

Table L-2. Lakes of Biological Significance within 0.5 mile of the Applicant's Preferred Route in Minnesota and Route Alternatives between Clearbrook and Carlton, Minnesota (acres)

LBS Class	Watershed	DNR Hydrology ID	Area (acres)	Shoreline (miles)	Applicant's Preferred Route		RA-03AM	RA-06	RA-07	RA-08
					ND Border to Clearbrook	Clearbrook to Carlton				
Outstanding	Bass	12592	2,713.6	24.4					27.7	
	Carr	14494	42.4	1.1					24.8	42.4
	Cass	14870	15,958.3	45.4					363.8	
	Dora	13286	429.8	6.7				2.4		
	East Four-Legged	23949	356.6	6.4					84.2	
	Fish	7417	505.8	10.0			13.9			
	Fish Trap	3878	1,163.8	13.1			52.8			
	Grant	15401	213.7	3.7						103.5
	Irving	15390	661.3	5.3					160.0	
	Island	14798	541.2	7.1		41.1	41.1			
	Leech	21722	110,309.9	232.6						9.4
	Marquette	14919	527.6	5.5						129.3
	Mud	11386	210.8	2.5		86.0	86.0			
	Pike Bay	14487	4,751.3	10.7					615.6	64.8
	Rice	29814	77.9	1.7		69.0				
	Roosevelt	14175	1,510.6	18.6		43.5				
	Round	26991	44.4	1.0		12.0				
	Salo WMA Impoundment	8169	312.7	4.6		29.1				
	Shallow	13543	539.0	5.1					196.6	372.4
	Six Mile	14395	1,323.0	7.8						44.3
	Washburn	12488	1,590.2	19.7		5.5				

Table L-2. Lakes of Biological Significance within 0.5 mile of the Applicant's Preferred Route in Minnesota and Route Alternatives between Clearbrook and Carlton, Minnesota (acres)

LBS Class	Watershed	DNR Hydrology ID	Area (acres)	Shoreline (miles)	Applicant's Preferred Route		RA-03AM	RA-06	RA-07	RA-08
					ND Border to Clearbrook	Clearbrook to Carlton				
	Waukenabo	13413	666.1	4.9		5.9				
	West Four-Legged	21300	432.0	8.0					244.3	73.3
	White Oak	13452	942.5	8.5					144.4	368.8
	Winnibigoshish	12798	56,471.6	69.8					61.9	
Outstanding Total						292.1	193.8	2.4	1,923.4	1,208.1
High	Big	12490	529.5	8.1				26.2	26.2	30.3
	Long	12005	132.4	4.1				84.2		
	Upper Twin	14867	212.5	3.2		4.9				
	Wawina	30415	375.5	3.9					166.5	
High Total						4.9		110.4	192.7	30.3
Moderate	Ball Club	14124	4,335.3	19.5					228.3	121.4
	Clear	6913	26.3	0.9			26.3			
	Grass	11897	232.6	3.4					28.2	
	Portage	15124	429.3	5.3		44.4	44.4			
	Twin	14906	168.8	3.2						68.7
	Unnamed	1805	208.8	7.3	111.3					
Moderate Total					111.3	44.4	70.6		256.4	190.1
TOTAL					111.3	341.3	264.4	112.9	2,372.5	1,428.5

Source: Minnesota DNR 2016, Minnesota DNR 2015b

DNR =Minnesota Department of Natural Resources, LBS = Lake of Biological Significance

Notes:

Rank Definitions: Outstanding – Plants: high aquatic plant richness, high floristic quality, and a population of an endangered or threatened plant; important wild rice lakes. Fish: exceptional fishery for selected game fish or an outstanding nongame fish community. Birds: endangered or threatened colonial waterbird nesting area, presence of several endangered, threatened or special concern lake bird species, or six or more lake bird Species of Greatest Conservation Need.

Table L-2. Lakes of Biological Significance within 0.5 mile of the Applicant's Preferred Route in Minnesota and Route Alternatives between Clearbrook and Carlton, Minnesota (acres)

LBS Class	Watershed	DNR Hydrology ID	Area (acres)	Shoreline (miles)	Applicant's Preferred Route		RA-03AM	RA-06	RA-07	RA-08
					ND Border to Clearbrook	Clearbrook to Carlton				

High – Plants: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. Fish: populations of more than one fish of special concern and/or Species of Greatest Conservation Need. Birds: colonial waterbird nesting area, history of endangered or threatened colonial waterbird nesting, presence of endangered, threatened, or special concern lake bird species, or five lake bird Species of Greatest Conservation Need.

Moderate – Plants: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant. Fish: populations of one fish species of special concern and/or fish Species of Greatest Conservation Need. Birds: history of colonial waterbird nesting, presence of an endangered, threatened, or several lake bird Species of Greatest Conservation Need.

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Appendix M

Unique Natural Resources Tables

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Table M-1. Number of Occurrences of Rare Invertebrate Animals for the Applicant's Preferred Route, Existing Line 3, and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
				Con WA	Op ROW	Total[c] Con	Total[c] Op	0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
Arthropods															
A caddisfly	*Anabolia ozburni*	MN	SPC			1		1	1	1					
A jumping spider	*Marpissa formosa*	MN	SPC					1					1		
A jumping spider	*Phidippus pius*	MN	SPC										1		
Iowa skipper	*Atrytone arogos iowa*	MN	SPC										1		
Leadplant flower moth	*Schinia lucens*	MN	SPC										1		
Red-tailed prairie leafhopper	*Aflexia rubranura*	MN	SPC										1		
Redveined prairie leafhopper	*Aflexia rubranura*	IL	THR										1		
Regal fritillary	*Speyeria idalia*	MN	SPC										2		
Regal fritillary	*Speyeria idalia*	IL	THR								1	1	1		
Mollusks															
Black sandshell	*Ligumia recta*	MN	SPC	2	2	2	2	2	2	5	2	2	7		
Black sandshell	*Ligumia recta*	IL	THR								1	1	2		
Butterfly	*Ellipsaria lineolata*	IA	THR										1		
Creek heelsplitter	*Lasmigona compressa*	MN	SPC	3	3	3	3	4	3	4			2		
Creeper	*Strophitus undulatus*	IA	THR										2		
Ellipse	*Venustaconcha ellipsiformis*	MN/IA	THR										2		
Fluted-shell	*Lasmigona costata*	MN	THR	1	1	1	1	1	1	1			1		
Higgins eye	*Lampsilis higginsii*	IL	END								1	1	1		
Monkeyface	*Quadrula metanevra*	MN	THR								1	1	1		
Mucket	*Actinonaias ligamentina*	MN	THR								2	2	4		
Pink heelsplitter	*Potamilus alatus*	ND	NA					1		1					
Pistolgrip	*Tritogonia verrucosa*	MN	END								1	1	1		
Round pigtoe	*Pleurobema sintoxia*	MN	SPC								1	1	1		
Spike	*Elliptio dilatata*	MN	THR								1	1	3		
Yellow sandshell	*Lampsilis teres*	MN/IA	END								1	1	4		
Total Number of Rare Invertebrate Species				**3**	**3**	**4**	**3**	**6**	**4**	**5**	**10**	**10**	**22**	**None**	**None**
Total Occurrences of Rare Invertebrate Animals				**6**	**6**	**7**	**6**	**10**	**7**	**12**	**12**	**12**	**41**	**None**	**None**
Total Occurrences of Endangered Invertebrate Animals				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**6**	**None**	**None**
Total Occurrences of Threatened Invertebrate Animals				**1**	**1**	**1**	**1**	**1**	**1**	**1**	**6**	**6**	**18**	**None**	**None**
Total Occurrences of Special Concern Invertebrate Animals				**5**	**5**	**6**	**5**	**9**	**6**	**11**	**3**	**3**	**17**	**None**	**None**

Sources: Minnesota DNR 2016e; Illinois DNR 2016; Iowa DNR 2016a; North Dakota GFP 2016, Wisconsin DNR 2016.

Table M-1. Number of Occurrences of Rare Invertebrate Animals for the Applicant's Preferred Route, Existing Line 3, and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
				Con WA	Op ROW	Total[c]		0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
						Con	Op								

Notes:

Species listing may occur more than once. Blank = no occurrence.

a State Status: END = Endangered, SPC = Species of Concern, THR = Threatened, NA = not applicable counted as SPC

b Enbridge provided footprints: Con WA = construction work area; Op ROW= operations right-of-way for Minnesota (note within 120-foot-wide construction work area for North Dakota and Wisconsin)

c Minnesota Only: Con = sum of pipeline construction work area, ATWS, Temporary Access Roads; Op = sum of pipeline permanent right-of-way, Permanent Access Roads, Pump Stations, Valves

d Con = Estimated construction impacts in numbers of occurrences acres based on 120-foot-wide construction work area, Op = Estimated operations impacts in numbers of occurrences based on 50-foot-wide right-of-way

e Based on review for presence absence based on available information on general locations for infrastructure

Table M-2. Number of Occurrences of Rare Vertebrate Animals for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
				Con WA	Op ROW	Total[c]		0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
						Con	Op								
Mammals															
Big brown bat	*Eptesicus fuscus*	MN	SPC	4	3	4	3	7		1					
Little brown myotis	*Myotis lucifugus*	MN	SPC	7	6	8	6	11		1					
Northern long-eared bat	*Myotis septentrionalis*	MN	SPC	13	12	16	15	27	1	3					
Northern long-eared myotis	*Myotis septentrionalis*	IL	THR								1	1	2		
Prairie vole	*Microtus ochrogaster*	MN	SPC					1							
Birds															
Acadian flycatcher	*Empidonax virescens*	MN	SPC										1		
Bald eagle	*Haliaeetus leucocephalus*	IL	RemTHR								1	1	4		
Bald eagle	*Haliaeetus leucocephalus*	IA	SPC										2		
Burrowing owl	*Athene cunicularia*	MN	END								1	1	1		
Cerulean warbler	*Setophaga cerulea*	MN	SPC										3		
Chestnut-collared longspur	*Calcarius ornatus*	MN	END										1		
Connecticut warbler	*Oporornis agilis*	WI	SPC					1		1					
Greater prairie-chicken	*Tympanuchus cupido*	MN	SPC	8	6	9	8	11					1		
King rail	*Rallus elegans*	IL	END										1		
Le Conte's sparrow	*Ammodramus leconteii*	WI	SPC					1		1					
Loggerhead shrike	*Lanius ludovicianus*	MN/IL	END										3		
Louisiana waterthrush	*Parkesia motacilla*	MN	SPC										1		
Marbled godwit	*Limosa fedoa*	MN	SPC										1		
Nelson's sparrow	*Ammodramus nelsoni*	MN	SPC	2	2	2	2	2	3	3					
Northern goshawk	*Accipiter gentilis*	MN	SPC					1							
Red-shouldered hawk	*Buteo lineatus*	MN	SPC					1							
Short-eared owl	*Asio flammeus*	MN	SPC	1	1	1+	1	1	1	1					
Trumpeter swan	*Cygnus buccinator*	MN	SPC					2	1	1					
Upland sandpiper	*Batramia longicauda*	IL	END										1		
Yellow rail	*Coturnicops noveboracensis*	MN	SPC						1	1					
Amphibians and Reptiles															
Four-toed salamander	*Hemidactylium scutatum*	MN	SPC					1							
Blanding's turtle	*Emydoidea blandingii*	MN/IA	THR										2		
Blanding's turtle	*Emydoidea blandingii*	IL	END								1	1	3		
North American racer	*Coluber constrictor*	MN	SPC								1	1	2		

Table M-2. Number of Occurrences of Rare Vertebrate Animals for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
				Con WA	Op ROW	Total[c]		0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
						Con	Op								
Ornate box turtle	*Terrapene ornata*	IA/IL	THR								1	1	3		
Plains hog-nosed snake	*Heterodon nasicus*	IL	THR										1		
Smooth softshell	*Apalone mutica*	MN	SPC								1	1	1		
Wood Turtle	*Glyptemys insculpta*	WI	THR					1		1					
Fish															
American brook lamprey	*Lampetra appendix*	IA	THR										1		
Banded killifish	*Fundulus diaphanous*	IL	THR										1		
Black buffalo	*Ictiobus niger*	MN	THR								1	1	1		
Blacknose shiner	*Notropis heterolepis*	IL	END								1	1	1		
Blue sucker	*Cycleptus elongatus*	MN	SPC								1	1	1		
Greater redhorse	*Moxostoma valenciennesi*	IL	END										2		
Least darter	*Etheostoma microperca*	MN	SPC	1	1	1	1	2			1	1	1		
Ozark minnow	*Notropis nubilus*	MN	SPC								1	1	1		
Pallid shiner	*Hybopsis amnis*	IL	END										1		
Pugnose shiner	*Notropis anogenus*	MN	THR	1	1	1	1	1							
Redfin shiner	*Lythrurus umbratilis*	MN	SPC										1		
River redhorse	*Moxostoma carinatum*	IL	THR										1		
Slender madtom	*Noturus exilis*	MN	END										1		
Total Number of Rare Vertebrate Species				**8**	**8**	**8**	**8**	**16**	**5**	**10**	**12**	**12**	**30**	**None**	**None**
Total Occurrences Rare Vertebrate Animals				**37**	**32**	**42**	**37**	**71**	**7**	**14**	**12**	**12**	**47**	**None**	**None**
Total Occurrences Endangered Vertebrate Animals				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**15**	**None**	**None**
Total Occurrences Threatened Vertebrate Animals				**1**	**1**	**1**	**1**	**2**	**0**	**1**	**3**	**3**	**12**	**None**	**None**
Total Occurrences Special Concern Vertebrate Animals				**36**	**31**	**41**	**36**	**69**	**7**	**13**	**6**	**6**	**20**	**None**	**None**

Sources: Minnesota DNR 2016e; Illinois DNR 2016; Iowa DNR 2016a; North Dakota GFP 2016; Wisconsin DNR 2016.

Notes:

Species listing may occur more than once. Blank = no occurrence.

a State Status: END = Endangered, SPC = Species of Concern, THR = Threatened, RemTHR = removed Threatened counted as SPC

b Enbridge provided footprints: Con WA = construction work area; Op ROW= operations right-of-way for Minnesota (note within 120-foot-wide construction work area for North Dakota and Wisconsin)

c Minnesota Only: Con = sum of pipeline construction work area, ATWS, Temporary Access Roads; Op = sum of pipeline permanent right-of-way, Permanent Access Roads, Pump Stations, Valves

d Con = Estimated construction impacts in numbers of occurrences acres based on 120-foot-wide construction work area, Op = Estimated operations impacts in numbers of occurrences based on 50-foot-wide right-of-way

e Based on review for presence absence based on available information on general locations for infrastructure

Table M-3. Number of Occurrences of Rare Plants for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
						Total[c]									
				Con WA	Op ROW	Con	Op	0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
Nonvascular Plants															
A species of lichen	*Buellia nigra*	MN	SPC										1		
A species of liverwort	*Trichocolea tomentella*	MN	THR					1							
Vascular Plants															
American ginseng	*Panax quinquefolius*	MN	SPC										1		
Barren strawberry	*Waldsteinia fragarioides var. fragarioides*	MN	SPC						1	1					
Beaked spikerush	*Eleocharis rostellata*	MN	THR	1	1	1	1	2	1	2				PP	PP
Blue sage	*Salvia azurea*	IL	THR										1		
Blunt sedge	*Carex obtusata*	MN	SPC	1	1	1	1	1	1	1					
Bog bluegrass	*Poa paludigena*	MN	THR	1	1	1	1	1							
Bog birch	*Betula pumila*	IA	THR										1		
Bristle-berry	*Rubus fulleri*	MN	THR					1							
Broomrape	*Orobanche ludoviciana*	IL	THR								1		1		
Buffalo grass	*Buchloe dactyloides*	MN	SPC								1	1	1		
Butternut	*Juglans cinerea*	MN	END	1	1	1	1	1							
Cleft phlox	*Phlox bifida*	IA	SPC										2		
Clinton's bulrush	*Trichophorum clintonii*	MN	THR	-	-	-	-	1							
Clustered bur-reed	*Sparganium glomeratum*	WI	THR	1	1	1	1	4	1	4					
Cutleaf ironplant	*Xanthisma spinulosum var. spinulosum*	MN	SPC										1		
Dwarf grape fern	*Botrychium simplex*	IL	END										1		
Edible valerian	*Valeriana edulis var. ciliata*	MN	THR										2		
English sundew	*Drosera anglica*	MN	SPC							1					
False mallow	*Malvastrum hispidum*	IL	END								1	1	1		
False mountain willow	*Salix pseudomonticola*	MN	SPC	2	1	2	1	2	1	2					
Few-flowered spikerush	*Eleocharis quinqueflora*	MN	SPC	2	2	2	2	3	3	4				PP	PP
Flat top white aster	*Aster pubentior*	IA	SPC										1		
Flax-leaved aster	*Aster linariifolius*	IA	THR										2		
Goblin fern	*Botrychium mormo*	MN	THR							1					
Grassleaf rush	*Juncus marginatus*	IA	SPC										1		
Gray ragwort	*Packera cana*	MN	END					1		1					
Green dragon	*Arisaema dracontium*	MN	SPC										1		

Table M-3. Number of Occurrences of Rare Plants for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
						Total[c]									
				Con WA	Op ROW	Con	Op	0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
Hair-like beak rush	*Rhynchospora capillacea*	MN	THR			1	1	1	1	2				PP	PP
Hair-like beak rush (Beakrush)	*Rhynchospora capillacea*	IA	THR										1		
Handsome sedge	*Carex formosa*	MN	END			1		2		2					
Hedge hyssop	*Gratiola quartermaniae*	IL	END										1		
Hidden-fruited bladderwort	*Utricularia geminiscapa*	MN	THR							1					
Kentucky coffee tree	*Gymnocladus dioica*	MN	SPC										1		
Lapland buttercup	*Ranunculus lapponicus*	MN	SPC							1					
Leafy prairie clover	*Dalea foliosa*	IL	END										1		
Least moonwort	*Botrychium simplex*	MN	SPC	3	1	3	1	4	5	12					
Mamillate spike-rush	*Eleocharis mamillata*	WI	SPC	1	1	1	1	1	1	1					
Marsh grass-of-Parnassus	*Parnassia palustris*	WI	THR					1		1					
McCalla's willow	*Salix maccalliana*	MN	SPC	1		1		3		3				PP	PP
Meadow beauty	*Rhexia virginica*	IA	THR										2		
Mingan moonwort	*Botrychium minganense*	MN	SPC						4	6					
Narrow triangle moonwort	*Botrychium lanceolatum* ssp. *angustisegmentum*	MN	THR	3	2	3	2	5		1					
Neat spike-rush	*Eleocharis nitida*	WI	END	2	2	2	2	5	2	5					
Nodding wild onion	*Allium cernuum*	MN	SPC										1		
Northern single-spike sedge	*Carex scirpoidea*	MN	SPC	2	2	2	2	5	2	5					
Northwestern sticky aster	*Canadanthus modestus*	WI	SPC					1		1					
Pale green orchid	*Platanthera flava*	IA	END										3		
Pale moonwort	*Botrychium pallidum*	MN	SPC						4	5					
Plains sedge	*Carex heliophila*	IL	END								1	1	1		
Plains wild indigo	*Baptisia bracteata* var. *glabrescens*	MN	SPC								1	1	1		
Purple-flowered bladderwort	*Utricularia purpurea*	MN	END					1							
Quillwort	*Isoetes butleri*	IL	END								2	1	3		
Ram's head orchid	*Cypripedium arietinum*	MN	THR							1					
Rattlesnake master	*Eryngium yuccifolium*	MN	SPC										5		
Red saltwort	*Salicornia rubra*	MN	THR			1		1		1					
Richardson's rush	*Juncus alpinoarticulatus*	IL	THR										1		
Sage willow	*Salix candida*	IA	SPC										3		
Seaside crowfoot	*Ranunculus cymbalaria*	WI	THR	2	2	2	2	4	2	4					

Table M-3. Number of Occurrences of Rare Plants for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
						Total[c]									
				Con WA	Op ROW	Con	Op	0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		
Slender arrow grass	*Triglochin palustris*	IA	THR										1		
Slender naiad	*Najas gracillima*	MN	SPC			1	1	2							
Slender sandwort	*Minuartia patula*	IL	THR										1		
Small fringed gentian	*Gentianopsis procera*	IA	SPC										1		
Small white lady's-slipper	*Cypripedium candidum*	MN	SPC	1	1	1	1	4	1	4	1	1	5		
Small yellow water crowfoot	*Ranunculus gmelinii*	WI	END	2	2	2	2	3	2	3					
Snow trillium	*Trillium nivale*	MN	SPC										1		
Soft rush	*Juncus effusus*	IA	SPC										1		
St. Lawrence grapefern	*Botrychium rugulosum*	MN	SPC						4	5					
Sterile sedge	*Carex sterilis*	MN	THR	2	2	2	2	6	2	6			1	PP	PP
Sullivant's milkweed	*Asclepias sullivantii*	MN	THR										1		
Swamp thistle	*Cirsium muticum*	IA	SPC										1		
Sweet Colt's Foot	*Petasites sagittatus*	WI	THR	5	5	5	5	8	5	8				PP	PP
Tea-leaved willow	*Salix planifolia* ssp. *planifolia*	WI	THR					1		1					
Torrey's mannagrass	*Torreyochloa pallida*	MN	SPC	2	2	2	2	2							
Tuberous Indian-plantain	*Arnoglossum plantagineum*	MN	THR										1		
Twig rush	*Cladium mariscoides*	MN	SPC					3		3				PP	PP
Valerian	*Valeriana edulis*	IA	SPC										1		
Vasey's rush	*Juncus vaseyi*	WI	SPC	3	3	3	3	4	3	4					
White adder's mouth	*Malaxis monophyllos* var. *brachypoda*	MN	SPC					1							
White wild indigo	*Baptisia lactea* var. *lactea*	MN	SPC										1		
Whorled nutrush	*Scleria verticillata*	MN	THR					1		1					
Whorled nutrush (Low nut rush)	*Scleria verticillata*	IA	THR										1		
Wild quinine	*Parthenium integrifolium*	MN	END										1		
Total Number of Rare Plant Species				**20**	**19**	**21**	**20**	**32**	**19**	**35**	**7**	**6**	**42**	**7**	**7**
Total Occurrences of Rare Plants				**38**	**33**	**39**	**34**	**84**	**45**	**104**	**8**	**6**	**60**	**7**	**7**
Total Occurrences of State Endangered Plants				**5**	**5**	**5**	**5**	**13**	**4**	**11**	**4**	**3**	**12**	**0**	**0**
Total Occurrences of State Threatened Plants				**15**	**14**	**15**	**14**	**35**	**11**	**34**	**1**	**0**	**17**	**4**	**4**
Total Occurrences of State Special Concern Plants				**18**	**14**	**19**	**15**	**36**	**30**	**59**	**3**	**3**	**31**	**3**	**3**

Sources: Minnesota DNR 2016e; Illinois DNR 2016; Iowa DNR 2016a; North Dakota GFP 2016; Wisconsin DNR 2016; Merjent 2016.

Notes:

Species listing may occur more than once. Blank = no occurrence.

Table M-3. Number of Occurrences of Rare Plants for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	State	State Status[a]	Applicant's Preferred Route[b]					Existing Line 3		System Alternative SA-04[d]			Rail[e]	Truck[e]
						Total[c]									
				Con WA	Op ROW	Con	Op	0.5 mile	Operations	0.5 mile	Con	Op	0.5 mile		

a State Status: END = Endangered, SPC = Species of Concern, THR = Threatened

b Enbridge provided footprints: Con WA = construction work area; Op ROW= operations right-of-way for Minnesota (note within 120-foot-wide construction work area for North Dakota and Wisconsin)

c Minnesota Only: Con = sum of pipeline construction work area, ATWS, Temporary Access Roads; Op = sum of pipeline permanent right-of-way, Permanent Access Roads, Pump Stations, Valves

d Con = Estimated construction impacts in numbers of occurrences acres based on 120-foot-wide construction work area, Op = Estimated operations impacts in numbers of occurrences based on 50-foot-wide right-of-way

e Based on review for presence absence based on available information for general location of required infrastructure in the United States

Table M-4. Mammal, Amphibian, Reptile, and Bird GAP Species Models Used to Estimate Impacts on Species of Conservation Need for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	Occurrence on State Lists							GAP Model Name
		IL	IA	MN	ND	SD	WI	Total	
MAMMALS									
Arctic Shrew	*Sorex arcticus*				1			1	mACSHx
American Badger	*Taxidea taxus*	1						1	mAMBAx
American Marten	*Martes americana*				1		1	1	mAMMAx
American Pygmy Shrew	*Sorex hoyi*	1			1			2	mAPSHx
American Water Shrew	*Sorex palustris*						1	1	mAWSHx
Canada lynx (Fed Status: T)	*Lynx canadensis*			1				1	mCALYx
Eastern Spotted Skunk	*Spilogale putorius*		1	1	1			3	mESSKx
Gray Wolf (Fed Status: E)	*Canis lupus*	1			1	1		3	mGRWOx
Little Brown Bat	*Myotis lucifugus*			1	1		1	3	mLBMYx
Long-eared Bat	*Myotis evotis*				1			1	mLEMYx
Long-legged Bat	*Myotis volans*				1			1	mLLMYx
North American River Otter	*Lontra canadensis*					1		1	mNAROx
Northern Flying Squirrel	*Glaucomys sabrinus*					1	1	2	mNFSQx
northern pocket gopher	*Thomomys talpoides*			1				1	mNPGOx
Silver-haired Bat	*Lasionycteris noctivagans*					1	1	2	mSHBAx
AMPHIBIANS AND REPTILES									
Four-toed Salamander	*Hemidactylium scutatum*	1		1			1	3	aFTSAx
Mudpuppy	*Necturus maculosus*	1	1	1				3	aMUDPx
Wood Frog	*Rana sylvatica*	1						1	aWOFRx
Blanding's Turtle	*Emydoidea blandingii*	1	1	1			1	4	rBTURx

Table M-4. Mammal, Amphibian, Reptile, and Bird GAP Species Models Used to Estimate Impacts on Species of Conservation Need for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	Occurrence on State Lists							GAP Model Name
		IL	IA	MN	ND	SD	WI	Total	
common five-lined skink	*Plestiodon fasciatus*			1				1	rCFLSx
Eastern Massasauga	*Sistrurus catenatus catenatus*	1					1	2	rMASSx
False Map Turtle	*Graptemys pseudogeographica*				1	1		2	rFMTUx
Northern Prairie Skink	*Plestiodon septentrionalis*				1			1	rPRSKx
Ornate Box Turtle	*Terrapene ornata*	1	1			1	1	4	rOBTUx
Plains Hog-nosed Snake	*Heterodon nasicus*	1		1	1			3	rPHNSx
Prairie Rattlesnake	*Crotalus viridis*		1					1	rPRRAx
Prairie Skink	*Plestiodon septentrionalis*						1	1	rPRSKx
Six-lined Racerunner	*Aspidoscelis sexlineata*						1	1	rSLRAx
Slender Glass Lizard	*Ophisaurus attenuatus*	1	1				1	3	rSGLIx
Smooth Softshell	*Apalone mutica*	1		1	1	1	1	5	rSMSOx
Snapping Turtle	*Chelydra serpentina*				1			1	rSNTUx
Spiny Softshell	*Apalone spinifera*				1			1	rSPSOx
Spotted Turtle	*Clemmys guttata*	1						1	rSPTUx
Timber Rattlesnake	*Crotalus horridus*	1		1			1	3	rTIRAx
Western Hognose Snake	*Heterodon nasicus*		1					1	rPHNSx
Wood Turtle	*Glyptemys [Clemmys] insculpta*		1	1			1	3	rWOTUx
BIRDS									
Acadian Flycatcher	*Empidonax virescens*	1		1			1	3	bACFLx
American Bittern	*Botaurus lentiginosus*	1			1		1	3	bAMBIx
Baird's Sparrow	*Ammodramus bairdii*			1	1	1		3	bBAISx

Table M-4. Mammal, Amphibian, Reptile, and Bird GAP Species Models Used to Estimate Impacts on Species of Conservation Need for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	Occurrence on State Lists							GAP Model Name
		IL	IA	MN	ND	SD	WI	Total	
Bald Eagle	*Haliaeetus leucocephalus*		1		1	1		3	bBAEAx
Bell's Vireo	*Vireo bellii*	1		1			1	3	bBEVIx
Black Tern	*Chlidonias niger*	1	1		1	1	1	5	bBLTEx
Black-billed Cuckoo	*Coccyzus erythropthalmus*	1			1			2	bBBCUx
Black-crowned Night-Heron	*Nycticorax nycticorax*	1					1	2	bBCNHx
Blue-winged Warbler	*Vermivora pinus*	1						1	bBWWAx
Bobolink	*Dolichonyx oryzivorus*	1			1		1	3	bBOBOx
Brown Thrasher	*Toxostoma rufum*	1						1	bBRTHx
Canada Warbler	*Wilsonia canadensis*							0	bCAWAx
Cerulean Warbler	*Dendroica cerulean*	1		1			1	3	bCERWx
Common Tern	*Sterna hirundo*	1		1			1	3	bCOTEx
Dickcissel	*Spiza americana*				1		1	2	bDICKx
Ferruginous Hawk	*Buteo regalis*				1	1		2	bFEHAx
Field Sparrow	*Spizella pusilla*							0	bFISPx
Golden Eagle	*Aquila chrysaetos*				1			1	bGOEAx
Golden-winged Warbler	*Vermivora chrysoptera*						1	1	bGWWAx
Grasshopper Sparrow	*Ammodramus savannarum*				1		1	2	bGRSPx
Henslow's sparrow	*Ammodramus henslowii*	1	1	1			1	4	bHESPx
Kentucky Warbler	*Geothlypis [Oporornis] formosa*	1					1	2	bKEWAx
Least Bittern	*Ixobrychus exilis*	1					1	2	bLEBIx
Least Tern (Interior, Fed Status: E)	*Sterna antillarum athalassos*	1	1		1	1		4	bLETEx

Table M-4. Mammal, Amphibian, Reptile, and Bird GAP Species Models Used to Estimate Impacts on Species of Conservation Need for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	Occurrence on State Lists							GAP Model Name
		IL	IA	MN	ND	SD	WI	Total	
Loggerhead Shrike	*Lanius ludovicianus*	1		1	1		1	4	bLOSHx
Marbled Godwit	*Limosa fedoa*			1	1	1		3	bMAGOx
Marsh Wren	*Cistothorus palustris*							0	bMAWRx
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*			1	1		1	3	bNSTSx
Northern Flicker	*Colaptes auratus*							0	bNOFLx
Olive-sided Flycatcher	*Contopus cooperi*						1	1	bOSFLx
Peregrine Falcon	*Falco peregrinus*		1	1	1	1	1	5	bPEFAx
Pied-billed Grebe	*Podilymbus podiceps*							0	bPBGRx
Piping Plover (Fed Status: E/T)	*Charadrius melodus*	1	1	1	1	1	1	6	bPIPLx
Prairie Falcon	*Falco mexicanus*				1			1	bPRFAx
Prothonotary Warbler	*Protonotaria citrea*						1	1	bPROWx
Red-headed Woodpecker	*Melanerpes erythrocephalus*	1			1		1	3	bRHWOx
[Rufa] Red Knot (Fed Status: T)	*Calidris canutus rufa*	1			1	1	1	4	bREKNx
Rusty Blackbird	*Euphagus carolinus*						1	1	bRUBLx
Short-eared Owl	*Asio flammeus*	1	1	1	1		1	5	bSEOWx
Sprague's pipit (Fed Status: C)	*Anthus spragueii*			1	1	1		3	bSPPIx
Swainson's Hawk	*Buteo swainsoni*	1			1			2	bSWHAx
Upland Sandpiper	*Bartramia longicauda*	1			1		1	3	bUPSAx
Western Grebe	*Aechmophorus occidentalis*							0	bWEGRx
Willow Flycatcher	*Empidonax traillii*	1						1	bWIFLx
Wood Thrush	*Hylocichla mustelina*	1						1	bWOTHx

Table M-4. Mammal, Amphibian, Reptile, and Bird GAP Species Models Used to Estimate Impacts on Species of Conservation Need for the Applicant's Preferred Route and System Alternative SA-04

Common Name	Scientific Name	Occurrence on State Lists							GAP Model Name
		IL	IA	MN	ND	SD	WI	Total	
Worm-eating Warbler	*Helmitheros vermivorum*	1					1	2	bWEWAx
Yellow Rail	*Coturnicops noveboracensis*	1		1	1		1	4	bYERAx

Sources: Cardno analysis based on state threatened, endangered, and species of conservation concern lists; USGS-GAP 2016.

Notes:

IL = Illinois, IA = Iowa, ND = North Dakota, SD = South Dakota, MN = Minnesota, WI = Wisconsin, Blank = no occurrence.

Table M-5. Birds of Conservation Concern Occurring within 1 mile of the Applicant's Preferred Route, Route Alternatives, and System Alternative SA-04

Alternative, Common Name	Scientific Name	Applicant's Preferred Route				Route Alternatives, Clearbrook to Carlton				Existing Line 3	SA-04 – North Dakota to Illinois
		North Dakota border to Clearbrook	Clearbrook to Carlton	Carlton to Wisconsin Border	North Dakota to Wisconsin (full route)	RA-03AM	RA-06-	RA-07-	RA-08		
Area (mi^2)		363.0	721.2	31.6	768.8	907.4	655.9	555.9	550.4	950.4	1,323.6
BCC Species (number)		23	24	15	27	26	22	22	22	26	35
Birds of Conservation Concern (BCC) Seasonal Occurrence											
Acadian Flycatcher	*Empidonax virescens*										B
American Bittern	*Botaurus lentiginosus*	B	B	B	B	B	B	B	B	B	B
Baird's Sparrow	*Ammodramus bairdii*										
Bald Eagle	*Haliaeetus leucocephalus*	W, B	YR	YR	YR	YR	YR	YR	YR	YR	YR
Bell's Vireo	*Vireo bellii*										B
Black Tern	*Chlidonias niger*	B	B	B	B	B	B	B	B	B	B
Black-billed Cuckoo	*Coccyzus erythropthalmus*	B	B	B	B	B	B	B	B	B	B
Black-crowned Night-heron	*Nycticorax nycticorax*										B
Blue-winged Warbler	*Vermivora pinus*										B
Bobolink	*Dolichonyx oryzivorus*	B	B		B	B	B	B	B	B	
Brown Thrasher	*Toxostoma rufum*	B	B		B	B	B	B	B	B	
Canada Warbler	*Wilsonia canadensis*		B	B	B	B	B	B	B	B	
Cerulean Warbler	*Dendroica cerulea*					B					B
Common Tern	*Sterna hirundo*		B	B	B	B	B	B	B	B	B
Dickcissel	*Spiza americana*	B	B		B	B	B	B	B	B	B

Table M-5. Birds of Conservation Concern Occurring within 1 mile of the Applicant's Preferred Route, Route Alternatives, and System Alternative SA-04

Alternative, Common Name	Scientific Name	Applicant's Preferred Route				Route Alternatives, Clearbrook to Carlton				Existing Line 3	SA-04 – North Dakota to Illinois
		North Dakota border to Clearbrook	Clearbrook to Carlton	Carlton to Wisconsin Border	North Dakota to Wisconsin (full route)	RA-03AM	RA-06-	RA-07-	RA-08		
Ferruginous Hawk	*Buteo regalis*										
Field Sparrow	*Spizella pusilla*										B
Golden Eagle	*Aquila chrysaetos*	W			W					W	W
Golden-winged Warbler	*Vermivora chrysoptera*	B	B	B	B	B	B	B	B	B	
Grasshopper Sparrow	*Ammodramus savannarum*	B			B					B	B
Henslow's Sparrow	*Ammodramus henslowii*										B
Hudsonian Godwit	*Limosa haemastica*	M			M					M	M
Kentucky Warbler	*Oporornis formosus*										B
Least Bittern	*Ixobrychus exilis*	B	B	B	B	B	B	B	B	B	B
Loggerhead Shrike	*Lanius ludovicianus*		B		B	B					B
Marbled Godwit	*Limosa fedoa*	B	B		B	B	B	B	B	B	B
Marsh Wren	*Cistothorus palustris*	B	B		B	B	B	B	B	B	
Nelson's Sparrow	*Ammodramus nelsoni*	B	B		B	B	B	B	B	B	B
Northern Flicker	*Colaptes auratus*										YR
Olive-sided Flycatcher	*Contopus cooperi*	B	B	B	B	B	B	B	B	B	
Peregrine Falcon	*Falco peregrinus*										B
Pied-billed Grebe	*Podilymbus podiceps*	B	B	B	B	B	B	B	B	B	B
Prairie Falcon	*Falco mexicanus*										

Table M-5. Birds of Conservation Concern Occurring within 1 mile of the Applicant's Preferred Route, Route Alternatives, and System Alternative SA-04

Alternative, Common Name	Scientific Name	Applicant's Preferred Route				Route Alternatives, Clearbrook to Carlton				Existing Line 3	SA-04 – North Dakota to Illinois
		North Dakota border to Clearbrook	Clearbrook to Carlton	Carlton to Wisconsin Border	North Dakota to Wisconsin (full route)	RA-03AM	RA-06-	RA-07-	RA-08		
Prothonotary Warbler	*Protonotaria citrea*										B
Red-headed Woodpecker	*Melanerpes erythrocephalus*	B	B	B	B	B	B	B	B	B	YR
Rusty Blackbird	*Euphagus carolinus*										W
Short-eared Owl	*Asio flammeus*	B	B	B	B	B	B	B	B	B	W, B
Sprague's Pipit	*Anthus spragueii*										
Swainson's Hawk	*Buteo swainsoni*	B	B		B	B	B	B	B	B	B
Upland Sandpiper	*Bartramia longicauda*	B	B	B	B	B	B	B	B	B	B
Western Grebe	*Aechmophorus occidentalis*	B	B		B	B				B	B
Willow Flycatcher	*Empidonax traillii*					B					B
Wood Thrush	*Hylocichla mustelina*		B	B	B	B	B	B	B	B	B
Worm-eating Warbler	*Helmitheros vermivorum*										B
Yellow Rail	*Coturnicops noveboracensis*	B	B	B	B	B	B	B	B	B	B

Source: USFWS 2016

Notes:

B = Breeding, M = Migration, W = wintering, YR = Year Round, blank = no occurrence.

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Appendix N

Minnesota State and County Population Data

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Table N-2. State and County Population Data along the System Alternative SA-04 Route M-3

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Table N-1. State and County Population Data along the Applicant's Preferred Route and Existing Line 3

Alternative/State/County	Population Estimates (2010)[a]	Population Estimates (2015)[b]	Population Percent Change (2010 – 2015)[a,b]	Population per Square Mile (2015)[a,b]
Applicant's Preferred Route				
North Dakota	**672,591**	**756,927**	**12.5**	**11.0**
Pembina County	7,413	7,091	-4.3	6.3
Minnesota	**5,303,925**	**5,489,594**	**3.5**	**68.9**
Kittson County	4,552	4,424	-2.8	4.0
Marshall County	9,439	9,423	-0.2	5.3
Pennington County	13,930	14,219	2.1	23.1
Red Lake County	4,089	4,055	-0.8	9.4
Polk County	31,600	31,533	-0.2	16.0
Clearwater County	8,695	8,803	1.2	8.8
Hubbard County	20,428	20,655	1.1	22.3
Wadena County	13,843	13,875	0.2	25.9
Cass County	28,567	28,706	0.5	14.2
Crow Wing County	62,500	63,428	1.5	63.5
Aitkin County	16,202	15,702	-3.1	8.6
Carlton County	35,386	35,569	0.5	41.3
Wisconsin	**5,687,289**	**5,771,337**	**1.5**	**106.6**
Douglas County	44,159	43,601	-1.3	33.4
TOTAL	**300,803**	**301,084**	**-0.1**	**18.3**
Existing Line 3				
Minnesota	**5,303,925**	**5,489,594**	**3.5**	**68.9**
Beltrami County	44,442	45,672	2.8	18.2
Hubbard County	20,428	20,655	1.1	22.3
Cass County	28,567	28,706	0.5	14.2
Itasca County	45,058	45,435	0.8	17.0
Aitkin County	16,202	15,702	-3.1	8.6
St. Louis County	200,226	200,431	0.1	32.1
TOTAL	**354,923**	**356,601**	**0.5**	**22.0**

[a] U.S. Census Bureau 2010 Census.

[b] U.S. Census Bureau 2015 population estimates.

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Table N-2. State and County Population Data along the System Alternative SA-04 Route

State/County	Population Estimates (2010)[a]	Population Estimates (2015)[b]	Population Percent Change (2010 – 2015)[a,b]	Population per Square Mile (2015)[a,b]
North Dakota	**672,591**	**756,927**	**12.5**	**11.0**
Pembina County	7,413	7,091	-4.3	6.3
Walsh County	11,119	10,897	-2.0	8.5
Grand Forks County	66,861	70,916	6.1	49.4
Traill County	8,121	8,014	-1.3	9.3
Cass County	149,778	171,512	14.5	97.2
Richland County	16,321	16,402	0.5	11.4
Minnesota	**5,303,925**	**5,489,594**	**3.5**	**68.9**
Traverse County	3,558	3,401	-4.4	5.9
Stevens County	9,726	9,796	0.7	17.4
Swift County	9,783	9,340	-4.5	12.6
Chippewa County	12,441	12,109	-2.7	20.8
Kandiyohi County	42,239	42,542	0.7	53.4
Renville County	15,730	14,892	-5.3	15.2
Sibley County	15,226	14,875	-2.3	25.3
Nicollet County	32,727	33,347	1.9	74.4
Le Sueur County	27,703	27,663	-0.1	61.6
Blue Earth County	64,013	65,787	2.8	88.0
Waseca County	19,136	18,989	-0.8	44.9
Freeborn County	31,255	30,613	-2.1	43.3
Mower County	39,163	39,116	-0.1	55.0
Iowa	**3,046,869**	**3,123,899**	**2.5**	**55.9**
Bremer County	24,276	24,722	1.8	56.8
Chickasaw County	12,439	12,097	-2.7	24.0
Howard County	9,566	9,410	-1.6	19.9
Mitchell County	10,772	10,832	0.6	23.1
Clinton County	49,116	47,768	-2.7	68.7
Jones County	20,638	20,466	-0.8	35.6
Delaware County	17,764	17,403	-2.0	30.1
Buchanan County	20,958	21,062	0.5	36.9

Table N-2. State and County Population Data along the System Alternative SA-04 Route

State/County	Population Estimates (2010)[a]	Population Estimates (2015)[b]	Population Percent Change (2010 – 2015)[a,b]	Population per Square Mile (2015)[a,b]
Fayette County	20,880	20,257	-3.0	27.7
Illinois	**12,831,549**	**12,859,995**	**0.2**	**231.6**
~~Livingston County~~	~~38,950~~	~~36,671~~	~~-5.9~~	~~35.1~~
LaSalle County	113,922	111,333	-2.3	98.1
Bureau County	34,978	33,587	-4.0	38.6
Lee County	36,031	34,584	-4.0	47.7
Whiteside County	58,498	57,079	-2.4	83.4
Rock Island County	147,546	146,133	-1.0	341.7
Grundy County	50,063	50.541	1.0	117.1
Will County	677,560	687,263	1.4	806.5
TOTAL	**1,887,320**	**1,864,349**	**1.0**	**73**

[a] Source: U.S. Census Bureau 2010 Census.

[b] Source: U.S. Census Bureau 2015 population estimates.

Appendix O

Cultural Resources Unanticipated Discovery Plan

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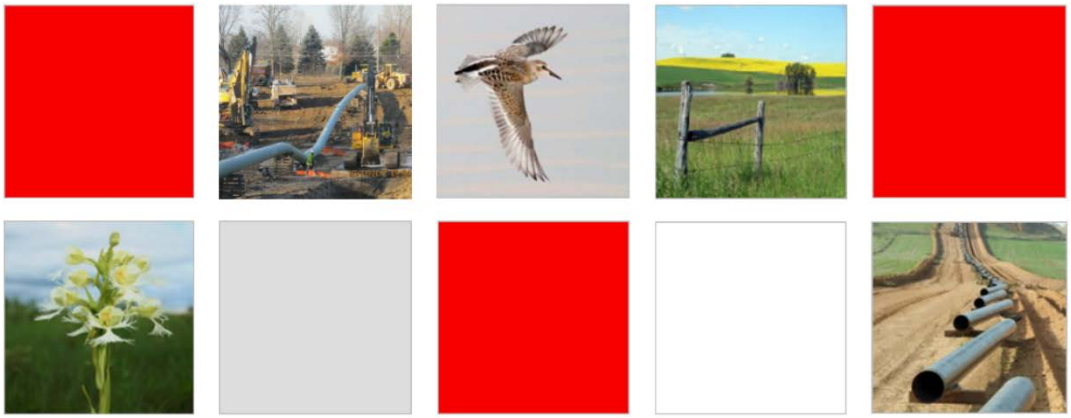
Appendix M
Unanticipated Discovery Plan

This Plan updates the information submitted as Appendix P of the Enbridge Energy, Limited Partnership Application for a Pipeline Routing Permit on April 24, 2015.



Enbridge

UNANTICIPATED DISCOVERIES PLAN

April 2015

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APPENDICES

Appendix A – Contact Lists: North Dakota, Minnesota, and Wisconsin

1.0 INTRODUCTION

This Unanticipated Discoveries Plan ("UDP") sets forth the guidelines to be used in the event archaeological resources or human skeletal remains are discovered during construction activities. These measures were developed by Enbridge in accordance with applicable state and federal guidelines. Early and frequent communications are essential in meeting both the spirit and law of those guidelines; therefore, Appendix A shows the most current list of relevant contacts in the event of an unanticipated discovery during construction.

2.0 UNANTICIPATED DISCOVERY CONDITIONS

Pipeline construction excavations have the potential to uncover previously unknown archaeological sites and human skeletal remains, as well as many other cultural and natural elements such as modern refuse and faunal remains. While extensive environmental surveys can effectively eliminate most discoveries during construction, Enbridge is aware that project planning should anticipate even the remote possibility of a discovery.

Enbridge will have the primary responsibility of distinguishing discoveries of significant archaeological sites or human skeletal remains from those that are neither. The former would require ceasing construction activities at the find location followed by a coordinated consultation effort among Enbridge, permitting agencies, landowners, and other interested parties. Identification of the latter (neither significant archaeological sites nor human skeletal remains) would not mean ceasing construction activities or initiation of the consultation process; however documentation of the event must be made.

When possible archaeological materials or suspected human skeletal remains are identified during ground disturbing activities within the construction corridor, the construction contractor ("Contractor") will immediately notify Enbridge's lead onsite Environmental Inspector ("EI") of the discovery.

1. Immediately following notification of the discovery, the lead EI shall:

   (a) Establish and delineate a 25 foot buffer around the edge of the discovery (using flagging and/or fencing), advise the on-site construction manager to halt all ground-disturbing activities within the buffered area until otherwise notified by Enbridge Environment, and implement measures to protect the discovery from looting and vandalism, including a 24-hour watch, if necessary; and

   (b) Contact a qualified Professional Archaeologist (possible archaeological materials) and/or Physical Anthropologist (suspected human skeletal remains) to conduct an assessment of the discovery. The Professional Archaeologist should meet the qualification standards outlined in 36 Code of Federal Regulations ("CFR") Part 61 in order to conduct the assessment. The Physical Anthropologist must be acknowledged as competent to positively identify human skeletal remains.

2. When contacted by the lead EI, the Professional Archaeologist shall gather additional information from the discovery area and assess the potential significance and condition

and integrity of the discovery according to the guidelines established by the National Park Service ("NPS") in Bulletin 15 and its amendments:

(a) The Professional Archaeologist will determine whether or not the discovery is an archaeological site or cultural resource over 45 years of age. If the discovery is an archaeological site or cultural resource greater than 45 years of age, the Professional Archaeologist will record as much information as possible to secure a Smithsonian Trinomial Number from the appropriate state agency. The lead EI would then notify Enbridge Environment to initiate the process outlined in *3.0 Discovery of Historic Properties* below.

(b) If the discovery is not an archaeological site or cultural resource greater than forty-five years of age, the Professional Archaeologist will document the discovery for the record and Enbridge's lead EI will advise the on-site construction manager to restart ground-disturbing activities.

3. When contacted by the lead EI, the Physical Anthropologist shall investigate the site to make an assessment of the likely nature of the remains:
   (a) If the remains are likely human then the lead EI would notify Enbridge Environment to initiate the process outlined in *4.0 Discovery of Human Skeletal Remains* below.
   (b) If the discovery does not represent human skeletal remains, the Physical Anthropologist will document the discovery for the record and Enbridge's lead EI will advise the on-site construction manager to restart ground-disturbing activities.

3.0 DISCOVERY OF HISTORIC PROPERTIES

Upon the discovery of an archaeological site or cultural resource greater than 45 years of age, the Professional Archaeologist will advise Enbridge Environment of the proper agency notification procedure and recommend a plan of action for the discovery area.

(a) If the discovery area is under the jurisdiction of a federal permit and/or approval, or otherwise subject to federally-mandated conditions, Enbridge Environment will advise the Responsible Federal Agency ("RFA") of the resource and provide information regarding its significance and condition and integrity (see *3.1 Federal Agency Jurisdiction* below).

(b) If the discovery is on state land, Enbridge Environment will first advise the land-managing agency of the resource and provide information regarding its significance, condition and integrity and, if directed by the land-managing agency, advise the appropriate State Archaeologist (see *3.2 State Lands* below).

(c) If the discovery is on private land, its disposition will still be subject to the authority of the appropriate state routing agency. Enbridge Environment will advise the state routing agency of the resource and provide information regarding its significance, condition and integrity (see *3.3 Public Lands Subject to State Routing Authority* below).

3.1 FEDERAL AGENCY JURISDICTION

(a) Enbridge Environment will notify the RFA of the resource and provide information regarding its significance and condition and integrity.

(b) Within 24 hours of notification, the RFA shall provide notice of the discovery to other parties who may wish to participate in consultation, including but not limited to the appropriate State Historic Preservation Office ("SHPO"), Native American tribal officials (as applicable), and private landowner(s).

(c) The RFA shall have 5 calendar days following notification to determine the discovery's eligibility for listing on the National Register of Historic Places ("NRHP") in consultation with the appropriate SHPO and other consulting parties. The RFA may extend the review period by an additional 7 calendar days by providing written notice to consulting parties prior to the expiration of the 5 day calendar period.

(d) For properties determined eligible for listing on the NRHP pursuant to (c) above, Enbridge Environment shall notify the RFA and other consulting parties of Enbridge's proposed treatment measures to resolve adverse effects to the discovered resource. The consulting parties shall comment on the proposed treatment measures within 48 hours. The RFA shall ensure that the recommendations of the consulting parties are considered prior to granting approval of Enbridge-proposed treatment measures. Once approval has been granted by the RFA, Enbridge Environment shall carry out the approved treatment measures and, after doing so, Enbridge may resume construction.

(e) In the event of any disagreements between the consulting parties regarding the NRHP eligibility of the newly discovered property or the treatment measures proposed to mitigate adverse effects to the property, the RFA shall seek and take into account the recommendations of the Advisory Council on Historic Preservation ("ACHP"). Within 48 hours of receipt of a request, ACHP shall provide the RFA with recommendations on how to resolve the dispute.

(f) If, after consultation, the RFA determines that the discovery does not represent an NRHP-eligible resource, the RFA will direct Enbridge Environment to resume ground-disturbing activities at the discovery location at its discretion.

3.2 STATE LANDS

(a) Enbridge Environment will notify the land-managing agency of the resource and provide information regarding its significance and integrity. If directed by the land-managing agency to do so, Enbridge Environment will advise the appropriate State Archaeologist.

(b) The land-managing agency will have 5 calendar days following notification to consult with the appropriate state archaeologist and other consulting parties, as necessary, about the assessment of the discovery. NPS criteria of eligibility for listing on the NRHP may be considered as a guideline to determine the significance of the find and SHPO may be consulted during the assessment, but the state agency is not obliged to apply NPS standards in making its decision. The land-managing agency may assume the resource is eligible for listing on the NRHP while consultation occurs and may require avoidance, impact minimization, or mitigation.

(c) For properties determined eligible for listing on the NRHP, Enbridge Environment shall notify the land-managing agency and other consulting parties of the treatment measures it proposes for resolving adverse effects to the resource. The consulting parties shall provide their views on the proposed treatment measures to Enbridge Environment, the land-managing agency and other consulting parties within 48 hours. The land-managing

agency shall ensure that the recommendations of the consulting parties are considered prior to granting approval of Enbridge's proposed treatment measures. Once approval has been granted by the land-managing agency, Enbridge Environment shall carry out the approved treatment measures and, after doing so, Enbridge may resume construction.

(d) If, after consultation, the land-managing agency determines that the discovery does not represent an NRHP-eligible or otherwise important resource, the land-managing agency will direct Enbridge Environment to resume ground-disturbing activities, at its discretion, at the discovery location.

3.3 PRIVATE LANDS SUBJECT TO STATE ROUTING AUTHORITY JURISDICTION

(a) Enbridge Environment will notify the state routing authority of the resource and provide information regarding its significance and integrity.

(b) Within 24 hours of notification, the state routing authority shall provide notice of the resource to other parties, including, but not limited to, the appropriate SHPO, the appropriate State Archaeologist, Native American tribal officials (as applicable), and private landowner(s).

(c) The state routing authority will have 5 calendar days following notification to consult with the appropriate SHPO and other consulting parties, as necessary, about assessing the discovery. Criteria for eligibility for listing on the NRHP may be considered as a guideline to determine the significance of the find and SHPO may be consulted during the assessment, but the state routing authority is not obliged to apply the standards in making its decision. The state routing authority may assume the resource is eligible for listing on the NRHP while consultation occurs and may require avoidance, impact minimization, or mitigation.

(d) For properties eligible for listing on the NRHP, Enbridge Environment shall notify the state routing authority and other consulting parties of the treatment measures it proposes to resolve impacts to the resource. The consulting parties shall provide their views on the proposed treatment measures within 48 hours. The state routing authority shall ensure that the recommendations of the consulting parties are considered prior to granting approval of Enbridge's proposed treatment measures. Once approval has been granted by the state routing authority, Enbridge Environment shall carry out the approved treatment measures and, after doing so, Enbridge may resume construction.

(e) If, after consultation, the state routing authority determines that the discovery does not represent an NRHP-eligible or otherwise important resource, the state routing authority will direct Enbridge Environment to resume ground-disturbing activities, at its discretion, at the discovery location.

4.0 DISCOVERY OF HUMAN SKELETAL REMAINS

1. When unmarked human burial or skeletal remains are encountered during construction activities, Enbridge will comply with all applicable laws, specifically:

    a) North Dakota's "Protection of human burial sites, human remains, and burial goods – Unlawful acts – Penalties – Exceptions" law (North Dakota Century Code ["NDCC"]

§23-06-27) and its accompanying administrative rules (North Dakota Administrative Code ["NDAC"] §40-02-03);

b) Minnesota's "Private Cemeteries Act" (Minnesota Statute ["Minn. Stat."] §307.08); and

c) Wisconsin Statute §157.70. In Wisconsin, in the case of accidental discoveries, state law does not distinguish between historic or prehistoric burials in the requirements for initial notifications or disinterment.

2. In the event a human burial or skeletal remains are encountered during ground-disturbing construction activity, Enbridge Environment will implement the following notification procedures:

   a) North Dakota – notify the local law enforcement agency (county sheriff) and the State Historical Society of North Dakota as required by NDCC §23-06-27. Pursuant to NDAC §40-02-03-03, upon receiving notification of the discovery of human skeletal remains, a human burial, or burial goods, the local law enforcement agency shall, as soon as practicable, report the receipt of such notification to State Historical Society of North Dakota and the North Dakota State Department of Health and Consolidated Laboratories. These two state agencies shall commence the initial examination of the discovery within 24 hours of notification.

   b) Minnesota – notify the local law enforcement agency (county sheriff). As required by Minn. Stat. §307.08 Enbridge Environment will also notify the Office of the State Archaeologist of the find.

   c) Wisconsin – notify the local law enforcement agency (county sheriff) and SHPO as stipulated by Wisconsin Statute §157.70.

3. Enbridge Environment also shall promptly notify the RFA, land-managing agency, or state routing authority of the find and consult regarding the appropriate measures to handle the discovery.

After permission to resume construction has been issued by the RFA, land-managing agency, or state routing authority, Enbridge's lead EI will advise the on-site construction manager to restart ground-disturbing activities.

Appendix A
Contact Lists – North Dakota, Minnesota, and Wisconsin

Contact Lists North Dakota, Minnesota, and Wisconsin		
State/County	Contact	Address/Telephone
NORTH DAKOTA	TBD, Lead Environmental Inspector	Cellphone: TBD E-mail: TBD
	Fern Swenson, Deputy SHPO	State Historical Society of North Dakota 612 East Boulevard Avenue Bismarck, ND 58505-0830 Telephone: (701) 328-2666 Fax: (701) 328-3710 E-mail: fswenson@nd.gov
	Edward C. Murphy, State Geologist	North Dakota Industrial Commission, Department of Mineral Resources, North Dakota Geological Survey 1016 East Calgary Ave. Bismarck, ND 58503 Telephone: (701) 328-8000
Williams County	Scott Busching, County Sheriff	223 East Broadway, Suite 301 Williston, ND 58801 Telephone: (701) 577-7700
Mountrail County	Kenneth Halvorson, County Sheriff	101 N Main St Stanley, ND 58784 Telephone: (701) 628-2975
Ward County	Steve Kukowski, County Sheriff	315 SE 3rd Street PO Box 907 Minot, ND 58702 Telephone: (701) 857-6500
McHenry County	Marvin Sola, County Sheriff	407 Main Street South, Room 303 Towner, ND 58788 Telephone: (701) 537-5633
Pierce County	Matt Lunde, County Sheriff	110 Industrial Park Road Rugby, ND 58368-0226 Telephone: (701) 776-5245 mmlunde@nd.gov
Towner County	Vaughn Klier, County Sheriff	315 2nd Street PO Box 366 Cando, ND 58324-0603 Telephone: (701) 968-4350
Ramsey County	Steve Nelson, County Sheriff	222 W Walnut Devils Lake, ND 58301-3596 Telephone: (701) 662-0708
Nelson County	Kelly Janke, County Sheriff	210 B Ave W Ste 102 Lakota, ND 58344-7410 Telephone: (701) 247-2475
Grand Forks County	Bob Rost, County Sheriff	122 South 5th Street Suite 210 PO Box 12608 Grand Forks, ND 58208-2608 Telephone: (701) 780-8280
Pembina County	Brian Erovick, County Sheriff	308 Courthouse Drive Cavalier, ND 58220 Telephone: (701) 265-4122

Contact Lists **North Dakota, Minnesota, and Wisconsin**		
State/County	Contact	Address/Telephone
MINNESOTA	TBD, Lead Environmental Inspector	Cellphone: TBD E-mail: TBD
	Barbara Mitchell Howard, Deputy SHPO	Minnesota State Historic Preservation Office Minnesota Historical Society 345 Kellogg Boulevard West St. Paul, MN 55102-1903 Telephone: (651) 259-3466 E-mail: barbara.howard@mnhs.org
	Scott Anfinson, Minnesota State Archaeologist	Office of the State Archaeologist Fort Snelling History Center 200 Tower Avenue St. Paul, MN 55111 Telephone: (612) 725-2411 E-mail: scott.anfinson@state.mn.us
	Jim L. Jones, Jr., Cultural Resource Director	Minnesota Indian Affairs Council 3801 Bemidji Avenue, Suite 5 Bemidji, MN 56601 Telephone: (218) 755-3825
	Harvey Thorleifson, Director	Minnesota Geological Survey 2642 University Ave. St. Paul, MN 55114-1057 Telephone: (612) 627-4780, ext. 224
Polk County	Barb Erdman, County Sheriff	600 Bruce Street P.O. Box 416 Crookston, MN 56716 Telephone: (218) 281-0431
Red Lake County	Mitch Bernstein, County Sheriff	124 Langevin Avenue, PO Box 367 Red Lake Falls, MN 56750 Telephone: (218) 253-2996
Clearwater County	Darin Halverson, Chief Deputy	213 Main Avenue North Bagley, MN 56621 Telephone: (218) 694-6226
Hubbard County	Cory Aukes, County Sheriff	301 Court Ave. Park Rapids, MN 56470 Telephone: (218) 737-3331
Becker County	Kelly Shannon, County Sheriff	925 Lake Ave. Detroit Lakes, MN 56501 Telephone: (218) 847-2661
Wadena County	Mike Carr, County Sheriff	415 So Jefferson St Wadena, MN 56482 Telephone: (218) 631-7600
Cass County	Tom Burch, County Sheriff	303 Minnesota Avenue Walker, MN 56484 Telephone: (218) 547-1424, ext. 309
Crow Wing County	Todd Dahl, County Sheriff	304 Laurel St. Brainerd, MN 56401 Telephone: (218) 829-4749
Aitkin County	Scott Turner, County Sheriff	217 2nd St. NW, Room 185 Aitkin, MN 56431 Telephone: (218) 927-7435
Carlton County	Kelly Lake, County Sheriff	317 Walnut Avenue Carlton, MN 55718 Telephone: (218) 384-3236

Contact Lists North Dakota, Minnesota, and Wisconsin		
State/County	Contact	Address/Telephone
Kittson	Kenny Hultgren, County Sheriff	410 5th Street South Suite 102 Hallock, MN 56728 Telephone: (218) 843-3535
Marshall	John D. Novacek, County Sheriff	208 East Colvin Avenue Suite #1 Warren, MN 56762 Telephone: 218-745-5411 Fax: (218) 745-9203
Pennington	Ray D. Kuznia, County Sheriff	102 1st Street West PO Box 484 Thief River Falls, MN 56701 Telephone: 218-681-6161 Fax: (218) 683-7006

Contact Lists **North Dakota, Minnesota, and Wisconsin**		
State/County	Contact	Address/Telephone
WISCONSIN	TBD, Lead Environmental Inspector	Cellphone: TBD E-mail: TBD
	John Broihahn, State Archaeologist, SHPO	Wisconsin Historical Society, Division of Historic Preservation 816 State Street Madison, WI 53706-1488 Telephone: (608) 264-6500
	James M. Robertson, State Geologist	Wisconsin Geological and Natural History Survey 3817 Mineral Point Road Madison, WI 53705-5100 Telephone: (608) 262-1705
Douglas County	Tom Dalbec, County Sheriff	1316 North 14th Street Superior, WI 54880 Telephone: (715) 395-1371

Appendix P

Tribal Resources and Impacts

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Chapter 9 - Tribal Resources and Impact Appendix

I. Tribal Consultation and Policies

i. Commerce Draft Consultation Policy
ii. EO 13-10
iii. Letters Requesting Consultation
iv. MN Stat. Field Archeology Act MS 138.31 - 138.42 and Private Cemeteries Act (MS 307.08)
v. 2012 MOU Regarding Tribal-USDA –Forest Relations ; -Forest Service Relations on Natural Forest Lands Within the Territories Ceded in Treaties of 1836, 1837, and 1842
vi. MOU Between Leech Lake Reservation Tribal Council and the Chippewa National Forest

II. Oral and Written Testimony

i. Transcript Oral Interview Taken March 17, 2017 at Mille Lacs DNR
ii. Letter From Jim Jones LLBO member and MIAC Cultural Expert addressed to Commerce in Response to Request to Identify Cultural Resources Identification and Mitigation on Line 3
iii. Honor the Earth Filings and Impact Discussion
iv. Mawinzo Asiginigaazo , Berry Pickers Gather, non-profit- letter filed on behalf of tribal resources
v. Letter from Sandy Lake Association

III. Coordination with Tribal Technical Staff

i. Letters Requesting Coordination
ii. Fond du Lac Response from Request to Meet

iii. Mille Lacs EIS Fisheries Concerns
iv. Maps

IV. Tribal Resolutions and Formal Reponses to Line 3

i. Mille Lacs Cultural Resources Statement
ii. Mille Lacs Letter filed addressing the EIS
iii. White Earth-Resolution No. 001-17-003 and filed comments
iv. Great Lakes Commission Filing
v. Red Lake Resolution No. 257-16 Follow up with Joe about 2nd resolution specific to Line 3 as result of consultation)
vi. Letter from MIAC About Legally Required Consultation
vii. Leech Lake Resolution (need to insert) and Filed Comments
viii. Minnesota Chippewa Tribe (MCT) Resolution 32-17 and Letter to Minnesota Pollution Control Agency
ix. Fond du Lac Scoping Comments
x. National Congress of American Indians Resolution #MSP-15-040
xi. Minnesota Chippewa Tribe Resolution and Letter Filed
xii. 1855 Treaty Authority Letter Filed

MINNESOTA DEPARTMENT OF COMMERCE

Minnesota Department of Commerce Minnesota Tribal Nations Consultation Policy

I. Introduction

A unique government-to-government relationship exists between the 11 Federally-recognized Minnesota Tribal Nations, the State of Minnesota, and the federal government. The U.S. Constitution, numerous treaties, statutes, federal case law, regulations, Executive Orders, as well as political, legal, moral, and ethical principles legally recognize the inherent self-governance and self-determination rights of Indian Tribes. On August 8, 2013, Governor Mark Dayton issued Executive Order 13-10 (EO 13-10) affirming this unique and legally established relationship between the State of Minnesota and Minnesota Tribal Nations and requiring certain Cabinet-level agencies to implement a Tribal Consultation Policy.

II. Policy Statement

2.1 The Minnesota Department of Commerce ("Commerce") recognizes Minnesota Tribal Nations ("MTNs") as sovereign entities, not political subdivisions of States or other governmental units, with the inherent authority and responsibility for self-governance.

2.2 In accordance with best practices and in support of EO 13-10, Commerce is implementing the following policy ("Policy") to create an accountable, mutual, and intentional consultation process that encourages and promotes dialogue between MTNs and Commerce when input and guidance is necessary because Commerce's proposed actions and/or policies may implicate or affect the interests of MTNs.

2.3 Commerce will encourage cooperation between tribal, federal, state, and local governments to resolve issues of mutual concern.

2.4 Commerce will intentionally and proactively identify and consider when its actions and/or decisions may affect Tribal Interests and facilitate informed decision-making with the ultimate goal of reaching consensus on any proposed actions and/or decisions.

III. Definitions

3.1 **"Commerce" -** is the agency, Agency Leadership, staff and/or designated officials including directors, managers, supervisors, and technical staff responsible for supporting and implementing this policy.

3.2 **"Consultation"** - is the process of meaningful communication and coordination between Commerce and Tribal officials prior to Commerce taking actions or implementing decisions that may directly affect Tribal Interests. Consultation emphasizes trust, respect, and shared responsibility. It is an open and free exchange of information and opinions among parties, which leads to mutual understanding and comprehension.

3.3 **"Coordination"** - is the process by which each party:

- Shares and compares, in a timely manner, its plans, programs, projects and schedules with the related plans, programs, projects, and schedules of the other parties; and
- Adjusts its plans, programs, projects, and schedules to optimize the efficient and consistent delivery of Commerce-related projects and services.

3.4 **"Effective Date"** — the effective date of this Policy is the date of execution. The Policy will remain in effect until it is amended, superseded by a Commerce Administrative Order, or revoked.

3.5 **"Minnesota Tribal Nations" (MTNs) -** Minnesota's 11 Federally-recognized Tribes: Bois Forte Band of Ojibwe; Fond Du Lac Band of Lake Superior Chippewa; Grand Portage Band of Chippewa Indians; Leech Lake Band of Ojibwe; Lower Sioux Indian Community; Mille Lacs Band of Ojibwe; Prairie Island Indian Community; Red Lake Nation; Shakopee Mdewakanton Sioux Community; Upper Sioux Indian Community; and the White Earth Nation.

3.6 **"Tribal Interests"** - shall include the health and well-being of Tribe members; Tribal sovereignty and other legal rights of Tribes and Tribe members; Tribal lands and property; and policies, issues, and events that MTNs have communicated, through the consultation process established in this Policy to Commerce as being significant to Tribes.

IV. Implementation

4.1 **Identification of Required Consultation.** The analysis, planning, and implementation of Consultation should take into account all aspects of the action under consideration, including but not limited to, the complexity, implications, and resource constraints of the activity.

4.2 **Timing.** Commerce will consult with MTNs prior to the agency taking action or implementing decisions that may directly affect Tribal Interests about whether, how, or

when to act on a matter under consideration. Consultation is required on an ongoing basis, including any additions or amendments that occur later in the process.

4.3 **Notification.** Consultation may be initiated by written notification or other method either by Commerce or any of the MTNs. Commerce's notification will be from the Commissioner, addressed to a Tribal Chairperson and the highest ranking applicable Executive Administrator, or Tribal Council officer and should include sufficient information for the MTN to make informed decisions about participation.

4.4.1 **Presence of Third-Parties.** Either the MTN or Commerce may invite third-parties to participate in consultation with the agreement of the consulting parties.

4.4.2 **Record-Keeping**. An Administrative Record shall be created by Commerce, if needed, and sent to the most senior Tribal Official involved in the consultation. The MTN will review and make changes and/or comments to be incorporated into a final administrative record created by and distributed by Commerce.

4.4.3 **Input.** Either Commerce or the MTN can provide input at meetings, through written and oral exchanges of information, phone calls, or other ways depending on the specific circumstances.

V. Roles and Responsibilities

5.1.1 **Commissioner of Commerce.** In accordance with this policy, the Commissioner will engage in Consultation with the identified Tribal Leader. The Commissioner will also appoint a person from Commerce to serve as the Department Tribal Liaison.

5.1.2 **Tribal Liaison.** The Tribal Liaison is responsible for the coordination and implementation of Consultation in accordance with this Policy and has the authority to:

i. Identify and define appropriate issues for Consultation;
ii. Evaluate the adequacy of that Consultation;
iii. Ensure that Commerce program and Consultation practices are consistent with this Policy;
iv. Ensure that a formal record of the Consultation is maintained, if needed; and
v. Identify the appropriate and essential Commerce staff necessary for Consultation.

VI. Preemption

6.1 Nothing in this policy shall require Commerce to violate or ignore any laws, rules, directives or other legal requirement or obligations imposed by state or federal law, set forth in agreements or compacts between one or more of the MTNs and the State or its agencies.

6.2 Consultations are not intended to preclude or replace the existing, ongoing, and future meetings, communications, and exchanges of information and input that occur between Commerce and MTN.

6.3 If any provision of this policy conflicts with state or federal law, administrative rules, or other legal requirements or obligations, state and federal law shall control.

Responsible Manager(s):

Contact Person(s):

Related Commerce Policies:

Agency Signature:
[Signature gif/jpg of Commissioner]

Tribal Liaison Signature:

Effective date of this policy:

STATE OF MINNESOTA

EXECUTIVE DEPARTMENT

MARK DAYTON
GOVERNOR

Executive Order 13-10

Affirming the Government –to-Government Relationship between the State of Minnesota and the Minnesota Tribal Nations: Providing for Consultation, Coordination, and Cooperation; Rescinding Executive Order 03-05

I, Mark Dayton, Governor of the State of Minnesota, by virtue of the power invested in me by the Constitution and applicable statutes, do hereby issue this Executive Order:

Whereas, the United States and the State of Minnesota have a unique legal relationship with federally recognized Tribal Nations, as affirmed by the Constitution of the United States, treaties, statutes, and case law; and

Whereas, the State of Minnesota is home to 11 federally recognized Tribal Nations ("the Minnesota Tribal Nations") with elected or appointed Tribal Governments; and

Whereas, the State of Minnesota recognizes and supports the unique status of the Minnesota Tribal Nations and their right to existence, self-government, and self-determination; and

Whereas, the Minnesota Tribal Nations are comprised of a majority of the State's 61,000 American Indians and provide significant employment in the State; and

Whereas, members of the Minnesota Tribal Nations are citizens of the State of Minnesota and possess all the rights and privileges afforded by the State; and

Whereas, the State of Minnesota and the Minnesota Tribal Nations significantly benefit from working together, learning about one another, and partnering where possible; and

Whereas, meaningful and timely consultation between the State of Minnesota and the Minnesota Tribal Nations will facilitate better understanding and informed decision making by allowing for collaboration on

matters of mutual interest, and helping to establish respectful relationships between the State and the Minnesota Tribal Nations.

Now, Therefore, I hereby order that:

1. All Executive Branch agencies of the State of Minnesota shall recognize the unique legal relationship between the State of Minnesota and the Minnesota Tribal Nations, respect the fundamental principles that establish and maintain this relationship, and accord Tribal Governments the same respect accorded to other governments.

2. By March 10, 2014, the following Cabinet-level Executive Branch agencies (hereinafter "Cabinet Agency" and "Cabinet Agencies") shall, in consultation with the Minnesota Tribal Nations, develop and implement tribal consultation policies to guide their work and interaction with the Minnesota Tribal Nations: the Department of Corrections, Department of Education, Department of Health, Housing Finance Agency, Department of Human Rights, Department of Human Services, Department of Natural Resources, Pollution Control Agency, Department of Public Safety, Department of Transportation, and Department of Veterans Affairs. All other Cabinet-level Executive Branch agencies shall coordinate, as needed, with the tribal liaison in the Governor's Office to consult with the Minnesota Tribal Nations. Prior to February 1 of each year, each Cabinet Agency shall consult with each of the Minnesota Tribal Nations to identify priority issues for consultation.

3. As appropriate, and at the earliest opportunity, Cabinet Agencies shall consult with the Minnesota Tribal Nations prior to undertaking actions or policies related to the list of priority issues identified in Paragraph 2. Cabinet Agencies shall consider the input generated from tribal consultation into their decision-making processes, with the goal of achieving mutually beneficial solutions.

4. Each Cabinet Agency shall designate a staff member to assume responsibility for implementation of the tribal consultation policy and to serve as the principal point of contact for the Minnesota Tribal Nations. Each Cabinet Agency's designated staff member shall work with a representative(s) designated by the Minnesota Tribal Nations, who shall serve as the Cabinet Agency's principal point of contact.

5. All Cabinet Agencies shall provide training for designated staff who work with the Minnesota Tribal Nations in an effort to foster a collaborative relationship between the State of Minnesota and the Minnesota Tribal Nations.

Nothing in this Order shall require state agencies to violate or ignore any laws, rules, directives, or other legal requirements or obligations imposed by state or federal law, or set forth in agreements or compacts between one or more of the Minnesota Tribal Nations or any other Tribal Nation and the State or its agencies. This Order is not intended to, and does not create, any right to administrative or judicial review, or any other right or benefit or responsibility, substantive or procedural, enforceable against the State of Minnesota, its agencies or instrumentalities, its officers or employees, or its subdivisions or any other persons. Nothing in this Order prohibits or limits any state agency from asserting any rights or pursuing any administrative or judicial action under state or federal law to effectuate the interests of the State of Minnesota or any of its agencies.

If any provision in this Order conflicts with any laws, rules, or other legal requirements or obligations imposed by state or federal law, state and federal laws shall control.

Under Minnesota Statutes, section 4.035, subdivision 2, this Executive Order is effective 15 days after publication in the State Register and filing with the Secretary of State and shall remain in effect until rescinded by proper authority or it expires in accordance with Minnesota Statutes, section 4.035, subdivision 3.

In Testimony Whereof, I have set my hand on this 8th day of August, 2013.

Mark Dayton
Governor

Filed According to Law:

Mark Ritchie

Mark Ritchie
Secretary of State

MINNESOTA DEPARTMENT OF COMMERCE

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AN EQUAL OPPORTUNITY EMPLOYER

April 11, 2017

Chairman Charles Vig
Shakopee Mdewakanton Sioux Community
2330 Sioux Trail NW
Prior Lake, MN 55372

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear Chairman Vig:

The Minnesota Department of Commerce began formal consultation in 2016 with the eleven tribal nations in Minnesota regarding the Department's Interim Tribal Consultation Policy. Although, I have not yet met with you in formal consultation on Commerce's Tribal Consultation Policy, which addresses all areas of the Department, I am reaching out to you on an important issue.

First, however, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy, which is enclosed for your review. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and the Shakopee Mdewakanton Sioux Community, whenever possible.

In addition to meeting on the Interim Tribal Consultation Policy, the Department has been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Shakopee Mdewakanton Sioux Community, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an

Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Shakopee Mdewakanton Sioux Community, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Shakopee Mdewakanton Sioux Community, on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosures: Tribal Consultation Policy
Map of Line 3 Proposed Route and Alternatives

MINNESOTA DEPARTMENT OF COMMERCE

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AN EQUAL OPPORTUNITY EMPLOYER

April 11, 2017

Chairman Kevin Jensvold
Upper Sioux Community
5722 Travers Lane P.O. Box 147
Granite Falls, MN 56241

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear Chairman Jensvold:

The Minnesota Department of Commerce began formal consultation in 2016 with the eleven tribal nations in Minnesota regarding the Department's Interim Tribal Consultation Policy. Although, I have not yet met with you in formal consultation on Commerce's Tribal Consultation Policy, which addresses all areas of the Department, I am reaching out to you on an important issue.

First, however, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy, which is enclosed for your review. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and the Upper Sioux Community, whenever possible.

In addition to meeting on the Interim Tribal Consultation Policy, the Department has been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Upper Sioux Community, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

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Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Upper Sioux Community, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Upper Sioux Community, on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosures: Tribal Consultation Policy
Map of Line 3 Proposed Route and Alternatives

MINNESOTA DEPARTMENT OF COMMERCE

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AN EQUAL OPPORTUNITY EMPLOYER

March 23, 2017

Chairman Terrence Tibbetts
White Earth Nation
P.O. Box 418
White Earth, MN 56591

RE: Consultation Process and Request Regarding the Line 3 Replacement EIS

Dear Chairman Tibbetts:

I greatly appreciated the opportunity to meet in formal government-to-government consultation on the Minnesota Department of Commerce's Tribal Consultation Policy last September. Our meeting was an important step in strengthening our relationship with White Earth Nation and providing information and help on Commerce's services and programs, from consumer protection to energy.

First, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as tribal liaison to represent the Department consistent with the Department's Interim Tribal Consultation Policy. With respect to important topics, I believe it is essential to maintain the ongoing working relationship between the Department's and White Earth's staff, whenever possible.

I would also like to follow up on one key topic in our consultation process, Enbridge pipeline's proposed replacement of Line 3. As you know, Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline, leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by others as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

Again, the process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is the responsible governmental unit for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Division of Energy, Environmental Review Unit (EERA) to conduct the EIS in collaboration with the Department of Natural Resources, and the Minnesota Pollution Control Agency.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, Commerce finds it vital to consult with your leadership about the Department's role in gathering the information for the draft EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

The Department requests a meeting with leadership to provide the following information: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we ask for your guidance on how to represent the interests and the impact that the Proposed Project would have on your members' historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with White Earth staff to facilitate communications on the preparation of the draft EIS.

Finally, we would ask leadership to identify the appropriate staff with whom our staff should coordinate on information gathering and scheduling forums for the draft EIS, and on subsequent public meetings for the public comment period of the draft EIS.

The Department appreciates and thanks your Administrative staff for suggesting a meeting sometime between March 27 – 31, 2017 and look forward to confirming the date. We also thank your staff for providing great insight into tribal interests and concerns.

If there is information that would be helpful to consider prior to the meeting, please contact Danielle. Additionally, as I mentioned in our previous meeting, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

MINNESOTA DEPARTMENT OF COMMERCE

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April 11, 2017

President Shelley Buck
Prairie Island Indian Community
5636 Sturgeon Lake Road
Welch, MN 55089

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear President Buck:

Thank you for meeting with me in formal consultation in 2016 regarding the Department's Interim Tribal Consultation Policy.

First, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and the Prairie Island Indian Community whenever possible.

In addition to meeting on the policy, the Department has also been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Prairie Island Indian Community, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS. Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in

gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Prairie Island Indian Community, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Prairie Island Indian Community on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosure: Map of Line 3 Proposed Route and Alternatives

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April 11, 2017

Chairman Darrell G. Seki, Sr.
Red Lake Nation
15484 Migizi Drive
Red Lake, MN 56671

Dear Chairman Seki,

Thank you for accommodating the Minnesota Department of Commerce during your Council meeting on April 11, 2017. We greatly appreciate the ongoing working relationship and consultation with the Red Lake Nation on all of the matters between the Minnesota Commerce Department and the Red Lake Nation.

We also appreciated the opportunity to listen to yours, the Council's and tribal members' thoughts and position on Enbridge's proposed Line 3 Replacement. Thank you also for providing the Red Lake Nation's guidance on tribal interests to the Department for the tribal resources portion for the draft Environmental Impact Statement (EIS).

Please understand again, as we discussed, the Commerce Department is committed to respect for tribal sovereignty and treaty rights. We are also working diligently to intentionally and accurately reflect the sacred knowledge and understanding that only your tribal members and leaders possess.

Following up to the consultation meeting, we asked for tribal participation. One opportunity is for leadership to identify a Tribal Historical Preservation Officer (THPO), other leader, or an elder to provide a face-to-face interview to discuss how the proposed pipeline could affect the natural and cultural resources that are important to the Red Lake Nation. If you would like us to conduct interviews on cultural resources for inclusion in the draft EIS, we would be happy to schedule a time and provide transcription services. The interview would not only inform our EIS drafting but could also be submitted into the public record for review by the judge and PUC.

The questions below will provide the context for framing tribal use of natural, spiritual, and cultural resources in the draft EIS:

- Describe the interconnectedness of Land, Identity and Spirituality. Can they be separated from one another and if not why?
- What obligations do the Anishinaabe have to Mother Earth and how can they be met today?

- There are many projects that affect tribal interests, such as energy transmission, rights of way, etc. Is there something specific about pipelines that threatens the Anishinaabe way of life and relationship to place?
- What are sacred places? How is this different from sacred sites? What are culturally significant sites or cultural sites?
- What do you see as the biggest difference between the Anishinaabe communal, traditional use of land and the Anglo-Saxon concept of private land ownership and land use?
- How could State agencies more effectively understand or respect the inherent right to self-govern and sovereignty when coordinating special projects that effect tribal interests?
- What cultural resources are most threatened by pipeline projects? Please describe.
- We have heard of the water protectors – please explain their role within the community.

We also discussed with Council our desire to collaborate and share information, including map shape files, which are attached. Our goal is to ensure the draft EIS accurately reflects tribal concerns and identification of resources. This would include adding the resolution passed by the Council concerning Line 3.

Interviews and additions to the tribal resources map will need to be completed by April 21, 2017 for inclusion in the draft EIS to be completed by May 15, 2017. This information can also be included in the Final EIS, allowing interviews and edits to be completed by July 3, 2017.

Our tribal Liason, Danielle Oxendine Molliver, and environmental review staff, Jamie MacAlister, are always available to you and your staff with any questions, concerns, supplemental information, and to request further consultation or interviews.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosure

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April 11, 2017

Tribal Chair Cathy Chavers
Bois Forte Band of Chippewa
5344 Lakeshore Drive
Nett Lake, MN 55772

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear Chair Chavers:

The Minnesota Department of Commerce began formal consultation in 2016 with the eleven tribal nations in Minnesota regarding the Department's Interim Tribal Consultation Policy. Although, I have not yet met with you in formal consultation on Commerce's Tribal Consultation Policy, which addresses all areas of the Department, I am reaching out to you on an important issue.

First, however, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy, which is enclosed for your review. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and Bois Forte Band of Chippewa, whenever possible.

In addition to meeting on the Interim Tribal Consultation Policy, the Department has been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Bois Forte Band of Chippewa Community, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an

Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Bois Forte Band of Chippewa, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Bois Forte Band of Chippewa Community, on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosures: Tribal Consultation Policy
Map of Line 3 Proposed Route and Alternatives

April 11, 2017

President Phyllis Rawls Goff
Lower Sioux Agency
32469 Redwood County Hwy. 2
Morton, MN 56270

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear President Goff:

The Minnesota Department of Commerce began formal consultation in 2016 with the eleven tribal nations in Minnesota regarding the Department's Interim Tribal Consultation Policy. Although, I have not yet met with you in formal consultation on Commerce's Tribal Consultation Policy, which addresses all areas of the Department, I felt the need to reach out to you on an important issue.

First, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy, which is enclosed for your review. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and the Lower Sioux Agency whenever possible.

In addition to meeting on the policy, the Department has been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Lower Sioux Agency, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS. Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Lower Sioux Agency, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with Lower Sioux Agency on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman
Commerce Commissioner

Enclosures: Tribal Consultation Policy
Map of Line 3 Proposed Route and Alternatives

MINNESOTA DEPARTMENT OF COMMERCE

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March 23, 2017

Chairman Kevin DuPuis
Fond du Lac Band of Lake Superior Chippewa
1720 Big Lake Road
Cloquet, MN 55720

RE: Consultation Process and Request Regarding the Line 3 Replacement EIS

Dear Chairman DuPuis:

I greatly appreciated the opportunity to meet in formal government-to-government consultation on the Minnesota Department of Commerce's Tribal Consultation Policy last month. Our meeting was an important step in strengthening our relationship with the Fond du Lac Band of Lake Superior Chippewa and providing information and help on the scope of Commerce's services and programs, from consumer protection to energy.

First, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as tribal liaison to represent the Department consistent with the Department's Interim Tribal Consultation Policy. With respect to important topics, I believe it is essential to maintain the ongoing working relationship between the Department's and Fond du Lac's staff, whenever possible.

I would also like to follow up on one key topic in our consultation process, Enbridge pipeline's proposed replacement of Line 3. As you know, Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline, leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by others as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

Again, the process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is the responsible governmental unit for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Division of Energy, Environmental Review Unit (EERA) to conduct the EIS in collaboration with the Department of Natural Resources, and the Minnesota Pollution Control Agency.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, Commerce finds it vital to consult with your leadership about the Department's role in gathering the information for the draft EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

The Department requests a meeting with leadership to provide the following information: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we ask for your guidance on how to represent the interests and the impact that the Proposed Project would have on your members' historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with Fond du Lac staff to facilitate communications on the preparation of the draft EIS.

Finally, we would ask leadership to identify the appropriate staff with whom our staff should coordinate on information gathering and scheduling forums for the draft EIS, and on subsequent public meetings for the public comment period of the draft EIS.

On behalf of the Department, we appreciate and thank your Administrative staff for suggesting and arranging an open house on March 29, 2017, and hope that we can find additional time to meet with leadership in the near future. We also thank your staff for providing great insight into tribal interests and concerns.

If there is information that would be helpful to consider prior to the meeting, please contact Danielle. Additionally, as I mentioned in our previous meeting, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman
Commerce Commissioner

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April 11, 2017

Chairman Norman W. Deschampe
Grand Portage Reservation Tribal Council
83 Stevens Road
Grand Portage, MN 55602

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear Chairman Deschampe:

The Minnesota Department of Commerce began formal consultation in 2016 with the eleven tribal nations in Minnesota regarding the Department's Interim Tribal Consultation Policy. Although, I have not yet met with you in formal consultation on Commerce's Tribal Consultation Policy, which addresses all areas of the Department, I am reaching out to you on an important issue.

First, however, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy, which is enclosed for your review. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and Grand Portage Reservation Tribal Council, whenever possible.

In addition to meeting on the Interim Tribal Consultation Policy, the Department has been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Grand Portage Reservation Tribal Council, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an

Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Grand Portage Reservation Tribal Council, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Grand Portage Reservation Tribal Council on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosures: Tribal Consultation Policy
Map of Line 3 Proposed Route and Alternatives

MINNESOTA DEPARTMENT OF COMMERCE

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April 11, 2017

President Wilfrid Cleveland
Ho Chunk Nation
P.O. Box 667
Black River Falls, WI 54615

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear President Cleveland,

The Minnesota Department of Commerce began formal consultation and collaboration in 2016 with the five sovereign tribal nations in Minnesota directly affected by Enbridge Energy's proposed replacement of Line 3. Through recent consultation with the Minnesota Indian Affairs Council, we have identified that the Ho Chunk Nation has land holdings in proximity to the proposed pipeline. I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS. Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Ho Chunk Nation, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the

impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Ho Chunk Nation on the preparation of the draft EIS.

If there is information that would be helpful, please contact Commerce's tribal liaison, Danielle Molliver at (651) 539-1480 or danielle.ox.molliver@state.mn.us. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

Enclosures: Map of Line 3 Proposed route and alternatives

MINNESOTA DEPARTMENT OF COMMERCE

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March 23, 2017

Chairman Faron Jackson, Sr.
Leech Lake Band of Ojibwe
190 Sailstar Drive NW
Cass Lake, MN 56633

RE: Consultation Process and Request Regarding the Line 3 Replacement EIS

Dear Chairman Jackson:

I greatly appreciated the opportunity to meet in formal government-to-government consultation on the Minnesota Department of Commerce's Tribal Consultation Policy last month. Our meeting was an important step in strengthening our relationship with Leech Lake Band of Ojibwe and providing information and help on the scope of Commerce's services and programs, from consumer protection to energy.

First, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as tribal liaison to represent the Department consistent with the Department's Interim Tribal Consultation Policy. With respect to important topics, I believe it is essential to maintain the ongoing working relationship between the Department's and Leech Lake's staff, whenever possible.

I would also like to follow up on one key topic in our consultation process, Enbridge pipeline's proposed replacement of Line 3. As you know, Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline, leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by others as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

Again, the process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is the responsible governmental unit for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Division of Energy, Environmental Review Unit (EERA) to conduct the EIS in collaboration with the Department of Natural Resources, and the Minnesota Pollution Control Agency.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, Commerce finds it vital to consult with your leadership about the Department's role in gathering the information for the draft EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

The Department requests a meeting with leadership to provide the following information: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we ask for your guidance on how to represent the interests and the impact that the Proposed Project would have on your members' historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with Leech Lake staff to facilitate communications on the preparation of the draft EIS.

Finally, we would ask leadership to identify the appropriate staff with whom our staff should coordinate on information gathering and scheduling forums for the draft EIS, and subsequent public meetings for the public comment period of the draft EIS.

The Department appreciates and thanks your Administrative staff for suggesting a meeting sometime between April 3 – 7, 2017 and look forward to confirming the date. We also thank your staff for providing great insight into tribal interests and concerns.

If there is information that would be helpful to consider prior to the meeting, please contact Danielle. Additionally, as I mentioned in our previous meeting, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman

Mike Rothman
Commerce Commissioner

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March 23, 2017

Chief Executive Melanie Benjamin
Mille Lacs Band of Ojibwe
43408 Oodena Dr
Onamia, MN 53659

RE: Consultation Process and Request Regarding the Line 3 Replacement EIS

Dear Chief Executive Benjamin:

I greatly appreciated the opportunity to meet in formal government-to-government consultation on the Minnesota Department of Commerce's Tribal Consultation Policy and Enbridge's former Sandpiper proposal. Both meetings were an important step in strengthening our relationship with the Mille Lacs Band of Ojibwe and the Department and providing information and help on the scope of Commerce's services and programs, from consumer protection to energy.

First, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as tribal liaison to represent the Department consistent with the Department's Interim Tribal Consultation Policy. With respect to important topics, I believe it is essential to maintain the ongoing working relationship between the Department's and Mille Lac's staff, whenever possible.

I would also like to follow up on one key topic in our consultation process, Enbridge pipeline's proposed replacement of Line 3. As you know, Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline, leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by others as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

Again, the process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is the responsible governmental unit for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Division of Energy, Environmental Review Unit (EERA) to conduct the EIS in collaboration with the Department of Natural Resources, and the Minnesota Pollution Control Agency.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, Commerce finds it vital to consult with your leadership about the Department's role in gathering the information for the draft EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

The Department appreciates and thanks your Administrative staff for arranging the meeting and open house on March 17 and 22. We also thank your staff for providing great insight into tribal interests and concerns.

The Department also requests an additional meeting with leadership, where we could provide the following information: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, however, we ask for your guidance on how to represent the interests and the impact that the Proposed Project would have on your members' historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to continue coordinating with Mille Lacs staff to facilitate communications on the preparation of the draft EIS.

Finally, we would ask leadership to identify the appropriate staff with whom our staff should coordinate with on information gathering and scheduling forums for the draft EIS and on subsequent public meetings for the public comment period of the draft EIS.

If there is information that would be helpful to consider prior to the meeting, please contact Danielle. Additionally, as I mentioned in our previous meeting, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman
Commerce Commissioner

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April 11, 2017

President Robert L. Larsen
Lower Sioux Indian Community
Chairman of MN Indian Affairs Council

RE: Consultation Request Regarding the Line 3 Replacement EIS

Dear President Larsen:

The Minnesota Department of Commerce began formal consultation in 2016 with the eleven tribal nations in Minnesota regarding the Department's Interim Tribal Consultation Policy. Although, I have not yet met with you in formal consultation on Commerce's Tribal Consultation Policy, which addresses all areas of the Department, I am reaching out to you on an important issue.

First, however, I am pleased to announce that Commerce has appointed Danielle Oxendine Molliver as Tribal Liaison to represent Commerce consistent with the Department's Interim Tribal Consultation Policy, which is enclosed for your review. With respect to identified matters that may affect tribal interests or rights, I believe it is essential to maintain ongoing working relationships between the Department and the Lower Sioux Agency, whenever possible.

In addition to meeting on the Interim Tribal Consultation Policy, the Department has been in consultation and collaboration with the five sovereign tribal nations directly affected by Enbridge Energy's proposed replacement of Line 3. Although, the proposed pipeline route and alternatives are not in proximity to the Lower Sioux Agency, I write today to provide an update and offer to meet to discuss the process.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. This, as well as other route alternatives proposed by other entities as alternatives to the Enbridge route, may profoundly affect your historical, cultural, land, and natural resources.

The process for pipeline approval is with the Minnesota Public Utilities Commission (PUC), which is responsible for deciding whether to issue a Certificate of Need and determining what route to permit for the proposed project. In this case, the PUC has ordered an

Environmental Impact Statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS.

Consistent with our Interim Tribal Consultation Policy and in recognition of your inherit right to self-governance, we find it vital to consult with your leadership about Commerce's role in gathering the information and creating an EIS that highlights the unique sovereign status of the tribe and its protected tribal resources, interests, and concerns.

If you deem consultation on Enbridge's proposed Line 3 replacement a priority to the Lower Sioux Agency, the Department would be happy to meet with leadership in consultation. The format of a meeting could include: a PowerPoint Overview of the proposed pipeline; Commerce's role in preparing the EIS; and the processes and proposed timeline. Most importantly, we would ask for your guidance on how to represent the interests and the impact the Proposed Project would have on your member's historical, cultural, land, and natural resources. This would include if and how leadership would like Commerce to coordinate with the Lower Sioux Agency, on the preparation of the draft EIS.

If there is information that would be helpful, please contact Danielle. Additionally, my Deputy Commissioner and Chief of Staff, Anne O'Connor is also available as a contact for your staff.

As always, I look forward to our continued partnership and collaboration.

Sincerely,

Mike Rothman
Commerce Commissioner

Enclosures: Tribal Consultation Policy
Map of Line 3 Proposed Route and Alternatives

307.08 DAMAGES; ILLEGAL MOLESTATION OF HUMAN REMAINS; BURIALS; CEMETERIES; PENALTY; AUTHENTICATION.

Subdivision 1. **Legislative intent; scope.** It is a declaration and statement of legislative intent that all human burials, human remains, and human burial grounds shall be accorded equal treatment and respect for human dignity without reference to their ethnic origins, cultural backgrounds, or religious affiliations. The provisions of this section shall apply to all human burials, human remains, or human burial grounds found on or in all public or private lands or waters in Minnesota.

Subd. 2. **Felony; gross misdemeanor.** (a) A person who intentionally, willfully, and knowingly does any of the following is guilty of a felony:

(1) destroys, mutilates, or injures human burials or human burial grounds; or

(2) without the consent of the appropriate authority, disturbs human burial grounds or removes human remains.

(b) A person who, without the consent of the appropriate authority and the landowner, intentionally, willfully, and knowingly does any of the following is guilty of a gross misdemeanor:

(1) removes any tombstone, monument, or structure placed in any public or private cemetery or authenticated human burial ground; or

(2) removes any fence, railing, or other work erected for protection or ornament, or any tree, shrub, or plant or grave goods and artifacts within the limits of a public or private cemetery or authenticated human burial ground; or

(3) discharges any firearms upon or over the grounds of any public or private cemetery or authenticated burial ground.

Subd. 3. **Protective posting.** Upon the agreement of the appropriate authority and the landowner, an authenticated or recorded human burial ground may be posted for protective purposes every 75 feet around its perimeter with signs listing the activities prohibited by subdivision 2 and the penalty for violation of it. Posting is at the discretion of the Indian affairs council in the case of Indian burials or at the discretion of the state archaeologist in the case of non-Indian burials. This subdivision does not require posting of a burial ground. The size, description, location, and information on the signs used for protective posting must be approved by the appropriate authority and the landowner.

Subd. 3a. **Authentication.** The state archaeologist shall authenticate all burial grounds for purposes of this section. The state archaeologist may retain the services of a qualified professional archaeologist, a qualified physical anthropologist, or other appropriate experts for the purpose of gathering information that the state archaeologist can use to authenticate or identify burial grounds. If probable Indian burial grounds are to be disturbed or probable Indian remains analyzed, the Indian Affairs Council must approve the professional archaeologist, qualified anthropologist, or other appropriate expert. Authentication is at the discretion of the state archaeologist based on the needs identified in this section or upon request by an agency, a landowner, or other appropriate authority.

Subd. 4. [Repealed by amendment, 2007 c 115 s 1]

Subd. 5. **Cost; use of data.** The cost of authentication, recording, surveying, and marking burial grounds and the cost of identification, analysis, rescue, and reburial of human remains on public lands or waters shall be the responsibility of the state or political subdivision controlling the lands or waters. On private lands or

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waters these costs shall be borne by the state, but may be borne by the landowner upon mutual agreement with the state. The state archaeologist must make the data collected for this activity available using standards adopted by the Office of MN.IT Services and geospatial technology standards and guidelines published by the Minnesota Geospatial Information Office. Costs associated with this data delivery must be borne by the state.

Subd. 6. [Repealed by amendment, 2007 c 115 s 1]

Subd. 7. **Remains found outside of recorded cemeteries.** All unidentified human remains or burials found outside of recorded cemeteries or unplatted graves or burials found within recorded cemeteries and in contexts which indicate antiquity greater than 50 years shall be dealt with according to the provisions of this section. If such burials are not Indian or their ethnic identity cannot be ascertained, as determined by the state archaeologist, they shall be dealt with in accordance with provisions established by the state archaeologist and other appropriate authority. If such burials are Indian, as determined by the state archaeologist, efforts shall be made by the state archaeologist and the Indian Affairs Council to ascertain their tribal identity. If their probable tribal identity can be determined and the remains have been removed from their original context, such remains shall be turned over to contemporary tribal leaders for disposition. If tribal identity cannot be determined, the Indian remains must be dealt with in accordance with provisions established by the state archaeologist and the Indian Affairs Council if they are from public land. If removed Indian remains are from private land they shall be dealt with in accordance with provisions established by the Indian Affairs Council. If it is deemed desirable by the state archaeologist or the Indian Affairs Council, removed remains shall be studied in a timely and respectful manner by a qualified professional archaeologist or a qualified physical anthropologist before being delivered to tribal leaders or before being reburied. Application by a landowner for permission to develop or disturb nonburial areas within authenticated or recorded burial grounds shall be made to the state archaeologist and other appropriate authority in the case of non-Indian burials and to the Indian Affairs Council and other appropriate authority in the case of Indian burials. Landowners with authenticated or suspected human burial grounds on their property are obligated to inform prospective buyers of the burial ground.

Subd. 8. **Burial ground relocation.** No non-Indian burial ground may be relocated without the consent of the appropriate authority. No Indian burial ground may be relocated unless the request to relocate is approved by the Indian Affairs Council. When a burial ground is located on public lands or waters, any burial relocations must be duly licensed under section 138.36 and the cost of removal is the responsibility of and shall be paid by the state or political subdivision controlling the lands or waters. If burial grounds are authenticated on private lands, efforts may be made by the state to purchase and protect them instead of removing them to another location.

Subd. 9. **Interagency cooperation.** The Department of Natural Resources, the Department of Transportation, and all other state agencies and local governmental units whose activities may be affected, shall cooperate with the state archaeologist and the Indian Affairs Council to carry out the provisions of this section.

Subd. 10. **Construction and development plan review.** When human burials are known or suspected to exist, on public lands or waters, the state or political subdivision controlling the lands or waters or, in the case of private lands, the landowner or developer, shall submit construction and development plans to the state archaeologist for review prior to the time bids are advertised and prior to any disturbance within the burial area. If the known or suspected burials are thought to be Indian, plans shall also be submitted to the Indian Affairs Council. The state archaeologist and the Indian Affairs Council shall review the plans within 30 days of receipt and make recommendations for the preservation in place or removal of the human burials or remains, which may be endangered by construction or development activities.

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Subd. 11. **Burial sites data.** Burial sites locational and related data maintained by the Office of the State Archaeologist and accessible through the office's "Unplatted Burial Sites and Earthworks in Minnesota" Web site are security information for purposes of section 13.37. Persons who gain access to the data maintained on the site are subject to liability under section 13.08 and the penalty established by section 13.09 if they improperly use or further disseminate the data.

Subd. 12. **Right of entry.** The state archaeologist may enter on property for the purpose of authenticating burial sites. Only after obtaining permission from the property owner or lessee, descendants of persons buried in burial grounds covered by this section may enter the burial grounds for the purpose of conducting religious or commemorative ceremonies. This right of entry must not unreasonably burden property owners or unnecessarily restrict their use of the property.

Subd. 13. **Definitions.** As used in this section, the following terms have the meanings given.

(a) "Abandoned cemetery" means a cemetery where the cemetery association has disbanded or the cemetery is neglected and contains marked graves older than 50 years.

(b) "Appropriate authority" means:

(1) the trustees when the trustees have been legally defined to administer burial grounds;

(2) the Indian Affairs Council in the case of Indian burial grounds lacking trustees;

(3) the county board in the case of abandoned cemeteries under section 306.243; and

(4) the state archaeologist in the case of non-Indian burial grounds lacking trustees or not officially defined as abandoned.

(c) "Artifacts" means natural or artificial articles, objects, implements, or other items of archaeological interest.

(d) "Authenticate" means to establish the presence of or high potential of human burials or human skeletal remains being located in a discrete area, delimit the boundaries of human burial grounds or graves, and attempt to determine the ethnic, cultural, or religious affiliation of individuals interred.

(e) "Burial" means the organic remnants of the human body that were intentionally interred as part of a mortuary process.

(f) "Burial ground" means a discrete location that is known to contain or has high potential to contain human remains based on physical evidence, historical records, or reliable informant accounts.

(g) "Cemetery" means a discrete location that is known to contain or intended to be used for the interment of human remains.

(h) "Disturb" means any activity that significantly harms the physical integrity or setting of a human burial or human burial ground.

(i) "Grave goods" means objects or artifacts directly associated with human burials or human burial grounds that were placed as part of a mortuary ritual at the time of interment.

(j) "Human remains" means the calcified portion of the human body, not including isolated teeth, or cremated remains deposited in a container or discrete feature.

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(k) "Identification" means to analyze organic materials to attempt to determine if they represent human remains and to attempt to establish the ethnic, cultural, or religious affiliations of such remains.

(l) "Marked" means a burial that has a recognizable tombstone or obvious grave marker in place or a legible sign identifying an area as a burial ground or cemetery.

(m) "Qualified physical anthropologist" means a specialist in identifying human remains who holds an advanced degree in anthropology or a closely related field.

(n) "Qualified professional archaeologist" means an archaeologist who meets the United States Secretary of the Interior's professional qualification standards in Code of Federal Regulations, title 36, part 61, appendix A, or subsequent revisions.

(o) "Recorded cemetery" means a cemetery that has a surveyed plat filed in a county recorder's office.

(p) "State" or "the state" means the state of Minnesota or an agency or official of the state acting in an official capacity.

(q) "Trustees" means the recognized representatives of the original incorporators, board of directors, or cemetery association.

History: *(7632) RL s 2964; 1976 c 48 s 1; 1980 c 457 s 1; 1983 c 282 s 1-4; 1986 c 463 s 1; 1989 c 335 art 1 s 199; 1993 c 326 art 4 s 9; 1999 c 86 art 1 s 64-67; 1Sp2003 c 8 art 2 s 17; 2007 c 115 s 1; 2010 c 392 art 1 s 14; 2013 c 134 s 30; 2013 c 142 art 3 s 36*

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Field Archeology Act

138.40 COOPERATION OF STATE AGENCIES; DEVELOPMENT PLANS.

Subdivision 1.**Cooperation.**

The Department of Natural Resources, the Department of Transportation, and all other state agencies whose activities may be affected, shall cooperate with the historical society and the state archaeologist to carry out the provisions of sections 138.31 to 138.42 and the rules issued thereunder, but sections 138.31 to 138.42 are not meant to burden persons who wish to use state property for recreational and other lawful purposes or to unnecessarily restrict the use of state property.

Subd. 2.**Compliance, enforcement, preservation.**

State and other governmental agencies shall comply with and aid in the enforcement of provisions of sections 138.31 to 138.42. Conservation officers and other enforcement officers of the Department of Natural Resources shall enforce the provisions of sections 138.31 to138.42 and report violations to the director of the society. When archaeological or historic sites are known or, based on scientific investigations are predicted to exist on public lands or waters, the agency or department controlling said lands or waters shall use the professional services of archaeologists from the University of Minnesota, Minnesota Historical Society, or other qualified professional archaeologists, to preserve these sites. In the event that archaeological excavation is required to protect or preserve these sites, state and other governmental agencies may use their funds for such activities.

Subd. 3.**Review of plans.**

When significant archaeological or historic sites are known or, based on scientific investigations, are predicted to exist on public lands or waters, the agency or department controlling said lands or waters shall submit construction or development plans to the state archaeologist and the director of the society for review prior to the time bids are advertised. The state archaeologist and the society shall promptly review such plans and within 30 days of receiving the plans shall make recommendations for the preservation of archaeological or historic sites which may be endangered by construction or development activities. When archaeological or historic sites are related to Indian history or religion, the state archaeologist shall submit the plans to the Indian Affairs Council for the council's review and recommend action.

As Approved and Recommended for Tribal Adoption at 3/1/12 Voigt Task Force Meeting

MEMORANDUM OF UNDERSTANDING

REGARDING

TRIBAL - USDA-FOREST SERVICE RELATIONS

ON

NATIONAL FOREST LANDS

WITHIN THE TERRITORIES CEDED

IN

TREATIES OF 1836, 1837, AND 1842

PREAMBLE

The Memorandum of Understanding (MOU) deals with the relationships of sovereign and federally recognized tribes of Lake Superior Chippewa Indians and of the USDA Forest Service, an agency of the government of the United States. The MOU is based on the principle of government-to-government interactions between the United States Government and federally recognized Indian tribes. The purpose of the agreement is to establish standards by which the Forest Service and the Tribes will act consistently across national forest lands within areas ceded in the treaties of 1836, 1837, and 1842.

The policies of the Forest Service toward federally recognized tribes are intended to strengthen relationships and further tribal sovereignty through fulfilling mandated responsibilities and through support and assistance of various kinds to tribal governments. The relationships between the Tribes and Forest Service are comprised of several parts, including honoring treaty-based usufructuary rights as well as policies of the Forest Service toward Indian nations. While court decisions, laws, regulations, policies and Executive Orders from the President of the United States have all shaped the Forest Service's policy toward Indian tribes, nothing in this agreement is in any way intended to abrogate or affect in any fashion judicial decisions which have interpreted such treaty rights.

This MOU recognizes existing treaty rights of Tribes to hunt and fish and to gather wild plants on national forest lands in accord with applicable regulatory authorities of the States or other federal agencies having jurisdiction over such activities. Reference in the MOU to such

activities as hunting and fishing are designed to recognize that the Forest Service manages and provides access to ecosystems which support these activities.

I. CEDED TERRITORIES AND NATIONAL FORESTS INVOLVED (Figure 1).

A. **Ceded Territories.** This MOU specifically pertains to the territories ceded [hereafter ceded territories] by various Chippewa Tribes in the following Treaties: Treaty of 1836, 7 Stat. 491; Treaty of 1837, 7 Stat. 536; and Treaty of 1842, 7 Stat. 591.

B. **National Forests.** This MOU specifically pertains to the portions of the following National Forests [hereafter National Forests] located in the ceded territories: Chequamegon-Nicolet in Wisconsin; and Ottawa, Hiawatha and Huron-Manistee in Michigan.

II. PARTIES.

The following entities may ratify this MOU in accordance with their respective applicable laws and procedures, and, upon proper ratification, shall be deemed a party to this MOU:

A. **Tribes.** In their respective sovereign capacities, the following federally-recognized Tribes [hereafter Tribes] that are members of the Great Lakes Indian Fish and Wildlife Commission [hereafter GLIFWC]: Bad River Band of the Lake Superior Tribe of Chippewa Indians; Fond du Lac Band of Lake Superior Chippewa Indians; Lac du Flambeau Band of Lake Superior Chippewa Indians; Lac Courte Oreilles Band of Lake Superior Chippewa Indians; St. Croix Chippewa Indians of Wisconsin; Sokaogon Chippewa Community of the Mole Lake Band; Red Cliff Band of Lake Superior Chippewa Indians; Mille Lacs Band of Chippewa Indians; Bay Mills Indian Community; Keweenaw Bay Indian Community; and Lac Vieux Desert Band of Lake Superior Chippewa Indians.

B. **USDA-FS.** On behalf of the United States Department Agriculture, Forest Service [hereafter Forest Service] as an agency of the United States Government: the Forest Service's Eastern Region; the Eastern Region's Law Enforcement and Investigations; and the Forest Service's Northern Research Station.

III. GOVERNING PRINCIPLES AND FUNDAMENTAL ASSUMPTIONS.

The parties agree that the MOU is based upon the following governing principles and fundamental assumptions and that the MOU shall be interpreted in accordance with them:

A. **Existence of Ceded Territory Rights.** The parties acknowledge and recognize the Tribes' treaty-guaranteed hunting, fishing and gathering rights [hereafter ceded territory rights] that may be exercised on lands administered by the Forest

Service located within the ceded territories.

B. **Tribal Sovereignty and Self-Regulatory Capacity.** The parties acknowledge and recognize:

1. The Tribes' inherent sovereignty and retained regulatory authority regarding their ceded territory rights; and

2. The Tribes' ability to administer and implement a system of effective tribal self-regulation regarding tribal member exercise of those rights.

C. **Federal Trust Responsibility and Treaty Obligations.** The parties acknowledge and recognize that the Forest Service shares in the United States Government's trust responsibility and treaty obligations to work with the Tribes on a government-to-government basis to protect the Tribes' ceded territory rights on lands administered by the Forest Service.

D. **Forest Service's Native American Policies.** The parties acknowledge and recognize the Forest Service's American Indian and Alaska Native Relations polices as presently set forth in Forest Service Manual 1563, Forest Service Handbook 1509.13, and other directives implementing provisions of the Food, Conservation, and Energy Act of 2008, Public Law 110-246 [hereinafter the "2008 Farm Bill"], to:

1. Maintain a governmental relationship with federally-recognized tribal governments consistent with Executive Order 13175 of November 6, 2000, Consultation and Coordination with Indian Tribal Governments, the President's Memorandum of November 5, 2009, Tribal Consultation and the President's Memorandum of April 29, 1994, Government-to-Government Relations with Native American Tribal Governments;

2. Implement programs and activities in a way that honors Indian treaty rights and fulfills legally-mandated trust responsibilities to the extent they apply to National Forest System lands;

3. Administer programs and activities to address and be sensitive to traditional Native religious beliefs and practices; and

4. Provide research, transfer of technology, and technical assistance to tribal governments.

E. **Forest Service's Forest Management Responsibilities.** The parties

acknowledge and recognize that the Forest Service is the agency of the United States Government authorized and responsible for implementing law and policies related to National Forest management.

F. **Forest Service's Law Enforcement Responsibilities.** The parties acknowledge and recognize that the Forest Service's Law Enforcement and Investigations Branch is responsible for enforcement of alleged violations of federal laws and regulations occurring on lands administered by the Forest Service.

G. **General Tribal/USDA-FS Government-to-Government Relationship Unaffected.** This MOU applies to the parties' government-to-government relationship, other Tribal -Forest Service interactions, the Tribes' ceded territory rights applicable on lands administered by the Forest Service, and the parties' relationships and dealings involving those rights. It is not intended, and should not be construed, to abrogate or otherwise affect any party's authority or responsibility in other areas. Similarly, it is not intended, and should not be construed, to otherwise define or restrict the parties' obligations, relationships or dealings in other areas of their respective authorities, responsibilities, or sovereign prerogatives.

H. **Effect of MOU on Non-Ratifying Tribes.** The parties' specific intent is that this MOU shall not bind or in any way affect the rights or claims of any GLIFWC member Tribe that chooses not to become a party or of any other Tribe that is a signatory to any of the treaties identified in Section I.B., above.

I. **Reservation of Rights, Claims and Defenses.**

1. The termination of or withdrawal from this MOU shall be without resulting liability to any other party or prejudice to any claim a party may have against any other party.

2. Except as expressly provided herein, the fact that any Tribe or the Forest Service is or may have been a party to this MOU shall not be construed as a waiver of any rights, claims or defenses that, absent this MOU, any of those entities may have under any treaty between the United States and a Tribe, or under other applicable law of the United States.

3. The parties acknowledge that this MOU contains provisions that may be the result of compromise and policy choices. As such, these provisions may not reflect the full extent of the Tribes' ceded territory rights or of the Forest Service's responsibilities to manage the National Forests. Therefore, in the absence of or outside the scope of this MOU, the

provisions contained herein are not intended to alter or abridge:

a. The Tribes' underlying ceded territory rights or those rights of any other treaty signatory Tribe that is not a party to this MOU; or

b. The Forest Service's authorities to manage the National Forests in accordance with applicable law.

4. This agreement is not intended to alter usufructuary rights recognized in *Lac Courte Oreilles Band v. Voigt*, 700 F.2d 341 (7th Cir. 1983) or *Minnesota v. Mille Lacs Band*, 119 S.Ct. 1187 (1999). The MOU does not alter the authority of any government regarding the regulation of treaty rights under those decisions.

IV. **PURPOSES.** To accomplish the primary purposes of recognizing and implementing the Tribes' ceded territory rights and furthering Forest Service Native American policies, the parties intend to:

A. **Government-to-Government Relationship.** Establish a framework for a cooperative, government-to-government relationship between the Tribes and the United States Government that:

1. Ensures the meaningful exercise of the Tribes' ceded territory rights on the lands administered by the Forest Service within the ceded territories;

2. Facilitates consistent and timely communication between parties at the appropriate levels of government; and

3. Fosters effective participation by the Tribes in National Forest management, in the development, revisions and implementation of Land and Resource Management Plans [hereafter Forest Plans] and in subsequent Forest Plan implementation decisions.

B. **Exercise of Ceded Territory Rights.** Establish agreed-upon parameters under which the Tribes' ceded territory gathering rights may be exercised within the provisions of and the protections afforded by this MOU on lands administered by the Forest Service within the ceded territories.

C. **Conservation of Natural Resources.** Protect, manage and enhance ecosystems and communities that support the natural resources subject to the Tribes' ceded territory rights on lands administered by the Forest Service.

V. **RECOGNITION OF THE PARTIES' MUTUAL INTERESTS.** Underlying the purposes of and specific agreements contained in this MOU, the parties recognize a number of mutual interests that they wish to address:

A. **Tribal Self-Determination and Self-Governance.** One of the Tribes' primary goals is to achieve self-determination and self-governance through the exercise of their retained sovereign governmental authority regarding their ceded territory rights. A key Forest Service policy is to administer its programs and activities in a manner that recognizes the governments of the Tribes and the authority that they carry out on behalf of the Tribes. Therefore, the parties seek to establish a government-to-government relationship that promotes collaboration and communication in the management of the National Forests, that provides for effective tribal self-regulation of the exercise of ceded territory rights on lands administered by the Forest Service, and, as noted below, that promotes efficient and effective law enforcement.

B. **Collaborative Approach in the Management of Natural Resources.** The Tribes' ceded territory rights include the right to gather wild plants and to harvest wild animals on lands administered by the Forest Service, and the Tribes want to ensure that management of these lands protects their ability to meaningfully exercise these rights. The Forest Service is tasked with the administration of the National Forests and is the federal agency responsible for the care and management of the land and natural resources that are part of the National Forests. Therefore, the Tribes and the Forest Service seek to establish a relationship and associated processes that facilitate consistent and timely communication between them and that integrate the Tribes' needs and wishes for the desired state of the National Forests into Forest Plans and subsequent Forest Plan implementation decisions.

C. **Sustainability of Ecosystems.** Since time immemorial, the Tribes have traditionally harvested certain plants and other resources found on lands now managed as the National Forests to meet subsistence, religious, cultural, medicinal and commercial needs. The Tribes' culture and lifeway depends on this harvest activity, and they wish to protect and enhance the natural resources upon which they rely. The Tribes measure the protection of these resources in terms of ensuring their sustainability for use by the seventh generation hence. The Forest Service is the federal agency responsible for managing the National Forests for the benefit of present and future generations. In addition, the Forest Service's policy is to carry out its programs and activities in a manner that is sensitive to the Tribes' traditional practices and beliefs. Therefore, the Tribes and Forest Service seek to collaboratively promote ecosystem management that protects and restores native communities and species, furthers the diversity of species, and ensures the

sustained yield and availability of natural resources that are subject to the Tribes' ceded territory rights.

D. **Efficient and Effective Law Enforcement.** As part of their self-regulatory system, the Tribes recognize the need to provide for the enforcement and adjudication of alleged violations of tribal laws governing the exercise of the ceded territory rights. To further compliance with tribal laws and to mete out meaningful and effective penalties, they recognize that the administration of justice in this context is best accomplished within their own communities and in their own forums. The Forest Service also recognizes that justice is best served in the communities most involved and affected. Therefore, the parties seek to establish a mutually beneficial efficient and effective system for enforcing applicable laws.

E. **Consistent Ceded Territory Gathering Regulations**. The meaningful exercise of the Tribes' ceded territory rights requires a consistent, conservation-based harvest regulatory system throughout the National Forests. To avoid administrative inefficiency and the associated confusion, the Forest Service recognizes the need for a consistent gathering policy and regulatory scheme in each of the National Forests. Therefore, the parties seek to establish a ceded territory-wide policy and regulatory framework that provides for the exercise of the ceded territory rights in a consistent manner that meets conservation goals, protects the public health and safety, and promotes efficient and effective law enforcement.

F. **Implementation of the Federal Trust Responsibility.** The Tribes continually seek to have United States Government and its agencies properly discharge the federal trust responsibility to assist in the development of the Tribes' governmental capabilities and to take actions for the Tribes' benefit. The Forest Service's policy is to administer its programs and activities in a manner sensitive to the Tribes' needs, beliefs, and practices, and to provide research, transfer of technology and technical assistance to the Tribes. Therefore, the parties seek to establish a framework for collaboration, communication and information exchange that will nurture understanding and maximize mutual benefits, and that will enhance the development of the Tribes' capabilities necessary to ensure effective tribal participation in the processes and procedures established in this MOU.

VI. SPECIFIC AGREEMENTS TO IMPLEMENT THE GOVERNMENT-TO-GOVERNMENT RELATIONSHIP

This section sets forth the specific agreements to implement the parties' government-to-government relationship in these areas: (A) MOU administration and implementation; (B) National Forest planning and decision-

making; (C) natural resource harvest management; (D) natural resource research and monitoring; (E) law enforcement; and (F) amendment of the MOU and its Appendices.

A. MOU Administration and Implementation.

1. The parties shall strive to reach consensus in all decisions, actions and processes contemplated by the MOU.

2. Unless otherwise specifically provided in this MOU, the parties shall attempt to resolve any dispute arising under the MOU at the lowest possible level on a government-to-government basis between properly authorized representatives of the parties who have the authority to resolve the dispute in question.

3. To facilitate on-going communication and the resolution of outstanding issues, the parties:

   a. Shall meet at least annually to facilitate on-going communication, to review progress made and discuss issues arising under this MOU, to ensure that the parties are faithfully and effectively implementing this MOU and adhering to its terms, and to discuss trends, issues or other matters that may effect the MOU. The Forest Service will accept comments from interested citizens about the implementation of the MOU at any time and, prior to the annual meeting, the Forest Service will solicit public comments. The parties will consider any comments at the annual meeting and jointly approved minutes will be made available for public review.

   b. Hereby establish a Technical Working Group (hereafter TWG) whose purpose shall be to review any scientific, technical or natural resource management issue referred to it in this MOU or by subsequent agreement of the parties. The TWG is empowered to make recommendations to the parties regarding the matters referred to it, such as the development and coordination of research projects, possible harvest monitoring and regulatory responses to particular circumstances, and data/information exchange regimens. The TWG also is empowered to suggest to the parties issues that may require the parties' attention and consideration.

      The TWG will be comprised of qualified natural resource scientists, managers and researchers designated by the Forest Service and the Tribes, and should include designates from the Northern Research Station and GLIFWC. Law enforcement

personnel should participate in the TWG as necessary to address enforcement-related issues.

The Forest Service and the Tribes will each appoint a TWG co-chair to coordinate communication and planning for the group's work. The TWG may appoint one or more working subgroups to address specified issues.

c. May, in addition to matters referred to the TWG, agree to refer specific questions or issues to designated representatives or *ad hoc* working groups for discussion, development of information, formulation of recommendations, or specific action.

d. Agree to provide such data and information as another party might request pertaining to matters addressed by the MOU, such as natural resource population and harvest data, law enforcement statistics and tribal court statistics.

4. The parties shall cooperate in identifying and seeking adequate funding for the enhancement of their infrastructures necessary to improve the implementation of this agreement. However, the parties acknowledge that this MOU does not modify or restrict the budgetary authority of any party.

5. The parties shall undertake cultural sensitivity training for their personnel who will be responsible for implementing this MOU. The parties also shall engage in joint and coordinated public education efforts to inform the public about this MOU and its underlying purposes.

B. **National Forest Planning and Decision-making.** The parties recognize that Forest Service decisions vary in their effects on the abundance of, distribution of or access to the natural resources on the lands that it administers. For example, the Forest Service, at various levels, makes a number of decisions that relate to such matters as the development, revision and implementation of Forest Plans for each of the National Forests covered by this MOU. They include decisions that commit to particular land management actions, such as project level decisions (including closures of temporary and permanent roads), and decisions that establish the policies or guidelines that govern these actions. Other decisions relate to such matters as the internal administration of the Forest Service as an agency regarding personnel, property and budgets, and do not commit to particular land management actions or establish policies governing those actions.

The Tribes and Forest Service agree that they shall consult on a government-to-

government basis on all Forest Service decisions that affect the abundance, distribution or access to the natural resources on lands administered by the Forest Service. In addition, they agree that the goal of such consultation shall be that any such Forest Service decision should expressly recognize and accommodate the Tribes' ceded territory rights, protect and enhance treaty-reserved natural resources, and accommodate exercise of ceded territory rights by tribal members under tribal regulations.

To achieve this end, the Tribes and Forest Service specifically agree that:

1. As to decisions that result in particular land management actions, in policies or guidelines governing those actions, or in research projects to be conducted by the Northern Research Station:

    a. The Forest Service shall consult with and facilitate effective participation by the Tribes at all stages and levels of the decision-making process. This collaboration is recognized as a dynamic process that must include consultation on a consistent and timely basis at the appropriate levels of government and that must be flexible to deal with ever-changing circumstances and adaptive natural resource management responses.

    b. The Forest Service shall consider the effects of its decisions on treaty resources and the ability of the Tribes to exercise treaty gathering rights. In decision and analysis documents, including those required by the National Forest Management Act and the National Environmental Policy Act, decision-makers will show how tribal information and involvement was taken into account in analyzing the effects of potential management actions and in making the decision.

    c. The Tribes and the Forest Service will strive to reach consensus. Where consensus cannot be reached:

        1) They will attempt to resolve any dispute or disagreement first by good faith discussions between the affected Tribe(s) and the Forest Service deciding official. The Tribe(s) may raise any matter not resolved at this level to a higher Forest Service official, including the appropriate Forest Supervisor and the Regional Forester. The Forest Service agrees to delay a final decision on the unresolved matter until this process has had the opportunity to take place within a reasonable amount of time.

2) The Forest Service may make and implement the decision.

3) In addition to the procedures provided by the MOU, a Tribe may challenge or appeal any Forest Service decision or action in accordance with applicable law.

2. As to decisions relating to the administration of Forest Service budgets, personnel or property, the parties shall cooperate in identifying and seeking adequate resources for the Tribes' and Forest Service's capabilities necessary to implement this MOU. In particular, the Forest Service shall seek input from the Tribes in a timely manner regarding the development of its budget proposal for upcoming fiscal years.

3. During the course of their dealings, the Tribes and Forest Service shall ensure that they have identified their representatives with whom the other parties should interact regarding particular decisions or particular types of decisions.

4. Nothing in this MOU shall preclude the Tribes and Forest Service from discussing matters or advancing particular requests that are not part of a particular pending Forest Plan implementation decision.

C. **Natural Resource Harvest Management.** The Tribes and Forest Service acknowledge their mutual interests in undertaking a collaborative approach in managing the harvest of natural resources on lands administered by the Forest Service to ensure the sustainability of ecosystems and the sustained yield of natural resources, in ensuring that the Tribes' ceded territory rights are meaningfully exercised, and in providing for a consistent conservation-based system under which the Tribes will exercise their ceded territory rights on those lands. Specifically, the Tribes and Forest Service agree:

1. Within the bounds of their respective authorities, to regulate and monitor the harvest of natural resources on lands administered by the Forest Service in a manner that provides for a sustained harvest of those resources and affords the Tribes the opportunity to harvest an equal allocation of the harvestable surpluses of those resources.

2. That the Tribes will regulate tribal member gathering on lands administered by the Forest Service by adopting regulations and implementing permit systems that are no less restrictive than those set forth in the Model Off-Reservation National Forest Gathering Code

[hereafter Model Code], which is attached as Exhibit A and specifically incorporated into this MOU.

3. That any changes making the Model Code, or any Tribe's enactment based upon the Model Code, less restrictive will fall within the scope of the MOU if the Forest Service's consent is obtained in accordance with the provisions of subsection F, below.

4. To monitor harvest levels in the most effective and precise manner needed to ensure resource protection and to exchange harvest monitoring data on a regular basis.

5. To designate areas for tribal sugar bushes that will meet needs identified by the Tribes and to jointly develop specific sugar bush management plans. The parties further agree to consider complementary and conflicting resource values, location of historical sugarbushes, proximity to reservations, and other relevant factors in choosing sugarbush locations.

6. To locate species of interest to the Tribes and to provide gathering opportunities for those resources, particularly regarding gathering opportunities associated with National Forest timber sales.

7. That once the Forest Service decides that it intends to solicit bids for timber sale contracts for down or damaged trees, trees in the designated timber salvage stands having a diameter of four inches or greater, whether they are alive, dead, down or standing, will be regulated in the same manner as standing live trees for treaty harvest purposes. For the purposes of the MOU and attached Model Code, the term "Forest Service timber salvage stand" means any stand of trees where the Forest Service has notified the Tribes of its decision to solicit bids for a salvage timber sale contract, and the term "salvage timber" means any tree in that stand, whether alive, dead, down or standing, having a diameter of four inches or greater.

8. That the Tribes will not issue a permit for the harvest of timber or of salvage timber, as set forth below, without the Forest Service's consent.

    a. In seeking the Forest Service's consent, the requesting Tribe shall inform the other Tribes that are parties to the MOU of the request and shall indicate in writing to the Forest Service the types and amounts of trees sought, the use to which the trees will be put, and the anticipated time frame for the harvest. The Forest Service shall promptly consider the request, consult with the requesting Tribe as

to the specifics of the proposal, and provide in writing its decision and the underlying rationale. The Forest Service shall make every attempt to accommodate the request and, before withholding consent, shall discuss with the Tribe possible alternatives. In any event, Forest Service consent shall not be unreasonably withheld. The Tribes will conduct inter-tribal coordination on requests for timber.

b. To further the purpose of this Section, the Tribes will implement a harvest management system pertaining to requests for timber, as set forth in the Tribal Timber Harvest Framework Agreement [Management Framework Agreement], which is attached as Appendix C and specifically incorporated into this Agreement. Any changes to the Management Framework Agreement or to any Tribe's enactment based upon it, which would result in less restrictive provisions relating to treaty rights exercise within the National Forest, will fall within the scope of the MOU only if the Forest Service's consent is obtained in accordance with the provisions of subsection F.6, below.

c. The tribes may issue a permit for the harvest of timber or of salvage timber for the following purposes:

1) For domestic purposes, as this term is defined in the attached Model Code (authorized pursuant to 16 U.S.C. 477, and the treaties between the Unites States and GLIFWC's member Ojibwe Tribes, specifically Treaty of 1836, 7 Stat 491, Treaty of 1837, 7 Stat. 536, and Treaty of 1842, 7 Stat. 591).

2) For non-commercial traditional and cultural purposes, as this term is defined in the attached Model Code (authorized pursuant to 25 U.S.C. 3055, and the treaties between the Unites States and GLIFWC's member Ojibwe Tribes, specifically Treaty of 1836, 7 Stat 491, Treaty of 1837, 7 Stat. 536, and Treaty of 1842, 7 Stat. 591).

9. That any requests for timber or miscellaneous forest products, as these terms are defined in the attached Model Code, from national forests made by Tribes not party to this MOU within the ceded territories will require immediate consultation with the signatory Tribes prior to the granting of such request.

10. That the Tribes and their members use National Forest campgrounds in the exercise of their ceded territory rights and that Forest Service fees and length of stay restrictions at campground should not interfere with the exercise of the rights. The parties acknowledge that, prior to completion and ratification of the MOU, time constraints have prevented them from developing the necessary Exemption Agreement and accompanying Implementation Plan regarding campground fee and length of stay exemptions for tribal members. Upon ratification of the MOU, the parties commit to immediately developing the Agreement and Implementation Plan. Once properly approved, the Exemption Agreement and Implementation Plan shall become part of the MOU and be specifically incorporated by reference herein as if set forth in their entirety.

11. That the parties have not resolved their disagreement regarding the Tribes' request for unrestricted motorized use of Crooked Lake in the Sylvania Wilderness located in the Ottawa National Forest. While the parties agree to disagree on this matter at this time, they will continue to strive for a resolution using the procedures and processes contained in the MOU. The parties acknowledge that on all other matters regarding wildernesses, their agreement is properly reflected in the provisions of the attached Model Code, including specifically those of §3.06(1)(a) that establish Tribal National Forest Wildernesses.

12. That, in accordance with the provisions of subsection F, below, the Forest Service will notify the Tribes of and obtain the Tribes' input on proposed changes in federal laws or regulations that are intended to regulate or otherwise restrict the harvest of natural resources on lands administered by the Forest Service within the ceded territories.

13. That the Tribes have implemented harvest management regulatory systems that govern the exercise of off-reservation treaty-reserved tribal deer hunting, bear hunting, migratory bird hunting, small game hunting and trapping, and wild rice gathering. To the extent that these activities occur within National Forests, the provisions of the Tribe's Off-Reservation Conservation Code are hereby declared, and shall be construed, to govern tribal members engaged in the exercise of these treaty-reserved rights within National Forests.

D. **<u>Monitoring and Evaluation</u>.** To ensure the sustainability of ecosystems, the Tribes and Forest Service acknowledge the importance of inventorying and monitoring the status of species and their habitats within the National Forests, evaluating the impacts of harvest on the resources subject to the Tribes' ceded

territory rights, and evaluating the effects of other land management activities on those resources. With the input and recommendations of the TWG, the Tribes and Forest Service agree to:

1. Review their respective existing research projects and administrative studies as needed for the purpose of encouraging research coordination.

2. Establish and implement a program of research, monitoring and evaluation regarding the resources subject to the Tribes' ceded territory rights that specifically would:

    a. Inventory species status and habitat requirements.

    b. Monitor the population dynamics and habitats of species as Forest Plans are implemented.

    c. Determine the effects of land management activities, such as timber harvest, on species' populations.

    d. Determine the effects of wild plant harvest on the status of the species being harvested.

    e. Evaluate such other matters that relate to the resources subject to the Tribes' ceded territory rights.

E. **Law Enforcement.** The parties acknowledge the Tribes' capabilities to implement a self-regulatory system governing the exercise of ceded territory rights applicable on lands administered by the Forest Service. The parties specifically agree that:

1. Any regulation adopted by Tribe consistent with the MOU will govern the exercise of the Tribes' ceded territory gathering rights within the National Forests and is within the scope of the MOU. Any Tribe's regulation that is not consistent with the MOU's provisions is outside the MOU's scope.

2. The enforcement of the Tribes' regulations and of any federal statute or regulation governing the conduct within the scope of a Tribe's regulations that are consistent with the terms of the MOU shall be governed by a properly ratified agreement that is no less restrictive than the Tribal Self-Regulation Agreement [hereafter Self-Regulation Agreement], attached as Appendix B and specifically incorporated into the MOU. For the purposes of this subsection, "properly ratified" means a party's approval of

and the agreement to be bound by the Self-Regulation Agreement in accordance with that party's required governmental procedures.

3. That any changes in the Self-Regulation Agreement shall be made in accordance with the provisions of subsection F, below.

4. Primary enforcement and administration of justice responsibilities for the Tribes' regulations lies with the Tribes and their properly authorized agencies.

5. The Tribes and Forest Service will coordinate their respective law enforcement activities and establish cooperative law enforcement ventures, such as joint patrols, effective communication systems, information and potential violation referral processes, and joint training activities. These coordinated law enforcement activities shall include at least annual meetings between designated enforcement personnel.

F. **Process for MOU Amendments, Regulatory Changes and Self-Regulation Agreement Changes.** The parties recognize the dynamic nature of their government-to-government relationship. They also recognize that changes in federal and tribal regulation and management of the harvesting of the National Forests' natural resources in the ceded territories are inevitable. To facilitate open communication and minimize disputes arising from the dynamics of their relationship and from the need to change harvest regulations, the parties agree:

1. Consensus/Resolution of Disputes. As for the matters addressed by this subsection F, the affected parties shall strive to reach consensus on the matter at hand. Where consensus cannot be reached:

   a. The affected parties will attempt to resolve any dispute or disagreement first by good faith discussions at the appropriate governmental level. A party may raise any matter not resolved at this level to a higher official of another party. If it has the authority to do so, a party will delay a final decision on the unresolved matter until this process has had the opportunity to take place within a reasonable amount of time.

   b. A party claiming the requisite authority may make and implement a decision on the unresolved matter.

   c. In addition to the procedures provided by the MOU, a party may challenge or appeal another party's decision or action in

accordance with applicable law.

2. MOU Amendment. Any party may propose an amendment to the MOU in writing to the other parties. Within 60 days of receipt, the parties shall convene a meeting to consider the proposal. An amendment may be adopted by and binding upon less than all of the parties provided that the adopting parties include at least one tribal party and the Forest Service.

3. Federal Laws and Regulations. The Forest Service agrees to seek the input of the Tribes on proposed changes to the Forest Service's regulation of natural resource harvesting within the ceded territories by providing written notice, including an explanation of the underlying rationale, to the Tribes at least 60 days in advance of the desired effective date of the proposed change. The Tribes shall have 45 days, or such other time period as may be agreed upon, to provide comments.

   In addition, the Tribes may submit a written request to the Forest Service for changes in the Forest Service's regulation of natural resource harvesting, including an explanation of the request's rationale. The Forest Service agrees to respond to the request within 45 days, or such other time period as may be agreed upon.

   Unless other time frames are specifically imposed by applicable law, the Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on the Forest Service proposal and on a Tribe's request.

4. Model Code or Tribal Enactments Based Upon the Model Code. The Tribes agree to notify the Forest Service in writing of any proposed change that would make the Model Code, or any Tribe's enactment based upon the Model Code, less restrictive than provided for in the MOU. In addition, the Forest Service may request the Tribes to change the Model Code, or any Tribe's enactment based upon the Model Code, to be more restrictive than provided for in the MOU.

   Except in cases of emergency, such notices and requests will be provided at least 60 days in advance of the desired effective date of the change and will include an explanation of the proposal's rationale. Within 45 days of receipt, or such other time period as may be agreed upon, the receiving party or parties shall respond expressing any objections and indicating any changes that are agreeable. The failure to object in writing to a proposed change within the 45-day period, or any extension thereof, will be deemed as agreement to the proposal.

The Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on any objection to a proposed or requested change.

A properly amended Model Code shall replace the then-current Appendix A to the MOU and is specifically incorporated by reference herein as if set forth in its entirety.

5. Tribal Self-Regulation Agreement. Any party may submit a written request to the other parties for a change in the Self-Regulation Agreement. Except in cases of emergency, such request will be provided at least 60 days in advance of the desired effective date of the change and will include an explanation of the proposal's rationale. Within 45 days of receipt, or such other time period as may be agreed upon, the receiving party or parties shall respond expressing any objections and indicating any changes that are agreeable. The failure to object in writing to a proposed change within the 45-day period, or any extension thereof, will be deemed as agreement to the proposal.

   The Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on any objection to a proposed change.

   A properly amended Self-Regulation Agreement shall replace the then-current Appendix B to the MOU and is specifically incorporated by reference herein as if set forth in its entirety.

6. Tribal Timber Harvest Framework Agreement. Any party may submit a written request to the other parties for a change in the Timber Harvest Framework Agreement. Except in cases of emergency, such request will be provided at least 60 days in advance of the desired effective date of the change and will include an explanation of the proposal's rationale. Within 45 days of receipt, or such other time period as may be agreed upon, the receiving party or parties shall respond expressing any objections and indicating any changes that are agreeable. The failure to object in writing to a proposed change within the 45-day period, or any extension thereof, will be deemed as agreement to the proposal.

   The Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on any objection to a proposed change.

A properly amended Timber Harvest Framework Agreement shall replace the then-current Appendix C to the MOU and is specifically incorporated by reference herein as if set forth in its entirety.

G. **Special Closures.** It is agreed that the Tribes or the Voigt Intertribal Task Force may submit a written request to the Forest Service requesting the temporary closure from public access areas of the National Forest to protect the privacy of tribal activities for traditional and cultural purposes.

1. The parties agree that in the implementation of the request the parties will cooperatively determine the smallest practicable area for the minimum period necessary to accommodate the requested activity.

2. It is further agreed that Tribal officials on behalf of the Tribe making the request or Voigt Intertribal Task Force Representatives shall be prepared to help the Forest Service understand the request, if necessary, by explaining how the intended activity is identifiable by the Tribe as traditional or cultural because of the long-established significance or ceremonial nature of the activity to the Tribe.

VII. CONGRESSIONAL INVOLVEMENT. Pursuant to 42 U.S.C. Section 22, no Member of or Delegate to the Congress of the United States shall be admitted to any share or part of this instrument, or any benefits that may arise therefrom.

VIII. MOU EFFECTIVE DATE/TERMINATION. The MOU shall take effect on the date when at least one Tribe, the Forest Service's Eastern Region, the Region's Law Enforcement and Investigations Branch, and the Northern Research Station have properly ratified it in accordance with their respective governmental procedures. The MOU shall be binding as to and between those entities upon notice to the other parties of their ratification as provided in Section IX, below. Any party may withdraw from this agreement at any time following the notice of withdrawal procedures of Section IX.B., below. This MOU shall no longer be in effect if the Forest Service withdraws or if all ratifying tribes have withdrawn.

IX. REQUIRED NOTICES/PARTIES' DESIGNATED REPRESENTATIVES.

A. **Notice of Ratification.** Within 30 days of ratification of the MOU, an entity shall notify all other entities listed in Section II, above, of the date of ratification. Each party's Notice of Ratification is specifically incorporated into the MOU as if set forth in its entirety.

B. **Notice of Withdrawal.** A party shall provide written notice to the other parties

of its intent to withdraw from the MOU at least 60 days in advance of the proposed withdrawal date. Within 45 days of such notice, or such other time period as may be agreed upon, the parties shall convene a meeting to discuss the intent to withdraw and to attempt to reach consensus on ways to prevent the withdrawal. Should a party ultimately withdraw from the MOU, it shall provide a written Notice of Withdrawal to the other parties, and such Notice is specifically incorporated into the MOU as if set forth in its entirety.

C. **Designated Representatives.** In providing notice of its ratification, a party may designate its representative for receiving the notices from the another party that are required by the MOU. Where a party has not formally designated a representative either with its Notice of Ratification or with respect to particular matters addressed by the MOU, another party may provide a required notice ex officio to the office of the official that provided the party's Notice of Ratification.

X. **INITIAL MEETING OF THE PARTIES.** Within 90 days of the MOU's effective date, the parties shall convene an initial meeting for the purposes of: (A) identifying those matters that require immediate attention in implementing the MOU's provisions, such as the agreement and implementation plan regarding campground fees and length of stay restrictions; (B) identifying and addressing any other matter regarding the MOU that requires the parties' attention; (C) setting forth a timetable for addressing those matters; and (D) identifying their representatives that will serve as their "keepers of the process" in ensuring that the MOU is faithfully implemented. These representatives may be persons other than a party's designated representative for receiving required notices from another party provided for in Article IX, above.

As Approved and Recommended for Tribal Adoption at 3/1/12 Voigt Task Force Meeting

APPENDIX A

MODEL

OFF-RESERVATION NATIONAL FOREST GATHERING CODE

OF THE

_____

CHAPTER 1 - INTRODUCTION

1.01 Title.

This ordinance shall be known as the _____ Off-Reservation National Forest Gathering Code.

1.02 Authority.

This ordinance is enacted pursuant to Article _____, Section _____ of the Constitution and By-Laws of the _____ Tribe.

1.03 Purpose.

It is the purpose of this ordinance to:

(1) Provide an orderly and effective system for tribal control and regulation of treaty-reserved gathering activities applicable to National Forests located in the ceded territory.

(2) Supplement the Tribal Off-Reservation Conservation Code for the purposes of regulating the exercise of treaty-reserved off-reservation gathering rights applicable to National Forests located in the ceded territory.

(3) Implement the provisions of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842*, as may be amended from time to time, which has been ratified by the Tribe and which is incorporated by reference herein as if set forth in its entirety.

1.04 Effective Date.

This ordinance shall be effective on the date adopted by the Tribe's governing body.

1.05 Interpretation.

The provisions of this ordinance:

(1) Shall be interpreted and applied as minimum requirements governing the exercise of treaty-reserved gathering rights applicable to National Forests located in the ceded territory;

(2) Shall be liberally construed in favor of the tribe;

(3) Shall be construed consistent with the purposes and provisions of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842*, as may be amended from time to time, which has been ratified by the Tribe and which is incorporated by reference herein as if set forth in its entirety; and

(4) Shall not be deemed a limitation or repeal of any other tribal power or authority.

1.06 Severability and Non-Liability.

If any section, provision or portion of this ordinance is adjudged unconstitutional or invalid by a court of competent jurisdiction, the remainder of this ordinance shall not be affected thereby. The Tribe further asserts immunity on its part and that of its agencies, employees, and/or agents from any action or damages that may occur as a result of reliance upon and conformance with this ordinance.

1.07 Relationship to Tribal Off-Reservation Conservation Code and other Tribal Ordinances.

(1) All other ordinances and resolutions that solely govern treaty-reserved ceded territory gathering rights applicable to National Forests located in the ceded territory are hereby repealed.

(2) (a) This ordinance is not intended to repeal or replace any provision of the Tribe's Off-Reservation Conservation Code. It is intended to supplement that Code for the purposes of authorizing or governing the exercise of treaty-reserved wild plant gathering rights applicable to National Forests. It is not intended to apply to the exercise of any other treaty-reserved ceded territory right that is authorized or governed by the Tribe's Off-Reservation Conservation Code.

(b) Unless otherwise specifically indicated in this ordinance, it is the intent of this ordinance that the provisions of the Tribe's Off-Reservation Conservation Code that generally govern the conduct of tribal members exercising treaty rights applicable in the ceded territory shall apply to tribal members exercising treaty-reserved off-reservation gathering rights applicable to National Forests pursuant to this ordinance, including but not limited to regulations pertaining to the gathering of wild rice. Such provisions of the Tribe's Off-Reservation Conservation Code are hereby declared, and shall be construed, to govern tribal members engaged in the exercise of treaty-reserved gathering rights applicable to National Forests.

1.08 Religious or Ceremonial Use of Natural Resources.

(1) Nothing in this ordinance shall prohibit the harvest or use of natural resources in a manner otherwise prohibited by this ordinance which is harvested, taken or otherwise obtained in a National Forest within the ceded territory for religious or ceremonial purposes in accordance with the traditions and customs of the Tribe and with the consent of the Tribe's governing body, or its designee.

(2) In reviewing and taking action on any request for religious or ceremonial harvest, the Tribes' governing body, or its designee, shall take into account the biological impact of the harvest, shall ensure that the harvest takes place in a manner that does not cause biological harm, and shall consult with the local National Forest District office if the requested gathering is to take place in a National Forest Research Natural Area (see Section 3.06(1)).

(3) No member shall fail to comply with the terms and conditions of the any permit issued pursuant to this section or to otherwise comply with the requirements imposed by the Tribe's regarding religious or ceremonial harvest of wild plants in National Forests in the ceded territory.

CHAPTER 2 - DEFINITIONS

2.01 Definitions.

(1) Except for specific terms defined in subsection (2), terms in this ordinance shall have the same definition as provided in the Tribe's Off-Reservation Conservation Code.

(2) The following terms, wherever used in this ordinance, shall be construed as follows:

(a) **"Ceded Territory"** means those off-reservation lands ceded by the Tribe or another signatory tribe to the United States of America in the Treaty of 1836, 7 Stat. 491, the Treaty of 1837, 7 Stat. 536, or the Treaty of 1842, 7 Stat. 591.

(b) **"Bark"** means the tough outer covering of the woody stems and roots of trees, shrubs, and other woody plants. It includes all tissues outside the vascular cambium.

(c) **"Bough"** means any branch of a tree less than 2 inches in diameter.

(d) **"Domestic Purpose"** means the use of timber or salvage timber, harvested for the construction of any structure, building or appenditia to be used for community or residential domestic purposes.

(e) **"Firewood"** means any dead tree or part thereof, either standing or downed, which is harvested for and is to be used as fuel.

(f) **"Forest Service"** means the United States Department of Agriculture, Forest Service.

(g) **"Forest Service Salvage Timber Stand"** means any stand of trees where the Forest Service has notified the Tribe of the decision to solicit bids for a Forest Service salvage timber sale contract.

(h) **"Gather"** or **"gathering"** means to take or acquire or attempt to take or acquire possession of any wild plant, or part thereof.

(i) **"Gathering Products"** means all products of miscellaneous forest products other than non-timber forest products such as: branchlets, roots, berries, fruits, nuts, and seeds.

(j) **"Lodgepoles"** means any tree that is less than 5 inches DBH (diameter at breast height).

(k) **"Miscellaneous Forest Products"** means any wild plant including: non-timber forest products, wild plants that are not trees such as herbaceous plants and shrubs, gathering products, endangered or threatened plant species, and species of special concern, but for the purposes of this ordinance excludes timber.

(l) **"National Forest"** means those lands located within the ceded territory owned by the United States of America and part of the Chequamegon-Nicolet National Forest, the Hiawatha National Forest, the Huron-Manistee National Forest, or the Ottawa National Forest.

(m) **"Non-Commercial Traditional and Cultural Purpose"** means the use of timber harvested with respect to a definable use, area, or practice, identified by an Indian tribe as traditional or cultural because of the long established significance or ceremonial nature of the use, area, or practice to the Indian tribe; and is not for commercial purposes.

(n) **"Non-Timber Forest Products"** means any of the following miscellaneous forest products: bark, boughs, firewood, lodgepoles, and sap as further defined in this section.

(o) **"Salvage Timber"** means any tree in a Forest Service salvage timber stand, whether alive, dead, down or standing, having a diameter of four inches or greater.

(p) **"Sap"** means the watery fluid that circulates through a tree or plant, carrying food and other substances to the various tissues.

(q) **"Shrub"** means a woody perennial plant usually branched several times at or near the base giving it a bushy appearance, and is usually less than five meters tall.

(r) **"Signatory Tribe"** means an Indian Tribe which is a signatory to the Treaty of 1836, 7 Stat. 491, the Treaty of 1837, 7 Stat. 536, or the Treaty of 1842, 7 Stat. 591, or such tribe's successor in interest.

(s) **"Species of Special Concern"** means any wild plant which is contained on the tribal species of special concern list.

(t) **"Timber"** means any tree that is not a lodgepole as defined in Section 2.01(2)(i) of this ordinance, or is not firewood as defined in Section 2.01(2)(d) of this ordinance.

(u) **"Tree"** means a woody, perennial plant with a single trunk that is typically unbranched at or near the base, and is usually greater than five meters tall.

(v) **"Wild Plant"** means any undomesticated species, or part thereof, of the plant and fungi kingdoms occurring in both forested and non-forested natural ecosystem, but for the purposes of this ordinance excludes wild rice.

CHAPTER 3 - GENERAL REGULATIONS

3.01 Regulatory Authority.

(1) The Tribe asserts legal authority to regulate the exercise of the Tribe's treaty-reserved ceded territory gathering rights applicable to wild plants found in National Forests.

(2) Any person authorized to enforce this ordinance may seize forthwith wherever found:

(a) any wild plant taken or reduced to possession in violation of this ordinance; or

(b) any wild plant lawfully taken or reduced to possession under this ordinance, upon violation of any provision of this ordinance relating to the possession, use, giving, sale, barter or transportation of such wild plant.

3.02 Permits and Identification -- General.

(1) No member shall gather any wild plant off-reservation in a National Forest without possessing a valid off-reservation harvesting permit approved by the Tribe, which may be the member's tribal identification card required by Subsection (2), or such other permit as this ordinance may require validated for the particular type of activity to be engaged in for the particular season in question, as follows:

(a) Generally. Except a provided in subs. (b) [Non-Timber Forest Products and Ginseng Gathering Permits], no member shall gather any miscellaneous forest products without possessing a valid general gathering permit issued by the tribal conservation department while harvesting off-reservation in a National Forest.

(b) Non-Timber Forest Product and Ginseng Gathering Permits.

(i) No member shall harvest or gather non-timber forest products or ginseng pursuant to this ordinance without possessing a valid gathering permit issued by the tribal conservation department as follows:

1) Small Scale Harvest Activity. For small scale activity, a tribal member may harvest the following non-timber forest products while possessing a valid gathering permit up to the following limits:

a) Bark;	Twenty (20) Trees
b) Boughs;	Two (2) Tons

c) Firewood; Ten (10) Cords

d) Lodgepoles; Seventy-Five (75) Lodgepoles

2) Large Scale Harvest Activity. For large scale activity, a tribal member may harvest non-timber forest products while possessing a valid large scale harvest activity gathering permit above the limits established for small scale harvest activity as follows:

a) No member shall gather non-timber forest products on a large scale without a valid large scale harvest activity gathering permit valid for a designated area established by the tribal conservation department in consultation with the Forest Service.

b) "Designated Area" means a specific site identified and established by the tribal conservation department, in consultation with the Forest Service, for which a species harvestable surplus has been determined and for which the appropriate number of large scale harvest activity permits are available for the designated area.

c) The tribal conservation department may issue a large scale harvest activity permit to one or more members based upon the determined species harvestable surplus and may impose such terms and conditions as it deems necessary or appropriate.

d) No member shall fail to comply with the terms and conditions of a large scale harvest activity permit.

(ii) No gathering permit is required of helpers of a permittee who participate only in the collection of the resource once it has been reduced to possession of a permittee.

(iii) The tribal conservation department may impose such other terms and conditions as it deems necessary or appropriate, including biological monitoring requirements in addition to those contained in Section 3.04 of this ordinance.

(2) No member shall gather any wild plant off-reservation in a National Forest except while carrying a valid picture identification card issued by the tribe, or other form of identification approved by the tribe for such gathering activities.

(3) No member shall refuse to display his or her identification documents upon request

of any tribal, Great Lakes Indian Fish and Wildlife Commission, federal, state, or local law enforcement officer.

(4) No member shall fail to comply with the terms, conditions and location restrictions of a permit issued pursuant to this ordinance.

(5) The tribal conservation department is authorized to issue to members permits required by this ordinance and to impose such terms, conditions and location restrictions in those permits as it deems necessary or appropriate. Except as otherwise required by this ordinance, the form of such permits shall be left to the discretion of the tribal conservation department, provided such form shall require the name, address and member's tribal identification number.

(6) The tribal conservation department may issue such harvesting permits to members of a signatory Tribe, provided such other Tribe has enacted an ordinance governing gathering in National Forests that is at least as restrictive as this ordinance.

3.03 Sale of Miscellaneous Forest Products Authorized.

(1) Nothing contained in this ordinance shall be construed to prohibit members from selling any miscellaneous forest products, or any part thereof, lawfully harvested pursuant to this chapter.

(2) With respect to the sale of any miscellaneous forest products, or part thereof, lawfully harvested pursuant to this ordinance in a National Forest, any requirement for maintaining records of commercial transactions contained in the Tribe's Off-Reservation Conservation Code shall not apply.

3.04 Harvest Monitoring.

(1) Generally. No member to whom any permit has been issued under this ordinance shall fail or refuse to provide harvest information when requested by the tribal conservation department, any person authorized to enforce this ordinance, or the Great Lakes Indian Fish and Wildlife Commission.

(2) Records of Ginseng Transactions.

(a) Unless otherwise required under the provisions of GLIFWC's and the Tribes' approved CITES export program, no member shall sell any ginseng harvested pursuant to this ordinance to any person unless the member maintains a written record of all transactions on forms prescribed by the tribal conservation department indicating the amount of ginseng involved, the parties to the transaction, the date of the transaction and the National Forest in which harvest occurred.

(b) Records maintained pursuant to this section shall be forwarded annually to the tribal conservation department, or its designee.

(c) No member shall fail to comply with the reporting requirements of this section.

(d) With respect to ginseng gathered in a National Forest, this section supersedes any requirement for maintaining records of commercial transactions contained in the Tribe's Off-Reservation Conservation Code.

3.05 Emergency Closures.

(1) Notwithstanding any other provision of this ordinance, the Director of the Biological Services Division of the Great Lakes Indian Fish and Wildlife Commission or the tribal conservation department may order the closure of the harvest activity of any wild plant in a National Forest generally or with respect to a particular location, whenever the continuation of the harvest is likely to cause biological harm to the species involved.

(2) Every reasonable effort shall be made to consult with and obtain approval of the Tribe prior to ordering an emergency closure, but such closure may be ordered without consultation or approval if circumstances require.

(3) An emergency closure shall become effective immediately upon issuance or at such time or date as the closure order may direct. Such closure shall be communicated to the Tribe by the best and swiftest practical method.

(4) No member shall violate the terms, conditions or restriction of an emergency closure order issued pursuant to this section.

3.06 Harvest and Other Location Restrictions.

(1) Tribal Wilderness, Research Natural Areas, and Special Use Areas Established. The following Great Lakes Indian Fish and Wildlife Commission document, as it may be amended from time to time, is hereby adopted and incorporated in this ordinance as if fully set forth herein, and no member shall fail to comply with the closures and other restrictions established by this document:

Tribal Wildernesses, Tribal Research Natural Areas, and Tribal Vehicle Permit Areas on National Forests, Version 1: [August 1998].

(2) Forest Service Administrative Sites. No member shall gather wild plants under authority of this ordinance on a Forest Service administrative site. For the purposes of this

ordinance, a "Forest Service administrative site" means a specific site where an office, storage or other building or structure is located and maintained by the Forest Service as part of its operation and management of a National Forest. It is the member's responsibility to be certain about a Forest Service administrative site. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(3) National Forest Campgrounds.

(a) Gathering in Developed Campgrounds.

(i) Except as provided in subs (ii), no member shall gather wild plants under authority of this ordinance on any land located within a developed National Forest Campground. For the purpose of this ordinance, a "developed National Forest Campground" means a location that is clearly marked and identified as a campground by the Forest Service and on which improvements clearly have been made to develop and maintain the site as a campground. It is the member's responsibility to be certain about a developed National Forest campground. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(ii) Except where firewood is provided at no cost by the campground or where firewood will be used while camping in the campground, no member shall gather firewood in a developed National Forest campground.

(b) Camping Fees and Length of Stay Restrictions. The Tribe and the Forest Service have entered into a Memorandum of Understanding that will exempt members from certain camping fees and length of stay restrictions that the Forest Service requires of the general public in the National Forests. Once the Tribe and the Forest Service have entered into a campground fee and length of stay Exemption Agreement and accompanying Implementation Plan, and the Tribe has ratified the Agreement and Plan, no member shall fail to comply with the requirements and restrictions contained in the Agreement and Plan. Information about the Exemption Agreement and Implementation Plan can be obtained by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or local National Forest District office.

(4) Non-National Forest Lands. No member shall gather wild plants under authority of this ordinance on any land located within the boundaries of a National Forest that is not owned by the United States of America and part of a National Forest. This provision does not apply to or otherwise restrict any wild plant gathering on non-National Forest lands that is authorized by another tribal ordinance.

3.07 Harvest of Trees Subject to a Timber Sale Contract or Located Within a Forest Service Timber Sale Contract Area.

(1) No member shall gather any tree under authority of this ordinance without a permit issued pursuant to subs. (4) that is subject to the harvest rights of another in a valid Forest Service timber sale contract. Sometimes these trees are marked with orange, green or yellow paint. However, it is the member's responsibility to be certain about trees that are subject to a valid Forest Service timber sale contract. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(2) Within an open Forest Service Timber Sale Contract Area as defined in subs. (3), no member shall undertake any of the following activities under authority of this ordinance without a permit issued pursuant to subs. (4):

(a) Cut down any live tree;

(b) Remove the bark of any live tree;

(c) Trim or remove the branches from the top half of any live tree; or

(d) Trim or remove the branches or other parts, except cones, of any tree that has been cut down by another person.

(3) For the purposes of this ordinance, an "Open Forest Service Timber Sale Contract Area" means a defined location of a National Forest which has been delineated by the Forest Service for the purposes of a timber sale offering and for which a valid Forest Service timber sale contract has been executed. Typically, a Forest Service Timber Sale Contract Area is marked with orange paint on trees around the perimeter of the Area. It is the member's responsibility to be certain about an open Timber Sale Contract Area. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(4) (a) The tribal conservation department, after first consulting with the Forest Service, is authorized to issue permits under this section on such terms and conditions as it deems necessary and appropriate.

(b) No member shall fail to comply with the terms and conditions of a permit issued pursuant to this section.

3.08 Harvest of Certain "Marked" Trees.

(1) No member shall cut down any tree that has been designated with any of the following markings, and no member shall remove, alter or deface any of the following markings:

(a) Orange Paint. Orange paint designates the boundaries of a payment unit within a Forest Service Timber Contract Sale Area;

(b) Red Paint. Red paint indicates boundaries between National Forest land and other ownerships, or may designate a witness tree at a legal corner;

(c) White Paint Stripes or Other White Bands. White stripes or bands indicate a tree being used to collect cones or seeds for nursery stock; or

(d) Metal or Wood Forest Service Signs. These signs designate property or National Forest boundaries, indicate legal corners or other survey data, indicate nursery stock, or provide other similar information.

3.09 Permissible Conduct/Assistance by Non-Members.

(1) Conduct which is not expressly prohibited, restricted or otherwise regulated by this ordinance shall be deemed permissible.

(2) Except as provided in subs. (3) or as otherwise provided herein, nothing in this ordinance shall be construed to prohibit a member from gathering in a National Forest with any other person who is not a member of the Band, provided that such other person possesses a license or permit, or is otherwise not prohibited from engaging in the activity involved and complies with applicable laws.

(3) No member shall allow any person who is not a member to assist, and no such person shall assist, in the activities authorized by this ordinance except that persons of the member's immediate family, including but not limited to grandparents, parents, spouses, siblings, wenh'enh, doodem, and bami'aagin may assist the member provided the member is present when the assistance is rendered.

CHAPTER 4 - ENFORCEMENT

4.01 Enforcement by Deputized Conservation Wardens and Issuance of Citations.

(1) Any provision of this ordinance may be enforced by tribal conservation wardens or by conservation wardens of the Great Lakes Indian Fish and Wildlife Commission. Said Commission wardens are hereby deputized by the Tribe as tribal conservation wardens for the purposes of enforcing this ordinance.

(2) Such Tribal and Commission wardens may issue a citation on a form approved by the Tribe or tribal court to any person whose conduct is regulated by the provisions of this ordinance upon reasonable belief that such person has violated or breached a provision of this ordinance.

4.02 Search and Seizure; When Authorized.

Tribal and Great Lakes Indian Fish and Wildlife Commission conservation wardens, and properly identified Forest Service law enforcement officers are empowered to:

(1) Conduct a search of an object, place or person whose conduct is regulated by the provisions of this ordinance, and may seize things when the search is made:

(a) with consent;

(b) pursuant to a valid search warrant;

(c) with the authority and within the scope of a right of lawful inspection as provided in this section;

(d) incident to the issuance of a lawfully issued citation under this ordinance; or

(e) as otherwise authorized by law or by the provisions of this ordinance;

(2) Conduct routine inspections, in a manner and at such times and locations as are reasonable and appropriate in the ordinary course of routine enforcement activities, of vessels, boats, wagons, trailers, automobiles, snowmobiles, off-highway vehicles, containers, packages, and other receptacles contained therein, utilized by a person in a harvest activity authorized by this ordinance and of record of commercial transactions required under this ordinance with have not yet been forwarded to the tribal conservation department;

(3) Execute and serve warrants and other process issued by the tribal court in accordance with applicable law;

(4) Stop any automobile or other vehicle as part of a lawful inspection authorized by this section or if the person reasonably suspects there is a violation or breach of this ordinance;

(5) With or without a warrant, open, enter and examine vessels, boats, wagons, trailers, automobile, vehicles, snowmobiles, off-highway vehicles, and packages and other receptacles contained therein, in which the person has probable cause to believe that contraband wild plants, may be contained or pursuant to a lawful inspection authorized by this section; and

(6) Seize and hold subject to the order of the tribal court any alleged contraband or property which such person reasonably believes may be needed as evidence in connection with the institution of proceedings in tribal court or any property otherwise authorized to be seized by the provisions of this ordinance.

4.03 Seized Items.

Any wild plant which is seized in connection with cases referred to Tribal Court for prosecution shall be turned over to the Tribe. No seized wild plant shall be returned by the tribal court or tribal officials to a convicted violator, his or her immediate family or other member of the gathering party.

4.04 Penalties.

Any person who, for himself or herself, or by his or her agent, servant or employee, or as an agent, servant or employee of another, violates this ordinance, shall be liable as follows:

(1) For any violation, a civil remedial forfeiture of not more than $5000.00;

(2) For any violation, a revocation or suspension of off-reservation National Forest gathering privileges for a period of time within the discretion of the court;

(3) For any violation, the court may order a natural resources assessment not to exceed 75% of the amount of the civil remedial forfeiture; and

(4) For any violation, appropriate court costs within the discretion of the court.

4.05 Civil Damages.

(1) In addition to any other penalty allowed by this ordinance, the tribal court may award to the Tribe or, in addition to an action to impose penalties, the Tribe may bring a civil action for recovery of, damages against any person unlawfully gathering or having unlawfully in possession any wild plant taken from a National Forest. The sum assessed for damages for each wild plant shall not be less than the amount stated in this section:

(a) Any endangered or threatened species protected under this ordinance, $875.00.

(b) Any wild plant for which a fair market value can be established, the fair market value.

(c) Any other wild plant, $17.50.

(2) Where the Forest Service or another person or entity has sustained damages as a result of unlawful harvest, the court may, with the consent of the Tribe, award all or part of any civil damages obtained pursuant to this section to the Forest Service or to such person or entity.

4.06 Enhancement of Forfeiture and Penalties.

Upon conviction of any member for a violation of this ordinance when such person has been convicted of a previous violation of this ordinance within a period of one year, the court may enhance any civil remedial forfeiture or other penalty as the court deems appropriate.

4.07 Collection of Money Penalties.

Enforcement of the money penalties imposed pursuant to this ordinance may be had through the collection of penalties from funds of the violator held by the Tribe, through the imposition of community service work requirements in lieu of money payment, through debt collection mechanisms of the courts of other jurisdictions, or through any other method authorized by law.

4.08 Parties to a Violation.

(1) Whoever is concerned in the commission of a violation of this ordinance shall be deemed a principal and may be charged with the violation although he or she did not directly commit it and although the person who directly committed it has not been convicted of the violation.

(2) A person is concerned in the commission of the violation if the person:

(a) directly commits the violation;

(b) aids or abets the commission of it; or

(c) is a party to a conspiracy with another to commit it, or advises, hires, or counsels or otherwise procures another to commit it.

4.09 Harvesting After Revocation or Suspension.

No person whose off-reservation National Forest wild plant gathering privileges have been revoked or suspended pursuant to Section 4.04(2), shall gather any wild plant in a National Forest, the harvest of which is regulated by this ordinance, during such revocation or suspension.

4.10 Schedule of Money Penalties; No Contest.

The tribal court, in consultation with the Tribe's Governing Body, may adopt a schedule of forfeitures to be imposed by the court upon the receipt of an admission that a violation of this ordinance has occurred, or a plea of not contest, which may be done either in person or in writing. This schedule shall not bind the court as to forfeitures assessed by the court after adjudicating a violation where the defendant has entered a plea of not guilty.

4.11 Hearings in Tribal Court.

The Tribal Court shall adjudicate all matters arising under this ordinance pursuant to the provisions of the Tribal Court Code.

4.12 Members of Other Tribes, Tribal Court Adjudications.

The tribal court is authorized to adjudicate alleged violations by any member of a signatory tribe of any off-reservation National Forest gathering code of that Tribe provided:

(1) The relevant provisions of such ordinance are in essential conformance with the parallel provisions of this ordinance; and

(2) The other Tribe has authorized the adjudication.

CHAPTER 5 -- SPECIFIC HARVEST REGULATIONS

5.01 Conifer Boughs.

No member shall:

(1) Cut down a tree for the purpose of gathering conifer boughs;

(2) Remove boughs from the upper half of a tree; or

(3) Gather for subsequent sale northern white cedar or hemlock boughs.

5.02 Princess Pine.

No member shall gather any *Lycopodium* species except by cutting the vertical above ground stem.

5.03 Sheet Moss.

No member shall harvest sheet moss except by harvesting no more than fifty percent (50%) of a species in any particular harvest area, including leaving the edges of the patch.

5.04 Lodgepoles.

No member shall harvest lodgepoles except by harvesting no more than fifty percent (50%) of a species in any particular harvest area, unless the location is a designated area as defined:

(1) "Designated Area" means a specific site identified and established by the tribal conservation department, in consultation with the Forest Service, for which a species harvestable surplus has been determined and for which the appropriate number of large scale harvest activity permits are available for the designated area.

5.05 Firewood.

(1) No member shall cut any live tree or gather any salvage timber for firewood unless the tree is included within a National Forest "firewood sale," other area designated for firewood either generally or on a case-by-case basis, or as permitted pursuant to a valid sugarbush site permit issued pursuant to Section 5.05.

(2) No member shall cut any standing dead tree more than 100 feet from the cleared edge

of any road where it is legal for highway vehicles to travel.

(3) No member shall cut any standing dead tree within 200 feet of any pond, lake, stream or river.

(4) No member shall use a farm tractor, rubber tired skidder, or similar vehicle for gathering firewood without written permission from the Tribe.

5.06 Ginseng.

No member shall gather ginseng from November 1 through August 31.

5.07 Maple Sap/Sugarbushes.

(1) No member shall gather maple sap without a sugarbush site permit valid for a designated tribal sugarbush or for such other location approved by the tribal conservation department in consultation with the Forest Service.

(2) "Designated tribal sugarbush" means a specific site identified and established by the tribal conservation department, in consultation with the Forest Service, for which a site management plan has been developed and for which a sugarbush site permit has been issued.

(3) The tribal conservation department may issue a sugarbush site permit to one or more members and may impose such terms and conditions as it deems necessary or appropriate.

(4) No member shall fail to comply with the terms and conditions of a sugarbush site permit.

5.08 Unsustainable Harvest Activity.

Member compliance with tribal harvest guidelines (bmp) shall be considered sustainable harvest activity, otherwise no member shall harvest any miscellaneous forest product in such a manner so as to impair the future viability and continued success of the miscellaneous forest product on the landscape or ecosystem from which the member is harvesting, as conditioned by the type of miscellaneous forest product, and must take reasonable precautions to prevent unsustainable harvest activity.

5.09 Harvest of Timber and Salvage Timber.

(1) Harvest for Sale as "Lumber" or Similar Wood Products.

(a) No member shall under authority of this ordinance cut down any timber or gather any salvage timber for the purposes of selling all or part of it, or any product derived from its wood, as bolts, pulpwood or lumber.

(b) No member shall sell under authority of this ordinance all or part of any timber, or any product derived from its wood, as bolts, pulpwood or lumber.

(2) Harvest for Domestic and Non-Commercial Traditional and Cultural Purposes.

(a) No member or tribal entity shall cut down any timber or gather any salvage timber under authority of this ordinance for domestic purposes, such as constructing a structure or dwelling, or for non-commercial traditional and cultural purposes, as those terms are defined in subs. (b), without a valid harvest permit issued pursuant to subs. (c).

(b) (i) For the purposes of this section, the terms "structure or dwelling" mean a building or other larger structure to be used for residential, commercial, or storage purposes, and include, for example, a home, cabin, garage, storage shed, store, office building, and manufacturing facility. The terms do not include smaller structures, such as hunting blinds, fish houses or sugarbush shacks, that are used in the exercise of treaty-reserved hunting, fishing or gathering rights. It is the member's responsibility to verify that the intended construction use is not prohibited by this ordinance. Any uncertainty should be resolved by contacting the tribal conservation department or the Great Lakes Indian Fish and Wildlife Commission.

(ii) For the purposes of this section, the terms " non-commercial traditional and cultural purpose" shall be defined by the Tribe issuing the harvest permit. Tribal officials on behalf of the Tribe issuing the harvest permit shall be prepared to help the Forest Service understand the request, if necessary, by explaining how the intended use is identifiable by the Tribe as traditional or cultural because of the long-established significance or ceremonial nature of the use to the Tribe. It is the member's responsibility to verify that the intended use is not prohibited by this ordinance. Any uncertainty should be resolved by contacting the tribal conservation department or the Great Lakes Indian Fish and Wildlife Commission.

(iii) For the purposes of this section, "tribal entity" means an agency, business, partnership, corporation, committee, body or other entity, and the officers, employees and agents thereof, that is chartered, directed, controlled, or

majority owned by the Tribe.

(c) (i) The tribal conservation department is authorized to issue harvest permits for domestic and non-commercial traditional and cultural purposes on such terms and conditions as set forth in the attached Tribal Timber Harvest Framework.

(ii) Prior to issuing a harvest permit for domestic or non-commercial traditional and cultural purposes, the tribal conservation department must consult with and obtain the concurrence of the Forest Service.

APPENDIX B

TRIBAL SELF-REGULATION AGREEMENT

This Tribal Self-Regulation Agreement [hereafter Self-Regulation Agreement] is entered into as part of the parties' ratification of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842* [hereafter MOU]. Specifically, the Self-Regulation Agreement implements the MOU's provisions regarding the Administration of Justice outlined in MOU Section VI.E.

1. **Parties.** The entities that may be parties to the Self-Regulation Agreement are the same as those that may be parties to the MOU, as set forth in MOU Section II.

2. **Incorporation of MOU's Provisions.** The MOU, as may be amended from time to time, is specifically incorporated by reference into the Self-Regulation agreement as if set forth in its entirety. The Self-Regulation Agreement shall be construed consistent with the purposes and provisions of the MOU, and, except as otherwise specifically provided herein, terms in the Self-Regulation Agreement shall have the same definition as provided in the MOU.

3. **Scope and Purposes of the Self-Regulation Agreement.** The Self-Regulation Agreement pertains to the administration of justice regarding the Tribes' exercise of their treaty-reserved ceded territory rights. Its primary purposes are to:

   a. Facilitate the exercise of the Tribes' self-regulatory authority over the exercise of those rights; and

   b. Prevent dual prosecution in tribal and federal forums stemming from conduct regulated by a Tribe's Off-Reservation National Forest Gathering Code that complies with the MOU's provisions [hereafter Complying Tribal Code].

4. **Enforcement and Prosecution of Alleged Violations of Tribal Law.** The parties acknowledge that conduct governed by a Complying Tribal Code also might be governed by federal statutes or regulations which the Forest Service is authorized to enforce in federal forums. Where the underlying conduct or act would be a violation of a Complying Tribal Code and of a federal statute or regulation, the parties agree that the Tribe's court is the preferred forum for dealing the alleged violation. Specifically, the parties agree:

   a. Except as provide in subs. b, any conduct or act which is an alleged violation of a Complying Tribal Code shall be administered and prosecuted in accordance with the provisions of the Complying Tribal Code, provided:

i. The Complying Tribal Code is in force at the time of the alleged violation; and

ii. The Tribe maintains a tribal court with jurisdiction to enforce the Complying Tribal Code.

b. After consultation with the affected Tribe, the Forest Service may initiate a federal enforcement action where the underlying conduct is egregious in nature. Factors to determine egregiousness shall include: the type of conduct involved; the amount of natural resources illegally taken; the nature and extent of the natural resource damages caused by the illegal act; considerations for specific and general deterrence; and considerations for compensating those persons or entities harmed or damaged by the conduct or act.

5. **Agreement Effective Date/Termination.** The Self-Regulation Agreement shall take effect when at least one Tribe, the Forest Service's Eastern Region and the Region's Law Enforcement and Investigations have properly ratified it in accordance with their respective governmental procedures. The Self-Regulation Agreement shall be binding as to and between those entities that ratify it upon notice to the other parties of their ratification as provided in MOU Section IX.

The Self-Regulation Agreement shall automatically terminate at such time when the requisite combination of parties to make it effective no longer exists, or when the MOU terminates.

6. **Dispute Resolution.** The parties agree that any controversies, disputes, differences or misunderstandings arising out of the Self-Regulation Agreement shall be addressed as disputes under the MOU and handled in accordance with the MOU's provisions.

7. **Amendment of Agreement.** The parties agree that amendments to the Self-Regulation Agreement shall be addressed in accordance with the provisions of MOU Section VI.F.

8. **Required Notices/Parties' Designated Representatives.** The parties agree that the provisions of MOU Section IX shall apply to Notices of Ratification of and Withdrawal from the Self-Regulation Agreement and to the parties' designation of representatives regarding the Self-Regulation Agreement.

APPENDIX C

TRIBAL TIMBER HARVEST FRAMEWORK AGREEMENT

This Tribal Timber Harvest Framework Agreement [hereafter Timber Harvest Framework] is entered into as part of the parties' ratification of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842* [hereafter MOU]. Specifically, the Timber Harvest Framework implements the MOU's provisions regarding Natural Resource Harvest Management outlined in MOU Section VI.C. It is through the implementation of the Timber Harvest Framework that the Forest Service exercises its authority pursuant to 16 U.S.C. 477; 25 U.S.C. 3055; and the treaties between the Unites States and GLIFWC's member Ojibwe Tribes, specifically the Treaty of 1836, 7 Stat 491, the Treaty of 1837, 7 Stat. 536, and the Treaty of 1842, 7 Stat. 591.

1. **Parties.** The entities that may be parties to the Timber Harvest Framework are the same as those that may be parties to the MOU, as set forth in MOU Section II.

2. **Incorporation of MOU's Provisions.** The MOU, as may be amended from time to time, is specifically incorporated by reference into the Timber Harvest Framework as if set forth in its entirety. The Timber Harvest Framework shall be construed consistent with the purposes and provisions of the MOU, and, except as otherwise specifically provided herein, terms in the Timber Harvest Framework shall have the same definition as provided in the MOU:

   a. For the purpose of this Timber Harvest Framework, timber shall be defined as any "tree" as defined in the attached Model Code, that is not a "lodgepole" or "firewood" as defined in the attached Model Code.

3. **Scope and Purposes of the Timber Harvest Framework.** The Timber Harvest Framework pertains to the Natural Resource Harvest Management principles regarding the Tribes' exercise of their treaty-reserved ceded territory rights. Its primary purposes are to:

   a. Facilitate the exercise of the Tribes' self-regulatory authority over the exercise of those rights through the implementation of a timber harvest management system; and

   b. To detail the process pertaining to the Tribes' implementation of the harvest of timber and salvage timber for domestic and non-commercial traditional and cultural purposes.

4. **Timber Harvest Conditions.** The Parties acknowledge the following conditions to the

Timber Harvest Framework:

a. Timber and salvage timber harvested pursuant to the Timber Harvest Framework may not be used for commercial purposes.

b. The harvesting of timber and salvage timber pursuant to the Timber Harvest Framework must comply with relevant land management plans, the National Environmental Policy act, and all other applicable laws and regulations.

c. The harvesting of timber and salvage timber pursuant to the Timber Harvest Framework shall be in compliance with 36 C.F.R. 223.8.

d. The harvesting of timber and salvage timber pursuant to the Timber Harvest Framework may be conditioned or denied for reasons including:

   i. Protecting public health and safety,

   ii. Preventing interference with Forest Service and/or tribal activities,

   iii. Complying with federal, tribal, and state laws and regulations,

   iv. Ensuring the sustainability of a forest product or tribal sensitive species;

   v. Otherwise protecting ceded territory land and resources.

5. **Timber Harvest Framework Principles.** The parties agree to the implementation of the following Timber Harvest Framework:

a. A tribe initiating a request for the harvest of timber or salvage timber for domestic or non-commercial traditional and cultural purposes shall inform the Voigt Intertribal Task Force [hereafter VITF] of such intent for the purpose of conducting intertribal coordination.

b. Once the VITF has conducted the proper intertribal coordination, the Commission shall send a letter to the tribe of such intent, thereby notifying it whether there is an intertribal conflict with the request.

c. If the VITF determines that there is no intertribal conflict with a request, the Commission staff shall notify the Forest Service that the VITF has conducted intertribal coordination pertaining to the tribe's initial intent to harvest timber or salvage timber for domestic or non-commercial traditional and cultural purposes and that there is no intertribal conflict pertaining to the request. Thereby, the notification shall include a request to consult on the tribe's initial desire to make a request for the harvest of timber or salvage timber for domestic or non-commercial traditional and cultural purposes.

d. The Commission, in consultation with the tribe, shall set up a meeting with the Forest Service, the Tribe and the Commission to discuss the specifics of the potential formal request, which shall include the following:

1) Potential locations where the Tribe may desire to harvest;

2) Approximate number of trees the Tribe desires to harvest;

3) The species and size of timber the Tribe desires to harvest;

4) The approximate year and season when the Tribe desires to harvest;

5) The purpose for which the timber or salvage timber will be put:

i) For domestic purposes, as this term is defined in the attached Model Code.

ii) For non-commercial traditional and cultural purposes, as this term is defined in the attached Model Code.

e. The Forest Service, the Tribe, and the Commission shall set up a site evaluation(s) to determine the feasibility of the proposed harvest location(s). Proposed harvest locations shall be agreed to by consensus of all parties.

f. The Tribe shall submit a formal "Letter of Request of the Tribe for Timber Harvest Purposes" to the District Ranger. The letter of request shall include:

1) The location of harvest;

2) The approximate number of trees to be harvested;

3) The species and size of timber to be harvest;

4) The approximate year and season the timber shall be harvested; and

5) The purpose for which the timber or salvage timber will be put:

i) For domestic purposes, as this term is defined in the attached Model Code.

ii) For non-commercial traditional and cultural purposes, as this term is defined in the attached Model Code.

The Tribe shall provide a courtesy copy (cc) of this letter of request to the Forest Supervisor, the Tribal Liaison for the Chequamegon-Nicolet, Hiawatha and Ottawa National Forests, the VITF, and Commission staff.

g. The Forest Service in consultation with the Tribe and the Commission shall develop an area of operation map.

h. The Forest Service in consultation with the Tribe and the Commission shall develop the necessary decision and analysis documents, including those required by the National Forest Management Act and the National Environmental Policy Act. If either the Tribe or the Commission has the capacity, they may exercise the option to jointly develop the necessary decision and analysis documents for the requested site location.

i. The Commission, the Tribe and the Forest Service shall develop the specific provisions of the "Operating Plan".

j. The Tribe shall issue a tribal permit to the "member" or "tribal entity" as defined in the attached Model Code.

k. The Tribe in consultation with the Commission and the Forest Service shall conduct the necessary monitoring and evaluation of the timber harvest operation.

l. The Tribe in consultation with the Commission shall provide the Forest Service with a final notification that the filed operations on the timber harvest operation are complete.

m. The Tribe in consultation with the Commission shall provide the Forest Service with a final briefing (success story) on the results of the timber harvest request.

5. **Agreement Effective Date/Termination.** The Timber Harvest Framework shall take effect when at least one Tribe, and the Forest Service's Eastern Region have properly ratified it in accordance with their respective governmental procedures. The Timber Harvest Framework shall be binding as to and between those entities that ratify it upon notice to the other parties of their ratification as provided in MOU Section IX. The Timber Harvest Framework shall automatically terminate at such time when the requisite combination of parties to make it effective no longer exists, or when the MOU terminates.

6. **Dispute Resolution.** The parties agree that any controversies, disputes, differences or misunderstandings arising out of the Timber Harvest Framework shall be addressed as disputes under the MOU and handled in accordance with the MOU's provisions.

7. **Amendment of Agreement.** The parties agree that amendments to the Timber Harvest Framework shall be addressed in accordance with the provisions of MOU Section VI.F.

8. **Required Notices/Parties' Designated Representatives.** The parties agree that the provisions of MOU Section IX shall apply to Notices of Ratification of and Withdrawal from the Timber Harvest Framework and to the parties' designation of representatives regarding the Timber Harvest Framework.

Approved by the Voigt Inter-tribal Task Force for tribal ratification June 3, 1999

MEMORANDUM OF UNDERSTANDING

REGARDING

TRIBAL - USDA-FOREST SERVICE RELATIONS

ON NATIONAL FOREST LANDS WITHIN THE TERRITORIES

CEDED IN TREATIES OF 1836, 1837, AND 1842

Preamble

This Memorandum of Understanding (MOU) deals with the relationships of sovereign and federally recognized tribes of Lake Superior Chippewa Indians and of the USDA Forest Service, an agency of the government of the United States. The MOU is based on the principle of government-to-government interactions between the United States Government and federally recognized Indian tribes. The purpose of the agreement is to establish standards by which the Forest Service and the Tribes will act consistently across national forest lands within areas ceded in the treaties of 1836, 1837, and 1842.

The policies of the Forest Service toward federally recognized tribes are intended to strengthen relationships and further tribal sovereignty through fulfilling mandated responsibilities and through support and assistance of various kinds to tribal governments. The relationships between the Tribes and the Forest Service are comprised of several parts, including honoring treaty-based usufructuary rights as well as policies of the Forest Service toward Indian nations. While court decisions, laws, regulations, policies, and Executive Orders from the President of the United States have all shaped the Forest Service's policy toward Indian tribes, nothing in this agreement is in any way intended to abrogate or affect in any fashion judicial decisions which have interpreted such treaty rights.

This MOU recognizes existing treaty rights of Tribes to hunt and fish and to gather wild plants on national forest lands in accord with applicable regulatory authorities of the States or other federal agencies having jurisdiction over such activities. Reference in the MOU to such activities as hunting and fishing are designed to recognize that the the Forest Service manages and provides access to ecosystems which support these activities.

I. CEDED TERRITORIES AND NATIONAL FORESTS INVOLVED (Figure 1).

A. Ceded Territories. This MOU specifically pertains to the territories ceded [hereafter ceded territories] by various Chippewa Tribes in the following Treaties: Treaty of 1836, 7 Stat. 491; Treaty of 1837, 7 Stat. 536; and Treaty of 1842, 7 Stat. 591.

B. National Forests. This MOU specifically pertains to the portions of the following National Forests [hereafter National Forests] located in the ceded territories: Chequamegon-Nicolet in Wisconsin; and Ottawa, Hiawatha and Huron-Manistee in Michigan.

II. PARTIES. The following entities may ratify this MOU in accordance with their respective applicable laws and procedures, and, upon proper ratification, shall be deemed a party to this MOU:

A. Tribes. In their respective sovereign capacities, the following federally- recognized Tribes [hereafter Tribes] that are members of the Great Lakes Indian Fish and Wildlife Commission [hereafter GLIFWC]: Bad River Band of the Lake Superior Tribe of Chippewa Indians; Lac du Flambeau Band of Lake Superior Chippewa Indians; Lac Courte Oreilles Band of Lake Superior Chippewa Indians; St. Croix Chippewa Indians of Wisconsin; Sokaogon Chippewa Community of the Mole Lake Band; Red Cliff Band of Lake Superior Chippewa Indians; Mille Lacs Band of Chippewa Indians; Bay Mills Indian Community; Keweenaw Bay Indian Community; and Lac Vieux Desert Band of Lake Superior Chippewa Indians.

B. USDA-FS. On behalf of the United States Department Agriculture, Forest Service [hereafter Forest Service] as an agency of the United States Government: the Forest Service's Eastern Region; the Eastern Region's Law Enforcement and Investigations; and the Forest Service's ***North Central Research Station***.

III. GOVERNING PRINCIPLES AND FUNDAMENTAL ASSUMPTIONS. The parties agree that the MOU is based upon the following governing principles and fundamental assumptions and that the MOU shall be interpreted in accordance with them:

A. Existence of Ceded Territory Rights. The parties acknowledge and recognize the Tribes' treaty-guaranteed hunting, fishing and gathering rights [hereafter ceded territory rights] that may be exercised on lands administered by the Forest Service located within the ceded territories.

B. Tribal Sovereignty and Self-Regulatory Capacity. The parties acknowledge and recognize:

1. The Tribes' inherent sovereignty and retained regulatory authority regarding their ceded territory rights; and

2. The Tribes' ability to administer and implement a system of effective tribal self-regulation regarding tribal member exercise of those rights.

C. Federal Trust Responsibility and Treaty Obligations. The parties acknowledge and recognize that the Forest Service shares in the United States Government's trust responsibility and treaty

obligations to work with the Tribes on a government-to-government basis to protect the Tribes' ceded territory rights on lands administered by the Forest Service.

D. Forest Service's Native American Policies. The parties acknowledge and recognize the Forest Service's Native American polices as presently set forth in Forest Service Manual 1563 [Tribal Governments] and Forest Service Publication FS-446 [Native American Policy — Friends and Partners] to:

1. Maintain a governmental relationship with federally-recognized tribal governments consistent with the President's Memorandum of April 29, 1994, Government-to-Government Relations with Native American Tribal Governments;

2. Implement programs and activities in a way that honors Indian treaty rights and fulfills legally-mandated trust responsibilities to the extent they apply to National Forest System lands;

3. Administer programs and activities to address and be sensitive to traditional Native religious beliefs and practices; and

4. Provide research, transfer of technology, and technical assistance to tribal governments.

E. Forest Service's Forest Management Responsibilities. The parties acknowledge and recognize that the Forest Service is the agency of the United States Government ***authorized and*** responsible for implementing law and policies related to National Forest management.

F. Forest Service's Law Enforcement Responsibilities. The parties acknowledge and recognize that the Forest Service's Law Enforcement and Investigations Branch is responsible for enforcement of alleged violations of federal laws and regulations occurring on lands administered by the Forest Service.

G. General Tribal/USDA-FS Government-to-Government Relationship Unaffected. This MOU applies to ***the parties' government-to-government relationship, other Tribal - Forest Service interactions,*** the Tribes' ceded territory rights applicable on lands administered by the Forest Service, and the parties' relationships and dealings involving those rights. It is not intended, and should not be construed, to abrogate or otherwise affect any party's authority or responsibility in other areas. Similarly, it is not intended, and should not be construed, to otherwise define or restrict the parties' obligations, relationships or dealings in other areas of their respective authorities, responsibilities, or sovereign prerogatives.

H. Effect of MOU on Non-Ratifying Tribes. The parties' specific intent is that this MOU shall not bind or in any way affect the rights or claims of any GLIFWC member Tribe that chooses not to become a party or of any other Tribe that is a signatory to any of the treaties identified in Section I.B., above.

I. Reservation of Rights, Claims and Defenses .

1. The termination of or withdrawal from this MOU shall be without resulting liability to any other party or prejudice to any claim a party may have against any other party.

2. Except as expressly provided herein, the fact that any Tribe or the Forest Service is or may have been a party to this MOU shall not be construed as a waiver of any rights, claims or defenses that, absent this MOU, any of those entities may have under any treaty between the United States and a Tribe, or under other applicable law of the United States.

3. The parties acknowledge that this MOU contains provisions that may be the result of compromise and policy choices. As such, these provisions may not reflect the full extent of the Tribes' ceded territory rights or of the Forest Service's responsibilities to manage the National Forests. Therefore, in the absence of or outside the scope of this MOU, the provisions contained herein are not intended to alter or abridge:

   a. The Tribes' underlying ceded territory rights or those rights of any other treaty signatory Tribe that is not a party to this MOU; or

   b. The Forest Service's ***authorities*** to manage the National Forests in accordance with applicable law.

4. ***This agreement is not intended to alter usufructuary rights recognized in Lac Courte Oreilles Band v. Voigt, 700 F.2d.341 (7th Cir. 1983) or Minnesota v. Mille Lacs Band of Chippewa Indians, 119S.Ct. 1187 (1999). The MOU does not alter the authority of any government regarding the regulation of treaty rights under those decisions.***

IV. PURPOSES. To accomplish the primary purposes of recognizing and implementing the Tribes ' ceded territory rights and furthering Forest Service Native American policies, the parties intend to:

A. Government-to-Government Relationship . Establish a framework for a cooperative, government-to-government relationship between the Tribes and the United States Government that:

1. Ensures the meaningful exercise of the Tribes ' ceded territory rights on the lands administered by the Forest Service within the ceded territories;

2. Facilitates consistent and timely communication between parties at the appropriate levels of government; and

3. Fosters effective participation by the Tribes in National Forest management, in the development, revisions and implementation of Land and Resource Management Plans [hereafter Forest Plans] and in subsequent Forest Plan implementation decisions.

B. Exercise of Ceded Territory Rights. Establish agreed-upon parameters under which the Tribes' ceded territory gathering rights may be exercised within the provisions of and the protections afforded by this MOU on lands administered by the Forest Service within the ceded territories.

C. Conservation of Natural Resources. Protect, manage and enhance ecosystems and communities that support the natural resources subject to the Tribes' ceded territory rights on lands administered by the Forest Service.

V. RECOGNITION OF THE PARTIES' MUTUAL INTERESTS. Underlying the purposes of and specific agreements contained in this MOU, the parties recognize a number of mutual interests that they wish to address:

A. Tribal Self-Determination and Self-Governance. One of the Tribes' primary goals is to achieve self-determination and self-governance through the exercise of their retained sovereign governmental authority regarding their ceded territory rights. A key Forest Service policy is to administer its programs and activities in a manner that recognizes the governments of the Tribes and the authority that they carry out on behalf of the Tribes. Therefore, the parties seek to establish a government-to-government relationship that promotes collaboration and communication in the management of the National Forests, that provides for effective tribal self-regulation of the exercise of ceded territory rights on lands administered by the Forest Service, and, as noted below, that promotes efficient and effective law enforcement.

B. Collaborative Approach in the Management of Natural Resources. The Tribes' ceded territory rights include the right to gather wild plants and to harvest wild animals on lands administered by the Forest Service, and the Tribes want to ensure that management of these lands protects their ability to meaningfully exercise these rights. The Forest Service is tasked with the administration of the National Forests and is the federal agency responsible for the care and management of the land and natural resources that are part of the National Forests. Therefore, the Tribes and the Forest Service seek to establish a relationship and associated processes that facilitate consistent and timely communication between them and that integrate the Tribes' needs and wishes for the desired state of the National Forests into Forest Plans and subsequent Forest Plan implementation decisions.

C. Sustainability of Ecosystems. Since time immemorial, the Tribes have traditionally harvested certain plants and other resources found on lands now managed as the National Forests to meet subsistence, religious, cultural, medicinal and commercial needs. The Tribes' culture and lifeway depends on this harvest activity, and they wish to protect and enhance the natural resources upon which they rely. The Tribes measure the protection of these resources in

terms of ensuring their sustainability for use by the seventh generation hence. The Forest Service is the federal agency responsible for managing the National Forests for the benefit of present and future generations. In addition, the Forest Service's policy is to carry out its programs and activities in a manner that is sensitive to the Tribes ' traditional practices and beliefs. Therefore, the Tribes and Forest Service seek to collaboratively promote ecosystem management that protects and restores native communities and species, furthers the diversity of species, and ensures the sustained yield and availability of natural resources that are subject to the Tribes' ceded territory rights.

D. Efficient and Effective Law Enforcement . As part of their self-regulatory system, the Tribes recognize the need to provide for the enforcement and adjudication of alleged violations of tribal laws governing the exercise of the ceded territory rights. To further compliance with tribal laws and to mete out meaningful and effective penalties, they recognize that the administration of justice in this context is best accomplished within their own communities and in their own forums. The Forest Service also recognizes that justice is best served in the communities most involved and affected. Therefore, the parties seek to establish a mutually beneficial efficient and effective system for enforcing applicable laws.

E. Consistent Ceded Territory Gathering Regulations. The meaningful exercise of the Tribes ' ceded territory rights requires a consistent, conservation-based harvest regulatory system throughout the National Forests. To avoid administrative inefficiency and the associated confusion, the Forest Service recognizes the need for a consistent gathering policy and regulatory scheme in each of the National Forests. Therefore, the parties seek to establish a ceded territory-wide policy and regulatory framework that provides for the exercise of the ceded territory rights in a consistent manner that meets conservation goals, protects the public health and safety, and promotes efficient and effective law enforcement.

F. Implementation of the Federal Trust Responsibility . The Tribes continually seek to have United States Government and its agencies properly discharge the federal trust responsibility to assist in the development of the Tribes' governmental capabilities and to take actions for the Tribes ' benefit. The Forest Service's policy is to administer its programs and activities in a manner sensitive to the Tribes' needs, beliefs, and practices, and to provide research, transfer of technology and technical assistance to the Tribes. Therefore, the parties seek to establish a framework for collaboration, communication and information exchange that will nurture understanding and maximize mutual benefits, and that will enhance the development of the Tribes' capabilities necessary to ensure effective tribal participation in the processes and procedures established in this MOU.

VI. SPECIFIC AGREEMENTS TO IMPLEMENT THE GOVERNMENT-TO- GOVERNMENT RELATIONSHIP. This section sets forth the specific agreements to implement the parties ' government-to-government relationship in these areas: (A) MOU administration and implementation; (B) National Forest planning and decision- making; (C) natural resource harvest

management; (D) natural resource research and monitoring; (E) law enforcement; and (F) amendment of the MOU and its Appendices.

A. MOU Administration and Implementation .

1. The parties shall strive to reach consensus in all decisions, actions and processes contemplated by the MOU.

2. Unless otherwise specifically provided in this MOU, the parties shall attempt to resolve any dispute arising under the MOU at the lowest possible level on a government-to-government basis between properly authorized representatives of the parties who have the authority to resolve the dispute in question.

3. To facilitate on-going communication and the resolution of outstanding issues, the parties:

   a. Shall meet at least annually to facilitate on-going communication, to review progress made and discuss issues arising under this MOU, to ensure that the parties are faithfully and effectively implementing this MOU and adhering to its terms, and to discuss trends, issues or other matters that may effect the MOU. ***The Forest Service will accept comments from interested citizens about the implementation of the MOU at any time and, prior to the annual meeting, the Forest Service will solicit public comments. The parties will consider any comments at the annual meeting and jointly approved minutes will be made available for public review.***

   b. Hereby establish a Technical Working Group (hereafter TWG) whose purpose shall be to review any scientific, technical or natural resource management issue referred to it in this MOU or by subsequent agreement of the parties. The TWG is empowered to make recommendations to the parties regarding the matters referred to it, such as the development and coordination of research projects, possible harvest monitoring and regulatory responses to particular circumstances, and data/information exchange regimens. The TWG also is empowered to suggest to the parties issues that may require the parties' attention and consideration.

      The TWG will be comprised of qualified natural resource scientists, managers and researchers designated by the Forest Service and the Tribes, and should include designates from the ***North Central Research Station*** and GLIFWC. Law enforcement personnel should participate in the TWG as necessary to address enforcement-related issues.

The Forest Service and the Tribes will each appoint a TWG co-chair to coordinate communication and planning for the group's work. The TWG may appoint one or more working subgroups to address specified issues.

c. May, in addition to matters referred to the TWG, agree to refer specific questions or issues to designated representatives or *ad hoc* working groups for discussion, development of information, formulation of recommendations, or specific action.

d. Agree to provide such data and information as another party might request pertaining to matters addressed by the MOU, such as natural resource population and harvest data, law enforcement statistics and tribal court statistics.

4. The parties shall cooperate in identifying and seeking adequate funding for the enhancement of their infrastructures necessary to improve the implementation of this agreement. However, the parties acknowledge that this MOU does not modify or restrict the budgetary authority of any party.

5. The parties shall undertake cultural sensitivity training for their personnel who will be responsible for implementing this MOU. The parties also shall engage in joint and coordinated public education efforts to inform the public about this MOU and its underlying purposes.

B. National Forest Planning and Decision-making . The parties recognize that Forest Service decisions vary in their effects on the abundance of, distribution of or access to the natural resources on the lands that it administers. For example, the Forest Service, at various levels, makes a number of decisions that relate to such matters as the development, revision and implementation of Forest Plans for each of the National Forests covered by this MOU. They include decisions that commit to particular land management actions, such as project level decisions (including closures of temporary and permanent roads), and decisions that establish the policies or guidelines that govern these actions. Other decisions relate to such matters as the internal administration of the Forest Service as an agency regarding personnel, property and budgets, and do not commit to particular land management actions or establish policies governing those actions.

The Tribes and Forest Service agree that they shall consult on a government-to-government basis on all Forest Service decisions that affect the abundance, distribution or access to the natural resources on lands administered by the Forest Service. In addition, they agree that the goal of such consultation shall be that any such Forest Service decision should expressly recognize and accommodate the Tribes' ceded territory rights, protect and enhance treaty-reserved natural resources, and accommodate exercise of ceded territory rights by tribal members under tribal regulations.

To achieve this end, the Tribes and Forest Service specifically agree that:

1. As to decisions that result in particular land management actions, in policies or guidelines governing those actions, or in research projects to be conducted by the ***North Central Research Station***:

    a. The Forest Service shall consult with and facilitate effective participation by the Tribes at all stages and levels of the decision-making process. This collaboration is recognized as a dynamic process that must include consultation on a consistent and timely basis at the appropriate levels of government and that must be flexible to deal with ever-changing circumstances and adaptive natural resource management responses.

    b. The Forest Service shall consider the effects of its decisions on treaty resources and the ability of the Tribes to exercise treaty gathering rights. In decision and analysis documents, including those required by the National Forest Management Act and the National Environmental Policy Act, decision-makers will show how tribal information and involvement was taken into account in analyzing the effects of potential management actions and in making the decision.

    c. The Tribes and the Forest Service will strive to reach consensus. Where consensus cannot be reached:

        1) They will attempt to resolve any dispute or disagreement first by good faith discussions between the affected Tribe(s) and the Forest Service deciding official. The Tribe(s) may raise any matter not resolved at this level to a higher Forest Service official, including the appropriate Forest Supervisor and the Regional Forester. The Forest Service agrees to delay a final decision on the unresolved matter until this process has had the opportunity to take place within a reasonable amount of time.

        2) The Forest Service may make and implement the decision.

        3) In addition to the procedures provided by the MOU, a Tribe may challenge or appeal any Forest Service decision or action in accordance with applicable law.

2. As to decisions relating to the administration of Forest Service budgets, personnel or property, the parties shall cooperate in identifying and seeking adequate resources for the Tribes' and Forest Service's capabilities necessary to implement this MOU. In

particular, the Forest Service shall seek input from the Tribes in a timely manner regarding the development of its budget proposal for upcoming fiscal years.

3. During the course of their dealings, the Tribes and Forest Service shall ensure that they have identified their representatives with whom the other parties should interact regarding particular decisions or particular types of decisions.

4. Nothing in this MOU shall preclude the Tribes and Forest Service from discussing matters or advancing particular requests that are not part of a particular pending Forest Plan implementation decision.

C. Natural Resource Harvest Management. The Tribes and Forest Service acknowledge their mutual interests in undertaking a collaborative approach in managing the harvest of natural resources on lands administered by the Forest Service to ensure the sustainability of ecosystems and the sustained yield of natural resources, in ensuring that the Tribes ' ceded territory rights are meaningfully exercised, and in providing for a consistent conservation-based system under which the Tribes will exercise their ceded territory rights on those lands. Specifically, the Tribes and Forest Service agree:

1. Within the bounds of their respective authorities, to regulate and monitor the harvest of natural resources on lands administered by the Forest Service in a manner that provides for a sustained harvest of those resources and affords the Tribes the opportunity to harvest an equal allocation of the harvestable surpluses of those resources.

2. That the Tribes will regulate tribal member gathering on lands administered by the Forest Service by adopting regulations and implementing permit systems that are no less restrictive than those set forth in the Model Off-Reservation National Forest Gathering Code [hereafter Model Code], which is attached as Exhibit A and specifically incorporated into this MOU.

3. That any changes making the Model Code, or any Tribe 's enactment based upon the Model Code, less restrictive will fall within the scope of the MOU if the Forest Service 's consent is obtained in accordance with the provisions of subsection F, below.

4. To monitor harvest levels in the most effective and precise manner needed to ensure resource protection and to exchange harvest monitoring data on a regular basis.

5. To designate areas for tribal sugar bushes that will meet needs identified by the Tribes and to jointly develop specific sugar bush management plans. ***The parties further agree to consider complementary and conflicting resource values, location of historical sugarbushes, proximity to reservations, and other relevant factors in choosing sugarbush locations.***

6. To locate species of interest to the Tribes and to provide gathering opportunities for those resources, particularly regarding gathering opportunities associated with National Forest timber sales.

7. That once the Forest Service decides that it intends to solicit bids for timber sale contracts for down or damaged trees, trees in the designated timber salvage stands having a diameter of four inches or greater, whether they are alive, dead, down or standing, will be regulated in the same manner as standing live trees for treaty harvest purposes. For the purposes of the MOU and attached Model Code, the term "Forest Service timber salvage stand" means any stand of trees where the Forest Service has notified the Tribes of its decision to solicit bids for a salvage timber sale contract, and the term "salvage timber" means any tree in that stand, whether alive, dead, down or standing, having a diameter of four inches or greater.

8. That the Tribes will not issue a permit for the harvest of live trees or of salvage timber for the purposes of constructing a structure/dwelling, as these terms are defined in the attached Model Code, without the Forest Service's consent. In seeking the Forest Service's consent, the requesting Tribe shall inform the other Tribes that are parties to the MOU of the request and shall indicate in writing to the Forest Service the types and amounts of trees sought, the use to which the trees will be put, and the anticipated time frame for the harvest. The Forest Service shall promptly consider the request, consult with the requesting Tribe as to the specifics of the proposal, and provide in writing its decision and the underlying rationale. The Forest Service shall make every attempt to accommodate the request and, before withholding consent, shall discuss with the Tribe possible alternatives. In any event, Forest Service consent shall not be unreasonably withheld. ***The Forest Service, within its existing authorities, will provide opportunities for the Tribes to take up to 40,000 board feet of timber per year per National Forest and the Tribes will conduct inter-tribal coordination on requests for timber for these purposes.***

9. That the Tribes and their members use National Forest campgrounds in the exercise of their ceded territory rights and that Forest Service fees and length of stay restrictions at campground should not interfere with the exercise of the rights. The parties acknowledge that, prior to completion and ratification of the MOU, time constraints have prevented them from developing the necessary Exemption Agreement and accompanying Implementation Plan regarding campground fee and length of stay exemptions for tribal members. Upon ratification of the MOU, the parties commit to immediately developing the Agreement and Implementation Plan. Once properly approved, the Exemption Agreement and Implementation Plan shall become part of the MOU and be specifically incorporated by reference herein as if set forth in their entirety.

10. That the parties have not resolved their disagreement regarding the Tribes' request for unrestricted motorized use of Crooked Lake in the Sylvania Wilderness located in the Ottawa National Forest. While the parties agree to disagree on this matter at this time, they will continue to strive for a resolution using the procedures and processes contained in the MOU. The parties acknowledge that on all other matters regarding wildernesses, their agreement is properly reflected in the provisions of the attached Model Code, including specifically those of §3.06(1)(a) that establish Tribal National Forest Wildernesses.

11. That, in accordance with the provisions of subsection F, below, the Forest Service will notify the Tribes of and obtain the Tribes' input on proposed changes in federal laws or regulations that are intended to regulate or otherwise restrict the harvest of natural resources on lands administered by the Forest Service within the ceded territories.

D. Monitoring and Evaluation. To ensure the sustainability of ecosystems, the Tribes and Forest Service acknowledge the importance of inventorying and monitoring the status of species and their habitats within the National Forests, evaluating the impacts of harvest on the resources subject to the Tribes' ceded territory rights, and evaluating the effects of other land management activities on those resources. With the input and recommendations of the TWG, the Tribes and Forest Service agree to:

1. Review their respective existing research projects and administrative studies as needed for the purpose of encouraging research coordination.

2. Establish and implement a program of research, monitoring and evaluation regarding the resources subject to the Tribes' ceded territory rights that specifically would:

   a. Inventory species status and habitat requirements.

   b. Monitor the population dynamics and habitats of species as Forest Plans are implemented.

   c. Determine the effects of land management activities, such as timber harvest, on species' populations.

   d. Determine the effects of wild plant harvest on the status of the species being harvested.

   e. Evaluate such other matters that relate to the resources subject to the Tribes' ceded territory rights.

E. Law Enforcement. The parties acknowledge the Tribes' capabilities to implement a self-regulatory system governing the exercise of ceded territory rights applicable on lands administered by the Forest Service. The parties specifically agree that:

1. Any regulation adopted by Tribe consistent with the MOU will govern the exercise of the Tribes' ceded territory gathering rights within the National Forests and is within the scope of the MOU. Any Tribe's regulation that is not consistent with the MOU's provisions is outside the MOU's scope.

2. The enforcement of the Tribes' regulations and of any federal statute or regulation governing the conduct within the scope of a Tribe's regulations that are consistent with the terms of the MOU shall be governed by a properly ratified agreement that is no less restrictive than the Tribal Self-Regulation Agreement [hereafter Self-Regulation Agreement], attached as Appendix B and specifically incorporated into the MOU. For the purposes of this subsection, "properly ratified" means a party's approval of and the agreement to be bound by the Self-Regulation Agreement in accordance with that party's required governmental procedures.

3. That any changes in the Self-Regulation Agreement shall be made in accordance with the provisions of subsection F, below.

4. Primary enforcement and administration of justice responsibilities for the Tribes ' regulations lies with the Tribes and their properly authorized agencies.

5. The Tribes and Forest Service will coordinate their respective law enforcement activities and establish cooperative law enforcement ventures, such as joint patrols, effective communication systems, information and potential violation referral processes, and joint training activities. These coordinated law enforcement activities shall include at least annual meetings between designated enforcement personnel.

F. Process for MOU Amendments, Regulatory Changes and Self-Regulation Agreement Changes . The parties recognize the dynamic nature of their government-to-government relationship. They also recognize that changes in federal and tribal regulation and management of the harvesting of the National Forests' natural resources in the ceded territories are inevitable. To facilitate open communication and minimize disputes arising from the dynamics of their relationship and from the need to change harvest regulations, the parties agree:

1. Consensus/Resolution of Disputes. As for the matters addressed by this subsection F, the affected parties shall strive to reach consensus on the matter at hand. Where consensus cannot be reached:

   a. The affected parties will attempt to resolve any dispute or disagreement first by good faith discussions at the appropriate governmental level. A party may

raise any matter not resolved at this level to a higher official of another party. If it has the authority to do so, a party will delay a final decision on the unresolved matter until this process has had the opportunity to take place within a reasonable amount of time.

b. A party claiming the requisite authority may make and implement a decision on the unresolved matter.

c. In addition to the procedures provided by the MOU, a party may challenge or appeal another party's decision or action in accordance with applicable law.

2. MOU Amendment. Any party may propose an amendment to the MOU in writing to the other parties. Within 60 days of receipt, the parties shall convene a meeting to consider the proposal. An amendment may be adopted by and binding upon less than all of the parties provided that the adopting parties include at least one tribal party and the Forest Service.

3. Federal Laws and Regulations. The Forest Service agrees to seek the input of the Tribes on proposed changes to the Forest Service's regulation of natural resource harvesting within the ceded territories by providing written notice, including an explanation of the underlying rationale, to the Tribes at least 60 days in advance of the desired effective date of the proposed change. The Tribes shall have 45 days, or such other time period as may be agreed upon, to provide comments.

In addition, the Tribes may submit a written request to the Forest Service for changes in the Forest Service's regulation of natural resource harvesting, including an explanation of the request's rationale. The Forest Service agrees to respond to the request within 45 days, or such other time period as may be agreed upon.

Unless other time frames are specifically imposed by applicable law, the Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on the Forest Service proposal and on a Tribe's request.

4. Model Code or Tribal Enactments Based Upon the Model Code. The Tribes agree to notify the Forest Service in writing of any proposed change that would make the Model Code, or any Tribe's enactment based upon the Model Code, less restrictive than provided for in the MOU. In addition, the Forest Service may request the Tribes to change the Model Code, or any Tribe's enactment based upon the Model Code, to be more restrictive than provided for in the MOU.

Except in cases of emergency, such notices and requests will be provided at least 60 days in advance of the desired effective date of the change and will include an explanation of the proposal's rationale. Within 45 days of receipt, or such other time period as may

be agreed upon, the receiving party or parties shall respond expressing any objections and indicating any changes that are agreeable. The failure to object in writing to a proposed change within the 45-day period, or any extension thereof, will be deemed as agreement to the proposal.

The Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on any objection to a proposed or requested change.

A properly amended Model Code shall replace the then-current Appendix A to the MOU and is specifically incorporated by reference herein as if set forth in its entirety.

5. Tribal Self-Regulation Agreement. Any party may submit a written request to the other parties for a change in the Self-Regulation Agreement. Except in cases of emergency, such request will be provided at least 60 days in advance of the desired effective date of the change and will include an explanation of the proposal 's rationale. Within 45 days of receipt, or such other time period as may be agreed upon, the receiving party or parties shall respond expressing any objections and indicating any changes that are agreeable. The failure to object in writing to a proposed change within the 45-day period, or any extension thereof, will be deemed as agreement to the proposal.

The Forest Service and the Tribes agree to afford as much time as is necessary and appropriate for consensus to be reached on any objection to a proposed change.

A properly amended Self-Regulation Agreement shall replace the then-current Appendix B to the MOU and is specifically incorporated by reference herein as if set forth in its entirety.

VII. CONGRESSIONAL INVOLVEMENT. Pursuant to 42 U.S.C. Section 22, no Member of or Delegate to the Congress of the United States shall be admitted to any share or part of this instrument, or any benefits that may arise therefrom.

VIII. MOU EFFECTIVE DATE/***TERMINATION***. The MOU shall take effect on the date when at least one Tribe, the Forest Service's Eastern Region, the Region's Law Enforcement and Investigations Branch, and the ***North Central Research Station*** have properly ratified it in accordance with their respective governmental procedures. The MOU shall be binding as to and between those entities upon notice to the other parties of their ratification as provided in Section IX, below. ***Any party may withdraw from this agreement at any time following the notice of withdrawl procedures of IX.B. This MOU shall no longer be in effect if the Forest Service withdraws or if all ratifying tribes have withdrawn.***

IX. REQUIRED NOTICES/PARTIES' DESIGNATED REPRESENTATIVES.

A. Notice of Ratification. Within 30 days of ratification of the MOU, an entity shall notify all other entities listed in Section II, above, of the date of ratification. Each party's Notice of Ratification is specifically incorporated into the MOU as if set forth in its entirety.

B. Notice of Withdrawal. A party shall provide written notice to the other parties of its intent to withdraw from the MOU at least 60 days in advance of the proposed withdrawal date. Within 45 days of such notice, or such other time period as may be agreed upon, the parties shall convene a meeting to discuss the intent to withdraw and to attempt to reach consensus on ways to prevent the withdrawal. Should a party ultimately withdraw from the MOU, it shall provide a written Notice of Withdrawal to the other parties, and such Notice is specifically incorporated into the MOU as if set forth in its entirety.

C. Designated Representatives. In providing notice of its ratification, a party may designate its representative for receiving the notices from the another party that are required by the MOU. Where a party has not formally designated a representative either with its Notice of Ratification or with respect to particular matters addressed by the MOU, another party may provide a required notice ex officio to the office of the official that provided the party's Notice of Ratification.

X. INITIAL MEETING OF THE PARTIES. Within 90 days of the MOU's effective date, the parties shall convene an initial meeting for the purposes of: (A) identifying those matters that require immediate attention in implementing the MOU's provisions, such as the agreement and implementation plan regarding campground fees and length of stay restrictions; (B) identifying and addressing any other matter regarding the MOU that requires the parties' attention; (C) setting forth a timetable for addressing those matters; and (D) identifying their representatives that will serve as their "keepers of the process" in ensuring that the MOU is faithfully implemented. These representatives may be persons other than a party's designated representative for receiving required notices from another party provided for in Article IX, above.

Approved and Recommended for Tribal Adoption by the Voigt Intertribal Task Force (August 6, 1998)

APPENDIX A

MODEL

OFF-RESERVATION NATIONAL FOREST GATHERING CODE

OF THE

CHAPTER 1 - INTRODUCTION

1.01 Title.

This ordinance shall be known as the _____ Off-Reservation National Forest Gathering Code.

1.02 Authority.

This ordinance is enacted pursuant to Article _____, Section _____ of the Constitution and By-Laws of the _____ Tribe.

1.03 Purpose.

It is the purpose of this ordinance to:

(1) Provide an orderly and effective system for tribal control and regulation of treaty-reserved gathering activities applicable to National Forests located in the ceded territory.

(2) Supplement the Tribal Off-Reservation Conservation Code for the purposes of regulating the exercise of treaty-reserved off-reservation gathering rights applicable to National Forests located in the ceded territory.

(3) Implement the provisions of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842*, as may be amended from time to time, which has been ratified by the Tribe and which is incorporated by reference herein as if set forth in its entirety.

1.04 Effective Date.

This ordinance shall be effective on the date adopted by the Tribe's governing body.

1.05 Interpretation.

The provisions of this ordinance:

(1) Shall be interpreted and applied as minimum requirements governing the exercise of treaty-reserved gathering rights applicable to National Forests located in the ceded territory;

(2) Shall be liberally construed in favor of the tribe;

(3) Shall be construed consistent with the purposes and provisions of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842*, as may be amended from time to time, which has been ratified by the Tribe and which is incorporated by reference herein as if set forth in its entirety; and

(4) Shall not be deemed a limitation or repeal of any other tribal power or authority.

1.06 Severability and Non-Liability.

If any section, provision or portion of this ordinance is adjudged unconstitutional or invalid by a court of competent jurisdiction, the remainder of this ordinance shall not be affected thereby. The Tribe further asserts immunity on its part and that of its agencies, employees, and/or agents from any action or damages that may occur as a result of reliance upon and conformance with this ordinance.

1.07 Relationship to Tribal Off-Reservation Conservation Code and other Tribal Ordinances.

(1) All other ordinances and resolutions that solely govern treaty-reserved ceded territory gathering rights applicable to National Forests located in the ceded territory are hereby repealed.

(2)(a) This ordinance is not intended to repeal or replace any provision of the Tribe's Off-Reservation Conservation Code. It is intended to supplement that Code for the purposes of authorizing or governing the exercise of treaty-reserved wild plant gathering rights applicable to National Forests. It is not intended to apply to the exercise of any other treaty-reserved ceded territory right that is authorized or governed by the Tribe's Off-Reservation Conservation Code.

(b) Unless otherwise specifically indicated in this ordinance, it is the intent of this ordinance that the provisions of the Tribe's Off-Reservation Conservation Code that generally govern the conduct of tribal members exercising treaty rights applicable in the ceded territory shall apply to tribal members exercising treaty-reserved off-reservation gathering rights applicable to National Forests pursuant to this ordinance. Such provisions of the Tribe's Off-Reservation Conservation Code are hereby declared, and shall be construed, to govern tribal members engaged in the exercise of treaty-reserved gathering rights applicable to National Forests.

1.08 Religious or Ceremonial Use of Natural Resources.

(1) Nothing in this ordinance shall prohibit the harvest or use of natural resources in a manner otherwise prohibited by this ordinance which is harvested, taken or otherwise obtained in a National Forest within the ceded territory for religious or ceremonial purposes in accordance with the traditions and customs of the Tribe and with the consent of the Tribe's governing body, or its designee.

(2) In reviewing and taking action on any request for religious or ceremonial harvest, the Tribes' governing body, or its designee, shall take into account the biological impact of the harvest, shall ensure that the harvest takes place in a manner that does not cause biological harm, and shall consult with the local National Forest District office if the requested gathering is to take place in a National Forest Research Natural Area (see Section 3.06(1)).

(3) No member shall fail to comply with the terms and conditions of the any permit issued pursuant to this section or to otherwise comply with the requirements imposed by the Tribe's regarding religious or ceremonial harvest of wild plants in National Forests in the ceded territory.

CHAPTER 2 - DEFINITIONS

2.01 Definitions.

(1) Except for specific terms defined in subsection (2), terms in this ordinance shall have the same definition as provided in the Tribe's Off-Reservation Conservation Code.

(2) The following terms, wherever used in this ordinance, shall be construed as follows:

(a) **"Ceded Territory"** means those off-reservation lands ceded by the Tribe or another signatory tribe to the United States of America in the Treaty of 1836, 7 Stat. 491, the Treaty of 1837, 7 Stat. 536, or the Treaty of 1842, 7 Stat. 591.

(b) **"Forest Service"** means the United States Department of Agriculture, Forest Service.

(c) **"Gather"** or **"gathering"** means to take or acquire or attempt to take or acquire possession of any wild plant, or part thereof.

(d) **"Forest Service Salvage Timber Stand"** means any stand of trees where the Forest Service has notified the Tribe of the decision to solicit bids for a Forest Service salvage timber sale contract.

(e) **"National Forest"** means those lands located within the ceded territory owned by the United States of America and part of the Chequamegon-Nicolet National Forest, the Hiawatha National Forest, the Huron-Manistee National Forest, or the Ottawa National Forest.

(f) **"Salvage Timber"** means any tree in a Forest Service salvage timber stand, whether alive, dead, down or standing, having a diameter of four inches or greater.

(g) **"Signatory Tribe"** means an Indian Tribe which is a signatory to the Treaty of 1836, 7 Stat. 491, the Treaty of 1837, 7 Stat. 536, or the Treaty of 1842, 7 Stat. 591, or such tribe's successor in interest.

(h) **"Wild Plant"** means any undomesticated species, or part thereof, of the plant and fungi kingdoms occurring in the natural ecosystem, but for the purposes of this ordinance excludes wild rice.

CHAPTER 3 - GENERAL REGULATIONS

3.01 Regulatory Authority.

(1) The Tribe asserts legal authority to regulate the exercise of the Tribe's treaty-reserved ceded territory gathering rights applicable to wild plants found in National Forests.

(2) Any person authorized to enforce this ordinance may seize forthwith wherever found:

(a) any wild plant taken or reduced to possession in violation of this ordinance; or

(b) any wild plant lawfully taken or reduced to possession under this ordinance, upon violation of any provision of this ordinance relating to the possession, use, giving, sale, barter or transportation of such wild plant.

3.02 Permits and Identification -- General.

(1) No member shall gather any wild plant off-reservation in a National Forest without possessing a valid off-reservation harvesting permit approved by the Tribe, which may be the member's tribal identification card required by Subsection (2), or such other permit as this ordinance may require validated for the particular type of activity to be engaged in for the particular season in question.

(2) No member shall gather any wild plant off-reservation in a National Forest except while carrying a valid picture identification card issued by the tribe, or other form of identification approved by the tribe for such gathering activities.

(3) No member shall refuse to display his or her identification documents upon request of any tribal, Great Lakes Indian Fish and Wildlife Commission, federal, state, or local law enforcement officer.

(4) No member shall fail to comply with the terms, conditions and location restrictions of a permit issued pursuant to this ordinance.

(5) The tribal conservation department is authorized to issue to members permits required by this ordinance and to impose such terms, conditions and location restrictions in those permits as it deems necessary or appropriate. Except as otherwise required by this ordinance, the form of such permits shall be left to the discretion of the tribal conservation department, provided such form shall require the name, address and member's tribal identification number.

(6) The tribal conservation department may issue such harvesting permits to members of a signatory Tribe, provided such other Tribe has enacted an ordinance governing gathering in National Forests that is at least as restrictive as this ordinance.

3.03 Commercial Wild Plant Gathering Permits.

(1) No member shall gather to sell conifer boughs, princess pine or ginseng without possessing a valid commercial wild plant gathering permit.

(2) A commercial wild plant gathering permit shall:

(a) identify the permittee or permittees, including the name, address, tribal affiliation and tribal identification number of all members authorized by the permit; and

(b) identify the amount and general location of the plants to be gathered;

(c) require that all members authorized by the permit must possess a duplicate of the permit while engaged in the gathering activity.

(3) A commercial wild plant gathering permit may:

(a) establish limits on the quantity of the plants which may be gathered;

(b) in addition to other area restrictions provided in this ordinance, limit gathering to a specific area or areas;

(c) define or limit the methods which may be employed to gather the plants; and

(d) establish such other conditions or requirements deemed necessary or appropriate by the tribal conservation department.

3.04 Harvest Monitoring.

(1) Generally. No member to whom any permit has been issued under this ordinance shall fail or refuse to provide harvest information when requested by the tribal conservation department, any person authorized to enforce this ordinance, or the Great Lakes Indian Fish and Wildlife Commission.

(2) Records of Commercial Ginseng Transactions.

(a) No member shall sell any ginseng harvested pursuant to this ordinance to any person unless the member maintains a written record of all transactions on forms prescribed by the tribal conservation department indicating the amount of ginseng involved, the parties to the transaction, the date of the transaction and the National Forest in which harvest occurred.

(b) Records maintained pursuant to this section shall be forwarded annually to the tribal conservation department, or its designee.

(c) No member shall fail to comply with the reporting requirements of this section.

(d) With respect to ginseng gathered in a National Forest, this section supersedes any requirement for maintaining records of commercial transactions contained in the Tribe's Off-Reservation Conservation Code.

3.05 Emergency Closures.

(1) Notwithstanding any other provision of this ordinance, the Director of the Biological Services Division of the Great Lakes Indian Fish and Wildlife Commission or the tribal conservation department may order the closure of the harvest activity of any wild plant in a National Forest generally or with respect to a particular location, whenever the continuation of the harvest is likely to cause biological harm to the species involved.

(2) Every reasonable effort shall be made to consult with and obtain approval of the Tribe prior to ordering an emergency closure, but such closure may be ordered without consultation or approval if circumstances require.

(3) An emergency closure shall become effective immediately upon issuance or at such time or date as the closure order may direct. Such closure shall be communicated to the Tribe by the best and swiftest practical method.

(4) No member shall violate the terms, conditions or restriction of an emergency closure order issued pursuant to this section.

3.06 Harvest and Other Location Restrictions.

(1) Tribal Wilderness, Research Natural Areas, and Special Use Areas Established. The following Great Lakes Indian Fish and Wildlife Commission document, as it may be amended from time to time, is hereby adopted and incorporated in this ordinance as if fully set forth herein, and no member shall fail to comply with the closures and other restrictions established by this document:

Tribal Wildernesses, Tribal Research Natural Areas, and Tribal Vehicle Permit Areas on National Forests, Version 1: [August 1998].

(2) Forest Service Administrative Sites. No member shall gather wild plants under authority of this ordinance on a Forest Service administrative site. For the purposes of this ordinance, a "Forest Service administrative site" means a specific site where an office, storage or other building or structure is located and maintained by the Forest Service as part of its operation and management of a National Forest. It is the member's responsibility to be certain about a Forest Service administrative site. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(3) National Forest Campgrounds. (a) Gathering in Developed Campgrounds. (i) Except as provided in subs (ii), no member shall gather wild plants under authority of this ordinance on any land located within a developed National Forest Campground. For the purpose of this ordinance, a "developed National Forest Campground" means a location that is clearly marked and identified as a campground by the Forest Service and on which improvements clearly have been made to develop and maintain the site as a campground. It is the member's responsibility to be certain about a developed National Forest campground. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(ii) Except where firewood is provided at no cost by the campground or where firewood will be used while camping in the campground, no member shall gather firewood in a developed National Forest campground.

(b) Camping Fees and Length of Stay Restrictions. The Tribe and the Forest Service have entered into a Memorandum of Understanding that will exempt members from certain camping fees and length of stay restrictions that the Forest Service requires of the general public in the National Forests. Once the Tribe and the Forest Service have entered into a campground fee and length of stay Exemption Agreement and accompanying Implementation Plan, and the Tribe has ratified the Agreement and Plan, no member shall fail to comply with the requirements and restrictions contained in the Agreement and Plan. Information about the Exemption Agreement and Implementation Plan can be obtained by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or local National Forest District office.

(4) Non-National Forest Lands. No member shall gather wild plants under authority of this ordinance on any land located within the boundaries of a National Forest that is not owned by the United States of America and part of a National Forest. This provision does not apply to or otherwise restrict any wild plant gathering on non-National Forest lands that is authorized by another tribal ordinance.

3.07 Harvest of Trees Subject to a Timber Sale Contract or Located Within a Forest Service Timber Sale Contract Area.

(1) No member shall gather any tree under authority of this ordinance without a permit issued pursuant to subs. (4) that is subject to the harvest rights of another in a valid Forest Service timber sale contract. Sometimes these trees are marked with orange, green or yellow paint. However, it is the member's responsibility to be certain about trees that are subject to a valid Forest Service timber sale contract. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(2) Within an open Forest Service Timber Sale Contract Area as defined in subs. (3), no member shall undertake any of the following activities under authority of this ordinance without a permit issued pursuant to subs. (4):

(a) Cut down any live tree;

(b) Remove the bark of any live tree;

(c) Trim or remove the branches from the top half of any live tree; or

(d) Trim or remove the branches or other parts, except cones, of any tree that has been cut down by another person.

(3) For the purposes of this ordinance, an "open Forest Service Timber Sale Contract Area" means a defined location of a National Forest which has been delineated by the Forest Service for the purposes of a timber sale offering and for which a valid Forest Service timber sale contract has been executed. Typically, a Forest Service Timber Sale Contract Area is marked with blue paint on trees around the perimeter of the Area. It is the member's responsibility to be certain about an open Timber Sale Contract Area. Any uncertainty should be resolved by contacting the tribal conservation department, Great Lakes Indian Fish and Wildlife Commission or the local National Forest District office.

(4) (a) The tribal conservation department, after first consulting with the Forest Service, is authorized to issue permits under this section on such terms and conditions as it deems necessary and appropriate.

(b) No member shall fail to comply with the terms and conditions of a permit issued pursuant to this section.

3.08 Harvest of Certain "Marked" Trees.

(1) No member shall cut down any tree that has been designated with any of the following markings, and no member shall remove, alter or deface any of the following markings:

(a) Blue Paint. Blue paint designates the boundaries of a payment unit within a Forest Service Timber Contract Sale Area;

(b) Red Paint. Red paint indicates boundaries between National Forest land and other ownerships, or may designate a witness tree at a legal corner;

(c) White Paint Stripes or Other White Bands. White stripes or bands indicate a tree being used to collect cones or seeds for nursery stock; or

(d) Metal or Wood Forest Service Signs. These signs designate property or National

Forest boundaries, indicate legal corners or other survey data, indicate nursery stock, or provide other similar information.

3.09 Permissible Conduct/Assistance by Non-Members.

(1) Conduct which is not expressly prohibited, restricted or otherwise regulated by this ordinance shall be deemed permissible.

(2) Except as provided in subs.(3) or as otherwise provided herein, nothing in this ordinance shall be construed to prohibit a member from gathering in a National Forest with any other person who is not a member of the Band, provided that such other person possesses a license or permit, or is otherwise not prohibited from engaging in the activity involved and complies with applicable laws.

(3) No member shall allow any person who is not a member to assist, and no such person shall assist, in the activities authorized by this ordinance except that persons of the member's immediate family, including but not limited to grandparents, parents, spouses, and siblings, may assist the member provided the member is present when the assistance is rendered.

CHAPTER 4 - ENFORCEMENT

4.01 Enforcement by Deputized Conservation Wardens and Issuance of Citations.

(1) Any provision of this ordinance may be enforced by tribal conservation wardens or by conservation wardens of the Great Lakes Indian Fish and Wildlife Commission. Said Commission wardens are hereby deputized by the Tribe as tribal conservation wardens for the purposes of enforcing this ordinance.

(2) Such Tribal and Commission wardens may issue a citation on a form approved by the Tribe or tribal court to any person whose conduct is regulated by the provisions of this ordinance upon reasonable belief that such person has violated or breached a provision of this ordinance.

4.02 Search and Seizure; When Authorized.

Tribal and Great Lakes Indian Fish and Wildlife Commission conservation wardens, and properly identified Forest Service law enforcement officers are empowered to:

(1) Conduct a search of an object, place or person whose conduct is regulated by the provisions of this ordinance, and may seize things when the search is made:

(a) with consent;

(b) pursuant to a valid search warrant;

(c) with the authority and within the scope of a right of lawful inspection as provided in this section;

(d) incident to the issuance of a lawfully issued citation under this ordinance; or

(e) as otherwise authorized by law or by the provisions of this ordinance;

(2) Conduct routine inspections, in a manner and at such times and locations as are reasonable and appropriate in the ordinary course of routine enforcement activities, of vessels, boats, wagons, trailers, automobiles, snowmobiles, off-highway vehicles, containers, packages, and other receptacles contained therein, utilized by a person in a harvest activity authorized by this ordinance and of record of commercial transactions required under this ordinance with have not yet been forwarded to the tribal conservation department;

(3) Execute and serve warrants and other process issued by the tribal court in accordance with applicable law;

(4) Stop any automobile or other vehicle as part of a lawful inspection authorized by this section or if the person reasonably suspects there is a violation or breach of this ordinance;

(5) With or without a warrant, open, enter and examine vessels, boats, wagons, trailers, automobile, vehicles, snowmobiles, off-highway vehicles, and packages and other receptacles contained therein, in which the person has probable cause to believe that contraband wild plants, may be contained or pursuant to a lawful inspection authorized by this section; and

(6) Seize and hold subject to the order of the tribal court any alleged contraband or property which such person reasonably believes may be needed as evidence in connection with the institution of proceedings in tribal court or any property otherwise authorized to be seized by the provisions of this ordinance.

4.03 Seized Items.

Any wild plant which is seized in connection with cases referred to Tribal Court for prosecution shall be turned over to the Tribe. No seized wild plant shall be returned by the tribal court or tribal officials to a convicted violator, his or her immediate family or other member of the gathering party.

4.04 Penalties.

Any person who, for himself or herself, or by his or her agent, servant or employee, or as an agent, servant or employee of another, violates this ordinance, shall be liable as follows:

(1) For any violation, a civil remedial forfeiture of not more than $5000.00;

(2) For any violation, a revocation or suspension of off-reservation National Forest gathering privileges for a period of time within the discretion of the court;

(3) For any violation, the court may order a natural resources assessment not to exceed 75% of the amount of the civil remedial forfeiture; and

(4) For any violation, appropriate court costs within the discretion of the court.

4.05 Civil Damages.

(1) In addition to any other penalty allowed by this ordinance, the tribal court may award to the Tribe or, in addition to an action to impose penalties, the Tribe may bring a civil action for recovery of, damages against any person unlawfully gathering or having unlawfully in possession any wild plant taken from a National Forest. The sum assessed for damages for each wild plant shall not be less than the amount stated in this section:

(a) Any endangered or threatened species protected under this ordinance, $875.00.
(b) Any wild plant for which a fair market value can be established, the fair market value.

(c) Any other wild plant, $17.50.

(2) Where the Forest Service or another person or entity has sustained damages as a result of unlawful harvest, the court may, with the consent of the Tribe, award all or part of any civil damages obtained pursuant to this section to the Forest Service or to such person or entity.

4.06 Enhancement of Forfeiture and Penalties.

Upon conviction of any member for a violation of this ordinance when such person has been convicted of a previous violation of this ordinance within a period of one year, the court may enhance any civil remedial forfeiture or other penalty as the court deems appropriate.

4.07 Collection of Money Penalties.

Enforcement of the money penalties imposed pursuant to this ordinance may be had through the collection of penalties from funds of the violator held by the Tribe, through the imposition of community service work requirements in lieu of money payment, through debt collection mechanisms of the courts of other jurisdictions, or through any other method authorized by law.

4.08 Parties to a Violation.

(1) Whoever is concerned in the commission of a violation of this ordinance shall be deemed a principal and may be charged with the violation although he or she did not directly commit it and although the person who directly committed it has not been convicted of the violation.

(2) A person is concerned in the commission of the violation if the person:

(a) directly commits the violation;

(b) aids or abets the commission of it; or

(c) is a party to a conspiracy with another to commit it, or advises, hires, or counsels or otherwise procures another to commit it.

4.09 Harvesting After Revocation or Suspension.

No person whose off-reservation National Forest wild plant gathering privileges have been revoked or suspended pursuant to Section 4.04(2), shall gather any wild plant in a National Forest, the harvest of which is regulated by this ordinance, during such revocation or suspension.

4.10 Schedule of Money Penalties; No Contest.

The tribal court, in consultation with the Tribe's Governing Body, may adopt a schedule of forfeitures to be imposed by the court upon the receipt of an admission that a violation of this ordinance has occurred, or a plea of not contest, which may be done either in person or in writing. This schedule shall not bind the court as to forfeitures assessed by the court after adjudicating a violation where the defendant has entered a plea of not guilty.

4.11 Hearings in Tribal Court.

The Tribal Court shall adjudicate all matters arising under this ordinance pursuant to the provisions of the Tribal Court Code.

4.12 Members of Other Tribes, Tribal Court Adjudications.

The tribal court is authorized to adjudicate alleged violations by any member of a signatory tribe of any off-reservation National Forest gathering code of that Tribe provided:

(1) The relevant provisions of such ordinance are in essential conformance with the parallel provisions of this ordinance; and

(2) The other Tribe has authorized the adjudication.

CHAPTER 5 -- SPECIFIC HARVEST REGULATIONS

5.01 Conifer Boughs.

No member shall:

(1) Cut down a tree for the purpose of gathering conifer boughs;

(2) Remove boughs from the upper half of a tree; or

(3) Gather for subsequent sale northern white cedar or hemlock boughs.

5.02 Princess Pine.

No member shall gather for subsequent sale any *Lycopodium* species except *Lycopodium obscurum, Lycopodium dendroidium,* or *Lycopodium hickeyi.*

5.03 Firewood.

(1) No member shall cut any live tree or gather any salvage timber for firewood unless the tree is included within a National Forest "firewood sale," other area designated for firewood either generally or on a case-by-case basis, or as permitted pursuant to a valid sugarbush site permit issued pursuant to Section 5.05.

(2) No member shall cut any standing dead tree more than 100 feet from the cleared edge of any road where it is legal for highway vehicles to travel.

(3) No member shall cut any standing dead tree within 200 feet of any pond, lake, stream or river.

(4) No member shall use a farm tractor, rubber tired skidder, or similar vehicle for gathering firewood without written permission from the Tribe.

5.04 Ginseng.

No member shall gather ginseng from November 1 through August 31.

5.05 Maple Sap/Sugarbushes.

(1) No member shall gather maple sap without a sugarbush site permit valid for a designated tribal sugarbush or for such other location approved by the tribal conservation department in consultation with the Forest Service.

(2) "Designated tribal sugarbush" means a specific site identified and established by the tribal conservation department, in consultation with the Forest Service, for which a site management plan has been developed and for which a sugarbush site permit has been issued.

(3) The tribal conservation department may issue a sugarbush site permit to one or more members and may impose such terms and conditions as it deems necessary or appropriate.

(4) No member shall fail to comply with the terms and conditions of a sugarbush site permit.

5.06 Harvest of Live Trees and Salvage Timber.

(1) Harvest for Sale as "Lumber" or Similar Wood Products. (a) No member shall under authority of this ordinance cut down any live tree or gather any salvage timber for the purposes of selling all or part of it, or any product derived from its wood, as bolts, pulpwood or lumber.

(b) No member shall sell under authority of this ordinance all or part of any tree, or any product derived from its wood, as bolts, pulpwood or lumber.

(2) Harvest for Construction Purposes. (a) No member or tribal entity shall cut down any live tree or gather any salvage timber under authority of this ordinance for the purposes of constructing a structure or dwelling, as those terms are defined in subs. (b), without a valid structure construction harvest permit issued pursuant to subs. (c).

(b) (i) For the purposes of this section, the terms "structure or dwelling" mean a building or other larger structure to be used for residential, commercial, or storage purposes, and include, for example, a home, cabin, garage, storage shed, store, office building, and manufacturing facility. The terms do not include smaller structures, such as hunting blinds, fish houses or sugarbush shacks, that are used in the exercise of treaty-reserved hunting, fishing or gathering rights. It is the member's responsibility to verify that the intended construction use is not prohibited by this ordinance. Any uncertainty should be resolved by contacting the tribal conservation department or the Great Lakes Indian Fish and Wildlife Commission.

(ii) For the purposes of this section, "tribal entity" means an agency, business, partnership, corporation, committee, body or other entity, and the officers, employees and agents thereof, that is chartered, directed, controlled, or majority owned by the Tribe.

(c) (i) The tribal conservation department is authorized to issue construction harvest permits on such terms and conditions as it deems appropriate.

(ii) Prior to issuing a construction harvest permit, the tribal conservation department must consult with and obtain the concurrence of the Forest Service.

APPENDIX B

TRIBAL SELF-REGULATION AGREEMENT

This Tribal Self-Regulation Agreement [hereafter Self-Regulation Agreement] is entered into as part of the parties' ratification of the *Memorandum of Understanding Regarding the Recognition and Implementation of Tribal Ceded Territory Rights Guaranteed by the Treaties of 1836, 1837, and 1842* [hereafter MOU]. Specifically, the Self-Regulation Agreement implements the MOU 's provisions regarding the Administration of Justice outlined in MOU Section VI.E.

1. Parties. The entities that may be parties to the Self-Regulation Agreement are the same as those that may be parties to the MOU, as set forth in MOU Section II.

2. Incorporation of MOU's Provisions. The MOU, as may be amended from time to time, is specifically incorporated by reference into the Self-Regulation agreement as if set forth in its entirety. The Self-Regulation Agreement shall be construed consistent with the purposes and provisions of the MOU, and, except as otherwise specifically provided herein, terms in the Self-Regulation Agreement shall have the same definition as provided in the MOU.

3. Scope and Purposes of the Self-Regulation Agreement. The Self-Regulation Agreement pertains to the administration of justice regarding the Tribes ' exercise of their treaty-reserved ceded territory rights. Its primary purposes are to:

a. Facilitate the exercise of the Tribes ' self-regulatory authority over the exercise of those rights; and

b. Prevent dual prosecution in tribal and federal forums stemming from conduct regulated by a Tribe's Off-Reservation National Forest Gathering Code that complies with the MOU 's provisions [hereafter Complying Tribal Code].

4. Enforcement and Prosecution of Alleged Violations of Tribal Law . The parties acknowledge that conduct governed by a Complying Tribal Code also might be governed by federal statutes or regulations which the Forest Service is authorized to enforce in federal forums. Where the underlying conduct or act would be a violation of a Complying Tribal Code and of a federal statute or regulation, the parties agree that the Tribe's court is the preferred forum for dealing the alleged violation. Specifically, the parties agree:

a. Except as provide in subs. b, any conduct or act which is an alleged violation of a Complying Tribal Code shall be administered and prosecuted in accordance with the provisions of the Complying Tribal Code, provided:

1) The Complying Tribal Code is in force at the time of the alleged violation; and

2) The Tribe maintains a tribal court with jurisdiction to enforce the Complying Tribal Code.

b. After consultation with the affected Tribe, the Forest Service may initiate a federal enforcement action where the underlying conduct is egregious in nature. Factors to determine egregiousness shall include: the type of conduct involved; the amount of natural resources illegally taken; the nature and extent of the natural resource damages caused by the illegal act; considerations for specific and general deterrence; and considerations for compensating those persons or entities harmed or damaged by the conduct or act.

5. Agreement Effective Date/Termination. The Self-Regulation Agreement shall take effect when at least one Tribe, the Forest Service's Eastern Region and the Region's Law Enforcement and Investigations have properly ratified it in accordance with their respective governmental procedures. The Self-Regulation Agreement shall be binding as to and between those entities that ratify it upon notice to the other parties of their ratification as provided in MOU Section IX.

The Self-Regulation Agreement shall automatically terminate at such time when the requisite combination of parties to make it effective no longer exists, or when the MOU terminates.

6. Dispute Resolution. The parties agree that any controversies, disputes, differences or misunderstandings arising out of the Self-Regulation Agreement shall be addressed as disputes under the MOU and handled in accordance with the MOU's provisions.

7. Amendment of Agreement. The parties agree that amendments to the Self-Regulation Agreement shall be addressed in accordance with the provisions of MOU Section VI.F.

8. Required Notices/Parties' Designated Representatives. The parties agree that the provisions of MOU Section IX shall apply to Notices of Ratification of and Withdrawal from the Self-Regulation Agreement and to the parties' designation of representatives regarding the Self-Regulation Agreement.

MEMORANDUM OF UNDERSTANDING

REGARDING

TRIBAL - USDA-FOREST SERVICE RELATIONS

ON

NATIONAL FOREST LANDS

WITHIN THE TERRITORIES CEDED

IN

TREATIES OF 1836, 1837, AND 1842

NATIONAL FOREST

CAMPGROUND FEE AND LENGTH OF STAY RESTRICTION

EXEMPTION AGREEMENT (VERSION 1.0)

MAY 2000

1. **PURPOSE AND INTERPRETATION.**

   a. **Purpose.** It is the purpose of this Exemption Agreement to:

      1) Implement the provisions of Article VI.C.8 of the *Memorandum of Understanding Regarding Tribal - USDA-Forest Service Relations on National Forest Lands Within the Territories Ceded in Treaties of 1836, 1837, and 1842* [hereafter MOU], as amended June 1999, regarding the use of National Forest campgrounds in the exercise of the Tribes' ceded territory rights; and

      2) Provide an orderly and effective system for regulating the use of National Forest campgrounds in the exercise of the Tribes' ceded territory rights.

   b. **Interpretation.** The Exemption Agreement shall be construed with the purposes and provisions of the MOU, as it may be amended from time to time.

2. **INCORPORATION INTO MOU.** The MOU, Article VI.C.8 provides that, once ratified, the campground fee and length of stay Exemption Agreement becomes part of the MOU. In addition, a properly amended Exemption Agreement shall replace the then-current Exemption Agreement in the MOU. Therefore, unless the Exemption Agreement specifically provides otherwise, the parties agree:

   a. **Application.** The Exemption Agreement applies to same ceded territories and National Forests as the MOU, and parties to the MOU may also ratify and become parties to the Exemption Agreement.

   b. **Terms Used.** Unless the context indicates to the contrary, the terms used in the Exemption Agreement and Implementation Plan shall have the same meaning as provided in the MOU and its Appendices. In addition, the term "MOU" includes its Appendices and the term "Exemption Agreement" includes its accompanying Implementation Plan.

   c. **Effect on MOU Provisions.** The Exemption Agreement does not change the MOU. Rather, it adds to it by implementing the specific provisions relating to campgrounds. For administrative and process purposes, it shall be treated as an amendment to the MOU.

3. **ADMINISTRATION.** Unless otherwise specifically provided, the Exemption Agreement shall be administered in accordance with the provisions of the MOU, in particular with the provisions of Article VI [Specific Agreements to Implement the Government-to-Government Relationship].

4. **RATIFICATION AND REQUIRED NOTICES.** The Exemption Agreement shall be ratified in the same manner as the MOU was ratified and a similar Notice of Ratification for the Exemption Agreement shall be provided. In addition, unless otherwise specifically provided, required and other notices under the Exemption Agreement shall be provided in the same manner as required by the MOU.

5. **IMPLEMENTATION PLAN.** The Implementation Plan attached as Appendix A is incorporated by reference herein as if set forth in its entirety and a properly amended Implementation Plan shall replace the then-current Appendix A. The parties recognize that the Implementation Plan may need to be amended from time to time to deal with changing circumstances, particularly regarding the identification of fee-exempt camping locations and length of stay restrictions. They agree that amending the Implementation Plan essentially is an administrative matter that should not require the same degree of formality as ratifying an amendment to the MOU or the Exemption Agreement itself. Therefore, the parties agree that the Implementation Plan may be amended upon consensus reached between the parties' "keepers of the process" identified pursuant to Article X of the MOU.

6. **FEE-EXEMPT CAMPING LOCATIONS.**

   a. **Campgrounds and Other Sites Involved.** The Implementation Plan identifies those National Forest campgrounds and other camping locations that may be used without charge in the exercise of the Tribes' ceded territory rights. The parties agree to periodically review and update these sites to ensure that they include:

      1) Campgrounds operated by a third party under a contract with the Forest Service where a contract specifically incorporates the MOU's fee exemption. For those contracts that currently do not incorporate the fee exemption, the Forest Service agrees to include the MOU fee exemption requirement in the solicitation of concessionaire operations as existing contracts expire and to incorporate those requirements in new contracts as they are awarded.

      2) All other National Forest locations where a fee otherwise would have to be paid by the general public to camp (i.e. stay overnight) and where some process (such as a registration form or campsite fee envelope) is used to identify the camper and the specific campsite that will be used.

   b. **Procedures for Using Fee-Exempt Campsites.** The Implementation Plan sets forth the procedures that will be followed when registering at a fee-exempt campsite. The parties agree to periodically review these procedures as necessary to ensure that they include the following elements:

1) Following the registration procedures and completing the paperwork generally used for the site; and

2) In lieu of fee payment, providing to campground compliance personnel and/or placing in a campsite fee envelope a document authorizing use in the exercise of the Tribes' ceded territory rights that has first been obtained from a Tribe or such other information as the Tribes and the Forest Service may agree upon.

c. **Reserving Fee-Exempt Campsites.** The Forest Service's local and national systems for reserving particular fee-exempt campsites may be used for reserving sites for use in the exercise of the Tribes' ceded territory rights with the following understandings:

1) The parties acknowledge that it is not possible at this time to implement a fee exemption for reservation and camping fees that are presently collected "up-front" when a reservation is made either through the Forest Service's national reservation system or through a local reservation system for a limited number of campsites. The parties agree to revisit this issue as part of the regular MOU monitoring and evaluation procedures upon the request of any party.

2) The Forest Service is not obligated to establish a campsite reservation system where one presently does not exist. However, where there is a particular need, including the demonstrated inability to obtain campsites on a first-come, first-served basis, a Tribe may ask the local Forest Service District to reserve a campsite for use in the exercise of the Tribes' ceded territory rights. The Forest Service agrees to make every attempt to accommodate the request and, before denying the request, to discuss possible alternatives with the Tribe. In any event, the Forest Service shall not unreasonably deny the request.

3) The Exemption Agreement will not be implemented in a way that displaces non-tribal users who are lawfully camping or that displaces reservations made by non-tribal users.

7. **LOCATIONS WITH LENGTH OF STAY LIMITATIONS.** The Implementation Plan identifies those campgrounds or other camping locations for use in the exercise of the Tribes' ceded territory rights where the parties agree to specific length of stay limitations between June 15 and August 15. The parties agree to periodically review these sites to ensure that the length of stay limitations do not interfere with the exercise of those rights. The Forest Service agrees to include the MOU length of stay exemption requirement in the solicitation of concessionaire operations as existing contracts expire and to incorporate those requirements in new contracts as they are awarded, unless the Tribes have agreed to length of stay

restrictions for the particular campground involved.

8. USE OF CAMPSITES THAT ARE "CLOSED" FOR THE SEASON. The parties acknowledge that the Forest Service provides services at campgrounds and campsites only during an annual operating season, generally from late spring to early fall. The parties agree that use of campgrounds and campsites outside of the annual operating season in the exercise of the Tribes' ceded territory rights shall be as follows:

   a. **"Closed" Campgrounds.** The Forest Service presently prohibits camping in certain campgrounds outside of their annual operating season and agrees to provide the Tribes with information identifying those campgrounds and the periods during which they are "closed." The Tribes agree to also prohibit camping in these locations with the understanding that camping in the exercise of the Tribes' ceded territory rights may take place under a special permit issued by a Tribe with the Forest Service's written consent. The Implementation Plan sets forth a list of these campgrounds. Request for Forest Service consent should be directed to the local Forest Service District. The requesting Tribe and Forest Service will then work out arrangements regarding sanitation and other issues of conservation, public health or public safety concerns. The Forest Service agrees to make every attempt to accommodate the request and, before withholding consent, to discuss possible alternatives with the Tribe. In any event, Forest Service consent shall not unreasonably be withheld.

   b. **Other Campgrounds.** For those campgrounds where the Forest Service does not specifically prohibit camping outside of their annual operating season, the Tribes may authorize and regulate camping in the exercise of their ceded territory rights on the same terms as the Forest Service regulates camping by the general public during the same period.

9. GENERAL CAMPING REGULATIONS. To supplement the protections already provided by the Tribes' Off-Reservation National Forest Gathering Code, the Implementation Plan contains a number of general regulations that will govern camping in the exercise of the Tribes' ceded territory rights pursuant to the Exemption Agreement. These regulations are intended to conserve the natural resources in and around the National Forest sites subject to the Exemption Agreement and to protect public health and safety. They are based upon parallel federal regulations found in 36 C.F.R. Part 261 and implementing Forest Service orders. These regulations generally relate to behavior while camping, fire prevention, sanitation, protection of government-owned facilities and other matters regarding occupation and use of National Forest camping facilities.

10. MONITORING AND INFORMATION EXCHANGE. In recognition of the dynamic nature of their relationship, the parties agree that any matter within the scope of the Exemption Agreement

may be reviewed and changes considered as part of the regular MOU and Exemption Agreement monitoring and evaluation procedures. In addition, the parties, through their respective "keepers of the process" identified pursuant to Article X of the MOU, agree to gather and exchange in a timely manner information relevant to the Exemption Agreement that will aid in monitoring and evaluating the Agreement's implementation.

MEMORANDUM OF UNDERSTANDING

REGARDING

TRIBAL - USDA-FOREST SERVICE RELATIONS
ON
NATIONAL FOREST LANDS
WITHIN THE TERRITORIES CEDED
IN
TREATIES OF 1836, 1837, AND 1842

NATIONAL FOREST

CAMPGROUND FEE AND LENGTH OF STAY RESTRICTION

IMPLEMENTATION PLAN (VERSION 1.0)

MAY 2000

1. PURPOSE, DEFINITIONS AND GENERAL OBLIGATIONS.

a. Purpose. It is the purpose of this Implementation Plan to:

1) Implement the provisions of the *National Forest Campground Fee and Length of Stay Restriction Exemption Agreement* ("*Exemption Agreement*"); and

2) Regulate the use of National Forest campgrounds and related matters in the exercise of the Tribe's ceded territory rights.

b. Definitions. For the purposes of this Implementation Plan:

1) Unless otherwise specifically provided or the context clearly indicates to the contrary, the terms used in this Implementation Plan shall have the same meaning as provided in the *Exemption Agreement*.

2) "Campground" means any site within a National Forest where the Forest Service, either directly or through third party contractor, would require a fee from the general public to camp and where some registration process is used to identify the camper and the specific campsite that will be used.

3) "Developed Forest Service recreation site" means an area of National Forest lands which has been improved or developed for public recreation.

4) "Tribe" means the particular *Exemption Agreement* signatory Tribe in which the tribal member who is attempting to exercise ceded territory rights is enrolled.

5) "Tribal member" means a member of that particular Tribe.

c. General Obligations. No member shall fail to comply with any provision or requirement of:

1) This Implementation Plan;

2) The Tribe's National Forest Ceded Territory Gathering Code;

3) The Great Lakes Indian Fish and Wildlife Commission's ("Commission") document entitled *Tribal Ceded Territory Fee-Exempt Campgrounds*; or

4) Any permit or other document issued pursuant to this Implementation Plan or the Tribe's National Forest Ceded Territory Gathering Code.

2. REQUIREMENTS AND CONDITIONS AT PARTICULAR CAMPGROUNDS.

a. Particular Campgrounds. The Commission's document entitled *National Forest Campgrounds (Version 1.0)*, as it may be amended from time to time, is hereby adopted and incorporated as if fully set forth herein. This document identifies the following National Forest campgrounds for use in the exercise of the Tribe's ceded territory rights:

1) Fee-Exempt Campgrounds – Those campgrounds where tribal members may camp for no charge;

2) Length of Stay Limitation Campgrounds – Those campgrounds where tribal members may not continuously camp for longer than the specific period indicated; and

3) Campgrounds "Closed" to Camping Outside of the Annual Operating Season – Those campgrounds that are closed to tribal member camping during the specified period, except pursuant to and in compliance with a permit issued by the Tribe's Conservation Department, or its designee, that authorizes camping in a named campground during the closed period.

The Commission, in conjunction with the Tribe and the other parties to the *Memorandum of Understanding Regarding Tribal - USDA-Forest Service Relations on National Forest Lands Within the Territories Ceded in Treaties of 1836, 1837, and 1842* ("*MOU*"), shall periodically update this publication to accurately implement and comply with the terms of the Exemption Agreement regarding these locations.

b. Procedures for Using Fee-Exempt Sites. In order to use any campsite within a fee-exempt campground, a tribal member must:

1) Obtain and follow the instructions of the Tribe's Conservation Department, or its designee, as to what forms, documents or information are necessary;

2) Follow the camping registration procedures and complete the paperwork generally used at the particular site in question; and

3) Instead of paying a fee, provide the document(s) or information required by the Tribe's Conservation Department, or its designee, to the campsite compliance personnel and/or place the required document(s) or information in and/or on a campsite fee envelope.

4) Camp only at a site for which he or she has registered.

c. Reserving a Fee-Exempt Campsite. Tribal members may use the Forest Service's local

or national systems for reserving particular fee-exempt campsites that are available through those systems, but members will still have to pay any camping and/or reservation fee that is collected as a condition for making the reservation. However, where there is a need, including the demonstrated inability to obtain campsites on a first-come, first-served basis, a tribal member may contact the Tribe's Conservation Department, or its designee. The Conservation Department, or its designee, may then ask the local Forest Service District to reserve a site for the member as provided in the Exemption Agreement.

d. Interference With Other Campers. No member shall interfere with or displace any person who is camping or who has a reservation to camp at a National Forest campsite.

e. Failure to Pay Non-Exempt Camping Fees. No member shall fail to pay any fee for camping for which the MOU, Exemption Agreement or Implementation Plan do not provide an exemption.

3. General Regulations and Requirements. While exercising the Tribe's ceded territory rights in a National Forest, the following are prohibited:

a. Interfering With a Forest Service Official. Threatening, resisting, intimidating, interfering with or giving false or fraudulent information to any Forest Service employee, official, representative or agent engaged in the performance of their duties.

b. Disorderly Conduct.

1) Engaging in fighting.

2) Addressing any offensive or derisive or annoying communication to any other person who is lawfully present when such communication has a direct tendency to cause acts of violence by the person to whom the remark is addressed.

3) Making statements or other actions directed toward inciting or producing imminent lawless action and likely to incite or produce such action.

4) Causing public inconvenience, annoyance, or alarm by making unreasonably loud noise.

c. Fire.

1) Carelessly or negligently throwing or placing any ignited substance or other substance that may cause a fire.

2) Firing any tracer bullet or incendiary ammunition.

3) Leaving a campfire without completely extinguishing it.

4) Allowing a fire to escape from control.

5) Building, attending, maintaining, or using a campfire without removing all flammable material from around the campfire adequate to prevent its escape.

d. Property.

1) Damaging or removing any natural feature or other property of the United States.

2) Entering any building, structure, or enclosed area owned or controlled by the United States when such building, structure, or enclosed area is not open to the public.

e. Occupancy and Use.

1) Discharging a firearm, bow or crossbow in or within 150 yards of a residence, building, campsite, developed Forest Service recreation site, or cave.
2) Abandoning any personal property.

3) Placing a vehicle or other object in such a manner that it is an impediment or hazard to the safety of any person.

4) Operating or using any device which produces noise, such as a radio, television, musical instrument, motor, engine or public address system (portable or vehicle mounted) in such a manner and at such a time so as to unreasonably disturb any person.

5) Failing to stop a vehicle when directed to do so by a properly identified Forest Service employee.

6) Failing to pay any fee or other charge for which the Exemption Agreement and Implementation Plan do not provide exemptions.

7) Discharging or igniting a firecracker, rocket or other firework, or explosive into or within any cave.

f. Sanitation.

1) Depositing in any toilet, toilet vault, or plumbing fixture any substance which could damage or interfere with the operation or maintenance of the fixture.

2) Possessing or leaving refuse, debris, or litter in an exposed or unsanitary condition.

3) Placing in or near a stream, lake, or other water any substance which does or may pollute the water.

4) Failing to dispose of all garbage, including any paper, can, bottle, sewage, waste water or material, or rubbish either by removal from the site or area, or by depositing it into receptacles or at places provided for such purposes.

g. Use of Vehicles Off Roads. Operating any vehicle off of any public road within a National Forest:

1) Carelessly, recklessly or without regard for the safety of any person, or in a manner that endangers, or is likely to endanger, any person or property.

2) In a manner which damages or unreasonably disturbs the land, wildlife or vegetative resources.

h. Developed Forest Service Recreation Sites.

1) Building, attending, maintaining, or using a fire outside of a fire ring provided by the Forest Service for such purpose or outside of a stove, grill or fireplace.

2) Cleaning or washing any personal property, fish, animal, or food, or bathing or washing at a hydrant or water faucet not provided for that purpose.

3) Discharging or igniting a firecracker, rocket or other firework, or explosive.

4) Occupying between 10 p.m. and 6 a.m. a place clearly posted for day use only.

5) Failing to remove camping equipment or personal property when vacating the area or site.

6) Placing, maintaining, or using camping equipment except in a place specifically designated or provided for such equipment.

7) Without permission from a campground official, failing to have at least one person

occupy a camping area during the first night after camping equipment has been set up.

8) Leaving camping equipment unattended for more than 24 hours without permission of a campground official.

9) Bringing in or possessing an animal, other than a seeing eye dog, unless it is crated, caged, or upon a leash not longer than six feet, or otherwise under physical restrictive control.

10) Bringing in or possessing in a swimming area an animal, other than a seeing eye dog.

11) Operating or parking a motor vehicle or trailer except in places developed or designated for this purpose.

12) Operating a bicycle, motorbike, or motorcycle on a trail unless designated for this use.

13) Operating a motorbike, motorcycle, or other motor vehicle for any purpose other than entering or leaving the site.

14) Depositing any body waste except into receptacles provided for that purpose.

i. **Requirements at Particular Locations.** When the Forest Service has notified the Tribe or has posted a particular location as to where the requirement or restriction is intended to apply:

1) Violating any Forest Service imposed fire ban or other restrictions on the possession or use of items that may cause fire in areas where a fire ban has been imposed.

2) Entering, using or camping in an area without permission that has been posted as closed either generally or as to specific dates or times where a fire ban has been imposed.

3) Occupying a site with prohibited camping equipment.

4) Using a campsite or other area by more than the number of users or vehicles allowed.

5) Parking or leaving a vehicle in violation of posted instructions.

6) Being publicly nude.

7) Discharging a firearm, air rifle, or gas gun.

8) Being in an area between 10 p.m. and 6 a.m. unless camping or visiting a person who is camping.

9) Possessing or storing any food or refuse in violation of posted instructions



TRIBAL WILDERNESSES, TRIBAL RESEARCH NATURAL AREAS, AND TRIBAL VEHICLE PERMIT AREAS ON NATIONAL FORESTS

VERSION 1: AUGUST 1998

Great Lakes Indian Fish & Wildlife Commission
Biological Services Division
P.O. Box 9
Odanah, WI 54861
(715) 682-6619

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INTRODUCTION

The intent of this publication is to provide a readily accessible means of identifying Tribal Wildernesses, Tribal Research Natural Areas, and Tribal Permit Areas along with associated regulations applicable to the Off-Reservation National Forest Gathering Code.

Tribal Wildernesses protect lands to be primarily affected by forces of nature, without human influence. Tribal Research Natural Areas protect lands to maintain biological diversity, allow for non-manipulative biological research, and foster natural history education. Tribal Vehicle Permit Areas are designated Forest Service lands which require parking permits.

The contents of this publication may be modified on occasion. Please contact the Biological Services Division or Policy Analyst of the Great Lakes Indian Fish and Wildlife Commission to confirm the most recent update.

TRIBAL WILDERNESSES

REGULATIONS

Motorized vehicles, boats, and machinery prohibited within designated wilderness areas; with the exception of motorized boats on Crooked Lake within the Sylvania Wilderness Area, Ottawa National Forest. Bicycles and other wheeled mechanisms also prohibited within designated wilderness areas.

TRIBAL WILDERNESSES

Chequamegon-Nicolet National Forest
Blackjack Springs
Headwaters
Porcupine Lake
Rainbow
Whisker Lake

Ottawa National Forest
McCormick
Sturgeon River Gorge
Sylvania

Hiawatha National Forest
Big Island Lake
Delirium
Horseshoe Bay
Mackinac
Rock River Canyon
Round Island

Huron-Manistee National Forest
Nordhouse Dunes

TRIBAL RESEARCH NATURAL AREAS

REGULATIONS

Gathering of wild plants prohibited within designated research natural areas except for religious or ceremonial use with permission from Tribe.

TRIBAL NATURAL RESEARCH AREAS

Chequamegon-Nicolet National Forest
Bose Lake
Chequamegon Hardwoods
Grandma Lake Wetlands
McCarthy Lake and Cedars
McCaslin Mountain
Memorial Grove Hemlocks
Moquah
South Branch Grove
Spider Lake
Tucker Lake Hemlocks
Twin Lakes Bog
Waupee Lake

Ottawa National Forest
McCormick

Hiawatha National Forest
Dukes
Grand Island
Horseshoe Bay

Huron-Manistee National Forest
Hayes Tower
Newaygo Prairies
Nordhouse Dunes

TRIBAL VEHICLE PERMIT AREAS

REGULATIONS

Vehicles parked in designated fee sites must have a sticker placed on the lower passenger corner of the windshield. Tribal offices will provide information on obtaining these stickers free of charge.

TRIBAL VEHICLE PERMIT AREAS

Chequamegon-Nicolet National Forest, Eagle River-Florence District

Developed Day-Use Charge-Sites

- Anvil Beach Parking and Boat Landing
- Anvil Trail Parking, Lots 1 & 2
- Butternut Lake Boat Landings, East/South
- Franklin Lake Boat Landing
- Franklin Lake Picnic, Beach, and Trail Parking
- Kentuck Lake Boat Landing
- Laurel Lake Boat Landing
- Luna Lake Boat Landing
- Sevenmile Lake Boat Landing
- Spectacle Boat Landing & Beach Parking
- White Deer Lake Beach Parking
- Stevens Lake Boat Landing
- Lost Lake Boat Landing, Picnic, and Beach Parking
- Morgan Lake Beach Parking
- Morgan Lake Boat Landing
- Perch Lake Trail Parking
- Lauterman Trail Parking
- Assessor's Trail Parking
- Chipmunk Rapids Parking Area at Artesian Well
- Nicolet North Trail Parking

Developed Campgrounds

- Windsor Dam
- Anvil Lake
- Brule River
- Chipmunk Rapids
- Franklin Lake North
- Franklin Lake South
- Kentuck Lake
- Stevens Lake
- Laurel Lake
- Lauterman Lake
- Lost Lake
- Luna-White Deer
- Morgan Lake
- Seven mile Lake
- Spectacle Lake

Dispersed Camping Charge-Sites

- Quartz Lake (1 site)
- Luna Lake-North Shore (2 sites)
- Indian Camp Lake
- Three Johns Lake
- Mckinley Lake
- Harriet Lake
- Perch Lake (5 sites)
- Lauterman Lake (5 sites)

Chequamegon-Nicolet National Forest, Great Divide District

Developed Day-Use Charge-Sites
Rock Lake
Mukwonago Ski Trail
Morgan Falls
Penokee
Day Lake Picnic Area & Boat Landing
Moose Lake Boat Landing
Camp Loretta
Black Lake Boat Landing & Picnic Area
Lake Three Boat Landing
West Torch

Dispersed Camping Charge Sites
Camp Loretta

Developed Campgrounds
Beaver Lake
Black Lake
Day Lake
East Twin
Lake Three
Mineral Lake
Moose Lake
Stockfarm Bridge

Chequamegon-Nicolet National Forest, Medford-Park Falls District

Developed Day-Use Charge-Sites
Newman Lake Rec Area
Wintergreen Trailhead
Sailor Picnic/Boat Area
Round Lake Boat Landing
Patterson Lake Boat Landing
Round Lake Dam Interpretive Site
Newman Springs Trailhead
Bayview Boat Landing
Chippewa Campground Boat Landing
Picnic Point Boat Landing
Perkinstown Motorized Trailhead
Lakeview Day Use & Boat Landing
Kathryn Lake Boat Landing

Dispersed Camping Charge-Sites
Patterson Lake (2 sites)
Glacial Springs "camp"
Wabasso Lake
South Twin Lake Boat Landing
East Mondeaux Spur

Developed Campgrounds
Chippewa
Eastwood
Emily Lake
Kathryn Lake
North Twin Lake
Picnic Point
Sailor Lake
Smith Rapids
Spearhead Point
Twin Lakes
Wabasso Lake
West Point

MEMORANDUM OF UNDERSTANDING

between the

Leech Lake Reservation Tribal Council

and the

Chippewa National Forest

In a spirit of mutual respect and understanding, the Leech Lake Reservation and the Chippewa National Forest will cooperate in their roles as stewards of the lands and resources within the Leech Lake Reservation and the Chippewa National Forest.

This partnership is a new beginning for cooperative management of the natural and human resources of the Leech Lake Reservation and the Chippewa National Forest.

We recognize and acknowledge our government to government relationship and our separate authorities and responsibilities, but believe they are not a barrier to significant interaction and cooperation.

To the greatest extent possible, the Leech Lake Reservation Tribal Council and Chippewa National Forest shall seek opportunities to form partnerships in natural and human resource management and will share knowledge, discuss and resolve issues, and exchange ideas, concepts and theories about the most effective strategies for managing the natural and human resources of the Leech Lake Reservation and Chippewa National Forest for the benefit of this and future generations.

Signed on this 9th day of August, 1993.

ALFRED R. PEMBERTON
Chairman
Leech Lake Reservation Tribal Council

STEVEN T. EUBANKS
Forest Supervisor
Chippewa National Forest

Anishinabe (Ojibwe/Chippewa) Pictograph of a Bald Eagle.
The Eagle Symbolizes Courage and Vision, Attributes of Leadership.

INTERVIEW - 14-916 15-137

MARCH 17, 2017

MINNESOTA DEPARTMENT OF COMMERCE

In the Matter of the Application of Enbridge Energy, Limited Partnership for a Certificate of Need for the Line 3 Pipeline Replacement Project in Minnesota from the North Dakota Border to the Wisconsin Border.

PUC DOCKET NO: CN-14-916

OAH DOCKET NO: 65-2500-32764

In the Matter of the Application of Enbridge Energy, Limited Partnership for a Route Permit for the Line 3 Pipeline Replacement Project in Minnesota from the North Dakota Border to the Wisconsin Border

PUC DOCKET NO: PPL-15-137

OAH DOCKET NO: 65-2500-33377

Mille Lacs Band of Ojibwe's
Department of Natural Resources
45380 US Highway 169
Onamia, Minnesota 56359

MR. TERRY KEMPER: So I know it's kind of different for everybody here, but if we could take our time just to say a little prayer. A little silence for those that are struggling. Say a prayer for that ecological system that we're going to talk about today, for your culture today. That we all have open minds and we're able to get out of this meeting this time that we're sharing together what we need to get out of it.

We thank -- for what's happening today, we're thankful. We're breaking new ground in things and we're really thankful for it and hope that everything goes good.

So right now we'll just take a little moment of silence for all of the people that are in a struggle today.

Miigwech.

(Silence.)

MR. TERRY KEMPER: So if we can just take our tobacco outside and put it someplace, wherever it feels comfortable to you.

(Break.)

MS. NATALIE WEYAUS: Thanks, Terry, for the prayer. We can get started if you want to start.

MS. JAMIE MACALISTER: Okay. Good morning. Boozhoo, Natalie. I just have a few questions for you today.

The first one is can you describe the interconnectiveness of land, identity, and spirituality? Can they be separated from one another? And if not, why?

MS. NATALIE WEYAUS: I can just give you my perspective on that. And being growing up as a Native American, my parents taught me that anything you take out of the environment, we just take what we need, and we always put tobacco for anything we take from the environment. We are not alone in this world. We are not above anything else. We're just part of the environment, and not better or not worse, just here with the environment.

And as I grow older, we were -- we are stewards of the environment and we don't waste anything that's out there. Even the little trees, we don't cut them down 'cause they need a chance to grow.

With that, then, I will pass and let John or Terry speak on what they want.

MR. TERRY KEMPER: Can you rephrase that question for me?

MS. JAMIE MACALISTER: Yes. Can you describe the interconnectiveness of land, identity, and spirituality? Can they be separated from one another? And if not, why?

MR. TERRY KEMPER: No, they can't be separated from one another. The land is who we are as people. In all of our ceremonies and all of our cultural teachings that we have, the land is part of us. And when we say the land is part of us, we are made up of iron or copper, zinc, we are water, this is our bodies. And in that we are the environment. Everything that's in the environment is what we are made of.

And so to us we can't separate the two and that's why it's such an impact to us as human beings, as Anishinabe people, as Native American people, when things are disrespected, moved around, cut down, hurt, trees are cut down, plants and ground is dug up, because basically you're digging up us. Our relatives, our ceremonies, our everything is interconnected to that earth, to those trees, to those plants. So you can't separate the two of those.

MR. JOHN REYNOLDS: I'd also like to add that for the Indigenous people of this area, the way

of life that they have is something that was given. And it's not something that they just live for today, it's something that they try and maintain for future generations. And that's not something that we really see taking place with government agencies today.

MS. NATALIE WEYAUS: Which is very true when you see and read our treaties. All of the grandfathers, our ancestors that signed the treaties were not only thinking of themselves then, they were thinking of the future generations. So when we get to practice our rights, our treaty rights to gather, hunt, and fish, that was thought of way before our time. They didn't give that up. That we're always connected to the land to do what we have to do to survive.

MR. TERRY KEMPER: And there's a big significance between that hunting, fishing, and gathering. To us it's a ceremony. To us it's not just sustenance, it's not just gathering something to eat, but it's bringing a whole community together to connect with the outside world. To connect with the trees, the water, the animals. And to honor them. So we do that in ceremony before we take anything from the land. Before we hunt, before we

fish, there's a ceremony that occurs. Before we even go into the woods we do a separate ceremony, we talk to the things that we go there.

So everything is thought of today, is what we do today is going to impact seven generations, how is it going to impact seven generations down the road. And our ancestors were very good at that.

One of the reasons why we're sitting here today, you know, 'cause we're talking about our environment. We're talking about making major changes to that environment. And any major changes to the environment affects not only our ceremony, our people, our mental, physical, our spiritual health, it affects all those. That's how interconnected we are to the earth, to everything, to the plants, to the animals.

MS. JAMIE MACALISTER: Does anyone have anything else they'd like to add to that?

MS. NATALIE WEYAUS: Just that there's a lot of medicines out there. We have medicine people that pick the medicines and know what they look like and where they can be found. And what they're trying to do now is to teach the younger generations, inviting them to come to their homes

and showing them how to make their fat grease, how to make these medicines that people need. There even is medicine for cancer that they use and they share with the community that comes to them for medicine. For doctors. And that is our connection to the land. 'Cause there are medicines out there that can help almost for every illness you can think of.

MR. TERRY KEMPER: So we've experienced in our -- in our lifetime, as Indian people, a continual digression and abuse of the world, of the outside world. With cutting timbers, with plowing the fields. We've continually seen this and it's affected us, whereas -- we know already by what's happened what will happen. Like we already know when you make major changes to the ecology, to the ecosystems, that there's major changes that happen not even to us as a people, but to the world itself.

And today we are struggling because we know that every plant has a purpose. Everything out there has a purpose and meaning to it. From the little rock, to the sand, to the gravel, to the dirt, to every leaf on the plant has a purpose and it has something to give to the people to help us.

But today we, because of all the things

that have happened to us as a people, we only know certain plants now that we're really trying to hang onto, that we understand the knowledge of them because it's been passed down.

But every plant out there today, they used to say every blade of grass had a significance to the whole world. And so that's what we're trying to retain. We don't want to see that more ecology, ecological system damaged more. We would rather be helping it to make it better than to see something major happen to the earth for miles and miles, you know.

We're talking impact of trees, animals, the whole works, the whole ecological system is the air quality, the water, the everything. Because when you change the environment, when you change the ground, even when it rains the waters will go a different way. You know, things happen, they get eroded.

And the animals lose home, you know. We consider like when you go into the woods that that's their home. That's where the animals all live, the squirrels, the mouse, the mole, everything from the little things to the insects, they all live there. It's not our home anymore 'cause we live in houses.

But we used to live with them and that's all their home so we respect that. So by our cultural standards and our spirituality, we're protecting their home. We're protecting what's already been damage to them. That's it.

MS. NATALIE WEYAUS: Water, too, is very sacred to the Anishinabe and all the Native American races, Nations. We talk about that pipeline coming through and there's a big watershed that comes down north of us that affects -- that'll affect everybody, not only the people, but the plants and the animals also.

We had rice lakes north of McGregor and the Army Corps of Engineers put in a big dam there and flooded out the rice lake. Now there's no rice lake there anymore. But people still remember that. And that's -- that's a hard thing to get over. When we had a meeting there, we had an Army Corps of Engineer woman there, and they really got after her as if she was the one that did that. But when you come to a meeting with the Native American people, it's things like that that they remember. And if you're part of that group, you're probably going to get a few words of reprimand. But she took it okay, she understood.

MS. JAMIE MACALISTER: Natalie, can you tell me about the obligations that the Anishinabe have to Mother Earth and how they're met today?

MS. NATALIE WEYAUS: We still teach our children to respect the earth, to respect the water, to respect the animals, the plants, even the bugs. My grandson was -- this summer was walking and seeing a bunch of ants crawling on the sidewalk and he starts stepping on them. And I said those are mommas and daddies, and he said I'm sorry. So just teaching them stuff, little stuff like that will teach them to respect the earth and the animals and the plants and the insects.

Our schools are teaching them that stuff also. So that's nothing that -- that isn't nothing new, we grew up with that. This is what we live, to respect the earth and the trees and the animals. We don't complain about the water, the rain, the snow. Look at what happened when Katrina came. We don't complain about the rain and the water. Too much rain, not enough rain, when stuff like that happens it makes you realize that you don't complain about stuff like that, just accept it. That's Mother Earth's way of, I suppose, taking care of us also.

MS. JAMIE MACALISTER: Can you tell me

how you see this pipeline threatening the Anishinabe way of life and your relationship to place? And is that different to other types of infrastructure around you?

MS. NATALIE WEYAUS: What -- you're a mom, aren't you?

MS. JAMIE MACALISTER: Yep.

MS. NATALIE WEYAUS: And somebody put something in you that was there before, and after a while it wasn't working, so are they just going to leave that in their body or are they going to take that out and clean it up? I would say I would take it out and clean it up. Why leave something that our mother, who takes care of us.

So they're going to remove that pipeline. Don't abandon it, take it out. There's always recycling you can do with the steel or whatever. But let the land come back to its natural state.

MR. TERRY KEMPER: So the -- she referred to the earth as Mother Earth because it gives us all the sustenance we need. It gives us our food, it gives us our spirituality. But most of it, all of it gives us love. It gives a kindness to us that helps us in our world. Because it's full of medicines, it's full of all kinds of things that we

use in ceremony. And like we said in the very beginning statement, it's interconnected to us. We are part of the earth.

So I think in the last meeting that we had we said when we go out to the woods we sing love to that, we sing love and we receive love from it. You can't love a pipeline. There's no love that comes back from a pipeline. It's just a tool they use to move stuff through. So thus being now they want to move it around to another place and leave something that's not loving to the environment there. Something that can't give us any love within what we love, what we receive our love from, we receive everything that we're about from. I mean, everything that we get as a people that has sustained us to this point in time in our lives today comes from out there.

So when you leave things behind like that, it's like -- or you create new avenues of putting those things in, it's like taking the love out of someplace and then how do you put that back? You know, how do you get that back into that area? So to us it's like -- it's like the whole ecological system is just set upside down. And so that affects us. It affects us mentally, physically, and

spiritually because we use all that.

The ceremony that you just did where we just used tobacco, we used sage, all comes from out there. All the plants and things that we use, kinnikinnick, cedar, all these things.

One of the major plants that we use is cedar. And cedar was such an aromic and beautiful wood that they cut down almost all cedar forests in the state of Minnesota. Not only here, but all across this country. And so you very rarely see a cedar forest. That affected us when they did that. Because it's such a ceremonial part for us.

When a baby is born, they're put on a cedar bed. And that cedar talks for us and it tells the whole world, it tells the universe that we're here. But they came in and took most of the cedar trees. Now we have to travel, you know, hundreds of miles, 50 miles, hundreds of miles away to get cedar.

So we know the impact that things have, just like the industry of cutting the trees down, you know. That industry came in and cut so many trees that we have babies out there now and those babies are little baby trees. They're even older than us but they're baby trees. And we go out to

the woods, and if you've ever been in a cedar forest, if you've ever experienced a cedar forest, we used to watch -- in the cedar forest there's like bowls, bowls of water. And in that forest, the roots are red, they run into the water and they're red. But we watch the animals go in there, is when they were sick and hurting, they would go into a cedar forest and drink out of that. And it was a tea from that tree and it would heal them, it would help them out. And here today we hardly have that. And we use that. We watched the animals, we learned that from them and we use that in a lot of our ceremonies and now we don't have that anymore. So our whole -- every time something happens out to that ecological system, there's outcomes that happen years later down the road.

Today, because we're striving for that cedar connection again, because we're trying to make that connection back to the cedar, we have to go to man-made bushes and plants that people are planting now in order to pluck that medicine, in order to get that medicine, because there's not very much of that tree around anymore.

So where people didn't see the impact that that would have on us at that time, we feel it

today, that impact, just of losing those cedar trees. Or even the pine trees. The pine trees are very -- even the people today, if you go and see an original pine tree, and it's just magnificent, you can feel it, you'll see that tree out of all the other trees and be drawn to that tree. But our people used to talk about how those pine trees covered this land from Mille Lacs Lake all the way to White Earth. And we were connected to that. And then they came in, and that was the worse thing that happened to us, was they chopped all those trees down and used them for something. And then we had to compromise and find other avenues in order to do.

Now, when we have certain medicines that we have, we have to travel a long ways to find those trees, you know. We're so interconnected to those things out there that even our Indian names are after them. Many people are named Zhingwaak for that pine tree. People are named after rocks, Asin, Asiniikaa, Asiniinini. They're named after these things 'cause that's how interconnected we are. We're interconnected so much that plants and things we're named after. The rocks, the earth, we're named after that. The universe and all the things that are there, people have names after that.

So when they say that, you know, there wouldn't be no damage, you know, digging eight feet in the ground and putting in a pipeline, that's not true to us. To us you're taking all of our relatives and you're turning them upside down. You're taking all of our medicines, all of our spirituality when you're turning it upside down and wasting it. And so it makes -- it hurts. It hurts the whole tribe to see something.

If you've ever gone and walked down or traveled down the road and have you ever seen clear cutting, if you know what clear cutting is, you walk, you drive down the road and you're just in awe of these beautiful forests and you can open your windows up and smell them. I mean, if you stopped along the side of the road you can hear these forests. And that's what we're connected to.

Then all of a sudden you come to a place where there's nothing but stumps. Nothing but stumps on the ground and just their arms and their legs and everything is laying about here and there 'cause they took the major stem, you know. That hurts us. I mean, you can't even explain.

That's like losing your grandmother, that's like losing your father or your little baby

that was just born. That's what it feels like to us when you see something like that. And it affects a whole community because all of our community is connected to that. We're taught from a young age that these things have meaning to them, they have life. And so now you have 100 miles of trees that are cut down, or 50 or 25 miles of trees that are just -- that's all death. They just took it. And then they come in and they plant the trees and they think that they're going to make up for it by creating a farm, you know, another ecological system. And that ecological system then is -- is like us as a people trying to survive. That ecological system is us trying to remember a time when this world was just beautiful. When this world was producing everything that we needed as a people in order for us to survive.

Now, with the things that have happened in the world, we have a hard time doing that. We have a hard time finding all those things that we once used because of the things that have happened. Because of big industry coming in and not taking into consideration how it affects the people that are here.

MR. JOHN REYNOLDS: I think something

else that's very important to acknowledge is that a lot of the resources or the environment that was in place prior to a lot of the things that Terry mentioned, such as clear cutting, they've been so substantially diminished that there's only really a fraction of the resources that once were, and that's something that Anishinabe people are trying hard to preserve. And that if a pipeline of this magnitude comes through, it has the potential to basically destroy, you know, just a very small amount of what's remaining.

MS. JAMIE MACALISTER: Can you tell us a little bit about sacred places and how they are different from sacred sites?

MS. NATALIE WEYAUS: Sacred places versus sacred sites. Sacred places, that would probably be like that stone in Garrison. There's a big stone on the shoreline that people used to stop and put tobacco there. And they still do today. And what happened is the highway, Minnesota Department of Transportation came through and destroyed a lot of mounds within that area. I presume it was an area where they had Ojibwe camps or Dakota camps all around the lake, the whole lake, and it has mounds and burials and camps.

And the only part of the lake, that became a national historic monument because of the archeology, was Kathio State Park. Because of the state park status, it got recognized for all its archeology there. But just by knowing that, how the whole Lake Mille Lacs, it has a lot of archaeological areas, sites, mounds, the old Brauer maps show that. But sacred sites, we consider those our sacred sites, and we want those protected. We don't want those dug up.

We just had a water sewer plant come through and we didn't really want it, but we had to do it 'cause we own a resort along the lakeshore now, and a gas station, so they needed that sewer, a sewer line. So we let them do that and sure enough they hit an -- we had inadvertent discoveries and there was a lot of artifacts found. Those are sites that are maybe not Anishinabe, but they are Dakotas, and we need to protect those, too. Not only ours, but everybody's. And so we contact, we let them know what was found and they have representatives from the other tribes come in and talk with us and that's how we decided what to do with what we found and we collaborated and made a decision on what happened.

Does that help any?

MS. JAMIE MACALISTER: Yeah, it does help. So in that description you see the work even done by the Band for things that you need to do --

MS. NATALIE WEYAUS: Oh, yes.

MS. JAMIE MACALISTER: -- a sewer line or sewer plants, as the same as other types of infrastructure that --

MS. NATALIE WEYAUS: Yes.

MS. JAMIE MACALISTER: -- cause damage.

MS. NATALIE WEYAUS: Any agency, state or federal or our local Bands, we monitor all those projects so they don't get into our sacred areas. We even had landowners that know there are mounds on their land that we work with and they respect our culture to not destroy those sites on their land.

MR. TERRY KEMPER: I think, too, is sacred sites, sacred places, you could almost break it down into a verbal or a communicational thing because a site is a place that you can still see. A site is a place that you can go and it's still there.

Sacred places are places of inadvertent discoveries, we don't discuss that with people. There's sacred places out there that we don't

discuss with people and tell where they're at. Sacred places for us is that whole waterway. Any waterway that's out there is a sacred place because it was a highway, a place that we lived. You can still see the water, the rivers, and stuff like that. Even though they've been damaged, they're still there and you can see them. So that's considered a sacred site to us, every river, every stream, every waterbed, every swamp that you see out there is a sacred site, you can see it.

Sacred places sometimes you can't see. You can't see those sacred places. The moon, that's a site, you can see it, it's sacred to us. Something in the earth, something in the water that's a sacred place, you can't see it. Sacred places are places you take in a spiritual journey that you can't see. When we get into a ceremony, we go places in a sacred site. Sacred places, when you go to sleep at night, you wander, your spirit wanders and travels. It's a place that is a sacred place, but when you come back into this world you can't see that site. You can't remember. You remember it as a human being, but you don't remember it as the place. You bring it into this world. So there's two different things there, and it's

basically language, and all your language sometimes doesn't fit into our language. It doesn't fit into how we categorize things out there.

Sure, we have infrastructure that we have to do, but we don't know where those sacred places are, those sacred places under this earth. And that's what we try to protect the most that we can. That's what our job is here. Is that we don't know if they're going to find an inadvertent discovery. If that place is there from a long time ago, there's a dinosaur bone, there's bones of our ancestors, there's sacred sites that people used to see all the time and go to, but now they're in the ground or buried there. So it's a place that we don't even know about. But we're trying to protect it. So we know it's there.

That's why archeology, when they're looking for our kind of sites, they'll look for places that are old sites, they'll look for places along river banks, along portages, between places where they know earth, you know, and so they'll go to that. But the thing they don't know is that how we -- how we moved from by the shorelines to end of the woods during the spring times and summer times and how our villages were set back away from lakes

and streams. And so they don't know those sites.

They don't know our hunting grounds. We would travel for miles hunting deer, caribou, moose, that were all here at the time, they used to be here. Again, another ecological thing that's happened that impacted us was the animals and stuff and what we sustained our lives on and now those aren't there either. And they're managing those again, too.

And so our village sites and things like that, those were sites, those were sites at one time, now they're places because you can't see them. So archeologists are out there trying to find those places and we don't want them found and we don't want them dug up.

So whenever you put -- you take a long tract, you can't go, as long as that pipeline is going to travel, there's no way that you can travel from that area to the other area without coming across our people, our villages, our sites. Because we've lived here long before America was here. And we traveled all that land. We lived in all that land, we died in all that land, and all the people before us we consider to be part of the trees, part of the, you know, they bury people today now and

they put them in boxes, you know, concrete boxes. When they buried us a long time ago we were buried in the ground or on top of the ground and we became one with everything.

So our bodies nourished the plants, the animals, the trees, everything was nourished by our bodies going back to the Mother Earth. So every tree that was out there, every old tree, every plant, everything is our relative. And literally it is our relative. And so if you have a plant that grew on top of one of our relatives, that plant died and a baby was born because it seeds out again too. So that baby that's born and all those plants that are born are now us. If a bird comes and eats a seed off of that plant and travels 100 miles away and that plant that was our relative that was created off our relative's bodies, then that seed 100 miles from here will be put back in the earth by that bird and that relative now becomes over there, part of over there.

That's how interconnected we are to this earth. That's how interconnected we are to the birds, to the trees, to the plants, to everything out there. And that's what we're looking at, that that will affect, when a pipeline, anything major

like that, highways, roads, anything like that that comes through affects us as a people. It affects our past, it affects everything that we're about.

MS. JAMIE MACALISTER: I feel this very strong disconnect in world philosophies with that.

MR. TERRY KEMPER: It's kind of interesting because there is a very big disconnect.

MS. JAMIE MACALISTER: Yeah.

MR. TERRY KEMPER: A very big disconnect. That's why you have such a hard time putting this into your EIS.

MS. JAMIE MACALISTER: Precisely.

MR. TERRY KEMPER: Because for a long period of time now, the companies and the organizations that have been in charge of this have not listened to our point of view. Have not listened to our world view. They do not know who we are as a people because systems have been putting us how they want us to be and taking us away from that environment to disconnect us.

Well, the problem with it is, what we seen with DAPL, was that even through all atrocities that they did to Native American people, taking our land, putting us in boarding schools, even killing us, murder, death, by the army, we're still

connected. And that's -- that is so profound to say that, to be sitting here and telling you that I still remember my relatives from long ago, hundreds of years ago, because they're in them trees and they are in them plants after all of everything that's happened. That's so profound because we've been under attack for many, many years. And it came out with DAPL because we're coming to a period of time where major companies and infrastructures of cities and towns and things like that are having impact to the water, to the medicines that are out there.

You know, main society looks at aspirin as a thing they use for migraine headaches. But aspirin came from Native American people. And knowing that the birch and the poplar had that medicine in it because we chewed that when we had toothaches, when we were sick, we chewed that medicine. And then their science came along and broke it down to where now they can synthesize it, you know. But they've disconnected themselves from the tree itself.

When we have a problem we still go out to that birch tree, if we have headaches and stuff we still utilize those medicines off that tree. We still take a piece of that tree and chew it to help

us because we're still connected to that. It's been passed down from our elders to us. And that's what we're trying to protect because our elders protected that for us to keep that.

And even today we're sharing that information back to you and your people because you guys have become disconnected from that. And there's such an awakening happening in the world today, because more and more people are realizing that everything out there has a life to it. That everything out there, the medicines, the trees and everything are actually what everybody uses today. Aspirins, morphine, all the things that people use today in their medicines come from out there. And it's just been synthesized. And broken down. But people are learning that today more and more.

And so that's why we stand up and we try to do the best that we can by explaining what that really means out there, what that system really means to not just Indian people, but to all people, you know. Because all people use it. In some way, some form. But the main system now is either recreation or, you know, something I own or something to be used as a resource, you know. And we've never viewed it like that. So I can

understand what you're saying.

MS. JAMIE MACALISTER: So you were talking about land use and land ownership and that's something I want to touch on here, in terms of what do you see as the biggest differences between how Anishinabe communal, traditional use of the land, and nonnative, or Anglo-Saxon private ownership and land use, that relationship?

MS. NATALIE WEYAUS: We have boundaries now. You have -- we have boundaries after they did the treaties, we were ceded land and all that stuff. We finally -- we were wild ricing and we had to buy a Minnesota license to do that. Then some of our elders said why are we buying licenses when we have treaty rights. So the Band finally took it to court and we won and now we got our treaty rights back, we can gather, hunt, and fish within our ceded territory. But the question was, again, was something about boundaries?

MS. DANIELLE OXENDINE MOLLWER: I think it was, basically, since the Anishinabe way is communal and there really is an ownership, and how that's different or how the contrast to the Anglo-Saxon where we want to own and have private ownership.

MS. NATALIE WEYAUS: We don't believe in we own the land. It belongs to everybody. And I know there is ownership now and you have a title and this land is my land and all that stuff, but the Anishinabe way of taking it is we all own the land, we all have to take care of it. Yeah, it may be in your name, but it's not yours.

MR. TERRY KEMPER: I was in a college class and an elder I think from Michigan came in. And we were talking about this subject, about that. Because we've been dealing with this since, you know, the coming of the jakanashi (phonetic) or what you call them Anglos, I think another one, what's the one that they're going to do now, is decolonizing. The colonists. You got so many nifty words for everybody nowadays.

But he explained to me, to our class at that time, that it's a made up man-made ideology that you own the land. He said you can't own the land. The only thing that you own is a piece of paper that says you own that land. But any government system, the United States government system by eminent domain can come and take that land or tell you it's this worth and that's it and give you your price for it. So he said that you can't

own the land, but you can own a piece of paper that says you own the land and that's it. That's all you own. That's all it is is a piece of paper that says you own that land.

Can you own your mother? Can you own your father? You know. Do you love your children or do you own your children? You know. Is that your ownership? You know. And when you put it in that kind of context, no, it's not, you wouldn't say, oh, I own my son here, he's mine, I own him. You wouldn't say that. And that's how we view the world. We view the earth.

We've been through this since farmlands became, they started putting up fences. When they started putting up fences that affected us. Because we travel from the lakes and the streams back into the woods to hunt and fish. They said a long time ago that we used to be able to run down the deer when we hunted. That we were such good runners that we would tire that deer out, we would stay doggedly on his trail and we would tire that deer out till we could get close enough to him and shoot him with a bow and arrow for food. And you could imagine how far that deer would run and we could still run that deer down. They still have that in Africa where

they do that. But we haven't done that -- I don't know, Natalie might have done that when she was a kid.

But that's how we used to live. So we could run these animals down and you can imagine how far we used to go. Well, now, even the animals have to jump fences, you know. So we've experienced this ownership deal for a long period of time.

Even from like minerals. People are claiming right now today that they own the water. And that's coming. People today are selling water and owning, buying up aquifers and the land above aquifers, governments are controlling water now. And ownership, they have ownership to that water, where in some states you can't even keep the rain water because they say they own it.

Electrical companies own electricity. You can't put a solar panel in an area without paying that company because they have rights to that electricity. So ownership, we don't understand that because it's not our cultural way. It's not our spiritual way. We don't own things. We live with them. They help us, we help them. It's part of our spiritual connection to all things.

So when it comes down to ownership and

things like that, it was a foreign thing to us. But with all the things in the assimilation process that we go through, we understand it, we know what it is because we have to have a car, pay our insurance and we have to have a place to live now, you know, that's like everybody else's. So we understand what ownership is, but we don't agree with it 'cause we cannot own things.

MS. JAMIE MACALISTER: Well, here is a really great question for all of you from our perspective. And that is how do you see us, as representatives of state agencies, more effectively understanding and respecting the inherent right of self governance when coordinating with these projects that affect tribal interests?

MR. TERRY KEMPER: Okay. Want to say that again?

MS. JAMIE MACALISTER: Yeah. How can we work more effectively with you and try to represent your interests in these processes? And maybe represent isn't really -- it's not the right word. But on these projects that affect --

MS. NATALIE WEYAUS: When agencies come to you to ask for your permit or whatever?

MS. DANIELLE OXENDINE MOLLWER: Yeah.

Also -- I'm Danielle, by the way, I apologize for arriving late, I got a little turned around. And I'm with the state. I'm an enrolled member with the Lumbee Tribe, which is back east.

But I think the basic idea is, unfortunately, like you said, there's consequent elements that now we have to adopt and we have projects in all of these things that we know will continue to go on. And the state is really trying to, as much as possible, be intentional and speak with people before we take action.

MS. NATALIE WEYAUS: That's what we need, is to speak with us before you send your archeologists out there. That's what you'll hear from all the tribes, not just before you, your archeology. We have our archeologists, too. They can do that, they can go out there and look and let you know if there's anything out there.

MS. DANIELLE OXENDINE MOLLWER: And so the other piece of the question is how can we, you know, balance sort of -- you know, how can we work better so that we can honor and respect the inherent right to self governance and sovereignty? And I'm hearing Natalie saying don't do it for us, talk to us and we can do it right.

MS. NATALIE WEYAUS: Yeah. Right. Include the tribes before you do the archeology and come to us and say here's what we found, all we need is your concurrence, so your agreement that this is what is there. And sometimes there isn't, there's more there than a lot of the projects in the city area, cold water springs, for instance, and around the Fort Snelling area, a lot of sites there that they should have spoke with the Native community first.

I like your coming here today to learn. And maybe your people need cultural sensitivity before you work with tribes, have somebody come in and talk to you and so you get a better understanding of where we're coming from.

MR. TERRY KEMPER: So one of the things that I hear you saying in your words were we have to adopt to things, right. And that's kind of how, whenever we deal with systems or agencies, that's what we get, we have to adopt to these things.

Indian people know firsthand that we don't have to adopt to things. We've been assimilated from the on-start. And one of the reasons why you guys are talking to us today is because we didn't have to adopt to those things. We

still retain the cultural information, we still retain spiritual connections to the things that have been tried to be taken away from us. Through military force, through policies and procedures, through education. It's all been tried. We haven't had to adopt to it.

We've learned to utilize it. We've learned to make it a part of what we are, but still retain our cultural information, our spirituality, our ceremony. And yet when a company comes in or an organization comes in they don't do that. They adhere to the policy that they had to adopt. They adhere to that, they don't break away. And so for many years we haven't sat at a table. Or we've sat at a table listening to them tell us what we need to do.

And so today, that's why it's so significant, and if you could get it and how you put it into this is that you're listening to the people now. You're not adopting to their rules and policies, you're actually breaking out of it and trying to implement something into it that should have been there from the very beginning of EISs, from the very beginning of all these programs that affected Native American cultures and people.

So there's a lot of other places. And I think one of the things that has pushed it is the realization with DAPL and stuff what a driving force the Native American community is. And so now organizations have to begin to look at that. And they have to see and try to work around it.

Now, are they going to listen? That's the question. Are they going to listen? Are they going to hear us? Because, you know, we as a people have been hurt. We sit at the table and we continually sit at the table from treaty rights to everything and we continually are hurt. We receive little victories every now and then, but we continue to sit at tables with organizations because that's the kind of people we are, because we're connected to the love that's out there in the system, ecosystem. And it gives us enough love to sit at these tables and continually to be heard over and over and over again because people won't listen.

And so we're moving ahead and we're happy to have you sit at the table, we were glad to hear that somebody's voices are now being heard a little bit. And that they can maybe make an impact that other people will take. Because I'm the kind of person that knows, okay, I know that there's --

whenever there's a change, there's going to be people that say no, but there's going to be people that say, hey, that's awesome, that's really great. And I'm a person that says, you know what, it's up to you to make that change as an individual. If you work at an organization or a company, to put your neck on the line and say, hey, you know what, enough is enough. Let's try it, let's at least do it, let's see what happens out of the whole thing. And we don't have enough of that. There are too many people that are scared by adopting to the policy and just living by that policy.

There's a lot of places we can go and we work together. We can actually become a community again. We don't have communities anymore because of the way things are looked at. Resources, owning. So we don't have community. Me, me, me, me, me, you know. I have to have this, I have to have that, I have to support this, I got to get that, I got to pay this, I got to get that. It's all about me. And then there's no family hardly anymore because it's only about me and my kids or, you know, we have no communities anymore.

If you look at the outside world as Native Americans view it, the trees are all of the

community. They live with the birch tree, the pine tree, a poplar tree, an oak tree. They live with these little plants that are on the ground. They live with these little insects and bugs. They live with the woodpeckers. And they all live together in a community and they all fit into that community and work together. Some form, some manner.

That's how Indian people used to be. Until assimilation came along and they tore our communities up. They took the trees down. They managed the lakes. They managed the swamp areas. They manage all these things that are our life. And they took our community away from us.

And now they try to manage that community out there and they're messing it up even more. They're saying this is good for that, so we'll introduce these ladybug beetles over here because it'll help the growth of the trees or it'll stop the aphids, or whatever they're called. So they introduce this bug. Now you got this bug in everybody's house. You got this little stink beetle that bothers everybody. That's their management of the system. But it affects our ecological system and it affects that community out there. And when it affects that community out there it affects the

people.

Now, I say the people because it affects the people, not just Native American people. The reason why you're talking to us today is because we're still connected to that environment. That environment is still our ceremony, it's still who we are as a people and will continue to be. And we'll continue to fight for that environment and that community out there no matter what they did.

The water system, what have they got now, the carps, you know, they got these flying carps that just jump in your boats, and it's coming this way up the Mississippi and up the major rivers. They introduced these fish to combat something else. They manage it with -- what's the weed that's out there? They introduced a weed to stop something, the little clams and little things that are out there now.

MR. CARL KLIMAH: Zebra muscles.

MR. TERRY KEMPER: Yeah, zebra muscles. So that's our system.

I can tell you that my friend here, you're a biologist, right?

MR. CARL KLIMAH: Yeah.

MR. TERRY KEMPER: So he got an education

as a biologist and he works for fish, right? He does fish and looks at the lakes and the waters and the temperatures of the waters and things like that and raises fish, right? When I introduced myself, Awaazisii domain, that means I'm from the Fish Clan, specifically the Bullhead Clan, which is from Mille Lacs Lake. There's a lot of Bullhead Clan here, a lot of Fish Clan here.

And being that as I'm from the water, I'm the Fish Clan, that teaches me everything I need to do as a human being. It teaches me my connection to water. It teaches me my connection to everything else. As a Fish Clan, how many of you have eaten my brothers and sisters, the fish? How many other clans eat that fish? The bear, the eagle, they eat me, they eat my brothers and sisters. They sustain life. I sustain life. My clan sustains life. And I have to know the water because the water is what I live in.

So what significant impact does the water have to us as a human being? When I walk outside, every animal, every plant outside perspires. When the sun comes out, the water leaves. What we see in this room today is the room, but what's in this room is water. There's 100 million molecules of water.

There's a swamp in this room right now that we don't see, but it's here. Within that lake is a hundred million years of DNA information from the very beginning of time lives in that lake. We know that. Because it is who we are.

We retain that cultural information to that. Whereas other people don't see that. Big companies don't see that. You know, people coming through here that want to cut the trees down, they don't see the connection between the water and the tree. They don't see the connection between that tree and that fish. They can't put the two together. But yet it's there. And we see that.

But the community has been broken up by major pipelines coming through, power lines coming through, gas lines coming through. All these things have disrupted that community out there and that affects us. It has impact on us as spiritual people, as people themselves. It has impact. Our whole communities are hurting because of the things that have happened. And that's the thing that we try to capture, but how do you capture that? How do you put that into what they want to see?

Now, they don't want to hear that shit. Oop, there I go. We don't hear that stuff, you

know, but that's basically how they look at it, they see it like that and they say that, you know. How do we put that in there? And for so long a period of time people haven't been trying to. They say, oh, we can't do it, we can't introduce that into that. But they can. It's what's going to affect people. And if it affects people, you know, that's what this is all about, you know, an environment impact not just to that environment, but everything around. And we are the environment and so how does it impact us? And we've been trying to explain that to people and it's sometimes hard to get it.

MR. JOHN REYNOLDS: I think another really progressive step and specific agencies working with our tribes is on specific environmental and cultural management policies such as this one. You can ask the tribe if this specific act is sufficient, and both acknowledging and managing whatever their resources are, whether that's an archaeological investigation, or how, with an EIS, you're asking tribes and putting in an additional chapter. And if we can somehow reach the point with whatever specific agency is overseeing whatever specific practice is taking place, if they can actually ask the tribes if they think that this is

sufficient, and then begin working with tribes to make adequate additions. And if that's unclear, I can explain further.

MS. JAMIE MACALISTER: No, I think that's great. And one of the things that we will be doing is trying to capture this information as best we can and get it in our document and let you review it before we put it out.

MR. JOHN REYNOLDS: And just two really clear examples is I don't think EISs in the past have really captured how tribes are perceiving this. And then further, I don't think archaeological investigations really capture how a tribe perceives its archaeological resources. And that if we're working government to government, that dialog needs to take place and figure out how we can expand these existing practices.

MS. JAMIE MACALISTER: Yeah. I think this is really just the beginning of our efforts here. You know, this helps fill in one little piece of the puzzle. But as we keep going forward with this, there will be many more ways that we will need to get information from you and keep getting information from you. Not just on this project, but certainly everything on this project, there's still

a ways to go on this, how this ends up turning out. But on other projects in the future, this is really the beginning of our work together.

MS. NATALIE WEYAUS: That is good.

MS. JAMIE MACALISTER: I really just have -- we kind of talked about this directly and indirectly, but are there other cultural elements, and I don't mean just sites or places, but traditions that you see being threatened by the pipeline?

MS. NATALIE WEYAUS: This will be made whether we have input or not. With our leadership now at the national level, we just don't know what's going to happen. And it's people like our President that will allow things to happen and that's something that we won't be able to control. But we'll be there. If our people are opposed to it, they will be standing there and opposing it. I'm sure we'll go through a lot. But you can just sit back and watch, you know, when things don't turn out the way they're supposed to, and I suppose we'll have to say we told you so.

MR. TERRY KEMPER: Just that in itself and how Natalie talks is the emotional part of our disconnect that's going to happen from these things.

We're already disconnected, just from the way she says, and most Native people believe this now, with the apple and stuff like that, is that why are we even, it's going to happen.

But, like I said, we're sitting at a table again, you know. And even though we know that, we still have hope, you know. But we have hurt. We also have hurt in us even just knowing that for so long this is the occurrence that's been happening to us as a people. That we can speak now about it like it's an everyday thing, you know, because it's happened so much.

We're waiting for the time when people begin to see it and hear it and say wait a minute, yeah, you know what, they do have a valid point, it will affect other people, and what if it does happen. What if they do do that, what's going to be the outcome of it, you know.

And for us, we know the outcome. We've been through it. We've been through it many times over, and over and over and over again we've been through it. And there will come a time in the world where all people will begin to see it. And there will just be garbage on the earth. In the earth, on the earth, it'll be all over. And then what? Like

Natalie said, we told you so, you know. And that's not -- that's not something we look forward to or that we want to pass down to our ancestors.

Seven generations from now, I don't want my ancestors telling your ancestors, you know, our ancestors told you so. It doesn't have to be like that. And that's kind of where we're at today, though, because with the tree cutting, with the ownership, farms, and with the mining, and we told you so. We told you it was going to happen.

And we're at a point in time where does it benefit any of us, you know, does it benefit really a lot of people? No. Who does it benefit? Rich people. That's what it benefits. Majority of the people in the United States or anywhere don't get benefit from it. And if you do get a benefit from it, it's only for a short period of time and you make wages to pay your living and who benefits from that? The same people that put the company there, the company that's putting the pipeline through. They get your dollars after.

So it's a system that's really corrupt, it's a system that's not going to go anywhere. You know, it's going to implode at some point in time.

And we have our ancestors, our elders

retaining information that says take a look at it. Take a look at it and see it for what's going to happen, what can occur, you know. What are the impacts in the long run of this? Seven years from now, what are the impacts? And then seven years after that, what are the impacts going to be?

We already know that when they put the original pipeline in there and it ran through there, there's six more pipes that lay next to it and so we already know the impact of that area. We already know that it messed up that whole area that comes through. That people are living in fear of oil spilling into lakes. People that live in that area are living in fear of that. When is it going to happen? And right now they're at a time where it's now, you know. They're living in fear that any day now that pipeline can burst because they haven't up kept it, they haven't taken care of it, they haven't monitored it, and they haven't done what they said they were going to do. And so now people are living in fear.

Native American communities, and not only them communities, but other communities are living in fear every day that a pipeline is going to burst in their backyard and pollute the water or pollute

that system. So, you know, the impact of that is just in itself. So seven years from now, who is, you know, and now they want to leave it. They want to leave that pipeline in a corridor and just leave it there. That's like, to us, okay, that was seven years ago, seven years ago and maybe beyond that that they put the pipelines in and they continue to do that, so we already know the impact. That impact is that we'll just leave the garbage in the ground. We'll just leave it.

So if you're going to just leave the garbage in the ground, what makes you think I want you to put more garbage in my backyard, you know? If you put a dump in my backyard, am I going to like that? No. And then you leave it without cleaning it out? No. So that's what they're doing. And they're just leaving it in there. And now there's six more pipes in there that'll have their lifetime coming up and what are they going to do with that? Leave that garbage in the ground, too?

And so now you got a whole ecosystem, 100 miles of ecosystem that's been damaged, 100 miles of ecosystem that's been hurt. You've got new plants that came in there that are foreign, foreign plants. You got plants that don't get along with other

plants, that don't allow other plants to live. You got plants that hurt human beings. You got plants that blister your skin now that grow in them lines. You know, they grow in them lines where they dug it all up. And you can walk through that area and it will be full of Poison Ivy, Poison Oak, different things like that. I mean, just massively full of it. And you can't walk through that area without having some impact to you as a human being. You're going to have blisters, you're going to have sores on you.

There's plants in there that have needles on them now because they turned that soil up and so there's plants with thorns on them now. You go anyplace where there's been a pipeline put through, you'll find thorny plants, you'll find Poison Ivy, Poison Oak, you'll find all these plants in that area that affect the human being.

And if they affect us as a human being, what do you think they do to the animals out there? You know, the birds and the different things that are in there. And you got these other plants that are in there now that are coming, invasive species coming in that are even worse than the Poison Ivy, you know. And then not only that, but you got a

ecosystem now that's harmful to the insects. The insects now are -- their whole areas are turned up and you got different plants in there and everything, you know.

So what I'm saying is you can look at these pipelines and the corridors that are there, they're dumps now. They're dumps. That's what they're going to call it, you know. If they don't have responsibility to take them out or clean up their mess, it's a dump. So if it's going to be a dump, you look at what the dump has in it. The dump has in it thorny bushes, Poison Ivy, all these things where people can't go anyhow.

People won't want to go there to collect medicines. There used to be a nice area where you can go. You can look at the corridor now, where it goes, and it used to be just a pristine area. I mean, just beautiful forests and everything. The lumber company came in, cut it down. Then the pipelines came in and then the overhead, what do you call, the lines came in. Now you look at that whole area in there and it's just full of invasive species, full of all kinds of other things, it's hard to find any medicines that are good in there. But there are medicines that are in there that are

trying to clean up that ecological system and we have to leave them sit there in order to try and clean it up. Because the system itself tries to clean itself up, but when you have that massive amount of moving things around and putting foreign objects in there.

Just a funny joke. Just imagine if you were walking from your living room to your bedroom and all of a sudden there's a wall. Just out of nowhere there's a wall, you know. And you walk into it and you say, well, who put that wall up in here? Well, this company came in and said that wall was the best thing for us so they just said they're going to put this wall in there.

You think about those little worms that come in there, boom, oh, there's a wall. Think about those little moles and mice and stuff that live in the ground and the woodchucks and the otters and other things that dig in a hole and, bam, they run into that pipe. Well, what the heck is this here? It messes up. They don't ever think of things like that. We do. We think about that whole ecological system out there because it affects us. And so all those animals now that live in the ground, all the insects that live in the ground with

a foreign object sitting right in there.

Like I said, imagine you going from your living room and having to go to the bathroom and all of a sudden you run into the wall, you know. Because somebody said it's the best thing for you, you know.

It'll mess up your environment. You got to figure out how to get around it, how to go over it, how to do whatever to get to the place you want to get to, you know. And that's what we're dealing with.

I don't know if that explains anything to you guys, but --

MS. JAMIE MACALISTER: I just have one --

MS. LOUISE MILTICH: Can I do a follow-up on this?

MS. JAMIE MACALISTER: Yeah, go ahead.

MS. LOUISE MILTICH: I guess the question was about how the impacts of this project, you know, change cultural practices, your experience with the land. We're discussing climate change in the EIS. Can you talk a little bit about climate change and how climate change is affecting the way you interact with the land, the way you experience it?

MS. NATALIE WEYAUS: Climate change is

not created by anything but the people. The cars, the airplanes, all the automobiles. So it's happening. With all the new technology in place now, climate change is happening. And you just have to accept it. And we believe the way nature will change itself is by maybe more rain, more snow, who knows. It's never happened before, has it? Or was there a big flood once upon a time or --

MR. TERRY KEMPER: So you look at the ecological system, climate changes the trees, the wind, the rain. But the trees and the plants, they all have a significant impact to everything. We know that. We know that they're alive and living.

If you have a flower in your house and you talk to it it's going to grow nice, you know. And it's going to put oxygen, H2O in the air for you to breathe. At one time they say in the earth here, it used to be like a forest, it used to be like a jungle just full of pines and things and stuff like that. And the ozone, like the H20 level of the earth was 100 percent. Can you imagine the H20 level of the earth being 100 percent?

And there's a scholar, Vine Deloria, that talks about if it was 100 percent, that would mean that you as a human being could justify being 10

feet tall. Because if you're breathing in 100 percent oxygen, ozone level, oxygen level, your body is nourished, there's a part of you that grows. And if you're 100 percent, that makes you grow, your 100 percent oxygen would make you grow. Thus, over 100 years, over the years that have happened with deforestation, with plowing, plowing of whole fields of natural stuff, the ozone layers continue to go down.

There used to be fires and things like that, now it's big companies, corporations, pumping in cars, pollutants, spraying on the ground. So now, over the period of time, everything is getting polluted. Everything. So your ozone layer, now the people are even getting smaller. So you don't have tall people anymore. You got littler people 'cause they're not breathing the good ozone level, they're not breathing good air, oxygen, it's depleted.

So then you got the ozone layer which oversees the earth and the universe and it goes out and they say that they got big holes in that. There was a time when that ozone layer was bad at one time. Whether it was the earth, the sun, whatever it was that happened, and the whole earth had to redo itself. So whether it was flooding, whether it

was tornadoes, storms, hurricanes, different things, but the earth had to replenish itself again and it had to have time to heal. So in that time to heal we became what we are today. But now it's getting worse again.

So now we got an ozone layer that's totally, you know, have you ever been to the Cascades, or you go up above, if you go above the tree line or anywhere where you breathe, you can tell the difference in the air quality if you're in different areas where there's more vegetation, where there's more everything, you can tell the difference.

You can walk outside on the lakeshore, smell the lake. You can walk into the woods and you can smell the woods. You can go to Los Angeles, Chicago, the Twin Cities area, you will not get that smell. You will not feel that nourishment. Your whole body will actually have a different -- but the whole world is getting like that now.

So with the ozone level comes heat. Look at everything that's happened to this day right now today. The birds are flying different. The weather is different. Everything is different because of those changes to those layers in the earth, to the

air. So everything is changing. And to us that's impact to all of us. To everything out there. That impacts the trees, the water, the air. Because there's a natural cycle that I talked about earlier that everything has. Everything has that.

There's things that the government does that we don't know about. They spray little molecules up in the air, you know, the chem trails, all these other kind of things that they do. And they don't ask our permission for that, they're not asking anybody's permission. They're just doing it to control weather, to control other things. We know that as Native American people. How do we know that? Do you want me to tell you how we know that? Back when the nuclear wars were going on, when there was a nuclear like threat from Russia, do you remember as little kids going underneath your desks.

MS. DANIELLE OXENDINE MOLLWER: Yes, practicing the drills.

MR. TERRY KEMPER: Practicing the drills. There used to be a drill that we had to practice as little kids. And the siren would go off and we'd all get underneath our desks in the classroom because it was for a nuclear fallout.

Well, what they did was they came over

with big military planes over the Chippewa National Forest, over reservations and different areas and they dropped down these particles to see how far, if there was a nuclear fallout, if the bomb hit, how far that would travel. So they did all these experiments already in Native communities, in different areas. And this is all stuff you can read about, it's all stuff that they did already to check out that. So we know that they're doing things still to this day that's affecting. Because that in itself affected it, because they used some kind of chemical that they let out of the planes when they did that to see how far the air currents would carry that if there was a nuclear disaster.

And they're doing this all the time because you have a nuclear reactor down here in Monticello, so they're doing these kind of things all the time but they're not telling you. They're not doing EISs on it, they're not doing all these things down there, they're just doing these things.

So I'm the kind of person, I don't know about any of you guys, but when I hear a big military plane coming over on our reservation, I'm like, awe, shit, what are they doing.

MR. CARL KLIMAH: I was going to say, so

you asked how does the climate change directly impact the culture here?

MS. JAMIE MACALISTER: And changing --

MR. CARL KLIMAH: You do not have to look far. The bottom line, we got a warming lake up there, already we've seen the burbot go extinct practically in Mille Lacs Lake. So now we've got a situation where Band members, they can't even harvest the burbot because it's not there anymore. And now with the law declining, now our quotas are going super low. Another big one is tullibee, if the water pressures get too warm, I mean, they're already projecting to go extinct. And so now what happens in the other parts is these pipelines is going to impact and put limitations on their rights and that's just what it comes down to. You don't have to look far, you know, so I was going to add in that.

MR. CHARLES LIPPERT: And one other difference. Biogenic climate change and anthropogenic climate change. Biogenic climate change is motivated by the planet earth and it allows for the change and allows all of the living entities on earth to move and change with earth. But the anthropogenic climate change, it's human

driven and it does not allow for any other life forms to change with it. So this is basically a suicide kill for all of us. And reality is, earth sustains for life, and if anything does not promote life, earth will make sure that we will no longer exist and replace us with something that is going to promote life.

MR. TERRY KEMPER: Dun-dun-dun-dah.

MS. JAMIE MACALISTER: Terry is getting a little punchy.

Our last question really has to do with the water protectors and how -- the importance that the water protectors are in the Anishinabe culture.

MR. TERRY KEMPER: Well, what we just talked about, they're standing up for, you know. In the world that we live in we try to maneuver around to figure out how to -- because people wouldn't come to the table, you know, because people aren't listening. So when you're backed into a corner, you use the avenues that are available to you in order to say things are going wrong. And those were the avenues that were given to them and to our people now in the world. And the water protectors are some of the most -- what do you want to say, beautiful people.

Before even DAPL started there was a group of ladies that started walking with water. They were called the water walkers. And they came from each shoreline, from the south, from east-west and from the north, they bring water in copper kettles. And they walk with this water to all meet at the Great Lakes here. And I got a chance to walk with them and sing with them and do ceremony with them.

And at that point in time there was a lady, Josephine Mandamin, who had a dream that we have to protect the water. And this was years before DAPL, before the pipelines. Because there's a pipeline going through the Great Lakes up there and she seen the pollution that was happening and that companies were coming to the Great Lakes to take water out of there. And so they did this walk, so there's been many walks since then, of water walkers and stuff. But the original people that was there, we sat in ceremony with them, we had that, and it's kind of progressed now down to this point where it's at now.

So these people are considered sacred on our part. They're considered to be people that are utilizing what tools we have today in order to make

it known how important it is, the water. Thus being why you're sitting with us, because this pipeline is going to go through a watershed. This pipeline is going to go through the Land of 10,000 Lakes. And we've already seen what has happened in other places where oil has hit and how much they have not took responsibility and cleaned it up. They've covered it up.

And so those water protectors to us and to the Anishinabe, to the Lakota, to all Indians, to even people of other countries are people that are making a statement that needs to be heard. And so we look at them, you know, we honor them.

I think last week we met with Army Corps of Engineers and when we met with them there was a man that was put in jail. And he told his story and it's such a sacred thing that he went to jail protecting the water, protecting the people that were there, the old people, because they were being pushed around, they were being sprayed, dogs were being put on them. They got military out there after people that are in prayer for the water. That's how that company reacted to the people saying water is sacred, we can't have you steal water. And he went to jail for that. And the little bit I

could do is I make drums so I give to him a hand drum and told him that I appreciate, that's how important it is. And we all sat up and we healed.

With what happened out there, there's a lot of people hurt, because of when President Trump came in and did what he did and allowed it to go through, there was a lot of people that were hurt by that. A lot of Indians, a lot of other people that just see where it's all going and they were really hurt. And so, again, we all came together and we'll continue to do ceremonies to help them out, but there's a lot of hurt out there. And there's a lot of, you know, this is the next battle right here, Minnesota, 10,000 lakes. So, you know, those people are considered very, very, you know, highly respected.

But, remember, it comes from -- that whole thing came not just because of the pipeline, it came from a long time ago. These ladies, Josephine Mandamin is her name, and she is the lady that started to have a dream that we would be sitting in a time where pipelines were coming through, other things were coming through to mess that water up. So it's like Indian people, when they're connected to these things, they already send

the people. They already created this movement long before that pipeline came through. Because they knew that there was going to be that people needed to stand up at some point in time for that water. They needed to stand up for them sacred sites. They needed to stand up for those things in the past because the future relies on it.

And we've been through this road, we've been down through this road, you know. With the archeology, you know, you got a pipeline coming through and then once you do archaeological survey, okay, so you're going to dig up, do shovel tests and all of a sudden you find the bones, you find the bones of our ancestors. So then what happens? Well, they call the police force, they call these people, they come in and what happens? They dig up our people.

If we went and took all the graves from the white man's graveyard, dressed it up and said, oh, it might be an archeological dig, we went and dug up their ancestors and, oh, we found bones, call the cops, how would they feel? You know. And you got a pipeline wanting to come through and then what happens is they're going to dig them up anyhow. If they find something, make an inadvertent discovery,

it's boom, and then what happens, we get hurt again, everything.

So you talk about impact, environmentally to us the impact is immeasurable. And we've been through that because they've been digging us up under an archaeological field, permitted to dig us up like we were some kind of, you know, I don't know what you want to call it. Putting us in museums, putting us in for show, show pieces and stuff. We've been through this road for many, many years and we're just sitting at the table now with archeologists trying to get them to understand, okay, you dug this little spot here, there's a bone that came up, but maybe this whole area here is a sacred place because they put somebody there.

If you go to your cemeteries where you bury your people at, isn't that a sacred place to everybody? On the Fourth of July's, and certain times, birthdays and stuff, people come there and pray. People come there and remember them, you know. But they don't treat us like that. They dig us up. And so those are the things that -- and they don't see that impact. Oh, it's just an archaeological survey. They don't see the impact of that.

I sat on an archaeological survey as a Native American person finding artifacts of our ancestors and I said where are they going? Well, we got a property owner, we got to do this, we got to do that. It's like why am I even here? Why do I want to dig up my past, my ancestors, the things that they used and then give them to somebody else and you're not going to put them back? That's what we're dealing with. The hurt. The pain.

And so now you got major companies coming through and they're going to make inadvertent discoveries, that's just the bottom line, they're going to find stuff. That's it. More hurt. More pain for all of our communities. And I just do not understand how one group of peoples cannot see that, you know. I mean, before we even got to where we're at with the archaeological field, we literally had Native American people going to white people's graveyards saying we're going to dig them up, then, before they recognized that we were significant, that what they were doing was hurting us.

I remember some of those protestors that went to the graveyards with shovels and got arrested in order for the archaeological field to begin to understand that they were digging us up. I remember

those times. I remember them when they did that. And here we are today. You got a major pipeline wanting to go through. Is it going have impact? You're darn right it's going to have impact. They're going to find something in that corridor and they're going to dig it up and they're going to wonder where does it go. There are either going to be inadvertent discoveries of bones and things and it's going to go to the thing where reburial process is all taking over and that hurts our people, you know. So there's impact in all of that.

I just can't understand how one group of people doesn't see that, you know. How they don't see that any kind of bones or any kind of things like that of our ancestors -- if it was your ancestors, is that okay? You know, I don't think so. You know, it wouldn't be okay. Well, I'm going to put your mom and dad on display over here, you know, or I'm going to go put them in a box someplace and leave them.

You know, I went to this place down in Indiana, and it was a room twice as big as this, right, twice the size of this, and every shelf stacked to the ceiling was full of Native American bones. Or the basement of the Smithsonian. And

that's what they did.

So now I'm going to shut up because it's time to eat.

(Concluded.)

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March 31, 2017

Anne O'Connor
Deputy Commissioner and Chief of Staff
MN Department of Commerce
85 7th Place East, Suite 500
St. Paul, MN 55101

Re: Proposed Enbridge Line Three Replacement

Dear Deputy Commissioner O'Connor,

My name is James L. Jones, Jr. I am the Cultural Resource Director for the Minnesota Indian Affairs Council. (MIAC) I am writing to you today in regards to the proposed Enbridge Line 3 replacement that is currently being planned in the northern half of Minnesota. You have sent some questions to my Executive Director, Dennis Olson. Mr. Olson forwarded a copy of these to me. I have also met with two staff members of the Department of Commerce yesterday here in my home community of Cass Lake, MN. This meeting was held with Jamie MacAalister, Environmental Review Manager at the Department of Commerce and with Danielle Oxendine Molliver, Commerce's Tribal Liaison During that meeting, we discussed the relevant questions.

The intent of this letter is to inform you about concerns that I have as an enrolled member of the MN Chippewa Tribe, Leech Lake Pillager Band and about the number of impacts a project of this nature will have to the Cultural Resource sites along the proposed routes. One major resource that is missing from the evaluations is where are the Traditional Cultural Places (TCP's)? These types of sites include; wild rice beds, areas that are utilized by Tribal Communities both on and off reservation areas. I know that the proposed route will go through these types of areas, the McGregor, MN area being one known example. This area is rich with wild rice beds that are beneficial to a number of tribal communities.

There are Cultural Corridors areas within the proposed pipeline route. These are areas that were important in the development of the Tribal Communities today. They are also historic routes that go back thousands of years and are based on historic trade routes that indigenous people have had with one another for centuries. The crossing of the proposed route north of Outing, MN, and north of Roosevelt Lake is another example of this type of corridor. There has to be a complete

survey of the entire proposed route and this survey needs to start taking place immediately and will need to involved a number of the tribal communities to gain their input, oral histories will have to be gathered to assist with the identification of these places. Consultation will have to take place with the northern Minnesota Ojibwe communities including the Red Lake Band of Chippewa Indians (the proposed route is going through Red Lake's 1889 Treaty areas). Additional consultation will have to include the Dakota Communities that are located in the southern part of the state. Because the Army Corps of Engineers have already started the Section 106 process with over 18 tribal nations, consultation will have to include these tribal nations.

The proposed impacts to these places are things that a standard archaeological survey can miss and are sometimes are outside of the scope of work for that Environmental Impact S Statement.(EIS) Due to the time line for the project, these surveys would need to start immediately. This type of survey will need people who are familiar with the types of places important to Ojibwe history and culture; they also need to have working relationships with the tribal communities within the state to confidently gain their trust and collaboration. While working with a number of diverse tribal nations.

There are both applicable state and federal laws which govern to cultural resource management and the different cultural areas of the state. Any survey work will have to meet certain federal requirements while concurrently . coordinating with the different tribal nations, multiple agencies,and the different land owners potentially impacted by this project.
Thank you for your attention to these important issues that will affect these cultural places important to the Indigenous Communities of Minnesota .
Sincerely,

James L. Jones, Jr.
Cultural Resource Director, MIAC

Cc: Governor Mark Dayton
Chairman Robert Larsen, Chairman MIAC.
Chairman Darrell G. Seki, Sr., Red Lake Band of Chippewa
Chairman Terrence Tibbitts, White Earth Band of Ojibwe
Chairman Faron Jackson, Leech Lake Band of Ojibwe

Chairman Kevin Jensvold, Upper Sioux Board of Trustee's
President Shelley Buck, Prairie Island Sioux Community
Chairman Charlie Vig, Shakopee Mdewankton Dakota Community
Dennis Olson, Executive Director, MIAC.
Commissioner Mike Rothman, MN Department of Commerce
Gary Frazer, Executive Director, MN Chippewa Tribe
David Mather, State Historic Preservation Office
Amanda Grovhold, Office of the State Archaeologist.
Winona LaDuke, Executive Director, Honor the Earth

BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

Beverly Jones Heydinger	Chair
David C. Boyd	Commissioner
Nancy Lange	Commissioner
J. Dennis O'Brien	Commissioner
Betsy Wergin	Commissioner

In the Matter of the Application of North Dakota Pipeline Company LLC for a Pipeline Routing Permit for the Sandpiper Pipeline Project in Minnesota

DOCKET NO. PL-6668/PPL-13-474

HONOR THE EARTH'S **MEMORANDUM OF LAW IN SUPPORT OF LACK OF JURISDICTION FOR USUFRUCTUARY PROPERTY RIGHTS PROTECTED BY FEDERAL TREATIES**

To: Administrative Law Judge Eric L. Lipman, Minnesota Department of Commerce and Applicant Enbridge

Pursuant to verbal order of Administrative Law Judge Eric L. Lipman for jurisdictional briefing, *Honor the Earth* does now serve its initial Memorandum of Law.

INTRODUCTION

Before there was a United States of America, it was understood by the new human immigrants to Turtle Island (North America) that

> We hold these truths to be self-evident, that ***all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness***. That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed.[1]

By 1787, nine of thirteen colonies (states) voted to adopt the U.S Constitution, which

[1] Declaration of Independence, July 4, 1776. *Remember also* Dr. Martin Luther King, Jr. championing civil rights nearly 200 years later.

recognized Indians as separate and apart and that "[t]he Congress shall have Power [t]o ...regulate Commerce...with the Indian Tribes[2]. . ." and that Treaties are the Supreme law of the land

> and the Laws of the United States which shall be made in pursuance thereof; *and all treaties made, or which shall be made, under the authority of the United States, shall be the supreme law of the land;* **and the judges in every state shall be bound thereby,** anything in the constitution or laws of any state to the contrary notwithstanding.[3]

(Emphasis added).

In *Minnesota v. Mille Lacs Band of Chippewa Indians*, 526 U.S. 172 (1999), the Supreme Court unanimously held that, by guaranteeing Anishinabe (Chippewa) rights to hunt, fish and gather in the 1837 Treaty in which the Chippewa ceded formal title to a small portion of Minnesota, and a larger area of Wisconsin, U.S. treaty negotiators severed the right to use the land for subsistence, usufructuary property rights, from formal title to the land in the same way a utilities easement, or mineral rights, might be severed from fee simple title. This was the choice of the United States government, which negotiated other treaties, with other native peoples, before and after 1837 that did not have these characteristics, as the *Milles Lacs* majority pointed out.

The *Mille Lacs* majority and dissent differed only as to whether these Treaty-guaranteed usufructuary property rights had been abrogated by certain subsequent events. The opinion was unanimous in the Court's analysis of Treaty acknowledged and guaranteed usufructuary property rights that are not extinguished by transfer of title to

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[2] U.S. Const., Art. 1, Sec. 8, Cl. 3
[3] Id. See Art. 6, Cl. 2.

land to the United States, since "title" was a meaningless concept to the Chippewa and "use for subsistence" was understood as continuing without interruption.[4]

TREATY HISTORY

In 1795, The Treaty of Greenville expressly reserved to "[t]he said tribes of Indians, parties to this treaty, shall be at liberty to hunt within the territory and lands which they have now ceded to the United States." This was a treaty of perpetual peace between the United States of America, and the tribes of Indians called the Wyandots, Delawares, Shawanees, Ottawas, ***Chippewas***, Pattawatimas, Miamis, Eel Rivers, Weas, Kickapoos, Piankeshaws, and Kaskaskias.

The Treaty of Prairie du Chien[5] of 1825 was the first Chippewa treaty to deal directly with land in Minnesota. The treaty created an east west boundary to separate the Chippewa and the Sioux and it was

> understood by all the tribes, parties hereto, that no tribe shall hunt within the acknowledged limits of any other without their assent . . . the Chiefs of all the tribes have expressed a determination, cheerfully to allow a reciprocal *right of hunting on the lands of one another, permission being first asked and obtained*, as before provided for.[6]

(Emphasis added).

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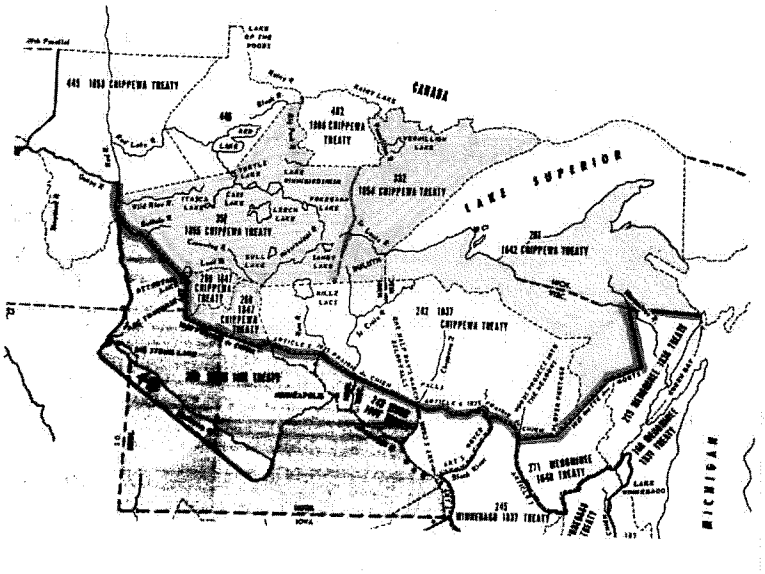
[4] *Minnesota v. the Mille Lacs Band of Chippewa Indians: 19th Century Treaty-Created Usufructuary Property Interests, the Foundation for 21st Century Indigenous Sovereignty*, by Peter Erlinder, Professor, William Mitchell College of Law and Director, International Humanitarian Law Institute, article currently invited for Law Review publication spring 2014. (See copy attached as Exhibit C).

[5] TREATY WITH THE SIOUX, ETC., August 19, 1825, Proclamation. Feb. 6, 1826., 7 Stat., 272. *Treaty with the Sioux and Chippewa, Sacs and Fox, Menominie, Ioway, Sioux, Winnebago, and a portion of the Ottawa, Chippewa, Potawattomie, Tribes.*

[6] Id. Article 13.



Here the red line is the Prairie du Chien boundary between the Chippewa and Sioux. Due to

> [t]he Chippewa tribe being dispersed over a great extent of country, and the Chiefs of that tribe having requested, that such portion of them as may be thought proper, by the Government of the United States, may be assembled in 1826, upon some part of Lake Superior, that the objects and advantages of this treaty may be fully explained to them, so that the stipulations thereof may be observed by the warriors. The Commissioners of the United States assent thereto, and it is therefore agreed that a council shall accordingly be held for these purposes.[7]

The 1826 Treaty, a conformation treaty for the 1825 Treaty, was conducted at Fond du Lac of the Michigan Territory, now Duluth, recognized that "this grant [from the Chippewa] ***is not to affect the title of the land, nor the existing jurisdiction over it.***[8] (Emphasis added).

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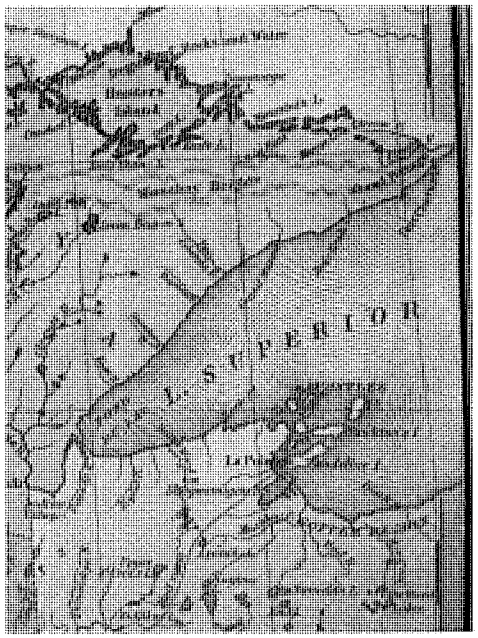
[7] Id. Art. 12.

[8] 1826 TREATY WITH THE CHIPPEWA, Aug. 5, 1826., Stat. 7,290, Proclamation, Feb. 7, 1827, Art. 3. Signed at *Fond du Lac* Michigan Territory, presently Duluth, Minnesota.



An important turn of the century U.S. Supreme Court case, Johnson v Geralds involved the consumption and sale of intoxicating liquors in the 1855 ceded territory, which the relevant treaty provided for liquor ban "and citizens of the city of Bemidji, Beltrami county, Minnesota, and at the time of the filing [. . .] were, and for a considerable time had been, engaged in business there as saloon keepers, selling at retail spirituous, vinous, and malt liquors at their respective places" in violation of federal law.[9] State citizens sued trying to argue the treaty protections only applied to Indian held lands but the Supreme Court held that

> it is unreasonable to give such a construction to the stipulation contained in the second portion of article 7 as would defeat its object, by removing the restriction from scattered parcels of land whenever it should come to pass that the Indian title therein was extinguished. The restriction would be of little force unless it covered the entire ceded area *en bloc*, so that no change in the situation of the reservations by way of extinguishing the residue of Indian title or otherwise should operate to limit its effect. And so, upon the whole, we deem it manifest that the second clause of article 7 dealt with the

[9] Johnson v Geralds, 234 U.S. 422, 424, 34 S. Ct. 794, 795 (1914).

> entire ceded country, including the reservations, as country proper to be subjected to the laws relating to the introduction, etc., of liquor into the Indian country ***until otherwise provided by Congress. <u>It was evidently contemplated that the bands of Indians, while making their permanent homes within the reservations, would be at liberty to roam and to hunt throughout the entire country, as before.</u>*** The purpose was to guard them from all temptation to use intoxicating liquors.[10]

(Emphasis added). This is the same, ceded, territory-wide protection the Chippewa also possess as a property interest to protect the environment against future oil spill contamination in perpetuity as we will "*be at liberty to roam and to hunt throughout the entire country, as before.*"

Conceivably, this prohibition on alcohol continued until the 21t Amendment in 1933 for most citizens of the United States. However, it was not until June 11, 1934 that for the Chippewa that

> the treaty of February 22, 1855 (10 Stat. L. 1165), between the United States and the Mississippi Bands of Chippewa Indians, shall no longer be considered as "Indian country" for the purposes of article 7 of said treaties . . .[11]

which involved the health, safety and welfare rights of the Chippewa throughout the ceded territories, in Minnesota, in this case for the 1854 and 1855 Treaties.

Consequently, unless Minnesota or Applicant Enbridge can show a similar Act of Congress to abrogate the usufructruary property rights of the Chippewa to hunt, fish and gather, in similar plain language, scope and breadth as above, and show compensation for

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[10] Id. at 438.

[11] An Act To modify the effect of certain Chippewa Indian treaties on areas in Minnesota, June 11, 1934. [S. 2980.] 48 Stat., 927.

the taking of the usufructuary property rights under US. v. Dion[12] and Minnesota v. Mille Lacs, the 1854 and 1855 ceded territories are Indian Country for all other purposes. Otherwise, Minnesota would have to show a grant of authority from Congress to exercise state jurisdiction over federally protected treaty rights.

Public Law 280

In 1953, Congress adopted what became known as Public Law 280, which gave certain states *criminal*[13] jurisdiction and limited *civil*[14] jurisdiction over tribal members, in several states including Minnesota. However, Congress specifically exempted from its *criminal* grant in clearly stated and unambiguous language that

> (b) Nothing in this section shall authorize the alienation, encumbrance, or taxation of any real or personal property, including water rights, ***belonging to any Indian or any Indian tribe***, band, or community that is held in trust by the United States or is subject to a restriction against alienation imposed by the United States; ***or shall authorize regulation of the use of such property in a manner inconsistent with any Federal treaty, agreement, or statute or with any regulation made pursuant thereto; or shall deprive any Indian or any Indian tribe, band, or community of any right, privilege, or immunity afforded under Federal treaty, agreement, or statute with respect to hunting, trapping, or fishing or the control, licensing, or regulation thereof.***

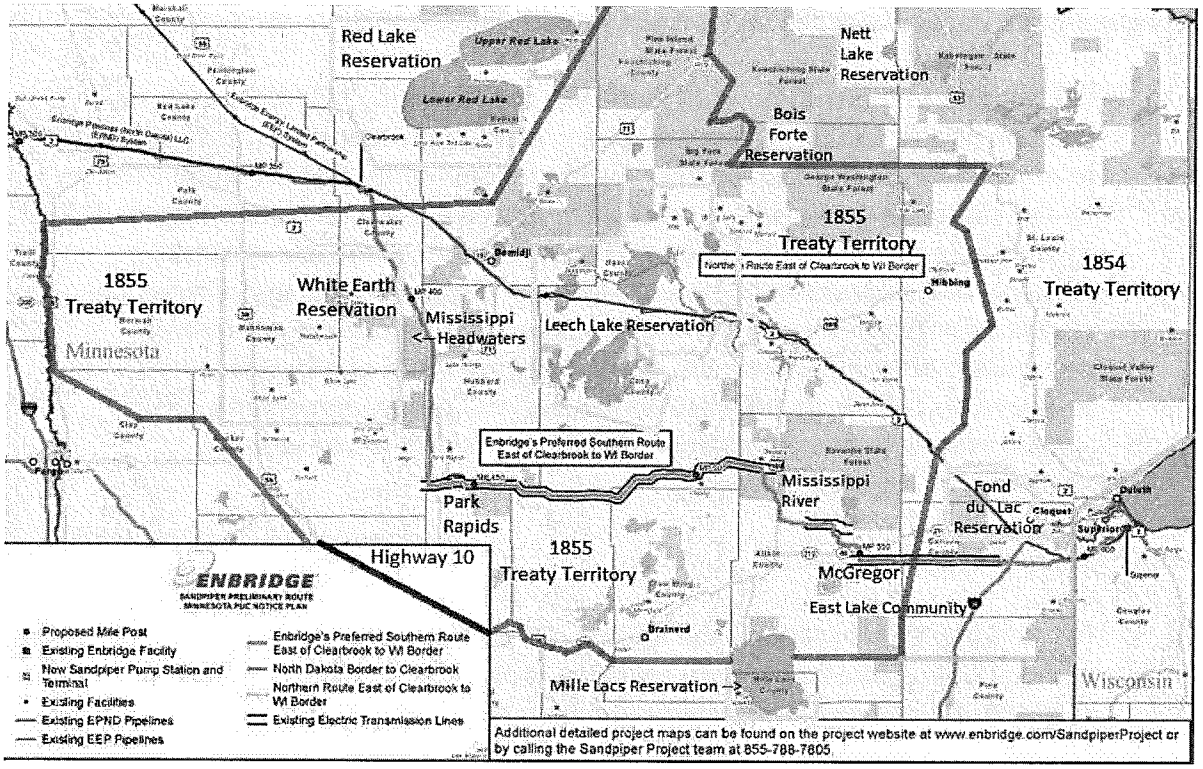
The *civil* grant also provides that

> (b) Nothing in this section shall authorize the alienation, encumbrance, or taxation of any real or personal property, including water rights, ***belonging to any Indian or any Indian tribe***, band, or community that is held in trust by the United States or is subject to a restriction against alienation imposed by the United States; ***or shall authorize regulation of the use of such property in a manner inconsistent with any Federal treaty, agreement, or statute or with any regulation made pursuant thereto***; or shall confer

[12] United States v. Dion, 476 U.S. 734, 738 (1986).
[13] 18 U.S.C. § 1162.
[14] 28 U.S.C. § 1360

> jurisdiction upon the State to adjudicate, in probate proceedings or otherwise, the ownership or right to possession of such property or any interest therein.

Clearly, Congress did not grant the State of Minnesota any authority or jurisdiction to decide matters related to treaty rights, federal agreement or statutes and which includes the present Public Utilities Commission proceedings considering the Application by Enbridge for a Routing Permit across the ceded territories, which in this case is primarily across the 1855 ceded territory.



The PUC should consider the Supreme Court's analysis in Chevron where

> [t]he Court, in an opinion by Justice John Paul Stevens, upheld the EPA's interpretation. A two-part analysis was born from the *Chevron* decision (called the "*Chevron* two-step test"), where a reviewing court determines:

> (1) First, always, is the question whether Congress has spoken directly to the precise question at issue. If the intent of Congress is clear, that is the end of the matter; for the court as well as the agency must give effect to the unambiguously expressed intent of Congress.
>
> If the Court determines Congress has not directly addressed the precise question at issue, the court does not simply impose its own construction of the statute . . . Rather,
>
> (2) [I]f the statute is silent or ambiguous with respect to the specific question, the issue for the court is whether the agency's answer is based on a permissible construction of the statute.[15]

Here, the PUC is not even a *federal* agency with any delegation from Congress, and the U.S. Constitution spells out the federal relationship with Indians.

In light of the usufructuary property rights analysis unanimously adopted by Supreme Court in Minnesota v. Mille Lacs Band of Chippewa Indians, which builds upon the analysis in the earlier Lac Courte Oreilles cases in the Seventh Circuit, *Honor the Earth* provides further legal analysis for a previously unrecognized sources of Treaty-guaranteed usufructuary property rights across all of northern Minnesota, both on and off reservations.

Minnesota is without authority when it comes to federal rights in Indian country, and there is no apparent effort by Applicant Enbridge or Minnesota law to respect our unique federal protections and usufructuary property rights.

A. The *usufructuary* property rights, created by U.S. treaty negotiators in 1825, 1826, 1837, 1854, as well as in 1855, which the Supreme Court of the United States unanimously recognized in *Minnesota v. Milles Lacs Band of Chippewa Indians* in 1999, determines due process rights of the Chippewa today.

[15] Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837 (1984).

The modern, seminal case establishing the foundation for interpreting treaty issues in Minnesota is *Minnesota v. Milles Lacs*[16], wherein several post-1855 treaties and Executive Orders, which the majority of the *Milles Lacs* Court held did not abrogate treaties agreed to with the Chippewa in 1855 and before, with a specific focus on the 1837 Treaty. In specific, the *Mille Lacs* majority and dissenting opinions were unanimous in finding that the "bundle of rights" which the U.S. treaty negotiators could retain or bargain away included "usufructuary property" rights, *i.e.* the right to "live off the land" irrespective of "fee ownership." This is a Roman Law concept, well known to U.S. treaty negotiators, who wrote such provisions out of treaties negotiated at about the same time. *See, generally,* O'Connor, J. *Minnesota v. Milles Lacs.*

Essentially, in many ways the *Minnesota v. Mille Lacs* opinion from 1999 made all prior cases obsolete with respect to understanding the genesis of usufructuary property rights recognized in U.S. courts. This is demonstrated in the 1854 Chippewa ceded territory, where the LCO cases from the Seventh Circuit helped the State of Minnesota recognize and compensate for off-reservation Ojibwe usufructuary property rights in the Arrowhead for more than 20-years. But that $15 million bi-annual compensation is only for tribal members to not exercise treaty rights, off-reservation in the 1854 ceded territory. What is the time value of money, today, for the loss of perpetual harvest rights and loss of the environment that supports that ecosystem? Priceless?

B. Prior to 1855, rights held by the Chippewa west of the 1854 Treaty Boundary were NOT "aboriginal title", but the more highly protected Treaty-

[16] Minnesota v. Mille Lacs Band of Chippewa Indians (Mille Lacs), 526 U.S. 172, 175–76 (1999).

guaranteed usufructuary property rights that were, and are, individually exercised.

Sections of the Treaty of 1825, 1826 and 1854 plainly state that the U.S. government recognized that the Chippewa were sovereign in the territory from which the 1837 Treaty territory had been ceded, and from which the 1855 territory would eventually be ceded.[17] But this was not "aboriginal title" at all. Rather the "usufructuary property right" to hunt-fish-and gather was recognized in treaties of 1825/26 then encompassed all of Minnesota Territory north of the boundary with the Lakota (Sioux) Nation, this division was ratified by Congress and recognized as a place to which Chippewa should return if they were to be removed from the 1837 ceded territory. This right was exercised individually in the geographical area the U.S. recognized as sovereign up to 1855.

This distinction makes a significant difference because the terms of the 1825-26 and 1854 Treaties describe with specificity the agreements that pre-existed the 1855 Treaty and those that followed. The territory west of the 1854 Treaty boundary was not vacant, nor was it without treaty guarantees that preceded the 1855 Treaty.

Further, because usufructuary property rights include "the right to modest living," environmental protection to maintain the long-term value of these property rights will have significant long term off-reservation land-use and wildlife

[17] The Court in U.S. v. Herbst, 334 F. Supp. 1001, 1006 (D. Minn 1971) made the same factual error. The Leech Lake Band (however defined) like all other Chippewa in Minnesota have Treaty-guaranteed usufructuary rights to hunt-fish-and gather dating to 1825-26, as sovereign people, and confirmed in the 1854 Treaty with the Chippewa of the Mississippi. This is *not inchoate and indistinct* "aboriginal title."

management implications for tribal governments and tribal members. Similarly, recent federal prosecutions of tribal members for violations of the federal Lacey Act for wildlife violations, predicated on tribal members violation of tribal game regulations are direct violations of the sovereignty explicitly guaranteed in the exercise usufructuary property rights in the heart of "Indian Country."[18] At least some of these prosecutions have been dismissed by federal district court judges who recognized the usufructuary rights established by treaties between sovereigns may be abrogated by Congress with a clear intention to do so, in language understood by both parties to accomplish that result, but cannot be set aside as merely incident to a federal statute.[19]

Another example from Supreme Court treaty analysis demonstrating that treaty-created usufructuary property rights must extend beyond the existence of any particular tribal government is Menominee v. United States in which Congress dissolved a Reservation which became Menominee County of the State of Wisconsin. The Court held that even though the entire reservation no longer existed, the usufructuary property rights created by the treaty which Congress had not specifically extinguished still

[18] For discussion of "Operation Squarehook" undercover "sting" operation, see Doug Smith and Dennis Anderson, *3-year Walleye-poaching Probe Nets More Charges in Minnesota*, STAR TRIBUNE, April 15, 2013, http://www.startribune.com/local/203006351.html

[19] United States v. Lyon, Case No. 13-68 and 13-70, Order of Judge John Tunheim, November 25, 2013, a*vailable at* http://turtletalk.files.wordpress.com/2013/11/90-dct-order-rejecting-mj-rr.pdf

remained to be exercised individually by members of the Menominee[20]. The usufructuary treaty rights were created by Congress for descendants of the signatories within the area covered by the Treaty. Individual ownership of all survival rights associated with the bundle of usufructruary rights and the right to earn a modest living[21] from and with the earth's creatures and resources, are held by the living people, reserved by prior living people in perpetuity for those Anishinabe (Chippewa) to come.

Likewise, the required *due process* for taking away individual property rights as described by US Attorney for Minnesota Renner[22] in 1971 (See Exhibit A, p. 6, item 10), would also be required for taking of a federally protected, conservation right-of-way belonging to the Chippewa. Therefore, the State's law violates all U.S. Constitutional protections and Chippewa treaty protected rights, and must be held invalid and consequently subject matter jurisdiction for the Minnesota Public Utilities Commission for the full, final and complete legal authority to grant a pipeline route permit does not independently and unilaterally exist.

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[20] The Menominee are signatories to the same 1825 Treaty with the Sioux, Menominee and Chippewa.

[21] See *Treaty-Guaranteed Usufructuary Rights: Minnesota v. Mille Lacs Band of Chippewa Indians Ten Years On* by Peter Erlinder, 41 ELR 10922, 10-2011. (See copy attached as Exhibit B).

[22] See United States v. State of Minnesota, Answers to Defendant's, State of Minnesota, Interrogatories, U.S. District Court of Minnesota, January 20, 1971, submitted by U.S. Attorney Robert G. Renner (No. 3-70 Civil 228). Attached as Exhibit A.

Respectfully submitted April 7, 2014.

/s/ Frank Bibeau

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ATTORNEYS FOR *HONOR THE EARTH*

From: Winona Laduke
To: MacAlister, Jamie (COMM)
Subject: Testimony for Scoping Energy Environmental Review and Analylis
Date: Monday, August 31, 2015 3:06:33 PM
Attachments: Rice Lake Line Three Hearing Final.docx
Who Owns Abandoned Pipelines.docx
Mille Lacs hearing submission final.doc

Jamie

I appreciate your hard work As I mentioned in my discussions with you and testimony, since the DOC has decided to run contemporaneous hearing processes and environmental review in the comparative environmental analysis process, I am submitting both my testimony from the Sandpiper and the Line 3 Hearings The Sandpiper submission is referred to as the Mille Lacs testimony . To be clear, some of the major concerns that you do not outline in your scoping request include:

Human Health Risk associated with pipelines, fossil fuels and climate change

Cumulative impact assessment or well to wheels impact. It is clear that there is nothing in your scoping outline which restricts testimony or impacts which are not along the pipeline corridor, therefore we are requesting that this is duly and comprehensively considered.

I remain deeply concerned and interested in your tribal community asssessment

Your scoping paper in Line V is absolutely unclear as to the process for completin the assessment relating to potential significant impact and as such cannot be discounted by your process, or a truncated process to expedite this critical regulatory process for the Enbridge Company or some other interest.

I believe that a full Line 3 assessment in the present location should be completed far in advance of any new projected route hearings.

I reserve the right to submit more testimony and would be happy to clarify or answer any questions

Miigwech, Winona LaDuke

Honor the Earth Comments to the PUC August I8, 2015

Submitted by Winona LaDuke

Overarching Policy Concerns:

Honor the Earth and the White Earth Band of Ojibwe are pleased that the Minnesota PUC has come to our community. It is interesting that when we requested this hearing for the initial Sandpiper Pipeline PUC process, we were denied such a hearing, but now that at a much larger corridor is proposed, you have come to our people. We appreciate this. ***To be clear, we believe a moratorium on large oil pipelines and projected pipeline abandonment projects is required until such time as a full environmental impact statement is made regarding the multitude of proposed projects, and the intersection of these projects with other mega mining projects and energy projections for the state of Minnesota and through Anishinaabe Akiing.***

In our testimony we will discuss the shortcomings and structural barriers within the present state of Minnesota's regulatory process to address these issues, and the absolute need to create a regulatory system which is secure in advance of a set of mega projects proposed by foreign companies. These regulations need to look at the issues of short term profits at the expense of the people, and ecosystem of Minnesota as well as the Anishinaabe people. We fully recognize the present economic and energy environment which has brought this crisis to the forefront, but also recognize that this is the opportunity for governance and community to lead rather than follow energy interests.

Or perhaps more clearly, it is incumbent upon a people who have lived omaa akiing, here in this Anishinaabe Akiing for over 8000 years to inform you of our observations. We have not seen either a prudent natural resource management by the state of Minnesota In the demise of fisheries, decline of water quality statewide, decline of major fauna, such as the wolf and the moose, and proposals for diminishing water quality in the state regulation of sulfide standards. We do not believe this is prudent management, and see that today the interests of a 65 year old Canadian corporation are not the interests of the Anishinaabe, or the people of Minnesota. We welcome the opportunity to build a collaborative and healthy relationship with the state of Minnesota to protect the water, land and future generations, and insure energy and food security. This is the role of governments.

In each deliberation we must consider the impact upon the seventh generation from now.

The Anishinaabeg people hold this as an essential tenet of behavior for our society, and for public policy. This intergenerational equity, responsibility, and opportunity is upon us now, and it is essential that we undertake this practice to carry on. This is responsible regulation. Anishinaabeg have tenets of sustainable governance that keep of our covenant with the Creator intact through intergenerational considerations of actions. *This was perhaps summarized in the June 4 Hearing held by the White Earth Tribal Government in Rice lake, where tribal member Michael Dahl testified, "We have treaties with creation. We have treaties with the fish, we have a treaty with the rice, [with] that lake. ... When we negotiated treaties with the United States we had to go back and renegotiate our treaties with*

creation. Creation doesn't give a second chance, we can't renegotiate again. Protect the land, live with the land, not off of it."

"Seems like folks don't want to hang around for a l000 years or so,"
Mike Wiggins, Tribal Chair of the Band River Band of Ojibwe

The fact is that the Anishinaabeg people have lived in this territory for 8000 years, and intend to be here for at least another l000 years. The short-sighted nature of US Federal oil pipeline regulations (of which there are very few) does not protect future generations from contemporary bad planning. In addition to the faulty siting, planning and oversight of the proposed Line 3 replacement, there is a drastic lack of regulatory authority over pipeline abandonment, a primary issue at stake here in the case of Line 3. This will be discussed in more details later in the testimony, but the underlying principle, that a lack of any regulatory scheme for protection of state assets remains a primary reason why such a proposal for both abandonment and a new pipe should not be forwarded.

In the broader scope, of policy making, internationally, enlightened governments are adopting new regulations which affirm the Rights of Mother Earth, (as enshrined in the Bolivian Constitution) and the Rights of Nature (as used in the Pennsylvania municipality) , and limit the rights of corporations. Prudent governments have also begun to adopt a precautionary principle in public policy. The precautionary principle has received widespread resonance in the European Economic Community, these countries, have longer term public policy and residence that the young United States and younger Minnesota. It is possible to learn from the older nation states in this way. This principle states:

"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."
Wingspread Statement on the Precautionary Principle, Jan. 1998 (http://www.sehn.org/precaution.html):

We advise the state of Minnesota to adopt this principal to protect the public interest, the commons and our collective future.

Formally, Honor the Earth and the White Earth band of Ojibwe are deeply concerned with the proposal for the Line 3 Replacement Project, in light of the lack of state and federal preparation for pipeline management, regulation, and the clear risk posed by the applicant Enbridge to the environment, public health and short and long term economic well being. Both the White Earth Band of Ojibwe and Honor the Earth submitted significant testimony in the previous hearings on the proposed Sandpiper Route. In these proceedings we will refer to that testimony, as the problems are augmented, and represent more than a cumulative impact of risk and direct impact on the health , well being and wealth of our people.

However, there are new, very significant problems which have become apparent In your regulatory process. These include: the inadequacy of the permitting process of oil pipelines

and the lack of any abandonment regulations. As well, the Minnesota Pollution Control Agency needs state primacy in assessment of the environmental impact of this project, as well as federal and tribal jurisdictions. The fact that that present regulations delegate environmental assessment to the Department of Commerce, as opposed to the 950 staffed MPCA is very problematic in terms of capacity. This scale of project would require an integrated environmental, social and economic assessment. **The regulatory problems we are facing put us all at risk.**

We are at a nexus point of opportunity in Minnesota and nationally, which provides us a chance to examine the infrastructure we invest in. Fifty to sixty years ago, when most of the country's oil and gas infrastructure was being built out, there was not much understanding of sustainable development. As a result, we now have a D in infrastructure. This is a national issue, which causes pipelines to break, bridges to collapse and the loss of millions of dollars of water and gas in aging urban infrastructure. Now, as we look towards a new generation of infrastructure development, we must decide if we want to replace our crumbling infrastructure with more of the same, or invest in the infrastructure for sustainability. This is an excellent opportunity for us all, as tribal governments and as the state of Minnesota.

We believe the state of Minnesota must recognize their inability to regulate a project of this scope and enact a moratorium until a full cost accounting and environmental impact statement can be developed for the various pipeline projects in the works. This action would acknowledge the immense, and intergenerational economic, and health impacts of this project proposal, in terms of not only opportunity forgone benefits (investments which could be made) as well as the implications of oil impacts on the immediate environment and the world climate.

Honor the Earth and the White Earth band are pleased that the Minnesota PUC has come to our community. This is an important step, we must however, recall to the PUC the problem of the general disregard the PUC has exhibited for tribal and non tribal citizens, by allowing the company to classify maps and marketing material, and, securing an unknown amount of insurance during the proposals for the Sandpiper, without a full analysis and disclosure of methodology to the tribes or the citizens of Minnesota. As it is 2015 and not l889 , it is important for the state of Minnesota , in accordance with not only Governor Dayton's executive memorandum on tribal/state cooperation, but as well, as a matter of political respect and decency to address our tribe and the Anishinaabeg with respect.

The absence of transparency by state agencies, has caused a great burden on our tribe, and on citizens of Minnesota, who are then forced to carry out extra work, while the state shields a Canadian Corporation. While we are very pleased to see that the PUC and Enbridge have scheduled a formal hearing in our community, we did not find satisfactory last year's PUC process with regards to the Sandpiper. In turn, the suggestion that this Line 3 proposal should follow the same route, with a skewed and perplexing process for determining " need" that we continue to challenge, without a route approval or any satisfactory conclusion of a Sandpiper process, causes problems for us all.

Honor the Earth had asked that these processes be combined, and a full disclosure of new pipeline projects to be put into this proposed corridor (Lines 2 and 4 are anticipated), to be considered. We requested a ***well to a pump impact*** assessment as a prudent approach to this project's evaluation.

Prudent regulatory policy would review projects in this manner, as myopic environmental, health, economic, and risk assessments do not result in prudent policy. ***As such, while the PUC seeks to review this project as the Line 3 Project, we will refer to this as the Enbridge Energy Corridor, and understand fully that there are cumulative impacts of the proposal by the Canadian Energy company, which are briefly outlined here. We are very clear that public policy should not be dictated by the needs of a foreign oil company, particularly through the lands of the 1867 and 1855 treaty areas. Indeed policy needs to be in advance of economic or environmental crisis, and the application of the precautionary principle would need to begin prior to the advent of any more permitting.***

In short, the Line 3 Abandonment and Replacement or ***Enbridge Energy Corridor*** is a bad idea that requires a sophisticated level of analysis. To date, we have not seen that level of analysis in any high-profile pipeline projects nationally, or within Minnesota. As a nation of Indigenous peoples recognized as having a right to continue our existence under our own covenant with the Creator, and as well under UN General Assembly passed UNDRIP, we will require a full consideration of the merits of this project, and it's risks, not an expedited process for the benefit of a limited liability Canadian energy corporation.

Comments on the Proposed Project:

The White Earth Band of Ojibwe and Honor the Earth object to this project, the Enbridge Energy Corridor for many reasons. Namely; the Rice Lake and East Lake communities the pipeline passes dangerously close to are communities already at risk; the preferred route would cross the highest concentration of wild rice lakes in the world, and some of the most pristine waters in North America; and finally, the proposed project represents a massive carbon impact on a climate change compromised world, and a short-sighted investment in greed rather than a long-term investment in future generations.

Over the past two years, Honor the Earth has developed several public statements on the various pipeline projects in Minnesota and have submitted several documents to docket PL-6668/CN-13-473.The White Earth band has also consistently submitted to the process. Please apply this previous testimony to this new process.

As suggested, we will address the questions the PUC has placed before the public on this docket, specifically:

1. **What human and environmental impacts should be studied in the environmental analysis?**
2. **Are there any specific methods to address these impacts that should be studied in the environmental analysis?**
3. **Are there any alternative routes or route segments that should be considered?**
4. **Are there any alternatives to the project that should be considered?**

The first half of the document will answer the first two questions, while the second will cover the second two.

1) Human and Environmental Health Impacts:

To look at the human health impact, it is essential to look at the ***well to the pump impacts*** of tar sands oil, although the primary concern, of the Minnesota PUC is the impact on Minnesota residents. To be clear there are three sets of communities directly impacted by this project: the First Nations Communities in the Athabascan Tar Sands, the communities along the proposed Enbridge Energy Corridor, as well as the communities around the refineries. Additionally, globally there are numerous communities at risk from continued climate change. Briefly, the three non Minnesota /tribal impacts will be summarized. Convenient and myopic accounting on environmental and public health issues has skewed externalizing losses and impacts. In an actual accounting full accounting, these will be deemed part of the need and consideration.

Athabascan River Tribal Community Impacts: Ft. Chipewyan

The small community of Fort Chipewyan (or Fort Chip) is on the front lines of Canadian Tar Sands expansions. This community has faced an increased rate of cancer and exposure to a variety of chemicals, far exceeding national and international standards. This impacts include direct impacts on current generations and lingering impacts that will be felt for future generations. HTE is attaching the National Resource Defense Council's fact sheet on the health impacts of tar sands, which includes more information on this community and other impacts of tar sands, including refining.

Excerpted from the NRDC report, *" In a 2009 study commissioned by the governments of Alberta and Canada, scientists studied the incidences of cancer found in the tiny community of Fort Chipewyan. Fort Chip, as it is commonly known, has 1,100 residents and is located where the Athabasca River empties into Lake Athabasca, 124 miles north (downstream) of the major tar sands developments in Fort McMurray. In the report, scientists noted a diagnosed cancer rate from 1995 to 2006 that was 30 percent higher than what would typically be expected for that period of time. Further, certain types of cancers -- biliary tract cancers, blood and lymphatic cancers, lung cancers in women, and soft tissue cancers -- all occurred at rates higher than expected, the government study showed. Scientific studies have linked elevated levels of these specific cancers to exposure to certain constituents in petroleum products and the chemicals produced in petroleum manufacturing. Fort Chip has also gained the attention of the media due in part to concerns raised by an Alberta physician, Dr. John O'Connor, who has called for further investigation of cancer incidences after noting the presence of at least three cases of cholangiocarcinoma in this small town within the past decade. Cholangiocarcinoma is a cancer that typically strikes only 1 in every 100,000 to 200,000 individuals.*

A 2009 study published by the National Academy of Sciences showed that the snow and water in an area extending outward 30 miles from upgrading facilities at Fort McMurray contained high concentrations of pollutants associated with fossil fuels, known as polycyclic aromatic hydrocarbons (PAHs). These chemicals often present serious risks to human health -- some are known to damage DNA, others are carcinogens, and many cause developmental impacts. They also typically accumulate and remain present in the environment over long periods of time, according to research

published by the U.S. Environmental Protection Agency. A follow up study in 2014, published by the National Academy of Sciences, modeled the PAH levels measured in the tar sands region and found that environmental impact studies conducted by the tar sands industry in support of further development have systematically underestimated PAH emission levels and thus did not adequately account for human health risks.

In a landmark study published in the November 2013 issue of the journal Atmospheric Environment, scientists noted the presence of elevated levels of numerous hazardous air pollutants near major upgrading facilities just north of Edmonton. Among the pollutants found at elevated levels, many are carcinogens, including benzene and styrene. The study also noted elevated rates of leukemia and other cancers of the lymph and blood-forming systems in areas surrounding upgrading and petrochemical manufacturing facilities just north of Edmonton. Further, this study also noted that experts have found similar elevated risks in other populations living downwind of industrial facilities with similar emissions, which have also been linked to increased rates of leukemia and childhood lymphohematopoietic cancers.

The impact of increased air pollutants and noxious odors from excavating tar sands has been the subject of significant attention in the remote community of Peace River. There, the Alberta Energy Regulator is finally responding to years of reports by residents that emissions and odors from tar sands drilling and processing are making them sick. According to news reports, public hearings began in early 2014 following complaints that the tar sands operations have caused nausea, headaches, skin rashes, memory loss, joint pain, exhaustion, and respiratory problems, and have forced several families to leave the area.

Pollutants in the water

The majority of tar sands oil production takes place in close proximity to the north-flowing Athabasca River, which eventually flows into the Arctic Ocean (via the Peace, Slave, and MacKenzie Rivers). According to a 2012 study published by the National Academy of Sciences, researchers confirmed through lake sediment sampling and modeling that the presence of elevated levels of toxic PAHs can be traced to the major expansion of tar sands production that began in the 1980s. In particular, certain water bodies within the Athabasca watershed now exceed current Canadian standards for pollutants in sediment for seven PAHs, including benzo(a)pyrene, a chemical that has been linked to cancer, genetic damage, reproductive impacts including birth defects, and organ damage.

In addition, scientists analyzed lake sediments and snow samples and found evidence that tar sands development is leading to increasing amounts of methylmercury in Alberta's waterways and landscape. Specifically, the researchers report an exponential increase in measured methylmercury levels within 30 miles of tar sands upgraders. Methylmercury is a potent neurotoxin that causes developmental and behavioral problems, including lower IQ in children, as well as cardiovascular effects in adults. Methylmercury is known to accumulate in the food chain and can result in unsafe exposures, particularly among populations who consume a lot of fish. This increased presence of mercury in the Canadian landscape poses a unique threat to First Nations who rely on hunting and fishing for sustenance, and whose right to hunt and fish has been guaranteed by treaty and by the Canadian Constitution.

Further health threats arise from ponds full of mining waste. These tailings ponds contain multiple toxic chemicals including arsenic, benzene, lead, mercury, naphthenic acid, and ammonia, according to a Pembina Institute analysis. A 2008 study by Environmental Defence Canada, based on industry data, found that as much as 2.9 million gallons of water leaks from tar sands tailings ponds into the environment every day. Another study, published by the National Academy of Sciences in 2014, shows that extreme concentrations of PAHs present in tailings may lead to the evaporation of those PAHs into the ambient air. Further, the releases of PAHs into the ambient air from tar sands

upgrading facilities discussed above are finding their way into the Athabasca River and its numerous tributaries. While the tailings leakages suggest the possibility of a significant future threat to waterways, emissions from upgrading and evaporating PAHs from tailings ponds appear to already be contaminating water resources with carcinogens and other chemicals linked to negative human health effects."

Source : http://www.nrdc.org/energy/tar-sands-health-effects.asp

Marathon Tar Sands Refinery

One of the communities at the end of this proposed pipeline is the Detroit community surrounded by the Marathon Tar Sands refinery. Testimony presented at the White Earth Band of Ojibwe and Mille Lacs Band of Ojibwe regulatory hearings on June 4 and 5 on the proposed Sandpiper project by Emma Lockridge (attached) shows the impact of this refinery. Notably, Marathon, the company which owns this refinery is a one third partner in the Sandpiper. This was the "need" established by Marathon which became the driving force for the PUC to issue a certificate of need. We continue to dispute this "need" in the Marathon case, and wish to offer excerpts from Ms. Lockridge's testimony to this hearing:

"...The refinery emissions are so strong it feels like we live in the refinery, not near it. News reporters have asked me to describe the odor coming from Marathon. I say it smells like death. The odors emitted from the refinery are so toxic smelling that on many nights I am forced to sleep in a mask. I awaken coughing and gagging on the emissions and I have a sore in my nose. The emissions seem particularly strong at night when people should be sleeping. In fact, it has become so unbearable I am looking for a new place to live even though my home is paid off. My home is virtually worthless due to the industrial atmosphere and its proximity to Marathon.

We are sick in my community. My sister had kidney failure and died after several years on dialysis. I have kidney failure and underwent a life-saving transplant, thanks to a kidney donation from my nephew. [It's worth noting that there are no other people in our extended family with kidney issues.] My neighbor who grew up next door to me is on dialysis and the lady across the street suffered kidney failure and died on dialysis. Our community is impacted by respiratory illnesses, kidney failure, autoimmune diseases, such as sarcoidosis and multiple sclerosis, and early deaths. We have a five-acre toxic play field in the heart of our community that is contaminated with such a high level of lead it is on an EPA brownfield list and has been cordoned off with a fence.

I am opposed to tars sands mining and refining and the installation of any new pipelines that carry toxic fuel. It is unconscionable for an oil company to place any more pipelines in Mother Earth, particularly in the sensitive life-giving lake areas where the Ojibwe people live."

The fact is, that the proposed pipeline reroute would continue to worsen the direct health impacts on this community. And, in the opinion of Honor the Earth and the White Earth Band of Ojibwe, this favoring of the rights of a foreign fossil fuel pipeline company over the health and well being of the people, in no way established the "Need" required to issue the certificate of need.

Pipeline Impact on Our Community Directly:

".... The manoomin is our buffalo ,". It is... our covenant with the creator. It is very spiritual...We have a symbiotic relationship with the rice. We don't need to beat around ....the rice tells the way. That's what he is bred to do.... I will continue ricing as long as I can lift a pole and lift knockers." Faron Jackson, Ojibwe Wild Rice Harvester

" I don't know who in their right mind, thought it was right to make the decision for my children, my grand children , my nieces and nephews and the generations to come after this....."

Algin Goodsky at the Rice Lake Hearing, June 4

Wild rice is an essential part of the spiritual, cultural, historical , nutritional and economic foundation of Anishinaabe well being. The proposed Enbridge Energy Corridor impacts this wild rice more than any proposed mega project in Minnesota, yet in a cumulative effect assessment, the impact on the rice by the other mega-projects must be taken into account. These include the proposed Polymet, Eagle Rock and the continuing interest in the Penokee Hills for taconite . Those mining proposals , although technically outside of the scope of the very limited review this PUC has undertaken so far, also impact our wild rice. This is particularly true, in light of the state of Minnesota's apparent interest in reducing the number of wild rice lakes in the state, so that a sulfate standard would not be applied to these mining operations, and EPA regulations could be skirted. That would not be our approach. The PUC needs to be cognizant of Tribal environmental knowledge and include this knowledge into a cumulative effect assessment.

Let us be clear, this is the only place in the world where there are Anishinaabeg and this is the only place in the world where there is wild rice. We understand that, and fully intend to protect both of those, as essential to our lives as Anishinaabeg people.

Proceeding, with some historic and regional knowledge, the proposed Enbridge Energy Corridor route already caused an immense amount of duress for our community.

"... I am afraid, I am very afraid. But we are Anishinaabeg people, and it is our way that has kept us alive for all these generations and will keep us alive for the next seven, fourteen, twenty one generations to come..." Michael Dahl, White Earth

People are stressed out already, and concerned about the pipeline. National and international studies on the impact of siting proposed megaprojects in communities all show that there is increased psychological and social trauma on these communities. It is important to note, that the most impacted tribal communities in the proposed Enbridge route for Line 3, are those of Rice Lake and East Lake. Both of these communities already suffer from health disparities and duress. The White Earth Tribal Health budget already consumes a vast proportion of the tribal budget in total, and adding more health problems to our community for the benefit of a Canadian Pipeline Company is a violation of state and federal, as well as tribal rights, laws, interests, and sensibilities.

The present mental and physical health conditions of the Ojibwe, in Minnesota has been documented recently to the Minnesota Commissioner of Health, with the Wilder Foundation. The study found:

"The evidence strongly suggests that social and economic conditions and structural racism contribute significantly to the relatively poor health outcomes of the American Indian population in Minnesota. Therefore, we feel that policy makers should take these critical factors into account in a systematic and transparent way when making decisions that potentially have wide ranging impacts..."[1]

As can be seen from the following statistics, Tribal communities currently have significant health disparities, which would be exacerbated by the proposed pipeline projects.

Native American youth 15-24 suicide rate more than 3 times more than national average
Suicide leading cause of death for those 10-34
Reservations among the poorest places in the nation
Rates of depression twice national average
Alcoholism 5.5 times national rates
Heart disease twice national average[2]

In the 2014, Advancing Health Equity Report to the Legislature, the Minnesota Department of Health highlighted structural racism as a key contributor to health inequities in our state: "Structural racism — the normalization of historical, cultural, institutional and interpersonal dynamics that routinely advantage white people while producing cumulative and chronic adverse outcomes for people of color and American Indians — is rarely talked about. Revealing where structural racism is operating and where its effects are being felt is essential for figuring out where policies and programs can make the greatest improvements.

While this may not appear to be a direct interest of the Department of Commerce in these proceedings, the fact that the baseline for the communities to be impacted most heavily by the Enbridge proposed pipeline corridor, means that this additional health burden must be considered by the Department of Commerce. And, although the Minnesota PUC told the Mille Lacs band of Ojibwe that it was not required to consult with tribal governments, as had been outlined in Governor Dayton's Executive Order of 2014 on tribal and state relations, we insist that the Department of Commerce is, not in fact, exempt from that order, and in that, since the state Department of Health has already recognized the underlying structural racism in Minnesota's health disparities, in relationship to First Nations, it is clear that our community is at high risk and that it would be, in fact, reprehensible to attempt to push threat onto our tribal people.

Impact is worsened by Mega Project

The psychological and social impacts of siting a project in an at-risk community is very significant. Widespread studies and stories from Canadian and other Indigenous Nations who have faced or become victims of mega-projects indicates that there is significant social and psychological trauma,

[1] Wilder Letter June 4, 2015
[2] McLeigh JD. 2014. What are the policy issues related to the mental health of Native Americans? PsycINFO.

resulting in additional deaths from these projects[3]. *For example, more than 43 % of victims of the Exxon Valdez oil spill, compared to 23 % of non-victims, had one or more psychological disorders (specifically depression, generalized anxiety disorder, or PTSD) one year after the oil spill (Palinkas et al. 1993). These psychological consequences persisted; six years later disaster victims had substantially higher than normative rates for depression, anxiety, and PTSD (Arata et al. 2000). Indeed, a review of studies assessing the psychological consequences of disasters invoking human culpability concluded that their psychological consequences are worse than for natural disasters (Norris et al. 2002)[4].*

The scope of oil projects, combined with large scale mining projects will cause significant additional stress on these communities which are already under duress . The pipeline corridor , if routed through the heart of the wild rice country would make the Tribal communities of Minnesota "victims of progress".

Price Tag for the Health Impact?

The State of Minnesota acknowledges that the risk of a pipeline failure would cause significant cost to the State. The State's Department of Commerce has arranged for expanded insurance under the PUC approval authority for a determination of the need for a pipeline disaster. The amount of and terms of the insurance need to be shared with the White Earth , Mille Lacs and other tribal governments and the I855 treaty authority so that we can see the estimates of potential liability and the terms and limits to this policy. From what we know of the DOC request, there is no acknowledgement that these tribal communities, and those within the I855 treaty area with their already significant health issues and numerous environmental injustices as a result of this pipeline, will be protected.

What we know is that based on the dearth of assessment by the state of Minnesota, the lack of a rigorous or robust assessment of risk and knowledge of the location of the impact of the pipeline proposal, the lack of integration of state agency cooperation, including , for instance the very accessible Department of Health report, any recommendations for insurance in the Sandpiper line and subsequently Line 3 would be grossly underestimated. The combined or actuarial risk of the Energy Corridor would need to be calculated as discussed elsewhere. We are concerned particularly that the present protection for the State of Minnesota makes no allowances for tribal communities already exposed to social, economic, and structural racism. Nor does it contemplate compensation for these communities in the event of an oil spill along the pipeline or other impacts. The present system allows for the state to protect its interests, but they have chosen not to implement a system to protect Tribal communities against potential loss of life and livelihood. In fact, they appear to be

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[3] Hoover E, et al. 2012. Indigenous Peoples of North America: Environmental Exposures and Reproductive Justice. Envir Heal Pers 120: 1645- 1649.; Tobias JK, Richmond CAM. 2014. "That land means everything to us as Anishinaabe...": Environmental dispossession and resilience on the North Shore of Lake Superior. Health & Place 29: 26-33.

[4] Cline RJW, Orom H, Chung JE, and Hernandez T. 2014. The Role of Social Toxicity in Responses to a Slowly-Evolving Environmental Disaster: The Case of Amphibole Asbestos Exposure in Libby, Montana, USA. Am J Comm Psychol 54: 12-27.

choosing to put these Tribal communities at risk and compounding environmental justice issues[5]. At a June 30th Environmental Justice meeting sponsored by Minnesota PCA, the staff identified that Minnesota had subjected its minority population to environmental justice issues and they have born a disproportion of the environmental issues[6]. The White Earth band of Ojibwe and Honor the Earth would like to know the full extent of the insurance agreement between the state of Minnesota and Enbridge, as this is a matter of concern to our people, in the management of the resources and assets of the 1855 treaty area, as well as the precedent it may set. We believe that this issue should be resolved long before any permits are added.

Environmental Risk and Environmental Justice

All of the comments submitted previously by Honor the Earth, as well as related organizations such as the Friends of the Headwaters, and tribal governments, including White Earth, Fond du Lac and Mille Lacs, would apply in the case of Line 3, or the Enbridge Energy Corridor. The environmental destruction from fossil fuels is already documented. The exact figures for the increase in risk by adding mega projects to new corridor, or achieving what Enbridge calls ' pipeline fatigue" have not yet been ascertained, and would require qualified assessment. All of this, should be assessed prior to any approval for a new line, as well, full disclosure by the Enbridge Company, as to potential additional lines in the corridor they hope to secure will need to be reviewed by qualified scientific and Indigenous experts. None of this is in place at present.

Environmental Justice Concerns:

During hearing before an Administrative Law Judge at St. Paul, Minnesota in January, 2015, Enbridge project staff provide testimony and were questioned about the development of this pipeline and pipeline corridor. This is part of the public record, yet transcripts are not available. Specifically, the company considered an alternate route of the pipeline going down Interstate 94 as too dangerous because of the possibility of pipe failure and crude oil flooding the highway, causing accidents and it's routing through populated areas[7]. Enbridge's preferred route place the pipeline is very close in proximity to two tribal communities: Rice Lake Community in Clearwater County and East Lake/Sandy Lake Community in Aitkin County. These two tribal communities are being told they should shoulder the entire risk of the pipeline (which was too dangerous to place along Interstate 94 or larger, non□Indian communities).[8]. At a June 30th Environmental Justice meeting sponsored by Minnesota PCA, the staff identified that Minnesota had subjected its minority population to environmental justice issues and they have born a disproportion of the environmental issues[9]. This process must not continue that discrimination. We believe that this issue should be resolved long before any permits are added.

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[5] In the Matter of the Application of North Dakota Pipeline Company LLC for a Certificate of Need for the Sandpiper Pipeline Project in Minnesota MPUC Docket No. PL-6668/CN-13-473; OAH Docket No. 8-2500-31260 May 22,2015

[6] MPCA notes of the meeting:
June 30th 2015.

[7] Testimony of Enbridge Sandpiper Project Officer PUC hearing January 2105

[8] In the Matter of the Application of North Dakota Pipeline Company LLC for a Certificate of Need for the Sandpiper Pipeline Project in Minnesota MPUC Docket No. PL-6668/CN-13-473; OAH Docket No. 8-2500-31260 May 22,2015

[9] MPCA notes of the meeting:
June 30th 2015.

Additional Environmental Problems: Dilbit, Carbon and Abandonment

I) Dilbit Corrosion and Special Characteristics

"Dilbit" is the abbreviation for diluted bitumen, the substance Enbridge is currently pumping through the existing LIne 3 and would continue to transport in the Line 3 replacement.

Because of the more viscous makeup of dilbit, it must be pumped at higher pressure and at higher temperatures than conventional crude oil. Additional toxic chemicals are added to allow the product flow. Some sand remains in dilbit. A combination of these attributes has led some engineers to compare dilbit to ***"fast, hot, and toxic liquid sandpaper."*** *Add this to the fact that 41 percent of the pipelines were built to carry conventional crude oil in the 1950's and 1960's. The alarming speed at which tar sands are being added to this pipeline network raise legitimate questions about the likelihood of many more accidents. The environmental group Natural Resources Defense Council (NRDC) notes that pipelines in the upper Midwest that routinely carry oil from tar sands have spilled 3.6 times more oil per pipeline mile than the U.S. average[10].*

Carbon

The Enbridge Company, and its subsidiary, the North Dakota Pipeline Company, in Canadian and US regulatory proceedings has wished to only account for the carbon used to power the transportation of the oil through the pipelines it is providing for the extreme extraction process. We reject this suggestion as self serving and inaccurate.

Responsibility for the total carbon footprint of the substance would be required to be considered. It is as if we are saying that in the Nazi Gas chambers, those who operated the railroads to the gas chambers were not complicit in the Jewish holocaust, but instead, only the SS which administered it, would be liable. That is preposterous. This pipeline and the further combustion of high impact fossil fuels, constitute the gas chambers of climate change.

In short, when analyzing the carbon impact of the pipeline, more than just the operational impacts must be calculated. As the pipeline project is being developed to deliver tar sands oil to refineries and foreign markets, the carbon impact of the use of the oil must be included. HTE has done preliminary calculations of this impact and reported to the EPA:

The Sandpiper pipeline will transport 355,000 bl/day, 365.25 days a year the equivalent of 129,663,750 barrels annually. Carbon emissions per barrel per US EPA estimates: .43 metric tons per barrel[11]. Total annual carbon emissions 55,755,412 metric tons. Cost to remove carbon at

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[10] http://www.oilandwaterdontmix.org/the_bigger_picture

[11] US EPA Carbon Calculation (Note: Due to rounding, performing the calculations given in the equations below may not return the exact results shown) {.5.80 mmbtu/barrel × 20.31 kg C/mmbtu × 44 kg CO2/12 kg C × 1 metric ton/1,000 kg = 0.43 metric tons CO2/barrel}
Sources: EPA (2013). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990□2011. Annex 2 (Methodology for estimating CO2 emissions from fossil fuel combustion), P. A□68, Table A□38 and Table A□45. U.S. Environmental Protection Agency, Washington, DC. U.S. EPA #430□R□13□001 (PDF) (429 pp, 10.6MB, About PDF).

present is $600.00 per metric ton (American Physics Society). Total cost to the atmosphere annually equals $33.5 billion. The new Line 3 is also proposed to follow this corridor. Line 3 would be a 36" pipe transporting 675,000 barrels of tar sands crude oil daily (Enbridge Number), 365.25 days a year equalling 246,643,750 barrels annually. Carbon emission per barrel of tar sands oil is estimated .51 metric tons per barrel (Extract calculation from the book). Total annual carbon emission is estimated at 125,737,313 metric tons. Total cost to the atmosphere annually $75.4 billion. The combined cost to the environment is $181 billion. Compare this to the $500 million Enbridge proposes to make. These figures do not include the loss of ecosystem services and values that would result from the development of the corridor. Nor does this include project costs of spills. " This also does not include the remaining Enbridge Lines, nor does it include the MinnCan expansion also being considered by the PUC.

Abandonment Problems- Significant in all ways.

In the 1960's, when the original Enbridge Mainline was developed, there was not much public knowledge around the environmental issues of pipeline development. Decades later, after living with the pipeline infrastructure, we have a much better understanding of the impact of these projects. This impacts include the risk of spills, the impact on landscape fracture, and hydrological disturbances. Now, as we move into an era of pipeline abandonment, the potential long-term impacts of leaving this corroding infrastructure in the environment must be analyzed before permitting corporations (such as Enbridge) to walk away from this remaining liabilities. We know that the existing Line 3 has over 900 structural anomalies, which represent increased risk of spills. This is why Enbridge wants to replace the line. However, Enbridge does not want the liability of soil testing and remediating contaminated soil, or restoring historical hydrological regimes. This is why Enbridge is proposing to abandon the existing pipeline in place.

Enbridge Line 3 was placed in by the Lakehead Pipeline Company in l96l and has experienced significant structural integrity problems. Latest public estimates by the Enbridge Company indicate over 900 integrity anomalies in the pipeline, which spans over 300 miles of northern Minnesota, crossing part of the Red Lake, Leech Lake and Fond du Lac reservations and the l855 and l842 treaty areas.

Enbridge has gathered extensive integrity data on Line 3 throughout its years of operation. The integrity data shows a high number of integrity anomalies – specifically, corrosion and long seam cracking. Because of its integrity anomalies, Line 3 has experienced a number of failures during its more than 50-year history. As a result, Line 3 requires a high level of integrity monitoring and an extensive on-going integrity dig and repair program to maintain safe operation of the line. For example, approximately 4,000 integrity digs in the United States alone are currently forecasted for Line 3 over the next 15 years to maintain its current level of operation. This would result in year-after-year impacts to landowners and the environment, and may result in repeated impacts to the same landowners and environmental features. (Enbridge Reports)

If Enbridge is not required to remove the pipeline and restore the damaged ecosystems, there may never be a full accounting of the contamination surrounding the pipeline. This contamination would become the responsibility of nearby landowners , tribal governments, state and federal authorities. Additionally, Enbridge has stated they plan to fill the pipelines with nitirious oxide. This would

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IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

constitute an underground storage tank according to Minnesota statue Minnesota Statute § 103I.681[12] We believe that the state of Minnesota will need to regulate the pipeline as such.

In terms of jurisdiction. We find an article in the Oil and Gas Pipeline Journal by David Howell, Senior Right of Way Agent, International Right of Way Association (2009 article), where he notes the problem of jurisdiction is immense and a major concern...

"A dictionary definition for abandonment means to "give up entirely." Defined in terms of federal regulations, abandonment means "permanently removed from service." In federal pipeline safety jargon, an abandoned pipeline is a pipeline that is "physically separated from its source of gas and is no longer maintained," or in another federal agency glossary, "no longer connected to the system and is no longer maintained. The pipeline can be abandoned in place, by removal, or sold." In still another set of federal guidelines, abandoned property means "a property that, because of its general disrepair or lack of activity, a reasonable person could believe that there is intent on the part of the current owners to surrender their rights to the property." All of these definitions apply to gas and hazardous liquid pipelines that are interstate and fall under federal jurisdiction.

However, there are no guidelines for abandoned crude oil pipelines that fall under the jurisdiction of the Interstate Commerce Commission, and, presumably, the agencies that have succeeded to that federal agency's role since it was abolished in 1995, as common carriers. At the state level, there are no abandonment guidelines or definitions for intrastate gas, liquids, or oil pipelines, and there are no abandonment guidelines or definitions for intrastate oil or gas gathering systems. Any mention of abandonment of pipeline procedures follows federal guidelines of disconnecting from active gas service and purging of any hazardous substance."

More information on the issue of abandonment can be found in HTE supplemental Pipeline Abandonment Briefing document.

We have devoted a great deal of our comments to the first question being asked by the PUC and now look at the remaining questions. Many of these questions have been answered in the primary comments on the Sandpiper.

2. Are there any specific methods to address these impacts that should be studied in the environmental analysis?
3. Are there any alternative routes or route segments that should be considered?
4. Are there any alternatives to the project that should be considered?

Methods:

The PUC has appeared to operate in an antiquated system of analysis, which neither is able to offer full assessments, nor able to integrate assessments, whether of the environment or the economy. This is particularly true when pipelines are considered singularly, jurisdiction is siloed, and information is withheld from the review. Governments on a worldwide scale are deploying policy analysis which includes full cost accounting, carbon footprint, social impact assessment, ecological analysis and the precautionary principle. This would offer a more conservative view of choices. We can provide the PUC with methodologies which could be included here. As well, NASA scientists and many others

[12] https://www.revisor.mn.gov/statutes/?id=103I.681

have come to understand the essential knowledge of Indigenous people in relationship to the earth. This would require a full quality assessment and full partnership with Indigenous peoples, first nations and the tribes of Minnesota.

Scientifically, there are a number of methods that these potential impacts may be assessed. For ecosystem-level impacts, the Invest GIS modeling tool should be used, along with the UCONN Landscape fracture tool. This will give an estimation of ecosystems impacted. Utilizing ecosystem services valuation will give an economic impact of the loss of these ecosystems services. To look at the human health impact, it must be understood that the impact on the Tribal communities will not be the same as the non-Native communities. When estimating the impact on these communities, a seven generations perspective must be taken, or looking at the cumulative impact over the next 140 years. Past research has shown that the loss of the ability to continue traditional ways negatively impacts the physical and psychological health of Tribal communities. Given the spiritual nature of the wild rice, the loss of the ability to harvest this crop could present a potential loss of the cultural and economic basis of these communities. There is no way to quantify this potential loss. .

Alternative Routes

We do not believe this pipeline is necessary. We believe that Line 3 should be dismantled, and recognize that the economic benefits of pipeline removal, in terms of jobs and long term remediation represent at least four times as many jobs as those proposed by Enbridge for a short term , quick laying of new pipeline, without remediating any of the present pipeline toxicity. This is a significant economic issue, which we believe would benefit the state of Minnesota.

The consensus of the Tribes is that this project is not wanted or needed by these communities. As such, Enbridge must find an alternative route that does not cross Treaty protected lands. If we are required to submit a corridor option for a pipeline which we do not see the need for, then the only proposal is that which we have previously submitted: 29 94 to go down major interstates, for the benefit of those who will be able to monitor this pipeline and for the benefit, if there is some of those who will proportionally use and consume this oil.

Frankly, as the Line 3 is scheduled to follow the Sandpiper corridor, which has already been restricted to SA-applicant and SA-03-AM; HTE suggests that perhaps Enbridge shouldn't have invested so much into Clearbrook before they had permits in place for the New Mainline Corridor. Enbridge and other large oil companies have been allowed to develop a (mostly) unregulated expansive network of pipelines and refineries across the country over the last 50-60 years. This is about the life span of most of that infrastructure. That is part of the "need" for this most recent round of pipeline projects. Not that demand has gone up, but that infrastructure has decayed and markets have shifted. While domestically, urban areas are still the largest consumers of fossil fuels, there has finally been substantial movement towards investment in sustainable urban development. A major component of this is investment in public transportation. Often these vehicles do not rely on fossil fuels. Why should we invest in an infrastructure our grandchildren will not need?

Long story short, if Enbridge actually upheld the social conscience which it represents in the annual reports, we would be discussing the expansion of a regional public transportation network, the use of

the Enbridge proposed $17 billion in oil pipeline additions in Minnesota into a renewable energy infrastructure. We would be discussing the prudent transition to a renewable and efficient energy economy and the reduction of the need for a fossil fuels economy as well as the need to invest in the aging infrastructure of this country. Indeed, just dismantling Line 3 will be a major employment opportunity for the unions of Minnesota, with likely four times the employment ratio that would be needed for the laying of a new pipe. This combined, with new energy infrastructure will insure that there is long term, sustainable benefit from new energy infrastructure in this state, not long term liability.

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May 26, 2016

Comments on Draft Scoping Document for the Environmental Impact Statement for the proposed Sandpiper/Line 3 crude oil pipeline projects

Sandpiper PUC Docket Number PL-6668/CN-13-473 & PL-6668/PPL-13-474
Line 3 PUC Docket Number PL-9/CN-14-916 & PL-9/PPL-15-137

Honor the Earth hereby submits the following comments on the draft scoping documents for the proposed Sandpiper and Line 3 crude oil pipeline projects. We contend that the scoping document is grossly inadequate and will fail to produce an EIS that will enable the State of Minnesota to protect the environment and prevent significant human harm. We object to geographic, jurisdictional, and project boundaries set in the draft scoping document. We object to the parameters of the scoping process. We object to the proposed timeline for the EIS, which does not provide enough time for adequate field work and research to evaluate sites and potential impacts on human health, natural resources, and cultural resources. Lastly, we object to the exclusion of many significant impact considerations, especially those at the point of extraction or refinement, the climate implications of downstream emissions, the human health impacts concentrated disproportionately on our already distressed Native communities, archaeological and cultural impacts, and impacts from the proposed abandonment of the existing Line 3 pipeline.

Because of these shortcomings, the current scoping parameters undermine the goals of the National Environmental Policy Act (NEPA) and the Minnesota Environmental Policy Act (MEPA). We also assert that the Department of Commerce remains unqualified to oversee the EIS and hostile to a robust process and the unique interests of our tribal Nations. We continue to call for an integrated federal, state, and tribal EIS that acknowledges the unique knowledge and expertise that tribal governments offer in regards to the natural and cultural resources of the area, and consistent with Governor Dayton's Executive Order 13-10, which outlines a high standard of govemment-to-govemment consultation with Indian tribes. The State of Minnesota's Environmental Quality Board's denial of its citizens request to transfer control of the EIS to the state's environmental agencies, in which we have invested many billions of dollars to develop environmental stewardship capacity, was grossly negligent. This is one of the largest fossil fuel projects the State of Minnesota has ever seen; we must ensure it is evaluated properly. To date, we are getting it wrong and are on a path to further litigation.

Our response is organized into the following sections:
1) High-Level Scoping and Process Issues
2) Economic Analysis
3) Well to Wheels Impact Analysis
4) Indigenous Human Health Impacts
5) Indigenous Cultural Impacts
6) Abandonment
7) Spill Modeling and Response

1) HIGH-LEVEL SCOPING AND PROCESS ISSUES

On January 11, 2016, the PUC — the RGU for this EIS — issued an order authorizing DOC-EERA staff to prepare a combined EIS for the CN and the Route Permit. The order also requested DOC-EERA administer the EIS process in consultation with the PUC's Executive Secretary, the MDNR, and the MPCA in order to meet the requirements of the MEPA and Chapter 4410 of the Minnesota Rules.

The Minnesota Environmental Policy Act (MEPA) states: "[w]here there is potential for significant environmental effects resulting from any major governmental action, the action shall be preceded by a detailed environmental impact statement prepared by the responsible governmental unit."[1]

According to the Minnesota Rules, the purpose of the scoping process is "to reduce the scope and bulk of an EIS before the preparation of the EIS, identifying only those potentially significant issues relevant to the proposed project, define the form, level of detail, content, alternatives, timetable for preparation and preparers of the EIS, and to determine the permits for which information will be developed concurrently with the EIS."[2] "All projects requiring an EIS must have an EAW [Environmental Assessment Worksheet] filed with the RGU [Responsible Governmental Unit]. The EAW shall be the basis for the scoping process."[3]

The Minnesota Rules being used to reduce the scope of the EAW and/or EIS directly undercuts the law and policy goals of the National Environmental Policy Act (NEPA) and the Minnesota Environmental Policy Act (MEPA). These two laws are designed to ensure that new projects consider and protect human safety and the environment, and do not violate existing environmental laws. To simply grant the Department of Commerce full authority to reduce the scope of the review to "potentially significant issues relevant to the proposed project" without exploring other issues and without any process of accountability for those scoping decisions violates NEPA and MEPA requirements. Within the current parameters, the promise to the citizens of Minnesota that a complete and comprehensive EIS would be undertaken for the Sandpiper and Line 3 pipelines will not happen. We must address these problems.

First, there must be a clear definition of what constitutes an issue "significantly relevant to the proposed project." This should include the criteria of how a determination is made, who makes the determination, and what factual information is relied upon to make that determination. It must be guaranteed that the proper level of data analysis required to indicate a significant issue is used.

Second, an issue found to not be "significantly relevant to the proposed project" must be published, with a public comment period established, in order to allow the public to engage in that decision and supplement the record with additional information and materials.

The timeline and methodology for data analysis are also inadequate. Section *4.3 Data and Analysis* states that field work on the preferred route has been completed by the Applicant. The scoping document lacks a full disclosure of the practices, methods, and standards used by the Applicant to complete this field work. The scoping document should include a plan for random inspection of site work completed on the preferred route to ensure it meets the applicable standards necessary for the project. The present scoping document does not provide enough time to do this field work in order to evaluate the sites that will be adversely affected by the project. By the time the public is aware of what sites have been identified, it will be mid-winter and there will be little opportunity to review or provide information about the impact. Therefore, the time frame for the EIS must be increased in order to allow for adequate review of potential sites.

Incorrect and Non-Existent Definitions of Project Purpose

The entire draft scoping document and scoping process for the EIS are based on a false premise. The draft scoping document is drafted around a "project purpose" defined as transporting oil from the Bakken region of North Dakota to Superior, Wisconsin. For a long time, the DOC defined the project purpose as moving oil from Clearbrook to Superior, but our persistent advocacy forced a partial correction. There is still another correction to make. Transporting a product to Superior is not a viable "public purpose" for the project, especially from the point of view of Minnesota residents who stand to have their land condemned through eminent domain. That is a "private purpose," according to Enbridge's whimsical desires and bottom line. Because Minnesota Rule 4410.2300(G) states an alternative route may be excluded from analysis in the EIS if it "would not meet the underlying purpose of the project," defining the project purpose in this way precludes many alternative routes that may transport product from the Bakken to Midwest refineries and coastal ports with far less social, environmental, and economic risk. The

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[1] Minnesota Statue § 116D.04, subpart 2a

[2] Minnesota Regulation 4410.2100, subpart 1

[3] Minnesota Regulation 4420.2100, subpart 2

current purpose statement is improper if not illegal in that it limits alternative routes on the basis of project cost increase alone. The scope should not assume that the criteria for route evaluation include any intermediate through-points (Clearbrook or Superior).

At the thirteen DOC scoping meetings, the public was asked to comment on a project with a purpose defined as getting oil to Superior, WI, but the giant maps on display included alternative routes that don't go to Superior. Are those routes included or not? No one knows. When it was pointed out to the Cardno Project Manager how confusing that was for the public, she stated it was likely incorrect and cited a lack of time and being rushed, and further that Governor Dayton denied their request for an extension. Several attendees pointed out the issues with the project purpose to the DOC, and received a variety of responses, depending on which day the response was provided. At one point, the DOC stated there would eventually be two Environmental Impact Statements, each with different purpose definitions, but that the documents would change in the final draft. This constitutes a reckless and negligent process. It has been stated that the Line 3 project's purpose is to address the safety and integrity concerns of the existing Line 3 pipeline. As such, replacement (in place) or complete removal from service need to be considered as alternatives. Holding public scoping meetings without disclosing these different purpose definitions clear to the public, is a violation of the duty owed to Minnesota's residents and counter to the intent of the environmental laws at issue. The public participation component of the scoping process is now complete, with most people lack clarity on whether there is one EIS or two, and without anyone being clear on what the definitions of the project or projects actually are, or what the criteria are for alternative routes to be considered or not. Despite lacking this critical information, these are projects that supposedly warrant condemnation of private land through eminent domain.

Honor the Earth also challenges the categorization of the new Line 3 pipeline as a "replacement," and objects to the faulty reasoning that as a replacement, its purpose can indeed be defined as reaching Superior, Wisconsin, even if Sandpiper pipeline cannot. The Line 3 project is not a replacement, it is a new line. It is located in a new corridor, it is larger in diameter (36 inch diameter vs. 34 inch = 12% larger by volume), and it has greater capacity (760,000 bpd vs. 880,000 bpd = 16% capacity increase). It therefore must have a new U.S. State Department approval. In the 1991 Presidential Permit for Line 3, Article 2 clearly states that one condition of the permit is "The operation and maintenance of the facilities shall be in all material respects as described in permittee's application of October 23, 1991, for a permit pursuant to Executive Order 11423."

An accurate project purpose definition for Sandpiper is transporting product from the Bakken to refineries and ports. The project purpose definition for Line 3 is transporting product from Hardisty to refineries and ports.

Enbridge's stated purpose of the Line 3 project is to "address safety and integrity concerns of the existing Line 3 pipeline." We agree that is a noble purpose, but we disagree that the way to address those safety and integrity concerns is by building a new pipeline. Realistically, building a new Line 3 will only double those concerns. Local residents are concerned about contamination along the existing corridor. Instead of building a new pipeline, we find that the best way to address safety and integrity concerns of the existing Line 3 pipeline is to dismantle it and clean up the mess underneath it. The State of Minnesota should immediately undertake a comprehensive survey of the existing corridor to identify any and all sites of contamination, and establish a regulatory code to oversee the responsible decommissioning of the line, according to scientific consultation and in accordance with the wishes of tribal nations and individual landowners that otherwise would retain the liability when the Enbridge company walks away. The section below entitled "Abandonment" outlines these concerns in detail.

Each separate EIS will have to address the other pipeline project as a "phased action" of the other. According to the Minnesota Rules, "phased actions" are defined as: "two or more projects by the same proposer that an RGU determines will have environmental effects on the same geographic area and are substantially certain to be undertaken sequentially over a limited period of time." (4410.0200, subpart 60). This definition involves three components: same proposer, same area affected, and timing. Only one and not all of a group of owners need be involved in both projects if that owner's stake is substantial. The same geographic area is affected if the effects of any potentially significant impacts overlap. The project sites do not need to be adjacent, or even nearby, if the impact zone is large.

Incorrect Geographic Boundaries for Impact Scope

The Sandpiper and Line 3 pipeline projects are perhaps the largest infrastructure proposals to be considered in recent years in the State of Minnesota. They are not just Minnesota projects, or U.S. projects, but transnational projects with global impacts. These projects require a diligent assessment that acknowledges the local, regional, and global contexts. We cannot simply assess the limited local impacts of construction. We cannot pretend that our actions in one "state" do not affect our neighbors, our descendants and the globe as a whole. The scope of the EIS should include the entirety of the project from beginning to end; from the Bakken and the Tar Sands of Alberta to the Midwest, East Coast, and Gulf Coast refineries and ports. There must be a full disclosure of where the oil is being transported in order for states, federal agencies, and tribal nations to properly coordinate and select the route that makes sense for the public and the environment across the region and across the US.

The document defines the scope of the EIS to ignore all impacts outside the state boundaries. This is ludicrous. Bureaucratic fragmentation is a primary method of regulatory agencies giving up their power in favor of industry. Each state puts on blinders and ignores everything occurring outside the imaginary lines, and assumptions are never questioned. Infrastructure impact analysis should start at the oil well and finish at the gas tank, plain and simple. In the section below entitled, "Well to Wheels Impact Analysis," we address elements in a comprehensive assessment.

Regarding geographic scope bounded by impacts, see "cumulative potential effects" in Mn Rule 4410.0200, Subp. 11a. Cumulative potential effects. "Cumulative potential effects" refers to environment impacts that result from the incremental effects of a project, in addition to other projects in the environmentally relevant area that might reasonably be expected to affect the same environmental resources, including future projects actually planned or for which a basis of expectation has been laid, regardless of what person undertakes the other projects or what jurisdictions have authority over the projects. According to these parameters, other major pipeline projects, mining projects and foreseeable climate impacts should be included within the scope of the EIS.

Incorrect Jurisdictional Boundaries for Project Scope

The State of Minnesota refuses to acknowledge environmental review in neighboring states (Wisconsin, Iowa, and potentially Michigan) and by federal units of government (especially USCOE and USFWS) for the same projects or projects that can be deemed "connected actions" induced by and/or dependant on these projects. Again, voluntary blindness precludes interstate coordination and any rational approach to route selection in order to meet the public purpose of transporting oil from the Bakken to refineries and ports while minimizing risk. Wisconsin is already rubber stamping their EIS for the 14-mile stretch of the route, despite requests to stand down and wait for MN.

Federal agencies, including the USGS, Fish and Wildlife, EPA, and the Corps of Engineers should be active in the development of the EIS along with the affected Chippewa Bands of Minnesota and their agencies such as the 1855 Treaty Authority.

Pipelines added or expanded by increased crude oil delivered to Wisconsin are "connected actions" and must be included in this EIS - this includes Enbridge's Line 61 expansion and Line 66 projects. These projects have cumulative impacts as "reasonably foreseeable future actions" under MEPA rules, which outline three types of relationship between projects, any one of which qualifies the projects as connected actions (part 4410.0200, subpart 9b):

- One induces the other;
- One is a prerequisite for the other and is not justified by itself (the first occurring previously or simultaneously);
- Neither is justified by itself; that is, the two projects are interdependent parts of a larger whole.

Whenever two or more projects have any of these relationships, they must be considered one project, regardless of ownership or timing (parts 4410.1000 and 4410.2000, subparts 4). See also "Cumulative Impacts" defined in 4410.0200: Subp. 11. (note the difference from "Cumulative Potential Effects above). "Cumulative Impact" refers to the impact on the environment resulting from incremental effects of the project in addition to other past, present, and reasonably foreseeable future projects regardless of what person undertakes the other projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.

EQB Guidance goes on to explain that Cumulative impacts must be included. From the EQB Guide to Environmental Rules: "Directives that cumulative potential effects be analyzed in EAWs, EISs, and AUARs. Although it has long been the practice to include such impacts to some extent in review documents, the rules formerly did not explicitly include requirements to do so. The directives appear at rule parts 4410.1200, 4410.2300, item H, which states: "Environmental, economic, employment, and sociological impacts: for the proposed project and each major alternative there shall be a thorough but succinct discussion of potentially significant adverse or beneficial effects generated, be they direct, indirect, or cumulative."

Regarding Project Segmentation, the EQB's Guidance for Environmental Review states "Network projects such as highways, utility systems and pipelines may be divided for review if "logical in relation to the design of the total system or network and must not be made merely to divide up a large system into exempted segments" (parts 4410.1000 and 4410.2000, subparts 4).."

Inadequate Public Process for EIS Scoping Comments

The DOC scheduled thirteen meetings along the Enbridge preferred new route from Clearbrook to Park Rapids to Superior, Wisconsin, with zero meetings about rebuilding Line 3 pipeline or abandoning it along the 150+ mile US Highway 2 corridor. It was an irresponsible process that thwarted public participation. In fact, the word 'abandonment' does not appear in the DOC Notice at all. Enbridge wants to create more environmental messes in Minnesota without cleaning up the old ones, and DOC is helping them. The hearing schedule was rushed, with meetings across northern Minnesota before the Governor's Fishing Opener, the customary start of the season in the affected lakes region. Children were still in school, summer residents had not returned to the lakes, Ojibwe tribal elections were being held, the State Legislature was in session, and resort owners were preparing for summer tourism. There were no meetings in the Pine River and Whitefish Chain watersheds, the areas with the most dense populations, the most resources, and the most access to the process.

The DOC Remains Unqualified to Oversee this EIS Process

The Department of Commerce conducting an Environmental Impact Statement is entirely inappropriate. That agency has no capacity or expertise and the people of Minnesota deserve better. It is baffling that Minnesota would waste its recent multi-billion dollar investments in the Pollution Control Agency by assigning such an important environmental process to a non-environmental agency. The State of Minnesota's Environmental Quality Board's denial of the citizen request to transfer control of the EIS to the state's environmental agencies, which clearly have the greater expertise, was grossly negligent if not outright illegal. A robust public record was built during the EQB's process for addressing the citizen request to change the RGU, in which hundreds of community members, organizations, elected officials, and advocates documented the case against the DOC and the clear rationale for transferring the EIS into the hands of the PCA or DNR. The largest fossil fuel infrastructure mega-project the State of Minnesota has ever seen should not be in the hands of the Department of Commerce.

Both the PUC and DOC have been consistently hostile to the concept of tribal consultation, and have resisted their duty to conduct thorough environmental review for these projects. They have ignored comments by the PCA and DNR about the extreme environmental risks associated with the proposed route and the need to consider alternative routes. The DOC does not have the structure or the capacity to uphold the state's responsibility to enter into formal government-to-government relationships with the tribes or to navigate the protection of constitutionally protected treaty resources and the complicated legal issues governing usufructuary property rights in ceded territory. The DNR and PCA have much greater expertise in analyzing the potential impacts of the project. The DOC does not have the intimate knowledge base of all of the disciplines along the entire corridor like DNR and PCA, with field offices throughout MN and relationships in place with the reservations. The DNR has field hydrologists, hydro-geologists, biologists, fisheries and wildlife managers, and ecologists who know the issues and resources intimately. DOC is a metro-based agency focused on accomplishing Enbridge's pipeline goals under Minnesota law.

Illegitimate Contract with Cardno

The contractual relationship between the DOC and the consulting firm hired to conduct the EIS, Cardno, was established prematurely and perhaps illegally. It is highly improper that the consulting firm was chosen before the

EIS had been scoped. The purpose of scoping process is to determine the special expertise necessary for the EIS. Cardno may or may not have that expertise; it was premature and negligent to select Cardno as a consultant. This selection makes clear that DOC never intended for the public participation in scoping process to meaningfully inform the scope of the EIS.

Joe Plummer, legal counsel for the White Earth Band of Ojibwe, addressed this issue in a December 2015 motion. Friends of the Headwaters also addressed it in its March 2016 motion. Both were ignored. It was handed off to the Administrative Law Judge (ALJ). By the time an ALJ can do anything about it, an inadequate EIS will already have been conducted. This is unacceptable and an example of the problems with the regulatory structure for oversight of the EIS. The DOC makes decisions arbitrarily, without consulting MPCA or MDNR, and in clear service of the pipeline company.

To properly follow MEPA procedures, the DOC should have released an official RFP (Request For Proposal) and submitted it to the docket for public review. Transparency would have allowed the public to weigh in on the necessary company qualifications, issues of company integrity, conflict of interest, etc. Instead, the DOC simply renegotiated an existing contract they already had with Cardno, which was based on Cardno's winning the RFP for the Sandpiper Route Permit Scoping CEA, ordered by the PUC on June 5, 2015 after voting 5-0 approving the Certificate of Need. The FOH/MCEA Appellate Court victory overturned that decision and ruled that the CEA was a violation of the MEPA. When the PUC was forced to order an EIS at their December 2015 hearing, the PUC threw out Deb Pile's Sandpiper Route Permit scope decision document. At that point, the DOC/Cardno contract should have been null and void. Instead, it was simply revised, which is a clear indication that the DOC intends to continue with the previous work Cardno performed on Pile's Sandpiper RP and carry that scoping decision forward into this EIS. That document should not be used because it is based on PUC CEA rules, not EIS MEPA rules.

Cardno is unqualified for the task at hand -- it is the company responsible for the first EIS on the proposed Keystone XL pipeline, a study which was thrown out for inadequacy.

Learning from Canada's National Energy Board

While various US permitting bodies are considering the Line 3 replacement project, the Canadian National Energy Board (NEB) has also been considering the project. The permitting and oversight process is much different in Canada, with the NEB serving as the national body responsible for pipelines over their entire lifecycle: from design, through construction and operation, to decommissioning and eventual abandonment. The NEB is a stronger and more robust regulatory body than those in the United States. The NEB's role does not end when a project is approved: the Board requires that people and the environment be protected throughout the entire pipeline lifecycle. The NEB imposes safety and environmental requirements on pipeline companies through a variety of means, including regulations and project-specific conditions.[4] Once the NEB makes its recommendations on a project, the final approval goes to the Canadian national government. Recently, the NEB granted conditional approval for the Line 3 replacement project. The approval document has many recommendations that the MN PUC should also consider, including many suggestions on how to make their process more comprehensive. Since there is no similar body in the United States, the responsibility falls to the individual state permitting bodies. A thorough review of the NEB's recommendations should be included in the EIS. Documents can be found here:
https://docs.neb-one.gc.ca/ll-eng/llisapi.dll?func=ll&objId=2949686&objAction=browse

There is a significant difference between the Line 3 project in Canada and the project in Minnesota: in Canada, the project is not a greenfield project and primarily follows the existing mainline corridor. This results in very different environmental impacts in either country, which should be taken into account when reviewing the NEB recommendations.

2) ECONOMIC ANALYSIS

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[4] http://bit.ly/1WJ5Pkl

Because all environmental stewardship and all environmental impacts occur within the context of specific economic conditions, the EIS should include a thorough economic analysis of the project. For example, if the project is not economically viable, or will not be in 10 years, that is an enormous liability concern for the people and tribes of Minnesota.

Local and Regional Economic Impacts

Enbridge and other proponents of these proposed pipelines often tout the anticipated property tax revenue for the poor counties proposed to receive the infrastructure. However, what is too often overlooked in Enbridge's recent and current lawsuits against several MN counties for refunds on property taxes already paid.[5] This information must be included in the EIS so that low-revenue counties have a clear understanding of the resources they stand to gain from the project compared to their financial risk.

This analysis must also include a comprehensive analysis of the economic impacts of these pipelines on the fishing, wildlife, agriculture, and tourism industries.

Enbridge Energy predicts its $2.6 billion Sandpiper construction project will create 3,000 construction jobs. However, Enbridge only hopes to give half of those jobs, about 1,500 of them, to Minnesota and North Dakota residents — there is no policy in place to guarantee a single one. More importantly, these are temporary jobs. These jobs never will trigger the additional indirect job creation that typically accompanies longer-term investments, and will disappear after one year. That is not long-lasting economic development.

Consider an alternative strategy of investment in water and sewer infrastructure, systems that actually benefit the people of Minnesota instead of the profits of a Canadian corporation. In 2007, the Environmental Protection Agency estimated Minnesota needs to invest more than $6 billion to improve drinking water systems over the next 20 years. In 2010, the Minnesota Pollution Control Agency estimated Minnesota needs to invest an additional $5.7 billion to improve wastewater systems. A steady investment in these essential services would create an estimated 11,560 jobs for Minnesota's workers every year for the next 20 years.

Economic Viability and Need

Simple math shows that the Sandpiper pipeline is not an economically viable project. The North Dakota Pipeline Authority says current pipeline export capacity from North Dakota is 739,000 bpd, and that total refinery capacity is 88,000 bpd, making total takeaway capacity 827,000 bpd. Construction is now starting on the Dakota Access pipeline, with an initial capacity of 450,000 bpd and an ultimate capacity of about 590,000 bpd. Sandpiper would have an initial capacity of 365,000 bpd. Together that means there is a proposed final total takeaway capacity of almost 1.7 million bpd, minus any inefficiencies. But total current North Dakota production peaked at around 1,160,000 bpd, plateaued, and is now at 1,000,000 and dropping, with no end in sight for these low oil prices. Plus, rail transport capacity from ND is over 2 million bpd, and rail is needed to reach East Coast refineries. This shows that there is no economic basis for the Sandpiper; the numbers do not add up. There is no public need for this project, and it is clear that the project is an investment in what will soon be a stranded asset. The EIS should include an assessment of what will become of such stranded assets, especially given the liability concerns of pipeline abandonment. Even if drilling in the Bakken continues, current estimates show they will be depleted in 20 years.

The EIS should include a full economic analysis of need for additional oil transportation through Minnesota. Minnesota's crude oil consumption is declining, despite population growth, so this additional infrastructure is not for us. And with oil prices remaining at historic lows, Bakken drillers are going bankrupt.[6] There were only 28 active rigs in May 2016, down from over 220 just a few years ago.[7] Most major players in the Alberta Tar Sands have either delayed, put on hold, and some firms, such as Stadtoil, have pulled out of the Tar Sands altogether.

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5 http://www.grandforksherald.com/news/business/3826004-pipeline-company-seeks-reduce-their-hubbard-county-property-taxes-336892

6 http://fuelfix.com/blog/2016/02/03/eagle-ford-bakken-shale-production-on-the-decline/

7 https://www.dmr.nd.gov/oilgas/riglist.asp

Marathon as Anchor Shipper

The proposed Sandpiper pipeline is a joint venture between Enbridge Energy and Marathon Petroleum Corporation. Marathon is the "anchor shipper" that makes the project economically viable by committing to use the pipeline to transport oil they extract in North Dakota. Marathon plans to pay 37.5% of the Sandpiper's construction costs in exchange for a 27% ownership interest in the project. The MN PUC issued a Certificate of Need for the Sandpiper based on Marathon's interest and "need." But Marathon doesn't need this pipeline. At its peak, Marathon had 7 active rigs in the Bakken, but as of April 2016, they have ZERO. Marathon Petroleum Corporation's stock prices have dropped more than 50% from recent highs in 2015. Marathon Oil Corporation, the sister subsidiary that does all the drilling, saw their prices drop more than 75% from recent highs. Last year they posted $2.2 billion in losses, cut their capital investments in half, and laid off over 10% of their employees. This is not a sound investment for the State of Minnesota.

Ecological Costs

Another element of the economic analysis should be the carbon and ecosystem costs of the proposed projects. Enbridge likes to tout the job creation and economic need of these projects, but the costs to the environment are never addressed. The science of ecological cost accounting is rapidly developing and it's methodologies should be used to account for the full costs of these projects.

Carbon Costs:

The American Physics Society has estimated that it costs $600 per metric ton to remove carbon from the atmosphere. If we convert the volume of oil moving through the Sandpiper and Line 3 into metric tons of carbon released, we can get an estimate of the cost to remove that carbon.

Sandpiper: 355,000 barrels of Bakken oil daily[8] (Enbridge Number) x 365.25 days a year= 129,663,750 barrels annually x .43 metric tons of carbon per barrel[9] = 55,755,412 metric tons of carbon annually

Line 3: 675,000 barrels of dilbit daily[10] x 365.25 days a year = 246,643,750 barrels annually x .51 metric tons of carbon per barrel[11] = 125,737,313 metric tons of carbon annually.

Ecosystem Costs:

As the science of climate change improves, more attention is being paid to the role key ecosystems play in the maintenance of the global climate. Ecosystems can absorb and store carbon, while providing flood control and other benefits to society. These benefits can be monetized in a process known as ecosystem services valuation. The Canadian boreal forests - where tar sands are mined - is one of the best stores of carbon on the planet. Wetlands are also valuable carbon sinks, and very important for flood control. To estimate the amount of boreal forests destroyed, we used the amount of tailings (mining waste) created per barrel extracted. Tailings are stored in pits for at least 40 years while they settle and compact. The volume of these tailings, converted to area represent the annual area of boreal forest lost from tar sands extraction.[12] The only available numbers for the worth of the boreal forest is $160/hectare[13], which is a low estimate.

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[8] Enbridge number

[9] US EPA estimates

[10] Enbridge number

[11] from Extract

[12] These estimates are based of the article "Waste Streams of Mined Oil Sands: Characteristics and Remediation" by Kim L. Kasperski and Randy J. Mikula printed in *Elements*, Dec 2011 vol 7 pp 387-392. These estimates- of the amount of land impacted by the oil sands are probably extremely low and will be updated as more studies are conducted.

[13] http://www.eurekalert.org/pub_releases/2006-09/cfc-ccw091806.php

Line 3 (new proposed route): 675,000 barrels of dilbit daily[14] x 365.25 days a year = 246,643,750 barrels annually x .00026544[15] = 654,69.117 hectares annually.

To estimate the worth of the wetlands impacted by the Enbridge expansion, we used the value of wetlands from the Earth Economics report: "The Value of Nature's Benefits in the St. Louis River Watershed". The value Earth Economics came up with is $5,625/year. Honor the Earth estimated the area of wetlands impacted by approximating the amount of wetlands destroyed during the construction of the new corridor. Since Enbridge's plans do not include restoring wetlands after construction, it is fair to assume these areas will be permanently lost.

Sandpiper (proposed route): 257,129 ft of wetlands x 95 ft of construction area = 24,427,255 sq ft = 560.77 acres.

Summary:

DESCRIPTION (Annual use)	QUANTITY metric tons	UNIT PRICE	AMOUNT
Sandpiper- Carbon (metric ton)	55,755,412.00	$600.00	$33,453,247,200.00
Line 3- Carbon (metric ton)	125,737,313.00	$600.00	$75,442,387,800.00
Line 3- boreal forest (hectare)	65,469.12	$160.00	$10,475,058.72
Clipper- boreal forest (hectare)	77,508.48	$160.00	$12,401,356.80
Sandpiper- wetland (acres- US)	560.77	$5,625.00	$3,154,331.25
		Per month cost	$108,921,665,455
			12
	Annual Cost		**$307,059,988,940**

3) WELL TO WHEELS IMPACT ANALYSIS

Infrastructure impact analysis should start at the oil well and finish at the gas tank, including all social and ecological costs associated with the extraction, transportation, refining, and combustion processes. The EIS for the Keystone XL pipeline considered carbon emissions at all of these stages.[16] The Sandpiper and Line 3 projects are much larger in scope, their impacts must also be understood in a larger scope. Impacts on the communities at the extractions points, refining points and combustions points should be examined. The global impacts of the project should be examined as well, including the well to wheels increase in greenhouse gases.

Social and Ecological Costs of Extraction

Extensive testimony was presented by Honor the Earth in previous hearings on the impact of the oil extraction in the Bakken on groundwater, human health and methane emissions. In short, we do not have a full picture of the impact of fracking in the Bakken because the increase occurred rapidly without proper oversight. What we do know is since the boom in the Bakken, there has been an increase in drilling waste, water usage, and spills and leaks, many of which have gone unreported.[17] A recent study from Duke University found widespread and persistent contamination from fracking, which will affect the area for millennia to come.[18] Reports have shown that methane emissions are much

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[14] Enbridge number

[15] Each barrel of tar sands creates 16.9 barrels of tailings, converting this to a hectare, we get approximately .00026544 hectares tailings per barrel of tar sands.

[16] Final Supplemental Environmental Impact Statement; Keystone XL Project; Dept. of State. Accessed online at: https://keystonepipeline-xl.state.gov/documents/organization/221190.pdf

[17] http://serc.carleton.edu/NAGTWorkshops/health/case_studies/hydrofracking_w.html

[18] "Brine Spills Associated with Unconventional Oil Development in North Dakota". Lauer, Nancy E., Harkness, Jennifer S., and Vengosh, Avner. *Environ. Sci. Technol.*

larger than previously suspected, with 275,000 tons leaked annually.[19] The third major greenhouse gas, ethane, is also on the rise (after a decades long decrease) specifically because of the oil boom Bakken, which is the third largest emitter of ethane on the planet.[20] Communities and workers in the oil patch are being exposed to known carcinogens, endocrine disruptors and other toxic chemicals.[21]

Much of the extraction in the Bakken takes place on Mandan, Hidatsa, and Arikara territory, on and near the Ft. Berthold Reservation. This is "fracked" oil, extracted by blasting millions of gallons of water and a slurry of toxic chemicals deep into the bedrock of Mother Earth. It is extreme extraction, proven to cause earthquakes and poison aquifers, and has been banned in a long list of cities, states, provinces, and countries around the world. Our relatives in the Three Affiliated Tribes are facing epidemics of health problems, drug and sex trafficking, violent crime, and traffic deaths.[22]

Social and Ecological Costs of Refinement

Marathon also operates a refinery in Detroit that is poisoning the surrounding neighborhoods. The refinery processes both light sweet crude and tar sands oil, and this is where some of the oil from the Sandpiper and Line 3 projects would end up. Its emissions are causing serious health problems in the African-American neighborhood of Boynton. The Marathon refinery in Detroit is located in zip code 48217, the most polluted in the state, where the Michigan Department of Health has documented consistently elevated rates of cancer, respiratory disease, and kidney failure. Emma Lockridge, a nearby resident, says "We don't live next to the refinery, we live IN the refinery...it is just horrific. We are a sick community." A reporter asked her what tar sands smell like, and she said "it smells like death. And that's what it is."

In 2012, Marathon Oil completed a $2.2 billion upgrade on their 81-year-old Detroit facility to process tar sands bitumen into oil. When the refinery switched from conventional oil to tar sands, Marathon bought the homes of approximately 275 people in the mostly white neighborhood of Oakwood Heights, which is not directly in the prevailing path of emissions, unlike the mostly black neighborhood of Boynton. Marathon has left the people of color in Boynton to suffer, consistently denying their requests for buyouts and emergency evacuation. Lockridge says: "There's 10 empty houses on my block...people don't even want the houses. We can't even get squatters." She says the message from Marathon and state regulators is clear: "Walk away or die...at the end of the day, they're killing us." There's an orange and black soot on her white house, from the refinery discharge. "I have had kidney failure. Neighbor died of dialysis. Neighbor next door with dialysis. Neighbor across the street has kidney failure. The chemicals in our pipelines and are in our water will be the same chemicals that come through your land and can break and contaminate. We have cancer, we have autoimmune illnesses, we have MS, we have chemicals that have come up into our homes through the sewer. Those are from the companies, they end up in the public water and sewer system... They are poisoning us. "When you step outside now, it feels as if you strike a match the air will explode. The chemicals come into our homes, come into our basements and we smell it all the time. Don't let them put that pipeline here. I mean, it has always been bad, but not this bad," says Emma Lockridge. "The air is just unbearable. It's like living inside a refinery."

Marathon recently received a controversial permit from the MI Department of Environmental Quality to increase emissions even more, in order to produce cleaner-burning vehicle fuel as required by new federal standards. In other words, this neighborhood is being further sacrificed in order to reduce pollution elsewhere. The permit was issued despite a threatened lawsuit from Detroit Mayor Mike Duggan and a statement from a coalition of state senators

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[19] http://phys.org/news/2016-05-bakken-oil-field-leaks-tons.html

[20] https://www.minnpost.com/earth-journal/2016/05/bakken-wells-drove-sudden-reversal-global-decline-ethane-emissions

[21] http://www.eesi.org/articles/view/new-research-documents-frackings-health-effects-on-workers-and-communities, Colborn T, Kwiatkowski C, Schultz K and Bachran M. 2011. Natural Gas Operations from a Public Health Perspective. Hum Eco Risk Asses: an Inter Jorn. Available at: http://www.tandfonline.com/doi/abs/10.1080/10807039.2011.605662#preview

[22] http://earthfirstjournal.org/newswire/2014/05/26/sexual-assault-in-the-bakken-shale-man-camps,
Gilbertson, Lydia. Letter: End Human Trafficking Wherever It's Happening. Bakken News, May 23, 2014.
http://bakken.com/news/id/182654/letter-end-human-trafficking-wherever-happening/,
McLaughlin, Shaymus. "Rise in Sex Trafficking on Bakken Oil Patch Poses New Challenges,: Minnesota Public Radio Interview with Bryan Lockerby, Administrator of the State's Department of Criminal Investigation. May 2014.

calling on them to reject it, comparing the situation to the poisoned water crisis in Flint. Residents filed a class-action lawsuit against Marathon in US District Court on February 23, 2016.

Climate Change Impacts

The current scoping document narrows the scope of climate change impacts considered in the EIS to only those emissions caused by pipeline construction or power plant generation of electricity to run the pumping stations. This is completely absurd. The document states: *"The air quality impacts analysis will include a review and estimate of the emission inventory of all criteria pollutant, greenhouse gas and hazardous air pollutant emissions related to construction and operation of the proposed project."* By only looking at emissions from construction equipment and pumping stations, major sources of greenhouse gasses from the projects are ignored.

The cumulative effects outlined in Section 4.7 of the draft scope should include the amount of carbon that will be released into the atmosphere if these two pipelines are built. The effects should be combined with an analysis of air quality impacts in Minnesota. The analysis should also include the overall impact of the carbon release, including the estimated cost to remove it from the atmosphere and an assessment of who gains and loses economically.

As noted before, the Environmental Impact Statement for the Keystone XL pipeline included emissions from production, refining, and combustion.. The report states:

"The total annual lifecycle emissions associated with production, refining, and combustion of 830,000 barrels per day (bpd) of oil sands crude oil transported through the proposed Project, as determined through this assessment, are approximately 147 to 168 MMTCO$_2$e. The equivalent annual lifecycle GHG emissions from 830,000 bpd of the four reference crudes (representing crude oils currently refined in Gulf Coast area refineries) examined in this section are estimated to be 124 to 159 MMTCO$_2$e. The range of incremental GHG emissions (i.e., the amount by which the emissions would be greater than the reference crudes) for crude oil that would be transported by the proposed Project is estimated to be 1.3 to 27.4 MMTCO2e annually. This is equivalent to annual GHG emissions from combusting fuels in approximately 270,833 to 5,708,333 passenger vehicles, the CO$_2$ emissions from combusting fuels used to provide the energy consumed by approximately 64,935 to 1,368,631 homes for 1 year, or the annual CO2 emissions of 0.4 to 7.8 coal fired power plants."[23]

A robust analysis is especially important for these two projects, as the Bakken fields are a major source of both methane and ethane, and the tar sands of Alberta are one of the most carbon-intensive fuels on the planet. Methane and ethane are greenhouse gases that also cause climate change.

"Pound for pound, the comparative impact of CH$_4$ (methane) on climate change is more than 25 times greater than CO$_2$ over a 100-year period.....Because gas is often found alongside petroleum, the production, refinement, transportation, and storage of crude oil is also a source of CH$_4$ emissions."[24]

Methane flaring: Fracking has exposed poor infrastructure in the state, which leads drillers to burn or "flare" much of the gas that cannot be captured or shipped. In a single month of 2014, gas wells burned 10.3 billion cubic feet of natural gas. The burning released millions of metric tons of CO_2 into the atmosphere, contributing to climate change. In 2012, burned gas added 4.5 million metric tons of CO_2 to the atmosphere, which was roughly the equivalent of adding one million cars to U.S. highways. It has also been shown that methane leaking is much greater in the Bakken than previously reported, and that drilling in the Bakken has reversed a global decline in ethane emissions.[25]

Oil sands are also one of the dirtiest fuel sources on the planet, and have caused leading scientists to call for a moratorium on further tar sands development, including infrastructure projects.[26] Over 100 scientists have signed on

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[23] Ibid, pg 4.14-4 (footnotes omitted)
[24] https://www3.epa.gov/climatechange/ghgemissions/gases/ch4.html
[25] http://phys.org/news/2016-05-bakken-oil-field-leaks-tons.html
https://www.minnpost.com/earth-journal/2016/05/bakken-wells-drove-sudden-reversal-global-decline-ethane-emissions
[26] http://www.oilsandsmoratorium.org/

the call, all of whom are leaders in climate change research, economics, geophysicists and biology. They have cited the following ten reasons as evidence for the need of a moratorium[27]:

1. Continued expansion of oil sands and similar unconventional fuels in Canada and beyond is incompatible with limiting climate warming to a level that society can handle without widespread harm.
2. Oil sands should be one of the first fuel sources we avoid using as society moves to non-polluting forms of energy, not the next carbon-intensive source we exploit. Extracting, refining, transporting, and burning oil-sands energy produces among the most greenhouse gases of any transport fuel per unit energy delivered (Brandt 2011, Gordon et al. 2015). Expansion of oil sands production will exacerbate the problem of carbon pollution and slow the transition to cleaner energy (Unruh 2000).
3. Current oil sands environmental protections and baseline data are largely lacking, and protections that exist are too seldom enforced. Too often, the development of the oil sands is presented as inevitable, while protections for human health and the environment are treated as optional.
4. Contaminants from oil sands development permeate the land, water and air of the Canadian boreal landscape, and many of these impacts are difficult to mitigate. Independent studies have demonstrated that mining and processing Albertan oil sands releases carcinogenic and toxic pollutants (e.g., heavy metals, polycyclic aromatic compounds) to the atmosphere from smoke stacks and evaporation, and to groundwater from leaching of tailings ponds. This pollution harms terrestrial and aquatic ecosystems and the species within them (Pollet and Bendell-Young 2000, Gurney et al. 2005, Nero et al. 2006, Gentes et al. 2007, Kelly et al. 2009, Kelly et al. 2010, Landis et al. 2012, Rooney et al. 2012, Kurek et al. 2013, Andrishak and Hicks 2011, Hebert et al. 2013, Galarneau et al. 2014, Parajulee and Wania 2014, Schindler 2014, Schwalb et al. 2015).
5. Less than 0.2% of the area affected by Canadian oil sands mining has been reclaimed, and none restored to its original state (Government of Alberta 2014).
6. Development and transport of oil sands is inconsistent with the title and rights of many Aboriginal Peoples of North America. Rapid expansion of the oil sands in Canada violates or puts at risk nation-to-nation agreements with Aboriginal peoples. In Alberta, oil sands mining is contributing to the degradation and erosion of treaty and constitutionally protected rights by disrupting ecological landscapes critical to the survival of Aboriginal culture, activities, livelihoods, and lifeways (Passelac-Ross and Potes 2007, Foote 2012, ACFN). In the US, proposed infrastructure projects threaten to undermine Treaty agreements between the federal government and Native American tribes (Mufson 2012, Hart 2014). In both countries, contamination of sacred lands and waters, disruption of cultural sites, lack of consultation, and long-term effects of climate change undermine sustainable social, ecological, and economic initiatives involving Aboriginal peoples across the continent and constitute violations of Native sovereignty (Passelac-Ross and Potes 2007, Foote 2012, Mufson 2012, Hart 2014, Irvine et al. 2014, McLachlan 2014, Wohlberg 2014, Athabasca Chipewyan First Nation, Tsleil-Waututh Nation).
7. What happens in North America will set a precedent for efforts to reduce carbon pollution and address climate warming elsewhere. The choices we make about the oil sands will reverberate globally, as other countries decide whether or how to develop their own large unconventional oil deposits (Balouga 2012). Strong North American leadership is needed now, because the impacts of current decisions will be felt for decades and centuries.
8. Controlling carbon pollution will not derail the economy. Most leading economists now agree that limits on carbon pollution – using mechanisms such as carbon taxes, cap-and-trade systems, or regulations – can facilitate a transition over several decades to low-emission energy without a dramatic reduction in global economic growth (Global Energy Assessment 2012, IPCC 2014, Nordhaus 2014).
9. Debates about individual pipeline proposals underestimate the full social costs of the oil sands, and existing policies ignore cumulative impacts. These are not simply business decisions. Responsible policies should address the interwoven, system-wide impacts of oil sands development, from mines and refineries, to pipelines, rail and tanker traffic, to impacts on economies and the global climate system. Current laws, regulations, and policies are not designed to assess cumulative impacts (Johnson and Miyanishi 2008, Office of the Auditor General of Canada 2011). When oil sands development is viewed as an integrated whole, the costs and benefits of individual decisions can be evaluated responsibly (Chan et al. 2014). Land use and

[27] http://www.oilsandsmoratorium.org/wp-content/uploads/2015/06/Oil-Sands-Moratorium-Message.pdf

regulatory decisions are considered lease-by-lease with no single agency responsible for oversight, accounting of cumulative impacts, or information flow. For example, decisions regarding mineral rights are made by Alberta Energy, those for timber by Alberta Sustainable Resource Development, while Alberta Environment decides on water and air impacts, and the National Energy Board decides on pipeline and rail transport of oil sands products (Johnson and Miyanishi 2008).

10. A majority of North Americans want their leaders to address climate change, and they are willing to pay more for energy to help make that happen.

Climate change is not an event in the future. Climate change was 30 years ago, we are living in climate chaos right now. We are seeing unprecedented human conflict and natural disaster. We are watching upwards of 200 species go extinct every day. A major contributor to climate change is the use of petroleum and petroleum bi-products. Many of the assumptions of need for this set of pipelines are based on a projected need for continued consumption of fossil fuels. But there is now international consensus, as illustrated in the Paris Climate Accord, that we need to rapidly shift away from fossil fuels. The U.S. energy system is extremely inefficient, wasting 61-86% of available energy.[28] The U.S. transportation system, with its heavy reliance on personal automobiles, powered by inefficient internal combustion engines is a perfect example of this. Not only are the better ways to move people (mass transit, bicycles, walking) but there are more efficient engine designs.[29] The time is now to say no to more dirty oil infrastructure.

Wildfires are an indicator very close to home. In the last two decades, North America has seen a dramatic increase in the number of wildfires and the total number of acres burning each year, as a result of climate change. In 2015, there were over 10 million acres burned by wildfire in the United States alone, approximately 67% more than the average for a given year.[30] According to the National Interagency Fire Center, 9 of the 10 worst years for acres burned in the U.S. have occurred since 2000.[31] The International Panel on Climate Change (IPCC) determined this increase will continue to accelerate. Wildfires, which already burn more than 350 million hectares globally causing an estimated 340,000 deaths, will double in number in the near future, leading forest-fire experts have warned. The early May 2016 wildfires that destroyed most of the town of Ft. McMurry, Alberta, was perhaps the most significant wildfire in North American history, in terms of human impact. It also destroyed tar sands industry infrastructure.[32] That massive fire has been raging out of control for nearly a month and is still going. It caused significant air quality concerns all across the region and resulted in a significant decline of tar sands production.[33] Experts say fires such as these will be a continuing reality in our new global climate, and will also increase in intensity.[34]

4) INDIGENOUS HUMAN HEALTH IMPACTS

The EIS must also address the unique human health concerns of the Native nations directly impacted by this project. The potential impacts of human health as a result of these projects are vastly underestimated in the scoping document. Native people are already under severe duress. Native peoples are already disproportionately impacted and suffering from structural racism due to unjust social and economic conditions. Throughout the scoping document, High Consequence Areas (HCA) are discussed. In human terms, these areas are defined by concentration of population. In general, Native communities are not considered HCAs. The EIS should factor this unique situation into the definition of an HCA, as pockets of poverty and concentrated environmental injustice should be included to consider oppressed communities equally.

Subpart 4.4.1.5 Environmental Justice is inadequate to address the issues of environmental justice associated with this project. The scope should include a detailed explanation of how the State of Minnesota will assess

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[28] http://cleantechnica.com/2013/08/26/us-wastes-61-86-of-its-energy/
[29] https://www.fueleconomy.gov/feg/atv-ev.shtml
[30] https://www.nifc.gov/fireInfo/nfn.htm
[31] http://www.usatoday.com/story/weather/2016/01/06/wildfires-burned-record-10-million-acres/78362786/
[32] http://www.wsj.com/articles/canada-wildfire-prompts-new-evacuation-of-oil-sands-workers-in-northern-alberta-1463473452
[33] http://www.nytimes.com/2016/05/06/world/americas/canadian-wildfires-curtail-oil-sands-production.html?_r=0
[34] Toronto Globe and Mail February l9,2012

environmental justice concerns, how it will address the findings of environmental justice inquiry, and how it will provide additional protections and insurance for communities and people subject to disparate impacts.

In the section above titled "Well to Wheels Impact Analysis," we outline the significant human health impacts on the Indigenous people in the Bakken region.

Risk and Tribal Health Impacts in Minnesota

Tribal communities, in both the United States and Canada are already at-risk communities, as evidenced by their high-rates of suicide and persistent poverty.[35] Numerous studies and reports have linked these conditions directly to historic trauma, the history of colonization, and negative impacts of mega-projects.[36] The largest pipelines in North America, and the tar sands and fracked oil extraction they support, are undoubtedly mega-projects. Studies have also shown that impacts on Tribal communities are consistently underestimated, as the methodologies used to analyze risk are based on healthy white-males, not at-risk peoples that live off the land. Recently, suicide crises have hit First Nations communities in Canada, with a direct link being drawn between large infrastructure projects and their impacts on the communities[37].

Ojibwe socio-economic conditions place our community at high health risks. The Amherst Wilder Foundation report on health inequities in Minnesota found that American Indians suffered from structural racism with regards to health disparities, and are a high risk population. "The evidence strongly suggests that social and economic conditions and structural racism contribute significantly to the relatively poor health outcomes of the American Indian population in Minnesota. "Therefore, we feel that policy makers should take these critical factors into account in a systematic and transparent way when making decisions that potentially have wide ranging impacts..."[38] In the 2014 Advancing Health Equity report, the Minnesota Department of Health found the "years of potential life lost" as a result of heart disease and stroke is 165 percent higher for American Indians than for whites in Minnesota.[39] The report also highlighted structural racism as a key contributor to health inequities in our state:

"Structural racism — the normalization of historical, cultural, institutional and interpersonal dynamics that routinely advantage white people while producing cumulative and chronic adverse outcomes for people of color and American Indians — is rarely talked about. Revealing where structural racism is operating and where its effects are being felt is essential for figuring out where policies and programs can make the greatest improvements".[40]

International studies indicate that adding mega projects to stressed communities significantly increases negative health impacts. Without any spills, the proposed pipelines will add significant duress to tribal communities. Studies from previous oil spills have shown a marked decrease in traditional practices following a spill due to perceived contamination.[41]

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[35] http://www.mcgilldaily.com/2016/03/reactive-measures-not-a-solution-to-cross-lake-suicide-crisis/
http://www.theglobeandmail.com/news/national/attawapiskat-four-things-to-help-understand-the-suicidecrisis/article29583059/

[36] Luginaah et al (2010). Surrounded by Chemical Valley and 'living in a bubble': the case of the Aamjiwnaang First Nation, Ontario. Journal of Environmental Planning and Management, 53(3) 2010.
Tobias, J., Richmond, C., Luginaah, I. (2014) "That Land Means Everything to us". Environmental Dispossession and Resilience on the North Shore of Lake Superior. Health and Place (29), 26-33.
McDoweel, G. (2014). The socio ecological dimensions of hydrocarbon development in the disko bay region of Greenland: opportunities, risks, and trade- offs. Applied Geography, 46. 98.

[37] http://www.theglobeandmail.com/news/national/manitoba-premier-apologizes-to-first-nation-for-damage-done-by-dam/article22541829/

[38] Wilder Letter June 4, 2015

[39] Minnesota Department of Health (2014): Advancing Health Equity. Retrieved from: http://www.health.state.mn.us/divs/chs/healthequity/aheexecutivesummary.pdf

[40] Advancing Health Equity in Minnesota: Report to the Legislature, February 1, 2014: Health's Commissioner's Office.

[41] Gill DA, Picou JS, Ritchie LA. 2012. The Exxon Valdex and BP Oil Spills: A Comparison of Intial Social and Psychological Impacts. Amer Beh Sci 56: 3-23.
Miraglia R. 2002. The Cultural and Behaviour Impact of the Exxon Valdez Oil Spill on the Natives Peoples of Prince William Sound, Alaska. Spill Sci & Tech Bull 7: 75-87.

The communities of Rice Lake and East Lake, which are most directly impacted by the proposed Sandpiper, are already experiencing these statistics and are now facing the addition of the proposed pipelines. These projects are placing significant additional stress on these communities, which will only increase health inequities and cause additional harm. At both the Rice Lake and McGregor meetings, emotional verbal comments addressed the community address associated with the prospect of these projects. In the case of Rice Lake and East Lake, the larger territory would be impacted by the proposed pipeline project, and in the case of East Lake, the community has not only the prospect of a pipeline, but also the proposed Tamarac Copper mine. The cumulative impacts of these pipeline projects, and other proposed or planned projects should be considered as part of this EIS process. In the case of both White Earth and Mille Lacs reservation, suicides are already much higher than the state average, along with many other health conditions. Reservations across North America are also suffering from major drug and suicide epidemics. The health impacts of the proposed Sandpiper and Line 3 damage to Ojibwe communities will be significant, and the full, cumulative human consequences must be considered. These consequences are not limited to the populous Twin Cities, but are spread across Native communities from Alberta, North Dakota, and here in Minnesota. As we have stated before, the front line communities in Alberta and North Dakota are suffering from increased sexual violence, exposure to toxic chemicals, and a loss of community and ecology.

In the recent suicide epidemics in northern Canadian Indigenous nations- Pimicikimak (Cross Lake Manitoba) and Attawapiskat (Ontario), there has been a link made between long term duress, historic trauma, colonialism and ***most recently, mega projects***.

"...The Pimicikamak Cree Nation in Manitoba, also known as Cross Lake, declared a state of emergency on March 9, in the wake of six suicides over the past two months and over 140 attempts in the community of 8,365 in the last two weeks alone... The suicide crisis, however, cannot be resolved without considering the other hardships affecting Cross Lake, including the destruction of its land by a Manitoba Hydro station and a lack of economic security with an 80 per cent unemployment rate. In order to seriously confront Cross Lake's suicide crisis, the government must, in consultation with the Nation, address the systemic roots of this crisis...."

"Aboriginal youth in Canada have a suicide rate 50 times higher than the general population. Attawapiskat, another Cree community in the north has a suicide epidemic... In both cases, Pimicikamik Cree and Attawapiskat Cree, the background of colonialism, and injustice -whether in health access or housing access is foundational to the present suicide crisis. The crisis is worsened significantly by the destruction of the primary territory by the dam projects."

McGill Daily (Canada April 5 2016)

Climate Refugees

Climate refugees are people who must leave their homes and communities because of the effects of climate change and global warming.[42] In 2013, there were an estimated 22 million people displaced by natural disaster.[43] There is consensus that these numbers will continue to rise.[44] Domestically, we have already seen the phenomena unfold as the Isle de Jean Charles Tribal community in Southern Louisiana has been forced to relocate.[45] The northwestern Alaskan village of Kivalina is perched on a remote and narrow strip of sand next to the frigid waters of the Chukchi sea. Its 400 residents are Iñupiat. The U.S. Army Corps of Engineers predicts that Kivalina will be completely uninhabitable by 2025, a victim of melting ice, coastal erosion and rising sea levels. This village is just one of three Inuit settlements that scientists believe will be destroyed by the effects of climate change. At least eight more are at serious risk.[46] Indigenous peoples on a worldwide scale are significantly impacted as climate change refugees. This is in part due to our majority population in the Arctic and the islands in the oceans, which are the most heavily impacted by climate change. The over l80,000,000 metric tons annually of additional carbon dioxide associated with the Sandpiper and Line 3 as well as the significant metric tonnage of methane gas from the Sandpiper front end is directly related to these human health impacts. The impacts of these projects are too much for the planet to take, and will result in more drastic climate change, and disparate negative impacts on Indigenous communities.

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[42] http://nationalgeographic.org/encyclopedia/climate-refugee/

[43] http://www.internal-displacement.org/publications/2014/global-estimates-2014-people-displaced-by-disasters/

[44] http://www.unhcr.org/pages/49e4a5096.html

[45] http://www.theguardian.com/environment/2016/mar/15/louisiana-isle-de-jean-charles-island-sea-level-resettlement

[46] New York Daily News July 30, 2013 Carolyne Kuruvilla

5) INDIGENOUS CULTURAL IMPACTS

In Minnesota, the majority of these projects run through the 1855 Treaty area, lands on which tribal people continue to harvest a significant amount of the food necessary for the well-being and survival of our people. The Anishinaabeg carry out ceremonies throughout that territory, as they have since time immemorial. Through an EPA Technical Assistance for Communities contract (submitted in hard copy at the Rice Lake EIS scoping meeting in May 2016), researchers identified significant areas of traditional cultural use and sacred sites directly within the pipeline impact zone. At least 280 of these sites were identified and are subject to the archaeological assessment requirements of the State of Minnesota's Indian Affairs Council, as well as federal requirements under the National Historic Preservation Act, the Executive Order on the Protection of Sacred Sites, and the United Nations Declaration on the Rights of Indigenous Peoples.

In subpart 4.4.4 Cultural Resources, we believe that Minnesota law requires an evaluation by the Minnesota Indian Affairs archaeological staff. The MIA staff is properly trained and qualified to identify and evaluate indigenous cultural sites. Destruction of religion and tradition due to a failure to understand such concepts is unacceptable and a loss for all peoples; adequate training is a must in this situation. The structure and applicable standards of a review by this staff should be included in the scope. All Cultural Resources identification will require MIA staff and any work performed should be completed in accord to their well-researched, established standards.

In subpart 4.4.4.2 Archaeological, Historical and Cultural Resources we find the use of spatial analysis within ArcGIS inadequate to protect archaeological sites. Again, this review should be completed by Minnesota Indian Affairs archaeological staff and their developed standards to provide protection of known and unknown sites. An overseeing agency must be able to properly analyze the resources at hand to fully understand what is at stake. The scoping document should include MIA staff authority and expertise in ensuring adequate protection of archaeological sites.

In subpart 4.4.5.4 Wild Rice and other Tribal Resources. The scoping document needs to be amended to describe how it is going to protect 'other Tribal Resources' and what is encompassed within that term. The scoping document fails to identify how it will identify, evaluate and protect other Tribal Resources and deals only with wild rice.

Throughout the NEB document on the Line 3 Replacement Project cited above, there is a focus on the inclusion of Indigenous communities in the process of monitoring and analyzing this project.[47] This includes utilizing Indigenous Knowledge and Science. The MN PUC should require the same level of inclusion. As part of the conditional approval for the project in Canada, the NEB made several requirements for Indigenous involvement including:

- The development of *consultation plans for Aboriginal groups going forward... developed in consultation with Aboriginal groups and are to reflect a collaborative and coordinated consultation approach, as opposed to only information sharing. ... Enbridge must demonstrably respond to and address concerns raised where reasonable. The plans should also respect the cultural interests of Aboriginal groups regardless of the nature of the land use in the Project area (for example, unoccupied Crown land, occupied Crown land, or privately owned land). Enbridge and participating Aboriginal groups are encouraged to be innovative in order to enhance the way consultation will occur during the operation of the Line 3 Replacement Pipeline, and after the Existing Line 3 Pipeline has been decommissioned.*
- The development of *an Aboriginal Monitoring Plan for the construction phase of the Line 3 Replacement Pipeline, and specifically for the construction of pipeline facilities... The Board appreciates Enbridge's concern that it cannot hire approximately 150 Aboriginal monitors for the Project while ensuring safety and efficiency. This will be taken into account when the Board reviews the Plan. While the Board does not expect Enbridge to hire 150 monitors, there is a reasonable middle ground. The Board expects Enbridge to make efforts to accommodate active monitoring where desired by an Aboriginal group and where reasonable and safe, although observational site visits may be a component of the Plan. If an Aboriginal group wishes to participate in monitoring and Enbridge cannot reasonably accommodate the request, Enbridge will be expected to provide an explanation to the Board as to why*

[47] https://docs.neb-one.gc.ca/ll-eng/llisapi.dll?func=ll&objId=2949686&objAction=browse

Furthermore, it was recommended that *"the NEB, the pipeline industry, and Aboriginal groups work together to create a set of principles, objectives or a framework approach that can be used to assist the development of Aboriginal monitoring programs for large pipeline projects."*

At the federal level, Section 106 of the National Historic Preservation Act [NHPA] mandates tribal consultation and respect for tribal sovereignty with an undertaking that could affect tribal lands and historic properties. This legislation complements the intent and purpose of the National Environmental Policy Act. The proposed projects at hand will pass through treaty territories of the Anishinaabe people, and carry the potential for permanently destroying the ability of tribal nations to engage in their treaty-protected rights to harvest wild rice, hunt, and fish. Proper consultation with all affected tribal nations must take place, and there must be a detailed analysis of the cultural impacts of these projects at the federal and state levels. The potential for harm is high -- destruction of culture and sacred sites cannot be easily, if ever, undone.

The United States is one of numerous countries that supports the United Nations Declaration on the Rights of Indigenous Peoples. The UNDRIP is an international instrument that contains many protections for Indigenous communities, who are so often subject to abuses and unjust treatment. Among the provisions are a right to practice cultural beliefs and practices.[48] Contamination from these pipeline projects would wipe out the practice of harvesting wild rice and all associated religious ceremonies. Wild rice is an intrinsic, identity-forming aspect of Anishinaabe life -- to lose access to these wild rice beds would devastate and permanently harm our culture.

The UNDRIP also contains provisions mandating free and informed consent from an affected tribal nation by the state.[49] In this case, the state of Minnesota has failed to properly consult or even adequately consider the impacts of these projects on the indigenous peoples of the region. The damages that will result from these projects cannot be undone, nor can they be measurable in terms of losing an entire culture that has existed prior to the formation of the United States. A fossil fuel project should not be considered without fully examining cultural impacts and the potential losses that will occur if spills occur, which is a mathematical certainty.

6) ABANDONMENT

Every day, over 2.5 million barrels of crude oil flow through MN in eight oil pipelines, and 4 of those lines, Enbridge's old Lakehead system, are ancient and full of holes, likely leaking crude oil throughout their length. They were built in the 50's and 60's before the more abrasive dilbit was being extracted. As such, these pipelines were not designed to handle the crude that now flows through them. States, tribes, and the federal government were not well informed of the risks and very few environmental regulations were in place. At many points, those pipes were never buried, and are sitting above ground, corroding, with their protective coating, single wrap of Polyken 960-13 polyethylene tape with an adhesive backing, peeling off. This peeling has been shown over and over again to cause ruptures. It's what caused the Kalamazoo rupture, the largest inland spill in US history (replacing the previous record holder, the 1979 Bemidji spill).[50] It has been 6 years and $1.2 billion has been spent, and that spill is still not cleaned up. The community near the spill has been suffering negative health effects, and it has been shown that Enbridge knew about the crack, but did nothing about it. We do not want this risk in our pristine waterways and sacred rice beds. These lines are catastrophes waiting to happen. Allowing Enbridge to abandon Line 3 without a sufficient review process will set a dangerous precedent.

The following are photos were taken by our staff member, Thane Maxwell of Line 4 and Line 1, on Enbridge's Mainline Corridor where it runs across the Fond du Lac reservation near Ditchbank Road.

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[48] http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf

[49] *Id.*

[50] http://www.ntsb.gov/investigations/AccidentReports/Pages/PAR1201.aspx





The next two photos are of Line 4, taken by John Ratzloff in the same location.





Over time, soil movement causes wear and tear on this coating and it breaks down, causing pipes to corrode. In section 1.7.1, the NTSB report for the Kalamazoo incident states:

"Corrosion was observed beneath the areas where the adhesive bond between the pipe and its protective tape coating had deteriorated. In the areas of disbondment, metal loss was found around and below the longitudinal seam in the upstream and downstream sections of pipe. Because the tape had become disbonded, the pipeline's cathodic protection was prevented from reaching the pipe; it no longer prevented corrosion from occurring. External corrosion was observed along the length of the pipe in areas where the coating had disbonded."

All of this is when the pipes are buried below the frost line. It is required to bury pipelines below the frost line, so we must wonder why these pipes are sitting above ground, exposed as they are. Fond du Lac Band members and

employees raised concerns about these exposed pipes in MN Public Utilities Commission proceedings regarding Enbridge's pipeline route restoration practices in 2008, but to no avail.[51]

This polyethylene tape was also documented in the TSB of Canada's incident report as a cause of the rupture that spilled near Hardisty, Alberta in 2001.[52] It was also documented as a major cause of corrosion on Enbridge's Line 9 pipeline, during their recent application to the TSB of Canada to reverse the direction of that line.[53] Enbridge's spokesperson Lorraine Little has also cited it as the cause of the corrosion motivating Enbridge to propose abandonment of their existing Line 3 pipeline, so that they can build a new one in the Sandpiper corridor.[54]

Line 3 is the 34" line that Enbridge wants to abandon and build anew, in the new corridor, so that they don't have to deal with the 900 "structural anomalies" they've found in it. Line 4, the exposed one in the pictures is a strange one, with 28 different segments of different sizes and lengths and product types, many of which are "loops" that work in combination with Line 3 and were added on in multiple stages over the years. Many governmental reports and newspaper articles refer to Lines 3 and 4 as a single unit. Together they are responsible for Minnesota's largest spill near Grand Rapids in 1991; the spill near Cohasset, MN, in 2002; the explosion in Clearbrook in 2007 that killed two workers; a spill in Regina, Alberta in December 2014; and countless other ruptures and spills. In other words, these are Minnesota's problem child pipelines - ticking time bombs. That risk falls disproportionately on Anishinaabe people. The real opportunity to create jobs lies in maintaining, cleaning up, and dismantling these old lines.

Honor the Earth agrees that the current Line 3 needs to be removed from service. However, we do not believe that Enbridge should be allowed to walk away from existing contamination and other issues. Enbridge has indicated that the current Line 3 has over 900 "integrity anomalies", while we have not seen a classification of the level of these anomalies, we know they can developed into ruptures, spills, or leaks. Enbridge knows this as well, which is why they are proposing to abandon this structurally impaired line in place and build a brand new one. This abandonment allows Enbridge to avoid opening the ground and potentially discovering contamination their "pigs" (pipeline inspection gauge) have not disclosed (or that has not been reported). There are also reports that there are several places where the existing pipe has been exposed, and other areas where invasive species have encroached on harvesting areas as a direct result of ROW maintenance activities. If Enbridge is not required to remove the pipeline and restore the damaged ecosystems, there may never be a full accounting of the contamination surrounding the pipeline. This contamination would become the responsibility of nearby landowners. Additionally, Enbridge has stated they plan to fill the pipelines with nitrogen. This would constitute an underground storage tank according to Minnesota statute Minnesota Statute § 103I.681[55]

Article 5 of Enbridge's 1991 Presidential Permit for the operation of Line 3 clearly states that they are responsible for removal of the line:[56]

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[51] concerns about these exposed pipes in MN Public Utilities Commission proceedings regarding Enbridge's pipeline route restoration practices in 2008

[52] http://www.bst-tsb.gc.ca/eng/rapports-reports/pipeline/2001/p01h0004/p01h0004.pdf
[53] http://www.landownerassociation.ca/rsrcs/OPLAFinalArgument_May24_2012.pdf
[54] http://www.startribune.com/enbridge-files-to-replace-problem-pipeline-in-minnesota/280528652/
[55] https://www.revisor.mn.gov/statutes/?id=103I.681
[56] http://mn.gov/commerce/energyfacilities/documents/34079/Appendix%20A%20-%201991%20Presidential%20Permit.pdf

Article 5. Upon the termination, revocation, or surrender of this permit, the United States facilities in the immediate vicinity of the international boundary line shall be removed by and at the expense of the permittee within such time as the Secretary of State of the United States or his delegate may specify, and upon failure of the permittee to remove this portion of the United States facilities as ordered, the Secretary of State of the United States or his delegate may direct that possession of such facilities be taken and that they be removed at the expense of the permittee; and the permittee shall have no claim for damages by reason of such possession or removal.

Enbridge promises to maintain the pipelines in perpetuity, but no one believes this. No infrastructure from 50 years ago is still in existence now without ongoing maintenance. In the NEB report. the Canadian government found that there was a very real risk that pipeline companies would not have money available forever and would eventually stop maintenance with the result that some landowner in the future would be stuck with a decaying pipeline causing drainage, subsidence, erosion and contamination, and no way to get the oil industry to pay for its mess.[57] The State of Minnesota needs to develop a set of abandonment regulations to avoid passing on this incredible liability to our future generations.

Realizing these issues, the NEB has made several recommendations directly related to the long-term oversight of the abandoned Line 3[58]:

- ***In the Panel's view, the Board's policy and regulatory framework needs to be responsive to the evolving statutory context and the likelihood of additional large decommissioning and abandonment applications in the future.***

- *Enbridge will be required to make additional filings with the Board before commencing decommissioning activities. These include a detailed Final Decommissioning Plan and a Minimally-Invasive Procedure Evaluation Report.*

- *Due to the uncertainty regarding the long-term impacts of decommissioning the Existing Line 3 Pipeline in-place... it is important that a robust monitoring plan be in place to ensure that remedial actions and adaptive management measures will be taken if required. Board-imposed conditions include the filing by Enbridge of a Decommissioning Treatment Monitoring Program and reporting by Enbridge of the monitoring results to the Board and stakeholders. Enbridge will also be required to notify the Board or obtain Board approval in the event that certain remedial actions or adaptive management measures are required after the Existing Line 3 Pipeline has been decommissioned*

- *There is a current restriction (other operating pipelines) on Enbridge's ability to complete some of the remaining steps in the lifecycle of the Existing Line 3 Pipeline, such as removal of above-ground facilities at shared facility sites. Enbridge suggested that the Board could require it to file a proposed plan to complete these remaining activities at the time of abandonment of the last operating pipeline in the corridor. The Board agrees that it should assess and approve these remaining activities before they are carried out. However, in the Board's view, this should be accomplished by way of a future abandonment application, not merely through the approval of a plan. A future abandonment application will address any and all remaining activities*

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57 https://docs.neb-one.gc.ca/ll-eng/llisapi.dll/fetch/2000/90464/90552/92263/2404881/2545522/2955931/2949686/Volume_I_-_Our_Decisions_and_Recommendations_-_OH-001-2015_-_A4Z5U2.pdf?nodeid=2949922&vernum=-2

58 https://docs.neb-one.gc.ca/ll-eng/llisapi.dll/fetch/2000/90464/90552/92263/2404881/2545522/2955931/2949686/Volume_I_-_Our_Decisions_and_Recommendations_-_OH-001-2015_-_A4Z5U2.pdf?nodeid=2949922&vernum=-2

in the lifecycle of the Existing Line 3 Pipeline, including those that may be required due to circumstances that exist at that time. This is consistent with current Board guidance in Guide K to the Filing Manual and its amended Decommissioning Guidance Notes, which are clear that all decommissioned pipelines will require an application to the Board for abandonment.

- *The Board therefore imposes a condition requiring Enbridge to file an abandonment application once the remaining steps in the lifecycle of the Existing Line 3 Pipeline can be carried out (excluding ongoing monitoring), or if the Board directs Enbridge to do so for all or any part of the pipeline. The Board also imposes a condition requiring Enbridge, after the Existing Line 3 Pipeline has been decommissioned, to report every five years on the status of the corridor. This information will help the Board regularly assess the ongoing status of the corridor, including the continued appropriateness of the Existing Line 3 Pipeline remaining in-place.*

These conditions were designed to mitigate some of the potential long-term consequences of abandonment, including:

- Long-term financial liability of pipeline[59]
- Drainage or sinkhole issues, including the creation of water conduits
- Corrosion issues[60]
- Subsidence
- Potential soil and groundwater contamination

Additionally the NEB has ordered Enbridge to set aside nearly $1 billion to pay for future abandonment of its pipelines in Canada. In the US, the responsibility to protect landowners and the public from the risks created by abandoned pipelines is on the states.

The State of Minnesota has the power to regulate abandoned pipelines. In particular, the Public Utilities Commission (PUC) has discretion to decide what actions a pipeline company takes to minimize risks posed by old pipelines, particularly when it approves a replacement. Since Line 3 is the first major crude oil pipeline to be abandoned in the state, there is a risk that the PUC will avoid this responsibility. Enbridge should be required to do a survey of Line 3 now to identify possible spill locations and investigate them, because that should be addressed now while the costs can still be passed on to the industry. Landowners need to clarify their right to control their own land by requiring Enbridge to remove or otherwise mitigate the pipeline, otherwise, if a conflict arises their only option may be to bring Enbridge to court.

Elements of an abandonment plan should include:
1) Clarifying landowner control over what happens to abandoned pipe so they don't have to sue Enbridge;
2) Landowner education about the full range of mitigation options available to landowners, including removal, plugging, and filling abandoned pipe;
3) A survey for contamination and remediation plan
4) To the degree that landowners want to put off the decision about what to do with the pipe, the should seek the creation of a trust fund to ensure that money is always available should future problems arise.

7) SPILL MODELING AND RESPONSE

The bottom line is that for a given pipeline in any 10-year period, there is a 57% chance of a major spill, as documented by USDOT study using PHMSA data.[61] So it's not a question of *if* these pipelines will poison our sacred

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[59] From: http://www.pipelineandgasjournal.com/who-owns-abandoned-pipelines

[60] https://docs.neb-one.gc.ca/ll-eng/llisapi.dll/fetch/2000/90463/501473/501488/501198/515103/A1F2Z4_-_TNS_Tech_Guidelines_on_Abandonment_(r12)_April_10_07_JKK.pdf?_gc_lang=en&nodeid=515104&vernum=0&redirect=3

[61] http://www.phmsa.dot.gov/pv_obj_cache/pv_obj_id_4A77C7A89CAA18E285898295888E3DB9C5924400/filenam

waters and destroy our way of life, but *when*. The EIS must include a thorough analysis of spill risk and response. The current scope is insufficient.

Incorrect Spill Modeling Methodology

The EIS should include spill modeling under both average and worst case weather conditions on river crossings as well nearby lakes, streams and wetlands. It should also include all of the High Consequence Areas (HCA). The original Sandpiper RP scope prepared by Deborah Pile contained 7 locations for oil spill risk assessment and analysis. However, it is not clear in the new scoping document where these locations are. As it currently stands, DOC seems to have chosen locations that are "low consequence areas" rather than high consequence areas (HCA). Upper Rice Lake is not included despite the fact that it is one of the premier wild rice lakes. Other HCA's that should be included include Hay Creek, the Straight River aquifer, the Pine River, the Whitefish Chain, Spire Valley, the Mississippi River and Big Sandy River crossings, the Kettle River, the western tributary to the St. Croix National Scenic Riverway, and of course, Lake Superior.

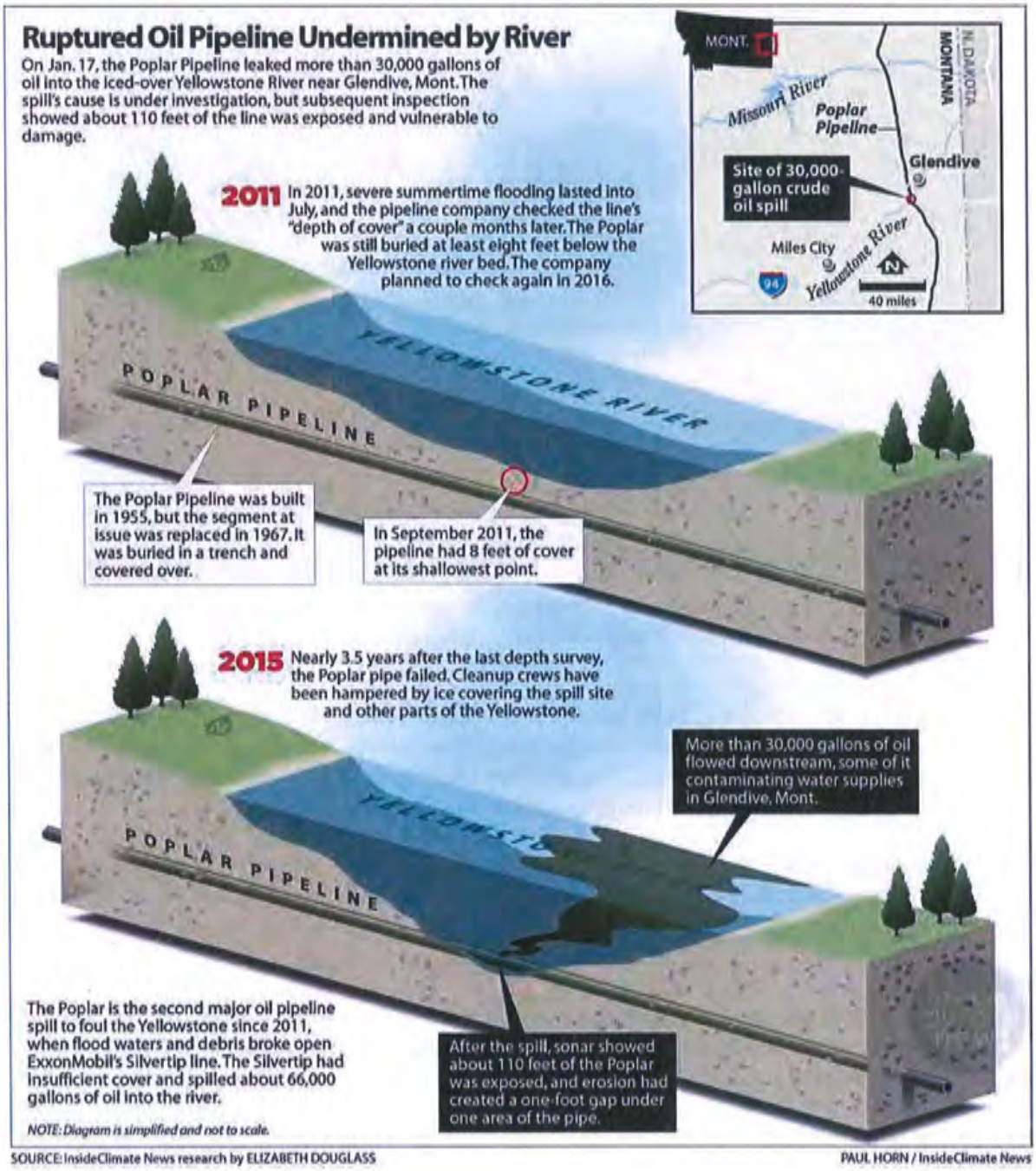
The draft scoping document relies on maximum spill data from Enbridge. As Enbridge is known to under-represent their spills, independent verification of maximum potential spills should be conducted. Relying on Enbridge's data for spill modeling results thwarts public participation in the process and prevents us from commenting on the methodology being employed to protect our precious resources.

Also, if Enbridge's offical response time is anywhere from 1 hour to 3 days, then a 24 hr modeling of a spill or leak is insufficient. The duration of the model runs should be determined by emergency spill response time from moment of release to fully deployed containment. Downstream impacts must also track dissolved fractions and submerged fractions of the product that defeat containment designed to collect floating fractions. These downstream models should predict the ultimate fate of all fractions that are subject to attenuation of any kind and to the remaining components including heavy metals that do not attenuate by any other means with exception of dilution. Heavy metals like mercury would have to be modeled through natural methylation in aquatic environments and eventual uptake into the food chain including fish, predators and humans. Dilbit and other dense, nonaqueous phase liquids (DNAPLs) are exceedingly hard to clean up from groundwater and sensitive wetlands, the exact environments the prefered route runs through.

River Crossings

Crude oil pipeline river crossings pose unique and significant risks to our freshwater resources. The Yellowstone River spill in 2015 showed how unpredictable river beds can be, and how impossible it is to cross a river safely. In that case, the Poplar Pipeline had been monitored in 2011 and measured to be more than 8 feet below the river bed at its shallowest point. In 2015, it was all of a sudden entirely exposed to the river's current for more than 100 feet along its length.[62] It actually had a foot of river water flowing underneath the pipe. It ruptured, spilling more than 30,000 gallons into the river.

[62] http://insideclimatenews.org/news/06022015/yellowstone-oil-spills-expose-threat-pipelines-under-rivers-nationwide



In 2014, an MPR report showed that 3 of the 6 Enbridge crude oil pipelines crossing Minnesota's Tamarac River were exposed by floodwater erosion years beforehand, but were still exposed.[63] None of the pipes had failed at that point, but one was being propped up by steel legs.

A study last year by the Pipeline and Hazardous Materials Safety Administration found "depletion of cover" was a factor in 16 significant pipeline spills at river crossings since 1991.[64]

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[63] http://www.mpmews.org/story/2014/07/29/enbridge-pipelines-exposed

[64] http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Rep_to_Congr_on_Res_of_Haz_Liq_Incid_at_Cert_In_Wat_Cross_Stu_Final_8_27_13.pdf



Exposed Enbridge crude oil pipeline in the Tamarac River in Marshall County, MN. (Photo: Dan Gunderson/MPR News)

The exposed pipes run the risk of pipelines being damaged, but no law requires Enbridge to rebury them. Risks increase the longer a line is exposed, but determining the level of risk is up to Enbridge, not the Office of Pipeline Safety. Although federal regulations specify how deep pipelines must be buried, the rules only apply during initial construction, and there is absolutely no law to require Enbridge to rebury the pipe.[65]

River crossing issues will continue to grow as the climate continues to change. Flood events and alterations of waterway dynamics, changes in freeze/thaw cycles are all elements of climate change. The rapidly shifting climate can increase scour in river beds, and increase the likelihood of a spill at river crossings.

Spill Response

The EIS should include a thorough analysis of Enbridge's performance history in responding to spills. According to the Wall Street Journal, an estimated 80% of spills are actually detected by civilians, despite pipeline companies enormous investments in state of the art detection systems.[66]

A federal audit of Enbridge's 2010 spill in Marshall, MI, showed that Enbridge was unable to stop leaks on aging pipelines, and still does not know the best way to completely clean up after a catastrophic spill. The audit showed that Enbridge could not prove that it knew how to monitor and repair pipeline cracks forming from corrosion - the key factor that had led to two major Enbridge oil spill disasters in 2007 and 2010 in Glenavon, Saskatchewan and Marshall, Michigan.[67] As it were, Enbridge lobbied hard to demand the NEB remove the most incriminating parts of that report, and covered up two secret environmental documents.

In fact, Enbridge has lobbied aggressively against responsible spill response regulations in Minnesota. In an October 2014 letter to the Environmental Quality Board, a number of Minnesota legislators pointed out Enbridge's resistance and determination to thwart any safety regulations by the state of Minnesota. The letter, from Minnesota Senators Steve Dribble, John Marty and Representatives Frank Hornstein and Jean Wagenius, stated:

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[65] Jon Wolfgram, chief engineer for the Minnesota Office of Pipeline Safety

[66] http://thinkprogress.org/climate/2014/01/21/3186261/pipeline-spills-discovered-people/

[67] http://www.nationalobserver.com/2016/05/02/news/heres-how-enbridge-edited-federal-pipeline-audit

" Enbridge and the pipeline industry were **unwilling to agree** to: Provide a qualified company employee to advise public sector incident commander by telephone within one hour of a major pipeline oil discharge;

- Provide monitoring equipment within three hours of a discharge, or to develop an annual plan to deliver monitoring equipment to a discharge site to comply with the provision;
- Provide qualified personnel to advise incident commanders at the discharge site within three hours of a major spill;
- Provide containment booms from land across sewer outfalls, creeks, ditches and other places where oil and other hazardous substances may drain in order to contain leaked material before it reaches those resources;
- To have capability to deliver containment booms, boats, oil recovery equipment and trained staff within eight hours of a confirmed discharge to recover 10% of a worst case discharge, including protection of listed sensitive areas and potable water intakes within one mile of a discharge site
- Deliver equipment to protect sensitive environmental areas and drinking water intakes, within 60 hours of a major spill
- Provide updated disaster prevention and response plans to the Pollution Control Agency every three years ..."

National Academy of Sciences Report on Diluted Bitumen Spills

A recently released National Academy of Sciences Report[68] document shows how uniquely dangerous the transportation of tar sands oil is for water-rich regions. The report, entitled "Spills of Diluted Bitumen from Pipelines: A Comparative Study of Environmental Fate, Effects, and Response," provides unprecedented data documenting the grave environmental, economic, and public health impacts of diluted bitumen or "dilbit" spills, especially in places with abundant freshwater resources such as Wisconsin and Minnesota. The relevant conclusions of that report are too many to list here, but the overall insight is that tar sands oil spills constitute a COMPLETELY different animal than that of any other type of crude oil, with uniquely devastating ecological effects when interacting with water. The study documents in detail how, in comparison to other commonly transported crude oils, many of the chemical and physical properties of diluted bitumen, especially those relevant to environmental impacts, differ substantially from other types of crude oil. The key differences are in the exceptionally high density, viscosity, and adhesion properties of the bitumen component of the diluted bitumen that dictate environmental behavior as the crude oil is subjected to weathering (physical and chemical changes of spilled oil over time). The report also documents the utter lack of methodology for cleaning up dilbit spills. In other words, we are entirely unprepared for what's coming our way.

CONCLUSIONS

These two projects, the Sandpiper and Line 3 Replacement, represent an enormous investment in dirty oil infrastructure that the world does not need. The existing scoping document downplays the enormity of the task at hand and recklessly narrows the scope of impacts being considered, to the detriment of the public, especially the Anishinaabeg. The scoping document is grossly inadequate and will fail to produce an EIS that will enable the State of Minnesota to protect the environment and prevent significant human harm. Residents of the State of Minnesota, acting as global citizens, demand a comprehensive and transparent EIS process. Honor the Earth has outlined a number of ways to improve the scope of the EIS including: correct project purpose definitions; changes to geographic and jurisdictional scope; a new regulatory structure; appropriate research methodology; an extended timeline; a critical economic review; a well to wheels assessment of emissions and climate impacts; an analysis of human health impacts in at-risk communities; a comprehensive investigation into cultural sites impacts; and a comprehensive spill modeling/response review. These changes are necessary to uphold the National Environmental Policy Act (NEPA) and the Minnesota Environmental Policy Act (MEPA).

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[68] National Academies Press, http://www.nap.edu/21834

TREATY RIGHTS AND OIL PIPELINES:
What You Need To Know

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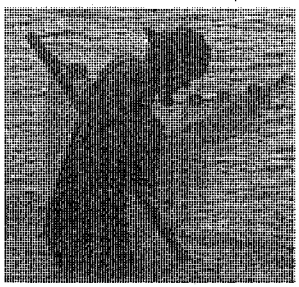
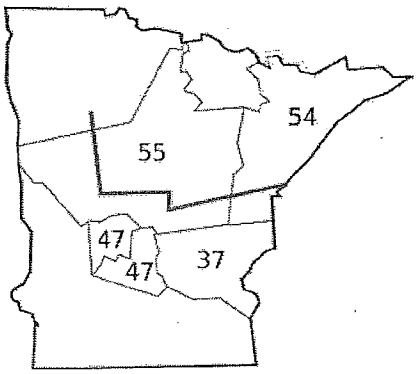
SUMMARY:
Even on ceded territory (off-reservation), Ojibwe tribal members retain certain property rights that allow them to "make a modest living from the land." These use-rights are called usufructuary rights, and are guaranteed by the treaties between Ojibwe bands and the US government, protected by the US Constitution, and affirmed by the US Supreme Court. They include the rights to hunt, fish, gather medicinal plants, harvest and cultivate wild rice, and preserve sacred or culturally significant sites.



The proposed new oil pipelines in northern MN violate the treaty rights of the Anishinaabeg by endangering critical natural resources in the 1854, 1855, and 1867 treaty areas. All pipelines leak, and catastrophes like Enbridge's 1 million gallon spill in 2010 on the Kalamazoo River are not unlikely. The pipelines threaten the culture, way of life, and physical survival of the Ojibwe people. Where there is wild rice, there are Anishinaabeg, and where there are Anishinaabeg, there is wild rice. It is our sacred food. Without it we will die. It's that simple.

HISTORY:

• **1837 White Pine Treaty** (aka Treaty of St. Peters) – July 29, 1837 at Fort Snelling.
The Ojibwe nations ceded to the US a large tract of modern-day MN and WI (east of the Mississippi River and south of Lake Superior). The purpose was to exploit the region's lumber resources, especially giant white pines, for use in the construction boom across the country. The United States bought millions of acres for about $24,000. In turn, Article 5 granted the signatory Ojibwe bands usufructuary rights to hunt, fish and gather within the ceded territory. An Ojibwe chief from Leech Lake known as Eshkibagikoonzhe (Flat Mouth) demanded that his people retain the right to "get their living from the lakes and rivers" because "we cannot live, deprived of our lakes and rivers."



• **1855 Treaty with the Chippewa** – February 22, 1855 in Washington DC.
The Ojibwe ceded 10 million acres of northern Minnesota lake country, including the headwaters of the Mississippi River, and the US government established 9 small reservations.

• **The Voigt Decision (1983)** - In the 1970s, the Lac Court Orielles Band of Ojibwe challenged Wisconsin's efforts to regulate their hunting and fishing off-reservation. The conflict started when 2 Ojibwe men were arrested for harvesting fish with spears, and charged with poaching. In 1983, the US 7th Circuit Court of Appeals delivered the "Voigt Decision" in *LCO Band of Chippewa Indians v. Lester P. Voigt, et al*, affirming Ojibwe rights to hunt and fish anywhere on ceded territory, even on privately owned land. Over the next 8 years, which were marked by civil unrest and racial conflict as white sport fishermen protested tribal members' exercising of treaty rights, the US District Court rejected repeated appeals by the State of Wisconsin. The US Supreme Court refused to hear the case, and the Voigt decision still stands today.

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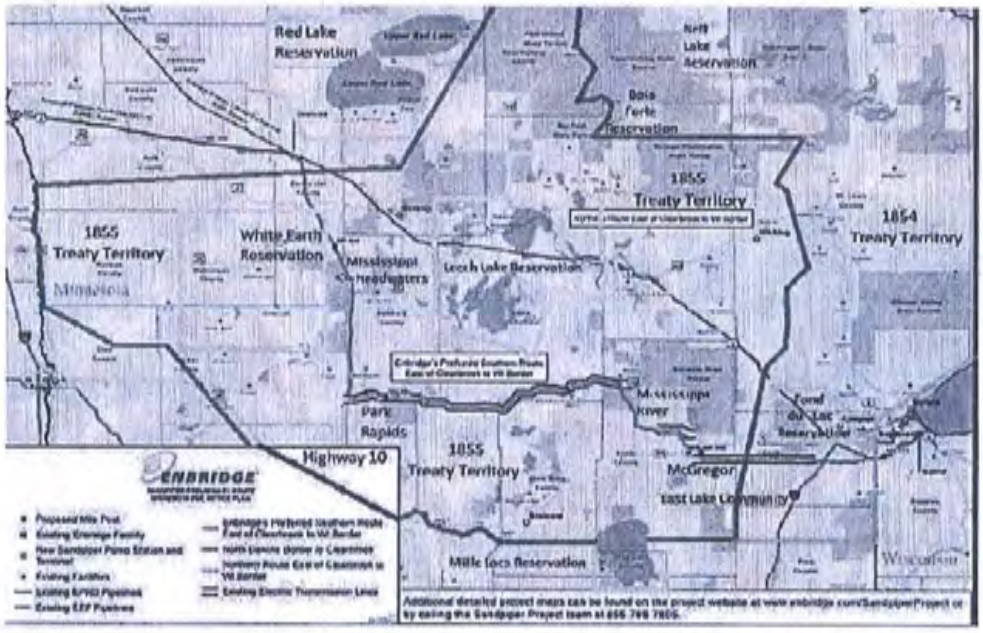
• 1999 Supreme Court Decision - Minnesota v. Mille Lacs Band of Chippewa Indians

This is the landmark decision. During the 70s and 80s, Ojibwe tribal members in Minnesota were repeatedly arrested and harassed for asserting their fishing rights. This led to a series of protracted legal battles, culminating in the 1999 U.S. Supreme Court decision *Minnesota v. Mille Lacs*. The Court ruled that the Ojibwe retained hunting, fishing, and gathering rights on the lands it had ceded to the federal government in the 1837 White Pine Treaty and that the state governments of MI, MN, and WI, had unfairly asserted authority of hunting and fishing rights without regard for treaty rights guaranteed to the Ojibwe before those states were even formed. The Court also concluded that the same protections survived in the 1855 Treaty, even though it did not explicitly outline usufructuary rights, because the Chippewa delegates that signed it clearly did not believe they were relinquishing such rights.

• 2015 Squarehook case

Operation Squarehook was a large multi-year state and federal investigation into black market walleye. On Feb. 10, 2015, the 8th Circuit U.S. Court of Appeals ruled that the federal government could not prosecute 4 Ojibwe men for netting walleye on Leech Lake Reservation and selling them. This upheld the 2013 US District Court decision to toss the cases. The men were accused of selling hundreds of thousands of dollars' worth of netted fish and charged with wildlife trafficking under the Lacey Act. The court upheld the rights guaranteed by the 1837 White Pine Treaty as the same rights the signatory Chiefs would have understood in 1855, even though the 1855 treaty did not directly apply because the Leech Lake Reservation did not exist yet. In its decision, the court repeatedly referenced the Supreme Court's landmark 1999 Mille Lacs decision. It effectively ended Operation Squarehook.



TRIBAL INTERVENTION AGAINST THE SANDPIPER/LINE 3 CORRIDOR:

Tribal nations have federally protected property rights in the treaty areas, yet have not even been consulted about the Sandpiper/Line 3 corridor. The PUC bluntly denied requests for public hearings on the reservations. So in June 2015, the White Earth and Mille Lacs Bands each held their own public hearings to document public sentiment and expert testimony on potential impacts. The bands also wrote letters to the PUC asking for a stay on the permitting process until tribes could be property consulted, and letters to Governor Mark Dayton asking him to fulfill his responsibilities for cooperation with tribal governments as outlined in Executive Order 13-10. Approval of this pipeline corridor is a declaration of war against the Anishinaabeg, a slap in the face of tribal governments, and a threat to the precious fresh water of Minnesota. Tribal governments are now exploring options for intervention at the federal level and expect a long and protracted legal and regulatory battle over the coming years.

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THE CASE AGAINST MARATHON

Withdraw from the Sandpiper Pipeline!

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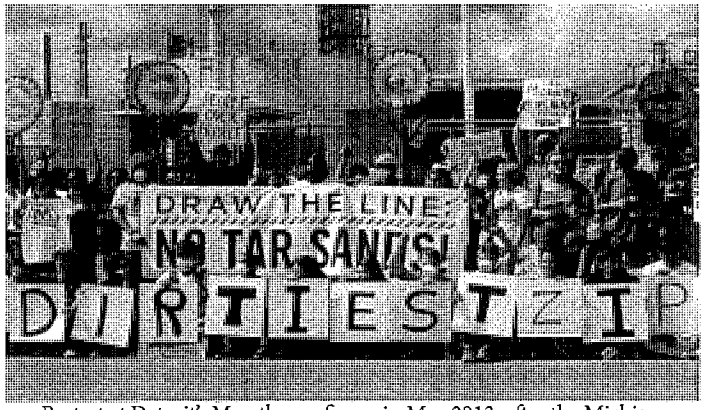
BACKGROUND:

The proposed Sandpiper pipeline is a joint venture between Enbridge Energy and Marathon Petroleum Corporation. Marathon is the "anchor shipper" that makes the project economically viable by committing to use the pipeline to transport oil they extract in North Dakota. Marathon plans to pay 37.5% of the Sandpiper's construction costs in exchange for a 27% ownership interest in the project. The MN PUC issued a Certificate of Need for the Sandpiper based on Marathon's interest and "need." But Marathon doesn't need this pipeline. None of us need this pipeline. It's time for Marathon to witrhdraw from the Sandpiper because it is a losing project - financially, and for all of us.

RISKY BUSINESS FOR MARATHON:

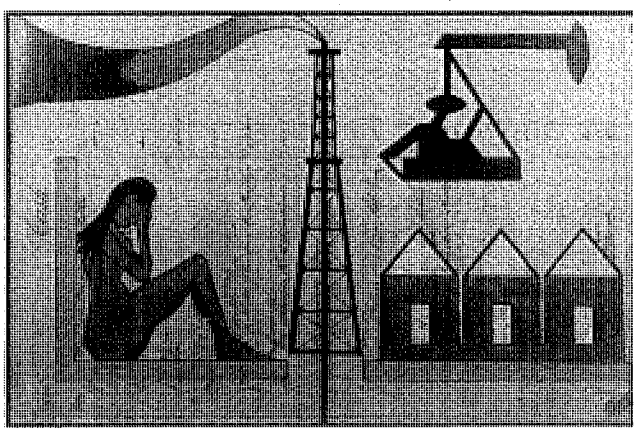
Marathon should withdraw from the Sandpiper because it is financially disastrous for them. With oil prices remaining at historic lows, Bakken drillers are going bankrupt. There were only 29 active rigs in April 2016, down from over 220 just a few years ago. Marathon recently had 7 active rigs in the Bakken, but as of April 2016, they have ZERO. Continued delays on the Sandpiper/Line 3 corridor are increasing project costs, and Minnesota's regulatory agencies are still debating how to proceed. It is not clear that the project will move forward. And Marathon is not in a position to make mistakes. Marathon Petroleum Corporation's stock prices have dropped more than 50% from recent highs in 2015. Marathon Oil Corporation, the sister subsidiary that does all the drilling, saw their prices drop more than 75% from recent highs. Last year they posted $2.2 billion in losses, cut their capital investments in half, and laid off over 10% of their employees.



Protest at Detroit's Marathon refinery in May 2013, after the Michigan OSHA announced it was giving Marathon a safety award, one week after the refinery had an explosion. (Photo by Emma Lockridge)

A "WELLS TO WHEELS" VIEW OF IMPACT:

Infrastructure impact analysis should start at the oil well and finish at the gas tank. Marathon has been one of the major drillers in the Bakken, in Mandan, Hidatsa, and Arikara territory. Their wells are located mostly around the sacred waters of Lake Sakakawea, on and near the Ft. Berthold Reservation. This is "fracked" oil, extracted by blasting millions of gallons of water and a slurry of toxic chemicals deep into the bedrock of Mother Earth. It's "Extreme Extraction," proven to cause earthquakes and poison aquifers, and has been banned outright in a long list of cities, states, provinces, and countries around the world. Our relatives in the Three Affiliated Tribes are facing epidemics of health problems, drug and sex trafficking, violent crime, and traffic deaths. Oil companies should be responsible for the damages their extraction causes to our communiites. Marathon is responsible for the major diesel spill on the Wabash River in April 2016 - not a drop of the 50,000 gallons was recovered. Marathon also operates a refinery in Detroit that is poisoning the surrounding neighborhoods. The refinery processes tar sands oil, one of the dirtiest fuels on the planet, and its emissions are causing serious health problems in the African-American neighborhood of Boynton (see reverse for details).



"Woman Lost in Man Camp," John Isaiah Pepion.

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TAKING ACTION:

As our opposition to the Sandpiper continues to grow, we ask you to join us in calling on Marathon to withdraw from the project. The Mille Lacs Band of Ojibwe has terminated the leases at all 3 of its Marathon gas stations. And we are contacting Marathon station owners in MN and asking them to switch to a more responsible alternative that supports the local economy and avoids these blatant human rights violations.

Marathon should not poison the people of Boynton at their Detroit refinery. They should buy those people out. Marathon should not be fracking in the Bakken. And they should not push that volatile Bakken crude oil throgh our territory and through the Great Lakes. The Sandpiper would be too destructive to our water, our wild rice, our climate, and our way of life as Anishinaabe. We have enough fossil fuel infrastructure, and it is time to transition to a new economy.

WHAT YOU CAN DO:

1. Contact Marathon and ask them to withdraw from the proposed Sandpiper pipeline project:
   Gary Heminger, CEO, Marathon Petroleum Corporation, 539 South Main St., Findlay, OH 45840
2. Help us tell people the truth about Marathon's projects - share our literature and images broadly.
3. Support our work by donating thru our website, or signing up for a monthly contribution.

ENVIRONMENTAL INJUSTICE IN DETROIT

The Marathon refinery in Detroit is located in zip code 48217, the most polluted in the state, where the MI Department of Health has documented consistently elevated rates of cancer, respiratory disease, and kidney failure. Emma Lockridge, a nearby resident, says "We don't live next to the refinery, we live IN the refinery...it is just horrific. We are a sick community." When the refinery switched from conventional oil to tar sands, Marathon bought the homes of about 200 people in the mostly white neighborhood of Oakwood Heights, which is not even directly in the prevailing path of emissions, as the mostly black neighborhood of Boynton is. They've left the black folks in Boynton there to suffer, consistently denying their requests for buyouts and emergency evacuation. Lockridge, a leader in the resistance movement, says: "There's 10 empty houses on my block...people don't even want the houses. We can't even get squatters." She says the message from Marathon and state regulators is clear: "Walk away or die...at the end of the day, they're killing us." Marathon is now applying for permits to increase emissions even more, in order to produce cleaner-burning vehicle fuel as required by new federal standards. In other words, this neighborhood is being further sacrificed in order to reduce pollution elsewhere. The MI Department of Environmental Quality says it is "poised to approve the project," despite a threatened lawsuit from Detroit Mayor Mike Duggan and a a statement from a coalition of state senators calling on them to reject it, comparing the situation to the poisoned water crisis in Flint. Residents filed a class-action lawsuit against Marathon in US District Court on February 23, 2016.



Emma Lockridge, neigborhood resident and activist demanding a buyout from Marathon in order to evacuate the Detroit refinery area.

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LINE 3 PIPELINE ABANDONMENT:
What You Need To Know

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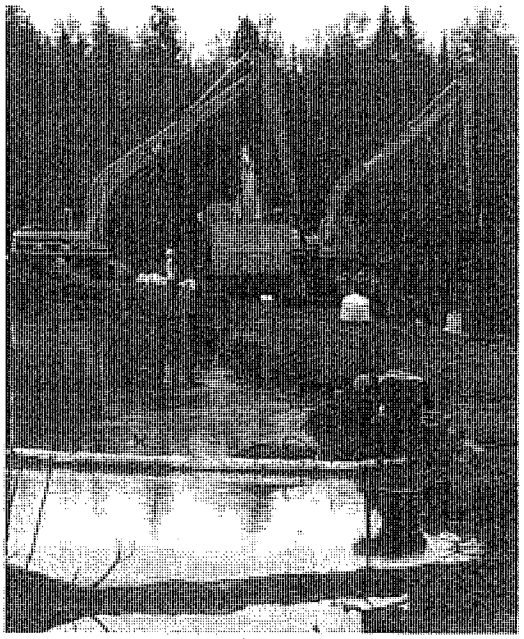
SUMMARY:
Enbridge's Line 3 Pipeline ships Tar Sands crude from Alberta to Superior, WI, spanning over 300 miles across Northern Minnesota, crossing the Red Lake, Leech Lake and Fond du Lac reservations and the 1855 and 1842 treaty areas. Line 3 was built in 1961 and now has significant structural integrity problems. Enbridge's latest public estimates indicate over 900 integrity "anomalies" in the pipeline. Instead of fixing it or removing it, they want simply to abandon the pipeline and build a new one, the Line 3 Replacement, in the Sandpiper corridor. The State of Minnesota has absolutely no regulatory guidelines for pipeline abandonment. Although Enbridge receives powers of eminent domain to build its pipelines, they are not required to assume any responsibility for them when they die. They are allowed to leave behind what is likely a superfund site. Tribal members, homeowners, local businesses, and people across the north are standing up to say no, and demand a state ordinance and regulatory process, as well as an insurance requirement.

DEATH OF A PIPELINE:
Enbridge has gathered extensive integrity data on Line 3 throughout its operation. The data shows a high number of integrity anomalies – specifically, corrosion and long seam cracking. As a result of these anomalies, Line 3 has experienced a number of failures during its 54 years of history. As a result, Line 3 requires a high level of integrity monitoring and an extensive on-going integrity dig and repair program to maintain safe operation. Approximately 4,000 integrity digs in the US alone are currently forecasted for Line 3 over the next 15 years, just to maintain its current level of operation. This would result in repeated impacts to landowners and the environment.



REGULATORY FAILURE (AGAIN):
At the state level, there are no abandonment guidelines or definitions for intrastate gas, liquids, or oil pipelines. Any mention of abandonment of pipeline procedures follows the federal guidelines for disconnecting from active gas service and purging of any hazardous substance. If Enbridge is not required to remove the pipeline and restore the damaged ecosystems, there may never be a full accounting of the on-going and future contamination surrounding the pipeline. All those "structural anomalies" mean there is likely a lot of oil in the soil now. This contamination would become the responsibility of nearby landowners, if discovered.

PIPELINE ABANDONMENT IN CANADA:
The US has vague and inadequate laws on pipeline abandonment, but the Canadian Energy Board has a pipeline abandonment guidance document. It includes info on pipeline corrossion and soil subsidence, reccommending any pipeline owner/operator considering the abandonment of a pipeline to conduct a professional, site-specific analysis to evaluate potential impact. Potential sources of soil and groundwater contamination include:

- substances produced in the reservoir and deposited on the walls of the pipeline;
- treatment chemicals in the pipeline;
- the line pipe and associated facilities;
- pipeline coatings and their degradation products;

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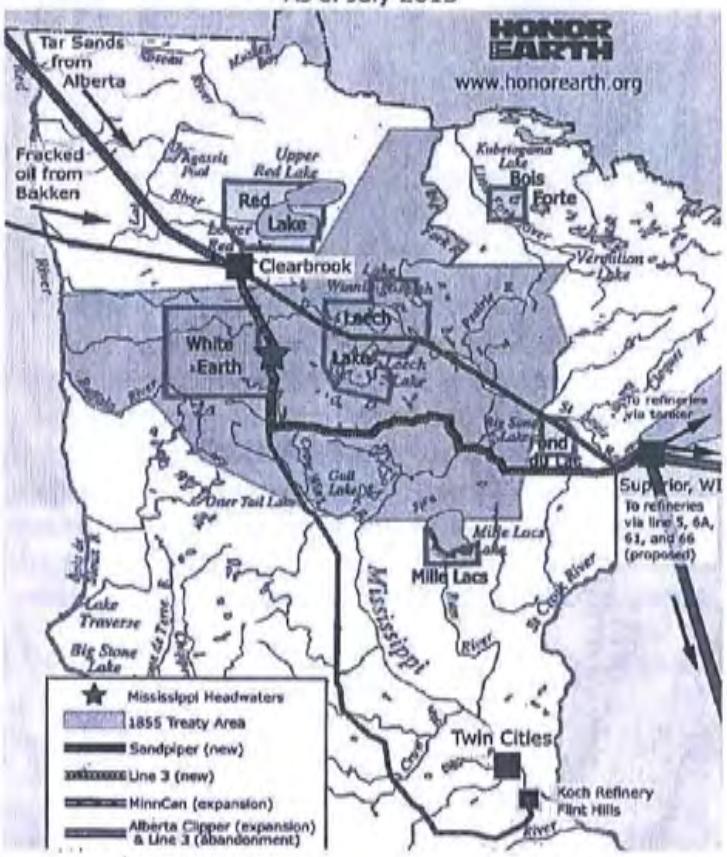
- historical leaks and spills;
- possible PCB contamination, from lubricants.

The document also discusses the enormous hydrological impact of abandoning a pipeline, which can transform over time into water conduits. Eventually, corrosion allows water to enter the pipe, which leads to unnatural drainage of areas such as muskegs, sloughs, or marshes, affecting the natural balance of the ecosystem and increasing the risk of soil and water contamination, especially in wetlands. Any water that infiltrates the pipeline is likely to carry residual contaminants left in the abandoned pipeline as it flows.

MINNESOTA OIL PIPELINE PROPOSALS
As of July 2015



PUBLIC HEARINGS ON LINE 3:

There is no regulatory process for the proposed abandonment of Line 3, so the public should voice their concerns at the MN Public Utilities Commission's public hearings on the new Line 3 construction permit, and recorded in that docket. Public hearings will be held in August 11-26, in 11 different towns across Northern Minnesota. See our website for details (honorearth.org/events) or the PUC website (mn.gov/puc). The Certificate of Need docket is CN-14-916 and the Route Permit docket is PPL-15-137. Comments are accepted through September 30, 2015. Always Include docket numbers! There are 4 ways to submit:

1. Online: mn.gov/commerce/energyfacilities/#comment
2. Email to jamie.macalister@state.mn.us
3. Fax to 651-539-0109
4. mail to: Jamie MacAlister, Environmental Review Manager, Minnesota Department of Commerce 85 7th Place East, Suite 500, St. Paul MN 55101

Tribal governments, environmental organizations, and citizens continue to intervene in the Sandpiper/Line 3 corridor. We expect federal intervention and a protracted legal and regulatory battle over the coming years.

OTHER WAYS TO TAKE ACTION:

1. Stay informed. Follow us on facebook + our website, come to our events this summer, contact us.
2. Speak out: Contact your tribal leaders, your City Councilmembers, County Commissioners, and especially Governor Mark Dayton (651-201-3400). Tell them they have a responsibility to protect Minnesota's precious resources, honor our treaties, and work with tribal governments.
3. Connect with your local environmental groups or faith communities.
4. Support our work by donating thru our website,, or signing up for a monthly contribution.

LOVE WATER NOT OIL

VISIT OUR WEBSITE FOR RESOURCES AND WAYS TO TAKE ACTION TODAY!

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Follow us on facebook:
@Winona LaDuke Honor the Earth



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STOP THE ENBRIDGE ENERGY CORRIDOR!

Join thousands of tribal members, homeowners, farmers, townships, businesses, and citizen groups opposing an oil superhighway across the northland. Love Water Not Oil!

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BACKGROUND:

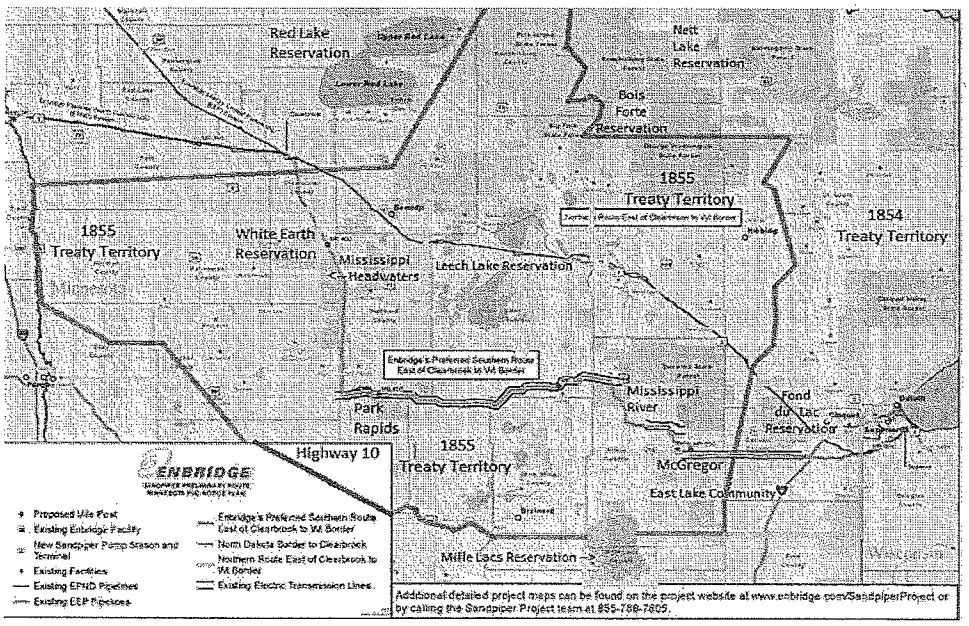
The development of new fossil fuel infrastructure is accelerating in Minnesota. We are becoming a superhighway for oil that we neither produce or consume, yet we take all the risk. Enbridge, a Canadian corporation, is proposing to transport 1.4 million barrels of oil per day through a new southern route, from the North Dakota border to Superior, WI. This is a dramatic increase from the original Sandpiper proposal of 375,000 bpd. To put this in context, this is more than triple the current capacity of the Alberta Clipper pipeline (450,000 bpd) and almost double the capacity of the proposed Keystone XL pipeline (830,000 bpd).

THE PIPELINES:

- **Sandpiper:** This new pipeline would carry highly volatile Bakken Crude oil, at an initial capacity of 375,000 barrels per day, with the potential to increase to 640,000 bpd.
- **Line 3 Replacement:** Enbridge is proposing to build the replacement of Line 3 along the same corridor as the Sandpiper, and abandon the old, rusted Line 3 pipeline, with unkown consequences. The new line would move up to 760,000 bpd of dirty Alberta Tar Sands oil.

THE ROUTE:

The proposed route crosses through some of the most delicate soils, aquifers and pristine lakes in northern Minnesota, the watersheds of Rice Lake , the Mississippi Headwaters, Crow Wing, Big Sandy Lake, Rice Lake Refuge and into Superior.



THE PROBLEMS:

- **Inevitable Spills:**

Enbridge has promised that safety will be of the upmost concern, but their history suggests otherwise. They have had over 800 spills in the last 15 years, including the largest inland oil spill in US history (1.2 million gallons) on the Kalamazoo River in 2010. In late December 2014, an Enbridge line leaked in Canada, spilling 57,000 gallons of oil in a few minutes. On Jan 2, 2015, tanks exploded at its offices

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in Williston, ND. In the last 2 years, over 300 pipeline spills went unreported in North Dakota alone! A full rupture of the Sandpiper would release over 20,000 gallons of oil per minute, making million-gallon spills entirely possible. Smaller spills are harder to detect and can last for days.

• Refusal to Respond Appropriately:
In the past MN legislative session, Enbridge lobbied agressively against legislation that would improve disaster response, and refused to agree with many reasonable measures that would improve preparedness, prevention, containment, and cleanup.

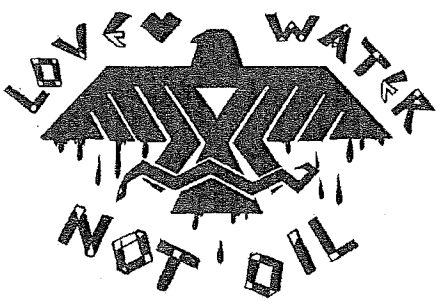
• Treaty Rights Violations:
The US government has a responsibility under federal law to honor the rights guaranteed to tribal members in their treaties. The proposed pipelines would violate the treaty rights of the Anishinaabeg by endangering primary areas of hunting, fishing, wild rice harvest, medicinal plant harvest, and organically certified wild rice crops outlined in the 1867, 1855 and 1854 treaty areas. The US Supreme Court has upheld the rights of native peoples to hunt, fish, and subsist off the land. An important February 2015 decision by the US 8th Circuit Court of Appeals upheld the rights of Ojibwe people to hunt and sell fish in the 1855 treaty area. These pipelines threaten the culture, way of life, and physical survival of the Ojibwe people.

• Property Rights and Insurance:
On June 5, 2015, the MN Public Utilities Commission granted Enbridge a Certificate of Need for the Sandpiper pipeline, which gives the company eminent domain, on grounds that it is a public utility providing a public benefit. This allows them to take property without landowner consent. This is a problem: Enbridge is a private Canadian corporation that will earn billions in profit by carrying privately owned oil for privately owned oil-companies. Enbridge is now suing North Dakota family James and Krista Botsford for their land, and the case may set precedent. The Botsfords found that no insurance company would insure their farm in case of a spill, and that is after an Enbridge cleanup.

GET INVOLVED:

This battle is just getting started!! The next phase of the PUC process is the route permit, and an alliance of tribes, landowners, and citizen groups are working to at least push the route south of the lake country. Meanwhile, our resistance is building and the tribes are asserting their political power, preparing for legal and regulatory interventions at the federal level. Here's how you can get involved:

1. Stay informed. Follow us on facebook + our website, come to our events this summer, contact us.
2. Speak out: Contact your tribal leaders, your City Councilmembers, County Commissioners, and especially Governor Mark Dayton (651-201-3400). Tell them they have a responsibility to protect Minnesota's precious resources, honor our treaties, and work with tribal governments.
3. Connect with your local environmental groups or faith communities.
4. Support our work by donating thru our website,, or signing up for a monthly contribution.



Visit our website for articles, videos, and resources to stay informed and organize:

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THE CLIMATE COSTS OF ENBRIDGE OIL PIPELINES

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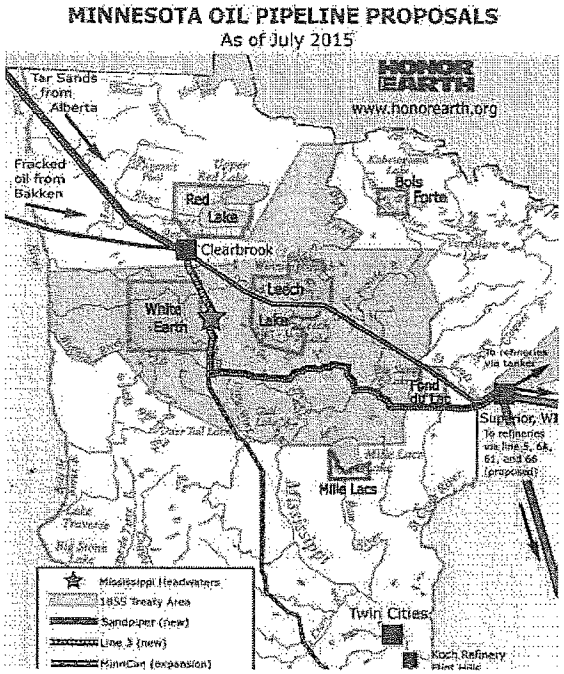
Accounting for the Climate Costs of Oil

As global leaders talk carbon capping at COP21 in Paris, Honor the Earth has prepared an invoice for the climate costs of Enbridge's proposed oil pipelines in Minnesota. Enbridge is liable for the carbon emissions their pipeline system enables. We want Enbridge to establish a fund to repair the damage they would cause with new lines and expansions.

Carbon Costs

To calculate the carbon costs of these pipelines, we take the total volume of oil moving through three pipelines - the Sandpiper, Line 3, and the Alberta Clipper - and convert that to carbon equivalents. This tells us how many metric tons of carbon will be released into the atmosphere through the refining and use of the oil. We then calculate the cost to remove that carbon. The American Physics Society estimates that removing carbon from the atmosphere costs $600 per metric ton. The total cost for these 3 pipelines would be over **$198 billion, annually!**



Ecosystem costs

We also calculate costs for the loss of vital ecosystems. Our boreal forests and wetlands sequester carbon, stabilize fluctuations, and provide a buffer against climate impacts. A full carbon accounting must include the loss of these ecological services. To do that, we first calculate the land area lost to tailing ponds. Each barrel of oil creates approximately 16.9 barrels of toxic tailings.[1] We multiply this by the proposed volume in the pipelines, and convert it to hectares. We also estimate the total area of wetlands destroyed during the construction of the new corridor, which Enbridge has no plan to restore. We then place values these areas of land using estiamtes from the field of Ecosystem Services Valuation.[2] The total cost of the loss of ecosystem services for the three pipelines is over **$26 billion, annually.** Our estimates for area impacted and cost per hectare are probably both extremely low.

An Incomplete Total

Adding these costs together give us a full cost of over **$224 billion annually.** Of course, there are currently no real plans to remove the carbon or restore the forests and wetlands. So these annual costs should be set aside for future generations. Even at a conservative compound interest rate of 1%, the costs for the next seven generations (140 years) total over **$68 trillion!!** Of course, we are still far from accounting for the TRUE cost of oil. We have not included the cost of climate conflicts, natural disasters caused by extreme weather events, the loss of biodiversity, or the inevitable damages to our fresh water and sacred manoomin when (not IF) these pipelines spill. Some things simply cannot be monetized.

LOVE WATER NOT OIL

1 "Waste Streams of Mined Oil Sands: Characteristics and Remediation," Kasperski and Mikula, Elements, Dec 2011 vol 7 pp 387-392.

2 For boreal forest we use $160/hectare/yr (Canadian Forest Congress, http://bit.ly/1m3MuL0). For wetlands we use $5,625/acre/yr (Earth Economics, "The Value of Nature's Benefits in the St. Louis River Watershed")

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From: paige [mailto:paigebusse@hotmail.com]
Sent: Wednesday, April 02, 2014 1:01 AM
To: Hartman, Larry (COMM)
Subject: Sandpiper routing permit public comment

To Whom it May Concern:

We are an alliance of berry pickers, we call ourselves Mawinzo Asiginigaazo, which means, berry pickers gathering. We are in opposition to the proposed Sandpiper pipeline and request that you do not grant a permit for the construction of this pipeline.

The relationship to this docket is that the pipeline would run adjacent to the largest berry patches in this region. This ecosystem lies east of the proposed route from Moose Creek Township in Clearwater County to Lake Alice Township in Hubbard County. The Mississippi River flows next to one particular area and is downstream from where the pipeline would cross beneath this said river. Due to the nature of oil with its known carcinogens, an oil spill would be detrimental to the groundwater and river habitat, therefore effecting the berries. We depend on these berries not only for nourishment but they are a key component of our cultural resources. There are seven types of berries that we harvest in this area, along with hazelnuts and many types of medicinal plants. These are all considered organic. The list of berries consist of; juneberries, pin cherry, strawberries, blueberries, huckleberries, raspberries and chokecherries.

The Anishinaabe have traveled and camped next to these berry patches for hundreds of years. We have continued to enjoy this perfect ecosystem along with our neighbors who are not Anishinaabe. We want to continue to pick these berries for our families, camp next to these berry patches as our ancestors did and we want our children, grandchildren and great-grandchildren to be able to do the same.

We do not propose an alternative route because we do not see an alternative. We do not want any additional pipelines built in the state of Minnesota. We want to see alternative fuel sources developed rather than our continued dependence upon fossil fuels which are known to increase carbon dioxide in the atmosphere. Increased carbon dioxide in the atmosphere has contributed to negative global weather changes.

We do not support the proposed project in this docket. Pipeline ruptures and oil spills are happening all over the world at increasing rates. We do not want to increase our chances of a spill by allowing this level 4 explosive oil to run through these lands via. the Sandpiper.

Thank you for your time,

The members of Mawinzo Asinigaazo

From: Janet Hill [mailto:janet.hill@rocketmail.com]
Sent: Wednesday, March 12, 2014 1:27 PM
To: Hartman, Larry (COMM)
Subject: Public Comment for PPL-13-474 (Sandpiper Pipeline Route), Alternative Routes

To the Minnesota Public Utilities Commission:

The Big Sandy Lake Association submits the following comment in response to the request for alternative routes for the Sandpiper project.

Who we are. The Big Sandy Lake Association (BSLA) is a strong, not-for-profit lake association in Aitkin County with 540 members. The BSLA has been in existence since the 1950s. Part of our mission is to promote good lake management for Big Sandy Lake, serve as the voice for our membership in matters under consideration by federal, state, and local government bodies and agencies, and promote the welfare of the lake, its watershed, and surrounding area.

About our area: Big Sandy Lake is located in the Big Sandy Lake Watershed, the largest acreage of which is in Aitkin County, and which includes parts of Carlton and St. Louis counties. The map below shows the watershed and the proposed pipeline route passing through it.

Big Sandy Lake is at the receiving end of water flow from this watershed; our lake is the last stop before the water heads into the Mississippi River via a short stretch of the Sandy River. As such, Big Sandy Lake receives all runoff -- natural and man-made -- that finds its way into our watershed.

Big Sandy Lake is one of Minnesota's premier recreational lakes. At 6,526 acres, it is among the largest lakes in Minnesota, and is a popular fishing lake. It has between 950 and 1,000 lake homes, of which about half are homesteaded. Its islands and peninsulas enhance its beauty, and its proximity to the Twin Cities make it a popular destination for cabins and camps. Many residents have property on the lake that has been in the family for generations.

Our lake has rich historical significance, in that Big Sandy Lake (formerly called Sandy Lake) was part of what was once the main trade route between the eastern and western United States. Many generations of native Americans, and later, fur-trading voyageurs, used this route as their main "highway." Their trail -- the Savannah Portage -- includes a six-mile portage between the West and East Savanna rivers (now within Savanna State Park, which is also within the Big Sandy Lake watershed). Beginning around 1755, this trail was used for more than a century as the main route between east and west by fur traders, explorers, and missionaries. It hosted explorers such as Zebulon Pike, Lewis Cass, and Henry Rowe Schoolcraft, who all wrote about Sandy Lake in their journals. During the fur-trade era in the early 19th century, two fur trading posts were located on Big Sandy Lake, and artifacts from these posts are still being found by local residents.

Our concerns: The BSLA has two main concerns with the proposed Sandpiper Project:

- Our first concern is with the very real possibility of oil spills and leaks within the Big Sandy Watershed if the Sandpiper corridor is built. Despite claims by Enbridge, pipeline spills and leaks *do* happen, and they have caused well-documented and widespread damage to regions through which Enbridge has installed pipelines. Our mission -- as an organization established to protect our waters
  -- makes it impossible for us to approve of a pipeline and its accompanying risk of spills and leaks to be constructed through the watershed that feeds our lake.
- We also are concerned with the number of pipelines that will eventually be installed in the Sandpiper corridor. Despite claims by Enbridge that this corridor is for one pipeline only, if the Sandpiper Project is completed, Enbridge will have in place the established infrastructure, the environmental protocol, and the market connections it needs to reduce its cost of installing more pipelines in this corridor in the future. It would be a stretch to assume that Enbridge, with its

apparent "need" for more pipelines, would not add pipelines to the Sandpiper corridor in the future. Each new pipeline increases the risk of spills and leaks. We also know that tar sands are among the materials being transported by Enbridge, and that there is a possibility that future pipelines could carry tar sands.

Enbridge claims that we take issue with: In the *North Dakota Pipeline Company LLC Minnesota Environmental Information Report*, Section 9.1 Major Basins and Watersheds, Enbridge writes, "The [Sandpiper] project also crosses the Big Sandy Lake Watershed Management Project between MPs 540.5 and 562.4 in Aitkin and Carlton counties, which includes Big Sandy Lake and Lake Minnewawa. Both lakes are currently listed as 303(d) impaired Waters List due to excessive nutrients, specifically phosphorous loading. Neither lake is crossed by the Project."

In this statement, Enbridge appears to be saying that because Big Sandy Lake would not be crossed by the Sandpiper pipeline, and because it is on the impaired waters list, that it can be dismissed from consideration for protection. We have a few comments to make on this:

- The impaired waters status of Big Sandy Lake is due in part to phosphorus levels. These phosphorus levels are, in turn, partly due to organic phosphorus being washed down from the many wetlands in our watershed. In other words, part of our higher-than-acceptable phosphorus numbers occur *naturally*.
- The impaired waters list was not designed by the state of Minnesota to condemn lakes that need no protection. Quite the opposite: listing lakes and rivers on the impaired waters list is the first step in attempts to repair them. Once they're on the list, the state works with local governments and citizen groups to design clean-up plans, and state funds are budgeted for this purpose. Forty percent of Minnesota's waters are on the impaired waters list and are receiving state funds.
- Over the past years, Big Sandy Lake and watershed has been the recipient of grants to study and help clean up our watershed from phosphorus. We received a grant for about $250,000 and have completed a TMDL study, and are working on projects that monitor phosphorus reductions of the watershed so it can meet Minnesota's water quality standards. Thousands of hours have been spent on protecting Big Sandy Lake over the decades, by Minnesota Pollution Control staff, DNR staff, Big Sandy Area Lakes Water Management Plan (BSALWMP), Big Sandy Lake Association, and other volunteers, all working to protect our water.
- The Big Sandy Lake was awarded Star Lake status in 2010. This award is given to lake and river associations who meet eligibility requirements: the development of a lake management plan, a membership of at least 50% of private shoreland owners, and participation in a water quality monitoring program meeting Minnesota Pollution Control Agency standards. In other words, residents on Big Sandy Lake are committed to our lake and we work hard to protect it. We reject the notion that its status as an impaired waters lake makes it unworthy of protection from an oil spill.

Because of the reasons stated above, the BSLA urges that the Minnesota Public Utilities Commission consider the Northern Route Alternative, as described in the Minnesota Environmental Information Report, as the route for the Sandpiper pipeline because:

- it meets Enbridge's own stated requirements.
- it is already established.
- it will impact far fewer Minnesota residents, lands, and waters than the added Sandpiper route.
- it limits future spills and leaks to just one pipeline corridor instead of spreading the potential of spills to additional Minnesota counties.
- we feel that Enbridge is merely looking for the most convenient and cheapest way to expand their pipeline corridors, and we don't feel that Minnesotans, now and in the future, should

have to pay such a huge price for the convenience of a corporation.

- the great risk to all of the water and lands that oil pipeline corridors cross prompts us to urge that the MNPUC work on behalf of current and future Minnesotans to keep new oil and tar sands pipeline corridors to a minimum, or reject them outright, for the future health of our state. Our state's waters and lands are much more important than moving oil and tar sands from one place to another.

The Big Sandy Lake Association takes this position not to protest Enbridge, but to protect the Big Sandy Watershed, Big Sandy Lake, and our county from harm. Our legacy to future generations of Minnesotans cannot take into consideration the desires of a company who puts its own profits ahead of our land and water. When the North Dakota Pipeline Company presented its "Certificate of Need," to the MNPUC, it sounded to us more like a "Certificate of Want." We all need to look ahead not just twenty years, but fifty years or two hundred years, and think hard about what we'll leave behind if we allow these pipeline corridors to proliferate, to benefit a handful of company executives.

Bruce Johnson
on behalf of the Big Sandy Lake Association Board of Directors

-----Original Message-----
From: Janet Hill [mailto:janet.hill@rocketmail.com]
Sent: Monday, March 24, 2014 11:50 AM
To: Hartman, Larry (COMM)
Subject: PUC Docket 13-474: Sandpiper

Dear MN PUC Commissioners,

The Big Sandy Lake Association submits the following comment in response to the request for alternative routes for the Sandpiper project, docket 13-474.

Who we are: The Big Sandy Lake Association (BSLA) is a strong, not-for-profit lake association with 540 members. The BSLA has been in existence since the 1950s. Part of our mission is to promote good lake management, serve as the voice for the membership in matters under consideration by federal, state, and local government bodies and agencies, and promote the welfare of the lake, its watershed, and surrounding area.

About our area: Big Sandy Lake is located in the Big Sandy Lake Watershed, the largest acreage of which is in Aitkin County, and which includes parts of Carlton and St. Louis counties. The attached map shows the watershed and the proposed pipeline route passing through it.

Big Sandy Lake is at the receiving end of water flow from this watershed; our lake is the last stop before the water heads into the Mississippi River via a short stretch of the Sandy River. As such, Big Sandy Lake receives all runoff -- natural and man-made -- that finds its way into our watershed.

Big Sandy Lake is one of Minnesota's premier recreational lakes. At 6,526 acres, it is among the largest lakes in Minnesota, and is a popular fishing lake. It has between 950 and 1,000 lake homes, of which about half are homesteaded. Its islands and peninsulas enhance its beauty, and its proximity to the Twin Cities make it a popular destination for cabins and camps. Many residents have property on the lake that has been in the family for generations. Our lake has rich historical significance, in that Big Sandy Lake (formerly called Sandy Lake) was part of what was once the main trade route between the eastern and western United States. Many generations of native Americans, and later, fur-trading voyageurs, used this route as their main "highway." Their trail -- the Savannah Portage -- includes asix-mile portage between the West and East Savanna rivers (now within Savanna State Park, which is also within the Big Sandy Lake watershed). Beginning around 1755, this trail was used for more than a century as the main route between east and west by fur traders, explorers, and missionaries. It hosted explorers such as Zebulon Pike, Lewis Cass, and Henry Rowe Schoolcraft, who all wrote about Sandy Lake in their journals. During the fur-trade era in the early 19th century, two fur trading posts were located on Big Sandy Lake, and artifacts from these posts are still being found by local residents.

Our concerns: The BSLA has two main concerns with the proposed Sandpiper Project:

* Our first concern is with the very real possibility of oil spills and leaks within the Big Sandy Watershed if the Sandpiper corridor is built. Despite claims by Enbridge, pipeline spills and leaks do happen, and they have caused well-documented and widespread damage to regions through which Enbridge has installed pipelines. Our mission -- as an organization established to protect our waters -- makes it impossible for us to approve of a pipeline and its accompanying risk of spills and leaks to be constructed through the watershed that feeds our lake.

* We also are concerned with the number of pipelines that will eventually be installed in the Sandpiper corridor. Despite claims by Enbridge that this corridor is for one pipeline only, if the Sandpiper Project is completed, Enbridge will have in place the established infrastructure, the environmental protocol, and the market connections it needs to reduce its cost of installing more pipelines in this corridor in the future. It would be a stretch to assume that Enbridge, with its apparent "need" for more pipelines, would not add pipelines to the Sandpiper corridor in the future. Each new pipeline increases the risk of spills and leaks. We also know that tar sands are among the materials being transported by Enbridge, and that there is a possibility that future pipelines could carry tar sands.

Enbridge claims that we take issue with: In the North Dakota Pipeline Company LLC Minnesota Environmental Information Report, Section 9.1 Major Basins and Watersheds, Enbridge writes, "The [Sandpiper] project also crosses the Big Sandy Lake Watershed Management Project between MPs 540.5 and 562.4 in Aitkin and Carlton

counties, which includes Big Sandy Lake and Lake Minnewawa. Both lakes are currently listed as 303(d) impaired Waters List due to excessive nutrients, specifically phosphorous loading. Neither lake is crossed by the Project."

In this statement, Enbridge appears to be saying that because Big Sandy Lake and Lake Minnewawa are not being crossed by the Sandpiper pipeline, and because they are on the impaired waters list, that they can be dismissed from consideration for protection. We have a few comments to make on this:

* The impaired waters status of Big Sandy Lake is due in part to phosphorus levels. These phosphorus levels are, in turn, partly due to organic phosphorus being washed down from the many wetlands in our watershed. In other words, part of our higher-than-acceptable phosphorus numbers occur naturally.

* The impaired waters list was not designed by the state of Minnesota to condemn lakes that need no protection. Quite the opposite: listing lakes and rivers on the impaired waters list is the first step in attempts to repair them. Once they're on the list, the state works with local governments and citizen groups to design clean-up plans, and state funds are budgeted for this purpose. Forty percent of Minnesota's waters are on the impaired waters list and are receiving state funds.

* Over the past years, Big Sandy Lake and watershed has been the recipient of grants to study and help clean up our watershed from phosphorus. We received a grant for about $250,000 and have completed a TMDL study, and are working on projects that monitor phosphorus reductions of the watershed so it can meet Minnesota's water quality standards. Thousands of hours have been spent on protecting Big Sandy Lake over the decades, by Minnesota Pollution Control staff, DNR staff, Big Sandy Area Lakes Water Management Plan (BSALWMP), Big Sandy Lake Association, and other volunteers, all working to protect our water.

* The Big Sandy Lake was awarded Star Lake status in 2010. This award is given to lake and river associations who meet eligibility requirements: the development of a lake management plan, a membership of at least 50% of private shoreland owners, and participation in a water quality monitoring program meeting Minnesota Pollution Control Agency standards. In other words, residents on Big Sandy Lake are committed to our lake and we work hard to protect it. We reject the notion that its status as an impaired waters lake makes it unworthy of protection from an oil spill.

Our proposed alternative route.

Because of the reasons stated above, the BSLA urges that the Minnesota Public Utilities Commission consider the Northern Route Alternative, as described in the Minnesota Environmental Information Report, as the route for the Sandpiper pipeline because:

* it meets Enbridge requirements.

* it is already established.

* it will impact fewer Minnesota residents, lands, waters, and counties than the additional "preferred" route.

* it limits future spills and leaks to just one pipeline corridor instead of spreading the potential of spills to additional Minnesota counties.

* we feel that Enbridge is merely looking for the most convenient and cheapest way to expand their pipeline corridors, and we don't feel that Minnesotans, now and in the future, should have to pay such a huge price for the convenience of a corporation.

* Enbridge has an available pipeline in the northern corridor -- the Alberta Clipper pipeline -- that it can use for transporting Bakken crude instead of tar sands.

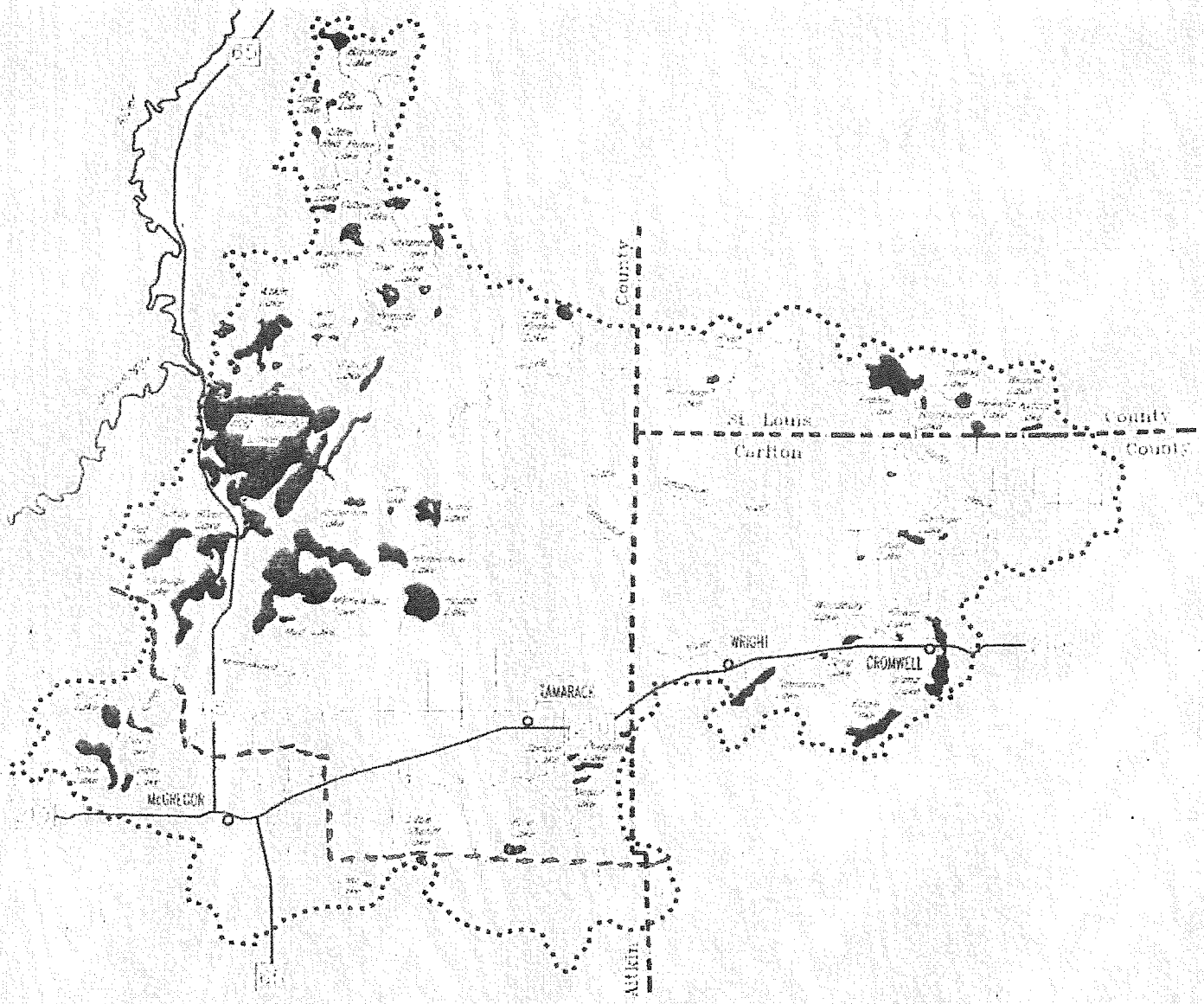
The great risk to all of the water and lands that oil pipeline corridors cross prompts us to urge that the MNPUC work for current and future Minnesotans to keep new oil and tar sands pipeline corridors to a minimum, or reject them outright. The Big Sandy Lake Association takes this position not to protest Enbridge, but to protect the Big Sandy Watershed, Big Sandy Lake, and our county from environmental and economic damage.

Our legacy to future generations of Minnesotans cannot continue to support a system that puts profits ahead of our

land and water. When the North Dakota Pipeline Company presented its "Certificate of Need," to the MNPUC, it sounded to us more like a "Certificate of Want" for all parties involved in making money off this pipeline. We all need to look ahead not just twenty years, but fifty years or two hundred years, and think hard about what we'll leave behind if we allow these pipeline corridors to proliferate, to benefit a handful of company executives.

Bruce Johnson
on behalf of the Big Sandy Lake Association Board of Directors

Map of the Big Sandy Area Lakes Watershed Management Project



PROPOSED SANDPIPER PIPELINE ROUTE - - -

MINNESOTA DEPARTMENT OF COMMERCE

85 7TH PLACE EAST, SUITE 500
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651.539.1500 FAX: 651.539.1547
AN EQUAL OPPORTUNITY EMPLOYER

Natalie Weyaus
Tribal Historic Preservation Officer
Mille Lacs Band of Ojibwe
43408 Oodena Drive
Onamia, MN 56359

February 1, 2017

RE: Meeting request regarding the Line 3 Replacement EIS

Dear Ms. Weyaus:

The Minnesota Department of Commerce greatly appreciates the ongoing working relationship and input from the Mille Lacs Band technical staff on pipeline issues. I write today with two requests. First, we would like to meet with you and other board members to continue the discussion as to how the proposed pipeline could affect the natural and cultural resources that are important to the Mille Lacs Band.

Second, we would like to hold a separate open forum to discuss the project with the members of the Mille Lacs Band tribal community. The intent of this forum would inform tribal members about the project and for the Department to gain additional insight into tribal members' concerns on Line 3.

As you are aware, Enbridge Energy is proposing to replace their existing Line 3 pipeline, a section of which crosses the Mille Lacs Indian Reservation. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route that does not cross the reservation. However, route alternatives (RAs) proposed by other entities as alternatives or Enbridge's preferred route are in the vicinity of the Mille Lacs Reservation. For your convenience, I have attached a map of the proposed routes.

The process for pipeline approval is that the Minnesota Public Utilities Commission (PUC) is responsible for deciding whether to issue a certificate of need and determining what route to permit for the proposed project. In this case, the PUC has ordered an environmental impact statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS. Additional information on the EIS process and the project can be found on the project web page (http://www.mn.gov//commerce/energyfacilities/line3/).

Over the last year, the department has worked with the environmental staff in the Mille Lacs Resources Department to gather information for the EIS. These discussions focused on construction impacts, land use and hydrology, as well as the potential effects on nearby natural resources, including wild rice and water resources. The Mille Lacs Band also provided comments during the EIS scoping comment period. Finally, Commerce's Commissioner and Chief of Staff consulted with the Mille Lacs Tribal Chairman and Council on August 5, 2016 regarding a variety of issues, including the proposed project.

Cultural and Natural Resources Meeting

The State of Minnesota's EIS for the proposed project does not replace any federal consultation or environmental review efforts on this project. For example, Section 106, 401 and 402 reviews required by the Army Corps of Engineers are separate from the State of Minnesota's environmental review process.

Like the federal government, however, the State of Minnesota is responsible for considering the cultural and natural resource issues that are important to the Mille Lacs Band. Therefore, at the proposed meeting we would like to discuss the following:

1. The types of effects the pipeline route and proposed alternatives could have on tribal resources.
2. The areas where the location of the pipeline could affect these resources.
3. The type and distribution of resources used by the Mille Lacs Band for hunting, gathering, economic, and cultural purposes.
4. How information that could benefit the EIS process is best obtained.

The resources the Department is currently considering include known cultural and historical resources in the area and tribal traditional and historical use areas for hunting, fishing, and gathering, which may also be properties of religious and cultural significance and sacred places. We seek input to accurately reflect the impact and understand that culturally significant data are sensitive and require careful consideration and protection. What the Department learns from the requested meetings would help us to achieve that.

Please extend this invitation to other members in your office or other band members to attend the meeting, please let us know. We would also like to extend the invitation to your Natural Resources Department (copied here).

A preliminary agenda for the meeting will follow. We would greatly appreciate suggestions for agenda items we may have missed from the consultation meeting. If possible, please provide suggested items no later than February 10, 2017.

Community Open Forum

As mentioned above, we would also request an opportunity to hold a community forum. The purpose of the forum is to help us better understand environmental justice issues in the project area, and are seeking meaningful input from members of environmental justice communities. EERA staff would attend the forum and be available to answer general questions about the proposed project, the process for preparing the EIS, and the state regulatory processes.

We would like to meet in person at your tribal headquarters office or alternate location at your suggestion. We are blocking time for the meeting during the week of February 20, 2017. If this time works for you please let us know what day (February 20 – March 3) works best for you. If possible, we would like to schedule the open forum on the same day as our meeting with you and other board members.

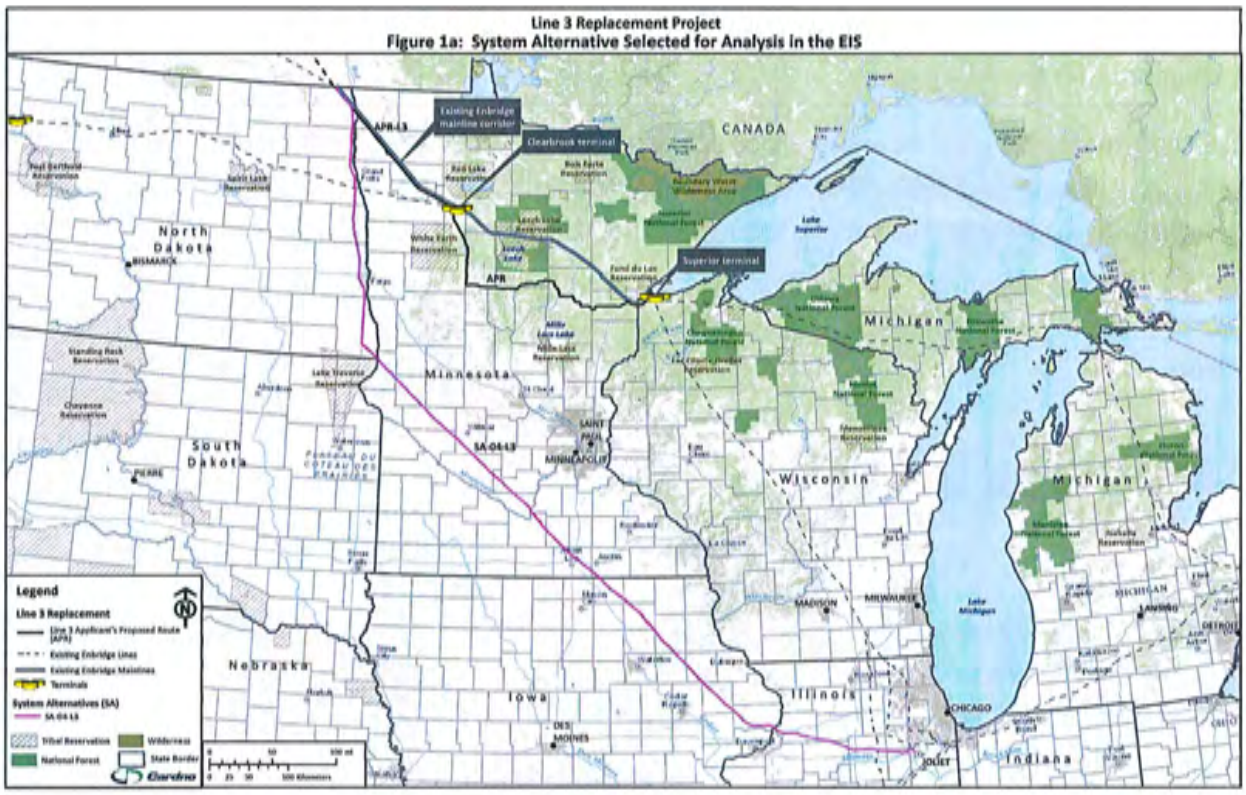
Please confirm your interest in, and availability for, an in-person meeting. I will follow up in a week or so to discuss your availability. My e-mail address and telephone are listed below. We look forward to meeting and consulting with the Mille Lacs Band of Ojibwe.

Sincerely,

Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 280
Saint Paul, MN 55101
Telephone: 651-539-1775
Email: Jamie.MacAlister@state.mn.us

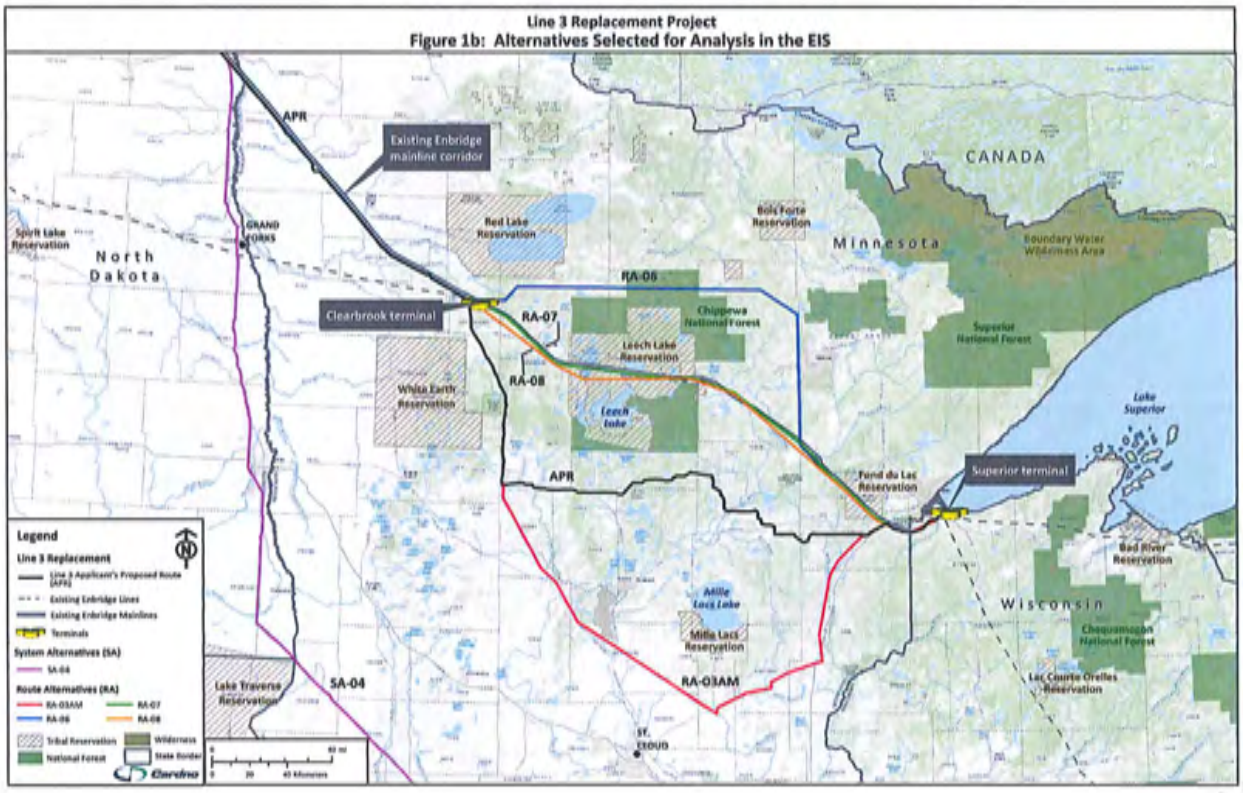
cc: Susan Klapel, Executive Director of Natural Resources
Perry Bunting, Director of Environmental Programs
Ryan Rupp, Environmental Programs Manager

Line 3 Replacement Project
Figure 1a: System Alternative Selected for Analysis in the EIS



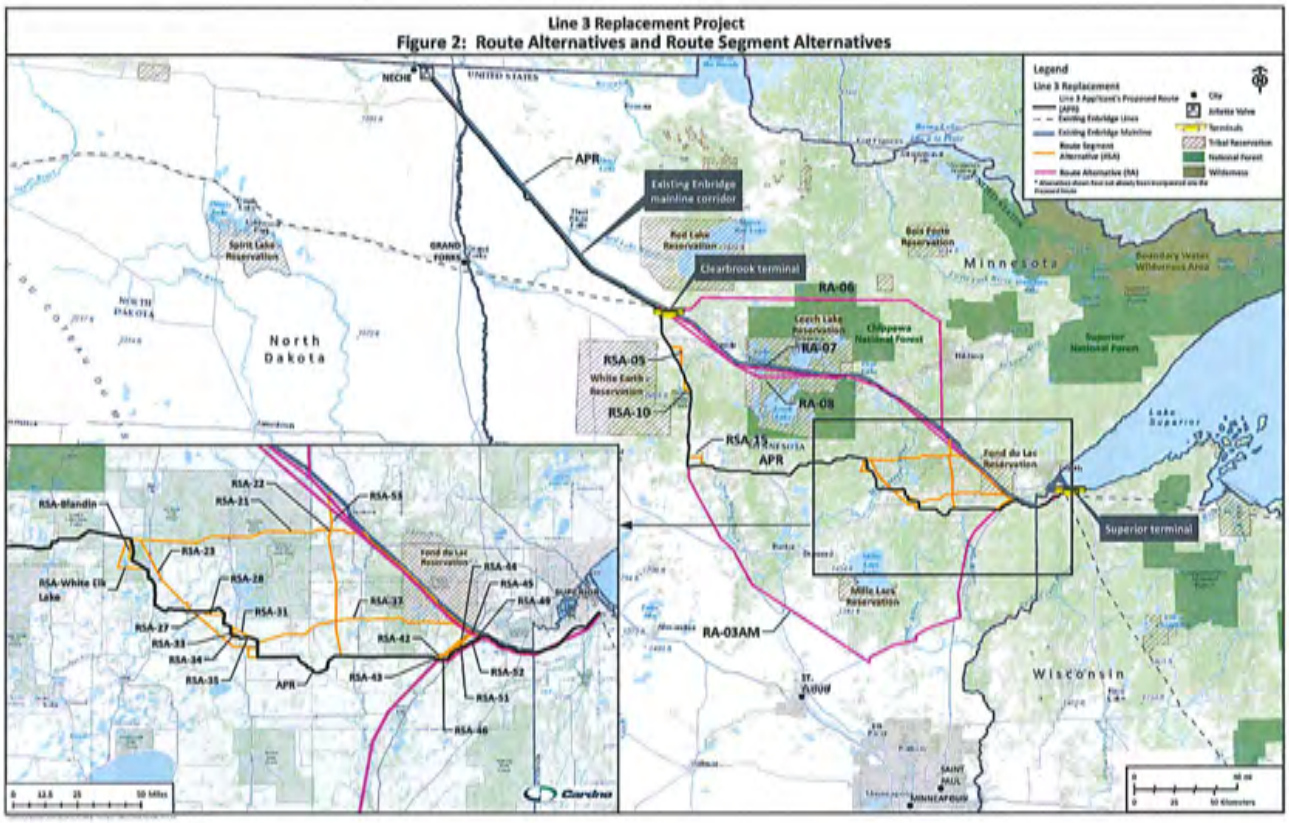
Line 3 Replacement Project

Figure 1b: Alternatives Selected for Analysis in the EIS



Line 3 Replacement Project

Figure 2: Route Alternatives and Route Segment Alternatives



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Kade Ferris
Tribal Historic Preservation Officer
Red Lake Band of Chippewa
P.O. Box 274
24200 Council Street
Red Lake, Minnesota 56671

February 9, 2017

RE: Meeting request regarding the Line 3 Replacement EIS

Dear Mr. Ferris:

The Minnesota Department of Commerce greatly appreciates the ongoing working relationship with the Red Lake Nation. On September 1, 2016 Commerce's Commissioner and Chief of Staff consulted with the Red Lake Tribal Chairman and Council regarding a variety of issues. However, those discussions were not focused on issues related to the proposed Enbridge pipeline project.

I write today with two requests. First, we would like to meet with you and other board members to discuss how the proposed Enbridge pipeline could affect the natural and cultural resources that are important to the Red Lake Band.

Second, we would like to hold a separate open forum to discuss the project with the members of the Red Lake tribal community. The intent of this forum would be to inform tribal members about the project and for the Department to gain additional insight into tribal members' concerns on Line 3.

Enbridge Energy is proposing to replace their existing Line 3 pipeline. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route. However, route alternatives (RAs) proposed by other entities as alternatives to the Enbridge route would be in the vicinity of the Red Lake Reservation. For your convenience, I have attached a map of the proposed routes.

The process for pipeline approval is that the Minnesota Public Utilities Commission (PUC) is responsible for deciding whether to issue a certificate of need and determining what route to permit for the proposed project. In this case, the PUC has ordered an environmental impact statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy,

Environmental Review Unit (EERA) to conduct the EIS. Additional information on the EIS process and the project can be found on the project web page (http://www.mn.gov//commerce/energyfacilities/line3/).

Cultural and Natural Resources Meeting

The State of Minnesota's EIS for the proposed project does not replace any federal consultation or environmental review efforts on this project. For example, Section 106, 401 and 402 reviews required by the Army Corps of Engineers are separate from the State of Minnesota's environmental review process.

Like the federal government, however, the State of Minnesota is responsible for considering the cultural and natural resource issues that are important to the Red Lake Band. Therefore, at the proposed meeting we would like to discuss the following:

1. The types of effects the pipeline route and proposed alternatives could have on tribal resources.
2. The areas where the location of the pipeline could affect these resources.
3. The type and distribution of resources used by the Red Lake Band for hunting, gathering, economic, and cultural purposes.
4. How information that could benefit the EIS process is best obtained.

The resources the Department is currently considering include known cultural and historical resources in the area and tribal traditional and historical use areas for hunting, fishing, and gathering, which may also be properties of religious and cultural significance and sacred places. We seek input to accurately reflect the impact and understand that culturally significant data are sensitive and require careful consideration and protection. What the Department learns from the requested meetings would help us to achieve that.

Please extend this invitation to other members in your office or other band members to attend the meeting, please let us know. We would also like to extend the invitation to your Natural Resources Department.

A preliminary agenda for the meeting will follow. We would greatly appreciate suggestions for agenda items we may have missed from the consultation meeting. If possible, please provide suggested items no later than February 15, 2017.

Community Open Forum

As mentioned above, we would also request an opportunity to hold a community forum. The purpose of the forum is to help us better understand environmental justice issues in the project area, and are seeking meaningful input from members of environmental justice communities.

EERA staff would attend the forum and be available to answer general questions about the proposed project, the process for preparing the EIS, and the state regulatory processes.

We would like to meet in person at your tribal headquarters office or alternate location at your suggestion. We are blocking time for the meeting during the week of February 20, 2017. If this time works for you please let us know what day (February 20 – March 3) is best for you. If possible, we would like to schedule the open forum on the same day as our meeting with you and other board members.

Please confirm your interest in, and availability for, an in-person meeting. I will follow up in a week or so to discuss your availability. My e-mail address and telephone are listed below. We look forward to meeting and consulting with the Red Lake Band.

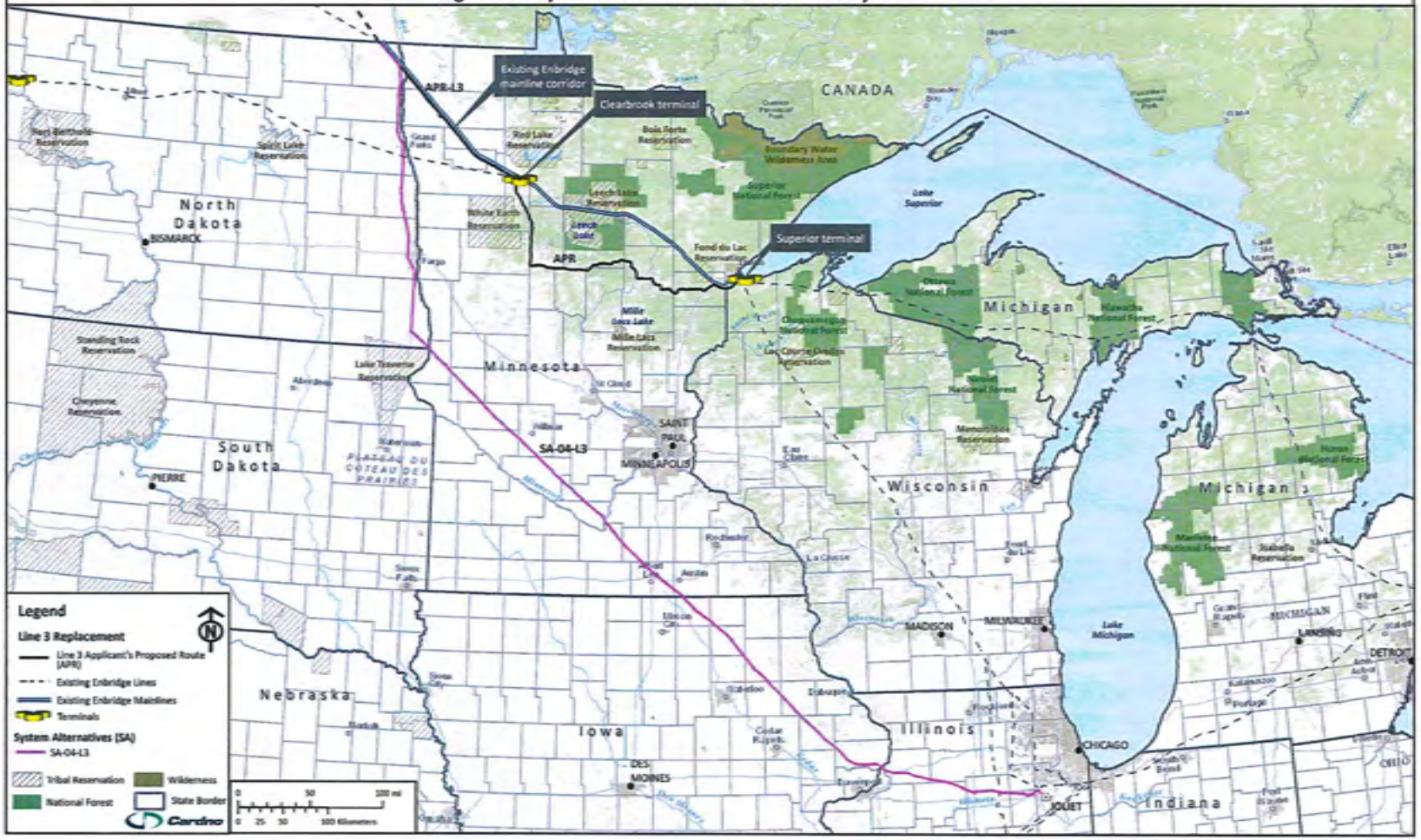
Sincerely,

Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 280
Saint Paul, MN 55101
Telephone: 651-539-1775
Email: Jamie.MacAlister@state.mn.us

Cc: Al Pemberton, Director of Natural Resources

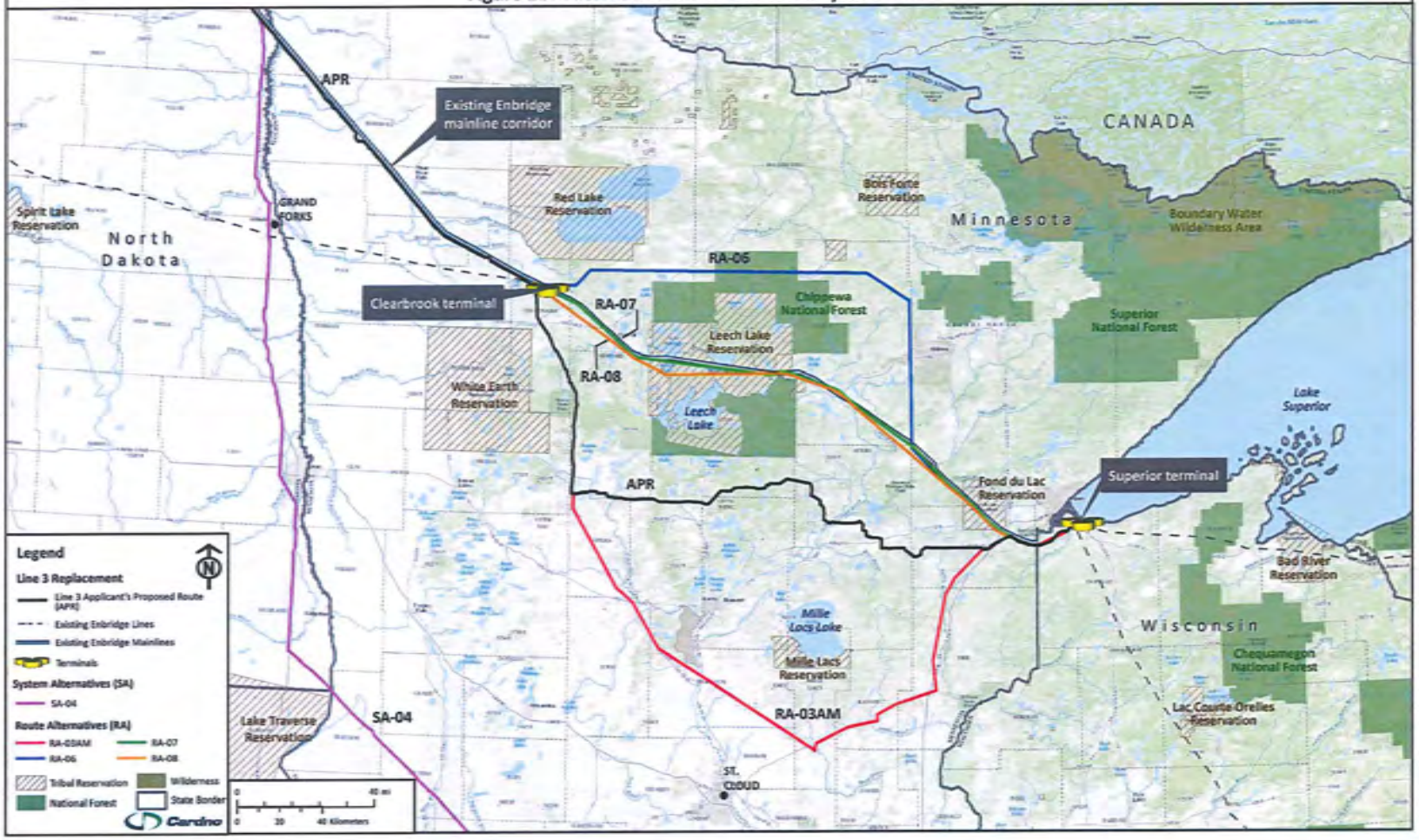
Line 3 Replacement Project

Figure 1a: System Alternative Selected for Analysis in the EIS



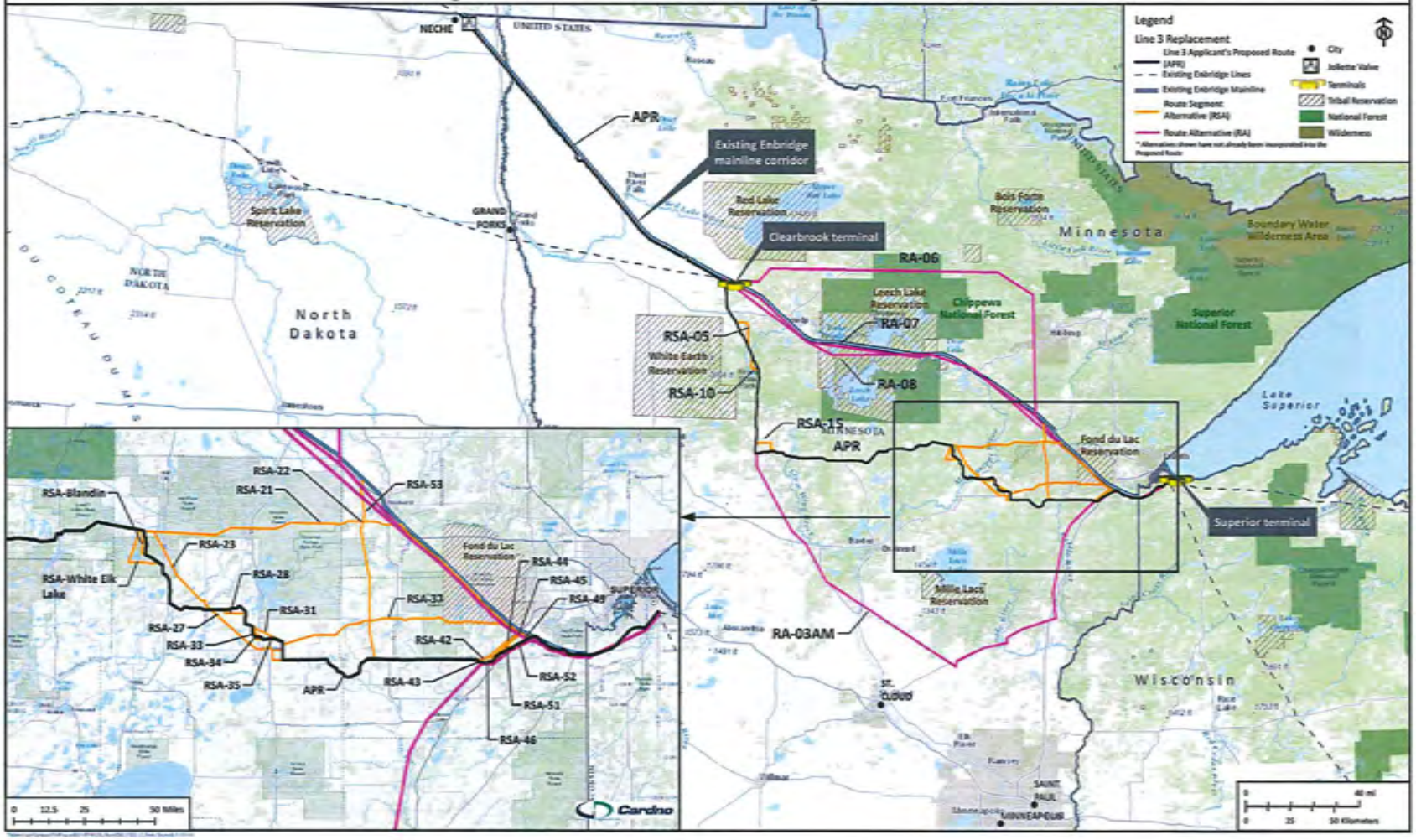
Line 3 Replacement Project

Figure 1b: Alternatives Selected for Analysis in the EIS



Line 3 Replacement Project

Figure 2: Route Alternatives and Route Segment Alternatives



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Cayla Olson
Tribal Historic Preservation Officer and NAGPRA Representative
Archives
White Earth Band of Minnesota Chippewa
PO Box 418
White Earth, MN 56591

February 1, 2017

RE: Meeting request regarding the Line 3 Replacement EIS

Dear Ms. Olson:

The Minnesota Department of Commerce greatly appreciates the ongoing working relationship and input from the White Earth technical staff on pipeline issues. I write today with two requests. First, we would like to meet with you and other board members to continue the discussion as to how the proposed pipeline could affect the natural and cultural resources that are important to the White Earth Band.

Second, we would like to hold a separate open forum to discuss the project with the members of the White Earth tribal community. The intent of this forum would inform tribal members about the project and for the Department to gain additional insight into tribal members' concerns on Line 3.

As you are aware, Enbridge Energy is proposing to replace their existing Line 3 pipeline, a section of which crosses the White Earth Indian Reservation. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route that does not cross the reservation. However, route alternatives (RAs) proposed by other entities as alternatives or Enbridge's preferred route are in the vicinity of the White Earth Reservation. For your convenience, I have attached a map of the proposed routes.

The process for pipeline approval is that the Minnesota Public Utilities Commission (PUC) is responsible for deciding whether to issue a certificate of need and determining what route to permit for the proposed project. In this case, the PUC has ordered an environmental impact statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS. Additional information on the EIS process

and the project can be found on the project web page (http://www.mn.gov//commerce/energyfacilities/line3/).

Over the last year, the department has worked with the environmental staff in the White Earth Resources Department to gather information for the EIS. These discussions focused on construction impacts, land use and hydrology, as well as the potential effects on nearby natural resources, including wild rice and water resources. The White Earth Band also provided comments during the EIS scoping comment period. Finally, Commerce's Commissioner and Chief of Staff consulted with the White Earth Tribal Chairman and Council on September 2, 2016 regarding a variety of issues, including the proposed project.

Cultural and Natural Resources Meeting

The State of Minnesota's EIS for the proposed project does not replace any federal consultation or environmental review efforts on this project. For example, Section 106, 401 and 402 reviews required by the Army Corps of Engineers are separate from the State of Minnesota's environmental review process.

Like the federal government, however, the State of Minnesota is responsible for considering the cultural and natural resource issues that are important to the White Earth Band. Therefore, at the proposed meeting we would like to discuss the following:

1. The types of effects the pipeline route and proposed alternatives could have on tribal resources.
2. The areas where the location of the pipeline could affect these resources.
3. The type and distribution of resources used by the White Earth Band for hunting, gathering, economic, and cultural purposes.
4. How information that could benefit the EIS process is best obtained.

The resources the Department is currently considering include known cultural and historical resources in the area and tribal traditional and historical use areas for hunting, fishing, and gathering, which may also be properties of religious and cultural significance and sacred places. We seek input to accurately reflect the impact and understand that culturally significant data are sensitive and require careful consideration and protection. What the Department learns from the requested meetings would help us to achieve that.

Please extend this invitation to other members in your office or other band members to attend the meeting, please let us know. We would also like to extend the invitation to your Natural Resources Department (copied here).

A preliminary agenda for the meeting will follow. We would greatly appreciate suggestions for agenda items we may have missed from the consultation meeting. If possible, please provide suggested items no later than February 10, 2017.

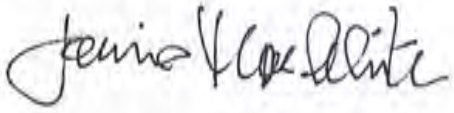
Community Open Forum

As mentioned above, we would also request an opportunity to hold a community forum. The purpose of the forum is to help us better understand environmental justice issues in the project area, and are seeking meaningful input from members of environmental justice communities. EERA staff would attend the forum and be available to answer general questions about the proposed project, the process for preparing the EIS, and the state regulatory processes.

We would like to meet in person at your tribal headquarters office or alternate location at your suggestion. We are blocking time for the meeting during the week of February 20, 2017. If this time works for you please let us know what day (February 20 – March 3) works best for you. If possible, we would like to schedule the open forum on the same day as our meeting with you and other board members.

Please confirm your interest in, and availability for, an in-person meeting. I will follow up in a week or so to discuss your availability. My e-mail address and telephone are listed below. We look forward to meeting and consulting with the White Earth.

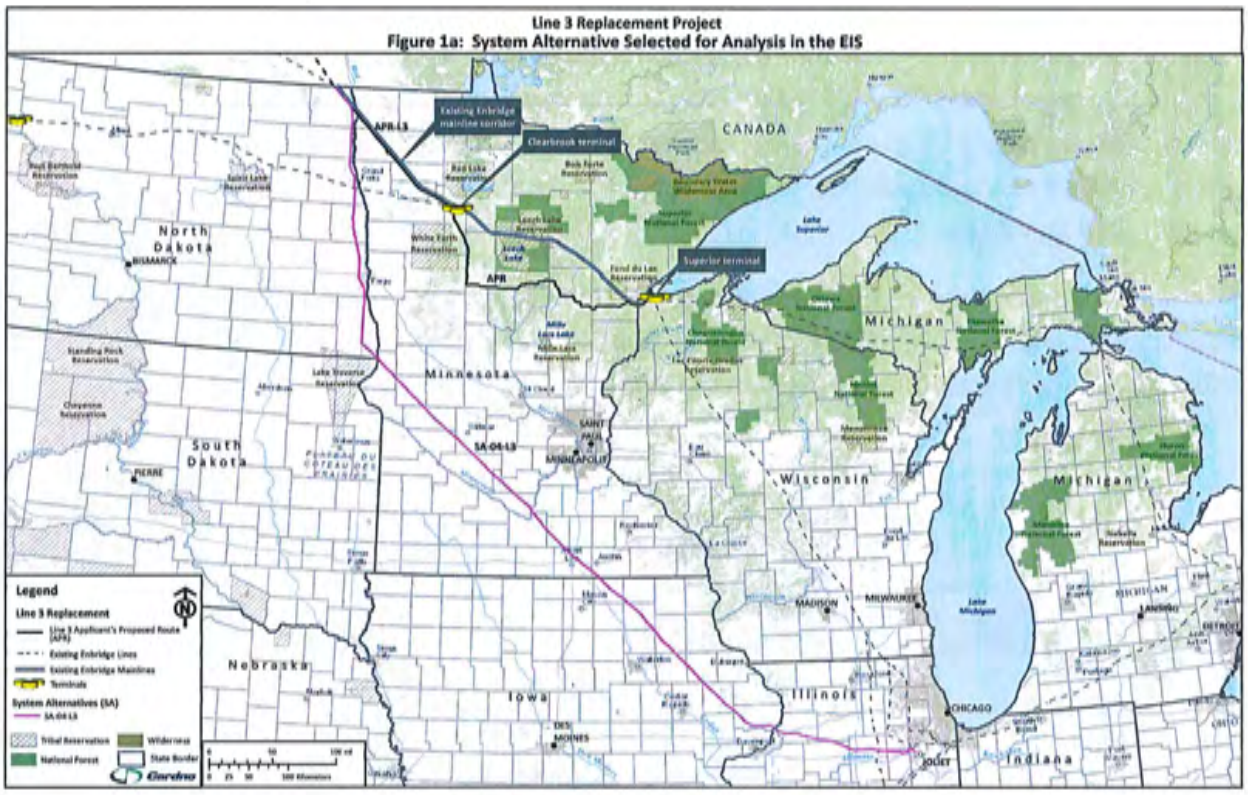
Sincerely,



Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 280
Saint Paul, MN 55101
Telephone: 651-539-1775
Email: Jamie.MacAlister@state.mn.us

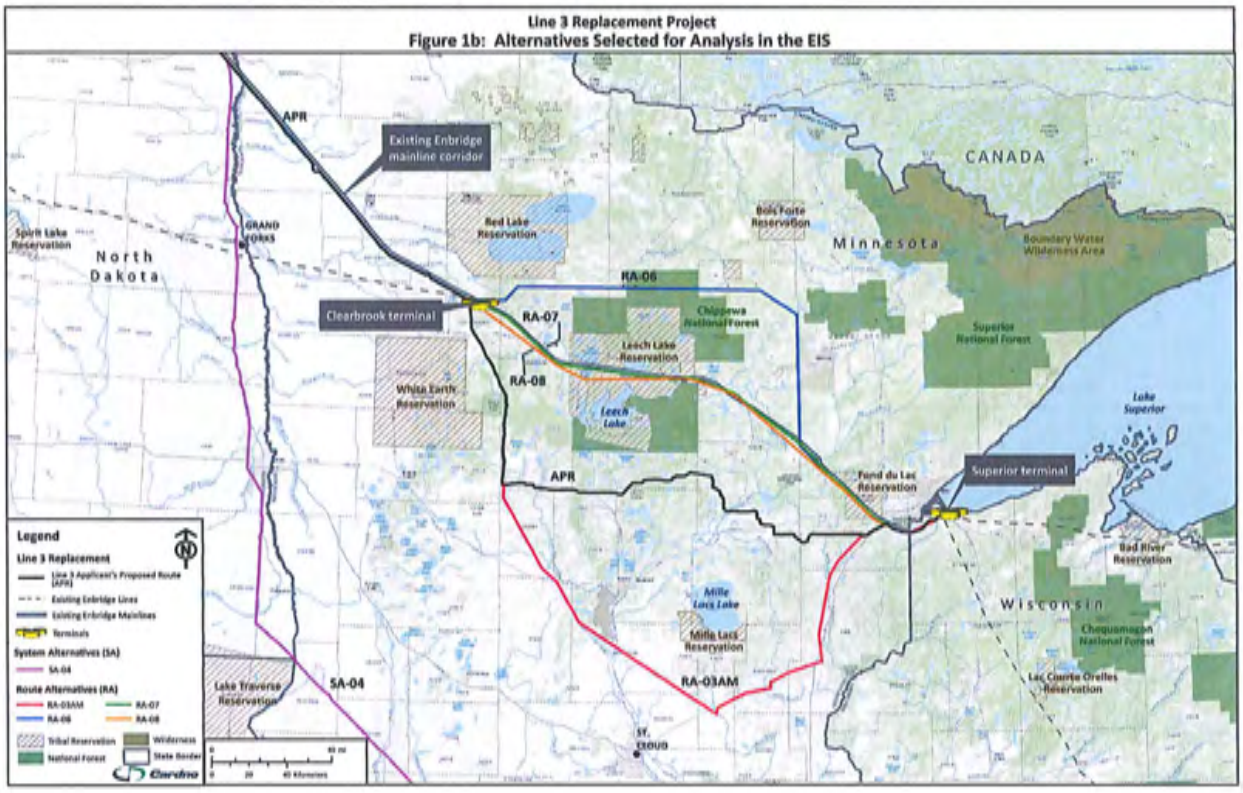
cc: Monica Hedstrom, Director of Natural Resources
Will Bement, White Earth Water Division Manager

Line 3 Replacement Project
Figure 1a: System Alternative Selected for Analysis in the EIS

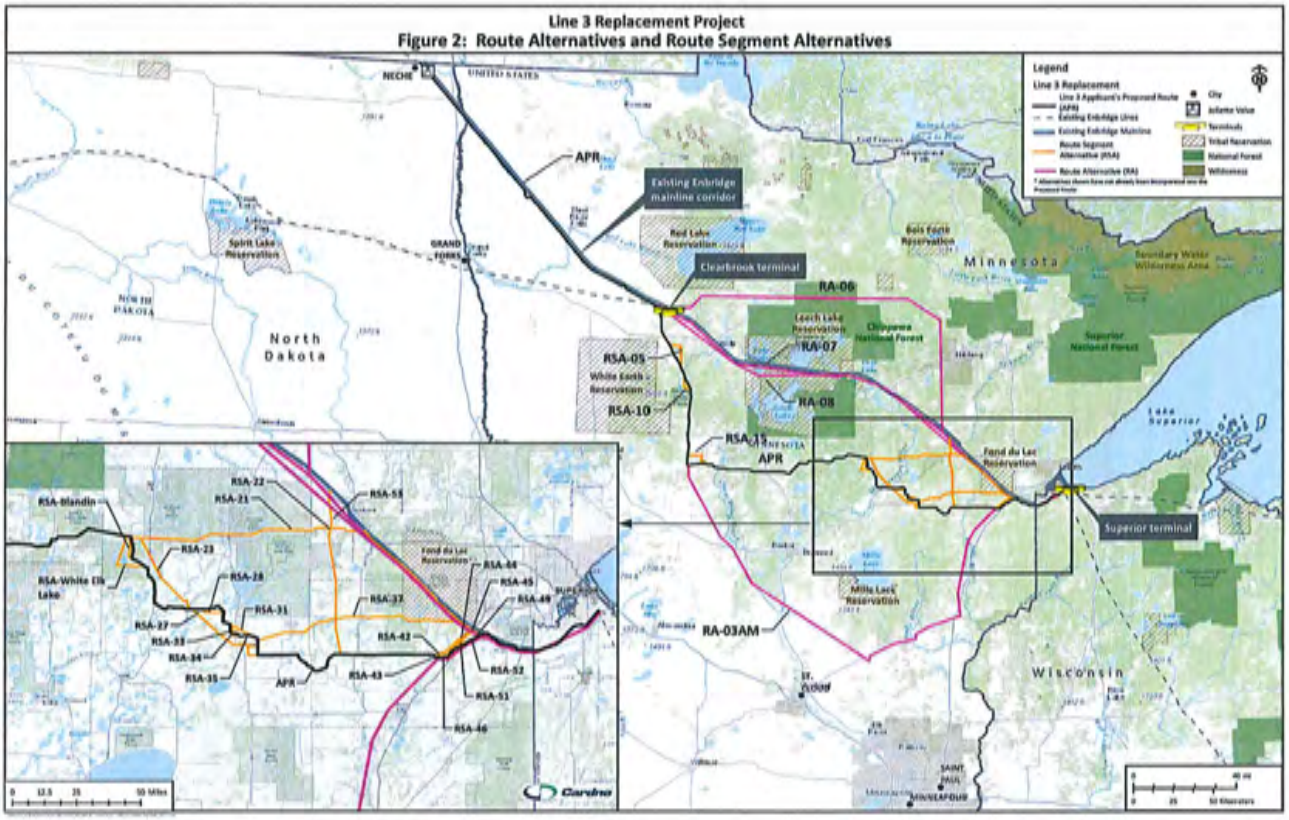


Line 3 Replacement Project

Figure 1b: Alternatives Selected for Analysis in the EIS



Line 3 Replacement Project
Figure 2: Route Alternatives and Route Segment Alternatives



Line 3 Replacement Project

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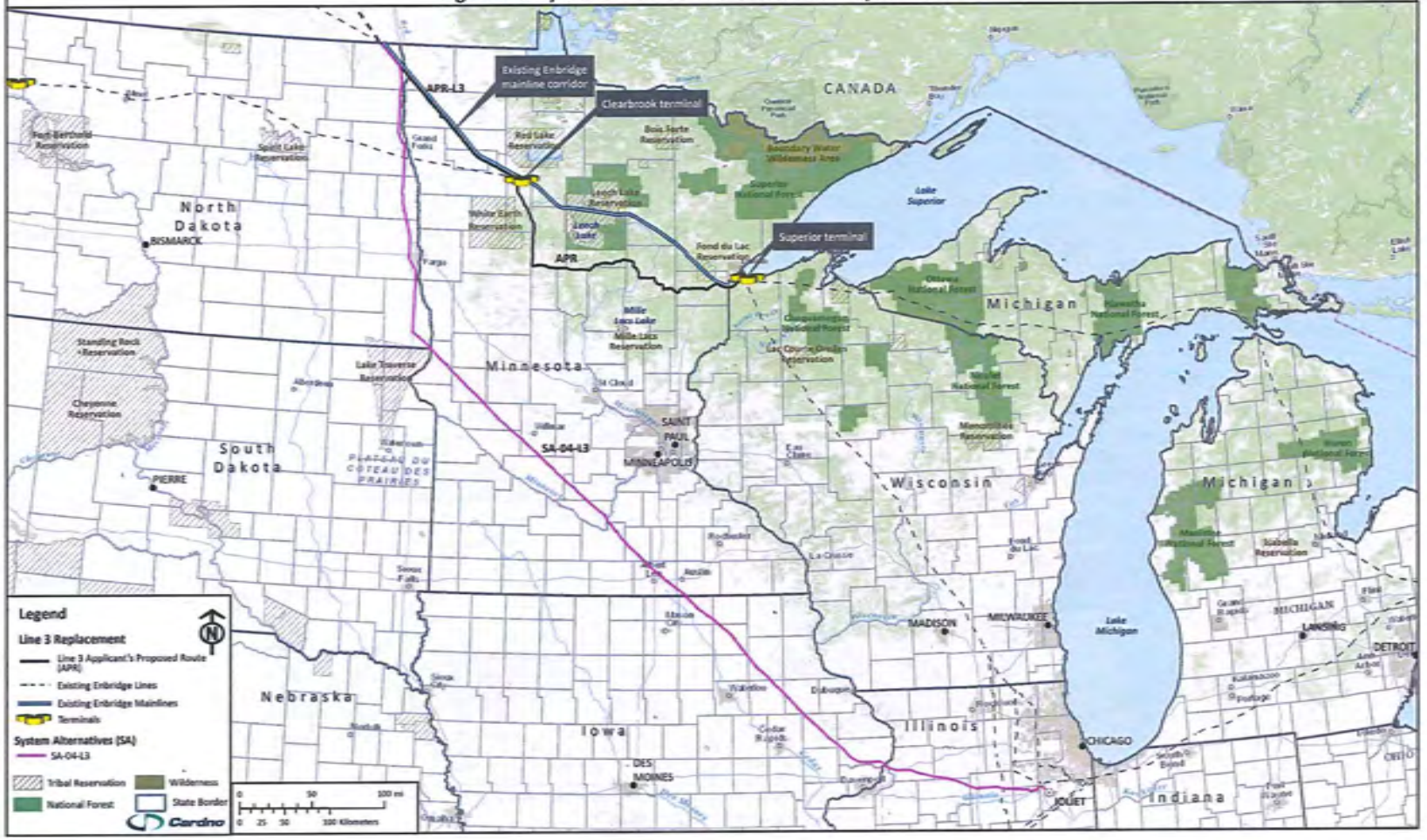

Line 3 Replacement Project

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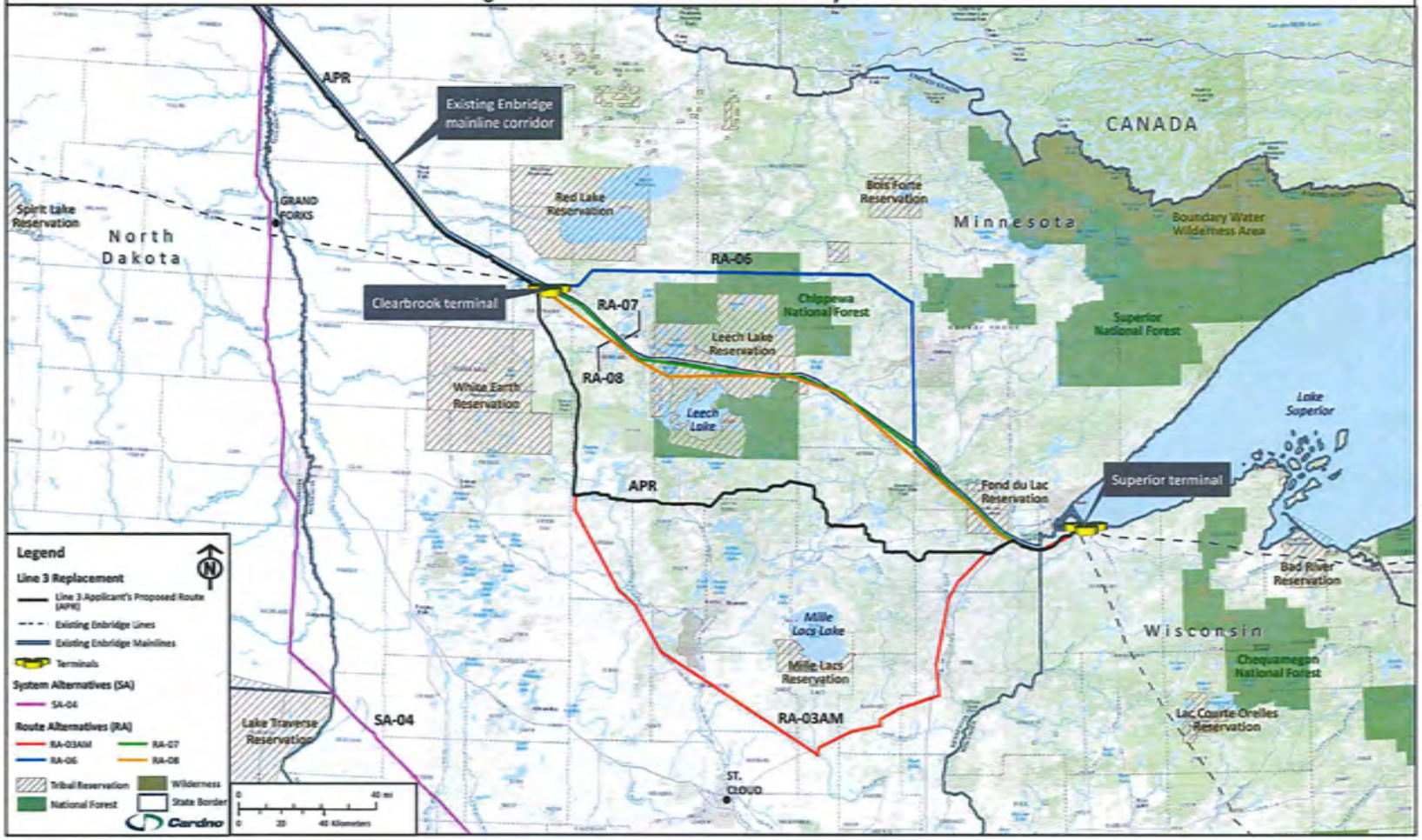

Line 3 Replacement Project

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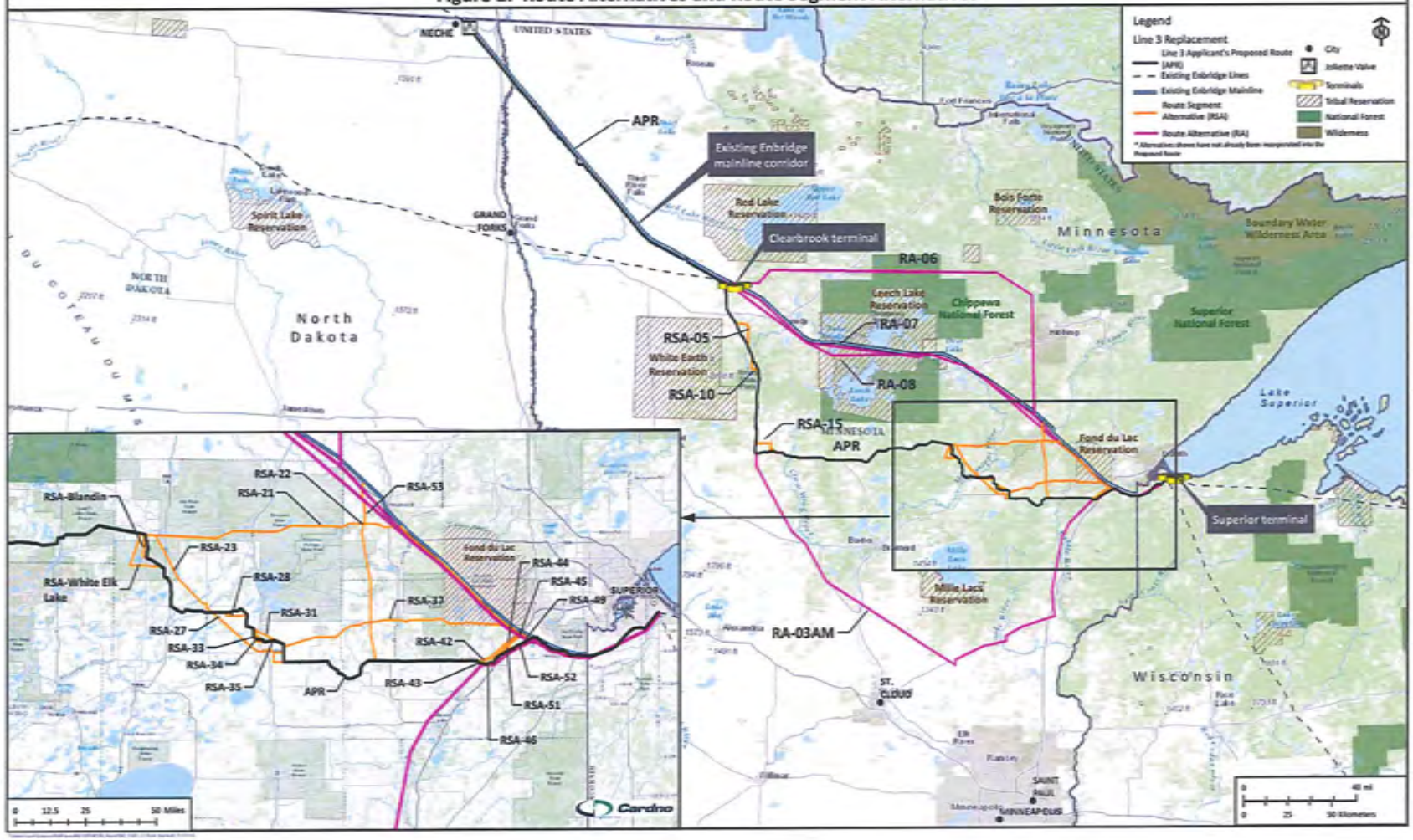

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AN EQUAL OPPORTUNITY EMPLOYER

Jill Hoppe
Tribal Historic Preservation Officer
Fond du Lac Band of Lake Superior Chippewa
1720 Big Lake Road
Cloquet, MN 55720

February 1, 2017

RE: Meeting request regarding the Line 3 Replacement EIS

Dear Ms. Hoppe:

The Minnesota Department of Commerce greatly appreciates the ongoing working relationship and input from the Fond du Lac technical staff on pipeline issues. I write today with two requests. First, we would like to meet with you and other board members to continue the discussion as to how the proposed pipeline could affect the natural and cultural resources that are important to the Fond du Lac Band.

Second, we would like to hold a separate open forum to discuss the project with the members of the Fond du Lac tribal community. The intent of this forum would inform tribal members about the project and for the Department to gain additional insight into tribal members' concerns on Line 3.

As you are aware, Enbridge Energy is proposing to replace their existing Line 3 pipeline, a section of which crosses the Fond du Lac Indian Reservation. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route that does not cross the reservation. However, route alternatives (RAs) proposed by other entities as alternatives or Enbridge's preferred route are in the vicinity of the Fond du Lac Reservation. For your convenience, I have attached a map of the proposed routes.

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Over the last year, the department has worked with the environmental staff in the Fond du Lac Resources Department to gather information for the EIS. These discussions focused on construction impacts, land use and hydrology, as well as the potential effects on nearby natural resources, including wild rice and water resources. The Fond du Lac Band also provided comments during the EIS scoping comment period. Finally, Commerce's Commissioner and Chief of Staff consulted with the Fond du Lac Tribal Chairman and Council on January 27, 2017 regarding a variety of issues, including the proposed project.

Cultural and Natural Resources Meeting

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Like the federal government, however, the State of Minnesota is responsible for considering the cultural and natural resource issues that are important to the Fond du Lac Band. Therefore, at the proposed meeting we would like to discuss the following:

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Community Open Forum

As mentioned above, we would also request an opportunity to hold a community forum. The purpose of the forum is to help us better understand environmental justice issues in the project area, and are seeking meaningful input from members of environmental justice communities. EERA staff would attend the forum and be available to answer general questions about the proposed project, the process for preparing the EIS, and the state regulatory processes.

We would like to meet in person at your tribal headquarters office or alternate location at your suggestion. We are blocking time for the meeting during the week of February 20, 2017. If this time works for you please let us know what day (February 20 – March 3) works best for you. If possible, we would like to schedule the open forum on the same day as our meeting with you and other board members.

Please confirm your interest in, and availability for, an in-person meeting. I will follow up in a week or so to discuss your availability. My e-mail address and telephone are listed below. We look forward to meeting and consulting with the Fond du Lac.

Sincerely,

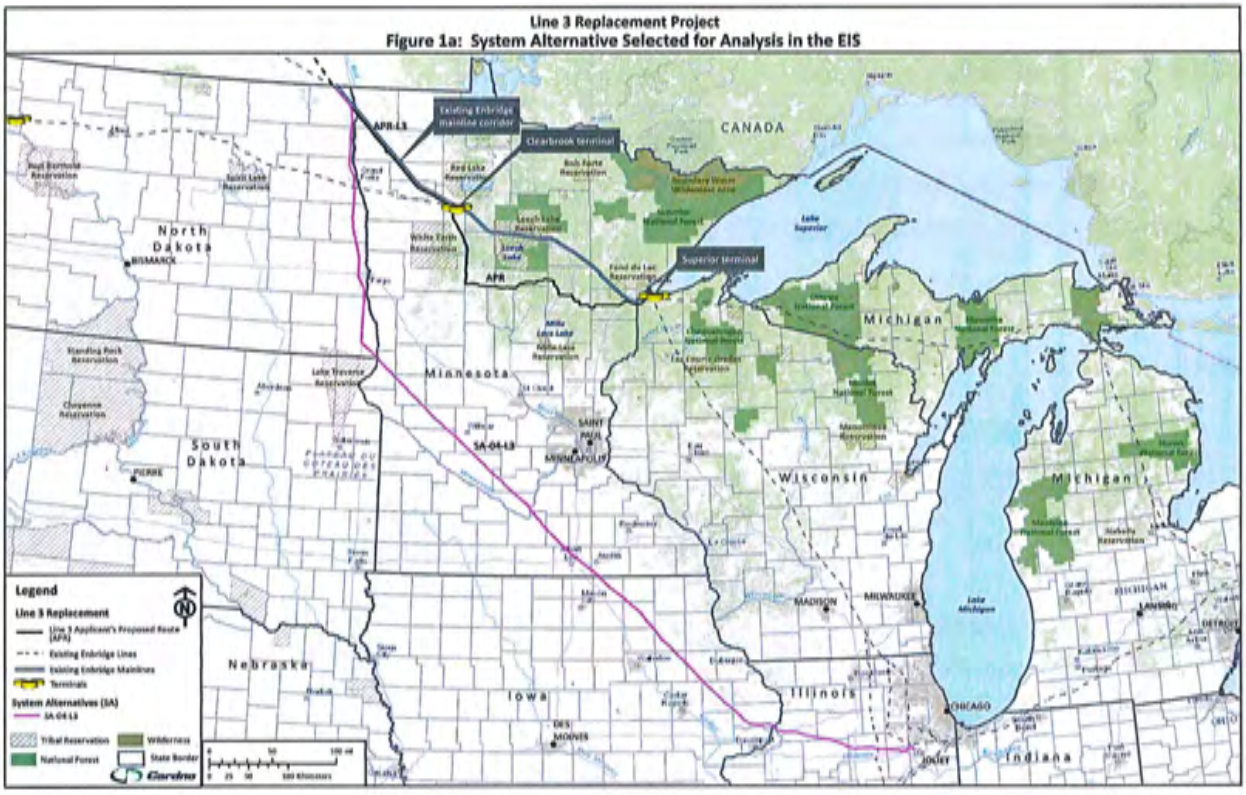


Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 280
Saint Paul, MN 55101
Telephone: 651-539-1775
Email: Jamie.MacAlister@state.mn.us

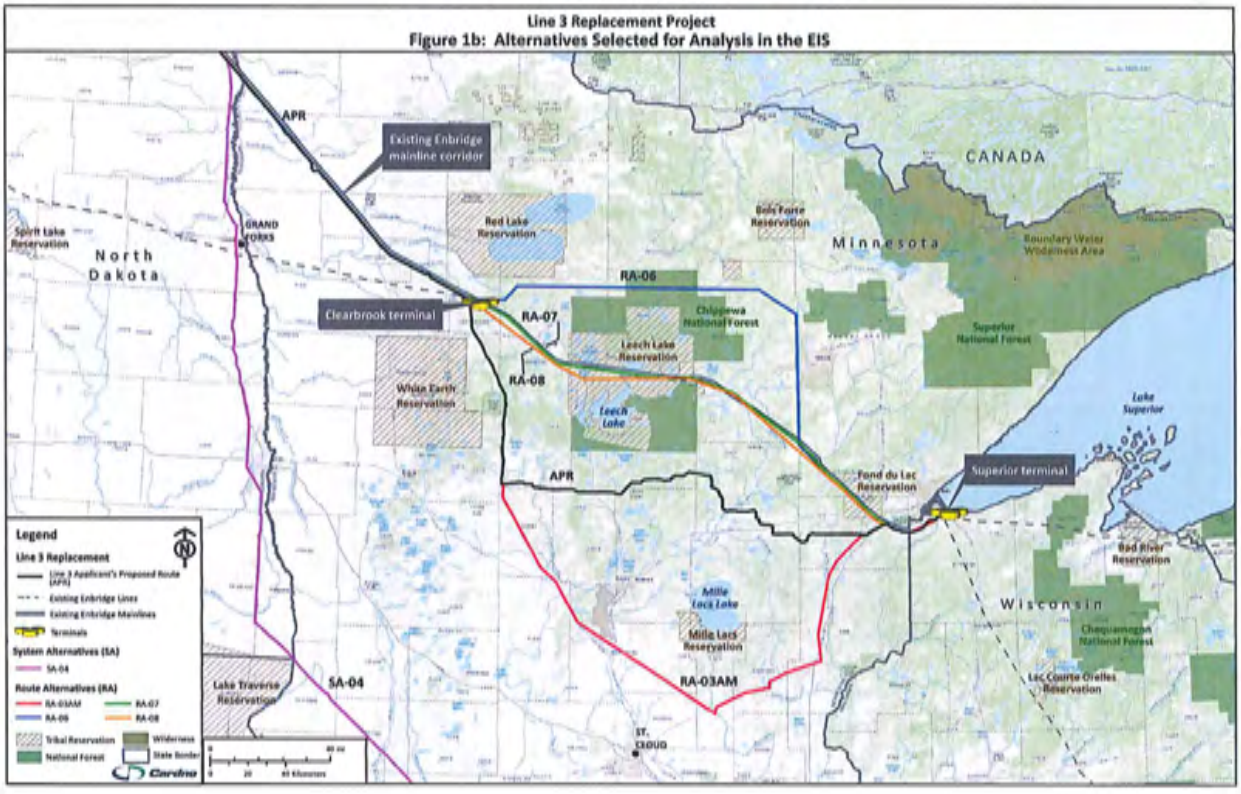
cc: Thomas Howes, Fond du Lac Natural Resources Program Manager
Reginald DeFoe, Fond du Lac Natural Resources Director
Richard D. Gitar, Fond du Lac Water Regulatory Specialist/Tribal Inspector

Line 3 Replacement Project

Figure 1a: System Alternative Selected for Analysis in the EIS

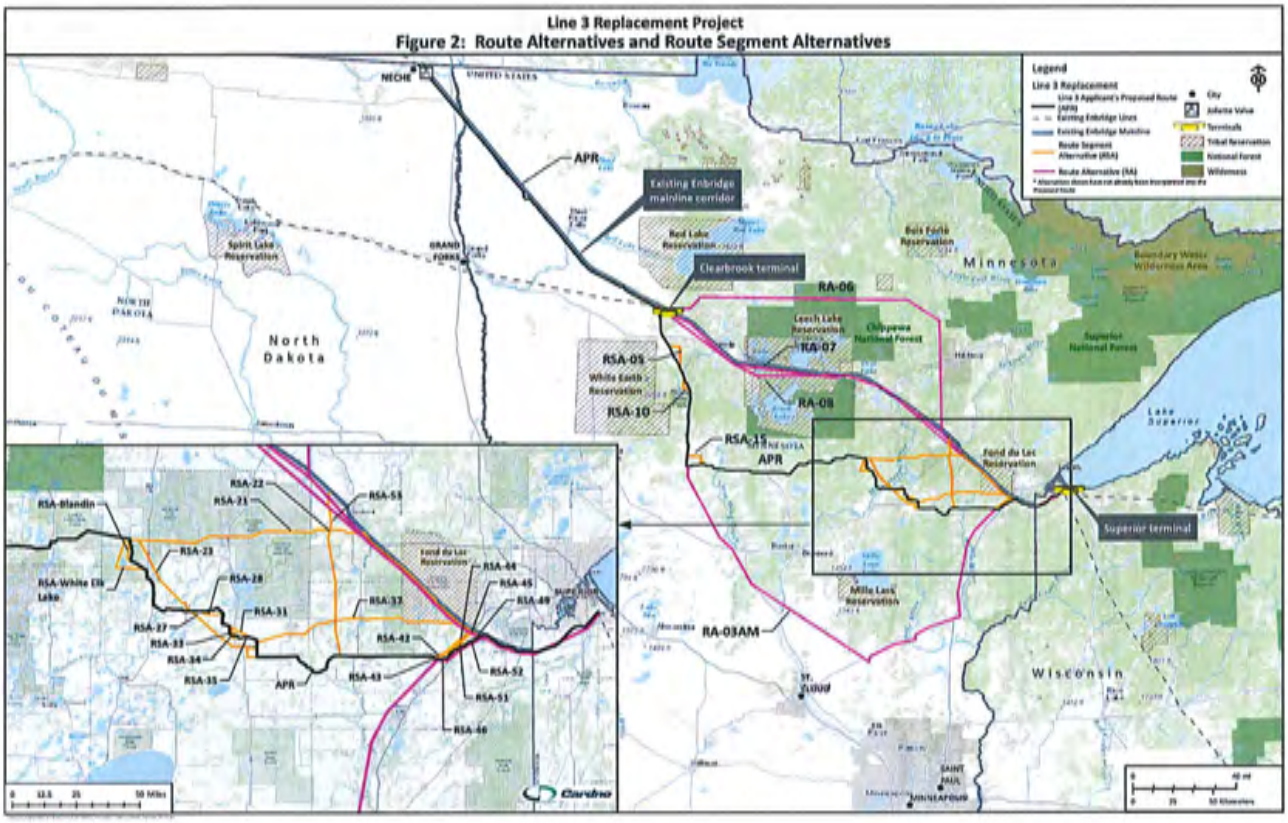


Line 3 Replacement Project
Figure 1b: Alternatives Selected for Analysis in the EIS



Line 3 Replacement Project

Figure 2: Route Alternatives and Route Segment Alternatives



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Amy Burnette
Tribal Historic Preservation Officer
Leech Lake Band of Ojibwe
115 6th Street NW, Suite E
Cass Lake, MN 56633

February 1, 2017

RE: Meeting request regarding the Line 3 Replacement EIS

Dear Ms. Burnette:

The Minnesota Department of Commerce greatly appreciates the ongoing working relationship and input from the Leech Lake technical staff on pipeline issues. I write today with two requests. First, we would like to meet with you and other board members to continue the discussion as to how the proposed pipeline could affect the natural and cultural resources that are important to the Leech Lake Band of Ojibwe.

Second, we would like to hold a separate open forum to discuss the project with the members of the Leech Lake tribal community. The intent of this forum would inform tribal members about the project and for the Department to gain additional insight into tribal members' concerns on Line 3.

As you are aware, Enbridge Energy is proposing to replace their existing Line 3 pipeline, a section of which crosses the Leech Lake Indian Reservation. Enbridge's proposal is to permanently deactivate the existing Line 3 pipeline and leave it in place, and construct a replacement pipeline along a new route that does not cross the reservation. However, route alternatives (RAs) proposed by other entities as alternatives or Enbridge's preferred route are in the vicinity of the Leech Lake Reservation. For your convenience, I have attached a map of the proposed routes.

The process for pipeline approval is that the Minnesota Public Utilities Commission (PUC) is responsible for deciding whether to issue a certificate of need and determining what route to permit for the proposed project. In this case, the PUC has ordered an environmental impact statement (EIS) for the project and has asked the Commerce Department's Divisions of Energy, Environmental Review Unit (EERA) to conduct the EIS. Additional information on the EIS process and the project can be found on the project web page (http://www.mn.gov//commerce/energyfacilities/line3/).

Over the last year, the department has worked with the environmental staff in the Leech Lake Resources Department to gather information for the EIS. These discussions focused on construction impacts, land use and hydrology, as well as the potential effects on nearby natural resources, including wild rice and water resources. The Leech Lake Band also provided comments during the EIS scoping comment period. Finally, Commerce's Commissioner and Chief of Staff consulted with the Leech Lake Tribal Chairman and Council on January 23, 2017 regarding a variety of issues, including the proposed project.

Cultural and Natural Resources Meeting

The State of Minnesota's EIS for the proposed project does not replace any federal consultation or environmental review efforts on this project. For example, Section 106, 401 and 402 reviews required by the Army Corps of Engineers are separate from the State of Minnesota's environmental review process.

Like the federal government, however, the State of Minnesota is responsible for considering the cultural and natural resource issues that are important to the Leech Lake Band. Therefore, at the proposed meeting we would like to discuss the following:

1. The types of effects the pipeline route and proposed alternatives could have on tribal resources.
2. The areas where the location of the pipeline could affect these resources.
3. The type and distribution of resources used by the Leech Lake Band for hunting, gathering, economic, and cultural purposes.
4. How information that could benefit the EIS process is best obtained.

The resources the Department is currently considering include known cultural and historical resources in the area and tribal traditional and historical use areas for hunting, fishing, and gathering, which may also be properties of religious and cultural significance and sacred places. We seek input to accurately reflect the impact and understand that culturally significant data are sensitive and require careful consideration and protection. What the Department learns from the requested meetings would help us to achieve that.

Please extend this invitation to other members in your office or other band members to attend the meeting, please let us know. We would also like to extend the invitation to your Natural Resources Department (copied here).

A preliminary agenda for the meeting will follow. We would greatly appreciate suggestions for agenda items we may have missed from the consultation meeting. If possible, please provide suggested items no later than February 10, 2017.

Community Open Forum

As mentioned above, we would also request an opportunity to hold a community forum. The purpose of the forum is to help us better understand environmental justice issues in the project area, and are seeking meaningful input from members of environmental justice communities. EERA staff would attend the forum and be available to answer general questions about the proposed project, the process for preparing the EIS, and the state regulatory processes.

We would like to meet in person at your tribal headquarters office or alternate location at your suggestion. We are blocking time for the meeting during the week of February 20, 2017. If this time works for you please let us know what day (February 20 – March 3) works best for you. If possible, we would like to schedule the open forum on the same day as our meeting with you and other board members.

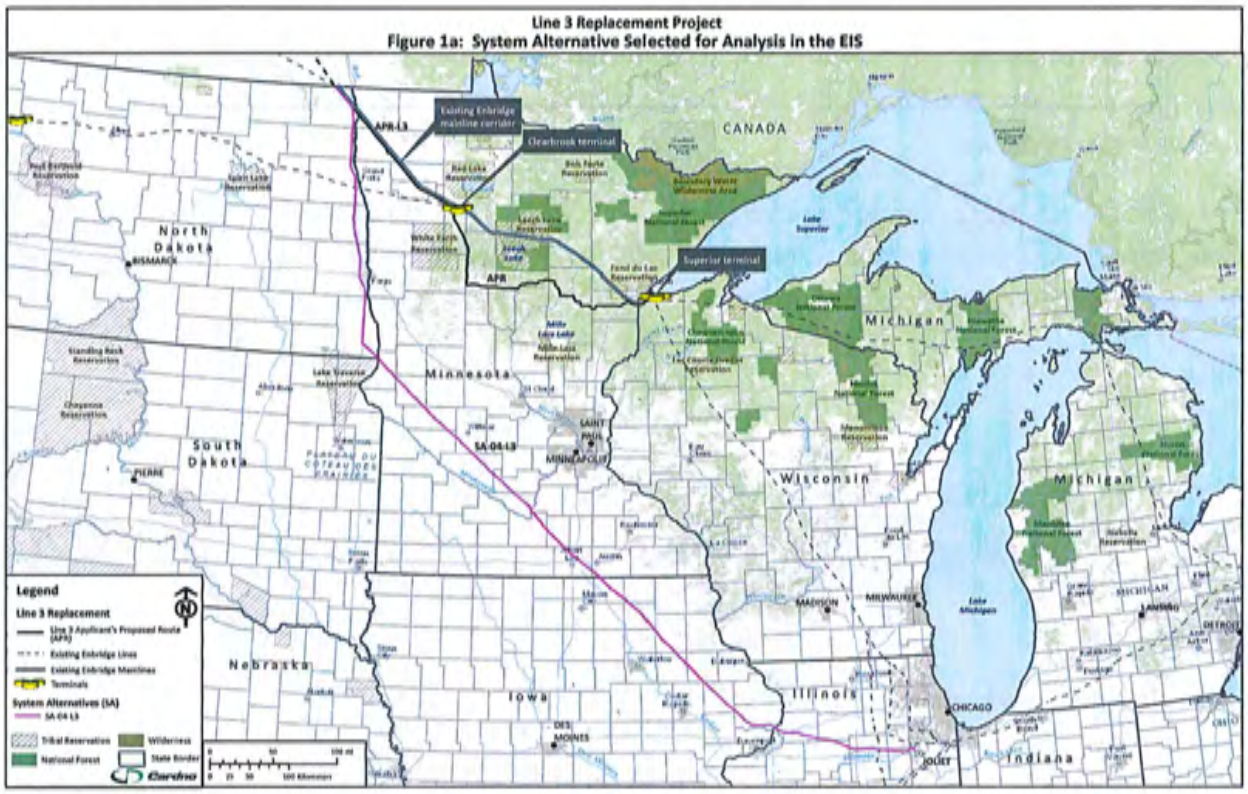
Please confirm your interest in, and availability for, an in-person meeting. I will follow up in a week or so to discuss your availability. My e-mail address and telephone are listed below. We look forward to meeting and consulting with the Leech Lake Band of Ojibwe.

Sincerely,

Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 280
Saint Paul, MN 55101
Telephone: 651-539-1775
Email: Jamie.MacAlister@state.mn.us

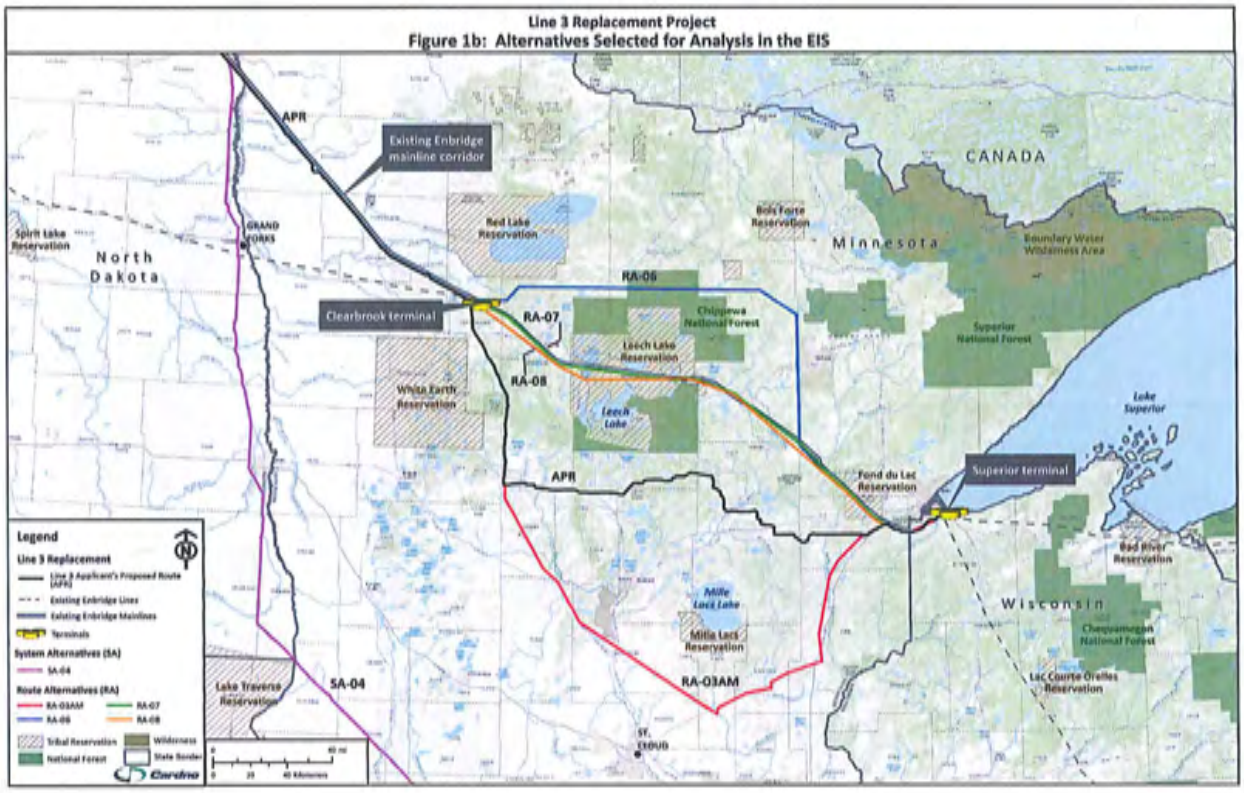
cc: Steve Mortensen, Fish, Wildlife & Plant Resources Program Director
James Reyes, Ojibwe Fisheries Manager
Levi Brown, Environmental Director
Brandy Toft, Environmental Deputy Director

Line 3 Replacement Project
Figure 1a: System Alternative Selected for Analysis in the EIS

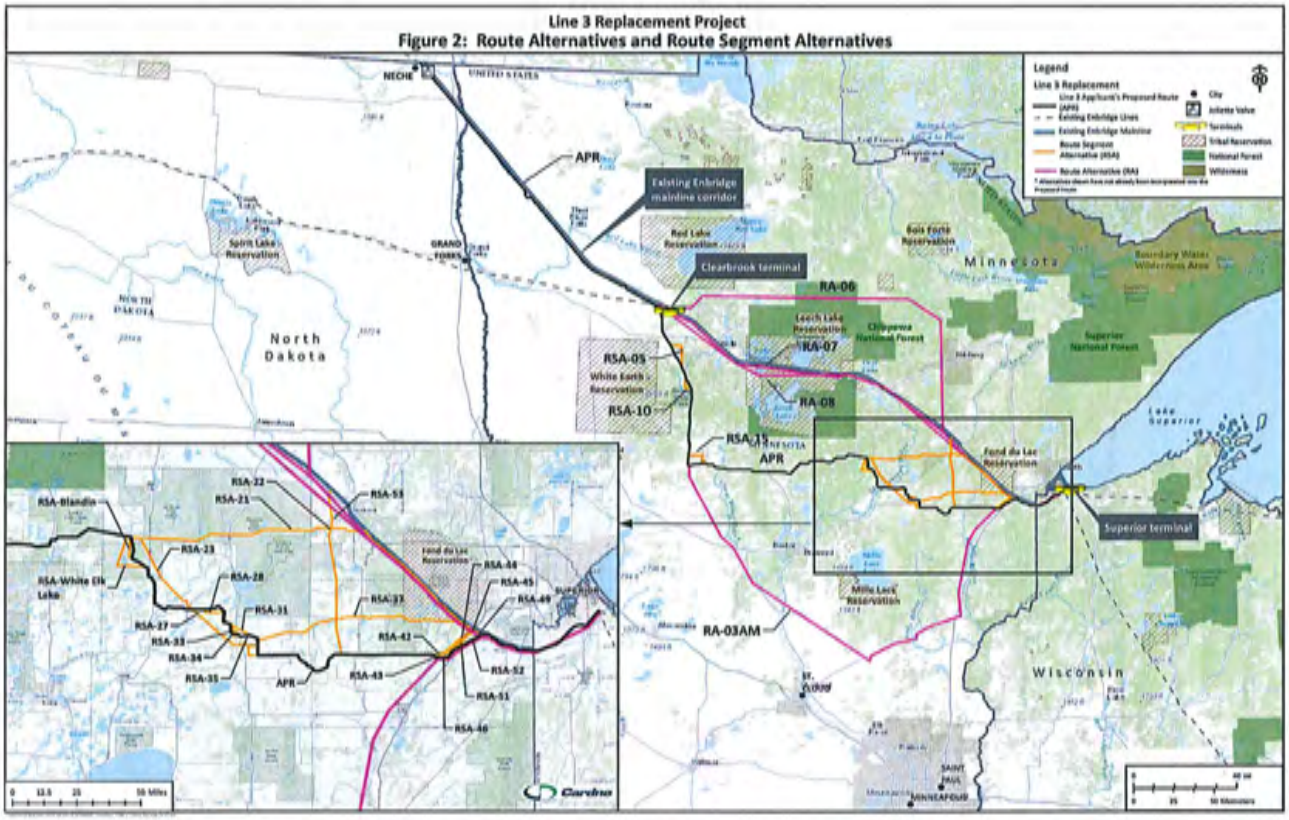


Line 3 Replacement Project

Figure 1b: Alternatives Selected for Analysis in the EIS



Line 3 Replacement Project
Figure 2: Route Alternatives and Route Segment Alternatives



Fond du Lac Band of Lake Superior Chippewa

TRIBAL HISTORIC PRESERVATION OFFICE

1720 Big Lake Road, Cloquet, MN 55720

Phone 218-878-7129 E-Mail jillhoppe@fdlrez.com

March 16, 2017

Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 500, Saint Paul, MN 55101

Dear Jamie,
Per the Fond du Lac Resource Management meeting with the Minnesota Department of Commerce held on 3/2/17, we discussed that if Fond du Lac Resource Management provided concerns in regard to Enbridge Line 3 Replacement Project by 3/17/17, the Minnesota Department of Commerce would include concerns provided in the Draft Environmental Impact Statement. As a result, Fond du Lac Resource Management has documented concerns, which are attached to this letter.

Please let me know if you have any questions or comments.

Sincerely,

Jill Hoppe

Jill Hoppe
Fond du Lac Tribal Historic Preservation Officer

Summary of Fond du Lac Resource Management Concerns Regarding Enbridge Line 3 Replacement Project

1 Treaty Rights

- Any Line 3 Route Alternatives, with exception of Line 3 System Alternative Route, would cut through the Band's Ceded Territories where the Band retains usufructuary rights. These lands were ceded to the U.S. Government in the Treaty of La Pointe of September 30, 1854, 10 Stat. 1109, the Treaty with the Chippewa October 4, 1842, 7 Stat., 591, and the Treaty with the Chippewa July 29, 1837, 7 Stat. 536. Pipeline leaks and ruptures would endanger the Mississippi headwaters and Lake Superior watersheds, and the wetlands that the Band relies on for our way of life. Any spill from the proposed pipelines would likely render cooking, cleaning, and drinking water unusable for hundreds of years or more.
- Within the external boundary of the Fond du Lac Reservation alone, 47% is water resources/wetland. Many of the wetlands on the Reservation are peat; any oil spilled into peat will continue to contaminate our resources for an unknown period of time.
- As Indigenous people of North America, we have been marginalized through the extraction of resources in this hemisphere, our socio economic means have been displaced and the emphasis on extraction of the resources of our homeland has appropriated our ways of life.

2 Wild Rice

- Wild rice is central to Ojibwe culture; it is considered a special gift from Manidoo, the Great Spirit.
- Wild rice waters are recognized by the Ojibwe as Traditional Cultural Properties—wild rice is basic to the traditional diet and important culturally, spiritually, economically as well as a central element in feasts and ceremonies.
- Wild rice plants are very sensitive to pollution, invasive species, changes in water levels and land use development and practices. A history of environmental degradation has taken its toll on wild rice waters with western expansion and development.
- Deadfish Lake on the Fond du Lac Reservation is an important wild rice lake upon which Band members depend. Although this wild rice lake is located more than 1,200 feet from Line 3 Existing Route, there is a location of a ditch that Line 3 Existing Route crosses that feeds directly into Dead Fish Lake. Any spill, regardless of size will likely impact this important wild rice water. If this were to occur, it is unlikely any member of the Fond du Lac Band of Lake Superior Chippewa would willingly harvest rice from this lake, regardless of the extent of spill recovery and remediation.

3 Water

- It is important to clearly articulate the importance of water to the Ojibwe people. Nibi (water) is the lifeblood of Mother Earth, coursing through streams and rivers like blood through vessels; for earth to be strong and healthy, capable of sustaining life for generations to come, it must be kept clean. Nibi is sacred and it is our responsibility to keep it pure; it is our source of life and the lives of all plants and animals that share the earth.
- Any Line 3 Route Alternatives, with exception of the Line 3 System Alternative, will pose a threat to the Lake Superior watershed and ultimately the Great Lakes, as well as the treaty-protected resources of the Band.
- Line 3 Existing Route and other pipelines in proximity have altered hydrology in areas within Fond du Lac Reservation and Ceded Territories.

- With the exception of the Line 3 System Alternative Route, all Line 3 Routes through Minnesota have the potential to impact millions of acres of freshwater wetlands.
- **Line 3 Applicant Preferred Route** would traverse at least 14 named rivers and 13 unnamed tributaries in the 1854 Ceded Territory, and 3 named rivers and 6 tributaries in the 1842 Ceded Territory. **Line 3 Route Alternative** would traverse at least 22 named rivers and 26 unnamed tributaries in the 1837 Ceded Territory, 4 named rivers and 4 tributaries in the 1854 Ceded Territory, and 3 named rivers and 6 tributaries in the 1842 Ceded Territory, and 3 named rivers and 6 tributaries in the 1842 Ceded Territory. **Line 3 Existing Route** traverses at least 2 named rivers and 7 tributaries in the 1854 Ceded Territory and 3 named rivers and 6 tributaries in the 1842 Ceded Territory.

4 Cultural Resources

- All Line 3 Route Alternatives in Minnesota would traverse numerous wetlands, streams, lakes, and fisheries. The quality of these waters is vitally important to Band members and possible effects from contaminated water include disruption of the Bands' traditional way of life based on the harvest of fresh water fish, game, wild rice and other aquatic habitat culturally significant to the Bands.
- The pipeline right-of-way permanently removes forest cover which fragments the forest and leaves unnatural open spaces which may lead to reduction of wildlife habitat and animal pattern/migration changes.
- FDL Ordinance #03/14 – Preservation of Cultural Resources was enacted to protect and preserve FDL Cultural Resources; a subsequent Cultural Preservation Zone was established around culturally sensitive areas within the external boundary of the FDL Reservation. Line 3 Existing Route traverses near FDL's Cultural Preservation Zone where there exists Traditional Cultural Properties, archaeological and historic sites and other cultural resources, all of which are vulnerable to the potential impact of contaminants from a crude oil release reaching cultural sites.

5 Climate Change

- The increase in capacity for pumping oil and bitumen will result in impacts to the climate. These impacts need to be accounted for through quantification of climate change impacts. For example, the cost of petroleum extraction, the cost to our climate from production of the steel used to transport the oil, the cost of pumping the oil, the cost of trucking to transport the pipe and other assorted materials used in construction of the pipeline, the cost of the refining process, and the cost of using the oil once it is transported and refined.
- Any new oil transportation infrastructure serves to encourage the country's reliance on an energy resource that is inherently damaging to the world's climate, locking us into an uncertain future for our children, grandchildren, and all future generations. The pipeline would lead to increasing greenhouse-gas emissions, reducing our chances of meeting pollution-reduction targets. Continued reliance on energy from oil is altering many resources on Earth, contributing to devastating climate change.

6 Air Emissions

- Air emissions generated during the pipeline development phase may include digging, increased vehicle traffic, and continuous idling. Spill mitigation can release significant amount of air emissions. Air emissions from refining and final usage are of significant local and global concern.

7 **Invasive Species**

- The pipeline corridor encourages the overgrowth of invasive non-native species such as wild parsnip (*Pastinaca sativa*), which was not present on the Fond du Lac Reservation prior to Enbridge pipeline work in 2009, but has now spread outside the corridor and is found along some roads within the external boundaries of the Reservation. Although an official survey has not occurred, Fond du Lac conservatively estimates at least 80 acres has been infested with wild parsnip which forms dense stands that compete with native plant growth thereby reducing plant biodiversity and altering the natural setting. Wild parsnip contains chemicals that cause severe dermatitis making it problematic in infested areas for harvesting/gathering medicinal plants, berries, and other forest products culturally significant to the Bands. Pipeline construction and maintenance activities have also introduced purple loosestrife (*Lythrum salicaria*) to new areas along the Enbridge pipeline; the locations of which are often difficult to access for proper control efforts. Other invasive species including sweet clover, tansy, and spotted knapweed are also a concern on the Enbridge right-of-way, the Reservation and in the Ceded Territory. The presence of invasive species diminishes resources on Reservation and Ceded Territories.

8 **Land Use**

- Line 3 Existing Route that traverses through the FDL Reservation takes up approximately 360 acres. Line 3 Applicant Preferred Route takes up approximately 482 acres in the 1854 Ceded Territory and approximately 124 acres in the 1842 Ceded Territory. This diminishes Reservation/Treaty resources.

9 **Environmental Justice**

- Line 3 Existing Route traverses through Fond du Lac and Leech Lake Reservations. If significant impacts were to occur, the damage could disproportionately affect tribal and low-income populations.
- Pipeline proponents anticipate pipeline development could benefit low-income, minority, and tribal populations by creating job opportunities and stimulating local economic growth; however, noise, dust, visual impacts, wildlife and plant habitat destruction, introduction of invasive species, adverse land use changes, and increased risks to the quality of water and land which the Bands depend upon for sustenance may adversely affect traditional tribal lifeways and sites of spiritual and cultural significance. Additionally, an insignificant number of Native Americans are employed by pipeline development.
- An increase in the Line 3 pipeline flow/expansion (from 34" to 36" pipe) certainly leads to an increase in the potential for spills and for the magnitude of the affected spill area to be large. Any diminishment of natural resources or access to those resources amounts to a diminishment of Treaty-protected rights, which are also tribal property rights. Accidental spills do occur, and any expected loss of natural resources should be analyzed and quantified.

10 **Soil Disturbance**

- Vegetation and topsoil removal and mixing of soil horizon leads to reduction in plant diversity, potential for increased erosion and introduction/perpetuation of invasive, noxious plant species.

11 **Financial Assurance**

- Through time, all pipelines will need to be removed or decommissioned. What is the financial assurance for total remediation and restoration of Line 3 Existing Route pipeline corridor?

12 Eco-System Valuation

- In 2015 Earth Economics published an eco-system valuation of the St. Louis River watershed, finding that the St. Louis River watershed provides an estimated $5 billion to $14 billion in ecosystem service benefits per year which provides each of the approximately 177 thousand people living in the watershed an annual benefit of $28,248 to $79,096. This innovative study recognizes that quantifying the value of our eco-systems gives us better tools to understand the impact that environmental decisions have on the economy as a whole. The study can be found here: https://www.glifwc.org/Events/Earth%20Economics%20St%20Louis%20River%20Project%20Report.pdf. A similar study of the eco-systems that could be impacted by Line 3 projects should be done by an independent third party, such as the Great Lakes Indian Fish & Wildlife Commission.

13 Energy Alternatives

- Since 2007, Fond du Lac has reduced our carbon footprint and reduced energy usage by 40%. It is FDL Resource Management's position that although the United States is currently dependent upon crude oil, the world needs to begin a concerted effort to greatly reduce this dependence. The construction of new crude oil pipelines and the increase of capacities of existing pipelines encourage an increase in our dependence. Discussion of this reduction should be included to help illustrate what a less dependent scenario would look like.
- Extractive industries should take a percentage of their profits and contribute towards alternative energy.

Misi-zaaga'igani Anishinaabeg EIS Fisheries Concerns

Introduction:

This document was compiled by the Misi-zaaga'igani Anishinaabeg (Mille Lacs Band of Ojibwe) Fisheries Department. It addresses the Mille Lacs Band of Ojibwe (MLBO) fisheries concerns regarding the construction of Enbridge's Line 3 Applicants Preferred Route pipeline. We give permission and encourage all government agencies and private parties drafting the Environmental Impact Statement (EIS) to utilize the information below at any step in the EIS process (especially the analysis). Please don't hesitate to contact the MLBO fisheries department for any questions or concerns relating to this document (contact information on last page).

McGregor, MN, area fisheries:

The MLBO has tribal members and lands less than 10 miles south of McGregor, MN, as well as in the Big Sandy region just north of Enbridge's Line 3 Applicant's Proposed Route (APR). Tribal members in this region subsistence fish the culturally important Ooga (walleye) as well as other fish species. Consequently, an oil spill in the watersheds in this region would contaminate aquatic resources thus posing a threat to the fish and thus our tribal members fishing rights. In particular the following waterbodies are of concern to the MLBO. Brief rational are included below:

Rice Lake, Rice River, and Wayfield Brook: If oil spilled where the Rice River HUC-10 watershed intersects the APR, Rice Lake (MN-DNR DOW #: 01006700), Rice River, and Wayfield Brook would be contaminated. Oil contamination would first occur in Wayfield Brook and eventually travel to Rice River, Rice Lake, and then into other waterbodies located in the Rice River watershed region. These three waterbodies are fished by tribal members. They contain the sacred Ooga (walleye), other fish species, crayfish, and clams all of which are great cultural importance.

Big Sandy Lake Reservoir: The APR goes almost entirely through the Big Sandy Lake HUC-10 watershed. A spill anywhere in this watershed would contaminate Big Sandy Lake (MN-DNR DOW #: 0100620) destroying or causing serious problems for fish species and other aquatic organisms. Big Sandy Lake contains one of the most valuable walleye fisheries in the region. While the walleye fishery in Big Sandy Lake remains stable, surveys conducted by the Minnesota DNR indicate that the walleye population suffers from poor recruitment. Several factors make this walleye fishery threatened and particularly sensitive to oil spills. First, Big Sandy Lake already has a pollution problem that is impacting resident fish species. The

Minnesota Pollution Control agency has listed the lake as "impaired" due to high phosphorus levels. Second, Big Sandy Lake is home to the culturally important odoonibiins (tullibee). The tullibee is not found in most Minnesota lakes as it is sensitive to warm summer water temperatures. Consequently the best walleye fisheries in Minnesota also have tullibee present as they are an important prey item. The APR poses a direct threat to tullibee (and therefore walleye). If pollutants get any greater they could destroy the tullibee population. Changes in water clarity, food web alteration, and increased water temperatures are just a few examples of how tullibee could be impacted by an oil spill. Tullibee are also modeled to become extinct in many Minnesota lakes due to climate change. Therefore, adding more stressors to the tullibee could create a population crash that would directly impact walleye abundance. All fish species, clams, crayfish, and other aquatic organisms are especially important to the Ojibwe in this region. The Ojibwe that survived in this region relied on these organisms for food and ceremonial purposes. When the oil spills, tullibee, walleye, other fish species, crayfish, and clams will become contaminated. This contamination will adversely impact our band member's health as they still consume these organisms. Furthermore, ceremonies to celebrate aquatic life in the spring are still conducted. It would be offensive to the Ojibwe if they had to conduct these ceremonies in an oil polluted lake.

Lake Minnewawa- This lake also has tribal lands and members in the vicinity. Lake Minnewawa also contains walleye and other fish species our tribal members harvest. Unfortunately, according to Minnesota DNR data poor walleye natural reproduction occurs and the population is well below their long term management goal. Like Big Sandy Lake an oil spill would be catastrophic as the walleye population is already vulnerable due to anthropogenic environmental changes.

Sandy River: The APR directly crosses the Sandy River. If an oil spill occurred at this location Big Sandy Lake, Flowage Lake, Sandy River Lake, Rat Lake, Lake Minnewawa, and any lakes in the Big Sandy Lake watershed would be contaminated and have their fish species negatively impacted. It is also possible that even the construction of the APR could cause problems for fish populations in this watershed. Sandy River is the source of water for these lakes. Disturbances resulting from pipeline construction could increase water temperatures primarily from increased erosion, deforestation, and diverted water flow. Furthermore, construction equipment could contaminate the water as well as bring in aquatic and terrestrial invasive species from other construction locations.

Trout Streams: If oil spilled in the Rice River watershed Long Lake Creek (M-115-4-1) would be impacted. Long Lake Creek is a Minnesota DNR designated trout stream and has contained a harvestable population of Brook Trout. The creek is also home to the Central Mudminnow, Blacknose Shiner, Creek Chub, and Pearl Dace.

Scientific description of oil spills impact on fish and humans: Oil containments have many negative short and long term effects on fish populations (Rosenthal and Alderdice 1976; Teal and Howarth 1984; Eisler 1987; Bue et al. 1996). These effects include reductions in embryonic survival, disrupted spawning activities, reduced growth, and genetic abnormalities that are passed on to offspring. (Bue et al. 1996; Marty et al. 1997; Murphy et al. 1999; Heintz

2000; Dubansky 2013). Oil spill contaminates would also reduce and disrupt benthic organisms which are essential to fishes survival (Elmgren et al. 1983; Jewett et al. 1999). Furthermore, Polyaromatic Hydrocarbons (PAH's) increase in fish tissues after oil spills (Birkholz 1988; Allan et al. 2012). PAH's may increase cancer risks in people that consume contaminated fish if concentrations get to high (Eisler 1987; Cheung 2007; Zhonghuan et al. 2010). Therefore our Band member's health could be jeopardized by consuming Ooga (walleye) or other fish species when the spill occurs.

Baseline data required: Prior to completion of the APR the MLBO would like to see an extensive fisheries baseline data collection completed in Big Sandy Lake, Lake Minnewawa, Rice Lake, and other surrounding lakes that are connected to the Sandy River. Therefore, when the oil spill occurs its impact can be evaluated and fisheries management adjustments can be made. This baseline data set should include compiling a microchemical profile on otoliths extracted from fish species. These otoliths should be analyzed and an elemental profile should be complied using at least 33 concentrations of isotopes. This will enable future otolith microchemistry studies once the spill occurs and will allow for managing agencies to identify chemicals associated with oil spills in Minnesota for use in future studies. For further explanation of methodology we suggest following the procedures outlined in Nelson et al. 2015. We also suggest establishing baseline abundances, growth rates, and relative condition of walleye and other fish species before construction of the APR. We suggest that this approach be used when considering any pipeline construction in Minnesota.

Mille Lacs Band of Ojibwe greater Minnesota concerns:

Mille Lacs Band of Ojibwe members have the right to fish anywhere in Minnesota. Therefore in this section I address the MLBO's fisheries concerns along the APR's route outside of the Big Sandy/Rice Lake region. Additionally, the concerns below mainly analyze the APRs impact in the 750 foot right of way (here on referred to as the 750 ROW). We hope that the agencies tasked to compile the EIS analyze the impacts of oil spills at the watershed level as well.

Trout streams – 750 ROW: There are approximately 7 trout streams the APR crosses directly (750 ROW). When the oil spills contamination will be immediate. Trout in general are a very sensitive fish that need cold/clean water to survive. Construction of the pipeline alone would cause damage to these trout populations. These streams are within the 750 ROW (Minnesota DNR ID in parentheses):

King Creek (M-050-046-029-023)
Unnamed Stream (M-050-046-029-023-002)
Straight River (M-096-035-002-002)
Spring Brook (M-106-004-002-001)
Blackhoof River (S-001-003)
Unnamed Stream (S-001-003-029)
LaSalle Creek (M-163)

Furthermore, many of the above trout streams are located in remote areas which will make oil spill clean-up difficult.

Trout Streams – 2 mile radius: 41 streams, comprising over 221 miles of trout and coldwater fish habitat, are located within 2 miles of the APR. While some do not have direct contact, based on their HUC-10s contamination from an oil spill will be likely.

Tullibee sensitive lakes: As the plant warms due to climate change tullibee will start to go extinct in many Minnesota lakes. The Minnesota DNR along with the University of Minnesota conducted a study identifying lakes (refuge lakes) that tullibee will survive in despite climate change (Fang et al. 2010). Using data from this study we have identified two lakes along the APR 750 ROW that are considered tullibee refuge lakes. County names are listed in parentheses below.

Lakes: Roosevelt (Cass) and Washburn (Cass).

Walleye Lakes: The following walleye lakes come in direct contact with the APR or have streams/rivers that come in contact with the APR that flow into them. Therefore, these are the lakes that will be impacted if a spill occurs within the APR 750 ROW. Note that many lakes are connected. So if the first lake upstream is impacted more lakes further downstream will be impacted as well. County names are listed in parentheses below.

Lakes: Big Lasalle (Clearwater), Two Inlets (Becker), Island (Hubbard), Blueberry (Wadena), Twin Lakes (Wadena), Roosevelt (Cass), Bass (Aitkin), Park (Carlton), Washburn (Cass), Upper Twin (Hubbard), Lower Twin (Hubbard), First Crow Wing (Hubbard).

The MLBO recommends looking further than the APR 750 ROW to assess the impact of oil spills on walleye and other fish species. Many of these lakes that are further downstream have invasive species and an oil spill could magnify the negative impacts already caused by these species.

Muskie Lakes: Roosevelt Lake (Cass County) is a designated Minnesota DNR muskie lake. Muskie are very important to non-native recreational anglers. When the oil pipeline bursts it will have negative impacts on muskie spawning habitat and survival.

Sentinel Lakes: These lakes are being monitored by the Minnesota DNR, USGS, University of Minnesota, and other government entities. These lakes were chosen for long-term monitoring so the impacts of invasive species and climate change could be evaluated. Sentinel Lakes are crucial as they provide data that is used to improve and construct other lake management plans. Below are lakes that are within or have streams that cross the APR 750 ROW. If oil spilled or even construction equipment disturbed the area, the research would be impacted. This would impact other lake management plans, thus interfering with the Minnesota DNRs ability to manage lakes within the 1837 Ceded Territory. The lakes below will be impacted. County names are listed in parentheses.

Lakes: Roosevelt (Cass).

Invasive Species Concerns: Several lakes that have water sources that intersect the pipeline have invasive species in them. Most invasive species present a direct threat to walleye and other native fish populations. An oil spill, pipeline construction, or any other anthropogenic disturbance could magnify the negative impacts aquatic invasive species have on resident fish communities. Below is list of infested lakes that would be negatively impacted by the APR. County names are listed in parentheses below.

Lakes: Upper and Lower Twins (Hubbard County): Faucet Snail, Washburn (Cass): Eurasian Milfoil, First Crow Wing (Hubbard County): Faucet Snail, Crow Wing River (Hubbard): Faucet Snail.

All aquatic species concerns: In Ojibwe teachings the creator created all living things. Therefore, all aquatic organisms were made in the eyes of the creator and should be respected. Additionally, it is our ethical obligation as natural resource managers (and humans) to protect all aquatic life. Therefore, we hope that the professionals drafting this EIS analyze the impact of an oil spill on all aquatic organisms and not just gamefish species of monetary value.

Data sets to add:

After further review of the EIS impact assessment draft the MLBO fisheries department is suggesting the following data sets be added:

- https://gisdata.mn.gov/dataset/biota-muskie-lakes-in-mn
- https://gisdata.mn.gov/dataset/water-dnr-hydrography
- https://gisdata.mn.gov/dataset/env-sentinel-lakes-slice-program
- http://dnr.state.mn.us/invasives/ais/infested.html (Download the spreadsheet). The current invasive species ARC GIS file does not list the actual invasive species names that infested waterbodies contain.
- https://gisdata.mn.gov/dataset/water-fisheries-reclamations
- Tullibee Refuge Data: http://files.dnr.state.mn.us/fish_wildlife/fisheries/slice/slice-sim-cisco.pdf. The impact the oil spill will have on tullibee refuge lakes should be analyzed. The above link is to a study containing 620 of them. The Minnesota DNR should be contacted to get the shapefile so these lakes can be plotted in ARC GIS. The authors are listed in this paper. It is also recommended that the impact of the oil spill on all tullibee lakes be analyzed, not just the refuge ones.

References*

Fang, X., S. R. Alam, L. Jiang, P. Jacobson, D. Pereira, H. G. Stefan. 2010. Simulations of Cisco Fish Habitat in Minnesota Lakes under Future Climate Scenarios. St. Anthony Falls Laboratory. Retrieved from the University of Minnesota Digital Conservancy: http://hdl.handle.net/11299/115600.

Nelson, T. R., D. R. Devries, R. A. Wright, and J. E. Gagnon. 2015. Fundulus grandis Otolith Microchemistry as a Metric of Estuarine Discrimination and Oil Exposure. Estuaries and Coasts 38: 2044.

*Additional references can be provided upon request

** This document was completed by utilizing all data outlined in the current EIS impact assessment draft. Additional data was obtained from the Minnesota Geospatial Commons/Minnesota DNR. All data analyses were completed using ARC GIS 10.4.1.

Contact information:

Carl Klimah
Fisheries Biologist/Director
Mille Lacs Band of Ojibwe
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847-404-7590

Misi-zaaga'igani Anishinaabeg Cultural Resources Statement/Definition

The Mille Lacs Band of Ojibwe (Misi-zaaga'igani Anishinaabeg), defines its cultural resources as the ceremonial areas, cemeteries, archaeological sites and artifacts, bodies of water, wild rice lakes and rivers, wildlife, and medicinal plants within the historical Ojibwe native region. Cultural resources also include the language, customs, beliefs, and significant items of the Ojibwe people. The Mille Lacs Band of Ojibwa's cultural resources were inherited from previous generations, sustaining the Ojibwe people of today, and are carefully managed for future generations.

Archaeological resources have been defined by the Mille Lacs Band of Ojibwe as, "'Archaeological Resources' means any remains of the past human life or activities which are of archaeological or historical interest. Such material remains shall include, but not limited to: pottery, basketry, bottles, weapons, weapon projectiles, tools, structures or portions of structures, pit houses, rock paintings, rock carvings, intaglios, talus slide depressions, cairns, graves, human skeletal remains, or any portions or piece of any of the foregoing items. The material may also include non-fossilized or fossilized paleontological species, or any portion or piece thereof, whether or not found in an archaeological context. No item shall be treated as an archaeological or historical resource unless such an item is at least fifty years of age."

The Mille Lacs Band of Ojibwe Department of Natural Resources adheres to the Cultural Resources Code (1072-MLB-23) for all cultural resource management activities, and specific definitions. The Cultural Resources Code was enacted prior to the formation of the Tribal Historic Preservation Office, but cultural resource management practices were always practiced by taking only what we needed from the environment and thanking the creator for what was taken.

To better understand when we talk cultural resources such as the wildlife, ceremonial areas, cemeteries, archaeological sites and artifacts, bodies of water, wild rice lakes and rivers, and medicinal plants within the historical Ojibwe native region, that these areas were named in Ojibwe and hold a cultural significance to its name. Below is a list of some Ojibwe wildrice lake names. Ojibwe place names of the wild rice lakes within the proposed pipeline route are: Waukenabo Lake – Waakonaaboo-zaaga`igan, White Elk Lake – Waabadiko-zaaga`igan, Steamboat Lake – Gaa-bakezaagidawaag-zaaga`igan, Portage Lake - Nitamaa-makandwe-zaaga`igan, Mud Lake – Gaa-baagwajiishkiwagaag-zaaga`igan, Island Lake – Gaa-minisiwaang-zaaga`igan, Rice Lake – Baagwaan-manoominikaani-zaaga`igan, Mud Lake – Gaa-baagwajiishkiwagaag-zaaga`igan, Washburn Lake – Jiiga`awe-zaaga`igan, Pine Lake -

Azhiganegamaag-zhingwaakokaag-zaaga`igan. It is important to note many Ojibwe names may have been forgotten. Therefore, many of the English names listed below once had Ojibwe names associated with them.

The Ojibwe lived amongst many village sites, located along the lakes and rivers, for subsistence. Hunting the animals of the region, the fish of their choice, medicines needed, and gathering certain plants and berries. The Ojibwe did not place boundaries around their homeland; families buried the deceased near their villages, usually along the lakes and rivers. For better understanding read Mille Lacs Band of Ojibwe statue Title 11. In particular 1.(d) states:

"(d) It is the purpose of Subchapters I and II of this chapter, to perpetuate commonly held traditional beliefs, amongst American Indian people that human beings have a duty to peacefully co-exist within the natural environment. Human beings further have a natural duty to protect the environment which provides humans with life-sustaining natural resources."

Due to the preferred route crossing many rivers, streams and running next to many lakes is why inadvertent discovery of artifacts and old village sites and even human remains may happen in the corridor of this pipeline.

Submitted by:
Tribal Historic Preservation Office of the Mille Lacs Band of Ojibwe
Natalie Weyaus, Tribal Historic Preservation Officer
John Reynolds, THPO Review and Compliance Officer
Terry Kemper, THPO Assistant and Cultural Advisor

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REPLY TO MINNEAPOLIS

May 26, 2016

Ms. Jamie MacAlister
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Environmental Review Manager
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Energy Environmental Review and Analysis
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Saint Paul, MN 55101-2198

Re: Draft Scoping Decision Document for Sandpiper Pipeline Project – PUC Dockets CN-13-473 and PPL-13-474; and Draft Scoping Decision Document for Line 3 Replacement Pipeline Project – PUC Dockets CN-14-916 and PPL-15-137

Dear Ms. MacAlister:

The Mille Lacs Band of Ojibwe ("Mille Lacs Band") submits the following comments regarding the scope of the Environmental Impact Statement ("EIS") for the Sandpiper Pipeline Project and the Line 3 Replacement Pipeline Project.[1] The proposed projects have the potential to cause serious and irreparable environmental impacts. The environmental review must be thorough and demonstrate that the Department has taken a hard look at the potential impacts of the proposed projects and has given careful consideration to all feasible and prudent alternatives consistent with the requirements of the Minnesota Environmental Policy Act.

Both projects are proposed to pass through Minnesota's lake country and have the potential to impact numerous pristine lakes, streams, and wetlands, including sensitive aquatic ecosystems where the Ojibwe people have gathered wild rice for hundreds of years. Wild rice is not merely a source of food; it is a spiritual resource and the act of harvesting wild rice remains an integral part of the Ojibwe culture. Moreover, wild rice is the product of a healthy environment and actions taken to protect wild rice will serve to protect the entire ecosystem. The EIS is the mechanism to evaluate potential adverse impacts and determine how to avoid or mitigate such impacts. Accordingly, the EIS must include a comprehensive analysis of potential

[1] The Mille Lacs Band is simultaneously filing these comments in each of the PUC dockets for the Sandpiper and Line 3 Replacement projects.

impacts and mitigation measures and must evaluate alternative routes which avoid these sensitive ecosystems altogether.

The Mille Lacs Band provides the following specific comments regarding the scope of the EIS:

1. **The purpose of the project must be defined broadly to encompass reasonable alternatives to the proposed project.** Narrowly defining the purpose of a project (e.g., creating a system to transport oil from Clearbrook, MN to Superior WI) allows the exclusion of alternatives which may use different endpoints to the system. By defining the purpose broadly (e.g., creating system to transport oil to market from North Dakota), the EIS can encompass more alternatives which may lessen environmental impact while also meeting the applicant's needs even though they may be significantly different from what the applicant initially contemplated. This facilitates the outside-of-the-box analysis that is particularly valuable in the context of environmental review. Moreover, adopting a broad purpose allows the EIS to test the economic and other assumptions underlying the applicant's choice of its preferred alignment.

2. **The EIS must evaluate all feasible and prudent alternatives for the proposed projects.** Many alternative routes have been suggested which would avoid the sensitive aquatic ecosystems of north central Minnesota. By fully evaluating these alternatives, the EIS will allow the public and the regulators to understand how the potential impacts of the proposed alignment and the alternatives compare to each other and identify the least environmentally harmful alternative. The draft scoping decision document contemplates that no field-level data will be collected for the alternative routes. The draft scoping decision document should not foreclose the possibility of gathering field-level data if it is necessary for a full analysis of the alternatives. Also, as is typical, the EIS should incorporate new alternatives developed through the course of the environmental review which may avoid unanticipated or particularly serious adverse impacts including detailed analysis of all potential mitigation measures.

3. **The EIS must evaluate potential impacts on water quality and include modeling of several "worst-case" scenario spills along each route included in the EIS.** This evaluation should include the anticipated impacts to surface and groundwater resources resulting from construction of the projects and the potential short- and long-term impacts of a major spill along the route of either pipeline. In order to provide a meaningful comparison of the potential impacts of the various alternatives, the EIS should include modeling of the potential impacts of spills at several locations along each route. The modeling should include "worst-case" assumptions regarding the location (in particularly sensitive areas),

duration, and magnitude of the spill. Finally, the analysis also must include evaluation of the costs of, and likely success of, remedial actions in the event of a spill and whether the applicant should be required to provide financial assurances sufficient to cover the expected response and clean-up costs.

4. **The EIS must evaluate potential impacts on water quantity and hydrology.** Groundwater and surface waters interact in complex systems and the grading, excavation, compaction, and filling necessary to construct the pipeline likely will impact these systems as will the long-term maintenance, operation, and eventual decommissioning. Wild rice and other aquatic species are sensitive to changes in water quality and water levels and the impacts on water quantity and flow must be understood in order to determine the scope of potential impacts on these sensitive and interconnected aquatic ecosystems. The environmental review also should detailed proposals for mitigation and an analysis of their effectiveness.

5. **The environmental review must evaluate long-term and short-term impacts to wild rice harvesting and identify areas of uncertainty in the analysis.** The proposed route for the Sandpiper and Line 3 Replacement projects passes through five counties which account for nearly one-half of the wild rice harvesting trips according to a 2006 survey conducted by the Minnesota Department of Natural Resources. The shallow and sediment-rich waters where the wild rice thrives are particularly vulnerable to the negative impacts from a potential oil spill. The EIS must analyze how the water quality, quantity, and hydrology impacts mentioned relate to the potential long-term and short-term impacts on the sensitive wild rice waters across the region. This analysis should rely on the best available information regarding the cultivation of wild rice and, where there is uncertainty regarding the potential impacts, explain what additional information is needed and describe the range of the potential impacts (i.e., whether they are likely to be minor, moderate, or severe).

6. **The environmental review must address the potential impact of a spill on fragile fisheries.** The proposed route for the pipeline projects poses a significant threat to the fisheries near McGregor, Minnesota including Lake Minnewawa and Big Sandy Lake. Mille Lacs Band members live near both of these lakes, which are sacred to the Ojibwe people, and utilize the lakes for subsistence fishing of the culturally important Ooga (Walleye). A oil spill along the proposed route could contaminate both lakes and result in many negative short- and long-term effects on fish populations. Rosenthal and Alderdice (1976); Teal and Howarth (1984); Eisler 1987; Bue et al. (1996). These effects include reductions in embryonic survival, disrupted spawning activities, reduced growth, and genetic abnormalities that are passed on to offspring. Bue et al. 1996; Marty et al. 1997; Murphy et al. 1999; Heintz 2000; Dubansky (2013). The petroleum contamination also would

reduce and disrupt benthic organisms which are essential to fish survival. Elmgren et al. (1983); Jewett et al. (1999). Furthermore Polyaromatic Hydrocarbons (PAH's), which include potential carcinogens, tend to increase in fish tissues after oil spills and pose a risk to populations that are dependent upon the consumption of fish as part of their diets. Birkholz (1988); Allan et al. (2012); Eisler (1987); Cheung (2007); Zhonghuan et al. (2010).

7. **The environmental review must address impacts caused by further fragmentation of Minnesota forests.** Minnesota's North Central landscape has some of the State's largest and most unique continuous forest landscape including some of the last large unfragmented forests in the Midwest. Further fragmentation of Minnesota forests caused by the construction of the proposed pipelines will leave the remaining forests smaller, more susceptible to invasive species, and could potentially result in a loss of species diversity. Forest fragmentation also reduces and divides habitat for wildlife species that specialize in forest interiors. Construction of the pipelines along the proposed routes, along with the long-term maintenance, operation, and eventual decommissioning, also would undermine the objectives of the Minnesota DNR's Forest Legacy Program that aims to protect private forests from further threats on fragmentation.

8. **The environmental review must analyze potential impacts on bird species including the regional and extra-regional impacts on migratory bird species.** Disturbances along the proposed pipeline routes may result in abandonment, decreased breeding success, and, in the event of leakage or pipeline system failure, a degraded habitat the cumulative effects of which will threaten these species. These impacts must be evaluated through the environmental review process and include impacts to migratory species which have the potential to extend well beyond the region. The Palisade area of Northern Minnesota is a unique boreal forest which is well known by ornithologists as a breeding and wintering ground for several avian boreal species. In addition, several species with direct ties to the Ojibwe cultural practices have been documented wintering in the area including Great Gray Owls, Northern Hawk Owls, Boreal Chickadees, and sharp-tailed Grouse. The sharp-tailed Grouse are also a food source for the Ojibwe. The area around McGregor, Minnesota is known among ornithologists as the "McGregor Marsh" and is the breeding location for Yellow Rail, and Nelson's Sparrow.

9. **The evaluation of impacts to cultural resources will require a unique approach.** The Ojibwe have lived for centuries in the areas where the pipelines are proposed to be constructed and have a rich and long-standing cultural connection to the land. The cultural resources in the region include burial sites, lands used for hunting, fishing, and gathering, and various plants with medicinal

uses. While some of these resources, such are burial sites, are found in discrete locations, many are spread across the entire region. Understanding the nature of these cultural resources and how they must be protected will require close coordination between the Department and the Mille Lacs Band's Tribal Historic Preservation Office. Moreover, the Department must understand and respect the desire of the Mille Lacs Band to maintain secrecy regarding the location of some of the cultural resources which may be vulnerable to destruction through vandalism or well-intentioned but harmful overuse by visitors.

The EIS also must address the possibility that construction of the pipelines along the proposed route will unearth Native American cultural items and describe the process that will be used to ensure the preservation and repatriation of such items as is required under the Native American Graves Protection and Repatriation Act.

Finally, the EIS also must evaluate the potential impacts to natural resources, in particular to wild rice waters, not only from the ecological perspective but also from the cultural perspective.

10. **The environmental review must consider the impacts on traditional Ojibwe gathering and medicine with an understanding of the breadth and variety of resources upon which the Band depends.** The Ojibwe have long collected medicines from the lands they have inhabited. The proposed pipeline projects will pass through the lands of the Mille Lacs Band's District II community. The native plant communities in the area are classified as Northern Rich Tamarack Swamp, Northern Spruce Bog, Northern Poor Conifer Swamp, Northern Open Bog (McGregor Marsh), and Northern Poor Fen. Traditional Cultural Medicines found in this area include original cultural foods, spiritual medicines, and plants used for other traditional purposes. The Ojibwe consider food as medicine for our bodies and these resources are important to the survival of the culture and the Band.

Some traditional foods threatened by the pipeline include: Wild Rice, Cattails, fish, mushrooms, game animals, a variety of berries and roots. Some spiritual Medicines are Bitterroot (WeKay), Lily pad roots (blood pressure medicine), sage, sweet grass, Labrador Tea, Cranberry, & Red-osier Dogwood (Kinnikinik), iron wood (Heart medicine), birch (aspirin and headache medicine), Cha Ga (fungus of birch trees along river areas used as a tea for the treatment of cancer), clams in water as well as the Megas Shell used in ceremonies, and red cedar (Ojibwe tobacco). Many other plants are used for traditional purposes, including reeds from wetlands (used for mats and housing), birch bark from birch trees (used our everyday utensils and containers), Tamarack (many uses in handmade structures for religious practices and crafts), Paper Birch (traditional basketry,

crafts and the inner bark is known as a traditional food), White Cedar (important tree for ceremonial purposes and medicinal values), Red Maple (sap is collected in the spring), and Balsam Fir (important tree where boughs are collected for ceremonial purposes). Many other culturally significant, even vital, species could be identified by the Band's gatherers. These are just a few of the many traditional and cultural resources that the Mille Lacs Band finds and uses in District II.

11. **The EIS must address cumulative impacts that would result from constructing both pipelines along the same corridor as well as the unique impacts that would occur if only one pipeline is constructed.** The EIS must evaluate the cumulative impacts that will result from constructing and operating both projects along the same route. Moreover, because economic efficiency dictates that it is preferable to co-locate several pipelines along a single route, the EIS should address how the potential impacts may change in nature or magnitude if additional future pipelines are developed along the routes for the Sandpiper and/or Line 3 Replacement projects. Finally, because it is unknown whether either of the proposed projects will be approved and constructed or whether, if constructed, they will follow the same route, the EIS should address any potential impacts which may change in nature or magnitude if only one of the pipelines is constructed.

12. **The EIS must include an analysis of socio-economic, mental health, and environmental justice impacts cause by the potential loss of cultural and environmental resources.** As noted above, the Ojibwe have a deep and long-standing connection to the natural environment. This connection is integral to their cultural identity and the loss of these resources has resulted in have profound impacts on mental health including increased incidence of alcoholism, depression, and suicide. The evaluation of health impacts in the EIS must include these impacts in addition to impacts to physical health resulting from potential exposure to pollutants, contaminants, and increased noise and dust during construction.

13. **The potential impacts are amplified by the fact that the proposed route for the pipelines runs through the middle of the Mille Lacs Band's District II Community.** District II's government services are located in the East Lake community south of the proposed pipelines while the Minnewawa and Sandy Lake communities are located north of the proposed pipelines. Closure of a roadway in the region as a result of a major pipeline failure would isolate the Minnewawa and Sandy Lake communities from the basic services provided through the East Lake community and would isolate family members living in different regions from each other. The effects of bisecting the community with the proposed pipelines would be particularly significant for the extremely

traditional community with strong ties to time-honored culture and the emotional toll of a spill in the area would be devastating.

14. **The environmental review must consider the consequences of abandonment of the old Line 3, as well as the long-term impact of a policy of abandoning defunct pipelines.** Enbridge currently proposes to leave the old Line 3 in the ground with only minimal remediation. The environmental review must evaluate the potential impacts of abandoning the existing Line 3 pipeline, the proposed pipelines at the end of their useful life, and the cumulative impacts of abandoning multiple pipelines in the same region.

15. **The environmental review should be informed by the unique information and expertise which the Mille Lacs Band and other tribal governments can provide.** The Mille Lacs Band's Department of Natural Resources has extensive information regarding the natural and cultural resources in the area along with a highly skilled and knowledgeable staff. Consistent with Governor Dayton's Executive Order 13-10, regarding government-to-government consultation with Indian tribes, the Mille Lacs Band is ready and willing to share its expertise with the Department in order to ensure that the best possible environmental impact statement is prepared. We appreciate the coordination that has occurred to date and look forward to engaging in a substantive and productive dialogue with the Department relating to the environmental review of the proposed pipeline projects.

Thank you.

Very truly yours,

LOCKRIDGE GRINDAL NAUEN P.L.L.P.

David J. Zoll

c: Mille Lacs Band of Ojibwe
Charles N. Nauen
Rachel Kitze Collins

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REPLY TO MINNEAPOLIS

September 30, 2015

Ms. Jamie MacAlister
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Environmental Review Manager
Minnesota Department of Commerce
Energy Environmental Review and Analysis
85 7th Place East, Suite 500
Saint Paul, MN 55101-2198

Re: Comparative Environmental Analysis Draft Scoping Document for Sandpiper Pipeline and Line 3 Pipeline Replacement – PUC Dockets PPL-13474 and PPL15-137

Dear Ms. MacAlister:

Mille Lacs Band of Ojibwe ("Mille Lacs Band") submits the following comments regarding the scope of the Comparative Environment Analysis ("CEA") for the Sandpiper and Line 3 Pipeline Replacement projects. The proposed projects have the potential to cause serious and irreparable environmental impacts. The environmental review must be thorough and demonstrate that the Department has taken a hard look at the potential impacts of the proposed projects and has given careful consideration to all feasible and prudent alternatives. Moreover, to the extent that the Public Utilities Commission intends to use the CEA to satisfy the environmental review requirements for the Certificate of Need ("CON") proceedings for both projects, the CEA must include analysis of alternative routes and potential impacts necessary to make fully informed decisions regarding the CON applications consistent with the requirements of the Minnesota Environmental Policy Act.

Both projects are proposed to pass through Minnesota's lake country and have the potential to impact numerous pristine lakes, streams, and wetlands, including sensitive aquatic ecosystems where the Ojibwe people have gathered wild rice for hundreds of years. Wild rice is not merely a source of food; it is a spiritual resource and the act of harvesting wild rice remains an integral part of the Ojibwe culture. Moreover, wild rice is the product of a healthy environment and actions taken to protect wild rice will serve to protect the entire ecosystem. The CEA is the mechanism to identify and determine how to avoid or mitigate the proposed

projects' adverse impacts. As such, it must include a comprehensive analysis of potential impacts and evaluate alternative alignments which avoid these sensitive ecosystems altogether.

Mille Lacs Band provides the following specific comments regarding the scope of the CEA:

1. The CEA must evaluate all feasible and prudent alternatives for the proposed projects. Many alternative routes, such as the current SA-03 alternative, exist which would avoid the sensitive aquatic ecosystems. No decisions regarding the projects can be made without fully evaluating these alternatives. Also, as is typical in the course of environmental review, the Department should continue to consider and evaluate additional alternatives which may avoid unanticipated or particularly serious adverse impacts that are revealed through the course of the analysis.

2. The CEA must evaluate water quality impacts. This includes anticipated impacts to surface and groundwater resources resulting from construction of the projects and the potential short- and long-term impacts of a major spill along the route of either pipeline. The analysis also must include evaluation of the costs of, and likely success of, remedial actions in the event of a spill.

3. The CEA must evaluate water quantity and hydrologic impacts. Groundwater and surface waters interact in complex systems and the grading, excavation, compaction, and filling necessary to construct the pipeline likely will impact these systems. Wild rice and other aquatic species are sensitive to changes in water quality and water levels and the impacts on water quantity and flow must be understood in order to determine the scope of potential on these sensitive and interconnected aquatic ecosystems.

4. Construction of the pipelines along the proposed route likely will unearth Native American cultural items. The CEA must address this possibility and describe the process that will be used to ensure the preservation and repatriation of such items as is required under the Native American Graves Protection and Repatriation Act. The CEA also must address the potential impacts to wild rice waters not only from the ecological perspective but also from the cultural perspective. Adequately addressing the potential cultural impacts of the proposed projects will require consultation with Mille Lacs Band officials. Mille Lacs Band is willing and prepared to meet with the Department to address these issues.

5. The Draft Scoping Document indicates that a single CEA will be prepared for both the Sandpiper and Line 3 Replacement projects. The CEA must evaluate the cumulative impacts that will result from constructing and operating both projects along the same route. Moreover, because economic efficiency dictates that it is preferable to co-locate pipelines along a single route, the CEA should address how the potential impacts may change in nature or magnitude if additional pipelines are developed along the route.

6. At this time, it is unknown whether either of the proposed projects will be approved and constructed or whether, if constructed, they will follow the same route. Accordingly, the CEA should address any potential impacts which may change in nature or magnitude if only one of the pipelines is constructed along a route.

Finally, we remind the Department of its obligation, pursuant to Governor Dayton's Executive Order 13-10, to engage in government-to-government consultation with Mille Lacs Band and other Indian tribes. Allowing tribal governments to participate in proceedings in the same capacity as members of the public is not sufficient. Rather, the Department must affirmatively consult with the Band to identify and address issues relating to the projects which may affect the Band and its members. Mille Lacs Band looks forward to engaging in a substantive and productive dialogue with the Department relating to the environmental review of the proposed pipeline projects.

Thank you.

Very truly yours,

LOCKRIDGE GRINDAL NAUEN P.L.L.P.

David J. Zoll

c: Mille Lacs Band of Ojibwe
Charles N. Nauen

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DISTRICT III
Kenneth Bevins

Beverly Jones Heydinger, Chair
Minnesota Public Utilities Commission
121 7th Place East, Suite 350
Saint Paul, Minnesota 55101-2147

Dear Chair Heydinger:

As Chairwoman of the White Earth Reservation Tribal Council, I can appreciate the many issues you must face as Chair of the Minnesota Public Utilities Commission.

I am writing today to ask for the comment period with respect to the routing permit requested by the North Dakota Pipeline Company for a petroleum pipeline between Tioga, North Dakota and Superior, Wisconsin be extended beyond the current April 4, 2014 deadline.

This company has done no outreach to the White Earth Tribal Nation or any other Tribal Nation in Minnesota. These lands are sacred to us. The pipeline company proposes to locate the pipeline through lands upon which our tribal members have off-Reservation gathering rights. The issue of locating a pipeline to transport crude oil through the Mississippi Headwaters Country cannot be rushed.

The information on this issue has been repeatedly changed by the pipeline company. We are very concerned about the potential for environmental destruction similar to the dumping of over 1.5 million gallons of oil from a ruptured oil pipeline through the Kalamazoo River. We are not speculating. Disasters of this magnitude have actually occurred.

Therefore, I am requesting that no action be taken by the Minnesota Public Utilities Commission at this time. At a minimum, this company needs to do serious outreach to Tribal Nations. Given the information I have received at this time, I am certain all Tribal Nations in Minnesota would oppose the location of the route now proposed by the North Dakota Pipeline Company.

I look forward to discussing this issue with you in the future, but we are very concerned the comment period not close on April 4 for many reasons.

Sincerely,

Emma J. Vizenor
Chairwoman

WHITE EARTH RESERVATION TRIBAL COUNCIL
A/K/A WHITE EARTH BUSINESS COMMITTEE
WHITE EARTH BAND OF CHIPPEWA INDIANS

Resolution No. 001-14-012

WHEREAS, the White Earth Reservation Tribal Council is the duly elected governing body of the White Earth Reservation pursuant to Article IV, Section 1, of the revised constitution of the Minnesota Chippewa Tribe, as amended, and organized under Section 16, of the Act of June 18, 1934 (48 Stat. 984), and

WHEREAS, the White Earth Reservation Tribal Council, also known as the White Earth Reservation Business Committee, is the duly authorized governing body of the White Earth Band, and

WHEREAS, the White Earth Reservation Tribal Council, as the duly elected governing body of the White Earth Reservation has the power under the constitution and by-laws to promulgate resolutions governing the conduct of business on the Reservation; as well as conduct taking place within or having a direct impact upon the 1855 Treaty Ceded territory, and

WHEREAS, the White Earth Reservation Tribal Council has reviewed the application filed by North Dakota Pipeline Company LLC with the Minnesota Public Utilities Commission ("PUC") with respect to a routing permit for a petroleum pipeline between Tioga, North Dakota and Superior, Wisconsin, and

WHEREAS, the White Earth Tribal Government and staff have been active in work to protect the environment for our present Tribal members and for our future generations through the approval and implementation of a body of tribal laws and regulations, and

WHEREAS, the White Earth Reservation Tribal Council is concerned about the potential impact to lands, wetlands and waters if a leak or rupture of North Dakota Pipeline Company's pipeline were to occur near the White Earth Reservation or in the 1855 Treaty Ceded territory, and

WHEREAS, the White Earth Reservation Tribal Council is mandated to take steps to protect tribal members; and to protect habitat for animals, plants and especially wild rice from the devastating potential effects of a pipeline leak or rupture, and

WHEREAS, the White Earth Reservation Tribal Council has not been provided with any assurances by the North Dakota Pipeline Company or any other party that additional pipelines for the transportation of crude oil, tar sands and diluents will be any safer than the current pipelines which have leaked and ruptured on countless occasions, now

THEREFORE BE IT RESOLVED, that the White Earth Reservation Tribal Council hereby declares that it is opposed to the application filed by the North Dakota Pipeline Company with the Minnesota PUC with respect to a routing permit for the Sandpiper petroleum pipeline between Tioga, North Dakota and Superior, Wisconsin, and

BE IT FURTHER RESOLVED, that the White Earth Reservation Tribal Council hereby directs Tribal environmental and legal staff to formally intervene in the proceedings now pending before the Minnesota PUC involving the North Dakota Pipeline Company's application for a routing permit for the purpose of informing the PUC of the White Earth Nation's opposition to the grant of such permits, now

BE IT FINALLY RESOLVED, that the White Earth Reservation Tribal Council further directs Tribal environmental and legal staff to document the potential harmful impacts to the White Earth Nation, its people, its natural environment, its water, both within the boundaries of the White Earth Reservation and in the 1855 Treaty Ceded territory.

We do hereby certify that the foregoing resolution was adopted by a vote of 3 for, 0 against, 2 silent, a quorum being present at a special meeting of the White Earth Reservation Tribal Council held on February 13, 2014 in Mahnomen, Minnesota.

Erma J. Vizenor, Chairwoman

Robert J. Durant, Secretary/Treasurer

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September 30, 2015

Minnesota Public Utilities Commission
121 7th Place East, Suite 350
St. Paul, MN 55101-2147

Re: Docket Nos. PPL-13-473 (Sandpiper)
PPL-15-137 (Line 3)

To the Minnesota Public Utilities Commission:

The White Earth Band of Ojibwe expects that an Environmental Impact Statement examining the cumulative effects of the Sandpiper Pipeline and the Line 3 Pipeline will be completed, considering all routes in consideration during the Sandpiper proceedings, and any additional route or project alternatives offered during the scoping period. Completion of an Environmental Impact Statement for both projects is consistent with the opinion of the Minnesota Court of Appeals,[1] and satisfies, in part, the obligations of the State of Minnesota to engage in meaningful consultation and co-management of resources with the Tribal Nations of the State.[2] Completion of an Environmental Impact

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[1] *In the Matter of the Application of the North Dakota Pipeline Company, LLC for a Certificate of Need for the Sandpiper Pipeline Project in Minnesota*, No. A15-0016 (Sept. 14, 2015), slip op.

[2] *See, e.g.*, Minnesota v. Mille Lacs Band of Chippewa Indians, 526 U.S. 172, 205 (1999); United States v. Dion, 476 U.S. 734 (1986); Washington et al. v. Washington State Commercial Passenger Fishing Vessel Ass'n, et al., 443 U.S. 658 (1979); Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Voigt, 700 F.2d 341, 365 (7th Cir. 1983); and Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Wisconsin, 653 F. Supp. 1420, 1430 (W.D. Wisc. 1987). As illustrated by *Minnesota v. Mille Lacs Band of Chippewa Indians*, 526 U.S. 172, 204, 208 (1999) and the agreements stemming from that litigation, and the litigation and subsequent agreement reached between the State of Minnesota and the Bois Forte Band of Chippewa and the Grand Portage Band of Lake Superior Chippewa, the State of Minnesota is well aware of its obligations to engage in co-management and meaningful consultation with the successors in interest to the Treaties for the management of resources within the treaty-ceded territories.

Statement is also consistent with the trust responsibility of the Federal Government to the Tribal Nations of the State.[3]

The following observations are offered, after participation in the Sandpiper Pipeline proceedings for approximately 18 months: the Commission and the Applicant have a preference for locating major pipeline infrastructure in less populated areas at the risk of damaging unimpaired natural habitats and burdening poorer, less politically mobilized populations. This is unequivocally "environmental injustice," and has measureable disproportionate impact on remote and impoverished communities within the State. This is unacceptable, and should be at the forefront of consideration for the Public Utilities Commission.

Additionally, the Applicant appears to be advantaged in the permitting proceedings, such that participation by the public and other State agencies has no impact at all on the substance of the proceedings. The Applicant and the Commission both asserted throughout the Sandpiper proceedings that no other party had met the specificity required for consideration of any alternative that did not closely mirror the route offered by the Applicant, despite the Applicant having the burden of proof in these proceedings, despite the Applicant acknowledging that it took years and significant man-power to develop its proposed route, and despite "failure of the Applicant to propose a viable alternative for consideration in this proceeding."[4] This cannot possibly be the intent of the statutes and rules governing pipeline permitting – what would be the purpose of allowing for public participation under these circumstances?

The White Earth Band of Ojibwe urges the Commission to use common sense and consider the policy and intent of the statutes and rules that govern permitting proceedings to meaningfully consider all reasonable alternatives offered (including the so-called "SA-03 to SA-08" alternatives in consideration for the Sandpiper proceeding). The statutes and rules cannot possibly be read to mean that only engineering firms with extensive time, resources, and man-power may offer route alternatives that deviate from the Applicant's route for consideration by the Commission. Moreover, the Applicant should be held to its obligations to propose "viable alternatives" at the risk of denial of its applications. What Enbridge (in any iteration including the North Dakota Pipeline Company, LLC) has asked of the State of Minnesota is to be "pass-through" state for a massive quantity of unrefined product, to be refined and placed into commerce elsewhere. The Company should be held to exacting standards given the gravity of its request, and must participate fully and meaningfully in an Environmental Impact Statement of all of the Company's pending and proposed projects within the State. If, as the Applicant avers, it has offered a technically sound and environmentally safe option, then it should have no objection to an Environmental Impact Statement which would demonstrate its position.

In the alternative, or additionally, the State of the Minnesota reaps the immeasurable benefit from an Environmental Impact Statement of being assured that all due consideration was made of the proposed locations for any major pipeline infrastructure project within the State. Although the Commission has given little weight to the comments of the public received to date, it is clear from the Commission's own materials, that thousands of members of the public have

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[3] *See*, Petition to Intervene, White Earth Band of Ojibwe (May 1, 2014).
[4] Order Authorizing Recommencing of Route Permit Proceedings and Providing Direction for the Scope of the Comparative Environmental Analysis (August 3, 2015), at Order (2).

offered comment, many of whom expressed sincere and immediate concern that the Applicant's projects as proposed pose a significant risk to an impaired natural habitat within the State. This was evident at the public hearings regarding the scope of environmental review as well - the public testimony was replete with opposition to the proposed (co-)location of the Sandpiper and Line 3 as offered by the Applicant. Thorough environmental review now before consideration of the Applications for Certificates of Need and Routing Permits for both Sandpiper and Line 3 is required for the Commission to make informed decisions and for the public to have any meaningful participation.[5]

The environmental assessment ordered by the Commission and completed at DOC-EERA staff on the "system alternatives" SA-03 through SA-08 was invalidated by the Minnesota Court of Appeals. That environmental review was significantly insufficient to meet the requirements of the Minnesota Environmental Policy Act. The Commission recognized this in its order that qualitative as well as quantitative consideration must be made of the impact of the proposed routes, and that Sandpiper and Line 3 must be considered cumulatively.[6] The routes SA-03 through SA-08 must be considered in the Environmental Impact Statement, along with any other route alternative currently in consideration or any route or other alternative offered during the scoping period. The Commission previously held that environmental review of these six routes would "provide [the Commission] with valuable information to be weighed along with other information of record while making its need decision,"[7] and that environmental review would "ensure that the record in the certificate of need proceeding contains an adequate, albeit preliminary, environmental analysis of the system alternatives."[8] The parties now understand that "preliminary" review is inadequate, but the conclusions of the Commission are no less true – meaningful environmental review of the alternative routes in consideration by DOC-EERA in fall of 2014 is necessary to the Certificate of Need proceedings for both the Sandpiper and Line 3.

The White Earth Band of Ojibwe emphasizes again for the Commission that the State of Minnesota has an obligation to engage in meaningful consultation and co-management of resources within the 1855 Treaty-ceded territory with the Tribal Nation successors in interest to the Treaty *which cannot be abrogated* by State statute or any other internal policy of the

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[5] *See*, In the Matter of the Application of the North Dakota Pipeline Company, LLC for a Certificate of Need for the Sandpiper Pipeline Project in Minnesota, No. A15-0016 (Sept. 14, 2015), slip op.pgs. 10-11 ("The United States Supreme Court has explained that early-stage environmental review . . . is critical because it ensures that that[sic] important environmental effects will not be overlooked or underestimated only to be discovered after resources have been committed or the die otherwise cast.") *citing* Robertson v. Methow Valley Citizens Council, 490 U.S. 349 (1989) (internal quotations and punctuation omitted).

[6] Order Authorizing Recommencing of Route Permit Proceedings and Providing Direction for the Scope of the Comparative Environmental Analysis (August 3, 2015), at Orders (9) & (10) (Although the Commission did not specifically find that the DOC-EERA environmental analysis was insufficient, its findings evidenced its acknowledgment of the criticisms made by many parties that to simple count resources in a proposed path of a pipeline is grossly inadequate and misleading because no consideration is made to the purity or impairment of the resources, a much more meaningful question for review.).

[7] Order of the Public Utilities Commission dated October 7, 2014 at VI(B), p. 11.

[8] *Id.* at p. 12.

Minnesota Department of Commerce or other Executive action of the State of Minnesota.[9] The obligations of the State of Minnesota are an extension of the Federal trust responsibility owed to Tribal Nations which cannot be met simply by participation of the White Earth Nation and Honor the Earth in the permitting proceedings. The obligation is one of nation-to-nation consultation, and must be done unequivocally and directly with the Tribal Nations. The White Earth Band of Ojibwe advises the Commission that to go any further with permitting of the Sandpiper Pipeline and the Line 3 Pipeline without meaningful consultation and co-management of usufructuary use rights resources is a violation of the trust responsibility.

The White Earth Band of Ojibwe looks forward to meaningful consultation with the State of Minnesota, and development of a co-management plan for usufructuary use rights resources within the 1855 Treaty-ceded territory. And, expects that an Environmental Impact Statement will be completed, considering all routes offered in the Sandpiper proceedings including SA-03, SA-04, SA-05, SA-06, SA-07, and SA-08, as well as all other route and alternative options offered during this scoping period, which considers both the proposal for the Sandpiper Pipeline and the proposal for the Line 3 Pipeline.

The White Earth Band of Ojibwe appreciates the consideration of the Commission in this matter.

Sincerely,

/s/ Joseph Plumer

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[9] *Cherokee Nation v. Georgia*, 30 U.S. (5 Pet.) 1 (1831). This case and its progeny establish that the United States Federal Government, and by extension the States, have an obligation to the Tribal Nations of the country, and that this obligation is enduring.

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September 30, 2015

Minnesota Public Utilities Commission
121 7th Place East, Suite 350
St. Paul, MN 55101-2147

Re: Docket Nos. PPL-13-473 (Sandpiper)
PPL-15-137 (Line 3)

To the Minnesota Public Utilities Commission:

The White Earth Band of Ojibwe expects that an Environmental Impact Statement examining the cumulative effects of the Sandpiper Pipeline and the Line 3 Pipeline will be completed, considering all routes in consideration during the Sandpiper proceedings, and any additional route or project alternatives offered during the scoping period. Completion of an Environmental Impact Statement for both projects is consistent with the opinion of the Minnesota Court of Appeals,[1] and satisfies, in part, the obligations of the State of Minnesota to engage in meaningful consultation and co-management of resources with the Tribal Nations of the State.[2] Completion of an Environmental Impact

[1] *In the Matter of the Application of the North Dakota Pipeline Company, LLC for a Certificate of Need for the Sandpiper Pipeline Project in Minnesota*, No. A15-0016 (Sept. 14, 2015), slip op.

[2] *See, e.g.*, Minnesota v. Mille Lacs Band of Chippewa Indians, 526 U.S. 172, 205 (1999); United States v. Dion, 476 U.S. 734 (1986); Washington et al. v. Washington State Commercial Passenger Fishing Vessel Ass'n, et al., 443 U.S. 658 (1979); Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Voigt, 700 F.2d 341, 365 (7th Cir. 1983); and Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Wisconsin, 653 F. Supp. 1420, 1430 (W.D. Wisc. 1987). As illustrated by *Minnesota v. Mille Lacs Band of Chippewa Indians*, 526 U.S. 172, 204, 208 (1999) and the agreements stemming from that litigation, and the litigation and subsequent agreement reached between the State of Minnesota and the Bois Forte Band of Chippewa and the Grand Portage Band of Lake Superior Chippewa, the State of Minnesota is well aware of its obligations to engage in co-management and meaningful consultation with the successors in interest to the Treaties for the management of resources within the treaty-ceded territories.

Statement is also consistent with the trust responsibility of the Federal Government to the Tribal Nations of the State.[3]

The following observations are offered, after participation in the Sandpiper Pipeline proceedings for approximately 18 months: the Commission and the Applicant have a preference for locating major pipeline infrastructure in less populated areas at the risk of damaging unimpaired natural habitats and burdening poorer, less politically mobilized populations. This is unequivocally "environmental injustice," and has measureable disproportionate impact on remote and impoverished communities within the State. This is unacceptable, and should be at the forefront of consideration for the Public Utilities Commission.

Additionally, the Applicant appears to be advantaged in the permitting proceedings, such that participation by the public and other State agencies has no impact at all on the substance of the proceedings. The Applicant and the Commission both asserted throughout the Sandpiper proceedings that no other party had met the specificity required for consideration of any alternative that did not closely mirror the route offered by the Applicant, despite the Applicant having the burden of proof in these proceedings, despite the Applicant acknowledging that it took years and significant man-power to develop its proposed route, and despite "failure of the Applicant to propose a viable alternative for consideration in this proceeding."[4] This cannot possibly be the intent of the statutes and rules governing pipeline permitting – what would be the purpose of allowing for public participation under these circumstances?

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Minnesota Department of Commerce or other Executive action of the State of Minnesota.[9] The obligations of the State of Minnesota are an extension of the Federal trust responsibility owed to Tribal Nations which cannot be met simply by participation of the White Earth Nation and Honor the Earth in the permitting proceedings. The obligation is one of nation-to-nation consultation, and must be done unequivocally and directly with the Tribal Nations. The White Earth Band of Ojibwe advises the Commission that to go any further with permitting of the Sandpiper Pipeline and the Line 3 Pipeline without meaningful consultation and co-management of usufructuary use rights resources is a violation of the trust responsibility.

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STATE OF MINNESOTA
PUBLIC UTILITIES COMMISSION

Beverly Jones Heydinger	Chair
Nancy Lange	Commissioner
Dan Lipschultz	Commissioner
John A. Tuma	Commissioner
Betsy Wergin	Commissioner

In the Matter of the Application of Enbridge Energy, Limited Partnership for a *Certificate of Need* and *Pipeline Routing Permit* for the Line 3 Replacement Project in Minnesota

PETITION TO INTERVENE

Docket Nos. PL-9/CN-14-916 and PL-9/PPL-15-137

To: The Minnesota Public Utilities Commission

Pursuant to Minnesota Rules 1400.6200, the White Earth Band of Ojibwe (White Earth Band) hereby respectfully petitions to intervene in the above-referenced Matter of the Application of Enbridge Energy, Limited Partnership for a Certificate of Need and Pipeline Routing Permit for the Line 3 Replacement Project in Minnesota.

Background and Issues

The Applicant, Enbridge Energy, Limited Partnership, applied for a Certificate of Need and Routing Permit for its proposed Line 3 Replacement Project in Minnesota, to be co-located in the corridor selected by the Applicant, Enbridge Pipelines d/b/a/ North Dakota Pipeline Company, LLC, for the proposed Sandpiper Pipeline Project. The proposed corridor for these projects traverses a significant portion of the 1855 Treaty-ceded territory, and goes through the northeast townships of the original White Earth Reservation. The White Earth Band is an intervening party to the Sandpiper Pipeline project proceedings, and has been since 2014. The interest of the White Earth Band in these proceedings is substantially similar to the interests of

White Earth in the Sandpiper Pipeline proceedings given the proposed co-location of these projects and the impact these projects could have on on-Reservation resources and usufructuary use rights resources within the 1855 Treaty-ceded territory.

Identity of Petitioner

The White Earth Band of Ojibwe (the White Earth Nation) is a federally recognized Indian Nation and a constituent member of the Minnesota Chippewa Tribe with its Reservation in west central Minnesota.[1] The members of the White Earth Band are amongst the successors in interest to a number of treaties entered into with the Ojibwe Bands between the 1830's and the 1860's.[2] The members of the White Earth Band hunt, fish, rice, and gather within the Reservation and the 1855 Treaty-ceded territory. The impact of large scale infrastructure energy projects like those proposed by Enbridge Energy, Limited Partnership and the North Dakota Pipeline Company, LLC during both construction and operation may have a significant impact on the health and availability of resources necessary to subsistence and use activities. The protection and health of wild rice within this region of the state is of particular concern to the White Earth Band given its supreme cultural significance to Ojibwe Anishinaabe people, and its importance as a source of food and income.

Argument

I. The State of Minnesota has an obligation to engage in meaningful consultation with the successors in interest to the 1855 Treaty including the White Earth Band of Ojibwe to address the impact of this Project to on-Reservation and off-Reservation usufructuary use rights resources prior to final determinations on the applications for permits.

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[1] Indian Entities Recognized & Eligible To Receive Services From the Bureau of Indian Affairs, 77 Fed. Reg. 47,868, 47,870 (Aug. 10, 2012).

[2] *See*, Treaty of 1836, 7 Stat. 491 (March 28, 1836); Treaty of 1837, 7 Stat. 536 (July 29, 1837); Treaty of 1842, 7 Stat. 591 (Oct. 4, 1842); Treaty of 1854, 10 Stats. 1109 (Sept. 30, 1854); Treaty of 1855, 10 Stat. 1165 (Feb. 22, 1855); Treaty of 1864, 13 Stat. 693 (May 7, 1864); Treaty of 1867, 16 Stats. 719 (March 19, 1867).

a. The White Earth Band of Ojibwe retains off-reservation usufructary rights in the 1855 Treaty ceded territory which have not been abrogated.

The White Earth Reservation Tribal Council is the governing body of the White Earth Reservation, and is among the successors in interest to the signatories of the 1855 Treaty with the Chippewa (hereinafter "1855 Treaty").[3] Although the 1855 Treaty was a land cession treaty, it did not dispossess the signatories of their retained usufructuary rights in the ceded territory. The Court in *Mille Lacs* noted in its conclusion that the 1855 Treaty did not abrogate previously guaranteed reserved rights. The Court stated:

> The entire 1855 Treaty, in fact, is devoid of any language expressly mentioning-much less abgrotating-usufructuary rights. Similarly, the Treaty contains no language providing money for the abrogation of previously held rights . . . The 1855 Treaty was designed primarily to transfer Chippewa land to the United States, not to terminate Chippewa usufructuary rights.[4]

In addition to the reserved rights provided for in the 1837 Treaty, the 1854 Treaty "also guarantees usufructuary property rights to the Mississippi Chippewa in the *unceded* territory west of the 1854 Treaty boundary . . ."[5] The Mississippi Band was a signatory to the 1854 Treaty, and the 1855 Treaty territory is west of the 1854 Treaty ceded territory.

The retained usufructuary rights of the White Earth Band were intact after the execution of the 1855 Treaty, and have not been subsequently divested.

b. The State of Minnesota is obligated to engage in meaningful consultation with the White Earth Band of Ojibwe regarding the impact of this Project to on and off-Reservation resources including resources within the 1855 Treaty-ceded territory.

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[3] 10 Stats. 1165 (Feb. 2, 1855). The signatory Bands to the Treaty of 1855 were the Mississippi, Pillager, and Lake Winnibigoshish Bands, whose people were among the Bands that would later organize under the Indian Reorganization Act (48 Stat. 987 (1934) as the Minnesota Chippewa Tribe, which is composed of White Earth, Leech Lake, Mille Lacs, Grand Portage, Bois Forte, and Fond Du Lac.

[4] *Minnesota v. Mille Lacs Band of Chippewa Indians*, 526 U.S. 172, 195, 196 (1999).

[5] Peter Erlinder, *Treaty-Guaranteed Usufructuary Rights:* Minnesota v. Mille Lacs Band of Chippewa Indians *Ten Years On*, 41 ELR 10921, 10930 (Oct. 2011) (emphasis added).

The White Earth Band and other successors in interest to the 1855 Treaty retain usufructuary use rights property interests in the 1855 Treaty-ceded territory.[6] The White Earth Band additionally retains original, sovereign jurisdiction over resources within the Reservation boundaries.[7] As demonstrated in the *Mille Lacs* case, tribes have the authority to regulate their membership within the treaty-ceded territories for the purposes of exercising usufructuary use rights in cooperation with the state agencies.[8] The State of Minnesota is unable to proceed with issuance of the Applicant's Certificate of Need and Routing Permit without the involvement of the White Earth Band and a detailed consideration of the impacts of the proposed project on resources both within the Reservation boundaries and within the 1855 Treaty-ceded territory.

The White Earth Band petitions for intervention in these proceedings as a necessary first step to meaningful consultation with the State of Minnesota for the preservation and protection of on and off-Reservation resources necessary to continued use by the members of the White Earth Band.

Conclusion

The State of Minnesota is required to meaningfully consult with the White Earth Band of Ojibwe regarding the impact of the Line 3 Replacement Project to on and off-Reservation resources, including resources necessary for the continued exercise of usufructuary use rights activities within the 1855 Treaty-ceded territory. The interests of the White Earth Band of

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[6] *See, e.g.*, Minnesota v. Mille Lacs Band of Chippewa Indians, 526 U.S. at 176 (finding that the Mille Lacs Band of Ojibwe retained usufructuary use rights within the 1837 Treaty-ceded territory including the right to regulate its own membership in the use of such resources).

[7] *See, e.g.*, Worchester v. Georgia, 31 U.S. 515, 557 (1832) (finding that Tribal Nations are "distinct political communities, having territorial boundaries, within which their authority is exclusive. . .").

[8] *Minnesota v. Mille Lacs Band of Chippewa Indians*, 526 U.S. 172, 205 (1999); *United States v. Dion*, 476 U.S. 734 (1986); *Washington et al. v. Washington State Commercial Passenger Fishing Vessel Ass'n, et al.*, 443 U.S. 658 (1979); *Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Voigt*, 700 F.2d 341, 365 (7th Cir. 1983); and *Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Wisconsin*, 653 F. Supp. 1420, 1430 (W.D. Wisc. 1987).

Ojibwe in these proceedings are substantially the same as the White Earth Band's interests in the Sandpiper Pipeline Project proceedings. The White Earth Band petitions for intervention in these proceedings to protect the interests of the White Earth Nation and its membership with regard to the continued health and production of on and off-Reservation resources, most important, the health of wild rice. The White Earth Band of Ojibwe does not believe that any other current or prospective party is able to represent and safeguard its interests.

Dated: 1/19/16

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Dated: 1/19/16

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Beimers	Sarah	sarah.beimers@mnhs.org	Minnesota Historical Society	Electronic Service	No
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Howe	Kari	kari.howe@state.mn.us	DEED	Electronic Service	No
Javaherian	Arshia	arshia.javaherian@enbridge.com	Enbridge Energy	Electronic Service	No
Jeffrey	Susu	susujeffrey@msn.com	Friends of Coldwater	Electronic Service	No
Jensen	Linda	linda.s.jensen@ag.state.mn.us	Office of the Attorney General-DOC	Electronic Service	No
Kirsch	Ray	Raymond.Kirsch@state.mn.us	Department of Commerce	Electronic Service	No
LaBerge	Kathy	labergeonthelake@yahoo.com	N/A	Electronic Service	No
LaDuke	Winona	winonaladuke1@gmail.com	Honor the Earth	Electronic Service	No
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GREAT LAKES INDIAN FISH & WILDLIFE COMMISSION
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• MEMBER TRIBES •

MICHIGAN	WISCONSIN		MINNESOTA
Bay Mills Community	Bad River Band	Red Cliff Band	Fond du Lac Band
Keweenaw Bay Community	Lac Courte Oreilles Band	St. Croix Chippewa	Mille Lacs Band
Lac Vieux Desert Band	Lac du Flambeau Band	Sokaogon Chippewa	

May 26, 2016

Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 500, Saint Paul, MN 55101

Ms. MacAlister,

Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an intertribal agency exercising delegated authority from 11 federally recognized Ojibwe (or Chippewa) tribes in Wisconsin, Michigan and Minnesota.[1] Those tribes have reserved hunting, fishing and gathering rights in territories ceded in the 1836, 1837, 1842, and 1854 treaties with the United States (Map 1). GLIFWC's mission is to assist its member tribes in the conservation and management of natural resources and to protect habitats and ecosystems that support those resources.

Enclosed are GLIFWC staff comments on the Draft Scoping Decision (DSD) documents for the Line 3 Replacement Pipeline Project and the Sandpiper Pipeline Project proposed by Enbridge Energy. At this stage of the Environmental Impact Statement (EIS), GLIFWC comments are general in nature. As the process moves forward, we expect that additional comment and interaction with the Minnesota Department of Commerce will occur. GLIFWC submits these comments from an off-reservation Ceded Territory perspective and an individual tribe may choose to submit comments from its own perspective.

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[1] GLIFWC member tribes are: in Wisconsin -- the Bad River Band of the Lake Superior Tribe of Chippewa Indians, Lac du Flambeau Band of Lake Superior Chippewa Indians, Lac Courte Oreilles Band of Lake Superior Chippewa Indians, St. Croix Chippewa Indians of Wisconsin, Sokaogon Chippewa Community of the Mole Lake Band, and Red Cliff Band of Lake Superior Chippewa Indians; in Minnesota -- Fond du Lac Band of Lake Superior Chippewa, and Mille Lacs Band of Chippewa Indians; and in Michigan -- Bay Mills Indian Community, Keweenaw Bay Indian Community, and Lac Vieux Desert Band of Lake Superior Chippewa Indians.

General Scoping Comments

Analysis of Impacts to Cultural Resources

The DSD Documents indicate that impacts to cultural and natural resources will be analyzed. However, it is important to note that for tribal members, natural resources *are* cultural resources. The Ojibwe have historically used and continue to use their natural resources within the Ceded Territories for spiritual, cultural, subsistence, medicinal and economic purposes. Tribal members harvest and consume freshwater fish, wild rice, and many other natural resources as part of their bimaadiziwin, or traditional lifeway, which incorporates culture, spirituality, language and traditions, including the harvest and consumption of traditional foods. The resources that tribal members depend on have been degraded over time through a combination of loss of access and environmental degradation. Pipelines are one of many constructed features that drastically alter the landscape and can diminish the resources tribes depend on.

The EIS, in its analysis of natural resources (surface and groundwater, wetlands, habitat, etc.) should recognize the importance of a healthy environment to tribes and describe the cultural ties of tribes to the potentially impacted areas of the proposed pipeline projects.

Spatial Extent of Analysis

The Sandpiper line is intended to transport Bakken shale oil from North Dakota to Superior, Wisconsin. Line 3 transports tar sands oil from Alberta Canada to Superior Wisconsin. Therefore, these projects are regional in scope and the impacts of these projects should be described at local and regional scales. We suggest that impacts of all existing pipelines in Minnesota should be done to define existing conditions for these projects. From GLIFWC's perspective, the impacts of pipeline projects on the 1837, 1842, 1836 and 1854 ceded territories should also be conducted (Map 1) with the Ceded Territories used as distinct geographic study areas.

Additionally, on a broader scale, the EIS should also use information developed for other pipeline environmental impact assessments in Wisconsin and North Dakota, and any pertinent information developed for other multi-jurisdictional pipeline projects, such as the Keystone XL project, because these proposals present similar permitting and environmental challenges as the Sandpiper project.

History of Pipeline Safety and History of Enbridge Energy

Enbridge Inc. has a questionable environmental record. From 1999 to 2010, Enbridge pipelines spilled over 7 million gallons of crude oil in over 800 different incidents across the United States and Canada (National Wildlife Federation, 2012). The

combined environmental effect of these incidents to wetlands and surface and ground waters has not been quantified. The most notorious spill involves a ruptured pipeline that spilled over a million gallons of heavy crude oil into the Kalamazoo River in the lower peninsula of Michigan in July of 2010. Thirty-five river miles downstream of the spill were closed by the EPA. Cleanup activities at this site continued until 2014 with costs exceeding 675 million dollars. Cleanup efforts were complicated by the heavy crude oil that, when spilled, sank to the bottom of the river and into the sediment. Line 3 replacement pipeline could transport this type of oil and the proposed Sandpiper pipeline could, potentially, transport heavy crude as well. Because of this, traditional oil cleanup techniques that involve surface skimming of affected waters could be ineffective and costlier dredging of substrates must be performed.

Given this history, the EIS must provide a complete accounting of all spills from pipelines. While it is important that Enbridge's historical operations record is identified, the information should include all companies operating in the region. Spills from local feeder lines should also be detailed. With each pipeline and feeder line operating in the region, the likelihood of spills increases and any cumulative impact of successive spills impacting the region is also potentially greater. This must be acknowledged by the EIS.

Surface and Groundwater Quality

The potential for these pipelines to rupture and cause an oil spill is a major concern. The EIS should document the environmental effects of past oil spills and scientifically assess the effects of a spill in the water rich regions of the Upper Midwest and Lake Superior regions. A systematic assessment of remediation and cleanup techniques must be provided for light and heavy crude oil along with a detailed review of the effectiveness of each technique. The EIS should also quantitatively assess the possible changes to surface and groundwater that may result from a spill.

The water quality assessment should pay special attention to potential impacts to Lake Superior. This analysis should be done in the context of the Great Lakes Water Quality Agreement, the bi-national Water Quality Agreement between Canada and the United States.

A cumulative assessment of all existing impacts from pipeline construction and pipeline spills on surface and groundwater should be conducted.

Wetland Impacts and Wetland Mitigation

Construction and expansion of pipelines involve wetland fill and hydrologic alteration that will affect wetland functions and values. Mitigation for wetland impacts that cannot be avoided will be required. However, the effectiveness of wetland mitigation, both through the use of wetland banks or rehabilitation of drained wetlands, is

questionable. The EIS should describe the effectiveness of wetland mitigation measures and assess whether all functions and values of lost wetlands are likely to be replaced.

Climate Change

Increased oil transportation capacity will contribute to existing CO2 emissions into the atmosphere and exacerbate global climate change. Potential impacts of climate change have been documented for the Ceded Territories through work of the Wisconsin Initiative on Climate Change Impacts (WICCI) and GLIFWC (Attachment 1). Potential impacts on the Lake Superior Basin have been described through the work of the Lake Superior Workgroup. Furthermore, the impacts on forest ecosystems have been described by the Northern Institute of Applied Climate Science (NIACS) of the USDA. The EIS should examine the effects that this project will have on carbon emissions as well as the effect on the climate change adaptation strategies that have been suggested for Minnesota and the Lake Superior region.

The DSD documents for both projects indicate that regional economic analysis of the effects of the projects will be conducted. These economic analyses should include information on the economic effects of climate change on the region and account for the contribution of the pipeline projects to these impacts.

The economic analysis should also describe treaty guaranteed usufructury rights of Tribes in the region and assess how the proposed pipeline projects would impact the ability of tribes to continue to exercise their rights.

Financial Assurance

As previously discussed, GLIFWC staff believe that spills of oil transported through these pipelines are likely. Cleanup and remediation are costly and require long periods of time to complete. The EIS should describe, in detail, the types of financial assurance that Enbridge will be required to provide to ensure that the public is not burdened with cleanup and remediation costs. Furthermore, financial assurance is needed to cover the costs of maintaining structural integrity of the abandoned Line 3 as well as the costs of ultimately removing pipelines from the right of way whenever that becomes feasible.

No Action Alternative

The no action alternative for the proposed Sandpiper project assumes that Bakken oil will continue to be shipped by other means. The assumption that oil extraction at current levels will continue to be necessary is not supported. The United States has decided against approving the Keystone XL pipeline. There are many reasons for this, but concerns over increased carbon emissions and their contribution to global climate change as well as concerns over accidental releases of oil are two of the most important reasons.

This same rationale applies to the proposed new Sandpiper line. The analysis in the EIS should acknowledge that the need for oil transported by the Sandpiper line and Line 3 is speculative and that this oil may not be needed nor desired, given the commitments the United States has made on climate change mitigation.

Cumulative Impact Analysis

In general, the description of cumulative impact analysis is appropriate. However, there are some points that should be clarified.

Page 13 of the Line 3 Replacement DSD document states:

> "Each project will have its own EIS, and the cumulative impacts of each project will be addressed in both EISs."

Page 15 of the Sandpiper Pipeline DSD Document states:

> "The Sandpiper EIS will analyze the potential impacts of the L3R Project as part of the EIS's cumulative impacts discussion. In addition, other projects throughout the Sandpiper corridor that may cause cumulative impacts will also be discussed at a local, county and larger regional levels."

Cumulative effects analysis must not be confined to the corridor of the pipeline projects. The analysis of cumulative effects should be broad enough to account for regional impacts such as habitat fragmentation and wetland fragmentation. Additional clarity on the spatial extent of the cumulative impact assessment is needed.

The EPA, in cooperation with Region 5 tribes, has developed a protocol for assessing cumulative effects on tribal resources. This guidance should be used in the EIS for the proposed pipeline projects.

Impacts of Routine Construction and Operation

The DSD documents for Sandpiper and Line 3 projects discuss the impacts of routine construction and operation activities. However, additional detail is needed to clarify the scope of the analysis. The EIS must describe the impacts of all activities related to pipeline maintenance into the future. This includes impacts from permanent and temporary access roads and activities needed to maintain cathodic protections in pipelines abandoned in place. The EIS must anticipate, based on past experience, all permits that the applicant will need over the lifetime of the pipelines and describe them in detail.

We look forward to working with the Minnesota Department of Commerce as the EIS process moves forward. Please contact me at 608-263-2873 with any questions.

Sincerely,

Esteban Chiriboga

Esteban Chiriboga
GLIFWC Environmental Specialist

cc. Jonathan Gilbert, GLIFWC Biological Services Director (Acting)
Ann McCammon Soltis, GLIFWC Director of Intergovernmental Affairs
John Coleman, GLIFWC Environmental Section Leader
Philomena Kebec, GLIFWC Policy Analyst

Sources Cited

National Wildlife Federation, 2012, "The Anatomy of Enbridge's Once and Future Oil Spills, www.nwf.org.

Great Lakes Indian Fish & Wildlife Commission (GLIFWC)

Preliminary Climate Change Vulnerability Assessment for the Ceded Territories

Introduction

Sound conservation practices and management decisions are vital to GLIFWC's core mission of protecting and enhancing natural resources in the ceded territories. Climate data have shown that average temperature and precipitation in the ceded territories have been changing since the mid-1950's at least. These changes are due to increased greenhouse forcing in the atmosphere associated with the burning of fossil fuels. These rapid climate changes are, at best, another stressor on the ecosystems that tribes depend upon to exercise their treaty rights. At worst, these climate changes are a direct threat to the continued existence of treaty-protected natural resources that tribal members depend upon. GLIFWC has begun the process of assessing the predicted effects of climate changes on ceded territory ecosystems with the ultimate goal of developing a climate change adaptation strategy. This strategy will outline the conservation and management practices that can be implemented to protect traditional resources. It is important to note that climate change adaptation is a temporary measure that may reduce some of the impacts of climate change. The only permanent solution is to reduce the emissions of fossil fuels to the atmosphere.

This vulnerability assessment is the first step in developing an adaptation. It characterizes the potential climate changes expected within the Ceded Territory (e.g. temperature, precipitation, snow cover, etc.). It is important to note that this analysis treats the ceded territories as a distinct geographic unit and it is this ceded territory unit that is the focus of the study. The potential effects of climate change on a subset of species that GLIFWC member tribes harvest is also provided to add context to changes that the ceded territory is likely to experience. Finally, recommendations for additional, more detailed, risk assessment analyses are presented.

Predicted Climate Changes to the Ceded Territory

Temperature and precipitation are the driving variables in regional climate change research and are the basis of this vulnerability assessment. From those 2 variables, other factors that affect the ceded territory ecosystems like snow (quantity and timing), soil moisture, growing degree days, can be computed. This report relies on 2 datasets to examine the vulnerability of the ceded territory to predicted climate changes -- the National Center for Atmospheric Research (NCAR) and the Wisconsin Initiative on Climate Change Impacts (WICCI) downscaled climate change databases. Both the NCAR and WICCI datasets are computed by statistically downscaling the output of global climate change models (GCM). The underlying models used in the downscaling procedure are different for NCAR and WICCI, but at a ceded territory scale, the results are very similar. This dataset cross-check increases the confidence that the downscaling procedure is valid.

It is important to note that the downscaled climate change predictions that are the basis of this report are not without uncertainty. There are general conclusions that can be made with a great deal of scientific confidence. First, the climate of the Ceded Territories has changed and will continue to change in the future. Second, these changes are the result of enhanced greenhouse effect in the atmosphere that is caused by human emissions of carbon. Third, these climate changes, will have profound effects on plants and animals because these changes are occurring faster than ecosystems can change. What is uncertain, is the precise changes that will occur and the exact consequences that climatic changes will bring. Research in these areas is ongoing. For example, downscaled models of temperature and the associated vegetation shift have a greater degree of confidence that downscaled models of precipitation and lake levels. This report presents the best available information for the Ceded Territories in order to provide a preliminary assessment of changes and stresses to the ecosystems of the region.

This vulnerability assessment looks at predicted changes to ceded territory climate variable under two different global climate change scenarios -- A1 and A1B. These two scenarios were selected because, based on current carbon emission trends, they appear to be likely to occur in the future. The scenarios are defined by the Intergovernmental Panel on Climate Change (IPCC) as:

- A2. The IPCC A2 scenario describes a future world of intense fossil fuel use, rapid economic growth, global population that reaches 10 billion by mid-century, and the slow introduction of new and more efficient technologies. Major underlying themes are regional economic development and a lack of international cooperation. It can be considered a high emissions scenario.
- A1B. The IPCC SRES A1B scenario is marked by a balance in the use of fossil fuels and renewable energy sources. It is often thought of a mid-level scenario. It assumes very high economic growth and relatively low population growth . A convergence of global living standards results in a high per-capita demand for food, fiber, and energy. As a result, there is an increase in the human footprint on the landscape, with a decline in natural land covers such as grassland, forest, and wetland.

Changes to temperature and Precipitation are analyzed for the end of the 21st century (2099). While annual averages of temperature and precipitation are important in defining the scale of changes, considerable attention is given to the expected changes in climate during winter (monthly averages of December, January, February), Spring (monthly averages of March, April, May), Summer (monthly averages of June, July, August), and Fall (monthly averages of September, October, November). These seasonal changes are important in characterizing effects on the many seasonal activities in which tribal members engage.

Predicted Temperature Changes

Temperatures are expected to increase throughout the ceded territory. By the end of the century, average annual temperatures are predicted to increase on average across the Ceded Territories by approximately 4°F under the A1B scenario (Map 1) and 5°F to 6 ^{o}F under the A2 scenario (Map 2).

There are no significant seasonal differences in the magnitude of warming at a ceded territory scale The data indicate that greater warming is associated with the high emissions scenario.

Table 1: Predicted Seasonal Temperature Changes in the Ceded Territories by the End of the Century:

Emissions Scenario	Winter	Fall	Summer	Spring
A1B	2.7°F to 3.5°F	3.1°F to 4.1°F	2.7°F to 4.2°F	2.3°F to 3.4°F
A2	5.1°F to 6.9°F	4.8°F to 6.3°F	4.3°F to 6.8°F	3.4°F to 5.1°F

Interesting spatial patterns can be detected from the seasonal temperature data. During winter, the 1837 ceded territory is predicted to warm less than other ceded territories. This pattern is evident for both emission scenarios (Map 3 and 4). Maps for the Fall (Map 5 and 6) and Summer seasons (Map 7 and 8) indicate that the 1854 and 1837 ceded territories are predicted to warm more than the 1842 and 1836 ceded territories. This pattern is likely the result of Lakes Superior and Michigan moderating temperatures. The lakeshore areas and areas downgradient of the prevailing wind patterns are predicted to warm less than the areas upgradient of the lakes. Model predictions for the Spring season (Map 9 and 10) show different spatial patterns for the A1B and A2 scenarios. While springs are expected to be warmer, greater warming is expected in the western half of the ceded territories under the A1B scenario. The opposite prediction is evident during the A2 scenario. Spring is a notoriously difficult season to model because of the rapid changes that occur in the transition from snow and ice cover conditions to a dynamic growing season. The predictions are also complicated by the fact that there will be fewer days of snow and ice cover over the winter. Additional data are needed to provide greater clarity to spring season predictions.

Predicted Precipitation Changes

Precipitation is expected to increase throughout the ceded territories by the end of the century under both the A1B and A2 modeling scenarios (Map 11 and 12). The annual average increases are relatively small and the spatial pattern is the same for both emission scenarios. The modest increases in precipitation combined with the expected temperature increases suggest that the ceded territories are predicted to become drier as the evaporation potential created by the increased temperatures exceeds the additional precipitation.

Table 2: Predicted Seasonal Precipitation Changes in the Ceded Territories by the End of the Century

Emissions Scenario	Winter	Fall	Summer	Spring
A1B	0.3" to 0.9"	0.1" to 1.1"	0.2" to 1.8"	0.5" to 2.4"
A2	0.7" to 1.8"	0.5" to 1.5"	0.4" to 2.2"	0.5" to 1.6"

Downscaled model predictions of winter (Map 13 and 14) and fall (Map 15 and 16) precipitation indicate small increases and the predicted changes do not constitute significant deviations from existing

conditions at a ceded territory scale. At more detailed scales, topography and microclimates, including seasonal wind patterns, could have dramatic effects on precipitation patterns and their changes. Additional work in this area is needed. Summer precipitation is predicted to increase for both the A1B and A2 scenarios (Map 17 and 18). Under both scenarios, the models indicate that precipitation increases, if any, would be the smallest in the northern half of the ceded territory and increase to the south of Lake Superior. Large storm events are predicted to increase so the increased precipitation may come in the form of large storm events with drier periods in between. When combined with the temperature predictions it is reasonable to assume that conditions by the end of the century may be drier overall. Spring precipitation is also predicted to increase (Map 19 and 20) but As described in the temperature section, Spring is a difficult season to model because of the rapid changes that occur in the transition from snow and ice cover conditions to a dynamic growing season. Additional research is needed to provide greater clarity to spring season predictions.

Predicted Snowfall Changes

New research and downscaled modeling indicates that annual mean snowfall is expected to decline throughout the ceded territories. In addition, the beginning of the snow season is expected to occur later in the year and snowmelt is expected to occur earlier in the year. Thus, the duration of snow cover will decrease throughout the region. Individual snowstorms are predicted to become less common but more intense. Map 21 illustrates the predicted reduction in snow depth by comparing the average winter snow depth for the present, mid-21st century and late 21st century time periods. The location of the modeled 15 centimeter snow depth contour retreats to the north over time. By the end of the 21st century, the 15 centimeter contour is located almost entirely outside the ceded territory.

Predicted Change in the Frequency of Extreme Precipitation Events

Extreme precipitation events are expected to become more frequent. This is particularly important for the long term stability of existing infrastructure and of large-scale projects like metallic mines. Mines leave behind large tailings basins and waste rock stockpiles that become permanent features of the landscape. These facilities were designed and constructed with tolerances for climate extremes that will not exist in the future. New mines must incorporate additional safety and structural tolerances to account for increased climatic stresses. Extreme events will also likely impact natural ecosystems through increased flooding events, droughts, erosion, etc. Additional work is needed to characterize the effect these events may have on natural resources in the ceded territory.

Climate Change and Manoomin (Wild Rice)

Manoomin is highly important to the traditional lifeway and has a key role in Ojibwe history. The Sokaogon Chippewa Community established the location of their reservation because of the importance of Rice Lake to the band. The annual harvest of rice is a major event in the tribal year. Because of its unique characteristics, wild rice may be particularly vulnerable to climate change-related impacts.

Manoomin (Wild rice) Life Cycle (information from Peter David, GLIFWC Manoomin Biologist)

- Wild rice is an annual, cross-pollinated species.
- It generally grows in muddy shallow areas of lakes and streams.
- Wild rice requires about 2600 growing degree days (4.4° C base).
- Grows effectively in depths ranging from 6 to 36 inches (ranges are approximate) and site-specific hydrology is very important.
- Natural stands are found in water with <10 ppm of sulfate.
- Wild rice requires a certain amount of water flow,

Germination – Germination begins in late April to early May when the soil/water reach 5.6° C. During the seedling stage the leaves are submerged.

Some factors affecting plant growth:

- Turbidity/light penetration.
- Water Temperature
- Plant Competition and Shading
- Water Depth

Floating Leaf Stage – In May and early June, the next set of leaves that appear after the submerged seedling stage float on the surface of the water. All subsequent leaves are aerial.

Some factors affecting wild rice at this stage:

- Large storm/wave events can uproot the plant.
- Increased water level can drown the floating leaves.
- Herbivory by muskrat, deer, geese and swans.

Emergent Leaf Stage – In late June to early July additional aerial leaves and the main stem appear. This stage occurs earliest in shallow waters and later with increasing depth.

Some Factors affecting wild rice at this stage:

- Herbivory by muskrat, deer, geese and swans.
- Possible hail damage.

Flowering Stage – Flowering occurs in July. Pollen viability appears to be negatively correlated with temperature and positively correlated with humidity. In late July and August tillers begin to emerge and their maturity lags roughly 7 to 14 days behind the growth of the main stem. During August the grain is at an early stage of development.

Some factors affecting wild rice at this stage:

- Hot dry calm days at time of pollen release may hinder fertilization success and reduce seed set.
- Rice worm infestation (noctuid moth larva) can reduce seed yield by 10% per larva.
- Wind storms can knock the plant over or tissue can be damaged by hail.
- Drought can leave plants on exposed soil, stressing the plant in several ways.

Maturation Stage – Seeds mature and drop from the plant from late August through mid to late September. After dropping, the grains sink and are generally deposited in the sediment near the parent plant. Seeds will not germinate for at least 3 months after dropping and require a dormant period in water at or near freezing (<=35). The seed lies dormant in the sediment until the following spring when roughly 50% of the seed will germinate. Approximately 10% of the seed can remain dormant for up to 5 years, possibly longer.

Some factors affecting wild rice at this stage:

- Excessive sedimentation. Seed buried under >8 centimeters results in no emergence.
- Mild winters may contribute to poor rice season because the dormant period is too warm and because of the possibility of increased rice worm infestation.
- Over-winter drought conditions might lead to seed desiccation.

Other Concerns

- Climate change may alter wild rice's ability to compete with various species, including invasives.
- Brown spot (formerly called *Helminthosporium* brown spot) is the most serious disease affecting wild rice. This disease is caused by *Bipolaris oryzae* Luttrell (*Helminthosporium oryzae* B. de Haan) and *B. sorokiniana* Luttrell (*H. sativum* P.K. and B.). These fungi are considered to cause brown spot since both are found on infected plants and cause similar symptoms in wild rice plants. Every variety of wild rice, at each stage of development, is susceptible to brown spot. This disease is most severe when day temperatures range from 77 to 95° F and nights are 68° F or warmer. High relative humidity (greater than 89%), and the continuous presence of free water on leaf surfaces for 11 to 16 hours, can also favor infection. All parts of the plant are susceptible to infection.

Climate Change Parameters Important in Detailed Vulnerability Assessment:

GLIFWC staff developed an initial list of parameters that may be used in a detailed climate change vulnerability assessment for wild rice. The parameters are listed below.

Brown Spot Disease:

- Change in frequency of 77 to 90+ degree days.
- Change in frequency of night temp of 68 F or warmer.
- Change in frequency of relative humidity (>89%)

Risk of Uprooting:

- Change in frequency of 20 year flood events

Germination Success:

- Changes in winter temperature (more mild winters)
- Increased regional drought leading to lower water levels

Changes in Plant Competition

- Increase in number of growing degree days favor southern species

Risk of Pollination Failure -

- Increase in frequency of dry weather in July/August?

Map 22 indicates that by the end of the century summers in the western half of the ceded territory are predicted to be 5.9°F to 6.8°F warmer than current conditions under the A2 emissions scenario. Map 23 indicates that summers are predicted to warm between 2.7°F to 4.2° across the ceded territory, with the eastern half of the ceded territory predicted to warm somewhat less than the western half. All wild rice waters depicted in the map could be affected, but some areas may more severely impacted. As outlined above, brown spot disease is likely to become more common as the climate warms. The increase in extreme precipitation events will contribute to uprooting of plants during the floating leaf stage. At the same time, an overall drier climate may reduce pollination success. Additional work is needed to assess the effects on individual rice waters and the effect of the various climatic factors on the plant in increased spatial detail. The overall conclusion is that wild rice is vulnerable throughout the ceded territories with increased vulnerability on the western half of the region. It is possible that wild rice beds along the coast of Lake Superior may be sheltered from temperature-related impacts but the effects of Lake Superior level changes should be characterized.

Climate Change and Cold Water Ogaa (Walleye) Fishery

Coldwater habitats are defined by their maximum seasonal water temperatures (17 degrees Celsius during June and August). In general, rising air temperatures will be associated with rising lake and stream temperatures as well. Increasing temperatures have the potential to change coldwater habitats to cool water or even warm water habitats, subsequently affecting the ecology and species composition in lakes or rivers.

The spring walleye spearing season begins immediately after ice-out in inland lakes. Predicted spring temperature changes are likely to cause earlier ice out. Maps 24 and Map 25 indicate that the temperature of the air above many of the inland walleye lakes that are open for tribal spearing is predicted to warm between 2.3°F and 5.1°F during the spring season depending on the emissions scenario. Maps 26 and 27 characterize summer impacts to trout streams. Brook trout are among the most vulnerable species to water temperature increases because their habitat consists of shallow cold streams, which are highly affected by changes in air temperature. The maps indicate that some streams in the ceded territory are more vulnerable than others. Under both scenarios, the western end of the ceded territories is predicted to have greater impacts on coldwater habitats than the eastern side. However, the future water temperature in the individual walleye lake and trout stream will depend on many other factors, such as the health and quality of riparian environments and the amount of groundwater in the water budget for each individual waterbody.

Research conducted by the coldwater fisheries working group of WICCI indicated that brook trout, walleye and northern pike habitat is expected to decline throughout the ceded territory. However, at a ceded territory scale it is not possible to assess lake-specific vulnerability because lake temperatures in many cases are moderated by groundwater inflow, differences in lake morphology, and the characteristics of riparian zones. For example, deep natural lakes will warm less than shallow ones. Also, the degree of dependence of a lake on groundwater, its shape and depth, and the character of shorelines and riparian habitat will ultimately determine the water temperature increase and the viability of coldwater fish species. Trout streams with abundant shade trees will warm less than exposed stream banks. Generally, cold and cool water fish species are vulnerable to climate change, and vulnerability is greater in rivers, streams and shallow lakes. Additional work is needed to characterize vulnerability on a lake by lake basis because of the implications that climate change has on the different tribal activities that occur in the ceded territories. For example, it is known that lakes in the western side of the ceded territories are the first to thaw in the spring and therefore, tribal walleye spearing activities occur there and moves eastward as those lakes lose ice cover. If the eastern ceded territory warms at a faster rate, this pattern may change.

Climate Change and Mooz (Moose)

Moose habitat includes boreal forests and subarctic mixed forests. The southern limit of moose range coincides with the northern limit of the ceded territories for GLIFWC member tribes in Wisconsin and Michigan and have populations in northern MN and upper MI. Moose have specific temperature tolerances and prefer areas where the average summer temperature does not exceed 60°F and winter temperatures that do not exceed 41°F. Because of this, moose are easily heat stressed, and the effects of climate change upon moose are likely to be greatest in the southern limits of their range where temperatures and exposure to white-tailed deer parasites and ticks are greatest. Moose populations in Minnesota have declined substantially in recent years, and this decline has been correlated with increasing temperatures. In the Upper Peninsula of Michigan, recent population estimates suggest the growth rate of this re-introduced population may have slowed in recent years. The decline in moose populations are attributed to summer heat stress, increased mortality from parasites (more ticks survive in mild winters), and brain parasites carried by white tail deer. Maps 28 and 29 indicate that current moose ranges are in areas that are predicted to warm the most in the future for both emission scenarios. This suggests that winter stress from ticks will only increase. Maps 30 and 31 suggest summer indicating that summer heat stress will continue to be a problem throughout the ceded territories regardless of emission scenario. However, the moose range in the 1854 ceded territory is predicted to be more severely impacted than the moose ranges in the Upper Peninsula of Michigan. Regardless of the emissions scenario, the future of moose in the Ceded Territories seems uncertain.

Climate Change and Makwa (Black Bear)

Black bear habitat is found throughout North America in areas without significant urbanization. Because of their large range it is unclear how climate change may affect this species. Bears hibernate during the winter months when food is scarce; in the ceded territories, changes in temperature and shortening of the winter season are likely to change the timing of winter hibernation. Additionally, bears typically leave the den when ambient temperature is above 50°F and snow is melting; this melting condition is predicted to occur earlier in the year, which may cause bears to emerge from hibernation before food is available. Map 32 and 33 depict the location of selected hibernacula and bear management zones where GLIFWC issues permits. The map indicates that spring temperatures are predicted to increase for both emission scenarios across the range of black bears in the ceded territories. It is therefore expected that bears will emerge from hibernation earlier in the year across all management zones. Additional research is needed to determine if this change in timing of hibernation is harmful to bear health, or if climate change will affect black bears in any other ways, such as impacts on food sources, access to water, etc.

Climate Change and Waabezheshi (American Marten) and Ochig (Fisher)

American Marten and Fisher are found in suitable habitats throughout the ceded territories. In the Wisconsin and Michigan ceded territories the Marten and Fisher are at the south fringe of their ranges and both species are sensitive to warm temperatures. The southern extent of the fisher range is determined by temperature. Aside from heat stress, a changing climate may provide fishers a competitive advantage over martens, because fishers appear to use a larger variety of forest cover types than martens. However, deep fluffy snow may give pine martens a competitive edge over fishers as well as thermal protection over the winter; the small rodents on which martens feed also need fluffy snow cover. The predicted reduction in winter snow cover (map 21) may allow fishers to outcompete martens throughout the ceded territory. Additional research is needed to fully characterize the effect that warmer temperatures and reduction of snow cover may have on these two species as well as the competitive relationship between them. In addition, both species have preferences for specific types of forest cover. The effect of climate change on those ecosystems should be assessed in greater detail.

Climate Change Parameters Important in Detailed Vulnerability Assessment:

- Change in temperature for summer and winter
- Change in snow depth
- Change in snow density
- Change in seasonal duration of snowpack
- Increased variability of spring temperature and precipitation. (Creates thawing and refreezing of snow which increase density.

Climate Change and Forest Species

Climate change is expected to affect the suitable habitat of tree species impacts to northern tree species are expected to lead to a conversion to other types of forests that are more common in southern parts of the country. This conversion is detailed in work conducted by the US Forest Service Northern Research Station. Three species are listed in this vulnerability assessment because of their importance to GLIFWC member tribes. The information is taken from the USDA tree atlas at http://www.fs.fed.us/nrs/atlas/. Additional information for other tree species is available at this site.

Wiigwaas (Paper Birch)

The historic range of paper birch encompasses the entire Ceded Territories (Map 34). Recently, a decline has been noted in populations of paper birch, potentially due to changes in climate. "Higher soil temperatures, windstorms and the arrival of new forest pests such as mountain pine beetles would impact almost every tree species found in the north woods today. Paper birch and Aspen would decline from increased drought. White cedar and white pine regeneration would be impacted by deer herds that expand thanks to milder winters".

Paper birch is expected to decline in the ceded territories by between 58 and 87 percent depending on the emissions scenario (Maps 35 and 36). Paper birch are known to be fairly drought-intolerant, sensitive to higher temperatures, and dependent on productive soils. This is one of the species most severely impacted in the models.

Aninaatig (Sugar Maple)

Sugar maple is an important species for tribal members and is found throughout the Ceded Territory (Map 37). Warmer years can mean the sugar maple -tapping season can get shorter and shorter. Warmer weather can also lead to problems with pests such as the Asian longhorn beetle. An Environmental Protection Agency Climate Action Report from 2002 notes that "climate change is likely to cause long-term shifts in forest species, such as sugar maples moving north out of the Ceded Territories." This can mean that the migration of sugar maple northwards may be unavoidable and ultimately threaten this aspect of Ojibwe sustenance living.

Sugar maple is expected to decline in the ceded territories by between 38 and 69 percent depending on the emission scenario (Maps 38 and 39). It is not expected to be completely eliminated from the CT but this species is vulnerable throughout the ceded territories.

Giizhik (Northern White Cedar)

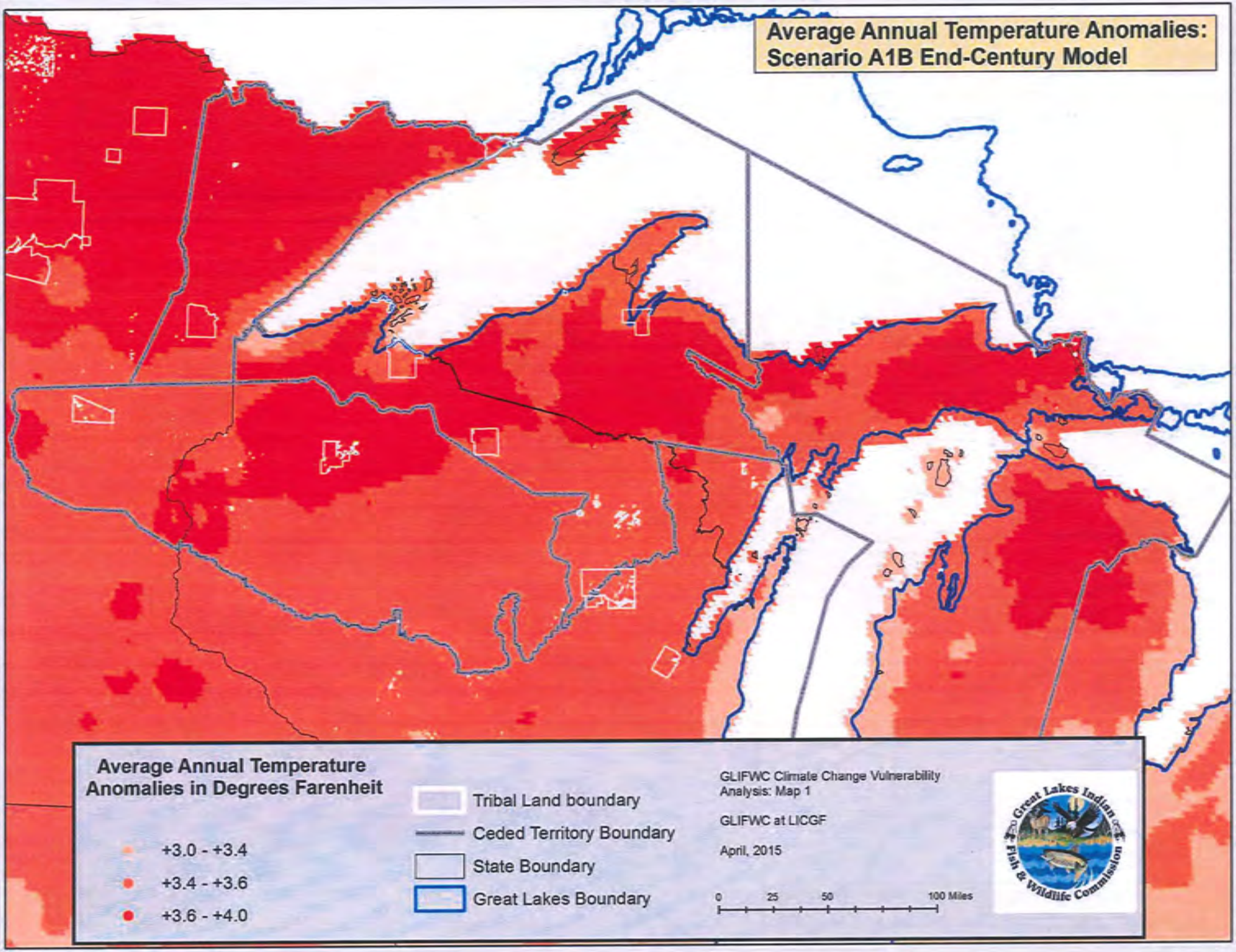
The current range encompasses the ceded territories but ends at the southernmost boundary, leaving it susceptible to northward migration, potentially eventually out of the ceded territories. In this area the warmer climates and longer growing seasons can have a "cumulative negative impact of all drivers of change. Storms, fires, invasive insects, and unsuitable climate will remove mature forests from the landscape, increasing deer populations will prevent reproduction of several species that would otherwise be resistant to the impacts of a warmer climate, including white pine, northern red oak, yellow birch, and northern white cedar".

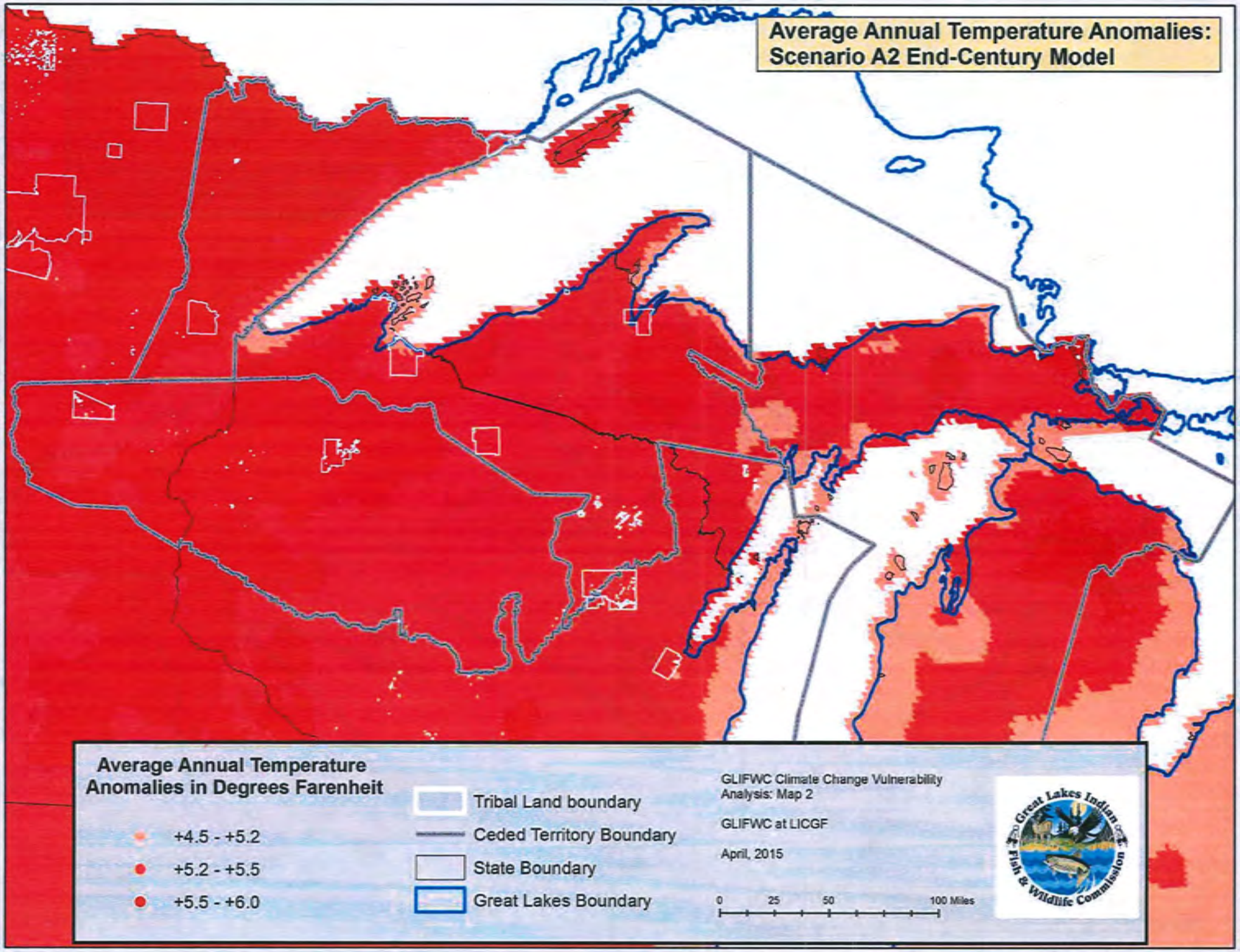
Discussion on Invasive Species

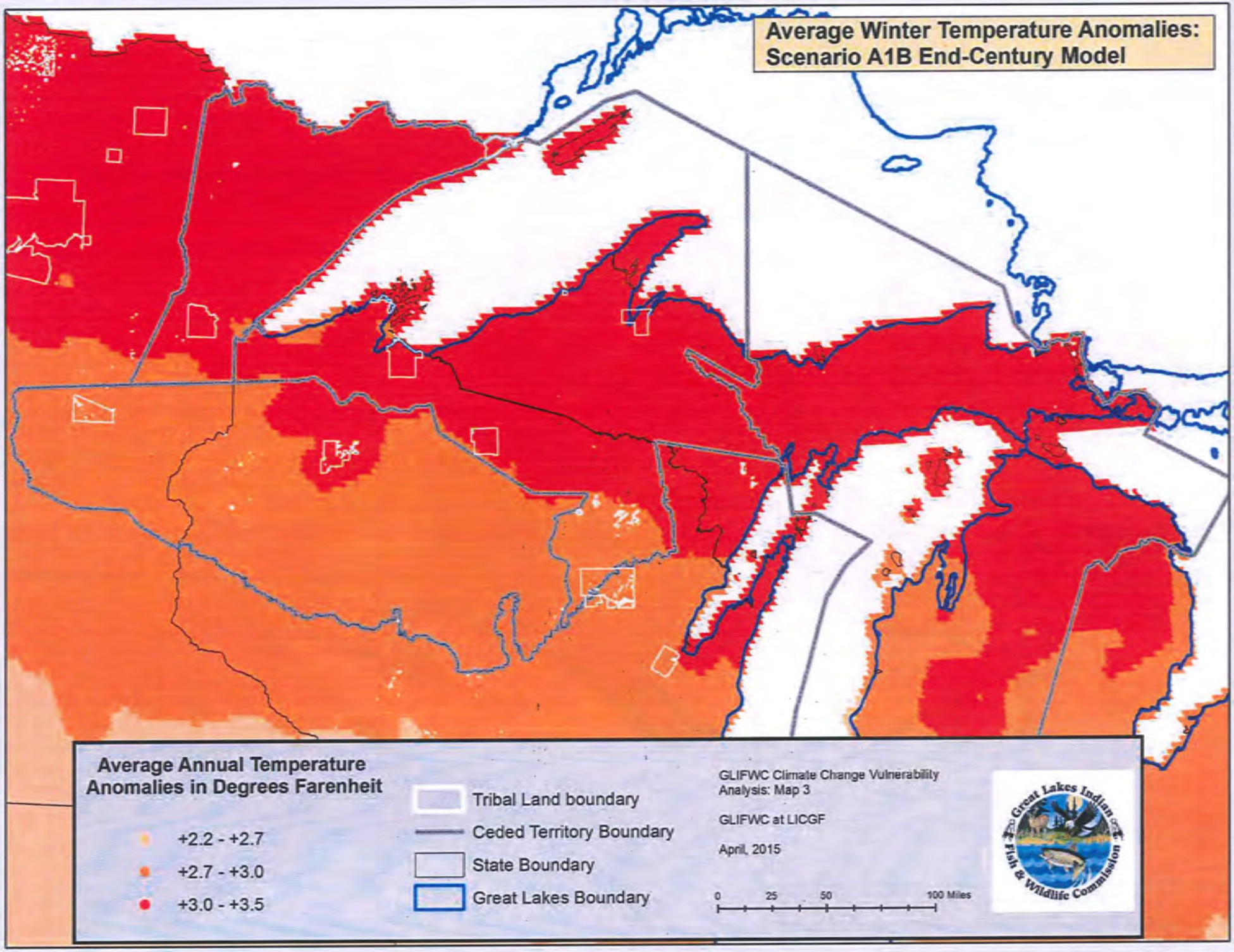
Invasive species are a non-climate stressor impacting habitats and species in the ceded territory. For example, emerald ash borer will have impacts on ash trees before the mid- and late century timeframes used in this assessment. Invasive species could create a positive feedback loop in which impacts from existing invasive species are expected to continue as climates change, and native habitats that have been degraded by invasive species become more vulnerable as climate changes. Future climates may then increase the likelihood of new infestations. For example, currently, the gypsy moth and asian carp cannot easily colonize areas of the ceded territory because they are limited by air and water temperatures. As both of these air and water temperatures rise, they may be able to invade areas farther north. This vulnerability assessment does not address invasive species in detail and additional research is needed to thoroughly assess each species and determine the potential impacts it may have on ecosystems throughout the Ceded Territories as climate change progresses.

Acknowledgements

Downscaled climate change data were developed by University of Wisconsin-Madison researchers through the Wisconsin Initiative on Climate Change Impacts. Downscaled climate change data developed by the National Center for Atmospheric Research (NCAR) was also used to provide context to WICCI data. The biologic information (e.g. species range, habitat descriptions, etc) are based on the expertise of the GLIFWC wildlife section biologists.


Average Annual Temperature Anomalies: Scenario A1B End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+3.0 - +3.4
+3.4 - +3.6
+3.6 - +4.0
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 1
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Annual Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.5 - +5.2
+5.2 - +5.5
+5.5 - +6.0
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 2
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Winter Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+2.2 - +2.7
+2.7 - +3.0
+3.0 - +3.5
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 3
GLIFWC at LICGF
April, 2015
0
25
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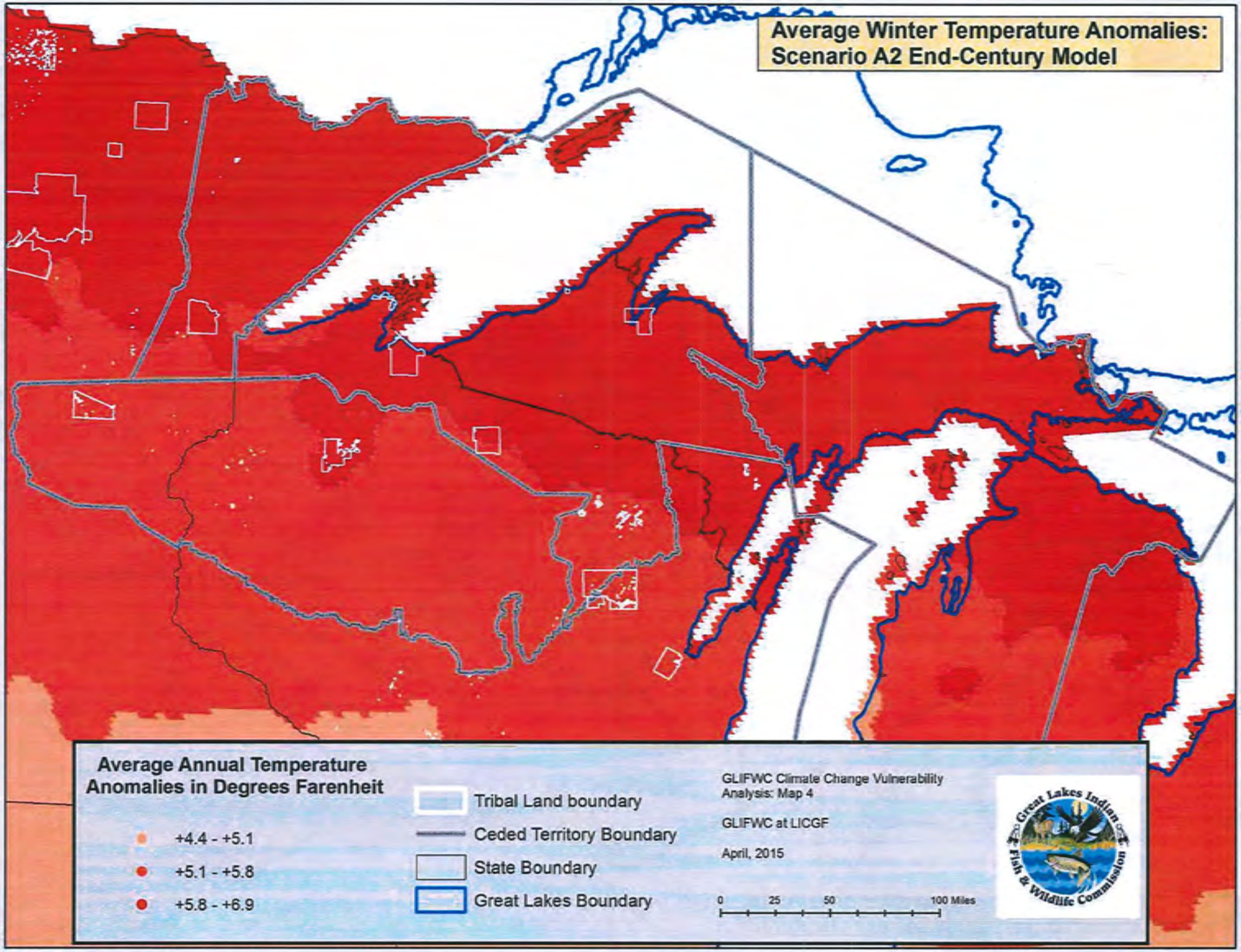
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Winter Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.4 - +5.1
+5.1 - +5.8
+5.8 - +6.9
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 4
GLIFWC at LICGF
April, 2015
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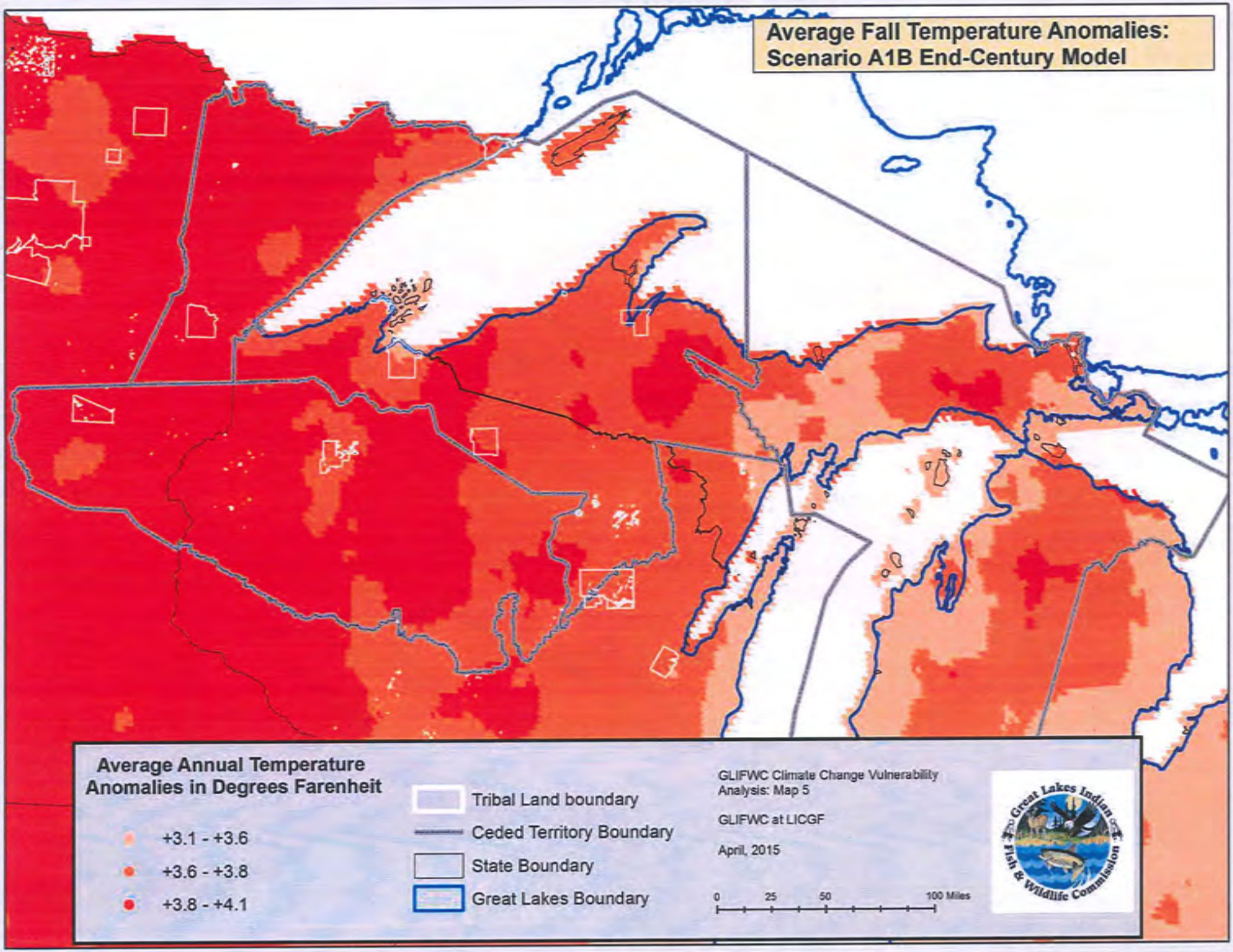
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Fall Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+3.1 - +3.6
+3.6 - +3.8
+3.8 - +4.1
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 5
GLIFWC at LICGF
April, 2015
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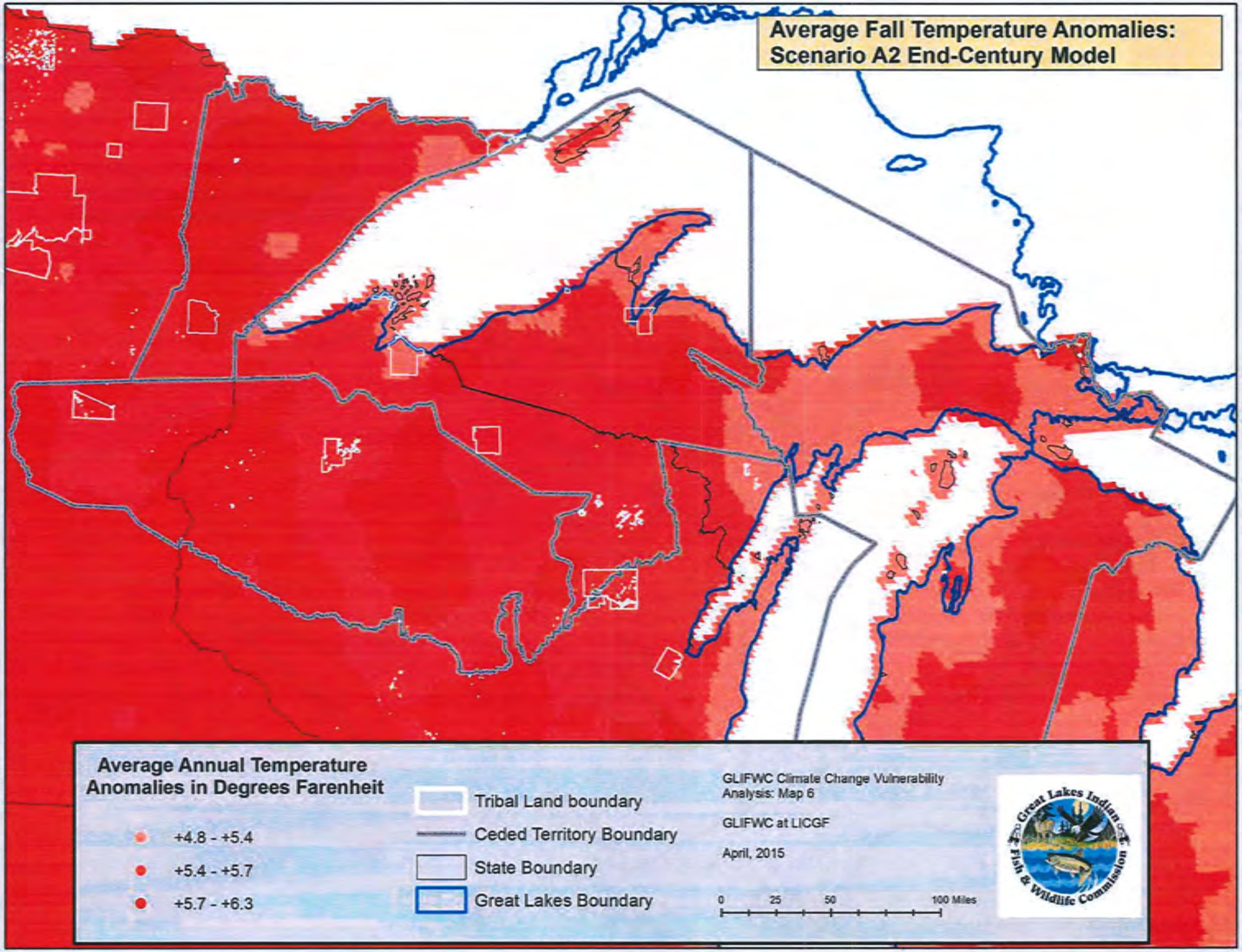
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Fall Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.8 - +5.4
+5.4 - +5.7
+5.7 - +6.3
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 6
GLIFWC at LICGF
April, 2015
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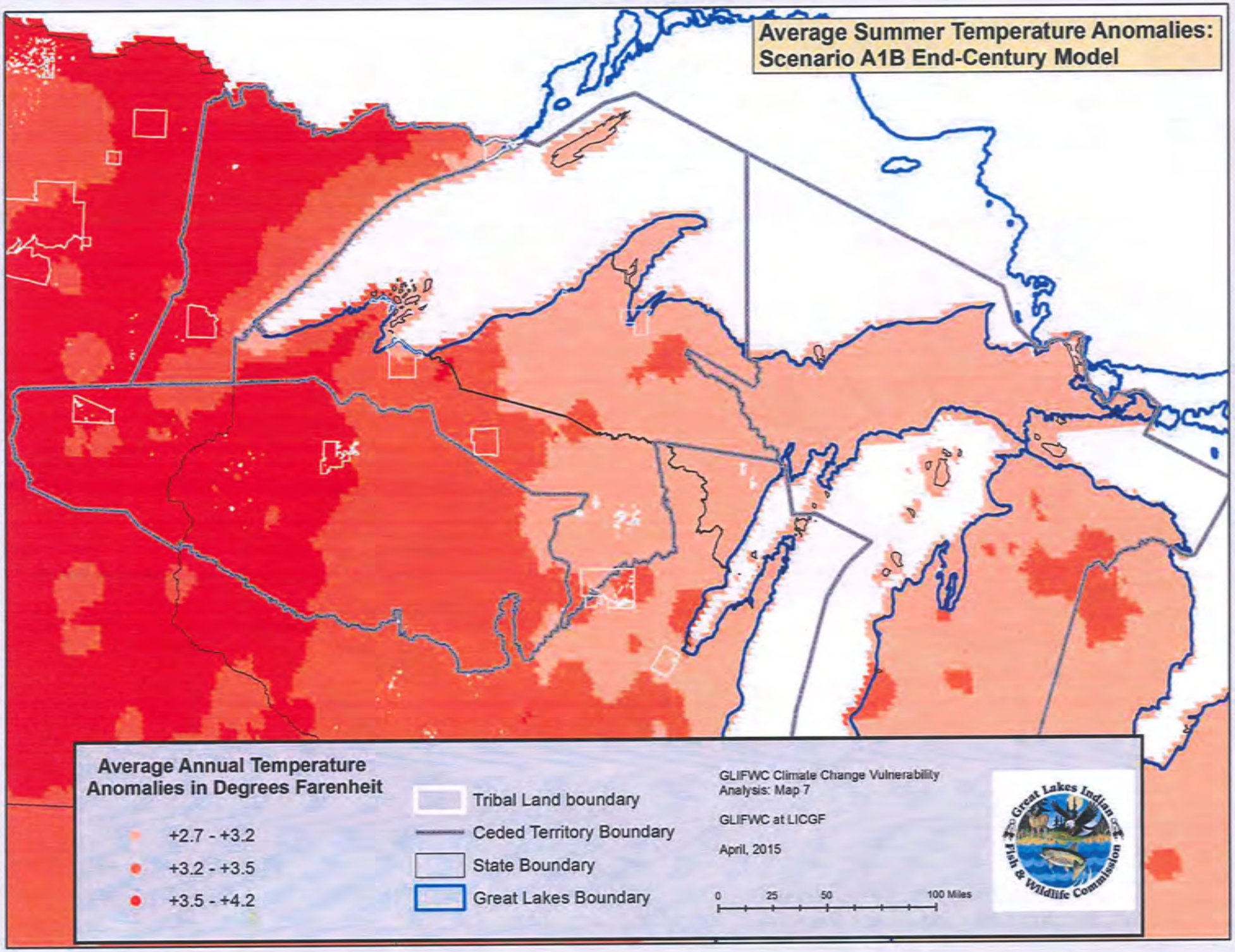
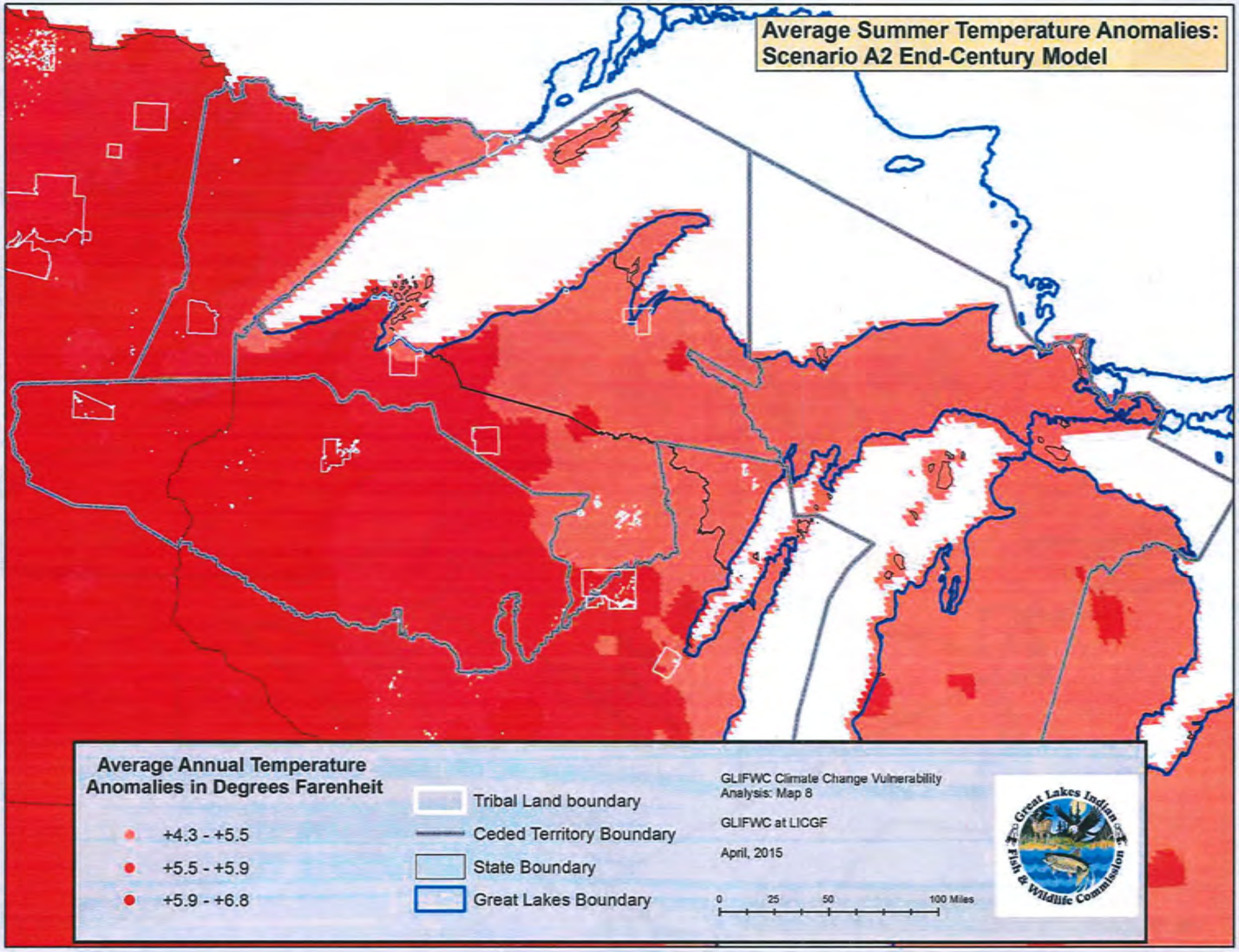
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Summer Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+2.7 - +3.2
+3.2 - +3.5
+3.5 - +4.2
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 7
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Summer Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+4.3 - +5.5
+5.5 - +5.9
+5.9 - +6.8
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 8
GLIFWC at LICGF
April, 2015
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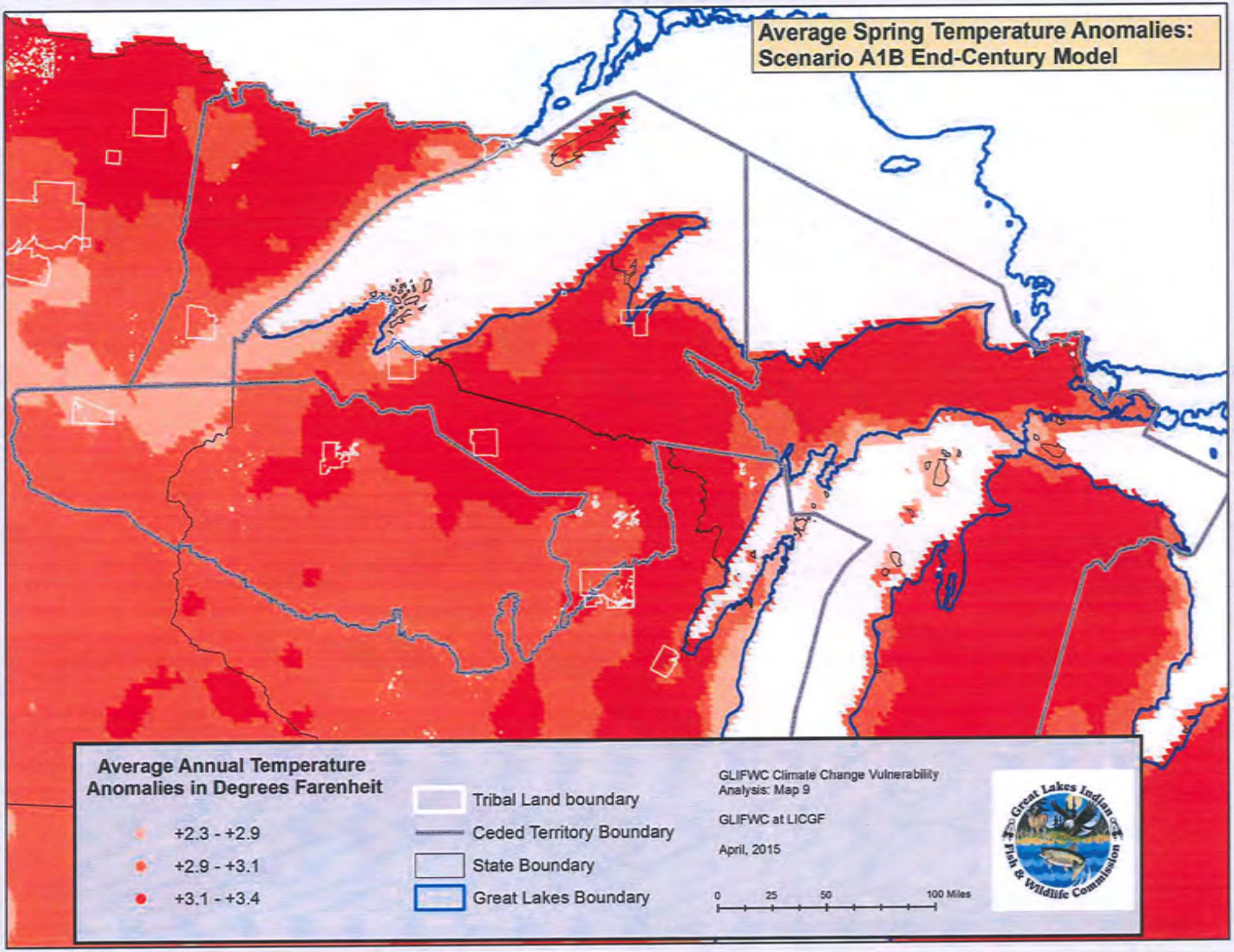
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Spring Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+2.3 - +2.9
+2.9 - +3.1
+3.1 - +3.4
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 9
GLIFWC at LICGF
April, 2015
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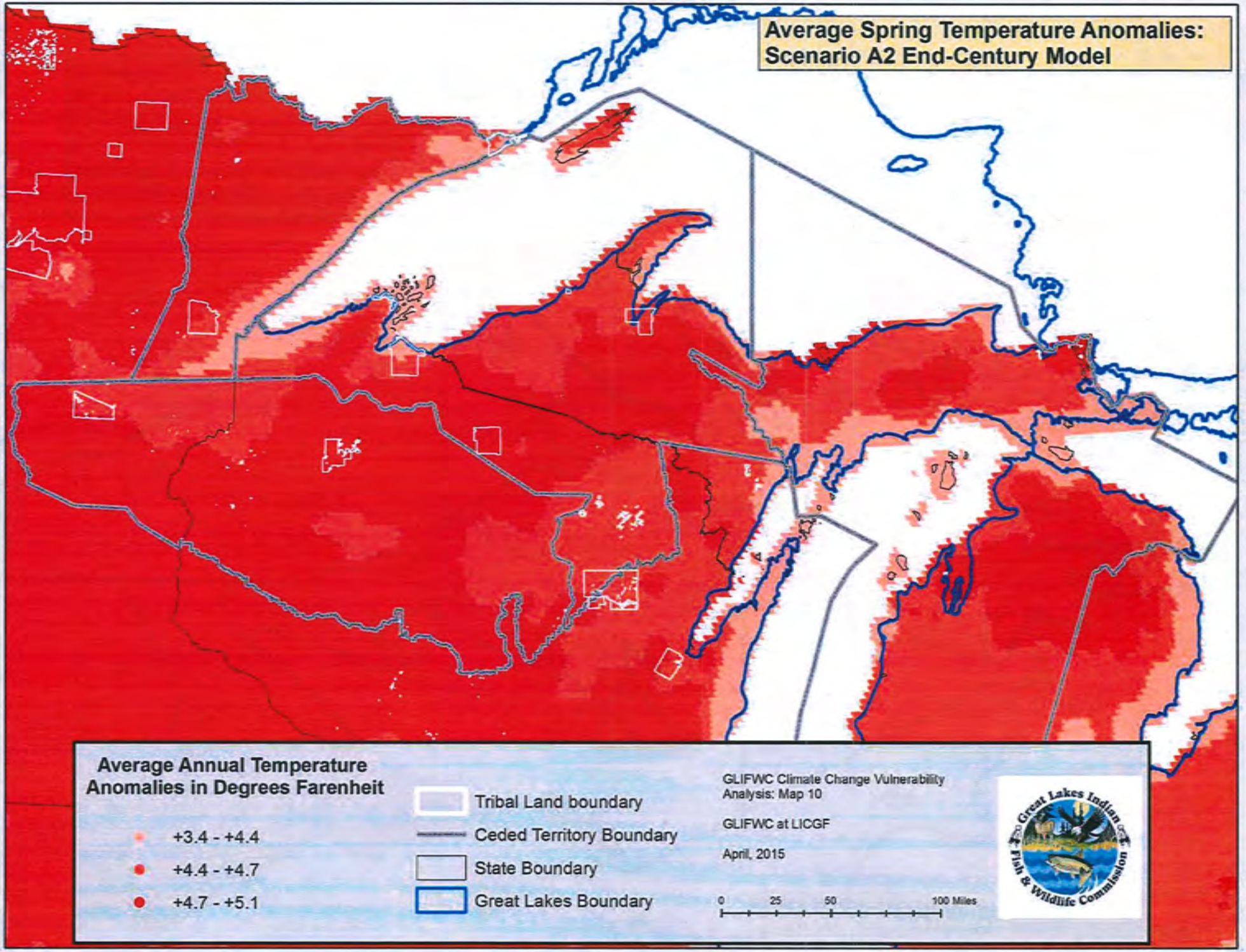
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Spring Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+3.4 - +4.4
+4.4 - +4.7
+4.7 - +5.1
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 10
GLIFWC at LICGF
April, 2015
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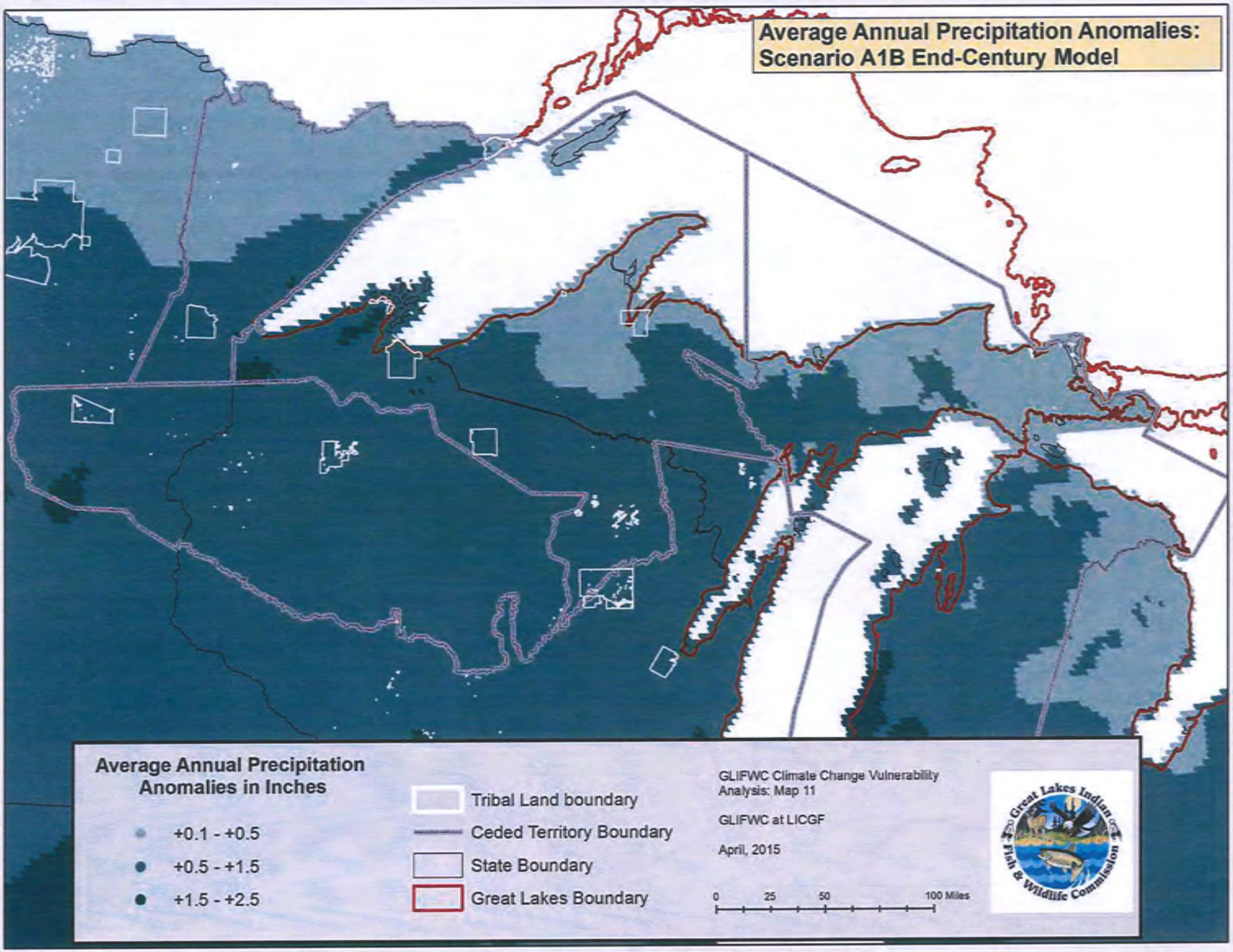
Great Lakes Indian Fish & Wildlife Commission


Average Annual Precipitation Anomalies: Scenario A1B End-Century Model
Average Annual Precipitation Anomalies in Inches
+0.1 - +0.5
+0.5 - +1.5
+1.5 - +2.5
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 11
GLIFWC at LICGF
April, 2015
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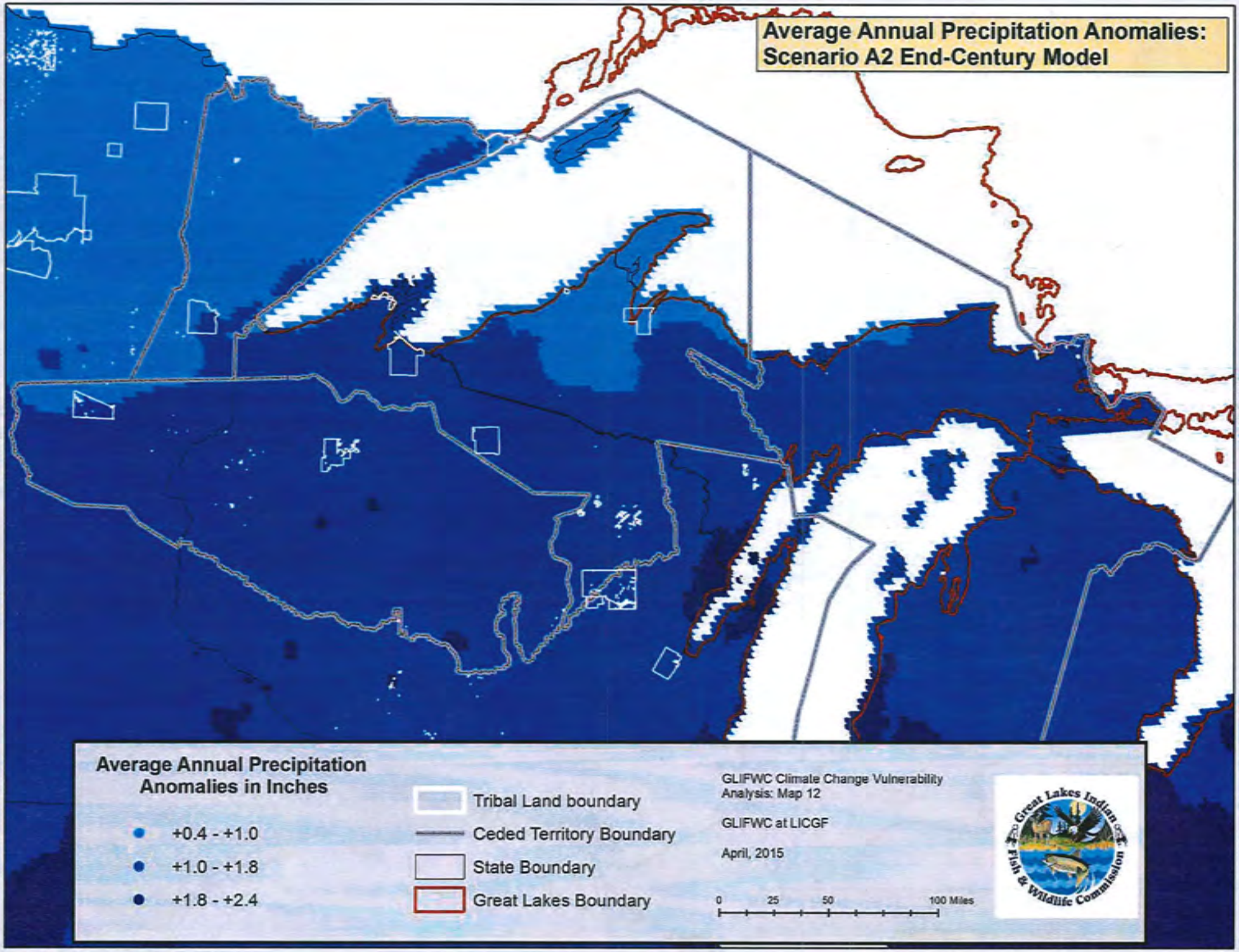
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Annual Precipitation Anomalies: Scenario A2 End-Century Model
Average Annual Precipitation Anomalies in Inches
+0.4 - +1.0
+1.0 - +1.8
+1.8 - +2.4
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 12
GLIFWC at LICGF
April, 2015
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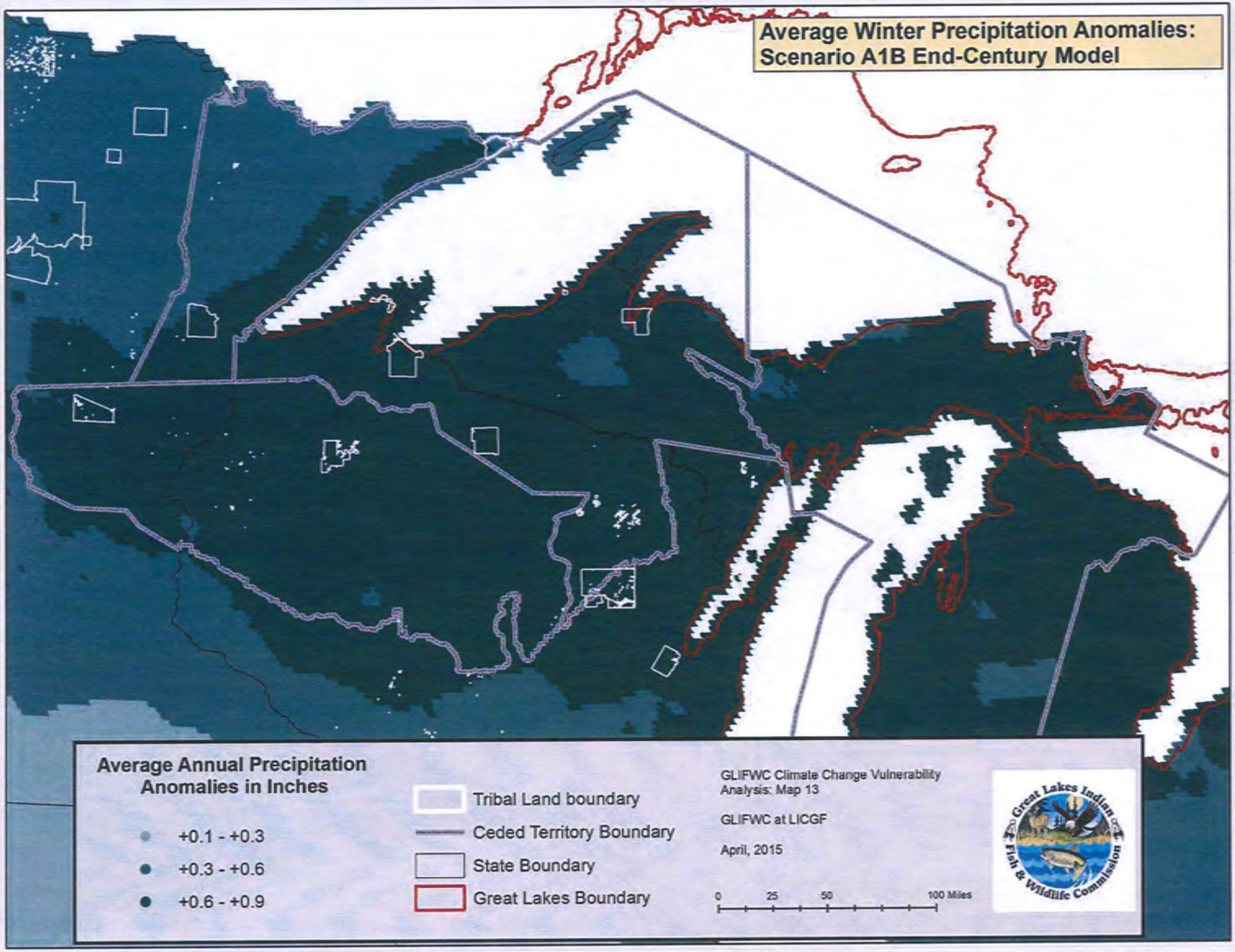
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Winter Precipitation Anomalies:
Scenario A1B End-Century Model
Average Annual Precipitation Anomalies in Inches
+0.1 - +0.3
+0.3 - +0.6
+0.6 - +0.9
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 13
GLIFWC at LICGF
April, 2015
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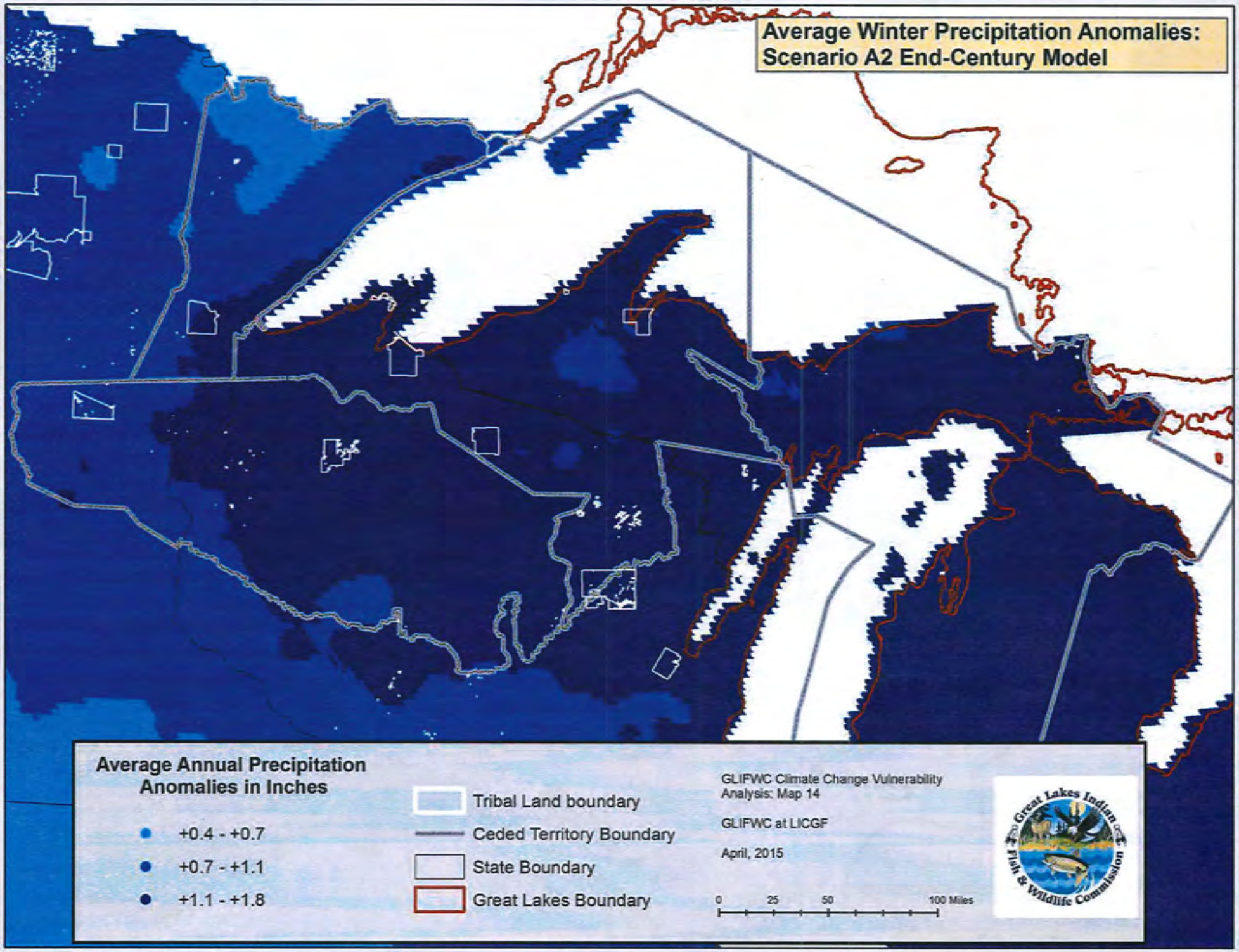
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Winter Precipitation Anomalies:
Scenario A2 End-Century Model
Average Annual Precipitation Anomalies in Inches
+0.4 - +0.7
+0.7 - +1.1
+1.1 - +1.8
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 14
GLIFWC at LICGF
April, 2015
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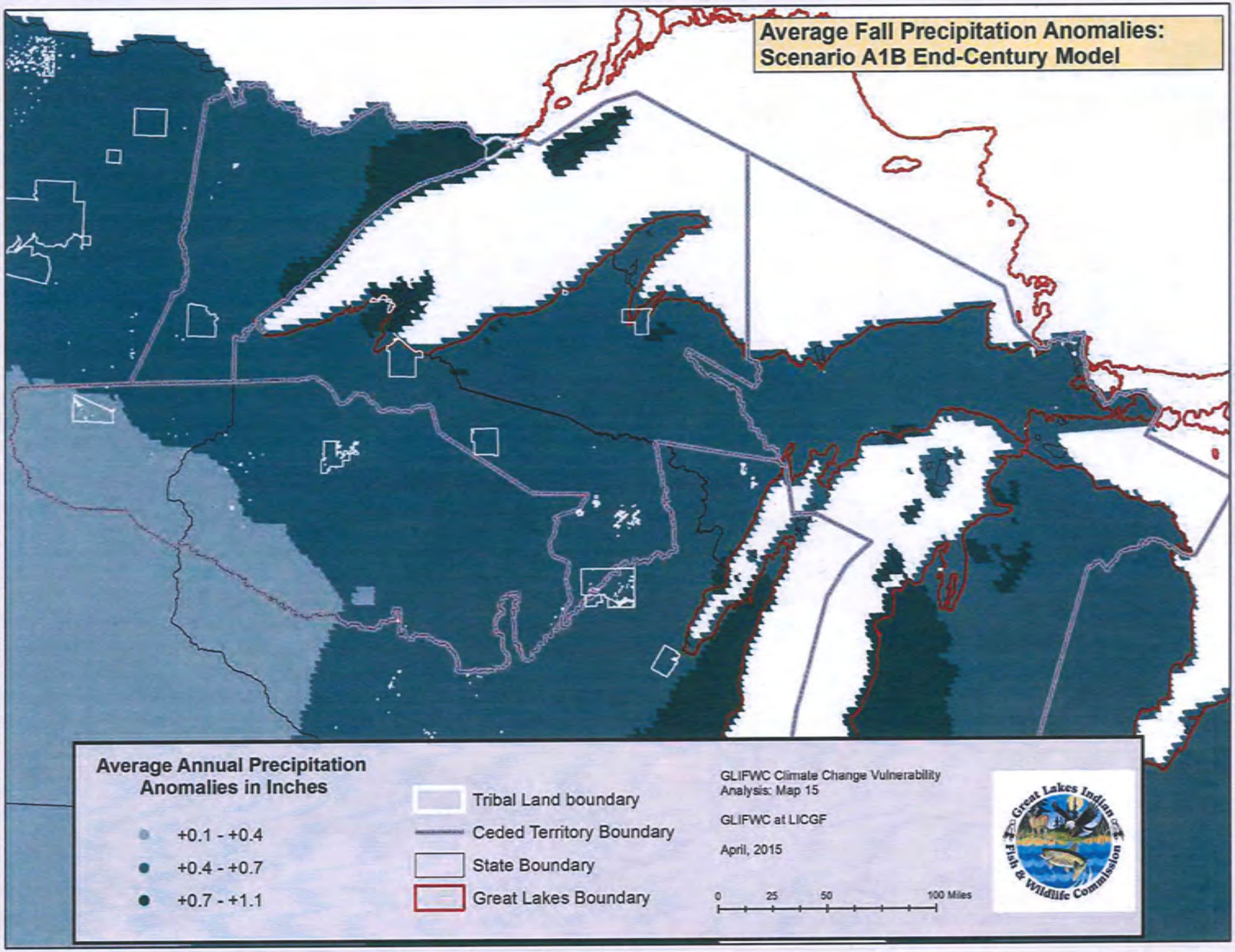
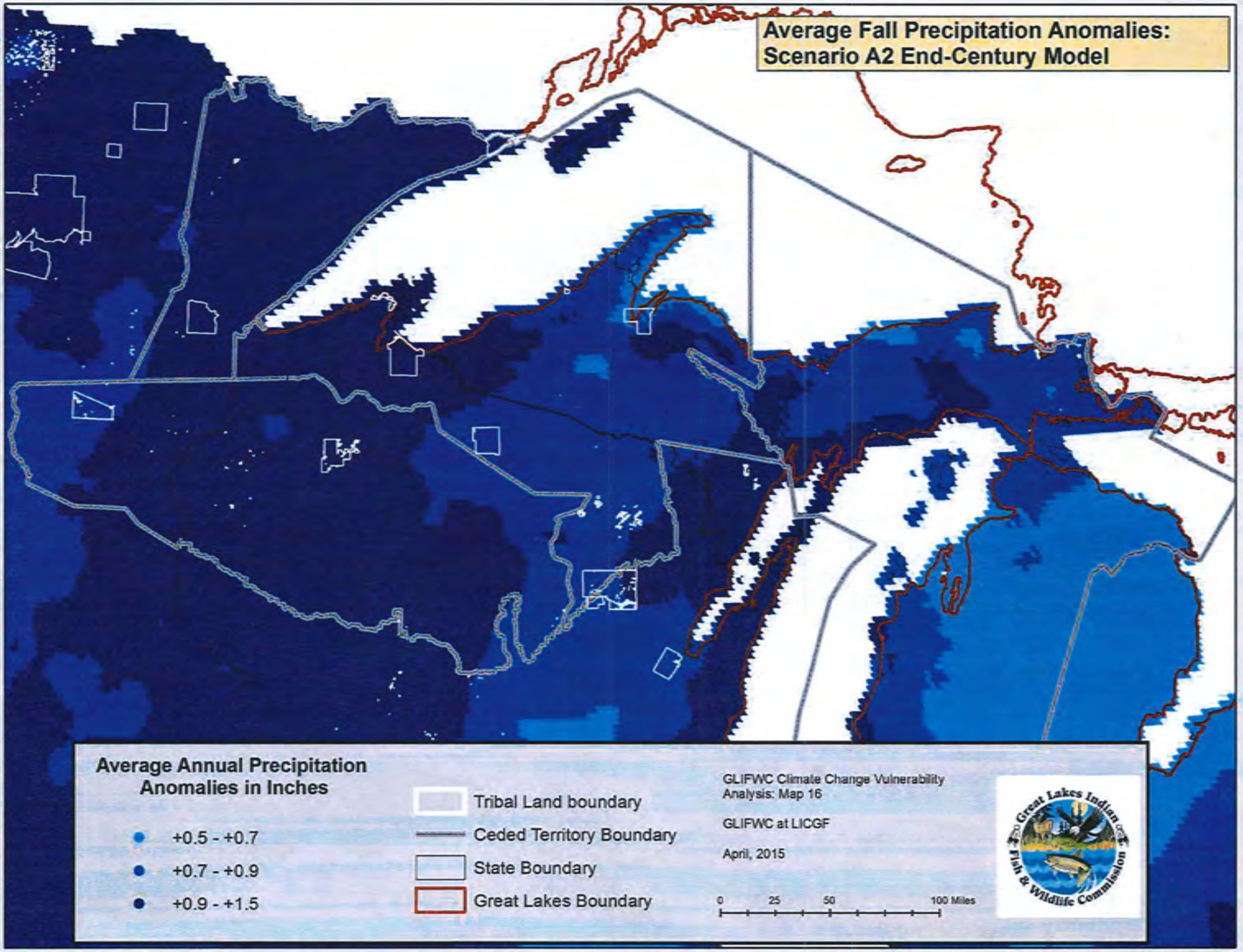
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Fall Precipitation Anomalies:
Scenario A1B End-Century Model
Average Annual Precipitation Anomalies in Inches
+0.1 - +0.4
+0.4 - +0.7
+0.7 - +1.1
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 15
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Fall Precipitation Anomalies:
Scenario A2 End-Century Model
Average Annual Precipitation Anomalies in Inches
+0.5 - +0.7
+0.7 - +0.9
+0.9 - +1.5
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 16
GLIFWC at LICGF
April, 2015
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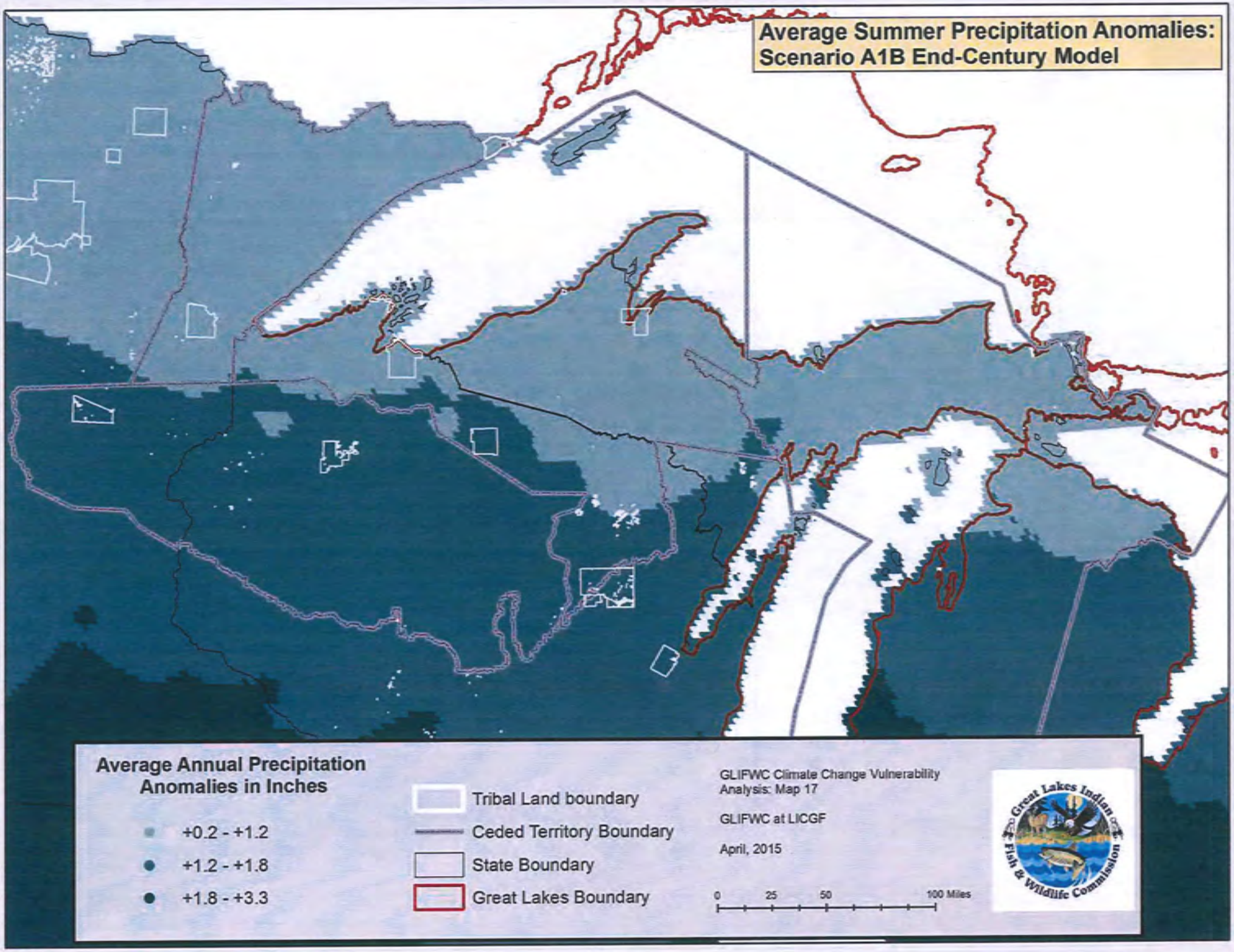
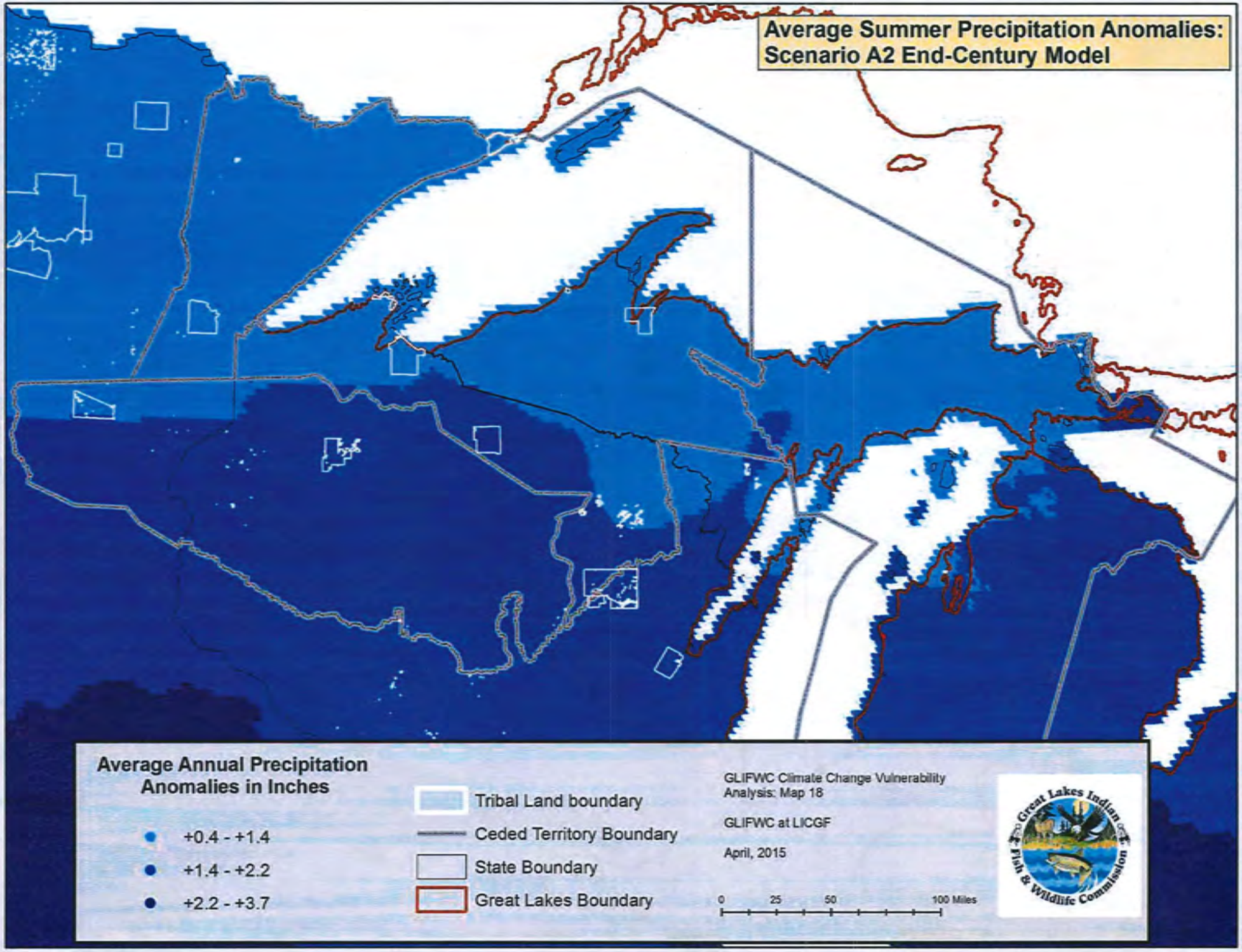
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Summer Precipitation Anomalies:
Scenario A1B End-Century Model
Average Annual Precipitation
Anomalies in Inches
+0.2 - +1.2
+1.2 - +1.8
+1.8 - +3.3
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 17
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Summer Precipitation Anomalies:
Scenario A2 End-Century Model
Average Annual Precipitation
Anomalies in Inches
+0.4 - +1.4
+1.4 - +2.2
+2.2 - +3.7
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 18
GLIFWC at LICGF
April, 2015
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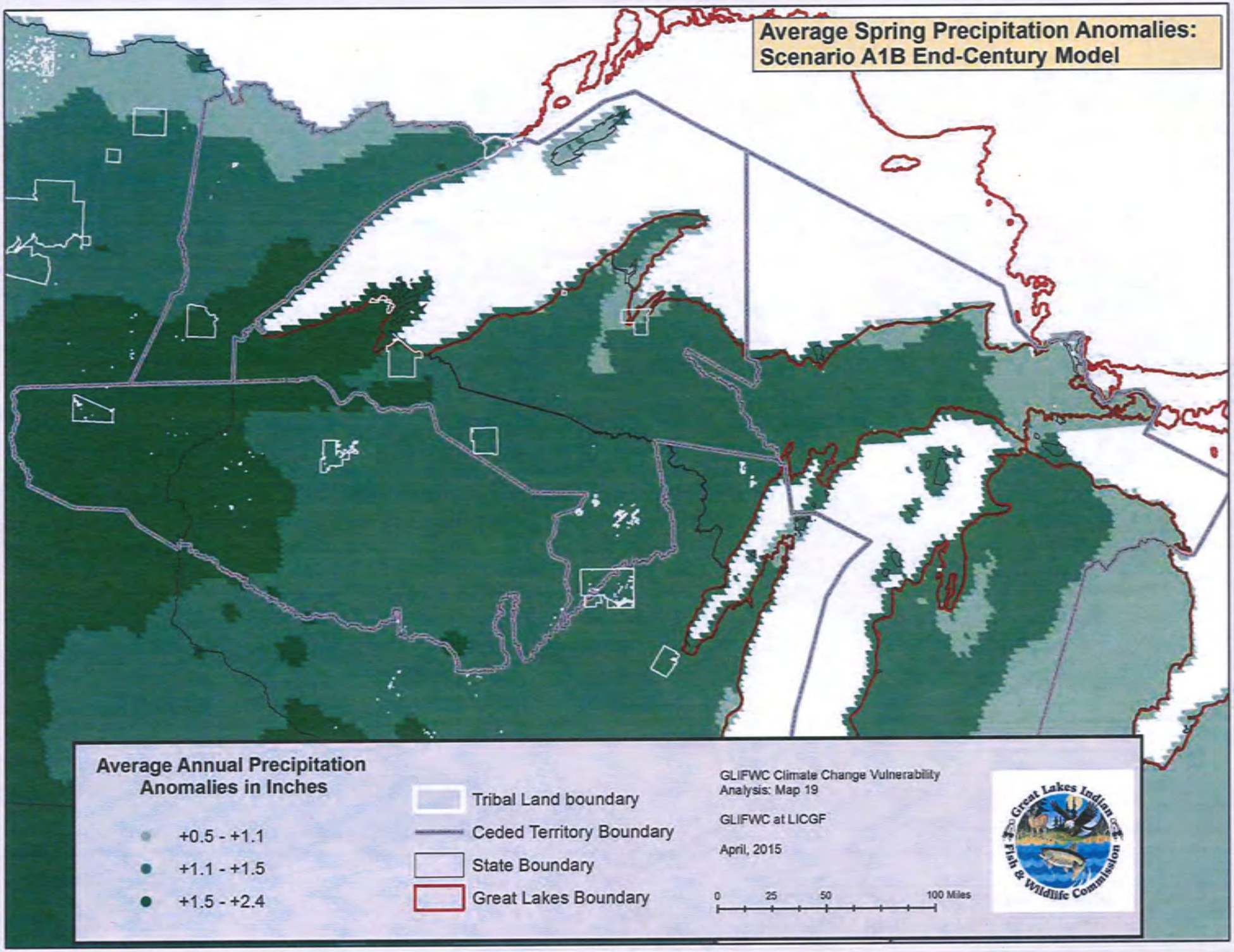
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Spring Precipitation Anomalies:
Scenario A1B End-Century Model
Average Annual Precipitation
Anomalies in Inches
+0.5 - +1.1
+1.1 - +1.5
+1.5 - +2.4
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 19
GLIFWC at LICGF
April, 2015
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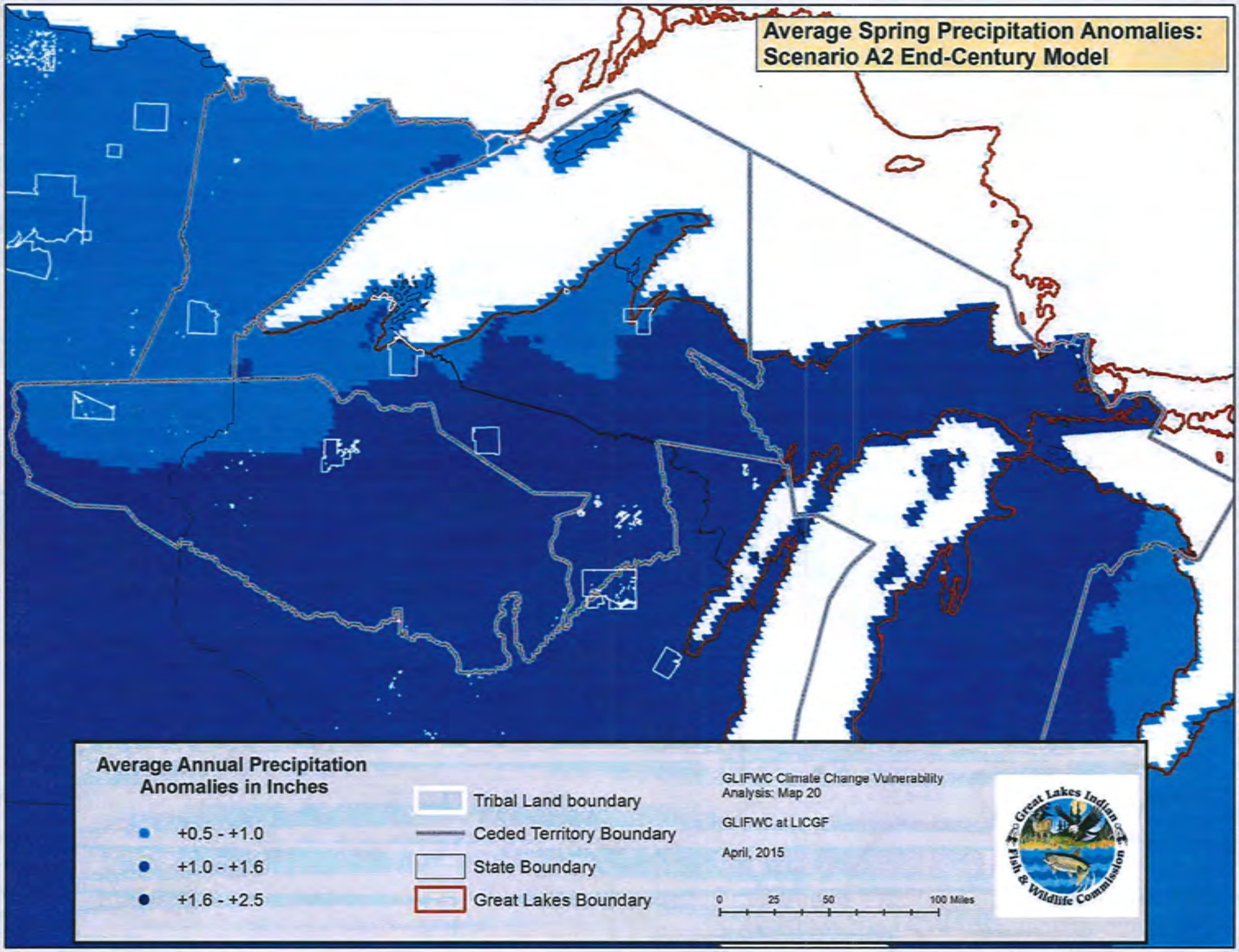
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Spring Precipitation Anomalies:
Scenario A2 End-Century Model
Average Annual Precipitation
Anomalies in Inches
+0.5 - +1.0
+1.0 - +1.6
+1.6 - +2.5
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 20
GLIFWC at LICGF
April, 2015
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25
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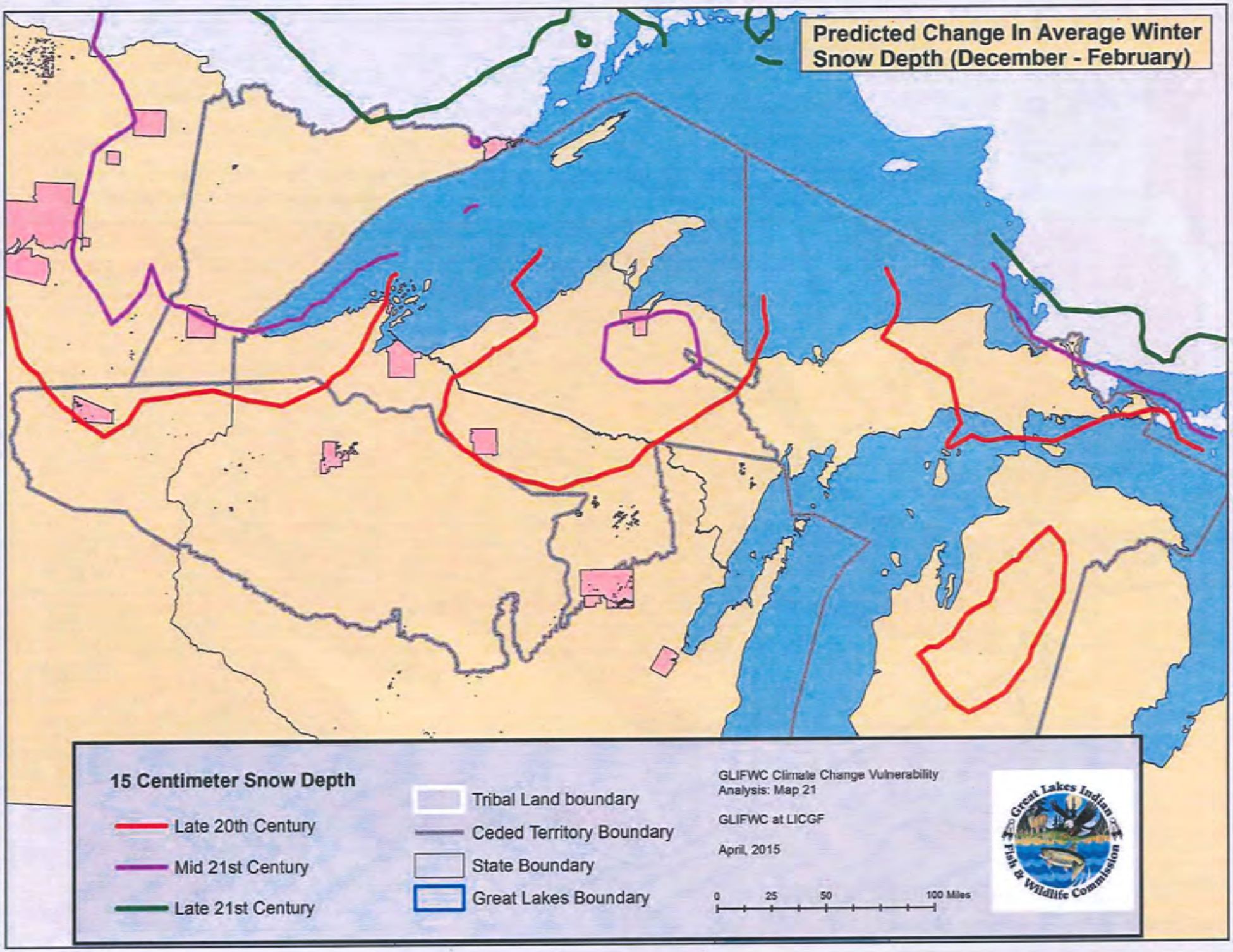
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Predicted Change In Average Winter Snow Depth (December - February)
15 Centimeter Snow Depth
Late 20th Century
Mid 21st Century
Late 21st Century
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 21
GLIFWC at LICGF
April, 2015
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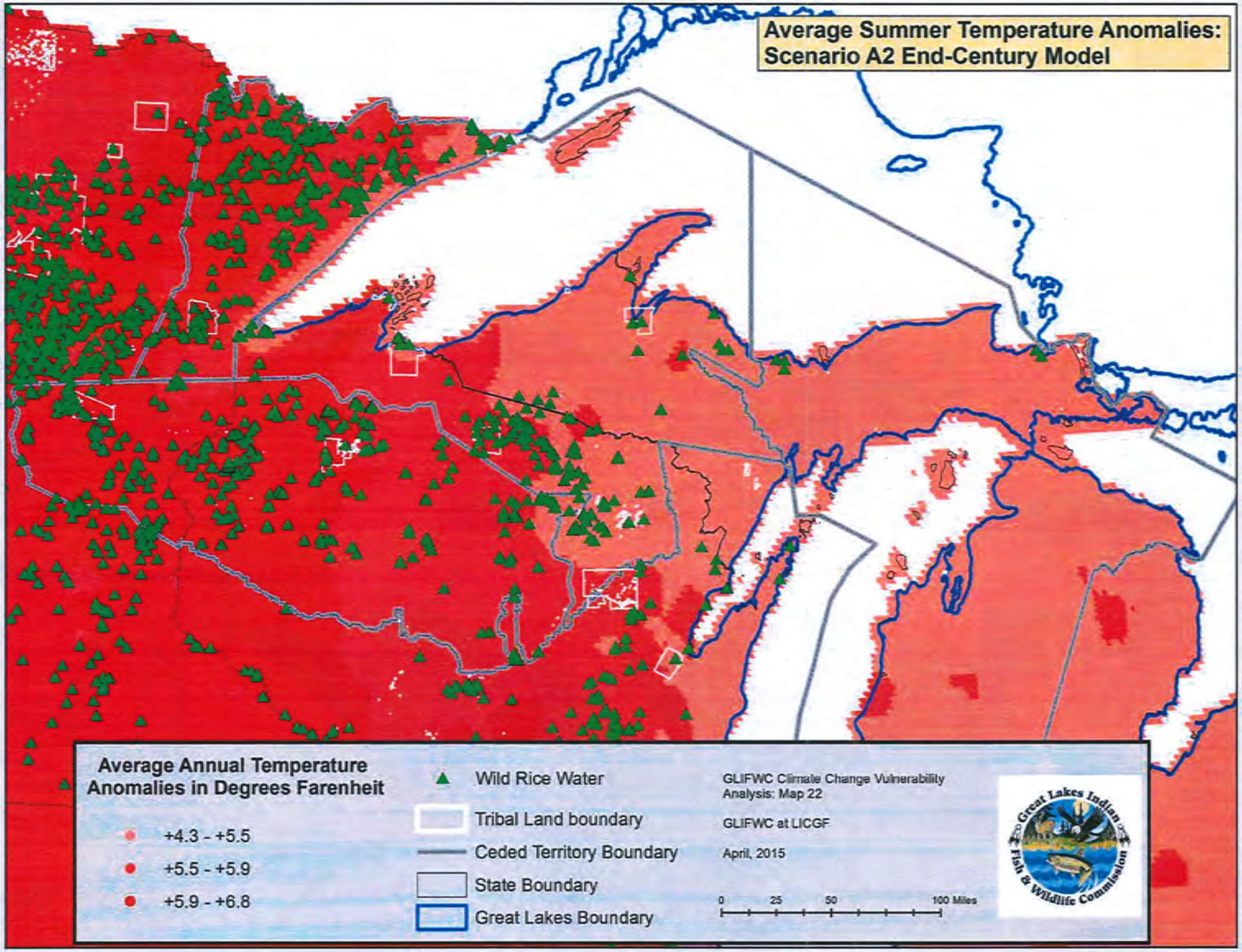
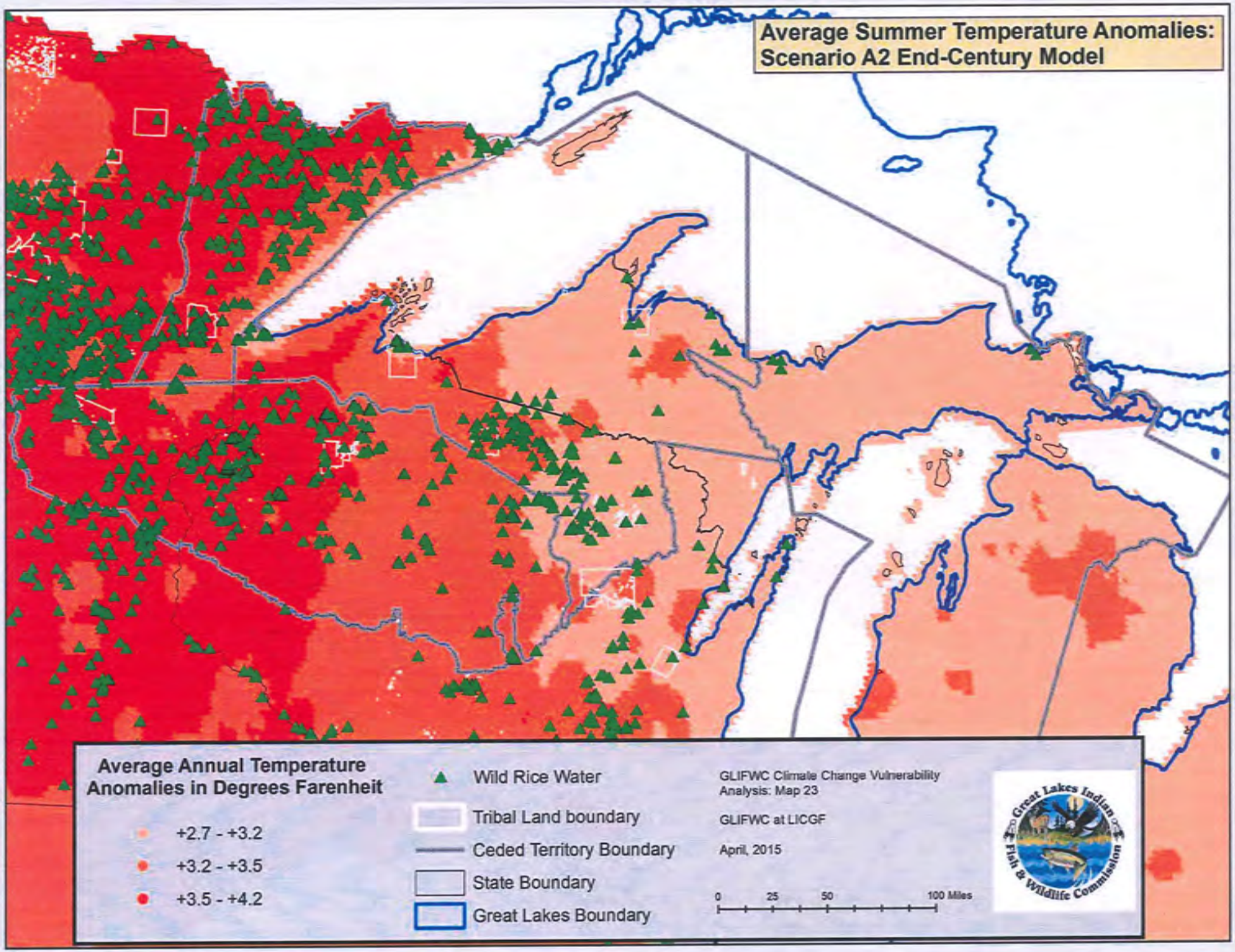
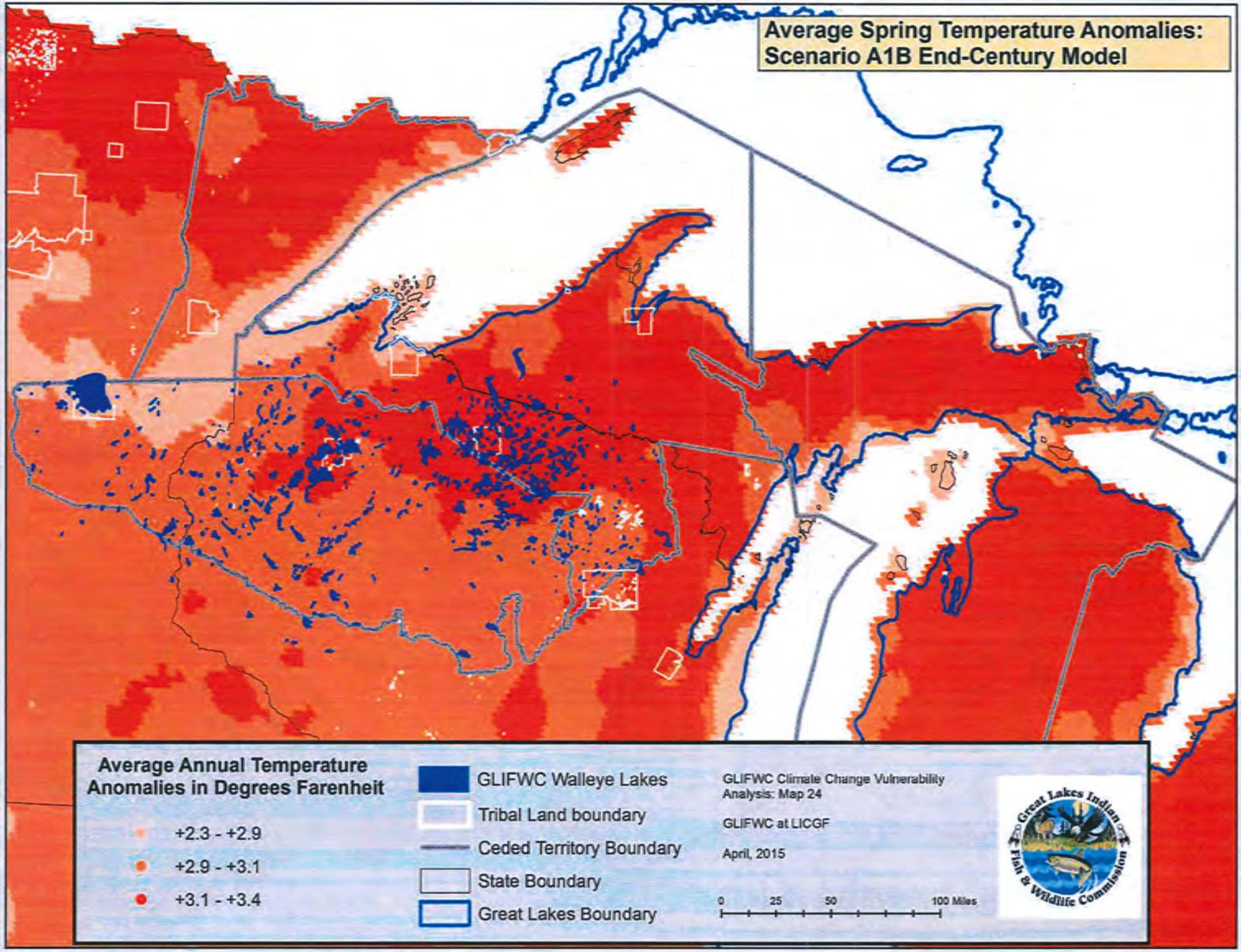
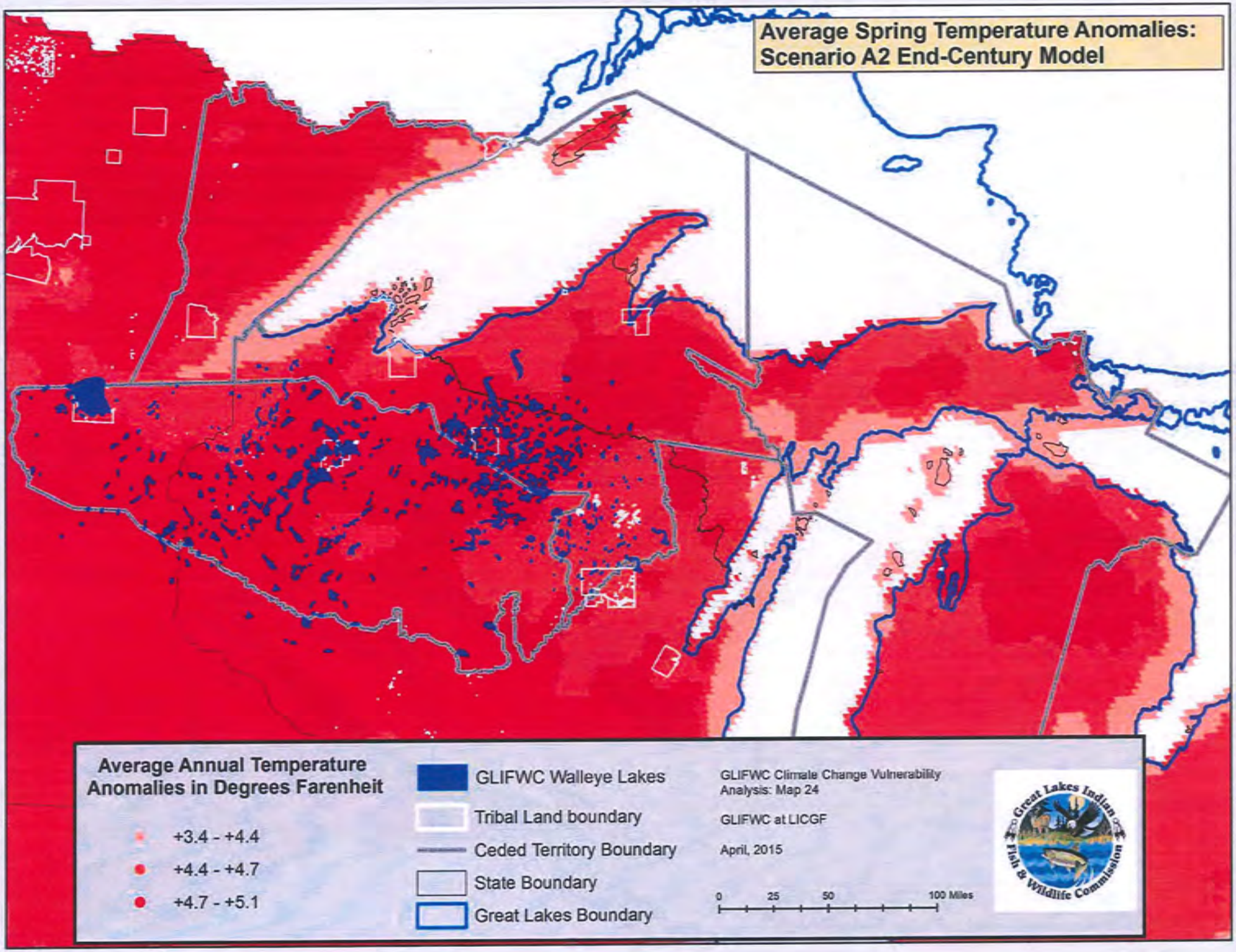
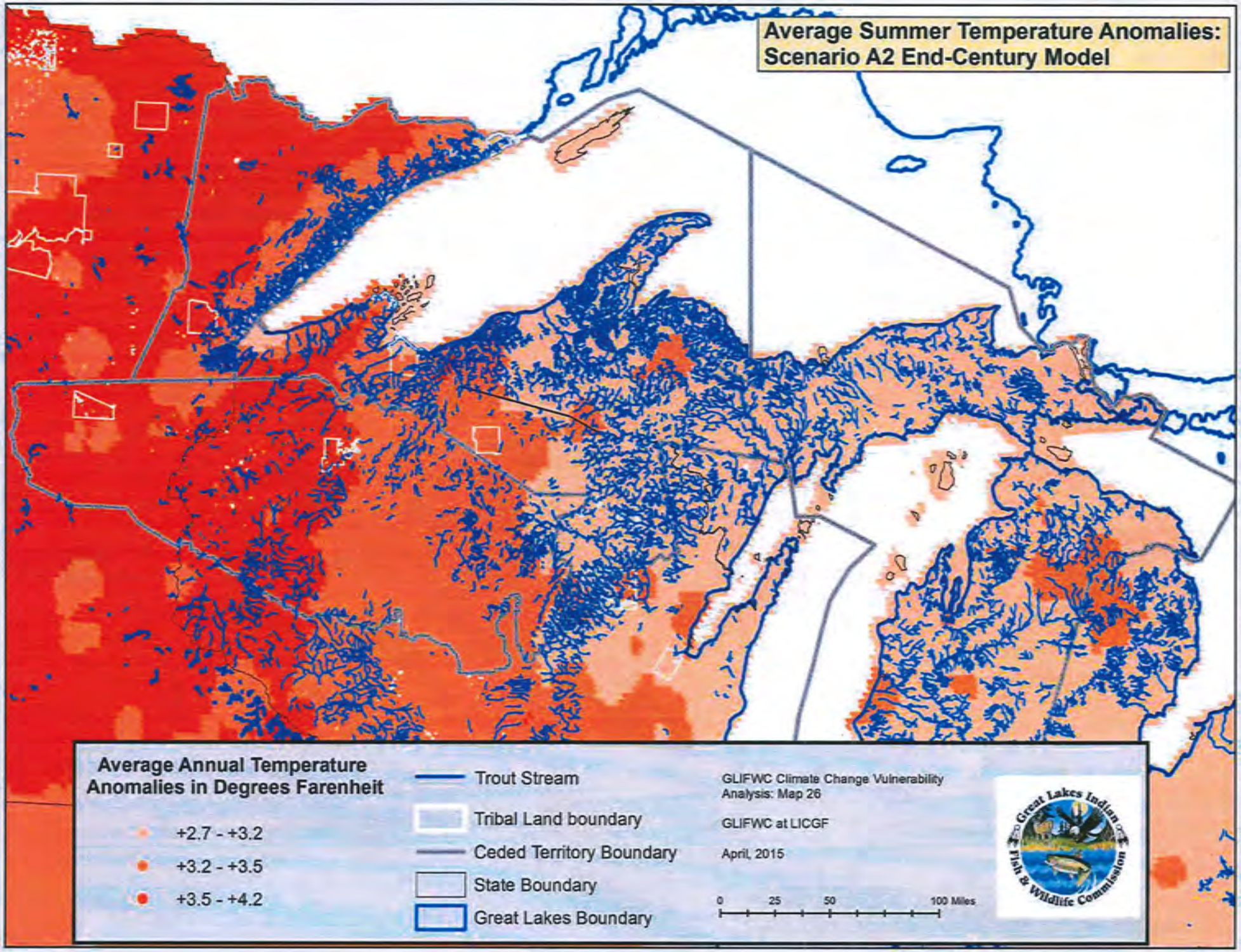
100 Miles
Great Lakes Indian Fish & Wildlife Commission

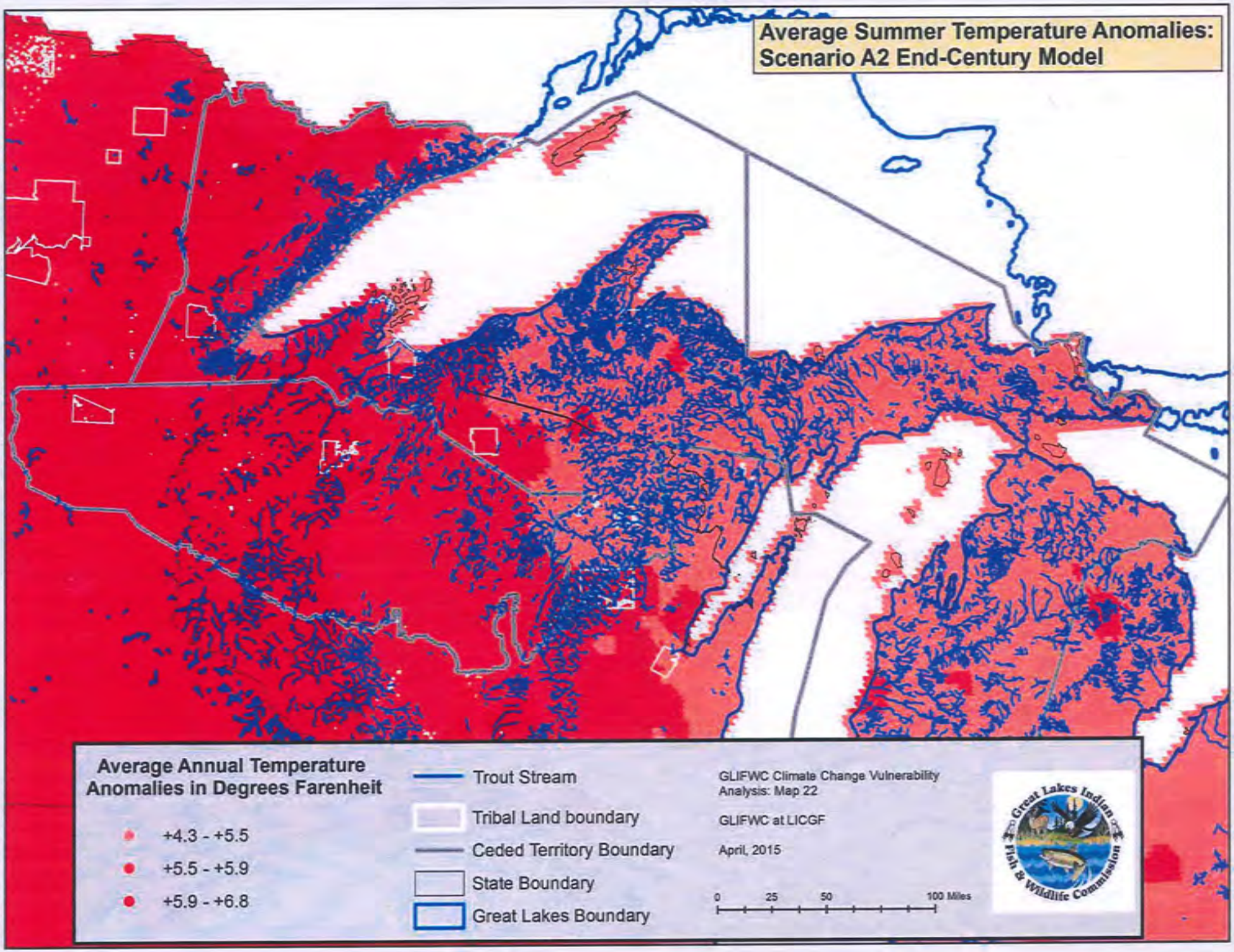

Average Summer Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.3 - +5.5
+5.5 - +5.9
+5.9 - +6.8
Wild Rice Water
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 22
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission

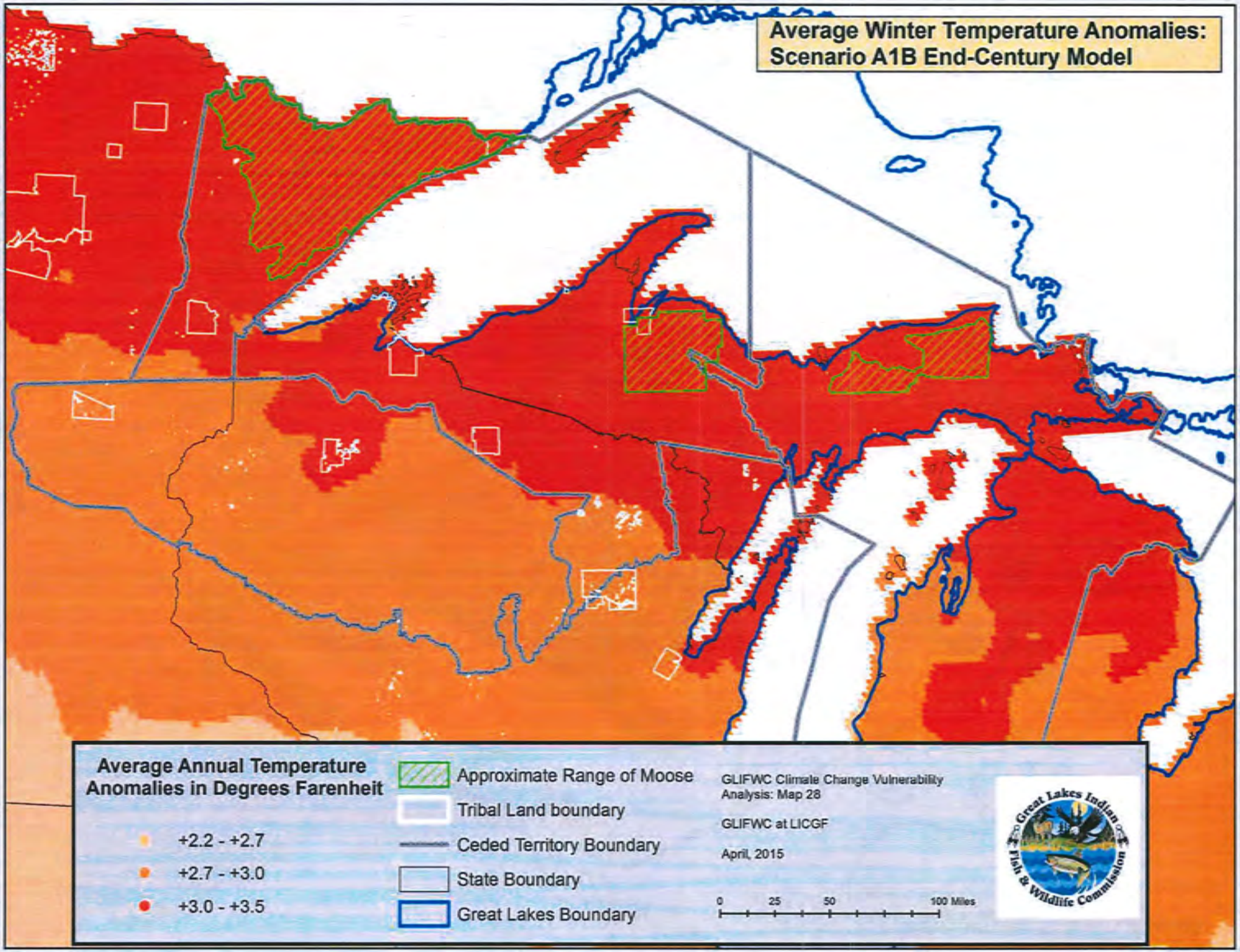

Average Summer Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+2.7 - +3.2
+3.2 - +3.5
+3.5 - +4.2
Wild Rice Water
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 23
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission

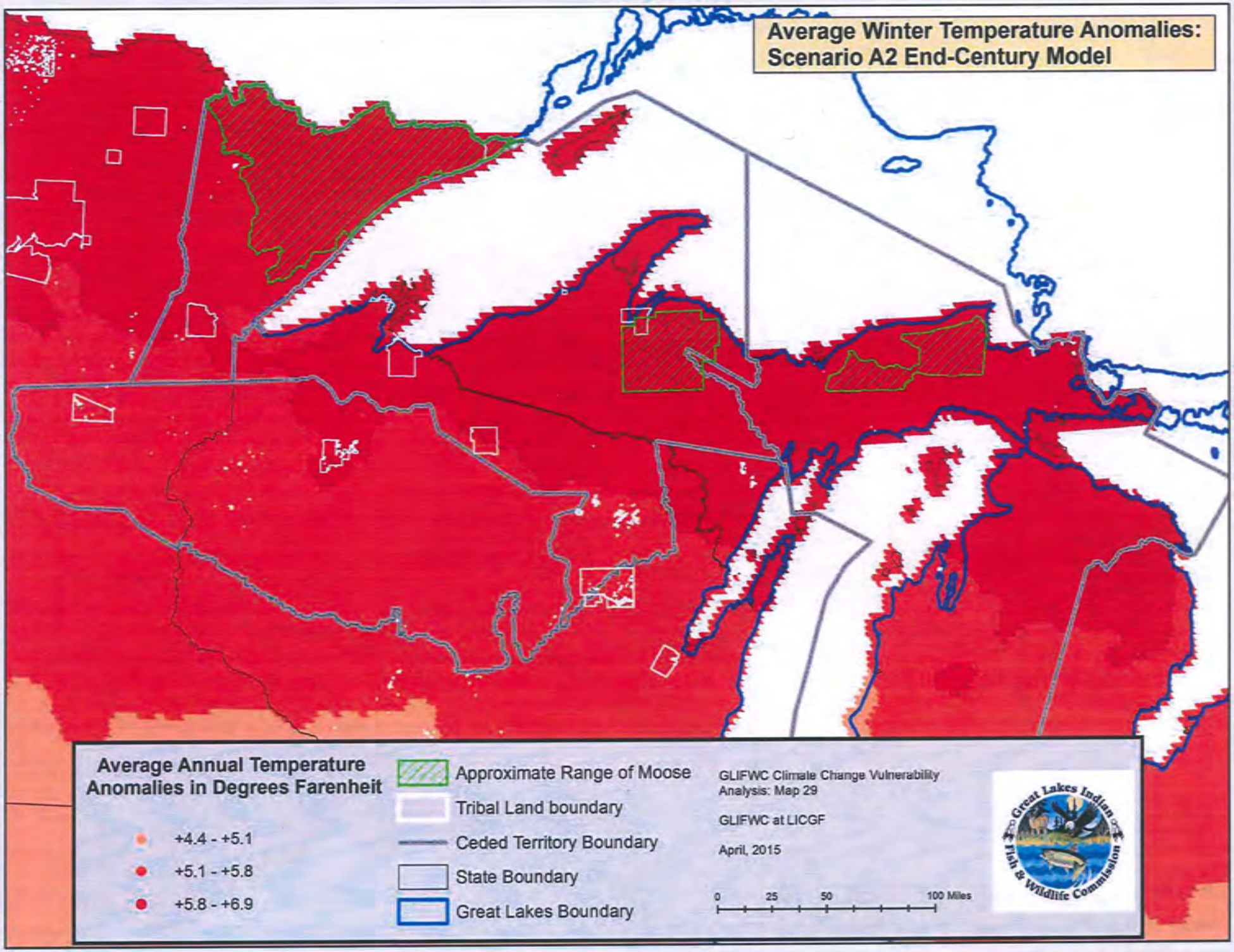

Average Spring Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+2.3 - +2.9
+2.9 - +3.1
+3.1 - +3.4
GLIFWC Walleye Lakes
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 24
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission

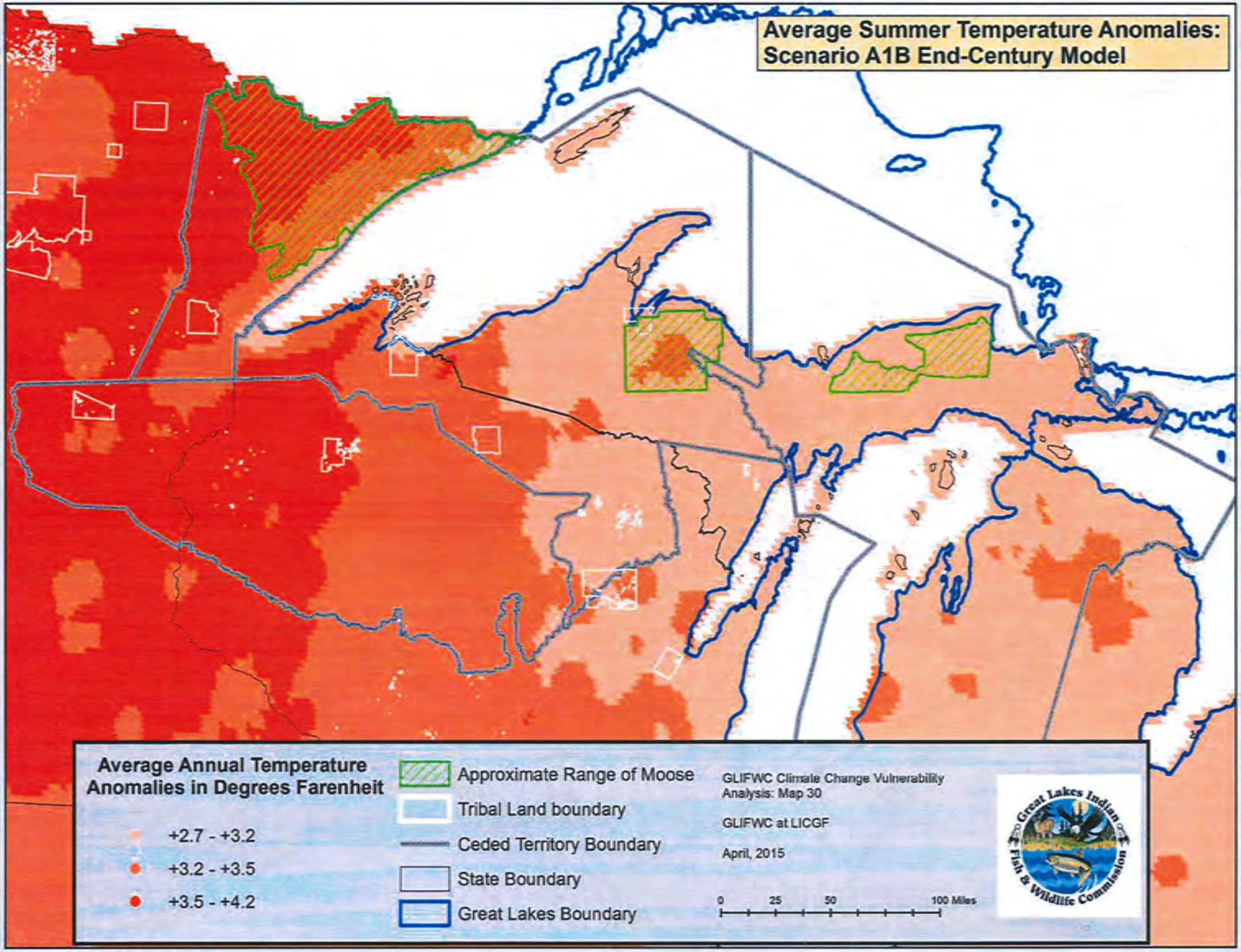

Average Spring Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+3.4 - +4.4
+4.4 - +4.7
+4.7 - +5.1
GLIFWC Walleye Lakes
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 24
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission

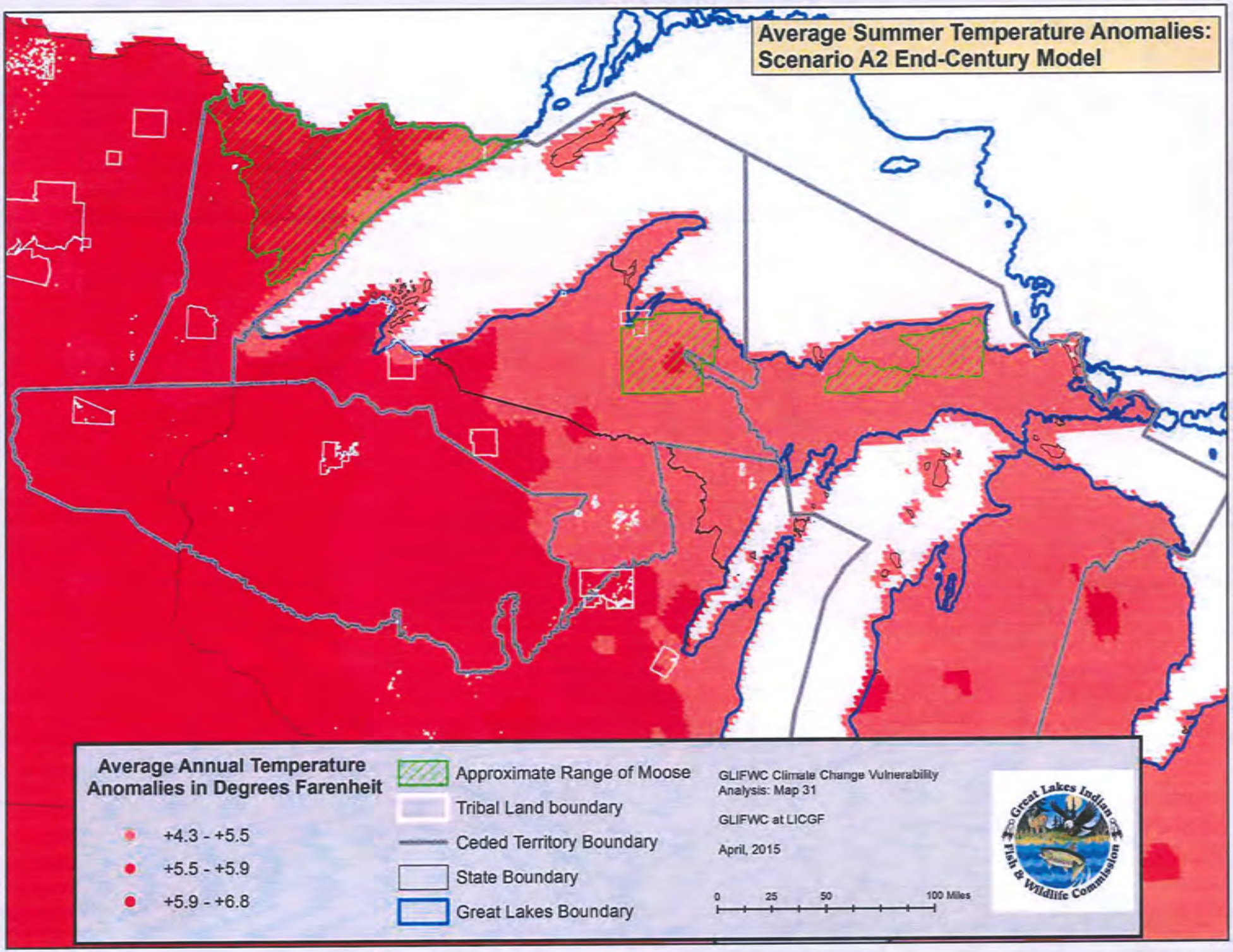

Average Summer Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+2.7 - +3.2
+3.2 - +3.5
+3.5 - +4.2
Trout Stream
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 26
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission

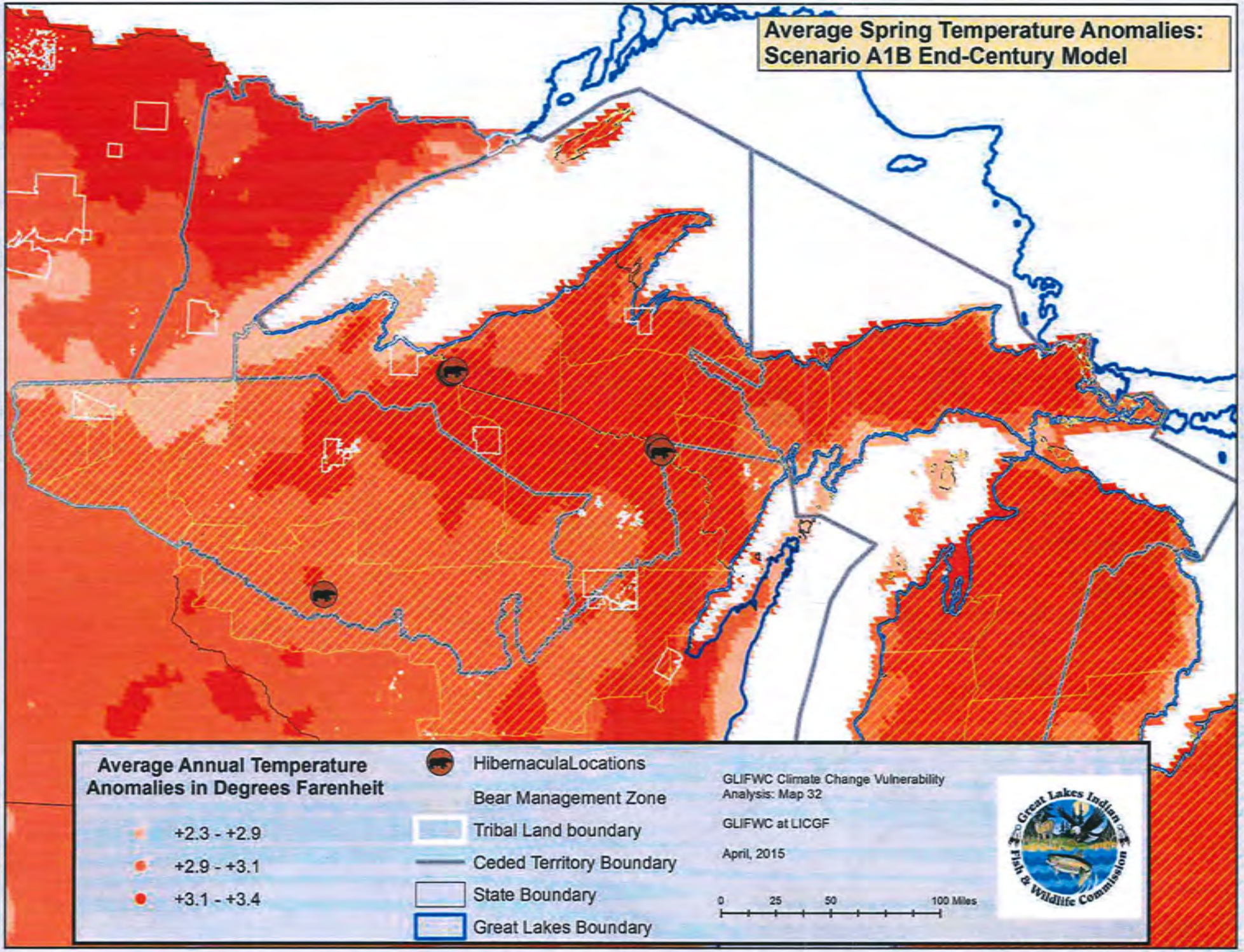

Average Summer Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.3 - +5.5
+5.5 - +5.9
+5.9 - +6.8
Trout Stream
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 22
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission

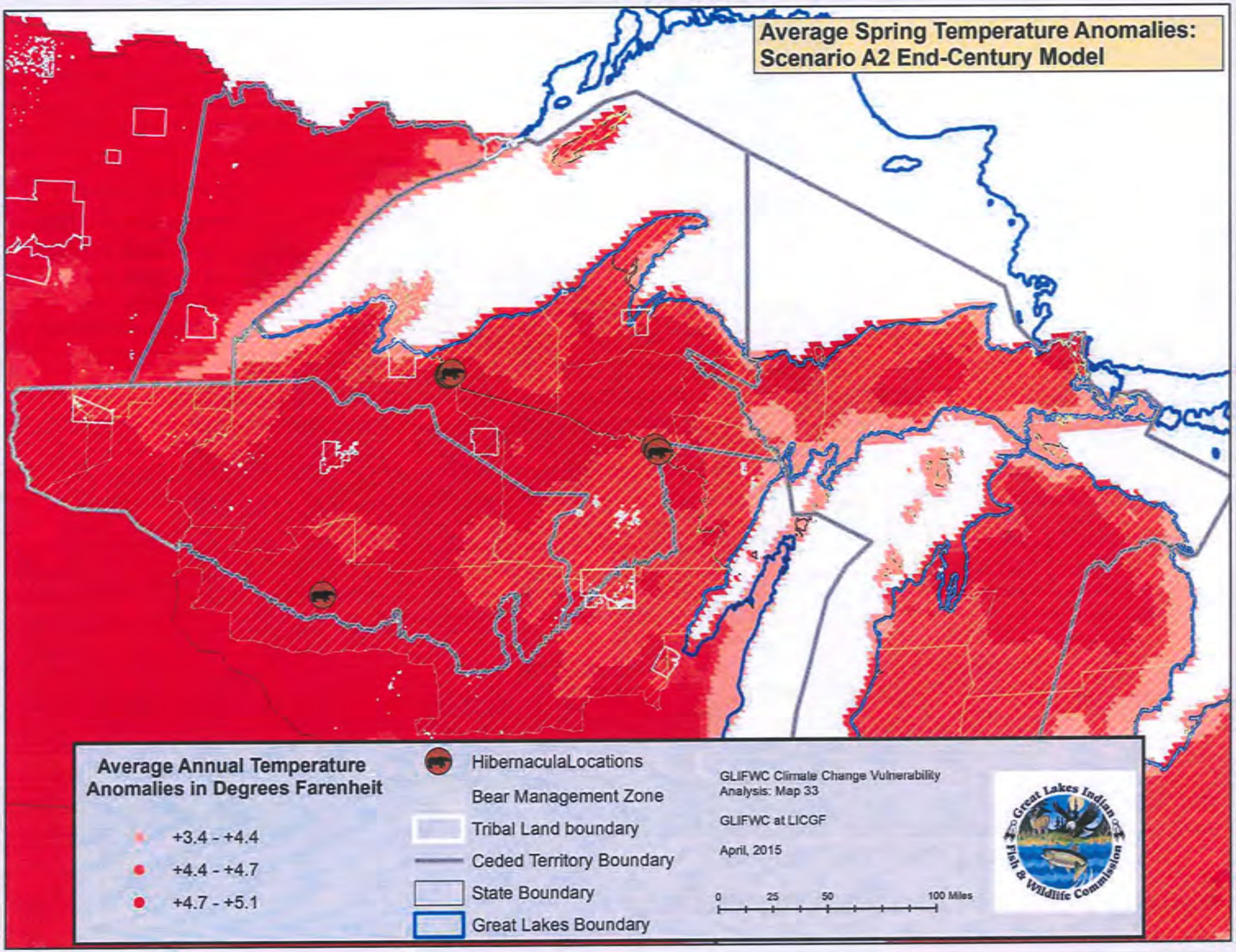

Average Winter Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+2.2 - +2.7
+2.7 - +3.0
+3.0 - +3.5
Approximate Range of Moose
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 28
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Winter Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.4 - +5.1
+5.1 - +5.8
+5.8 - +6.9
Approximate Range of Moose
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 29
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission


Average Summer Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+2.7 - +3.2
+3.2 - +3.5
+3.5 - +4.2
Approximate Range of Moose
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 30
GLIFWC at LICGF
April, 2015
0 25 50 100 Miles
Great Lakes Indian Fish & Wildlife Commission

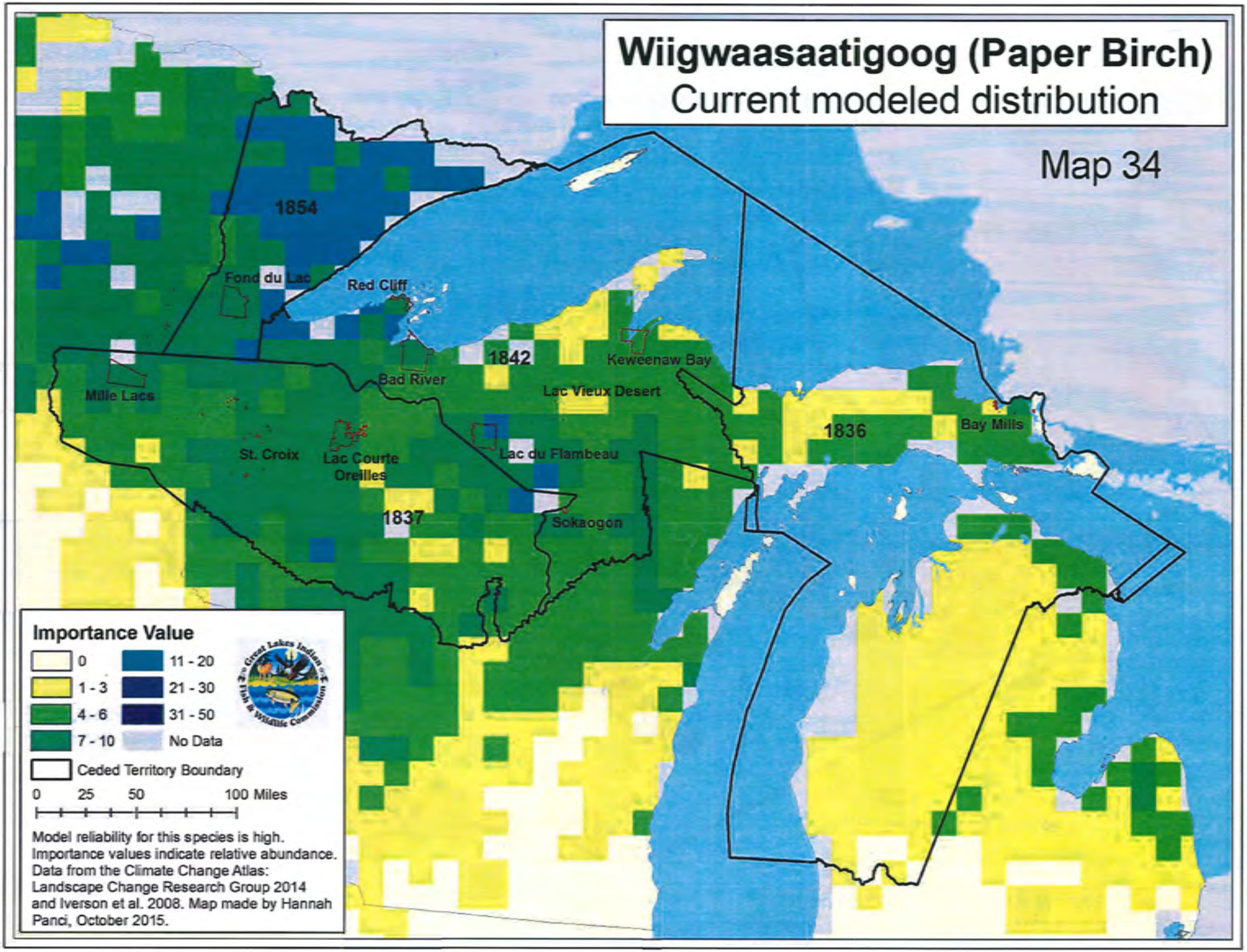

Average Summer Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+4.3 - +5.5
+5.5 - +5.9
+5.9 - +6.8
Approximate Range of Moose
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 31
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission

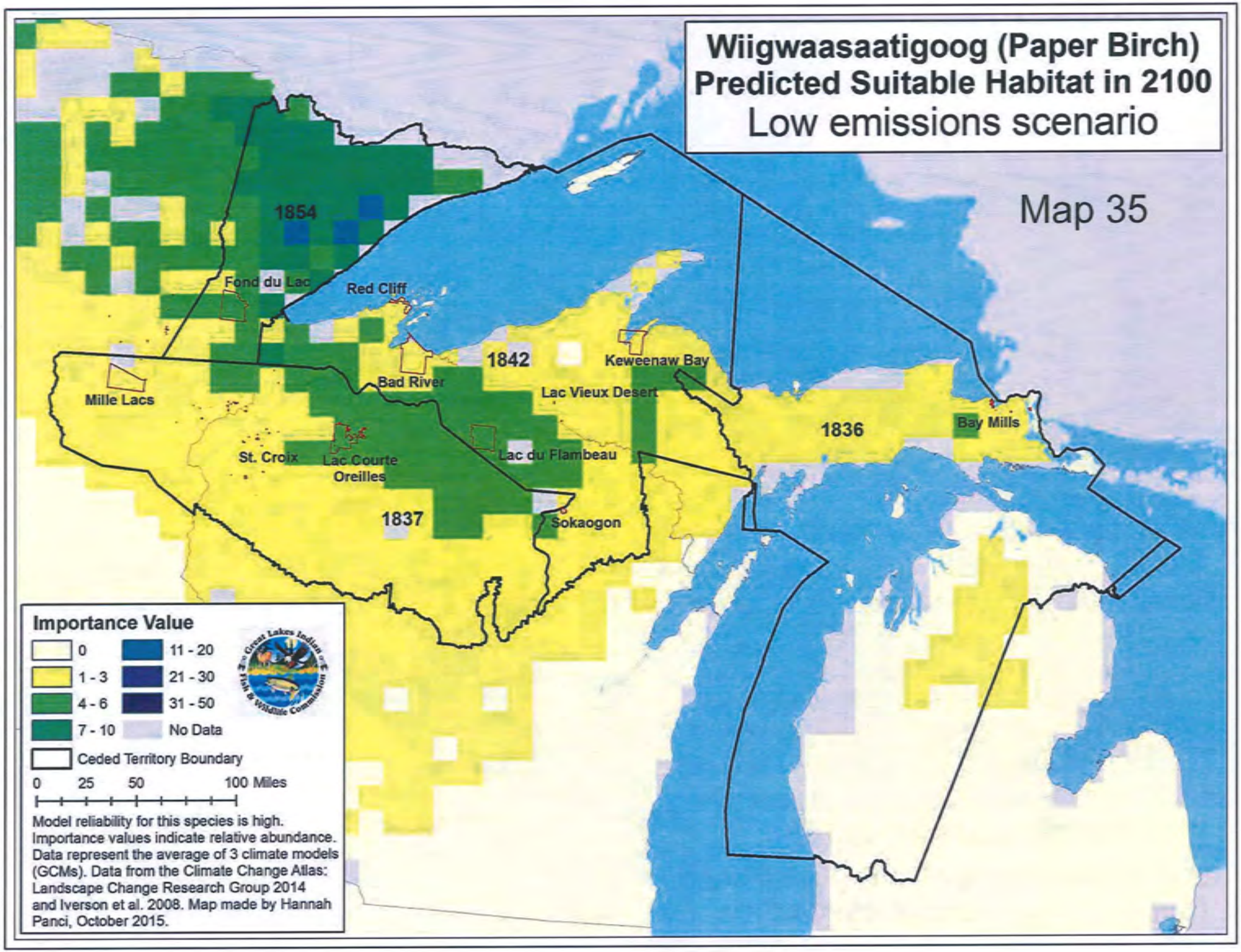

Average Spring Temperature Anomalies:
Scenario A1B End-Century Model
Average Annual Temperature
Anomalies in Degrees Farenheit
+2.3 - +2.9
+2.9 - +3.1
+3.1 - +3.4
HibernaculaLocations
Bear Management Zone
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability
Analysis: Map 32
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission

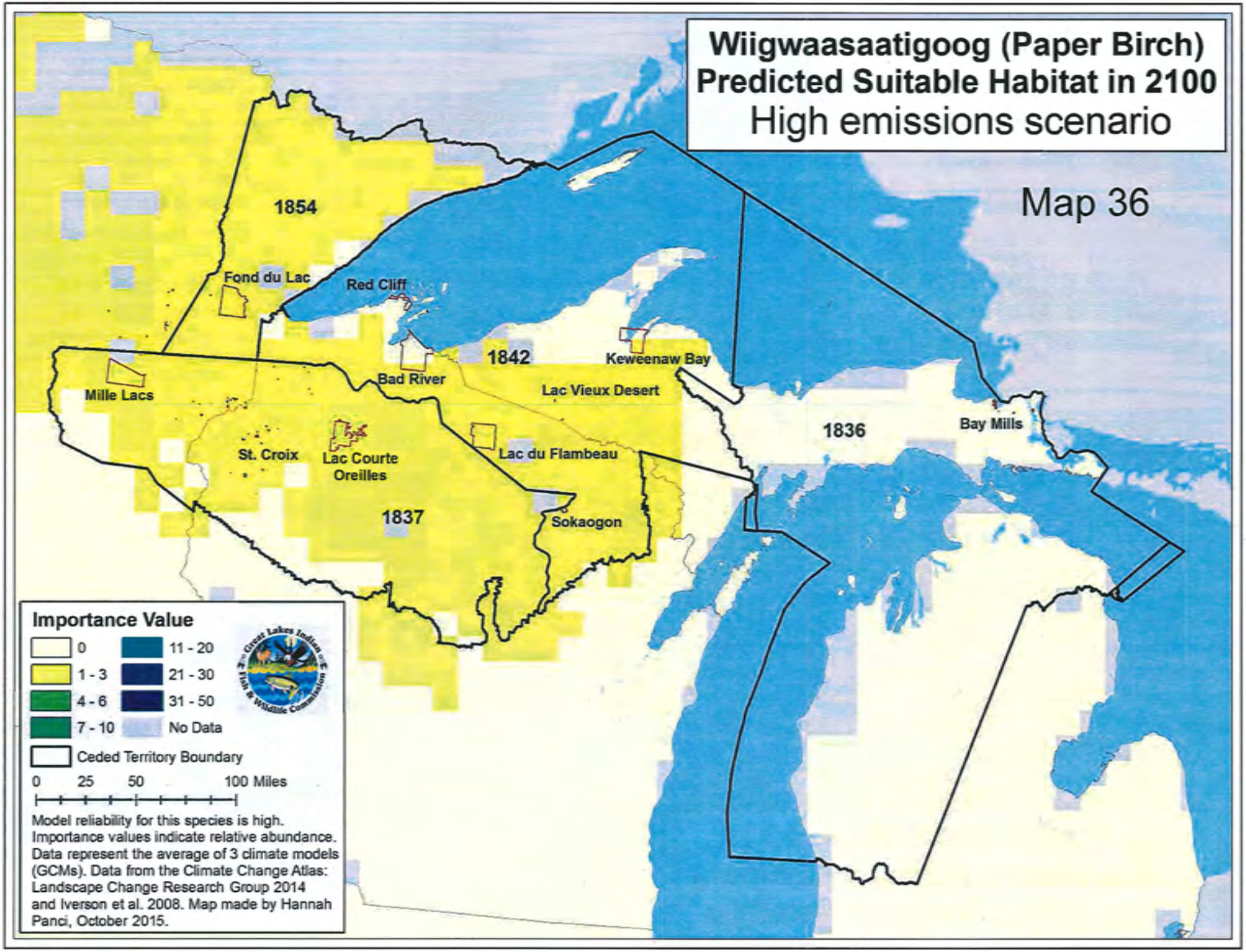

Average Spring Temperature Anomalies:
Scenario A2 End-Century Model
Average Annual Temperature Anomalies in Degrees Farenheit
+3.4 - +4.4
+4.4 - +4.7
+4.7 - +5.1
HibernaculaLocations
Bear Management Zone
Tribal Land boundary
Ceded Territory Boundary
State Boundary
Great Lakes Boundary
GLIFWC Climate Change Vulnerability Analysis: Map 33
GLIFWC at LICGF
April, 2015
0
25
50
100 Miles
Great Lakes Indian Fish & Wildlife Commission

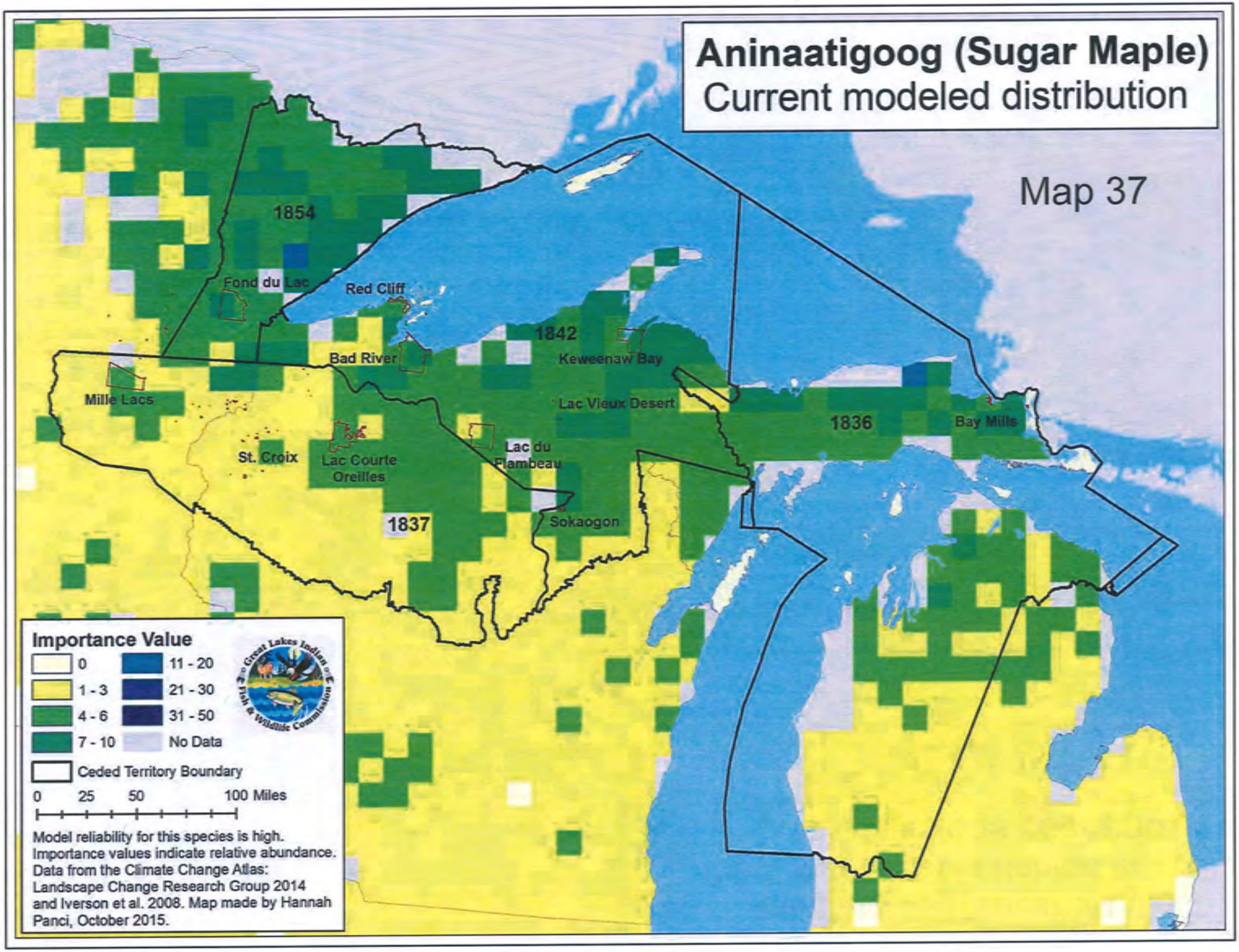
Wiigwaasaatigoog (Paper Birch)
Current modeled distribution

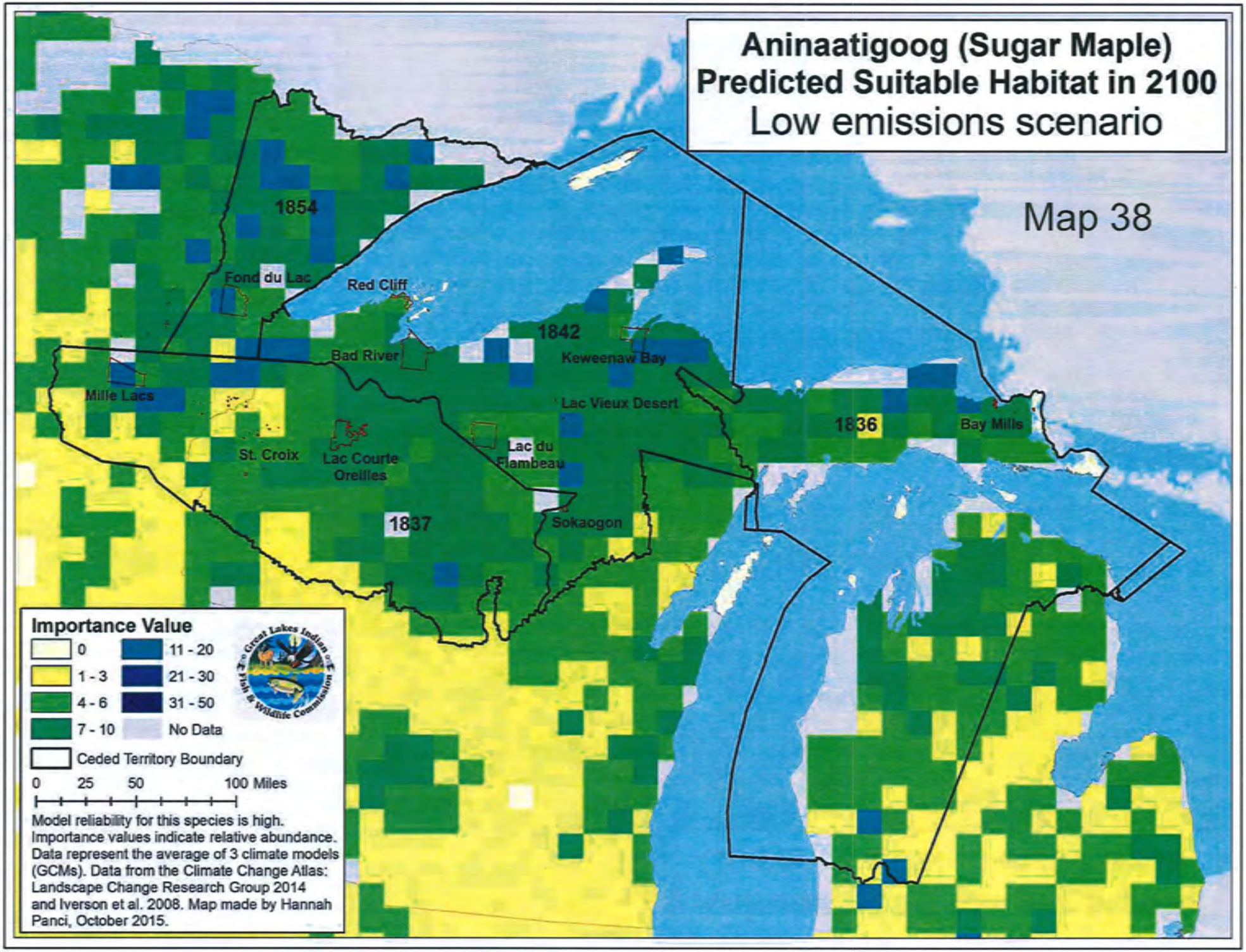
Map 34

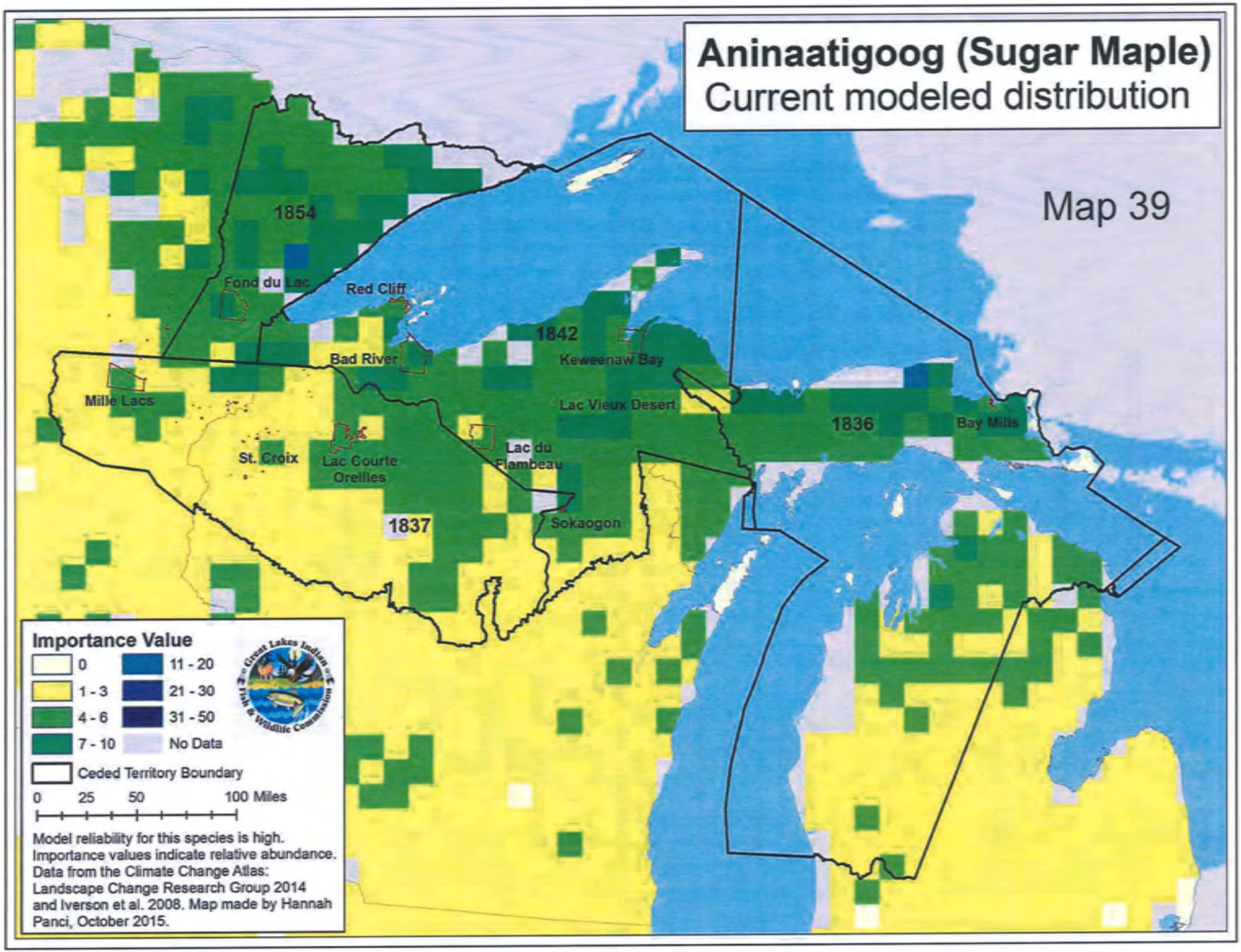



Wiigwaasaatigoog (Paper Birch)
Predicted Suitable Habitat in 2100
Low emissions scenario
Map 35
1854
Fond du Lac
Red Cliff
1842
Keweenaw Bay
Bad River
Lac Vieux Desert
Mille Lacs
1836
Bay Mills
St. Croix
Lac Courte Oreilles
Lac du Flambeau
1837
Sokaogon
Importance Value
0
1 - 3
4 - 6
7 - 10
11 - 20
21 - 30
31 - 50
No Data
Ceded Territory Boundary
0 25 50 100 Miles
Model reliability for this species is high. Importance values indicate relative abundance. Data represent the average of 3 climate models (GCMs). Data from the Climate Change Atlas: Landscape Change Research Group 2014 and Iverson et al. 2008. Map made by Hannah Panci, October 2015.


Wiigwaasaatigoog (Paper Birch)
Predicted Suitable Habitat in 2100
High emissions scenario
Map 36
1854
Fond du Lac
Red Cliff
1842
Keweenaw Bay
Bad River
Lac Vieux Desert
Mille Lacs
1836
Bay Mills
St. Croix
Lac Courte Oreilles
Lac du Flambeau
1837
Sokaogon
Importance Value
0
1 - 3
4 - 6
7 - 10
11 - 20
21 - 30
31 - 50
No Data
Ceded Territory Boundary
0 25 50 100 Miles
Model reliability for this species is high. Importance values indicate relative abundance. Data represent the average of 3 climate models (GCMs). Data from the Climate Change Atlas: Landscape Change Research Group 2014 and Iverson et al. 2008. Map made by Hannah Panci, October 2015.


Aninaatigoog (Sugar Maple)
Current modeled distribution
Map 37
1854
Fond du Lac
Red Cliff
1842
Bad River
Keweenaw Bay
Mille Lacs
Lac Vieux Desert
1836
Bay Mills
St. Croix
Lac Courte Oreilles
Lac du Flambeau
1837
Sokaogon
Importance Value
0
1 - 3
4 - 6
7 - 10
11 - 20
21 - 30
31 - 50
No Data
Ceded Territory Boundary
0 25 50 100 Miles
Model reliability for this species is high.
Importance values indicate relative abundance.
Data from the Climate Change Atlas:
Landscape Change Research Group 2014
and Iverson et al. 2008. Map made by Hannah
Panci, October 2015.


Aninaatigoog (Sugar Maple)
Predicted Suitable Habitat in 2100
Low emissions scenario
Map 38
1854
Fond du Lac
Red Cliff
1842
Bad River
Keweenaw Bay
Mille Lacs
Lac Vieux Desert
1836
Bay Mills
St. Croix
Lac Courte Oreilles
Lac du Flambeau
1837
Sokaogon
Importance Value
0
1 - 3
4 - 6
7 - 10
11 - 20
21 - 30
31 - 50
No Data
Ceded Territory Boundary
0 25 50 100 Miles
Model reliability for this species is high. Importance values indicate relative abundance. Data represent the average of 3 climate models (GCMs). Data from the Climate Change Atlas: Landscape Change Research Group 2014 and Iverson et al. 2008. Map made by Hannah Panci, October 2015.


Aninaatigoog (Sugar Maple)
Current modeled distribution
Map 39
1854
Fond du Lac
Red Cliff
1842
Bad River
Keweenaw Bay
Mille Lacs
Lac Vieux Desert
1836
Bay Mills
St. Croix
Lac Courte Oreilles
Lac du Flambeau
1837
Sokaogon
Importance Value
0
1 - 3
4 - 6
7 - 10
11 - 20
21 - 30
31 - 50
No Data
Ceded Territory Boundary
0 25 50 100 Miles
Model reliability for this species is high. Importance values indicate relative abundance. Data from the Climate Change Atlas: Landscape Change Research Group 2014 and Iverson et al. 2008. Map made by Hannah Panci, October 2015.

Annotated Bibliography

Lake Superior Fish

Lake Whitefish: Adikameg

1. Bronte, C.R., Ebener M.P., Schreiner D.R., DeVault D.S., Petzold M.M., Jensen D.A., Richards C., and Lozano S.J. (2003). Fish Community Change in Lake Superior, 1970-2000. *Canadian Journal of Fisheries and Aquatic Sciences,* 60(12), 1552–1574. Available at http://www.fws.gov/midwest/fisheries/scientific-pubs/p-2003-2.pdf

Summary: The Fish Community Change in Lake Superior discusses the changes in Lake Superior's fish communities from 1970 – 2000. In specific it touches on habitat degradation, contaminants, effects of climate warming, phosphorus loading, intentional and unintentional species introductions, as well as other topics. Habitat protection and enhancement to prevent additional damaging effects is needed to further restoration.

Specific pages to note: Pg. 1554: Climate warming is projected to increase thermal habitat; would be for Lake Trout, Lake Whitefish, Northern Pike, where non-indigenous species would benefit. This article focuses on fish species recovery.

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- Bronte, C.R., and Hoff, M.H. 1996. Population status and trends for Lake Superior forage fishes, 1978–95. In Minutes of the 1996 Annual Meeting of the Lake Superior Committee, Great Lakes Fishery Commission. Great Lakes Fishery Commission, Ann Arbor, Mich.
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- *Magnuson, J.J., Meisner J.D., and Hill, D.K. 1990. Potential changes in thermal habitat of Great Lakes fishes due to global climate warming. Trans. Am. Fish. Soc. 119: 254–264.*
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- Sinokrot, B.A., Stefan, H.G., McCormick, J.H., and Eaton, J.G. 1995. Modeling of climate change effects on stream temperatures and fish habitats below barrier dams and near groundwater inputs. Clim. Change, 30: 181–200.

2. Great Lakes Area National Park Service U.S. Department of the Interior. 2007. Climate Change: Dying Birch trees, minimal snowpack, and ice-free lakes are just some Impacts of Midwest Warming. Available at http://www.nps.gov/apis/naturescience/upload/2007%20MWR%20Climate%20Change%20Site%20Bulletin%20-%20Great%20Lakes%20FINAL.pdf

Summary: This article, Dying Birch Trees, Minimal Snowpack, and Ice-Free Lakes Are Just Some Impacts of Midwest Warming discusses climate change effects in the Midwest Region. It touches on the science reports by the U.S. Global Change Research Program as well as others and how they show that this is due to greenhouse gases produced by human activities. In specific the article has sections on Temperature and Precipitation, The Ecological Effects, New Faces in New Places, and Recreation, Health and Safety.

Specific pages to note: * Cool tree species are projected to lose habitat in the U.S. Sugar Maple and Paper Birch are expected to shift towards Canada. For the Apostle Island Lakeshore and Michigan Upper peninsula Paper Birch may lose all habitats. *Coldwater fish such as Trout will decrease in abundance. Whitefish spawning areas will be disturbed and Native fish will be threatened.

3. Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J. Wuebbles, and D.R. Zak. 2003. Confronting Climate Change in the Great Lakes Region. A Report of the Union of Concerned Scientists and the Ecological Society of America. Available at

http://www.ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf

Summary: Confronting Climate Change in the Great Lakes Region is a report of The Union of Concerned Scientists and The Ecological Society of America. This report explains that growing evidence suggests that climate change is already affecting the Great Lakes Region: winters are shorter, average temperatures are warmer, lake ice cover is decreasing, and heavy rainstorms are more common. The potential consequences from climate change for the Great Lakes Region are confronted for the economic as well as the environmental impacts.

Specific pages to note: **Pg. 2:** Whitefish reproduction could be threatened with the loss of winter ice [Coldwater fish (Lake Trout, Whitefish, Herring) and Coolwater fish (Northern Pike, Walleye) are likely to decline in abundance]. **Pg. 54-55**: If warmwater fish species expand and increase in number in Lake Superior, this could lead to the extirpation (local extinction) of native minnows. This could have negative impacts on Lake Trout and other Native predators. "Climate warming will greatly reduce the amount of thermally suitable habitat for Lake Trout in many inland lakes." **Pg. 60:** Moose could be harmed by warming: increase in deer populations could carry disease that will stress the moose population.

References Cited to Consider:

- *Hill, D.K., and J.J. Magnuson (1990). Potential effects of global climate warming on the growth and prey consumption of Great Lakes fi sh. Transactions of the American Fisheries Society 119:265–275. American Fisheries Society 119:265–275.*
- Magnuson, J.J., et al. (1997). Potential effects of climate change on aquatic systems: Laurentian Great Lakes and Precambrian Shield Region. In Freshwater Ecosystems and Climate Change in North America: A Regional Assessment. C.E. Cushing, ed. New York: John Wiley & Sons, pp. 7–53.
- *Magnuson, J.J., J.D. Meisner, and D.K. Hill (1990). Potential changes in the thermal habitat of Great Lakes fish after global climate warming. Transactions of the American Fisheries Society 119:254–264. American Fisheries Society 119:254–264*
- Shuter, B.J., C.K. Minns, and N. Lester (2002). Climate change, freshwater fi sh and fi sheries: Case studies from Ontario and their use in assessing potential impacts. In Fisheries in a Changing Climate. N.A. McGinn, ed. Bethesda, Md.: American Fisheries Society, pp. 77–88.
- *Stefan, H.G., X. Fang, and J.G. Eaton (2001). Simulated fish habitat changes in North American lakes in response to projected climate warming. Transactions of the American Fisheries Society 130:459–477.*

4. National Wildlife Federation. 2010. Improving the Odds: Using Climate-Readiness Planning to Reduce the Impacts of Climate Change on the Great Lakes Ecosystem. Available at http://www.nwf.org/News-and-Magazines/Media-Center/News-by-Topic/Global-Warming/2010/10-29-10-Great-Lakes-Adaptation-Report.aspx.

Summary: Improving the Odds was created by the National Wildlife Federation to bring awareness to Climate Change and to reduce the impacts of Climate Change. The report describes and analyzes climate-readiness initiatives in the Great Lakes Region. There are specifically looking at restoration practices that reduce climate impacts, implementing climate ready strategies and others. This is crucial to protect our natural resources, infrastructures, public health, as well as fresh water.

Specific pages to note: **Pg. 31:** It is expected that the Pine Marten will find no suitable habitat in Wisconsin. **Pg. 40:** Increased temperature of Lake Superior would benefit Sea Lamprey. This in turn will negatively affect fish species. Sea Lamprey feed on fish and warmer waters would allow for bigger growing Sea Lamprey. This will negatively affect Lake Trout, Herring, Whitefish as well as other species.

References Cited to Consider:

- Wisconsin Initiative on Climate Change Impacts. 2010. Wildlife Working Group. http://wicci.wisc.edu/workinggroups/wildlife/index.htm
- US Environmental Protection Agency. Climate Change. http://www.epa.gov/climatechange/impacts-adaptation/
- U.S. Department of the Interior National Park Service. 2007. Climate Change and Impacts to Resources around the Great Lakes. August 2007

5. Sousounis, P.J. and J.M. Bisanz, eds. 2000. Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change. A Summary by the Great Lakes Regional
Assessment Group. U.S. Global Change Research Program. Available at http://www.geo.msu.edu/glra/PDF_files/GLRA_report.pdf.

Summary: Preparing for a Changing Climate was for the U.S. Global Change Research Program as an investment in science for the Nation's future. This report covers the potential consequences of climate variability and change. Climate change may bring negative affects to water resources, ecology, coastlines, human health, and others. They discuss the Great Lakes region and the impacts that are found in stream flow, aquatic and terrestrial ecosystems,

agriculture, and quality of life.

Specific pages to note: **Pg. 45**: Lake Trout would either potentially increase in size due to global warming (If their prey also increases in size) but would decrease in size if their prey simply stays the same size. **Pg. 92:** Less ice coverage may cause a fast decline of Whitefish; there would be a growing number of unprotected spawning areas.

References Cited to Consider:

- Chao, P.T.,1999: Great Lakes Water Resources-Climate Change Impact Analysis. Proceedings of the Speciality Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States. American Water Resources Association, Atlanta Georgia, May 10-12. pp. 307-310
- Davis, M.B., and C. Zabinski, 1992: Changes in geographical range resulting from greenhouse warming: effects on biodiversity in forests. P. 297-308 in Global Warming and Biological Diversity, R.L. Peters and T.E. Lovejoy, eds, Yale University Press, New Haven CT.
- Eaton, J.G. and R.M. Scheller, 1996: Effects of climate warming on fish thermal habitat in streams of the United States. Limnology and Oceanography 41:1109-1115
- He, H.A.S., D.J. Mladenoff, and T.R. Crow, 1999: Link- ing an ecosystem model and a landscape model to study for- est species response to climate warming. Ecological Modelling , 114, 213-233
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- *Magnuson, J.J., H.A. Regier, B.J. Shuter, D.K. Hill, J.A. Holmes, and J.D. Meisner, 1989: Potential responses of Great Lakes fishes and their habitat to global climate warming. University of Wisconsin and Toronto. U.S. Environmental Protection Agency, Washington, D. C. Report number EPA-230-05-89-055.*

Lake Trout: Namegos

1. Betz, C.R., Asplund T., and Hurley J. (2010). Water Resources Working Group Report. *Wisconsin Initiative on Climate Change Impacts.* Available at

http://www.wicci.wisc.edu/report/Water-Resources.pdf.

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- Bradley et al., 1999. Phonological Changes Reflect Climate Change in Wisconsin. Proc. Natl. Acad. Sci., 96: 9701-9704
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2. Bronte, C.R., Ebener M.P., Schreiner D.R., DeVault D.S., Petzold M.M., Jensen D.A., Richards C., and Lozano S.J. (2003). Fish Community Change in Lake Superior, 1970-2000. *Canadian Journal of Fisheries and Aquatic Sciences,* 60(12), 1552–1574. Available at http://www.fws.gov/midwest/fisheries/scientific-pubs/p-2003-2.pdf

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3. Casselman, J.M. 2002. Effects of temperature, global extremes, and climate change on year-class production of warmwater, coolwater, and coldwater fishes in the Great Lakes basin. Am. Fish. Soc. Symp. 31: 39–60. Available at ftp://142.36.245.139/.virtual/slk6ftp/pub/outgoing/requests/lage_analysis/CD1/Selected%20Age-Growth%20Publications/Climate%20and%20year-class%20production%20of%20fish,%20AFS%20Symposium,%20C.pdf

Summary: The Effects of Temperature, Global Extremes, and Climate Change on Year-Class Production of Warmwater, Coolwater, and Coldwater fishes in the Great Lakes Basin discuss the impacts of global warming on fisheries. For this they explain the effects of temperature change on fish. Global warming will substantially increase the year-class strength of warmwater species. It will also significantly impact the year-class strength and structure of fish communities in the Great Lakes Basin. Notably decreasing amounts of coldwater and coolwater fish species and increasing warrmwater fish species.

Specific pages to note: **Pg. 51:** Increased water temperature could have affected Northern Pike negatively; decreasing their year-class strength. **Pg. 52:** For Lake Trout, temperature increase would affect their spawning success. If the water temperature increases, their successful spawning survival would drastically decrease. *Water temperature increase would alter the food web and prey base. *Increase of water temperature would positively affect warmwater fish.

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- Christie, W. J., and H. A. Regier. 1973. Temperature as a major factor influencing reproductive success of fish—two examples. Rapports et Proces-Verbaux des Reunions Conseil International pour l'Exploration de la Mer 164:208–218
- *Hill, D. K., and J. J. Magnuson. 1990. Potential effects of global climate warming on the growth and prey consumption of Great Lakes fish. Transactions of the American Fisheries Society 119:265–275.*
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- King, J. R., B. J. Shuter, and A. P. Zimmerman. 1999b. Empirical links between thermal habitat, fish growth, and climate change. Transactions of the American Fishieries Society 128:656–665.
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- Meisner, J. D., J. L. Goodier, H. A. Regier, B. J. Shuter, and W. J. Christie. 1987. An assessment of the effects of climate warming on Great Lakes Basin fishes. Journal of Great Lakes Research 13:340–352.
- *Stefan, H. G., X. Fang, and J. G. Eaton. 2001. Simulated fish habitat changes in North American lakes in response to projected climate warming. Transactions of the American Fisheries Society 130:459–477.*

4. Great Lakes Area National Park Service U.S. Department of the Interior. 2007. Climate Change: Dying Birch trees, minimal snowpack, and ice-free lakes are just

some Impacts of Midwest Warming. Available at http://www.nps.gov/apis/naturescience/upload/2007%20MWR%20Climate%20Change%20Site%20Bulletin%20-%20Great%20Lakes%20FINAL.pdf

Summary: This article, Dying Birch Trees, Minimal Snowpack, and Ice-Free Lakes Are Just Some Impacts of Midwest Warming discusses climate change effects in the Midwest Region. It touches on the science reports by the U.S. Global Change Research Program as well as others and how they show that this is due to greenhouse gases produced by human activities. In specific the article has sections on Temperature and Precipitation, The Ecological Effects, New Faces in New Places, and Recreation, Health and Safety.

Specific pages to note: * Cool tree species are projected to lose habitat in the U.S. Sugar Maple and Paper Birch are expected to shift towards Canada. For the Apostle Island Lakeshore and Michigan Upper peninsula Paper Birch may lose all habitats. *Coldwater fish such as Trout will decrease in abundance. Whitefish spawning areas will be disturbed and Native fish will be threatened.

5. International Joint Commission (IJC). 2003. Climate Change and Water Quality in the Great Lakes Basin. Available at http://www.ijc.org/rel/pdf/climate_change_2003.pdf.

Summary: Climate Change and Water Quality in the Great Lakes Basin is a report of the Great Lakes Water Quality Board to the International Joint Commission. It discusses how our climate has been changing and will continue to change in the future. Investigations on climate change were undertaken. In the full report it is broken into the Water Quality Board's Advice to the International Joint Commission, Climate Change and Water Quality in the Great Lakes Region – Risks, Opportunities and Responses, Summary of the Climate Change Workshop, and Cross Boarder Tools and Strategies.

Specific pages to note: **Pg. 52:** Lake warming may shorten breeding windows for fish. This could affect both Lake Trout and Northern Pike. These fish species as well as coldwater fish species could potentially lose their habitat area.

References Cited to Consider:

- Brandt, S., D. Mason, M. McCormick, B. Lofgren, and T. Hunter. 2002. "Climate change: implications for fish growth performance in the Great Lakes." American Fisheries Society Symposium 32: 61-76.

- *Casselman, J.M., D.M. Brown, J.A. Hoyle, and T.H. Eckert. 2002. "Effects of climate change and global warming on year-class strength and relative abundance of smallmouth bass in eastern Lake Ontario." American Fisheries Society Symposium 31: 73-9.*
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6. Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J. Wuebbles, and D.R. Zak. 2003. Confronting Climate Change in the Great Lakes Region. A Report of the Union of Concerned Scientists and the Ecological Society of America. Available at http://www.ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf

Summary: Confronting Climate Change in the Great Lakes Region is a report of The Union of Concerned Scientists and The Ecological Society of America. This report explains that growing evidence suggests that climate change is already affecting the Great Lakes Region: winters are shorter, average temperatures are warmer, lake ice cover is decreasing, and heavy rainstorms are more common. The potential consequences from climate change for the Great Lakes Region are confronted for the economic as well as the environmental impacts.

Specific pages to note: **Pg. 2:** Whitefish reproduction could be threatened with the loss of winter ice [Coldwater fish (Lake Trout, Whitefish, Herring) and Coolwater fish (Northern Pike, Walleye) are likely to decline in abundance]. **Pg. 54-55**: If warmwater fish species expand and increase in number in Lake Superior, this could lead to the extirpation (local extinction) of native minnows. This could have negative impacts on Lake Trout and other Native predators.

"Climate warming will greatly reduce the amount of thermally suitable habitat for Lake Trout in many inland lakes." **Pg. 60:** Moose could be harmed by warming: increase in deer populations could carry disease that will stress the moose population.

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7. National Wildlife Federation. 2010. Improving the Odds: Using Climate-Readiness Planning to Reduce the Impacts of Climate Change on the Great Lakes Ecosystem. Available at http://www.nwf.org/News-and-Magazines/Media-Center/News-by-Topic/Global-Warming/2010/10-29-10-Great-Lakes-Adaptation-Report.aspx.

Summary: Improving the Odds was created by the National Wildlife Federation to bring awareness to Climate Change and to reduce the impacts of Climate Change. The report describes and analyzes climate-readiness initiatives in the Great Lakes Region. There are specifically looking at restoration practices that reduce climate impacts, implementing climate ready strategies and others. This is crucial to protect our natural resources, infrastructures, public health, as well as fresh water.

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allow for bigger growing Sea Lamprey. This will negatively affect Lake Trout, Herring, Whitefish as well as other species.

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- US Environmental Protection Agency. Climate Change. http://www.epa.gov/climatechange/impacts-adaptation/
- U.S. Department of the Interior National Park Service. 2007. Climate Change and Impacts to Resources around the Great Lakes. August 2007

8. Sousounis, P.J. and J.M. Bisanz, eds. 2000. Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change. A Summary by the Great Lakes Regional Assessment Group. U.S. Global Change Research Program. Available at http://www.geo.msu.edu/glra/PDF_files/GLRA_report.pdf.

Summary: Preparing for a Changing Climate was for the U.S. Global Change Research Program as an investment in science for the Nation's future. This report covers the potential consequences of climate variability and change. Climate change may bring negative affects to water resources, ecology, coastlines, human health, and others. They discuss the Great Lakes region and the impacts that are found in stream flow, aquatic and terrestrial ecosystems, agriculture, and quality of life.

Specific pages to note: **Pg. 45**: Lake Trout would either potentially increase in size due to global warming (If their prey also increases in size) but would decrease in size if their prey simply stays the same size. **Pg. 92:** Less ice coverage may cause a fast decline of Whitefish; there would be a growing number of unprotected spawning areas.

References Cited to Consider:

- Chao, P.T.,1999: Great Lakes Water Resources-Climate Change Impact Analysis. Proceedings of the Speciality Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States. American Water Resources Association, Atlanta Georgia, May 10-12. pp. 307-310
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Lake Sturgeon: Name

Lake Herring:

1. Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J. Wuebbles, and D.R. Zak. 2003. Confronting Climate Change in the Great Lakes Region. A Report of the Union of Concerned Scientists and the Ecological Society of America. Available at http://www.ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf

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In land Fish

Walleye: Ogaa

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Northern Pike: Ginoozhe

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- *Mandrak, N.E. 1989. Potential invasion of the Great Lakes by fish species associated with climate warming. J. Gt. Lakes Res. 15:306–316.*
- Selgeby, J.H. 1982. Decline of lake herring (Coregonus artedii)in Lake Superior: an analysis of the Wisconsin herring fishery. Can. J. Fish. Aquat. Sci. 39: 554–563.
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2. Casselman, J.M. 2002. Effects of temperature, global extremes, and climate change on year-class production of warmwater, coolwater, and coldwater fishes in the Great Lakes basin. Am. Fish. Soc. Symp. 31: 39–60. Available at ftp://142.36.245.139/.virtual/slk6ftp/pub/outgoing/requests/lage_analysis/CD1/Selected%20Age-Growth%20Publications/Climate%20and%20year-class%20production%20of%20fish,%20AFS%20Symposium,%20C.pdf

Summary: The Effects of Temperature, Global Extremes, and Climate Change on Year-Class Production of Warmwater, Coolwater, and Coldwater fishes in the Great Lakes Basin discuss the impacts of global warming on fisheries. For this they explain the effects of temperature change on fish. Global warming will substantially increase the year-class strength of warmwater species. It will also significantly impact the year-class strength and structure of fish communities in the Great Lakes Basin. Notably decreasing amounts of coldwater and coolwater fish species and increasing warrmwater fish species.

Specific pages to note: **Pg. 51:** Increased water temperature could have affected Northern Pike negatively; decreasing their year-class strength. **Pg. 52:** For Lake Trout, temperature increase would affect their spawning success. If the water temperature increases, their successful

spawning survival would drastically decrease. *Water temperature increase would alter the food web and prey base. *Increase of water temperature would positively affect warmwater fish.

References Cited to Consider:

- Christie, W. J., and H. A. Regier. 1973. Temperature as a major factor influencing reproductive success of fish—two examples. Rapports et Proces-Verbaux des Reunions Conseil International pour l'Exploration de la Mer 164:208–218
- *Hill, D. K., and J. J. Magnuson. 1990. Potential effects of global climate warming on the growth and prey consumption of Great Lakes fish. Transactions of the American Fisheries Society 119:265–275.*
- Kawasaki, T. 2001a. Global warming could have a tremendous effect on the world fisheries production. Journal of International Fisheries 4(1):17–21
- King, J. R., B. J. Shuter, and A. P. Zimmerman. 1999b. Empirical links between thermal habitat, fish growth, and climate change. Transactions of the American Fishieries Society 128:656–665.
- *Mandrak, N. E. 1989. Potential invasion of the Great Lakes by fish species associated with climatic warming. Journal of Great Lakes Research 15:306–316.*
- Meisner, J. D., J. L. Goodier, H. A. Regier, B. J. Shuter, and W. J. Christie. 1987. An assessment of the effects of climate warming on Great Lakes Basin fishes. Journal of Great Lakes Research 13:340–352.
- *Stefan, H. G., X. Fang, and J. G. Eaton. 2001. Simulated fish habitat changes in North American lakes in response to projected climate warming. Transactions of the American Fisheries Society 130:459–477.*

3. International Joint Commission (IJC). 2003. Climate Change and Water Quality in the Great Lakes Basin. Available at http://www.ijc.org/rel/pdf/climate_change_2003.pdf.

Summary: Climate Change and Water Quality in the Great Lakes Basin is a report of the Great Lakes Water Quality Board to the International Joint Commission. It discusses how our climate has been changing and will continue to change in the future. Investigations on climate change were undertaken. In the full report it is broken into the Water Quality Board's Advice to the International Joint Commission, Climate Change and Water Quality in the Great Lakes Region – Risks, Opportunities and Responses, Summary of the Climate Change Workshop, and Cross Boarder Tools and Strategies.

Specific pages to note: **Pg. 52:** Lake warming may shorten breeding windows for fish. This could affect both Lake Trout and Northern Pike. These fish species as well as coldwater fish species could potentially lose their habitat area.

References Cited to Consider:

- Brandt, S., D. Mason, M. McCormick, B. Lofgren, and T. Hunter. 2002. "Climate change: implications for fish growth performance in the Great Lakes." American Fisheries Society Symposium 32: 61-76.
- *Casselman, J.M., D.M. Brown, J.A. Hoyle, and T.H. Eckert. 2002. "Effects of climate change and global warming on year-class strength and relative abundance of smallmouth bass in eastern Lake Ontario." American Fisheries Society Symposium 31: 73-9.*
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- *Hill, D. and J. Magnuson. 1990. "Potential effects of global climate warming on the growth and prey consumption of Great Lakes fish." Transactions of the American Fisheries Society 119: 265-275.*
- Iverson, L. and A. Prasad. 2001. "Potential changes in tree species richness and forest community types following climate change." Ecosystems 4: 186-199.
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4. Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J. Wuebbles, and D.R. Zak. 2003. Confronting Climate Change in the Great Lakes Region. A Report of the Union of Concerned Scientists and the Ecological Society of America. Available at http://www.ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf

Summary: Confronting Climate Change in the Great Lakes Region is a report of The Union of Concerned Scientists and The Ecological Society of America. This report explains that growing evidence suggests that climate change is already affecting the Great Lakes Region: winters are shorter, average temperatures are warmer, lake ice cover is decreasing, and heavy rainstorms

are more common. The potential consequences from climate change for the Great Lakes Region are confronted for the economic as well as the environmental impacts.

Specific pages to note: **Pg. 2:** Whitefish reproduction could be threatened with the loss of winter ice [Coldwater fish (Lake Trout, Whitefish, Herring) and Coolwater fish (Northern Pike, Walleye) are likely to decline in abundance]. **Pg. 54-55**: If warmwater fish species expand and increase in number in Lake Superior, this could lead to the extirpation (local extinction) of native minnows. This could have negative impacts on Lake Trout and other Native predators. "Climate warming will greatly reduce the amount of thermally suitable habitat for Lake Trout in many inland lakes." **Pg. 60:** Moose could be harmed by warming: increase in deer populations could carry disease that will stress the moose population.

References Cited to Consider:

- *Hill, D.K., and J.J. Magnuson (1990). Potential effects of global climate warming on the growth and prey consumption of Great Lakes fi sh. Transactions of the American Fisheries Society 119:265–275. American Fisheries Society 119:265–275.*
- Magnuson, J.J., et al. (1997). Potential effects of climate change on aquatic systems: Laurentian Great Lakes and Precambrian Shield Region. In Freshwater Ecosystems and Climate Change in North America: A Regional Assessment. C.E. Cushing, ed. New York: John Wiley & Sons, pp. 7–53.
- *Magnuson, J.J., J.D. Meisner, and D.K. Hill (1990). Potential changes in the thermal habitat of Great Lakes fish after global climate warming. Transactions of the American Fisheries Society 119:254–264. American Fisheries Society 119:254–264*
- Shuter, B.J., C.K. Minns, and N. Lester (2002). Climate change, freshwater fi sh and fi sheries: Case studies from Ontario and their use in assessing potential impacts. In Fisheries in a Changing Climate. N.A. McGinn, ed. Bethesda, Md.: American Fisheries Society, pp. 77–88.
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Wildlife

Pine Marten (American Marten): Waabizheshi

1. National Wildlife Federation. 2010. Improving the Odds: Using Climate-Readiness Planning to Reduce the Impacts of Climate Change on the Great Lakes Ecosystem. Available at http://www.nwf.org/News-and-Magazines/Media-Center/News-by-

Topic/Global-Warming/2010/10-29-10-Great-Lakes-Adaptation-Report.aspx.

Summary: Improving the Odds was created by the National Wildlife Federation to bring awareness to Climate Change and to reduce the impacts of Climate Change. The report describes and analyzes climate-readiness initiatives in the Great Lakes Region. There are specifically looking at restoration practices that reduce climate impacts, implementing climate ready strategies and others. This is crucial to protect our natural resources, infrastructures, public health, as well as fresh water.

Specific pages to note: **Pg. 31:** It is expected that the Pine Marten will find no suitable habitat in Wisconsin. **Pg. 40:** Increased temperature of Lake Superior would benefit Sea Lamprey. This in turn will negatively affect fish species. Sea Lamprey feed on fish and warmer waters would allow for bigger growing Sea Lamprey. This will negatively affect Lake Trout, Herring, Whitefish as well as other species.

References Cited to Consider:

- Wisconsin Initiative on Climate Change Impacts. 2010. Wildlife Working Group. http://wicci.wisc.edu/workinggroups/wildlife/index.htm
- US Environmental Protection Agency. Climate Change. http://www.epa.gov/climatechange/impacts-adaptation/
- U.S. Department of the Interior National Park Service. 2007. Climate Change and Impacts to Resources around the Great Lakes. August 2007

2. Wisconsin Department of Natural Resources: Bureau of Endangered Resources. 2011. Management and Conservation Plan for American Martens in Wisconsin. Available at http://dnr.wi.gov/files/PDF/pubs/ER/ER0697.pdf

Summary: Management and Conservation Plan For American Martens In Wisconsin was created by the Wisconsin Department of Natural Resources as a plan to update the conservation status of the American Marten to ensure they remain a viable member in Wisconsin today and for generations to come. This plan provides background information on Martens including both the cultural significance and socio-economic importance of the Marten. It also provides past and current status of the Marten's life histories, habitats, and threats. It provides information on current research, management goals, and research needs.

Specific pages to note: **Pg. 20:** Climate change will decrease the amount of snowfall or snow pack. Martens need this snow to help them escape from predators. They will also lose their advantage over fishers and other competitors resulting from climate change or climate

warming.

References Cited to Consider:

- Dumyahn, J.B., P.A. Zollner, and J.H. Gilbert. 2007. Winter home-range characteristics of American marten (Martes americana) in Northern Wisconsin. American Midland Naturalist 158:382-394.
- Proulx, G., K. Aubry, J. Birks, S. Buskirk, C. Fortin, H. Frost, W. Krohn, L. Mayo, V. Monakhov, D. Payer, M. Saeki, M. Santos-Reis, R. Weir, and W. Zielinski. 2004. World distribution and status of the genus Martes in 2000. Pp. 21-76 in in D.J. Harrison, A.K. Fuller, and G. Proulx, eds. Martens and fishers (Martes) in human-altered environments: An international perspective. Springer, New York, NY.
- Woodford, J., C. Eloranta, T. Rinaldi, and B. Kohn. 2005. Inventory, status, and management needs of American Marten in northeast Wisconsin. Wisconsin Department of Natural Resources, Madison, WI. 10pp.
- Wydeven, A.P., J.E. Wiedenhoeft, and J.E. Woodford. 2007. Status of the American marten in Wisconsin. Wisconsin Endangered Resources Report No. 135. Wisconsin Department of Natural Resources, Madison, WI. 9pp.

3. Wisconsin Initiative on Climate Change Impacts. 2011. Wisconsin's Changing Climate: Impacts and Adaptation. Nelson Institute for Environmental Studies, University of Wisconsin- Madison and the Wisconsin Department of Natural Resources. Available at http://www.wicci.wisc.edu/publications.php

Summary: This report was created by the Wisconsin Initiative on Climate Change Impacts. It discusses Wisconsin's changing climate in which we now have a warmer, wetter Wisconsin climate. This change has affected precipitation, air temperatures, the quantity and quality of Wisconsin's water resources, natural habitats, agriculture, as well as others. This report is to provide information so that Wisconsin can adapt to the impacts of climate change and create strategies to adapt successfully to current and future climate change.

Specific pages to note: **Chapter 4:** The marten needs areas underneath the snow. Climate warming will lead to increasing in snow density. This will decrease the amount of thermal insulation which the Marten needs for survival. Climate warming will expose the Marten to the cold weather. Also Climate change will threaten the Marten's food source. Martens will also be threatened by more preditation; there will be fewer areas for the Marten to hide.

Fisher: Ojiig Martes pennanti

1. Olson, L. E., Sauder, J. D., Albrecht, N. M., Vinkey, R. S., Cushman, S. A., & Schwartz, M. K. (2014). Modeling the effects of dispersal and patch size on predicted fisher (Pekania [Martes] pennanti) distribution in the US Rocky Mountains. *Biological Conservation, 169*, 89-98.

Summary: Modeling the effects of dispersal and patch size on predicted fisher distribution in the US Rocky Mountains is an article discussing the impacts climate change will have on habitats. This article specifically looks at the fisher, an already threatened species. They specifically look at fishers located across western Montana and Northern Idaho.

Specific pages to note: **Pg. 93:**The variables that contribute the most to fisher habitat suitability are 25-20 m canopy height, montane riparian vegetation, topographic positions index and mean annual precipitation. 3.2: Fisher habitat is predicted to increase. Fisher habitat is also predicted to shift north. **Pg. 95:** Fishers were more likely to occur in areas with higher mean annual precipitation, mid-range minimum winter temperatures... across both models. **Pg. 97:** Fishers are predicted to expand under climate warming but if they cannot find suitable habitat to disperse in distance greater than 4km then they will likely decline over time.

References Cited to Consider:

- Chen, I.C., Hill, J.K., Ohlemuller, R., Roy D.B., Thomas C.D., 2011. Rapid range shifts of species associated with high levels of climate warming. Science 333, 1024–1026.
- Early, R., Sax, D.F., 2011. Analysis of climate paths reveals potential limitations on species range shifts. Ecology Letters 14, 1125–1133
- Jones, J.L., Garton, E.O., 1994. Selection of successional stages by fishers in north central Idaho. In: Buskirk, S.W., Harestad, A.S., Raphael, M.G., Powell, R.A. (Eds.), Marten, Sables and Fisher: Biology and Conservation. Cornell University Press, Ithaca, NY.
- *Krohn, W.B., Elowe, K.D., Boone, R.B., 1995. Relations among fishers, snow, and martens: development and evaluation of two hypotheses. The Forestry Chronicle 71, 97–105.*
- Wasserman, T.N., Cushman, S.A., Shirk, A.S., Landguth, E.L., Littell, J.S., 2012. Simulating the effects of climate change on population connectivity of American marten (Martes americana) in the northern Rocky Mountains, USA. Landscape Ecology 27, 211–225.

2. McCamman J. (2010). Report to the California Fish and Game Commission: A Status Review of the Fisher (Martes pennanti) in California. State of California Natural Resources Agency Department of Fish and Game. Available at, https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=27900

Summary: A status Review of the Fisher in California was created to report to the California Fish and Game Commission about the current status of the fisher. This report was designed to give background history on the Fisher and their habits, what is needed for their survival, their distribution and abundance, and potential threats to the Fisher. One threat indicated for the Fisher is the current and projected future climate change.

Specific pages to note: **Pg. 57-60:** Prey and den availability for the Fisher may change. Climate Change may exacerbate wildfires which would have negative impacts on Fishers. Stress caused by unideal temperature conditions may lead Fishers to become more susceptible to disease. Lack of deep snow may allow w the Fisher to inhabit areas otherwise not available (as long as wildfires do not destroy the areas making them unsuitable first).

References Cited to Consider:

- Green, G.A., L.A. Campbell, and D.C. MacFarlane. 2008. Submitted. A conservation assessment for fishers (*Martes pennanti*) in the Sierra Nevada of California. USDA Forest Service, Pacific Southwest Region, Vallejo, California, 72pages.
- Harvell, C. D., C. E. Mitchell, J. R. Ward, S. Altizer, A. P. Dobson, R. S. Ostfeld, and M.D. Samuel. 2002. Climate warming and disease risks for terrestrial and marine biota. Science 296 No. 5576: 2158-2162.
- Heinemeyer, K. S. and J. L. Jones. 1994. Fisher biology and management in the western United States: a literature review and adaptive management strategy. Version 1.1. USDA Forest Service Northern Region and Interagency Forest Carnivore Working Group. 120 pp.
- Moritz, C, J. L. Patton, C. J. Conroy, J. L. Parra, G. C. White, S. R. Beissinger. 2008. Impact of a century of climate change on small mammal communities in Yosemite National Park, USA. Science 322:261-264.
- *Safford, H.D. 2006. Potential impacts of climate change to fisher habitat in California: a preliminary assessment. Unpublished report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA.*

3. Safford, H.D. 2006. Potential impacts of climate change to fisher habitat in California: a preliminary assessment. Unpublished report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. Available at http://www.sierraforestlegacy.org/Resources/Conservation/SierraNevadaWildlife/PacificFisher/PF-Safford06.pdf

Summary: This unpublished article addresses the potential impacts that Climate Change could have on the Fisher. Findings indicate that fire is likely to become much more frequent which

would have negative impacts on the Fisher. Fires are likely to destroy many habitats needed by the Fisher for denning.

Specific pages to note: **Pg. 9:** Fishers will more than likely lose crucial denning habitat due to fire increases. However, Fishers may be enhanced by climate warming as long as precipitation levels stay about what they are currently.

References Cited to Consider:

- Harrison, D. J., A. K. Fuller, and G. Proulx. 2004. Martens and fishers (Martes) in human-altered environments: an international perspective. Springer, New York, New York, USA.
- *Krohn, W. B, W. J. Zielinski, and R. B. Boone. 1997. Relations among fishers, snow, and martens in California: results from small-scale spatial comparisons. Pp. 211-232, in: G. Proulx, H. N. Bryant, and P. M. Woodard (eds). Martes: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Canada.*

Bobcat: Gidaagaa – Bizhiw

Moose: Mooz

1. Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J. Wuebbles, and D.R. Zak. 2003. Confronting Climate Change in the Great Lakes Region. A Report of the Union of Concerned Scientists and the Ecological Society of America. Available at http://www.ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf

Summary: Confronting Climate Change in the Great Lakes Region is a report of The Union of Concerned Scientists and The Ecological Society of America. This report explains that growing evidence suggests that climate change is already affecting the Great Lakes Region: winters are shorter, average temperatures are warmer, lake ice cover is decreasing, and heavy rainstorms are more common. The potential consequences from climate change for the Great Lakes Region are confronted for the economic as well as the environmental impacts.

Specific pages to note: **Pg. 2:** Whitefish reproduction could be threatened with the loss of winter ice [Coldwater fish (Lake Trout, Whitefish, Herring) and Coolwater fish (Northern Pike, Walleye) are likely to decline in abundance]. **Pg. 54-55**: If warmwater fish species expand and increase in number in Lake Superior, this could lead to the extirpation (local extinction) of

native minnows. This could have negative impacts on Lake Trout and other Native predators. "Climate warming will greatly reduce the amount of thermally suitable habitat for Lake Trout in many inland lakes." **Pg. 60:** Moose could be harmed by warming: increase in deer populations could carry disease that will stress the moose population.

References Cited to Consider:

- *Hill, D.K., and J.J. Magnuson (1990). Potential effects of global climate warming on the growth and prey consumption of Great Lakes fi sh. Transactions of the American Fisheries Society 119:265–275. American Fisheries Society 119:265–275.*
- Magnuson, J.J., et al. (1997). Potential effects of climate change on aquatic systems: Laurentian Great Lakes and Precambrian Shield Region. In Freshwater Ecosystems and Climate Change in North America: A Regional Assessment. C.E. Cushing, ed. New York: John Wiley & Sons, pp. 7–53.
- *Magnuson, J.J., J.D. Meisner, and D.K. Hill (1990). Potential changes in the thermal habitat of Great Lakes fish after global climate warming. Transactions of the American Fisheries Society 119:254–264. American Fisheries Society 119:254–264*
- Shuter, B.J., C.K. Minns, and N. Lester (2002). Climate change, freshwater fi sh and fi sheries: Case studies from Ontario and their use in assessing potential impacts. In Fisheries in a Changing Climate. N.A. McGinn, ed. Bethesda, Md.: American Fisheries Society, pp. 77–88.
- *Stefan, H.G., X. Fang, and J.G. Eaton (2001). Simulated fish habitat changes in North American lakes in response to projected climate warming. Transactions of the American Fisheries Society 130:459–477.*

2. Lankester, M.W. 2010. Understanding the Impact of Meningeal Worm, Parelaphostrongylus tenuis, on Moose Populations. Alces Vol. 46: 53-70.

Summary: Understanding the Impacts of Meningeal Worm on Moose Populations is an article that explores the declines in moose populations that have occurred during the past century. In general these decreases in moose population are associated with higher deer populations. This inverse relationship is caused by the Meningeal worm, a parasite that white-tailed deer carry and have shown deadly to moose population when stressed. Climate change causing warmer winters is a factor that has caused an increase in deer population in moose habitat.

Specific pages to note: **Pg. 54:** There is a seen inverse relationship between moose and deer density. Less severe winters allow for an increase of deer density that then transmits diseases to the moose populations. *With Climate warming the frequency of less-severe winters would increase. This would allow for an increase in deer density which would negatively affect moose

populations.

References Cited to Consider:

- *Lenarz, M. S., Nelson, M. E., Schrage, M. W., & Edwards, A. J. (2009). Temperature mediated moose survival in northeastern Minnesota. The Journal of Wildlife Management, 73(4), 503-510.*
- *Murray, D. L., Cox, E. W., Ballard, W. B., Whitlaw, H. A., Lenarz, M. S., Custer, T. W., ... & Fuller, T. K. (2006). Pathogens, nutritional deficiency, and climate influences on a declining moose population. Wildlife Monographs, 166(1), 1-30.*

3. Michigan Technical University. 2007. Global Warming Threatens Moose, Wolves. Michigan Tech News/Media, August 15, 2007. Available at http://www.admin.mtu.edu/urel/news/media_relations/592.

Summary: The article Global Warming Threatens Moose, Wolves discusses the fact that if moose and wolves go extinct it will because of humans that make climate change increase at a faster rate. Hot summers exacerbate moose ticks which combined with the heat are detrimental to moose populations. The hot summers and ticks make moose easy prey for wolves to kill. If moose continue to drop in population it will not only affect the moose themselves but wolf population as well.

Specific pages to note: *The heat threatens the Moose. Hot weather causes moose to forage less and rest more. If they forages less it will be less likely that they survive in the winter.

4. Minnesota Department of Natural Resources. 2011. Minnesota Moose Research and Management Plan. Available at http://www.dnr.state.mn.us/moose/index.html.

Summary: The Minnesota Moose Research and Management Plan which was created by the Minnesota Department of Natural Resources because the moose population in Minnesota is currently in decline. Their findings show that moose population decline is associated with increasing summer temperature. This report is recommendations to DNR to better understand what the moose populations need to reverse this decline.

Specific pages to note: **Pg. 30:** Research implies that climate warming is contributing to the high mortality rates of moose. Higher temperatures are contributing to stress on moose, which leave them vulnerable to disease, predators, parasites, etc. There is a link between moose populations and climate warming.

References Cited to Consider:

- *Lenarz, M. S., Nelson, M. E., Schrage, M. W., & Edwards, A. J. (2009). Temperature mediated moose survival in northeastern Minnesota. The Journal of Wildlife Management, 73(4), 503-510.*
- *Murray, D. L., Cox, E. W., Ballard, W. B., Whitlaw, H. A., Lenarz, M. S., Custer, T. W., ... & Fuller, T. K. (2006). Pathogens, nutritional deficiency, and climate influences on a declining moose population. Wildlife Monographs, 166(1), 1-30.*
- Post, E. and N. C. Stenseth. 1998. Large-Scale Climatic Fluctuation and Population Dynamics of Moose and White-Tailed Deer. Journal of Animal Ecology. 67: 537-543.

Plants

Wild Rice: Manoomin

1. Cuffe, S. 2014. Wild Rice and High Water: A Northern Harvest Under Threat. Briarpatch Magazine. Available at: http://briarpatchmagazine.com/articles/view/wild-rice-and-high-water

Summary: An article written to discuss Wild Rice and harvesters in Saskatchewan and Minnesota. Methods to try and control the wild rice while facing the effects of climate change. This article touches on the sensitivity wild rice has to environment change and that climate change can cause stress on the rice. Wild Rice is a traditionally important crop to the Anishinaabe and now there are domesticated hybrids of it, which also bring risks to the natural wild rice.

Specific Pages to Note: Wild rice is very susceptible to water change. If it gets too high at certain times of the year it will drown out the wild rice which, climate change could have an effect on. Strong winds, heavy rains, and hail can cause damage to wild rice crops. This plant also depends on a certain amount of natural water circulation, and is very particular of when, where, and how it grows.

2. Ojibwe Lifeway: Wild Rice Harvesting ("Dagwaagin" – Fall). Gikinoo'wizhiwe Onji Waaban (Guiding For Tomorrow) "G-WOW" Changing Climate, Changing Culture. Available at: http://www.g-wow.org/en-us/wildrice/default.aspx

Summary: Gikinoo'wizhiwe Onji Waaban is a website designed to look at Ojibwe lifeways and how they are affected by climate change. This specific one looks to understand wild rice, the importance of the crop to the Ojibwe people and climate related stressors that have been and

will affect these wild rice crops.

Specific Pages to Note: Climate Related issues: water level has dire consequences to wild rice; it can kill the plants with either too little or too much water. Intense rainfall can also drown wild rice plants or uproot them. Certain invasive species are out competing wild rice crops. Disease and insects that damage wild rice have been increasing noticeable with the warming climate.

3. Hoene, N. 2010. Climate Change, an Ojibwe Perspective. The Seiche. Minnesota Sea Grant, March 2010. Available at http://www.seagrant.umn.edu/newsletter/2010_03.html.

Summary: Climate Change, an Ojibwe Perspective is an article discussing different Tribal members and their observation on the effects of climate change. Wild Rice, Maple Sugar, Birch, Pine, and other elements used in the Ojibwe culture are discussed on how climate change will impact them.

Specific pages to note: **Maple Sugar:** Sap has been running sooner; with a warmer climate it could start to run, and then stop. **Wild Rice:** It cannot stand extreme water level changes. **Coldwater Fish:** They will not stay if the streams warm by even a few degrees. **Tree:** A warmer climate means the loss of Birch, and potentially Sugar Maple if there is an increase in forest fires.

4. Myers, J. 2014. Wild Rice Under the Microscope: Scientists Work Fast to Learn What Sulfate Does to Minnesota's Iconic Natural Food. Minnesota Department of Natural Resources. Available at: http://www.dnr.state.mn.us/volunteer/mayjun13/wild_rice.html

Summary: This is a study conducted by the University of Minnesota on wild rice, specifically on the impact sulfate has on wild rice. It is specifically meant to understand the relationship between sulfate and wild rice. It discusses what wild rice needs for growth and factors could affect its growth. One factor briefly mentioned is climate change.

Specific Pages to Note: If sulfate is placed in the lakes, wild rice will not immediately die; there is a whole ecosystem that has to react which happens over years. Climate warming, floods and droughts also cause problems for wild rice crops. There are seen decreases in the amount of wild rice crops that have been having rice in them.

5. Pember, Mary A. 2012. Climate Change Threatens the Ojibwe's Wild Rice Harvest. Indian Country Today Media Network. Available at: http://indiancountrytodaymedianetwork.com/2012/11/02/climate-change-threatens-ojibwes-wild-rice-harvest-143579

Summary: An article written for Indian Country Today Media Network first discussing the importance of Wild Rice to the Ojibwe stories, mentioning their migration story. It mentions how wild rice crops have seen a total loss in 2012. Finally it goes through how climate change is a factor relating to the decreased amounts of wild rice in the sloughs.

Specific Pages to Note: Wild rice, manoomin favor colder temperatures, climate warming could cause manoomin to shift farther north. It could also have caused higher rates of disease within the crops of manoomin.

6. Yeager, C. Where Food Grows on Water: Environmental and Human Threats to Wisconsin's Wild Rice. 2011. Circle of Blue. Available at: http://www.circleofblue.org/waternews/2011/world/where-food-grows-on-water-environmental-and-human-made-threats-to-wisconsins-wild-rice/

Summary: This article is written on Wisconsin's rice beds and the threats that they face from both humans and the environment. It discusses the various growing stages wild rice goes through. Examples of climate change harming wild rice being water levels in the Great Lakes, storms, and heavy rains. Lastly, the article touches on the importance of Wild Rice to the Anishinaabe with an interview from Joe Rose, Bad River Tribal Elder.

Specific Pages to Note: A warming climate could lead to lower water levels in the Great Lakes; this would have dire impacts on wild rice crops. Increased flooding or heavy rains caused from climate change could drown or uproot wild rice crops especially when it is in its floating leaf stage (a critical and fragile time in the growth cycle). There have been seen changes in wild rice beds caused by climate change in Wisconsin.

Trees

Sugar Maple: Ziinzibaakwadaatig

1. *Frumhoff, P.C.; McCarthy, J.J.; Melillo, J.M.; Moser, S.C.; Wuebbles, D.J. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment (NECIA). Cambridge,*

MA: Union of Concerned Scientists. Available at: http://www.northeastclimateimpacts.org/pdf/confronting-climate-change-in-the-u-s-northeast.pdf

Summary: This report discusses the Northeast and how they experience huge climate diversity within a small area. This area has also experienced drastic climate change since 1970, with a warming rate of almost 0.5 degrees Fahrenheit per decade. With the experienced climate warming there have been seen changes in the environment. This report was created to understand past and future climate change, to understand the potential effects that climate change could bring about.

Specific pages to note: **Pg. 49 & 55:** Projections indicate that male habitat will shift northward under either climate change scenario. Southern species of trees eventually become their replacements in the Northeast. Climate change will also leave the maple tree more susceptible to disease, pests, drought, wildfire, and storm damage. **Pg. 55 & 58:** Sugar maple is expected to lose drastic amounts of suitable habitat. It could have the chance of surviving under climate warming but a warmer winter is expected disrupt the winter pattern sugar maples need for optimal syrup production. **Pg. 59:** With a projected decrease in Maples and the loss of their colorful changing leaves in the fall, tourism could suffer in the Northeast. **Pg. 74:** Maple Syrup has seen a shift in the time it usual is produced, which has caused a decline in the syrup industry. Global warming is one possibility as to why this shift has occurred, and is likely to keep occurring.

References Cited to Consider:

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- *Clean Air-Cool Planet. 2007. Climate Change and the Northern Forest. Available at:* http://www.cleanair-coolplanet.org/information/factsheets.php.
- *Hayhoe, K., C.P. Wake, B. Anderson, X.-Z. Liang, E. Maurer, J. Zhu, J. Bradbury, A. DeGaetano, A. Hertel, and D. Wuebbles. 2008. Regional Climate Change Projections for the Northeast U.S. Mitigation and Adaptation Strategies for Global Change. In press.*

- *Iverson, L., A. Prasad, and S. Matthews. 2008. Potential Changes in Suitable Habitat for 134 Tree Species in the Northeastern United States. Mitigation and Adaptation Strategies for Global Change. In press.*
- *Mohan, J.E., J.M. Melillo, K. Lenoir, R. Hanifin, J.H. Blanchard, T. Sipe, S. Sistla, P.A. Steudler, F. Bowles, and F.A. Bazzaz. 2007. Shifting Temperate Forest Composition with Soil Warming. Nature. In review.*
- *Ollinger, S.V., C.L. Goodale, K. Hayhoe, and J.P. Jenkins. 2008. Potential Effects of Climate Change and Rising CO_2 on Ecosystem Processes in Northeastern U.S. Forests. Mitigation and Adaptation Strategies for Global Change. In press.*
- Sheehan, J.F., and The Adirondack Council. 1998. Acid rain: A Continuing National Tragedy. Elizabethtown, NY. Available at: http://www.adirondackcouncil.org/acrapub.pdg.

2. Great Lakes Area National Park Service U.S. Department of the Interior. 2007. Climate Change: Dying Birch trees, minimal snowpack, and ice-free lakes are just some Impacts of Midwest Warming. Available at http://www.nps.gov/apis/naturescience/upload/2007%20MWR%20Climate%20Change%20Site%20Bulletin%20-%20Great%20Lakes%20FINAL.pdf

Summary: This article, Dying Birch Trees, Minimal Snowpack, and Ice-Free Lakes Are Just Some Impacts of Midwest Warming discusses climate change effects in the Midwest Region. It touches on the science reports by the U.S. Global Change Research Program as well as others and how they show that this is due to greenhouse gases produced by human activities. In specific the article has sections on Temperature and Precipitation, The Ecological Effects, New Faces in New Places, and Recreation, Health and Safety.

Specific pages to note: * Cool tree species are projected to lose habitat in the U.S. Sugar Maple and Paper Birch are expected to shift towards Canada. For the Apostle Island Lakeshore and Michigan Upper peninsula Paper Birch may lose all habitats. *Coldwater fish such as Trout will decrease in abundance. Whitefish spawning areas will be disturbed and Native fish will be threatened.

3. Hoene, N. 2010. Climate Change, an Ojibwe Perspective. The Seiche. Minnesota Sea Grant, March 2010. Available at http://www.seagrant.umn.edu/newsletter/2010_03.html.

Summary: Climate Change, an Ojibwe Perspective is an article discussing different Tribal members and their observation on the effects of climate change. Wild Rice, Maple Sugar, Birch,

Pine, and other elements used in the Ojibwe culture are discussed on how climate change will impact them.

Specific pages to note: **Maple Sugar:** Sap has been running sooner; with a warmer climate it could start to run, and then stop. **Wild Rice:** It cannot stand extreme water level changes. **Coldwater Fish:** They will not stay if the streams warm by even a few degrees. **Tree:** A warmer climate means the loss of Birch, and potentially Sugar Maple if there is an increase in forest fires.

4. Ojibwe Lifeway: Maple Sugaring and Birch Bark Harvesting ("Ziigwan" – Spring). Gikinoo'wizhiwe Onji Waaban (Guiding for Tomorrow) "G-Wow" Changing Climate, Changing Culture. Available at: http://www.g-wow.org/en-us/maple_birch/default.aspx

Summary: Gikinoo'wizhiwe Onji Waaban is a website designed to look at Ojibwe lifeways and how they are affected by climate change. This specific one looks to understand both sugar maples and birch bark trees. It covers the specific cultural importance of these trees. As well as, includes impacts they face resulting from climate change and possible climate change stressors.

Specific Pages to Note: Climate warming will cause a decrease in suitable habitat for Sugar Maple. Climate warming could also have an impact on soil moisture which will inhibit Sugar Maple's effectiveness to receive water and nutrients. Climate change may also allow for an increase in disease and pests. Lastly, shorter winters may cause stress on the Sugar Maple and allow for greater vulnerability to pests. This in turn will cause a decrease in the Maple Sap production.

5. *Rustad, L., Campbell, J., Dukes, J.S., Huntington, T., Lambert, K.F., Mohan, J., Rodenhouse, N. Changing Climate, Changing Forests: The Impacts of Climate Change on Forests of the Northeastern United States and Eastern Canada. United States Department of Agriculture. 2012. Available at*: http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs99.pdf

Summary: This was created to study climate change and the effects it poses on forest ecosystems with the goal to provide important insights for forest science, management, and policy. Climate change is predicted to have dire effects on habitat locations of tree species. A decline in suitable habitats is expected with a change in abundance and distribution of wildlife.

Specific pages to note: **Pg. 13**: Tourism would be affected with a shift from Sugar maples to Oaks. **Pg. 17 & 18:** Table 2. Shows that Sugar maple is expected to lose suitable habitat. Maple will lose habitat in either climate change scenario. **Pg. 20:** Sugar maple could decline based on prolonged thaw-freeze events.

References Cited to Consider:

- Bertrand, A.; Robitaille, G.; Nadeau, P.; Boutin, R. 1994. Effects of Soil Freezing and Drought Stress on Abscisic Acid Content of Sugar Maple Sap and Leaves. Tree Physiology. 14(4): 413-425.
- Burton, A.J.; Pregitzer, K.S; Zogg, G.P.; Zak, D.R. 1998. Drought Reduces Rot Respiration in Sugar Maple Forests. Ecological Applications. 8: 771-778.
- *Frumhoff, P.C.; McCarthy, J.J.; Melillo, J.M.; Moser, S.C.; Wuebbles, D.J. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists. 146 p.*
- *Iverson, L.R.; Prasad, A.; Matthews, S. 2008. Modeling Potential Climate Change Impacts on the Trees of the Northeastern United States. Mitigation and Adaptation Strategies for Global Change. 13: 517-540.*
- *Ollinger, S.V.; Goodale, C.L.; Hayhoe, K.; Jenkins, J.P. 2008. Potential Effects of Climate Change and Rising CO_2 on Ecosystem Processes in Northeastern U.S. Forests. Mitigation and Adaptation Strategies for Global Change. 13: 467-485.*
- *Woodall, C.W.; Oswalt, C.M.; Westfall, J.A.; Perry, C.H.; Nelson, M.D.; Finley, A.O. 2009. An Indicator of Tree Migration in Forests of the Eastern United States. Forest Ecology and Management. 257: 1434-1444.*

6. http://www.fs.fed.us/nrs/atlas/tree/241
   http://www.fs.fed.us/nrs/atlas/tree/318
   http://www.fs.fed.us/nrs/atlas/tree/375
   http://www.fs.fed.us/nrs/atlas/tree/543

Summary: These websites show the current distribution of the Northern White Cedar, Sugar Maple, Paper Birch, and Black Ash respectively. They are maps created by the United States Department of Agriculture Forest Service to show the current distribution, projected future habitat, and predictor maps of these tree species. They are interactive maps where you can see climate change affecting the tree species with consideration of specific factors.

Paper Birch: Wiigwaasaatig

1. *Frumhoff, P.C.; McCarthy, J.J.; Melillo, J.M.; Moser, S.C.; Wuebbles, D.J. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists.* Available at: http://www.northeastclimateimpacts.org/pdf/confronting-climate-change-in-the-u-s-northeast.pdf

Summary: This report discusses the Northeast and how they experience huge climate diversity within a small area. This area has also experienced drastic climate change since 1970, with a warming rate of almost 0.5 degrees Fahrenheit per decade. With the experienced climate warming there have been seen changes in the environment. This report was created to understand past and future climate change, to understand the potential effects that climate change could bring about.

Specific pages to note: **Pg. x:** Birch forests are predicted t shift dramatically northward in predicted climate change scenarios. **Pg. 49:** Figure 6. Shows the predicted shift birch is expected to take under two climate change scenarios. **Pg. 55:** Birch is projected to shift northward in either climate change scenario, with oak trees taking over to replace them. Climate change may leave birch more vulnerable to disease, pests, drought, wildfire, and storm damage. **Pg. 59:** The loss of birch with their colorful leaves in the fall could cause a decrease in tourism.

References Cited to Consider:

- *Clean Air-Cool Planet. 2007. Climate Change and the Northern Forest. Available at:* http://www.cleanair-coolplanet.org/information/factsheets.php.
- *Hayhoe, K., C.P. Wake, B. Anderson, X.-Z. Liang, E. Maurer, J. Zhu, J. Bradbury, A. DeGaetano, A. Hertel, and D. Wuebbles. 2008. Regional Climate Change Projections for the Northeast U.S. Mitigation and Adaptation Strategies for Global Change. In press.*
- *Iverson, L., Prasad, and S. Matthews. 2008. Potential Changes in Suitable Habitat for 134 Tree Species in the Northeastern United States. Mitigation and Adaptation Strategies for Global Change. In press.*
- *Mohan, J.E., J.M. Melillo, K. Lenoir, R. Hanifin, J.H. Blanchard, T. Sipe, S. Sistla, P.A. Steudler, F. Bowles, and F.A. Bazzaz. 2007. Shifting Temperate Forest Composition with Soil Warming. Nature. In review.*
- *Ollinger, S.V., C.L. Goodale, K. Hayhoe, and J.P. Jenkins. 2008. Potential Effects of Climate Change and Rising CO_2 on Ecosystem Processes in Northeastern U.S. Forests. Mitigation and Adaptation Strategies for Global Change. In press.*

2. Great Lakes Area National Park Service U.S. Department of the Interior. 2007. Climate Change: Dying Birch trees, minimal snowpack, and ice-free lakes are just some Impacts of Midwest Warming. Available at http://www.nps.gov/apis/naturescience/upload/2007%20MWR%20Climate%20Change%20Site%20Bulletin%20-%20Great%20Lakes%20FINAL.pdf

Summary: This article, Dying Birch Trees, Minimal Snowpack, and Ice-Free Lakes Are Just Some Impacts of Midwest Warming discusses climate change effects in the Midwest Region. It touches on the science reports by the U.S. Global Change Research Program as well as others and how they show that this is due to greenhouse gases produced by human activities. In specific the article has sections on Temperature and Precipitation, The Ecological Effects, New Faces in New Places, and Recreation, Health and Safety.

Specific pages to note: * Cool tree species are projected to lose habitat in the U.S. Sugar Maple and Paper Birch are expected to shift towards Canada. For the Apostle Island Lakeshore and Michigan Upper peninsula Paper Birch may lose all habitats. *Coldwater fish such as Trout will decrease in abundance. Whitefish spawning areas will be disturbed and Native fish will be threatened.

3. Hoene, N. 2010. Climate Change, an Ojibwe Perspective. The Seiche. Minnesota Sea Grant, March 2010. Available at http://www.seagrant.umn.edu/newsletter/2010_03.html.

Summary: Climate Change, an Ojibwe Perspective is an article discussing different Tribal members and their observation on the effects of climate change. Wild Rice, Maple Sugar, Birch, Pine, and other elements used in the Ojibwe culture are discussed on how climate change will impact them.

Specific pages to note: **Maple Sugar:** Sap has been running sooner; with a warmer climate it could start to run, and then stop. **Wild Rice:** It cannot stand extreme water level changes. **Coldwater Fish:** They will not stay if the streams warm by even a few degrees. **Tree:** A warmer climate means the loss of Birch, and potentially Sugar Maple if there is an increase in forest fires.

4. Iverson, L., A.M. Prasad, S.N. Matthews, M. Peters. 2008. Estimating Potential Habitat for 134 Eastern US Tree Species Under Six Climate Scenarios. Forest Ecology and Management 254: 390-406.

Summary: This article is a map of 134 tree species selected from random forests to study their responses to climate change. It is to show the current as well as potential future habitats of these species according to two emission scenarios with three climate models. Generally most specie habitats move northeast, with it being more drastically in a higher emission scenario. Generally there are quite a lot of species predicted to lose suitable habitat areas.

Specific Pages to Note: **Pg. 401:** Birch can sustain some habitat under low emissions but once under high emissions, it is eliminated. **Pg. 404:** Forests are expected to lose habitat under either scenarios.

References Cited to Consider:

- Chaing, J., Iverson, L.R., Prasad, A.M., Brown, K., 2006. Interactions of Changing Climate and Shifts in Forest Composition on Stand Carbon Balance. In: Ecological Society of America, 91st Annual Meetings, Memphis, TN.
- DeHayes, D.H., Jacobson, G.L., Schaber, P.G., Bongarten, B., Iverson, L.R., Dieffenbacker-Krall, A., 2000. Forest Responses to Changing Climate: Lessons From the Past and Uncertainty for the Future. In: Mickler, R.A., Birdsey, R.A., Horn, J.L. (Eds.), Responses of Northern Forests to Environmental Change. Springer- Verlag, New York, NY, (ecological studies series), pp. 495-540.
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- Iverson, L.R., Prasad, A.M., Matthews, S., in press. Modelling potential climate change impacts on the trees of the Northeastern United States. Mitigat. Adapt. Strateg., in press-b.
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- Prasad, A.M., Iverson, L.R., 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database]. http://www.fs.fed.us/ne/delaware/atlas
- Schwartz, M.W., Iverson, L.R., Prasad, A.M., Matthews, S.N., O'Connor, R.J., 2006. Predicting extinctions as a result of climate change. Ecology 87 (7), 1611–1615.
- Thuiller, W., Lavorel, S., Sykes, M.T., Araujo, M.B., 2006. Using niche-based modelling to assess the impact of climate change on tree functional diversity in Europe. Divers. Distrib. 12, 49–60.

5. Ojibwe Lifeway: Maple Sugaring and Birch Bark Harvesting ("Zilgwan" – Spring). Gikinoo'wizhiwe Onji Waaban (Guiding for Tomorrow) "G-Wow" Changing Climate, Changing Culture. Available at: http://www.g-wow.org/en-us/maple_birch/default.aspx

Summary: Gikinoo'wizhiwe Onji Waaban is a website designed to look at Ojibwe lifeways and how they are affected by climate change. This specific one looks to understand both sugar maples and birch bark trees. It covers the specific cultural importance of these trees. As well as, includes impacts they face resulting from climate change and possible climate change stressors.

Specific Pages to Note: Climate warming will cause a decrease in suitable habitat for Paper Birch. Climate warming could also have an impact on soil moisture which will inhibit birch effectiveness to receive water and nutrients. Climate change may also allow for an increase in disease and pests. Lastly, shorter winters may cause stress on the paper birch and allow for greater vulnerability to pests.

6. *Rustad, L., Campbell, J., Dukes, J.S., Huntington, T., Lambert, K.F., Mohan, J., Rodenhouse, N. Changing Climate, Changing Forests: The Impacts of Climate Change on Forests of the Northeastern United States and Eastern Canada. United States Department of Agriculture. 2012. Available at:* http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs99.pdf

Summary: This was created to study climate change and the effects it poses on forest ecosystems with the goal to provide important insights for forest science, management, and policy. Climate change is predicted to have dire effects on habitat locations of tree species. A decline in suitable habitats is expected with a change in abundance and distribution of wildlife.

Specific pages to note: **Pg. 17:** Graph shows that Paper birch will experience a (87%) loss in suitable habitat under predicted climate change scenarios. **Pg. 18:** Under either climate change scenario, birch habitat experiences habitat loses out to oak and hickory habitats. **Pg. 20** Birch experiences habitat loss due to extended winter thaw cycles.

References Cited to Consider:

- Balch, R.E. 1944. The Dieback of Birch in the Maritime Region. Contribution No. 3. Fredericton, NB: Dominion of Canada, Department of Agriculture, Division of Entomology.

- Bourque, C.P.A.; Cox, R.M.; Allen, D.J.; Arp, P.A.; Meng, F.R. 2005. Spatial Extent of Winter Thaw Events in Eastern North America: Historical Weather Records in Relation to Yellow Birch Decline. Climate Change Biology. 11: 1477-1492.
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- *Frumhoff, P.C.; McCarthy, J.J.; Melillo, J.M.; Moser, S.C.; Wuebbles, D.J. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists. 146 p.*
- *Iverson, L.R.; Prasad, A.; Matthews, S. 2008. Modeling Potential Climate Change Impacts on the Trees of the Northeastern United States. Mitigation and Adaptation Strategies for Global Change. 13: 517-540.*
- *Ollinger, S.V.; Goodale, C.L.; Hayhoe, K.; Jenkins, J.P. 2008. Potential Effects of Climate Change and Rising CO_2 on Ecosystem Processes in Northeastern U.S. Forests. Mitigation and Adaptation Strategies for Global Change. 13: 467-485.*
- *Woodall, C.W.; Oswalt, C.M.; Westfall, J.A.; Perry, C.H.; Nelson, M.D.; Finley, A.O. 2009. An Indicator of Tree Migration in Forests of the Eastern United States. Forest Ecology and Management. 257: 1434-1444.*

7. http://www.fs.fed.us/nrs/atlas/tree/241
   http://www.fs.fed.us/nrs/atlas/tree/318
   http://www.fs.fed.us/nrs/atlas/tree/375
   http://www.fs.fed.us/nrs/atlas/tree/543

Summary: These websites show the current distribution of the Northern White Cedar, Sugar Maple, Paper Birch, and Black Ash respectively. They are maps created by the United States Department of Agriculture Forest Service to show the current distribution, projected future habitat, and predictor maps of these tree species. They are interactive maps where you can see climate change affecting the tree species with consideration of specific factors.

Northern White Cedar: Nookomis Giizhik

1. *Rustad, L., Campbell, J., Dukes, J.S., Huntington, T., Lambert, K.F., Mohan, J., Rodenhouse, N. Changing Climate, Changing Forests: The Impacts of Climate Change on Forests of the Northeastern United States and Eastern Canada. United States Department of Agriculture. 2012. Available at:* http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs99.pdf

Summary: This was created to study climate change and the effects it poses on forest ecosystems with the goal to provide important insights for forest science, management, and policy. Climate change is predicted to have dire effects on habitat locations of tree species. A decline in suitable habitats is expected with a change in abundance and distribution of wildlife.

Specific pages to note: **Pg. 17:** Graph shows a decrease in Northern White Cedar is expected to have a (73%) decrease in suitable habitat.

References Cited to Consider:

- *Frumhoff, P.C.; McCarthy, J.J.; Melillo, J.M.; Moser, S.C.; Wuebbles, D.J. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists. 146 p.*
- *Iverson, L.R.; Prasad, A.; Matthews, S. 2008. Modeling Potential Climate Change Impacts on the Trees of the Northeastern United States. Mitigation and Adaptation Strategies for Global Change. 13: 517-540.*
- *Ollinger, S.V.; Goodale, C.L.; Hayhoe, K.; Jenkins, J.P. 2008. Potential Effects of Climate Change and Rising CO_2 on Ecosystem Processes in Northeastern U.S. Forests. Mitigation and Adaptation Strategies for Global Change. 13: 467-485.*
- *Woodall, C.W.; Oswalt, C.M.; Westfall, J.A.; Perry, C.H.; Nelson, M.D.; Finley, A.O. 2009. An Indicator of Tree Migration in Forests of the Eastern United States. Forest Ecology and Management. 257: 1434-1444.*

2. United States Department of Agriculture. 2014. Michigan Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Northwoods Climate Change Response Framework Project. Available at: http://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs129.pdf

Summary: This report was created by the United States Department of Agriculture to explain how the forests in northern Michigan will be affected by Climate Change. It specifically discusses the forests in the eastern and northern parts of the Upper Peninsula. It identifies major forest trends and stressors that are currently threatening Michigan forests. Using climate projections they identified the potential future impacts of climate change on forests.

Specific pages to note: **Pg. 96:** Table 17. Northern White Cedar decreases in both climate change scenarios. **Pg. 101:** Northern White Cedar experienced increased climate stress in both scenarios of climate change. As the climate warms it is expected to face increasing climate

related stress. **Pg. 121 & 128 & 134:** Northern White Cedar is expected to lose suitable habitat for survival. **Pg. 134:** Deer will inhibit the regeneration ability of Northern White Cedar which will add the future climate related stress. **Pg. 157:** Native American Tribes are likely to face decreased availability of culturally important tree species such as the Northern White Cedar.

References Cited to Consider:

- Chhin, J.M.; Iverson, L.R.; Prasad, A.; Brown, K.J. 2008. Effects of Climate Change and Shifts in Forest Composition on Forest Net Primary Production. Journal of Integrative Plant Biology. 50(11): 1426-1439.
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- Hall, K. 2012. Climate Change in the Midwest:Impacts on Biodiversity and Ecosystesms. In: Winkler, J.; Andersen, J.; Hatfield, J.; Bidwell, D.; Brown, D., coordinators. U.S. National Climate Assessment Midwest technical input report. Available at http://glisa.msu.edu/docs/NCA/MTIT_Biodiversity.pdf.
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- Iverson, L.R.; Prasad, A.M.; Matthews. S.N.; Peters, M. 2008. Estimating Potential Habitat for 134 Eastern US Tree Species under Six Climate Scenarios. Forest Ecology and Management. 254(3): 390 – 406.
- Ollinger, S.; Goodale, C.; Hayhoe, K.; Jenkins, J. 2008. Potential effects of Climate Change and Rising CO_2 on Ecosystem Processes in Northeastern U.S. Forests. Mitigation and Adaptation Strategies for Global Change. 13(5): 467-485.
- Pastor, J.; Post, W. 1988. Response of Northern Forests to CO_2 induced Climate Change. Nature. 334(6177): 55-58.
- Scheller, R.M.; Mladenoff, D.J. 2005. A spatially interactive Simulation of Climate Change, Harvesting, Wind, and Tree Species Migration and Projected Changes to Forest Composition and Biomass in Northern Wisconsin, USA. Global Change Biology. 11(2): 307-321.

3. Whitman, A. 2013. Suggested Climate Change Adaptation Strategies for The Narrows WMA, Stands 1 and 5. Manomet Center for Conservation Sciences. Available at: https://www.manomet.org/sites/default/files/publications_and_tools/2013%20Manomet%20-%20Suggested%20Climate%20Change%20Adaptation%20Strategies%20for%20The%20Narrows%20WMA%20VT%20FINAL.pdf

Summary: This article is on Climate Change of the forests and forest habitats in Vermont. They have the projected climate change impacts that Vermont's forests in the south will experience including temperature, drought, lack of snow cover, and wildfire. The article gets over the current challenges that Vermont is facing and how they are trying to manage the impacts from climate change.

Specific Pages to Note: **Pg. 2 & 3:** Cedar seedling have a high mortality is greatest at temperatures above 90 degrees F, global warming could impact the mortality rate of cedar seedling. **Pg. 3:** Drought may have negative impacts on white cedar's regeneration abilities.

References Cited to Consider:

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4. http://www.fs.fed.us/nrs/atlas/tree/241
   http://www.fs.fed.us/nrs/atlas/tree/318
   http://www.fs.fed.us/nrs/atlas/tree/375
   http://www.fs.fed.us/nrs/atlas/tree/543

Summary: These websites show the current distribution of the Northern White Cedar, Sugar Maple, Paper Birch, and Black Ash respectively. They are maps created by the United States Department of Agriculture Forest Service to show the current distribution, projected future habitat, and predictor maps of these tree species. They are interactive maps where you can see climate change affecting the tree species with consideration of specific factors.

Black Ash: Baapaagimaak

1. http://www.fs.fed.us/nrs/atlas/tree/241
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   http://www.fs.fed.us/nrs/atlas/tree/375
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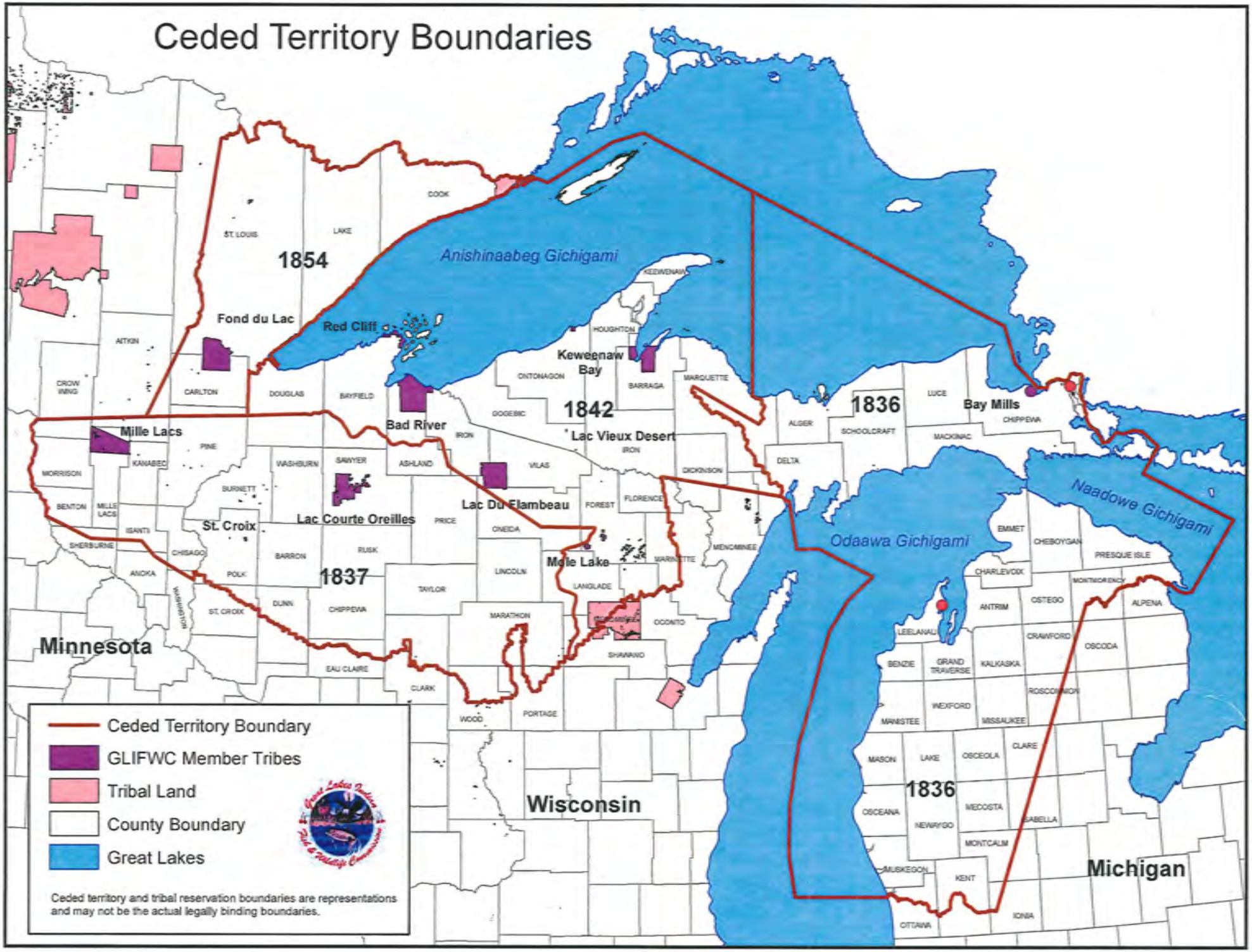
Summary: These websites show the current distribution of the Northern White Cedar, Sugar Maple, Paper Birch, and Black Ash respectively. They are maps created by the United States Department of Agriculture Forest Service to show the current distribution, projected future habitat, and predictor maps of these tree species. They are interactive maps where you can see climate change affecting the tree species with consideration of specific factors.


Ceded Territory Boundaries
1854
1842
1837
1836
1836
Anishinaabeg Gichigami
Naadowe Gichigami
Odaawa Gichigami
Fond du Lac
Red Cliff
Keweenaw Bay
Bad River
Lac Vieux Desert
Mille Lacs
Lac Courte Oreilles
Lac Du Flambeau
St. Croix
Mole Lake
Bay Mills
Minnesota
Wisconsin
Michigan
Ceded Territory Boundary
GLIFWC Member Tribes
Tribal Land
County Boundary
Great Lakes
Ceded territory and tribal reservation boundaries are representations and may not be the actual legally binding boundaries.

RED LAKE BAND
of CHIPPEWA INDIANS
RED LAKE NATION HEADQUARTERS

PO Box 550, Red Lake, MN 56671 Phone 218-679-3341 • Fax 218-679-3378

OFFICERS:
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DON R. COOK, SR., Secretary
ANNETTE JOHNSON, Treasurer

DISTRICT REPRESENTATIVES:
GARY NELSON
GLENDA J. MARTIN
JULIUS "TOADY" THUNDER
ALLEN PEMBERTON
ROMAN "DUCKER" STATELY
ROBERT "BOB" SMITH
RICHARD BARRETT, SR.
ROBERT "CHARLIE" REYNOLDS

ADVISORY COUNCIL:
7 HEREDITARY CHIEFS

RESOLUTION NO. 257-16

Upon a motion by Treasurer Johnson and second by Representative Reynolds, the following was enacted:

WHEREAS, the Red Lake Tribal Council is the governing body of the Red Lake Band of Chippewa Indians, a federally recognized Indian Tribe; and

WHEREAS, pursuant to the Constitution and Bylaws of the Red Lake Band the Red Lake Tribal Council is entrusted with the responsibility to protect the human and natural environment throughout the diminished Reservation and the ceded territories; and

WHEREAS, chief among the Tribal Council's responsibility is the protection of water, which sustains all life, and the protection of clean water is our sacred responsibility as Anishinabe people; and

WHEREAS, manoomin, or wild rice, is also sacred to Anishinabe people, and because all waters are interconnected, even subtle changes in water quality or levels can profoundly harm the health of manoomin, which is a trust resource with federal protections; and

WHEREAS, private companies, including Enbridge are proposing and planning multiple oil and gas pipeline and other large infrastructure projects that would cross lands and waters where Tribal members gather wild rice and other natural resources, and where Tribal cultural resources are located; and

WHEREAS, construction of such large infrastructure poses a threat to waters, natural resources and cultural resources from disturbance during construction and permanent destruction by project activities; and

WHEREAS, oil pipelines in particular pose a unique threat to the Red Lake Nation where those pipelines cross over, under or through waters, wetlands and ecosystems on which tribal members depend for wild rice, fish, game, and other culturally-important natural resources; and

WHEREAS, impacts to natural and cultural resources from large-diameter pipeline construction include streambank degradation, increased sedimentation of waters, long-term wetland disruption, and destruction of fish and wildlife habitat corridors through permanent vegetation removal; and

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WHEREAS, wild rice is particularly sensitive to changes in water levels, water quality, increased sedimentation, and pollutants; and

WHEREAS, pipeline proponents deliberately select new pipeline routes with the intent of avoiding all possible environmental review of pipeline projects; and

WHEREAS, as a result, routes for pipelines and other large infrastructure projects frequently avoid passing through Indian reservations and Tribal trust lands but still pass through treaty-ceded territories and tribal aboriginal lands where Tribal members hunt, fish, and gather, and where Tribal cultural resources are located; and

WHEREAS, Enbridge's proposed Line 3 Replacement Project will, if constructed, carry Canadian tar sands oil through a 36-inch diameter pipeline through pristine wild rice lakes, waters, rivers and interconnected aquifers located in the Red Lake Nation's ceded territory, as well as the headwaters of the Mississippi and two other major North American watersheds;

WHEREAS, many of those wild rice waters, rivers, lakes and aquifers are interconnected downstream and upstream with ecosystems which are the primary sources of natural resources important to Tribal members; and

WHEREAS, many of those interconnected waters flow through Red Lake treaty-ceded territories and aboriginal lands where Tribal members exercise reserved hunting, fishing and gathering rights and where cultural resources are located, or through Tribal trust lands, as well as the diminished Red Lake Reservation; and

WHEREAS, the Line 3 Replacement Project proposed route fastidiously avoids actually crossing any Indian Reservations or Tribal trust lands, yet will still impact important natural and cultural resources ; and

WHEREAS, the significance of treaty rights and treaty resources in Minnesota has been acknowledged in judicial decisions that have addressed those rights both on and off reservations; and

WHEREAS, current federal law and state law pertaining to the permitting of oil pipelines places greater emphasis on meeting the needs of the pipeline proponent than ensuring that natural resources, cultural resources, and Tribal rights, interests and resources are considered and protected; and

WHEREAS, current Army Corps of Engineers tribal consultation policy requires consultation with tribes on activities that occur within a tribe's aboriginal lands, regardless of land status; and

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WHEREAS, the Army Corps of Engineers has looked to guidelines drafted in 1997 (Attached as Exhibit A) when ascertaining its trust responsibilities to Indian tribes and since that time there have been developments in the law both generally and specifically with respect to treaties with Minnesota tribes; and

NOW THEREFORE BE IT RESOLVED that the Tribal Council hereby requests that the U.S. Army Corps of Engineers initiate early and robust tribal consultation for any infrastructure projects proposed to be located within Red Lake aboriginal lands, regardless of land status or reservation status;

BE IT FURTHER RESOLVED that the Tribal Council hereby requests that such tribal consultations be initiated at the earliest stages of project proposal to allow tribes to identify tribal natural and cultural resources that may be impacted;

BE IT FURTHER RESOLVED that the Tribal Council hereby requests that the U.S. Army Corps of Engineers work with the Red Lake Nation and other Ojibwe tribes in Minnesota and Wisconsin to develop new Clean Water Act Section 404 permitting processes for wild rice waters in recognition of the special impacts created to wild resources by activities covered under Section 404;

BE IT FURTHER RESOLVED that the Tribal Council hereby requests that the U.S. Army Corps of Engineers seek all necessary authority to condition Section 404 permit approval over infrastructure projects occurring within tribal aboriginal lands with serious potential impacts to tribal cultural and natural resources on receipt of the informed consent of the impacted tribes; and

BE IT FINALLY RESOLVED that the Tribal Council hereby requests that the U.S. Army Corps of Engineers: (1) consult with the Red Lake Nation to update the guidelines (Exhibit A); (2) make a firm, unequivocal commitment that it will follow those guidelines and fulfill its trust obligations to Indian tribes; and (3) enter into an agreement with the Red Lake Nation to establish protocols for tribal input and consultation on proposed actions impacting tribal cultural and natural resources.

FOR : 9
AGAINST: 0

We do hereby certify that the foregoing resolution was duly presented and enacted upon at a Special Meeting of the Tribal Council held on November 30, 2016, with a quorum present, at the Red Lake Nation Headquarters, Red Lake.

DARRELL G. SEKI, SR., CHAIRMAN DONALD R. COOK, SR., SECRETARY

SEP 29 1997

Construction-Operations
Regulatory (94-01298-IP-DLB)

Mr. James Schlender
Executive Administrator
Great Lakes Indian Fish & Wildlife Commission
P.O. Box 9
Odanah, Wisconsin 54861

Dear Mr. Schlender:

As a result of issues that have arisen during our evaluation of a permit application by Crandon Mining Company to establish a mining operation near Crandon, Wisconsin, the St. Paul District has been asked by several Native American tribes to address the nature and extent of the Corps trust responsibilities toward Indian tribes in the Corps regulatory permitting process. I have indicated at past consultation meetings that I had requested guidance from Corps Headquarters to address this question.

Enclosed is an issue paper that provides the guidelines that the District will follow to insure that it fulfills its trust obligations. This paper, while very useful for illustrative purposes, may not resolve issues that are specific to any individual treaty or pending permit action.

I propose that we hold a consultation meeting in approximately 60 days. This will provide you time to review the paper and to develop any questions or concerns that you may have regarding these guidelines, as well as to how they will be applied in our review of the Crandon Mining Company permit application. I suggest that the consultation meeting be held in early December in Eau Claire, Wisconsin. Mr. Dave Ballman, of my staff, will coordinate with your staff in scheduling the meeting.

Please contact me at (612) 290-5300 if you have any questions.

Sincerely,

/S/

J. M. Wonsik
Colonel, Corps of Engineers
District Engineer

SCANNED

Identical Letters:

Arlyn Ackley, Sokaogon Chippewa Community
Philip Shopodock, Forest County Potawatomi Community
Apesanahkwat, Menominee Indian Tribe of Wisconsin
James Schlender, Great Lakes Indian Fish & Wildlife Commission

Ballman	CO-R DB 9/17
Ahlness	CO-R 9/18/97
Hauger	CO-R
Wopat	CO-R BW 24 Sep 97
Haumersen	CO
Adamski	OC
Crump	PP-PM
Breyfogle	DDE 9/29

ISSUE PAPER
AND
DISTRICT RECOMMENDATION

THE AGENCY'S TRUST RESPONSIBILITIES TOWARD INDIAN TRIBES IN THE REGULATORY PERMITTING PROCESS

1. ISSUE. Work activities performed pursuant to permits issued under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act have the potential to impact Indian treaty rights[1] and to impact resources owned or used by Indian Tribes. Because of this, questions have arisen about the Corps' trust obligations to Indian tribes with respect to the Corps' permitting processes. This paper shall attempt to delineate trust issues related to the permitting process and will attempt to set forth guidelines with respect to those issues[2]. A question and answer format will be used to accomplish this purpose.

2. **May the Corps issue a permit that will impinge on or abrogate treaty rights?**

No, treaty rights[3], absent consent of Congress, may not be impinged or abrogated[4]. As the

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[1]The term "treaty rights", as used in this paper, includes not only rights derived from treaties, per se, but also rights derived from federal statutes, agreements executive orders and the like. The terms "Tribal resources" or "Treaty resources", as used in this paper, refers to resources that the Tribe, pursuant to a treaty, has a right to exploit and includes resources that they own and resources that they have a right to gather. The term "trust resources" refers to resources held in trust by the United States (the title is held by the United States) for the benefit of the Tribe.

[2]The paper, other than as may be useful for illustrative purposes, will not attempt to resolve issues that are specific to any individual treaty or pending permit action, but will attempt to formulate guidelines which will insure that the agency fulfils all of its trust obligations.

[3]It should be noted that the terms "treaty rights" and "treaty resources" are not synonymous. For example, a treaty that guarantees a tribe the right to hunt and fish on its reservation, the "treaty right" is the right to take the resource (game or fish), the "treaty resource"

SCANNED

Court held in *Northwest Sea Farms, Inc., v. U.S. Army Corps of Engineers*, 931 F. Supp. 1555 (W.D. Wash. 1996) 1519-1520:

> The Supreme Court has recognized "the undisputed existence of a general trust relationship between the United States and the Indian people." *United States v. Mitchell*, 463 U.S. 206, 225, 103 S.Ct. 2961, 2972, 77 L.Ed.2d 580 (1983). This obligation has been interpreted to impose a fiduciary duty owed in conducting "any Federal Government action"[5] which relates to Indian Tribes. *Nance v. Environmental Protection Agency*, 645 F.2d 701, 711 (9th Cir.), *cert. Denied*, 454 U.S. 1081, 102 S.Ct. 635, 70 L.Ed.2d 615 (1981), ... In previous cases, this Court has tacitly recognized that the duty extends to the Corps in the exercise of its permit decisions. *See e.g. Muckleshoot Indian Tribe v. Hall*, 698 F. Supp. 1504, 1523 (W.D.Wash.1988) (granting an injunction against the construction of a marina in consideration of the effect upon Indian treaty rights).
>
> In carrying out its fiduciary duty, it is the government's and subsequently the Corps', responsibility to ensure that Indian treaty rights are given full effect. *See e.g. Seminole Nation v. United States*, 316 U.S. 286, 296-297, 62 S. Ct. 1049, 1054-55, 86 L.Ed. 1480, 86 L.Ed.1777 (1942) (finding that the United States owes the highest fiduciary duty to protect Indian contract rights as embodied by treaties). Indeed, it is well established that only Congress has the authority to modify or abrogate the terms of Indian treaties. *United States v. Eberhardt*, 789 F.2d 1354, 1361 (9th Cir.1986). As such, the Court concludes that the Corps owes a fiduciary duty to ensure that the Lummi Nation's treaty rights are not abrogated or impinged upon absent an act of Congress.

3. How are treaty rights determined?

Treaty rights are determined on a case by case (treaty by treaty) basis. Each individual treaty or series of treaties must be examined to determine the specific rights provided by those treaties.

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is the game or fish. Although courts have, almost universally held that treaty rights may not be impinged, they have not held that the resource may not be negatively impacted. See also question 6.

[4]Note, however, that the same Court that decided *Northwest Sea Farms, Inc.* issued an order in *Lummi Indian Nation v. Cunningham*, case No. C92-1023C on September 1, 1992, to the effect that before a claim that treaty rights have been impinged or abrogated is cognizable "the interference with the treaty right must reach a level of legal significance".

[5]A permit is a Federal Government action"

4. How are Indian treaties to be interpreted?

There are three basic rules of treaty construction. They are: (1) Ambiguities in treaties must be resolved in favor of the Indians, (2) Indian treaties must be interpreted as the Indians would have understood them at the time they consented to the treaty, and (3) Indian treaties must be construed liberally in favor of the Indians. This does not mean, however, that the treaties are to be construed in any manner that the Indians wish them to be construed. The rules of construction do not permit the clear intent of the treaties to be disregarded.

The Court in *Menominee Indian Tribe of Wisconsin v. Thompson*, 922 F.Supp. 184, (198-199), (W.D. Wis. 1996) described the rules of construction as follows:

> It is well known that Indian treaties must be interpreted as the Indians understood them, that doubtful expressions are to be resolved in favor of the Indians and that treaties must be construed liberally in favor of the signatory tribes. ... treaties are not to be construed by "the technical meaning of [their] words to learned lawyers, but in the sense in which they would naturally be understood by the Indians." *Id.*
>
> Determining the Indians' understanding may require expert testimony to explain the historical and cultural context in which the Indians viewed the treaty provisions. *See, e.g. McClanahan v. State Tax Comm'n of Arizona*, 411 U.S. 164, 174, 93 S.Ct. 1257, 1263, 36 L.Ed.2d 129 (1973) ... ("Doubtful expressions are to be resolved in favor of the weak and defenseless people who are the wards of the nation, dependent upon its protection and good faith."); *Winters v. United States*, 207 U.S. 564, 576-77, 28 S.Ct. 207, 211, 52 L.Ed. 340 (1908) ("ambiguities occurring [in treaties] will be resolved from the standpoint of the Indians").
>
> It is true that "[t]he cannon of construction regarding the resolution of ambiguities ... does not permit reliance on ambiguities that do not exist; nor does it permit disregard of the clearly expressed intent of Congress." *South Carolina v. Catawba Indian Tribe*, 476 U.S. 498, 506, 106 S.Ct. 2039, 2044, 90 L.Ed.2d 490 (1986). See also *Amoco Production Co. V. Gambell*, 480 U.S. 531, 555, 107 S.Ct. 1396, 1409, 94 L.Ed.2d 542 (1987) (citing *Catawba Indian Tribe*); *Choctaw Nation*, 318 U.S. at 432, 63 S.Ct. At 678 ("even Indian treaties cannot be rewritten or expanded beyond their clear terms to remedy a claimed injustice or to achieve the asserted understanding of the parties").

Moreover, many of the issues of treaty construction that are likely to arise in the permitting process, have already been determined by the Courts[6]. Thus, the first step in

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[6]Even if the case law is not dispositive of the specific issue, it may provide rationale or additional information which will aid in the decision process. Additionally, it is recommend that Office of Counsel (or similar resource) be consulted before making a determination, in questionable cases, whether a treaty right exists or does not exist and whether the proposed

construing a treaty should be to review any Court decision that may be relevant.

5. How can we determine if treaty rights may be an issue with respect to a specific permit application?

The geographic extent[7] of all treaty rights and Tribal resources should be known to the regulatory staff. If the proposed activity could have any effect within that geographic area the treaties should be reviewed to determine if treaty rights may be affected. A determination should also be made as to whether the proposed activity may affect Tribal resources. Most importantly, the Indian Tribes that may be affected by the permitted activity should be apprised of the permit application and be given the opportunity to comment or consult with the Corps. If any Tribe asserts that the proposed permit activity would impinge on or abrogate its treaty rights or would negatively impact its resources, it should be requested[8] to provide all substantiating information it has available as to: (1) the existence of treaties, (2) claimed treaty rights, (3) any Court cases relevant to the Tribe's assertions, (4) an explanation of how the proposed activity would violate treaty rights, (5) identification of any Tribal resources that may be impacted, (6) an explanation of how the proposed activity would impact Tribal resources, and (7) a description of how the proposed activity would impact the Tribe[9]. BIA should also be informed of any proposed activity (needing a Corps permit) that might impact Tribal resources and should be requested to identify any treaty rights or Tribal resources that may be impacted by the proposed permit.

6. Does the Corps have a trust responsibility to protect Tribal resources from environmental degradation that may result from the proposed permit activity?

The Corps must consider the effect that the activity needing a Corps permit would have on the Tribe's resources, however, the fact that the Tribe's resource may be degraded, or reduced in value or utility, does not necessarily compel denial of the permit. This principle was explained by the Court in *Nez Perce Tribe v Idaho Power Co.*, 847 F.Supp. 791 807-813 (D.Idaho 1994) in a

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permit will or will not violate those rights.

[7]Including the area within the external boundaries of any Indian reservation and the geographic area in which usufructuary rights, if any, may be exercised.

[8]The Tribes are not required to respond.

[9]This request would be made to afford the Tribes every practicable opportunity to present their views. Neither the failure of the Tribes to respond nor a response from the Tribes relieves the Corps of its obligation to consider all impacts the proposed activity would have on any treaty rights or any impacts to Tribal resources that Corps is aware of, or reasonably should have been aware of. See also *Pueblo of Sandia v. United States*, 50 F.3d 856 (10th Cir. 1995).

case concerning permanent usufructuary rights[10], as follows:

> ... In other words, the Tribe argues that developments such as dams which damage, reduce or destroy the fish runs violate their 1855 Stevens treaty fishing rights and entitles them to an award of monetary damages.
>
> b) *Treaty Rights to Preservation of Fish Runs*
>
> The ultimate issue presented is whether the treaty provides the Tribe with an absolute right to preservation of the fish runs in the condition existing in 1855, free from environmental damage caused by a changing and developing society. Only if such a right exists is the Tribe entitled to an award of monetary damages.
>
> The parties have cited, and the Court's own independent research has disclosed only three cases which directly address this ultimate issue. *United States v. Washington* (hereinafter *"Washington 1982"*), 694 F.2d 1374 (9th Cir. 1982); *Muckleshoot Tribe v Puget Sound Power and Light*, CV No. 472-72C2V (W.D. Wash.1986); and *Nisqually Tribe v. City of Centralia*, No. C75-31 (W.D. Wash.1981). However, *Washington 1982* was vacated by the Ninth Circuit on other grounds in a subsequent en banc decision. *United States v. Washington*, 759 F.2d 1353 (9th Cir. 1985). *Muckleshoot Tribe v. Puget Sound* expressly relied on the *Washington 1982* opinion which was not vacated until after the decision in *Muckleshoot* was issued. Therefore, it appears that this Court is required to address and determine an issue of first impression without the benefit of any binding guidance and direction. ...
>
> ... State regulation cannot discriminate against the Indian fishery. *Puyallup II*, 414 U.S. [44] at 48, 94 S.Ct. [330] at 333 [38 L.Ed.2d 254 [(1973)]. This principle is broad enough to encompass discriminatory granting of permits for projects with potentially adverse environmental effects.
>
> *Id.* At 1382.
>
> In addition, the Ninth Circuit rejected the trial court's conclusion that other previous cases implied a general right to environmental protection of the fish: ...
>
> Thus, according to the Ninth Circuit's persuasive reasoning in *Washington 1982*, the states may allow or even authorize development which reduces the number of fish in the annual runs as long as such action does not discriminate against treaty fishermen in determining what development will be authorized. Although the opinion was vacated on other grounds, the Court agrees with the

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[10]The treaty at issue in the case has been interpreted as creating permanent usufructuary rights (non-exclusive) to fish in all of the Tribes usual and customary places. Not all usufructuary rights are permanent as some are subject to termination upon the occurrence of a defined event. For example, Chippewa usufructary rights with respect to territory ceded by them to the United States are terminated or extinguished whenever the land is owned by private entities rather than the public. The (trust) duty to mitigate for damage to resources that may be harvestable pursuant to permanent usufructuary rights discussed by the Court in *Nez Perce* may not be applicable to usufructuary rights that can be terminated or extinguished in their entirety. .

legal analysis in *Washington 1982*. In the Court's view, the Stevens treaties do not protect the Indians from degradation of the fish runs caused by development which is not part of a pattern of discrimination against Indian treaty fish runs.

... In the Court's view, the 1855 treaty does not provide a guarantee that there will be no decline in the amount of fish available to take. The only method that would guarantee such protection would be to prevent all types of development, whether or not it is discrimatory of Indian treaty rights. The Stevens treaties simply do not provide the Tribe with such assurance or protection.

... Stevens treaties require that any development authorized by the states which injure the fish runs be non-discrimatory in nature *see Fishing vessel*, 443 U.S. 658, 99 S.Ct. 3055, 61 L.Ed.2d 823 but does not, however, guarantee that subsequent development will not diminish or eventually, and unfortunately, destroy the fish runs.

7. Does the Corps trust responsibility to Indian tribes require mitigation for impacts to off reservation resources that the Tribes have a right to harvest (usufructuary rights)?

The answer to this question depends on the nature of the usufructuary rights reserved or held by the Tribes. All usufructuary rights are not alike. For example, courts have held that a number of Tribes in the Pacific Northwest have usufructuary rights that are permanent in nature and are not subject to termination[11]. Those rights were held to have both a geographic component[12] and a component that entitled the Tribes to take a share of the available fish. Those courts have also held that while the Tribes were not entitled to be protected against off reservation activity that would result in a reduction of available fish, they were entitled to reasonable steps to mitigate adverse impacts from the activity.[13] The theoretical basis for the holding that reasonable mitigation is required was explained in *United States v. State of Washington*, 506 F.Supp. 187, 203 (1980)[14] as follows:

> At the outset the Court holds that implicitly incorporated in the treaties' fishing clause is the right to have the fishery habitat protected from man-made

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[11]Other than by an Act of Congress.

[12]The right to fish forever in certain locations defined in the Treaty.

[13]"We do not find such an obligation in the treaty. Where the decision to allow development is not tinged with any discrimatory animus, the treaty fishing clause, as we read it, does not require compensation of the Indians on a make whole basis if reasonable steps, in view of the available resources and technology, are incapable of avoiding a reduction in the amount of available fish." *U.S. v. State of Washington*, 694 F.2d 1374, 1386 (1983)

[14]The Court's decision was vacated by the Ninth Circuit on other grounds in "*U.S. v. State of Washington*, 694 F.2d 1374. See also question 6.

despoilation. Virtually every case construing this fishing clause has recognized it to be the cornerstone of the treaties and has emphasized its overriding importance to the tribes. ... The Indians understood, and were led by Governor Stevens to believe, that the treaties entitled them to continue fishing in perpetuity and that the settlers would not qualify, restrict, or interfere with their right to take fish. ...

In contrast to the Pacific Northwest cases, the Chippewa in Wisconsin and Minnesota have been found to have usufructuary rights to hunt, fish and gather that are extinguished upon the land passing to private ownership[15]. Thus the underlying rationale in the Pacific Northwest cases - perpetual usufructuary rights - for requiring mitigation, as a trust responsibility, is not present with respect to the Chippewa's usufructuary rights. Moreover, a determination that the United States' trust obligations would require it to ensure that mitigation would be performed would be logically inconsistent with case law which has held that the usufructuary rights were extinguished when the land over which they originally could have been exercised passed to private ownership. Under the relevant case law no compensation would be due the Tribes, even if all of the land passed to private ownership, as it was understood that usufructuary rights "were subject to and limited by the demands of the settlers." *Lac Courte Oreilles Band v. State of Wisconsin*, 760 F.2d 177, 183 (1985)

Therefore, the specific usufructuary right in question should be examined to determine if mitigation would be required as a trust obligation. However, even if it is determined that mitigation would be required, it is not unlikely that mitigation that is or would be required in conjunction with the permit, even absent a trust responsibility,[16] would be sufficient to satisfy any Government trust obligation to mitigate.[17]

8. Does the Corps trust responsibility to Indian Tribes require mitigation for adverse impacts to Tribal resources on reservations?

Each treaty at issue must be reviewed to determine what is or is not required under that treaty. Under the rationale of the Pacific Northwest cases it would appear that mitigation, to the extent reasonable and practicable is owed. However, those cases do not indicate that there is an environmental servitude owed the Tribes such that mitigation must ensure that there is no net adverse effect resulting from the federal action. In fact, the Court in *United States v. State of*

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[15] *Lac Courte Oreilles Band, Etc. v Voigt*, 700 F.2d 341 (1983) and *Lac Courte Oreilles Band v. State of Wisconsin*, 760 F.2d 177.

[16] Mitigation that would be required of the applicant even if there were no usufructuary rights or trust obligation to mitigate.

[17] See *Pyramid Lake Paiute Tribe v. U.S. Department of Navy*, 898 F.2d 1410 (9th Cir. 1990); *Havasupai Tribe v. United States*, 752 F. Supp. 1471 (D. Ariz. 1990); and *Nance v. Environmental Protection Agency*, 645 F.2d 701 (1981)

Washington, 694 F.2d 1374 (1982) has indicated that a resource may be rendered valueless without abrogation of treaty rights or trust responsibilities[18]. As stated by that Court at page 1381 "Any right may be subject to contingencies which would render it valueless." and at page 1382:

> The spectre the district court raises of tribal fishermen unprotected by the environmental right dipping their nets into the water and bringing them out empty, 506 F.Supp. at 203, cannot alter the scope of *Fishing Vessel*. Only the extension of the servitude to ban even non-discriminatory development occurring both within and without treaty fishing areas assure against any decline in the amount of fish taken. The treaty does not grant such assurance.

It is also not unlikely that any trust obligation owed to require mitigation would be satisfied by mitigation that would be required in conjunction with the 404 permit process, absent a trust obligation.

Accordingly, mitigation, to the extent it is reasonable and practicable, for impacts to Tribal resources sited on reservations should be required.

9. May an activity whose impact to a reservation's resources be such that it would defeat the purpose for which the reservation was established be permitted?

Before one can begin to address this question, in practice, the terms of the treaty in question must be examined to determine if the Treaty specifically contemplates the activity to be permitted and if that activity, under the terms of the treaty takes precedence over or is subservient to the interests of the Tribe[19] Assuming the treaty is not dispositive, the following is applicable.

I am not aware of a line of cases directly addressing this issue; however, *Pyramid Lake Paiute Tribe of Indians v. Morton*, 354 F.Supp. 252 (1973) gives us guidance as to how one court decided the issue and may be illustrative of how such issues would be decided in the future. The case concerned the Department of Interior's regulation, which the Tribe contended delivered "more water to the District than required by applicable court decrees and statutes, and improperly diverts water that otherwise would flow into nearby Pyramid Lake located on the Tribe's

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[18]This discussion is not applicable to impacts which would defeat the purpose for which the reservation was established.

[19]See *Sokaogon Chippewa Community v. Exxon Corp.*, 805 F.Supp. 680, 706 (E.D.Wis, 1992) "If the Sokoagon were to prevent Exxon from mining on the subject territory, it would be in contravention of the very considerations prompting the two treaties. Even assuming that the Sokaogon have rights in the land, the language and intent of the 1842 and 1854 Treaties demand that mineral development should take precedence over those rights.

reservation." Although the Court could have analyzed the case under the Winters doctrine[20] It chose not to do so. The Court noted, at pages 254-255, that:

> This Lake has been the Tribe's principal source of livelihood. Members of the Tribe have always lived on its shore and have fished its waters for food. ...
>
> Recently, the United States, by original petition in the Supreme Court of the United States, filed September, 1972 claims the right to use sufficient water of the Truckee River for the benefit of the Tribe to fulfill the purposes for which the Indian Reservation was created, "including the maintenance and preservation of Pyramid Lake and the maintenance of the lower reaches of the Truckee as a natural spawning ground for fish and other purposes beneficial to and satisfying the needs of the Tribe. ...

The Court then determined (page 256) that:

> ... The Secretary's duty was not to determine a basis for allocating water between the District and the Tribe in a manner that hopefully everyone could live with for the year ahead. This suit was pending and the Tribe had asserted well-founded rights. The burden rested on the Secretary to justify any diversion of water from the Tribe with precision. It was not his function to attempt an accommodation.
>
> In order to fulfill his fiduciary duty, the Secretary must insure, to the extent of his power that, that all water not obligated by court decree or contract with the District goes to Pyramid Lake.

Accordingly, should the Corps determine that an activity needing a Corps permit would impact the reservation's resources to an extent that they would defeat the purpose for which the reservation was established the permit should be denied.[21]

10. What is the Winter's doctrine and is it applicable to permit decisions?

Felix S. Cohen's Handbook of Federal Indian Law, 1982 Edition, pages 575 to 576 offers a good explanation of the doctrine:

> The Supreme Court first articulated this doctrine in *Winters v. United States* in 1908 and reaffirmed it in 1963 in *Arizona v. California. Cappaert v.*

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[20] *Winters v. United States, 207 US 564, (1908)*

[21] It is likely that if the impacts were so great as to defeat the purpose of the reservation that, even without considering the Corps' trust obligations, the permit would be denied as not being in the public interest. (A permit whose impact would deprive any community of the ability to maintain a moderate living standard is not likely to be in the public interest.)

United States contains the Court's most succinct and lucid statement of the governing principles of reserved water rights:

> This Court has long held that when the Federal Government withdraws its land from the public domain and reserves it for a federal purpose, the Government, by implication, reserves appurtenant water then unappropriated to the extent needed to accomplish the purpose of the reservation. In so doing the United States acquires a reserved right in unappropriated water which vests on the date of reservation and is superior to the rights of future appropriators. ... The doctrine applies to Indian reservations and other Federal enclaves, encompassing water rights in navigable and nonnavigable streams.
>
> In determining whether there is a federally reserved water right implicit in a federal reservation of public land, the issue is whether the Government intended to reserve unappropriated and thus available water. Intent is inferred if the previously unappropriated waters are necessary to accomplish the purpose for which the reservation was created.

This doctrine arose and has been applied extensively in appropriative water law states (generally western states that have limited supplies of water). The doctrine has not been applied to riparian water law states and may not be applicable to them.

11. When, in the permitting process sequence, should the Corps trust obligations be considered?

Since the Tribal trust issues, alone, may be determinative[22] of the outcome of the permit decision, those issues should be considered immediately after or in conjunction with consideration of the avoidance issue.

12. If the Tribal trust issues are not dispositive of the permitting decision, do we need to consider the Tribe's concerns further?

Yes. The Tribal concerns and the impacts of the proposed activity on Tribal resources should be considered in the public interest review just as any other similarly sized community would be. Such consideration should not be evaluated based on Tribal trust responsibility considerations[23] but should take into account the relative impact the proposed activity would have

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[22]For example, if the permitted activity would violate a treaty provision, the permit application would be denied.

[23]These considerations should have been addressed previously.

on the community[24]. The same impact to natural resources may have a greater effect on individual Indians than it would on non-Indians, not only because of greater dependence on those resources, but also because the individual Indian may be more closely tied to the defined land area than his non-Indian counterpart. Additionally, any spiritual or cultural impact to the Tribe that would result from the proposed permit activity should be evaluated in the public interest review.

13. Should the Corps apply different criteria to permit applications for activities within a reservation's exterior boundaries than would be applied to a permit application for activities outside a reservation's exterior boundaries?

No. The criteria applied should be the same. However, it is very likely that an activity that is sited within the reservation's exterior boundaries would have a greater impact on Tribal resources than would an activity that is sited off reservation. Moreover, the applicant would still have to comply with all applicable local regulations, thus the Tribe may be able to impose its requirements[25] on the applicant. Such requirements would be independent of and in addition to any Corps' permit requirement or condition. Further, if the Tribe has jurisdiction over the activity and exercises its jurisdiction to prohibit the activity[26] the permit application to the Corps should be denied without prejudice.

14. Who is the Federal Trust Obligation owed to?

The Trust obligation is owed to Federally Recognized Indian Tribes.

Edwin C. Bankston
District Counsel

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[24]For example, an activity that would diminish the supply of game may affect Indian communities to a greater degree than non-Indian communities, because the Indian community may be more dependent on game than the non-Indian community. This greater importance to the Indian community should be factored into the evaluation.

[25]Including preventing the activity if the Tribe has sufficient authority to do so.

[26]Such as denying a required Tribal permit.

STATE OF MINNESOTA

INDIAN AFFAIRS COUNCIL

website: http://mn.gov/indianaffairs/

May 26, 2016

Jamie MacAlister, Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 500
St. Paul, MN 55101

Re: Sandpiper Pipeline and Line 3 Route

Dear Mr. MacAlister,

I am writing to you in regards to the Proposed Sandpiper and Line 3 routes. The Cultural Resource Program of the Minnesota Indian Affairs Council (MIAC) is concerned with the proposed routes through the northern half of Minnesota. Our concern is that the proposed preferred routes will go through the richest cultural resources areas within the State of Minnesota. As established by MN Statue 307.08, MIAC has the joint responsibility under the law to protect all American Indian Burial Sites within the State. The potential of adverse effects on identified burial and archaeology sites and important sacred sites as well as sites that have yet to be identified is too great for us not to be concerned.

Thank you for your attention to this important matter.

Jim L. Jones, Jr.

Cultural Resource Director, MIAC

Cc: Chairman Robert Larson, Lower Sioux Community
Chairman Kevin Jensvold, Upper Sioux Board of Trustee's
Chairman Charlie Vig, Shakopee Mdewakanton
President Shelly Buck, Prairie Island Indian Community
Chairman Norman Dechampe, Grand Portage Band of Lake Superior Chippewa
Chairman Wanye Depuis Fond Du Lac Band of Chippewa
Leonard Wabasha, Shakopee Mdewakanton Dakota
Amy Burnette, Leech Lake THPO
Grace Goldtooth Campos, Lower Sioux THPO
Sharon Pazi Zea, Upper Sioux Board of Trustee's

113 2nd Street NW, Suite 110A • Bemidji, MN 56601 • phone (218)755-3739 • fax (218) 755-3739
161 St. Anthony Avenue, Suite 919 • St. Paul, MN 55103 • phone (651)296-0041 • fax (651) 296-0132

LEECH LAKE BAND OF OJIBWE
DIVISION OF RESOURCE MANAGEMENT
115 6th ST. NW Suite E, Cass Lake, MN 56633

Date 4/3/15

Jamie MacAlister
Environmental Review Manager
Minnesota Department of Commerce
85 7th Place East, Suite 500, Saint Paul, MN 55101

Re: Comments to Scoping Request of MN Department of Commerce

Dear Ms. MacAlister,

We appreciate the conversation that was had on February 16th, 2016 at the Leech Lake Division of Resource Management in Cass Lake on the Leech Lake Indian Reservation. To ensure clarity my letter in no way speaks for the White Earth government or any other Minnesota tribal entity, it is only meant to clarify and ensure the conversation was captured correctly. Below I have bulleted all the major discussion items from our February 16th, 2016 conversation;

- The Line 3 Project application is not only a requesting of a new corridor but reviewing whether current placement is appropriate and also the decommissioning of the existing Line 3 which a portion would take place within Indian country. Leech Lake Band of Ojibwe would be the decision maker on how any decommissioning would be implemented within our regulator boundaries.

- Scoping of the alternative route through Indian country should involve the decision makers along that route. In this case ACOE, CNF, BIA and EPA.

- If these decision makers are not included in the scoping process as decision makers it makes the NEPA process incomplete and no federal agency can use the State EIS document.

- The alternative route would have an incomplete review of a section of 46 miles through the LLR and my recommendation is that it is dropped from the alternative routes because of the lack of decision making authority.

- All appropriate regulators along a route should be listed as cooperatives agencies because the permits and activities needed will and should be scoped in any MEPA/NEPA process.

Why do Tribal and Federal trustees need to be cooperative agencies when scoping involves Indian Country?

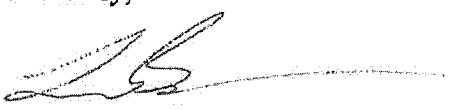
- Because Tribes are adversely affected by climate change because of the subsistence lifestyles and cultural identification.
- Environmental Justice issues such as why would a route currently with 6 crude pipelines, 2 natural gas pipelines, railroad corridor and major powerline corridor **even be considered.**
- Historically it is easier for applicants of such permits to get approved permits through the lands of minority people who are perceived to historically have a limited voice.
- The socio-economic impacts to natural resource access and loss of resources mitigation would be required to offset these impacts.
- NEPA requires that decision making authorities be addressed up front and not as general public entities but instead as cooperating agencies.
- In this case LLBO is a decision maker along alternative route through LLR with our federal partners and we are not cooperating agencies to the NEPA document which would be a fundamental flaw in the NEPA process or document.
- The Alternative routing issue can be easily addressed by simply dropping the route through LLR from consideration.

Why is the cooperative approach to decision making important through Indian country?

- Shared information
- Accurate and defensible Studies/NEPA Documents
- Reach Common Decisions in multiple jurisdictional routes

In closing it is our hope that the Minnesota Department of Commerce recognizes that to properly scope the existing corridor for Line 3 as an alternative route that there is a whole spectrum of issues and regulators would need to be addressed outside of a Minnesota State Environmental Impact Statement. If there are questions or comments please feel free to contact my office at (218)-335-7400.

Sincerely,



Levi Brown, Director
Environmental-Land Department
Leech Lake Band of Ojibwe

LEECH LAKE BAND OF OJIBWE
DIVISION OF RESOURCE MANAGEMENT
115 6th ST. NW Suite E, Cass Lake, MN 56633

Date 1/2/17

RECEIVED
JAN 17 2017
MINNESOTA PUBLIC
UTILITIES COMMISSION

Daniel Wolf, Executive Secretary
Minnesota Public Utilities Commission
121 7th Place E Suite 350
Saint Paul, Minnesota 55101

Re: **Final Scoping Decision**

Dear Mr. Wolf,

I'm writing to ensure decision makers are not make conflicting decisions and clarity between our two entities in regards to work that Minnesota Department of Commerce (MNDOC) is preforming on the Line 3 Replacement Proposed Final Scoping Decision Document undertaken at the order of the Minnesota Utilities Commission (MNPUC). There are several flaws with the document which have yet to be rectified by MNDOC which I have specifically outlined in the bullets;

- Scoping Document lists Tribal Coordination with the 2 sentences injected in the Environmental Review Process Section 2.0 of the Proposed Scoping Decision Document. There are two standalone Route Alternatives that are listed in your scoping document that cross the Leech Lake Indian Reservation (LLIR) this section does not accurately portray the role of Leech Lake Band of Ojibwe and other decision makers within the LLIR.

- Page 13, of the Proposed Scoping Decision Document states that RA-03 AM was eliminated because it was based on Screening Analysis of economic and regulatory feasibility, Environmental impacts and socioeconomic effects. Routes RA- 07 and RA - 08 should be dropped as well because they too overriding reasons such as regulatory feasibility (See Attached Leech Lake Resolution) that eliminates these routes from consideration.

- Section 3.3.5 of the Proposed Scoping Decision Document discusses evaluating removing line in place and replacing it with new pipe with no discussion with other governmental decision makers to discuss whether that would be regulatory feasible.

- The First Paragraph on page 19 of the Proposed Scoping Decision Document is not only inaccurate it seems to have a mischievous intend to escape the issue that the Leech Lake Band of Ojibwe and other federal agencies will be issuing permits and making decision if

RA -07 and RA-08 are selected. None of the required permits or approval decisions is listed in section 7.0 which the document is portraying. Yet all the requirements for the Applicants proposed route are listed.

- The State Environmental Impact Statement (EIS) will be analyzing the removal of existing line and construction of pipeline in same trench and yet does not list any of those permits and decisions that will have to take place within the exterior boundaries of the LLIR.

- Section 4.4.4.3 Wild Rice and Other Tribal Resources There is mention of Leech Lake Band of Ojibwe hunting and fishing agreement with the State of Minnesota which clearly states that LLBO has exclusive authority to regulate Wild rice within the exterior boundaries of the LLIR.

I understand that this scoping document is being drafted for state use but strongly urge you share these issues with alternative routes or lack of information with the decision makers to ensure that integrity of the EIS is protected. I'm also aware there was not a public meeting on the LLIR when developing this state document which has selected two alternatives to be scoped that lie within the LLIR. In closing Routes RA-07 and RA-08 cross an Indian reservation and/or the National Forest which it shares a common border and the document which state officials will be making a decision fail to address this in any shape or form. If there are questions or comments please contact myself at (218)-335-7400.

Sincerely,

Levi Brown, Director
Environmental-Land Department
Leech Lake Band of Ojibwe

Cc:
U.S. Forest Service
Bureau of Indian Affairs
Army Corp of Engineers

Attachments: LLBO Letter to MNDOC Dated April 3, 2015

LEECH LAKE BAND OF OJIBWE

Carri Jones, Chairwoman
Donald Finn, Secretary-Treasurer

Robbie Howe, District I Representative
Steve White, District II Representative
LeRoy Staples-Fairbanks III, District III Representative

Friday, October 25, 2013

RECEIVED
OCT 28 2013
MINNESOTA PUBLIC UTILITIES COMMISSION

Tracy Smetana
Minnesota Public Utilities Commission
121 7th Place E., Suite 350
St. Paul, Minnesota 55101

Re: MN-PUC Docket No. PL6668/CN-13-473

To Tracy Smetana:

The Leech Lake Band of Ojibwe (the "Band") is in receipt of your letter dated October 4, 2013 regarding the Notice of Certificate of Need Application for the Sandpiper Pipeline Project to Chairwoman Carri Jones. I am writing this letter regarding the proposed alternate route, which runs through the Leech Lake Indian Reservation (the "Reservation").

Enbridge Pipelines (North Dakota) ("Enbridge") does not have legal or regulatory approval to expand its existing corridor through the Reservation. I understand that Minnesota State law may require the Public Utilities Commission ("PUC") to have applicants outline a preferred route and an alternate route, but the Band needs to inform the PUC and the State of Minnesota at this early stage that Enbridge **does not** have legal or regulatory approval to build an additional pipeline across the Reservation. Therefore, I respectfully request that the PUC insist on a new alternate route that does not enter the exterior boundaries of the Reservation.

Enbridge lists the route through the Reservation as an "alternate route" and not the "preferred route." However, the "alternate route" is not an alternate at all as it is an impossible route. The perplexing aspect of this situation is that Enbridge is fully aware that it has neither the legal nor regulatory capability to build another pipeline through the Reservation, and should have listed their alternate route as a route that does not enter the exterior boundaries of the Reservation.

The reason Minnesota law requires applicants to list both a preferred route and an alternate route is in the event the preferred route does not work for one reason or another. Because Enbridge's proposed alternate route is a legal impossibility at this time, I respectfully ask the PUC to insist on a new alternate route that does not enter the Reservation.

115 Sixth St NW, Cass Lake, MN 56633
Telephone: 218-335-8200 Fax: 218-335-8309

Thank you for your time and attention to this important matter. I look forward to hearing your response at your earliest convenience. If you have any questions or concerns, please contact me at (218) 335-8200.

Sincerely,

Steven Howard
Executive Director
Leech Lake Band of Ojibwe

Cc: Leech Lake Tribal Council Members
Lenny Fineday, LLBO Legal Director
Jim Crawford, Enbridge Project Director

RESOLUTION 32-17

WHEREAS, the Minnesota Chippewa Tribal Executive Committee is the duly elected governing body of the Minnesota Chippewa Tribe, comprised of six member reservations (Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs and White Earth), each of which is separately recognized by the United States as an Indian tribe; and

WHEREAS, the Revised Constitution and Bylaws of the Minnesota Chippewa Tribe provides that the purposes of the tribal organization under the Act of June 18, 1934 (48 Stat. 984) include the conservation of tribal resources and promotion of the general welfare of members of the Tribe; and

WHEREAS, water sustains all life, and the protection of clean water is our sacred responsibility as Anishinabe people; and

WHEREAS, manomin, or wild rice, is also sacred to Anishinabe people, and because all waters are interconnected, even subtle changes in water quality or levels can profoundly harm the health of manomin, which is a trust resource with federal protections; and

WHEREAS, private companies are proposing and planning several oil and gas pipeline and other large infrastructure projects that would cross lands and waters where Tribal members gather wild rice and natural resources, and where Tribal cultural resources are located; and

WHEREAS, construction of such large infrastructure poses a threat to waters, natural resources and cultural resources from disturbance during construction and permanent destruction by project activities; and

WHEREAS, oil pipelines in particular pose a unique threat to Ojibwe in Minnesota where those pipelines cross over, under or through waters, wetlands and ecosystems on which Ojibwe depend for wild rice, fish, game, and other culturally-important natural resources; and

WHEREAS, impacts to natural and cultural resources from large-diameter pipeline construction include streambank degradation, increased sedimentation of waters, long-term wetland disruption, and destruction of fish and wildlife habitat corridors through permanent vegetation removal; and

WHEREAS, wild rice is particularly sensitive to changes in water levels, water quality, increased sedimentation, and pollutants; and

WHEREAS, pipeline proponents deliberately select new pipeline routes with the intent of avoiding all possible environmental review of pipeline projects; and

WHEREAS, as a result, routes for pipelines and other large infrastructure projects frequently avoid passing through Indian reservations and Tribal trust lands but still pass through treaty-ceded territories and tribal aboriginal lands where Tribal members hunt, fish, and gather, and where Tribal cultural resources are located; and

WHEREAS, Enbridge's proposed Line 3 Replacement Project will, if constructed, carry Canadian tar sands oil via 36-inch diameter pipeline through pristine wild rice lakes, waters, rivers and interconnected aquifers of Minnesota including the headwaters of the Mississippi and two other major North American watersheds; and

WHEREAS, many of those wild rice waters, rivers, lakes and aquifers are interconnected downstream and upstream with ecosystems which are the primary sources of natural resources important to Tribal members; and

WHEREAS, many of those interconnected waters flow through Ojibwe treaty-ceded territories and aboriginal lands where Tribal members exercise reserved hunting, fishing and gathering rights and where cultural resources are located, or through Tribal trust lands and Reservations; and

WHEREAS, the Line 3 Replacement Project proposed route fastidiously avoids actually crossing any Indian Reservations or Tribal trust lands yet will still impact important natural and cultural resources; and

WHEREAS, the significance of treaty rights and treaty resources in Minnesota has been acknowledged in judicial decisions that have addressed those rights both on and off reservations; and

WHEREAS, current federal law and state law governing permitting of oil pipelines places greater emphasis on meeting the needs of the pipeline proponent than ensuring that natural resources, cultural resources, and Tribal rights, interests and resources are considered and protected; and

WHEREAS, current Army Corps of Engineers tribal consultation policy requires consultation with tribes on activities that occur within a tribe's aboriginal lands, regardless of land status; and

WHEREAS, the Army Corps of Engineers has looked to guidelines drafted in 1997 (Attached as Exhibit A) when ascertaining its trust responsibilities to Indian tribes and since that time there have been developments in the law both generally and specifically with respect to treaties with Minnesota tribes; and

NOW THEREFORE BE IT RESOLVED that the Tribal Executive Committee hereby requests that the U.S. Army Corps of Engineers initiate early and robust tribal consultation for any infrastructure projects proposed to be located within Ojibwe aboriginal lands, regardless of land status or reservation status; and

BE IT FURTHER RESOLVED that the Tribal Executive Committee hereby requests that such tribal consultations be initiated at the earliest stages of project proposal to allow tribes to identify tribal natural and cultural resources that may be impacted; and

BE IT FURTHER RESOLVED that the Tribal Executive Committee hereby requests that the U.S. Army Corps of Engineers work with Ojibwe tribes in Minnesota and Wisconsin to develop new Clean Water Act Section 404 permitting processes for wild rice waters in recognition of the special impacts created to wild rice resources by activities covered under Section 404; and

BE IT FURTHER RESOLVED that the Tribal Executive Committee hereby requests that the U.S. Army Corps of Engineers seek all necessary authority to condition Section 404 permit approval over infrastructure projects occurring within tribal aboriginal lands with serious potential impacts to tribal cultural and natural resources on receipt of the informed consent of the impacted tribes; and

BE IT FINALLY RESOLVED that the Tribal Executive Committee hereby requests that the U.S. Army Corps of Engineers: (1) consult with the Minnesota Chippewa Tribe and its constituent Bands to update the guidelines (Exhibit A); (2) make a firm unequivocal commitment that it will follow those guidelines and fulfill its trust obligations to Indian tribes; and (3) enter into agreements with the MCT or a constituent Band to establish protocols for tribal input and consultation on proposed actions impacting tribal cultural and natural resources.

We do hereby certify that the foregoing Resolution was duly presented and acted upon by a vote of 9 For, 1 Against (Dennis Morrison), 0 Silent, at a Special Meeting of the Minnesota Chippewa Tribal Executive Committee, a quorum present, held on November 30, 2016 via electronic polling, Cass Lake, Minnesota.

Kevin R. Dupuis, President
THE MINNESOTA CHIPPEWA TRIBE

Melanie Benjamin, Secretary
THE MINNESOTA CHIPPEWA TRIBE

NORMAN W. DESCHAMPE, PRESIDENT
KAREN R. DIVER, VICE PRESIDENT

GARY S. FRAZER, EXECUTIVE DIRECTOR

DONALD FINN, SECRETARY
DAVID C. MORRISON, SR., TREASURER

The Minnesota Chippewa Tribe

Administration
218-335-8581
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Fax : 218-335-8496
Home Loan
218-335-8582
Fax: 218-335-6925
Economic Development
218-335-8583
Fax: 218-335-8496
Education
218-335-8584
Fax: 218-335-2029
Human Services
218-335-8585
Fax: 218-335-8080

February 7, 2014

John Linc Stine, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-419

Re: Definition of "waters used for the production of wild rice"; wild rice water quality standards

Dear Commissioner Stine:

The Minnesota Chippewa Tribe appreciates having the opportunity to continue discussions with your agency regarding the definition of "waters used for the production of wild rice." We commend the Minnesota Pollution Control Agency (MPCA) for the work done to clarify this definition and to strengthen protection for this critical resource. As you know, wild rice is a culturally significant resource for the tribes in Minnesota. From historical reports,[1] Band member accounts,[2] and current Minnesota Department of Natural Resources ("DNR") and tribal reports,[3] wild rice has declined significantly throughout Minnesota, and in southern Minnesota wild rice has virtually disappeared. Minnesota tribes have a unique relationship with the state regarding the protection of wild rice, as demonstrated through multiple rulemaking processes[4] and executive orders.[5]

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[1] Jenks, A.E., The Wild Rice Gatherers of the Upper Great Lakes: A Study in American Primitive Economics (Washington: GPO, 1901), available on-line at http://greatlakeswater.uwex.edu/library/articles-and-white-papers/wild-rice-gatherers-upper-lakes-study-american-primitive-economics (last visited Oct. 12, 2012).

[2] Rosemary Berens, Bois Forte Tribal Historic Preservation Officer

[3] *See, e.g.*, 1854 Treaty Authority website, "Wild Rice Survey" (including list of wild rice waters in the 1854 Ceded Territory), available at http://1854treatyauthority.org/wildrice/survey.htm (last visited Oct. 12, 2012); MN DNR website, "Wild rice management," available at http://www.dnr.state.mn.us/wildlife/shallowlakes/wildrice.html (last visited Oct. 12, 2012).

[4] *See, e.g.*, Laws of Minnesota 2007, chapter 7, article 1, section 168

[5] *See, e.g.*, Executive Order 13-10, "Affirming the Government-to-Government Relationship between the State of Minnesota and the Minnesota Tribal Nations: Providing for Consultation, Coordination, and Cooperation."

Maintain the existing sulfate criterion for protection of wild rice waters

Minnesota tribal staff have participated in and followed closely the MPCA's research program related to the existing sulfate criteria for protecting wild rice waters[6]. Our thorough review and interpretation of the research results for the state-led hydroponics studies, the field surveys, the mesocosm studies, and the sediment studies leads to our conclusion that the existing federally approved sulfate criterion is well-supported by multiple lines of evidence, and should be maintained. There is no scientific defensible basis for raising this sulfate limit, which is the clear benchmark required by the US Environmental Protection Agency for considering approval of a revised criterion[7], as was clearly communicated to the Minnesota legislative body in 2011[8].

The MPCA proposed approach for listing wild rice waters is inconsistent with the Clean Water Act

The Minnesota tribes have fundamental concerns regarding MPCA's proposed approach for meeting the intent of the 2011 state legislation that directs the agency to establish criteria considering "history of wild rice harvests, minimum acreage, and wild rice density."[9] In January of 2014, the Fond du Lac, Grand Portage, Leech Lake, White Earth and Bois Forte Bands communicated clear concerns for the agency's proposed 'watch list' approach in letters to MPCA; specifically, that this approach would violate the Clean Water Act (the Act) and Minnesota water quality standards (WQS). The agency had proposed to create a 'watch list' for those wild rice waters listed by the DNR for which the state lacked specific acreage and/or stand density measurements; only those waters with quantified stands would be formally listed as wild rice waters. The DNR list of Minnesota wild rice waters[10] was compiled as part of a legislatively directed study of the threats to wild rice in Minnesota, and represented significant contributions from Minnesota tribal resource management staff. State and tribal staff also explicitly qualified this 2008 compiled listing as 'not comprehensive', and that it would be continuously updated as new data became available.

Under the Act, the Nation's waters are to be restored and maintained for the protection and propagation of fish, shellfish, and wildlife, and for recreation in and on the water.[11] The goal of a water quality standards program is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.[12] States and authorized Tribes adopt water quality

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[6] http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/minnesotas-sulfate-standard-to-protect-wild-rice.html#assessment

[7] *See, generally,* 40 CFR §§ 131.5, 131.11, and 131.21 (2013).

[8] Letter from USEPA to Sens. Dill, Bakk, May 13, 2011.

[9] Laws of Minnesota 2011, 1st Spec. Sess,, chapter 2, article 4, section 32 –Wild Rice Rulemaking and Research) https://www.revisor.mn.gov/laws/?id=2&doctype=Chapter&year=2011&type=1

[10] MN DNR "Statewide Inventory of Wild Rice Waters" (2008) available at http://www.dnr.state.mn.us/wildlife/shallowlakes/wildrice.html (last visited Jan. 27, 2014).

[11] *See* 33 U.S.C.§ 1251(a)(2).

[12] *Id.*

standards to protect public health, enhance the quality of water, and serve the purposes of the Clean Water Act[13] and are free to add use classifications, as well as adopt any use classification system they see as appropriate (with the exception of waste transport and assimilation, which are not acceptable uses in any case). Among the uses listed in the Act, there is no hierarchy.

A primary objective for classifying a water body is to designate uses by evaluating and describing the ecosystem. "Designated uses" are based on the relationship and quality, i.e., the integrity, of all ecosystem components. States and authorized Tribes, through their approved WQS, specify appropriate, designated uses in order to achieve and protect existing and potential uses.[14] They can select the level of specificity they desire for identifying designated uses and subcategories of uses. Subcategories of aquatic life uses may be on the basis of attainable habitat, innate differences in community structure and function, or fundamental differences in important community components. Special uses may also be designated to protect particularly unique, sensitive, or valuable aquatic species, communities or habitats.

The current state standard for listing wild rice waters is found at Minnesota Rule 7050.0224, "Specific Water Quality Standards for Class 4 Waters of the State: Agriculture and Wildlife," which at Subpart One states:

> The numeric and narrative water quality standards in this part prescribe the qualities or properties of the waters of the state that are necessary for the agriculture and wildlife designated public uses and benefits. Wild rice is an aquatic plant resource found in certain waters within the state. The harvest and use of grains from this plant serve as a food source for wildlife and humans. In recognition of the ecological importance of this resource, and in conjunction with Minnesota Indian tribes, selected wild rice waters have been specifically identified [WR] and listed in part 7050.0470, subpart 1. The quality of these waters and the aquatic habitat necessary to support the propagation and maintenance of wild rice plant species must not be materially impaired or degraded. If the standards in this part are exceeded in waters of the state that have the Class 4 designation, it is considered indicative of a polluted condition which is actually or potentially deleterious, harmful, detrimental, or injurious with respect to the designated uses.

Natural Wild Rice Waters should be classified as a distinct aquatic life use

The fundamental use in §101(a) of the Act for 'protection and propagation of fish, shellfish and wildlife' may also include the protection of aquatic flora. However, the agricultural use class (Minnesota's Class 4 waters) is intended to define *waters that are suitable for the irrigation of crops, consumption by livestock, support of vegetation for range grazing, and other uses in support of farming and ranching and protects livestock and crops from injury due to irrigation*

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[13] *See EPA's* Water Quality Standards Handbook Chapter 2: *Designation of Uses* (40 CFR 131.10) at http://waterepa.gov/scitech/swguidance/standards/handbook/chapter02.cfm

[14] *See* 40 C.F.R. § 131.10 (2013).

and other exposures.[15] The Minnesota tribes have consistently recommended to the MPCA, during multiple consultation sessions over the past three years specifically focusing on wild rice water quality standards, that natural wild rice stands (manoomin) are more appropriately classified under a distinct aquatic life use (i.e., Minnesota's Class 2 waters). It may be appropriate to leave paddy rice, a true cultivated agricultural product, in Class 4, but it is inaccurate and inherently offensive to Minnesota tribes to classify manoomin as a 'crop', and ecologically ignorant to categorize the naturally occurring hydrology of a natural wild rice bed as "irrigation." Irrigation is defined as "...to supply (dry land) with water by means of ditches, pipes, or streams."[16] This is simply not an appropriate or accurate concept for describing a native plant species growing without cultivation in a natural water body.

Wild Rice Waters listed by the Minnesota DNR and Tribes are an 'existing use'

Tribal staff have also elevated the importance of distinguishing between a "designated use" and an "existing use" in consultation with the MPCA. An "existing use" can be demonstrated by either a) that fishing/swimming has actually occurred since November 28, 1975, or b) that the water quality is suitable to allow the use to be attained--unless there are physical problems, such as substrate or flow, that prevent the use from being attained.[17] Following, "No activity is allowable under the antidegradation policy which would partially or completely eliminate any existing use *whether or not that use is designated in a State's water quality standards*. The aquatic protection use is a broad category requiring further explanation. *Non-aberrational resident species must be protected, even if not prevalent in number or importance.* Water quality should be such that it results in no mortality and no significant growth or reproductive impairment of resident species. Any lowering of water quality below this full level of protection is not allowed. A use attainability analysis or other scientific assessment should be used to determine whether the aquatic life population is in fact an artifact or is a stable population requiring water quality protection."[18]

Designated uses may be changed only based upon findings of a use attainability analysis that has demonstrated that attaining the designated use is not possible because of naturally occurring pollutant concentrations, natural flow conditions, hydrologic modifications, substantial widespread economic impact resulting from more stringent controls, or human-caused pollution that cannot be remedied. A designated use cannot be removed if the use can be attained by implementing effluent limits and best management practices.[19] Therefore, attainable uses are, at a minimum, the uses (based on the State's system of water use classification) that can be achieved: (1) when effluent limits under sections 301 (b)(l)(A) and (B) and section 306 of the

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[15] *Id.* at Chapter 2, EPA Water Quality Standards Handbook

[16] Webster's II New College Dictionary (ISBN 0-395-70869-9) 1999. Houghton Mifflin Co.

[17] *See* Chapter 4, Water Quality Standards Handbook, *Protection of Existing Uses*

[18] *Id.*

[19] Per 40 C.F.R. Section 131.10(d), "[w]hen designating uses, States may wish to designate only the uses that are attainable. However, if the State does not designate the uses specified in section 101(a)(2) of the Act, the State must perform a use attainability analysis under section 131.10(j) of the regulation. States are encouraged to designate uses that the State believes can be attained in the future."

Act are imposed on point source dischargers; and (2) when cost-effective and reasonable best management practices are imposed on nonpoint source dischargers.

Minnesota's existing WQS require that the quality of listed and unlisted wild rice waters, and the aquatic habitat necessary to support the propagation and maintenance of wild rice plant species, not be materially impaired or degraded. In other words, Minnesota already requires the listing of *all* wild rice waters, regardless of production—the rules make no distinction based upon productivity.[20] As noted, most of the waters that now appear on MPCA, DNR, and the 1854 Treaty Authority lists *already* have an "existing use" as "waters used for the production of wild rice," whether or not they include an estimate of acres of wild rice present for any given year. These waters must remain on the wild rice waters lists for regulatory purposes. They cannot be pulled off and dropped instead onto the proposed "watch list," in effect, de-listing them as Class 4 waters of the state with the stroke of a pen. The Clean Water Act clearly states that this can only happen after significant process, including a reasoned determination has been made that production of wild rice is a designated use, not an existing use, and based upon the findings of a use attainability analysis, that the designation of "waters used for the production of wild rice" should be eliminated.

If a *designated use* is an *existing use* (as defined in 40 CFR 131.3) for a particular water body, the existing use **cannot be removed** unless a use requiring more stringent criteria is added. However, uses requiring more stringent criteria may **always be added** because doing so reflects the goal of further improvement of water quality. This is entirely consistent with the intent of not only the Clean Water Act goals, but also the intent of the DNR and Tribes in continually updating the list of wild rice waters within the state.

Productivity thresholds are not appropriate for defining wild rice waters

Even if the Act did not prohibit the watch list, it makes no sense as a conservation measure. Minnesota Chippewa Tribe Bands have consistently urged the MPCA to broadly, not narrowly, define wild rice waters, and to be as protective of this diminishing resource as possible. An unnecessarily restrictive list of "waters used for the production of wild rice" is not consistent with the principles of ecosystem management, whereby a management or regulatory agency seeks to maintain ecosystems such as wild rice waters in the appropriate condition to meet that beneficial use, while recognizing that all ecosystems have limited ability to accommodate stressors and still maintain that desired state. Using an arbitrary threshold of productivity to define "waters used for the production of wild rice" ignores the entire body of published scientific research *and* traditional ecological knowledge provided by tribal staff and tribal members that provides substantial evidence of the interannual variability in even traditionally productive waters. Given the scarcity of wild rice productivity and stand density data that the MPCA has compiled at this point in time, it is entirely premature to attempt to incorporate a representative productivity or density metric into the actual definition of a wild rice water body.

Furthermore, the Minnesota tribes with authorized water quality standards would *not* move to a less-inclusive definition or less-protective criterion even if the state adopted it. So the "watch

[20] *See* Minn. R. 7050.0224 subp. 1.

list" would also likely mean an end to an ongoing, cooperative, state-tribal conservation effort and would likely have a ripple effect on other aspects of these relationships, as wild rice is of such central importance to the Bands. As a practical matter, the result would be that the state and tribes would no longer maintain the same wild rice waters lists (at least within the 1854 Ceded Territory and on the reservations), which would undoubtedly create both administrative and permitting problems.

The "watch list" approach would have additional consequences, including delays in the environmental review process for projects with the potential to affect wild rice waters. Minnesota's wild rice waters, whether designated by the state or not, are also federally protected as tribal traditional cultural properties under Section 106 of the National Historic Preservation Act (NHPA).[21] The NHPA requires not only that a project with the potential to impact traditional cultural properties must carefully analyze potential impacts, but also stipulates that appropriate mitigation must be done or a project cannot proceed. If the same waters are not also listed at the state level, it will create a disconnect between the state and federal permitting processes and records, to the detriment of applicants, tribes, and agencies alike.

The Legislative directive can be fulfilled through MPCA's watershed-based monitoring and assessment processes

MPCA should instead continue to list all wild rice waters *regardless* of current levels of production, and should simply add productivity measurements to their assessment database as they become available over time. This is appropriately accomplished through the state's established ten-year cycle for major watershed assessments. MPCA assesses state waters through physical, chemical and biological monitoring. Biological evaluations provide a more precise statement of which species exist in a water body and therefore should be protected, determine the biological health of the water body, and determine the species that could potentially exist in the water body if the physical and chemical factors impairing a particular use were corrected. Over time, with adequate data, the MPCA should be able to make reasonably specific recommendations concerning the natural potential of a water body, levels of attainability consistent with this natural potential, confirm appropriate use designations, and identify impairments. The MPCA can most directly and appropriately address the legislative requirement for considering minimum acreage and wild rice density **through their established monitoring and assessment processes**, rather than struggling to clarify it in the definition of the wild rice designated use.

MPCA should expedite the listing of impaired wild rice waters

We also urge MPCA expedite the listing of "impaired" wild rice waters in order to ensure that water-quality-based effluent limits can be applied to discharges that exceed WQS criteria - just as Minnesota Rules already mandate. Any water body that is currently listed by the DNR, 1854 Treaty Authority, or MPCA as a wild rice water body, and is known to exceed Minnesota sulfate WQS for wild rice, should be designated as "impaired."[22] This would be consistent with the

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[21] *See* 36 C.F.R. §§ 800 *et seq.* (2013)
[22] *See* Minn. R. 7050.0224 subp. 1.

MPCA's approach to designating any other type of impairment with assigned numeric or narrative criteria.

Conclusion

Natural stands of wild rice (manoomin) should be protected as a distinct Class 2 aquatic life use in Minnesota WQS, and the existing sulfate criteria (10 mg/l) should be maintained for this use class. Paddy rice may continue to be appropriately designated for protection under the Class 4 agricultural use. Narrowly defining waters used for the production of wild rice, based upon an arbitrary measure of human harvest potential, is inconsistent with Clean Water Act requirements. Creating a "watch list" to determine if waters already known as "wild rice waters," and listed by on the MN DNR, MPCA, or 1854 Treaty Authority, but that do not have estimated acreages, is also inconsistent with the Act. In order to protect and restore wild rice waters, natural variability in stand density and annual changes in location of stands in both streams and lakes must be acknowledged. The legislative mandate to consider wild rice acreage and stand density is most appropriately dealt with as an integral part of the MPCA's water body monitoring and assessment programs, not as a component of the water quality standard definition.

The goal should be continuing to build an inventory of natural wild rice waters that facilitates both conservation and monitoring, and that will dovetail with other procedures the MPCA is already implementing to require dischargers to do improved quality-assured monitoring. And properly listing impaired wild rice waters will ensure that water quality based effluent limits can be applied to dischargers that exceed Minnesota WQS criteria for the protection of these waters.

Sincerely,

Norman W. Deschampe
President

cc. Patricia Engelking, MPCA
Katrina Kessler, MPCA
Shannon Lotthammer, MPCA
Susan Hedman, US EPA
Tinka Hyde, US EPA
Linda Holst, US EPA

Fond du Lac Band of Lake Superior Chippewa
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May 25, 2016

Jamie MacAlister, Environmental Review Manager
Minnesota Department of Commerce
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Pipeline.Comments@state.mn.us

RE: Scoping Comments Regarding the Sandpiper Pipeline and Line 3 Replacement Projects, PUC Docket Numbers for Sandpiper: PL-6668/CN-13-473 and PPL-13-474; Line 3: PL-9/CN-14-916 and PPL-15-137

Dear Ms. MacAlister:

The Fond du Lac Band of Lake Superior Chippewa is a federally-recognized Indian tribe located in Northeastern Minnesota with a reservation consisting of roughly 100,000 acres. In addition to the reservation, the Band also retains usufructuary rights in an additional 9.5 million acres surrounding the reservation. These lands were ceded to the U.S. Government in the Treaties of 1837 and 1854. The Band retains all rights in the Ceded Territories that were not specifically reserved by treaty, including hunting, fishing, and gathering.

The proposed routes for both Sandpiper and Line 3 cut through the Band's Ceded Territories. The Fond du Lac Band of Lake Superior Chippewa submits the following comments regarding Enbridge's Sandpiper Pipeline and Line 3 Replacement projects.

Climate Change

Any new oil transportation infrastructure serves to encourage the country's reliance on an energy resource that is inherently damaging to the world's climate, locking us into an uncertain future for our children, grandchildren, and all future generations. The pipeline would lead to increasing greenhouse-gas emissions, killing our chances of meeting pollution-reduction targets. Continued reliance on energy from oil is altering many resources on Earth, contributing to devastating climate change.

The effects of a changing climate impact the resources on our reservation and Ceded Territories. Several species of interest to the Band are already being adversely impacted by climate change. Wild rice, for instance, is very dependent on steady water levels during the floating leaf stage. Floods on the Reservation in 2012 destroyed the wild rice crop that year. The steep decline of the moose population in northern Minnesota that has been noted over the past twelve years is believed to have been

exacerbated by hotter summers and the increased occurrence of pests. The emerald ash borer has destroyed stands of ash around the state. The health of many Native people, many of whom suffer from asthma, is worsened by mold outbreaks caused by wetter weather and higher ozone levels caused by a hotter climate. A study completed by the National Wildlife Federation ("Facing the Storm: Indian Tribes, Climate-Induced Weather Extremes, and the Future for Indian Country", 2011) details the many ways in which tribes are disproportionately impacted by climate change and the many challenges tribes face in responding to climate-related disasters.

In evaluating the no-action alternative, the DOC must consider the fact that because of the relatively easy availability of things like the tar sands oil, companies like Enbridge continue to exploit damaging energy sources rather than exploring more sustainable alternatives. Projects like this contribute to a significant loss of carbon sequestration related to the forests and wetlands that will be converted or degraded. This continues to bring us down an unsustainable path of reliance on dirty fossil fuels and more carbon emissions, while simultaneously diminishing the natural landscape's inherent resilience and the natural resource services it provides.

Instead of investing in the Sandpiper Pipeline and re-routing Line 3, the no-action alternative allows more investment in alternative energy infrastructure and promotion. Alternative energy resources like solar, wind, and water have the potential to ultimately replace our reliance on dirty oil.

1837 and 1854 treaty rights

The proposed Sandpiper route would pump 375,000 barrels per day of fracked oil across the Band's Ceded Territories. The Treaties of 1837 and 1854 promised the Band a continuation of sustenance from Reservation and Ceded Territories' water and land. Leaks and ruptures would endanger the Mississippi headwaters, Lake Superior watershed, and the wetlands that the Band relies on for our way of life.

Enbridge has a demonstrated history of negligence in pipeline safety. For instance, in 2010 in Michigan, an Enbridge pipe spilled dilbit into the Kalamazoo River, contaminating nearly forty miles of the river. It's not clear if the river will ever go back to pre-spill quality, as it is now six years after the spill and there remain lingering chemicals and crude oil in the river. In 2012, an Enbridge pipe spilled more than 50,000 gallons of light crude oil in rural Wisconsin.

Any spill from the proposed pipelines would likely render cooking, cleaning, and drinking water unusable for hundreds of years. In addition, many of the wetlands on the reservation are peat; any oil spilled into peat will continue to contaminate our resources for eons.

System Alternative

Any route alternative proposed will impact the Great Lakes, as well as the treaty-protected resources of the Band. If Enbridge is allowed to proceed with the Sandpiper and Line 3 projects, they should be required to move the system entirely away from our forest resources, wetlands, and essential water systems. The route alternative options bring pipelines through the Duluth area and create unnecessary harms to the Band's treaty resources, and to Lake Superior.

Pipeline rights-of-way (ROW) do not allow forest cover, causing fragmentation of the forest, including forested wetlands. In turn, that fragmentation disrupts the free movement of wildlife. In addition, fragmentation provides a corridor for invasive plant species to move through the area, since

most invasive plant species in this area are dependent upon full to partial sunlight provided by pipeline ROWs.

Existing pipelines on the Reservation, both active and inactive, have already negatively impacted our wetlands and forests through fragmentation and wetland degradation. The Band needs very clear assurances that our future generations are not left with an Enbridge graveyard to remember us by.

If the Band is to support a pipeline project at all, any system alternative must completely avoid the Great Lakes, not only in Minnesota but in our Ceded Territories in Wisconsin and Michigan as well. The projects should be moved to more agricultural areas of the state, where the cleanup of the anticipated spills will be easier to access and contain.

Cathodic protection and access road and locations

At numerous locations throughout any pipeline route, Enbridge will need to install cathodic protection as well as access roads. When Enbridge completed their installation of Line 67 (Alberta Clipper) and Line 13 (Southern Lights) through the Fond du Lac Reservation, they did not include any cathodic protection or access road locations in their original wetland permit application. The Band later received a separate wetland permit application for Enbridge to install cathodic protection and access roads in wetlands adjacent to MN Highway 210, essentially "piecemealing" the pipeline project. Enbridge needs to identify all locations to be impacted in their project description so that those facilities can also be properly evaluated.

Eco-system valuation

In 2015 Earth Economics published an eco-system valuation of the St. Louis River watershed, finding that

> [t]he St. Louis River watershed provides an estimated $5 billion to $14 billion in ecosystem service benefits per year which provides each of the approximately 177 thousand people living in the watershed an annual benefit of $28,248 to $79,096.
> https://www.glifwc.org/Events/Earth%20Economics%20St%20Louis%20River%20Project%20Report.pdf.

This innovative study recognizes that quantifying the value of our eco-systems gives us better tools to understand the impact that environmental decisions have on the economy as a whole.

A similar study of the eco-systems that could be impacted by the Sandpiper and Line 3 projects should be done by an independent third party, such as the Great Lakes Indian Fish & Wildlife Commission.

Financial assurances

Enbridge must be held responsible for any oil spill that might happen from its pipelines. Before the company is allowed to take on these projects, it should be required to provide evidence of financial assurance, such as insurance or alternative financial security, which covers the full cost of recovery from any disaster which could happen as a result of the presence of its pipelines. The cost should be evaluated using an eco-system valuation study as discussed in the previous section. Enbridge must show that it has

the resources to cover the full costs of pollution damage as well as both remediation and restoration costs incurred by public and tribal agencies in preventing and cleaning up any spill that could happen.

Enbridge's purpose and need for this project is based on the assumption that the global economy will need more oil. This assumption is not well-founded, given recent international commitments to reduce carbon emissions as well as recent plunges in global oil markets. The DOC should fully analyze the no-build, no-replacement alternative, including a full quantification carbon impacts.

The Band looks forward to continued consultation on these issues.

Sincerely,

Wally Dupuis
Chairman

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June 7, 2016

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RE: Scoping Comments Regarding the Sandpiper Pipeline Project and the Line 3 Replacement Pipeline Project, PUC Docket Numbers for Sandpiper: PL-6668/CN-13-473 and PPL-13-474; Line 3: PL-9/CN-14-916 and PPL-15-137

Dear Ms. MacAlister:

The Sandpiper Route Alternative-37 (RA-37), which would traverse through the southern edge of the external boundary of the Fond du Lac Reservation, has been reviewed pursuant to the responsibilities given to the Fond du Lac Tribal Historic Preservation Office (THPO) by the National Historic Preservation Act (NHPA) of 1966 and the Procedures of the Advisory Council on Historic Preservation (36CFR800).

A spatial/graphic review of Fond du Lac's Cultural Resources Inventory identified that RA–37 would traverse within Fond du Lac's Cultural Preservation Zone that includes significant cultural/natural resources that provide a water source and several wild rice waters that the Band depends upon. Wild rice is basic to the traditional diet and important both culturally and spiritually as well as a central element in feasts and ceremonies. The quality of these waters and the aquatic habitat is essentially important to Band members.

From a cultural perspective, in recognition of the ecological importance of key cultural/natural resources within the external boundary of the Reservation, our concerns in regard to RA-37 footprint from both direct and indirect damage potential are substantial.

The Fond du Lac Band of Lake Superior Chippewa strongly requests that the Route Alternative RA-37 be omitted from the EIS Scoping Decision Document and no further analysis of this alternative be conducted.

The Band looks forward to continued coordination and consultation on this issue.

Sincerely,

Wally Dupuis

Wally Dupuis
Chairman

NATIONAL CONGRESS OF AMERICAN INDIANS

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The National Congress of American Indians
Resolution #MSP-15-040

TITLE: Calling for Environmental Justice and a Full Environmental Impact Statement on Enbridge Energy's Proposed Tar-Sands Oil Pipeline Across Treaty-Ceded Territory in Minnesota

WHEREAS, we, the members of the National Congress of American Indians of the United States, invoking the divine blessing of the Creator upon our efforts and purposes, in order to preserve for ourselves and our descendants the inherent sovereign rights of our Indian nations, rights secured under Indian treaties and agreements with the United States, and all other rights and benefits to which we are entitled under the laws and Constitution of the United States, to enlighten the public toward a better understanding of the Indian people, to preserve Indian cultural values, and otherwise promote the health, safety and welfare of the Indian people, do hereby establish and submit the following resolution; and

WHEREAS, the National Congress of American Indians (NCAI) was established in 1944 and is the oldest and largest national organization of American Indian and Alaska Native tribal governments; and

WHEREAS, Manoomin, or Wild Rice, is a sacred food to the Anishinaabe of tremendous spiritual and cultural importance, a federally-protected tribal resource, and tribal harvesters in Minnesota are the largest producers of hand-harvested wild rice in the United States; and

WHEREAS, tribal governments throughout Minnesota and Wisconsin have significant concerns that the development of, and any release from, Enbridge Corporation's Sandpiper oil pipeline along its proposed route would have devastating impacts on unique spiritual and cultural resources, as the proposed pipeline route will cross directly through the most sensitive wild-rice producing lakes and rivers within the treaty-ceded territories in Minnesota; and

WHEREAS, over tribal objections, the Minnesota Public Utilities Commission (MPUC) rescheduled its determination meeting to a date two weeks earlier than the notice provided to tribes, and no testimony from the tribes' own hearings could be entered into the MPUC record; and

WHEREAS, the MPUC issued a project determination of need approval on June 5, 2015, without any tribal consultation, consideration of testimony, investigation of impacts to tribal resources, or environmental justice issues—raising the concern that future approvals will issue in a similarly perfunctory manner; and

WHEREAS, Enbridge has begun initial consultation with the U.S. Army Corps of Engineers regarding Section 404 Permits for the project, and the U.S. Environmental Protection Agency (EPA) will perform, at least, a consulting role under Section 106 of the National Historic Preservation Act and oversight on the Army Corps' environmental impact statement, pursuant to Section 309 of the Clean Air Act.

NOW THEREFORE BE IT RESOLVED, that the NCAI calls upon EPA to engage with the Army Corps immediately to stress concerns and advocate for the most thorough environmental review possible, including respect of tribal resources and environmental justice issues; and

BE IT FURTHER RESOLVED, that EPA must assist the appropriate Bands of Chippewa/Ojibwe to become designated as "cooperating agencies" during NEPA review; and

BE IT FURTHER RESOLVED, that EPA urge that a joint Federal-State Environmental Impact Statement be undertaken to enhance coordination around novel and complex tribal resource and environmental issues; and

BE IT FURTHER RESOLVED, that NCAI requests that EPA investigate whether the pipeline requires other federal environmental permits that fall within the agency's direct jurisdiction; require a jurisdictional determination be made by Army Corps; designate a high-level EPA official as a liaison to tribal governments on all aspects of the Sandpiper project; and meet with the affected tribes and bands following issuance of the recommendations from the June 5, 2015, hearing on the Sandpiper pipeline; and

BE IT FINALLY RESOLVED, that this resolution shall be the policy of NCAI until it is withdrawn or modified by subsequent resolution.

CERTIFICATION

The foregoing resolution was adopted by the General Assembly at the 2015 Midyear Session of the National Congress of American Indians, held at the St. Paul River Centre, St. Paul, MN, June 28 to July 1, 2015, with a quorum present.

Brian Cladoosby, President

ATTEST:

Aaron Payment, Recording Secretary

RESOLUTION 72-17

WHEREAS, the Minnesota Chippewa Tribal Executive Committee is the duly elected governing body of the Minnesota Chippewa Tribe (MCT), comprised of six member reservations (Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs and White Earth), each of which is separately recognized by the United States as an Indian tribe; and

WHEREAS, the Revised Constitution and Bylaws of the Minnesota Chippewa Tribe provides that the purposes of the tribal organization under the Act of June 18, 1934 (48 Stat. 984) include the conservation of tribal resources and promotion of the general welfare of members of the Tribe; and

WHEREAS, water sustains all life, and the protection of clean water is high on our list of sacred responsibilities as Anishinabe people; and

WHEREAS, because manoomin, or wild rice, is also sacred to Anishinabe people, it has been recognized by the federal government as a trust resource with protections to guarantee its survival; and

WHEREAS, because all surface waters and ground waters are interconnected, even subtle changes in water quality or levels can profoundly harm the health of manoomin; and

WHEREAS, private companies have been planning several oil pipelines, underground and strip mines, and other large infrastructure projects that will cross and/or impact lands and waters where Tribal members gather wild rice and other natural resources, and where Tribal cultural resources are located; and

WHEREAS, construction of large infrastructure and large energy projects pose substantial threats to waters, natural resources and important cultural resources from disturbance during construction and permanent environmental destruction through ongoing project activities; and

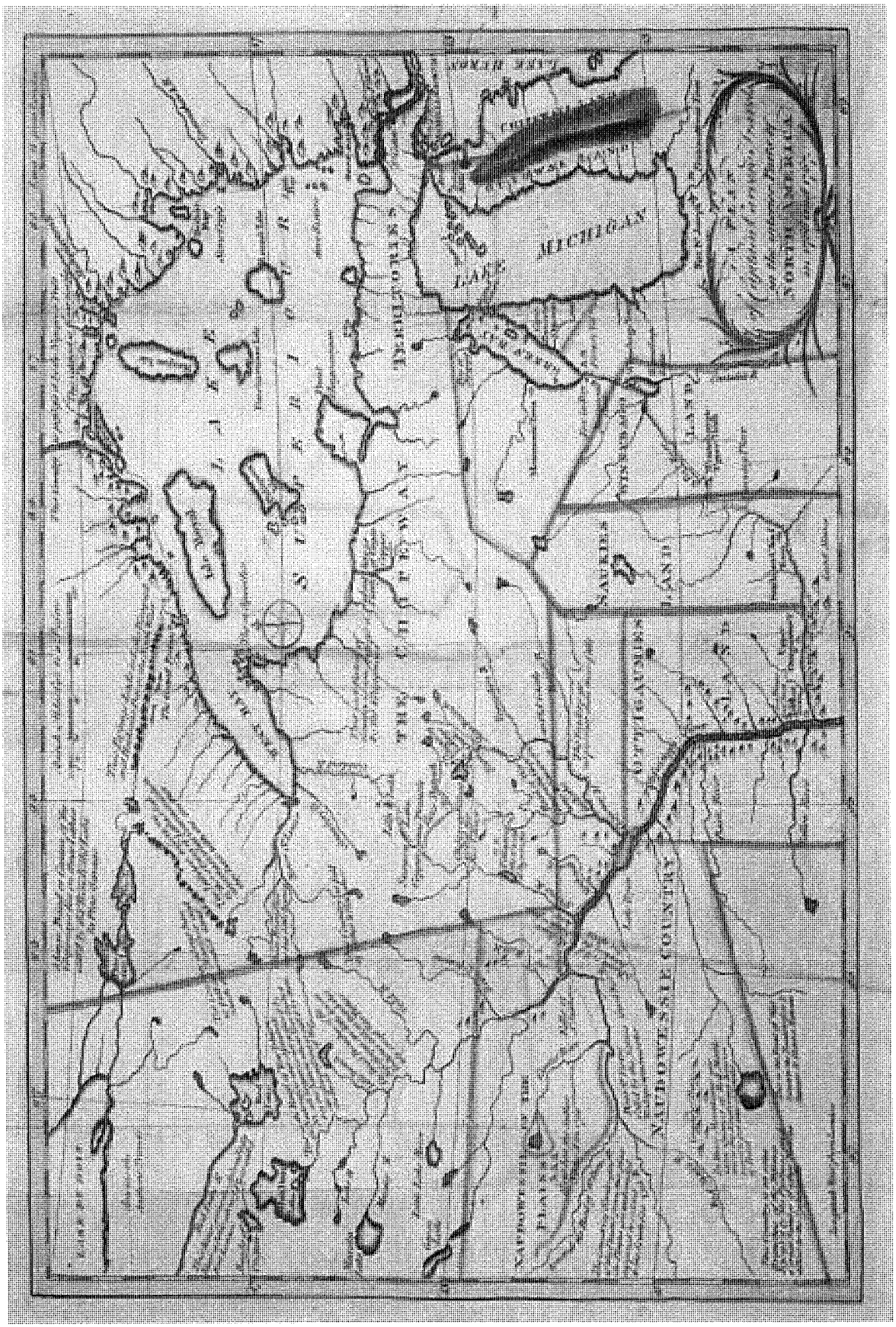
WHEREAS, it is now essential for the MCT to conduct a tribal cumulative impacts analysis with input and collaboration among the MCT Bands that may be incorporated into the administrative record of an EIS to preserve legal arguments and standing; and to also serve as substantive, relevant comments for any future proposed large infrastructure project that may impact reservations, treaty lands or treaty-protected resources; and

BE IT FURTHER RESOLVED, that the Tribal Executive Committee hereby directs that such *tribal cumulative impacts assessment* be initiated immediately to allow Bands to identify tribal natural and cultural resources that may be impacted by the large infrastructure projects; and

We do hereby certify that the foregoing Resolution was duly presented and acted upon by a vote of 8 For, 1 Against, 1 Silent, at a Special Meeting of the Minnesota Chippewa Tribal Executive Committee, a quorum present, held on March 15, 2017 at Hinckley, Minnesota.

Kevin R. Dupuis Sr., President
THE MINNESOTA CHIPPEWA TRIBE

Melanie Benjamin, Secretary
THE MINNESOTA CHIPPEWA TRIBE



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PO BOX 418
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1855 TREATY AUTHORITY

EAST LAKE ♦ LEECH LAKE ♦ MILLE LACS ♦ SANDY LAKE ♦ WHITE EARTH

December 30, 2016

Lawrence Roberts, Principal Deputy
Assistant Secretary - Indian Affairs
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Office of Tribal Justice
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Washington, DC 20530-0001
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Re: Guidance on how federal agencies can better ensure meaningful tribal input into infrastructure-related reviews and decisions
AND
Minnesota Chippewa Tribe environmental protection
Resolutions 30-17 and 32-17

Dear Administrators:

Please accept this letter along with the two (2) Minnesota Chippewa Tribe Resolutions adopted last month as tribal input for the 2016 consultation period that just concluded. We share your understanding the tribal nations voices must be

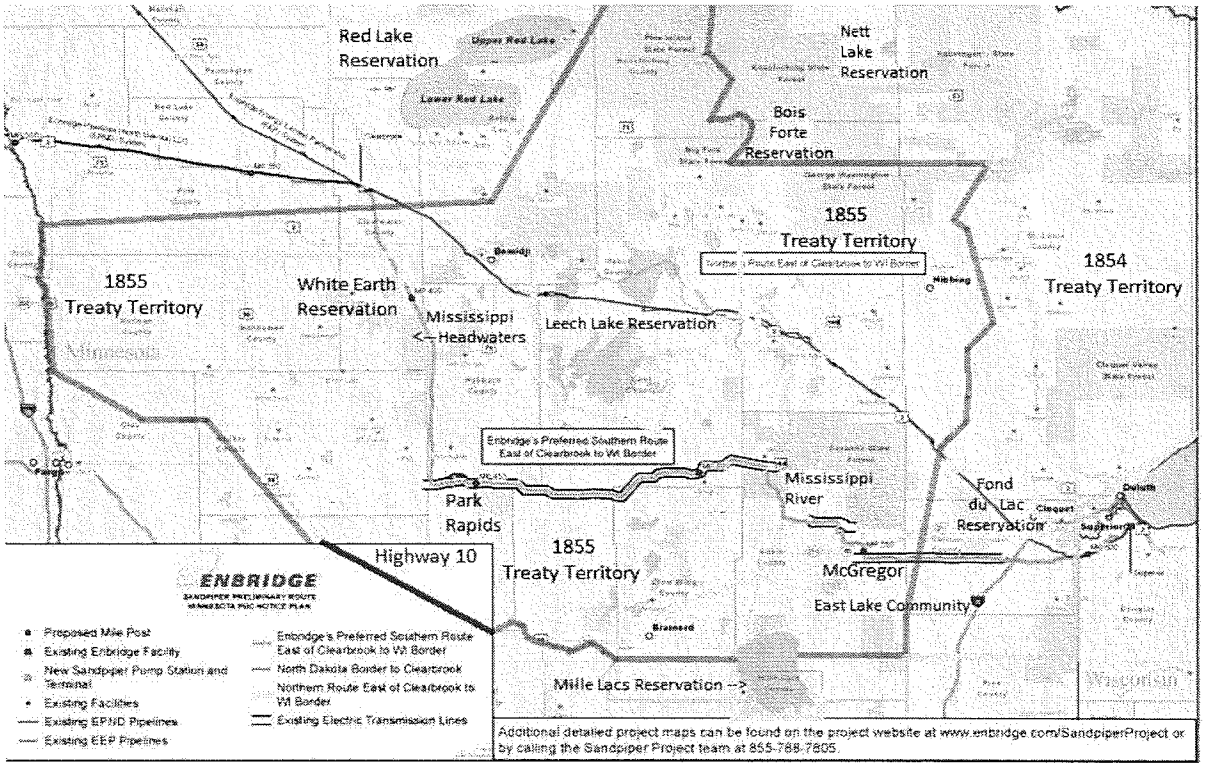
heard with regard to federal decisions that will affect our treaties, homelands, environment, cultural properties, and sacred sites. The two (2) MCT resolutions provide tribal guidance on how federal agencies can better ensure meaningful tribal input into infrastructure-related reviews and decisions, to protect tribal lands, resources, and treaty rights within the existing statutory framework.

Additionally, the MCT Resolutions request federal coordination with US Army Corps of Engineers to develop new Clean Water Act Section 404 permitting processes for wild rice waters in recognition of the special impacts created to wild rice resources, and to condition 404 permit approval over infrastructure projects occurring within tribal aboriginal lands with serious potential impacts to tribal cultural and natural resources on receipt of the informed consent of the impacted tribes, and that the US Army Corps of Engineers:

> (1) consult with the Minnesota Chippewa Tribe and its constituent Bands to update the guidelines (Exhibit A);
> (2) make a firm unequivocal commitment that it will follow those guidelines and fulfill its trust obligations to Indian tribes; and
> (3) enter into agreements with the MCT or a constituent Band to establish protocols for tribal input and consultation on proposed actions impacting tribal cultural and natural resources.

The 1855 Treaty Authority is comprised of approximately 30,000 tribal members of the 40,000 enrolled members of the MCT. The majority of the environmental impacts from the proposed Line 3 Pipeline project will occur within the 1855 ceded territory by (1) establishing a new, east-west pipeline corridor where none previously exists, crossing new aquifers and wild rice lakes and rivers, and (2) by abandoning many miles of pipeline in the Mainline corridor of previously compromised wild rice lakes and rivers and aquifers. The Enbridge Sandpiper pipeline map has been modified to identify the 1855 and 1854 ceded territories and

Minnesota Chippewa reservations and is the same preferred corridor for Enbridge's Line 3 Replacement route.



The concerns and goals represented in the two MCT Resolutions identify the same problem areas facing all of *Indian Country* and ultimately resulting in the Dakota Access pipeline standoff; (1) States acting as though states can unilaterally risk important environmental and cultural tribal resources, and (2) the United States Army Corps of Engineers failing to fulfill trust responsibility described under the 1997 Issue Paper. (See Exhibit A attached to MCT Res. 32-17).

We believe it is important to work with the DOI, BIA, DOJ, EPA and USACE to develop a 2017 Issue Paper to provide guidance for all the federal agencies and states for tribal consultation. While the MCT EIS (Res. 30-17) process is important for self-governance and environmental protection, it will best be

accomplished in a new cooperative model with the aforementioned federal agencies. A good place to start is with the EIS how to identify our necessary and important cultural resources while recognizing the number one global threat identified by the Department of Defense is climate change and will necessarily require a full cycle environmental analysis as described by the EPA. The MCTEIS Coordinator is Michael Northbird and may be reached at 218-335-8581, ext. 128 and mnorthbird@mnchippewatribe.org Meetings regarding the preparation of the MCT EIS and public notices for upcoming information sessions to take comments or other hearings are scheduled in the near future, starting with Leech Lake Reservation on January 4, 2017.

We look forward to hearing back from you in the near future about upgrading the 1997 Issue Paper with regard to Chippewa treaty rights and developing a broader tribal guidance paper of how the Corps of Engineers may better carry out its trust responsibilities.

If you have any questions, or if I may be of further assistance, please call on me at 218-760-1258 or via email at frankbibeau@gmail.com. Mii gwitch.

Best wishes,

/s/ Frank Bibeau

Frank Bibeau
Executive Director

Enclosures: (3)

cc: Kevin DuPuis, MCT President
Gary Frazer, MCT Executive Director
Michael Northbird, MCT Environmental Program Coordinator
1855 Treaty Authority
Danny Gogal, EPA Environmental Justice
Ken Westlake, EPA Region 5
Justin Lock, DOJ

Appendix Q

Environmental Justice Statistics in Affected Counties in Minnesota

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Table Q-1 Minority Population

State/County/Census Tract	Percent Minority Population	If 10 Percentage Points Higher than County Level	If 10 Percent Points Higher than State Level	If 50 Percent of Total Population Minority
Minnesota	18.3			
Aitkin County	5.6			
Census Tract 7701	5.4			
Census Tract 7702	6.6			
Census Tract 7703	3.8			
Census Tract 7704	12.1			
Census Tract 7905.01	2.4			
Census Tract 7905.02	2.6			
Beltrami County	26.6			
Census Tract 4501	11.9			
Census Tract 4502	10.4			
Census Tract 4503	6.1			
Census Tract 4504	9.6			
Census Tract 4505	3.6			
Census Tract 4506	19.7			
Census Tract 4507.01	22.9			
Census Tract 4507.02	22.5			
Census Tract 9400.01	96.8	TRUE	TRUE	TRUE
Census Tract 9400.02	46.1	TRUE	TRUE	
Benton County	7.3			
Census Tract 201	4.7			
Census Tract 202.02	2.8			
Census Tract 202.03	6.6			
Census Tract 202.05	1.7			
Census Tract 202.06	6.4			
Census Tract 203	2.8			
Census Tract 211.01	7.2			
Census Tract 211.02	10.1			
Census Tract 212	15.5			
Carlton County	11.4			
Census Tract 701	13.1			
Census Tract 702	9.0			
Census Tract 703	4.2			
Census Tract 704	6.6			
Census Tract 705	10.1			
Census Tract 706	4.3			
Census Tract 9400	49.7	TRUE	TRUE	

Table Q-1 Minority Population

State/County/Census Tract	Percent Minority Population	If 10 Percentage Points Higher than County Level	If 10 Percent Points Higher than State Level	If 50 Percent of Total Population Minority
Cass County	15.8			
Census Tract 9400.01	24.7			
Census Tract 9400.02	72.9	TRUE	TRUE	TRUE
Census Tract 9601	9.3			
Census Tract 9602	20.3			
Census Tract 9603.01	1.9			
Census Tract 9603.02	2.5			
Census Tract 9606	6.8			
Census Tract 9607	2.5			
Census Tract 9608.01	1.9			
Census Tract 9608.02	5.8			
Clearwater County	14.2			
Census Tract 1	9.7			
Census Tract 2	25.3	TRUE		
Census Tract 3	8.4			
Crow Wing County	4.5			
Census Tract 9501	1.2			
Census Tract 9502.04	2.0			
Census Tract 9504	3.8			
Census Tract 9505.01	3.4			
Census Tract 9505.02	1.4			
Census Tract 9507	6.4			
Census Tract 9508	3.6			
Census Tract 9509	2.3			
Census Tract 9510	5.9			
Census Tract 9511	8.6			
Census Tract 9512	11.6			
Census Tract 9513.01	1.5			
Census Tract 9513.02	5.8			
Census Tract 9514	4.5			
Census Tract 9516	6.3			
Census Tract 9517	1.7			
Hubbard County	6.5			
Census Tract 701	9.5			
Census Tract 702	4.2			
Census Tract 703	7.5			
Census Tract 704	6.0			
Census Tract 705	4.7			
Census Tract 706	7.1			
Census Tract 707	3.4			

Table Q-1 Minority Population

State/County/Census Tract	Percent Minority Population	If 10 Percentage Points Higher than County Level	If 10 Percent Points Higher than State Level	If 50 Percent of Total Population Minority
Itasca County	7.7			
Census Tract 4801	6.0			
Census Tract 4803	11.7			
Census Tract 4804	5.4			
Census Tract 4805	6.8			
Census Tract 4806	1.4			
Census Tract 4807	6.2			
Census Tract 4808.01	5.7			
Census Tract 4808.02	4.3			
Census Tract 4809	4.6			
Census Tract 4810	7.9			
Census Tract 9400	34.7	TRUE	TRUE	
Kanabec County	4.7			
Census Tract 4801	6.6			
Census Tract 4802	4.3			
Census Tract 4803	3.7			
Census Tract 4804	4.4			
Kittson County	3.6			
Census Tract 901	3.1			
Census Tract 902	4.2			
Marshall County	6.0			
Census Tract 801	3.5			
Census Tract 802	2.8			
Census Tract 803	10.0			
Census Tract 804	7.4			
Mille Lacs County	10.1			
Census Tract 1704	3.9			
Census Tract 1705	5.9			
Census Tract 1706	5.9			
Census Tract 1707	8.1			
Census Tract 9701	10.6			
Census Tract 9702	40.4	TRUE	TRUE	
Census Tract 9703	5.1			
Morrison County	3.7			
Census Tract 7801	2.7			
Census Tract 7802	3.7			
Census Tract 7803	4.4			
Census Tract 7804	1.6			
Census Tract 7805	3.5			
Census Tract 7806	6.6			
Census Tract 7807	1.6			
Census Tract 7808	2.5			

Table Q-1 Minority Population

State/County/Census Tract	Percent Minority Population	If 10 Percentage Points Higher than County Level	If 10 Percent Points Higher than State Level	If 50 Percent of Total Population Minority
Pennington County	8.7			
Census Tract 901	9.9			
Census Tract 902	13.2			
Census Tract 903	1.8			
Census Tract 904	10.6			
Census Tract 905	6.8			
Pine County	10.1			
Census Tract 9501	4.9			
Census Tract 9502	6.4			
Census Tract 9503	5.1			
Census Tract 9504	25.9	TRUE		
Census Tract 9505	11.6			
Census Tract 9506	8.1			
Census Tract 9507	3.9			
Census Tract 9508	4.1			
Polk County	11.0			
Census Tract 201	14.8			
Census Tract 202	14.5			
Census Tract 203	9.9			
Census Tract 204	2.3			
Census Tract 205	7.3			
Census Tract 206	14.3			
Census Tract 207	25.9	TRUE		
Census Tract 208	5.8			
Census Tract 209	5.7			
Census Tract 210	7.6			
Red Lake County	6.9			
Census Tract 101	8.0			
Census Tract 102	5.9			
St. Louis County	8.3			
Census Tract 1	4.1			
Census Tract 10	6.5			
Census Tract 101	4.0			
Census Tract 102	2.5			
Census Tract 103	3.7			
Census Tract 104	3.3			
Census Tract 105	4.8			
Census Tract 106	5.7			
Census Tract 11	6.8			
Census Tract 111	4.6			
Census Tract 112	20.1	TRUE		
Census Tract 113	2.3			

Table Q-1 Minority Population

State/County/Census Tract	Percent Minority Population	If 10 Percentage Points Higher than County Level	If 10 Percent Points Higher than State Level	If 50 Percent of Total Population Minority
Census Tract 114	2.7			
Census Tract 12	22.0	TRUE		
Census Tract 121	2.5			
Census Tract 122	10.0			
Census Tract 123	8.3			
Census Tract 124	6.2			
Census Tract 125	5.6			
Census Tract 126	6.5			
Census Tract 127	9.0			
Census Tract 128	2.7			
Census Tract 13	15.3			
Census Tract 130	5.0			
Census Tract 131	19.7	TRUE		
Census Tract 132	4.9			
Census Tract 133	6.1			
Census Tract 134	5.6			
Census Tract 135	2.0			
Census Tract 136	1.8			
Census Tract 138	3.7			
Census Tract 139	2.1			
Census Tract 14	17.7			
Census Tract 140	1.5			
Census Tract 141	3.5			
Census Tract 151	3.2			
Census Tract 152	6.2			
Census Tract 153	1.9			
Census Tract 154	9.5			
Census Tract 155	23.6	TRUE		
Census Tract 156	33.2	TRUE	TRUE	
Census Tract 157	12.2			
Census Tract 158	6.1			
Census Tract 16	26.3	TRUE		
Census Tract 17	15.6			
Census Tract 18	24.7	TRUE		
Census Tract 19	27.9	TRUE		
Census Tract 2	5.7			
Census Tract 20	13.1			
Census Tract 22	6.3			
Census Tract 23	2.7			
Census Tract 24	7.9			
Census Tract 26	12.2			
Census Tract 29	5.0			
Census Tract 3	16.6			
Census Tract 30	9.4			
Census Tract 33	13.9			
Census Tract 34	5.4			
Census Tract 36	3.0			

Table Q-1 Minority Population

State/County/Census Tract	Percent Minority Population	If 10 Percentage Points Higher than County Level	If 10 Percent Points Higher than State Level	If 50 Percent of Total Population Minority
Census Tract 37	10.7			
Census Tract 38	5.2			
Census Tract 4	8.3			
Census Tract 5	12.1			
Census Tract 6	5.6			
Census Tract 7	5.4			
Census Tract 9	10.1			
Census Tract 9901	0.0			
Todd County	8.1			
Census Tract 7901	4.8			
Census Tract 7902	3.9			
Census Tract 7903	5.6			
Census Tract 7904	4.1			
Census Tract 7905	2.2			
Census Tract 7906	31.5	TRUE	TRUE	
Census Tract 7907	2.4			
Census Tract 7908	3.6			
Wadena County	5.0			
Census Tract 4801	4.5			
Census Tract 4802	5.6			
Census Tract 4803	4.6			
Total True		18	8	2

Table Q-2 Native American Population

State/County/Census Tract	Native American or in Combination with Another Race	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 50 Percent of Total Population Native American
Minnesota	1.9			
Aitkin County	3.5			
Census Tract 7701	2.8			
Census Tract 7702	4.2			
Census Tract 7703	1.6			
Census Tract 7704	9.4			
Census Tract 7905.01	1.2			
Census Tract 7905.02	1.0			
Beltrami County	23.0			
Census Tract 4501	9.4			
Census Tract 4502	6.3			
Census Tract 4503	3.7			
Census Tract 4504	6.0			
Census Tract 4505	3.3			
Census Tract 4506	11.4			
Census Tract 4507.01	20.8		TRUE	
Census Tract 4507.02	18.2		TRUE	
Census Tract 9400.01	93.8	TRUE	TRUE	TRUE
Census Tract 9400.02	44.0	TRUE	TRUE	
Benton County	0.9			
Census Tract 201	1.0			
Census Tract 202.02	0.6			
Census Tract 202.03	0.3			
Census Tract 202.05	0.5			
Census Tract 202.06	0.2			
Census Tract 203	0.3			
Census Tract 211.01	0.5			
Census Tract 211.02	1.0			
Census Tract 212	2.4			
Carlton County	7.2			
Census Tract 701	8.1			
Census Tract 702	4.3			
Census Tract 703	1.6			
Census Tract 704	2.3			
Census Tract 705	4.4			
Census Tract 706	1.7			
Census Tract 9400	46.9	TRUE	TRUE	

Table Q-2 Native American Population

State/County/Census Tract	Native American or in Combination with Another Race	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 50 Percent of Total Population Native American
Cass County	13.2			
Census Tract 9400.01	23.0		TRUE	
Census Tract 9400.02	69.2	TRUE	TRUE	TRUE
Census Tract 9601	6.5			
Census Tract 9602	18.7		TRUE	
Census Tract 9603.01	0.9			
Census Tract 9603.02	0.6			
Census Tract 9606	2.1			
Census Tract 9607	1.5			
Census Tract 9608.01	0.7			
Census Tract 9608.02	1.1			
Clearwater County	11.7			
Census Tract 1	6.8			
Census Tract 2	23.2	TRUE	TRUE	
Census Tract 3	5.9			
Crow Wing County	1.6			
Census Tract 9501	0.0			
Census Tract 9502.04	1.2			
Census Tract 9504	0.8			
Census Tract 9505.01	0.8			
Census Tract 9505.02	0.0			
Census Tract 9507	2.1			
Census Tract 9508	1.0			
Census Tract 9509	2.3			
Census Tract 9510	1.6			
Census Tract 9511	3.6			
Census Tract 9512	2.7			
Census Tract 9513.01	0.1			
Census Tract 9513.02	1.1			
Census Tract 9514	1.7			
Census Tract 9516	4.6			
Census Tract 9517	0.5			
Hubbard County	3.6			
Census Tract 701	5.9			
Census Tract 702	1.1			
Census Tract 703	5.4			
Census Tract 704	3.7			
Census Tract 705	1.4			
Census Tract 706	3.9			
Census Tract 707	2.1			
	3.6			

Table Q-2 Native American Population

State/County/Census Tract	Native American or in Combination with Another Race	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 50 Percent of Total Population Native American
Itasca County	5.0			
Census Tract 4801	3.2			
Census Tract 4803	9.1			
Census Tract 4804	3.4			
Census Tract 4805	2.3			
Census Tract 4806	0.4			
Census Tract 4807	3.3			
Census Tract 4808.01	2.3			
Census Tract 4808.02	2.2			
Census Tract 4809	2.4			
Census Tract 4810	5.0			
Census Tract 9400	29.9	TRUE	TRUE	
Kanabec County	1.5			
Census Tract 4801	2.8			
Census Tract 4802	1.6			
Census Tract 4803	1.2			
Census Tract 4804	1.0			
Kittson County	0.5			
Census Tract 901	0.6			
Census Tract 902	0.4			
Marshall County	1.0			
Census Tract 801	1.8			
Census Tract 802	1.0			
Census Tract 803	0.5			
Census Tract 804	0.6			
Mille Lacs County	6.7			
Census Tract 1704	1.3			
Census Tract 1705	1.5			
Census Tract 1706	3.0			
Census Tract 1707	4.5			
Census Tract 9701	8.2			
Census Tract 9702	35.0	TRUE	TRUE	
Census Tract 9703	3.4			
Morrison County	0.9			
Census Tract 7801	0.5			
Census Tract 7802	0.8			
Census Tract 7803	0.6			
Census Tract 7804	0.5			
Census Tract 7805	1.6			
Census Tract 7806	2.4			
Census Tract 7807	0.1			
Census Tract 7808	0.1			

Table Q-2 Native American Population

State/County/Census Tract	Native American or in Combination with Another Race	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 50 Percent of Total Population Native American
Pennington County	2.3			
Census Tract 901	1.4			
Census Tract 902	4.5			
Census Tract 903	0.3			
Census Tract 904	2.8			
Census Tract 905	1.8			
Pine County	4.0			
Census Tract 9501	1.8			
Census Tract 9502	1.7			
Census Tract 9503	2.6			
Census Tract 9504	9.1			
Census Tract 9505	6.8			
Census Tract 9506	3.3			
Census Tract 9507	0.9			
Census Tract 9508	1.1			
Polk County	2.4			
Census Tract 201	3.0			
Census Tract 202	4.7			
Census Tract 203	2.9			
Census Tract 204	0.3			
Census Tract 205	1.6			
Census Tract 206	2.3			
Census Tract 207	2.8			
Census Tract 208	0.9			
Census Tract 209	2.6			
Census Tract 210	3.1			
Red Lake County	2.5			
Census Tract 101	3.4			
Census Tract 102	1.7			
St. Louis County	3.4			
Census Tract 1	1.0			
Census Tract 10	1.2			
Census Tract 101	0.0			
Census Tract 102	2.1			
Census Tract 103	1.3			
Census Tract 104	1.1			
Census Tract 105	1.6			
Census Tract 106	1.3			
Census Tract 11	2.4			
Census Tract 111	2.3			
Census Tract 112	17.5	TRUE	TRUE	
Census Tract 113	1.5			

Table Q-2 Native American Population

State/County/Census Tract	Native American or in Combination with Another Race	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 50 Percent of Total Population Native American
Census Tract 114	1.7			
Census Tract 12	6.1			
Census Tract 121	1.0			
Census Tract 122	6.2			
Census Tract 123	1.0			
Census Tract 124	1.0			
Census Tract 125	0.5			
Census Tract 126	2.9			
Census Tract 127	3.4			
Census Tract 128	2.1			
Census Tract 13	6.9			
Census Tract 130	1.8			
Census Tract 131	16.5	TRUE	TRUE	
Census Tract 132	4.1			
Census Tract 133	3.1			
Census Tract 134	1.5			
Census Tract 135	0.1			
Census Tract 136	0.7			
Census Tract 138	0.4			
Census Tract 139	1.4			
Census Tract 14	2.8			
Census Tract 140	1.4			
Census Tract 141	3.1			
Census Tract 151	1.3			
Census Tract 152	4.6			
Census Tract 153	0.3			
Census Tract 154	9.2			
Census Tract 155	21.9	TRUE	TRUE	
Census Tract 156	10.5			
Census Tract 157	2.7			
Census Tract 158	1.0			
Census Tract 16	6.9			
Census Tract 17	4.8			
Census Tract 18	9.9			
Census Tract 19	5.5			
Census Tract 2	1.6			
Census Tract 20	5.8			
Census Tract 22	1.2			
Census Tract 23	1.4			
Census Tract 24	6.0			
Census Tract 26	7.2			
Census Tract 29	1.7			
Census Tract 3	3.3			
Census Tract 30	4.1			
Census Tract 33	5.0			
Census Tract 34	1.2			
Census Tract 36	2.5			

Table Q-2 Native American Population

State/County/Census Tract	Native American or in Combination with Another Race	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 50 Percent of Total Population Native American
Census Tract 37	3.5			
Census Tract 38	2.1			
Census Tract 4	1.7			
Census Tract 5	3.9			
Census Tract 6	3.3			
Census Tract 7	0.0			
Census Tract 9	3.0			
Census Tract 9901	0.0			
Todd County	1.0			
Census Tract 7901	1.5			
Census Tract 7902	1.7			
Census Tract 7903	1.7			
Census Tract 7904	0.7			
Census Tract 7905	1.3			
Census Tract 7906	0.0			
Census Tract 7907	0.6			
Census Tract 7908	0.8			
Wadena County	1.3			
Census Tract 4801	0.6			
Census Tract 4802	0.9			
Census Tract 4803	2.3			
Total True		10	14	2

Table Q-3 Poverty Population

EJ Census Tracts: 185 PERCENT OF POVERTY
Counties with Proposed or Alternate Route Crossing

State/County/Census Tract	Percentage Below 185 Percent of Poverty Level	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 40 Percent of Population Below 185 Percent
Minnesota	24.3			
Aitkin County	34.0			
Census Tract 7701	25.2			
Census Tract 7702	35.2		TRUE	
Census Tract 7703	42.3		TRUE	TRUE
Census Tract 7704	42.5		TRUE	TRUE
Census Tract 7905.01	33.0			
Census Tract 7905.02	22.7			
Beltrami County	38.9			
Census Tract 4501	30.2			
Census Tract 4502	23.4			
Census Tract 4503	21.5			
Census Tract 4504	35.0		TRUE	
Census Tract 4505	33.4			
Census Tract 4506	54.6	TRUE	TRUE	TRUE
Census Tract 4507.01	38.7		TRUE	
Census Tract 4507.02	42.7		TRUE	TRUE
Census Tract 9400.01	69.1	TRUE	TRUE	TRUE
Census Tract 9400.02	40.2		TRUE	TRUE
Benton County	30.5			
Census Tract 201	22.6			
Census Tract 202.02	19.1			
Census Tract 202.03	15.3			
Census Tract 202.05	16.1			
Census Tract 202.06	23.8			
Census Tract 203	13.1			
Census Tract 211.01	40.2		TRUE	TRUE
Census Tract 211.02	34.2			
Census Tract 212	51.6	TRUE	TRUE	TRUE
Carlton County	28.9			
Census Tract 701	30.2			
Census Tract 702	34.0			
Census Tract 703	14.6			
Census Tract 704	25.2			
Census Tract 705	36.8		TRUE	
Census Tract 706	30.1			
Census Tract 9400	37.0		TRUE	

Table Q-3 Poverty Population

State/County/Census Tract	Percentage Below 185 Percent of Poverty Level	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 40 Percent of Population Below 185 Percent
Cass County	34.2			
Census Tract 9400.01	37.3		TRUE	
Census Tract 9400.02	54.2	TRUE	TRUE	TRUE
Census Tract 9601	34.0			
Census Tract 9602	37.4		TRUE	
Census Tract 9603.01	16.7			
Census Tract 9603.02	22.8			
Census Tract 9606	38.8		TRUE	
Census Tract 9607	36.0		TRUE	
Census Tract 9608.01	18.6			
Census Tract 9608.02	31.3			
Clearwater County	37.6			
Census Tract 1	41.6		TRUE	TRUE
Census Tract 2	39.4		TRUE	
Census Tract 3	32.6			
Crow Wing County	29.0			
Census Tract 9501	25.5			
Census Tract 9502.04	15.0			
Census Tract 9504	27.9			
Census Tract 9505.01	17.5			
Census Tract 9505.02	23.5			
Census Tract 9507	37.2		TRUE	
Census Tract 9508	27.2			
Census Tract 9509	11.6			
Census Tract 9510	35.7		TRUE	
Census Tract 9511	47.3	TRUE	TRUE	TRUE
Census Tract 9512	44.1	TRUE	TRUE	TRUE
Census Tract 9513.01	23.6			
Census Tract 9513.02	39.7	TRUE	TRUE	
Census Tract 9514	23.3			
Census Tract 9516	27.9			
Census Tract 9517	23.5			
Hubbard County	30.7			
Census Tract 701	25.3			
Census Tract 702	24.2			
Census Tract 703	32.4			
Census Tract 704	33.6			
Census Tract 705	32.3			
Census Tract 706	41.8	TRUE	TRUE	TRUE
Census Tract 707	22.8			

Table Q-3 Poverty Population

State/County/Census Tract	Percentage Below 185 Percent of Poverty Level	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 40 Percent of Population Below 185 Percent
Itasca County	31.1			
Census Tract 4801	33.8			
Census Tract 4803	29.1			
Census Tract 4804	21.5			
Census Tract 4805	33.6			
Census Tract 4806	25.2			
Census Tract 4807	22.4			
Census Tract 4808.01	19.1			
Census Tract 4808.02	42.1	TRUE	TRUE	TRUE
Census Tract 4809	37.6		TRUE	
Census Tract 4810	31.7			
Census Tract 9400	35.2		TRUE	
Kanabec County	33.1			
Census Tract 4801	28.8			
Census Tract 4802	34.5		TRUE	
Census Tract 4803	41.7		TRUE	TRUE
Census Tract 4804	28.8			
Kittson County	27.7			
Census Tract 901	35.4		TRUE	
Census Tract 902	18.3			
Marshall County	22.2			
Census Tract 801	19.5			
Census Tract 802	23.0			
Census Tract 803	22.1			
Census Tract 804	23.9			
Mille Lacs County	30.4			
Census Tract 1704	26.8			
Census Tract 1705	29.3			
Census Tract 1706	12.5			
Census Tract 1707	34.3		TRUE	
Census Tract 9701	35.2		TRUE	
Census Tract 9702	47.8	TRUE	TRUE	TRUE
Census Tract 9703	29.8			
Morrison County	29.1			
Census Tract 7801	34.3		TRUE	
Census Tract 7802	29.7			
Census Tract 7803	19.2			
Census Tract 7804	25.3			
Census Tract 7805	26.8			
Census Tract 7806	40.8	TRUE	TRUE	TRUE
Census Tract 7807	36.3		TRUE	
Census Tract 7808	25.5			

Table Q-3 Poverty Population

State/County/Census Tract	Percentage Below 185 Percent of Poverty Level	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 40 Percent of Population Below 185 Percent
Pennington County	28.7			
Census Tract 901	25.0			
Census Tract 902	38.2		TRUE	
Census Tract 903	15.8			
Census Tract 904	34.7		TRUE	
Census Tract 905	26.4			
Pine County	34.3			
Census Tract 9501	26.7			
Census Tract 9502	31.3			
Census Tract 9503	31.8			
Census Tract 9504	39.4		TRUE	
Census Tract 9505	36.0		TRUE	
Census Tract 9506	29.3			
Census Tract 9507	45.7	TRUE	TRUE	TRUE
Census Tract 9508	30.0			
Polk County	27.3			
Census Tract 201	27.5			
Census Tract 202	43.3	TRUE	TRUE	TRUE
Census Tract 203	7.8			
Census Tract 204	12.9			
Census Tract 205	17.2			
Census Tract 206	34.3			
Census Tract 207	30.8			
Census Tract 208	29.3			
Census Tract 209	32.1			
Census Tract 210	35.5		TRUE	
Red Lake County	26.6			
Census Tract 101	30.5			
Census Tract 102	22.9			
St. Louis County	31.0			
Census Tract 1	16.6			
Census Tract 10	39.6		TRUE	
Census Tract 101	20.5			
Census Tract 102	8.2			
Census Tract 103	13.5			
Census Tract 104	17.0			
Census Tract 105	18.9			
Census Tract 106	12.1			
Census Tract 11	32.8			
Census Tract 111	14.3			
Census Tract 112	35.5		TRUE	
Census Tract 113	27.4			
Census Tract 114	23.5			

Table Q-3 Poverty Population

State/County/Census Tract	Percentage Below 185 Percent of Poverty Level	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 40 Percent of Population Below 185 Percent
Census Tract 12	71.4	TRUE	TRUE	TRUE
Census Tract 121	19.5			
Census Tract 122	60.9	TRUE	TRUE	TRUE
Census Tract 123	30.9			
Census Tract 124	50.0	TRUE	TRUE	TRUE
Census Tract 125	37.4		TRUE	
Census Tract 126	41.3	TRUE	TRUE	TRUE
Census Tract 127	25.4			
Census Tract 128	24.6			
Census Tract 13	61.8	TRUE	TRUE	TRUE
Census Tract 130	47.1	TRUE	TRUE	TRUE
Census Tract 131	55.7	TRUE	TRUE	TRUE
Census Tract 132	31.9			
Census Tract 133	45.4	TRUE	TRUE	TRUE
Census Tract 134	15.3			
Census Tract 135	35.1		TRUE	
Census Tract 136	35.1		TRUE	
Census Tract 138	35.8		TRUE	
Census Tract 139	19.9			
Census Tract 14	62.1	TRUE	TRUE	TRUE
Census Tract 140	20.5			
Census Tract 141	38.2		TRUE	
Census Tract 151	20.3			
Census Tract 152	21.9			
Census Tract 153	39.3		TRUE	
Census Tract 154	20.1			
Census Tract 155	34.0			
Census Tract 156	70.7	TRUE	TRUE	TRUE
Census Tract 157	51.3	TRUE	TRUE	TRUE
Census Tract 158	36.7		TRUE	
Census Tract 16	68.9	TRUE	TRUE	TRUE
Census Tract 17	69.1	TRUE	TRUE	TRUE
Census Tract 18	58.7	TRUE	TRUE	TRUE
Census Tract 19	80.4	TRUE	TRUE	TRUE
Census Tract 2	15.4			
Census Tract 20	53.9	TRUE	TRUE	TRUE
Census Tract 22	17.1			
Census Tract 23	15.4			
Census Tract 24	34.2			
Census Tract 26	44.7	TRUE	TRUE	TRUE
Census Tract 29	22.9			
Census Tract 3	32.8			
Census Tract 30	27.9			
Census Tract 33	40.8		TRUE	TRUE
Census Tract 34	38.3		TRUE	
Census Tract 36	30.1			
Census Tract 37	49.1	TRUE	TRUE	TRUE
Census Tract 38	30.9			

Table Q-3 Poverty Population

State/County/Census Tract	Percentage Below 185 Percent of Poverty Level	If 10 Percentage Points Higher than County Level	If 10 Percentage Points Higher than State Level	If 40 Percent of Population Below 185 Percent
Census Tract 4	32.4			
Census Tract 5	22.5			
Census Tract 6	15.9			
Census Tract 7	3.4			
Census Tract 9	36.9		TRUE	
Census Tract 9901	0.0			
Todd County	33.1			
Census Tract 7901	39.0		TRUE	
Census Tract 7902	38.6		TRUE	
Census Tract 7903	38.9		TRUE	
Census Tract 7904	32.3			
Census Tract 7905	28.8			
Census Tract 7906	37.0		TRUE	
Census Tract 7907	23.9			
Census Tract 7908	23.9			
Wadena County	38.1			
Census Tract 4801	38.4		TRUE	
Census Tract 4802	32.2			
Census Tract 4803	45.0		TRUE	TRUE
Total True		31	81	39

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

Line 3 Replacement Project: Assessment of Accidental Releases: Technical Report

Prepared for:
Department of Commerce, Energy
Environmental Review Analysis Staff

Prepared by:
Stantec Consulting Services Inc.
RPS/ASA
Dynamic Risk Assessment Systems Inc.

January 13, 2017

PREFACE

Stantec Consulting Ltd. (Stantec), RPS Group PLC (RPS), and Dynamic Risk Assessment Systems, Inc. (Dynamic Risk) were retained to prepare a risk assessment for potential large releases of crude oil from the Line 3 Replacement Project (L3RP).

PURPOSE

The purpose of this document is to provide information on the risk of an accidental large volume release of crude oil from the proposed L3RP at seven individual watercourse crossing sites. These seven sites were selected to be representative of the broad geographic and environmental diversity, including environmentally sensitive areas, that are: (1) present throughout the State of Minnesota; and (2) intersected by both the preferred and alternative L3RP routes.

Risk is defined most concisely as the 'chance of loss'. Accordingly, in the context of the risk associated with the operation of the L3RP pipeline, the term 'risk' is used as a joint expression of chance (the annual probability of incurring a rupture in the L3RP pipeline) and loss (the consequences associated with such a rupture).

As stated in the Final Scoping Decision Document for Line 3 Pipeline Replacement Project, the risk assessment was conducted to assess potential effects (i.e., consequences) associated with an accidental large volume release of crude oil using computational modeling to investigate releases at seven individual representative sites throughout north and central Minnesota. Information from the modeling of large crude oil releases at these representative sites will be used to make broad assessments of the potential consequences that are predicted across a range of geographic and environmental regions. Results can be used to make comparisons between similar environments to understand the potential effects that may occur at other locations with similar features among and across all proposed or alternative routes.

DIRECTION ON TECHNICAL WORK

Stantec, RPS and Dynamic Risk (referred to collectively as the Consulting Team) were retained by Enbridge Energy, Limited Partnership (Enbridge). The Consulting Team was responsible for identifying potential approaches for assessing the risk (as both failure likelihood/probability and potential consequences) of large crude oil releases, and identifying a preferred approach based on comments from the Minnesota Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA) (including state and federal agencies and their consultant) and Enbridge. Once the preferred approach was identified, the Consulting Team undertook the technical work under its own direction. Presentations on the preliminary results of the technical work were made to the DOC-EERA, state and federal agencies, and Enbridge at several points during the completion of the technical work. Every party was involved in each phase of the

work, including formulating the questions, identifying an approach, specifying the model inputs, assessing the outputs, and discussing the conclusions.

The Consulting Team then prepared a technical report on the risk assessment, with the exception of Chapter 2: Project Description, which was prepared by Enbridge. Comments on the draft report were received from the DOC-EERA and Enbridge. In response to these comments, revisions to the draft report were undertaken by the Consulting Team, but only where the Consulting Team deemed the changes to be appropriate. The work's technical conclusions were unchanged by the revisions accepted. A final report was prepared by the Consulting Team for submission to the DOC-EERA.

FUNDING

Funding for the work undertaken by the Consulting Team was provided by Enbridge.

AUTHORSHIP

The risk assessment of large releases of crude oil was prepared by the Consulting Team. The Technical Lead for each section of the report was as follows:

Chapter	***Technical Lead(s) Responsible for the Chapter***
1.0 INTRODUCTION	Jeff Green, Stantec
2.0 PROJECT DESCRIPTION	Enbridge Application
3.0 FRAMING THE SITE SELECTION AND MODELING ANALYSIS	Jeff Green, Stantec and Matt Horn, RPS
4.0 FAILURE PROBABILITY ANALYSES	Jim Mihell, Dynamic Risk
5.0 MODELING OF OIL RELEASES	Matt Horn, RPS
6.0 TRAJECTORY AND FATE RESULTS FOR MODELING LOCATIONS	Matt Horn, RPS
7.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS OF OIL RELEASES	Malcolm Stephenson, Stantec
8.0 REVIEW OF ENVIRONMENTAL RECOVERY FOLLOWING RELEASES OF OIL	Heidi Tillquist, Stantec
9.0 SUMMARY AND CONCLUSIONS	Consulting Team
10.0 REFERENCES	Consulting Team

DECLARATION

As the Technical Leads for the Risk Assessment of Large Releases of Oil for the Line 3 Replacement Project, we verify that we are responsible for leading and managing the preparation of the chapters of the report, as described in the above table. All technical analyses and all conclusions reflect our work and opinions. Modifications in response to verbal or written comments from the DOC-EERA, state and federal agencies or Enbridge have not modified the technical aspects and results of our work or our conclusions.

Jeff Green, Stantec



Jim Mihell, Dynamic Risk



Matt Horn, RPS



Malcolm Stephenson, Stantec



Heidi Tillquist, Stantec



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ATTACHMENT A

Abbreviations

AOI	Area of Interest
API	American Petroleum Institute
ATSDR	United States Department of Health Agency for Toxic Substances and Disease Registry
AST	Aboveground Storage Tank
AUT	Automated Ultrasonic Testing
BFGRID	Boundary Conforming Gridding Model
BFHYDRO	Boundary Conforming Hydrodynamic Model
bgs	below ground surface
BLM	Bureau of Land Management
BS&W	basic sediment and water
BTEX	Benzene, toluene, ethylbenzene, and xylene
CAA	Clean Air Act
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	United States Code of Federal Regulations
CLB	Cold Lake Blend
CLSB	Cold Lake Summer Blend
CLWB	Cold Lake Winter Blend
cm	centimeter
CO	Carbon Monoxide
Commission	Minnesota Public Utilities Commission
COPC	Chemical of Potential Concern
CP	Cathodic Protection
DARP	Damage Assessment and Restoration Plan
DEM	Digital Elevation Model
Dilbit	Diluted Bitumen
DOC	Dissolved Oxygen Content
DSAW	Double Submerged Arc Welded
DSD	Droplet Size Distribution

Abbreviations
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Dynamic Risk	Dynamic Risk Assessment Systems, Inc.
EAC	Environmentally-Assisted Cracking
ECS	Ecological Classification System
EERA	Energy Environmental Review and Analysis
EIS	Environmental Impact Statement
Enbridge	Enbridge Energy Limited Partnership
EPRG	European Pipeline Research Group
EPT	Ephemeroptera spp., Plecoptera spp., and caddisfly Trichoptera spp.
EROM	Extended Unit Runoff Method
ERW	Electric Resitance Welded
FBE	Fusion Bond Epoxy
FSDD	Final Scoping Decision Document
ft	feet
ft/yr	feet per year
g/cm3	gram per cubic centimeter
GMAW	Gas Metal Arc Welding
HCA	High Consequence Areas
HDD	Horizontal Directional Drill
H_2S	Hydrogen Sulfide
HSLA	High Strength Low Alloy
HVAC	High Voltage AC
HVDC	High Voltage DC
ILI	In-Line Inspection
km	kilometer
L3RP	Line Three Replacement Project
lvp	low vapor pressure
m	meter
m^3	m3
MAH	Monoaromatic Hydrocarbons
MAOP	Maximum Allowable Operating Pressure
MI DCH	Michigan Department of Community Health
MI DEQ	Michigan Department of Environmental Quality
MN DA	Minnesota Department of Agriculture

Abbreviations
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MN DH	Minnesota Department of Health
MN DNR	Minnesota Department of Natural Resources
MN DOC	Minnesota Department of Commerce
MOC	Measurement of Change
mph	miles per hour
mg/kg	milligram per kilogram
MN PCA	Minnesota Pollution Control Agency
MRL	Minimum Risk Level
MT DEQ	Montana Department of Environmental Quality
NAAQS	National Ambient Air Quality Standards
NAS	National Academies of Sciences, Engineering and Medicine
NED	National Elevation Database
NHD	National Hydrography Dataset
NHN	National Hydro Network
NLCD	National Land Cover Database
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NRDAM/CME	NRDA Models for Coastal and Marine Environments
NRDAM/GLE	NRDA Models for Great Lakes Environment
NTSB	National Transportation Safety Board
NWI	National Wetlands Inventory
O&M	Operations and Maintenance
OD	Outside Diameter
OHWL	Ordinary High Water Line
OPA	Oil Particular Aggregate
PAH	Poly-Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEC	Probable Effect Concentration
PGPR	Plant Growth Promoting Rhizobacteria
PHC	Petroleum Hydrocarbon Fraction

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PHC F1-F4	Petroleum Hydrocarbon Fractions F1 to F4
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	Particulate Matter
PM2.5	Particulate Matter with an aerodynamic diameter less than 2.5 micrometers
PM10	Particulate Matter with an aerodynamic diameter less than 10 micrometers
ppb	parts per billion
ppm	parts per million
PRCI	Pipeline Research Committee International
ROW	Right-of-Way
RPS	RPS Group PLC
SCADA	Supervisory Control and Data Acquisition
SCC	Stress Corrosion Cracking
SGCN	Species in Greatest Conservation Need
SIP	State Implementation Plan
SMYS	Specified Minimum Yield Strength
SO_2	Sulfur Dioxide
SPM	Suspended Particulate Matter
SQT	Sediment Quality Triad
Stantec	Stantec Consulting Services Inc.
TEC	Threshold Effect Concentration
THC	Total Hydrocarbon Concentration
TMCP	Thermomechanical Controlled Processing
TPAH	Total Petroleum Aromatic Hydrocarbon
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
µg/L	microgram per liter
UOE	U&O Expanded
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	ultraviolet
VOC	Volatile Organic Compound

Abbreviations
January 13, 2017

Vol %	volume percent
WBD	National Watershed Boundary Dataset
WMA	Wildlife Management Area
WSF	Water Soluble Fraction
Wt %	weight percent
WQMAP	Water Quality Mapping and Analysis Program

Glossary

Actinomycetes: bacteria that resemble fungi because their elongated cells form long filaments or hyphae.

Aquatic Benthic Macroinvertebrates: Invertebrates that spend at least some portion of their life cycle in an aquatic habitat, that live in or on the bottom substrate and that are large enough to be seen without magnification.

Automatic Ultrasonic Testing (AUT) Phased Array Inspection: An advanced ultrasonic testing process in which timed pulsed ultrasonic signals from an array of ultrasonic transducers are swept through a range of angles, and subsequently analyzed by a computer algorithm to identify and size defects that might reside in a weld.

Biophysical Environment: The biotic (living) and abiotic (non-living) surroundings.

Biosparging: Compressed air injected at low flow rates below the water table used to increase dissolved oxygen levels in the groundwater to enhance biodegradation.

Bioventing: Ambient air injected or extracted at low flow rates and used to replenish oxygen for microbial respiration in the vadose zone.

Clean up: collection and removal of oil from the environment.

Direct Current Voltage Gradient (DCVG): An above-ground electrical survey technique used for assessing the effectiveness of corrosion protection and for locating coating faults on buried steel pipelines.

Dissolution: Water soluble compounds in oil dissolve into surrounding water.

Double Submerged Arc Welded (DSAW) steel line pipe: Steel line pipe manufactured from skelp that is formed into a tubular shape, and in which the seam is welded using the double submerged arc welding process.

Ectomycorrhizae: mycorrhizal fungi with a sheath that forms around the root tips of a plant and hyphae that penetrate into the root structure.

Electric Resistance Welded (ERW) steel line pipe: Steel line pipe manufactured from skelp that is formed into a tubular shape, and in which the seam is welded using the electric resistance welding process.

Emulsification: Combination of two liquids with one being suspended in the other.

Fish Kill: A significant and sudden death of fish, shellfish and other aquatic animals. Such events are characterized by large numbers of animals dying over a short time, usually in a defined area.

Gas Metal Arc Welding (GMAW): A welding process that utilizes an electric arc to fuse both the base metal and a consumable wire, both of which are shielded by an inert gas to prevent undesirable reaction of atmospheric gases with the molten metal that is formed during the welding process.

Groundwater: Water below the earth's surface that occurs below the water table in the soil pores and bedrock fractures.

Hard Spot: Associated with vintage pipe manufacturing processes, hard spots are local changes in hardness of steel pipe resulting from non-uniform quenching procedures during manufacture, or changes in chemistry of the steel. Hard spots, when stressed, are subject to failure from mechanisms such as hydrogen-stress cracking.

Hardenability: The characteristic of steel, related to its chemical constituents, which enables it to become hard when subjected to heat treatment, such as heating and quenching, or welding.

High Strength Low Alloy (HSLA): A type of steel alloy steel that provides superior mechanical properties and weldability through the use of small additions of micro-alloy elements such as niobium and / or vanadium along with thermal-mechanical controlled processing.

Horizontal Directional Drilling (HDD): A steerable trenchless method of installing underground pipe in an arc along a prescribed bore path by using a surface-launched drilling rig, with minimal impact on the surrounding area.

Hydrostatic testing: Hydrostatic testing is a process of verifying the integrity of the pipeline before it is placed into service. Hydrostatic testing involves filling the pipeline with water to a designated pressure and holding it for a specified period of time.

In situ: in place or on site.

Internal Coupon: A metal strip that can be inserted at strategic locations within a pipeline and subsequently retrieved and evaluated at periodic intervals to monitor corrosion during the operation of a pipeline.

Monte Carlo Analysis: A computer-based technique that employs stochastic resampling of randomly-selected variables from probability density functions representing the distribution of those variables. In reliability analysis, the selection of each unique combination of random variables is used to establish whether a limiting condition has been exceeded. By iterating this analysis numerous times, the fraction of times that the limiting condition is exceeded can be estimated with a degree of confidence that is related to the number of iterations used in the analysis.

Lentic: Still waters such as lakes and ponds.

Lotic: Flowing waters such as rivers, streams and brooks.

Macrophytes: Aquatic plants large enough to be visible with the naked eye.

Mycelium: vegetative part of a fungus consisting of the hyphae (branching filaments).

Natural Attenuation: A variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants (from USEPA).

Phytoremediation: use of plants to clean contaminated sites.

Photo-oxidation: The degradation of oil by sunlight that results in the loss of alkylated polycyclic aromatic hydrocarbons.

Photolysis: Process whereby molecules are broken down into smaller units by the absorption of light.

Phytotoxic: harmful or lethal to plants.

Reclamation: return of areas disturbed by cleanup activities to approximate pre-disturbance conditions through reseeding and other methods.

Recovery: Return of an ecosystem or Valued Ecosystem Component to some desired state following disturbance.

Remediation: physical chemical or biological processes applied post cleanup to reduce contaminant concentrations.

Rehabilitation: the transfer of oiled wildlife to specialized treatment to clean up the oil and return the specimen to health.

Restoration: Taking action to return natural resources to pre-spill conditions (from USFWS). Rehabilitating, replacing, or acquiring the equivalent of injured natural resources and the services they provided. Restoration includes both primary and compensatory restoration projects (from NOAA). Physical alterations of habitat and environmental structures to restore the habitat.

Riffle Habitat: Lotic habitat of shallow fast flowing turbulent water.

Rhizome: horizontal underground stem able to produce roots and shoots.

Silt fence: A silt fence is a sediment control device used on construction sites to protect nearby wetlands and waterbodies from stormwater runoff. A typical fence consists of a piece of synthetic fabric (sometimes referred to as geotextile fabric) stretched between a series of stakes where runoff is expected to reach wetlands or waterbodies. The fabric filters remove sediment from the water before it reaches the wetland or waterbody.

Skelp: Steel that is rolled into plate form so that it can subsequently be formed and welded into pipe.

Slope breaker: A slope breaker is an erosion control device to reduce stormwater runoff velocity and divert it from the disturbed construction area to more stable ground. A typical slope breaker consists of a ridge or channel constructed diagonally across the right-of-way on a hill.

Sorption: Removal of solutes from solution onto mineral surfaces.

Specified Minimum Yield Strength (SMYS): The specified minimum stress that a material can be subjected to before it experiences permanent deformation.

Temperate Zone: In the Northern Hemisphere, the area between the tropic of Cancer and the Arctic Circle.

Thermomechanical Controlled Processing (TMCP): A steelmaking technique that utilizes carefully-designed hot-reduction and cooling schedules, typically in conjunction with micro-alloying with elements such as niobium and / or vanadium, along with other elements in order to achieve superior mechanical properties and weldability.

Transmissivity: Ability of a formation to transmit oil to a recovery well.

U & O Expansion (UOE) steel line pipe: Steel line pipe manufactured from skelp that is formed into a tubular shape by first forming a U-shape, and subsequently forming a cylinder with a longitudinal seam, which is then sealed by welding.

Vadose zone: Region of aeration above the water table, including the capillary fringe.

Volatilization: Vapors from volatile components of the oil disperse into the soil gas above the water table and diffuse laterally and upwards.

Weldability: The ease with which welding of a given material can be performed without producing defects such as cracks due to undesirably high hardenability (See also Hardenability).

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec), RPS Group PLC (RPS), and Dynamic Risk Assessment Systems, Inc. (Dynamic Risk) (referred to collectively as the Consulting Team) were retained to prepare a risk assessment for potential large releases of oil from the Line 3 Replacement Project (L3RP). The proposed preferred route for the L3RP is provided in Figure 1-1.

1.1 BACKGROUND ON L3RP

Enbridge Energy, Limited Partnership (Enbridge) is proposing the L3RP to replace Enbridge's existing Line 3 pipeline, from the Joliette Valve in Pembina County, North Dakota to Clearbrook, Minnesota, and then on to an existing terminal in Superior, Wisconsin (Figure 1-1).

The L3RP route is approximately 363 miles long, 337 of which are in Minnesota. The remainder of the pipeline is located in North Dakota and a small portion in Wisconsin. Within Minnesota, L3RP would involve the construction and operation of a 36-inch diameter, underground crude oil pipeline. The Project would also include a new pump station and improvements at the existing Clearbrook Terminal, the expansion of three other existing pump stations west of Clearbrook, and the addition of four new pump stations in Minnesota east of Clearbrook.

The replacement pipeline will be co-located with the existing Line 3 and Enbridge's Mainline Corridor from the Minnesota/North Dakota border to Clearbrook. This portion of L3RP would be parallel to and approximately 25 feet (ft) from the existing Line 67 pipeline. For the remaining 246 miles of the L3RP route south and east of Clearbrook, the pipeline would be located in a new right-of-way (ROW), portions of which will parallel other existing third-party pipelines, electric transmission corridors, and transportation corridors.

L3RP would transport a variety of crude oils that range from light to heavier crude oils, including diluted bitumen.

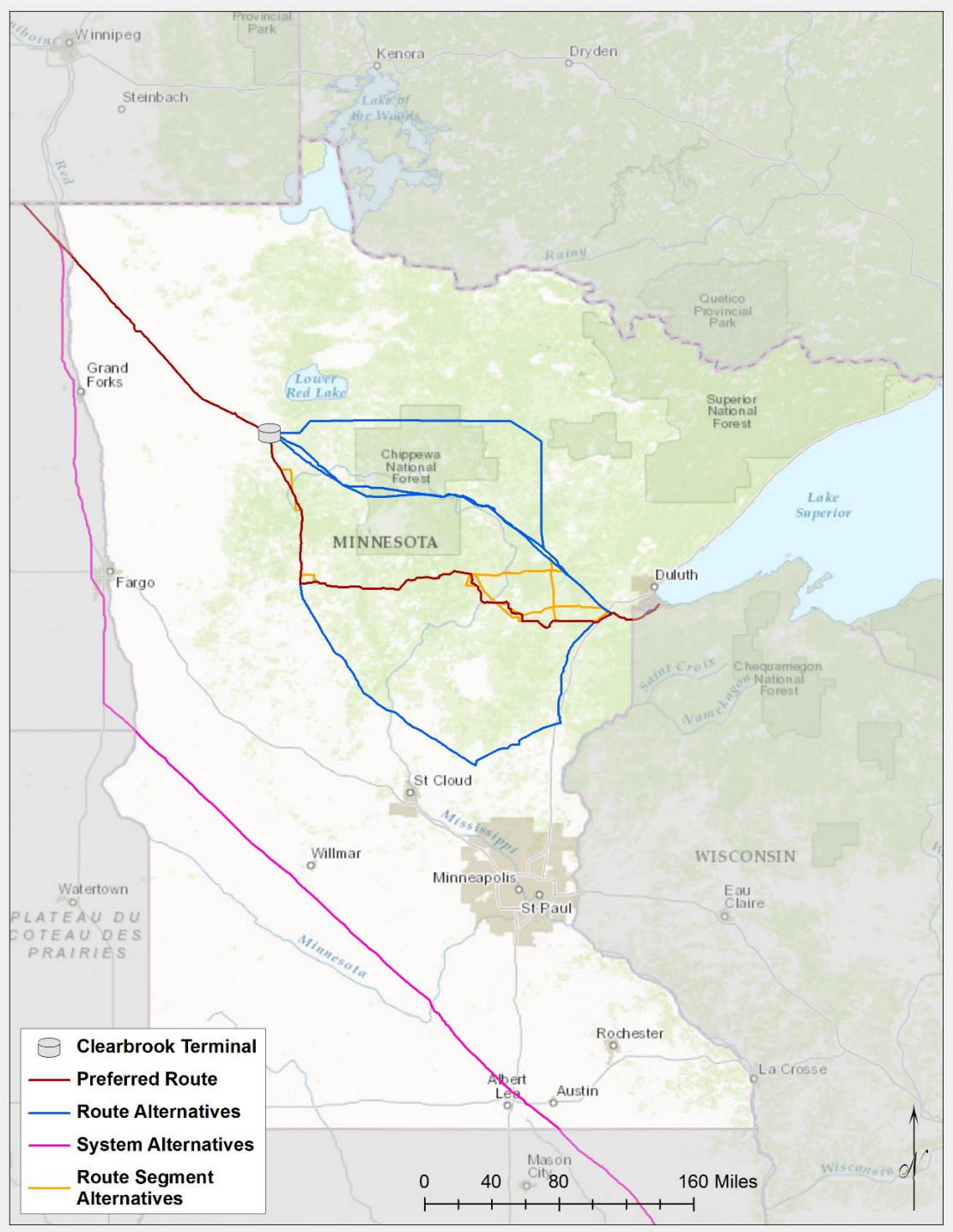

Figure 1-1 Map of the Preferred Route for L3RP, Route Alternatives, Route Segment Alternatives and System Alternatives

1.2 SCOPE OF THE ASSESSMENT

The Final Scoping Decision Document (FSDD) for L3RP (Minnesota DOC-EERA 2016) describes the topics that need to be addressed in the Environmental Impact Statement (EIS) to be prepared by the Minnesota Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA).

In regard to the analysis of large oil releases, the EIS is to include "spill modeling and a summary and application of analysis methods from other projects." The FSDD states that the Applicant (Enbridge) will provide "data on maximum spill volumes, spill frequency, and the types of crude oil to be transported based on the proposed engineering and operations for the pipeline". This information will be applied to all large-volume spill impact analysis methods. An estimated large-volume spill footprint will be established using these data and based on methods used by other current or recent investigations. The methods will consider general geomorphic conditions in Minnesota to develop a general spill footprint. The analysis will also include a review of crude oil release data from the Pipeline and Hazardous Materials Safety Administration (PHMSA) database."

In addition, the FSDD states that "to assess potential impacts associated with an accidental release, the Applicant will provide maximum spill volume estimates based on response times, valve locations, and pipeline volumes at seven representative sites assuming a complete pipeline rupture. Data generated from modeling at representative sites will be used to make broad environmental comparisons among and across routes in areas with similar features." Modeling will include "a set of scenarios that include the following crude oil types: light sweet Bakken crude oil, Cold Lake Blend (CLB), and Cold Lake Winter Blend (CLWB). These crude oils represent the range of oil densities and chemical compositions expected. Additional modeling parameters include seasonal variation to capture water flow volumes (high flow, low flow, and snow/ice covered), and a 24-hour model run with outputs at 6, 12, and 24 hours. The combinations of model inputs will result in more than 40 modeling scenarios from which to analyze potential impacts to resources along route alternatives."

1.3 PURPOSE

The purpose of this document is to provide information on the risk of a large volume release of crude oil from the proposed L3RP. Risk is defined most concisely as the "chance of loss". Accordingly, in the context of the risk associated with the operation of the L3RP pipeline, the term "risk" is used as a joint expression of chance (the annual probability of incurring a rupture in the L3RP pipeline), and loss (the consequences associated with such a rupture).

For an oil release, there are several probabilities that should be considered in a risk assessment:

- Probability that a release will occur (i.e., failure frequency)
- Probability that any released oil will reach an environmentally sensitive area or receptor (modeling helps to understand spatial and temporal behavior of oil releases)

- Probability that environmentally sensitive and vulnerable species will be present or a human use will occur in the area affected by a release during the period in which there is a possibility of exposure to oil (i.e., knowing how an oil release behaves in space and time provides a better understanding of how an environmental component might be exposed to the release and what the environmental effects might be if a spill occurred)

To address the probability of large volume releases of crude oil, as well as the likely consequences associated with large volume releases of crude oil release if it were to occur, a number of factors and aspects are considered in this report, including:

- Probability that a large release of oil will occur, including an assessment of natural and human-caused threats to the pipeline, an assessment of the likelihood of a specific type of threat resulting in a large oil release (i.e., failure frequency), and the corresponding reasonable worst-case volume of oil released
- Modeling hypothetical large releases of several types of crude oil in terrestrial and freshwater environments to understand the fate of potential large oil releases with respect to the likely trajectory from specific release locations and the potential behavior of the oil within the environment, taking into account the geographic and environmental conditions where the modeled release occurs, including seasonal variability in the conditions
- Based on the results of the oil release modeling, assessment of the resources that may be affected and the range of potential effects that may result, should a large release of oil occur in the natural (physical and biological) and human environment[1]
- Potential for the natural and human environment to recover from the effects of a large oil release following the event, including a discussion of factors that can promote or impair recovery and the approximate timing of recovery

Each of these topics is discussed in the corresponding chapters of this report (see Section 1.4 for a discussion of the report structure and content).

Other topics of relevance to understanding the potential for, and management of, accidental releases of crude oil include:

- Understanding how the likelihood of an oil release can be reduced through pipeline design, construction techniques, technical specifications, operational protocols, ongoing monitoring, inspection, and maintenance
- Preparation of emergency response plans, including the incident command structure, internal communications, and ongoing commitments by the project proponent, Enbridge, and government agencies for preparedness of personnel and equipment, training, and regular exercises and drills
- Development of measures to reduce and manage the physical spread of hydrocarbons if a release occurs
- Range of measures that would be employed by Enbridge to clean up and rehabilitate areas affected by an oil release

[1] The natural environment includes the atmospheric environment, ground water and surface water, terrain, soils, freshwater fish, vegetation, wetlands, and wildlife, including rare and endangered species. The human environment includes human uses, social, cultural and economic values, and heritage resources.

These topics will be addressed in other submissions to the DOC-EERA by Enbridge.

1.4 OVERVIEW AND RATIONALE OF APPROACH TO ASSESSING THE LIKELIHOOD AND EFFECTS OF OIL RELEASES

1.4.1 Differences in Assessing the Effects of Routine Activities versus Accidental Releases of Oil

Environmental assessments are generally intended to predict the type and range of effects on the natural and human environment that could occur as a result of the construction, operation and decommissioning of a project. In addition, they typically describe recommended measures to mitigate and reduce effects of the Project, such as the effects of the routine activities during any phase of a project, as well as potential accidents and malfunctions.

However, there are number of key differences in how effects of routine activities differ from accidents and malfunctions (especially oil releases) and how they can be assessed. These include the following:

- While the effects of routine activities will or are likely to occur if the Project is constructed, operated and decommissioned, accidents and malfunctions and associated effects on the environment are, by definition, not common or may not occur at all. The likelihood of a large oil release occurring (i.e., the failure frequency) and the potential outflow volume (e.g., lower volume versus larger volume releases) are therefore important considerations in a risk assessment for an accident or malfunction.
- Effects of routine activities on the natural and human environment can be adverse (e.g., air emissions, loss of habitat) or positive (e.g., economic benefits). In contrast, effects of oil releases are almost always adverse. The significance of these effects to the natural or human environment will therefore depend on existing conditions and the characteristics of the resulting effects.
- While the specific effects of routine activities and infrastructure (e.g., the physical footprint, intakes and outputs to the environment) can often be predicted with a high degree of confidence through the multiple phases of the Project (e.g., construction, operation, decommissioning), the effects of an accidental release of crude oil must be based on a number of assumptions about the release and some form of modeling. Modeling results are specific to the assumptions and inputs used in modeling, including the conditions for the release (e.g., seasonal and weather conditions), the type and volume of crude oil released, the duration of the release, the specific location of the release, and several other factors. Modeling results for the same location can vary greatly, depending on the timing of the release (e.g., seasons, month), temporally-specific conditions such as weather and water flows (which can vary at scales of minutes to hours), release duration (instantaneous versus protracted duration of release), and other associated site conditions.
- Because there are differences in the certainty for routine activities (which will or will likely happen), versus a hypothetical release of crude oil (which may never happen), the resulting effects carry different weights or certainty. Routine activities are often quantified by estimating the physical and temporal overlap with environmentally sensitive components (e.g., distribution patterns of biota, movement patterns of biota, important habitats for fish or

wildlife, human use areas). There is less certainty in the estimates and likely spatial and temporal overlap of potential trajectories and site-specific behaviors of an accidental crude oil release with biological species or human uses. This is especially the case as species presence and human use also may be changing in space and time.
- When quantifying potential effects, the certainty of the value or benefit of mitigation measures for effects associated with routine activities is greater than those of accidents and malfunctions (i.e., a release of crude oil).

Statutes and regulations are in place that account for risks from potential future release incidents; this includes response preparedness and coordination, as well as full restoration of natural resource losses resulting from actual release incidents (i.e., the federal Oil Pollution Act and its implementing natural resource damage regulations at 15 United States Code of Federal Regulations [CFR] part 990).

1.4.2 Approach Used in Assessing Large Releases of Crude Oil

Given these differences in assessment approaches between routine activities and accidental releases, as well as the requirements for the assessment as described in the FSDD, the approach used for assessing the risks of a large release of crude oil from L3RP included several important components to improve an understanding of:

- How a large release of crude oil might occur and the likelihood of such a release (i.e., a threat assessment and failure frequency analysis)
- Likely trajectory and fate (i.e., behavior) of large unmitigated (i.e., no emergency response) releases of several types of crude oil under different environmental and seasonal conditions
- Range of potential effects an unmitigated large release of crude oil may have on the natural and human environment
- Potential and timing for the recovery of the natural and human environments following a large release of crude oil

To predict the potential threats, failure frequencies, and the trajectory and fate of hypothetical releases of crude oil, several representative sites along the preferred route for L3RP were suggested by the Consulting Team for consideration by the DOC-EERA and other state and federal agencies. Based on input from the DOC-EERA and these agencies, sites on some alternative routes were also considered. The approach for engagement of these agencies, the process used to select sites, and the methods used to characterize each hypothetical release location are described in Section 3.1.

The sites selected for the threat and failure frequency assessments, modeling of hypothetical releases, and assessment of effects were deliberately chosen to represent a variety of biophysical conditions, including the type and size of water features (e.g., size of watercourse, size of water body, speed and turbulence of water flow, and water depth), the type and density of vegetation cover, the type and intensity of land use, and human and ecological values. Issues raised through consultation with government agencies, affected stakeholders, the general public and native tribes also influenced the types of sites chosen. As discussed in Section 3.1,

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Introduction
January 13, 2017

DOC-EERA coordinated a collaborative process with state and federal agencies to develop criteria for selection of preferred sites for modeling of hypothetical releases of crude oil and the assessment of effects. The criteria that were developed by this group took into account a range of biophysical conditions, as well as issues raised through consultation and regulatory processes.

For the assessment of large releases of crude oil from L3RP, once the criteria for selection of modeling locations had been determined, the needs of the assessment (as described in DOC-EERA 2015) were considered in developing the general assumptions for the spill modeling with respect to:

- **Type of crude oil:** To account for the differences in the types of crude oil that could be transported by the proposed L3RP, and the behavior of these crude oils within the environment, both a light crude oil (i.e., Bakken Crude) and two mixtures of a single heavy crude oil (i.e., CLB and CLWB) were considered. Note that CLWB was only used in winter time scenarios with low river flow conditions in the receiving water body. CLB was used in the spring high river flow and summer average river flow scenarios, corresponding to the seasonal availabilities of these two products.
- **Volume of oil:** To model a large release of crude oil (DOC-EERA 2015), a full bore rupture (i.e., complete severing of the pipeline) of the pipeline at a modeling site was modeled. In addition, conservative assumptions were used to account for the time for full shutdown of the affected pipeline (i.e., taking into account elapsed time for alarm notification, stopping the pumps, and closure of the shut-off valves). The maximum volume of crude oil hypothetically released at each site included both the initial release volume prior to shutdown (i.e., actively pumping out), as well as hydraulic drain down of the pipeline (i.e., gravity drained oil within the pipeline between the valves), following shutdown at that site.
- **Duration of model run:** To provide a conservative estimate of the trajectory and fate of crude oil, it was assumed that the maximum volume of crude oil released would flow downstream for 24 hours without mitigation (i.e., the initiation of an emergency response and clean up). However, modeling results were captured at 6, 12, 18, and 24 hours to approximate the downstream/down current extent and weathering of crude oil over the 24-hour period. Of note, a response would be initiated in a shorter period; therefore, this is a conservative assumption for these hypothetical release scenarios.
- **Seasonal differences in river flow conditions:** To account for seasonal fluctuations in the characteristics of water features, especially watercourses; high river flow (spring), average river flow (summer), and low river flow (winter) conditions were modeled at each site.
- **Seasonal differences in weather:** To account for differences in the behavior of several types of crude oil under different weather conditions, the corresponding weather information (e.g., temperature, wind speed) for each river flow condition (i.e., season) were identified and used in modeling.

Pinhole leaks were identified as a concern by regulators and the public; pinhole leaks are addressed in a separate report (Stantec and Barr 2016).

Based on the selection criteria for modeling locations (Chapter 3.0), the DOC-EERA, in collaboration with other state and federal agencies and the Consulting Team, chose seven representative sites across western, central, and northern Minnesota for modeling of hypothetical releases of crude oil. The seven sites represent a broad geographic range

throughout areas of Minnesota that could be crossed by L3RP. In combination, the seven sites represent a diversity of water features including large rivers down to small streams and ditches, with a range of flows from slow to rapid, varying amounts of turbulence, differences in channel types (e.g., sinuous to straight), and several lakes. They also represent a wide range of vegetation types and land uses, including several different forest types, protected areas, cultivated land, rice lakes, recreational areas, and human settlements.

For each of the seven representative sites that were selected, a threat assessment, failure frequency assessment, modeling of the potential trajectory and fate of large crude oil releases, and an assessment of effects to the biophysical and human environment were completed. Combined with the three flow conditions/seasons and the two types of crude oil (CLB and CLWB are considered one type of crude oil), the modeling completed for the seven representative sites equates to a total of 42 release scenarios (7 sites x 3 flow conditions x 2 types of crude oil).

During the public scoping comment period, questions were raised about the total number of sites to be investigated in these analyses. Some comments/questions implied that more than seven representative sites should have been chosen, with the same analyses completed for each site as those described in this report. Because the seven sites were selected to reflect a broad range of geographic and environmental characteristics, together they provide an understanding of a broad range of potential effects, should there be a large release of crude oil. This is consistent with the FSDD that "data generated from modeling at representative sites will be used to make broad environmental comparisons among and across routes in areas with similar features". Therefore, while modeling a larger number of sites may address site-specific concerns raised by stakeholders, the public, and native tribes, the incremental information gained regarding the potential fate of released crude oil and the associated range of effects would be marginal. The range of potential effects on the biophysical and human environment at these additional sites would not be expected to differ greatly from those assessed for the seven modeled sites.

It is the opinion of the principal authors of this report (as described in the preface) that additional modeling would not add proportionately to a better understanding of hypothetical releases of crude oil, nor would it change the conclusions of the anticipated environmental effects should there be a large release of crude oil. The breadth of water features and biophysical conditions included within the combined footprint of the seven modeling locations and the associated oil release trajectories are large. When this is combined with the seasonal differences and variable behavior of several types of crude oil, a broad range of potential environmental effects has been considered relating to physical and biological attributes of the environment and the socio-economic aspects and cultural values of the human environment (Chapter 7.0). It is the opinion of the principal authors of this report that adding additional modeling locations would not greatly alter the breadth of environmental effects considered, nor would it affect the conclusions that are made in this report.

1.5 USE OF THE OIL RELEASE MODELING INFORMATION

As noted in the FSDD, "information from the modeling is to be used to make broad environmental comparisons along and across routes in areas with similar features" (DOC-EERA 2016). The modeling of oil release trajectories and fate for each of the seven representative sites was intended to assist the DOC-EERA in addressing the environmental consequences of accidental large releases of crude oil as part of their broader assessment of the preferred and alternate routes for L3RP.

The analysis of environmental effects of an accidental large release of crude oil presented in this report (Chapters 5 through 7) is known as a consequence assessment. The intent of the assessment was to investigate the range of potential outcomes (effects) to the natural and human environment if an accidental release of a large volume of crude oil was to occur at any point along the pipeline (including preferred and alternative routes). The assessment involved quantitative modeling at carefully selected sites to predict the likely trajectory and fate and behavior of released oil, as well as assessments of the probable range of environmental effects under a variety of conditions. Through a careful and deliberate selection of representative sites across northern and central Minnesota, a broad spectrum of terrain, land-cover types, watercourses, waterbodies, wetlands, associated freshwater and riparian habitat types, vegetation, environmentally-sensitive areas, and human land uses were considered in the modeling and effects assessment. Therefore, this assessment can be used to consider the range of consequences that may be possible should there be an accidental release of crude oil along the proposed route or the proposed alternative routes for L3RP. Several different summary tables are provided in Chapter 3.0 to assist in the application of information from modeled locations to other locations.

As discussed in detail in Chapters 3 and 5, the consequence assessment for accidental large releases of crude oil involved quantitative modeling and assessment of potential environmental effects for 42 scenarios to demonstrate the anticipated range of outcomes that might occur in different seasons following an accidental large release of crude oil in a number of representative site conditions in central and northern Minnesota. The assessment considered:

- the range of product types (i.e., light and heavy crude oils) that may be shipped on the proposed pipeline
- environmental variability (i.e., 3 time periods including seasonal differences in river flow rate, snow/ice coverage, temperature, wind speed, etc.)
- biogeographic variability (i.e., 7 sites carefully chosen to represent different biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation, as well as human land use)

Results pertaining to the potential trajectory (movement), fate (behavior and weathering), and potential environmental effects of an accidental full bore rupture and resulting release of crude oil are provided for each of the scenarios. Together, these scenarios can be used to bound the

range of potential consequences at potential accidental release points in areas with similar features.

While seven specific representative release locations were investigated in this study, the careful and deliberate selection of the 42 representative release scenarios allows this consequence assessment to be used to determine the range of potential effects that may be possible should there be an accidental release at other locations along the preferred or alternate routes for L3RP. An equivalency table has been provided (Table 3-4) to aid users of this report in applying the results of the consequence assessment to other locations. Should an interested party have concerns over a specific watercourse that was not modeled, this table can be used to find an equivalent representative release location. From there, the interested party can consider the range of seasons to bound and/or determine the range of potential consequences for their specific location. As an example, should an individual near Bemidji be concerned about the possible effects of a release into Lake Irving, they can refer to Table 3-4 to find an equivalent site. The Lake Irving location includes a small watercourse (<10 m) that travels a short distance and connects to a lake/pond with recreational use and sensitive ecosystems. Upon comparison, the Shell River representative release location would be a logical substitute. Similarly, if one were to consider another release location that entered a medium watercourse that traveled a longer distance before entering a lake/pond system, they could consider the Sandy River representative release location as an equivalent site.

The term "representative" release location is used, as each site serves as a proxy for other similar sites. Because oil behaves similarly in water bodies and locations with similar geographic and environmental conditions, there is not a need to model multiple watercourses that have similar features. The predicted trajectory, fate, and effects results would essentially be the same or similar. While results would be very similar, there would be small differences in the actual downstream distance traveled and the potential location-specific sensitive receptors or regions of interest, should a release occur at a site that was not modeled. Similarly, should a release occur during a transitional season that was not modeled, the end result may be slightly different given differences in water flows, vegetation condition, etc. However, as the consequence assessment did include a broad range of geographic and environmental variability that are representative of the areas of Minnesota that are crossed by the preferred and alternate routes for L3RP, it is expected that the likely outcomes for sites not modeled would be bounded by the results provided in this report.

1.6 ORGANIZATION OF THE REPORT

This report consists of individual chapters that have been prepared by one or more members of the consultant team, consisting of Stantec, RPS, and Dynamic Risk. Enbridge prepared Chapter 2.0. The lead authors for each chapter of the report are identified in the Preface.

In addition to this Introduction, the report includes the following chapters and topics.

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Introduction
January 13, 2017

- Chapter 2: Project Description—provides a description of the proposed L3RP.
- Chapter 3: Framing the Site Selection and Modeling Analyses—documents the approach used to frame the modeling analyses for L3RP. This chapter includes a summary of regulatory and agency engagement in developing release modeling scenarios, the identification of important considerations in modeling (e.g., hydrodynamic, seasonal, environmental, geographic, and oil chemistry considerations for modeling of crude oil releases), selection of oil release modeling tools, the development of criteria for selecting modeling locations, and the rationale for selecting specific sites for modeling.
- Chapter 4: Pipeline Failure Probability Analysis—this chapter includes an analysis of the types of threats that could cause failure, as well as a failure frequency analysis for each of the seven specific segments of L3RP associated with the modeling sites. As part of this analysis, a review of releases, as documented in the Hazardous Liquids Incident database of the U.S. Department of Transportation's PHMSA was undertaken.
- Chapter 5: Modeling of Crude Oil Releases—provides a description of the modeling tools used to predict the trajectory and fate of several types of crude oil under different seasonal conditions, including a description of key assumptions and the input data used for modeling.
- Chapter 6: Trajectory and Fate Results for Modeling Locations—this chapter describes the oil release modeling outputs for hypothetical, unmitigated, full bore releases of several types of crude oil and varying environmental conditions at the seven representative modeling locations in western, central, and northern Minnesota.
- Chapter 7: Assessment of Environmental Effects of Crude Oil Releases—the assessment begins with a description of the observed and expected effects of crude oil on key ecological and human receptors, including how crude oil behaves (i.e., its fate) in atmospheric, freshwater and terrestrial environments, followed by an assessment of effects for each of the seven representative sites. The assessment for each site includes a description of the environmental setting, the potential overlap of the modeled oil releases on High Consequence Areas (HCAs) and Areas of Interest (AOIs), and a description of the effects of a large release of crude oil on the natural and human environment.
- Chapter 8: Review of Environmental Recovery Following Releases of Crude Oil—this chapter describes the current state of knowledge of how various components of the natural and human environment are known to recover following a release of crude oil. The review focuses on information most relevant to environmental conditions in Minnesota. It also addresses how emergency response, clean up, and remediation measures can promote or impair recovery.
- Chapter 9: Summary and Conclusions—this chapter provides general conclusions on the risks of large releases of crude, including types of threats, the likelihood of occurrences of these threats for specific segments of the pipeline, the range of potential effects, including the benefits of emergency response, site clean-up and remediation, and environmental recovery of the receiving environment.

2.0 PROJECT DESCRIPTION

2.1 OVERVIEW

2.1.1 Line 3 Replacement Project

The integrity concerns on the existing Line 3 necessitate constructing of the proposed L3RP. Construction will consist of a new pipeline and associated facilities to replace Enbridge's existing Line 3 pipeline, which transports crude oil from the Joliette Valve in Pembina County, North Dakota to Clearbrook, Minnesota; and then on to an existing terminal in Superior, Wisconsin. The proposed L3RP route is approximately 363 miles long, 337 of which are in Minnesota. L3RP includes in Minnesota a new pump station and improvements at the existing Clearbrook Terminal, the expansion of three existing pump stations west of Clearbrook, and the addition of four new pump stations east of Clearbrook.

2.2 PROPONENT

Enbridge is the project proponent of L3RP.

2.3 PIPELINE ROUTES

2.3.1 Line 3 Replacement Project

Approximately 337 miles of new 36 inch diameter, underground crude oil pipeline would be constructed along the proposed L3RP route between the North Dakota/Minnesota and the Minnesota/Wisconsin borders, crossing portions of Kittson, Marshall, Pennington, Red Lake, Polk, Clearwater, Hubbard, Wadena, Cass, Crow Wing, Aitkin, and Carlton Counties.

West of Clearbrook, the L3RP route would generally follow the existing Enbridge Mainline Corridor and would be installed approximately 25 ft from the existing Line 67 pipeline. East of Clearbrook, the L3RP would generally follow other existing third-party pipelines, electric transmission corridors, and transportation corridors.

2.4 PIPELINE FACILITIES AND INFRASTRUCTURE

2.4.1 Line 3 Replacement Project

2.4.1.1 Clearbrook Terminal Modification

As part of L3RP, Enbridge would modify equipment and construct a new pump station at the existing Clearbrook Terminal, located near MP 909.4 of the existing Enbridge Mainline Corridor in Clearwater County, Minnesota.

2.4.1.2 Pump Stations

As described in Table 2-1, Enbridge would install three new pump stations adjacent to existing pump stations west of Clearbrook. The four new pump station sites would be located east of Clearbrook. Mainline valves, metering, monitoring equipment, and associated electrical facilities would also be installed at all facilities. In addition, Enbridge would install new pipeline inspector gauge launcher and receiver traps at the Backus Pump Station.

Table 2-1 L3RP Minnesota Pump Stations

County	Facility	MP	Description
West of Clearbrook			
Kittson	Donaldson	814.5	Expansion of pump capacity to 7,000 HP at existing Donaldson Pump Station
Marshall	Viking	848.2	Expansion of pump capacity to 7,000 HP at existing Viking Pump Station
Red Lake	Plummer	877.0	Expansion of pump capacity to 7,000 HP at existing Plummer Pump Station
Clearbrook			
Clearwater	Clearbrook Terminal	909.4	Installation of terminal connectivity, a new 7,000 HP Clearbrook Pump Station, PIG receiver and launcher traps, and injection from existing tanks 61, 62, 63 and 64
East Of Clearbrook			
Hubbard	Two Inlets	956.6	New 7,000 HP Pump Station
Cass	Backus	1,007.1	New 7,000 HP Pump Station and receiver and launcher traps
Aitkin	Palisade	1,061.7	New 7,000 HP Pump Station
Carlton	Cromwell	1,106.4	New 7,000 HP Pump Station

2.4.1.3 Mainline Valves

A valve is a shutoff mechanism that would be used to isolate a segment of pipeline in the rare event of a leak. At each valve location, Enbridge proposes to install the following equipment: a slab gate valve that would be remotely controlled from the Enbridge Control Center and that could be operated manually as well; digital pressure and temperature monitoring devices that would provide real-time pressure and temperature information to the Control Center; and associated electrical and communications equipment required to control the valve and monitor instrumentation.

2.5 PIPELINE CONSTRUCTION

For when pipeline construction is referenced at later parts of the report, the typical pipeline construction sequence is as follows.

First, appropriate safety measures would be implemented, including notification through the One-Call system to ensure third-party utilities and adjacent pipelines are properly marked. Next, the workspace would be surveyed, staked, and prepared for clearing. The workspace would then be cleared and graded, as necessary, to provide construction access and safe movement of equipment and personnel during construction. Silt fence[2] and other erosion control measures would be installed, and sensitive areas would be marked for avoidance. Pipe, valves, and fittings would be transported to the workspace by truck and placed along the workspace by sideboom tractors (also known as pipelayers) or cranes. After individual pipe sections are strung along the workspace, they would be bent to conform to the contours of the trench and terrain. The pipe segments would be lined up, clamped, welded, the welds inspected and subsequently treated with a protective coating. Trenching may occur before or after the pipe has been welded. Trenching is typically conducted using a backhoe or trenching machine. Where appropriate, topsoil would be segregated according to applicable permit conditions. The prepared pipe would be lowered into the trench and, where applicable, tied into existing facilities. Precautions such as padding the trench with soil would be taken during backfilling to protect the pipe from rock damage. During backfilling, subsoil would be replaced first and then the topsoil would be replaced.

[2] Silt fence: A silt fence is a sediment control device used on construction sites to protect nearby wetlands and waterbodies from stormwater runoff. A typical fence consists of a piece of synthetic fabric (sometimes referred to as geotextile fabric) stretched between a series of stakes where runoff is expected to reach wetlands or waterbodies. The fabric filters remove sediment from the water before it reaches the wetland or waterbody.

Once the pipeline has been welded and inspected and the trench has been backfilled, the pipeline would be hydrostatically tested[3] to ensure its integrity prior to the line being filled with crude oil and placed into service. The construction workspace would then be cleaned up and restoration activities would commence. Restoration would include implementing temporary and permanent stabilization measures such as slope breakers[4], mulching, and seeding.

[3] Hydrostatic testing: Hydrostatic testing is a process of verifying the integrity of the pipeline before it is placed into service. Hydrostatic testing involves filling the pipeline with water to a designated pressure and holding it for a specified period of time.

[4] Slope breaker: A slope breaker is an erosion control device to reduce stormwater runoff velocity and divert it from the disturbed construction area to more stable ground. A typical slope breaker consists of a ridge or channel constructed diagonally across the ROW on a hill.

3.0 FRAMING THE SITE SELECTION AND MODELING ANALYSIS

3.1 INTRODUCTION

As noted in the Introduction, the approach used for assessing the risks of a large release of crude oil from L3RP involves:

- Analyses of how a large release might occur and the likelihood of such a release
- Prediction of the trajectory and fate (behavior) of a large unmitigated release under different seasonal conditions, environmental settings and with different types of oils
- Assessment of the environmental effects on and recovery by the natural and human environment from hypothetical oil releases

As each of these aspects are strongly determined by the biophysical conditions at the time and location of the release, it is necessary to choose specific locations for these hypothetical releases, and make assumptions regarding the environmental conditions at the time of the release.

The DOC-EERA worked collaboratively with cooperating state and federal agencies and the Consulting Team to frame the selection of sites for hypothetical releases and develop specific assumptions about a release for use in the modeling analyses. The site selection process developed and implemented by this group was also informed by concerns and issues raised by members of the public, local communities, and Native American tribes during the scoping process.

This chapter describes:

- Engagement of state and federal agencies in identifying important considerations for site selection, including feedback from local communities and Native American tribes, and developing criteria for selecting sites for detailed assessment
- Process for identifying an array of potential sites for modeling of large oil releases along preferred and alternate routes, and then selecting a smaller number of representative sites for detailed assessment
- Rationale for the selection of the models used

This chapter concludes with an overview regarding how the modeling results are used in other sections of the report for understanding the potential effects of an accidental release of crude oil on environmental and human resources. The use of information from the threat assessment, failure frequency analysis, and modeling in planning emergency and remediation efforts is also discussed.

3.2 ENGAGEMENT IN FRAMING THE ASSESSMENT APPROACH

The engagement process for framing the assessment for large releases of crude oil involved three sequential approaches:

- Discussions with DOC-EERA to develop an overarching approach for the risk assessment of large releases
- Engagement of other State of Minnesota and federal agencies in refining the approach for assessment of large releases, including the development of criteria for selecting sites, the screening of candidate sites and the selection of sites for detailed assessment; and the selection of modeling tools and conditions for each of the selected sites
- Incorporation of scoping comments received from the public, local communities and Native American tribes in the approach for assessment of large releases of crude oil

3.2.1 Initial Discussions with DOC-EERA and Enbridge

DOC-EERA began investigating oil release modeling methodologies in July 2015, following the Commission's decision directing DOC-EERA to analyze the risk of pipeline ruptures. DOC-EERA met with representatives from Enbridge to discuss the types of approaches that might be used to assess the effects of large releases of crude oil. Technical consultants from Stantec and RPS were asked to provide technical support for these meetings.

Initial discussions focused on approaches for understanding the probability of a large release of crude oil and analyzing the potential effects of a large release of crude oil (e.g., purpose of modeling, types of models that could be used, and approaches for assessing potential effects to and recovery by important components or indicators of the natural and human environment).

Additional information was gathered and discussed that addressed the types of modeling tools, including a presentation on two modeling packages developed by RPS: OILMAP Land and SIMAP[5]. An example of the use of OILMAP Land for the Enbridge Line 3 Pipeline application to the National Energy Board in Canada was reviewed.

3.2.2 Engagement of Additional State of Minnesota and Federal Agencies

From October 2015 to March 2016, DOC-EERA met multiple times with state and federal agencies to discuss the approaches being considered for assessment of hypothetical large release of crude oil from the L3RP with a focus on developing approaches for selecting sites and the detailed analyses and modeling that would be conducted. State participation in the

[5] OILMAP Land and SIMAP are two separate computational oil spill modeling tools that have been developed by RPS to predict the trajectory, fate, and potential acute effects of released hydrocarbons on land and into water. Both models have been used extensively in the United States and internationally to meet regulatory requirements and other recommendations and guidelines. Computational oil spill models such as OILMAP Land and SIMAP meet these requirements and are used frequently by industry, government, and academia. See also Section 4.2.1.

consultations included representatives from DOC-EERA, the Minnesota Department of Natural Resources (MN DNR), the Minnesota Pollution Control Agency (MN PCA), the Minnesota Department of Agriculture (MN DA), and the technical consultant for the State of Minnesota, Cardno ENTRIX. At the federal level, the United States Army Corps of Engineers (USACE) was involved.

DOC-EERA also arranged for Enbridge, Stantec, RPS, and Dynamic Risk to provide technical presentations and participate in discussions with the attending state and federal agency representatives. These meetings occurred over a series of conference calls, in-person meetings, and workshops.

Key topics discussed during the various presentations included:

- Assessing threats to the pipeline and estimating the site-specific likelihood of an incident (i.e., failure frequency)
- Reviewing and providing guidance on modeling approaches for assessment of large release of crude oils. This included framing the desired information to be provided by modeling, selecting appropriate modeling tools and representative sites, and estimating the trajectory and fate of released hydrocarbons in space and time.
- Assessing the range of effects that might occur to different components of the natural and human environment if a release of crude oil were to occur

The primary focus of the Q4 2015/Q1 2016 meetings was the development of methods for predicting the behavior, eventual fate, and environmental effects of several hypothetical large volume releases of crude oil from L3RP spanning the diversity of the geographic and environmental conditions through areas of Minnesota where the pipeline passes. Other topics discussed included the assessment of pinhole leaks.

This dialogue yielded a number of recommendations regarding:

- Framing the modeling exercise with respect to the types of information to be provided through modeling and the assessment of effects
- Modeling tools to be used for predicting the trajectory and fate of oil releases (OILMAP Land and SIMAP were the models chosen)
- Data required for modeling (e.g., watercourse flows and characteristics, biophysical conditions, land use, and availability of data from state and federal agencies)
- Criteria for selection of specific sites for modeling of accidental releases, identification of a large number of potential sites, and subsequently the identification of the specific representative sites for modeling large release of crude oils (note: the potential locations that were considered, as well as the locations that were selected as representative site involved locations on both the preferred and alternative routes for L3RP)
- Variables to be modeled such as the type of release (full bore rupture), volume of the release at each site, the type of oil released, weather and seasonal conditions, receiving environmental characteristics, and flood stages
- Required documentation of modeling methods and results
- Assessment of environmental effects

In addition to the discussions on scoping, there also were separate meetings on pinhole leaks (addressed in Stantec and Barr 2016), the assessment of threats to the pipeline, and associated failure frequency analyses.

The results of consultation are further discussed in the sections below.

3.3 SELECTION OF MODELING RELEASE SITES

3.3.1 Environmental and Geographic Diversity along Pipeline Route

The preferred and alternative routes for the proposed L3RP pipeline traverse the width of Minnesota, starting in the northwestern part of MN (at the state border between Drayton, North Dakota and Hallock, Minnesota), and extending over 300 miles south-east before reaching the Wisconsin border south of Duluth (Figure 3-1).

The proposed pipeline covers a diversity of landscape and habitat types, including grasslands, agricultural lands, forests, streams, rivers, lakes, and wetlands. There are also regional and seasonal differences in aspects such as temperature, wind speed, river flow conditions, and amounts of rain, snow, and ice. Differences in terrain, land-cover types, habitat types, and land use exist and will influence how released crude oil might be transported over land into water features, as well as how much oil may be retained on different land and shore types.

3.3.2 Framing the Assessment of Hypothetical Large Releases of Crude Oil

During the initial meetings with the DOC-EERA and the state and federal agencies, discussions focused on the overall approach to the assessment of the fate and effects of large release of crude oils, important considerations with respect to natural and human environments, and the types of information that would be provided by oil release modeling.

Conservative choices for modeling purposes perform several functions. First, conservative choices tend to maximize predicted effects and help to improve our understanding of worst case outcomes with respect to oil trajectories, behavior and associated effects. Second, as not all factors can be anticipated, a conservative choice allows the model to bound upper and lower limits, thereby reducing the number of scenarios required, while still maintaining the integrity and likelihood of the model and scenario. Lastly, the modeling of worst case scenarios aids pipeline engineers and emergency response planners to better understand and prepare for a potential worst case scenario.

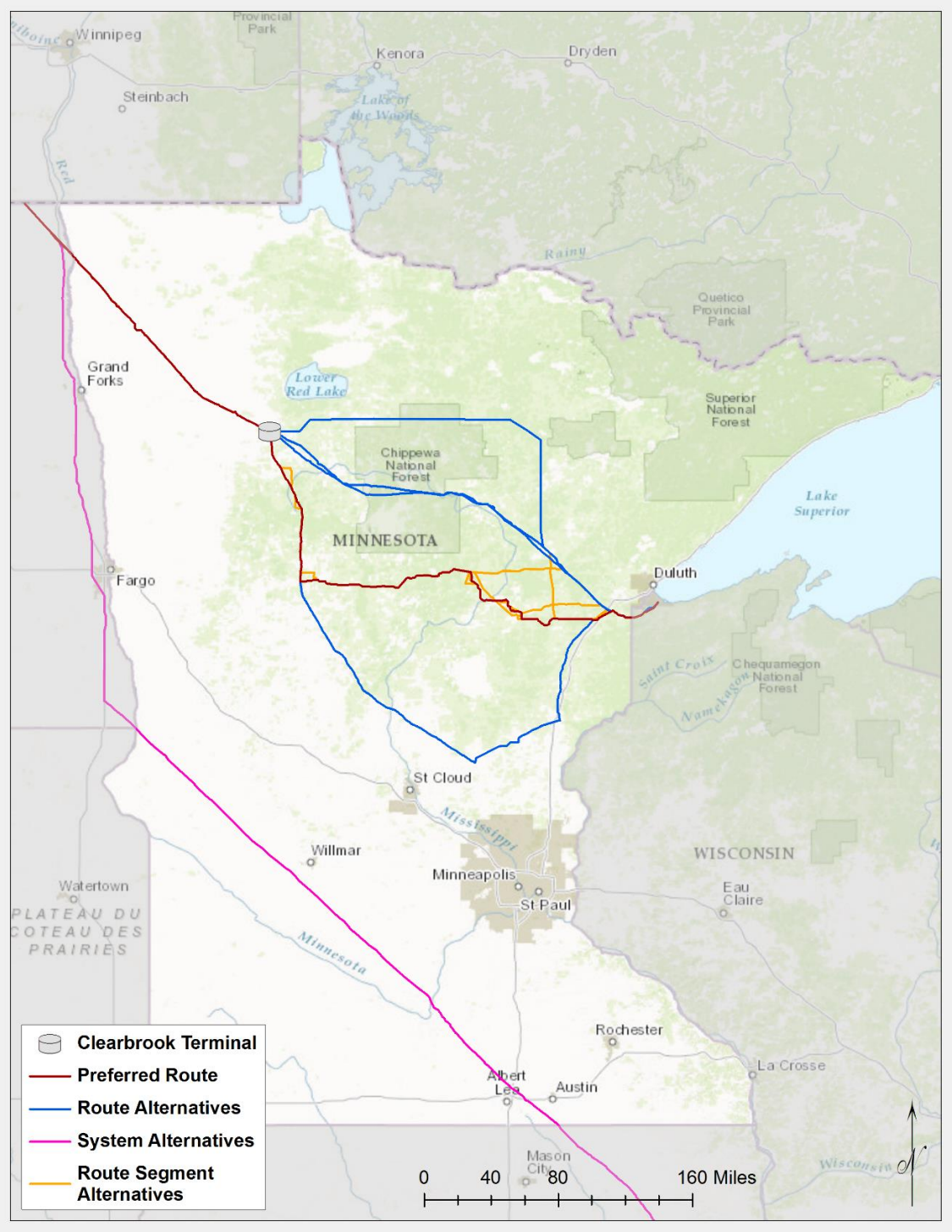

Figure 3-1 Map of the Preferred and Alternate Routes for L3RP

A primary consideration for developing appropriate scenarios for modeling of large releases of crude oil was the understanding that in the event of a full bore rupture incident (where the pipeline is essentially severed across the full diameter of the pipe), crude oil releases to land (as opposed to releases in water) often result in only small areas of land (i.e., a few acres) becoming contaminated by released oil. On land, crude oil will pool and collect in depressions and adhere to vegetation and soil. In contrast, if crude oil was accidentally released into water, crude oil can travel over larger distances due to water movement and the behavior of crude oil in water, thereby potentially exposing a larger area to contact with crude oil. This is not to suggest that effects of a release of crude oil on land would not be consequential, but it does justify the selection of locations for the hypothetical releases of crude oil that would result in oil entering watercourses (rivers or lakes) as being a conservative choice with respect to the fate, transport, and potential effects of released oil.

Given the larger spatial distribution possible from releases of crude oil into water features, unmitigated releases of oil would have greater potential to cause adverse effects to larger numbers and a greater diversity of ecological and human receptors downstream of the hypothetical release location. Therefore, it was decided that the modeling scenarios would focus on release locations where the hypothetical release of oil would either occur directly into a watercourse or would travel overland before reaching a watercourse. This approach was considered to be conservative with respect to the potential trajectory of released oil, the fate of released oil, and the potential effects of accidental oil releases on the natural and human environment.

Early discussions also focused on the type of releases to be considered and the specifics regarding these releases. Given that DOC-EERA wanted to focus on an assessment of potential large releases of crude oil (DOC-EERA 2015), the Consulting Team recommended that a full bore rupture (complete severing of the pipeline) be considered as a worst case scenario. A full bore rupture would result in a large instantaneous release of oil both through the initial release volume prior to shutdown (i.e., active pumping of oil), as well as the hydraulic drain down of the pipeline (i.e., gravity drained oil within the pipeline between the valves). This type of incident would result in more crude oil being released into the environment in a shorter period than partial ruptures or pinhole leaks (see Stantec and Barr 2016 for an assessment of pinhole leaks). While a full bore rupture is unlikely, it is again, a conservative choice used for modeling purposes. Accordingly, the maximum volume that could be released from each of the seven representative sites along the L3RP was calculated (Section 3.4); the specific maximum volume for that location was then used in the modeling of large releases of oil.

As a range of crude oils will be carried by the proposed pipeline, it was decided that several types of crude oil should be considered in the modeling of crude oil releases and the assessment of environmental effects. To reflect differences in the chemical make-up, density and viscosity of the crude oils that could be transported in the L3RP, a light crude oil (Bakken) and two blends of a heavy crude oil (CLB for spring and summer conditions, CLWB for winter conditions) were selected as representative crude oils that bound the anticipated range of products to be

shipped in the pipeline. The latter heavy crude oil would be representative of what is commonly referred to as diluted bitumen (i.e., dilbit). These two different types of crude oil were used in modeling and the assessment of environmental effects.

A number of issues and concerns were identified during public input to the regulatory review (e.g., via written submissions, comments during public meetings, and open houses) and through comments from the State of Minnesota and federal agencies. These issues and concerns were used to identify the type and range of conditions that would need to be considered in the assessment of large releases of crude oils. This information was also used to identify potential locations for the modeling of releases, as well as the types of issues and concerns that should be considered in the framing of the assessment of large releases of crude oil. Such modeling considerations included:

- Sites where the downstream movement of a crude oil release could overlap with and potentially affect a range of human uses (e.g., sources of drinking water, wild rice cultivation, agricultural lands, fishing, recreational uses, urban areas), as well as sensitive ecosystems (wetlands, sensitive fish spawning habitat for species such as walleye and trout, sensitive vegetation communities, forested regions, rare and endangered species).
- The need to assess potential effects of crude oil releases into large watercourses such as the Mississippi River. This reflected concerns for effects on environmental and human receptors, as well as concerns for interaction of the crude oil with suspended sediments in the water column and the potential for the oil-mineral aggregates, which may result in "sinking oil".
- The importance of considering differences in the characteristic of water features, including river width, the length of watercourses before entering larger water bodies, and differences in turbulence (e.g., flat calm water, riffles, rapids, and waterfalls) and other water feature characteristics (e.g., sediment loads, presence of emergent vegetation).

3.3.3 Development of Site Selection Criteria for Hypothetical Oil Releases

Information from the discussions with the public and state and federal agencies was used by the DOC-EERA and the Consulting Team in the development of specific criteria to guide the identification of the range of potential locations and the selection of a representative sites for modeling and assessment of hypothetical releases of crude oil.

The selection criteria for the modeling locations addressed engineering and environmental/ socio-economic considerations as follows:

- Be located so that a hypothetical large release of crude oil could potentially enter a watercourse; this included selection of locations where the hypothetical release of crude oil would either occur directly into a watercourse or would travel overland into a watercourse
- Be located where shut-off valves would not overly restrict the volume of crude oil that could potentially be released (i.e., the hydraulic drain down of pipeline would be a substantial contributor to the oil release volume)
- Include sites along both the preferred and alternate routes for L3RP

- Be representative of the geographic and environmental conditions and land uses along the proposed ROW for L3RP to aid in the evaluation of the range of potential effects to the natural and human environment along the pipeline
- Include a range of watercourse types (e.g., size, flow, energy level) and water bodies, including wetlands
- Support evaluation of potential effects to environmentally sensitive resources (e.g., spawning grounds for fish, wild rice lakes, or other sensitive habitats)
- Represent areas of expressed concern by Native American tribes, the general public, and/or state and federal agencies
- Support evaluation of potential effects to traditional use, other human use or infrastructure (e.g., potable water intakes or treatment facilities)

3.3.4 Identification of Potential Sites

A series of meetings was used to identify a number of candidate locations where modeling of crude oil releases might be conducted and, based on these candidate locations, select a suite of representative locations for the detailed analysis and modeling. The meetings involved representatives of the state and federal agencies, and the technical support consultant for the DOC-EERA, as well as Enbridge and their corresponding technical support consultants (Stantec, RPS, and Dynamic Risk).

Each water crossing transected by the preferred and alternative routes was identified and investigated as a potential location for hypothetical release modeling (major water crossings are shown in Figure 3-1). In total, nearly 1,000 watercourses were considered. The preferred route for L3RP transects 274 watercourses, and the alternative routes transect 641 watercourses.

To facilitate timely and effective modeling to inform decision-making, site selection criteria (described above) were then used to identify a number of candidate sites from the large number of watercourse crossings. Regions of interest to regulatory agencies and identified locations from discussions with the public were considered in selecting the candidate sites. Through several meetings with DOC-EERA, state and federal agencies, and the Consulting Team, a total of 27 candidate sites were identified for detailed evaluation as modeling locations. The selection of the candidate sites took into account the geospatial distribution of the sites along the preferred and alternate routes in central and northern Minnesota (Figure 3-2).

To facilitate the selection of the representative sites from the candidate sites, tables were constructed to summarize the attributes of candidate site with respect to:

- Location (within the portion of Minnesota crossed by the preferred and alternate routes for L3RP)
- Geomorphology
- Ecological land classification (see below)
- Location of sensitive resources or habitats in proximity to the preferred and alternate routes
- Watercourse characteristics
- Potential human uses (Table 3-1)

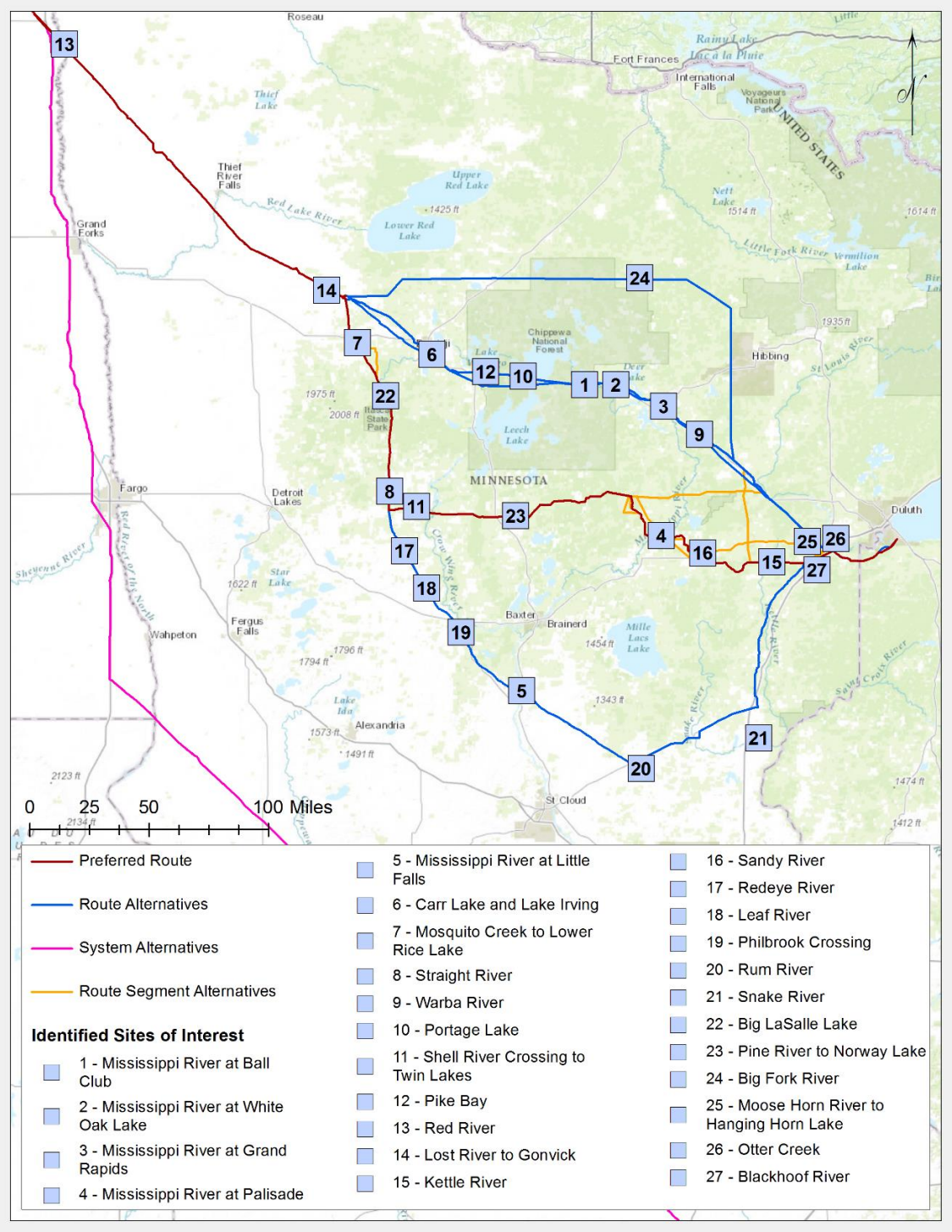

Figure 3-2 Candidate Locations Considered for Modeling along the Preferred and Alternative Routes for L3RP

Table 3-1 Characteristics of Candidate Locations for Modeling along the Preferred and Alternative Routes for L3RP

Site Name	Proposed Route	N	W	Nearest Municipality	Description	Rice Lake	Agricultural Land	Forested Region	Urban Area	Mississippi River	MN EcoRegion			River Width			River Length to Nearest Waterbody		Watercourse Characteristics			Identified Uses			
											Province	Section	Subsection	Small (<10 m)	Med. (10-50 m)	Large (>50 m)	Short (<5 km)	Long (>5 km)	Flat Water	Rapids / Falls	Lake	Recreational	Drinking Water	Populated Area	Sensitive Ecosystem
Big Fork River	Northern Alternative	47.760 810	93.625 157	Big Fork	Water crossing of Big Fork River (~25 m wide). River has many bends and does include sections with rapids passing through dense forest and some State Forest and Parks.			X			Laurentian Mixed Forest Province	N. Minnesota Forest & Ontario Peatlands	Littlefork-Vermillion Uplands		X			X		X		X	~		~
Blackhoof River	Preferred Route	46.603 105	92.553 646	Atkinson	Water crossing of the Blackhoof River (~5 m wide), with a sinuous marshy and scrub channel winding through forest and agricultural land before draining into the Nemadji River.		X	X			Laurentian Mixed Forest Province	Western Superior Uplands	Mille Lacs Uplands	X				X				X	~		X
Carr Lake and Lake Irving	Northern Alternative	47.447 557	94.886 677	Bemidji	Water crossing of (~25 m wide) river connecting Lake Irving and Carr Lake. The waterway is mainly lined by wetland passing beneath Route 2. To the south, Carr Lake contains wild rice, is lined with marshy wetlands and sporadic forest with some houses, and connects to Lake Marquette. To the north, Lake Irving has wild rice, two large marsh areas, residential housing along the banks, and an industrial complex of Bemidji on the north shore, connecting to Lake Bemidji.	X			X		Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains		X		X		X		X	X		X	X
Deer River Crossing to White Oak Lake	Northern Alternative	47.323 131	93.772 166	Zemple	Water crossing through (~10–15 m wide) winding channel leading to White Oak Lake (~4 x 0.6 km) shallow lake and wetland system and Mississippi River. Wildlife is present, as well as the extensive marshes and wetlands lining the perimeter. No residences.	X		X		X	Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains		X		X		X		X	~		X	X
Kettle River	Preferred Route	46.588 802	92.823 334	Cromwell	Water crossing of the Kettle River (~15 m wide) which winds through forested regions with few houses along the banks.			X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	St. Louis Moraines		X		N/A	N/A	X			X			
LaSalle Creek	Preferred Route	47.276 260	95.167 827	Lake Itasca	Water crossing to small creek (~2-5 m wide) running through marsh lands adjacent to forest. Leading to southern edge of Big LaSalle Lake (0.5 x 2 km), which has extensive forest cover along banks and sporadic housing along the shores.			X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains	X			X		X		X	X			
Leaf River	Southern Alternative	46.478 883	94.918 511	Aldrich	Water crossing at Leaf River (~25–35 m wide) meandering through predominantly agricultural land with forested banks.		X	X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Pine Moraines & Outwash	X			N/A	N/A	X					X	X

Table 3-1 Characteristics of Candidate Locations for Modeling along the Preferred and Alternative Routes for L3RP

Site Name	Proposed Route	N	W	Nearest Municipality	Description	Rice Lake	Agricultural Land	Forested Region	Urban Area	Mississippi River	MN EcoRegion			River Width			River Length to Nearest Waterbody		Watercourse Characteristics			Identified Uses			
											Province	Section	Subsection	Small (<10 m)	Med. (10-50 m)	Large (>50 m)	Short (<5 km)	Long (>5 km)	Flat Water	Rapids / Falls	Lake	Recreational	Drinking Water	Populated Area	Sensitive Ecosystem
													Plains												
Lost River to Gonvick	Preferred Route	47.710 842	95.525 294	Gonvick	Water crossing of Lost River (~5 m wide) with marshy grassland and forest along the banks leading to Gonvick through agricultural land.		X		X		East Broadleaf Forest Province	Minnesota & NE Iowa Morainal	Hardwood Hills	X				X	X						X	
Mississippi River at Ball Club	Northern Alternative	47.323 602	93.959 643	Ball Club	Water crossing through sinuous (~25 m wide) channel of the Mississippi River with oxbows through extensive wetlands leading to White Oak Lake.	X		X		X	Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains		X			X	X		X		X		X	X
Mississippi River at Grand Rapids	Northern Alternative	47.233 729	93.480 856	Grand Rapids	Water crossing at Prairie River (~30–40 m wide) approximately 2 km east of Grand Rapids with several bends leading into Mississippi River (~50 m wide). Mainly forested banks with some residences and sporadic agriculture.				X	X	Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	St. Louis Moraines		X		N/A	N/A		X		X		X		X	X
Mississippi River at Little Falls	Southern Alternative	46.048 333	94.341 999	Little Falls	Water crossing at Little Falls into Mississippi River (~250 m wide) with forested banks buffering agriculture and urban areas (Little Falls). The damn and falls at Little falls could potentially entrain a large amount of oil if released.		X		X	X	Eastern Broadleaf Forest Province	Minnesota & NE Iowa Morainal	Anoka Sand Plain			X	N/A	N/A		X	X	X		X		X	X
Mississippi River at Palisade	Preferred Route	46.698 284	93.494 993	Palisade	Water crossing of the Mississippi River (~75 m wide) approximately 1.5 km S of Palisade. Sinuous channel and oxbows, some turbulent stretches of water, and forest and some agriculture lining the banks.		X	X		X	Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Tamarack Lowlands			X	N/A	N/A		X		X		~	~	X
Moose Horn River to Hanging Horn Lake	Northern Alternative	46.668 779	92.608 862	Sawyer	Water crossing of the Moose Horn River (~5 m wide) through marshy wetlands leading to Hanging Horn Lake.	X					Laurentian Mixed Forest Province	Northern Superior Uplands	North Shore Highlands	X			X		X		X	X	X	X	X	~
Mosquito Creek to Lower Rice Lake	Preferred Route	47.460 399	95.306 555	Bagley	Seasonal water crossing that forms drainage into Mosquito Creek (~1 m wide) with marshy grassland and sporadic forest cutting through agriculture and nature preserves to Lower Rice Lake (~1 x 6.5 km) with a large amount of wild rice.	X	X				Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains	X				X	X		X	X		X	X
Otter Creek	Northern Alternative	46.643 024	92.493 218	Otter Creek	Water crossing of the Otter Creek (~5 m) in a marshy wetland area ultimately draining into Lake Superior.						Laurentian Mixed Forest Province	Western Superior Uplands	Mille Lacs Uplands	X				X	X	X	X	X	X	X	X	X

Table 3-1 Characteristics of Candidate Locations for Modeling along the Preferred and Alternative Routes for L3RP

Site Name	Proposed Route	N	W	Nearest Municipality	Description	Rice Lake	Agricultural Land	Forested Region	Urban Area	Mississippi River	MN EcoRegion			River Width			River Length to Nearest Waterbody		Watercourse Characteristics			Identified Uses			
											Province	Section	Subsection	Small (<10 m)	Med. (10-50 m)	Large (>50 m)	Short (<5 km)	Long (>5 km)	Flat Water	Rapids / Falls	Lake	Recreational	Drinking Water	Populated Area	Sensitive Ecosystem
Philbrook Crossing	Southern Alternative	46.295 106	94.709 837	Philbrook	Water crossing at Philbrook (~50 m wide) is meandering through agricultural regions with patchy forest along the bank. There are several oxbows and small island.		X				Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Pine Moraines & Outwash Plains			X		X	X	X	X	X		X	X
Pike Bay	Northern Alternative	47.376 184	94.560 297	Cass Lake	Release location between Route 2 and train tracks, approximately 60 m from Pike Bay (~5.4 x 4.5 km). Extensive forest (Chippewa National Forest) and some marshy wetland along the shores, with a number of houses along the banks.			X	X		Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains	N/A	N/A	N/A	N/A	N/A			X	X		X	X
Pine River to Norway Lake	Preferred Route	46.781 178	94.377 541	Pine River	Water crossing of the Pine River (~20 m wide) with extensive forest along the banks and eventually marshy wetland leading to Norway Lake. The Lake is lined with patchy forest, wetland, and many houses, including Chickamaw Beach and the town of Pine River likely affected in the event of a release.	X		X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Pine Moraines & Outwash Plains		X			X	X		X	X	~	X	X
Portage Lake	Northern Alternative	47.358 011	94.333 189	Ryan Village	Water crossing of marshy wetland leading 150 m to Portage Lake (~4.5 x 1.5 km) lined extensively with forest and some marshy wetlands. Wild rice is present, with many residences along the NE shore.	X		X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Chippewa Plains	X			X		X		X	X		~	X
Red River	Preferred Route	48.705 332	97.114 837	Drayton and Hallock	Water crossing of Red River, which flows north through a moderately sinuous channel with a width of 40–60 m. The river passes through areas predominantly used for agriculture with patchy forested regions along the banks.		X	~			Prairie Parkland Province	Red River Valley	Red River Prairie			X	N/A	N/A	X			X	X	X	X
Redeye River	Southern Alternative	46.634 343	95.051 682	Sebeka	Water crossing at the Redeye River (~10 m wide) meandering through predominantly agricultural land with some forested banks.		X				Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Pine Moraines & Outwash Plains	X			N/A	N/A	X		X				~
Rum River	Southern Alternative	45.719 326	93.617 614	Milaka	Water crossing at Rum River (~50 m wide) into meandering channel with partial forested and mainly agricultural banks. Some small islands and a few oxbows.		X				Laurentian Mixed Forest Province	Western Superior Uplands	Mille Lacs Uplands			X	N/A	N/A	X	X		X		X	~
Sandy River	Preferred Route	46.626 342	93.243 089	McGregor	Water crossing of (~10 m wide) Sandy River flowing to the west through a bifurcated channel with one sinuous channel and another straight drainage	X	X	X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Tamarack Lowlands	X	X			X	X		X	X			X

Table 3-1 Characteristics of Candidate Locations for Modeling along the Preferred and Alternative Routes for L3RP

Site Name	Proposed Route	N	W	Nearest Municipality	Description	Rice Lake	Agricultural Land	Forested Region	Urban Area	Mississippi River	MN EcoRegion			River Width			River Length to Nearest Waterbody		Watercourse Characteristics			Identified Uses			
											Province	Section	Subsection	Small (<10 m)	Med. (10-50 m)	Large (>50 m)	Short (<5 km)	Long (>5 km)	Flat Water	Rapids / Falls	Lake	Recreational	Drinking Water	Populated Area	Sensitive Ecosystem
					type ditch. The waterway is lined mainly by marshy grasses and wetland, with some forested regions. The river flows through Steamboat and Davis lake to Flowage Lake and eventually Big Sandy Lake. The region is known to contain fish spawning habitat.																					
Shell River Crossing to Twin Lakes	Preferred Route	46.819 605	95.042 982	Hubbard	Water crossing of the Shell River (~25 m wide) through a straight marshy channel in agricultural land leading to Upper Twin and Lower Twin Lakes. The lakes contain wild rice, have forest along the shores, and many houses lining Lower Twin Lake.	X	X	X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Pine Moraines & Outwash Plains		X		X		X		X	X			X
Snake River	Southern Alternative	45.848 879	92.903 915	Pine City	Water crossing at Snake River (~75 m wide) flowing through a meandering channel to the east leading to the St. Croix River. Banks extensively forested with some agricultural lands.		X	X			Laurentian Mixed Forest Province	Western Superior Uplands	Mille Lacs Uplands			X	N/A	N/A	X	X		X		X	X
Straight River	Preferred Route	46.882 162	95.143 189	Park Rapids	Water crossing of the Straight River (~10–25 m wide), with a sinuous marshy channel winding through agricultural land with agriculture on either side.		X	X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Pine Moraines & Outwash Plains		X			X	X		X	X	X		X
Warba River	Northern Alternative	47.118 892	93.264 112	Warba	Water crossing of Warba River (~10–15 m wide) is sinuous, traveling through dense forest. This is a tributary to Mississippi River.			X			Laurentian Mixed Forest Province	N. Minnesota Drift & Lake Plains	Tamarack Lowlands		X			X	X			~			X

Shading legend:
Selected for a SIMAP Scenario
Selected for a OILMAP Land Scenario

The objective was to identify a smaller number of representative sites that would reflect most of the major attributes described above.

Minnesota uses an Ecological Classification System (ECS) for ecological mapping and landscape classification (MN DNR 1999). As stated by the MN DNR and the U.S. Forest Service: "Ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The system uses associations of biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation. ECS mapping enables resource managers to consider ecological patterns for areas as large as North America or as small as a single timber stand and identify areas with similar management opportunities or constraints relative to that scale. There are eight levels of ECS units in the United States. Map units for six of these levels occur in Minnesota: Provinces, Sections, Subsections, Land Type Associations, Land Types, and Land Type Phases."

The ECS breaks the state up into 4 ecological Provinces (Figure 3-3), which include a total of 10 ecological Sections (Figure 3-4). Provinces are units of land defined using major climate zones, native vegetation, and biomes such as prairies, deciduous forests, or boreal forests. Sections are units within Provinces that are defined by origin of glacial deposits, regional elevation, distribution of plants, and regional climate.

Portions of the preferred and alternative routes for L3RP pass through each of the four Provinces (Table 3-2). The preferred route includes six Sections, while the alternative routes include eight Sections. Table 3-2 summarizes the locations identified in Table 3-1 by their respective Provinces and Sections.

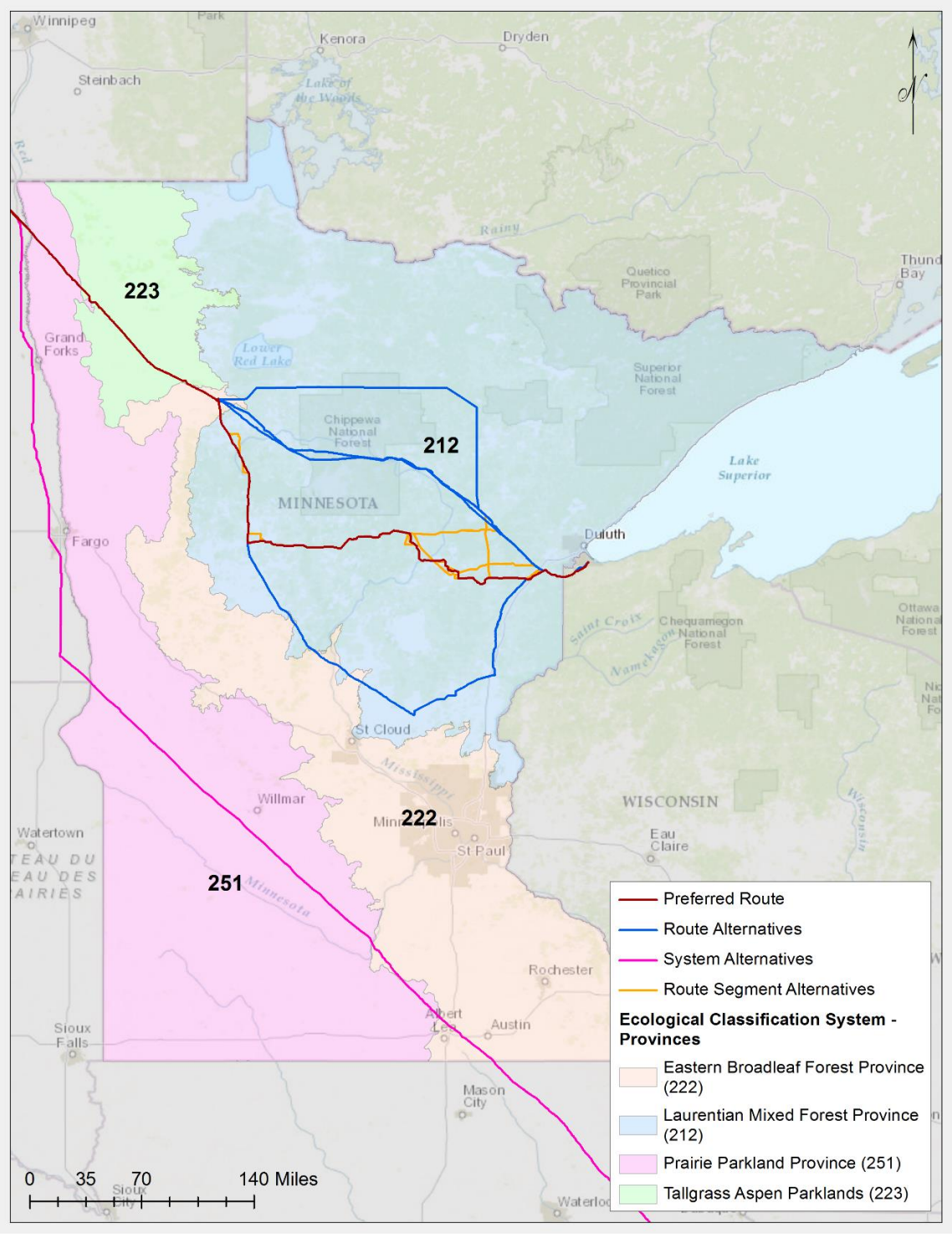

Figure 3-3 Ecological Provinces along the Preferred and Alternative Routes for L3RP

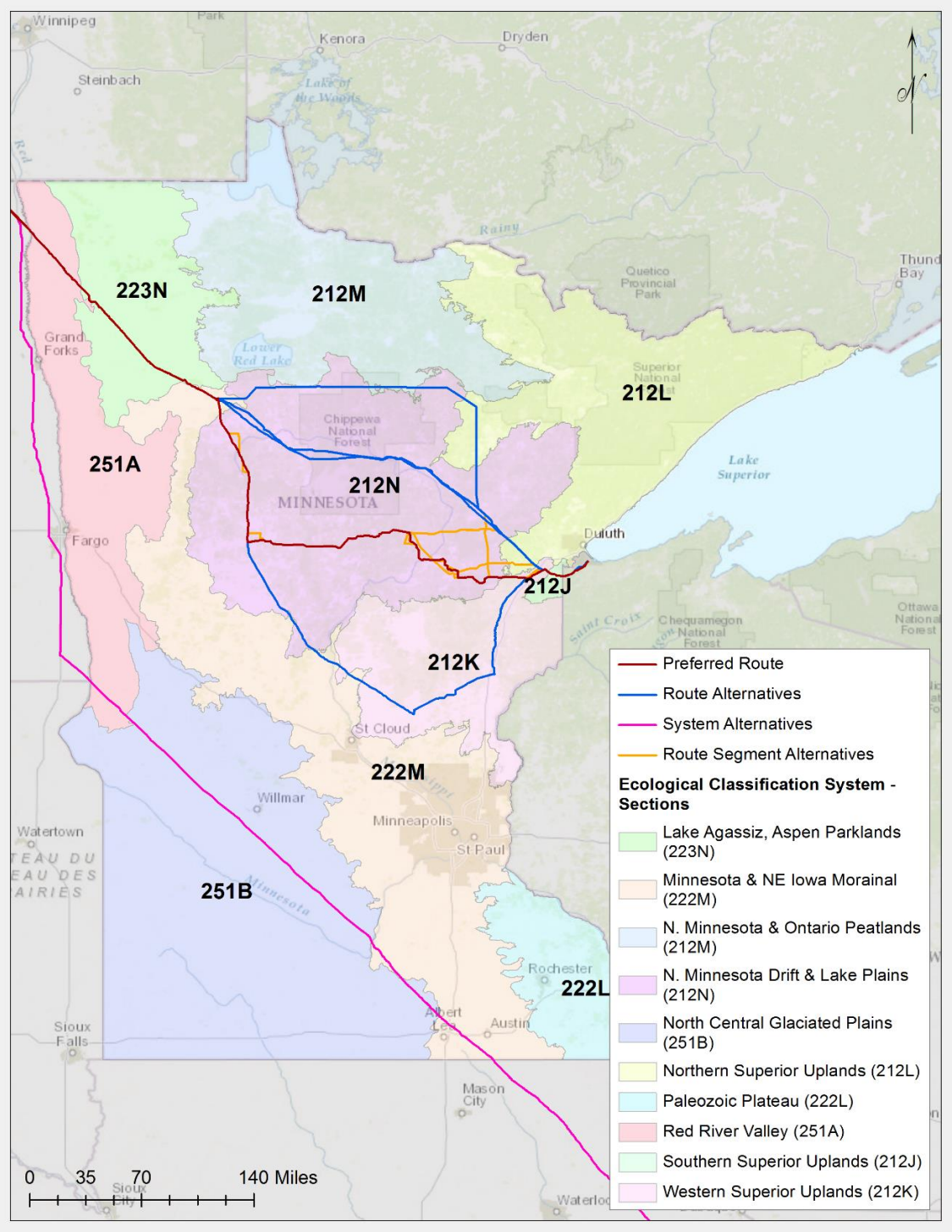

Figure 3-4 Ten Ecological Sections along the Preferred and Alternative Routes for L3RP

Table 3-2 Representation of Ecological Provinces and Sections by the Candidate Locations along the Preferred and Alternate Routes for L3RP

Province	Sections	Locations Considered	Preferred Route	Route Alternative
Prairie Parkland Province	Red River Valley	*Red River	X	X
	North Central Glaciated Plains	---	---	---
Tall Grass Aspen Parklands	Lake Agassiz, Aspen Parklands	---	X	---
East Broadleaf Forest Province	Minnesota and NE Iowa Morainal	Lost River to Gonvick ***Mississippi River at Little Falls**	X	X
	Paleozoic Plateau	---	---	---
Laurentian Mixed Forest Province	Southern Superior Uplands	---	X	---
	Western Superior Uplands	Blackhoof River Otter Creek Rum River Snake River	X	X
	Northern Superior Uplands	Moose Horn River to Hanging Horn Lake	---	X
	No. Minnesota and Ontario Peatlands	Big Fork River	---	X
	No. Minnesota Drift Lake Plains	Carr Lake and Lake Irving Deer River Crossing to White Oak Lake LaSalle Creek Leaf River Kettle River ***Mississippi River at Ball Club** Mississippi River at Grand Rapids ***Mississippi River at Palisade** ***Mosquito Creek to Lower Rice Lake** Philbrook Crossing Pike Bay Pine River to Norway Lake Portage Lake Redeye River ***Sandy River** ***Shell River Crossing to Twin Lakes** Straight River Warba River	X	X

NOTES:

Dark grey cells depict regions along the preferred route
Light grey cells depict regions along the route alternatives
Bolded locations with a (*) depict the representative locations used in the detailed modeling and assessments.

3.3.5 Selected Sites for Modeling and Comparison of Site Characteristics and Equivalency

The DOC-EERA, together with state and federal agencies and the Consulting Team, employed the above criteria and considerations to select a total of 7 representative locations for detailed modeling and assessment from the 27 candidate locations; specifically:

- Site 1—Mosquito Creek to Lower Rice Lake
- Site 2—Mississippi River at Ball Club
- Site 3—Sandy River
- Site 4—Shell River to Twin Lakes
- Site 5—Red River
- Site 6—Mississippi River at Palisade
- Site 7—Mississippi River at Little Falls

For each of the seven modeling locations, the following detailed analyses were completed.

- An assessment to identify the potential threats to the pipeline from natural and human causes at the modeling location, and an assessment to quantify the failure frequency for a full bore rupture specific to the conditions at that location (i.e., within the potential impact segment; Chapter 4.0). The maximum volume of crude oil that could be hypothetically released at each site was determined based on the pipeline specifications and topographic conditions in proximity to each modeling location. The maximum volume out was calculated as a full bore rupture, with a conservative response in the pipeline Control Center of a maximum of 10 minutes, followed by a 3-minute period to allow for valve closure, and then drain-down of the elevated segments of pipeline. The maximum 13-minute duration of Control Center response time to valve closure is a standard for safe operations and leak detection for Enbridge. The total volume out included both the initial release volume prior to shutdown (i.e., actively pumping out), as well as hydraulic drain down of the pipeline (i.e., gravity drained oil within the pipeline between the valves), following shutdown at that site.
- The trajectory of an unmitigated oil release and the associated fate or behavior of the crude oil (i.e., weathering and physical distribution [e.g., on shore, on the water surface]) was predicted for each location using two different modeling tools (see Chapters 5.0 and 6.0). The volumes used in the hypothetical release were based on the largest quantity of oil from the L3RP pipeline at that specific location. At each location, separate models were run for three flow conditions for watercourses (low, average and high) and three types of crude oil (Bakken crude oil, CLB, and CLWB). Maps of the trajectory of the release and tabular summaries of the fate of the crude oil were developed for 6, 12, 18, and 24 hours following the hypothetical release.
- The effects of the hypothetical release of crude oil at each location on key receptors in the natural and human environment were assessed using two methods. The first method involved determining the potential overlap of the predicted trajectory of an oil release on HCAs, as defined under federal law, and AOIs, as defined under state law (Chapter 7.0). The HCAs were based on the PMHSA data for each location. The types of AOIs to be considered were identified by the state and federal agencies and included databases from the MN DNR. The second method considered known effects of crude oil releases on key receptors, with a focus on ecological and human health risks. The recovery of the natural and human

environment from exposure to crude oil, based on current literature, is discussed in Chapter 8.0.

As shown in Figure 3-5 and summarized in Table 3-3, the seven representative modeling locations are well distributed along the preferred and alternate routes for L3RP. To better illustrate how the seven representative modeling locations represent different combinations of hydrological conditions, watercourse widths, water features and uses, the detailed summary of features and characteristics (i.e., site attributes) described in Table 3-1 was condensed into a simpler format (Table 3-3). As shown in this table, for each attribute and the specific categories within each attribute (other than overland flow), at least two of the representative modeling locations and typically several were representative of that specific attribute and category. This summary demonstrates that the seven representative modeling locations did include a robust diversity of site characteristics that were identified in the scoping sessions. This included the features that are representative of most of the predominant ecological units along the pipeline, as well as the major hydrological features, watercourse widths, watercourse features along the preferred and alternative routes.

It is the opinion of the authors of this report that the modeled crude oil releases under different seasonal flow conditions and the predicted trajectory and fates information at each of the seven modeled sites will adequately represent the likely outcomes of an oil release in central and northern Minnesota. In combination with a broader understanding of the literature regarding the effects of an oil release on key receptors in the natural and human environment (Section 7.1), as well of site-specific assessments of potential effects on environmentally-sensitive areas (e.g., HCAs and AOIs; Section 7.3) and on key receptors at each of the seven modeling locations (Sections 7.4 to 7.10), a wide range of potential effects on key receptors under different seasonal flows conditions and with light and heavy crude oils are considered and analyzed. Further, the authors of this report believe that modeling and assessment of effects at additional inland sites would not add proportionately to a better understanding of environmental effects stemming from hypothetical oil releases, nor would additional modeling change the conclusions of the anticipated environmental effects, should there be a release of oil.

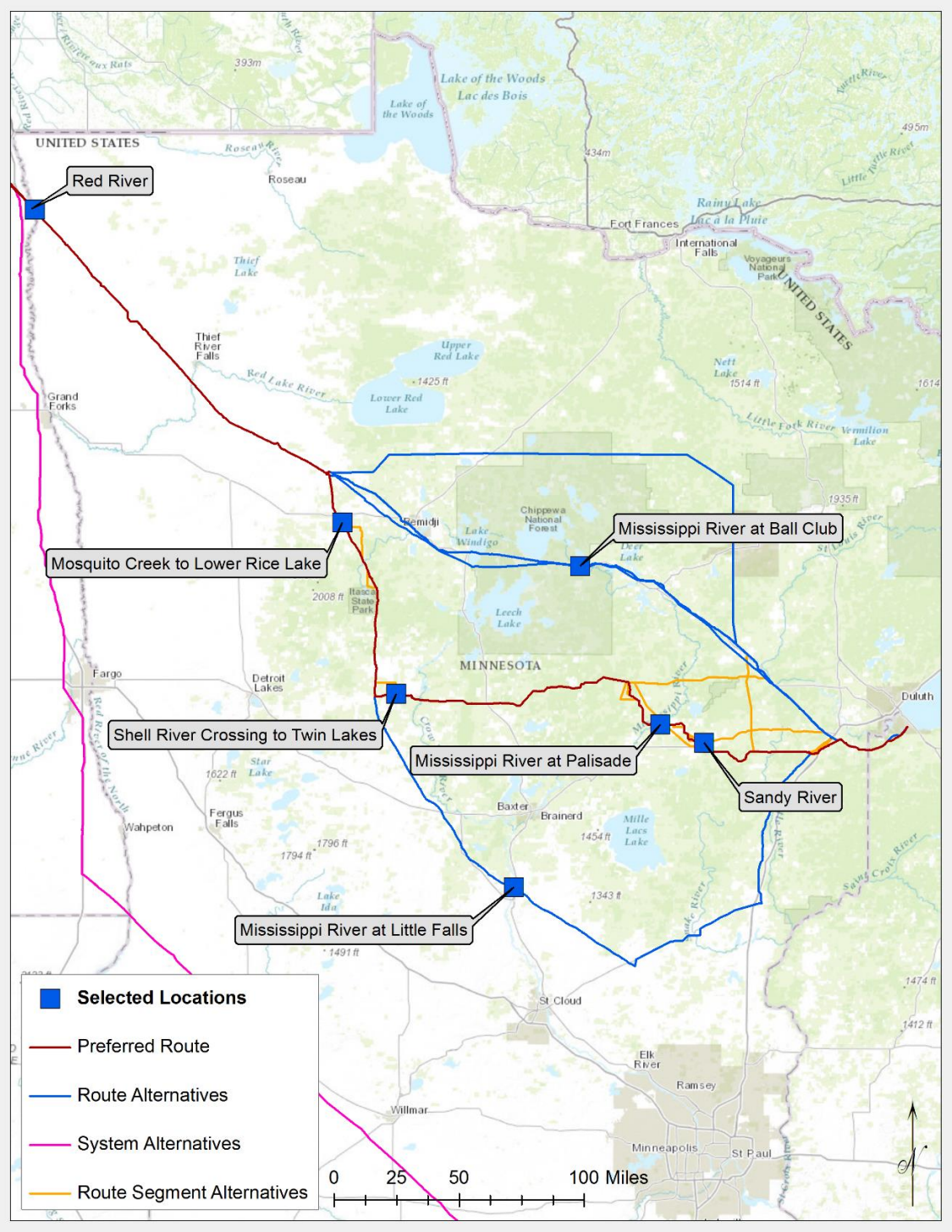

Figure 3-5 Location of Representative Sites Selected for Modeling of Hypothetical Large Releases of Crude Oil

Table 3-3 Summary of Characteristics of Each Representative Release Location

Representative Release Location		Mississippi River at Ball Club	Mississippi River at Little Falls	Mississippi River at Palisade	Mosquito Creek to Lower Rice Lake	Red River	Sandy River	Shell River Crossing to Twin Lakes
EcoProvince		Laurentian Mixed Forest Province	East Broadleaf Forest Province	Laurentian Mixed Forest Province	Laurentian Mixed Forest Province	Prairie Parkland Province	Laurentian Mixed Forest Province	Laurentian Mixed Forest Province
Site Features								
Hydrology Features	Ditch/Creek				X		X	
	Watercourse (stream/river)	X	X	X	X	X	X	X
	Lake/Pond	X			X		X	X
	Flat Water	X		X	X	X	X	X
	Rapids / Falls		X	X				
	Dams		X	X				
	Wetland/Marsh/Fen	X			X		X	X
Watercourse Width	Small (<10 m)				X		X	
	Medium (10–50 m)	X		X				X
	Large (>50 m)		X			X		

Table 3-3 Summary of Characteristics of Each Representative Release Location

Representative Release Location		Mississippi River at Ball Club	Mississippi River at Little Falls	Mississippi River at Palisade	Mosquito Creek to Lower Rice Lake	Red River	Sandy River	Shell River Crossing to Twin Lakes
EcoProvince		Laurentian Mixed Forest Province	East Broadleaf Forest Province	Laurentian Mixed Forest Province	Laurentian Mixed Forest Province	Prairie Parkland Province	Laurentian Mixed Forest Province	Laurentian Mixed Forest Province
Site Features								
Watercourse Features	Agricultural Land		X		X	X	X	X
	Forested Region	X		X			X	X
	Mississippi River	X	X	X				
	Urban Area		X					
	Wild Rice	X			X		X	X
Identified Uses	Recreational	X	X	X	X	X	X	X
	Drinking Water			X		X		
	Populated Area		X			X		
	Sensitive Ecosystem	X	X	X	X	X	X	X
Includes Overland Transport					X			

3.3.6 Description of Representative Release Locations

3.3.6.1 Site 1—Mosquito Creek to Lower Rice Lake

The Mosquito Creek to Lower Rice Lake modeling location captures both the potential for overland flow of crude oil and the downstream transport of crude oil in a very small watercourse. The hypothetical release location is in a relatively flat, forested region that forms a drainage area that has a gentle slope towards agricultural and grassland habitats. The swale collects into a narrow and seasonal water crossing that ultimately forms Mosquito Creek, a channel approximately 3 ft in width that flows to the south and west. Mosquito Creek flows through marshy grassland and sporadic forest, cutting through agriculture and nature reserves. After approximately 12.5 miles, the watercourse grows to around 35 ft in width, before entering Lower Rice Lake. Lower Rice Lake is approximately 1,600 acres in size and supports large areas of wild rice.

This modeling location represents the environmental conditions of a small quiescent watercourse that contains wetlands, marsh, and fen. The agricultural lands, nature preserve, and wild rice that may be present are representative of lands that may be used as a source of food and recreation. In addition, portions of the ecosystem have been classified as sensitive (i.e., included in the PHMSA database for HCAs and/or the State of Minnesota data base for AOIs).

3.3.6.2 Site 2—Mississippi River at Ball Club

The Mississippi River at Ball Club modeling location contains a sinuous water channel that is approximately 80 ft wide. The channel flows to the south and east through a relatively well defined channel that has a large number of oxbows. The banks are lined with extensive wetlands and forested areas adjacent to some parts of the water course. Under high river flows, the watercourse connects to White Oak Lake, before extending to the south through more sinuous channels and marshy wetlands.

This modeling location captures the environmental conditions of a quiescent watercourse of intermediate size that contains wetlands, marsh, and fen. The lake is approximately 9 miles downstream of the hypothetical release location. This location is representative of lands where food may be harvested, including fish and wild rice. In addition, the location includes an upstream portion of the Mississippi River and forested land. This region is used for outdoor recreation, and near the populated area of Deer River and sensitive ecosystems.

3.3.6.3 Site 3—Sandy River

The Sandy River modeling location is a bifurcated channel, approximately 30 ft wide, and flows to the west. The southern channel is a natural sinuous feature, while the northern channel is a straight drainage-type ditch. The waterway is mainly lined by marshy grasses and wetland with some forests. The river flows through Steamboat and Davis lakes to Flowage Lake and eventually Big Sandy Lake. The region is known to contain fish spawning habitat.

This modeling location captures a small ditch/creek type water course that enters into lakes and ponds after passing through areas with wetlands, marsh, and fen. The lakes are between approximately 6 and 12 miles downstream. The site is representative of forested and agricultural lands where food may be harvested. Due to the fish species present, this watercourse is used for recreation, specifically focused around recreational fishing. The region is known to contain sensitive ecosystems.

3.3.6.4 Site 4—Shell River to Twin Lakes

The Shell River Crossing to Twin Lakes modeling location contains a straight marshy channel, approximately 80 feet wide, that passes through forested areas that are nestled between agricultural lands. The watercourse enters the northern end of Upper Twin Lake before draining into a small reach that feeds Lower Twin Lake. There are many houses lining the lakes, with docks that provide access to swimming and boating.

This modeling location captures a medium width quiescent watercourse that enters directly into lakes after passing through areas with wetlands, marsh, and fen. The lakes are approximately 0.6 to 1.2 miles downstream of the hypothetical release location. The presence of residences with docks does make this location representative of inhabited areas that may be used recreationally. In addition, this region is known to contain sensitive ecosystems.

3.3.6.5 Site 5—Red River

The Red River is located along the border of Minnesota and North Dakota, and runs to the north into Canada. The pipeline crossing is located approximately 3 miles (4.82 km) due east of Bowesmont, North Dakota and 9 miles (14.48 km) southwest of Hallock, Minnesota adjacent to Route 16. At the proposed pipeline crossing location and downstream, the Red River is a large, wide (150–400 ft) river that flows north along a well-defined sinuous channel. The Red River passes the communities of Pembina, North Dakota and St. Vincent, Minnesota approximately 32 river miles downstream from the crossing location, and crosses into Canada approximately 34.5 miles downstream. The communities of Emerson and West Lyme, Manitoba are located on the Canadian side of the international border.

This modeling site captures a large, low-gradient (dropping approximately 6 ft in 35 river miles) watercourse, with a sinuous channel that is subject to flooding. The shore types are predominantly vegetated, often with shrubs and trees above the level of ice-scour. These waters are known to be a major area for recreation use, and also pass through or adjacent to sensitive ecosystems. The riparian banks are generally well vegetated, including some trees. Patches of forest are often present where the river meanders, although the surrounding land use is primarily agricultural. The Red River is subject to moderate to extreme flooding, particularly in the spring. Under low or average flow conditions, the stream banks are a combination of grass and soil. Under higher flow conditions the river can overtop the banks and spread into the surrounding farm and grassland.

3.3.6.6 Site 6—Mississippi River at Palisade

The Mississippi River at Palisade modeling location is a large river, approximately 250 ft wide, which flows to the south and west. The hypothetical release location is approximately 1 mile south of Palisade, MN. The sinuous channel is mostly flat water passing through a number of oxbows. There are some turbulent waters with the presence of a flood diversion dam and spillway. Under high flow rates, this small region would have very turbulent waters containing rapids from a waterfall. The banks are mainly forested, with residences and some agricultural lands on either side.

This modeling location captures the environmental conditions of a large and relatively quiescent watercourse that has predominantly forested banks. In addition, the site does include a midstream portion of the Mississippi River and forested lands. While the majority of the channel is relatively flat water, the flood diversion channel, with its dam and spillway, have the potential to result in localized turbulence, that could entrain oil if a release were to occur and crude oil was to reach the spillway. The sinuous channel is used recreationally and contains sensitive ecosystems. In addition, the watercourse is known to be a source of drinking water to residences in the area.

3.3.6.7 Site 7—Mississippi River at Little Falls

The Mississippi River at Little Falls modeling location is a large river, approximately 820 ft wide, which flows to the south. This modeling location captures the environmental conditions of a large watercourse that has predominantly forested banks. The hypothetical release location is approximately 5 miles north of Little Falls. This small urban area contains the Little Falls Dam, which has a large waterfall that induces a large amount of turbulence, which would entrain surface oil into the water column, if a release of crude oil were to travel downstream to this dam. A second dam and waterfall, known as the Blanchard Dam, is located approximately 8 miles downstream of Little Falls, providing the potential for further entrainment of crude oil into the water column in the event of a release. The shore types in this region are mainly forested, with some small portions of agricultural lands and urban areas along the banks. The waters are used recreationally and sensitive ecosystems are present.

3.4 SELECTION OF MODELING TOOLS

3.4.1 Approach

The types of models to be used to predict the trajectory and fate of hypothetical releases of crude oil were discussed at the initial meetings with the State of Minnesota and Enbridge. The types of models, including the desired output information, were also discussed during the initials meetings with state and federal agencies and Enbridge. Through these discussions, it was agreed that modeling of the trajectory and fate (i.e., behavior and weathering) of hypothetical releases would be conducted using both the OILMAP Land and SIMAP computation models.

OILMAP Land provides a two-dimensional prediction of the trajectory and fate of the released crude oil (i.e., downslope and downstream in the horizontal direction), whereas SIMAP provides a three dimensional prediction (i.e., movement in both the horizontal and vertical directions, meaning the possibility for movement within the water column and on bottom sediments). Because SIMAP calculates the trajectory and fate of crude oil in three dimensions, it is a considerably more complex model that contains more interactions and processes and requires more site-specific data than OILMAP Land. Both are state-of-the-art models used by industry, government, and academics throughout the world.

Both models have been used extensively in the United States and internationally to meet regulatory requirements and other recommendations and guidelines. The PHMSA regulations (CFR, Title 49, Parts 190-199) discuss hazardous liquid integrity management, stipulating identification of HCAs and determination of direct and indirect effects from a potential spill, which are addressed with this modeling. Regulatory requirements for pollution control in offshore waters are overseen by the Bureau of Safety and Environmental Enforcement, with 30 CFR 254 requiring worst case trajectory modeling. For inland waters, the U.S. Environmental Protection Agency (USEPA) oversees Spill Prevention, Control, and Counter-measure and Facility Response Plans. Finally, increasingly comprehensive regulations for transportation of crude by rail have begun with rulings from the U.S. Department of Transportation Federal Rail Administration. The SIMAP model also has been used on numerous Natural Resource Damage Assessments (NRDA).

As shown in Table 3-4, either the OILMAP Land or SIMAP model was used at each representative location. The choice of model for each location was based on the characteristics of the site, as well as the desired outputs from the modeling. SIMAP was chosen for two of the sites on the Mississippi River. This was primarily based on a desire by the State of Minnesota to better understand how turbulent flow could result in the entrainment of crude oil from the water surface into the water column, and the possibility for the creation of oil-mineral aggregates which have the potential to sink (i.e., "sinking oil"). The two modeling locations on the Mississippi River chosen for SIMAP include dams and waterfalls downstream of the hypothetical oil release location. OILMAP Land was used at the remaining five sites. More detailed descriptions of each of the models and their application is provided below.

Unmitigated releases (i.e., no emergency response to contain or remove released oil) were simulated at each hypothetical release location, using a range of site-specific environmental conditions over multiple seasons.

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Table 3-4 Locations and Predicted Volume Out for the Representative Release Locations

Case #	Representative Release Location	Latitude (N)	Longitude (W)	Model Used	Predicted Volume Out (bbl)[1]
1	Mosquito Creek to Lower Rice Lake	47.4604	95.3066	OILMAP Land	
2	Mississippi River at Ball Club	47.2360	93.9596	OILMAP Land	
3	Sandy River	46.6263	93.2431	OILMAP Land	
4	Shell River to Twin Lakes	46.8196	95.0430	OILMAP Land	
5	Red River	48.70533	97.1148	OILMAP Land	
6	Mississippi River at Palisade	46.6983	93.4950	SIMAP	
7	Mississippi River at Little Falls	46.0483	94.3420	SIMAP	

NOTE:

[1] The maximum volume of oil hypothetically released at each modeling location included both the initial release volume prior to shutdown (i.e. actively pumping out), as well as hydraulic drain down of the pipeline (i.e. gravity drained oil within the pipeline between the valves), following shutdown at that site. The calculation is specific to the pipeline and topographic conditions at the modeling location.

...NONPUBLIC DATA HAS BEEN EXCISED]

As noted earlier, multiple modeling runs were completed for each of the seven release locations. A total of five release locations were modeled using OILMAP Land, while the remaining two were modeled using SIMAP (Table 3-4). This involved separate model runs for each of the two oil types (Bakken crude oil and CLB[6]) for each of the three flow conditions/seasons (high water flow—corresponding to spring; moderate water flow—corresponding to summer and fall; and low flow—corresponding to winter). In total, 42 physical fates scenarios were modeled (7 sites x 2 crude oils x 3 flow conditions/seasons).

Each of the hypothetical unmitigated releases was modeled for 24 hours, with outputs provided at 6, 12, 18 and 24 hours. The 24-hour duration for an unmitigated release was chosen as it is a conservative assumption that the release would be unmitigated for 24 hours, and that the released crude oil would travel downstream unimpeded for that length of time. A similar duration and time steps were used for the ecological and human health risk assessment for Line 3 in Canada that was submitted to the National Energy Board of Canada (Enbridge 2015).

[6] Two crude oil types were considered: Bakken crude oil and CLB. The composition of CLB varies throughout the year. Therefore, the properties of CLB during the summer and winter were determined. A Cold Lake Summer Blend (CLSB) was used for modeling of the average (summer) and high (spring) conditions, whereas CLWB was used for modeling of winter conditions.

3.4.2 OILMAP Land

OILMAP Land is a two-dimensional modeling system that is used to simulate the movement of released oil in the environment. It simulates the flow of oil or chemicals over land as it travels over the land surface and into any surface water body. The model itself has three components, including the overland release model, the surface water transport model, and the evaporative model that define the weathering of oil in the environment under specified conditions. The outputs include an assessment of overland and downstream trajectory of crude oil and resulting locations (e.g., shoreline reaches or segments) where oil may be found at specific times following a release. A simplified mass balance is provided to determine how much oil is retained on land, evaporates, is on the water surface, or oils shorelines. The trajectory results from OILMAP Land can be used in an HCA and AOI analysis, which consists of overlaying the presence of oil onto specific identified regions of interest to determine which resources potentially may be affected.

At each of the five modeling locations where OILMAP Land was used, the trajectory and fate of the hypothetical release of crude oil into riverine and lacustrine environments were modeled based upon the assumption of a full bore release and drain down (Table 3-4). Worst-case release volumes, based on a full bore release for 13 minutes and complete drain down, were calculated for each location. The methodology used to calculate release volumes may be found in Section 4.2. Three seasonal and environmental conditions were modeled, including high, average, and low river flows that represented spring, summer, and winter conditions, respectively. Two oil types were modeled for each flow/season at each site, including Bakken crude and CLB. The chemical and physical parameters of CLB were varied between warmer conditions (CLSB was used for spring, summer/fall conditions) and winter months (CLWB was used) due to changes in the composition of the oil over the course of a year.

For each of the three flow-defined seasons, scenarios for the hypothetical oil releases were run under the corresponding environmental conditions including temperature, wind speed, the concentration of total suspended solids within the water column, etc.

3.4.3 SIMAP

SIMAP is a three-dimensional modeling system that is used to simulate the physical fates of crude oil in the water. It estimates the distribution (as mass and concentrations) of whole oil and components of oil on the water surface, on shorelines, in the water column, in sediments, and evaporated to the atmosphere. This comprehensive modeling system allows for a more in depth understanding of the behavior of oil in the environment, when compared to OILMAP Land. Oil fate processes included in SIMAP are oil spreading (gravitational and by shearing), evaporation, transport, randomized dispersion, emulsification, natural entrainment, dissolution, volatilization of dissolved hydrocarbons from the surface water, adherence of oil droplets to suspended sediments, adsorption of soluble and sparingly-soluble aromatics to suspended sediments, sedimentation, and degradation.

The outputs of the SIMAP physical fates model include the distribution of the released crude oil in three dimensional space and time. This can include the cumulative area covered by a thickness of oil on the water surface, volumes of water at various concentrations of dissolved aromatics and total hydrocarbons, masses of total hydrocarbon and aromatics on surface sediments, and the lengths and location of shoreline affected by oil.

At each of the two modeling locations where SIMAP was used, the effects of potential releases into riverine environments were modeled at each location based on the assumption of a full bore release (Table 3-4). The same three seasonal and environmental conditions, two types of crude oil, and approach for determining the site-specific release volumes modeled in the OILMAP Land assessment were used for the two SIMAP sites.

4.0 PIPELINE FAILURE PROBABILITY ANALYSIS

As part of the route permitting process for L3RP, the MN DOC-EERA was directed to complete an environmental review. The review was required to include an assessment of the risk of large oil releases, including the probability of such events, modeling of oil releases, and an assessment of the potential corresponding environmental effects.

Risk is commonly defined as the product of the probability of an event occurring (i.e., an oil release) and the resulting consequence (i.e., trajectory, fate and effects) of a release. This chapter focuses on the first component of risk: the probability of a large oil release occurring.

To address the probability of a large oil release, quantitative estimates of rupture frequency were determined for each of the seven modeling locations. In linear infrastructure such as pipelines, the probability of failure over a given time period is proportional to segment length, with longer segments being associated with greater probabilities. Therefore, given that each of the seven sites were associated with river crossings, the length of the pipeline segment that was considered in the failure frequency analysis for each modeled site was established through a high resolution analysis of outflow and overland spill modeling of full-bore rupture release scenarios. Specifically, the failure frequency analysis for each site considered the longest length of pipeline around the river crossing where crude oil from a hypothetical full bore rupture was predicted to reach the immediately adjacent waterbody. This analysis took into account both direct releases into the waterbody, as well as local topography and land cover type on each side separately, as well as the associated overland flow.

Having established the segment length at each of the seven modeled sites, quantitative estimates of rupture frequency were made, based on a two-step analysis. The first step involved a Threat Assessment in which the relevant threats at each site were identified (described in Section 4.2). As part of the Threat Assessment, approaches for quantifying threat-specific rupture frequency were selected, giving consideration to threat attribute data, as well as best practice methodologies. Using these approaches, threat-specific quantitative estimates of rupture frequency were then generated in the second step of the analysis—the Frequency Analysis (described in Section 4.2).

4.1 THREAT ASSESSMENT

4.1.1 Overview of the Threat Assessment

The primary objective of the Threat Assessment was to evaluate the potential threats to the integrity of the L3RP at each of the seven modeling locations. The threat assessment approach described in ASME B31.8S (Attachment A) was used as the basis of the Threat Assessment. Threats were divided into nine categories, plus an additional category (Other Threats):

- External corrosion
- Internal corrosion
- Stress corrosion cracking (SCC)
- Manufacturing defects
- Construction defects
- Equipment failure
- Third party damage
- Incorrect operations
- Weather related and outside force
- Other threats (e.g., forest fires, concomitant failures, access restrictions, and exposure to vandalism)

As the results of the threat assessment form the basis of a subsequent analysis to provide quantitative estimates of the likelihood of failure at each of the seven sites, the other objective of the threat assessment is to establish candidate approaches for estimating failure likelihood based on the availability, quality, and completeness of the data attributes for each threat.

The results of the threat assessment showed that of all threats considered, only two (SCC and "Other" threats) are characterized as negligible (i.e., given the location, materials and design/build specifications of the L3RP, these threats do not contribute in a substantial way to the overall failure likelihood). Additionally, the threat of Equipment Failure was considered out of the scope of this assessment, since there are no non-pipe components within the study area for any of the seven modeling locations. For the remainder of threats, quantitative estimates of failure frequency were made in a separate failure frequency analysis.

4.1.2 Introduction

The primary objective of the threat assessment is to review the attributes for all potential threats to a pipeline system taking into account the design, materials, construction methods and operational variables for the pipeline system of interest. Through this review, the relevance and severity of each threat can be assessed in the context of the operating environment for the pipeline being reviewed.

As a variety of failure likelihood estimation approaches exist, with each requiring specific data sets, the threat assessment also considered the availability and type of data for each threat to

assist in the selection of the optimal approach of determining the failure frequency for that threat.

This Chapter is structured as follows:

- Section 4.1.3: Scope—description of the pipeline segments being addressed by the threat assessment documented in this report, as well as a description of the future operating conditions that are likely for the pipe segments for the seven modeling locations
- Section 4.1.4: Threat Assessment Approach—identification of the threats considered and a description of the approach
- Section 4.1.5: Assessment of Threats—review of all threat attributes and an assessment of threat potential
- Section 4.1.6: Threat Potential Summary—summary of the threat potential for each threat, as well as description of the candidate approaches for estimating failure likelihood based on the availability, quality, and completeness of the data attributes for each threat

4.1.3 Scope

The threat assessment was conducted for seven separate segments of the 36 inch outside diameter (OD) L3RP. At each of the seven modeling locations, the segment length for each pipeline was determined by outflow and overland spill analysis. Specifically, the threat assessment and failure frequency analysis for each site considered the length of pipeline around the site of the hypothetical full bore rupture from which a crude oil release could affect (i.e., reach) the immediately adjacent waterbody through direct release or overland flow.

The design details of these seven pipeline segments are summarized in Table 4-1. Aerial imagery of each of the seven modeling locations is provided in Figure 4-1 to Figure 4-7.

Table 4-1 L3RP Pipe Segment Summary

Site No.	Stationing			Mile Post			Design Details				Installation	
	Start (ft)	End (ft)	Total Length (ft)	Start	End	Comment	OD (in)	WT (in)	Grade	MOP (psi)	Method	Min. Depth (ft)
Site 1: Mosquito Creek Crossing	741,337.644	743,162.474	1,824.830	396.01	396.36	Preferred Route MP	36	0.515	X70	654.26	Open trench	4
Site 2: Mississippi River at Ball Club	400,739.478	400,946.857	207.379	79.38	79.41	Miles from divergence from Preferred route, along RA-07	36	0.750	X70	728.91	HDD	40
Site 3: Sandy River Crossing	1,573,712.316	1,574,863.425	1,151.109	553.84	554.06	Preferred Route MP	36	0.750	X70	453.76	HDD	40
Site 4: Shell River Crossing	1,025,970.305	1,028,513.301	2,542.996	449.99	450.47	Preferred Route MP	36	0.750	X70	440.23	HDD	40
Site 5: Red River Crossing	64,422.101	66,010.025	1,587.924	801.65	801.93	L3RP existing corridor MP	36	0.750	X70	513.13	HDD	40
Site 6: Mississippi River at Palisade	1,488,560.525	1,490,030.446	1,469.921	537.68	537.96	Preferred Route MP	36	0.750	X70	734.68	HDD	40
Site 7: Mississippi River at Little Falls	1,355,723.087	1,357,034.285	1,311.198	67.97	68.22	Miles from divergence from Preferred route, along RA-55	36	0.750	X70	438.69	HDD	40

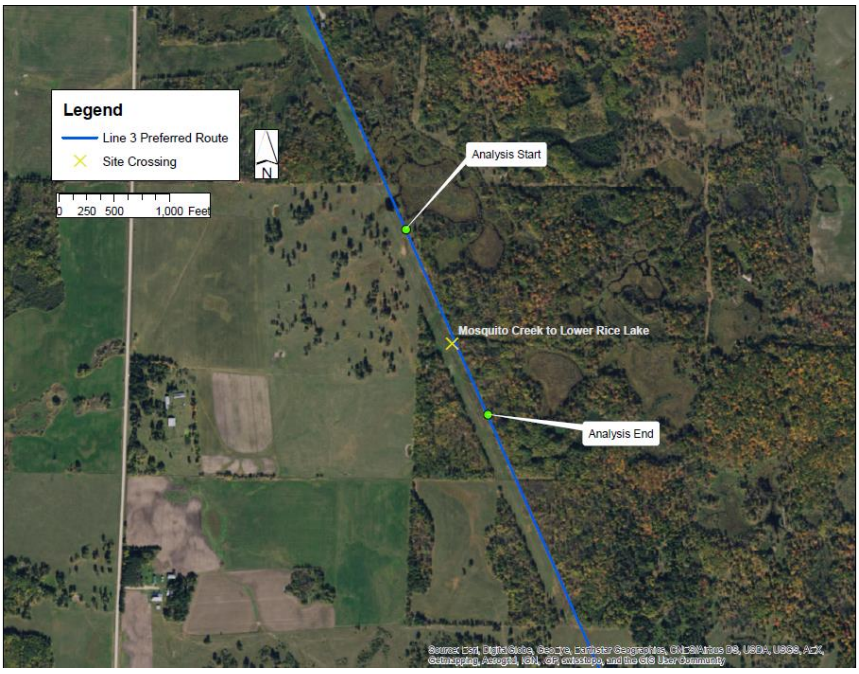


Figure 4-1 Site 1: Mosquito Creek Crossing

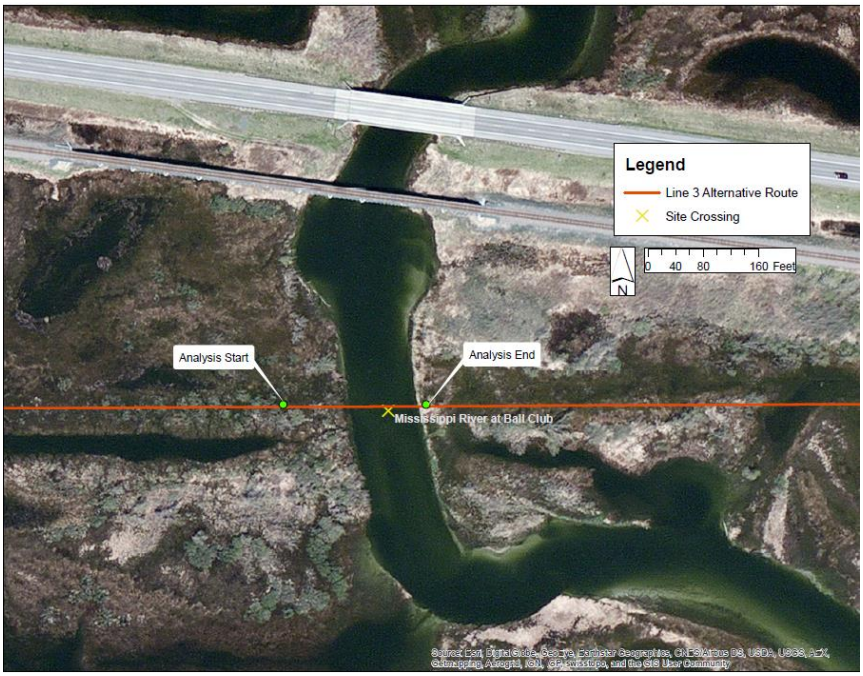


Figure 4-2 Site 2: Mississippi River Crossing at Ball Club



Figure 4-3 Site 3: Sandy River Crossing

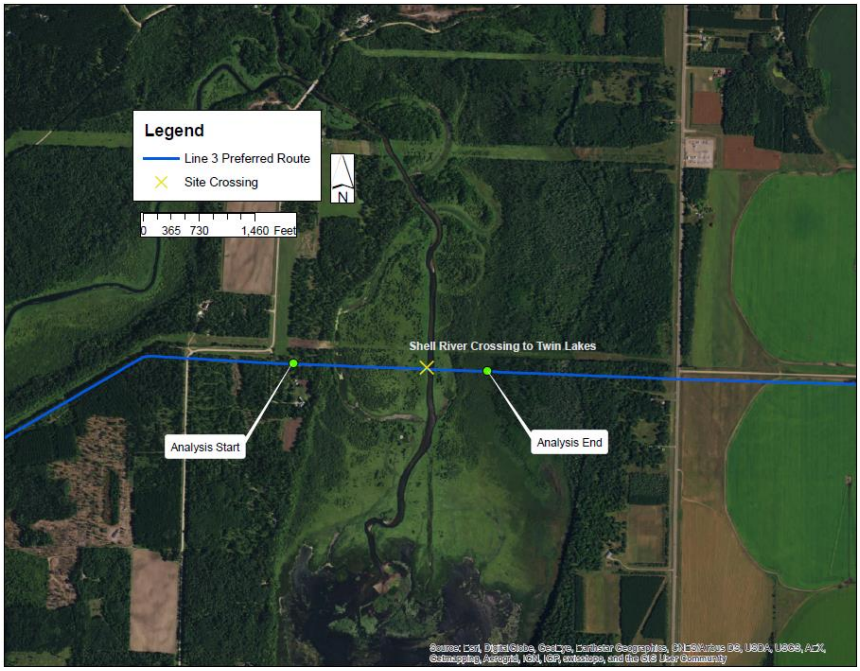


Figure 4-4 Site 4: Shell River Crossing

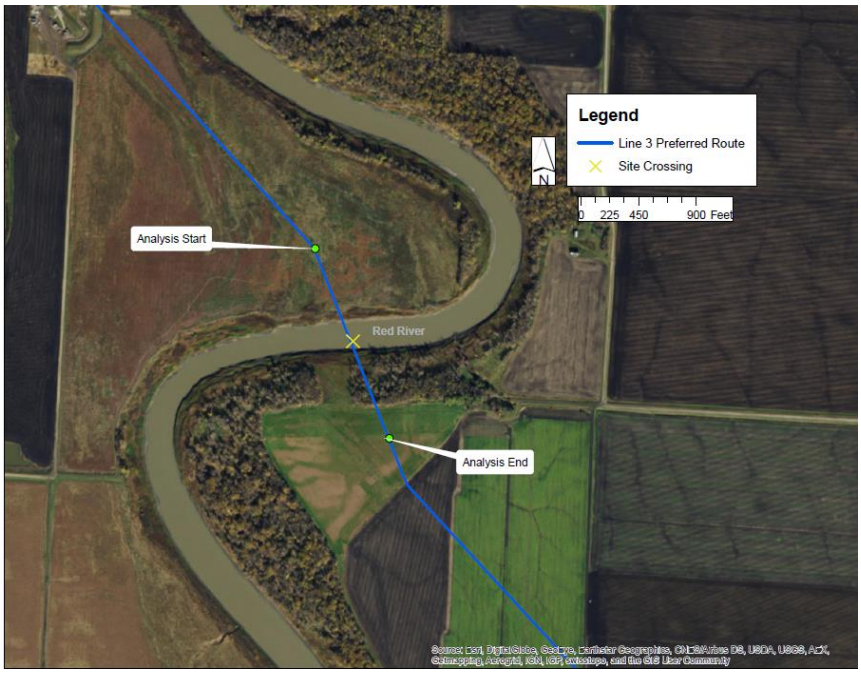


Figure 4-5 Site 5: Red River Crossing

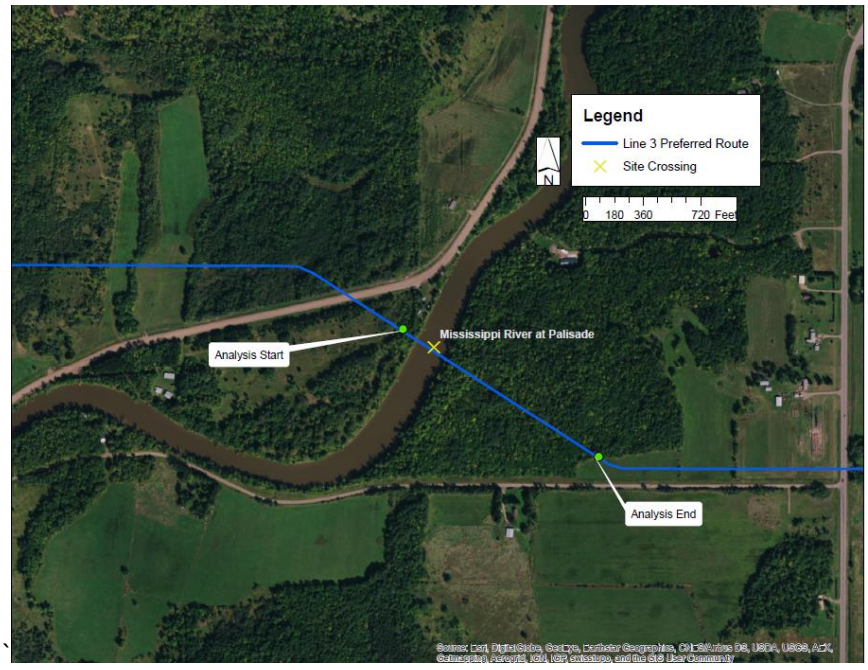


Figure 4-6 Site 6: Mississippi River Crossing at Palisade

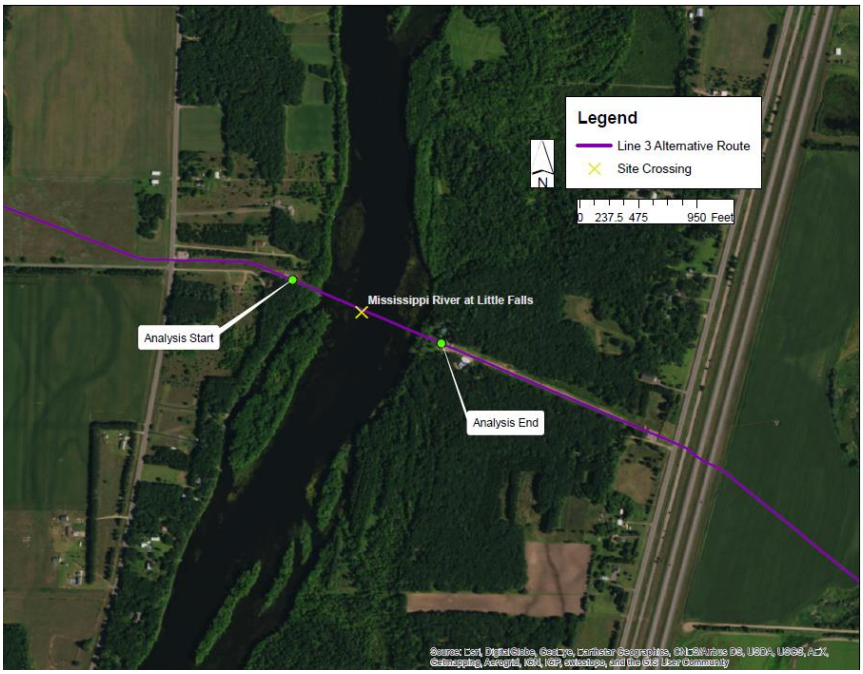


Figure 4-7 Site 7: Mississippi River Crossing at Little Falls

4.1.4 Threat Assessment Approach

The threat assessment was based on ASME B31.8S (Attachment A). Although the scope of ASME B31.8S is the management of system integrity of gas pipelines, this standard was employed as the basis of the threat assessment due to the comprehensive list of threats considered in Attachment A, and the applicability of these threats to crude oil pipelines. Based on this standard, threats are divided into nine categories, plus an additional category (Other Threats).

- External corrosion
- Internal corrosion
- SCC
- Manufacturing defects
- Welding / fabrication defects
- Equipment failure
- Third party damage
- Incorrect operations
- Weather related and outside force
- Other threats

A Threat Assessment Workshop was conducted in Enbridge's offices in Duluth, Minnesota on December 9 and 10, 2015. The list of attendees at this workshop, along with their affiliations and job titles is provided in Table 4-2.

The objectives of the workshop were to review information from sources such as maps, imagery, design records, operating data, and the opinions of subject matter experts to meet the objectives of the analysis as outlined in Section 4.1.1.

During the workshop, standardized threat assessment forms were utilized to focus the discussion. Information from the workshop and from follow-up data collection exercises is presented in Section 4.1.5.

Table 4-2 Threat Assessment Workshop Attendees

Company	Name	Title
Dynamic Risk Assessment	Jim Mihell	Chief Engineer
Dynamic Risk Assessment	Tyler Klashinsky	Integrity Engineer E.I.T
Kelly Geotechnical	Shane Kelly	Geotechnical Engineer
Wim M. Veldman Consulting Inc.	Wim Veldman	Geotechnical Specialist
Enbridge	Matt Bordson	Senior Engineer, L3R Mainline
Enbridge	Kyle Bridell	Region Engineer, Superior Region
Enbridge	Kelly Sullivan	Engineer, L3R Mainline
Enbridge	Andrew Onken	Corrosion Engineering Lead–Lake Superior Consulting
Enbridge	Andrew Nielson	Asset Lead, Pipeline Integrity
Enbridge	Claudia Schrull	Sr. Manager, Regulatory
Enbridge	David Carmona Ruiz	Engineer, Pipeline Integrity–L3RP
Enbridge	David Weir	Manager, Risk Management Modeling
Enbridge	John Pechin	Manager, Bemidji Operations, Superior Region
Enbridge	Jonathan Minton	Project Supervisor, US Regulatory Affairs
Enbridge	Matthew Martin	Engineering Specialist, L3R Mainline
Enbridge	Brent Eliason	Region Engineer, Superior Region
Enbridge	Theresa Picton	Compliance Coordinator Superior Region Operations
RPS Group	Matt Horn	Senior Scientist

4.1.5 Assessment of Threats

The attributes for each of the potential threats are discussed below.

4.1.5.1 External Metal Loss

External corrosion is a form of wall loss caused by interaction of the outside steel pipe surface with the environment. The primary form of defense against external corrosion is the external

corrosion coating on the pipe. Corrosion cannot occur so long as this coating is intact, and well-bonded to the surface of the pipe. In the event of a "holiday" (an area of missing coating), or disbondment of the coating from the surface of the pipe, the secondary defense is cathodic protection, which is designed to maintain the surface of the pipeline more electro-negative than its corrosion potential. Failure of both systems can lead to areas of localized wall loss caused by corrosion.

A summary of the threat assessment for external metal loss as it relates to L3RP is provided in Table 4-3 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

Table 4-3 External Metal Loss Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Coating Type	The following coating types will be used for L3RP: • Mainline pipe body coating system: Fusion Bond Epoxy (FBE) • Hot bends and field girth welds: 2-Part Liquid Epoxy • Horizonal Directional Drill (HDD) Sections: FBE with Abrasion-resistant overcoat Maximum temperature performance rating of all coatings is compatible with the 140°F maximum operating temperature.	All coating types being considered for the pipeline projects can be characterized as high-performance coating systems that form an efficient corrosion barrier, and that resist degradation with time.
Cathodic Protection	L3RP will have a remote-bed impressed cathodic protection (CP) system. Potential sources of interference such as High Voltage DC (HVDC) and High Voltage AC (HVAC) power lines, and adjacent pipelines will undergo testing to establish the most effective mitigation measures. If necessary, bonding will be completed to adjacent structures. Site-specific circumstances and plans are outlined below: • Site 1 – Mosquito Creek Crossing: – Additional existing lines parallel (4 Minnesota Pipe Line Company crude oil pipelines). Closest pipe 25 ft to L3RP – Interference testing will be completed. If necessary will bond to existing system – No potential AC interference • Site 2 – Mississippi River Crossing at Ball Club: – HVAC line running south of line which is currently mitigated for existing lines. – Great Lakes gas pipelines (2-3 lines) in vicinity but not parallel. Minimum separation distance would be 50 ft – Existing parallel Enbridge line (6 total) Min separation would be 25 ft (Enbridge Energy Partners [EEP]corridor) – Line would be bonded to EEP which fully mitigates existing lines. Site 3 – Sandy River Crossing: – No other existing lines (foreign or Enbridge-owned) – No sources of Interference (HVAC or HVDC) • Site 4 – Shell River Crossing: – Nearby overhead power line <300 ft HVDC – Far enough away that interference should not be an issue – No additional interference sources – No foreign pipelines	The proposed CP system design and testing measures represent industry best practice for cathodic protection systems.

Table 4-3 External Metal Loss Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
	• Site 5 – Red River Crossing: – 7 different parallel lines all Enbridge-owned min 25 ft separation. Plan is to bond to all 7 Lines at this location • Site 6 – Mississippi River Crossing at Palisade: – No adjacent pipelines – No foreign or Enbridge pipelines – No Sources of interference (HVAC or HVDC) • Site 7 – Mississippi River Crossing at Little Falls: – Viking parallel gas line will be minimum 50 ft away. – Testing for interference and appropriate mitigation such as bonding will be implemented if necessary	
CP Survey Plan	A Direct Current Voltage Gradient coating quality check will be completed on the L3RP following construction and within 18 months of commissioning. Annual test surveys to be completed on the L3RP. Additionally, close interval surveys will be completed every five years post construction. Rectifier readings will be completed on a minimum bi-monthly schedule. HDD sections will undergo coating quality testing after installation.	The proposed CP survey plans represent industry best practice for cathodic protection systems.
Soil Characteristics	No problematic conditions (acid rock drainage, high microbiological activity, etc.) have been identified along the L3RP.	There are no special concerns related to soil characteristics along L3RP.
Above-ground pipe	All piping within the scope of the analysis will be below-grade.	No consideration required for atmospheric corrosion or aeration cells.
Casings	There are no cased crossings within the scope of the analysis.	No consideration required for casing shorts.

Table 4-3 External Metal Loss Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Assessment Plan	Types of assessment to be performed, and assessment intervals to be used	Magnetic metal loss, ultrasonic crack detection, and high resolution geometry tool with an Inertial Mapping Unit as part of the baseline inspection will be completed within 1 year of in service. Inspection intervals will depend on previous findings, however currently planning 5 year inspection intervals for crack, corrosion and deformation tools. Features identified by in-line assessment tools will be evaluated against acceptability criteria, and those that exceed those criteria will be excavated and evaluated to assess the need for repair, replacement or recoating.
Analogue In Line Inspection (ILI) Data	During the Threat Assessment Workshop potential sources of Inline Inspection (ILI) data were discussed in consideration of: • Similar geographic region / terrain • Same CP standards and practices • Same coating systems • Reliability of ILI dataset • Preferably 15 years between installation date and inspection date	The following candidate ILI datasets were discussed in terms of their potential to provided suitable ILI analogues: • Line 64 – 2003 FBE – potential option • Line 4 in Canada – FBE Portions built in 90s and 2000s – follows same route as L3RP • To be provided

4.1.5.2 Internal Metal Loss

Internal metal loss is a form of degradation caused by corrosion, erosion, or a combination of the two. Internal corrosion is a form of wall loss caused by exposure of the inside surface of the pipe to an electrolyte (typically water). Internal corrosion may be enhanced by erosion, which is caused by sediment entrained within the product stream impinging against the internal surface of the pipe. Under extreme circumstances of sediment loading and product stream velocity, erosion can become a significant cause of metal loss without contributions from corrosion processes.

Internal corrosion can be eliminated by preventing water from coming into contact with the pipe surface. This can be achieved by eliminating water from the product stream and/or minimizing water content and maintaining turbulent flow conditions so as to keep water entrained within the product stream, thereby keeping it from coming into contact with the pipe surface. Erosion can be eliminated by maintaining the solid content of the product stream to low levels.

A summary of the threat assessment for internal metal loss as it relates to L3RP is provided in Table 4-4 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

Table 4-4 Internal Metal Loss Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Product Stream Characteristics	Tariffs for L3RP were reviewed, and elements of those tariffs that are relevant to internal corrosion are as follows: • L3RP Tariff FERC No. 41.10.0: – BS&W limited to 0.5%	A CEPA study (Penspen Integrity 2013) indicates that under normal operations, oil pipelines, including dilbit pipelines with low BS&W (0.25–0.5%) are unlikely to have free water present in them and, with a sufficiently high flow velocity inside the pipe, any free water presence caused by operation upsets will be entrained in the oil by turbulent flow, and the pipe wall will continue to be oil wetted. At low BS&W levels, in conjunction with turbulent flow, water will remain entrained in oil. Therefore, internal corrosion is unlikely to occur.
Product Stream Flow Characteristics	The products to be transported through the L3RP will be operated in such a manner as to maintain fully-turbulent and steady flow.	Turbulent flow controls solids deposition, and maintains what little water exists entrained in the product stream. The product stream, in conjunction with the operating and flow characteristics should render the pipe wall in an oil-wet (i.e., non-corrosive) condition, although monitoring and the implementation of appropriate mitigation strategies, where warranted, is required. Flow rates will be monitored to confirm turbulent flow, as well as no sediment or water drop-out.
Corrosion Detection Devices	Means of monitoring for internal corrosion	The use of internal coupons and in-line inspection will be employed to monitor for internal corrosion.
Receipt Points	L3RP will receive product from Clearbrook West and Superior receipt points.	Product is monitored to confirm that it meets Enbridge's tariff.
Chemical Inhibition Program	None planned	Monitoring and the implementation of appropriate mitigation strategies will be implemented, where warranted.
Cleaning Pig Program	None planned	

Table 4-4 Internal Metal Loss Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Assessment Plan	Types of assessment to be performed, and assessment intervals to be used	Magnetic metal loss, ultrasonic crack detection, and high resolution geometry tool with an Inertial Mapping Unit as part of the baseline inspection will be completed within one year of in service. Inspection intervals will depend on previous findings, however currently planning 5 year inspection intervals for crack, corrosion and deformation tools. Features identified by in-line assessment tools will be evaluated against acceptability criteria, and those that exceed those criteria will be excavated and evaluated to assess the need for repair, replacement or recoating.
Potential source of Analogue ILI Datasets	During the Threat Assessment Workshop potential sources of In-Line Inspection (ILI) data were discussed in consideration of: • Similar product type • Similar hydraulic regime • Similar continuity of flow • Similar inhibition and pigging program • Reliable ILI dataset • Preferably >15 years between installation date and inspection date	For liquid products, the important parameters that should be included in a comparison of corrosivity are water content, erosion and erosion/corrosion, flow velocity, flow mechanism, temperature, susceptibility to under-deposit corrosion (solid deposition, MIC potential, and water chemistry), and mitigation measures (use of inhibition, biocides, or pigging). To confirm that the corrosion mechanism and corrosivity that is represented by the analogue ILI dataset is representative of that which would be expected in the L3RP, an evaluation of all of these parameters were conducted. Through this process, it was determined that ILI data obtained from Enbridge's 36 inch Line 4 would be most representative of the corrosivity conditions expected on this pipeline.

4.1.5.3 Stress Corrosion Cracking

SCC in pipelines is a type of environmentally-assisted cracking (EAC). EAC is a generic term that describes the formation of cracks caused by various factors combined with the environment surrounding the pipeline. Together these factors reduce the pressure carrying capacity of the pipeline. When water (electrolyte) comes into contact with steel, the minerals, ions, and gases in the water can attack or corrode the steel. These chemical or electrochemical reactions may result in general wall thinning, corrosion pits, and/or cracks.

SCC involves corrosive mechanisms and depends on both an aggressive environment and tensile stress. SCC in pipelines is further characterized as "high pH SCC" or "near-neutral pH SCC," with the "pH" referring to the environment on the pipe surface at the crack location and not the soil pH. (pH is the measure of the relative acidity or alkalinity of water. It is defined as the negative log [base 10] of the hydrogen ion concentration. Water with a pH of 7 is neutral; lower pH levels indicate an increasing acidity, while pH levels above 7 indicate increasingly basic solutions). SCC flaw growth can be enhanced by pressure cycling and fatigue.

In terms of perspective relative to other threats, SCC is a relatively small causal factor for gas transmission pipeline incidents in the U.S., and SCC failures on hazardous liquid pipelines have been less frequent when compared with SCC occurrences on natural gas pipelines.

Based on industry experience, susceptibility to SCC has been associated with buried pipelines that have the following threat characteristics (Baker 2005):

- SCC susceptible coating system
- Pipe in operation greater than 10 years
- Operating stress levels greater than 60% Specified Minimum Yield Strength (SMYS)
- Located within 20 miles downstream of a pump station
- Temperatures greater than 100°F (specific to high-pH SCC)

SCC is found in areas of coating damage. Vintage coating systems (i.e., pre-FBE) are considered to be generally susceptible to the type of coating damage associated with SCC.

The use of effective, high-performance coatings for new pipeline design and installation is the most practical way preventing failures due to SCC in pipelines, and FBE, liquid epoxies, and urethanes are the preferred coatings for managing this threat.

A summary of the threat assessment for SCC as it relates to the L3RP is provided in Table 4-5 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

Table 4-5 Stress Corrosion Cracking Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
SCC Susceptibility	The following design and operating variables were reviewed for the L3RP: • Operating stress level – Max stress level 32.7% SMYS • Operating temperature – 140°F max • Distance from Pump Station – Minimum distance: 8 mi (Site 6) • Coating type – Mainline pipe body coating system: FBE; Hot bends and field girth welds: 2-Part Liquid Epoxy; HDD Sections: FBE with Abrasion-resistant overcoat	All the specified pipeline coating systems are characterized as high-performance coating systems, and as such, are resistant to the formation of significant SCC. To date, no operating company has ever experienced a failure that was attributed to SCC in a pipeline that was coated with these coating systems.
Pressure cycling and fatigue	A pressure cycling and fatigue study was conducted on L3RP (Enbridge 2015). This study concluded that fatigue life in this segment was deemed to be acceptable per the requirements of D02-110 (2013) - Fatigue Design of New Pipelines.	A Fatigue Life Analysis design process accounts for the type of pipe selected, the different pressure ranges encountered throughout the pressure cycles, and the operational parameters selected by the operator. The main purpose of these calculations is to aid operators in quickly avoiding unacceptable pressure cycling. This represents industry best practice, as it allows the operator to be aware of the threat environment, and to pre-emptively mitigate potential threats before they can manifest themselves as a failure.
Assessment Plan	Types of assessment to be performed, and assessment intervals to be used	Magnetic metal loss, ultrasonic crack detection, and high resolution geometry tool with an Inertial Mapping Unit as part of the baseline inspection will be completed within one year of in service. Inspection intervals will depend on previous findings. In addition, Enbridge is currently planning 5 year inspection intervals for crack, corrosion and deformation tools. Features identified by in-line assessment tools will be evaluated against acceptability criteria, and those that exceed those criteria will be excavated and evaluated to assess the need for repair, replacement or recoating.

4.1.5.4 Manufacturing Defects

Based on historical industry experience, manufacturing defects failures have been associated primarily with pipe seam defects and hard spots[7]. Other issues related to pipe manufacture such as out-of-roundness, out-of-dimensional-tolerance conditions in preparation of pipeline ends, and high hardenability[1] have contributed to field weldability[1] problems, which in themselves have constituted a threat.

In modern pipe manufacture, with the universal adoption of continuous casting in lieu of ingot casting practices, and with the advent of High Strength Low Allow (HSLA) steel designs, hard spots have been fully eliminated; however, for the most part, the remainder of the above-listed issues are still a concern. In addition, in recent years, hydrostatic test failures and dimensional out-of-spec conditions have resulted from the production of pipe that does not meet minimum yield strength criteria.

The best way to safeguard against manufacturing defect related pipeline failures is through the application of carefully designed and executed pipe manufacturing and quality control practices, as dictated by rigorous skelp and pipe mill pre-qualification procedures and pipe purchase specifications.

A summary of the threat assessment for manufacturing defects as it relates to the L3RP is provided in Table 4-6 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

[7] See Glossary

Table 4-6 Manufacturing Defects Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Manufacturing procedure specification	Manufacturing procedure specifications reviewed for pipe to be used on L3RP addresses: • Steelmaking • Slab and skelp manufacturing • Forming • Welding • Finishing • Hydrostatic testing • Inspection • Repair • Tracking and control • Laboratory testing • Quality management system • Material tracking system • Inspection and test plan • Non-conformances • Handling, shipping, storage • Third party inspection • Marking	The manufacturing procedure specification, together with the inspection and test plan constitute key quality assurance documents that form the basis of good pipe procurement practices.
Manufacturing Process	• All sites will use 36 in. Double Submerged Arc Welded (DSAW) straight-seam pipe.	While some vintage manufacturing processes are prone to manufacturing defects, modern line pipe manufacturing processes are not associated with characteristic chronic manufacturing defects. Well-developed manufacturing procedure specifications and inspection test plans are instrumental in maintaining quality assurance.
Use of Third Party Pipe Mill Auditors	• Roving auditors + final bench at pipe mills • Third party inspector during loading and unloading	While third party audits and inspection does not guarantee quality, the effective deployment of auditors promotes a quality focus during line pipe manufacture, while alerting purchasers to potential quality problems during manufacture and prior to delivery.
Line pipe manufacturer	• Site 1: 36 inch DSAW UOE line pipe	None of the pipe mills being used are associated with

Table 4-6 Manufacturing Defects Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
	manufactured by EVRAZ, Portland. • All other sites: 36 inch DSAW UOE line pipe manufactured by EVRAZ, Camrose	documented chronic quality problems.
Pressure cycling	• A pressure cycling and fatigue study was conducted on this segment of pipeline (Enbridge Pressure Cycling Analysis L3R 2015). This study concluded that fatigue life in this segment was deemed to be acceptable per the requirements of D02-110 (2013)—Fatigue Design of New Pipelines.	Fluctuating operating pressures, that are typical of liquids pipelines, can activate pre-existing manufacturing defects. Nevertheless, the Fatigue Life Analysis design process accounts for the type of pipe selected, the different pressure ranges encountered throughout the pressure cycles, and the operational parameters selected by the operator. The main purpose of these calculations is to aid operators in quickly avoiding unacceptable pressure cycling. This represents industry best practice, as it allows the operator to be aware of the threat environment, and to pre-emptively mitigate potential threats before they can manifest themselves as a failure.
Hydrostatic test	• A review was conducted of Enbridge Specification USPCS-Spec-Hydro-005 "Specification for Pipeline Construction (USA) Pipeline Hydrostatic Testing".	The L3RP pipeline will be tested to a maximum test pressure of 2003 psi. For the seven sites being evaluated, this test pressure ranges from 272% to 457% of maximum operating pressure. These represent significant safety factors, ensuring that any manufacturing defects left after the hydrostatic test are not operating at stress levels where they would be considered to be structurally significant.

4.1.5.5 Construction Defects

Historically, construction defect failures have been associated primarily with welding defects and installation defects such as dents and buckles, which may be associated with improper ditch preparation and backfill, or with the use of excessive tie-in strains. For a given pipe material, failures from construction defects are influenced by the following factors:

- Construction practices
- Joining practices
- Joint inspection practices
- Hydrostatic inspection practices
- Inspections
- Operating pressure

A summary of the threat assessment for construction defects as it relates to the L3RP is provided in Table 4-7 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

Table 4-7 Construction Defects Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Construction Practices	The following information related to construction practices proposed for L3RP were reviewed: • Welding processes: – Mechanized gas metal arc welding (GMAW)—mainline – Tie-ins—cellulosic root and hot pass with mechanized GMAW fill and cap – Weld zone assessment – 100% automated ultrasonic testing (AUT)/phased array – Potential for supplemental X-ray – Post-construction inspection – Caliper tool inspection – Post-construction pressure testing – Minimum test pressure 2003 psi Additionally, the Enbridge specification of Mainline Construction was reviewed, which addresses construction procedures related to activities such as trenching, lowering-in and backfilling.	Welding and non-destructive inspection procedures are representative of industry best practices, which maximize the use of low-hydrogen welding processes, and state-of-the-art inspection systems. Although construction specifications are comprehensive, leading to minimized potential for construction-related damage, such damage can occur, particularly on pipelines that have high diameter: wall thickness ratio. Post-construction in-line inspection is an effective measure of identifying such damage, and enabling repairs to be made before defects can grow to failure during operation. For the 7 modeling locations being evaluated along the L3RP pipeline, hydrostatic test pressure ranges from 272% to 457% of maximum operating pressure. These represent important safety factors, and help confirm that any construction defects left after the hydrostatic test are not operating at stress levels where they would be considered to be structurally significant.
Operating Pressure	• A pressure cycling and fatigue study was conducted on this segment of pipeline (Enbridge Pressure Cycling Analysis L3R, 2015). This study concluded that fatigue life in this segment was deemed to be acceptable per the requirements of D02-110 (2013) - Fatigue Design of New Pipelines.	Fluctuating operating pressures that are typical of liquids pipelines can activate pre-existing construction defects. Nevertheless, the Fatigue Life Analysis design process accounts for the type of pipe selected, the different pressure ranges encountered throughout the pressure cycles, and the operational parameters selected by the operator. The main purpose of these calculations is to prevent unacceptable pressure cycling at the earliest stages possible. This represents industry best practice, as it allows the operator to be aware of the threat environment, and to pre-emptively mitigate potential threats before they can manifest themselves as a failure.

4.1.5.6 Equipment Failure

Equipment failure is defined in the context of pipeline transmission infrastructure as failures occurring in pressure retaining components other than pipe and fittings such as valves, flanges, and gaskets. These components require the same types of quality surveillance and inspection as the pipe itself. Risk factors for equipment failure are related to operating and maintenance (O&M) procedures, and the quality management systems that detail when and how inspections and maintenance of equipment will be performed and what specific action is required.

As the pipeline segments associated with each of the seven modeling locations does not include non-pipe equipment, this threat was determined to be out of scope for this assessment.

4.1.5.7 Third Party Damage

Third party damage is defined as third-party-inflicted damage, typically caused by ground disturbance by heavy equipment, such as excavators. All pipelines experience some level of threat due to third party damage. The magnitude of this threat is a function of the effectiveness of damage prevention measures, adjacent land use and depth of cover, as well as damage resistance characteristics of the pipe. Although damage prevention measures can help to offset this threat, third party damage can never be fully neutralized. In this respect, failure susceptibility due to third party damage can be established as the product of two independent variables; the frequency of incurring a hit and the probability of failure given such a hit.

Impact frequency due to external interference has been characterized in terms of damage prevention factors; specifically (Chen and Nessim 1999a):

- Adjacent land use
- One-call system availability and promotion
- Signage placement
- Use of buried marker tape
- Response time for locate requests
- Patrol frequency
- Marking and locating methods
- Depth of cover

A summary of the threat assessment for third party damage as it relates to the L3RP is provided in Table 4-8 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

Table 4-8 Third Party Damage Threat Attribute Summary

Threat Attribute	Data Evaluation	Threat Considerations
Adjacent land use	For the purposes of evaluating exposure to accidental interference, Chen and Nessim (1999) characterizes adjacent land use as commercial / industrial / high density residential / low density residential / agricultural / remote	Enbridge's damage prevention measures are representative of industry best-practice. Nevertheless, the potential for third party damage cannot be discounted.
One-call system availability and promotion	The one-call promotion practice to be employed on L3RP includes the promotion and use of an 811 call number, community involvement, and community meetings.	
Signage placement	The signage placement practice to be adopted on L3RP includes warning signs at road, railways, water crossing, both sides of pipeline, irrigation, areas where third party might occur, fence crossings, and areas of population growth (i.e., all crossings plus areas of potential activity). Sign placement also takes into account line of sight and potential activity.	
Use of buried marker tape	Buried marker tape is not used, and is not relevant to HDD crossings.	
Response time for locate requests	The response time standard for locate requests within Minnesota is within two business days.	
Patrol frequency	Patrol frequency is 26 times per year but not exceeding every 3 weeks (helicopter and fixed wing)	
Marking and locating methods	The marking and location practices to be employed on L3RP are as follows: • Excavations within 100 ft: locate and mark • Excavations within 16 ft: expose by vacuum truck • Excavations within 2 ft: expose by hand digging	
Depth of cover	All HDD installations have a minimum cover of 40 ft All trenched installations have a minimum cover of 4 ft (3 ft in rock ditch).	

4.1.5.8 Incorrect Operations

Incorrect operations failure is defined in the context of pipeline transmission infrastructure as failures that have causal factors that are related to design, as well as operation and maintenance procedures. A review of these procedures as they relate to the L3RP was evaluated by means of an Operations Questionnaire which was completed by workshop attendees during the threat assessment workshop. Results of the questionnaire are summarized below.

The threat environment associated with this threat is best evaluated through dialogue that is focused on design and operational factors related to the following attributes:

- Design attributes
  - Hazard identification
  - Maximum Allowable Operating Pressure (MAOP) potential
  - Safety systems
  - Checks
- Operations attributes
  - Operating procedures
  - Management of change procedures
  - Supervisory Control and Data Acquisition (SCADA) / communications
  - Drug testing procedures
  - Safety programs
  - Surveys / maps / records
  - Training procedures and programs
  - Mechanical error preventers

To facilitate the collection of information related to the above, an Operations Questionnaire, focused on the above attributes was administrated during the Threat Assessment Workshop. This questionnaire, along with the results of the targeted discussion associated with each of the attributes, is reproduced in Table 4-9.

Table 4-9 Operations Questionnaire

Contents

Section	Subject	Title	Questions	Possible Points
1.1	Design	Hazard Identification	4	4
1.2		MAOP Potential	1	12
1.3		Safety Systems	1	10
1.4		Material Selection	2	2
1.5		Checks	1	2
2.1	Operations	Operating Procedures	7	7
2.2		Management of Change	7	7
2.3		SCADA/Communications	1	3
2.4		Drug Testing	2	2
2.5		Safety Programs	1	2
2.6		Surveys/Maps/Records	2	5
2.7		Training	10	10
2.8		Mechanical Error Preventers	4	7
		Total	43	73

NOTES:

Survey questions for all topics other than Management of Change were based on the Incorrect Operations approach contained in *Pipeline Risk Management Manual*, Third Edition [Muhlbauer, W.K.]. Management of Change approach was based on API RP 581 Part 2 "Risk Based Inspection Technology" – Annex 2.A – Management Systems Workbook.

Scores are assigned such that higher scores are associated with the most favorable response.

Table 4-9 Operations Questionnaire

Question #	Question	Possible Score	Actual Score
1. Design			
1.1	Hazard Identification		
	a. Has a threat assessment been performed that entertains all possible threats?	1	1
	b. Do the results of the threat assessment reflect current conditions?	1	1
	c. Have possible hazards and risks associated with the work been identified through studies such as HAZOP, risk assessment, or reliability analysis?	1	1
	d. Are the results of the above studies available in documented form?	1	1
	Section Totals	***4***	***4***
1.2	MAOP Potential		
	Characterize the ease with which MAOP could be reached on the pipeline system (select one response only):		
	a. Routine. Routine, normal operations could allow the system to reach MAOP. Overpressure would occur fairly rapidly due to incompressible fluid or rapid introduction of relatively high volumes of compressible fluids. Overpressure is prevented only by procedure or single-level safety device.	0	
	b. Unlikely. Overpressure can occur through a combination of procedural errors or omissions, and failure of safety devices (at least two levels of safety).	5	
	c. Extremely Unlikely. Overpressure is theoretically possible (sufficient source pressure), but only through an extremely unlikely chain of events including errors, omissions, and safety device failures at more than two levels of redundancy.	10	10
	d. Impossible. Overpressure cannot occur, under any conceivable chain of events.	12	
	Section Totals	***12***	***10***

Table 4-9 Operations Questionnaire

Question #	Question	Possible Score	Actual Score
1.3	Safety Systems		
	Describe the safety systems that are in place (select one response only):		
	a. No Safety Devices Present. No safety devices are present to prevent overpressure.	0	
	b. On Site, One Level. A single on-site device offers protection from overpressure.	3	
	c. On Site, ≥2 Levels. Two or more independent on-site devices offer protection from overpressure.	6	5*
	d. Remote, Observation Only. Pressure is monitored from a remote location. Remote control is not possible, and automatic overpressure protection is not present.	1	
	e. Remote, Observation and Control. Pressure is monitored from a remote location. Remote control is possible, and automatic overpressure protection is not present.	3	
	f. Non-Owned, Active Witnessing. Overpressure prevention devices exist, but are not owned, maintained, or controlled by the owner of the equipment that is being protected. The owner takes steps to ensure that the safety device(s) is properly calibrated and maintained by witnessing such activities.	-2	
	g. Non-Owned, No Involvement. Overpressure prevention devices exist, but are not owned, maintained, or controlled by the owner of the equipment that is being protected. The owner does not take steps to ensure that the safety device(s) is properly calibrated and maintained by witnessing such activities.	-3	
	h. Safety Systems Not Needed. Safety systems not needed because overpressure cannot occur.	10	
	Section Totals	***10***	***5***
1.4	Materials Selection		
	Are design documents available that illustrate that all piping systems were designed with consideration given to all anticipated stresses?	1	1
	Do control documents, including material specifications and design drawings for all systems and components exist and maintained in an up-to-date manner?	1	1
	Section Totals	***2***	***2***
1.5	Checks		
	Do procedures exist that require design calculations and decisions to be checked by a licensed professional	2	1

* Less than full marks awarded reflecting less than complete independence of overpressure protection.

Table 4-9 Operations Questionnaire

Question #	Question	Possible Score	Actual Score
	engineer at key points during the design process?		
	Section Totals	2	1
2. Operation			
2.1	Operating Procedures		
	Do written procedures covering all aspects of pipeline operation exist?	1	1
	Are these procedures actively used, reviewed, and revised?	1	1
	Are copies of these procedures available at field locations?	1	1
	Does a protocol exist that specifies the responsibility for procedure development and approval?	1	1
	Does a protocol exist that specifies how training is performed against these procedures?	1	1
	Does a protocol exist that specifies how compliance to these procedures is verified?	1	1
	Does a document management system exist that ensures version control, and proper access to the most current procedure documents?	1	1
	Section Totals	7	7
2.2	Management of Change		
	Is there a written MOC procedure that must be followed whenever processes, procedures or physical assets are changed?	1	1
	Are authorization procedures clearly stated and at an appropriate level?	1	1
	Do physical changes, changes in operating conditions, and changes in operating procedures invoke the MOC procedure?	1	1
	Is there a clear understanding of what constitutes a 'temporary change', and does the MOC procedure address temporary changes?	1	1
	Are temporary changes tracked to ensure that they are either removed after a reasonable period of time or reclassified as permanent?	1	1
	Do the MOC procedures specifically require the following actions whenever a change is made to an operating procedure?	1	1
	Update all affected operating procedures		
	Update all affected maintenance programs and inspection schedules		

Table 4-9 Operations Questionnaire

Question #	Question	Possible Score	Actual Score
	Modify drawings, statement of operating limits, and any other safety information affected?		
	Notify all operations and maintenance employees who work in the area of the change, and provide training as required		
	Review the effect of the proposed change on all separate but interrelated procedures		
	When changes are made in operating procedures, are there written procedures requiring that the impact of these changes on the equipment and materials of construction be reviewed to determine whether they will cause any increased rate of deterioration or failure, or will result in different failure mechanisms in the equipment?	1	1
	Section Totals	7	7
2.3	SCADA / Communications		
	Describe the SCADA / Communications systems that are in place (select one response only):		
	a. Level 1. No SCADA system exists, or is not used in a manner that promotes human error reduction.	0	
	b. Level 2. Some critical activities are monitored; field actions are informally coordinated through a control room; system is at least 80% operational.	1	
	c. Level 3. Most critical activities are monitored; field actions are usually coordinated through a control room; system up-time exceeds 95%.	2	
	d. Level 4. All critical activities are monitored; all field actions are coordinated through a control room; SCADA system reliability (measured in up-time) exceeds 99.9%.	3	3
	Section Totals	3	3
2.4	Drug Testing		
	Does a drug testing program exist that applies to employees who play substantial roles in pipeline operations?	1	1
	Does the testing program incorporate elements of random testing, testing for cause, pre-employment testing, post-accident testing, and return-to-work testing?	1	1
	Section Totals	2	2
2.5	Safety Programs		
	Does the company's safety program incorporate the following elements? (award partial marks for compliance with only a portion of the elements):	2	2
	Written company statement of safety philosophy		

Table 4-9 Operations Questionnaire

Question #	Question	Possible Score	Actual Score
	Safety program designed with high level of employee participation		
	Strong safety performance record		
	Good attention to housekeeping		
	Signs, slogans, etc. to show an environment tuned to safety		
	Full-time safety personnel		
	Section Totals	***2***	***2***
2.6	Surveys, Maps, Records		
	Are surveys such as those listed below conducted on a regular basis? (award partial marks for compliance with only a portion of the elements):	3	3
	Close interval pipe-soil surveys		
	Coating condition surveys		
	Water crossing surveys		
	In Line Inspection (ILI) assessments		
	Population density surveys		
	Depth of cover surveys		
	Leak detection surveys		
	Patrols (aerial or ground-based)		
	Are detailed, clear maps and records updated regularly, and are they available to all operations staff?	2	2
	Section Totals	***5***	***5***
2.7	Training		
	Evaluate the operator training program in terms of the following elements:		
	a. Minimum training requirements are documented	2	2
	b. Incorporates testing	2	2
	c. Covers the following:		
	i. Product characteristics	0.5	0.5

Table 4-9 Operations Questionnaire

Question #	Question	Possible Score	Actual Score
	ii. Pipeline material stresses	0.5	0.5
	iii. Pipeline corrosion	0.5	0.5
	iv. Control and operations	0.5	0.5
	v. Maintenance	0.5	0.5
	vi. Emergency drills	0.5	0.5
	d. Training is job-procedure specific	2	2
	e. Incorporates requirements for scheduled re-training	1	1
	Section Totals	***10***	***10***
2.8	Mechanical Error Preventers		
	Evaluate the availability and effectiveness of the following devices designed to prevent operator error:		
	a. Lock-out devices. Installed on safety-critical valves (e.g., during blow-down and repair)	2	2
	b. Key-lock Sequence Programs. If a job procedure calls for several operations to be performed in a certain sequence, and deviations from that prescribed sequence may cause serious problems, a key-lock sequence program may be employed to prevent any action from being taken prematurely.	2	2
	c. Computer permissives. Electronic equivalent to key-lock sequence programs.	2	2
	d. Highlighting of critical instruments. e.g., painting critical valves with specific colors.	1	1
	Section Totals	***7***	***7***
Total Points		**73**	**65**

4.1.5.9 Geotechnical / Hydrotechnical Forces

This threat category is associated with outside forces associated with geophysical factors that can act on a pipeline. These outside forces can be caused by earth movement, erosion / water impingement, rock fall, flooding, etc. The primary means of preventing outside forces associated with these factors is to identify and avoid the area of potential geotechnical or Hydrotechnical activity.

The assessment of geotechnical and hydrotechnical threats involved a separate detailed study in which all information relevant to each site was integrated and evaluated. The report describing the process and findings is summarized in Attachment A.

4.1.5.10 Other Threats

During the Threat Assessment Workshop, an open discussion was held to identify potential threat mechanisms that do not fall into one of the nine categories listed in Section 4.1.4. A wide variety of operating threats were discussed, including forest fires, concomitant failures, access restrictions, and exposure to vandalism.

A summary of the threat assessment for other defects as it relates to the L3RP is provided in Table 4-10 (note that the Threat Attributes identified in this Table are those factors that influence both the causal and mitigation factors within the threat environment).

Table 4-10 Other Threats Threat Attribute Summary

<table>
<tr><th>Threat Attribute</th><th>Data Evaluation</th><th>Discussion of Threat Potential</th></tr>
<tr><td>Concomitant Failures</td><td>Concomitant failures occur where the catastrophic failure of one pipe (typically a natural gas pipe, in which rapid decompression of a compressible fluid results in the formation of a large blast crater, and in which the ensuing release of natural gas is readily ignitable), can result in the uncovering of an adjacent pipe, which may become involved in an ensuing fire.
Design considerations to address the potential for concomitant failure are addressed in Clause 4.11.6 of CSA Z662-11, which references criteria outlined in IGEM/TD/1. This Standard provides safe separation distance to existing gas pipelines as a function of diameter and soil conditions. The maximum safe separation distance published by this standard is associated with 48-inch diameter gas pipelines operating at pressures up to 1160 psi, and is listed as 12 m (39.4 ft).</td><td>A review of spacing between existing pipeline infrastructure (if any) was conducted at each site, and is summarized below:
<table><tr><th>Site No.</th><th>Adjacent Pipeline Considerations</th></tr><tr><td>1</td><td>Existing Minnesota Pipe Line Company oil pipelines with minimum 25 ft separation to L3R. Concomitant failure not considered to be a threat.</td></tr><tr><td>2</td><td>Great Lakes gas pipelines in vicinity will have minimum separation distance of 50 ft This meets the safe separation requirements of IGEM/TD/1. Existing Enbridge oil pipelines (6 in total) with minimum separation distance of 25 ft Concomitant failure not considered to be a threat.</td></tr><tr><td>3</td><td>No adjacent parallel pipelines.</td></tr><tr><td>4</td><td>No adjacent parallel pipelines.</td></tr><tr><td>5</td><td>7 separate LVP liquids pipelines with minimum separation distance of 25 ft Concomitant failure not considered to be a threat.</td></tr><tr><td>6</td><td>No adjacent parallel pipelines.</td></tr><tr><td>7</td><td>Parallel Viking gas pipeline will have minimum separation distance of 50 ft This meets the safe separation requirements of IGEM/TD/1.</td></tr></table></td></tr>
<tr><td>Access</td><td>Presence of segments where accessibility constraints</td><td>None such access restrictions were identified.</td></tr>
</table>

Table 4-10 Other Threats Threat Attribute Summary

Threat Attribute	Data Evaluation	Discussion of Threat Potential
Restrictions	(whether due to landowner relations or physical) are such that they act as a barrier to regular pipeline maintenance activities, such as corrosion surveys, defect excavations, etc.	
Forest fires	With respect to forest fires, experience dictates that where a pipe is buried in a cleared ROW, forest fires do not constitute a significant loss-of-containment hazard in and of themselves, since the ROW acts as a fire break, and the ground cover acts to insulate the pipe.	Industry experience indicates that forest fires are not a threat for buried pipelines. There are no above-ground sections of pipeline on L3RP, except in the immediate vicinity of pump stations and valves.
Exposure to Vandalism	Exposure to vandalism is greatest at above-ground facilities, where measures such as fenced compounds and locks are installed.	There are no above-ground sections of pipeline within the scope of work.

4.1.6 Threat Potential Summary

In this Section, a summary of threat potential is provided based on a review and analysis of the information contained in Section 4.1.5. Additionally, based on the available data for each threat, this Section provides overviews of appropriate approaches for estimating failure likelihood. A detailed description of the failure frequency estimation approach for each threat is provided in Section 4.2.

Where appropriate, assumptions that will be incorporated into the quantitative failure analysis are identified for each threat.

4.1.6.1 External Metal Loss

4.1.6.1.1 Threat Potential

It is expected that the pipeline will have some degree of exposure to the threat of external corrosion. Therefore, the threat potential for external corrosion was included in the quantitative failure frequency estimate.

4.1.6.1.2 Approach

As will be discussed in greater detail in Section 4.2.3.1, reliability approaches for providing quantitative estimates of failure likelihood exist for some threats, including corrosion. Reliability approaches have the benefit of accounting for design and material performance characteristics. In addition, for time-dependent threats such as corrosion, they accurately reflect that failure likelihood changes with time.

For the external metal loss threat, a reliability approach was used that leverages existing "analogue" ILI datasets, along with the specific design details (diameter, wall thickness, grade, operating pressure) of the L3RP at each site of interest. With this approach, it is important to confirm that the analogue datasets are representative (or slightly conservative) relative to the expected external corrosion performance of the proposed pipeline segments. In this way, the reliability parameters from the analogue ILI datasets for external corrosion feature incident rate, external corrosion feature size distribution, and external corrosion growth rate will be representative, or conservative relative the same parameters for the L3RP. To ensure that this is the case, the considerations outlined in Table 4-11 were incorporated into the assessment.

Table 4-11 Considerations for Quantitative Failure Likelihood Estimates—External Corrosion

Threat Factor	Issue	Controls	Action
Mainline Coating Type	The mainline external coating system used in the pipeline from which the analogue ILI data are taken should be representative or conservative, relative to the expected corrosion coating performance on the L3RP.	Analogue ILI datasets that are representative of FBE coating systems will address this issue.	To be addressed during selection of analogue ILI dataset
Field Joint Coating	The field joint external coating system used in the pipeline from which the analogue ILI data are taken should be representative or conservative, relative to the expected corrosion coating performance on the L3RP.	Analogue ILI datasets that are representative of high performance field joint coating systems will address this issue.	To be addressed during selection of analogue ILI dataset
Temperature effects on external coatings	Operating temperatures that exceed the maximum temperature rating of the mainline and field joint coating systems can result in significantly degraded coating performance over time	Coating systems are being specified for mainline and field girth welds are rated to withstand the expected maximum operating temperatures of the L3RP	Addressed by purchase specifications and detailed design
		Analogue ILI datasets must be selected so that they are representative of pipelines that have not been operated above the maximum temperature rating of either the mainline or field girth weld coating systems.	To be addressed during selection of analogue ILI dataset
Cathodic Protection	Ensure that CP performance in pipeline from which analogue ILI dataset is obtained is representative of CP performance expected on the L3RP.	Design measures for L3RP incorporate identification of potential sources of interference, and incorporation of appropriate mitigations	Addressed by L3RP detailed design, and in operating procedures.
		Analogue ILI datasets must be selected so that they are representative of CP design and operating practices for L3RP.	To be addressed during selection of analogue ILI dataset

Table 4-11 Considerations for Quantitative Failure Likelihood Estimates—External Corrosion

Threat Factor	Issue	Controls	Action
Soil Characteristics	Ensure that soil characteristics in pipeline from which analogue ILI dataset is obtained is representative of soil characteristics on the L3RP.	Identify any locations of highly corrosive ground conditions on L3RP, such as acid-generating rock. If present, ensure that analogue ILI dataset is representative of similar conditions.	Undertaken during threat assessment – no such highly corrosive ground conditions identified.
ILI Data	Potential for manufacturing defects to be misinterpreted as corrosion defects, leading to unrealistically high corrosion feature incidence rates and aggressive apparent growth rate distributions	Utilize a dataset from a pipeline that is old enough to mask the effects of manufacturing defects.	To be addressed during selection of analogue ILI dataset

4.1.6.2 Internal Metal Loss

4.1.6.2.1 Threat Potential

The corrosivity analysis contained in Section 4.1.5.2 indicated that the product stream in conjunction with the operating and flow characteristics should render the pipe wall in an oil-wet (i.e., non-corrosive) condition, although ongoing monitoring with a view to implementing appropriate mitigation strategies is warranted. While the threat of internal corrosion is not anticipated to be a significant contributor to overall failure likelihood for the L3RP, it is not possible to disqualify this threat entirely.

4.1.6.2.2 Approach

As will be discussed in greater detail in Section 4.2.3.1, reliability approaches for providing quantitative estimates of failure likelihood exist for some threats, including corrosion. Reliability approaches have the benefit of accounting for design and material performance characteristics. In addition, for time-dependent threats such as corrosion, they accurately reflect that failure likelihood changes with time.

For the internal metal loss threat, a reliability approach was used that leverages existing "analogue" ILI datasets along with the specific design details (diameter, wall thickness, grade, operating pressure) of the L3RP at each site of interest. Under such an approach it is important to confirm that the analogue datasets are representative (or slightly conservative) relative to the expected internal corrosion performance of the proposed pipeline segments. In this way, the reliability parameters from the analogue ILI datasets for internal corrosion feature incident rate, internal corrosion feature size distribution, and internal corrosion growth rate will be representative, or conservative relative the same parameters for the L3RP. To ensure that this is the case, the considerations outlined in Table 4-12 were incorporated into the assessment.

Table 4-12 Considerations for Quantitative Failure Likelihood Estimates—Internal Corrosion

Threat Factor	Issue	Controls	Action
Water Content	Elevated water content can result in stratification in some flow regimes, and may result in enhanced corrosivity	• Control BS&W to 0.5% max, reflecting standards for transmission pipelines. • Maintain turbulent flow to entrain what little water that exists in the product stream flow, causing pipe wall to remain in oil-wet condition.	• 0.5% BS&W reflects current tariff specifications. • Hydraulic design of L3RP ensures turbulent flow. • Flow rates will be monitored to ensure turbulent flow, and to ensure that no sediment or water drop-out occurs
		Ensure that BS&W and hydraulic flow regime in pipeline from which analogue ILI dataset is obtained is representative of conditions in L3RP.	To be addressed during selection of analogue ILI dataset
Deposit of Solids	Solid deposition can result in under-deposit corrosion	• Control BS&W to 0.5% max, reflecting standards for transmission pipelines. • Maintain turbulent flow to entrain what little solids that exists in the product stream, and to prevent deposition of solids	• 0.5% BS&W reflects current tariff specifications. • Hydraulic design of L3RP ensures turbulent flow. • Flow rates will be monitored to ensure turbulent flow, and to ensure that no sediment or water drop-out occurs
		Ensure that BS&W and hydraulic flow regime in pipeline from which analogue ILI dataset is obtained is representative of conditions in L3RP.	To be addressed during selection of analogue ILI dataset
Corrosion Monitoring	Regardless of interpreted susceptibility to corrosion based on product composition and flow characteristics, monitoring is required to ensure that the pipeline remains in a condition that is not susceptible to internal corrosion.	Corrosion detection devices	• The use of internal coupons and in-line inspection will be employed to monitor for internal corrosion. • Flow rates will be monitored to ensure turbulent flow, and to ensure that no sediment or water drop-out occurs
ILI Data	Potential for manufacturing defects	Utilize a dataset from a pipeline that is old	To be addressed during selection of

Table 4-12 Considerations for Quantitative Failure Likelihood Estimates—Internal Corrosion

Threat Factor	Issue	Controls	Action
	to be misinterpreted as corrosion defects, leading to unrealistically high corrosion feature incidence rates and aggressive apparent growth rate distributions	enough to mask the effects of manufacturing defects.	analogue ILI dataset

4.1.6.3 Stress Corrosion Cracking

4.1.6.3.1 Threat Potential

Based on industry experience, susceptibility to SCC has been associated with coatings other than the following:

- FBE
- Urethane and liquid epoxy
- Extruded polyethylene
- Multi-layer or composite coatings

The threat potential for SCC is anticipated to be negligible (i.e., this threat will not contribute in a substantial way to overall failure likelihood), since the coating systems used on the L3RP are limited to those listed above.

4.1.6.4 Manufacturing Defects

4.1.6.4.1 Threat Potential

Enbridge's pipe procurement program specifies rigorous controls to confirm the quality of line pipe to be supplied to the L3RP Project. Although line pipe for LVP pipelines is not required to have proven notch toughness, pipe with minimum notch toughness values of 29.5 ft-lbs (40 J) will be used. Additional controls will be implemented that include supplier pre-qualification practices that focus on technical and quality criteria, as well as third party pipe mill quality surveillance. While the threat of manufacturing defects is not anticipated to be a significant contributor to overall failure likelihood for the L3RP, it is not possible to disqualify this threat entirely.

4.1.6.4.2 Approach

The threat of manufacturing defects does not lend itself to failure likelihood estimation using a reliability approach due to the lack of a limit state model that is supported by probability distributions for its input parameters (Section 4.2.3). Despite the fact that this threat is not anticipated to contribute significantly to overall failure likelihood, an attempt will be made to achieve an estimate of failure frequency based on industry operating experience of recent installations of hazardous liquids pipelines.

4.1.6.5 Construction Defects

4.1.6.5.1 Threat Potential

Enbridge's construction practices that will be used in the construction of the L3RP Project specifies rigorous controls to confirm the quality of the pipeline installation, including welding processes. In addition, quality checks will be employed, including 100% NDT using phased array ultrasonics and/or X-ray inspection, as well as 100% inspection with a pipe size and deformation tool after installation to confirm that the pipeline is free of dents, buckles, and excessive out-of-round conditions. The use of a mechanized low hydrogen welding process, in which procedural

variables are tightly controlled, is an effective means of maintaining weld quality and procedural control.

While the threat of construction defects is not anticipated to be a significant contributor to overall risk for the L3RP, it is not possible to disqualify this threat entirely.

4.1.6.5.2 Approach

The threat of construction defects does not lend itself to failure likelihood estimation using a reliability approach due to the lack of a limit state model that is supported by probability distributions for its input parameters (Section 4.2.3). Despite the fact that this threat is not anticipated to contribute significantly to overall failure likelihood, an attempt will be made to achieve an estimate of failure frequency based on industry operating experience of recent installations of hazardous liquids pipelines.

4.1.6.6 Equipment Failure

As the pipeline segments associated with each of the seven modeling locations do not include non-pipe equipment, this threat was determined to be out of scope for this assessment.

4.1.6.7 Third Party Damage

4.1.6.7.1 Threat Potential

All pipelines experience some level of threat due to third party damage, the magnitude of this threat being a function of the effectiveness of damage prevention measures, adjacent land use, depth of cover, material properties, and pipeline design. Although damage prevention measures can help to offset this threat, third party damage can never be fully neutralized, and so this is expected to be one of the primary threats in contributing to overall pipeline failure likelihood.

4.1.6.7.2 Approach

A reliability model exists that considers all the parameters of damage prevention measures, adjacent land use, depth of cover, material properties and pipeline design; this model will be used in the failure frequency analysis (Section 4.2) (Chen and Nessim 1999). The reliability approach employs a fault tree model to estimate hit frequency, and a separate stochastic model to predict probability of failure, given a hit.

4.1.6.8 Incorrect Operations

4.1.6.8.1 Threat Potential

All pipelines experience some level of threat due to incorrect operations, the magnitude of this threat being a function of the effectiveness of design-related and operations/maintenance related practices and measures. Although design, operations and maintenance practices can help to offset this threat, incorrect operations can never be fully neutralized, and so this is expected to be one of the primary threats in contributing to overall failure likelihood.

4.1.6.8.2 Approach

The threat of incorrect operations does not lend itself to failure likelihood estimation using a reliability approach due to the lack of a limit state model that is supported by probability distributions for its input parameters (Section 4.2.3). Reflecting this fact, an attempt will be made to achieve an estimate of failure frequency based on operating incident data, related to this threat, modified by the results of the Operations Questionnaire that was administered during the Threat Assessment Workshop (Table 4-9).

4.1.6.9 Geotechnical / Hydrotechnical Forces

To assess the degree of threat that a pipeline will be exposed to, a thorough evaluation of information related to the potential for geotechnical and hydrotechnical threats was undertaken at each of the seven modeling locations within the scope of work. A description of the threat potential and the approach by which estimates of failure likelihood were derived is provided in Attachment A.

4.1.6.10 Other Threats

During the Threat Assessment Workshop, an open discussion was held to identify potential threat mechanisms that do not fall into one of the nine categories listed above. The following potential threats were reviewed:

- Potential for concomitant failure associated with adjacent pipelines
- Access restrictions
- Forest fires
- Exposure to vandalism

As discussed in Section 4.1.5.10, none of the "Other Threats" were found to represent significant potential for failure.

4.2 QUANTITATIVE FREQUENCY ANALYSIS

4.2.1 Overview and Summary

To be consistent with the assessment of full bore ruptures in the consequence analysis, the frequency analysis focused on the occurrence of ruptures (as opposed to smaller leaks). Based on the guidance provided in the Threat Assessment, the frequency analysis undertook to estimate rupture frequency using optimal approaches for each threat. These approaches included:

- Methods based on Industry Incident Data—PHMSA Hazardous Liquids Database, 2010–2015 (threats assessed using this method included manufacturing defects, construction defects and incorrect operations)
- Methods based on mechanistic, reliability approaches (external corrosion, internal corrosion, and third party damage)

- Site-specific evaluation of hydrotechnical and geotechnical hazards (weather related and outside forces)

The annual probability of a large oil release (i.e., a full bore rupture) was determined for each of the seven modeling locations for L3RP. The length of the pipeline segment that was considered in the failure frequency analysis for each modeling site was established through outflow and overland spill modeling of full-bore rupture release scenarios for the modeling site. Specifically, the failure frequency analysis for the site considered the length of pipeline around the site of the hypothetical full bore rupture from which a crude oil release could affect (i.e., reach) the immediately adjacent waterbody through direct release or overland flow.

The annual probability values, as well as the average annual return periods (defined as the inverse of the annual probability values) at each modeling site are summarized in Table 4-13.

Table 4-13 Annual Probability of Rupture and Average Return Period within the Potential Impact Segment of Each of the Seven Modeling locations

Site Number	Annual Probability of Rupture	Average Return Period (yr)
1—Mosquito Creek	3.402×10^{-06}	293,945
2—Mississippi River at Ball Club	3.961×10^{-07}	2,524,615
3—Sandy River	1.939×10^{-06}	515,730
4—Shell River	4.388×10^{-06}	227,894
5—Red River	2.781×10^{-06}	359,583
6—Mississippi River at Palisades	2.527×10^{-06}	395,726
7—Mississippi River at Little Falls	2.287×10^{-06}	437,254

Of note, for linear infrastructure, such as pipelines, the probability of incurring a failure is proportional to segment length (i.e., the longer the segment that is being considered, the greater is the likelihood of incurring a failure at some point along that segment). This is reflected in the above results, with the longest potential impact segment (the 2,543 ft-long segment associated with the Shell River crossing), having the greatest probability of failure.

The likelihood of a large oil release occurring ranges from 3.96×10^{-07} to 4.39×10^{-06}; this is equivalent to average annual return periods that range from 227,894–2,524,615 years.

4.2.2 Introduction

This Section describes the approach and the results of a quantitative failure frequency assessment at seven modeling locations along the L3RP pipeline:

- Site 1—Mosquito Creek Crossing
- Site 2—Crossing of the Mississippi River at Ball Club

- Site 3—Sandy River Crossing
- Site 4—Shell River Crossing
- Site 5—Red River Crossing
- Site 6—Crossing of the Mississippi River at Palisades
- Site 7—Crossing of the Mississippi River at Little Falls

As described in the Threat Assessment (Section 4.1), seven threats were identified, and are addressed by the quantitative failure frequency analysis contained in this Section:

- External corrosion
- Internal corrosion
- Third party damage
- Manufacturing defects
- Construction defects
- Incorrect operations
- Geotechnical / hydrological forces

In the remainder of this chapter, the approach used to complete the failure frequency analysis is first described. Results of the failure frequency analysis are then described.

4.2.3 Failure Frequency Approach

For the purposes of the failure frequency analysis described here, the term "failure" refers to loss-of-containment of the L3RP pipeline. To be consistent with the assessment of full bore ruptures in the consequence analysis, the frequency analysis focused on the occurrence of ruptures (as opposed to smaller leaks).

In the following section of this chapter, quantitative estimates of annual failure probability for a full bore rupture were determined on a threat-by-threat basis. As was discussed in the Threat Assessment (Section 4.1), the most appropriate method for estimating failure frequency was identified for each threat, taking into account the type and availability of data, and the methods available that are applicable to failure estimation for each threat.

4.2.3.1 Quantitative Approach for Estimating Failure Frequency

As outlined below, there are a variety of approaches for making quantitative estimates of pipeline failure likelihood. One method is to use industry incident statistics as the basis for the making the estimate. Another method is to estimate failure likelihood based on a first-principles approach, known as "reliability methods". A third method, specific to the estimation of failure frequency related to geohazards, employs an approach that expresses the frequency of loss of containment as the product of the potential for the geohazard to occur, the frequency of occurrence, the unmitigated system vulnerability, and the effects of the mitigations used in the segment.

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Pipeline Failure Probability Analysis
January 13, 2017

One of the challenges of making quantitative estimates of failure likelihood on a new pipeline using industry incident statistics is that without careful selection and filtering of data, industry failure statistics are not directly applicable to modern pipeline designs, materials, and operating practices. As a result, industry failure statistics tend to over-state failure frequencies associated with new pipelines.

A review of industry failure statistics suggests that the majority of pipeline failures occur on pipelines that were installed in the 1970s or earlier (Mihell and Rout 2012). These pipelines were developed prior to the advent of several technologies that have enhanced pipeline reliability, such as:

- Continuous casting of steel slabs
- Thermomechanical controlled processing (TMCP) technology for skelp production (i.e., steel that is rolled or forged into narrow strips and ready to be made into pipe by being bent into a cylindrical shape and welded)
- HSLA steel design
- Low sulfur steels
- Inclusion shape control
- High toughness steels
- Implementation of quality systems and the use of highly constrained process control variables during pipe manufacture
- Highly-constrained mechanized welding processes using low-hydrogen welding processes
- Use of only non-destructive inspection methods
- High performance coating systems such as fusion bonded epoxy coatings
- Design-phase identification of internal corrosion threat factors and design of mitigation plans through internal corrosion modeling
- Identification of HVAC interference effects and development of mitigation plans through diagnostic testing of cathodic protection systems
- Implementation of quality management systems during design, construction and operations

Another challenge associated with the use of industry failure databases as the basis of a quantitative failure frequency assessment is that they do not address site-specific threats for a pipeline segment, such as geotechnical hazards.

Reliability methods have been widely adopted in the nuclear and aerospace industry, where they are used to identify and manage threats. In recent years, the pipeline industry has moved towards adopting this as a tool for risk studies. Pipeline industry research organizations such as the Pipeline Research Committee International (PRCI) and European Pipeline Research Group (EPRG) have developed reliability-based models for various threats. Reliability models employ limit state functions for the specific damage mechanism of interest in which the load variables and resistance variables are characterized in terms of probability density functions. This enables us to use reliability modeling techniques such as Monte Carlo Analysis to characterize the probability of incurring a failure on a pipeline. Reliability methods provide a powerful tool to make accurate, quantitative predictions on likelihood of failure over the expected lifespan of a pipeline.

Figure 4-8 illustrates how reliability methods can be utilized to quantify the probability of failure, based on a defendable approach.

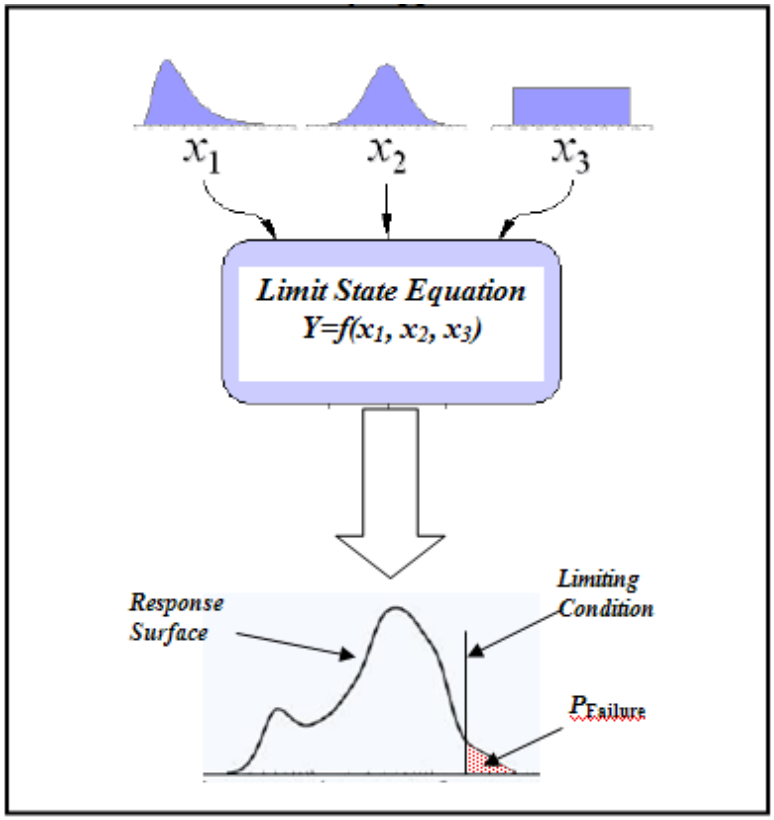


Figure 4-8 Reliability Approach

In the pipeline industry, reliability models exist for the most significant threats, including third party damage, internal corrosion and external corrosion.

The basis of every reliability model is a limit state equation that describes the failure conditions for the mechanism being considered. Furthermore, at least one of the input variables to this limit state equation must be characterized as a probability density function, as illustrated in Figure 4-8.

Therefore, a reliability approach is not possible for some threats, such as incorrect operations, where these probability density functions are not available. For these threats (which usually constitute second-order threats, in terms of failure likelihood magnitude), an alternative is to employ industry failure statistics, incorporating techniques such as the careful selection and filtering of incident data and/or means of accounting for differences in materials, design and operations that are characteristic of modern pipelines. For geotechnical threats, the likelihood of failure can be characterized in terms of expected magnitude and associated frequency of

occurrence, thereby enabling pipeline reliability to be established at each geotechnically-active site.

The approach used in estimating failure frequency for each threat is described in the remainder of this section.

4.2.3.2 External Corrosion

The reliability approach for external corrosion employs the application of an analogue ILI dataset, taking into account the design and materials for the L3RP (Mihell and Rout 2012).

As the wall thickness of the pipe segments vary between the seven modeling locations, a separate analysis was conducted for each wall thickness (in all cases, the pipe grade was X70) (Table 4-14). To provide a conservative assessment, the highest maximum operating pressure of any of the seven modeling locations for the L3RP was used in the analysis. The combinations of diameter, wall thickness, grade and maximum operating pressure that were used in the analysis are summarized in Table 4-14.

Table 4-14 Design Parameters Employed in Analysis

Diameter (in.)	Wall Thickness (in.)	MOP (psi)	Segments Represented
36	0.750	734.7	Sites 2,3,4,5,6,7
36	0.515	734.7	Site 1

4.2.3.2.1 Selection of Analogue ILI Data

Based on Mihell and Rout (2012), to estimate defect incidence rate, defect size distribution, and defect growth rate distribution, it is important that the analogue ILI dataset is representative of the degradation process and performance characteristics of the coating system to be used in with the L3RP.

After a review of candidate ILI datasets, the external wall loss feature list of interacted features (6t x 6t interaction rule) from the 2010 in-line inspection of Enbridge's Line 4 (BU-QU) was chosen.

As outlined in Mihell and Rout (2012), to reduce over-conservativism in the analysis, candidate ILI datasets were reviewed to remove wall loss data that cannot be attributed to active corrosion (e.g., benign manufacturing features). One effective method that can be used to screen for active wall loss is to use data derived from pit-matching for the same pipeline of separate in-line inspections. However, because pit-matched data was not available, and as described in Section 4.2.3.2.2, a conservative approach to determining corrosion growth rate was used.

Beyond the quality of ILI data, several other factors were considered in selecting the Line 4 dataset:

- Coating type (FBE in both Line 4 and in the proposed L3RP pipelines)
- Coating specification (i.e., the same Enbridge coating specification will apply to both Line 4 and the proposed L3RP pipelines)
- Operating environment (Western Plains are common to Line 4 and L3RP pipelines)
- Cathodic protection and other operating standards (i.e., the same Enbridge standards apply to Line 4 and L3RP pipelines)

Another important consideration was that the Line 4 data set represents fusion bond epoxy coated pipeline segments that were 11 years old at the time of inspection, having been installed in 1999, thereby enabling sufficient time for evidence of corrosion susceptibility to manifest itself on the ILI logs.

4.2.3.2.2 Reliability Approach

The reliability approach described in Mihell and Rout (2012) was used to estimate failure frequency as a function of pipeline age.

A Monte Carlo approach was developed to assimilate distributions derived from size and growth rate distributions derived from the analogue ILI dataset, and apply those distributions against the modified ASME B31G failure limit state criterion, which, for the purposes of the analysis, was rearranged to determine flaw depth at failure:

Equation 1

$$d_f = \mathrm{MIN}\left[(0.8t), \left(\frac{t\left(\sigma_{op} - \overline{\sigma}\right)}{0.85\left(\frac{\sigma_{op}}{M} - \overline{\sigma}\right)}\right)\right]$$

Where,

d_f = Depth at failure
t = Wall thickness
σ_{op} = Operating stress
$\overline{\sigma}$ = Flow stress
$M = \sqrt{1 + 0.6257\frac{L^2}{Dt} - 0.003375\left(\frac{L^2}{Dt}\right)^2}$
$(\text{for } L \le \sqrt{50Dt})$
$M = 3.3 + 0.032\frac{L^2}{Dt}$
$(\text{for } L > \sqrt{50Dt})$
L = Defect length

In the Monte Carlo analysis, the variables of pipe diameter, pipe wall thickness, yield strength, and operating pressure specific to each of the pipeline design combinations (Table 4-14) were used and a separate reliability analysis was completed for each combination of variables. Corrosion feature incidence rates and the distribution parameters for corrosion feature length and depth were determined from the analogue ILI data, as were corrosion feature growth rates.

When using ILI data for the purposes of establishing these parameters, it is important to recognize that the quantities derived represent values at a particular point in time (i.e., the date of last inspection). Furthermore, these quantities are subject to tool measurement error. Corrosion feature depth is therefore considered characteristic of the depth after some period of time. When applied to a new pipeline, the depth distribution must be adjusted downwards (accounting for some assumed corrosion growth rate) when the modeled pipeline age is less than that from which the analogue ILI data was obtained. Similarly, the depth distribution must be adjusted upwards when the modeled pipeline age is greater than that from which the analogue ILI data was obtained. This is illustrated in Figure 4-9, which shows how the flaw distribution flattens and translates with time (t). Specifically, as time increases, the mean of the flaw depth distribution and the standard deviation of the flaw depth distribution increase.

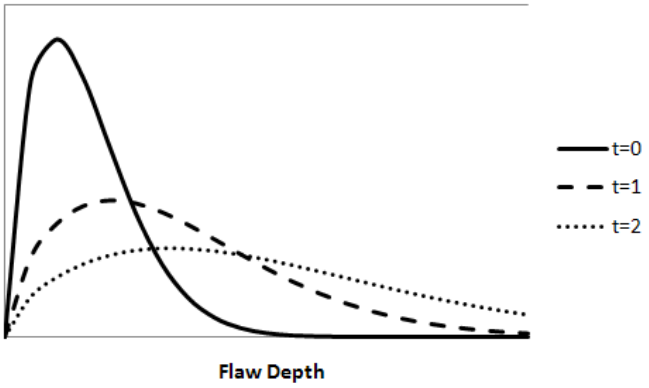


Figure 4-9 Illustration of How Flaw Depth Distribution Changes With Time

In the absence of any other information pertaining to how flaw depth growth rate varies with time, a linear growth rate assumption can generally be considered a reasonable, yet conservative approximation, since it ignores the polarizing effects of the accumulation of corrosion product.

The high-performance coating systems that are characteristic of modern pipelines, such as fusion bond epoxy are not susceptible to time-dependent coating degradation to the extent that older vintage coating systems are. Therefore, it was considered realistic to assume that any coating damage that is inferred from the presence of a corrosion feature was created at the

time of installation, and that the areal extent of coating damage, and hence the potential for increases in wall loss area (i.e., length and width) does not change appreciably with time.

In the Monte Carlo simulation, corrosion feature depth, as a function of time, and feature length are sampled stochastically, based on the probability density functions for those parameters derived from the analogue ILI dataset. A further stochastic adjustment on flaw depth is made to account for the tool error associated with the ILI tool from which the analogue data was derived. Because correlations derived from <Tool-Predicted> to <In-Ditch Measurement> data pairs were not available for the analogue dataset, a standard tool measurement error of ±10% wall thickness, 80% of the time was used. In statistical terms, this corresponds to a normal error distribution having a mean of 0, and a standard deviation of 7.8% of the wall thickness.

Assuming a linear flaw depth growth model, the stochastically-sampled flaw depth estimate was adjusted to account for the difference between the age of the analogue pipeline at the time that the ILI data was acquired, and the modeled age of the new pipeline:

Equation 2

$$\overset{o}{d}_A = \frac{\overset{o}{d} \cdot T_A}{T_{ILI}}$$

Where,

$\overset{0}{d}_A$ = Stochastically sampled flaw depth at the specific time assumed in the analysis

$\overset{0}{d}$ = Stochastically sampled flaw depth, derived from the analogue ILI dataset (incorporating stochastic adjustment for analogue ILI tool error)

T_A = Year of operation for the pipeline that is being assumed in the analysis

T_{ILI} = Year of operation for the analogue pipeline when the ILI assessment was completed.

For the purposes of the Monte Carlo simulation, all pipe parameters that are contained in the limit state function shown in Equation 1 (i.e., pipe wall thickness, operating stress level, and flow stress) correspond to each of combination of pipeline design variables reported in Table 4-14.

Failure is predicted when the stochastically sampled flaw depth derived from Equation 2 exceeds the flaw depth that defines the limiting condition (derived from Equation 1). When the Monte Carlo simulation is performed through multiple iterations, the probability of failure for the given year of analysis is defined as the proportion of those iterations that return a failure prediction. This probability is defined as the probability of failure, given the presence of a corrosion feature, $P_{f,F}$. The overall probability of failure for a given pipeline segment in the year of operation being considered in the analysis is defined as:

Equation 3

$$P_{f,DS} = \rho_{ILI} \cdot \frac{D_N}{D_{ILI}} \cdot L_{DS} \cdot P_{f,F}$$

Where:

$P_{f,DS}$ = Probability of failure for the pipeline segment
ρ_{ILI} = Corrosion feature density per unit length of pipeline derived from the analogue ILI dataset
D_N = Diameter of the pipeline
D_{ILI} = Diameter of the pipeline from which the analogue ILI data was derived
L_{DS} = Length of the pipeline segment
$P_{f,F}$ = Probability of failure, given the presence of a corrosion feature.

4.2.3.2.3 Determination of Leak and Rupture

To support a risk analysis, the output from the failure frequency analysis must be relevant to the fates and effects analysis (Chapters 6.0 and 7.0). Therefore, the results of a failure frequency analysis must specify more than frequency of occurrence; instead, the frequencies of occurrence must be tied to an outcome, with the outcome being the volume of the crude oil release. As discussed in Chapter 3.0, a release volume corresponding to a most-credible worst-case scenario, involving a rupture was determined for each of the seven modeling locations.

In the reliability analysis for external corrosion failure likelihood, the proportion of ruptures are determined by first calculating the critical through-wall flaw size as a function of material properties and operating parameters of the pipeline segment. The NG-18 flaw equation was used to determine the critical through-wall flaw size (Eiber and Leis 2001):

Equation 4

$$K_c^2 = \frac{12 \cdot C_v \cdot E}{A_c} = \frac{8 \cdot c \cdot \overline{\sigma}^2}{\pi} \ln \sec\left[\frac{\pi \cdot M_T \cdot \sigma_h}{2 \cdot \overline{\sigma}}\right]$$

The above relationship is commonly used to determine the maximum size defect that will leak rather than rupture. At high fracture toughness values, it represents a flow-stress or plastic instability criterion (typical of the failure mode of most corrosion features), whereas at lower fracture toughness values, it may represent a conservative representation of the leak/rupture boundary for corrosion features.

As illustrated in Figure 4-10, the cumulative distribution function for flaw length, derived from the analogue ILI dataset was compared against the critical through-wall flaw length for each set of pipeline design variables modeled. Using this approach, the proportion of features that have the

potential to penetrate through-wall at a length greater than the critical through-wall flaw length can conservatively be said to have the potential to fail in rupture mode, while the remainder of the flaws will fail as leaks.

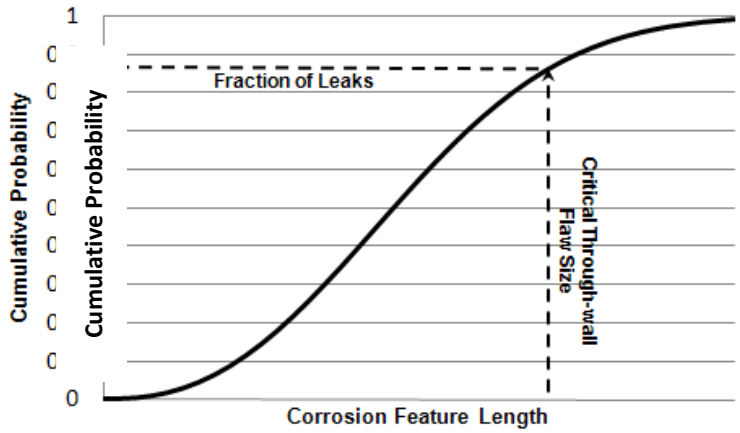


Figure 4-10 Determination of Fraction of Leaks and Ruptures from Corrosion Feature Length CDF and Critical Through-Wall Flaw Size

Because critical through-wall flaw length is a function of wall thickness and operating pressure, the proportion of leaks was determined for each combination of pipeline design variables modeled, based on the feature length distribution obtained from the analogue ILI dataset.

4.2.3.2.4 Results—Unmitigated Analysis

By performing a separate analysis for each year of operation, and for each dynamic segment, an external corrosion reliability plot was generated for each year of operation for each wall thickness for the L3RP for the 7 modeling locations out to 20 years after installation. It is important to note that in the unmitigated analysis, each corrosion feature is allowed to grow throughout the full time period covered for the analysis. This represents a significantly conservative assumption, as in reality, several measures will be employed to mitigate corrosion, including:

- Regular cathodic protection surveys will be conducted, and any lows will be immediately remediated
- ILIs will be completed on a regular basis, and any features that exceed the acceptance criteria established in CFR 49 Part 195 will be excavated, examined, and repaired or re-coated
- In practice, even when left unmitigated, corrosion growth rates tend to decline with the passage of time due to the accumulation of corrosion products. This natural tendency for decreasing corrosion growth rates with time has been disregarded in the analysis.

Two sets of analyses were performed; one for 36-inch diameter, 0.515-inch wall thickness (Site 1), and one for 36-inch diameter, 0.750-inch wall thickness (Sites 2,3,4,5,6,7).

The reliability plot for the 0.515-inch wall thickness case is presented in Figure 4-11. As can be seen from this plot, the estimated rupture frequency is essentially zero (less than 10^{-40}) for at least the first 20 years of operation. No reliability plot has been provided for the 36-inch diameter, 0.750-inch wall thickness case, as finite (non-zero) values were not obtained through the 20 year analysis period. This reflects a lack of failure sensitivity of both of the L3RP design cases to the expected probability distributions that characterize corrosion feature initiation and growth over that 20 year period.

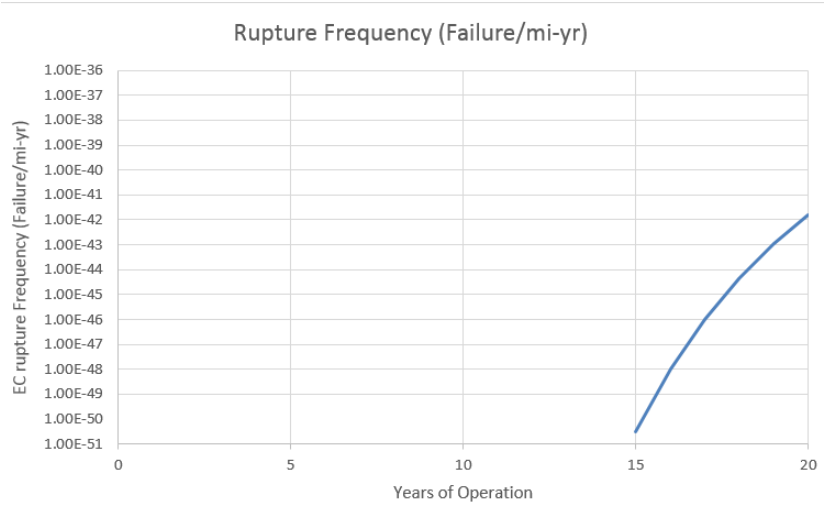


Figure 4-11 External Corrosion Reliability Plot: 36" L3RP 0.515" WT

4.2.3.2.5 Results—Consideration of Operations and Maintenance

The analysis of unmitigated external corrosion failure likelihood demonstrates the relative lack of sensitivity of external corrosion rupture frequency over time, relative to the planned five-year ILI reassessment interval. Specifically, the rupture frequency attributed to the threat of external corrosion is essentially zero for the first 20 years of operation for each of the L3RP design cases evaluated. This 20-year period reflects a time period during which 5 ILIs (including a baseline inspection) for wall loss are planned to occur. Given this lack of time-sensitivity to failure, relative to the planned ILI interval, it is reasonable to expect that any external corrosion features that may initiate will be detected and monitored for pre-emptive repair so that they can be mitigated before they can reach a critical size for failure. Given this circumstance, it is not possible to arrive at a finite value of expected failure frequency over the long term. Nevertheless, a failure frequency value of 10^{-08} ruptures/mi.yr (which the analysis shows to be conservative) will be assigned to this threat, and will be applied to all seven modeling locations.

4.2.3.3 Internal Corrosion

The reliability approach for internal corrosion is consistent with the approach described for external corrosion. However, in regard to the selection of candidate analogue ILI data, the considerations required to evaluate and compare the corrosion conditions for the L3RP with those of the candidate analogue datasets are different than those employed for an assessment of external corrosion.

4.2.3.3.1 Selection of Analogue ILI Data

One of the simplest methods to perform screening for internal corrosion is to view orientation charts for internal wall loss features. Where water drop-out and accumulation is an essential aspect of the internal corrosion mechanism that is associated with the product and flow characteristics being considered (as is the case here), wall loss that is associated with internal corrosion should be expected at the bottom of the pipe, as illustrated in Figure 4-12.

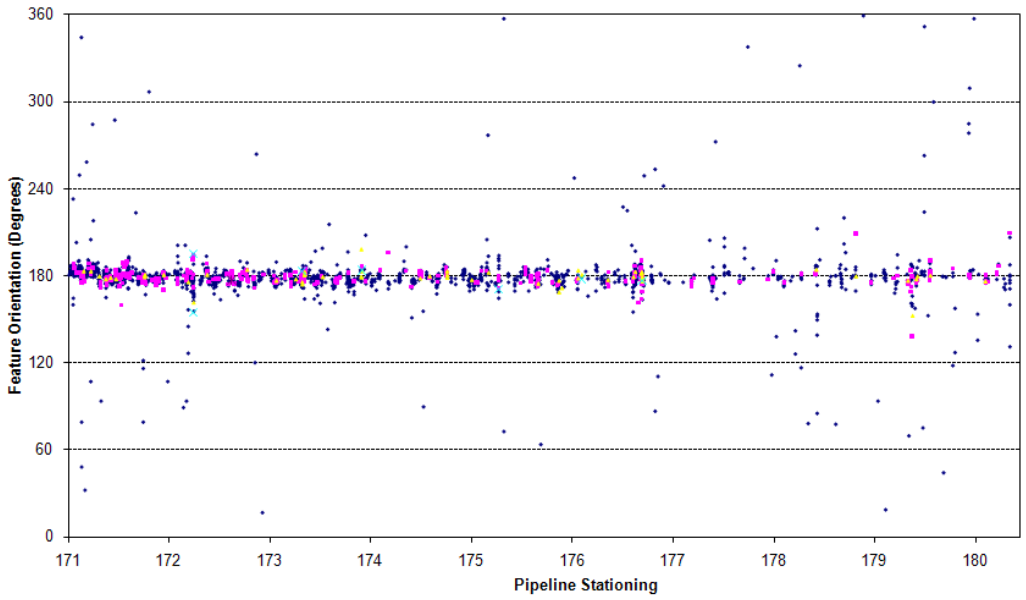


Figure 4-12 Six O'Clock Orientation Typical of Water Drop-out and Accumulation

On the other hand, a random distribution of internal wall loss features around the circumference of the pipe, with no apparent trends relative to inclination angle or receipt points might be more representative of benign manufacturing imperfections, as is represented in Figure 4-13.

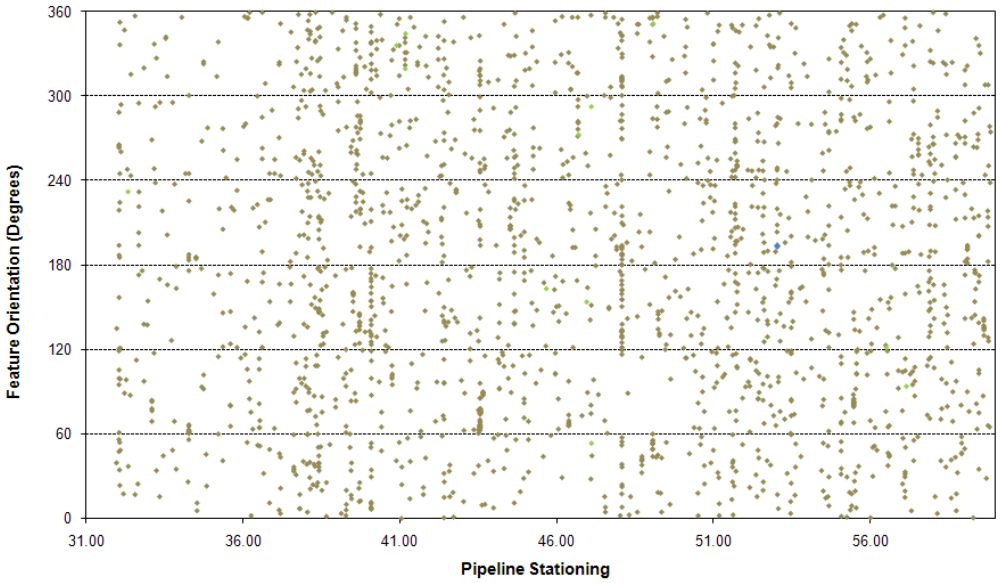


Figure 4-13 Random Wall Loss Orientation Typical of Manufacturing Imperfections—No Apparent Active Internal Corrosion

Internal corrosion evaluation techniques are largely based on product stream characteristics and flow rates. For liquid products, the important parameters that should be included in a comparison of corrosivity are water content, erosion and erosion/corrosion, flow velocity, flow mechanism, temperature, susceptibility to under-deposit corrosion (solid deposition, MIC potential, and water chemistry), and mitigation measures (use of inhibition, biocides, or pigging).

To ensure that the corrosion mechanism and corrosivity that is represented by the analogue ILI dataset is representative of that which would be expected in the L3RP, an evaluation of all of these parameters was conducted. Through this process, it was determined that ILI data obtained from Enbridge's 36-in. Line 4 would be most representative of the corrosivity conditions expected on the L3RP, since Line 4 transports similar products with similar tariffs in similar hydraulic regimes. A review of historical operating conditions on Line 4 indicates that like the proposed L3RP, the product flows in a fully-turbulent regime. Line 4 has historically transported both conventional and heavy crude oil and dilbit, with a tariff of 0.5% basic sediment and water (BS&W), which is the same tariff assigned to the L3RP.

4.2.3.3.1.1 Line 4 ILI Data

Approximately 10,000 km/year of ILI data from the 36-inch Line 4 was reviewed (i.e., approximately 1,000 km of 36-inch Line 4, having an average age of approximately 10 years at the time of inspection), with no evidence of active internal corrosion. The fully-turbulent mode of flow that is characteristic of 36-inch Line 4 and that will also be characteristic of the L3RP results in full entrainment of what little water is present at a BS&W content of less than 0.5%.

In such circumstances, water cannot stratify or accumulate adjacent to the pipe wall, and the internal surface of the pipeline remains in an oil-wet condition. This condition is not associated with internal corrosion.

Regular assessments for corrosion on the L3RP will be completed at no more than 5-year intervals. Given the demonstrated lack of failure-sensitivity to the initiation and growth of internal corrosion over a time period that is approximately double the inspection interval, it was concluded that it is not possible to arrive at a finite value of expected failure frequency for this threat. Nevertheless, a failure frequency value of 10-08 ruptures/mile/year (which the analysis shows to be conservative) will be assigned to this threat, and will be applied to all seven modeling locations.

4.2.3.4 Third Party Damage

The approach used for determining the reliability of a pipeline from the perspective of third party damage was based on the approach developed by Chen and Nessim (1999a). In this approach, failure frequency can be established as the product of two independent variables; the frequency of incurring a hit by an excavator, and the probability of failure given such a hit:

Equation 5

$$FF_{3PD} = F_H \cdot P_{F,H}$$

Where,

FF_{3PD} = Failure frequency due to third party damage
F_H = Excavator hit frequency (hits/km.yr)
$P_{F,H}$ = Probability of failure, given a hit

Chen and Nessim (1999b) demonstrated that machines smaller than excavators do not significantly affect predicted failure probability. Based on this finding, only impacts by large machines such as excavators are addressed by this model.

4.2.3.4.1 Determination of Impact Frequency Due to Third Party Activity

The impact frequency due to third party activity was determined by using a fault tree model developed by Chen and Nessim (1999b). This fault tree model is illustrated in Figure 4-14 and Table 4-15.

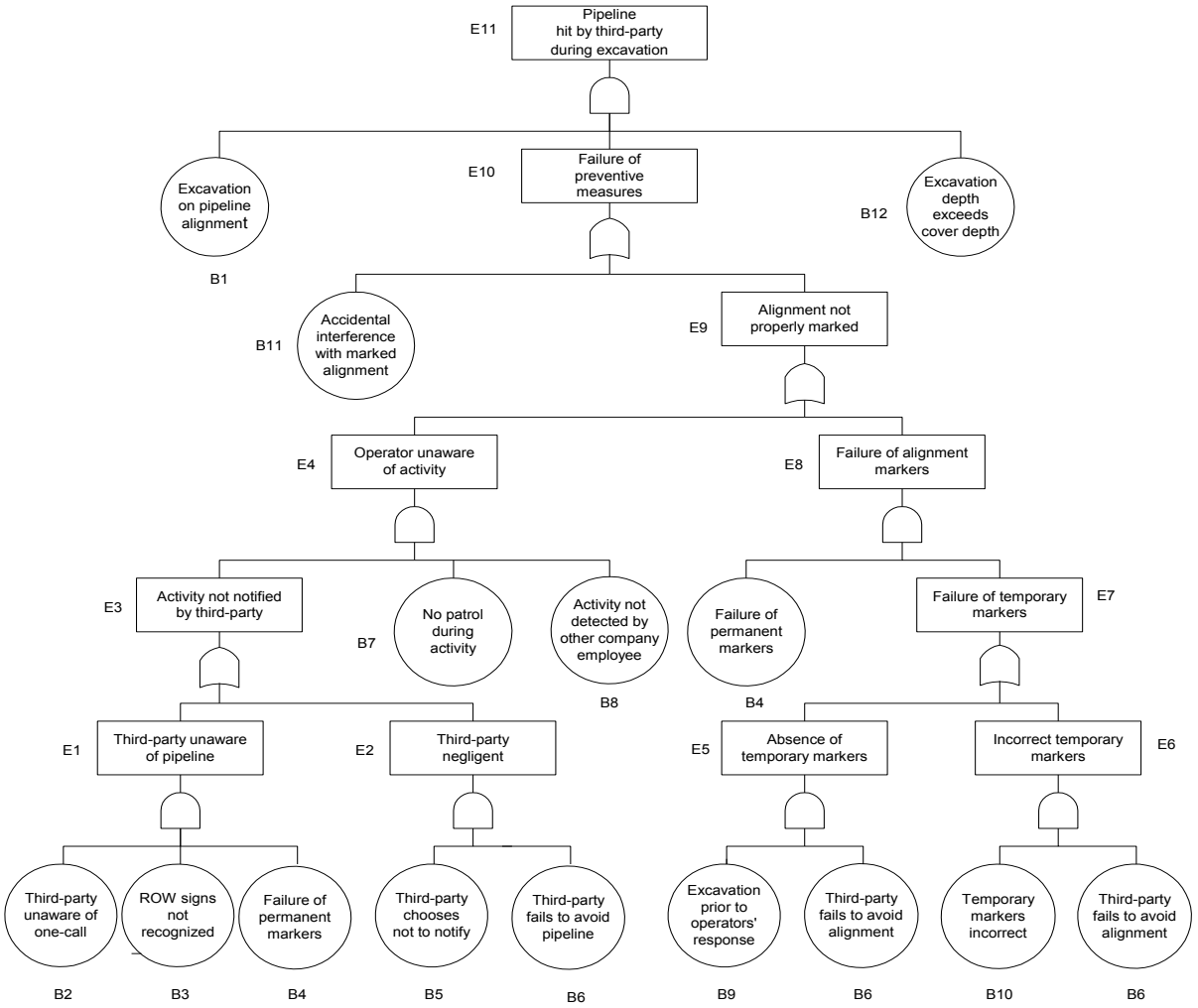


Figure 4-14 Impact Frequency Fault Tree

Table 4-15 Probability Values for Fault Tree Modeling

No	Event	Conditions	Probability
B1	Excavation on pipeline alignment	Commercials/Industrial	0.52/km-year
		High density residential	0.26/km-year
		Low density residential	0.36/km-year
		Agricultural	0.076/km-year
		Remote	0.06/km-year
B2	Third-party unaware of one-call	Advertising via direct mail-outs and promotion among contractors	0.24
		A1+Community meetings	0.10
		Community meetings only	0.50
B3	Right-of-way signs not recognized	Signs at selected crossings	0.23
		Signs at all crossings	0.19
		All crossings plus intermittently along route	0.17
B4	Failure of permanent markers	No buried markers	1.00
		With buried markers	0.10
B5	Third-party chooses not to notify	Voluntary	0.58
		Mandatory	0.33
		Mandatory plus civil penalty	0.14
		Right-of-way agreement	0.11
B6	Third-party fails to avoid pipeline	N/A	0.40
B7	ROW patrols fail to detect activity	Semi-daily patrols	0.13
		Daily patrols	0.30
		Bi-daily patrols	0.52
		Weekly patrols	0.80
		Biweekly patrols	0.90
		Monthly patrols	0.95
		Semi-annual patrols	0.99
		Annual patrols	0.996
B8	Activity not detected by other employees	N/A	0.97
B9	Excavation prior to operator's response	Response at the same day	0.02
		Response within two days	0.11
		Response within three days	0.20

Table 4-15 Probability Values for Fault Tree Modeling

No	Event	Conditions	Probability
B10	Temporary mark incorrect	By company records	0.20
		By magnetic techniques	0.09
		By pipe locators/probe bars	0.01
B11	Accidental interference with marked alignment	Provide route information	0.35
		Locate/mark	0.17
		Locate/mark/site supervision	0.03
		Pipe exposed by hand	0.06
B12	Excavation depth exceeding cover depth	Cover depth = 0.8 m (2.5 ft)	0.42
		0.9 m (3 ft)	0.25
		1.2 m (4 ft)	0.08
		1.5 m (5 ft)	0.07
		1.8 m (6 ft)	0.06

The fault tree model was used in conjunction with design, installation and operations data for the L3RP that was supplied during the Threat Assessment Workshop.

4.2.3.4.2 Determination of Failure Probability, Given Excavator Impact

Given a failure in the measures to prevent the accidental contact of an excavator with the pipeline, a loss of containment may occur due to gouge-in-dent or puncture mechanisms, or alternatively a failure may not occur. The frequency of having a gouge-in-dent or puncture failure, given a contact with an excavator, is a function of whether or not the pipeline resistance (a function of grade, wall thickness, and toughness) is greater or less than the driving forces for failure (a function of excavator force, bucket tooth dimensions, operating pressure). Where the resistance of the pipeline to failure exceeds the driving forces, no failure will occur. Otherwise, failure will occur.

Where failures occur that are related to external interference, the mode of failure is more likely to be gouge-in-dent than puncture (Fuglem et al. 2001; Eiber and Leis 2001). This is in part due to the fact that less force is required to cause a gouge-in-dent failure than is required to puncture a pipeline.

The model that determines the probability of failure, given a hit was derived based on the work reported in Fuglem et al. (2001), utilizes a Monte Carlo analysis to assimilate the probability distributions of the various parameters employed. An overview of the approach is provided below.

4.2.3.4.2.1 Test for Gouge-in-Dent

Gouge-in-dent failure has been empirically described by the NG-18 Q-Factor Relationship (Eiber and Leis 2001).

Equation 6

$$\sigma_h = \sigma_{fl}\left[\frac{(Q - C_2)^{0.6}}{C_3}\right]$$

Where,

- σ_h = Hoop stress at failure (ksi or MPa)
- σ_{fl} = Flow stress (ksi or MPa)
  = Y.S. + 10 ksi or Y.S. + 68.9 MPa
- C_2 = a constant
  = 300 ft-lbs/in or 16 J/mm
- C_3 = a constant
  = 90 (ft-lbs/in)0.6 or 4.80 (J/mm)0.6

Equation 7

$$Q = c_{v,2/3}\left[\frac{R\,t}{D\,d_g\,c_g}\right]$$

Where,

- $C_{v,2/3}$ = 2/3 upper-shelf charpy toughness (ft-lbs or J)
- R = Pipe radius (in. or mm)
- t = Wall thickness (in. or mm)
- D = Maximum dent depth at the time of defect introduction (in. or mm)
- d_g = Depth of gouge (in. or mm)
- c_g = ½ gouge length (in. or mm)

The input parameters utilized in the analysis are described below.

4.2.3.4.2.2 Flow Stress (σfl)

As defined above, flow stress is a function of yield strength. Yield strength distribution parameters were obtained from Fuglem et al. (2001), which indicates that yield strength is normally distributed, with distribution parameters as follows:

- μ = 1.1(SMYS)
- COV = 0.035(SMYS)

4.2.3.4.2.3 Charpy Toughness (cv)

The toughness for the L3RP was conservatively estimated at 40J (29.5 ft-lb), full-size, which corresponds to the minimum specified value for pipe that will be ordered for this pipeline. This is considered quite conservative, since modern pipeline materials easily exceed this value.

4.2.3.4.2.4 Pipe Radius (R)

Pipe radius is a function of pipe diameter (D). Pipe diameter distribution parameters were obtained from Fuglem et al. (2001), which indicates that pipe diameter is normally distributed, with distribution parameters as follows:

μ = 1.0 (nominal diameter)
COV = 0.0006 (nominal diameter)

4.2.3.4.2.5 Wall Thickness (t)

Wall thickness distribution parameters were obtained from Fuglem et al. (2001), which indicates that wall thickness is normally distributed, with distribution parameters as follows:

μ = 1.0 (nominal wall thickness)
COV = 0.01 (nominal wall thickness)

4.2.3.4.2.6 Ultimate Tensile Strength (UTS)

Ultimate tensile strength distribution parameters were obtained from Fuglem et al. (2001) which indicates that ultimate tensile strength is normally distributed, with average and standard deviation values on API 5L X70 pipe of 639.2 MPa (92.7 ksi) and 22.4 MPa (3.2 ksi), respectively.

4.2.3.4.2.7 Excavator Force (Fd)

Maximum Excavator Force Capacity (Fd, kN) has been shown to be a function of excavator mass (mex, tonnes) (Roovers et al. 2000).

Equation 8

$$F_d = 14.2 \cdot m_{ex}^{0.928}$$

Driver and Zimmerman (1998) presented a distribution of excavators by machine mass. This is the same excavator mass distribution that was employed in Fuglem et al. (2001); specifically the entire excavator mass distribution may be applied for Class 1 and Class 2 locations, while a sub-set of that distribution (i.e., excluding excavator masses in excess of 40 tonnes) is applicable to Class 3 and 4 locations. By performing cumulative probability transformations of the excavator mass distributions, and applying Equation 8, sixth-order polynomial curve fits can be made to the data for both the Class 1/2 and Class 3/4 datasets, as illustrated in Figure 4-15 and Figure 4-16. These regression functions were incorporated directly in the Monte Carlo simulations.

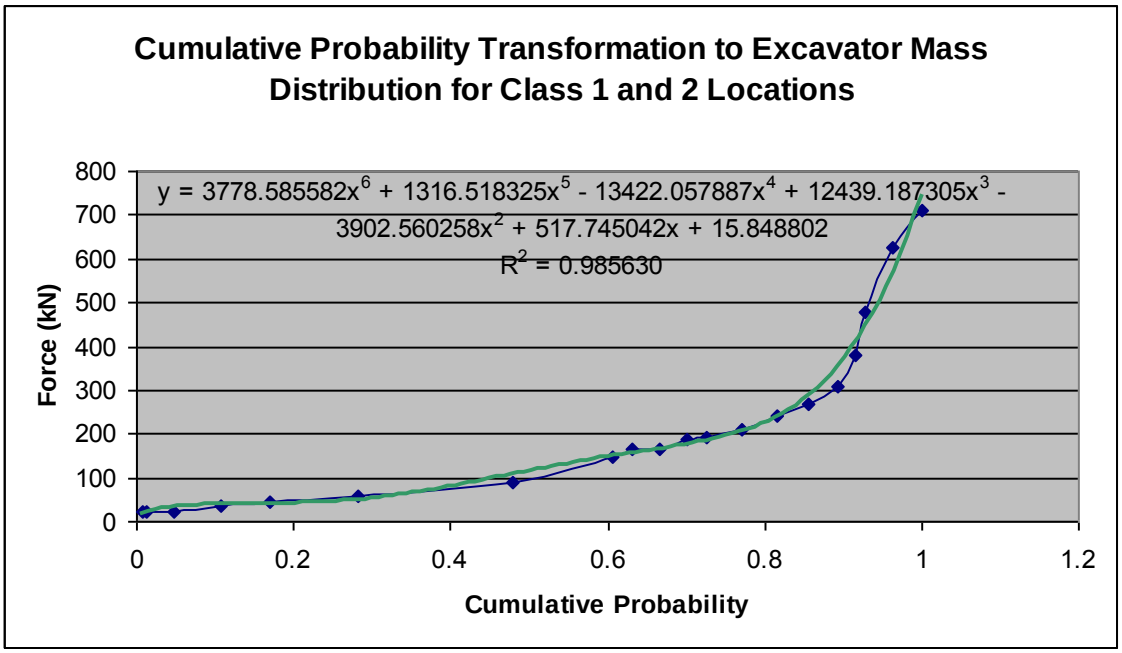


Figure 4-15 Excavator Mass Distribution, Class 1 and 2 Locations

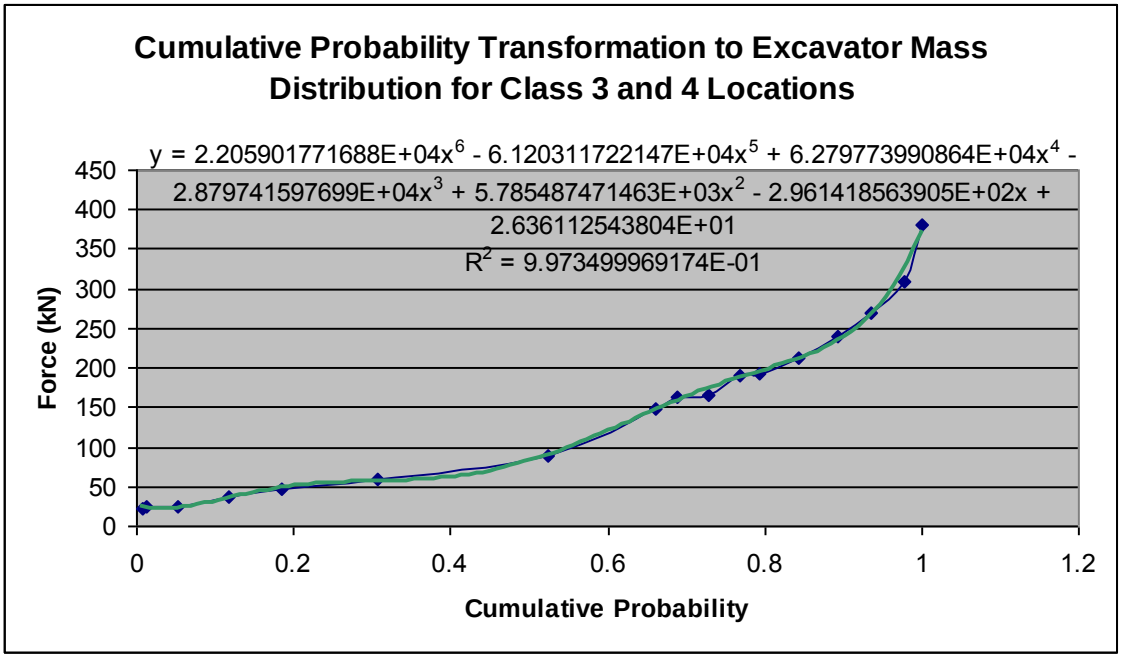


Figure 4-16 Excavator Mass Distribution, Class 3 and 4 Locations

4.2.3.4.2.8 Excavator Tooth Dimensions: Length (L) and Width (W)

The excavator bucket tooth size parameters tooth length (L, mm) and tooth width (W, mm) have been shown to be a function of excavator mass (mex, tonnes) (Roovers et al. 2000).

Equation 9

$$(L + W) = 29.4 \cdot m_{ex}^{0.400}$$

Equation 10

$$L = 24.6 \cdot m_{ex}^{0.420}$$

These parameters were therefore derived as functions of the excavator mass distribution.

4.2.3.4.2.9 Dent Depth (H)

Dent depth has been shown to be a function of pipe diameter, ultimate tensile strength, excavator tooth Length, wall thickness, operating pressure (Pop) and excavator force (Roovers at al. 2000).

Equation 11

$$P_r = \sqrt{t^3 \cdot UTS \cdot L}\left[1 + 0.7\left(\frac{P_{op} \cdot D}{t \cdot UTS}\right)\right]$$

Where,

- UTS = Ultimate Tensile Strength (MPa),
- L = Tooth Length (mm),
- P_{op} = Maximum Operating Pressure (MPa),
- D = Pipe Diameter (mm),
- t = Pipe Wall Thickness (mm),
- P_r = Pipeline Resistance Parameter (mm(N)0.5), where:

Equation 12

$$\text{If } P_r \le 2000\,mm \cdot \sqrt{N} : H = \left(\frac{F_d}{0.007 \cdot P_r}\right)^2$$

Equation 13

$$\text{If } P_r > 2000\ \text{mm}\cdot\sqrt{N} : H = \left(\frac{F_d}{0.31\cdot\sqrt{P_r}} \right)^2$$

Where,

F_d = Denting Force (kN),
H = Dent depth, measured after damage under pressure (i.e., after re-rounding under pressure) (mm).

A relationship exists between H and Ho (the dent depth prior to re-rounding under pressure) (Roovers et al. 2000):

Equation 14

$$H_o = 1.43 \cdot H$$

4.2.3.4.2.10 Gouge Depth (dg)

In Fuglem et al. (2001), reference was made to a judgment-based decision to assume that the gouge depth distribution could be defined as a random variable described by a Weibull distribution having μ = 0.5 mm and σ = 0.5 mm. Conversations with researchers who were involved in full-scale experimental testing of third party damage revealed an unpublished dataset showing that gouge depth is a function of excavator force. A straight-line regression was found to fit this dataset having the form:

Equation 15

$$\text{Gouge Depth (in)} = 3.268 \times 10^{-4} \cdot F_d\text{(kN)} - 5.851 \times 10^{-3}$$

It should be noted that the 50th percentile force from Figure 4-17 is approximately 100 kN. If this value is substituted into Equation 15, a gouge depth of 0.027" is obtained, which corresponds very closely to the mean value of 0.5 mm that is cited in Fuglem et al. (2001).

Accordingly, it was decided to correlate the gouge depth distribution to the excavator force distribution by means of Equation 15.

4.2.3.4.2.11 Half Gouge Length (cg)

Fuglem et al. (2001) and Eiber and Leis (2001) were referenced to establish a basis for a gouge length distribution. It was determined that unlike gouge depth, gouge length is independent of other variables such as excavator force. In Fuglem et al. (2001), the gouge length distribution was described using a Weibull distribution having a mean of 6.0 in., and a COV of 1.25. Gouge length was described as having an approximate value of 3 in., and an upper-bound value of 25 in. (Eiber and Leis 2001). It was noted that the dataset compiled in Eiber and Leis (2001) was

derived from mechanical damage defects that failed in-service, and so the upper-bound gouge length may be taken as a statistical outlier. On the basis of this review, it was decided to describe the gouge length distribution as a Weibull distribution, having the shape parameters a = 1.2 and β = 3.2. This distribution is illustrated in Figure 4-17.

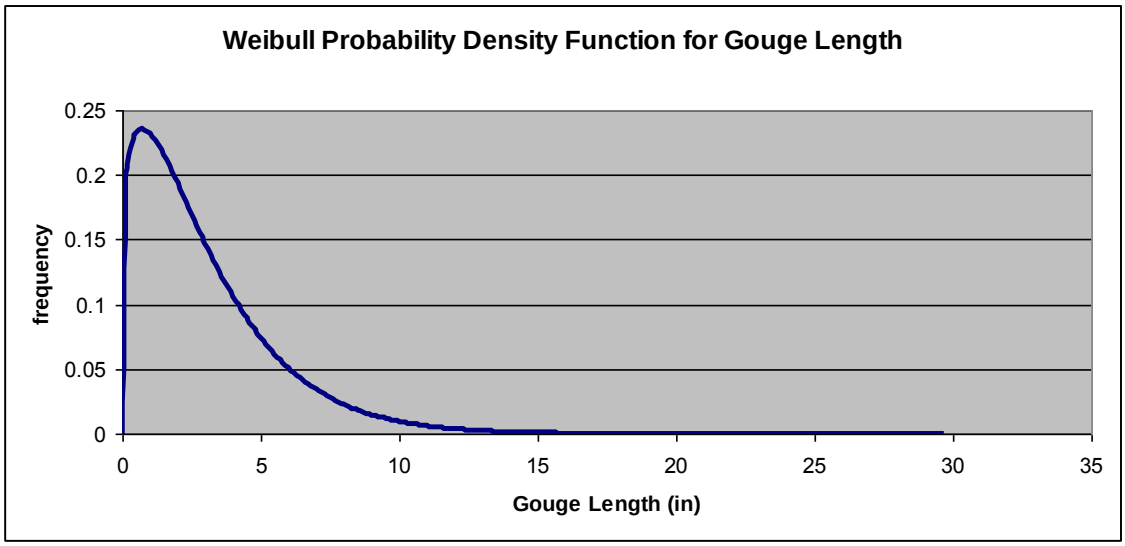


Figure 4-17 Gouge Length Distribution

Because gouges may be randomly oriented with respect to the axis of the pipe, a gouge orientation factor is applied against the gouge length. This is derived by recognizing the fact that the projected length of a gouge on the pipe axis is proportional to the cosine of the angle between the gouge and the pipe axis. The gouge length orientation factor; therefore, varies between 0 and 1 and is equal to the cosine of a uniform distribution of random angles between 0 and π/2 radians. A cumulative probability transformation on this distribution was performed, and a second order polynomial curve fit was derived for this function, as depicted in Figure 4-18.

This polynomial function was incorporated directly within the Monte Carlo simulation.

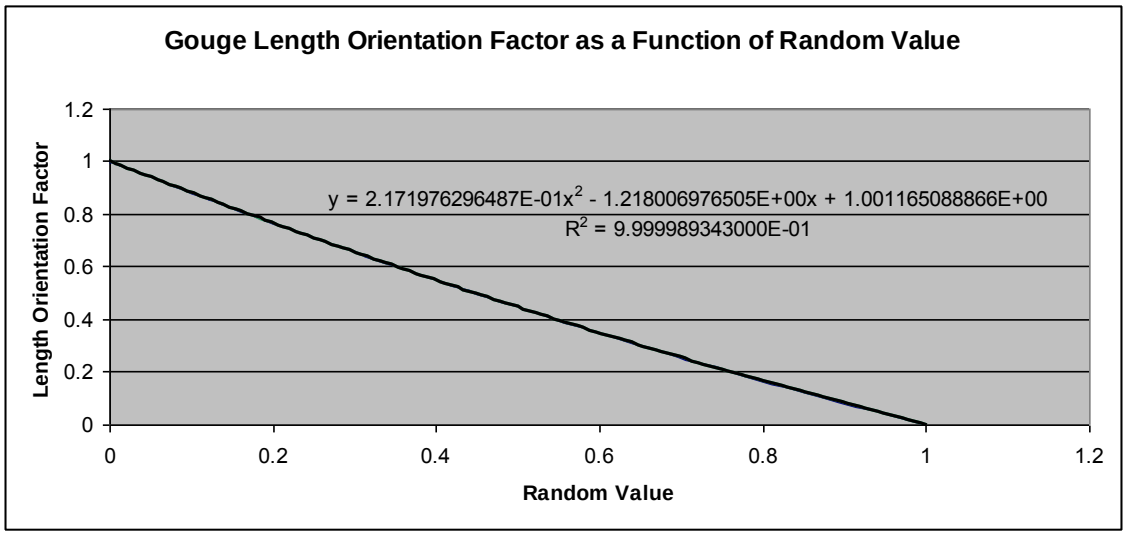


Figure 4-18 Gouge Length Orientation Factor

4.2.3.4.2.12 Off-Angle Force Reduction Factor

When the excavator force is applied normal to the pipeline, the full penetrating force of the excavation equipment can be brought to bear against the pipeline. When the applied force is at an angle θ to the pipe, the component of the maximum applied force that is directed towards penetration of the pipeline is equal to FMax Cos θ, as illustrated in Figure 4-19.

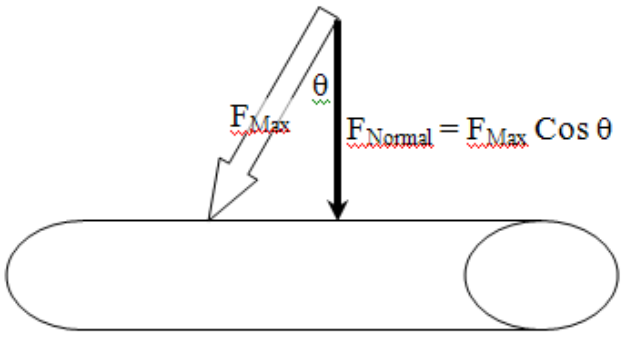


Figure 4-19 Off-Angle Force Reduction Factor

As presented by Fuglem et al. (2001), since the angle of the application of excavator force may be equally likely to be any angle between 0 and 90°, the off-angle force reduction factor is best described as a uniform distribution between 0 and 1.

4.2.3.4.2.13 Operator Control Factor

As discussed in Fuglem et al. (2001), the operator of a piece of excavation equipment will, in most cases, apply a load that is considerably less than the maximum quasi-static load. The typical actual capacity at which the machine is used will depend on the soil type and how aggressively the operator digs. It may also be expected that an operator may dramatically cut back on the load if he detects a foreign object. This may be particularly true for gouge-in-dent type damage, which is inflicted more gradually than puncture damage. Because of the uncertainty regarding the distribution of applied force, the approach by Fuglem et al. (2001) was used to calibrate the model against "Probability of Failure, Given a Hit" data for the operator control factor.

4.2.3.4.2.14 Test of Failure Due to Puncture

Puncture failure has been empirically described by the model described by Chen and Nessim (1999b).

Equation 16

$$R = \left[1.17 - 0.0029 \cdot \left(\frac{D}{t}\right)\right] \cdot (L + W) \cdot t \cdot \sigma_u + E_R$$

Where:

- R = The resistance to puncture (N)
- D = Pipe diameter (mm)
- t = Wall thickness (mm)
- L = Excavator tooth length (mm)
- W = Excavator tooth width (mm)
- σ_U = Ultimate tensile strength (MPa)
- E_R = Model error (N)

This is the same limit state equation used to define puncture resistance in Fuglem et al. (2001).

4.2.3.4.2.15 Input Parameters

With the exception of the operator control factor, all of the input parameters that are required for the puncture model have been defined in the discussion on the gouge-in-dent model. To avoid repetition, only the operator control factor will be described in this section.

As was done for the gouge-in-dent model, due to the lack of certainty regarding the distribution that describes the degree of operator control, the puncture model was calibrated against "Probability of Failure, Given a Hit" data contained in Fuglem et al. (2001).

4.2.3.4.2.16 Monte Carlo Simulation

Monte Carlo simulation is a numerical approach for arriving at a solution when the variables within a mathematical expression are best described as random variables derived from probability density functions, rather than discrete values, as is the case with a conventional

deterministic analysis. When used as part of a reliability analysis, the mathematical expression is known as a "limit state equation", and the usual objective of the analysis is to estimate the probability of an event or "limiting condition" occurring.

The limiting condition is usually one which describes the onset of failure, or some other undesirable event. In the case at hand, two limit state equations are used; one to define the onset of gouge-in-dent failure (Equation 6) and the other to define the onset of failure due to puncture (Equation 16).

The probability of failure given a hit due to gouge-in-dent is obtained by employing a Monte Carlo Simulation to determine the frequency of occurrence (over a set number of iterations) of events where the operating hoop stress due to internal pressure (σh) exceeds the operating stress at failure, as defined in Equation 6. Similarly, the probability of failure given a hit due to puncture is obtained by employing a Monte Carlo Simulation to determine the frequency of occurrence (over a set number of iterations) of events where the factored excavator force exceeds the resistance, R, as defined in Equation 16.

The overall probability of failure given a hit is determined by executing the Monte Carlo Simulations for gouge-in-dent and puncture simultaneously, and determining the frequency of occurrence (over a set number of iterations) of events where either the limit state for gouge-in-dent or puncture is exceeded.

4.2.3.4.3 Calibration

Calibration of this model was undertaken as described in the Sections describing the operator control factor for each of the two limit states. This approach is consistent with what was carried out in Fuglem et al. (2001), and it was achieved utilizing the calibration data from that study.

4.2.3.4.4 Leaks and Ruptures

It has been reported that the respective percentages of leak and rupture for third party damage failures are 75% and 25%, based on the mechanical damage incidents reported to the U.S. Department of Transportation during 1984 to 1992 (Chen and Nessim 1999b). Accordingly, third party damage failure rates established by the reliability approach described above are sub-divided into leaks and failures in accordance with this guideline.

4.2.3.4.5 Results

The length-averaged third party damage rupture frequency values for each of the seven modeling locations are summarized in Table 4-16.

Table 4-16 Third Party Damage Summary

Site	Third Party Damage Rupture Frequency (Ruptures/mi.yr)
1—Mosquito Creek	1.026×10^{-06}
2—Mississippi River at Ball Club	6.680×10^{-08}
3—Sandy River	6.680×10^{-08}
4—Shell River	6.680×10^{-08}
5—Red River	8.183×10^{-08}
6—Mississippi River at Palisades	6.680×10^{-08}
7—Mississippi River at Little Falls	1.733×10^{-07}

4.2.3.5 Manufacturing Defects

Manufacturing Defects failures are those that are attributed to pipe as a direct result of the presence of pipe body or seam weld defects.

The threat of manufacturing defects does not lend itself to failure frequency estimation using a reliability approach due to the lack of a limit state model that is supported by probability distributions for its input parameters. Therefore, the approach that was used to estimate the frequency of occurrence for this threat applies a failure frequency derived from industry failure statistics for modern (1980 installation or later) pipeline materials, design, and installation practices.

4.2.3.5.1 Failure Frequency for Manufacturing Defects

4.2.3.5.1.1 Analysis if Incident Data

The PHMSA Hazardous Liquids incident database (2010–present, current to December 31, 2015) was filtered for onshore, pipelines installed since 1980. For the purposes of isolating only those incidents associated with pipelines (i.e., not including facilities), the PHMSA incident database was filtered so that it included only those incidents that were related to "Onshore Pipelines, Including Valve Sites".

For the purposes of the "Pipelines Only" analysis, failures related to non-pipe equipment were not considered, thereby providing a suitable basis for estimating failure rates associated with pipeline ROWs.

To highlight failures characterized as "ruptures", a filter was applied to the "Release Type" field of the PHMSA flagged hazardous liquids incident database. The *Instructions for Form PHMSA F700-1 Accident Report—Hazardous Liquid Pipeline Systems* defines the term "leak" as follows: "Leak means a failure resulting in an unintentional release of the transported commodity that is often small in size, usually resulting in a low flow release of low volume, although large volume leaks can and do occur on occasion."

Conversely, the term "rupture" is defined as follows: "Rupture means the pipeline facility has burst, split, or broken and the operation of the pipeline facility is immediately impaired. Pipeline ruptures often result in a higher flow release of larger volume. The terms "circumferential" and "longitudinal" refer to the general direction or orientation of the rupture relative the pipe's axis. They do not exclusively refer to a failure involving a circumferential weld such as a girth weld, or to a failure involving a longitudinal weld such as a pipe seam."

For the purposes of categorization, failures that were characterized as "Mechanical Puncture" were included within the "Rupture" category.

Once the above filters were applied, the number of ruptures that were associated with materials defects over the reporting period was counted.

4.2.3.5.1.2 Analysis of Mileage Data

The PHMSA Liquid Annual Data for the years 2010 and higher were filtered so that they represented infrastructure mileage for onshore liquids pipelines. Further filters were applied so that mileage data could be broken down by year of installation.

4.2.3.5.2 Calculation of Failure Frequency

To express pipeline incident frequency in a manner that is independent of timeframe or length of infrastructure, failure frequency estimates are conventionally expressed in normalized terms, using units of failures per mile per year of operation. To provide results in such normalized terms, this was calculated as follows:

Equation 17

$$FF_R = \frac{I_R}{L \times A}$$

Where,

- FF_R = Failure frequency (ruptures/mi.yr)
- I_R = Incident count obtained from the PHMSA flagged hazardous liquids incident database 2010–present (# ruptures)
- L = Average length of infrastructure in miles (i.e., infrastructure length values averaged over the PHMSA Liquid Annual Data for the years 2010 and higher)
- A = Number of years of incident data represented by the PHMSA flagged hazardous liquids incident database (for the "2010–present" database used, this value was 6 years)

Based on the above analysis, the failure frequency for Materials Defects was determined to be 2.775×10^{-06} ruptures/mi-yr.

4.2.3.6 Construction Defects

Construction defects failures are those that are attributed to construction or installation defects, such as girth weld defects.

The threat of construction defects does not lend itself to failure frequency estimation using a reliability approach due to the lack of a limit state model that is supported by probability distributions for its input parameters. Therefore, the approach that was used to estimate the frequency of occurrence for this threat applies a failure frequency derived from industry failure statistics for modern (1980 installation or later) pipeline materials, design, and installation practices.

4.2.3.6.1 Failure Frequency for Construction Defects

The PHMSA Hazardous Liquids incident database (2010–present, current to December 31, 2015) was sorted and failure frequency was calculated as described in Section 4.2.3.5.1. Once the above filters were applied, the number of ruptures that were associated with construction defects over the reporting period were counted.

Based on this analysis, the failure frequency for construction defects was determined to be 5.551×10^{-06} ruptures/mi- yr.

4.2.3.7 Incorrect Operations

Failures due to incorrect operations are related to human error and procedural error during the operation of a pipeline. The threat of incorrect operations failures does not lend itself to failure frequency estimation using a reliability approach due to the lack of a limit state model that is supported by probability distributions for its input parameters. In consideration of this fact, estimates of failure frequency were based on operating incident data related to this threat, modified by the results of the operations questionnaire that was administered during the Threat Assessment Workshop. This approach is similar to that described in the second edition of API RP 581 "Risk Based Inspection Technology", where operations-related failure frequency is obtained by multiplying a baseline operations-related failure rate by a management systems adjustment factor, as highlighted below:

Equation 18

$$FF_{IO} = FF_{IO,\,Baseline} \times AF_{MS}$$

Where,

FF_{IO}	= Incorrect operations failure frequency (ruptures/km yr)
$FF_{IO,\,Baseline}$	= Baseline rupture frequency for incorrect operations derived from industry failure statistics
AF_{MS}	= Operational Management Systems Adjustment Factor (0.1 – 10.0)

4.2.3.7.1 Baseline Failure Frequency for Incorrect Operations

The PHMSA Hazardous Liquids incident database (2010–present, current to December 31, 2015) was sorted and failure frequency was calculated as described in Section 4.2.3.5.1. Once the above filters were applied, the number of ruptures that were associated with incorrect operations over the reporting period were counted. Included in that count were all first and second party external interference incidents, since failures associated with first and second party damage can be considered as principally related to process failure and human error.

Based on this analysis, the failure frequency for incorrect operations was determined to be 2.775×10^{-06} ruptures/mi- yr.

4.2.3.7.2 Operational Management Systems Adjustment Factor

During the threat assessment, an operations questionnaire was administered. That questionnaire covered topics that were intended to gauge the performance of Enbridge operations in terms of the causal factors of failures related to incorrect operations. As detailed in the threat assessment, the results of the questionnaire were evaluated and scored, resulting in a score of 65 out of a possible 73 points (i.e., 89.0%).

Adopting the quantitative failure frequency estimation approach of API RP 581, an operational management systems adjustment factor is derived in accordance with the following expression:

Equation 19

$$AF_{MS} = 10^{[-0.02P_{Score}+1]}$$

Where,

P_{Score} = the percent score obtained on the Operations Questionnaire.

Based on a P^{Score} value of 89.0%, AFMS was determined to be 0.166.

From Equation 18, the adjusted incorrect operations rupture frequency was therefore determined to be 4.607×10^{-07} ruptures/km yr.

4.2.3.8 Geotechnical / Hydrotechnical Threat

To assess the degree of threat that a pipeline will be exposed to threats associated with geotechnical and hydrological factors, an evaluation of these factors was completed at each of the seven modeling locations. The review included published information (textbooks and reports), including soils maps, topographic maps, hydrological maps, pipeline alignment sheets, and incident reports related to ground movement, hydrological and geological events and floods.

A full description of the approach that was adopted for the determination of failure frequency is provided in Attachment A.

Failure likelihood estimates, expressed in terms of annual rupture probability were derived for each geohazard or hydrotechnical hazard identified at each site. The combined annual probability of pipeline rupture for all threats was then determined as the statistical "OR" function of all probability values associated with each threat for each site. The combined annual probability of rupture associated with geohazards / hydrotechnical hazards for each site is summarized in Table 4-17.

Table 4-17 Geohazard / Hydrotechnical Hazard Annual Probability of Rupture

Site	Annual Rupture Probability
1—Mosquito Creek	0.000
2—Mississippi River at Ball Club	5.000×10^{-08}
3—Sandy River	5.000×10^{-09}
4—Shell River	1.105×10^{-07}
5—Red River	1.050×10^{-07}
6—Mississippi River at Palisades	6.000×10^{-08}
7—Mississippi River at Little Falls	6.000×10^{-08}

4.2.4 Summarized Estimates of Failure Frequency

In Section 4.1, threat-specific estimates of failure frequency were provided for each unique combination of design variables associated with the L3RP at each of the seven modeling locations. Knowing the failure frequency associated with a given segment of pipeline (expressed in units of failures per mile per year of operation), the annual probability of failure over that segment length can be determined as:

Equation 20

$$P_f = 1 - (1 - FF)^{SL}$$

Where,

Pf = Annual probability of failure over a defined segment of length SL (miles)
FF = Failure Frequency (failures per mile per year of operation)

For multiple threats, the combined annual probability of failure is expressed as:

Equation 21

$$P_{Comb} = P_{f,Threat1} \, U \, P_{f,Threat2} \, U \, P_{f,Threat3} \ldots U \, P_{f,Threatn}$$

Where the operator U represents the statistical "OR" function.

From the above relationships, a summary of annual failure probability values for each of the seven modeling locations is provided for all threats identified in the threat assessment based on the threat-specific failure frequency values identified in Section 4.1. Results are provided below for each modeling site.

4.2.4.1 Mosquito Creek

The threat-specific failure annual probability of failure values for the L3RP at the Mosquito Creek modeling site are provided in Table 4-18.

Table 4-18 Failure Probability Summary L3RP, Mosquito Creek

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.346	3.460×10^{-09}
Internal corrosion	1.000×10^{-08}		3.460×10^{-09}
Third party damage	1.026×10^{-06}		3.549×10^{-07}
Manufacturing defects	2.775×10^{-06}		9.602×10^{-07}
Construction defects	5.551×10^{-06}		1.921×10^{-06}
Incorrect operations	4.607×10^{-07}		1.594×10^{-07}
Geotechnical/hydrological forces	-		0.000
All threats combined			**3.402×10^{-06}**

4.2.4.2 Mississippi River at Ball Club

The threat-specific failure annual probability of failure values for the L3RP at the Mississippi River at Ball Club modeling site are provided in Table 4-19.

Table 4-19 Failure Probability Summary L3RP, Mississippi River at Ball Club

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.039	3.900×10^{-10}
Internal corrosion	1.000×10^{-08}		3.900×10^{-10}
Third party damage	6.680×10^{-08}		2.605×10^{-09}
Manufacturing defects	2.775×10^{-06}		1.082×10^{-07}
Construction defects	5.551×10^{-06}		2.165×10^{-07}
Incorrect operations	4.607×10^{-07}		1.797×10^{-08}
Geotechnical/hydrological forces	-		5.000×10^{-08}
All threats combined			**3.961×10^{-07}**

4.2.4.3 Sandy River

The threat-specific failure annual probability of failure values for the L3RP at the Sandy River modeling site are provided in Table 4-20.

Table 4-20 Failure Probability Summary L3RP, Sandy River

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.218	2.180×10^{-09}
Internal corrosion	1.000×10^{-08}		2.180×10^{-09}
Third party damage	6.680×10^{-08}		1.456×10^{-08}
Manufacturing defects	2.775×10^{-06}		6.050×10^{-07}
Construction defects	5.551×10^{-06}		1.210×10^{-06}
Incorrect operations	4.607×10^{-07}		1.004×10^{-07}
Geotechnical/hydrological forces	-		5.000×10^{-09}
All threats combined			**1.939×10^{-06}**

4.2.4.4 Shell River

The threat-specific failure annual probability of failure values for the L3RP at the Shell River modeling site are provided in Table 4-21.

Table 4-21 Failure Probability Summary L3RP, Shell River

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.482	4.820×10^{-09}
Internal corrosion	1.000×10^{-08}		4.820×10^{-09}
Third party damage	6.680×10^{-08}		3.220×10^{-08}
Manufacturing defects	2.775×10^{-06}		1.338×10^{-06}
Construction defects	5.551×10^{-06}		2.676×10^{-06}
Incorrect operations	4.607×10^{-07}		2.221×10^{-07}
Geotechnical/hydrological forces	-		1.105×10^{-07}
All threats combined			**4.388×10^{-06}**

4.2.4.5 Red River

The threat-specific failure annual probability of failure values for the L3RP at the Red River modeling site are provided in Table 4-22.

Table 4-22 Failure Probability Summary L3RP, Red River

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.301	3.010×10^{-09}
Internal corrosion	1.000×10^{-08}		3.010×10^{-09}
Third party damage	8.183×10^{-08}		2.463×10^{-08}
Manufacturing defects	2.775×10^{-06}		8.353×10^{-07}
Construction defects	5.551×10^{-06}		1.671×10^{-06}
Incorrect operations	4.607×10^{-07}		1.387×10^{-07}
Geotechnical/hydrological forces	-		1.050×10^{-07}
All threats combined			**2.781×10^{-06}**

4.2.4.6 Mississippi River at Palisades

The threat-specific failure annual probability of failure values for the L3RP at the Mississippi River at Palisades modeling site are provided in Table 4-23.

Table 4-23 Failure Probability Summary L3RP, Mississippi River at Palisades

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.278	2.780×10^{-09}
Internal corrosion	1.000×10^{-08}		2.780×10^{-09}
Third party damage	6.680×10^{-08}		1.857×10^{-08}
Manufacturing defects	2.775×10^{-06}		7.715×10^{-07}
Construction defects	5.551×10^{-06}		1.543×10^{-06}
Incorrect operations	4.607×10^{-07}		1.281×10^{-07}
Geotechnical/hydrological forces	-		6.000×10^{-08}
All threats combined			**2.527×10^{-06}**

4.2.4.7 Mississippi River at Little Falls

The threat-specific failure annual probability of failure values for the L3RP at the Mississippi River at Little Falls modeling site are provided in Table 4-24.

Table 4-24 Failure Probability Summary L3RP, Mississippi River at Little Falls

Threat	Annual Failure Frequency (ruptures/mi.yr)	Segment Length (mi)	Annual Rupture Probability
External corrosion	1.000×10^{-08}	0.248	2.480×10^{-09}
Internal corrosion	1.000×10^{-08}		2.480×10^{-09}
Third party damage	1.733×10^{-07}		4.298×10^{-08}
Manufacturing defects	2.775×10^{-06}		6.882×10^{-07}
Construction defects	5.551×10^{-06}		1.377×10^{-06}
Incorrect operations	4.607×10^{-07}		1.143×10^{-07}
Geotechnical/hydrological forces	-		6.000×10^{-08}
All threats combined			**2.287×10^{-06}**

5.0 MODELING OF OIL RELEASES

This chapter contains a description of the computational models used for different scenarios (Sections 5.1.1 and 5.1.2, respectively), the key assumptions made for these simulations (Section 5.2), and the input data sources, processing, and assumptions for environmental and chemical data (Section 5.3). Trajectory and fates results are presented in Chapter 6.0; results are organized by location, then type of crude oil and season.

Hypothetical oil releases from the proposed preferred and alternate pipeline routes for the L3RP were modeled using the OILMAP Land and SIMAP computation models that have been developed by RPS. The L3RP route is depicted in Figure 5-1.

Large releases of crude oil were simulated from five representative release locations along the pipeline using the OILMAP Land computation model. Two additional locations were selected for more comprehensive three dimensional modeling using the SIMAP modeling system. Modeling of large releases of crude oil at these seven locations provided quantitative predictions of the trajectory and fate of released oil under a range of environmental conditions (in-stream flows and seasons) and a range of crude oils (i.e., light and heavy crude oils). The rational for the selection of the two computational models; and the selection of a specific modeling system for different locations, are provided in Chapter 3.0. Details are also provided on the criteria used to select preferred locations for modeling of large releases of crude oil; how a specific range of conditions were determined for each hypothetical release (i.e., volume of the release, flow conditions, types of crude oil); and the types of output desired.

Information on the trajectory and fate of crude oil for these hypothetical releases was used to assess a wide range of potential effects on key receptors under different seasonal flows conditions and with light and heavy crude oils. The assessment of potential environmental effects included site-specific assessments of potential effects on environmentally-sensitive areas (e.g., HCAs and AOIs; Section 7.3), and on key receptors at each of the seven modeling locations (Sections 7.4 to 7.10).

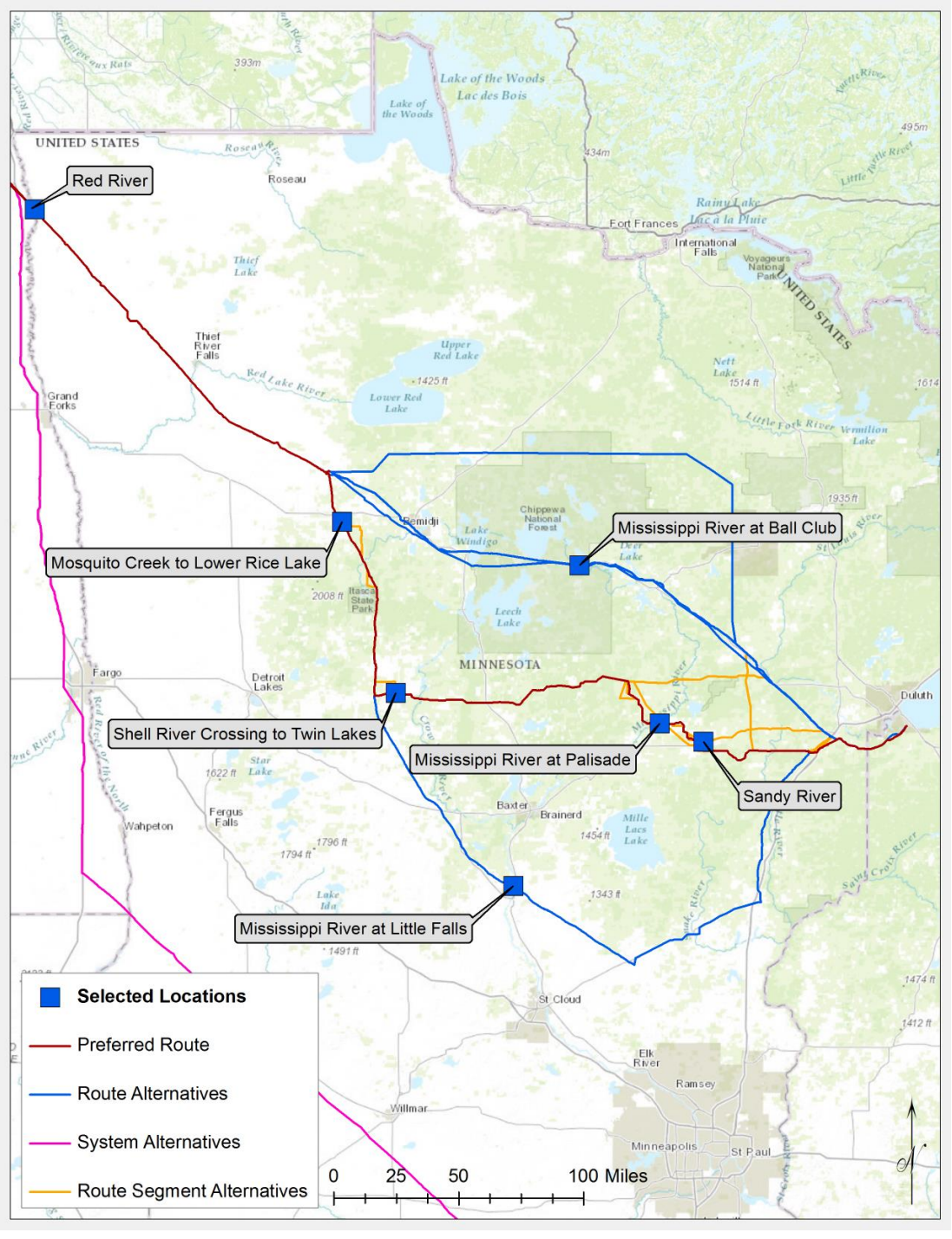


Figure 5-1 Map of the Enbridge Line 3 Replacement Pipeline Route, Preferred and Alternative Routes, and Selected Hypothetical Release Locations for Modeling

Of note, seasonal variations in river flow rate, temperature, wind speed, and snow and ice cover are expected at each of the modeled locations and would affect the trajectory and fate of a crude oil release. Because river discharge controls the downstream velocity of water and, therefore, the potential transport of oil, a hydrologic analysis was conducted to characterize seasonal differences at each hypothetical release location. Historical stream discharge (flow) data was used to determine the monthly average flow rate for each location. The seasonally appropriate environmental conditions that would be present during each of these months were then identified for use in modeling. The combination of multiple environmental conditions and oil types modeled at each location provide a realistic range of anticipated seasonal conditions upon which to base the hypothetical release scenarios. The three seasons modeled bound the range of likely conditions spanning high to low river flow rate, temperature, ice cover, and wind speed.

Months representing the average, maximum, and minimum river flow rates were identified, and the corresponding temperatures and wind speeds during those seasons were used in the modeling. The average monthly river flow rate month was considered representative of baseline conditions. As mean flow can occur in two seasons, typically observed around summer and fall, the month with the warmest temperature (i.e., August) was selected to represent the maximum amount of evaporation, potentially resulting in the largest exposure to hydrocarbon vapors in air as a potential trigger for human health effects. The month with the highest flow rate represented the spring freshet (i.e., a spring thaw and increased river flow rates from snow and ice melt typically occurring between April and June), a result of rising temperatures and snowmelt. The month with the lowest flow rate represented the winter (i.e., January–March), and was typified by freezing conditions and probable snow cover on land and ice cover on water.

5.1 DESCRIPTION OF MODELING TOOLS

The OILMAP Land modeling system was used to predict the trajectory and fate of hypothetical large releases of crude oil at five modeling locations: Mosquito Creek to Lower Rice Lake, Mississippi River at Ball Club, Sandy River, Shell River to Twin Lakes, and Red River (Table 3-5).

5.1.1 OILMAP Land

The OILMAP Land model simulates the flow of oil or chemicals from a given rupture point along a pipeline (Figure 5-2). The release is modeled as it propagates over the land surface and then into any surface water network until the entire amount of product is released. Oil flow over land is governed by the physical characteristics and slope of the land surface. The overland model calculates an oil mass balance that includes losses from oil adhesion to land over the oiled path, the formation of small puddles, oil pooling in large depressions on the land surface, and oil evaporation to the atmosphere.

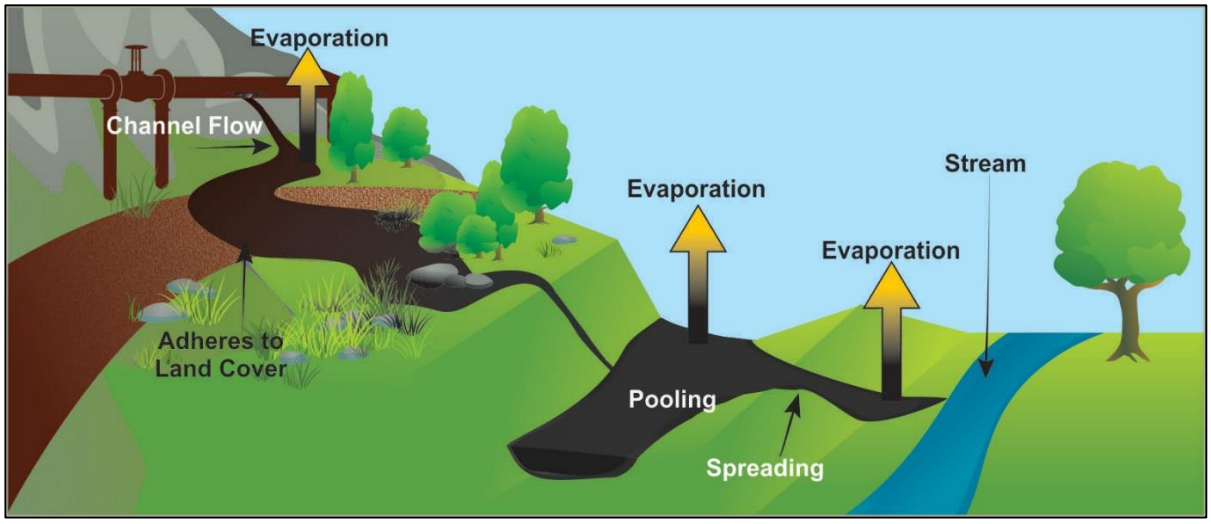


Figure 5-2 Conceptual Diagram of the Land Transport Model Depicting the Possible Fate of Oil as it Moves Over the Land Surface in OILMAP Land

In many cases, oil may reach a watercourse. The flow of oil within a watercourse is governed by surface currents, which require a different modeling approach (Figure 5-3). The water transport model simulates the downstream movement of oil on the water surface in streams at a defined velocity. As oil moves downstream, estimates of the amount of oil lost to the shore from adhesion and to the atmosphere by evaporation are made. Any oil entering a lake is allowed to spread over the water surface of the lake in a radial pattern to a minimum thickness that reflects the density and viscosity of the released oil.

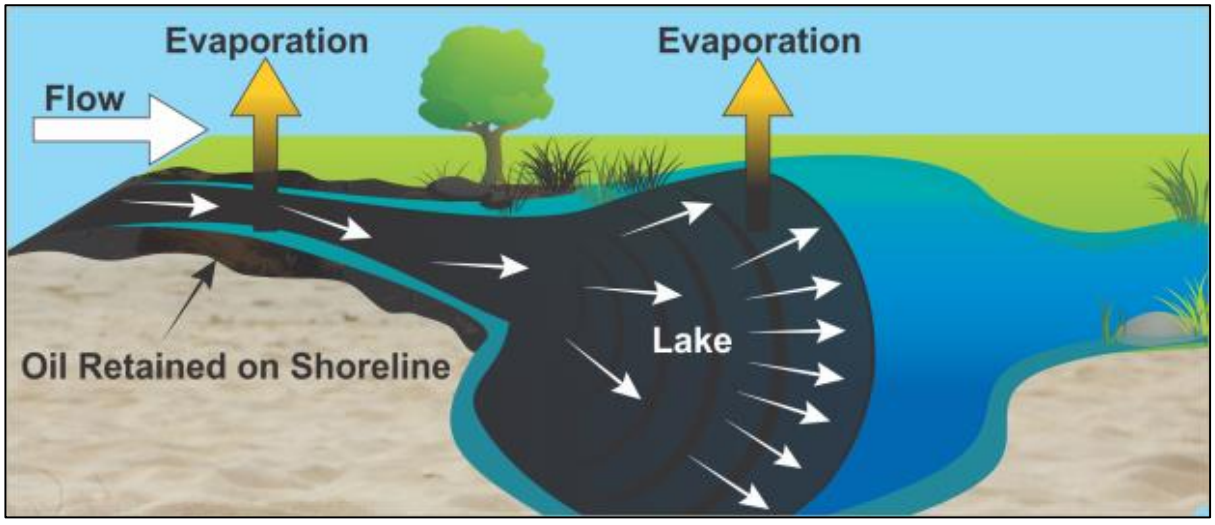


Figure 5-3 Conceptual Diagram of the Downstream Transport Model Depicting the Possible Fate of Oil Entering the Surface Water Network in OILMAP Land

While OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled 24-hour period, it is not able to provide detailed predictions of 3-D oil fate and transport. Therefore, complex processes such as entrainment of oil into the water column, dissolution of soluble fractions of hydrocarbons, and emulsion formation were not modeled for the five hypothetical release sites that were simulated with the OILMAP Land system. Two additional release locations on the Mississippi River were modeled using SIMAP to characterize a more comprehensive investigation of 3-D trajectory and fates process within the water column (Section 5.1.1.5).

5.1.1.1 Overland Release Model

For the purpose of the OILMAP Land computational model, the overland flow of oil is simulated using a square land elevation grid. Starting at the release location, the model searches the eight neighboring cells to determine the steepest down slope direction. The adjacent cell with the lowest elevation becomes the next starting location (Figure 5-4). This process repeats successively until a flat or depression area is reached. In a flat area, the model searches (i.e., looks beyond adjacent cells) to determine the minimum distance path to a next lowest cell. In a depression area, the area assumed to fill with liquid until the elevation of the surface of the pool equals the elevation of a grid cell on its boundary. At this point the boundary of the pool is breached, and the grid cell becomes the next starting point for farther down slope movement of oil. The lowest elevation cell becomes the next starting location.

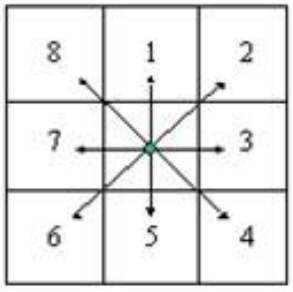


Figure 5-4 Diagram Showing How the OILMAP Land Model Searches the Eight Neighboring Cells to Determine the Steepest Down Slope Gradient and Resulting Direction of Flow

As a release path is established, the release area is calculated and the loss of oil is computed as a function of three process terms (i.e., adherence, pooling, and evaporation; Figure 5-2). Adherence, or depression storage, is the process by which oil is lost to the ground surface and vegetation as it spreads overland. Depression storage values vary by land type (as a function of surface area, roughness, etc.) and oil type (as a function of viscosity). Depression storage represents both the puddling of oil within small surface depressions on a scale smaller than the elevation grid, and physical adhesion of oil on surfaces. Pooling is larger-scale process by which oil is trapped within depressions in the local topography (i.e., depressions that can be resolved at the resolution of the available elevation grid). Such depressions are assumed to fill with oil

before additional down slope transport occurs. Evaporation is the process by which the volatile portion of the liquid oil becomes a gas that enters the atmosphere.

In the first calculation, the rate of oil loss to adhesion and puddle formation is dependent primarily on the physical characteristics of the land surface (vegetation type, land cover, slope) and the physical and chemical characteristics of the released product. A data grid specifying land cover type is used to determine the amount of oil retention on each grid cell. As oil traverses the land, a variable loss rate is calculated based upon changes in land cover type. Oil retention loss values vary by land type and oil type, with values spanning five orders of magnitude (between 0.02 and less than 200 mm) (Table 5-1). These loss rates for oil are based on surface hydrologic studies (ASCE 1969; Kouwen et al. 2002; Schwartz et al. 2002). The puddling or depression storage portion of the rate of oil loss represents the loss of oil based upon predicted sub-elevation grid scales within a grid cell, as elevation may have some heterogeneity within the scale of a single elevation grid cell.

Land cover was only used in the Mosquito Creek scenarios, as oil was assumed to enter directly into the river channels at the other four modeling locations for the OILMAP Land computational modeling. In the Mosquito Creek scenarios, a 0.5 mile stretch of grassland/herbaceous cover (during spring through fall) or snow/ice land cover (during winter months) extended downslope from the hypothetical release site to the waters of Mosquito Creek. Snow would retain a larger proportion of oil, than the grassland/herbaceous ground cover. A more complete description of the effects of snow cover may be found in Section 5.3.2.5.

Table 5-1 Range of Oil Retention Values for Each Land Cover Type, for a Light and Heavy Oil

OILMAP Land Code	Description	Light Oil (mm)	Heavy Oil (mm)
19	Unknown—data gaps, cloud cover, etc.	0.6	3.8
31	Bare rock/sand/clay	0.7	4.5
41	Deciduous forest	2.0	13.4
42	Evergreen forest	2.0	13.4
43	Mixed forest	2.0	13.4
51	Shrubland	0.6	3.8
71	Grasslands/herbaceous	0.6	3.8
82	Row crops	0.6	3.8
91	Woody wetlands	33.8	225.4
92	Emergent herbaceous wetlands	33.8	225.4
97	Tundra	0.7	4.5
98	Barren land	0.7	4.5
99	Snow/ice	*see section 5.2	

Table 5-1 Range of Oil Retention Values for Each Land Cover Type, for a Light and Heavy Oil

OILMAP Land Code	Description	Light Oil (mm)	Heavy Oil (mm)
103	Wetland	33.8	225.4
108	Impervious Surface	0.02	0.2

The second loss calculation includes oil lost to pooling on the land surface. This is defined as the volume of oil that would be retained within depressions defined by the land elevation grid. Released oil would need to fill the calculated volume of the depression before any additional oil would be allowed to travel downslope. When combined, the oil lost to the ground is the sum of adhesion, puddling and pooling.

The third loss calculation includes the evaporation of oil into the atmosphere. Evaporative loss is dependent upon the chemical and physical parameters of the oil, as well as the shape (i.e., surface area) of the release, and other environmental conditions. Some or all of the available/remaining released product may evaporate. The total amount of oil retention and loss during a release simulation includes both losses to the ground in addition to the evaporative loss to the atmosphere.

The leading edge of a release travels with a specific velocity (V), as the oil travels over the land surface. The velocity of the oil is determined using Manning's Equation, which uses the slope of the land surface and the width of the oil plume:

$$V = 1/n\ R^{2/3}\ S^{1/2}$$

Where R is the hydraulic radius and S is the slope, and n is a dimensionless number that characterizes the flow resistance from surface roughness. The hydraulic radius is a slope dependent metric of cross sectional area of flow divided by the wetted perimeter. It is calculated iteratively at each time step and is based upon flow rate. Typically R is approximately 0.122 m, which corresponds with velocity calculation that is dependent upon slope alone:

$$V = 4.92\ S^{1/2}\ \text{(meter/sec)}$$

Down-slope speed never reaches more than a few meters per second and has a minimum of 0.001 m/s. The maximum advance rate is limited by the release rate of the released oil.

In many cases, the elevation grid defining the land surface is not of sufficient resolution to define channels that direct the path of the oil. The width of the flow path increases as the slope of the land surface decreases and downslope velocity slows. Conversely, the path width decreases to a narrower channel with increasing land surface slope and increasing downslope velocity. The

model uses the land surface slope to calculate the path width of the oil. It is typically around 1 m, and cannot exceed the dimension of the land elevation grid cells.

The total volume of oil loss is equal to the sum of adherence and puddling, pooled oil, and evaporation. If total oil loss equals the total release volume during overland flow, then the release is terminated at this point. If the release volume is not a limiting factor, release propagation over land terminates when the leading edge encounters a surface water feature, or when the model's set duration is reached (i.e., 24 hours for modeling described here).

As noted earlier, the total volume of oil loss on land was only applied to the Mosquito Creek scenarios. The remaining six sites involved immediate release of oil into water.

5.1.1.2 Surface Water Transport Model

For the purpose of the OILMAP Land computational model, once the released product encounters a surface water feature during the high flow in spring or the average flow in summer, it is transported through the surface water network at a velocity defined by the speed and direction of each stream segment. As oil is transported down the surface water network, there are two potential loss terms including adhesion of the released product to the stream shoreline and loss of the released product through evaporation to the atmosphere. The modeled portions of the downstream release model and the factors influencing a release in surface waters are illustrated in Figure 5-3.

During winter conditions, the surface water transport model assumes complete ice coverage (100% ice cover) of the water surface. Any oil that makes its way to the watercourse from a land spill is predicted to not enter the water body due to the coverage of ice. However, if a hypothetical release were to occur into the watercourse from an underground/underwater crossing then the model assumes all of the oil would enter into the water column itself. In this case, oil is assumed to rise through the water column and be trapped by the ice cover at the surface. The model assumes that evaporation is completely prevented (0% evaporation) due to the layer of ice on the water surface.

For the winter modeling scenarios, it is assumed that the speed of the downstream transport of oil within river sections is at the same speed as the local water velocity. However, oil is assumed to pool under the ice in lakes, due to the lower velocity. These conservative approximations maximize the extent of potential oiling. A more complete description of the effects of ice cover may be found in Section 5.3.2.6.

The distance oil is allowed to travel downstream during any season is limited by one of three factors, including:

- Adherence of all available released product on the water surface to the stream bank as shoreline oiling
- Loss of all available /remaining released product to evaporation

- Reaching a user-specified travel time limit (i.e., model duration)

User-specified travel times are typically defined in release response plans as the time required to respond to a catastrophic release. Note that the model may not run for the full user-specified travel time limit (i.e., in the case of the modeling for L3RP this was 24 hours) if either of the second two criteria are met before this point.

The amount of oil adhering to the stream shoreline varies according to the stream shore type and oil type. Five different stream shore types were defined, each with a specified bank width and range of oil retention thickness, based upon the type of oil (Table 5-2). Oil volume lost to the shoreline is calculated as the product of the length of the shoreline oiled, the specified bank width, and the oil retention thickness, which is controlled by the density and viscosity of the oil.

Table 5-2 Typical Shoreline Oil Loss Values in Oil Thickness

Shore Type	Shore Width (m)	Light Oil (mm)	Heavy Oil (mm)
Bedrock	0.5	1	4
Soil	1	2	15
Sand/Gravel	2	3	20
Grass	5	4	25
Marsh	20	6	40

Oil movement across lakes is simulated based on lake size, shape, and water flow characteristics. Oil is assumed to spread radially across the lake surface until it covers the entire lake, or until the oil slick reaches a specified minimum thickness. If the minimum thickness is reached, spreading stops and the oil travels no farther. The minimum slick thickness is dependent upon the oil type, as density, viscosity, and other chemical and physical parameters control the behavior of oil on the water surface. Typical values for minimum slick thickness range from microns (µm) to millimeters (mm). In the case of the OILMAP Land computational model, if oil covers the entire lake surface before reaching the minimum thickness, the remaining oil is allowed to continue to move down any out-flowing streams at the velocity defined for that specific stream segment.

Dissolution—the process where water-soluble components of oil diffuse out of the oil and into the water—is not addressed by the OILMAP Land computational model. Dissolution is considered by SIMAP; accordingly this modeling system was used for the two modeling locations on the larger sections of the Mississippi River where dissolution and entrainment of oil was identified as a concern.

5.1.1.3 Evaporation in Overland and Surface Water Models

Evaporation is the process where volatile components of the oil diffuse out of the oil and enter a gaseous phase in the atmosphere. Oil evaporates as it spreads over land and water. The most volatile hydrocarbons (i.e., those having a low carbon number) evaporate most rapidly, typically in less than a day and sometimes in under an hour (McAuliffe 1989). As oil evaporates its composition changes, affecting its density and viscosity, as well as subsequent evaporation. As lighter components evaporate off, the remaining "weathered" oil becomes more viscous. As the oil continues to weather and, particularly, if it forms a water-in-oil emulsion, evaporation will be substantially decreased.

OILMAP Land uses a method called the Evaporative Exposure Model[8] of Stiver and Mackay (1984), which is used in oil release models of all kinds, both water and land based, to predict the volume fraction evaporated.

Several simplifying assumptions are made in modeling that directly affects the amount of oil predicted to evaporate. In general, the rate of evaporation depends on surface area, oil thickness, and vapor pressure, which are functions of the composition of the oil, wind speed, and air and land temperature. The mass of oil evaporated is particularly sensitive to the surface area of the spreading oil and the time period over which evaporation is calculated. On the land surface, the exposed surface area and evaporation time are functions of the slope, which is defined by the elevation grid. Steeper slopes cause the oil to travel faster but along a narrower path, while a lower slope slows the speed of advance and increases the width of the oiled path. In general, evaporation from surface and shoreline oil increases as the oil surface area, temperature, and wind speed increase.

In the stream network, the surface area of oiled water is a function of the total length of the oiled reach of the stream, times the average width of the same reach. The total length oiled is a function of stream velocity. The surface area of the oil surface then defines the rate of evaporation. Oil loss to evaporation is assumed to continue until the simulation is terminated. Termination may occur for a number of reasons, including:

- Oil loss to the ground surface, stream banks, and evaporation exceeds the volume released
- Release reaches its minimum thickness on a lake surface
- Release reaches either a dead end in the stream network or the coastline
- User-specified travel time limit (i.e., model duration) is reached

[8] The Evaporative Exposure Model of Stiver and Mackay (1984) is used to determine the rate of evaporation for spills of hydrocarbons and petroleum mixtures. The model uses the specified oil type's physical and chemical characteristics to determine the rate of evaporation, which includes the initial boiling point, the gradient of the distillation curve (i.e., the relationship between the oils liquid temperature and the fraction of oil condensed), and relationships between Henry's Law Constant, along with environmental parameters including temperature and wind speed.

In reality, oil will continue to evaporate from the ground or water surface, increasing the total evaporation amount. This conservative calculation of evaporative loss used in the OILMAP Land modeling system is consistent with a worst-case scenario approach.

For a release on the water surface, the gravitational spreading of the released oil occurs very rapidly (within hours) to a minimum slick thickness. Thus, the area exposed to evaporation is high relative to the oil volume. Evaporation proceeds faster than dissolution. Thus, most of the volatiles and semi-volatiles evaporate, with a smaller fraction dissolving into the water.

Evaporation is faster as the wind speed increases. However, above about 12 knots (6 m/s) of wind speed and in open water, white caps begin to form and the breaking waves entrain oil as droplets into the water column. Higher wind speeds (and turbulence) increase entrainment and results in smaller droplet sizes. These fates processes are not captured in the OILMAP Land model. More sophisticated (3D) modeling of oil transport and fate such as SIMAP take these factors into account.

5.1.1.4 Use of the OILMAP Land Modeling System for the L3RP

OILMAP Land was used for five of the seven modeling locations to predict the trajectory and fate of a large release of crude oil under different seasonal flow conditions and with different types of crude oil. The modeled scenarios did not include any response activities (i.e., unmitigated). The OILMAP Land modeling system was used to predict the expected downstream extent of oil transport (i.e., maximum downstream distance of a release at a specific time period) and the predicted mass balance of oil over the first 24 hours following the hypothetical release, including time steps at 6 and 12 hours. The mass balance reflects the amount of shoreline retention, evaporation, and oil remaining on the water surface over the first 24 hours following a release, or until no further oil is predicted to remain on the river surface (i.e., all oil is predicted to have evaporated or adhered to shorelines before 24 hours had passed). If there was oil on the river surface after 24 hours and the release was left unmitigated, it would continue downstream, and would continue to oil shorelines and evaporate until no oil remained. As an emergency response would be initiated soon after a release, the 24 hour time limit is considered appropriate and consistent with the conservative approach taken in this assessment.

5.1.1.5 Uncertainties in the OILMAP Land Modeling System

The OILMAP Land model is a simplified modeling system that was developed over many years to provide a conservative approximation of the maximum extent and maximum shoreline oiling that may be possible in the event of a release. However, there are limits to the complexity of processes that are modeled, as well as gaps in the underlying data that were used. As has been discussed, some simplifications have been made regarding steady-state currents and the behavior of oil on water and under ice. Additionally, the model does not take into account the influence of wind on the transport of oil on water. There is a degree of uncertainty related to the

terrain, as these datasets do not contain the full-scale horizontal resolution (i.e., <1 cm) that may affect an actual release. Furthermore, the assumptions of 100% shoreline oil retention and land retention values do err on the side of conservatism. Finally, the radial spreading of oil in lakes is a simplification that would err on the side of maximum surface oiling and maximum extent. While OILMAP Land may simplify real world releases, results from several actual releases on land compared well to the modeled predictions (Fontenault 2015; and other unpublished work).

5.1.2 SIMAP

The SIMAP modeling system was used to predict the trajectory and fate of hypothetical large releases of crude oil at two modeling locations on the Mississippi River: Mississippi River at Palisade and Mississippi River at Little Falls (Table 3-5).

The SIMAP modeling system was developed by RPS. It originated from the oil fate and biological effects submodels in the NRDA Models for Coastal and Marine Environments (NRDAM/CME) and Great Lakes Environments (NRDAM/GLE), which ASA developed in the early 1990s for the U.S. Department of the Interior for use in "type A" NRDA regulations under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). The most recent version of the type A models, the NRDAM/CME (Version 2.4, April 1996) was published as part of the CERCLA type A NRDA Final Rule (Federal Register, May 7, 1996, Vol. 61, No. 89, p. 20559-20614). The technical documentation for the NRDAM/CME is in French et al. (1996). This technical development involved several in-depth peer reviews, as described in the Final Rule.

While the NRDAM/CME and NRDAM/GLE were developed for simplified natural resource damage assessments of small releases in the U.S., SIMAP is designed to evaluate fate and effects of both real and hypothetical releases in marine, estuarine, and freshwater environments worldwide. Additions and modifications to SIMAP were made to increase model resolution, allow modification and site-specificity of input data, allow incorporation of spatially and temporally varying current data, evaluate subsurface releases and movements of subsurface oil, track multiple chemical components of the oil, enable stochastic modeling, and facilitate analysis of results.

The fates and effects models in the SIMAP modeling system are described below. Detailed descriptions of the algorithms and assumptions in the model are provided in French McCay 2002, 2003, 2004, and 2009. The model has been validated with more than 20 case histories, including the Exxon Valdez and other large releases (French and Rines 1997; French McCay 2003 and 2004; French McCay and Rowe 2004), as well as test releases designed to verify the model (French et al. 1997).

SIMAP estimates the distribution of whole oil and oil components (as mass and concentrations) on the water surface, on shorelines, in the water column, and in sediments. Oil fate processes in SIMAP are oil spreading (gravitational and by shearing), evaporation, transport, randomized dispersion, emulsification, entrainment (natural and facilitated by dispersant), dissolution,

volatilization of dissolved hydrocarbons from the surface water, adherence of oil droplets to suspended sediments, adsorption of soluble and sparingly-soluble aromatics to suspended sediments, sedimentation, and degradation.

Oil is a mixture of hydrocarbons of varying physical, chemical, and toxicological characteristics. Thus, oil hydrocarbons have varying fates and effects on organisms. In the SIMAP model, oil is represented by component categories, and the fate of each component is tracked separately. The "pseudo-component" approach (Payne et al. 1984 and 1987; French et al. 1996; Jones 1997; Lehr et al. 2000) is used, where chemicals in the oil mixture are grouped by physical-chemical properties, and the resulting component category behaves as if it were a single chemical with characteristics typical of the chemical group.

The most toxic components of oil to aquatic organisms are low molecular weight aromatic compounds (monoaromatic and polycyclic aromatic hydrocarbons, MAHs and PAHs), which are both volatile and soluble in water. Their acute toxic effects are caused by non-polar narcosis, where toxicity is related to the octanol-water partition coefficient (Kow), a measure of hydrophobicity. The more hydrophobic the compound, the more toxic it is likely to be. However, as Kow increases, the compound also becomes less soluble in water, so there is less exposure to aquatic organisms. The toxicity of compounds with log (Kow) values greater than about 5.6 is limited by their very low solubility in water and consequent low bioavailability (French McCay 2002; Di Toro et al. 2000). Thus, the potential for acute effects is the result of a balance between bioavailability, toxicity once exposed, and duration of exposure. French McCay (2002) contains a full description of the oil toxicity model in SIMAP. French McCay (2003, 2009) describes the implementation of the toxicity model in SIMAP.

Because of these considerations, the SIMAP fates model focuses on tracking the lower molecular weight aromatic components divided into chemical groups based on volatility, solubility, and hydrophobicity. In the model, the oil is treated as comprising eight components (Table 5-3).

Table 5-3 Definition of Four Distillation Cuts and the Eight Pseudo-Components in SIMAP (MAHs; benzene + toluene + ethybenzene + xylene, BTEX; PAHs)

Characteristic	Volatile and Highly Soluble	Semi-Volatile and Soluble	Low Volatility and Slightly Soluble	Residual (non-volatile and very low solubility)
Distillation cut	1	2	3	4
Boiling point (°C)	< 180	180–265	265–380	> 380
Molecular weight	50–125	125–168	152–215	> 215
Log (K_{ow})	2.1–3.7	3.7–4.4	3.9–5.6	> 5.6
Aliphatic pseudo-components: number of carbons	volatile aliphatics: C4 - C10	semi-volatile aliphatics: C10 - C15	low-volatility aliphatics: C15 - C20	non-volatile aliphatics: > C20
Aromatic pseudo-	MAHs:	2 ring PAHs: C4-	3 ring PAHs: C3-,	≥ 4 ring aromatics:

Table 5-3 Definition of Four Distillation Cuts and the Eight Pseudo-Components in SIMAP (MAHs; benzene + toluene + ethybenzene + xylene, BTEX; PAHs)

Characteristic	Volatile and Highly Soluble	Semi-Volatile and Soluble	Low Volatility and Slightly Soluble	Residual (non-volatile and very low solubility)
component name: included compounds	BTEX, MAHs to C3-benzenes	benzenes, naphthalene, C1-, C2-naphthalenes	C4-naphthalenes, 3-4 ring PAHs with log(K_{ow}) < 5.6	PAHs with log(K_{ow}) > 5.6 (very low solubility)

Six of the components (i.e., all but the two non-volatile residual components representing non-volatile aromatics and aliphatics) evaporate at rates specific to the pseudo-component. Solubility is strongly correlated with volatility, and the solubility of aromatics is higher than aliphatics of the same volatility. The MAHs are the most soluble, the two-ring PAHs are less soluble, and the three-ring PAHs slightly soluble (Mackay et al. 1992). Both the solubility and toxicity of the non-aromatic hydrocarbons are much lower than for the aromatics, and dissolution (and water concentrations) of non-aromatics is safely ignored. Thus, dissolved concentrations are calculated only for each of the three soluble aromatic pseudo-components.

This number of components provides sufficient accuracy for the evaporation and dissolution calculations, particularly given the time frame (minutes) over which dissolution occurs from small droplets and the rapid resurfacing of large droplets. The alternative approach of treating oil as a single compound with empirically-derived rates (e.g., Mackay et al. 1980; Stiver and Mackay 1984) does not provide sufficient accuracy for environmental effects analyses because the effects to water column organisms are caused by MAHs and PAHs, which have specific properties that differ from the other volatile and soluble compounds. The model has been validated both in predicting dissolved concentrations and resulting toxic effects, supporting the adequacy of the use of this number of pseudo-components (French McCay 2003).

The lower molecular weight aromatics dissolve from the whole oil and are partitioned in the water column and sediments according to equilibrium partitioning theory (French et al. 1996; French McCay 2004). The residual fractions in the model are composed of non-volatile and insoluble compounds that remain in the "whole oil" that spreads, is transported on the water surface, strands on shorelines, and disperses into the water column as oil droplets or remains on the surface as tar balls. This is the fraction that composes black oil, mousse, and sheen.

5.1.2.1 Oil Fate Model Processes

Because oil contains many chemicals with varying physical-chemical properties and the environment is spatially and temporally variable, the oil rapidly separates into different phases or parts of the environment; specifically:

- Surface oil

- Emulsified oil (mousse) and tar balls
- Oil droplets suspended in the water column
- Oil adhering to suspended particulate matter in the water
- Dissolved lower molecular weight components (MAHs, PAHs, and other soluble components) in the water column
- Oil on and in the sediments
- Dissolved lower molecular weight components (MAHs, PAHs, and other soluble components) in the sediment pore water
- Oil on and in the shoreline sediments and surfaces

The oil fate processes simulated by SIMAP in near shore and riverine environments are shown schematically in Figure 5-5.

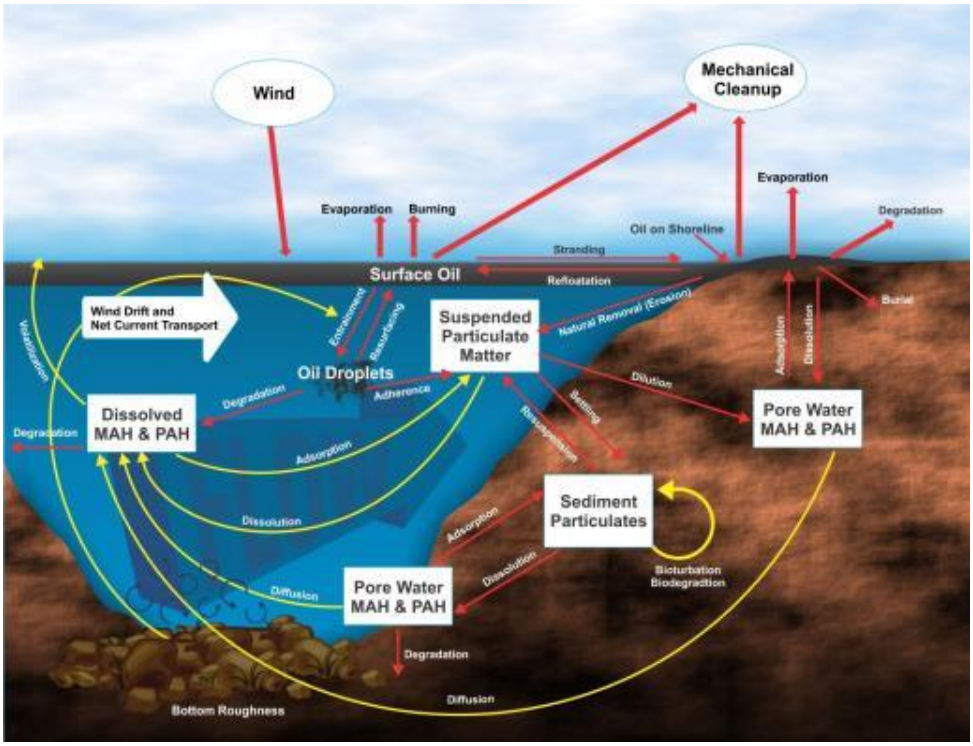


Figure 5-5 Oil Fates Processes in Lakes and Rivers That are Simulated by SIMAP

- **Spreading** is the thinning and broadening of surface slicks caused by gravitational forces and surface tension. This occurs rapidly after oil is released on the water surface. The spreading rate is faster when oil viscosity is lower at higher temperatures. Viscosity increases as oil emulsifies.
- **Transport** is the process where oil is carried by currents.
- **Turbulent dispersion** is the process by which turbulence ("sub-scale" currents that mix oil in three dimensions) spreads oil components on the surface and into the water column.

- **Evaporation** is the diffusion of volatile compounds from oil into a gaseous phase in the atmosphere. Evaporation from surface and shoreline oil increases as the oil surface area, temperature, and wind speed increase. As lighter components evaporate, the remaining "weathered" oil becomes more viscous.
- **Emulsification** is the mixture of water into the oil, such that the oil forms a matrix with embedded water droplets. The resulting mixture is commonly called mousse, which is technically a water-in-oil emulsion. The rate of emulsification increases with increasing wind speed and turbulence on the surface of the water. Viscosity increases as oil emulsifies.
- **Entrainment** is the process by which waves break over surface oil and carry oil droplets into the water column. At higher wind speeds (about 12 knots, or 6 m/s) or where currents and bottom roughness induce turbulence in a river or stream, wave heights may reach a threshold where they break. Thus, entrainment becomes increasingly important (higher rate of mass transfer to the water) with higher wind speeds.
- **Resurfacing** of entrained oil occurs rapidly for larger oil droplets. Smaller droplets resurface when the wave turbulence decreases. The smallest droplets do not resurface, as typical turbulence levels in the water keep them indefinitely suspended. Local winds at the water surface can also prevent oil from surfacing.
- **Dissolution** is the diffusion of water-soluble components out of the oil and into the water. Dissolution rate increases as the surface area of the oil relative to its volume increases. Since the surface area to volume ratio is higher for smaller spherical droplets, smaller droplet sizes have higher dissolution rates.
- **Volatilization** of dissolved components from the water to the atmosphere occurs as they mix, diffuse to the water surface boundary, and enter the gas phase. Volatilization rates increase with increasing air and water temperature.
- **Adsorption** of dissolved components to particulate matter in the water occurs because the soluble components (MAHs and PAHs) preferentially adsorb to particulates when the latter are present. The higher the concentration of suspended particulates, the more adsorption occurs. Also, the higher the molecular weight of the compound, the less soluble it is, and the more it tends to adsorb to particulate matter.
- **Adherence** is combination of oil droplets with particles in the water. If the particles are suspended sediments, the combined oil/suspended sediment agglomerate is heavier than the oil and the surrounding water. If turbulence subsides, the oil-sediment agglomerates will settle.
- **Sedimentation (settling)** is the process where oil-sediment agglomerates and particles with adsorbed sparingly-soluble components (MAHs and PAHs) settle to the bottom sediments. Sedimentation can be an important oil pathway in near shore areas when waves are strong and subsequently subside. Generally, oil-sediment agglomerates transfer more PAHs to the bottom than sediments with PAHs adsorbed from the dissolved phase in the water column.
- **Resuspension** of settled oil-sediment agglomerates and particles with adsorbed sparingly-soluble components (MAHs and PAHs) may occur if current speeds and turbulence exceed threshold values for overcoming cohesive forces.
- **Diffusion** is the process where dissolved compounds move from higher to lower concentration areas by random motion of molecules and micro-scale turbulence. Dissolved components in bottom and shoreline sediments can diffuse out to the water column where concentrations are relatively low. Bioturbation, groundwater discharge, and hyporheic flow of water through stream-bed sediments can greatly increase the rate of diffusion from sediments (see below).
- **Hyporheic flow** is the movement of water through stream bed sediments, induced by pressure differentials associated with stream bed irregularities or groundwater discharge.

- **Dilution** occurs when water of lower concentration is mixed into water with higher concentration by turbulence, currents, or shoreline groundwater.
- **Bioturbation** is the process by which benthic fauna mix the surface sediment layer while burrowing, feeding, or passing water over their gills. In open-water soft-bottom environments with minimal or no pollution, bioturbation effectively mixes the top 10 cm of the sediment layer.
- **Degradation** is when oil components are changed either chemically or biologically (biodegradation) into another compound. Degradation occurs through breakdown to simpler organic carbon compounds by bacteria and other organisms, photo-oxidation by solar energy, and other chemical reactions. Higher temperature and higher light intensity (particularly ultraviolet wavelengths) increase the rate of degradation.
- **Stranding and refloatation** occur when floating oil meets the shorelines and then refloats as water levels rise, allowing the oil to move further down current or downstream.

5.1.2.2 Overview of Processes Affecting a Release of Oil

Following a release of oil on the water surface, gravitational spreading occurs very rapidly (within hours) to a minimum thickness. Thus, the area exposed to evaporation is high relative to the oil volume. Evaporation proceeds faster than dissolution. Thus, most of the volatiles and semi-volatiles evaporate, with a smaller fraction dissolving into the water. Degradation (photo-oxidation and biodegradation) also occurs at a relatively slow rate compared to these processes.

As mentioned previously, evaporation is faster as the wind speed increases. Above about 12 knots (6 m/s) of wind speed and in open water conditions, white caps begin to form and the breaking waves entrain oil as droplets into the water column. These processes are modeled in SIMAP and higher wind speeds (and turbulence) increase entrainment and results in smaller droplet sizes. From Stoke's Law, larger droplets resurface faster and form surface slicks. Thus, a dynamic balance evolves between entrainment and resurfacing. As high- wind events occur, the entrainment rate increases. When the winds subside to less than 12 knots, the larger oil droplets resurface and remain floating. Similar dynamics occur in turbulent streams.

The smallest oil droplets remain entrained in the water column for an indefinite period. Larger oil droplets rise to the surface at varying rates. While the droplets are under water, dissolution of the light and soluble components occurs. Dissolution rate is a function of the surface area available. Thus, most dissolution occurs from droplets, as opposed to from surface slicks, since droplets have a higher surface area to volume ratio, and they are not in contact with the atmosphere (and so the soluble components do not preferentially evaporate as they do from surface oil).

If oil is released or driven underwater, it forms droplets of varying sizes. The more turbulent the conditions, the smaller the droplet sizes. From Stoke's Law, larger droplets rise faster, and surface if the water is shallow. Resurfaced oil behaves as surface oil after gravitational spreading has occurred. The surface oil may be re-entrained. In most cases, the smallest droplets remain in the water permanently. As a result of the higher surface area per volume of small droplets, the dissolution rate is much higher from subsurface oil than from floating oil on the water surface.

Because of these interactions, the majority of dissolved constituents (which are of concern because of potential effects on aquatic organisms) are from droplets entrained in the water. For a given release volume and oil type/composition, with increasing turbulence either at the water surface and/or at the stream bed: there is an increasing amount of oil entrained; the oil is increasingly broken up into smaller droplets; there is more likelihood of the oil remaining entrained rather than resurfacing; and the dissolved concentrations will be higher. Entrainment and dissolved concentrations increase with (1) higher wind speed, (2) increased turbulence from other sources of turbulence (waves on a beach, rapids, and waterfalls in rivers, etc.), and (3) subsurface releases (especially under higher pressure and turbulence.

These processes that increase the rate of supply of dissolved constituents are balanced by loss terms in the model: (1) transport (dilution), (2) volatilization from the dissolved phase to the atmosphere, (3) adsorption to suspended particulate material (SPM) and sedimentation, and (4) degradation (photo-oxidation or biologically mediated). Other processes slow the entrainment rate: (1) emulsification increases viscosity and slows or eliminates entrainment, (2) adsorption of oil droplets to SPM and settling removes oil from the water, (3) and stranding on shorelines removes oil from the water. Thus, the model-predicted concentrations are the resulting balance of all these processes and the best estimates based on our quantitative understanding of the individual processes.

5.1.2.3 Oil Fate Algorithms

The algorithms used to model oil fate processes are described in French McCay (2004). Lagrangian elements (spillets) are used to simulate the movements of oil components in three dimensions over time. Within the model, releases of oil are broken down into many thousands of discrete or individual elements (i.e., Lagrangian Elements referred to as spillets) that are forced and tracked individually throughout the modeled domain. Surface floating oil, subsurface droplets, and dissolved components are tracked in separate spillets. Transport is the sum of advective velocities based on the input on watercourse currents to the model, surface wind drift, vertical movement according to buoyancy, and randomized turbulent diffusive velocities in three dimensions. The vertical diffusion coefficient is computed as a function of wind speed in the surface wave-mixed layer. The horizontal and deeper water vertical diffusion coefficients are model inputs.

The model separates oil (whole and as pseudo-components [Section 5.1.2]) into different phases or parts of the environment. SIMAP considers: surface slicks; emulsified oil (mousse) and tar balls; oil droplets suspended in the water column; dissolved lower molecular weight components (MAHs and PAHs) in the water column; oil droplets adhered and hydrocarbons adsorbed to suspended particulate matter in the water; hydrocarbons on and in the sediments; dissolved MAHs and PAHs in the sediment pore water; and hydrocarbons on and in the shoreline sediments and surfaces.

The algorithms used to calculate these fates processes are briefly described in the subsections below.

5.1.2.3.1 Transport

Spillets are moved in three dimensions over time. For each model time step, the new vector position of the spillet center is calculated from the old location plus the vector sum of east-west, north-south, and vertical components of advective and diffusive velocities:

$$Xt = X\,t\text{-}1 + \Delta t\,(\,Ut + Dt + Rt + Wt\,)$$

where Xt is the vector position at time t, Xt-1 is the vector position the previous time step, Δt is the time step, Ut is the sum of all the advective (current) velocity components in three dimensions at time t, Dt is the sum of the randomized diffusive velocities in three dimensions at time t, Rt is the rise or sinking velocity of whole oil droplets in the water column, and Wt is the surface wind transport ("wind drift"). The magnitudes of the components of Dt are scaled by horizontal and vertical diffusion coefficients (Okubo and Ozmidov 1970; Okubo 1971). The vertical diffusion coefficient is computed, based on Thorpe (1984), as a function of wind speed in the surface wave-mixed layer (which ranges from centimeter scales in rivers and near lee shorelines to potentially meters in large water bodies away from shore when wind speeds are high). Rt is computed by Stokes law, where velocity is related to the difference in density between the particle and the water, and to the particle diameter. The algorithm developed by Youssef and Spaulding (1993) is used for wind transport in the surface wave-mixed layer (Wt, described below).

5.1.2.3.2 Shoreline Stranding

The fate of released oil that reaches the shoreline depends on characteristics of the oil, the type of shoreline, and the energy environment. The stranding algorithm is based on work by CSE/ASA/BAT (1986), Gundlach (1987), and Reed and Gundlach (1989) in developing the COZOIL model for the U.S. Minerals Management Service. In SIMAP, deposition occurs when an oil spillet intersects shore surface. Deposition ceases when the model determines that the volume holding capacity for the shore surface is reached. The model does not allow subsequent oil coming ashore to remain on the shore surface. It is assumed to be refloated by rising water, and carried away by currents and wind drift SIMAP then removes the remaining shoreline oil exponentially over time. Data for holding capacity and removal rate are taken from CSE/ABA/BAT (1986) and Gundlach (1987), and are a function of oil viscosity and shore type. The algorithm and data are provided in French et al. (1996).

5.1.2.3.3 Spreading

Spreading determines the areal extent of the surface oil which, in turn, influences its rates of evaporation, dissolution, dispersion (entrainment), and photo-oxidation, all of which are functions of surface area. Spreading results from the balance among the forces of gravity, inertia, viscosity, and surface tension (which increases the diameter of each spillet). The model also considers two other processes that can influence the spreading of an oil release: turbulent

diffusion (which spreads the spillets apart); and entrainment followed by resurfacing, which can spatially separate the leading edge of the oil from resurfaced oil transported in a different direction by subsurface currents.

For many years, Fay's (1971) three-regime spreading theory was widely used in oil spill models (ASCE 1996). Mackay et al. (1980, 1982) modified Fay's approach and described the oil as thin and thick slicks. Their approach used an empirical formulation based on Fay's (1971) terminal spreading behavior. They assumed the thick slick feeds the thin slick and that 80–90% of the total slick area is represented by the thin slick. In SIMAP, oil spillets on the water surface increase in diameter according to the spreading algorithm empirically-derived by Mackay et al. (1980, 1982). Sensitivity analyses of this algorithm led to the discovery that the solution was affected by the number of spillets used. Thus, a formulation was derived to normalize the solution under differing numbers of surface spillets (Kolluru et al. 1994). Spreading is stopped when an oil-specific terminal thickness is reached.

5.1.2.3.4 Evaporation

The rate of evaporation depends on surface area, thickness, vapor pressure, and mass transport coefficient which, in turn, are functions of the composition of the oil, wind speed, and temperature (Fingas 1996, 1997, 1998, 1999; Jones 1997). As oil evaporates, its composition changes, affecting its density and viscosity, as well as subsequent evaporation. The most volatile hydrocarbons evaporate most rapidly, typically in less than a day and sometimes in under an hour (McAuliffe 1989). As the oil continues to weather, and particularly if it forms a water-in-oil emulsion, evaporation will be significantly decreased.

The evaporation algorithm in SIMAP is based on accepted evaporation theory, which follows Raoult's Law that each component will evaporate with a rate proportional to the saturation vapor pressure and mole fraction present for that component. The pseudo-component approach (Payne et al. 1984; French et al. 1996; Jones 1997; Lehr et al. 2000) is used, such that each component evaporates according to its mean vapor pressure, solubility, and molecular weight. The mass transfer coefficient is calculated using the methodology of Mackay and Matsugu (1973), as described in French et al. (1996).

5.1.2.3.5 Entrainment

As oil on the water surface is exposed to wind and waves, or if oil moves into a turbulent area of a stream or river, it is entrained (or dispersed) into the water column. Entrainment is a physical process where globules of oil are transported from the water surface into the water column due to breaking waves or other turbulence. It has been observed that entrained oil is broken into droplets of varying sizes. Smaller droplets spread and diffuse in the water column, while larger ones rise back to the surface.

5.1.2.3.5.1 Entrainment by Breaking Surface Wave Action

In open waters, breaking waves created by the action of wind and waves on the water surface are the primary sources of energy for entrainment. Entrainment is strongly dependent on turbulence and is greater in areas of high wave energy (Delvigne and Sweeney 1988).

Delvigne and Sweeney (1988), using laboratory and flume experimental observations, developed a relationship for entrainment rate and oil droplet size distribution as a function of turbulent energy level and oil viscosity. Entrained droplets in the water column rise according to Stokes law, where velocity is related to the difference in density between the particle and the water, and to the particle diameter. The data and relationships in Delvigne and Sweeney (1988) are used in SIMAP to calculate the mass and particle size distribution of entrained droplets. Particle size decreases with higher turbulent energy level and lower oil viscosity. The natural dispersion particle sizes observed by Delvigne and Sweeney (1988) are confirmed by field observations by Lunel (1993a, 1993b).

Entrained oil is mixed uniformly throughout the wave-mixed zone. Vertical mixing is simulated by random placement of particles within the wave-mixed layer each time step. Settling of particles does not occur in water depths where waves reach the bottom (taken as 1.5 times wave height). Wave height is calculated from wind speed, duration, and fetch (distance upwind to land), using the algorithms in CERC (1984). Wave height is on the scale of centimeters in small rivers and streams and near lee shorelines; whereas it may increase to meters in open waters under windy conditions.

5.1.2.3.5.2 Entrainment by Bottom Roughness in Streams

When modeling oil releases in rivers, entrainment of oil into the water column by turbulent flow over bottom structures and around obstacles must be taken into consideration. It is clear that in rapid flow where turbulence is large, rocks or other obstacles may break the surface and a plunging wake may occur where the possibility of entrainment increases. Delvigne (1993) demonstrated that breaking wave dispersion to fast flow past an obstacle, such as a pile, generates a plunging wake. This is sufficiently similar to breaking waves from alternative sources of turbulence such as the fast flow past an obstacle, flow over a dam, cataract with a hydraulic jump, or a vessel crossing an oil slick. In the breaking wave model, the dispersion of energy leads to the plunging of oil into water and the formation of oil droplets.

To relate this more generally to a river formulation, an energy dissipation relationship was developed. In this formulation, energy dissipation is proportional to the stream flow rate and bottom roughness, and is inversely proportional to the local depth. The generation and propagation of turbulent energy through the water column due to bottom roughness is applied with a typical quadratic stress equation to the plunging flow (Anderson et al. 1995). The dispersed mass of oil is determined by scaling the surface area covered by oil at the dispersion source and the range of oil droplet sizes, which is a function of the dispersion energy.

5.1.2.3.6 Emulsification (Mousse Formation)

The formation of water-in-oil emulsions, or mousse, depends on oil composition and turbulence level. Emulsified oil can contain as much as 80% water in the form of micrometer-sized droplets dispersed within a continuous phase of oil (Daling and Brandvik 1988; Fingas et al. 1997). Viscosities are typically much higher than that of the parent oil. The incorporation of water also dramatically increases the oil/water mixture volume.

SIMAP uses the Mackay and Zagorski (1982) emulsification scheme for floating oil. Water content increases exponentially, with the rate related to the square of wind speed and previous water incorporation. Viscosity is a function of water content. The change in viscosity feeds back in the model to the entrainment rate.

5.1.2.3.7 Dissolution

Dissolution is the process by which soluble hydrocarbons enter the water from a surface slick or from entrained oil droplets. The lower molecular weight hydrocarbons tend to be both more volatile and more soluble than those of higher molecular weight. For surface slicks, since the partial pressures tend to exceed the solubility of these lower molecular weight compounds, evaporation accounts for a larger portion of the mass than dissolution (McAuliffe 1989), except perhaps under ice. Dissolution and evaporation are competitive processes. The dissolved component concentration of hydrocarbons in water under a surface slick shows an initial increase followed by a rapid decrease after some hours due to the evaporative loss of components. Most soluble components are also volatile and direct evaporation (volatilization) from the water column depletes their concentrations in the water. Dissolution is a particularly important weathering process where evaporation is low (dispersed oil droplets and ice-covered surfaces). Dissolution can be substantial from entrained droplets because of the lack of atmospheric exposure and because of the higher surface area per unit of volume.

SIMAP uses the model developed by Mackay and Leinonen (1977) to calculate dissolution from a surface slick. The slick (spillet) is treated as a flat plate, with a mass flux (Hines and Maddox 1985) related to solubility and temperature. It assumes a well-mixed layer with most of the resistance to mass transfer lying in a hypothetical stagnant region close to the oil. For subsurface oil, dissolution is treated as a mass flux across the surface area of a droplet (treated as a sphere) in a calculation analogous to the Mackay and Leinonen (1977) algorithm. The dissolution algorithm was developed in French et al. (1996).

5.1.2.3.8 Volatilization from the Water Column

SIMAP uses the procedure outlined by Lyman et al. (1982), based on Henry's Law and mass flux (Hines and Maddox 1985) to calculate volatilization from the water column. The volatilization depth for dissolved substances is limited to the maximum of one half the wave height. Wave height is computed from the wind speed and fetch (CERC 1984). The volatilization algorithm was developed in French et al. (1996).

5.1.2.3.9 Adsorption and Sedimentation

Aromatics dissolved in the water column are carried to the sediments primarily by adsorption to suspended particulates and subsequent settling. The ratio of adsorbed (C_a) to dissolved (C_{dis}) concentrations is computed from standard equilibrium partitioning theory as:

$$C_a / C_{dis} = K_{oc} C_{ss}$$

K_{oc} is a dimensionless partition coefficient and C_{ss} is the concentration of SPM in the water column expressed as mass of particulate per volume of water. As a default, the model uses a mean value of total suspended solids of 10 mg/l (Kullenberg 1982); alternatively data on suspended sediment concentrations in a watercourse can be used as model input.

Sedimentation of oil droplets occurs when the specific gravity of oil increases over that of the surrounding water. Several processes may act on entrained oil and surface slicks to increase density: weathering (evaporation, dissolution and emulsification), adhesion or sorption onto suspended particles or detrital material, and incorporation of sediment into oil during interaction with suspended particulates, bottom sediments, and shorelines. Rates of sedimentation depend on the concentration of suspended particulates and the rates of particulate flux into and out of an area. In areas with high suspended particulate concentrations, rapid dispersal and removal of oil is found due to sorption and adhesion (Payne and McNabb 1984).

Kirstein et al. (1987) and Payne et al. (1987) used a reaction term to characterize the water column interactions of oil and suspended particulates. The reaction term represents the collision of oil droplets and suspended matter, accounting for both oiled and unoiled particulates. The model formulation developed by Kirstein et al. (1987) is used to calculate the volume of oil adhered to particles. In the case where the oil mass is larger than the adhered sediment (i.e., the sediment has been incorporated into the oil), the buoyancy of the oil droplet will control its settling or rise rate. Within SIMAP, the Stoke's law formulation is used to adjust the vertical position of these particles. If the mass of adhered droplets is small relative to the mass of the sediment it has adhered to, the sediment settling velocity will control the fate of the combined particulate.

5.1.2.3.10 Degradation

Degradation may occur as the result of photolysis or photo-oxidation, which is a chemical process energized by ultraviolet light from the sun, and by microbial breakdown, termed biodegradation. In SIMAP, degradation occurs on the surface slick, deposited oil on the shore, the entrained oil and aromatics in the water column, and oil in the sediments. SIMAP employs a first order decay algorithm, with a specified (total) degradation rate for each oil type: surface oil, water column oil, and sedimented oil (French et al. 1999).

5.1.2.4 The Application of SIMAP for Effects Assessment

For both of the Mississippi River locations that were modeled with SIMAP, multiple release scenarios were run to simulate the expected behavior of two oil types (Bakken crude or CLB/CLWB) under three seasonal and environmental conditions (high-, average-, and low-river

flow, representing spring, summer, and winter, respectively). This resulted in a total of 12 SIMAP trajectory and fates scenarios (2 locations x 2 oils x 3 seasons). The intent was to provide a range of representative trajectories and fates to understand the range of potential effects that may be anticipated under varying geographic and environmental conditions.

A deterministic modeling approach was used to provide a prediction of a representative individual release, based on specific parameters for each single event. The deterministic trajectory simulations provided representative estimates of the oil's fate and transport for a specific set of environmental conditions. Each scenario assumed that the total volume of released oil for the release location (Table 3-5) was released in a series of spillets over 10 minutes, where the trajectory, fate, and effects were tracked for the following 24 hours after the release. All modeled releases were assumed to be unmitigated, meaning that no response efforts were undertaken (e.g., booming, burning, skimming, collection).

The results of the deterministic simulations provide a time history of oil weathering (i.e., mass balance) over the 24 hour duration for the spill modeling, expressed as the percentage of released oil on the water surface, on the shoreline, evaporated, entrained in the water column, and decayed. In addition, times series snapshots of the individual trajectories showing location of floating surface oil, shoreline oil, and the concentration of dissolved aromatics in the water column (surface and profile view) are provided. Summary figures of results are provided for each combination of release location, oil type, and modeled season (Section 6.2).

As was discussed in the OIMLAP Land Application (Section 5.1.1), the SIMAP modeling results were used to assess potential environmental effects through two major methods: an overlay of the predicted trajectory of the oil release of HCAs and AOIs; and an assessment of effects on key receptors of the natural and human environment.

5.1.2.5 Uncertainties in the SIMAP Modeling System

The SIMAP model has been developed over many years to greatly increase the types and amount of information to simulate the fates and effects of oil releases. However, as in all science, there are limits to the complexity of processes that can be modeled, as well as gaps in knowledge regarding the environment that is affected. As described in the preceding sections, assumptions based on available scientific information and professional judgments were made in the development of the model.

The major sources of uncertainty in the oil fates processes considered by SIMAP are:

- Oil contains thousands of chemicals of differing physical and chemical properties that determine their fate in the environment. The model must of necessity treat the oil as a mixture of a limited number of components, grouping chemicals by physical and chemical properties.
- The fates model contains a series of algorithms that are simplifications of complex physical-chemical processes. These processes are understood to varying degrees.

- Information on physical parameters including but not limited to hydrodynamics, water depth, river width, total suspended solids concentration, and wind speed were based on the available data for the release location and the predicted downstream trajectory. When data was lacking, previous experience and sources from other similar locations were used to determine the parameter values that were implemented in the model. In some cases, professional judgment was required to make appropriate assumptions.

In addition, in the unlikely event of an actual oil release, the fates and effects will be strongly determined by the specific environmental conditions, and a myriad of details related to the event. Thus, the results are a function of the scenarios simulated and the accuracy of the input data used. The goal of the SIMAP modeling was not to forecast every detail that could potentially occur, but to describe a range of possible consequences so that an informed analysis could be made as to the likely effects of oil releases under various scenarios. The model inputs are designed to provide representative conditions to inform such an analysis for the scenarios considered.

5.2 KEY ASSUMPTIONS

The OILMAP Land and SIMAP modeling was based on a number of assumptions relating to the type of release event (i.e., full bore rupture, release of oil into watercourses), the volume of oil released, the duration of the release and subsequent downstream movement prior to mitigation (i.e., 24 hours), and the types of crude oil released. Each of these are discussed below.

5.2.1 Full Bore Rupture is an Unlikely Event

A full bore rupture means that the pipeline is severed or burst, such that the opening is equivalent to the cross-sectional area of the pipe (regardless of the mechanism leading to the rupture) and crude oil is assumed to spill freely from this opening. By design, and as a result of Enbridge's pipeline operation and maintenance programs (Enbridge 2014), a full bore rupture pipeline incident is considered to be a highly unlikely event. The selection of full bore, and the calculation of release volumes based on a full bore rupture, is therefore a highly conservative assumption.

5.2.2 Identification of Representative Hypothetical Release Scenarios

Even in the event of a full bore rupture incident, crude oil releases to land often result in only small areas of land (i.e., a few hectares) becoming contaminated by released oil. This is not to suggest that such effects would not be consequential. Rather, it justifies the selection of crude oil releases that enter watercourses (rivers or lakes) as being a conservative choice with respect to the fate, transport, and potential effects of released oil. With a larger spatial distribution, unmitigated releases of oil into water would have greater potential to cause adverse effects to larger numbers of ecological and human receptors. Therefore, this analysis focused on scenarios that result in the release of crude oil to watercourses as a conservative assumption.

Seven locations, each adjacent or close to a watercourse, were selected for modeling of hypothetical large releases of crude oil. The selection of these seven modeling locations was guided by consideration of the following engineering and environmental/socio-economic risk factors (Section 3.3.3):

- Located so that crude oil release volumes could potentially enter a watercourse; this included selection of locations where the hypothetical release of oil would either occur directly into a watercourse or would travel a short distance overland into a watercourse
- Located where shut-off valves would not overly restrict the volume of oil that could potentially be released (i.e., the hydraulic drain down of pipeline would be a substantial contributor to the oil release volume)
- Include sites along both the preferred and alternate routes
- Representative of the geographic and environmental conditions and land uses along the proposed ROW for the pipeline to allow for an evaluation of the range of potential effects to the natural and human environment along the pipeline
- Include a range of watercourse types (e.g., size, flow, energy level) and water bodies, including wetlands
- Support evaluation of potential effects to environmentally sensitive resources (e.g., spawning grounds for fish, wild rice lakes, or other sensitive habitats)
- Represent areas of expressed concern by Native American tribes, the general public, and/or state and federal agencies
- Support evaluation of potential effects to traditional use, other human use or infrastructure (e.g., potable water intakes or treatment facilities)

Based on a review of potentially sensitive hypothetical release locations and collaboration with the MN DNR and MN PCA (Sections 3.3.4 and 3.3.5), the scenarios were narrowed to seven general areas:

- Site 1—Mosquito Creek to Lower Rice Lake
- Site 2—Mississippi River at Ball Club
- Site 3—Sandy River
- Site 4—Shell River to Twin Lakes
- Site 5—Red River
- Site 6—Mississippi River at Palisade
- Site 7—Mississippi River at Little Falls

Modeling of hypothetical release scenarios at these seven locations was completed to predict the potential trajectory of released oil, the fate of released oil, and the potential effects of accidental oil releases on the natural and human environment. The intent of these analyses for each modeling location was to infer a range of potential effects that may occur at other locations in Minnesota with similar biophysical and human use characteristics.

5.2.3 Crude Oil Release Volume

At each of the seven identified potential release locations, the environmental effects of a hypothetical full-bore pipeline rupture were evaluated.

For each hypothetical release scenario, other than the Mosquito Creek land release, it was conservatively assumed that released oil would enter directly into the watercourse with no retention of oil on land. These circumstances would produce a scenario where most of the estimated volume of released crude oil would enter the aquatic environment close to the point of release. Making the assumption that the damage to the pipeline occurred near a topographic low point maximizes the hypothetical release volume (due to drain-down of the pipeline following the initial volume that was released under pressure before the pipeline was shut down), but also implies that the hypothetical release occurred in proximity to a watercourse. This is a conservative assumption, due to the potential for watercourses to effectively and rapidly transport released crude oil away from the release location.

The hypothetical release scenario is modeled such that a change in pipeline flow characteristics due to the rupture would be detected at the Control Center and the pipeline would be shut down (see next paragraph). For the purposes of this analysis, it is assumed that the location of the full-bore rupture would be at a low point (e.g., in proximity to a watercourse) between two control valves, and that oil would continue to drain by gravity from the pipeline, between the location of the rupture and the nearest valves.

The crude oil release volume was calculated as a full bore rupture, with a conservative response in the pipeline Control Centre of a maximum of 10 minutes, followed by a 3-minute period to allow for valve closure, and then drain-down of the elevated segments of pipeline. The maximum 13-minute duration of Control Center response time to valve closure is a standard for safe operations and leak detection for Enbridge. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown and full valve closure in the affected pipeline section. While 13 minutes is the maximum time, this is a conservative assumption, since a response through to valve closure would be expected to occur in less than 13 minutes in a full bore rupture leak scenario.

The maximum volume of oil that could be hypothetically released at each site was determined based on the pipeline specifications and topographic conditions in proximity to each modeling location; the maximum volume out included both the initial release volume prior to shutdown (i.e., actively pumping out), as well as hydraulic drain down of the pipeline (i.e., gravity drained oil within the pipeline between the valves), following shutdown at that site. The maximum volume of oil that could hypothetically be released from the L3RP at each modeling location is summarized in Table 3-5.

The release duration is the amount of time required for the released oil volume to be released from the ruptured pipeline, including drain-down. The OILMAP Land and SIMAP modeling systems use a constant release rate based upon the defined total release volume and duration of release. The release duration was calculated using the release volume, pipeline diameter, pipeline shutdown time, pipeline design flow rate, and elevation profile of the pipeline.

5.2.4 24 hour Unmitigated Oil Release

The analysis was carried out following a highly conservative assumption that the release would be unmitigated for 24 hours, and that the released crude oil would travel downstream unimpeded for that length of time. This is a conservative assumption because Enbridge would immediately mobilize a response that would contain and collect oil in the event that a release were to be detected. The 24-hour time frame is consistent with guidance from the USEPA, which stipulates a 27-hour period, representing 24-hours for arrival and 3-hours for deployment (USEPA 2003). As such, modeled results should not be interpreted as representative of expected effects, but rather as an unlikely, unmitigated worst-case potential outcome.

Crude oil release simulations that reach the 24 hour time limit may still have oil remaining on the surface of the river or lake that has not adhered to a shoreline or spread to the defined minimum thickness. If there was oil on the water surface after 24 hours, it could (if not mitigated) continue to move downstream, further oiling shorelines until it either evaporated or stranded. The simulations assumed the releases were unmitigated for the modeled 24 hour period (i.e., no benefits of emergency response operations were incorporated into the model). In a real-life scenario, emergency response procedures would mitigate the effects of the modeled incidents.

5.2.5 Crude Oil Types

The range of product types expected to be shipped in the L3RP may range from light crude oils such as those in the Alberta Light Sweet Crude category, to heavy oils such as conventional heavy crude oils and diluted bitumen products. The physical and chemical characteristics of light and heavy crude oils are quite different, although the characteristics of diluted bitumens are very similar to those of heavy conventional crude oils (Zhou et al. 2015). Therefore, two crude oil types were selected for their representative characteristics and conservatively high potential for effects to serve as the basis for the analysis. The two oil types include Bakken Crude Oil (a light conventional crude oil with a high aromatic content) and CLB (a diluted bitumen). The characteristics of these oils are detailed in Section 5.3.1 of this document.

5.3 INPUT DATA SETS

5.3.1 Oil Property Data

A range of product types are expected to be shipped in the L3RP pipeline, including heavier oils such as diluted bitumen and lighter oils such as Alberta Light Sweet Crude light crudes, with similar product characteristics to Bakken oils. The chemical and physical characteristics of these oil types are quite different. To account for these differences, two representative product types were selected for this modeling assessment that bound the range of anticipated products that may be shipped: the heavier diluted bitumen CLB and the lighter Bakken Crude oil. The differences between these oils will result in a range of potential outcomes related to the trajectory, fate, and effects of releases under varying environmental conditions.

CLB is a diluted bitumen with a high viscosity and density, falling in the upper range of characteristic values allowed by the pipeline tariff specifications for Enbridge. This product exhibits generally mid-range density and viscosity characteristics for the range of diluted bitumen products. Seasonal variations in environmental temperatures affect the viscosity of the diluted bitumen, which directly affects the ability to pump the fluid through the pipeline. To address this, the amount of diluent added to Cold Lake bitumen is varied through the year to attain a viscosity that meets shipping requirements. The largest amount of diluent is added to the bitumen during winter to reduce the viscosity to a level suitable for shipping at low temperatures. As a consequence, the density, viscosity, and aromatic content changes through the year. During the winter months, CLB has a lower density and viscosity and a greater aromatic content, when compared to the summer months.

As the chemical and physical characteristics of the CLB will vary seasonally, CLSB and CLWB were considered in the modeling of hypothetical releases. CLSB was used for spring and summer scenarios, while the CLWB was used for winter scenarios.

Bakken Crude Oil is produced in North Dakota, Montana, and the bordering Canadian provinces of Manitoba and Saskatchewan. Bakken crude is a light crude oil with an API gravity generally between 40° and 43° and a sulfur content less than 0.2 wt.%. Bakken is a relatively light crude oil with low density, low viscosity, and a high aromatic content.

The chemical and physical characteristics of each representative product, including chemical and physical properties, were derived from publicly available data from Environment Canada's Oil Properties database, technical data reports, assays, and other related project work (Enbridge 2014; S.L. Ross 2010; ESTC 2016; Exxon Mobil 2015; CrudeMonitor 2016). The level of detail, including the type of variables and number of analytes measured did vary between data sources. When specific oil property data was not available, the properties from similar oil types were assumed (ESTC 2016). For all three oils, minimum oil slick thicknesses were determined based on Coastal Response Research Center categories and observations of releases compiled by RPS ASA (2013) and the previous work of Allen and Dale (1997), McAuliffe (1987), NRC (1985, 2002) and the Bonn Agreement (Daling et al. 1999).

5.3.1.1 Physical Properties of the Oils

The physical properties of the three crude oils considered in modeling of hypothetical releases at each of the seven modeling locations are shown in Table 5-4.

Table 5-4 Physical Properties of the Three Crude Oils

Oil Property	Bakken Crude	Cold Lake Winter Blend	Cold Lake Summer Blend
Oil Type	Crude	Emulsion	Emulsion
Minimum Slick Thickness (µm)	0.1	10.0	10.0

Table 5-4 Physical Properties of the Three Crude Oils

Oil Property	Bakken Crude	Cold Lake Winter Blend	Cold Lake Summer Blend
Surface tension (dyne/cm)	27.3	27.1	27.1
Pour Point (°C)	-55.0	-45.0	-45.0
API Gravity	41.80	22.69	20.73
Density (g/cm^3) at 16°C	0.81650	--	--
Density (g/cm^3) at 15°C	--	0.91770	0.92950
Viscosity (cP) at 10°C	3.88	--	--
Viscosity (cP) at 15°C	--	150.0	342.0
Viscosity (cP) at 30°C	2.49	--	--

5.3.1.2 Chemical Properties of the Oils

The chemical properties of CLB were estimated using information from the Crude Monitor (2016) for the period of 2009 through 2016 (Figure 5-6). Seasonal variations in the fractional composition of the whole oil was used to determine volume of BTEX and the total hydrocarbon concentration (THC), by pseudo-component, of CLWB and CLSB. These results provide the variability and ultimately the ratio of BTEX and THC between winter and summer blends. BTEX concentrations (modeled as AR1) that were measured directly for the Exxon Mobil (2015) assay were used for CLWB, and the ratio of winter to summer calculated from Crude Monitor (2016) was used to scale BTEX values for the CLSB. Additional aromatic concentrations (AR2 and AR3) for CLWB were available from direct measurements for the S.L. Ross (2010) assay. For CLSB, the winter to summer ratio was used to scale the S.L. Ross (2010) values for AR2 and AR3. The total hydrocarbon breakdown (THC1, THC2, and THC3) for CLWB was determined from distillation data (Exxon Mobil 2015). The aliphatic breakdown (AL1, AL2, and AL3) was calculated by difference (e.g., AL1 = THC1 – AR1). For CLSB, the THC was again scaled based upon the winter to summer ratio from Crude Monitor (2016). Together, this analysis provides a breakdown of the chemical composition of CLB by pseudo-component for the winter and summer blends.

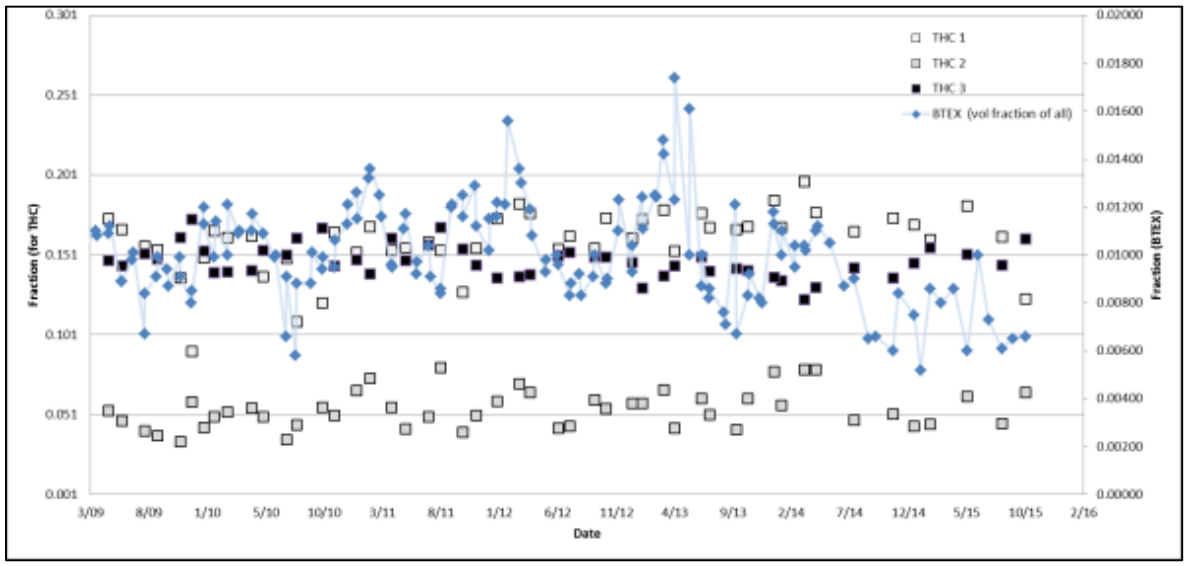


Figure 5-6 Fractional Composition of the THC and BTEX (AR1) Components in CLB from 2009 through 2016 (CrudeMonitor 2015)

The aromatic, aliphatic, and total hydrocarbon concentration and percentage composition of fresh whole oil for the three crude oils considered in modeling of hypothetical releases at each of the seven modeling locations are shown in (Table 5-5). BTEX content peaks in winter month blends and can make up greater than 1.6% of the fractional volume of the whole oil.

Table 5-5 Aromatic (AR), Aliphatic (AL), and Total Hydrocarbon Concentration (THC) and Percentage Composition of Fresh Whole Oil for the Three Crude Oils

Oil Type	Oil Component	% AR	% AL	% THC[1]
Bakken Crude	**1** (AR = BTEX & MAHs >C8-C10) (AL = >C6-C10)	0.029300	0.250700	0.280000
	2 (AR = MAHs and PAHs >C10-C12) (AL= >C10-C12)	0.022045	0.167955	0.190000
	3 (AR = PAHs >C12-C16) (AL = >C12-C16)	0.037668	0.242332	0.280000
Cold Lake Winter Blend	**1** (AR = BTEX & MAHs >C8-C10) (AL = >C6-C10)	0.012460	0.213302	0.225762
	2 (AR = MAHs and PAHs >C10-C12) (AL= >C10-C12)	0.000880	0.059265	0.060145
	3 (AR = PAHs >C12-C16) (AL = >C12-C16)	0.004400	0.136629	0.141029
Cold Lake	**1**	0.009003	0.154127	0.163130

Table 5-5 Aromatic (AR), Aliphatic (AL), and Total Hydrocarbon Concentration (THC) and Percentage Composition of Fresh Whole Oil for the Three Crude Oils

Oil Type	Oil Component	% AR	% AL	% THC[1]
Summer Blend	(AR = BTEX & MAHs >C8-C10) (AL = >C6-C10)			
	2 (AR = MAHs and PAHs >C10-C12) (AL= >C10-C12)	0.000748	0.050367	0.051115
	3 (AR = PAHs >C12-C16) (AL = >C12-C16)	0.004300	0.133538	0.137838

NOTE:
[1] THC is the sum of AR and AL. (Numbers of carbons in the included compounds are listed, e.g., >C8-C10 indicates greater than 8 carbons and including 9- and 10-carbon hydrocarbons.)

In some cases, additives are combined with the oil to reduce drag or turbulence in a pipeline, allowing it to pump at lower pressure. Additives are mainly comprised of polymers, solid-particle suspensions, biological additives, and surfactants that serve as drag-reducing agents or polymers. These compounds make up only a very small portion of the total volume of shipped product (i.e., oil) moving through the pipeline and are measured at part-per-million (ppm) levels. Because of this, the ultimate trajectory, fate, and effects would not be significantly different between a crude oil with or without these agents. This modeling exercise did not take any additive substances into account.

5.3.2 OILMAP

5.3.2.1 Elevation Data

The OILMAP Land model uses land elevation data to determine the overland pathways of releases occurring in the terrestrial environment. The elevation data are stored in a grid (raster) format and the model calculates the down slope pathway by determining the direction of steepest slope, as the leading edge of the release moves from grid cell to grid cell.

The ability of the model to accurately determine the overland release pathways is in large part controlled by the vertical and horizontal resolution of the elevation grid.

The horizontal resolution refers to the size of the individual grid cells of the elevation data in north-south and east-west directions. As the horizontal resolution increases it is possible to include smaller terrain features in the elevation data in the OILMAP Land model. This may include roads, ditches, and other smaller-scale features. As each horizontal grid cell is assigned a single elevation value, small-scale features can be flattened or smoothed in the larger grid cell and have limited effects on the elevation, especially when the resolution of the horizontal elevation data is course.

The vertical resolution refers to the level of precision available for each cell's elevation value. Sub-meter precision is critical for accurate modeling of flow over a land surface. Without the small sub-meter variations in the elevation surface, larger areas of no apparent elevation change may be present. In this case, the surface flow model will have greater difficulty in determining an overland flow direction, as multiple cells need to be crossed to find the downslope gradient.

Elevation data was obtained from the U.S. Geological Survey (USGS) National Elevation Dataset (USGS 2015). These data have either a 1/3 arc second (approximately 32.8 ft [10 m]) or 1 arc second (approximately 98.4 ft [30 m]) horizontal resolution and were primarily used as a reference for the topography surrounding the various rivers modeled. The higher resolution data covered all portions of land within the U.S., while the coarser one arc second resolution data was used to define the small portion of Canadian land area north of the release location. Elevation data used for modeling was obtained from the MN DNR (MN DNR 2014). The elevation data used was a digital elevation model (DEM) that was derived from LiDAR data. The DEMs have a 9.8 ft (3 m) horizontal resolution and 0.4 in (1 cm) vertical resolution. The Accuracy of the raw LiDAR data is reported as less than 9.8 ft (1 m) in the horizontal and less than 5.9 in (15 cm) in the vertical. They were used in OILMAP Land overland modeling at the Mosquito Creek site and for the stream crossing analysis at all sites. Land elevation maps for all sites modeled in OILMAP Land are presented below (Figure 5-7 through Figure 5-11).

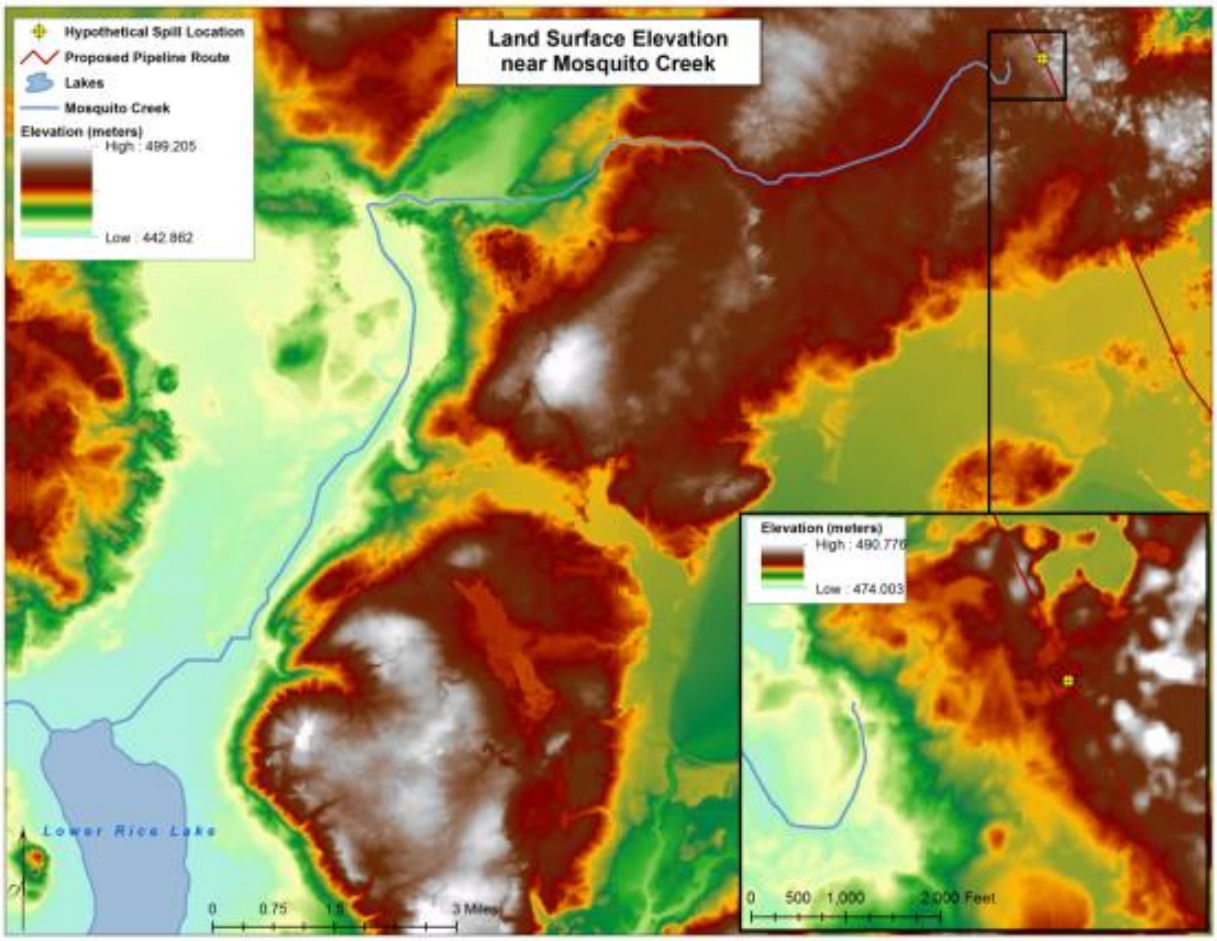


Figure 5-7 Land Surface Elevation (m) for the Mosquito Creek Release Location

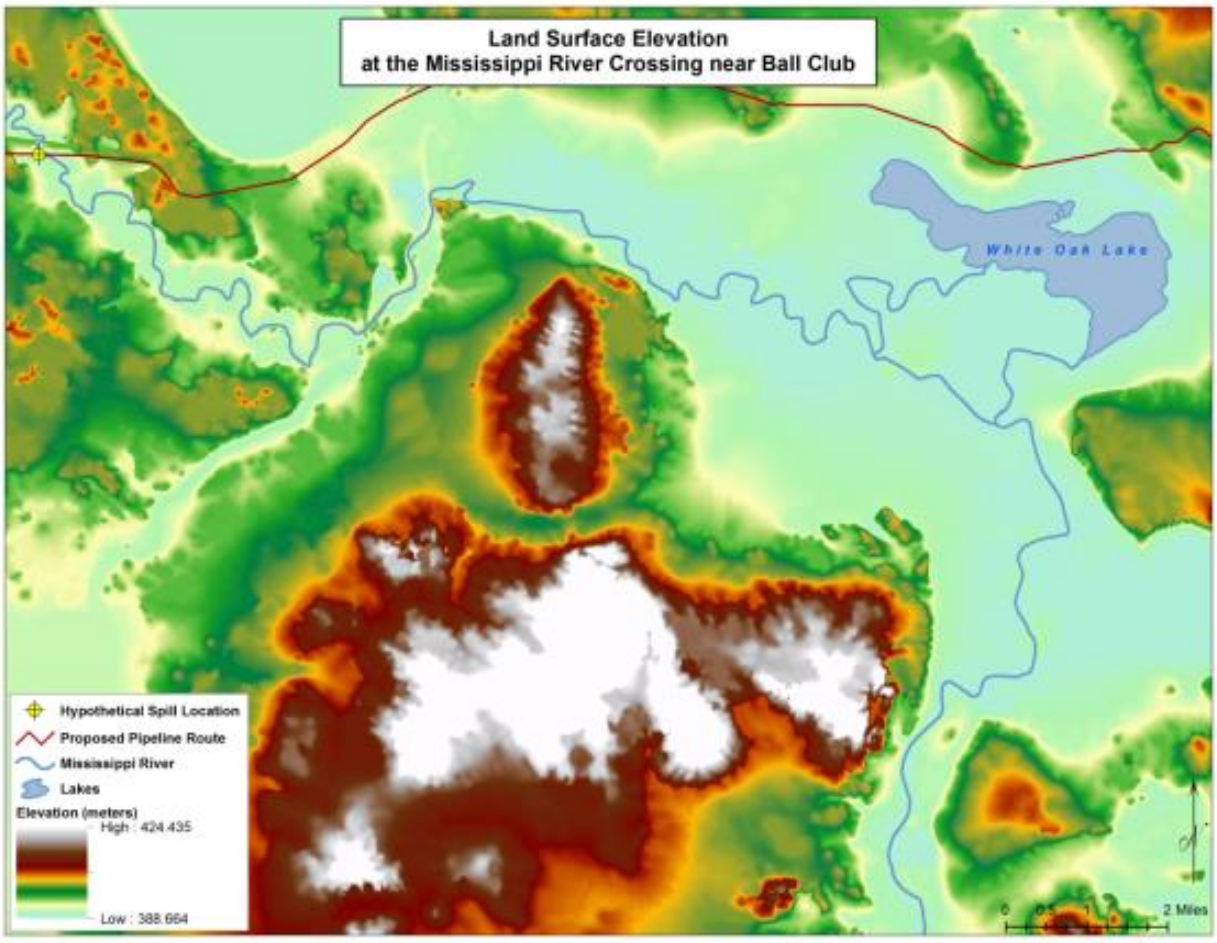


Figure 5-8 Land Surface Elevation (m) for the Mississippi River at Ball Club Release Location

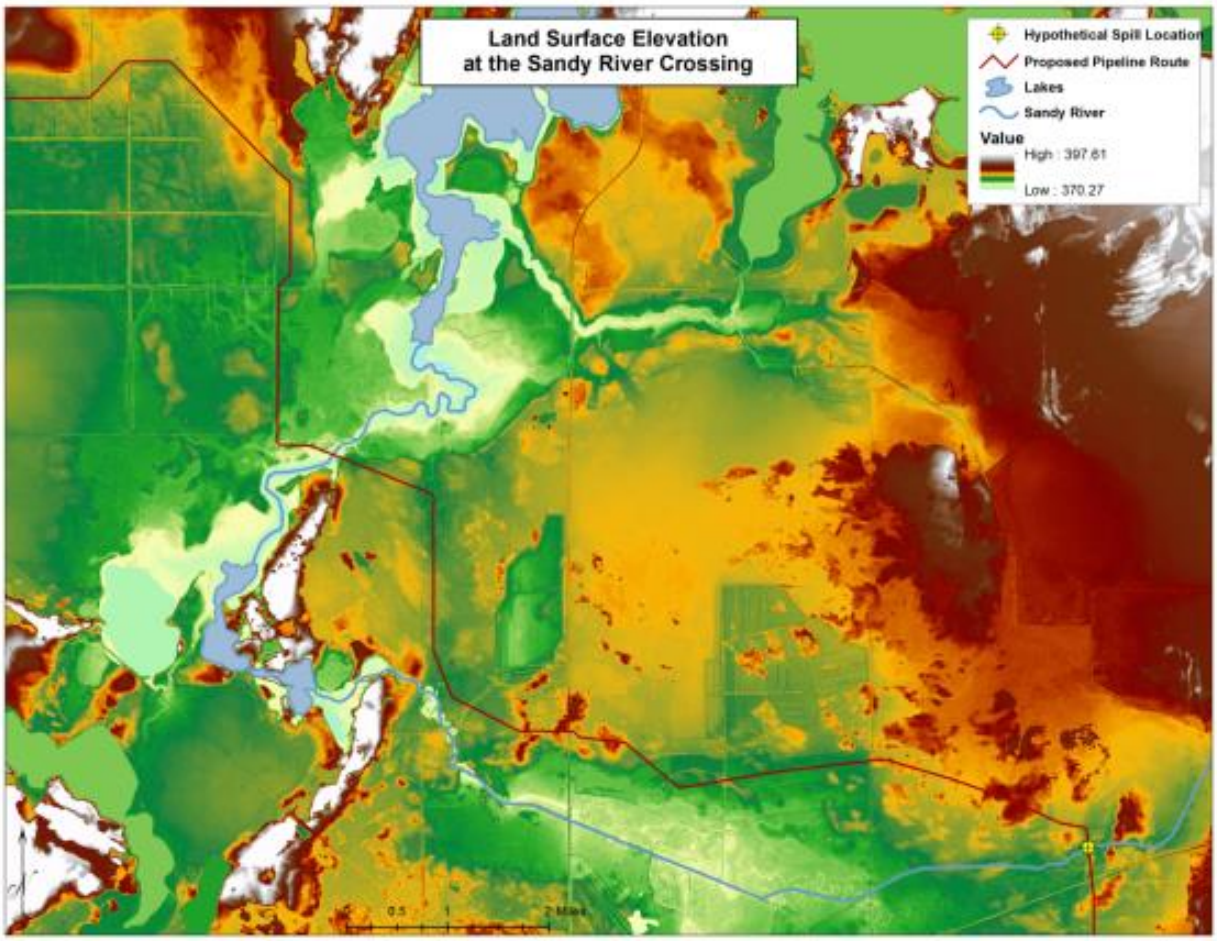


Figure 5-9 Land Surface Elevation (m) for the Sandy River Release Location

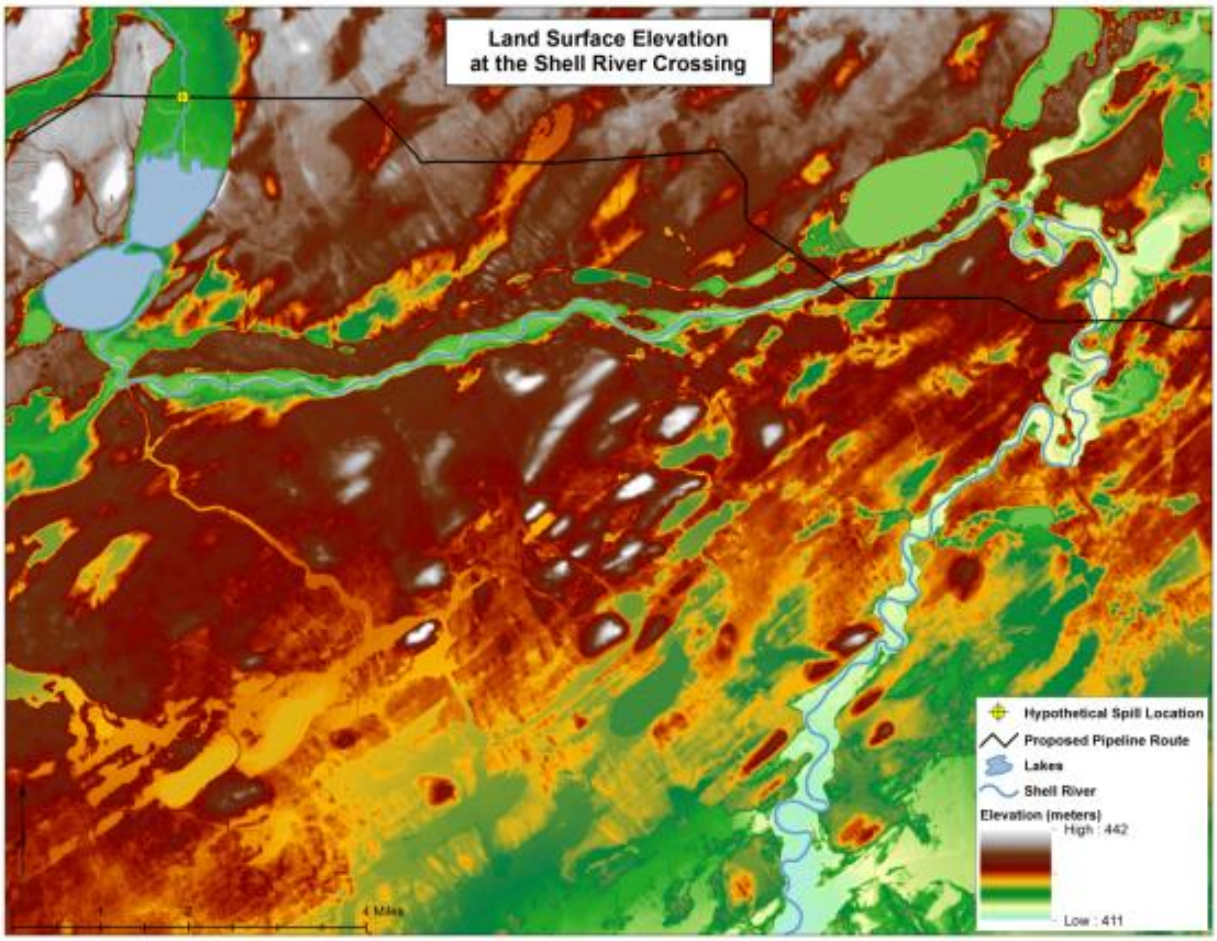


Figure 5-10 Land Surface Elevation (m) for the Shell River to Twin Lakes Release Location

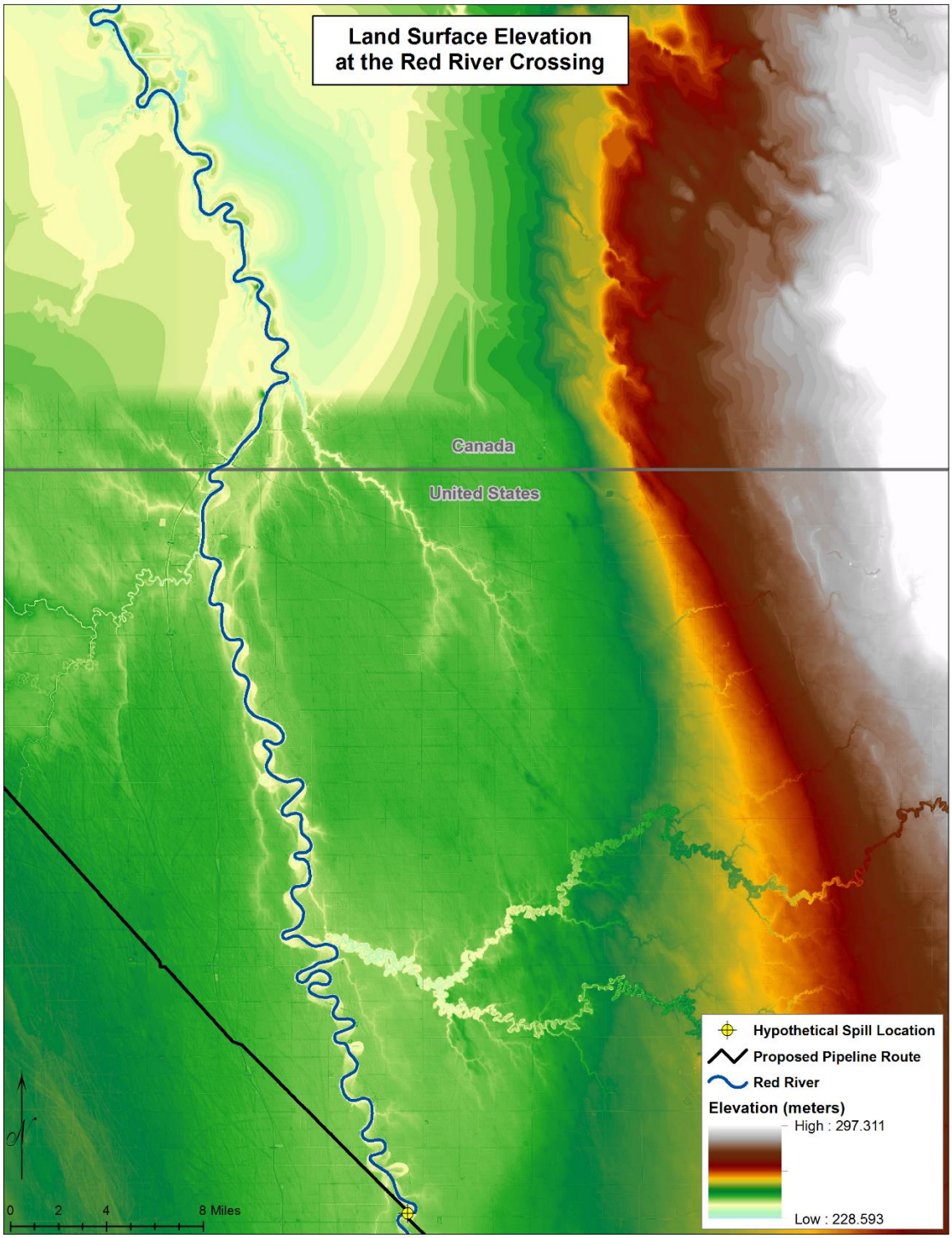


Figure 5-11 Land Surface Elevation (m) for the Red River Release Location. Elevation Data for Canadian Land is at a Coarser Resolution than the U.S.

5.3.2.2 Surface Water Data

The OILMAP Land release model uses data for networked streams and lakes to model the pathways of oil once it reaches surface water. Streams and rivers are represented in the model as a polyline feature of the stream centerline, which has been digitized according to the flow direction. The streams must be networked in a way such that the model can determine where each single stream segment joins the next, as the downstream movement of oil is modeled. Lakes are represented as polygon features, and connect to the streams that both feed and drain them, as appropriate.

Each individual stream segment has its own defined stream velocity and width. Therefore, the model calculates an appropriate downstream transport as a river or stream changes. As an example, a section of a river may widen and slow, and be followed by a narrower and faster reach. The OILMAP Land model uses the location specific river velocity to more accurately model the oil pathway and fate in the stream network.

Surface water data were derived from multiple sources. Stream centerlines, stream polygons and lake polygons were derived from the USGS high resolution National Hydrography Dataset (NHD) (USGS 2014). This data provides geospatial vector data, at a 1:24,000 scale, describing hydrographic features such as lakes, reservoirs, rivers, streams and canals in the form of a linear drainage network. Stream centerlines, networking, and flow information was used from the USEPA's NHDPlus version 2 data (NHDPlus v2; Horizon Systems 2012). NHDPlus integrates the USGS's medium resolution (1:100,00 scale) NHD, the 1/3 arc-second resolution National Elevation Database (NED), and National Watershed Boundary Dataset (WBD) to improve stream networking information, and estimate stream flow and velocity for every stream segment. Stream centerlines for the Canadian portion of the Red River were taken from the National Hydro Network (NHN) of Canada.

NHDPlus includes an estimated monthly and annual average stream flow rate and velocity for each stream segment. Flow is estimated using the Extended Unit Runoff Method (EROM). This method determines flow based on estimate of accumulated runoff based on the elevation data, evaporative loss, and various adjustments based on gages in the region. The velocities are calculated based on the estimated flow using the Jobson Method (Jobson 1996).

The Canadian NHN data does not have the same flow rate and velocity information as the NHDPlus data for the U.S. watercourses. In order to estimate the river velocity for the Canadian portion of the Red River, flows and velocities were calculated separately using a similar process as in the NHDPlus data. The contributing drainage area for each stream segment was determined based on the elevation data. An equation was then used to determine flow, as a function of drainage area, based on the NHDPlus data. The flow for the NHN streams was calculated based on these relationships for each flow period. The flow was then used to determine the velocity for each stream segment using the Jobson Method. A major input to this relationship is the stream slope. However, the resolution of the elevation data in Canada was not

adequate to define a unique slope for each stream segment. Instead the overall change in elevation was used to determine an average slope. The result of these calculations was stream velocities that matched well with the NHDPlus data and a seamless stream network for the US and Canadian portions of the Red River.

The stream centerline network was originally extracted for each river from the NHDPlus network to maintain the networking and flow and velocity information found there. The stream centerlines were adjusted to be more accurately aligned using the NHD high-resolution stream centerlines as well as aerial photography. Stream widths were calculated based on the NHD high-resolution stream polygons where available (USGS 2014) using a series of transects along the river centerline. Where not available, stream widths were measured for each stream segment based on aerial photographs. Stream shore types were determined based on aerial photographs and land cover data (see next section). Low and average flow scenarios used the visible shore types, while high flow scenarios assumed the shore type of the surrounding land cover above the stream bank. Lake polygons were derived from the high resolution NHD dataset. The size and shape of some of the lakes were updated for different seasons based on aerial photographs.

River velocity varied between seasons for each hypothetical release site. The mean monthly river velocities for the identified seasons/months are presented in Table 5-6.

Table 5-6 Mean River Velocity Modeled for Each OILMAP Land Release Site and Season

Case #	Release Site	River Flow	Season	Corresponding Month	Average River Velocity (m/s)
1	Mosquito Creek to Lower Rice Lake	Low	Winter	February	0.16
		Average	Summer	July	0.21
		High	Spring	April	1.03
2	Mississippi River at Ball Cub	Low	Winter	March	0.12
		Average	Summer	August	0.31
		High	Spring	April	0.47
3	Sandy River	Low	Winter	March	0.13
		Average	Summer	July	0.24
		High	Spring	April	0.35
4	Shell River to Twin Lakes	Low	Winter	March	0.25
		Average	Summer	August	0.35
		High	Spring	April	0.54
5	Red River	Low	Winter	February	0.31
		Average	Summer	August	0.44
		High	Spring	April	1.02

5.3.2.3 Land Cover Data

The OILMAP Land model uses land cover data to vary the amount of oil that adheres to the land surface as oil moves down slope. The land cover data are used in a gridded format, with each grid cell value representing the type of land cover at that specific location. Land cover code values are then matched to the categories that define oil retention, so that the loss by retention can be accurately calculated as oil flows over the land surface.

The land cover data used was the National Land Cover Database ([NLCD] 2011), created by the Multi-Resolution Land Characteristics Consortium (Homer et al. 2015). The NLCD 2011 is based on a decision-tree classification of 2011 Landsat satellite data with 30-m resolution.

The NLCD 2011 data was transformed to the appropriate coordinate system. The dataset required reclassification of land cover classes to assign them to OILMAP Land values. The classification conversions for the NLCD 2011 data are provided in Table 5-7.

Table 5-7 Mapping Used to Convert the NLCD 2011 Land Cover Categories to OILMAP Land Classification Scheme

NLCD 2011 Code	NLCD 2011 Description	OILMAP Land Code	OILMAP Land Description
11	Open water	5	Water
12	Perennial snow/ice	12	Perennial ice/snow
21	Developed, open space	21	Low intensity residential
22	Developed, low intensity	21	Low intensity residential
23	Developed, medium intensity	22	High intensity residential
24	Developed, high intensity	22	High intensity residential
31	Barren land (rock/sand/clay)	31	Bare rock/sand/clay
41	Deciduous forest	41	Deciduous forest
42	Evergreen forest	42	Evergreen forest
43	Mixed forest	43	Mixed forest
51	Dwarf scrub	51	Shrubland
52	Shrub/scrub	51	Shrubland
71	Grasslands/herbaceous	71	Grasslands/herbaceous
72	Sedge/herbaceous	92	Emergent herbaceous wetlands
73	Lichens	98	Barren land
74	Moss	98	Barren land
81	Pasture/hay	81	Pasture/hay
82	Cultivated crops	82	Row crops
90	Woody wetlands	91	Woody wetlands

Table 5-7 Mapping Used to Convert the NLCD 2011 Land Cover Categories to OILMAP Land Classification Scheme

NLCD 2011 Code	NLCD 2011 Description	OILMAP Land Code	OILMAP Land Description
95	Emergent herbaceous wetlands	92	Emergent herbaceous wetlands

For each seasonal scenario, the release was simulated using both Bakken Crude and CLSB/CLWB oil types. Along with the varying chemical and physical properties of the two oil types, other model settings were adjusted for each oil type such as oil retention values for the shore type and the minimum thickness on lake surfaces. The oil retention values used by OILMAP Land for the shore and oil types are provided below (Table 5-8).

Table 5-8 Shoreline Retention Values Applied for Both Oils and Multiple Shore Types

Shore Type	Total Shore Width (m)	Oil Retention Thickness (mm)		Oil Volume Retained (m^3 per km of river)	
		Bakken Crude	Cold Lake Blend	Bakken Crude	Cold Lake Blend
Rock / Concrete	0.5	1	4	0.5	2
Soil	1	2	15	2	15
Sand	2	3	20	6	40
Grass	5	4	25	20	125
Marsh	20	6	40	120	800

Overland trajectory modeling was conducted only for the Mosquito Creek site. The land cover and lake surface oil retention thicknesses used in the model are presented in Table 5-9.

Table 5-9 Land and Lake Surface Retention Values Applied for Both Oils at the Mosquito Creek Site *

Land Cover Type	Oil Retention Thickness (mm)	
	Bakken Crude	Cold Lake Blend
Deciduous Forest	2	13.4
Pasture / Hay	0.6	3.8
Snow [1]	69.6	139.2
Vegetated Lake	0.28	1.68
Lake Surface	0.001	0.1
Under Ice in Lake	1.9	10.6

Table 5-9 Land and Lake Surface Retention Values Applied for Both Oils at the Mosquito Creek Site *

Land Cover Type	Oil Retention Thickness (mm)	
	Bakken Crude	Cold Lake Blend

NOTE:
[1] Snow cover based on average February snow depth of 34.8 cm

Maps depicting the shore types and corresponding river velocities modeled for each release location and season are presented below in Figure 5-12 through

Figure 5-29.

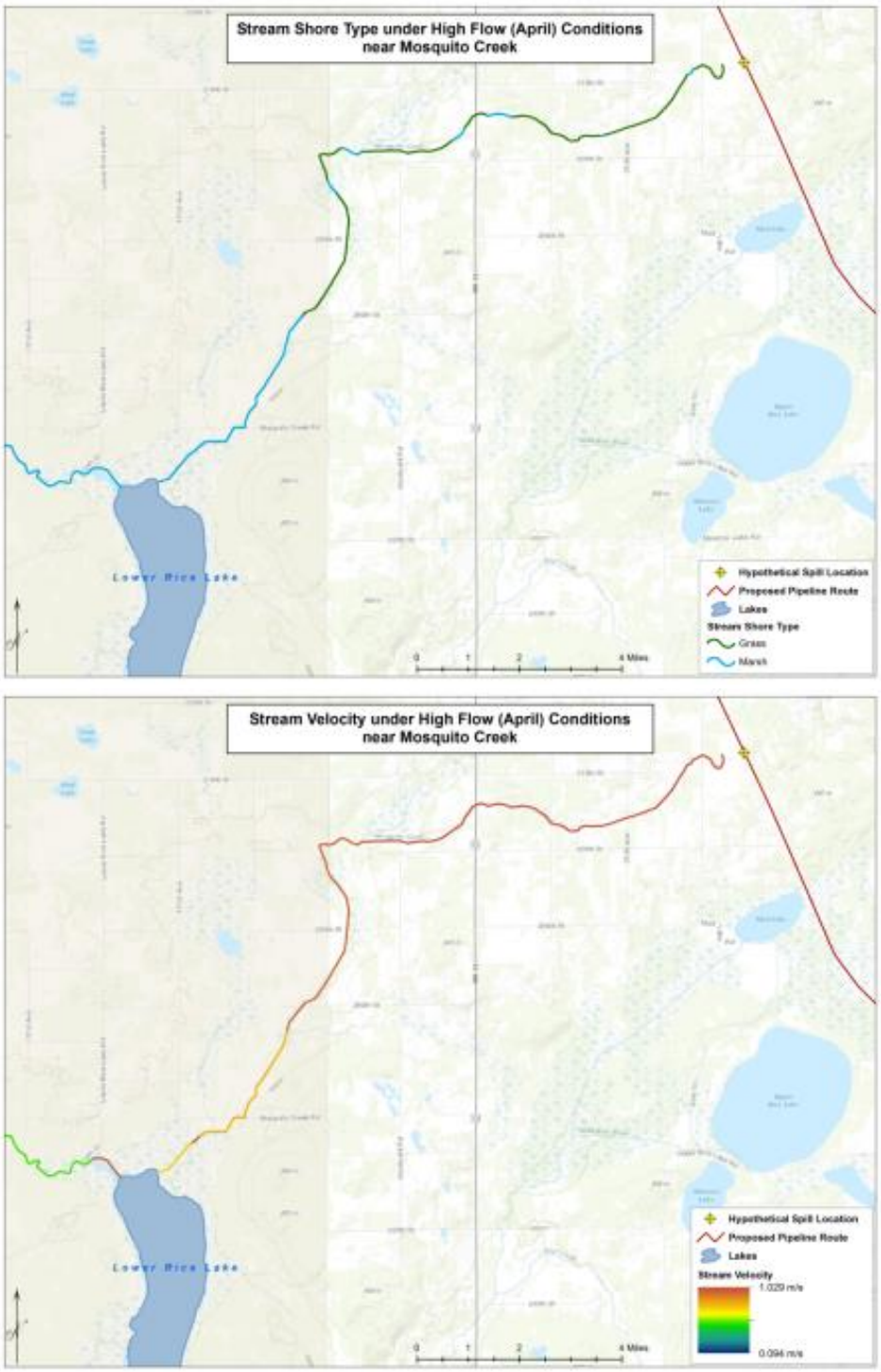


Figure 5-12 Stream Shore Type (top) and Velocity (bottom) Modeled Under High Flow Conditions for the Mosquito Creek Release Location

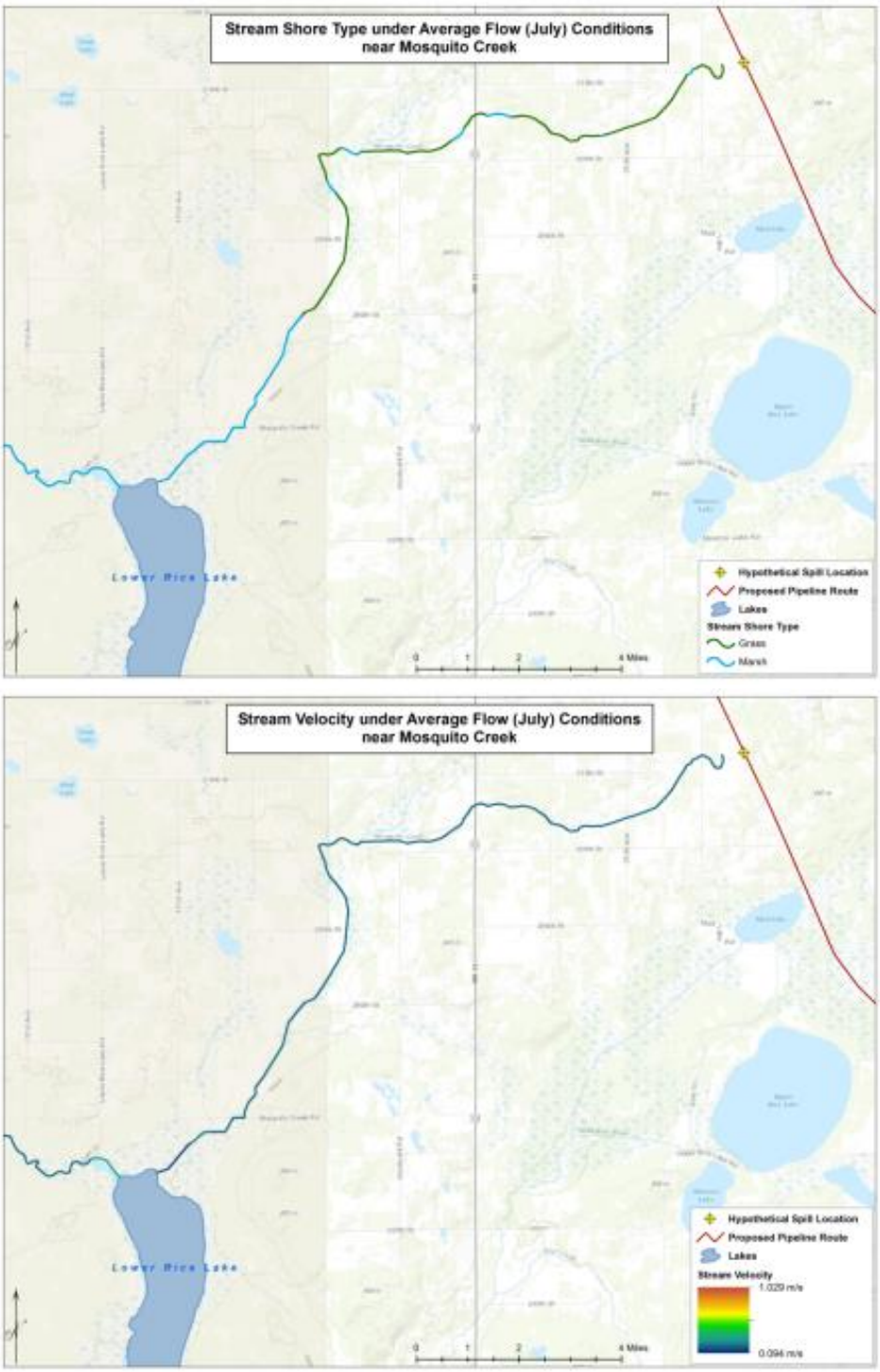


Figure 5-13 Stream Shore Type (top) and Velocity (bottom) Modeled Under Average Flow Conditions for the Mosquito Creek Release Location

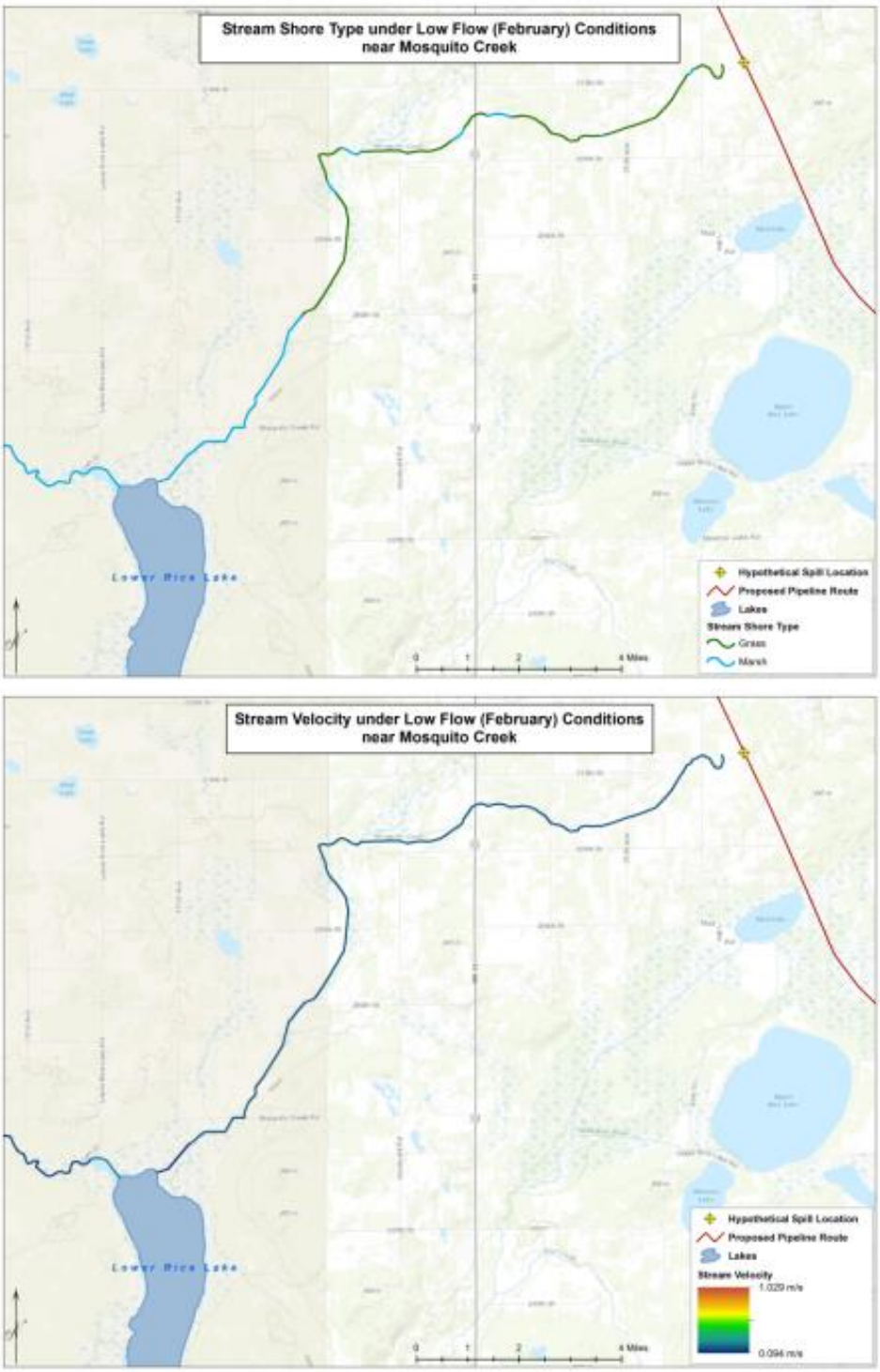


Figure 5-14 Stream Shore Type (top) and Velocity (bottom) Modeled Under Low Flow Conditions for the Mosquito Creek Release Location

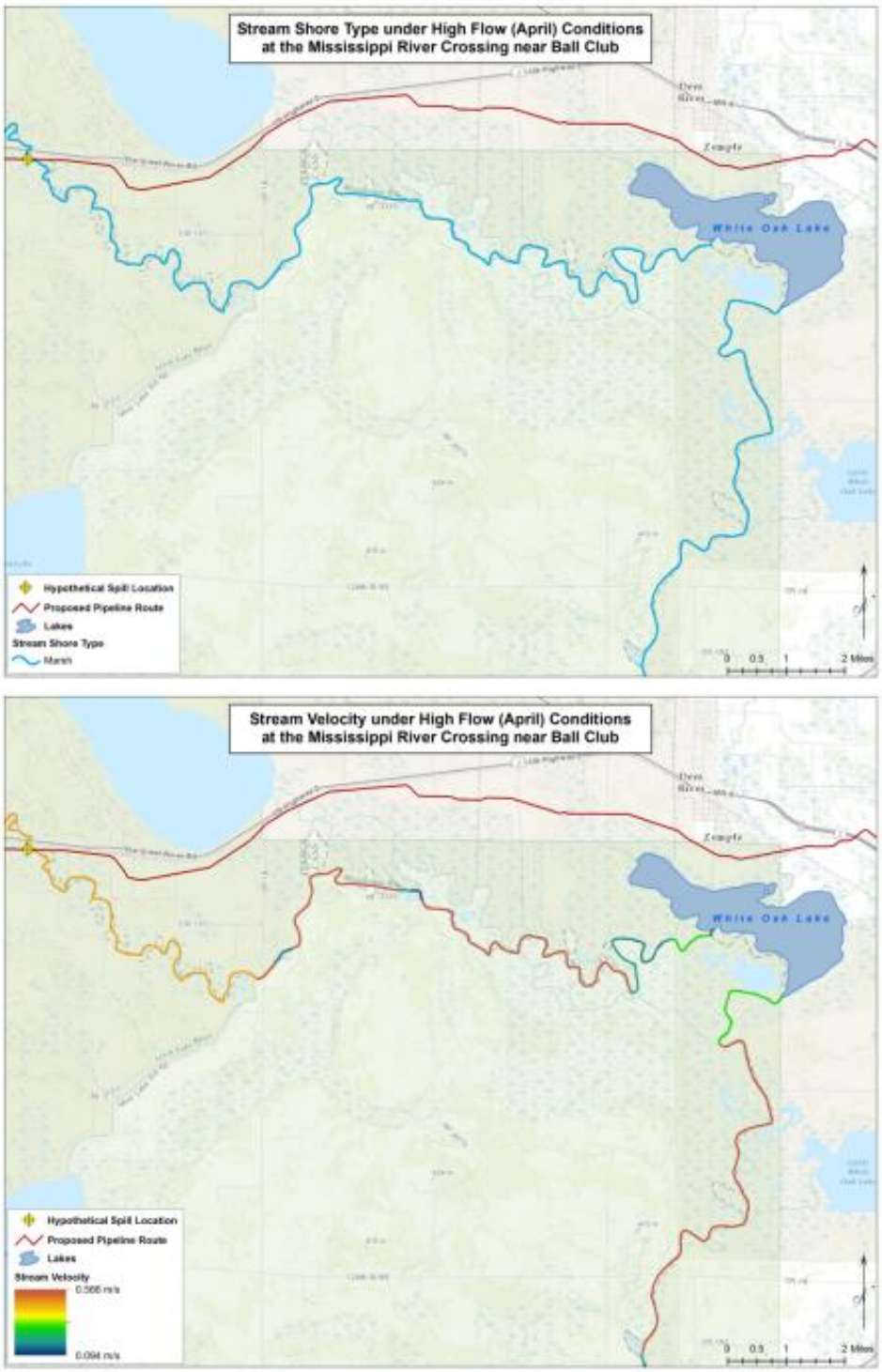


Figure 5-15 Stream Shore Type (top) and Velocity (bottom) Modeled Under High Flow Conditions for the Mississippi River Near Ball Club Release Location

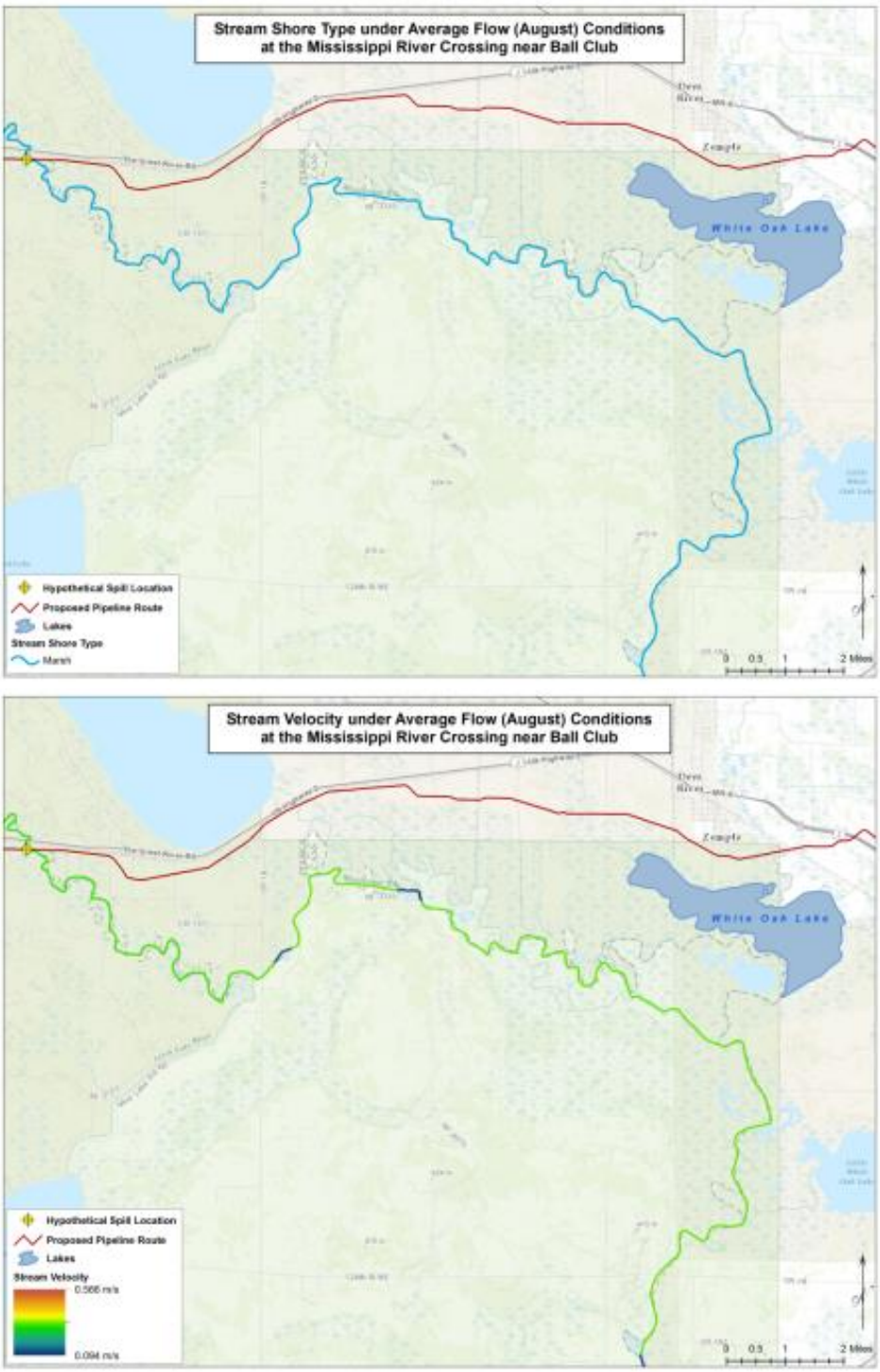


Figure 5-16 Stream Shore Type (top) and Velocity (bottom) Modeled Under Average Flow Conditions for the Mississippi River Near Ball Club Release Location

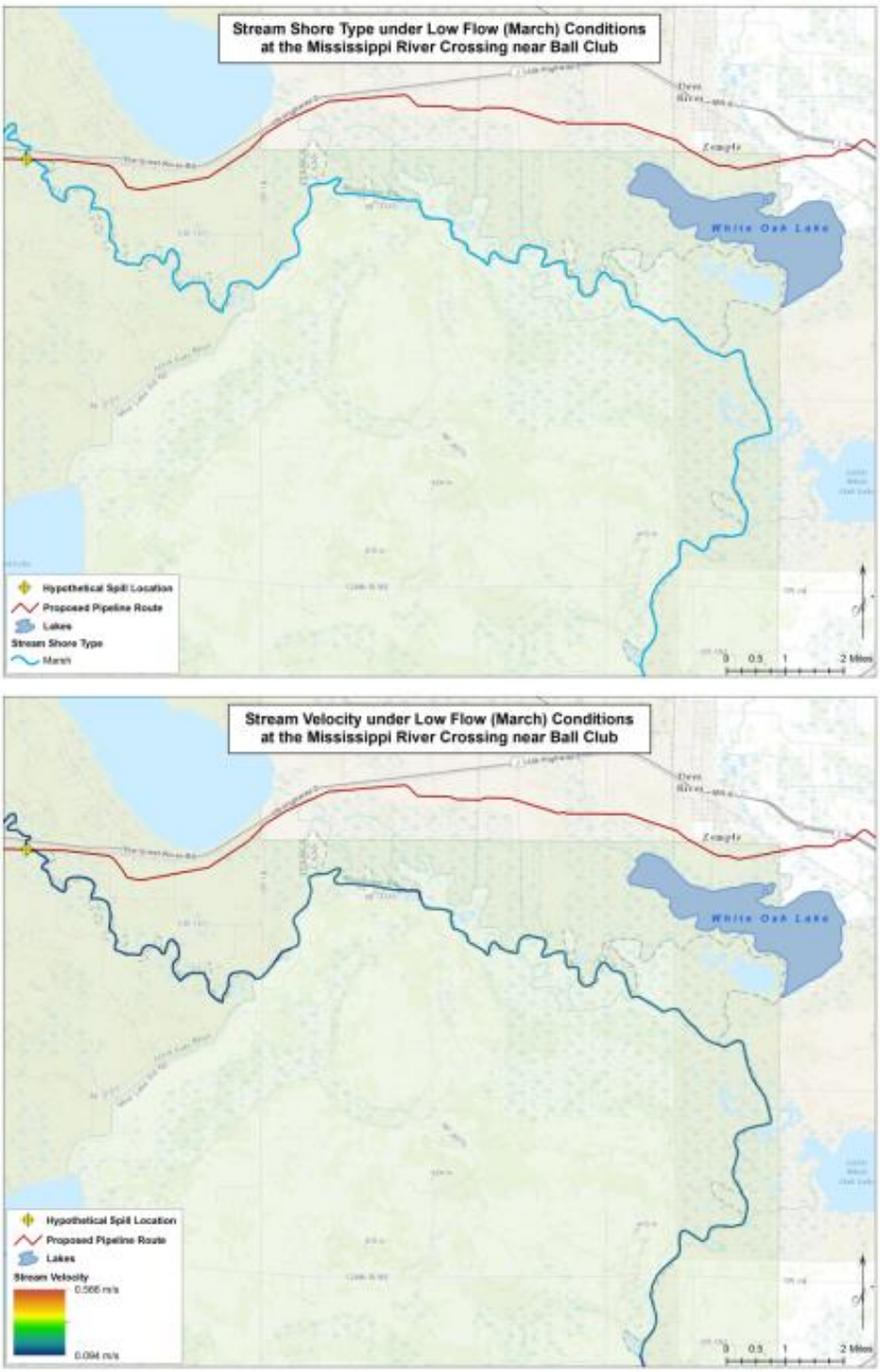


Figure 5-17 Stream Shore Type (top) and Velocity (bottom) Modeled Under Low Flow Conditions for the Mississippi River Near Ball Club Release Location

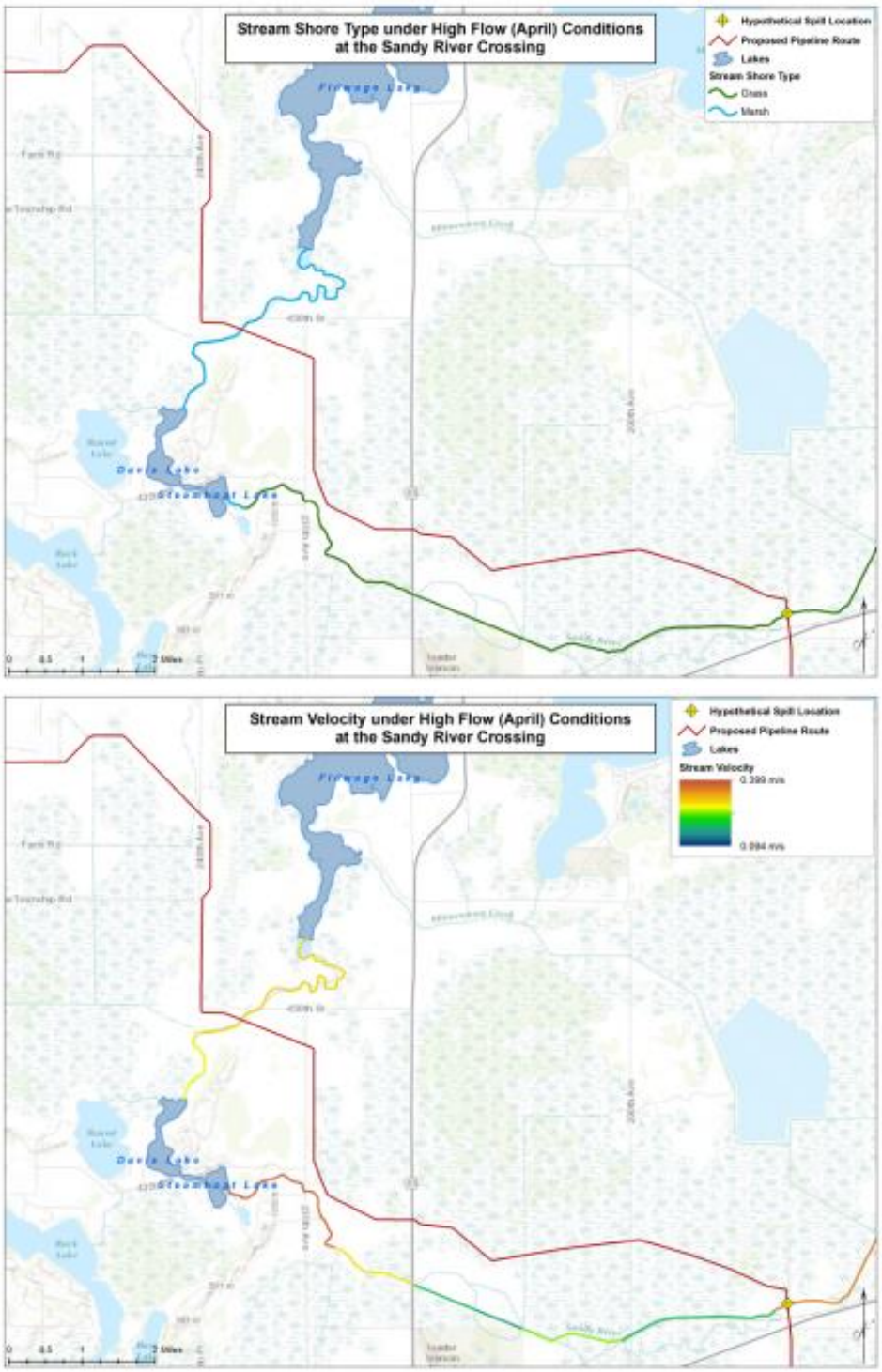


Figure 5-18 Stream Shore Type (top) and Velocity (bottom) Modeled Under High Flow Conditions for the Sandy River Release Location

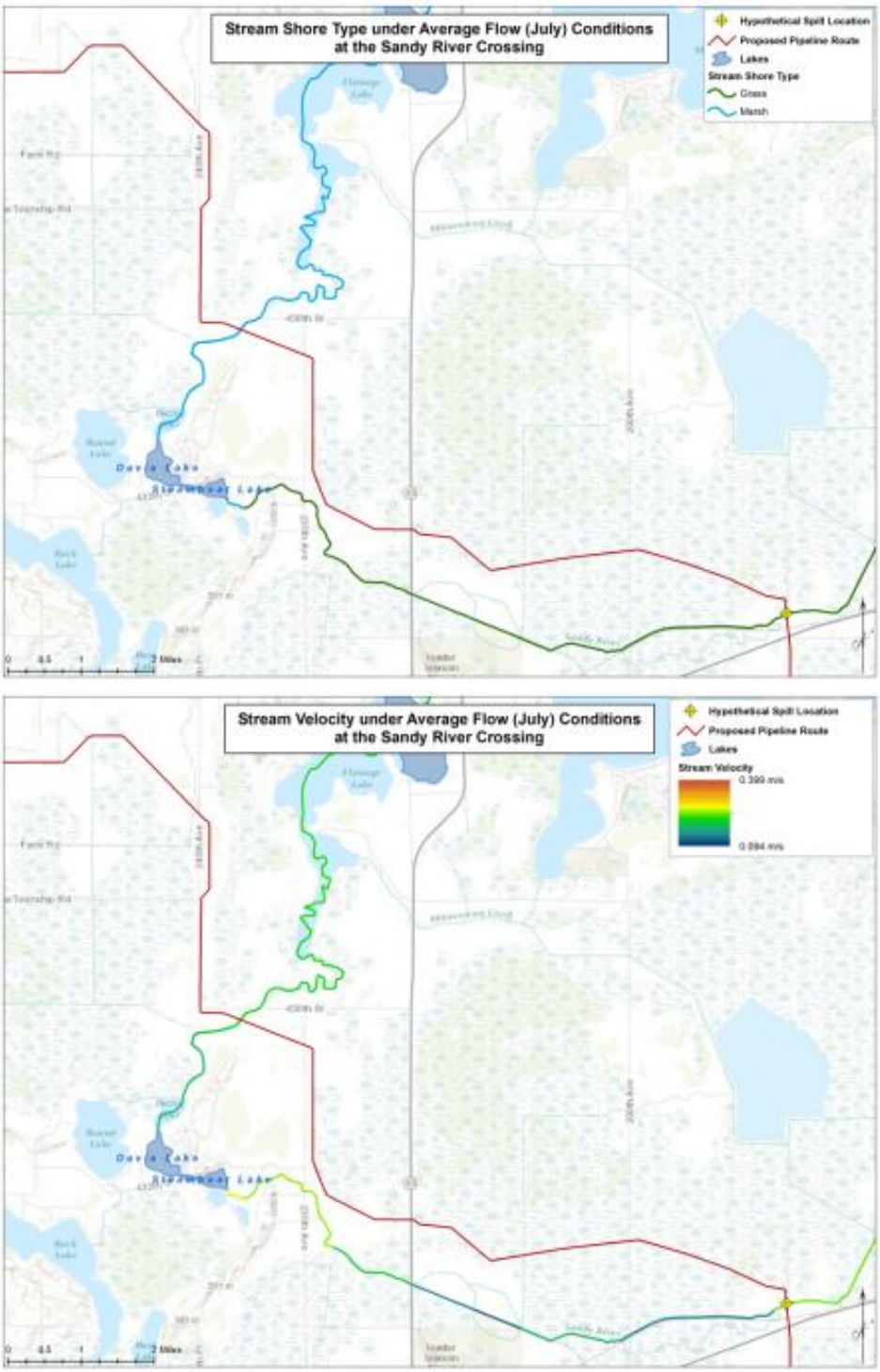


Figure 5-19 Stream Shore Type (top) and Velocity (bottom) Modeled Under Average Flow Conditions for the Sandy River Release Location

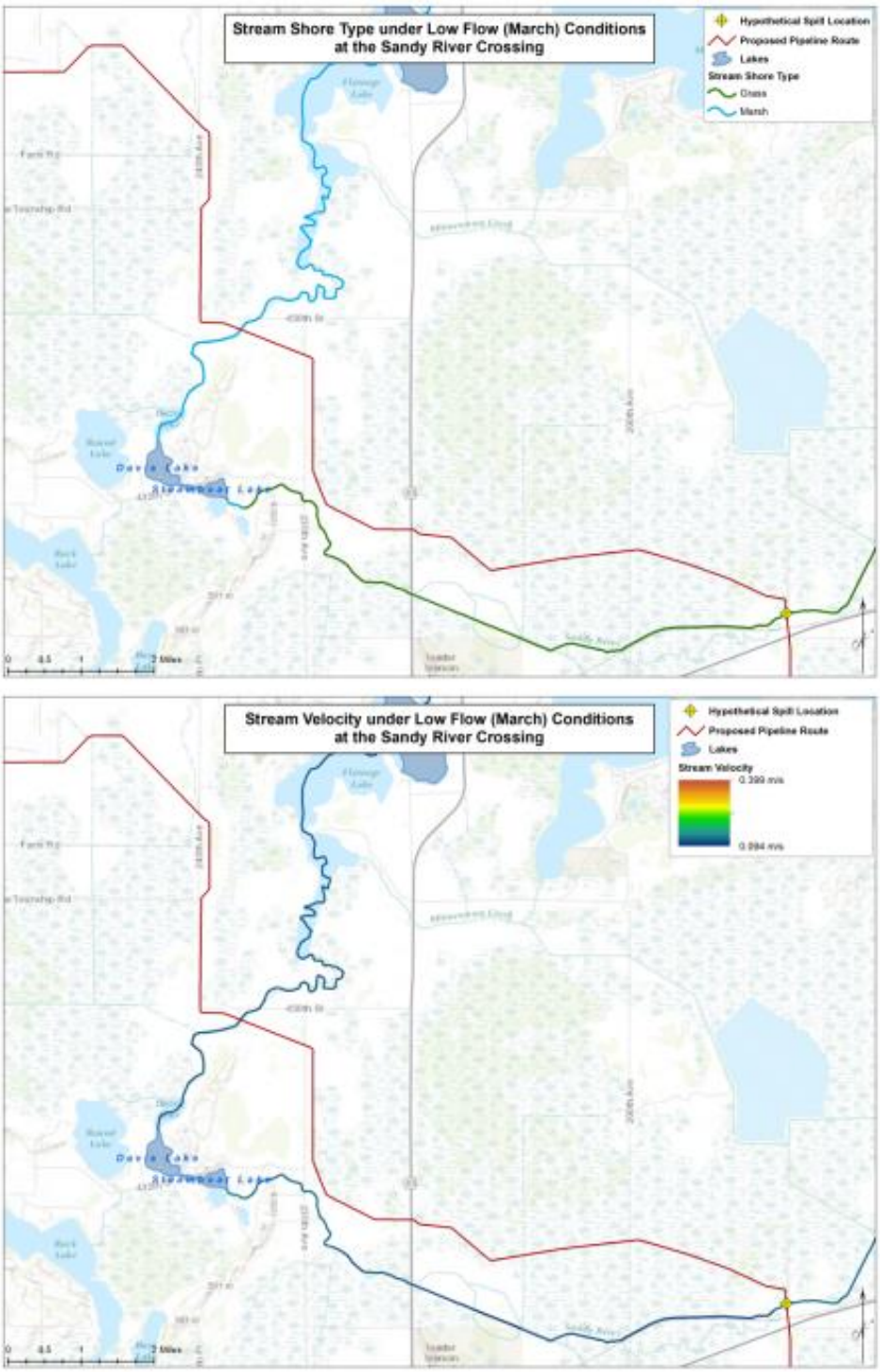


Figure 5-20 Stream Shore Type (top) and Velocity (bottom) Modeled Under Low Flow Conditions for the Sandy River Release Location

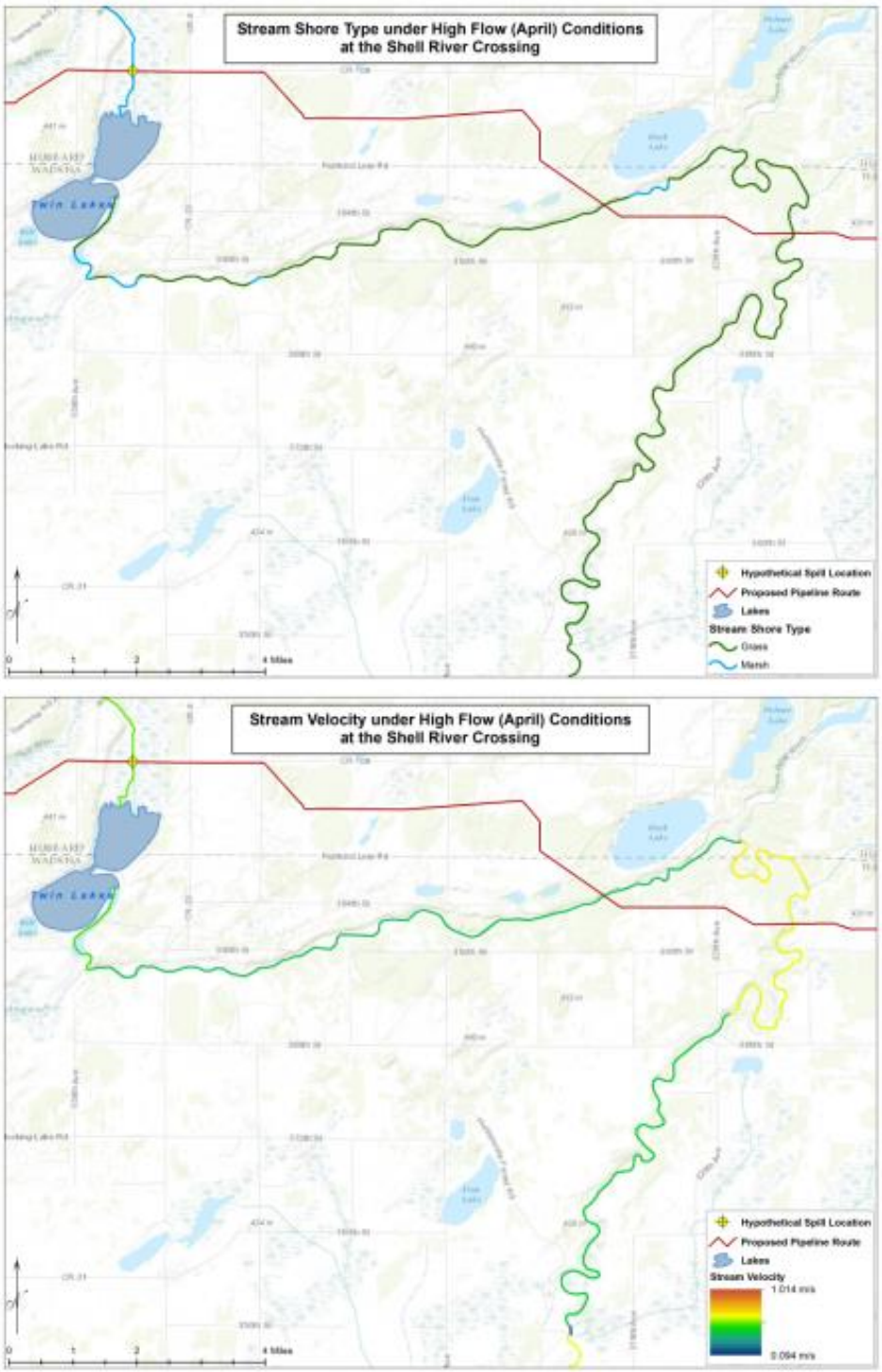


Figure 5-21 Stream Shore Type (top) and Velocity (bottom) Modeled Under High Flow Conditions for the Shell River to Twin Lakes Release Location

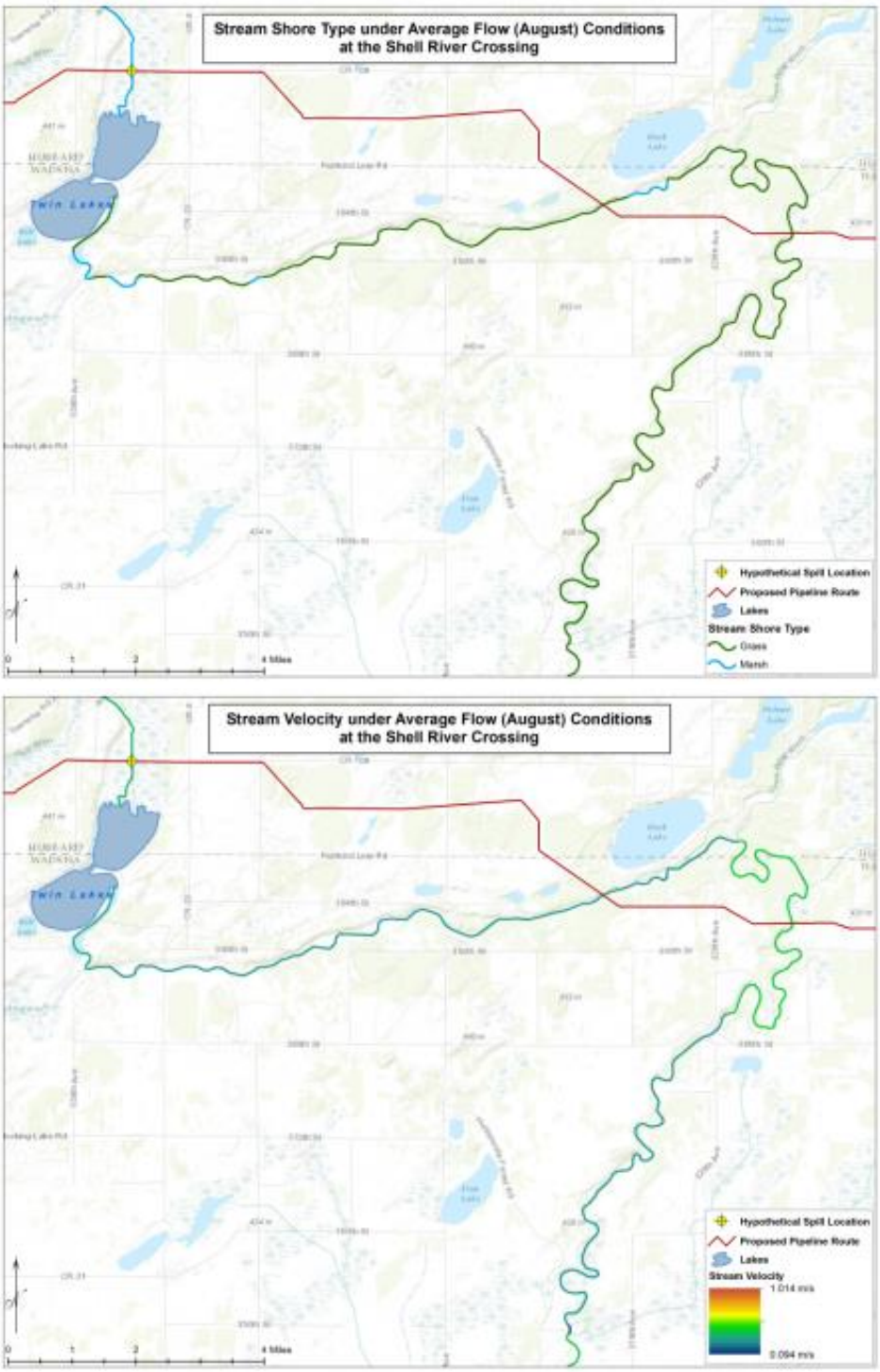


Figure 5-22 Stream Shore Type (top) and Velocity (bottom) Modeled Under Average Flow Conditions for the Shell River to Twin Lakes Release Location

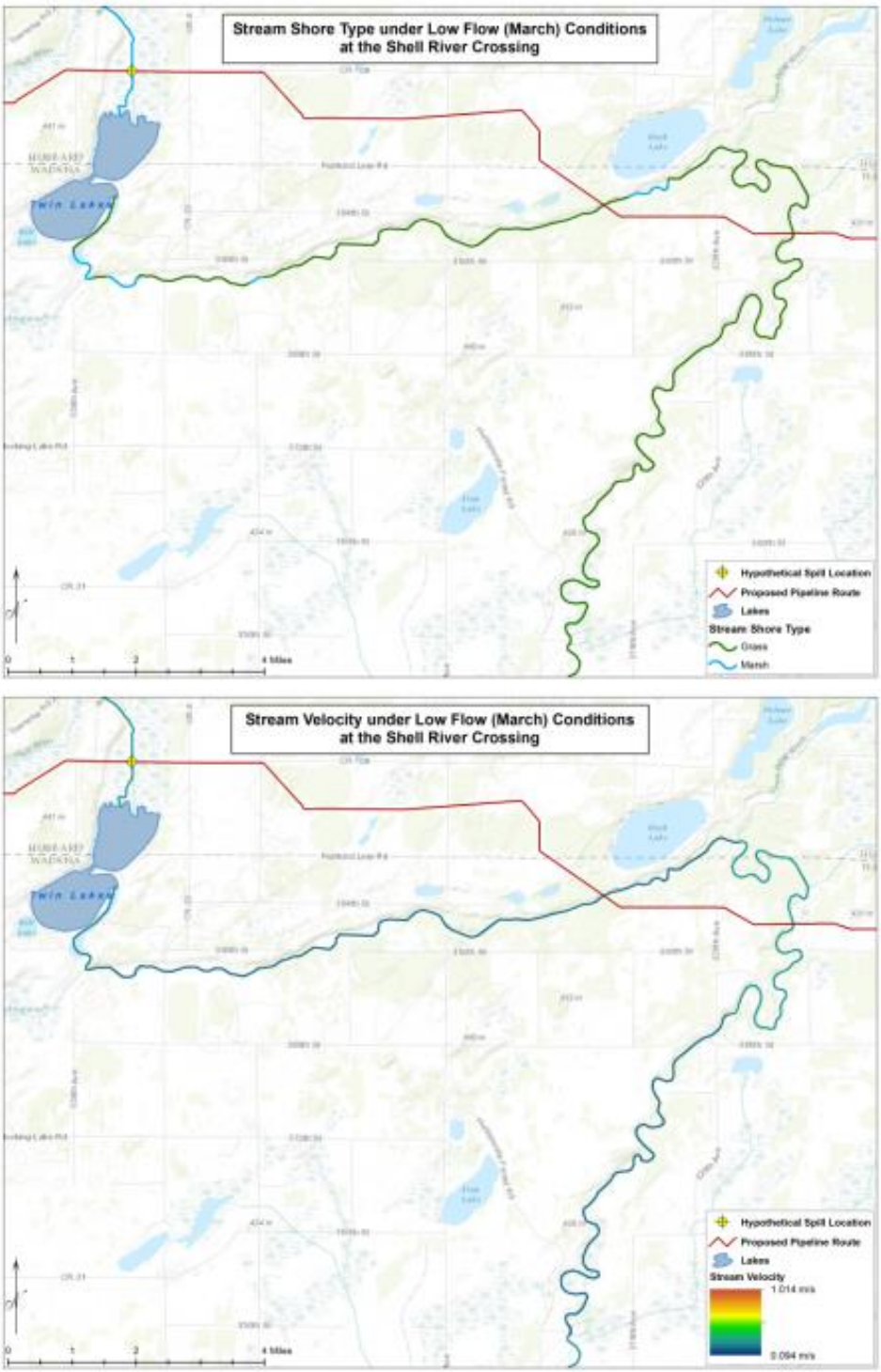


Figure 5-23 Stream Shore Type (top) and Velocity (bottom) Modeled Under Low Flow Conditions for the Shell River to Twin Lakes Release Location

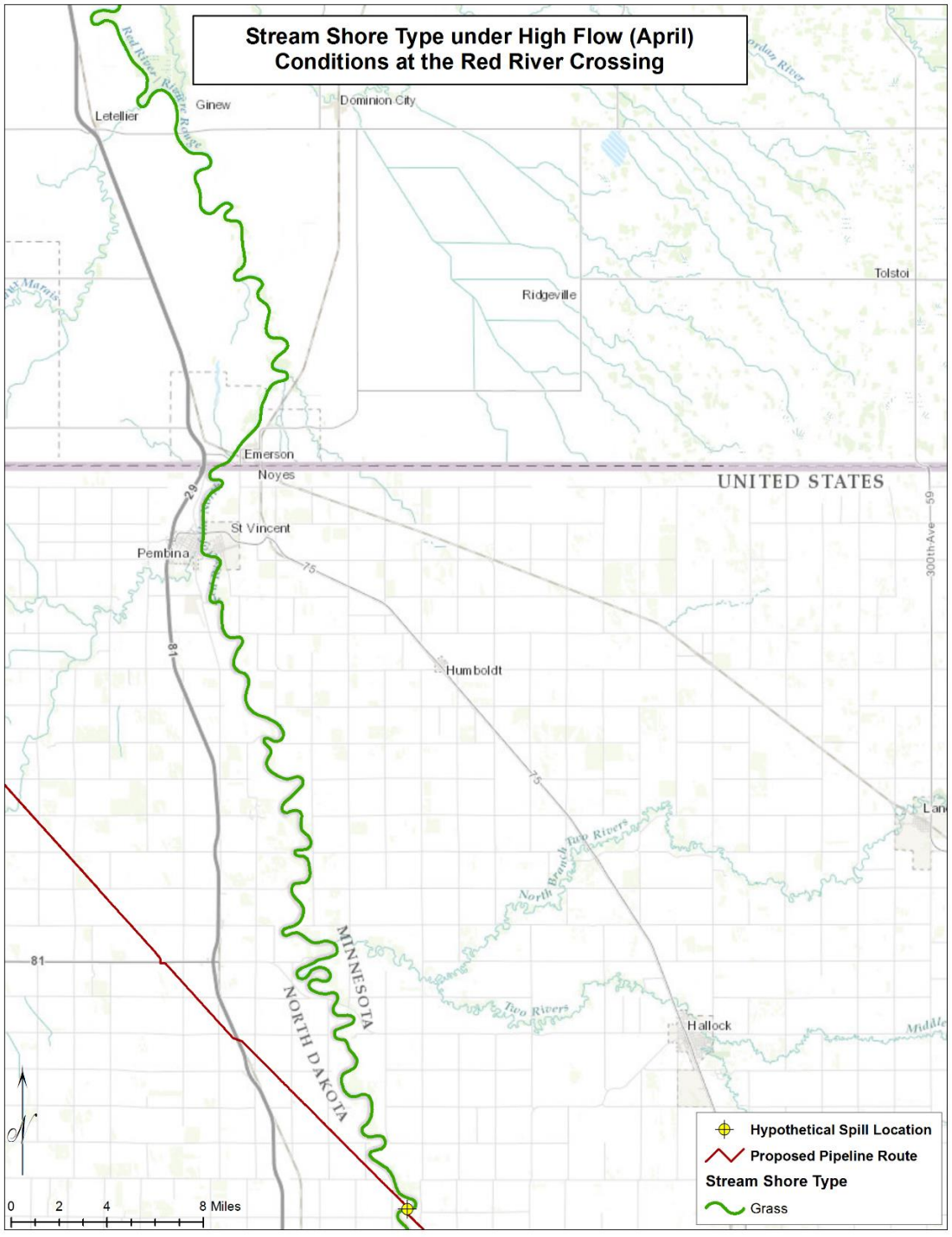


Figure 5-24 Stream Shore Type Modeled Under High Flow Conditions for the Red River Release Location

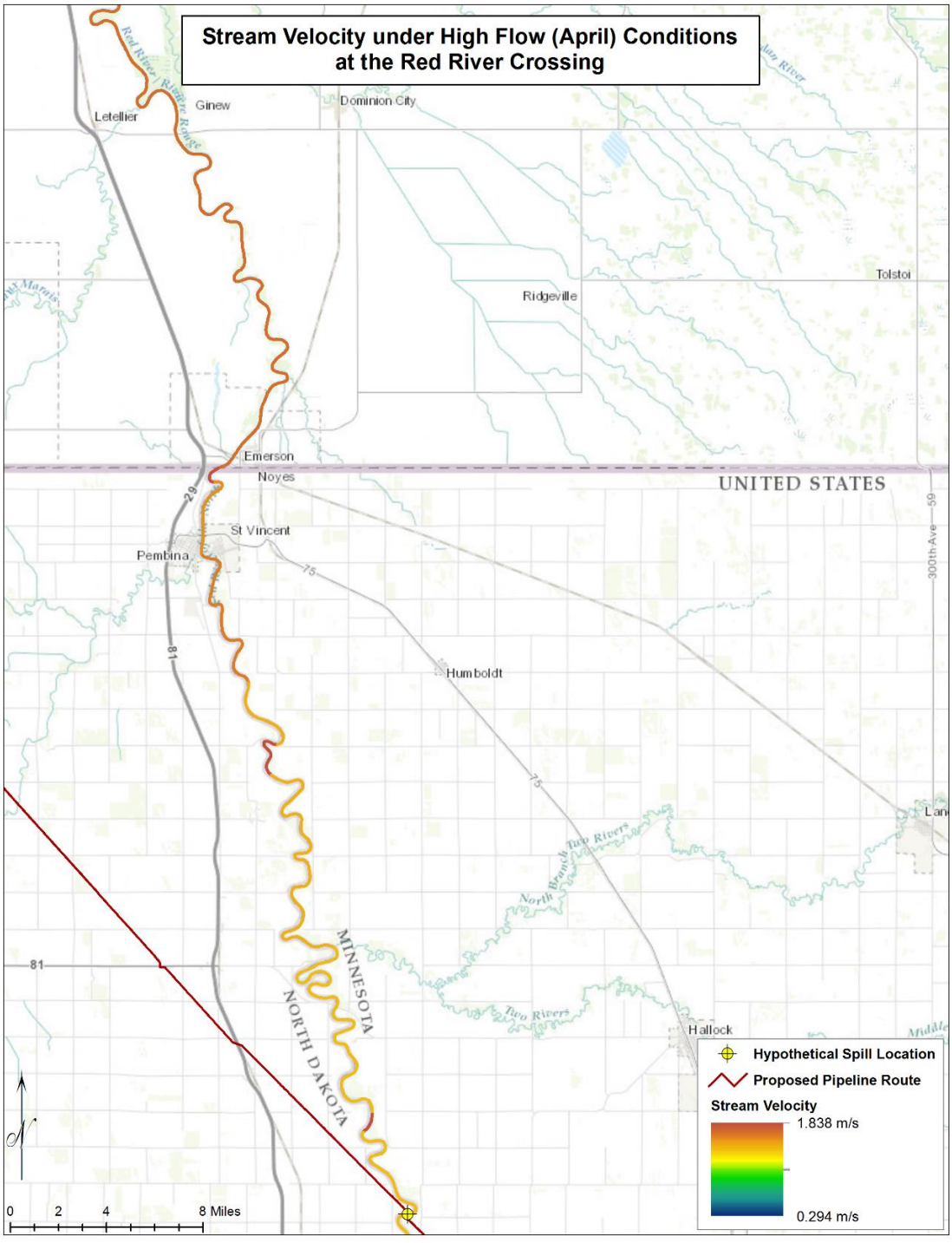


Figure 5-25 Stream Velocity Modeled Under High Flow Conditions for the Red River Release Location

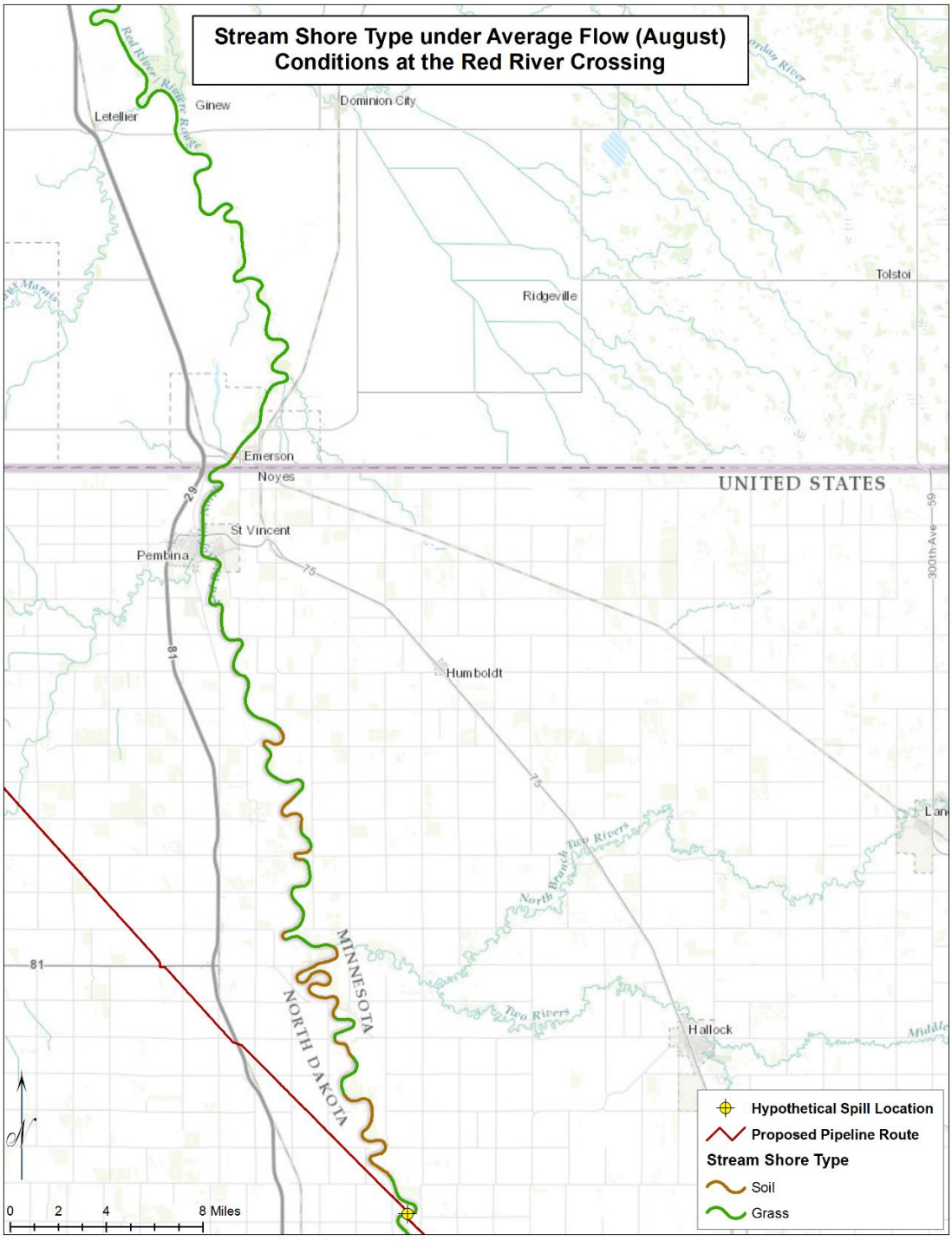


Figure 5-26 Stream Shore Type Modeled Under Average Flow Conditions for the Red River Forks Release Location

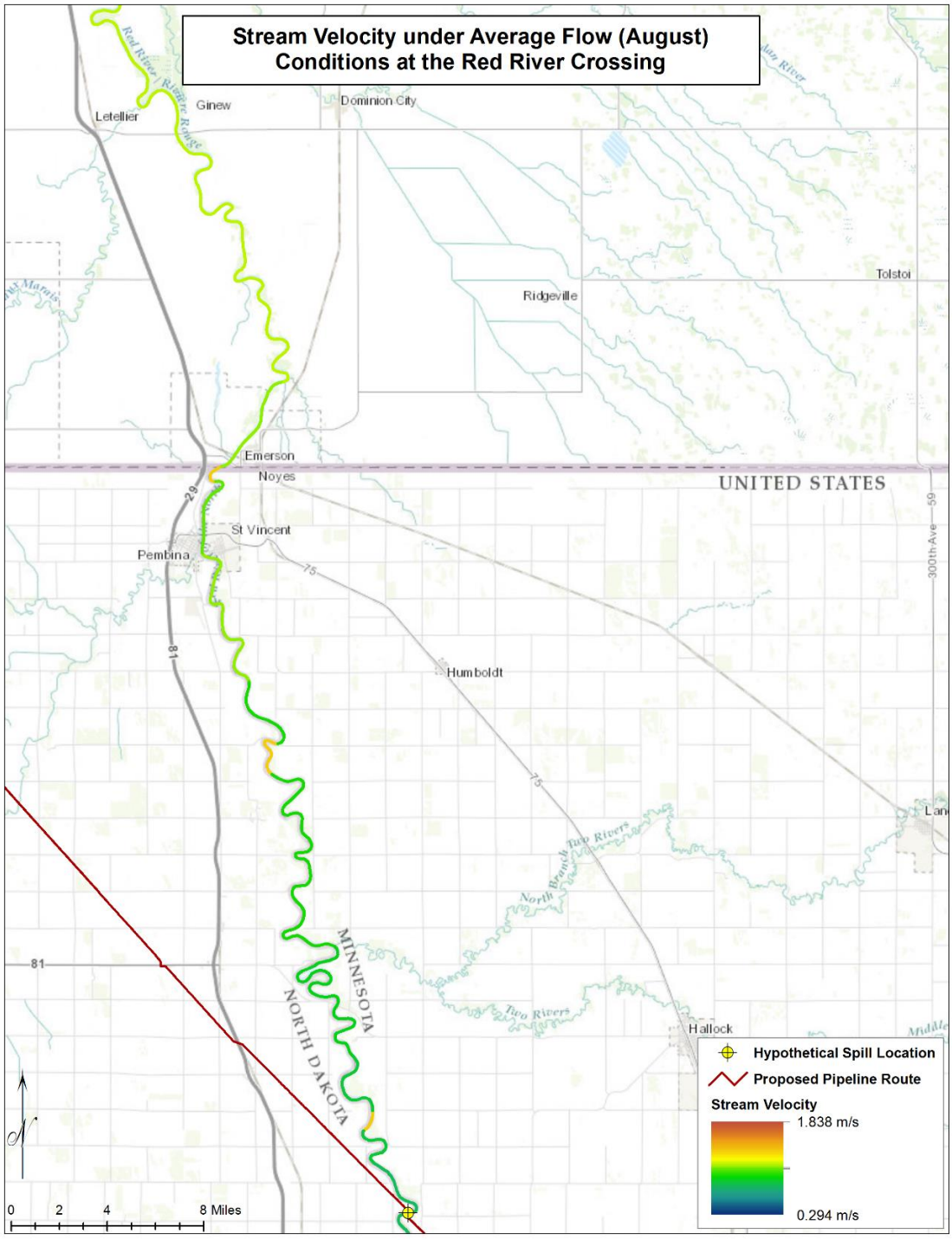


Figure 5-27 Stream Velocity Modeled Under Average Flow Conditions for the Red River Release Location

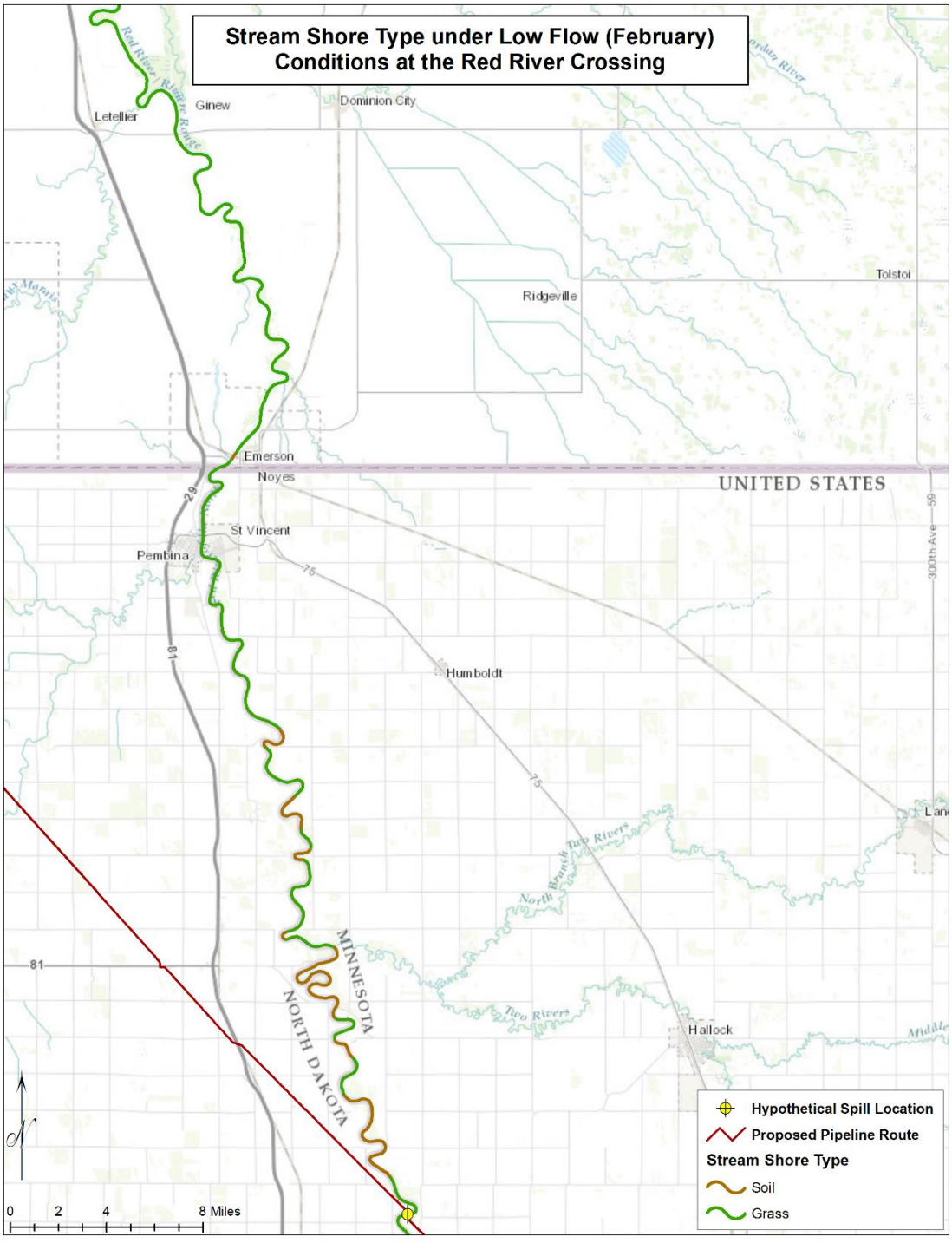


Figure 5-28 Stream Shore Type Modeled Under Low Flow Conditions for the Red River Release Location

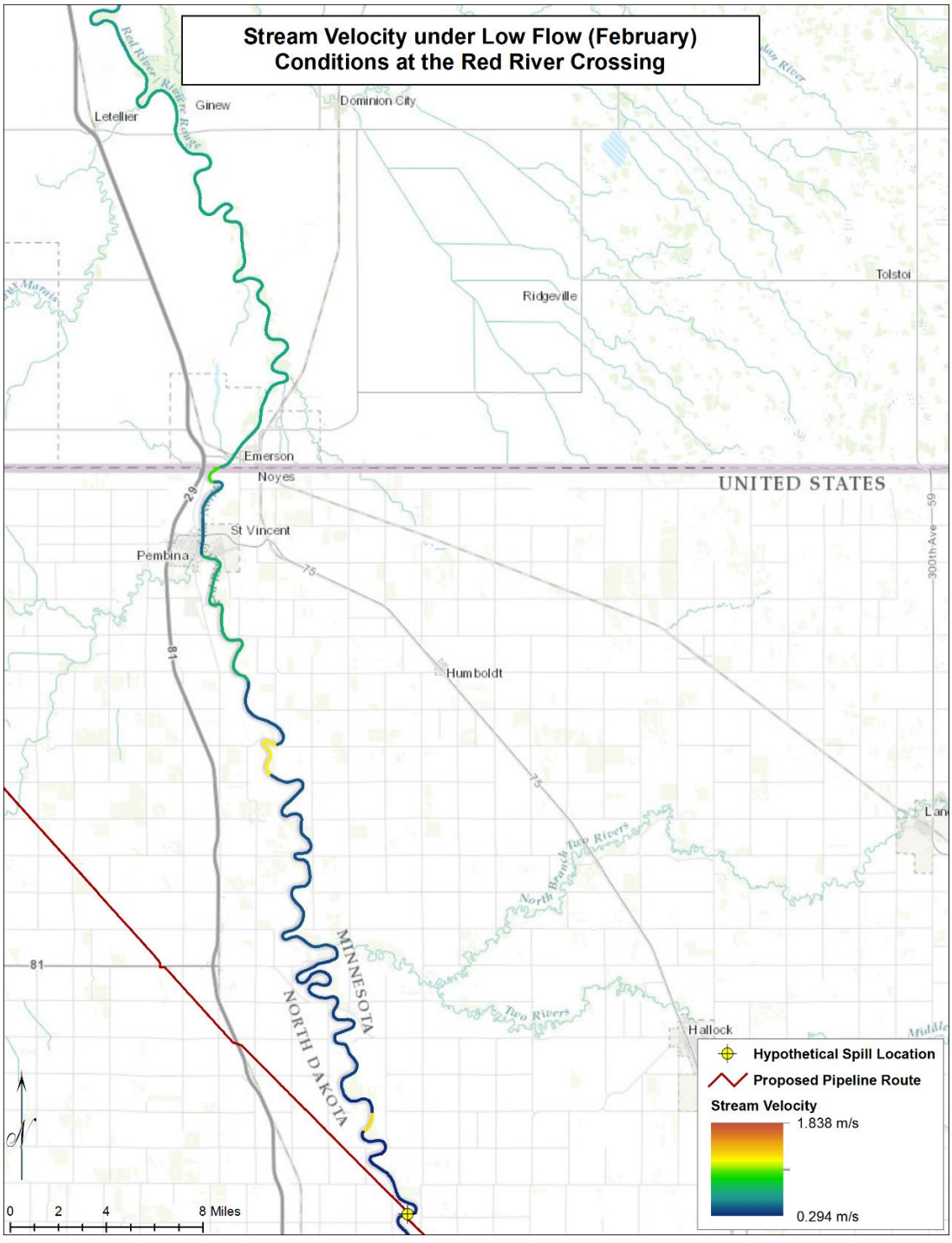


Figure 5-29 Stream Velocity Modeled Under Low Flow Conditions for the Red River Release Location

5.3.2.4 Wind and Temperature Data

Daily climatological statistics consisting of wind speed, wind direction, and air temperature were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information website (NOAA 2016a) and from data provided by Environment and Climate Change Canada's Canadian Climate Normals database (Environment Canada 2016). The preliminary climate datasets consist of three parts:

- Site information: the station location (latitude/longitude) and the month and year of the report
- Daily climatological data
- Monthly averages and totals for the month

The available data for both air temperature and wind speed between 2010 and 2015 (in the U.S.) and 1981 and 2010 (in Canada) were averaged by month. Releases scenarios were simulated under different meteorological conditions (i.e., different wind speed and air temperature for each flow condition/season), which cover the range of weather at the release locations and provide a conservative approach to assessing potential outcomes of a release (i.e., trajectories, fates and effects). Table 5-10 shows the temperatures and wind speeds used for different seasonal scenarios in the model at each release location. Because these were river simulations, salinity was assumed to be zero for all modeling locations.

Table 5-10 Air Temperature (°C and °F) and Wind Speed (m/s) Values Used as Model Inputs for Each OILMAP Land Release Location and Seasonal Scenario

Case #	Release Location	Season / River Flow	Month	Air Temp. (°C)	Air Temp. (°F)	Wind Speed (m/s)
1	Mosquito Creek to Lower Rice Lake	Low	February	-11.50	11.30	4.44
		Average	July	19.25	66.65	3.68
		High	April	4.17	39.51	4.88
2	Mississippi River at Ball Club	Low	March	-3.61	25.50	4.51
		Average	August	18.92	66.06	3.51
		High	April	5.00	41.00	4.88
3	Sandy River	Low	March	-3.07	26.47	4.21
		Average	July	19.96	67.93	3.50
		High	April	5.00	41.0	4.73
4	Shell River to Twin Lakes	Low	March	-4.65	23.63	4.58
		Average	August	18.61	65.50	3.52
		High	April	4.04	39.27	5.05
5	Red River	Low	February	-14.68	5.54	5.19
		Average	August	19.78	67.64	3.98

Table 5-10 Air Temperature (°C and °F) and Wind Speed (m/s) Values Used as Model Inputs for Each OILMAP Land Release Location and Seasonal Scenario

Case #	Release Location	Season / River Flow	Month	Air Temp. (°C)	Air Temp. (°F)	Wind Speed (m/s)
		High	April	4.02	39.20	5.05

5.3.2.5 Snow Cover Depth

Snow cover depth was considered for only the Mosquito Creek overland scenario. Daily snow depth data are available from the NOAA National Centers for Environmental Information (NOAA 2016b). The data are compiled by NOAA from observations collected by the National Weather Service Cooperative Observer stations and First Order stations. The daily data from January 2006 to December 2014 was acquired and the snow cover depth was averaged for each month at each station. The values for the two closest stations to the Mosquito Creek site were selected and averaged, including Thorhult, Minnesota and the University of Minnesota Itasca Biological Station. The monthly average snow cover depth ranged from 0.0 to 34.8 cm (Table 5-11).

Table 5-11 Monthly Average Daily Snow Cover Depth from 2006–2014

Average Daily Snow Cover Depth (cm)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.5	34.8	29.4	14.7	0.6	0.0	0.0	0.0	0.0	1.5	2.5	9.3

During non-winter months, the groundcover is predominantly a grassland/herbaceous cover. However, the area is known for its long cold winters with periods of extensive snow cover. A snow cover of 13.5 in. (34.8 cm) was assumed for the month of February (Table 5-11). The retention of oil in snow was assumed to be 20% for the lighter Bakken Crude, corresponding to a retention depth of 2.7 in. (6.96 cm) and 40% for the heavier CLWB, corresponding to a retention depth of 5.5 in. (13.92 cm) (Allen 2015; Belore and Buist 1988; ACS 2013). While the specific retention of oil by snow will depend upon environmental parameters, the temperature of the released oils, snow cover and type, solar insolation, slope, and other factors, these values align within the expected range from previous studies (Bech and Sveum 1991; Allen 1978; Etkin et al. 2007; Fingas and Hollebone 2015). These studies all indicate that heavier oils with higher viscosities tend to spread less, forming thicker layers in the snow, than lighter oils and diesel fuel.

5.3.2.6 Thickness of Oil Under Ice

Ice coverage is important to consider as it may affect the ultimate trajectory and fate of oil within the winter environment. Ice may reduce the quantity or prevent oil from entering a water

body altogether. Furthermore, it may affect the potential downstream transport and potential for pooling of oil under ice. Fates processes such as evaporation may be affected as well.

Ice cover was considered at each of the modeled locations. During winter conditions, complete coverage (100% ice cover) of the water surface is assumed. If a release were to originate on land (e.g., Mosquito Creek) and travel downslope towards the surface water network, it would be absorbed to some extent by the local snow cover. Any oil that made its way to the watercourse would be prevented or delayed from entering the water body due to the coverage of ice. However, if a release were to occur into the watercourse from the underground/underwater crossing (e.g., all modeled locations other than Mosquito Creek), then all oil would enter into the water column itself. For the purpose of modeling, oil is assumed to rise through the water column and be trapped by the ice cover at the surface. The model assumes that evaporation is prevented completely (0% evaporation) due to the layer of ice on the water surface. The downstream transport of oil is modeled within river sections at the local water velocity; however, oil pools under the ice in lakes. As modeled in the ice-free conditions, complete shoreline oiling occurs in the complete ice cover season as well. However, rather than referring to true shoreline oiling, this term in the winter would more appropriately be named edge-oiling. Shorelines are set to ice-edge and shoreline retention values are lower than those found in non-winter conditions. The retention of oil along the banks during winter seasons refers to the oil that would be trapped below the ice surface along the edge of the river in the narrow region between the ice and the bottom. These conservative approximations maximize the extent of potential oiling.

The equilibrium thickness of oil under ice has been measured in many environments. However, the main focus has been in the marine environment, where thicknesses may range from 1-30 cm (Dickins et al. 2008). Freshwater environments, particularly rivers, are quite different than the open ocean, notably with the level of energy within the environment (e.g., waves and other turbulent processes). Assuming that new ice formed in calm conditions and the underside was flat and smooth, the oil will spread underneath to an equilibrium based upon the balance between surface tension and buoyancy (Barnes et al. 2013). The equilibrium slick thickness may be determined using the equation of Cox et al. (1980):

$$\delta = -8.5(\rho_w - \rho_o) + 1.67$$

Where δ is the thickness of oil under ice in cm and $(\rho_w - \rho_o)$ is the density difference between oil and water. Under the smoothest ice conditions, 5.2–11.5 mm are typical for oils with densities in the range crude oils (Cox et al. 1981). The minimum stable drop thickness for crude oil under ice is approximately 8 mm (Lewis 1976). The equilibrium thickness of CLWB was determined to be 0.4 in. (1.06 cm), while the thickness for Bakken was calculated to be 0.07 in. (0.19 cm). The CLWB is thicker than the aforementioned predictions as it is a heavy crude oil. The Bakken was slightly thicker than the previous values due to the smaller density difference between oil and freshwater, as opposed to saltwater.

5.3.3 SIMAP

5.3.3.1 Geographic and Habitat Data

For geographical reference, SIMAP uses a rectilinear grid to designate the location of the shoreline, the water depth (bathymetry), slope, bottom roughness, and the shore or habitat type. The grid is generated from a digital shoreline or other geographical information using the ESRI Arc/Info compatible Spatial Analyst program. The cells are coded for depth and habitat type; the model then identifies the shoreline using this grid. Thus, in model outputs, the land-water map is only used for visual reference; it is the habitat grid that defines the actual location of the shoreline in the model.

Geographical data including digital shoreline basemap, river geometry, and habitat mapping were obtained from the USGS NHD high-resolution dataset. This includes river polygons that were used to define river area, with slight improvements based upon aerial imagery. Variations in the water area between low/average river flow and high river flow were determined based upon aerial imagery from different seasons. The NHD data followed a high flow condition well. Areas that were regularly dry in summer, fall, or winter were excluded from the river area for the average and low flow conditions. Basemap data were used to define the land/water boundary and habitat data were used to define the types of habitats present within the study area. Habitat grids were used to define the bottom type and vegetation found in watered areas, areas of extensive mud flats and wetlands, and the shore type.

Shore types were characterized based on aerial imagery and photographs posted by Google Earth. For average river flow conditions, the shore type was based upon visible bank type. For low river flow conditions, the shore type was assumed to be ice along natural shorelines and man-made structures (e.g., ditches) where present. For high river flow conditions, the shore types were assigned based upon the land cover data above the riverbank, except for man-made structures. The bottom type was defined as silt and mud with some regions characterized as wetlands from imagery and mapping that identified wetlands.

River depth was characterized based on flood insurance studies for Palisade and Aitkin County (FEMA 1983, 1996) and the St Paul District Corps of Engineers (1980). Depths were provided at various distances from known locations along the river. These locations were mapped and assigned their corresponding depth. Depths were linearly interpolated along the river centerline between these known values. Lacking any cross sectional river profiles, a rectangular river channel was assumed. To create a rectangular shaped depth profile (i.e., constant depth from bank to bank at any cross section in the river), a grid was created based upon these centerline depths.

River depth and habitat are presented for the Mississippi River at Palisade and Little Falls in Figure 5-30 through Figure 5-37 for each of the modeled seasons.

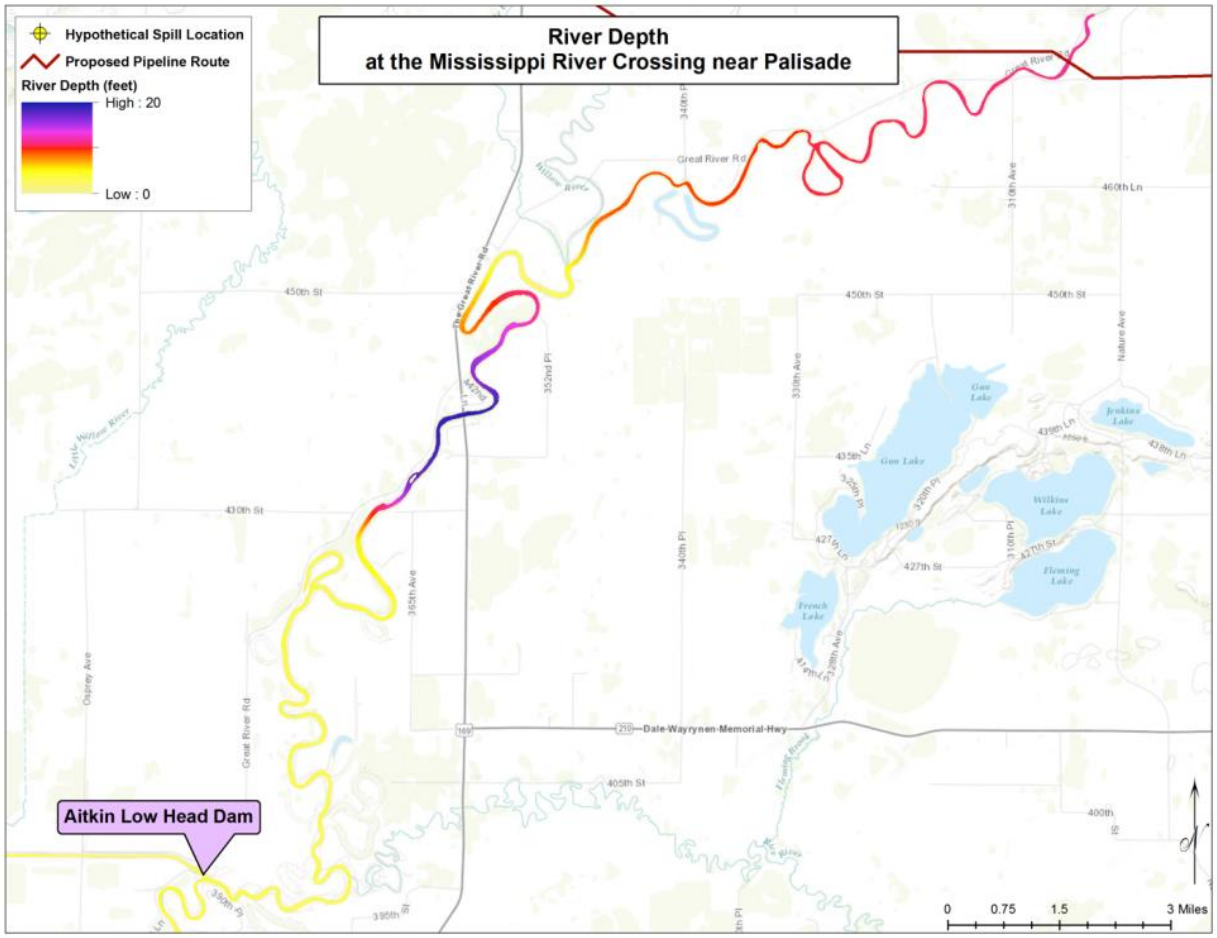


Figure 5-30 River Depth for the Mississippi River at Palisade Release Location

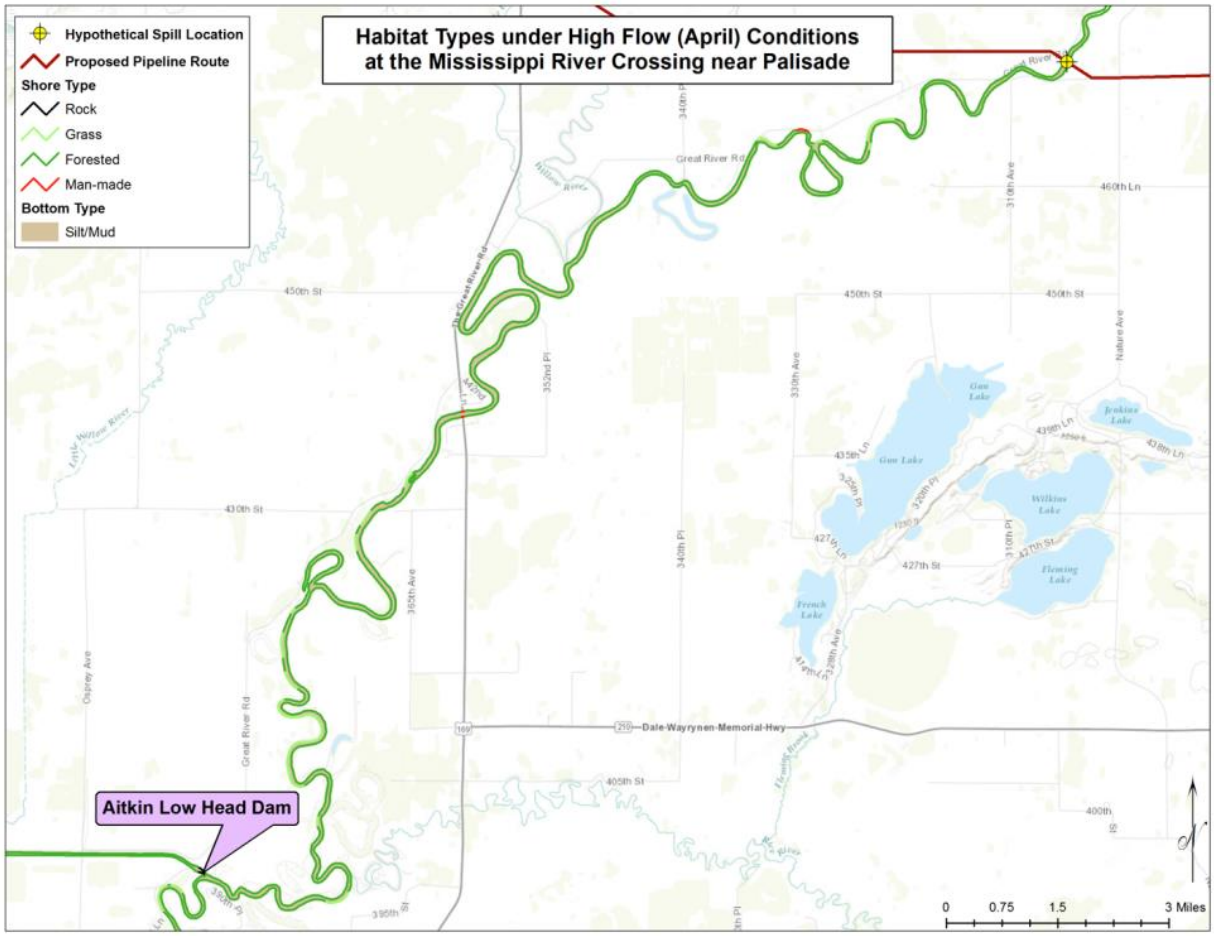


Figure 5-31 Habitat Types for the Mississippi River at Palisade Release Location Under High Flow Conditions

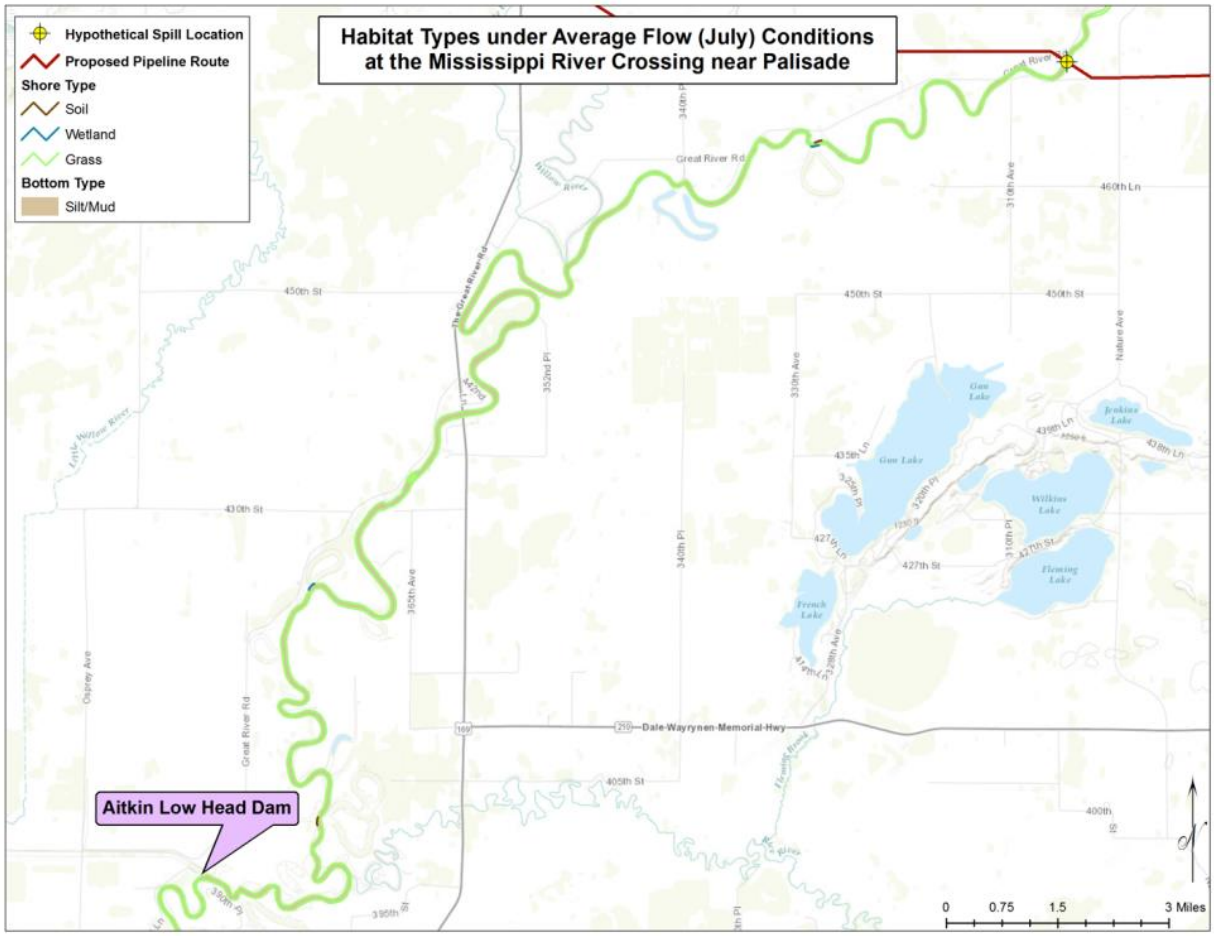


Figure 5-32 Habitat Types for the Mississippi River at Palisade Release Location Under Average Flow Conditions

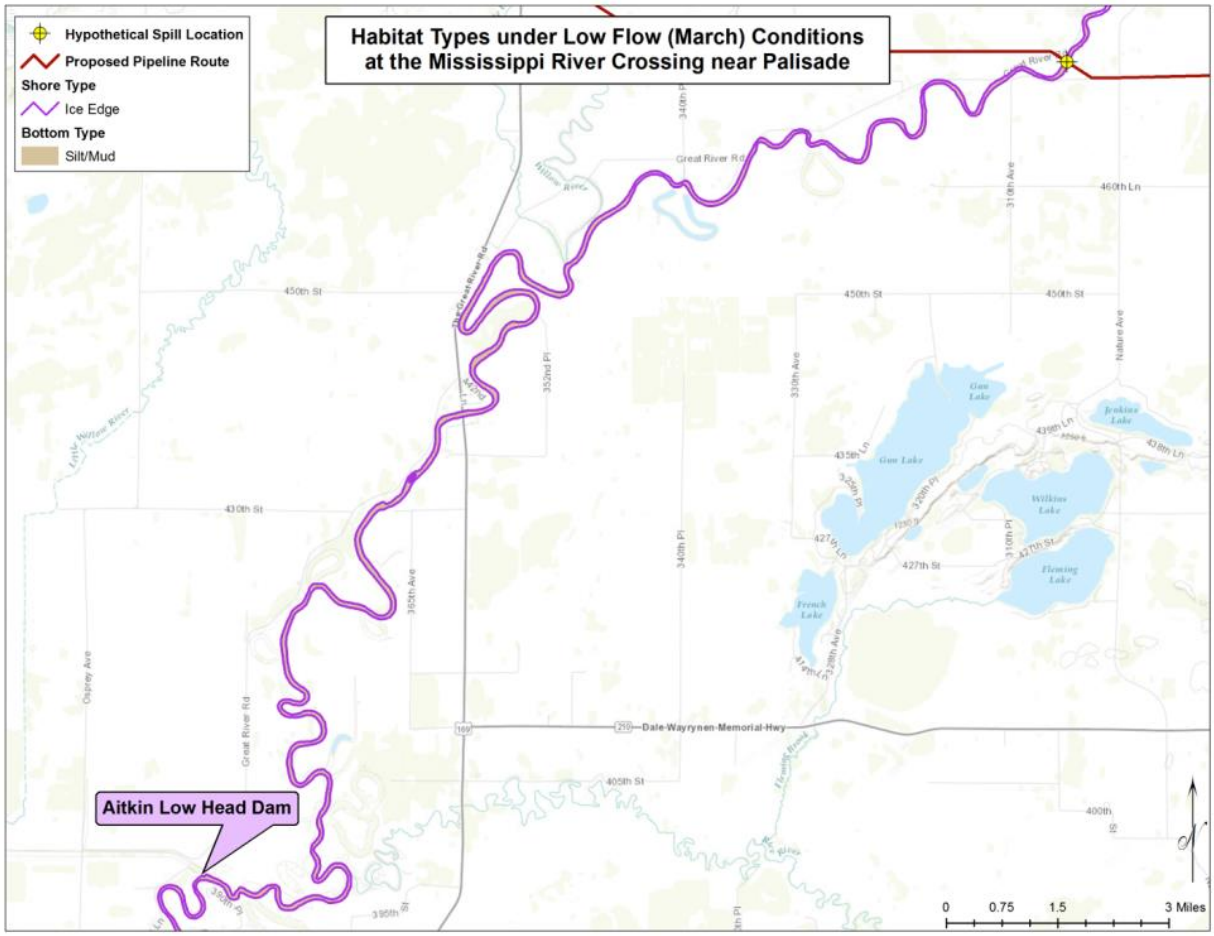


Figure 5-33 Habitat Types for the Mississippi River at Palisade Release Location Under Low Flow Conditions

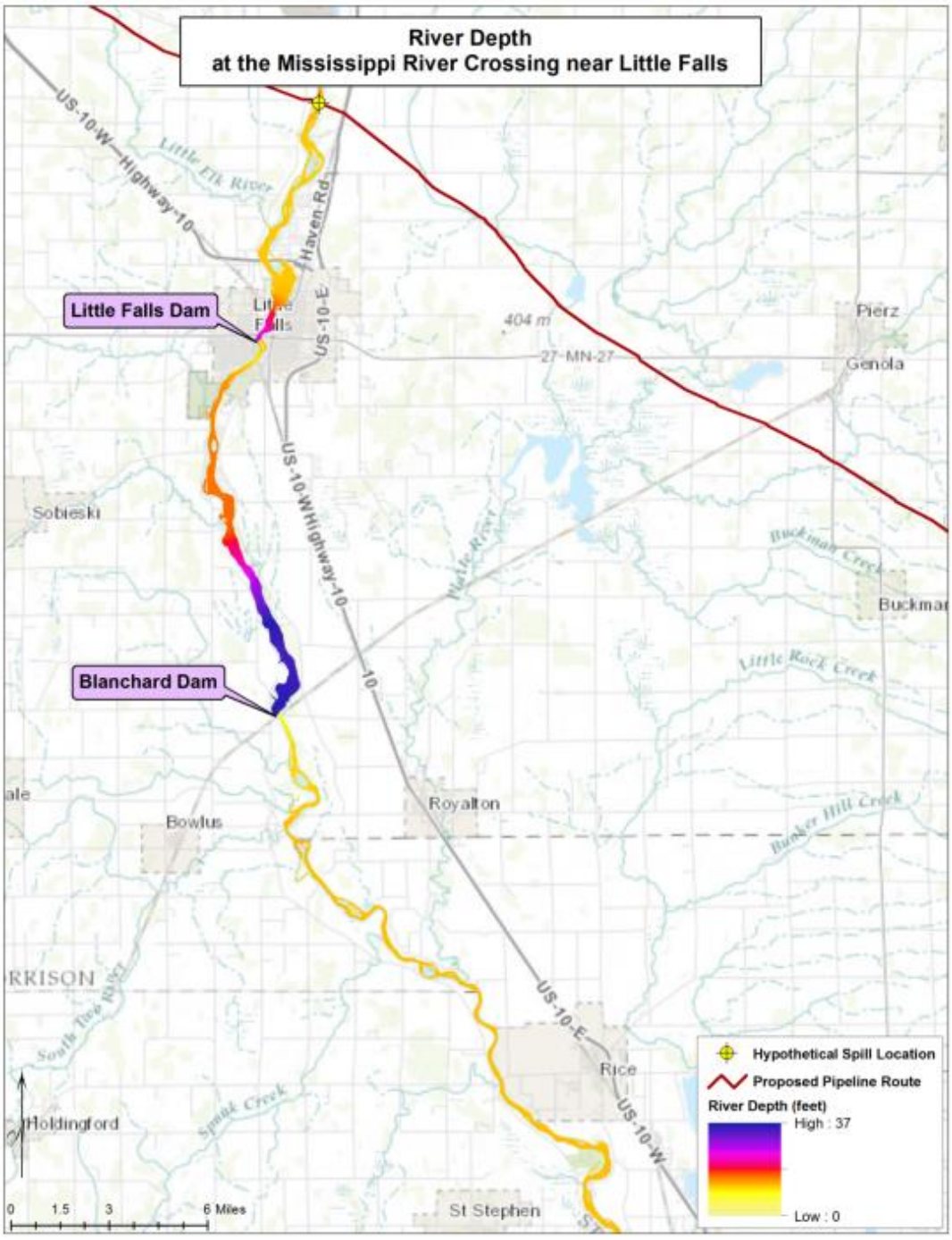


Figure 5-34 River Depth for the Mississippi River at Little Falls Release Location

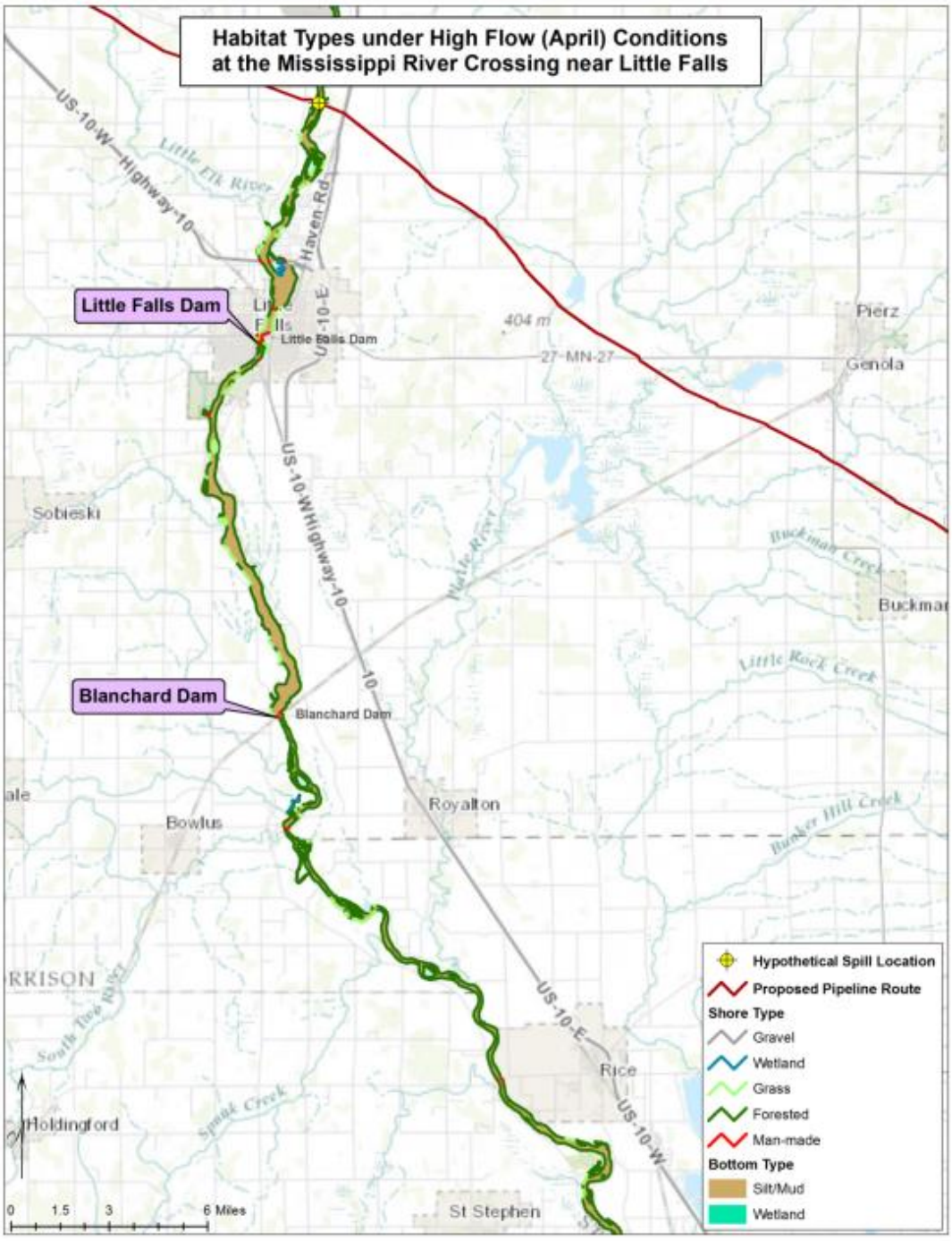


Figure 5-35 Habitat Types for the Mississippi River at Little Falls Release Location Under High Flow Conditions

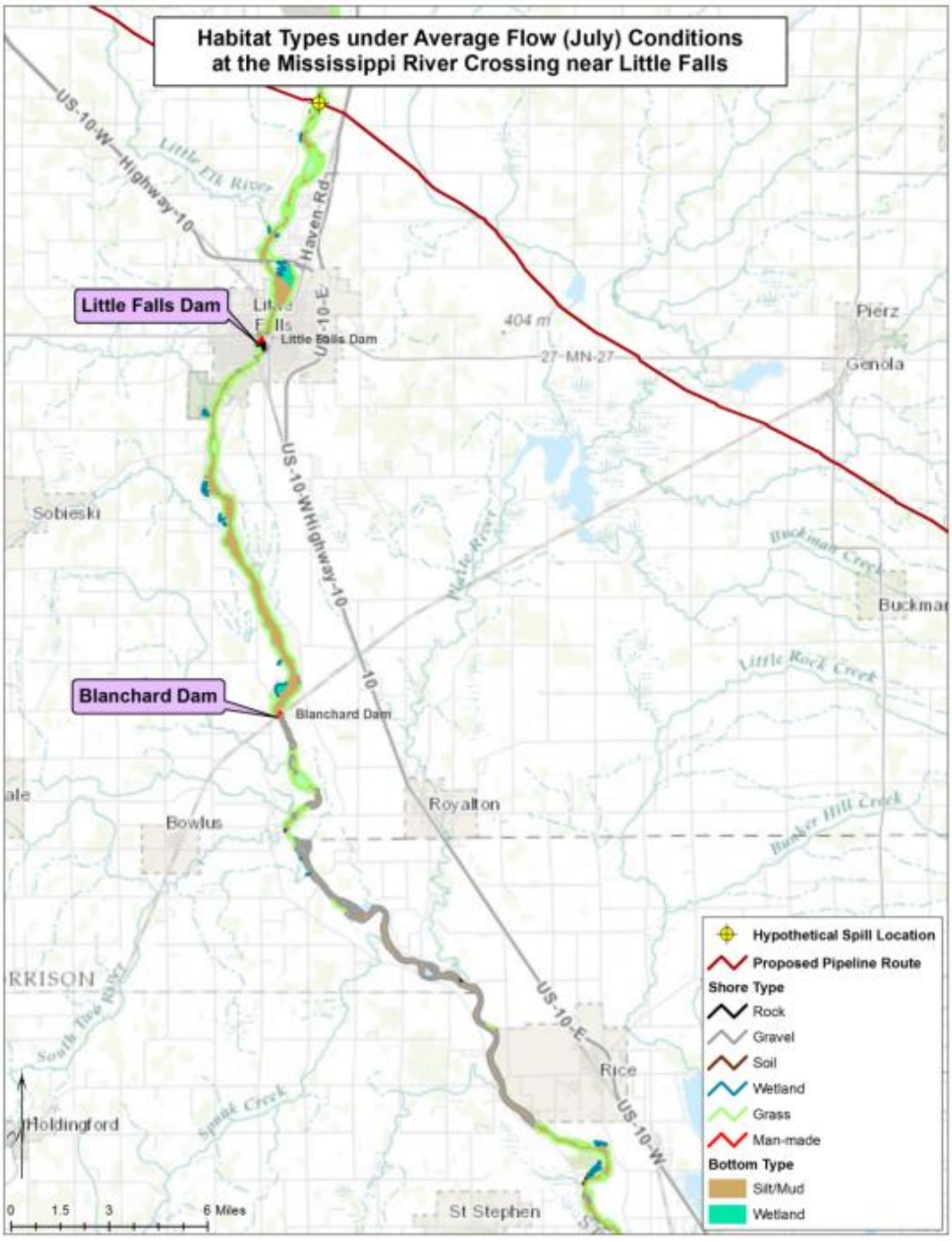


Figure 5-36 Habitat Types for the Mississippi River at Little Falls Release Location Under Average Flow Conditions

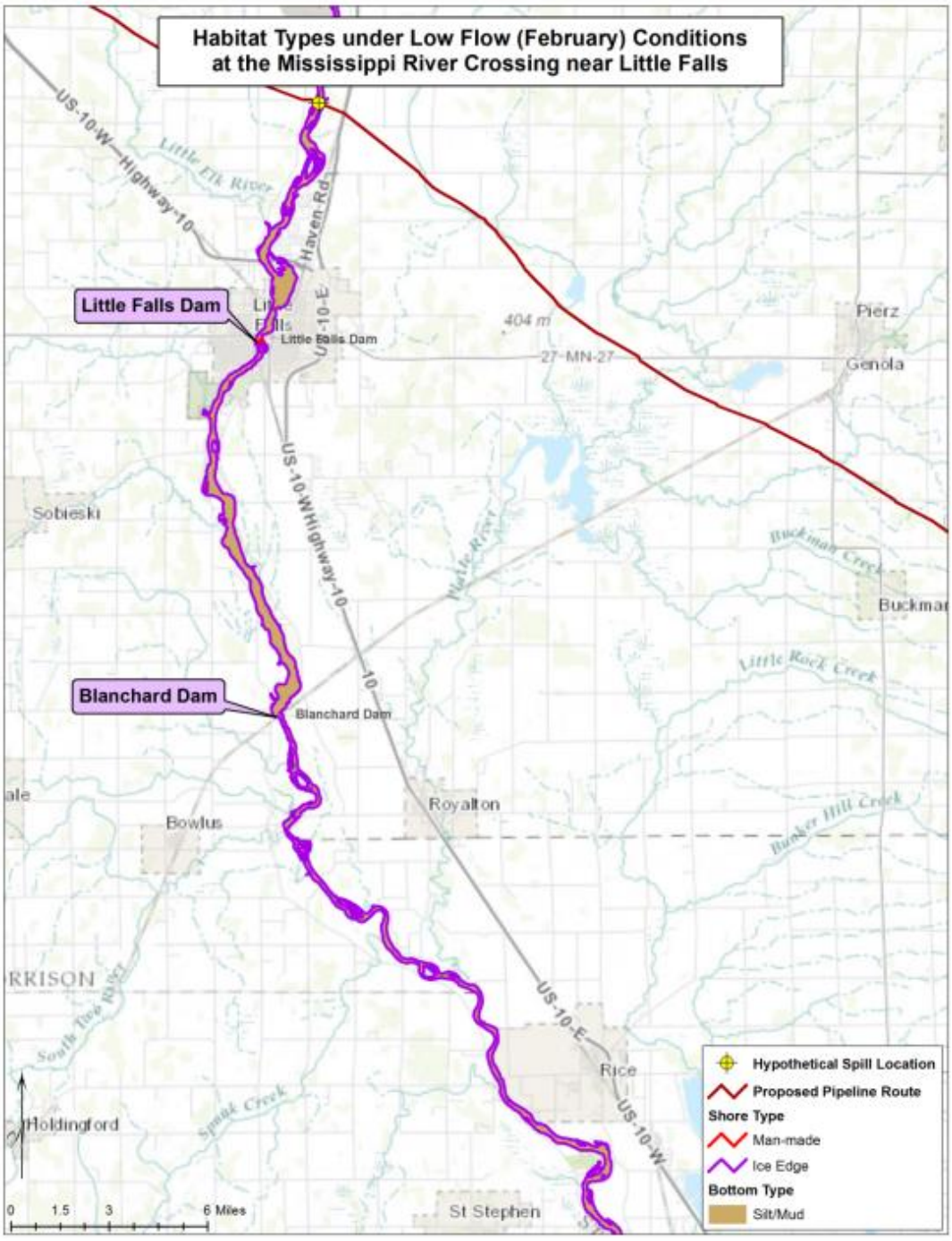


Figure 5-37 Habitat Types for the Mississippi River at Little Falls Release Location Under Low Flow Conditions

5.3.3.2 Environmental Data

5.3.3.2.1 River Currents

Currents have an important influence on the trajectory and fate of the oil, and are critical data inputs. The SIMAP modeling system used spatially varying current fields throughout a gridded domain of the river within the study area to force oil throughout the domain. The current fields were generated using BFHYDRO, a hydrodynamic model created by RPS ASA. The model was used to first generate a boundary fitted grid mapped to the wetted domain, as defined by the NHD. It was then used to generate a spatially varying current field for three different environmental conditions representing low, average, and high monthly average river flows and associated current speeds.

5.3.3.2.1.1 Hydrologic Analysis

NHDPlus is a geo-spatial, hydrologic framework dataset built by the US EPA Office of Water, assisted by the USGS. The NHDPlus data set was queried to determine the variability in monthly flows and river reach speeds within the study area. NHDPlus includes an estimated monthly and annual average stream flow rate and velocity for each stream segment. Flow is estimated using EROM. This method determines river flow based on estimates of accumulated runoff based on the elevation data, evaporative loss, and various adjustments based on gages within the region. The velocities are calculated based on the estimated flow using the Jobson Method (Jobson 1996). A summary of the monthly flows and current speeds at points within the Palisade and Little Falls domains are presented in Table 5-12. Based on analysis of this data, it was determined that the months representing low river flow conditions were March for the Mississippi River at Palisade and February for the Mississippi River at Little Falls. Average river flow conditions occurred in July, with high river flow conditions in April for both locations.

Table 5-12 Summary of Monthly River Flows and Current Speeds for SIMAP Release Sites

Month	Mississippi River at Palisade		Mississippi River at Little Falls	
	Flow (m^3/s)	Current Speed (m/s)	Flow (m^3/s)	Current Speed (m/s)
January	53.8	0.35	99.5	0.47
February	52.9	0.35	95.2	0.46
March	45.6	0.33	142.1	0.54
April	109.6	0.47	276.8	0.74
May	92.2	0.44	252.3	0.70
June	72.5	0.40	167.1	0.58
July	66.1	0.38	178.2	0.60
August	50.6	0.34	113.4	0.49
September	48.2	0.34	109.0	0.48

Table 5-12 Summary of Monthly River Flows and Current Speeds for SIMAP Release Sites

Month	Mississippi River at Palisade		Mississippi River at Little Falls	
	Flow (m^3/s)	Current Speed (m/s)	Flow (m^3/s)	Current Speed (m/s)
October	79.5	0.41	138.7	0.54
November	85.2	0.42	142.0	0.54
December	63.0	0.37	117.5	0.50
Low	45.6	0.33	95.2	0.46
Average	68.3	0.38	152.7	0.55
High	109.6	0.47	276.8	0.74

5.3.3.2.1.2 Hydrodynamic Modeling System

The hydrodynamic modeling was carried out using the in-house modeling tool BFHYDRO within the Water Quality Mapping and Analysis Program (WQMAP) modeling system, both of which were created by RPS ASA (Mendelsohn et al. 1995). WQMAP integrates geographic information (land use, watersheds, etc.), environmental data (water quality parameters, surface elevations and velocities, stream flows, bathymetry, etc.), and models (analytical and numerical, hydrodynamic, pollutant transport, etc.). The WQMAP computational engine is a family of general curvilinear coordinate system computer models including a boundary conforming gridding model (BFGRID) and a hydrodynamic model (BFHYDRO). This study used BFGRID to generate a grid of the model domain and BFHYDRO to perform simulations to generate current fields.

The boundary fitted grid generation model BFGRID is a tool used to build a grid of the study area on which the hydrodynamics and pollutant transport models run. The boundary-fitted coordinate system approach generates transformation functions such that all domain boundaries are coincident with coordinate lines. The grid generation is accomplished by using a set of coupled quasi-linear elliptic transformation equations to map an arbitrary horizontal multi-connected region from physical space to a rectangular mesh structure in the transformed horizontal plane (Mendelsohn et al. 1995; Spaulding 1984; Thompson et al. 1977). While the transformed set of equations is considerably more complex than the original set, the transformed boundary conditions are specified on straight lines and the coordinate spacing is uniform in the transformed plane. It should further be noted that the orthogonal and conformal curvilinear grids, as well as the simple stretched rectangular and square grids, are special cases of the general curvilinear, boundary-fitted coordinate approach used here.

Key boundary points are specified by the user and the structure of computational grid (I,J coordinates) is defined interactively on a map using a graphical user interface. After specifying key grid nodes (grid corners) along the domain boundary, the model interpolates the remaining

boundary node locations and then solves the transformed equations to locate the interior nodes. The resulting non-orthogonal grid contains quadrilaterals of various sizes and orientation to both resolve fine detail where needed, and cover large areas with coarse resolution where resolution is not required. The hydrodynamic and water quality models then use this grid in their numerical solution of the appropriate conservation equations.

BFHYDRO is a three dimensional, general curvilinear coordinate, boundary-fitted computer model (Mendelsohn 1998; Muin and Spaulding 1997; Huang and Spaulding 1995; Muin 1993) and is used to predict elevations, and current velocities within the gridded domain. The boundary-fitted model matches the model coordinates with the shoreline boundaries of the water body, accurately representing the study area. This system also allows the user to adjust the model grid resolution as desired. This approach is consistent with the variable geometry of the riverine shoreline. The model may be applied in either two or three dimensions, depending on the nature of the inquiry and its complexity. The hydrodynamic model uses the boundary fitted method and grid system as described above. The three dimensional conservation of mass and momentum equations, with approximations suitable for lakes, rivers, and estuaries (Swanson 1986; Muin 1993) that form the basis of the model, are then solved in this transformed space. In addition, a sigma stretching system is used in the vertical dimension to map the free surface and bottom onto coordinate surfaces to resolve variable surface elevations and bathymetric variations. The resulting equations are solved using an efficient semi-implicit finite difference algorithm for the exterior mode (two dimensional vertically averaged), and by an explicit finite difference leveled algorithm for the vertical structure of the interior mode (three dimensional) (Swanson 1986). The velocities are represented in their contra-variant form.

The basic equations are written in spherical coordinates to allow for accurate representation of large modeled areas. The conservation equations for water mass and momentum (in three dimensions) form the basis of the model, and are well established. It is assumed that the flow is incompressible, that the fluid is in hydrostatic balance, the horizontal friction is not significant, and the Boussinesq approximation applies all customary assumptions.

The boundary conditions are as follows:

- At land, the normal component of velocity is zero
- At open boundaries, the free surface elevation must be specified, and temperature (and salinity for estuarine and coastal applications) specified on inflow
- A bottom stress or a no slip condition is applied at the bottom. No temperature (heat) is assumed to transfer to or from the bottom, a conservative assumption as some transfer of heat to the bottom is expected to occur.
- A wind stress and appropriate heat transfer terms are applied at the surface

The set of governing equations with dependent and independent variables transformed from spherical to curvilinear coordinates, in concert with the boundary conditions, is solved by a semi-implicit, split mode finite difference procedure (Swanson 1986). The equations of motion are vertically integrated and, through simple algebraic manipulation, are recast in terms of a single

Helmholtz equation in surface elevation. This equation is solved using a sparse matrix solution technique to predict the spatial distribution of surface elevation for each grid.

The vertically averaged velocity is then determined explicitly using the momentum equation. This step constitutes the external or vertically averaged mode. Deviations of the velocity field from this vertically averaged value are then calculated, using a tridiagonal matrix technique. The deviations are added to the vertically averaged values to obtain the vertical profile of velocity at each grid cell, thereby generating the complete current patterns. This constitutes the internal mode. The methodology allows time steps based on the advective, rather than the gravity, wave speed (as in conventional explicit finite difference methods) and, therefore, results in a computationally efficient solution procedure (Swanson 1986; Muin 1993).

5.3.3.2.1.3 Hydrodynamic Solution

Hydrodynamic modeling was performed to generate river current speeds that matched the average reach speeds in the NHDPlus data set for the designated months. The BFHYDRO model was used to generate current fields that matched the NHDPlus average reach estimates. The NHDPlus estimates are simplifications that assign constant current speeds for a reach. In reality, there are variations across and along each reach due to bottom elevation changes, river cross-section changes, and other local features. The BFHYDRO model was used to simulate this variability, while representing the NHDPlus average reach speed. A summary of the range of river current speeds (10th, 50th and 90th percentile) for each representative season for both the Mississippi River at Palisade and the Mississippi River at Little Falls domains are summarized in Table 5-13. Illustrations of the spatial variability of current speeds location for low, average and high flow seasons are presented in Figure 5-38 through Figure 5-40 for the Mississippi River at Palisade release location and in Figure 5-41 through Figure 5-43 for the Mississippi River at Little Falls release, respectively.

Table 5-13 Mean River Velocity Modeled for Each SIMAP Release Site and Season

Case #	Release Site	Season / River Flow	Month	River Velocity (m/s)
6	Mississippi River at Palisade	Low	March	0.33
		Average	July	0.38
		High	April	0.47
7	Mississippi River at Little Falls	Low	February	0.46
		Average	July	0.60
		High	April	0.74

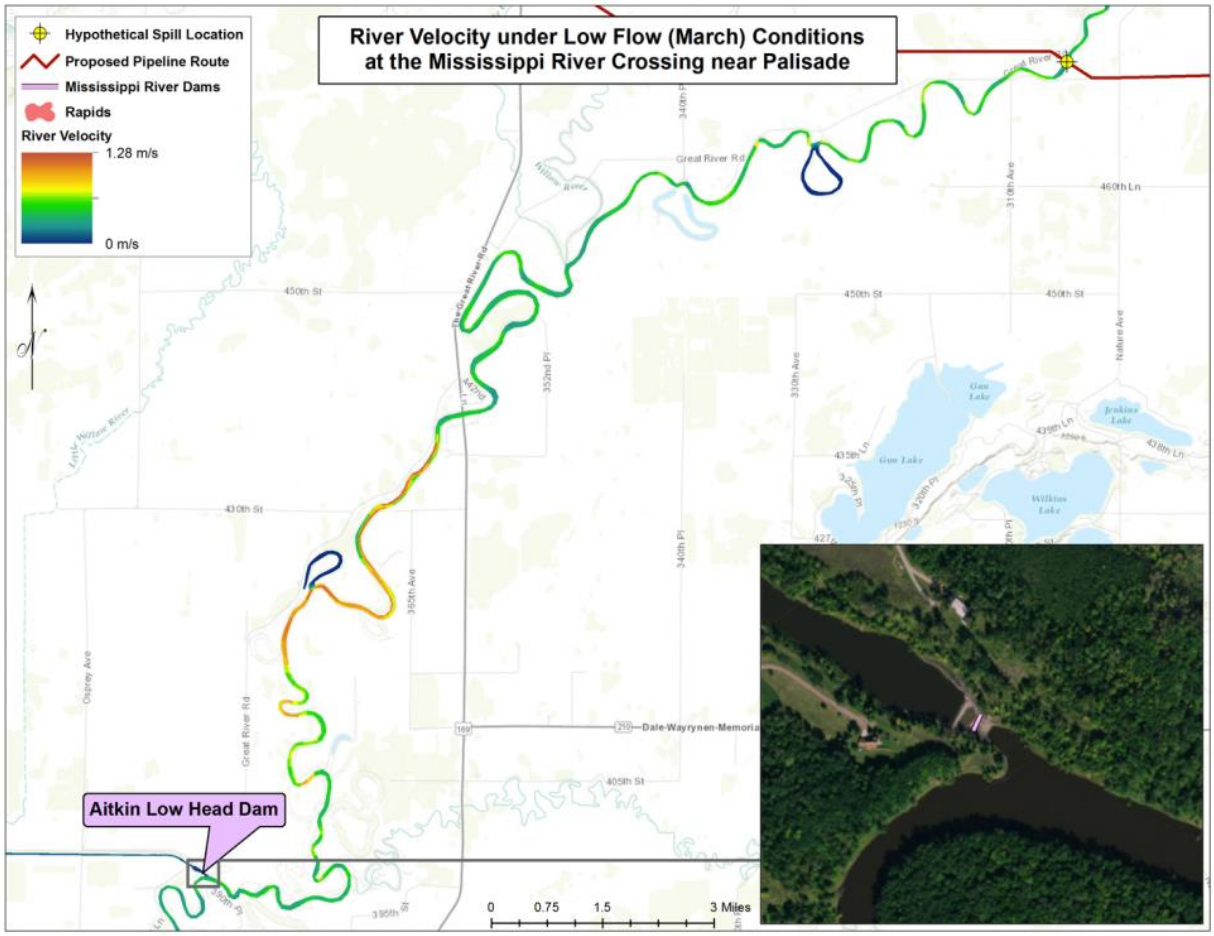


Figure 5-38 Spatial Variability of Downstream Current Speeds for Low Flow Conditions at the Mississippi River Crossing Near Palisade

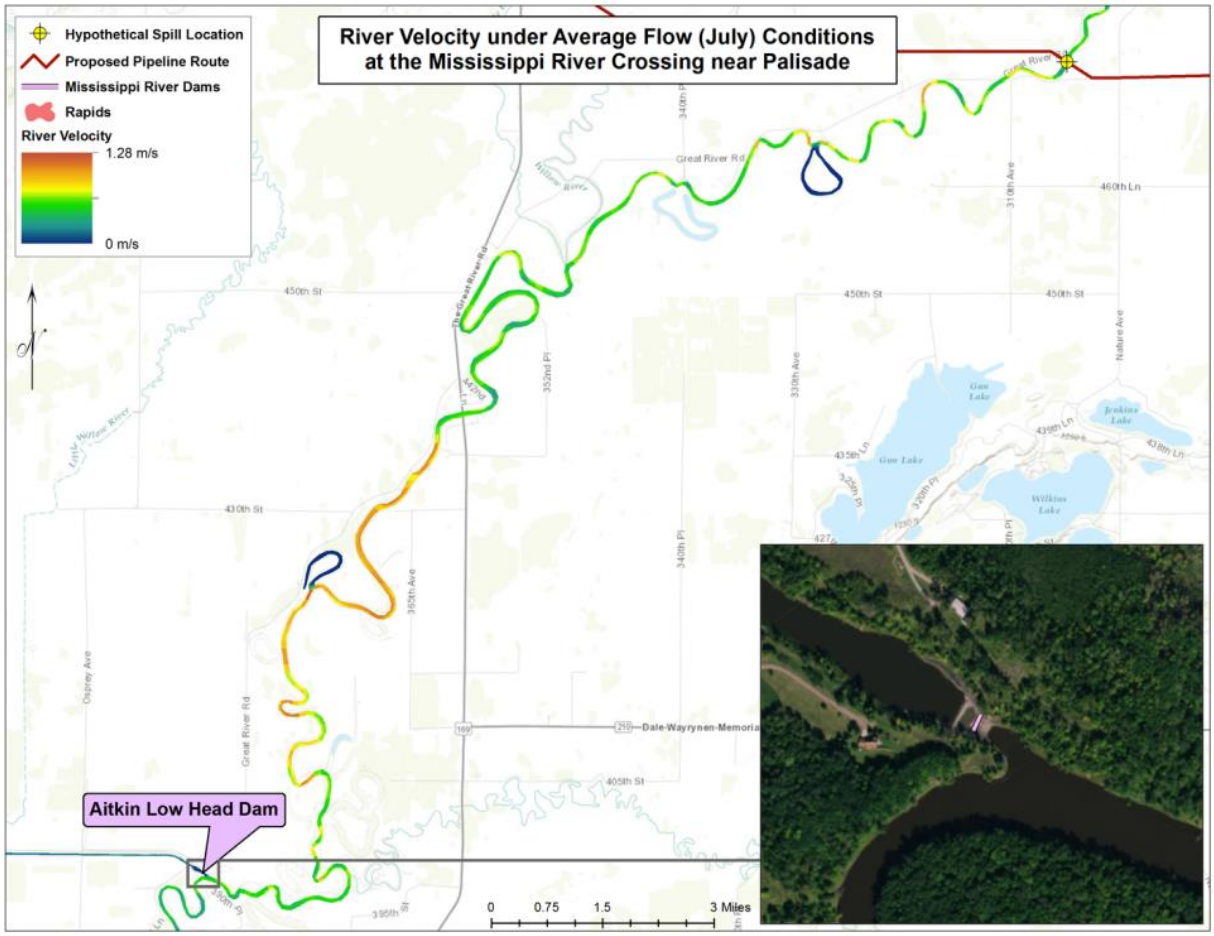


Figure 5-39 Spatial Variability of Downstream Current Speeds for Average Flow Conditions at the Mississippi River Crossing Near Palisade

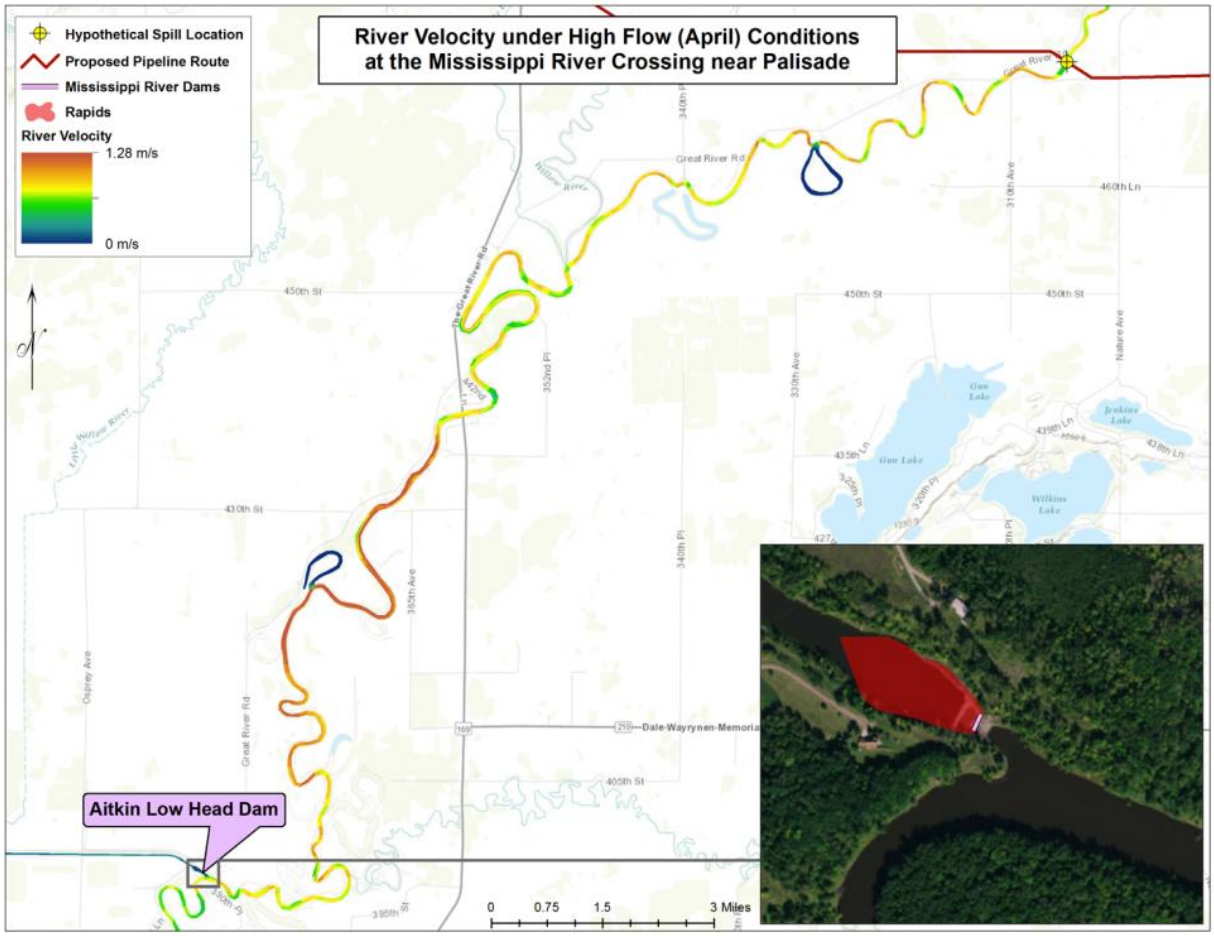


Figure 5-40 Spatial Variability of Downstream Current Speeds for High Flow Conditions at the Mississippi River Crossing Near Palisade

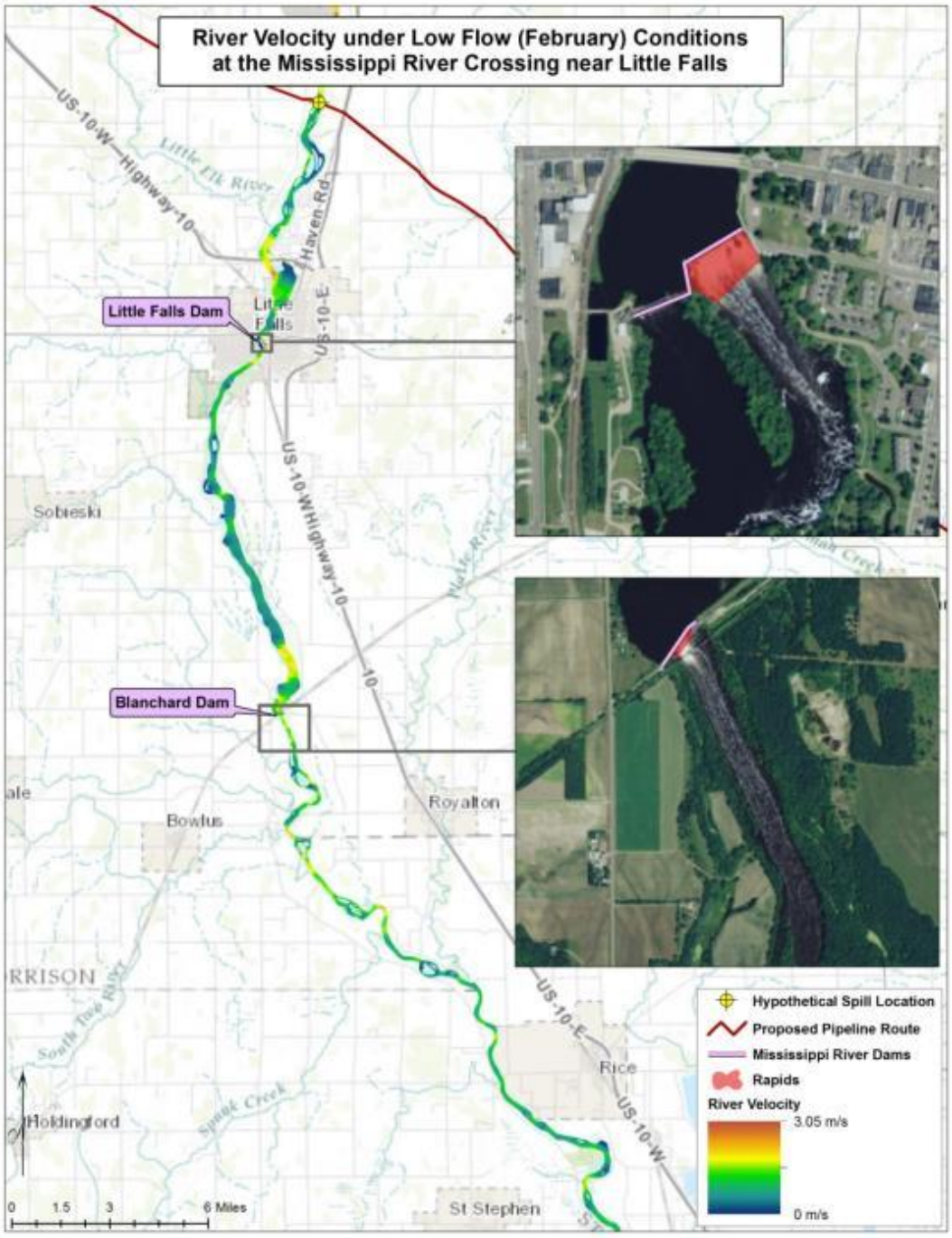


Figure 5-41 Spatial Variability of Downstream Current Speeds for Low Flow Conditions at the Mississippi River Crossing Near Little Falls

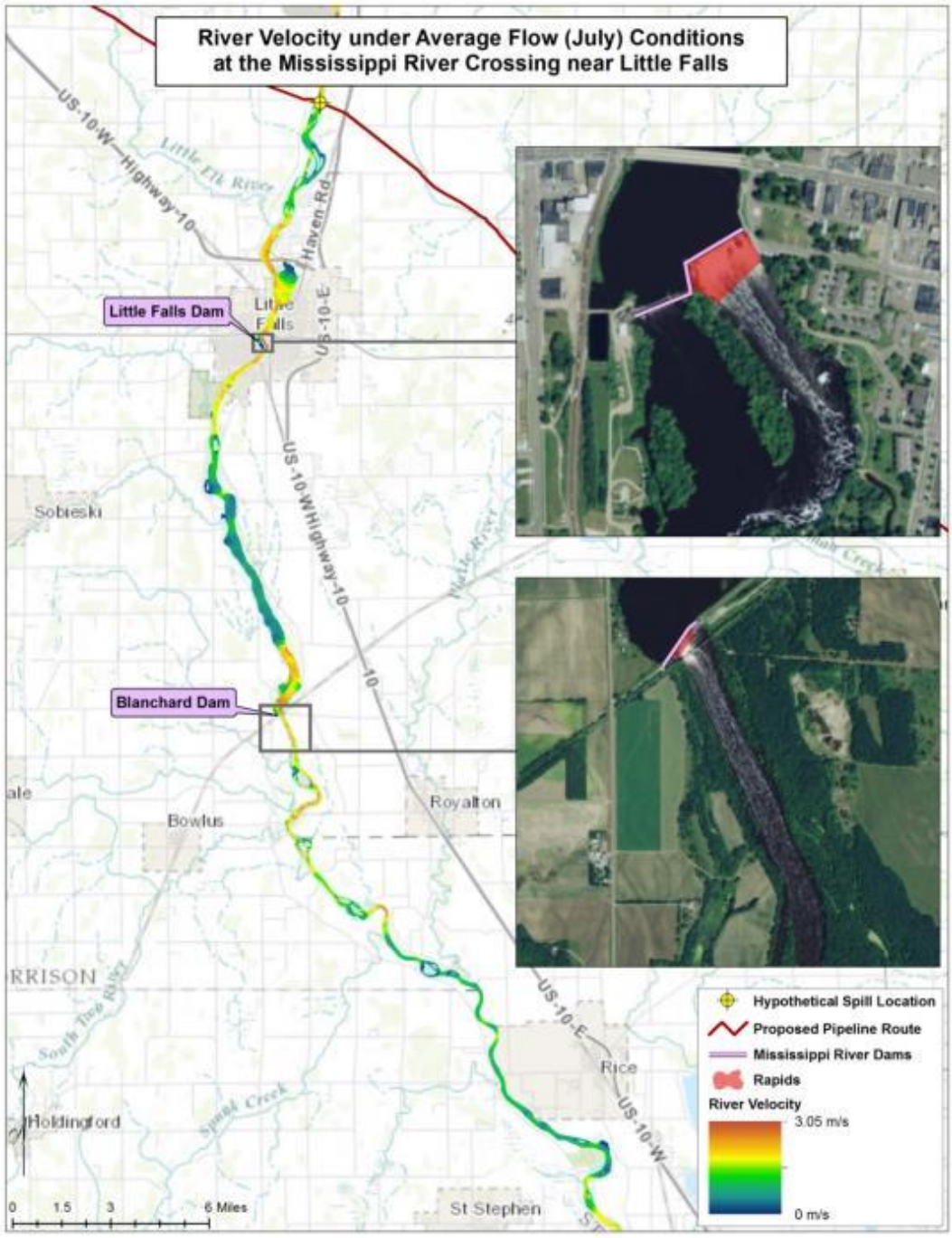


Figure 5-42 Spatial Variability of Downstream Current Speeds for Average Flow Conditions at the Mississippi River Crossing Near Little Falls

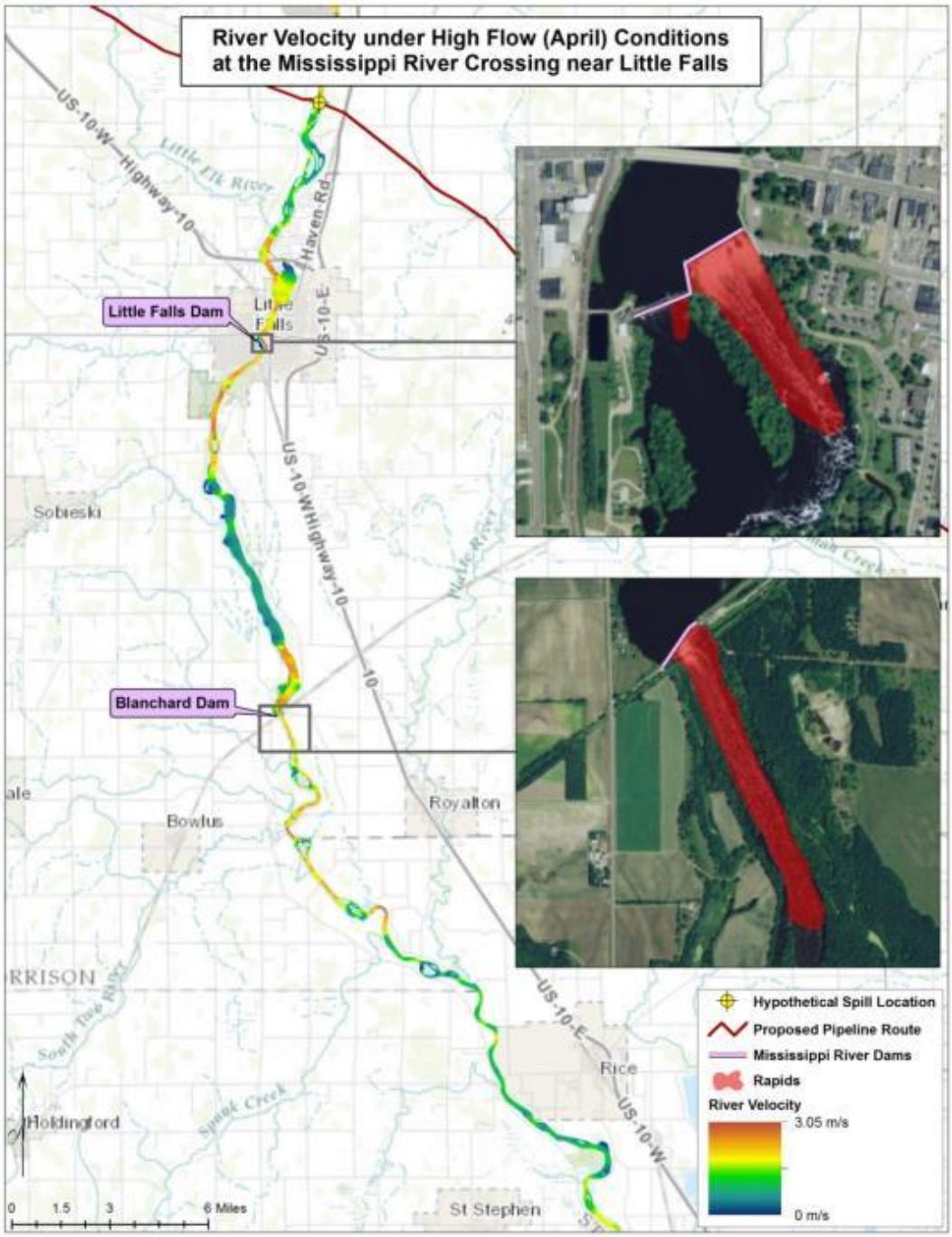


Figure 5-43 Spatial Variability of Downstream Current Speeds for High Flow Conditions at the Mississippi River Crossing Near Little Falls

5.3.3.2.2 Wind and Temperature

The same wind and temperature data sources for that were used as inputs for the OILMAP Land scenarios (Section 5.3.2.4) were also used to develop wind and temperature information for the two Mississippi River SIMAP scenarios. Daily climatological statistics from 2000 to 2015 consisting of wind speed, wind direction, and air temperature were obtained from the NOAA National Centers for Environmental Information website (NOAA 2016a) and were averaged by month. Table 5-14 depicts the temperatures and wind speeds used for each seasonal scenario at each release location. Because these were river simulations, salinity was assumed to be zero for all modeling locations.

Table 5-14 Air Temperature and Wind Speed Values Used as Model Inputs for Each SIMAP Release Location and Seasonal Scenario

Case #	Release Location	Season / River Flow	Month	Air Temp. (°C)	Air Temp. (°F)	Wind Speed (m/s)
6	Mississippi River at Palisade	Low	March	-3.19	26.26	4.78
		Average	July	20.19	68.34	3.95
		High	April	5.03	41.05	5.24
7	Mississippi River at Little Falls	Low	February	-8.33	17.01	4.30
		Average	July	22.06	71.71	3.47
		High	April	7.06	44.71	4.85

Winds may physically transport oil on the water surface and wind speed and direction at the water surface may make a difference between limited (especially in windy sections of river) or extensive transport. The wind data available is for open areas at some distance from the release sites examined, as opposed to in the forested stream areas modeled; thus, local winds at each point downstream from the release location may be different than the reported wind speed and direction. Because of these uncertainties and the expected variability in direction, the SIMAP model conservatively assumed wind drift transport as zero (i.e., winds did not laterally transport oil or push it ashore) for each of the modeling locations. The modeled wind was therefore not a true vector as it had magnitude, but no direction. Because of this assumption, winds may add to the evaporation of surface oil in the model output, and could enhance the vertical mixing of the surface water, in some instances keeping subsurface oil entrained or entraining more oil under higher wind speeds.

5.3.3.2.3 Total Suspended Solids

The amount of sediment transport can change by several orders of magnitude based on location and flow conditions, with extensive of sediment transport during high river flow conditions (especially storm events), and very low sediment transport and clear water during low river flow conditions (e.g., under winter ice cover). During peak storm events, it is not uncommon to have values exceeding 1,000 mg/L in some locations. Oil droplets may stick to suspended

sediments and settle out to the bottom. The sedimentation rate was set to 1 mm/day for high flow scenarios and 0.1 mm/day for low flow scenarios. At suspended sediment concentration of about 100 mg/L, sedimentation of oil and PAHs becomes substantial. Sediment loads were assumed to be 99, 25, and 10 mg/l for the high, average, and low river flow conditions, respectively.

5.3.3.2.4 Ice Cover

Oil interactions with mobile and immobile ice involve several processes that affect the transport and fate of the oil. Oil released under water may become trapped under the ice in ridges and keels, or build up along and become trapped (Drozdowski et al. 2011). Many of these interactions and processes are at a finer scale than can be captured in oil spill models using inputs from the available large scale meteorological, hydrodynamic and coupled hydrodynamic-ice models. SIMAP simulates the influence of ice on net transport and fate processes by considering potential reduction in the surface area of the oil and the water in contact with the atmosphere, which changes the effects of the wave environment, spreading, movements, dissolution, volatilization, and mixing on the released oil.

In SIMAP, when oil encounters ice at the surface of the river, it is assumed to trap along the ice edge and remain immobile until ice retreats. In areas deep enough for ice to have subsurface open channels (i.e., where the ice sheet may not extend completely to the riverbed in all areas), SIMAP allows entrained oil to circulate underneath the surface ice using subsurface current data for transport. The 100% ice coverage on the rivers during the winter was assumed to have a thickness of ice of 0.5 m. Therefore, subsurface oil spillets continued to move downstream with currents, until the spillets reached the water-ice interface, at which point they "stick."

The presence of ice can shelter oil from the wind and waves (Drozdowski et al. 2011). Thus, weathering processes such as evaporation and emulsification, and behaviors such as spreading and entrainment are slowed (Spaulding 1988). Field data show evaporation, dispersion, and emulsification s slowed substantially in ice leads, contrary to some laboratory experiments. Wave-damping, the limitations on spreading dictated by the presence of sea ice, and temperature appear to be the primary factors governing observed spreading and weathering rates (Sørstrøm et al. 2010).

During the low flow river conditions, corresponding with the winter months, ice cover was assumed to be 100%. With 100% ice coverage, SIMAP stops the processes of evaporation, emulsification, entrainment, volatilization, and spreading.

6.0 TRAJECTORY AND FATE RESULTS FOR MODELING LOCATIONS

6.1 DESCRIPTION OF OILMAP LAND MODEL OUTPUTS

This section provides modeled predictions of expected downstream transport and mass balance information for CLB (either Winter or Summer) and Bakken Crude oil under high, average, and low river flow conditions at five hypothetical release locations modeled in OILMAP Land.

As described in Section 5.1.1, OILMAP Land predicts the trajectory and fate of released oil. The model includes a land component that predicts how much oil will adhere to vegetation and soils and remain in depressions in the landscape, as well as the quantity that would be lost to evaporation during overland flow. Overland trajectory and fate were modeled only for the Mosquito Creek site (Section 6.2), as the other four sites assumed that oil was released directly into a watercourse. OILMAP Land also predicts the downstream trajectory and fate of released oil in water. The model calculates the amount of released oil that would evaporate, adhere to the shoreline, and remain on the water surface. In an actual oil release, other processes such as dissolution and dispersion would come into play (Section 7.1.2).

Figures are provided for each of the five modeling locations and two oil types in Sections 6.1.1 through 6.1.5. Each figure includes each of the three modeled seasons that correspond with high, average, and low river flow. In these figures, symbols with different color/shape combinations denote the location and time in hours of the farthest downstream movement of released crude oil for each set of scenarios at a given location. The mass balances are also provided, summarizing how much of the oil remained on the river surface, evaporated to the atmosphere, or stranded on the riverbanks. The model was run for 24 hours, or until no further oil remained on the river surface (i.e., all oil had evaporated or adhered to shorelines). If there was oil on the river surface after 24-hours, it would continue downstream, further oiling shorelines, until it either evaporated and stranded, or was captured by emergency response operations.

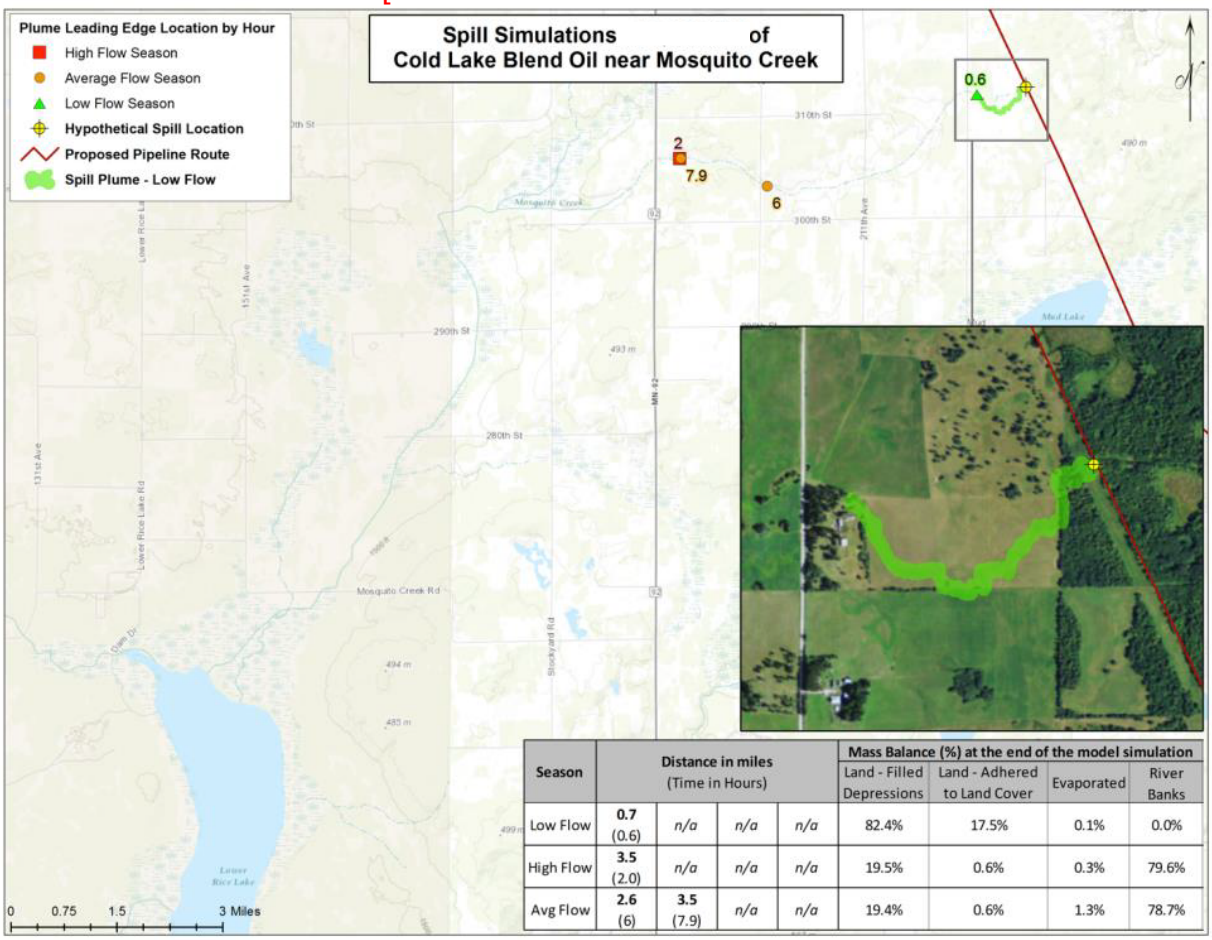
6.1.1 Unmitigated Hypothetical Release Case 1—Mosquito Creek to Lower Rice Lake

Mosquito Creek is a small stream located approximately 6 miles (9.7 km) south of Bagley, Minnesota. The pipeline does not actually cross Mosquito Creek; however, the simulated release location is located approximately 2,000 ft (610 m) to the northeast from the head of the creek and at a higher elevation. Based on local topography, oil would need to travel overland approximately 3,300 ft (1,006 m) before entering Mosquito Creek. Mosquito Creek flows to the southwest for approximately 12 miles (19.3 km) before entering Lower Rice Lake. Mosquito Creek is the smallest stream of the sites investigated with an average width of approximately 15 ft (5 m). At the widest points around its entrance into Lower Rice Lake, it is approximately 30 ft

(10 m) across, while the upper portions of the creek are much less ranging from approximately 3–15 ft (1–5 m) wide. Expected environmental and river flow conditions throughout the year for Mosquito Creek are provided in Table 5-6. In all release scenarios, spills were not predicted to enter Lower Rice Lake before all of the oil had either evaporated or adhered to the land cover or stream shorelines. Maps of the predicted downstream trajectory and mass balance tables of CLB (Figure 6-1) and Bakken Crude (Figure 6-2) seasonal scenarios for the Mosquito Creek release site are provided at the beginning of the following subsections.

6.1.1.1 Cold Lake Blend Scenarios

[NONPUBLIC DATA HAS BEEN EXCISED...



Season	Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Land - Filled Depressions	Land - Adhered to Land Cover	Evaporated	River Banks
Low Flow	0.7 (0.6)	n/a	n/a	n/a	82.4%	17.5%	0.1%	0.0%
High Flow	3.5 (2.0)	n/a	n/a	n/a	19.5%	0.6%	0.3%	79.6%
Avg Flow	2.6 (6)	3.5 (7.9)	n/a	n/a	19.4%	0.6%	1.3%	78.7%

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Figure 6-1 Predicted Downstream Transport of CLB Oil Near Mosquito Creek

6.1.1.1.1 Trajectory and Fate Results for High River Flow (Spring)

Flow rates on Mosquito Creek during the spring season (April) resulted in peak average river velocities ranging from 1.67 to 2.30 miles per hour (mph) (0.75 to 1.03 m/s). Under high river flow, CLSB was predicted to travel approximately 3.5 miles (5.6 km) downstream. After 2.0 hours, approximately 0.3% of the CLSB evaporated to the atmosphere, 20.1% filled depressions on land or adhered to land cover, and the remaining 79.6% oiled shorelines. Note that the model predicts that no CLSB would remain on the water surface after 2.0 hours since all of the released oil would have been retained in depressions, adhered to land cover, or evaporated by that point in time.

6.1.1.1.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Flow rates on Mosquito Creek during the summer (July) and fall resulted in average river velocities ranging between 0.43 to 0.47 mph (0.19 and 0.21 m/s). These velocities were significantly slower than the high river flow conditions during the spring. As in the high flow condition, all of the released CLSB was predicted to adhere to the land cover, adhere to the shorelines, or evaporate to the atmosphere within the same 3.5 miles from the release site. However, under average river flow conditions with lower velocities, it took approximately 7.9 hours to reach that same distance. After 7.9 hours, approximately 1.3% of the CLSB evaporated to the atmosphere, 20.0% filled depressions on land or adhered to land cover, and the remaining 78.7% oiled shorelines. Note that the model predicted that there would be no CLSB on the water surface after 7.9 hours.

Under the average river flow condition (i.e., summer), more of the CLSB was predicted to evaporate, when compared to the high flow conditions (i.e., spring). This is partially due to the higher temperatures in this summer scenario, however, the main factor in the increased evaporation was the longer time required for the CLSB to move downstream due to the slower stream velocities. The longer time allowed for more complete evaporation of the CLSB.

6.1.1.1.3 Trajectory and Fate Results for Low River Flow (Winter)

Under winter (February) conditions, the region near the Mosquito Creek release location was assumed to be covered in snow at a depth of 34.8 cm. In addition, it was assumed that Mosquito Creek would be frozen over (100% coverage of ice), with a layer of snow on top. Therefore, a release of CLWB from the pipeline onto land would result in a spill traveling over the snow surface and onto Mosquito Creek, but the oil would not enter the water.

Under winter conditions, CLWB was predicted to travel approximately 0.7 miles (1.13 km) over the land surface. Approximately 82.4% of the CLWB filled depressions in the land surface, 17.5% adhered to the land cover, and only 0.1% evaporated. After 0.6 hours, all of the released CLWB evaporated, adhered to the land cover, or filled depressions in the land surface; therefore, the model simulation stopped at that time.

Considerably more CLWB was predicted to adhere to the land cover in winter conditions due to the holding capacity of the snow cover, which is over 35 times greater than that of the typical

land cover in this area for CLWB (Table 5-9). With Mosquito Creek frozen over, additional depressions were created in surface of the stream that allowed more CLWB to form pools on the ice surface.

Very little evaporation was predicted to occur under winter conditions due to the very short (0.6 hour) duration of the simulation. Lower air temperatures also slow evaporation. Additionally, a reduced surface area for exchange was predicted due to less spreading of oil and no downstream transport. This resulted in a smaller surface area over which evaporation could occur.

6.1.1.1 Bakken Crude Scenarios

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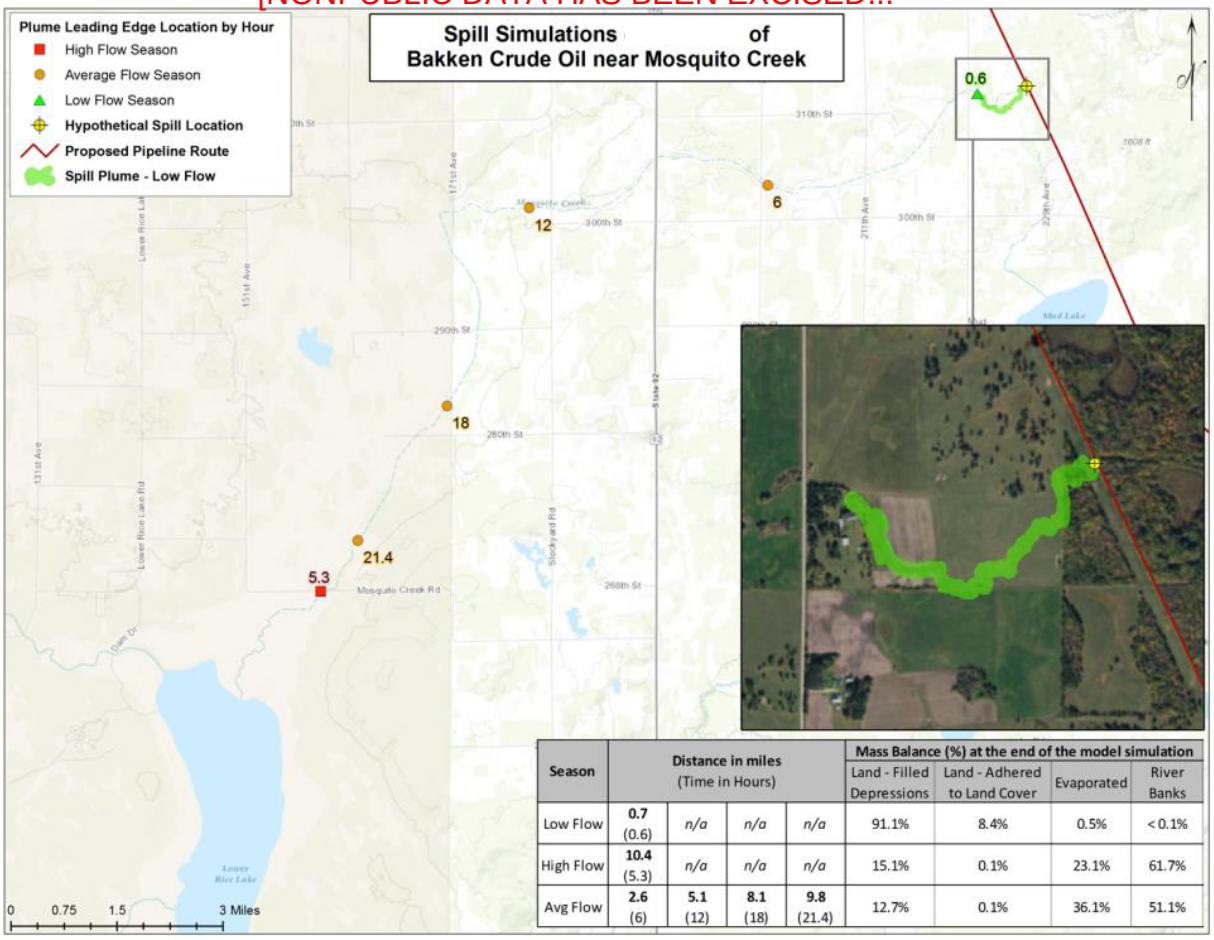

Season	Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Land - Filled Depressions	Land - Adhered to Land Cover	Evaporated	River Banks
Low Flow	0.7 (0.6)	n/a	n/a	n/a	91.1%	8.4%	0.5%	< 0.1%
High Flow	10.4 (5.3)	n/a	n/a	n/a	15.1%	0.1%	23.1%	61.7%
Avg Flow	2.6 (6)	5.1 (12)	8.1 (18)	9.8 (21.4)	12.7%	0.1%	36.1%	51.1%

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Figure 6-2 Predicted Downstream Transport of Bakken Crude Oil Near Mosquito Creek

6.1.1.1.4 Trajectory and Fate Results for High Flow (Spring)

Under high river flow conditions (April), Bakken crude traveled approximately 10.4 miles (16.7 km) downstream. After 5.3 hours, approximately 23.1% of the Bakken crude had evaporated to the atmosphere, 15.2% filled depressions on land or adhered to land cover, and the remaining 61.7% oiled shorelines. Note that there was no Bakken crude remaining on the water surface after 5.3 hours, as the model predicted that all of the oil would have been lost from the water surface by that point.

Under high river flow conditions, the Bakken crude resulted in oiling of shorelines nearly 3 times farther downstream (10.4 miles) than the CLSB (3.5 miles). The difference in the extent of downstream transport was primarily due to differences in the shoreline oil retention between the two oils. Because of its higher viscosity and other parameters, CLSB stranded upon shorelines more thickly than Bakken Crude oil, resulting in larger amounts of CLSB along the same length of shoreline. In contrast, the same amount of Bakken Crude oiled longer lengths of shoreline with a reduced thickness. While this result is logical, it is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point was oiled to its maximum holding capacity) as oil made its way downstream. In the event of an actual release, the downstream extents of CLSB and Bakken Crude may be more similar, and the effects of CLSB may extend farther downstream than presented, with patchy coverage.

Due to its lighter nature and higher volatile content, Bakken Crude was predicted to evaporate more completely (23.1%) than the CLSB (0.3%) oil. The Bakken Crude oiled farther downstream, which also took more time. The additional time for downstream transport allowed for more time over which the oil evaporated to the atmosphere.

6.1.1.1.5 Trajectory and Fate Results for Average Flow (Summer-Fall)

Under average river flow conditions (July), the Bakken Crude traveled approximately 9.8 miles downstream. At that point, approximately 36.1% of the Bakken Crude had evaporated to the atmosphere, 12.7% filled depressions on land or adhered to land cover, and the remaining 51.1% would have adhered to shorelines. The model predicted that no Bakken Crude would remain on the water surface after 21.4 hours.

Under average flow conditions, the Bakken Crude was predicted to oil 0.6 fewer miles (0.97 km) of shoreline than during high river flow conditions. Under average river flow conditions, the Bakken Crude was transported downstream at a slower velocity than that of the high river flow conditions. Since this allowed more time for evaporation from the stream surface, less oil was available for shoreline retention. Although the land surface retained the same volume of oil under high flow and average flow conditions, more of the released oil evaporated over the 21.4 hours of the average flow simulation, than during the 5.3 hour high flow simulation. This resulted in less oil remaining on the land surface at the end of the simulation.

6.1.1.1.6 Trajectory and Fate Results for Low Flow (Winter)

Under winter conditions (February) Bakken crude traveled approximately 0.7 miles over the land surface. At that point, approximately 91.1% of the oil filled depressions in the land surface, 8.4% adhered to the land cover, and only 0.5% evaporated. After 0.6 hours, all of the released Bakken Crude evaporated, adhered to the land cover, or filled depressions in the land surface; therefore, the model simulation stopped.

Considerably more Bakken Crude adhered to the land cover during low flow (winter) conditions than during high or average river flow conditions, due to the holding capacity of snow cover. The holding capacity of snow for Bakken Crude was over 100 times the retention values of the typical land cover in this area (Table 5-9). However, the holding capacity on snow for Bakken Crude is about half of that for CLWB; therefore, a release of Bakken will create a footprint that is nearly double the areal extent of CLWB. The model predicts that very little evaporation will occur over the 0.6 hours of the simulation under winter conditions, since lower air temperatures slowed evaporative losses. Additionally, the smaller surface area, due to reduced spreading of either type of oil without entering the creek, resulted in a smaller surface area for evaporation.

6.1.2 Unmitigated Hypothetical Release Case 2—Mississippi River at Ball Club

The Mississippi River passes to the south and west of the town of Ball Club, Minnesota. The pipeline route crosses the Mississippi River 1.25 miles (2.01 km) to the west of Ball Club, and 400 ft (122 m) south of U.S. Highway 2. At this location the Mississippi River flows to the east through an extensively marshy area. Approximately 12.2 miles (19.6 km) downstream, the river passes through the southern end of White Oak Lake, and then turns to the south. Under low or average river flow conditions the main channel of the Mississippi River passes to the south of White Oak Lake, with only small marshy streams connecting them. Under high river flow conditions, hydraulic connections are present between the river and lake; therefore, it was assumed that under high river flow conditions that the main pathway of the Mississippi River could transport oil into White Oak Lake. The width of the Mississippi River averages approximately 160 ft (48.8 m) in this area. Expected environmental and flow conditions throughout the year for Mississippi River near Ball Club are provided in Table 5-6.

The shore type for the majority of the Mississippi River in this region is marsh. An initial set of scenarios was run using this marsh shore type. However, the high retention value for marsh shore types (120 m^3/km of river for Bakken crude and 800 m^3 for CLB (Table 5-8) resulted in minimal transport of oil down the Mississippi River. Due to the uncertainty of how much oil would be able to infiltrate the marshy shoreline, based on the water level, a second set of scenarios were run assuming that the marsh shoreline was instead grass, with a lower oil retention capacity. Both sets of results are presented. It is anticipated that if an actual release were to occur that downstream oil transport may be somewhere between the two predicted downstream distances.

Trajectory and Fate Results for Modeling Locations
January 13, 2017

The predicted downstream trajectory and mass balance tables for CLB (Figure 6-3) and Bakken Crude (Figure 6-5) seasonal scenarios for the Mississippi River near Ball Club release site with marsh shore type are provided. Results for an assumed grass shore type for CLB (Figure 6-4) and Bakken Crude (Figure 6-6) are also provided.

6.1.2.1 Cold Lake Blend Scenarios

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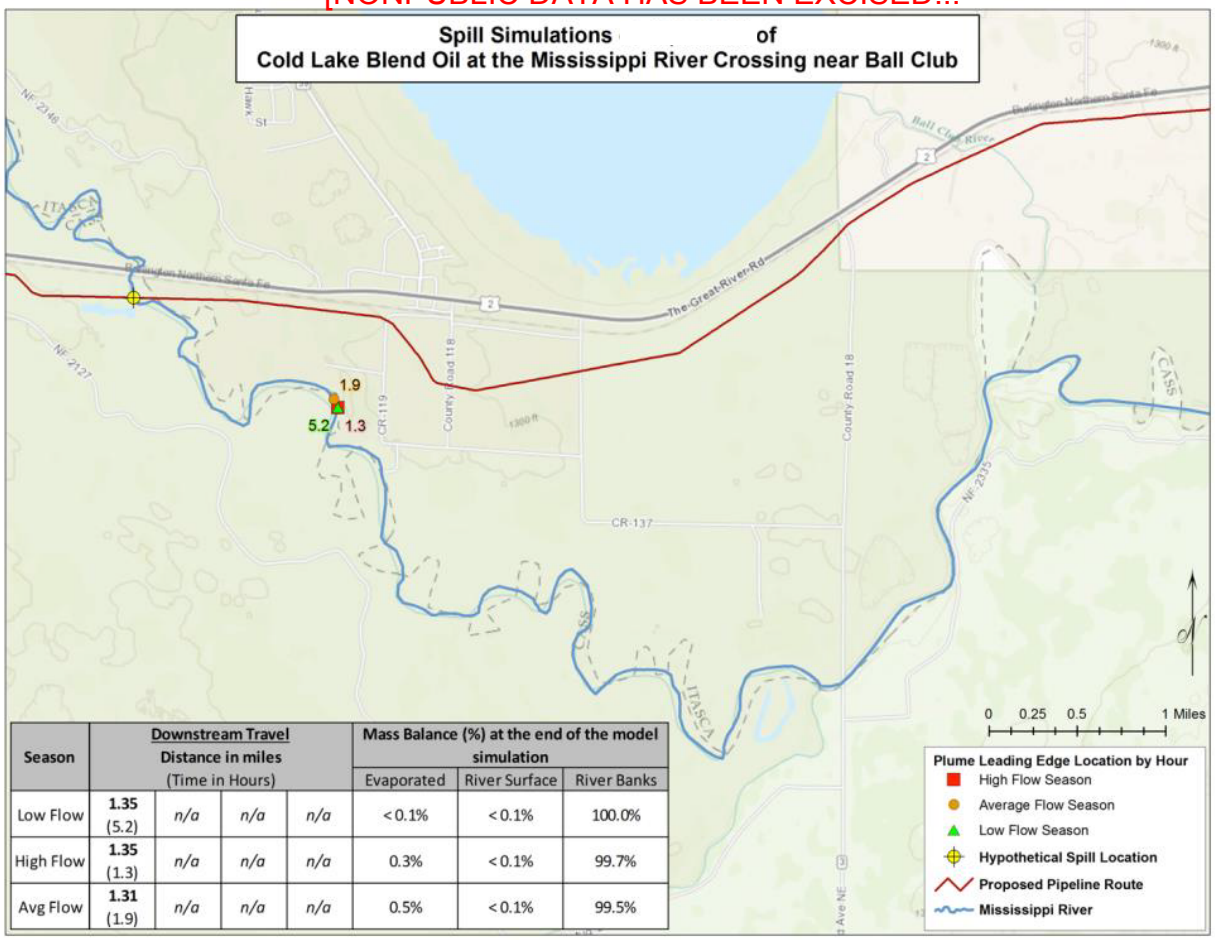

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation		
					Evaporated	River Surface	River Banks
Low Flow	**1.35** (5.2)	*n/a*	*n/a*	*n/a*	< 0.1%	< 0.1%	100.0%
High Flow	**1.35** (1.3)	*n/a*	*n/a*	*n/a*	0.3%	< 0.1%	99.7%
Avg Flow	**1.31** (1.9)	*n/a*	*n/a*	*n/a*	0.5%	< 0.1%	99.5%

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Figure 6-3 Predicted Downstream Transport of CLB at the Mississippi River at Ball Club Release Location with Marsh Shoreline

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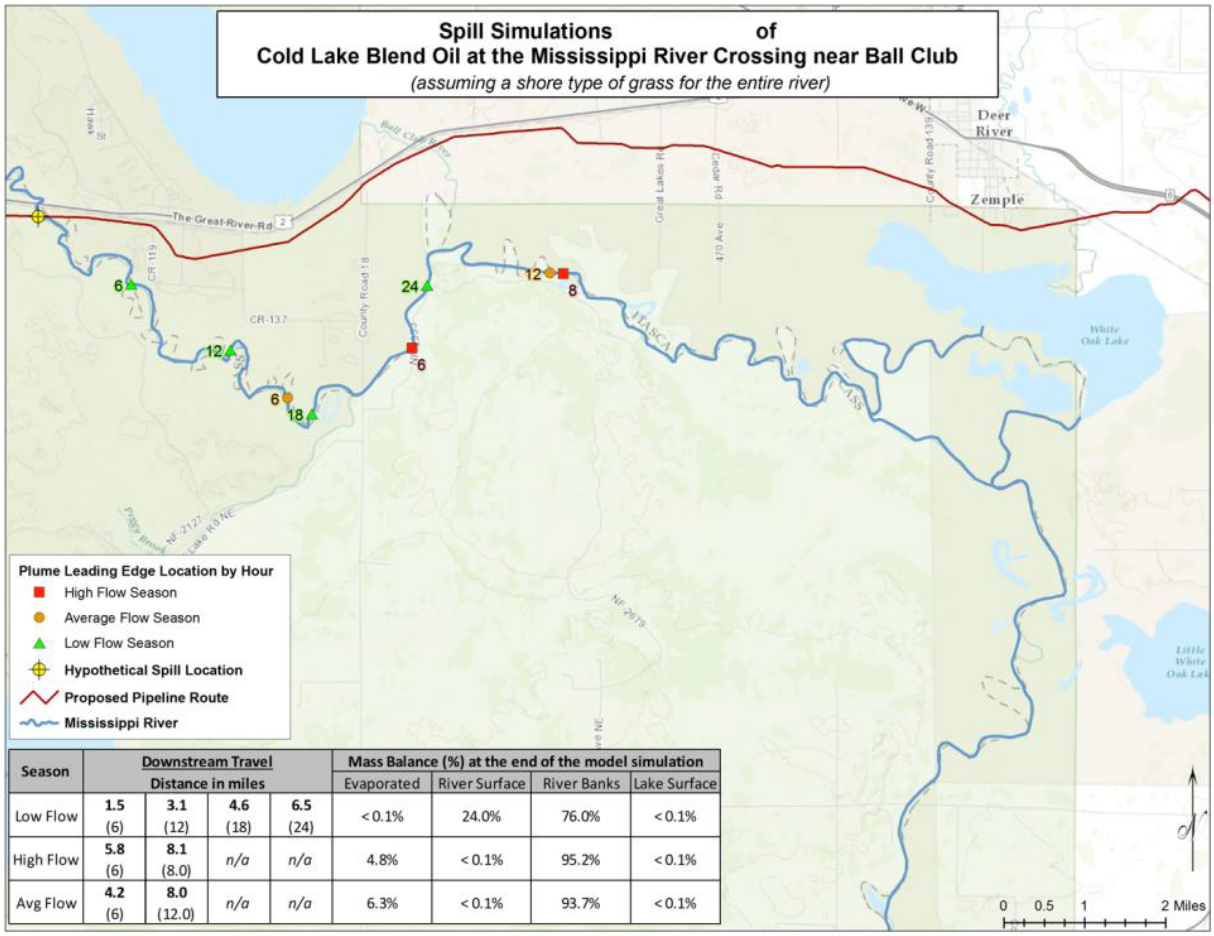

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.5 (6)	3.1 (12)	4.6 (18)	6.5 (24)	< 0.1%	24.0%	76.0%	< 0.1%
High Flow	5.8 (6)	8.1 (8.0)	*n/a*	*n/a*	4.8%	< 0.1%	95.2%	< 0.1%
Avg Flow	4.2 (6)	8.0 (12.0)	*n/a*	*n/a*	6.3%	< 0.1%	93.7%	< 0.1%

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Figure 6-4 Predicted Downstream Transport of CLB oil at the Mississippi River at Ball Club Release Location With Assumed Grass Shoreline

6.1.2.1.1 Trajectory and Fate Results for High Flow (Spring)

Flow rates for the Mississippi River during the spring (April) resulted in peak average river velocities during April. Velocities ranged between 0.34 to 1.25 mph (0.15 and 0.56 m/s) for the portion of the river modeled in the marsh shoreline scenario runs and between 0.27 and 1.28 mph (0.12 and 0.57 m/s) for the longer portion of river modeled in the grass shoreline runs. The OILMAP Land model transported oil downstream with these velocities to a point where all oil had evaporated and/or adhered to the shoreline.

Under high river flow for marsh shorelines, CLSB was predicted to travel a total of approximately 1.35 miles (2.17 km) downstream, within 1.3 hours of the release. At this time, the model predicts that no CLSB would remain on the water surface. Approximately 99.7% of the CLSB was

predicted to oil the shorelines of the Mississippi River, and 0.3% would have evaporated into the atmosphere.

Under high river flow conditions with grass shorelines, CLSB was predicted to travel a total of approximately 8.1 miles (13.0 km) downstream, within 8.0 hours of the release. At this time, the model predicted that all of the oil would have been lost from the water surface. Approximately 95.2% of the CLSB was predicted to oil shorelines of the Mississippi River, and 4.8% would have evaporated into the atmosphere.

6.1.2.1.2 Trajectory and Fate Results for Average Flow (Summer-Fall)

Average flow rates for Mississippi River occurred during the summer (August) with river velocities ranging between 0.27 to 0.72 mph (0.12 and 0.32 m/s) for the portion of river modeled in the marsh runs and between 0.22 and 0.72 mph (0.10 and 0.32 m/s) for the longer portion of river modeled in the grass shoreline runs. These river velocities were approximately 58–67% of those that would occur under the modeled high flow conditions.

Similar to the high river flow conditions with marsh shorelines, CLSB was predicted to travel a total of approximately 1.31 miles (2.11 km) downstream, under average river flow. However, under average river flow conditions, it would take approximately 1.9 hours to reach this same distance due to the lower stream velocities. At this time, there would be no remaining CLSB on the river surface; approximately 99.5% of the CLSB was predicted to be on the shorelines, while the remainder (0.5%) would have evaporated into the atmosphere.

Under average river flow with grass shorelines, CLSB was predicted to travel a total of approximately 8.0 miles (12.9 km) downstream. However, with lower stream velocities, it took approximately 12.0 hours to reach this distance. At this time the model predicted that there would be no CLSB on the river surface; approximately 93.7% of the CLSB would have adhered to the shorelines of the Mississippi River, and 6.3% would have evaporated into the atmosphere.

Relative to the high river flow condition, more of the CLSB was predicted to evaporate. This is mainly due to the longer time required for the CLSB to move down stream, due to the lower stream velocities. In addition, the higher temperatures during the summer conditions results in more evaporation. The slight reduction in oil remaining on the river shoreline in the average river flow condition was the result of this increase in evaporation.

6.1.2.1.3 Trajectory and Fate Results for Low Flow (Winter)

Under winter conditions (March), it was assumed that Mississippi River would be frozen over completely (100% coverage of ice). It was also assumed that CLWB would be released directly into the river from the pipeline, which is located under the riverbed. Oil released into the water would remain in the water or be trapped under the ice. The ice cover would prevent any evaporation to the atmosphere. Flow rates for the Mississippi River during these winter conditions resulted in minimum river velocities during March, which ranged between 0.22 to 0.34 mph (0.10 and 0.15 m/s). These river velocities were approximately 30% of the high river flow conditions.

Under low river flow conditions with marsh shorelines, CLWB was predicted to travel a total of approximately 1.35 miles (2.17 km) downstream. However, under low river flow conditions with the lowest stream velocities, it took approximately 5.2 hours to reach this same distance. At this time there was no CLWB on the river surface, as the model predicts that all of the CLWB (100%) would have adhered to the shoreline. In an actual spill, the released oil would collect in pockets under the ice, as well as dissolve and disperse in the water column. Some released oil might also collect in openings in the ice where a small portion of the oil would evaporate.

Under low river flow with grass shorelines, CLWB was predicted to travel a total of approximately 6.5 miles (10.5 km) downstream, over the full 24-hour modeled period. Approximately 76.0% of the CLWB was predicted to adhere to the shorelines of the Mississippi River, and the remaining 24.0% would remain in the river, below the ice, at the end of the 24 hour simulation. If left unmitigated, it is expected that the remaining CLWB would continue downstream, oiling shorelines until all of the oil was removed from the water.

Relative to the average and high river flow conditions, the CLWB is predicted to travel approximately the same distance downstream before all of the oil had adhered to the marsh or grass shoreline.

6.1.1.2 Bakken Crude Scenarios

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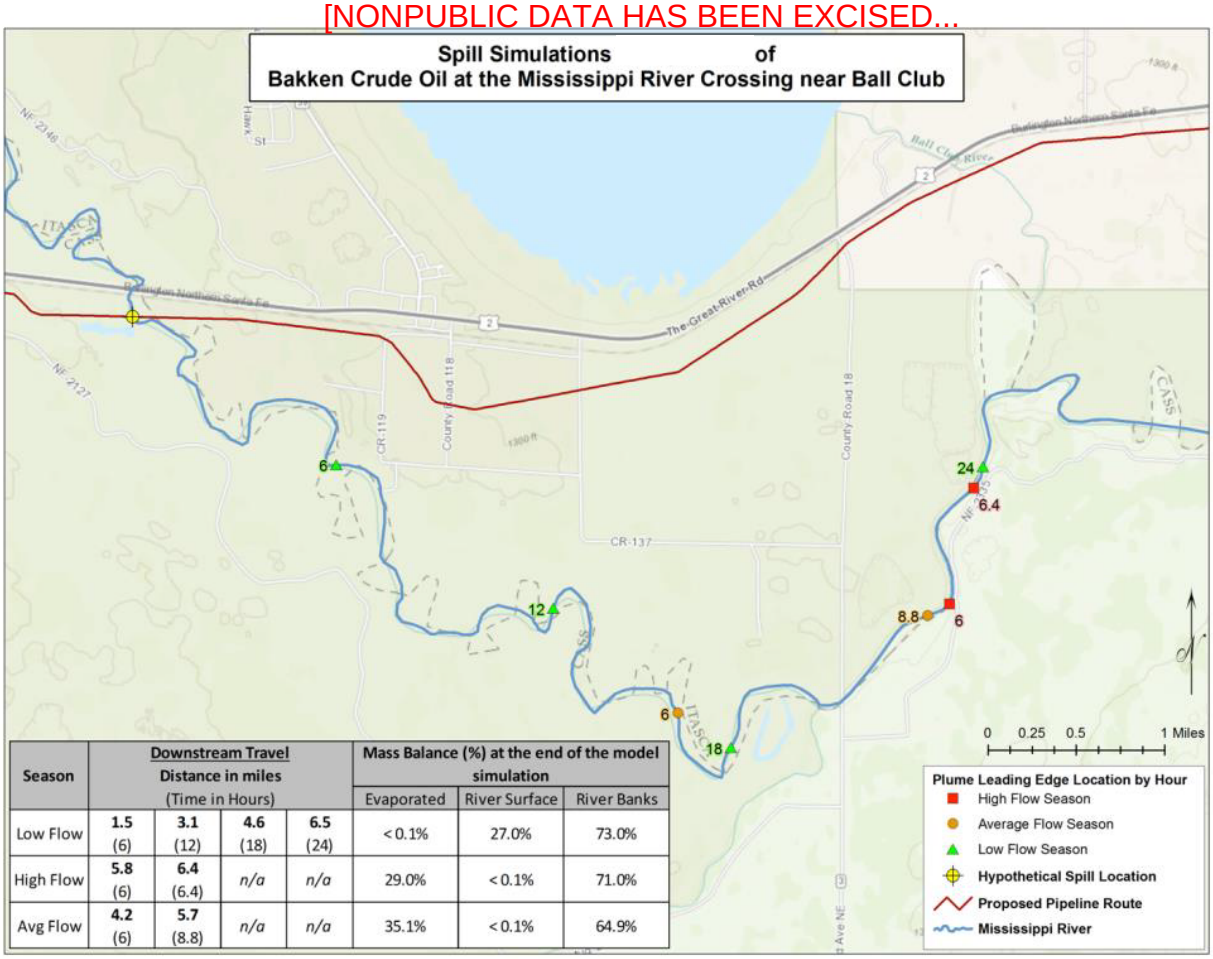

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation		
					Evaporated	River Surface	River Banks
Low Flow	**1.5** (6)	**3.1** (12)	**4.6** (18)	**6.5** (24)	< 0.1%	27.0%	73.0%
High Flow	**5.8** (6)	**6.4** (6.4)	*n/a*	*n/a*	29.0%	< 0.1%	71.0%
Avg Flow	**4.2** (6)	**5.7** (8.8)	*n/a*	*n/a*	35.1%	< 0.1%	64.9%

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Figure 6-5 Predicted Downstream Transport of Bakken Crude at the Mississippi River at Ball Club Release Location With Marsh Shoreline

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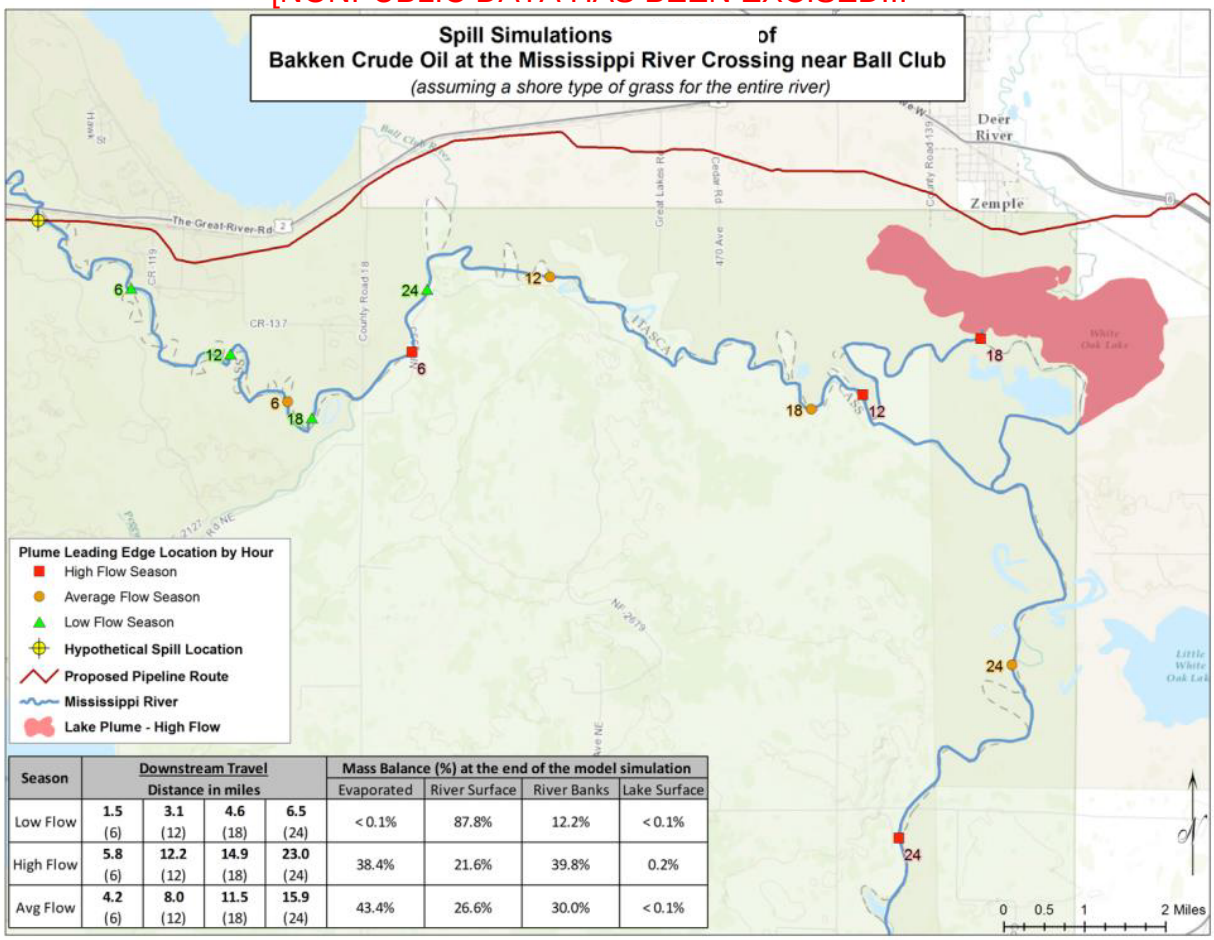

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.5 (6)	3.1 (12)	4.6 (18)	6.5 (24)	< 0.1%	87.8%	12.2%	< 0.1%
High Flow	5.8 (6)	12.2 (12)	14.9 (18)	23.0 (24)	38.4%	21.6%	39.8%	0.2%
Avg Flow	4.2 (6)	8.0 (12)	11.5 (18)	15.9 (24)	43.4%	26.6%	30.0%	< 0.1%

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Figure 6-6 Predicted Downstream Transport of Bakken Crude Oil at the Mississippi River at Ball Club Release Location with Assumed Grass Shoreline

6.1.2.1.4 Trajectory and Fate Results for High Flow (Spring)

Under high river flow for marsh shorelines, Bakken crude was predicted to travel a total of approximately 6.4 miles (10.3 km) downstream, within 6.4 hours of the release. At this time, the model predicts that all of the oil would have been lost from the water surface; approximately 71.0% of the Bakken crude was predicted to adhere to the shorelines of the Mississippi River, and 29.0% would have evaporated into the atmosphere.

Under high river flow for the grass shorelines, Bakken crude was predicted to travel a total of approximately 23.0 miles (37.0 km) downstream, over the full 24 hour modeled period. The Bakken crude was predicted to be transported down the Mississippi River for approximately 14.9 miles (24.0 km), before reaching White Oak Lake. Bakken was allowed to spread over the

surface of the White Oak Lake (for total area of 1.47 miles^2) to a thickness of 0.001 mm. The remaining surface oil was then able to continue downstream another 6.9 miles (11.1 km). Approximately 39.8% of the Bakken crude was predicted to oil the shorelines of the Mississippi River, 0.2% would have spread over the surface of White Oak Lake, 38.4% would have evaporated into the atmosphere, and 21.6% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude on the river surface after 24 hours was expected to continue downstream, with weathering and oiling of shorelines continuing until all the oil was removed from the water surface.

The Bakken crude was predicted to result in oiling of marsh shorelines that extended 5.05 miles (8.13 km) further downstream than the CLSB scenario under high flow river conditions, which only oiled 1.35 miles (2.17 km). For grass shorelines, the Bakken crude was predicted to result in oiling 14.9 miles (24.0 km) further downstream then the CLSB (8.1 miles) under high flow river conditions.

The difference in the extent of downstream transport was primarily the result of the difference in the shoreline oil retention between the two oils. Because of its higher viscosity and other parameters, CLSB is expected to strand upon shorelines more thickly (Table 5-8) than Bakken crude oil, resulting in larger amounts of CLSB along the same length of shore. In contrast, the same amount of Bakken crude would oil longer lengths of shoreline with a reduced thickness. While this result is logical, it is based on the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point is oiled to its maximum holding capacity) as oil made its way downstream. In the event of an actual release, the downstream extents of CLSB and Bakken crude may be more similar, and the effects of CLSB may extend farther downstream than presented, with patchy coverage.

Bakken crude was predicted to evaporate much more completely (29% for marsh and 38.4% for grass) than the CLSB (0.3% for marsh and 4.8% for grass). This was partially due to the lighter nature and higher volatile content of the Bakken crude, when compared to CLSB. Additionally, the Bakken crude was predicted to oil further downstream for marsh shorelines and spread over White Oak Lake for grass shorelines, which took more time reach and also resulted in a larger surface area over which the oil could evaporate.

6.1.2.1.5 Trajectory and Fate Results for Average Flow (Summer-Fall)

Under average river flow conditions (August), Bakken crude was predicted to be transported approximately 5.7 miles (9.17 km) downstream, within 8.8 hours of the release for the marsh shorelines and approximately 15.9 miles (25.6 km) downstream, over the full 24-hour modeled period for the grass shorelines. At this time no Bakken crude was predicted to remain on the river surface; approximately 64.9% of the Bakken crude was predicted to adhere to the shorelines of the Mississippi River, and 35.1% would have evaporated into the atmosphere.

Under average river flow (August) and grass shorelines, Bakken crude was predicted to be transported approximately 15.9 miles (25.6 km) downstream, over the full 24-hour modeled period. The Bakken crude was predicted to be transported down the Mississippi River, past White

Oak Lake and stop just west of Little White Oak Lake. Approximately 30.0% of the Bakken crude was predicted to adhere to the shorelines of the Mississippi River, 43.4% to have evaporated into the atmosphere, and 26.6% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude on the river surface after 24 hours would be expected to continue downstream, with weathering and oiling of shorelines continuing until all the oil was removed from the water surface.

The Bakken crude for marsh shorelines was predicted to be transported 0.7 miles (1.13 km) less under average river flow conditions, when compared to the high river flow conditions. For grass shorelines Bakken crude was predicted to be transported 7.1 miles (11.4 km) less under average river flow conditions, when compared to the high river flow conditions. The lower river velocities of the average river flow condition, compared to the high river flow, transported the oil over less distance. The Bakken crude evaporated more completely under the average flow condition (35.1% for marsh and 43.4% for grass) when compared to the high river flow conditions (29.0% for marsh and 38.4% for grass). This difference is mainly due to the longer length of the simulation, for the average river flow conditions, as opposed to the high river flow conditions, that allowed for more time to evaporate before the end of the simulation. Additionally, the higher air temperatures during August enhanced evaporation.

When compared to the CLSB under average river flow conditions for marsh shorelines, the Bakken crude was transported 4.4 miles (7.08 km) further downstream (Bakken crude 5.7 miles, CLSB 1.31 miles). When compared to the CLSB under average river flow conditions for grass shorelines, the Bakken crude was transported 7.9 miles (12.7 km) further downstream before reaching the 24 hour model limit, with 26.6% of the Bakken crude still remaining on the river surface at the end of the simulation. The Bakken crude was able to travel further downstream than the CLSB scenario under the same river velocities due to the differences in the viscosity of the two oils and the greater adherence of CLSB to shorelines than Bakken Crude. For grass shorelines, the Bakken crude was able to travel further downstream, under the same river velocities due to the lower shoreline oil retention for the Bakken, when compared to the CLSB.

6.1.2.1.6 Trajectory and Fate Results for Low Flow (Winter)

Under low river flow (March) conditions, where oil was released underwater with 100% ice cover, Bakken crude was predicted to be transported approximately 6.5 miles (10.5 km) downstream, over the full 24-hour modeled period. Approximately 73.0% of the Bakken crude was predicted to oil the shorelines of the Mississippi River, and the remaining 27.0% would remain in the river below the ice at the end of the 24 hour simulation for marsh shorelines. Approximately 12.2% of the Bakken crude for grass shorelines was predicted to adhere to the shorelines of the Mississippi River, and the remaining 87.8% would remain in the river, below the ice at the end of the 24 hour simulation. If left unmitigated, it is expected that the remaining Bakken crude in the river after 24 hours would continue to move downstream and oil shorelines, until all the oil was removed from the water surface (i.e., under the ice).

Relative to the high river flow conditions, the Bakken crude for the marsh shorelines was predicted to be transported 0.1 miles (0.16 km) further downstream. Relative to the average river flow conditions, the Bakken crude was predicted to be transported 0.8 miles (1.29 km) further downstream. Under low river flow conditions the shore types were conservatively assumed to be the same as the average flow condition. Retention of oil under ice conditions may be lower or higher in reality, but is expected to be variable due to irregularities in the ice and the ice/shoreline interface Rather than having an extent controlled by the loss of all surface oil, this scenario reached the 24 hour modeled time limit.

Relative to the high river flow condition, the Bakken crude for grass shorelines was predicted to be transported 16.5 miles (26.6 km) less downstream. Relative to the average river flow condition, the Bakken crude was predicted to be transported 9.4 miles (15.1 km) less downstream. Due to the winter conditions, the oil was transported at a slower velocity and therefore traveled a shorter distance then than the average and high river flow conditions. Because the Bakken crude was released below the ice of the river, no oil is lost to the atmosphere through evaporating. This further extended the potential downstream transport. With the oil being transported at a slower velocity, the 24 hour modeled time limit was reached before oil was lost to shorelines or evaporation. Additionally, with the Bakken crude below the ice of the river, no oil is lost to the atmosphere through evaporating.

The Bakken crude for grass shorelines under low flow river conditions was transported 5.15 miles (8.29 km) further downstream than the CLWB for the same conditions. The Bakken crude was able to travel further downstream, under the same river velocities due to the lower shoreline oil retention for Bakken, compared to CLWB. For this reason 27% more oil can be transported downstream under the ice.

6.1.3 Unmitigated Hypothetical Release Case 3—Sandy River

The Sandy River is located approximately 1 mile (1.6 km) north of McGregor, Minnesota. The pipeline route crosses the Sandy River approximately 3.3 miles (5.3 km) north east of McGregor, and 0.2 miles (0.32 km) north of Highway 210. The Sandy River flows to the west for approximately 6 miles (9.7 km) before reaching Steamboat Lake and Davis Lake. This stretch of the river is fairly narrow (approximately 40 ft wide, or 12.2 m, on average), and travels through several marshy areas. From there, the Sandy River flows to the north an additional 3.5 miles (5.6 km) where it enters Flowage Lake. The Sandy River for this stretch can average 53 ft (16.2 m) wide during low river flow conditions, and average 270 ft (82.3 m) wide during high flow conditions.

The seasonal extent of Steamboat, Davis, and Flowage Lakes also vary from low to high river flow conditions. During low and average river flow conditions, the area of Steamboat Lake is 0.036 miles^2 (0.093 km^2), and during high river flow conditions the area is typically 0.065 miles^2 (0.168 km^2). During low and average river flow conditions, the area of Davis Lake is 0.07 miles^2 (0.181 km^2), and during high river flow conditions the area is typically 0.117 miles^2 (0.303 km^2). During low river flow conditions, Sandy River does not join Flowage Lake until approximately

7 miles (11.3 km) north of Davis Lake. Under high river flow conditions, Sandy River transitions to Flowage Lake after approximately 3.5 miles (5.63 km). Expected environmental and flow conditions throughout the year for Sandy River are provided in Table 5-6.

Maps depicting the predicted downstream trajectory and mass balance tables of CLB (Figure 6-7) and Bakken Crude (Figure 6-8) seasonal scenarios for the Sandy River release site are provided at the beginning of the following subsections.

6.1.3.1 Cold Lake Blend Scenarios

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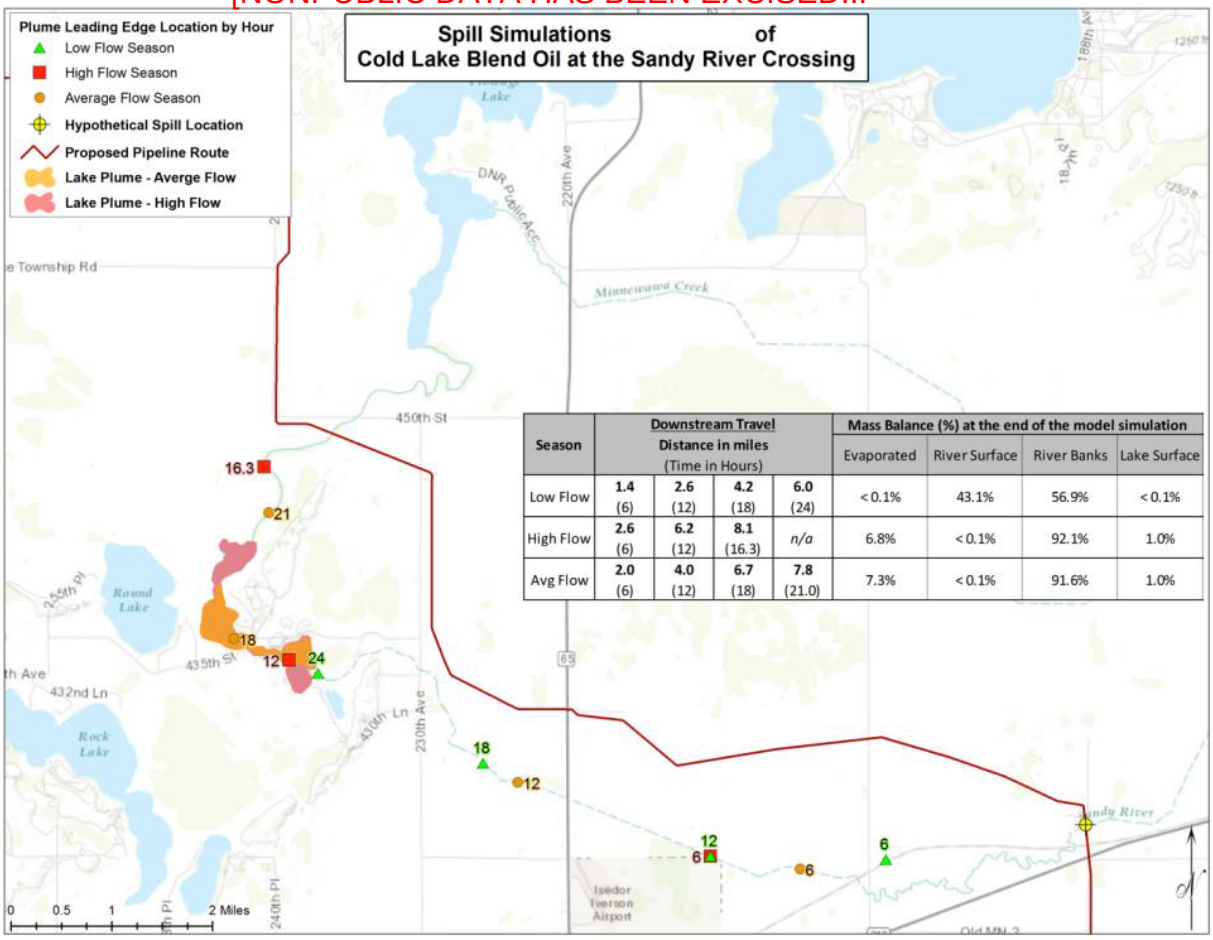

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.4 (6)	2.6 (12)	4.2 (18)	6.0 (24)	< 0.1%	43.1%	56.9%	< 0.1%
High Flow	2.6 (6)	6.2 (12)	8.1 (16.3)	*n/a*	6.8%	< 0.1%	92.1%	1.0%
Avg Flow	2.0 (6)	4.0 (12)	6.7 (18)	7.8 (21.0)	7.3%	< 0.1%	91.6%	1.0%

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Figure 6-7 Predicted Downstream Transport of CLB Oil at the Sandy River Release Location

6.1.3.1.1 Trajectory and Fate Results for High River Flow (Spring)

Flow rates for Sandy River during the spring resulted in peak average river velocities during April ranging between 0.35 and 0.89 mph (0.16 and 0.4 m/s). The OILMAP Land model transported oil downstream with these velocities to a point where all oil had evaporated and/or adhered to the shoreline.

Under high river flow conditions, CLSB was predicted to travel a total of approximately 8.1 miles (13.0 km) downstream, within 16.3 hours of the release. At this time, there was no CLSB on the water surface, as the model had predicted that the oil would have been lost completely from the water surface by this point in time. The CLSB was predicted to be transported down the Sandy River, then spread covering the surfaces of both Steamboat Lake and Davis Lake (for a total area of 0.182 miles^2 or 0.471 km^2), and then continue another 0.7 miles (1.12 km) down Sandy River. Approximately 92.1% of the CLSB was predicted to oil the shorelines of Sandy River, 1.0% to have spread over the surface of Steamboat and Davis Lakes, and 6.8% to have evaporated into the atmosphere.

6.1.3.1.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Flow rates for Sandy River during the summer and fall result in average river velocities during July ranging between 0.27 and 0.60 mph (0.12 and 0.27 m/s). These river velocities were approximately 70% of those in the high flow conditions.

Under average river flow conditions, CLSB was predicted to travel a total of 7.8 miles (12.6 km) downstream, within 21 hours of the release. At this time, there was no CLSB on the water surface, as the model predicted that the oil would have been lost from the water surface by this point in time. The CLSB was predicted to be transported down the Sandy River, then spread covering the surfaces of both Steamboat Lake and Davis Lake (for total area of 0.106 miles^2 or 0.275 km^2), and then continue another 0.7 miles (1.12 km) in Sandy River. Approximately 91.6% of the CLSB was predicted to adhere to the shorelines of Sandy River, 1.0% to have spread over the surface of Steamboat and Davis Lakes, and 7.3% to have evaporated into the atmosphere.

Relative to the high river flow condition, the CLSB was predicted to be transported less distance downstream (0.3 miles or 0.48 km). This was predominantly due to the length of the scenario which allowed for more evaporation due to the longer time required for the CLSB to move down stream due to the lower stream velocities. Under both high and average flow conditions, oil spread over the entire surface of both Davis and Steamboat Lakes, however the area of the lakes was smaller in the average flow condition. The slightly reduced area of the lakes only accounts for approximately 0.01% difference in the volume remaining on the lakes.

6.1.3.1.3 Trajectory and Fate Results for Low River Flow (Winter)

Under winter conditions (March), it was assumed that the Sandy River and all lakes would be frozen over completely (100% coverage of ice). It was assumed that CLWB would be released directly into the river from the pipeline under the riverbed, and that all oil would remain trapped under the ice. The ice cover would prevent any evaporation to the atmosphere. Flow rates for

Sandy River during these winter conditions resulted in minimum river velocities during March ranging between 0.20 and 0.31 mph (0.09 and 0.14 m/s). These river velocities were approximately 50% of that of the high flow condition.

Under low river flow conditions, CLWB was predicted to be transported a total of 6.0 miles (9.7 km) downstream, over the full 24-hour modeled period. The CLWB was predicted to stop just before reaching Steamboat Lake. Approximately 43.1% of the CLWB was predicted to remain in the river below the ice, and the remaining 56.9% would have oiled the shorelines of Sandy River. Any CLWB remaining in the river after 24 hours would continue to move downstream, oiling shorelines and Steamboat Lake, if not intercepted by emergency response teams.

Relative to the high and average river flow conditions, the CLWB was predicted to be transported over a shorter distance, stopping before reaching Steamboat Lake. This was due to the reduced river velocities under the low river flow conditions.

6.1.3.2 Bakken Crude Scenarios

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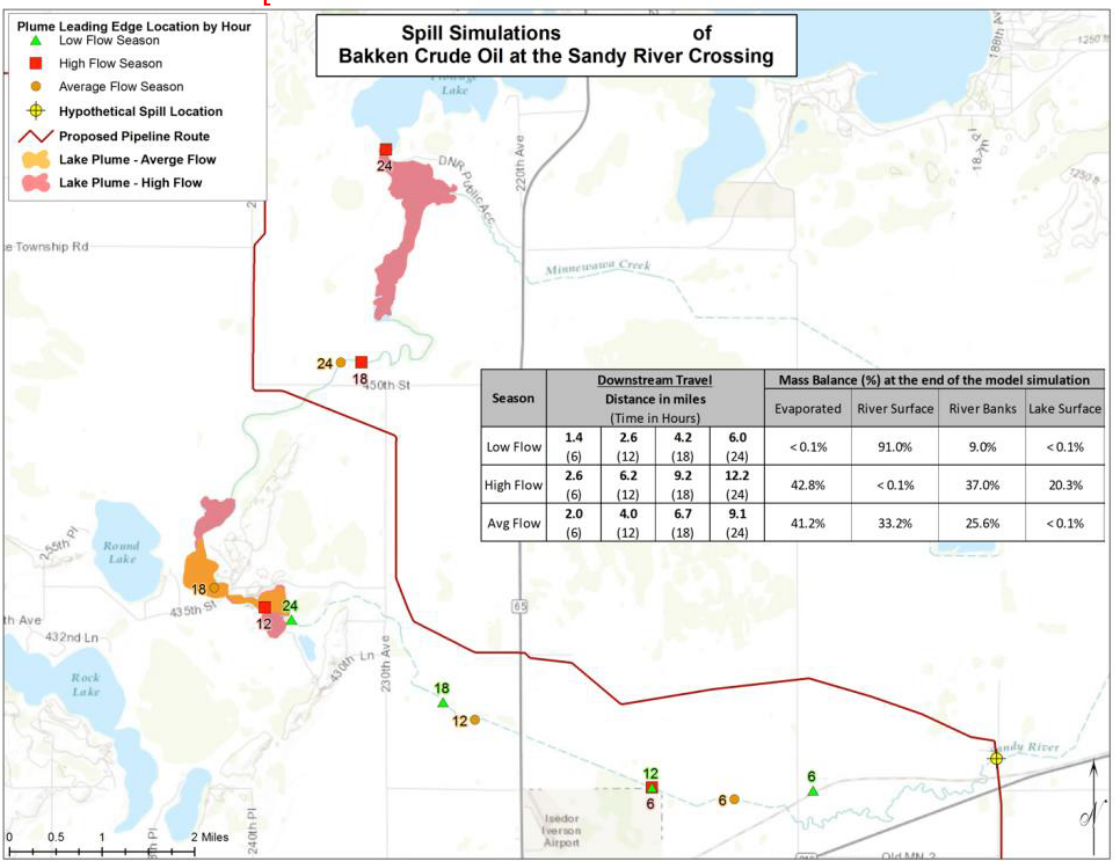

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.4 (6)	2.6 (12)	4.2 (18)	6.0 (24)	< 0.1%	91.0%	9.0%	< 0.1%
High Flow	2.6 (6)	6.2 (12)	9.2 (18)	12.2 (24)	42.8%	< 0.1%	37.0%	20.3%
Avg Flow	2.0 (6)	4.0 (12)	6.7 (18)	9.1 (24)	41.2%	33.2%	25.6%	< 0.1%

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Figure 6-8 Predicted Downstream Transport of Bakken Crude Oil at the Sandy River Release Location

6.1.3.2.1 Trajectory and Fate Results for High River Flow (Spring)

Under high river flow (April), Bakken crude was predicted to be transported approximately 12.2 miles (19.6 km) downstream, over the full 24-hour modeled period. The Bakken crude was predicted to be transported down the Sandy River, and then spread covering the surfaces of both Steamboat Lake and Davis Lake (for total area of 0.182 miles^2 or 0.471 km^2). It was then able to continue another 3.5 miles (5.6 km) in Sandy River, before reaching Flowage Lake. Oil was predicted to spread over the surface of Flowage Lake covering an area of approximately 0.22 miles^2 or 0.570 km^2. Approximately 37.0% of the Bakken crude was predicted to adhere to the shorelines of Sandy River, 20.3% would have spread over the surface of Steamboat, Davis, and Flowage Lakes, and 42.8% would have evaporated into the atmosphere.

OILMAP Land spreads the mass of oil entering the lake radially upon the lake surface until the specified minimum slick thickness is reached, or the simulation duration is reached. This modeling tool is used to characterize regions of potential effects on relatively short time scales (i.e., hours

to days). After 24 hours, the Bakken crude oil did not yet spread in Flowage Lake to the defined minimum thickness of 0.001 mm (Table 5-9). If left unmitigated, it is expected that this spreading would continue to occur after 24 hours, covering a larger surface area of the lake.

The Bakken crude was predicted to result in oiling 4.1 miles (6.6 km) further downstream, then the CLSB (8.1 miles or 13.0 km) under high flow river conditions. The difference in the extent of downstream transport was primarily the result of the differences in the shoreline and lake surface oil retention between the two oil types. Because of its higher viscosity and other parameters, CLSB would be expected to strand upon shorelines and spread on a lake surface more thickly than Bakken crude oil, resulting in larger amounts of CLSB along the same area. In contrast, the same amount of Bakken crude would oil longer lengths of shoreline and more lake surface, but with a reduced thickness. While this result is logical, it is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point is oiled to its maximum holding capacity) as oil makes its way downstream, and the assumption that oil would spread evenly within lake. In the event of an actual release, the downstream extents of CLSB and Bakken crude may be more similar, and the effects of CLSB may extend farther downstream than presented, with patchy coverage.

Due mostly to the lighter nature and higher volatile content, Bakken crude was predicted to evaporate over 6 times more (42.8%) than the CLSB (6.8%). The Bakken crude was predicted to oil further downstream, which took more time and resulted in a larger surface area over which the oil would evaporate.

6.1.3.2.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Under average river flow (July), Bakken crude was predicted to be transported approximately 9.1 miles (14.6 km) downstream, over the full 24-hour modeled period. The Bakken crude was predicted to be transported down the Sandy River, and then spread covering the surfaces of both Steamboat Lake and Davis Lake (for total area of 0.106 miles^2 or 0.274 km^2). It was then able to continue another 2.05 miles (3.3 km) down Sandy River. Approximately 25.6% of the Bakken crude was predicted to adhere to the shorelines of Sandy River, less than 0.1% would have spread over the surface of Steamboat and Davis Lakes, 41.2% would have evaporated into the atmosphere, and 33.2% would remain on the river surface at the end of the 24 hour simulation. If left unmitigated, it is expected that the remaining Bakken crude on the river surface would continue downstream, with weathering and oiling of shorelines continuing until all the oil is removed from the water surface.

The Bakken crude was predicted to be transported 3.1 miles (5.0 km) less when compared to the high river flow conditions. The lower river velocities of the average river flow condition prevented the oil from being transported as far downstream within the 24 hour simulation period. The Bakken crude evaporated less in the average flow condition (41.2 %) than the high flow condition (42.8%) due to the reduced surface area oiled. This was a result of smaller area of Steamboat and Davis Lakes, and the reduced downstream transport.

When compared to the CLSB under average river flow conditions, the Bakken crude was transported 3 miles (4.8 km) further downstream before reaching the 24 hour model limit. Approximately 33.2% of the Bakken crude was still remaining on the river surface at the end of the simulation. The Bakken crude was able to travel further downstream, under the same river velocities due to the differences in the shoreline and lake surface oil retention between the two oil types.

6.1.3.2.3 Trajectory and Fate Results for Low River Flow (Winter)

Under low river flow conditions (March), released under 100% ice cover, Bakken crude was predicted to be transported a total of 6.0 miles (9.7 km) downstream, over the full 24-hour modeled period to a point just before Steamboat Lake. Approximately 91.0% of the Bakken crude was predicted to remain in the river below the ice, and the remaining 9.0% to adhere to the shorelines of Sandy River. If not intercepted by emergency response teams, the remaining Bakken crude in the river after 24 hours would be expected to move downstream, oiling shorelines and Steamboat Lake.

Relative to the high river flow conditions, the Bakken crude under low river flow was predicted to be transported 6.2 miles (10.0 km) less downstream. Relative to the average river flow condition, the Bakken crude was predicted to be transported 3.1 miles (5.0 km) less downstream. Under low river flow conditions, the shore types were conservatively assumed to be the same as the average flow condition. Retention of oil under ice conditions may be lower or higher in reality, but is expected to be variable due to irregularities in the ice and the ice/shoreline interface With the oil being transported at a slower speed, the 24 hour modeled time limit was reached at a distance that was shorter than that of the average river flow condition with oil remaining on the surface. With the Bakken crude below the ice of the river, no oil was allowed to evaporate from the surface.

When compared to the CLWB under low river flow conditions, 47.9% more of the Bakken crude remained in the river and under the ice. This was due to the lower shoreline oil retention for Bakken, relative to the CLWB.

6.1.4 Unmitigated Hypothetical Release Case 4—Shell River to Twin Lakes

Shell River is located approximately 7.4 miles (11.9 km) south of Park Rapids, Minnesota. The pipeline route crosses the Shell River and Crow Wing River at four locations. The crossing used for this release location is the eastern crossing of the Shell River located 0.6 miles (0.97 km) north of Twin Lakes and 0.75 miles (1.21 km) southeast of Arbor Road. At this location the Shell River flows directly south where it reaches the Twin Lakes (Upper Twin Lake and Lower Twin Lake). This section of the Shell River passes through a large marshy area, north of the lakes and is approximately 95 ft (29 m) wide. The Twin Lakes cover a total area of approximately 0.75 miles^2 (1.94 km^2). The outlet from Lower Twin Lake is located at the northeastern edge of the lake. From there Shell River flows to the west for approximately 9 miles (14.5) before flowing into the Crow Wing River. This stretch of river has an average width of 223 ft (68 m). From there, the Crow Wing

River flows to the south through Huntersville State Forest at an average width of 184 ft (56 m). Expected environmental and flow conditions throughout the year for Shell River/ Crow Wing River are provided in Table 5-6.

Maps of the predicted downstream trajectory and mass balance tables of CLB (Figure 6-9) and Bakken Crude (Figure 6-10) seasonal scenarios for the Shell River to Twin Lakes release site are provided at the beginning of the following subsections.

6.1.4.1 Cold Lake Blend Scenarios

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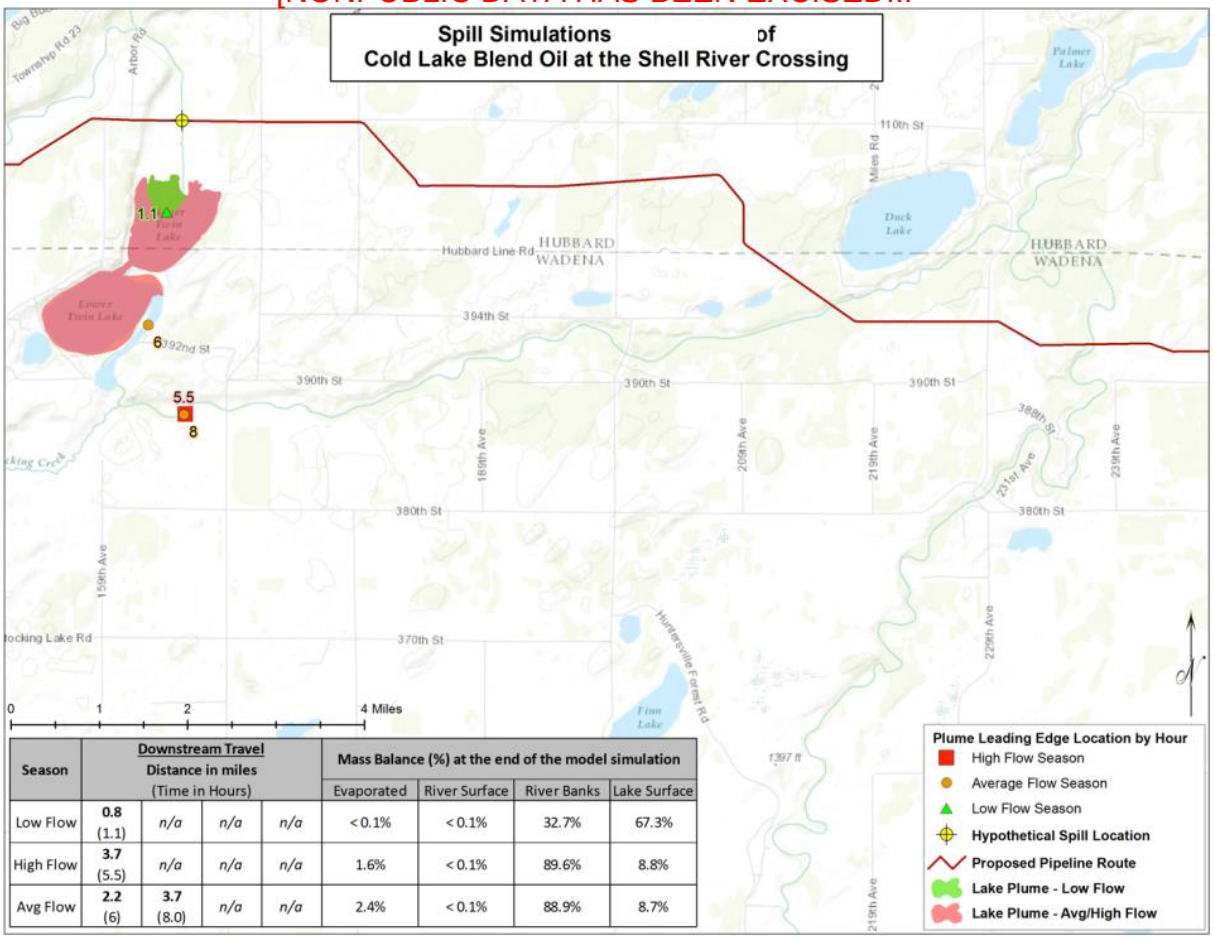

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	0.8 (1.1)	n/a	n/a	n/a	< 0.1%	< 0.1%	32.7%	67.3%
High Flow	3.7 (5.5)	n/a	n/a	n/a	1.6%	< 0.1%	89.6%	8.8%
Avg Flow	2.2 (6)	3.7 (8.0)	n/a	n/a	2.4%	< 0.1%	88.9%	8.7%

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Figure 6-9 Predicted Downstream Transport of CLB Oil at the Shell River Release Location

6.1.4.1.1 Trajectory and Fate Results for High River Flow (Spring)

Flow rates for Shell River during the spring (April) result in peak average river velocities ranging between 0.85 and 2.26 mph (0.38 and 1.01 m/s). The OILMAP Land model transported oil downstream with these velocities to a point where all oil had evaporated and/or adhered to the shoreline.

Under high river flow, CLSB as predicted to travel a total of approximately 3.7 miles (6.0 km) downstream, within 5.5 hours of the release. At this time there was no CLSB on the river surface as the model predicted that the oil would have been lost from the water surface by this point in time. The CLSB was predicted to be transported down the Shell River 0.6 miles (0.97 km), then spread, covering the surfaces of both Upper and Lower Twin Lakes (for total area of 0.75 miles^2 or 1.94 km^2) to a thickness of 0.1 mm (Table 5-8), and then continue another 1.8 miles (2.9 km)down the Shell River. Approximately 89.6% of the CLSB was predicted to adhere to the shorelines of Shell River, 8.8% to have spread over the surface of Upper and Lower Twin Lake, and 1.6% to have evaporated into the atmosphere.

6.1.4.1.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Flow rates for Shell River during the summer and fall result in average river velocities during August ranging between 0.58 and 1.3 mph (0.26 and 0.62 m/s). These river velocities were approximately 68% of that of the high flow condition.

As in the high river flow condition, CLSB under average river flow was predicted to travel a total of approximately 3.7 miles (6.0 km) downstream. However, under average river flow conditions with lower stream velocities, it took approximately 8.0 hours to reach this same distance. At this time there was no CLSB on the river surface as the model predicted that the oil would have been lost from the water surface by this point in time. The CLSB was predicted to be transported down the Shell River 0.6 miles (0.97 km), then spread covering the surfaces of both Upper and Lower Twin Lake (for total area of 0.75 miles^2 or 1.94 km^2) to a thickness of 0.1 mm (Table 5-9), and then continue another 1.8 miles (2.9 km) down the Shell River. Approximately 88.9% of the CLSB was predicted to adhere to the shorelines of Shell River, 8.7% to have spread over the surface of Upper and Lower Twin Lake, and 2.4% to have evaporated into the atmosphere.

Relative to the high river flow condition, more of the CLSB was predicted to evaporate. This was partially due to the higher temperatures in the summer conditions, but mainly due to the longer time required for the CLSB to move down stream due to the lower stream velocities. The slight reduction in oil remaining on the river shoreline and lake surface in the average river flow condition was the result of this increase in evaporation.

6.1.4.1.3 Trajectory and Fate Results for Low River Flow (Winter)

Under winter conditions (March), it was assumed that Shell River and Twin Lakes would be frozen over completely (100% coverage of ice). Additionally, it was assumed that CLWB would be released directly into the river from the pipeline under the river bottom, and remained trapped under the ice. The ice cover would prevent any evaporation to the atmosphere. Flow rates for

Shell River during these winter conditions resulted in minimum river velocities during March with a value of 0.56 mph (0.25 m/s). These river velocities were approximately 55% that of the high flow conditions.

Under low river flow conditions, the CLWB was predicted to be transported down the Shell River for 0.6 miles (0.97 km), and then spread under the ice to a thickness of 10.6 mm (Table 5-9; Section 5.3.2.6). CLWB was predicted to be transported a total of 0.8 miles (1.29 km) downstream, within 1.1 hours of the release. The oil was predicted to spread under the ice covering an area of 0.054 miles^2 (0.140 km^2) of Upper Twin Lake. Approximately 32.7% of the CLWB was predicted to adhere to the shorelines of Shell River, and the remaining 67.3% to spread under the ice within the lake. Relative to the high and average river flow conditions, the CLWB was predicted to be transported 2.9 miles (4.7 km) less downstream. This was due to the increased capacity for the ice to trap CLWB (10.6 mm) under the frozen surface of the lake.

6.1.4.2 Bakken Crude Scenarios

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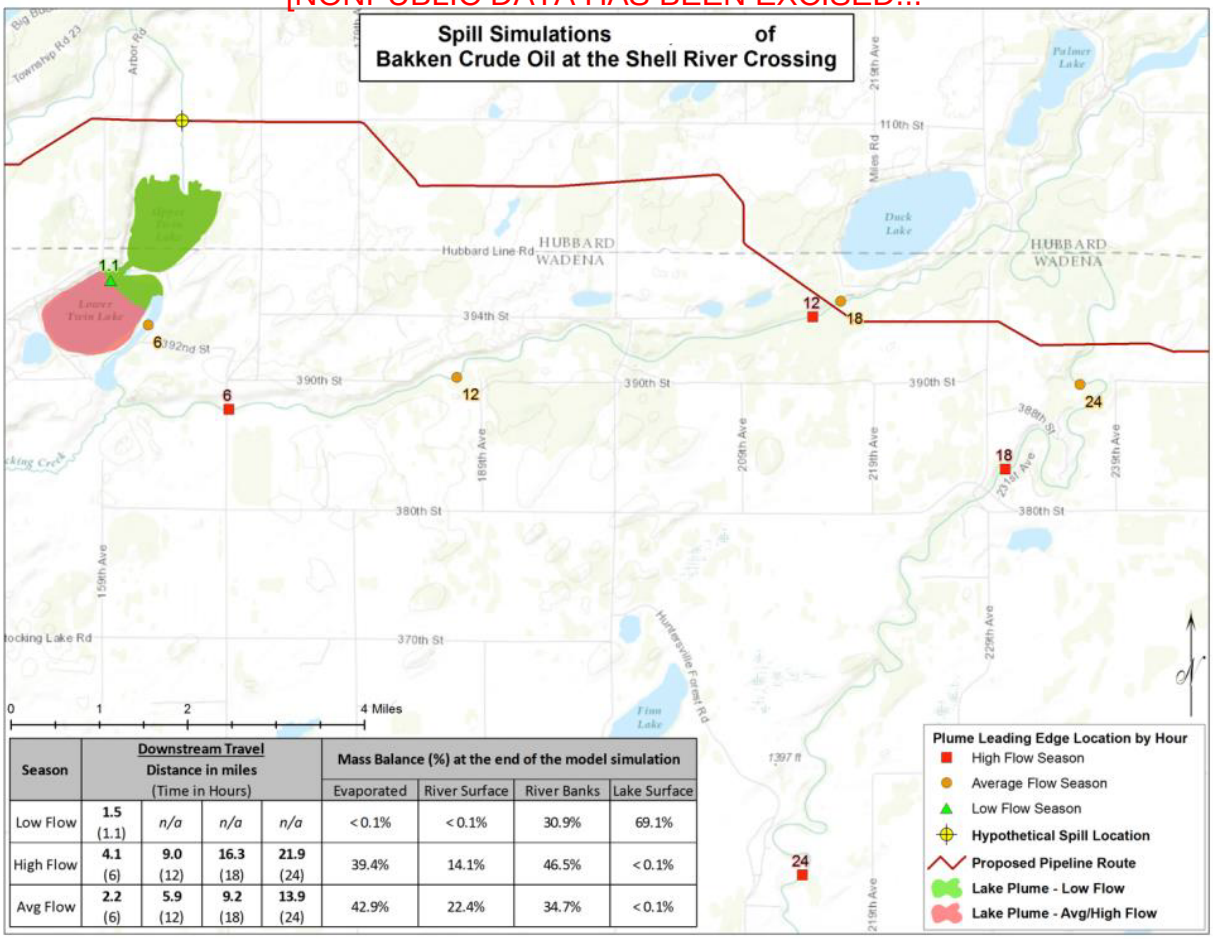

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.5 (1.1)	*n/a*	*n/a*	*n/a*	< 0.1%	< 0.1%	30.9%	69.1%
High Flow	4.1 (6)	9.0 (12)	16.3 (18)	21.9 (24)	39.4%	14.1%	46.5%	< 0.1%
Avg Flow	2.2 (6)	5.9 (12)	9.2 (18)	13.9 (24)	42.9%	22.4%	34.7%	< 0.1%

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Figure 6-10 Predicted Downstream Transport of Bakken Crude Oil at the Shell River Release Location

6.1.4.2.1 Trajectory and Fate Results for High River Flow (Spring)

Under high river flow (April), Bakken crude was predicted to be transported approximately 21.9 miles (35.2 km) downstream, over the full 24-hour modeled period. The Bakken crude was predicted to be transported down the Shell River, and then spread covering the surfaces of both Upper and Lower Twin Lake (for total area of 0.75 miles^2 or 1.94 km^2) to a thickness of 0.001 mm (Table 5-9). It was then able to continue another 20.0 miles (32.2 km) down Shell River and Crow Wing River. Approximately 46.5% of the Bakken crude was predicted to oil the shorelines of Shell River and Crow Wing River, less than 0.1% would have spread over the surface of Upper and Lower Twin Lake, 39.4% to have evaporated into the atmosphere, and 14.1% to remain on the

river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude on the river surface after 24 hours would be expected to continue downstream, weathering and oiling of shorelines until all the oil was removed from the water surface.

The Bakken crude was predicted to result in oiling 18.2 miles (29.3 km) further downstream than the CLSB (3.9 miles) under high flow river conditions. The difference in the extent of downstream transport was primarily the result of the differences in the shoreline and lake surface oil retention between the two oil types. Because of its higher viscosity and other parameters, CLSB would be expected to strand upon shorelines and spread on a lake surface more thickly than Bakken crude oil, resulting in larger amounts of CLSB along the shore and lake surface. In contrast, the same amount of Bakken crude would oil longer lengths of shoreline and more lake surface with a reduced thickness. While this result is logical, it is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point is oiled to its maximum holding capacity) as oil makes its way downstream, and the assumption that oil would spread evenly within lake. In the event of an actual release, the downstream extents of CLSB and Bakken crude may be more similar, and the effects of CLSB may extend farther downstream than presented, with patchy coverage.

Bakken crude was predicted to evaporate nearly 25 times more (39.4%) than the CLSB (1.6%). This was partially due to the lighter nature and higher volatile content of the Bakken crude. Additionally, the Bakken crude was predicted to oil further downstream, which took more time and resulted in more surface area with oil. The additional time for downstream transport and oiled surface area allowed for more oil to evaporate to the atmosphere.

6.1.4.2.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Under average river flow (August), Bakken crude was predicted to be transported approximately 13.9 miles (22.4 km) downstream, over the full 24-hour modeled period. The Bakken crude was predicted to be transported down the Shell River, and then spread covering the surfaces of both Upper and Lower Twin Lake (for total area of 0.75 miles^2 or 1.94 km^2) to a thickness of 0.001 mm (Table 5-9). It then continued another 12.0 miles (19.3 km) down the Shell River and Crow Wing River. Approximately 34.7% of the Bakken crude was predicted to adhere to the shorelines of Shell River and Crow Wing River, less than 0.1% to have spread over the surface of Upper and Lower Twin Lake, 42.9% to have evaporated into the atmosphere, and 22.4% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude on the river surface after 24 hours would be expected to continue downstream.

The Bakken crude was predicted to be transported 8 miles (12.9 km) less under average river flow conditions (13.9 miles or 22.4 km), when compared to the high river flow conditions (21.9 miles or 35.2 km). The lower river velocities of the average river flow condition prevented the oil from being transported as far within the 24 hour simulation period. The Bakken crude evaporated more under the average flow conditions (42.9%) than the high flow conditions (39.4%) due to the higher air temperatures. The higher air temperature causes the Bakken crude

to evaporate more in the same 24 hour period despite the surface area being oiled being higher in the high river flow condition.

When compared to the CLSB under average river flow conditions (3.7 miles or 6.0 km), the Bakken crude is transported 10.2 miles (16.4 km) further downstream before reaching the 24 hour model limit. Additionally 22.4% of the Bakken crude was remaining on the river surface at the end of the simulation. The Bakken crude was able to travel further downstream, under the same river velocities due to the differences in the shoreline and lake surface oil retention between the two oil types.

6.1.4.2.3 Trajectory and Fate Results for Low River Flow (Winter)

Under low river (March) flow conditions, with oil released underneath 100% ice cover, Bakken crude was predicted to be transported a total of 1.5 miles (2.4 km) downstream, within 1.1 hours of the release. The Bakken crude was predicted to be transported down the Shell River for 0.6 miles (0.97 km), and then spread under the ice to a thickness of 1.9 mm (Table 5-9). The oil was predicted to spread under the ice covering an area of 0.42 miles^2 (1.09 km^2) including all of Upper Twin Lake and a portion of Lower Twin Lake. Approximately 30.9% of the Bakken crude was predicted to oil the shorelines of Shell River, and the remaining 69.1% to spread under the ice within the lake.

When compared to the CLWB under low river flow conditions (32.7%), 1.8% less of the Bakken crude remained on the river shorelines under the ice. This was due to the lower shoreline oil retention for Bakken crude oil, compared to CLWB. For this reason 1.8% more oil was able to spread under the ice surface in Upper and Lower Twin Lake for the Bakken release. The Bakken crude was also able to spread in the lakes under the ice to a greater extent (0.42 miles^2) than the CLWB (0.054 miles^2 or 0.140 km^2) due to the reduced capacity of the ice to trap the Bakken crude.

6.1.5 Unmitigated Hypothetical Release Case 5—Red River

The Red River is located along the border of Minnesota and North Dakota, and runs to the north into Canada. The pipeline crossing is located approximately 3 miles (4.82 km) due east of Bowesmont, North Dakota and 9 miles (14.48 km) southwest of Hallock, Minnesota adjacent to Route 16. At the proposed pipeline crossing location and downstream, the Red River is a large, wide (150-400 ft) river that flows north along a well-defined sinuous channel. The Red River passes the communities of Pembina, North Dakota and St. Vincent, Minnesota approximately 32 river miles downstream from the crossing location, and crosses into Canada approximately 34.5 miles downstream. The communities of Emerson and West Lyme, Manitoba are located on the Canadian side of the international border.

This modeling site captures a large, low-gradient (dropping approximately 6 ft in 35 river miles) watercourse, with a sinuous channel that is subject to flooding. The shore types are predominantly vegetated, often with shrubs and trees above the level of ice-scour. These waters

are known to be a major area for recreation use, and also pass through or adjacent to sensitive ecosystems. The riparian banks are generally well vegetated, including some trees. Patches of forest are often present where the river meanders, although the surrounding land use is primarily agricultural. The Red River is subject to moderate to extreme flooding, particularly in the spring. Under low or average flow conditions, the stream banks are a combination of grass and soil. Under higher flow conditions the river can overtop the banks and spread into the surrounding farm and grassland. Expected environmental conditions throughout the year for the Red River are provided in Table 5-6.

The predicted downstream trajectory and mass balance tables for CLB (Figure 6-11) and Bakken crude (Figure 6-12) seasonal scenarios for the Red River release location are provided.

6.1.5.1 Cold Lake Blend Scenarios

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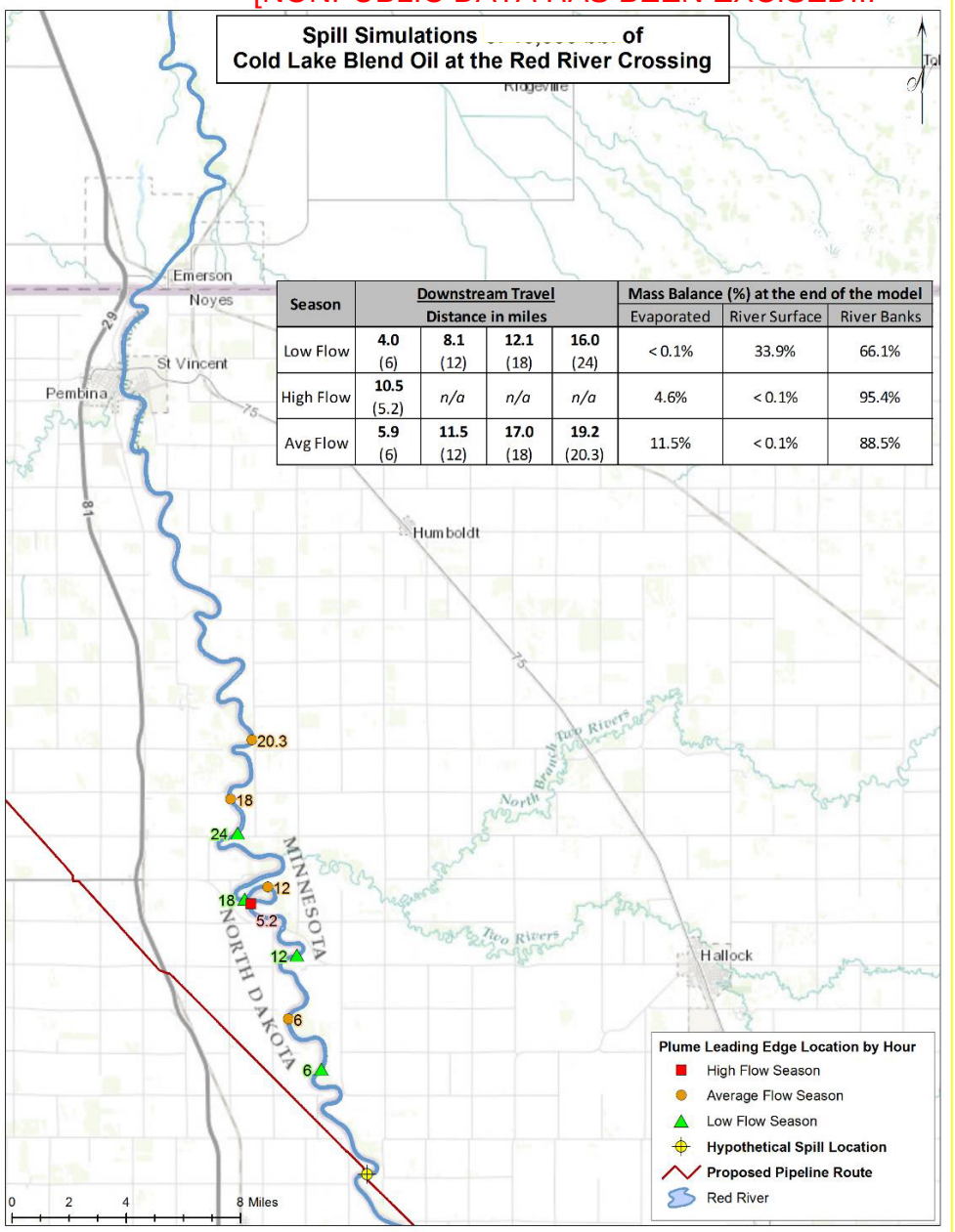

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model		
					Evaporated	River Surface	River Banks
Low Flow	**4.0** (6)	**8.1** (12)	**12.1** (18)	**16.0** (24)	< 0.1%	33.9%	66.1%
High Flow	**10.5** (5.2)	*n/a*	*n/a*	*n/a*	4.6%	< 0.1%	95.4%
Avg Flow	**5.9** (6)	**11.5** (12)	**17.0** (18)	**19.2** (20.3)	11.5%	< 0.1%	88.5%

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Figure 6-11 Predicted Downstream Transport of CLB Oil at the Red River Release Location

6.1.5.1.1 Trajectory and Fate Results for High River Flow (Spring)

Flow rates for the Red River during the spring result in peak average river velocities during April ranging from 1.97 and 4.12 mph (0.88 and 1.84 m/s). The OILMAP Land model transports oil downstream with these velocities to a point where all oil has evaporated and/or adhered to the shoreline.

Under high river flow, CLB was predicted to travel a total of approximately 10.5 miles (16.9 km) downstream, within 5.2 hours of the release. At this time, there was no CLB on the river surface as the model predicted that the oil would have been lost from the water surface by this point in time. After this distance, the oil would have been transported to the north through agricultural lands, stopping before the confluence with the Two Rivers. Approximately 95.4% of the CLB would be predicted to oil the shorelines of the Red river, and the remaining 4.6% would have evaporated into the atmosphere.

6.1.5.1.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Flow rates for the Red River during the summer (August) and fall resulted in average river velocities ranging between 0.94 and 1.81 mph (0.42 and 0.81 m/s). These river velocities were approximately 43% of that of the high flow condition.

Under average river flow, CLB was predicted to travel a total of approximately 19.2 miles (30.9 km) downstream, within 20.3 hours of the release. At this time there would be no CLB on the river surface as the model predicted that the oil would have been lost from the water surface by this point in time. After 19.2 miles (30.9 km) the oil would have been transported to the north, passed the confluence with the Two Rivers to roughly a point just north of 310th Street in Minnesota, where County Ditch Number 26 enters the Red River. Approximately 88.5% of the CLB was predicted to oil shorelines of the Red River, and 11.5% to evaporate into the atmosphere.

Relative to the high river flow condition, the CLB was predicted to travel further downstream under average flow conditions. Under average flow conditions the stream shorelines are predominantly a mixture of grass and soil. Under high flow conditions all of the stream shorelines are assumed to be underwater and the shore type would be grass. The soil shorelines are capable of retaining 15 m^3 of CLB per kilometre of river, while the grass shoreline is capable of retaining 125 m^3 of CLB per kilometre of river. In the average river flow condition, less of the CLB would have adhered to the soil shorelines, allowing it to be transported further downstream. The volume of oil retained on the shoreline was less under the average flow conditions because more of the CLB was able to evaporate. This was partially due to the higher temperatures in the summer/fall conditions, but mainly driven by the longer time the CLB was able to move downstream and the greater surface area containing oil that was able to evaporate.

6.1.5.1.3 Trajectory and Fate Results for Low River Flow (Winter)

The lowest river flow winter conditions for the Red River occurs in February. To maximize downstream oiling potential, it was conservatively assumed that the Red River would be frozen over completely (100% coverage of ice). It was assumed that CLWB would be released directly

into the river from the pipeline, which was under the river bed, and that all oil would remain trapped under the ice. The ice cover would prevent any evaporation to the atmosphere. Flow rates for the Red River during these winter conditions resulted in river velocities that ranged between 0.65 and 1.21 mph (0.29 and 0.54 m/s).

Under low river flow conditions, CLWB was predicted to be transported a total of 16.0 miles (25.7 km) downstream, over the full 24-hour modeled period. Approximately 66.1% of the CLWB was predicted to oil shorelines of the Red River, and the remaining 33.9% to remain in the river below the ice at the end of the 24 hour simulation. If left unmitigated, the remaining CLWB in the river after 24 hours would be expected to continue downstream, oiling shorelines until all of the oil was removed from the water surface. At the end of the 24-hour model period the CLWB was predicted to reach just north of 290th Street in Minnesota.

Relative to the high river flow conditions, the CLWB was predicted to be transported 5.5 miles (8.9 km) further downstream. Relative to the average river flow condition, the CLWB was predicted to be transported 3.2 miles (5.1 km) fewer downstream. Under low river flow conditions, the shore types were assumed to be the same as the average flow conditions. With the oil being transported at a lower velocity, 24 hour modeled time limit was reached at a shorter distance than the average river flow condition. With the CLWB below the ice of the river, no oil was evaporating from the surface.

6.1.5.2 Bakken Crude Scenarios

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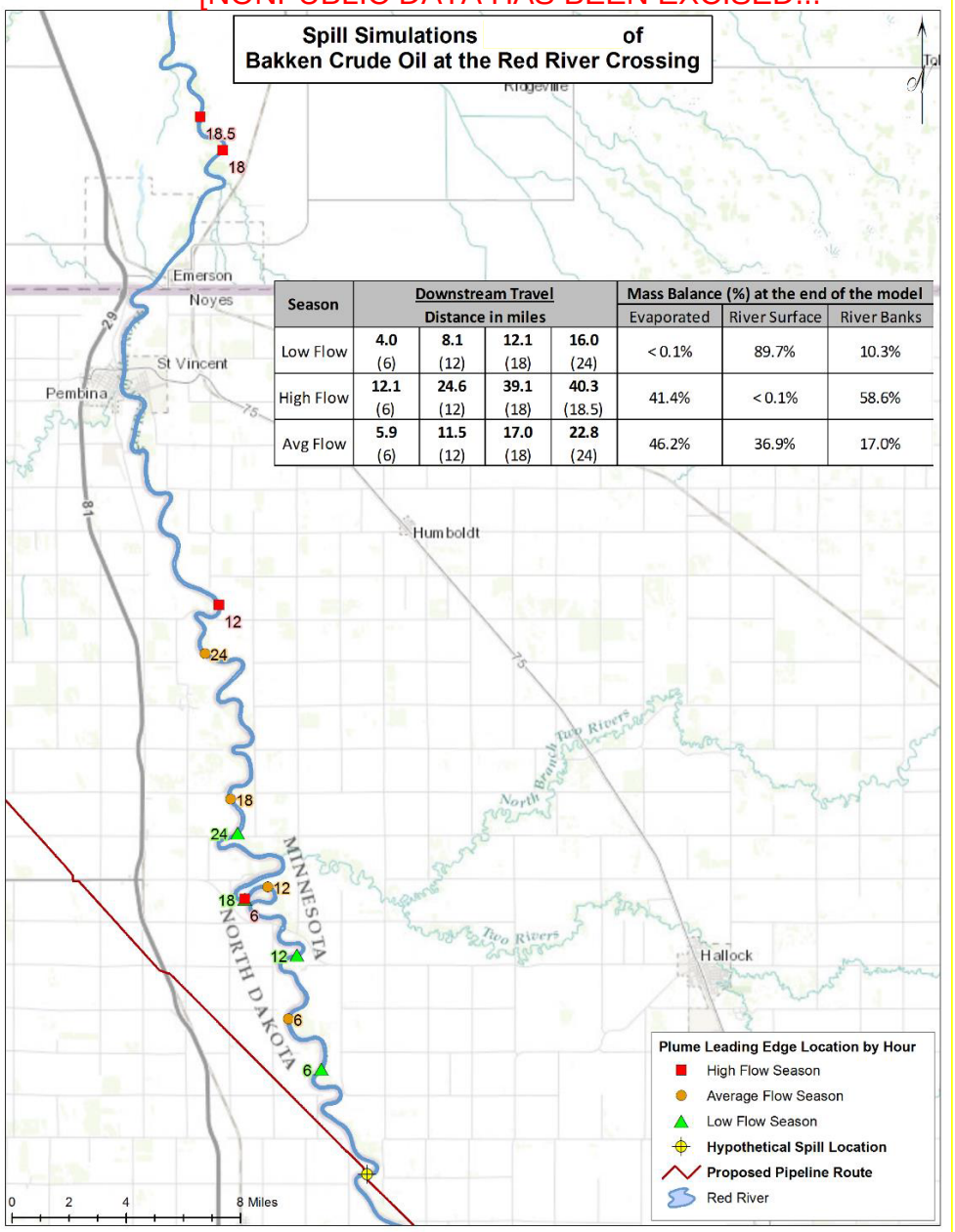

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model		
					Evaporated	River Surface	River Banks
Low Flow	**4.0** (6)	**8.1** (12)	**12.1** (18)	**16.0** (24)	< 0.1%	89.7%	10.3%
High Flow	**12.1** (6)	**24.6** (12)	**39.1** (18)	**40.3** (18.5)	41.4%	< 0.1%	58.6%
Avg Flow	**5.9** (6)	**11.5** (12)	**17.0** (18)	**22.8** (24)	46.2%	36.9%	17.0%

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Figure 6-12 Predicted Downstream Transport of Bakken Crude Oil at the Red River Release Location

6.1.5.2.1 Trajectory and Fate Results for High River Flow (Spring)

Under high river flow, Bakken crude was predicted to be transported approximately 40.3 miles (64.9 km) downstream, within 18.5 hours of the release. At this time there was no Bakken crude on the river surface as the model predicted that the oil would have been lost from the water surface by this point in time. After 40.3 miles (64.9 km) the oil has been transported to the north, past Pembina, into Canada, past Emerson and the confluence of the Joe River and terminating before the Ginew Roseau River Reserve. Approximately 58.6 of the Bakken crude was predicted to oil shorelines of the Red River and 41.4% to evaporate into the atmosphere.

The Bakken crude was predicted to result in oiling 29.8 miles (48.0 km) further downstream than the CLB (10.5 miles or 16.9 km) under high flow river conditions. The difference in the extent of downstream transport was the result of the differences in the shoreline oil retention between the two oil types. Because of its higher viscosity and other parameters, CLB was expected to strand upon shorelines more thickly than Bakken crude oil, resulting in larger amounts of CLB along the shore. In contrast the same amount of Bakken crude would oil longer lengths of shoreline with a reduced thickness. While this result is logical, it is based upon the assumption of 100% shoreline oiling coverage (i.e. all shoreline up to that point is oiled to its maximum holding capacity) as oil makes its way downstream. In the event of an actual release, the downstream extents of CLB and Bakken crude may be more similar, and the effects of CLB may extend farther downstream than presented, with patchy coverage.

Bakken crude was predicted to evaporate approximately 9 times more (41.4%) than the CLB (4.6%). This was partially due to the lighter nature and higher volatile content of the Bakken crude. Additionally, the Bakken crude was predicted to oil further downstream, which took more time and resulted in more surface area with oil. The additional time for downstream transport and oiled surface area therefore allowed for more oil to evaporate to the atmosphere.

6.1.5.2.2 Trajectory and Fate Results for Average River Flow (Summer-Fall)

Under average river flow, Bakken crude was predicted to be transported approximately 22.8 miles (36.7 km) downstream, over the full 24-hour modeled period. After this distance, the oil would have been transported to the north to a point between the entry of the Two Rivers and Pembina, close to 101st Street NE in North Dakota. Approximately 17% of the Bakken crude was predicted to oil the shorelines of the Red River, 46.2% to have evaporated to the atmosphere, and 36.9% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude oil on the river surface after 24 hours would be expected to continue downstream, weathering and oiling shorelines until all of the oil was removed from the water surface.

The Bakken crude was predicted to be transported 17.5 miles (28.2 km) less under average river flow conditions, when compared to the higher river flow conditions. The lower river velocities of the average river flow condition prevented the oil from being transported as far within the 24 hour simulation period. The Bakken crude evaporated more under the average flow conditions (46.2%) than the high river flow condition (41.4%) partially due to the higher air temperatures.

Additionally, under the average river flow condition the oil was transported downstream for the full 24 hours, as opposed to the high river flow condition that ends after 18.5 hours. This longer time allowed the Bakken crude to evaporate more before the end of the simulation.

When compared to the CLB under average river flow conditions, the Bakken crude was transported 3.6 miles (5.8 km) further downstream before reading the 24 hour model limit. Additionally 36.9% of the Bakken crude was still remaining on the river surface at the end of the simulation. The Bakken crude was able to travel further downstream, under the same river velocities, due to the lower shoreline oil retention value for Bakken, when compared to CLB.

6.1.5.2.3 Trajectory and Fate Results for Low River Flow (Winter)

Under low river flow, Bakken crude was predicted to be transported approximately 16.0 miles (25.7 km) downstream, over the full 24-hour modeled period. Approximately 10.3% of the Bakken crude was predicted to oil shorelines of the Red River, and the remaining 89.7% to remain in the river below the ice at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude in the river after 24 hours would be expected to continue downstream, oiling shorelines until all the oil was removed from the water surface.

Relative to the high river flow condition, the Bakken crude was predicted to be transported 24.3 miles (39.1 km) fewer downstream. Relative to the average river flow conditions, the Bakken crude is predicted to be transported 6.8 miles (10.9 km) fewer downstream. Under low river flow conditions, the shore types were assumed to be the same as the average flow condition. With the oil being transported at a slow velocity, the 24 hour time limit was reached, resulting in a shorter distance oiled than that average river flow condition. With the Bakken crude below the ice of the river, no oil was allowed to evaporate from the surface.

When compared to the CLWB under low river flow conditions, 55.8% less of the Bakken crude remained on the river shorelines under the ice. This was due to the differences in the shoreline oil retention between the two oils. For this reason, 55.8% more oil was able to be transported downstream under the ice.

6.1.2 Summary of OILMAP Land Trajectory and Fate Results

The most important factor driving the transport of released oil in a river is the volume (discharge) of water and resulting velocity moving downstream. Typically, higher flow rates result in further downstream transport and more extensive shoreline oiling (Table 6-1). Based upon the river velocities at each location, the furthest downstream release extent is expected for the Red River. In some cases, changing shoreline types with the range of seasons did result in further downstream transport under low or average river flow conditions, when compared to high river flow conditions.

Table 6-1 Downstream Distance (miles) Maximum Oil Flow at the End of the Simulations

Location	Oil Type	Season / River Flow		
		Low	Average	High
Mosquito Creek	Bakken Crude	0.8	9.7	10.5
	Cold Lake Blend	0.8	3.5	3.5
Mississippi River at Ball Club (assumed grass shore type)	Bakken Crude	6.5 (6.5)	5.7 (15.9)	6.4 (23.0)
	Cold Lake Blend	1.3 (6.5)	1.3 (8.0)	1.3 (8.1)
Sandy River	Bakken Crude	6.0	9.1	12.2
	Cold Lake Blend	6.0	7.8	8.1
Shell River to Twin Lakes	Bakken Crude	1.5	13.9	21.9
	Cold Lake Blend	0.8	3.7	3.7
Red River	Bakken Crude	16.0	22.8	40.3
	Cold Lake Blend	16.0	19.2	10.5

Under winter conditions, snow and ice may significantly affect the predicted transport and fate of oil. Snow has the potential to slow downslope oil transport, with high absorbency. For releases at Mosquito Creek, snow cover under winter conditions prevented the releases from entering the water course, which did occur during summer and spring conditions. Ice has the potential to prevent oil from entering a waterway if the oil is released on land. However, if oil were to be released under ice, the in-water effects could be substantially greater due to the "capping" of the river, which would prevent evaporative losses and result in substantially more dissolution of hydrocarbons into the water column.

Two main differences between oil fates were observed when the CLB results were compared to those of the Bakken crude oil releases. Of primary importance, CLWB and CLSB have a higher density and viscosity, relative to the Bakken. This affects its shoreline oil retention values and results in more extensive shoreline oiling (thicker) for CLWB and CLSB, relative to the Bakken. In most scenarios, this results in further downstream transport of Bakken. In the event of an actual release, the downstream extents of CLSB and Bakken Crude may be more similar, and the effects of CLSB may extend farther downstream than presented, with patchy coverage. This is most important under high and average flow conditions, where the transport is directly limited by shoreline retention, as opposed to the downstream extent in low flow conditions predominantly being controlled by the low velocity. Of secondary importance is the volatile content, which controls the amount and rate of evaporation. More Bakken is expected to evaporate and at a higher rate, compared to CLWB and CLSB.

OILMAP Land is not able to provide detailed predictions of 3-D oil fate and transport. This includes processes such as entrainment of oil into the water column, dissolution of soluble fractions of hydrocarbons, emulsion formation, potential biological effects from exposure to oil, and other complex interactions. While these processes were not modeled for these five sites, they were modeled at the Mississippi River at Palisade and Little Falls using the SIMAP model application. These results are discussed in Section 6.2.

6.2 DESCRIPTION OF SIMAP MODEL OUTPUTS

This section provides modeled predictions of the expected trajectory and fate of hypothetical releases of two crude oils at two hypothetical releases located along the Mississippi River at Little Falls and Palisade and under multiple environmental conditions. Trajectory and fate results are depicted for each combination of season (high, average, and low river flow) for releases of both CLB and Bakken Crude oil types. A set of figures is provided for each of the twelve modeled scenarios.

The hydrocarbon trajectory provides a history of oil transport throughout the modeled domain in both time and space. Components of the oil are tracked as entrained droplets of oil within the water column, dissolved aromatics, floating surface oil, stranded oil on shorelines, oil in the sediment, and that which evaporated or decayed. The following points describe the types of figures produced through the modeling process and the information portrayed. Summary figures of trajectory and fate are provided for each location, season, and release volume. Mass balance information at the end of the 24-hour simulation is provided in tables for each of the release scenarios in terms of percent of oil spilled.

1. **Mass Balance Plots**: Provide an estimate of the weathering and fate of oil for a specific run for the entire model duration as a fraction of the oil spilled up to that point. Components of the oil tracked over time include the amount of oil on the water surface, the total entrained hydrocarbons in the water column, the amount of oil on shore, the oil evaporated into the atmosphere, the oil in sediments, and the amount of oil that has decayed (accounts for both photo-oxidation and biodegradation).
2. **Hydrocarbon Trajectory Maps:** Show the history of each individual particle of oil throughout the modeled domain in both time and space. Components of the oil were tracked as entrained droplets of oil, dissolved aromatic constituents, floating surface oil, and stranded shoreline oil. Trajectory maps are provided for 6, 12, and 24 hours after the initial release.
3. **Surface Oil Thickness Maps:** Depict the footprint of maximum floating surface oil and the associated oil thicknesses (mm) of each individual spill simulation at 24 hours.
4. **Water Column Concentration Maps:** Depict the footprint of the vertical maximum water column concentration of dissolved aromatics (µg/l or ppb) at 24 hours for each individual spill simulation. Dissolved aromatics are the portion of the oil having the greatest potential to affect water column biota, and the footprints were typically smaller than the extent of total oil contamination in the water column. Water column contamination figures show only concentrations ≥ 1 ppb. Concentrations below 1 ppb are considered low and result in little water column impact.

5. **Shoreline and Sediment Impact Maps:** Depict the total mass of oil deposited onto the shoreline and on sediments. Note that 1 µm thickness is roughly equivalent to 1 g/m^2.

6.2.1 Unmitigated Hypothetical Release Case 6—Mississippi River at Palisade

The Mississippi River passes to the south and east of the town of Palisade, Minnesota. The pipeline route crosses the Mississippi River 1.08 miles (1.74 km) to the south-south west of Palisade and to the southern edge of Great River Road (Rt. 10). At this location the Mississippi River flows to the south and west through a low energy and sinuous channel that passes through mainly agricultural lands with forested banks. Approximately 11 miles (17.7 km) to the south west of the hypothetical release location, the main stem of the Mississippi River continues to the south and west before continuing to the north and then west towards Wolford. At this point, the Aitkin Low Head Dam may be found with its flood diversion channel that flows due west along Great River Road (Rt. 21), 400th Lane, and then 400th St (Rt. 11) before rejoining the main stem of the Mississippi River. This flood diversion channel was only hydraulically connected to the Mississippi River during the modeled high river flow conditions. The width of the Mississippi River averages approximately 200-250 ft (61-76 m) in this area. Expected environmental and flow conditions used in modeling for the Mississippi River at Palisades are provided in Figure 5-5 and Tables 5-13 and 5-14.

6.2.1.1 Cold Lake Blend Scenarios

The Mississippi River at Palisade scenarios represent a low energy environment for the SIMAP analysis. Hypothetical releases of CLB at the Mississippi River at Palisade under high flow conditions resulted in oil that was transported downstream approximately 4, 8, and 17.5 miles (6.4, 12.8, and 28.2 km) after 6, 12, and 24 hours, respectively (Figure 6-15, Figure 6-16, and Figure 6-17). Under average river flow conditions, the release had a maximum extent of approximately 14 miles (22.5 km) after 24 hours (Figure 6-22, Figure 6-23, and Figure 6-24). During low river flows, the majority of the release was trapped at the ice-water interface within 1.5 miles (2.4 km) of the hypothetical release point, while the maximal extent of oil was approximately 2.5 miles (4.0 km) (Figure 6-37, Figure 6-38, and Figure 6-39). Table 6-2 provides a summary of the mass balance information at the end of the 24-hour simulation, while Figure 6-13 provides the furthest predicted downstream extent of whole oil.

Table 6-2 Summary of the CLB (CLSB or CLWB) Mass Balance Information at the Mississippi River at Palisade Release Location at the End of the 24-Hour Simulation [1]

Scenario	Surface (%)	Evaporated (%)	Water Column (%)	Sediment (%)	Ashore (%)	Decayed (%)
CLSB—High Flow (Spring)	71.3	19.7	<0.1	<0.1	8.1	0.8
CLSB—Average Flow (Summer-Fall)	70.3	21.1	<0.1	<0.1	7.8	0.8

Table 6-2 Summary of the CLB (CLSB or CLWB) Mass Balance Information at the Mississippi River at Palisade Release Location at the End of the 24-Hour Simulation [1]

Scenario	Surface (%)	Evaporated (%)	Water Column (%)	Sediment (%)	Ashore (%)	Decayed (%)
CLWB—Low Flow (Winter)	97.7	0.4	0.6	<0.1	0.3	1.0

NOTE:
[1] All values represent a percent of the total spilled oil

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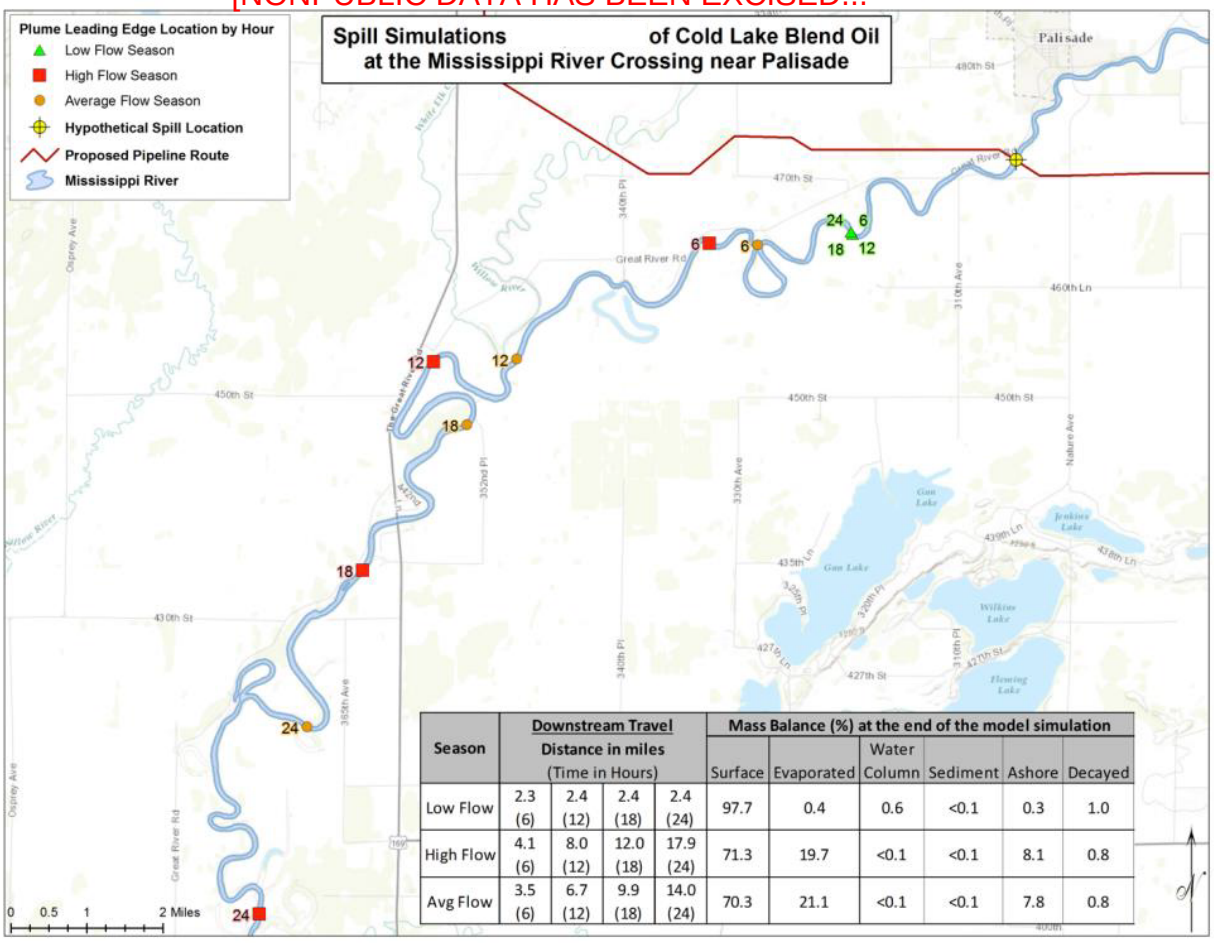

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	2.3 (6)	2.4 (12)	2.4 (18)	2.4 (24)	97.7	0.4	0.6	<0.1	0.3	1.0
High Flow	4.1 (6)	8.0 (12)	12.0 (18)	17.9 (24)	71.3	19.7	<0.1	<0.1	8.1	0.8
Avg Flow	3.5 (6)	6.7 (12)	9.9 (18)	14.0 (24)	70.3	21.1	<0.1	<0.1	7.8	0.8

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Figure 6-13 Predicted Downstream Transport of CLB Oil at the Mississippi River at Palisade Release Location

During high and average river flow conditions, the relatively calm waters (i.e., not a lot of surface breaking disturbances) of the Mississippi River near Palisade did not entrain oil into the water column. Rather, these releases were typified by large amounts of floating oil, which formed thick surface oil slicks over much of the river (Figure 6-18 and Figure 6-25). At the end of the 24-hour simulation, floating oil thicknesses greater than 1 mm (heavy black oil) remained on the water surface. There was no floating surface oil less than 0.01 mm thick (dark brown oil). The presence of extensive surface slicks resulted in significant evaporation, with approximately 20% of the total release ending up in the atmosphere (Table 6-3).

Extensive shoreline oiling and limited sediment oiling was observed for approximately 17.5 miles (28.2 km) of the river below the release location under high river flow conditions (



Figure 6-20) and 14.5 miles (23.3 km) under average river flow conditions (Figure 6-27).

Surface oil evaporated rapidly over the 24-hour simulation (Figure 6-14, Figure 6-21, and Table 6-2). This natural weathering resulted in increased viscosity of the CLSB, which further reduced

the likelihood of potential entrainment into the water column. Because of this, total hydrocarbon concentrations (i.e. whole oil in the water column) were extremely low due to the oil remaining on the surface and not entrained within the water column.

The maximum concentration of dissolved aromatics was greater than 5,000 ppb in small regions within the spill extent; however, most of the dissolved aromatic concentrations were between 1 and 100 ppb (Figure 6-19). Of the oil that made its way into the water column, a portion did interact with SPM (also referred to as Total Suspended Solids or TSS). THCs on the sediment were generally less than 0.01 g/m^2, with small segments as high as 1 g/m2 (



Figure 6-20 and Figure 6-27). The concentrations on the shore were primarily greater than 500 g/m^2. The highest sediment concentrations were predicted for the high river flow scenario due to the higher concentration of TSS in the water column.

For the low river flow scenario, the hydrocarbon trajectory at the end of the 24-hour simulation extended 2.5 miles (4 km) from the spill location (Figure 6-31). Under low river flow conditions the

100% surface coverage of ice kept the entrained oil in the water column at the ice/water interface (97.7%) (Figure 6-31 and Figure 6-32). Patchy oiling along river banks was observed, however the majority of the oil remained trapped under the ice (Table 6-2). Concentrations on the shore were primarily greater than 500 g/m^2, with some segments less than 1 g/m^2 (Figure 6-34). A large portion of the soluble portion of the CLWB dissolved into the water column and was transported downstream, resulting in elevated dissolved aromatic concentrations within the water column (Figure 6-33). Dissolved aromatic components traveled downstream from the initial spill location with maximum concentrations greater than 5,000 ppb in regions within the spill extent (Figure 6-33). Much larger portions of the river are predicted to experience dissolved aromatic concentrations in excess of 5,000 ppb, when compared to average or low flow scenarios. At the end of the 24-hour simulation, floating oil greater than 1 mm thick (heavy black oil) remained under the ice (Figure 6-32). There was no floating surface oil less than 0.1 mm thick (black oil). Small amounts of sediment oiling did extend down to approximately 2.5 miles (4 km) (Figure 6-34), although the total hydrocarbon concentrations on the sediment were generally less than 0.01 g/m^2. There was very little decay from any of the three hypothetical releases within the timeframe modeled.

6.2.1.1.1 Trajectory and Fate Results for High Flow (Spring)

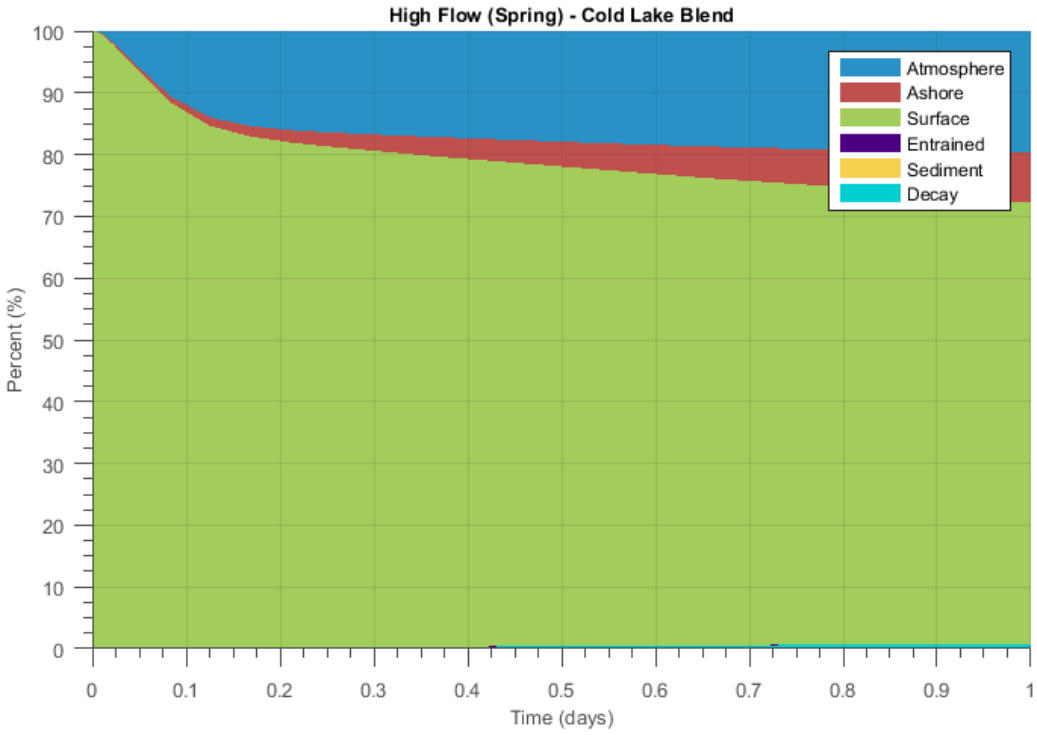

Figure 6-14 Oil Mass Balance Graph for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

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Trajectory and Fate Results for Modeling Locations
January 13, 2017

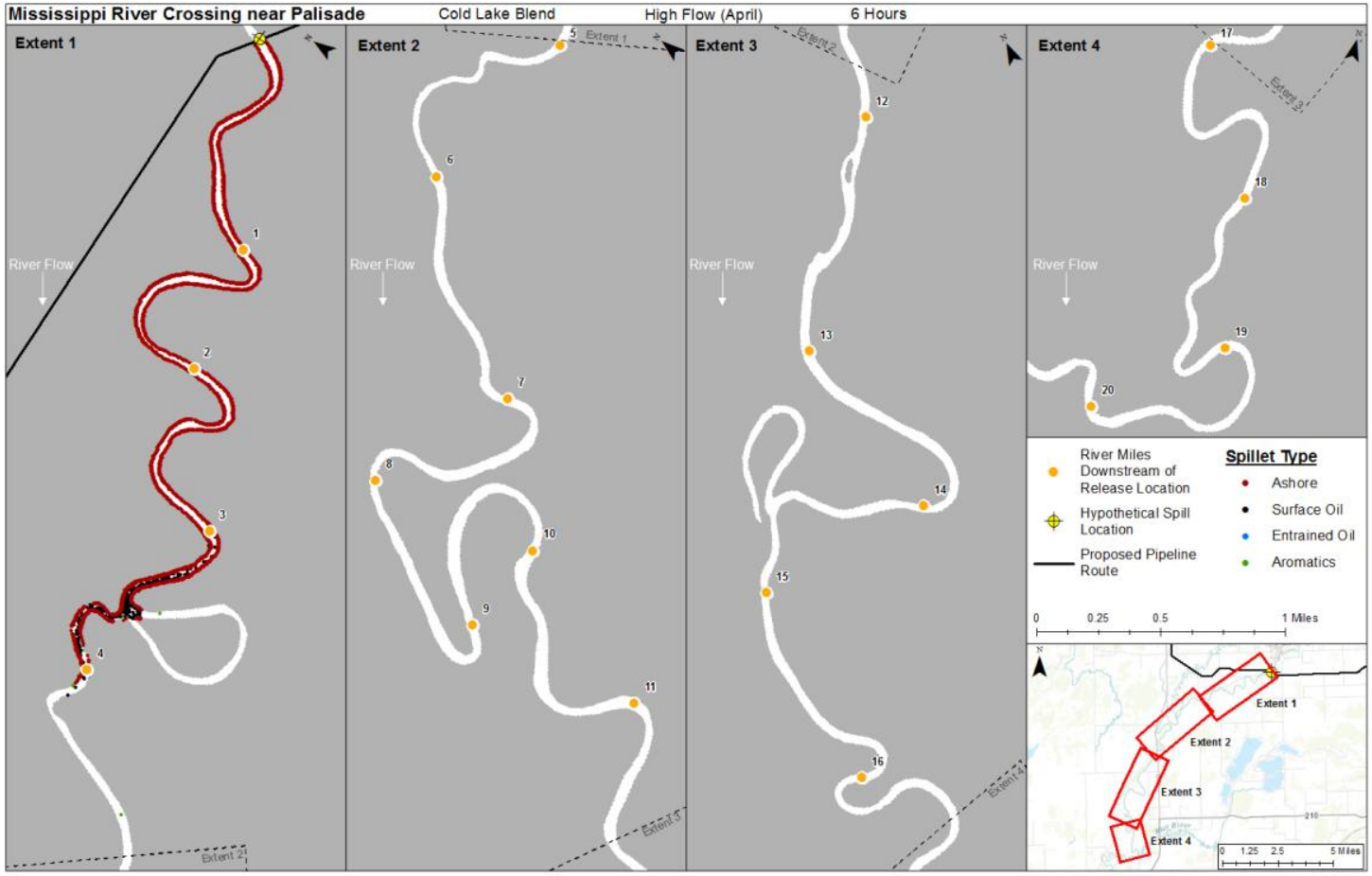


Figure 6-15 Oil Trajectory at 6 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

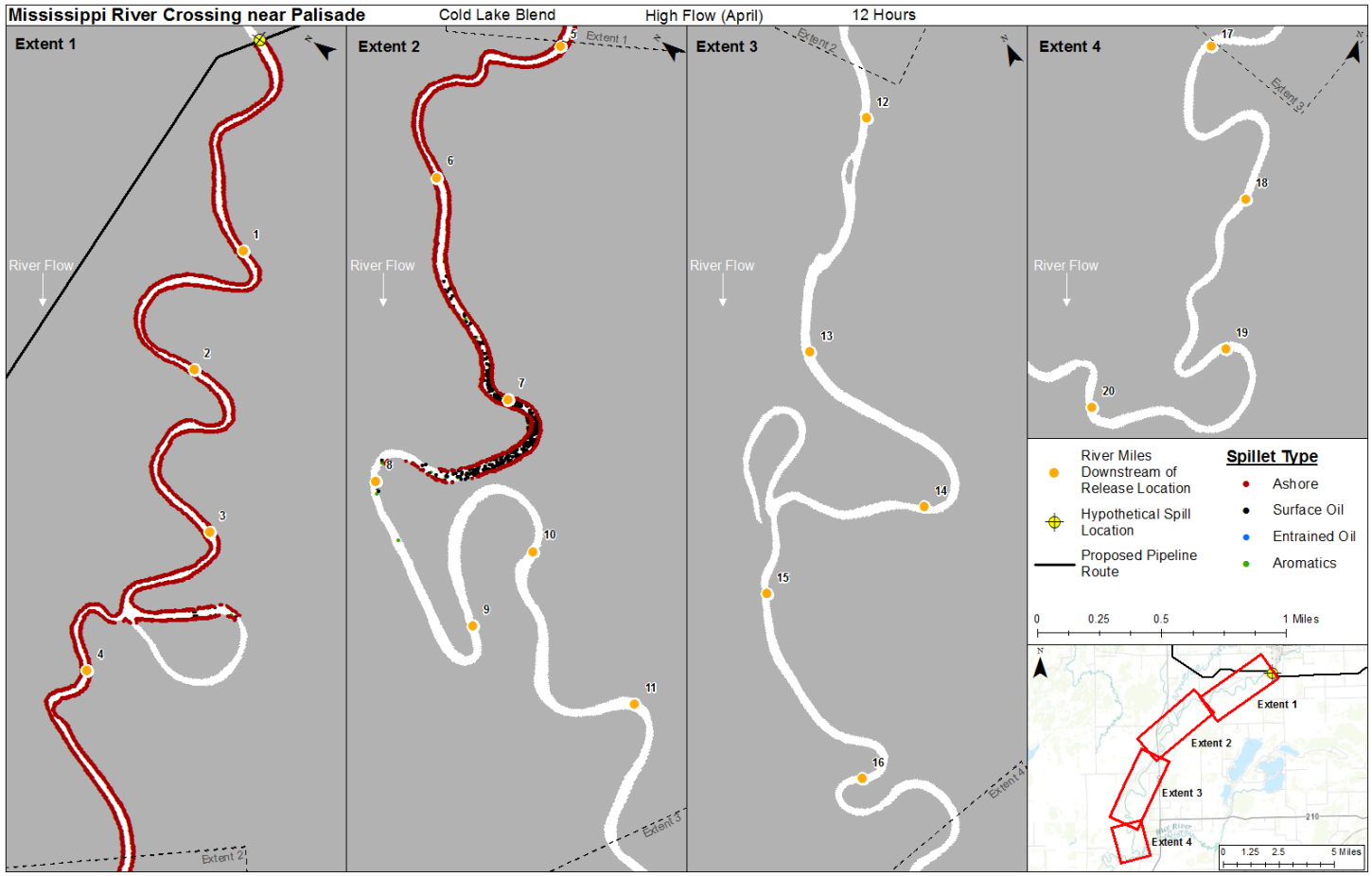
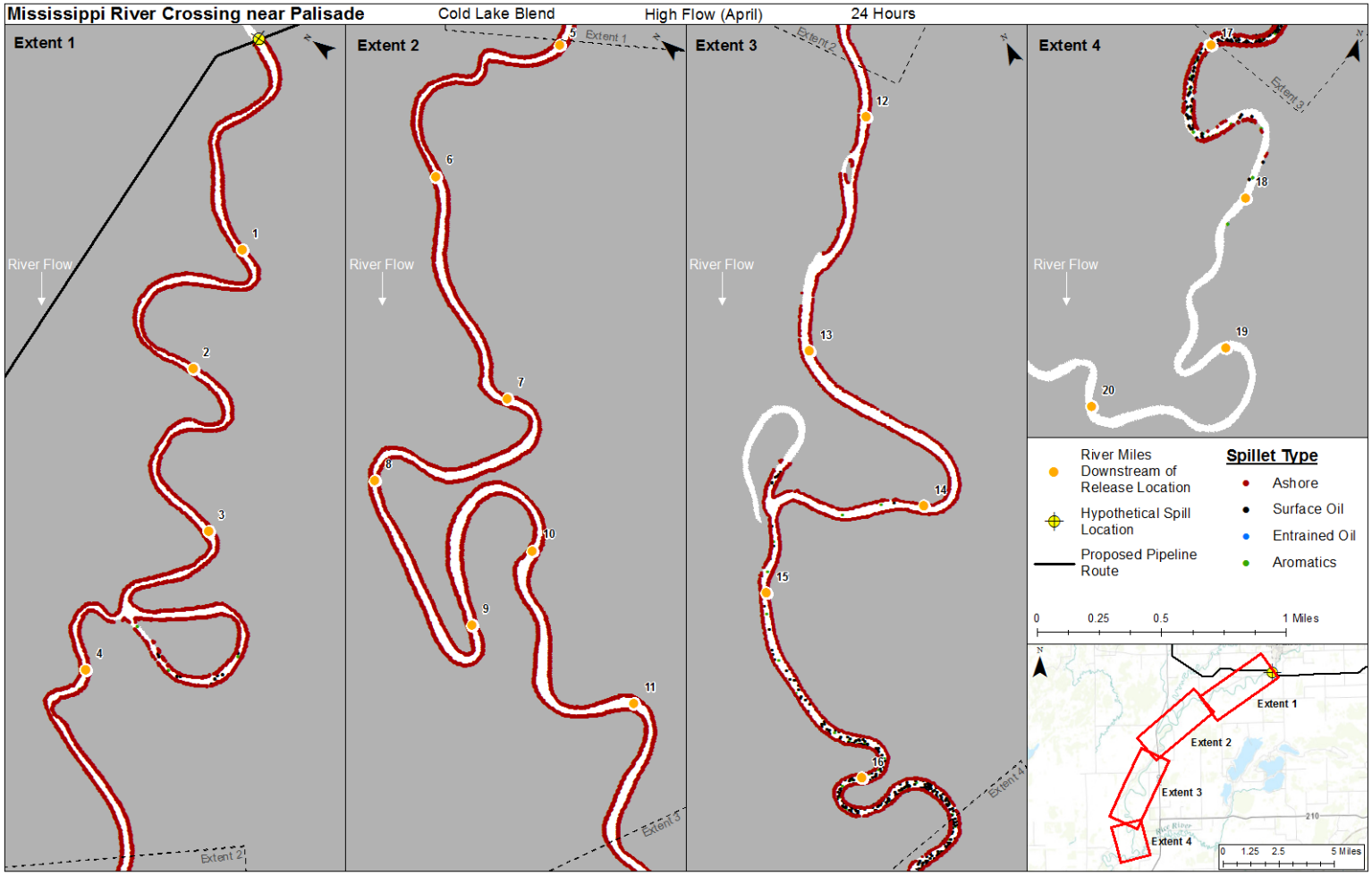


Figure 6-16 Oil Trajectory at 12 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season



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Trajectory and Fate Results for Modeling Locations
January 13, 2017

Figure 6-17 Oil Trajectory at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

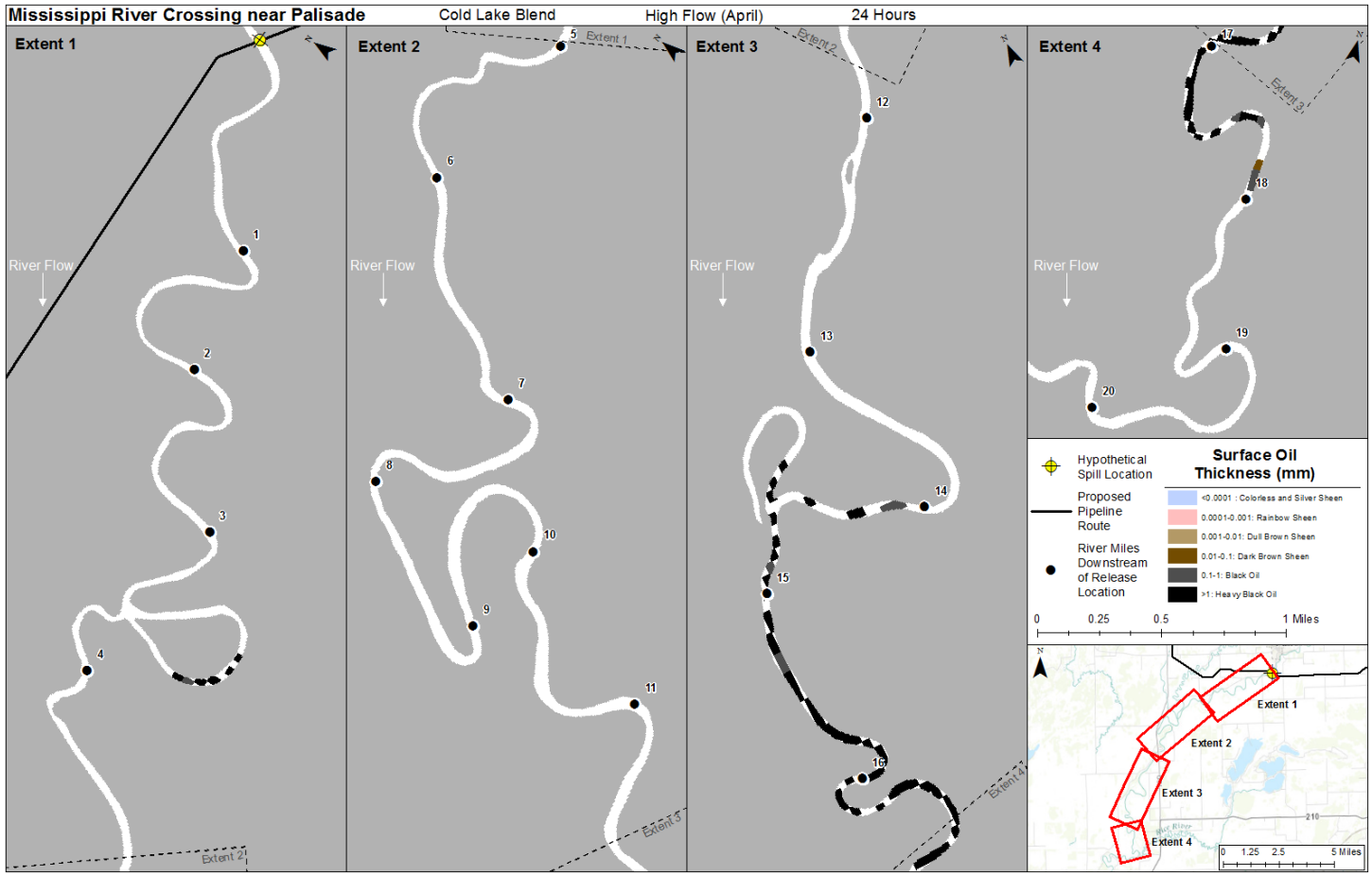


Figure 6-18 Maximum Floating Surface Oil Thickness at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

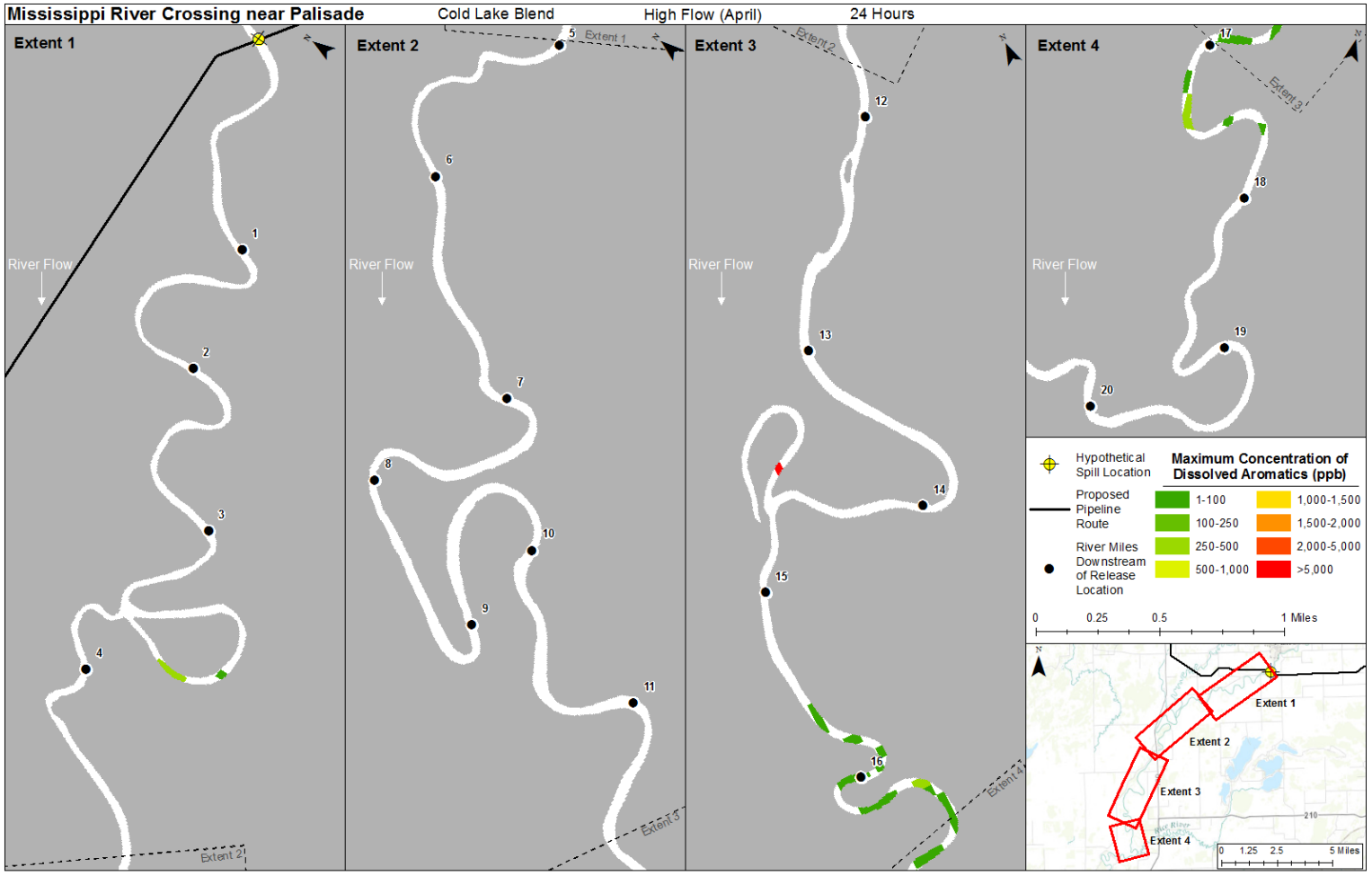
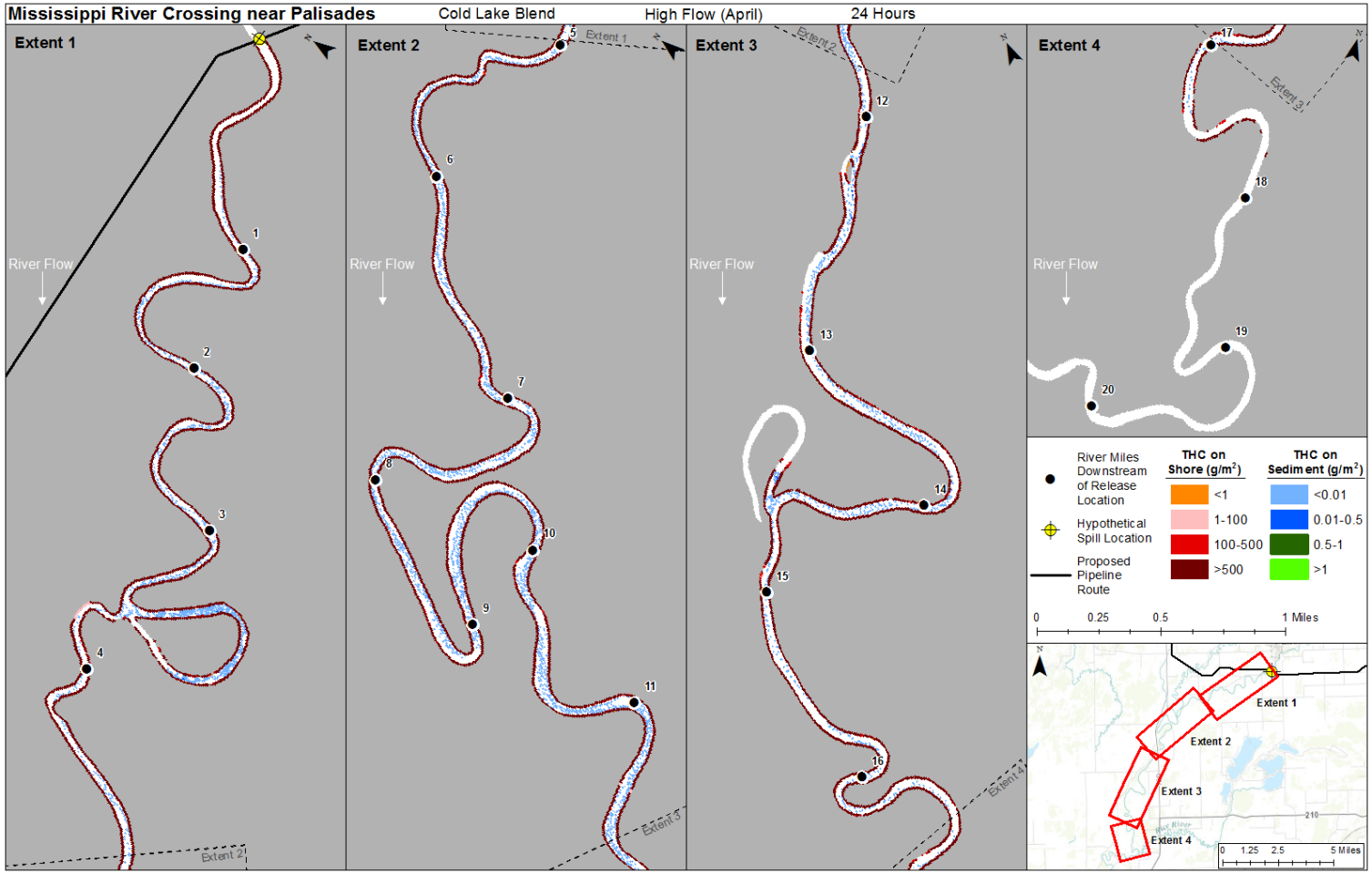


Figure 6-19 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season



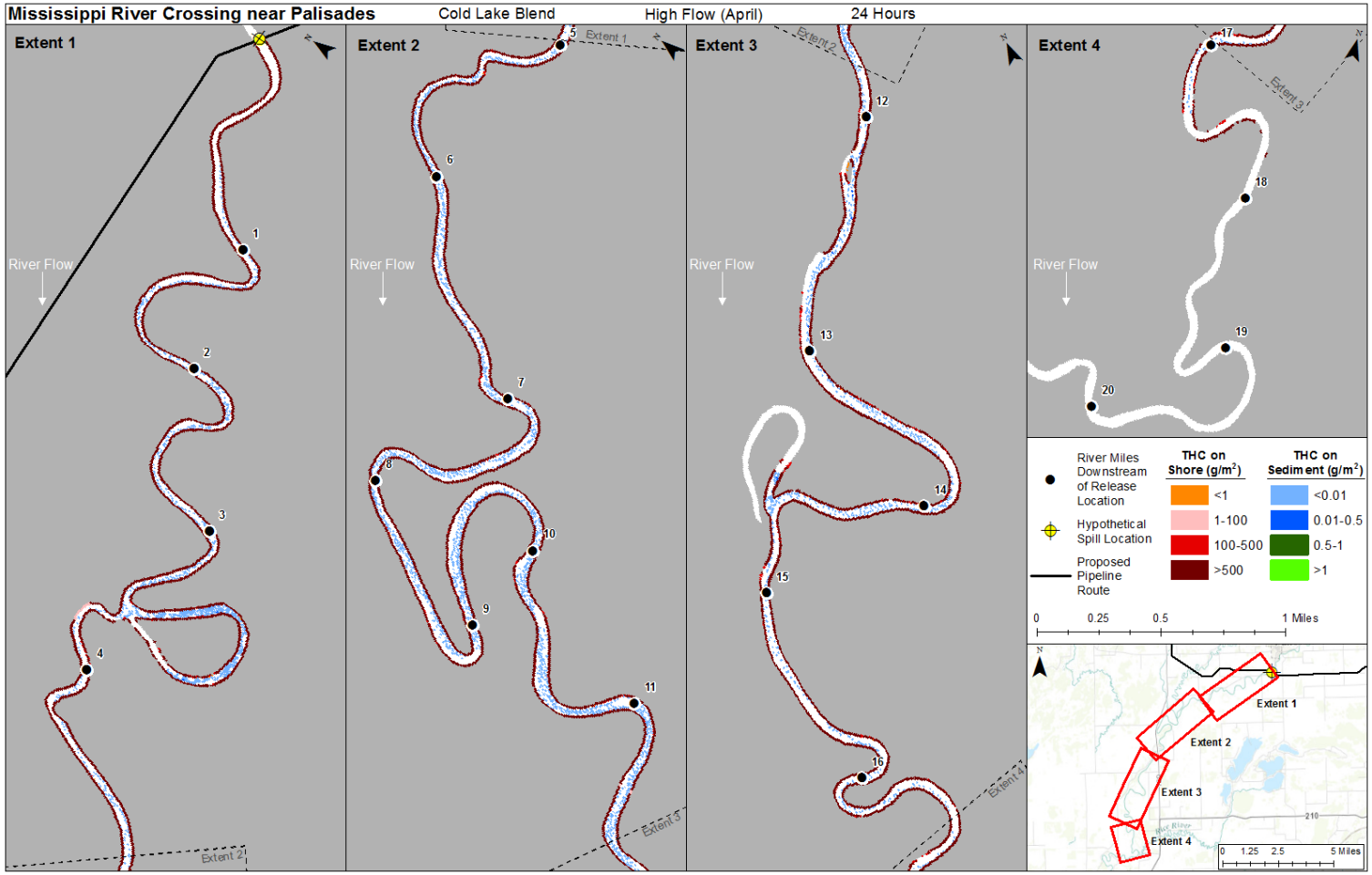


Figure 6-20 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

6.2.1.1.2 Trajectory and Fate Results for Average Flow (Summer-Fall)

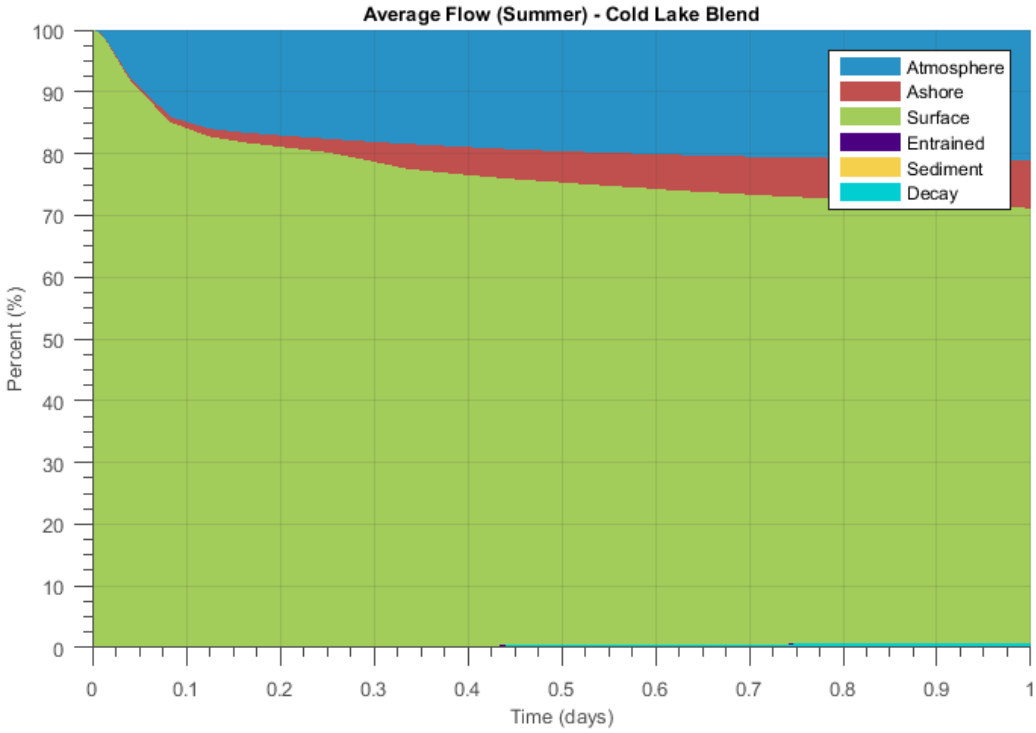


Figure 6-21 Oil Mass Balance Graph for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

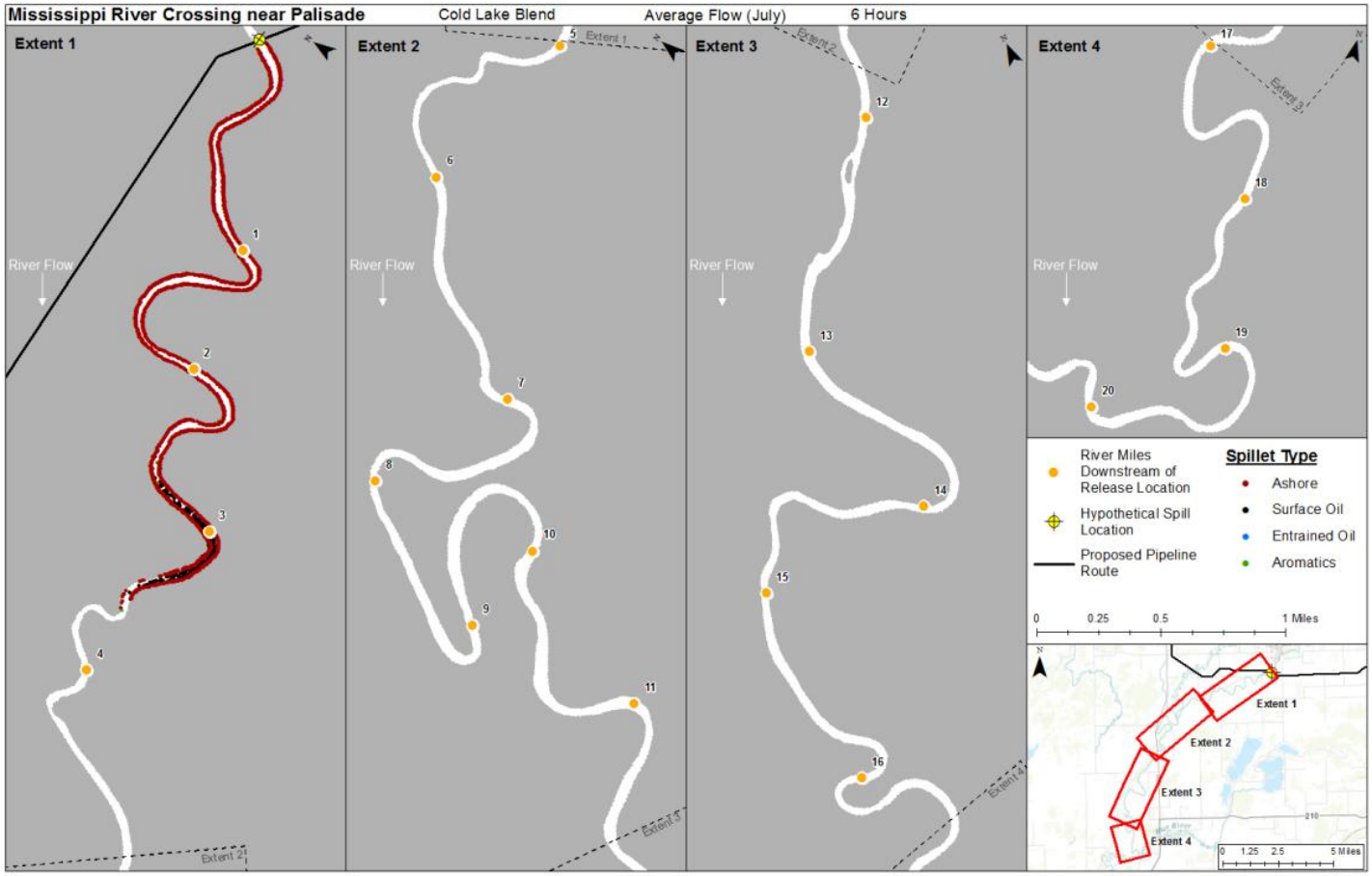


Figure 6-22 Oil Trajectory at 6 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

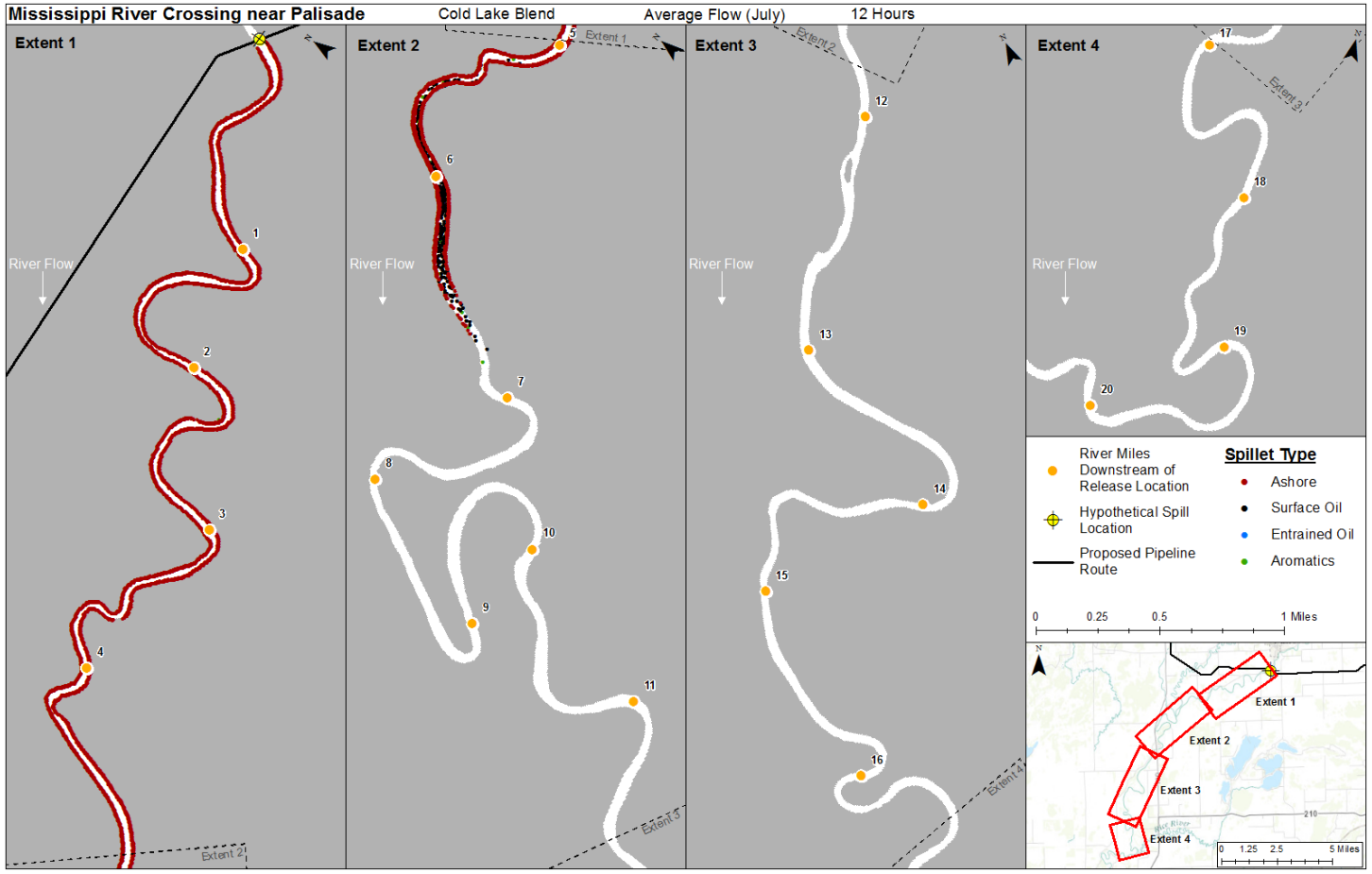


Figure 6-23 Oil Trajectory at 12 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

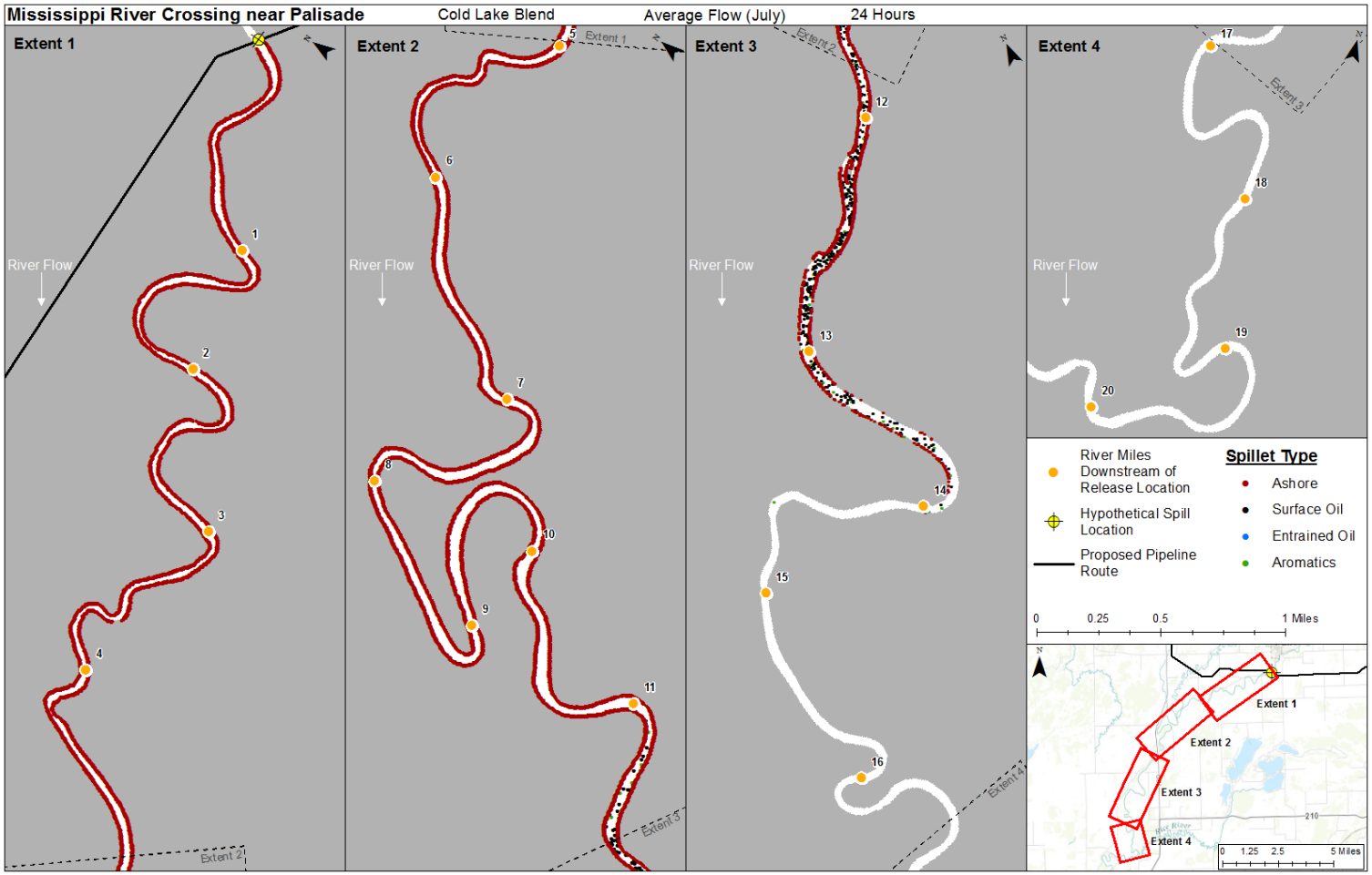


Figure 6-24 Oil Trajectory at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

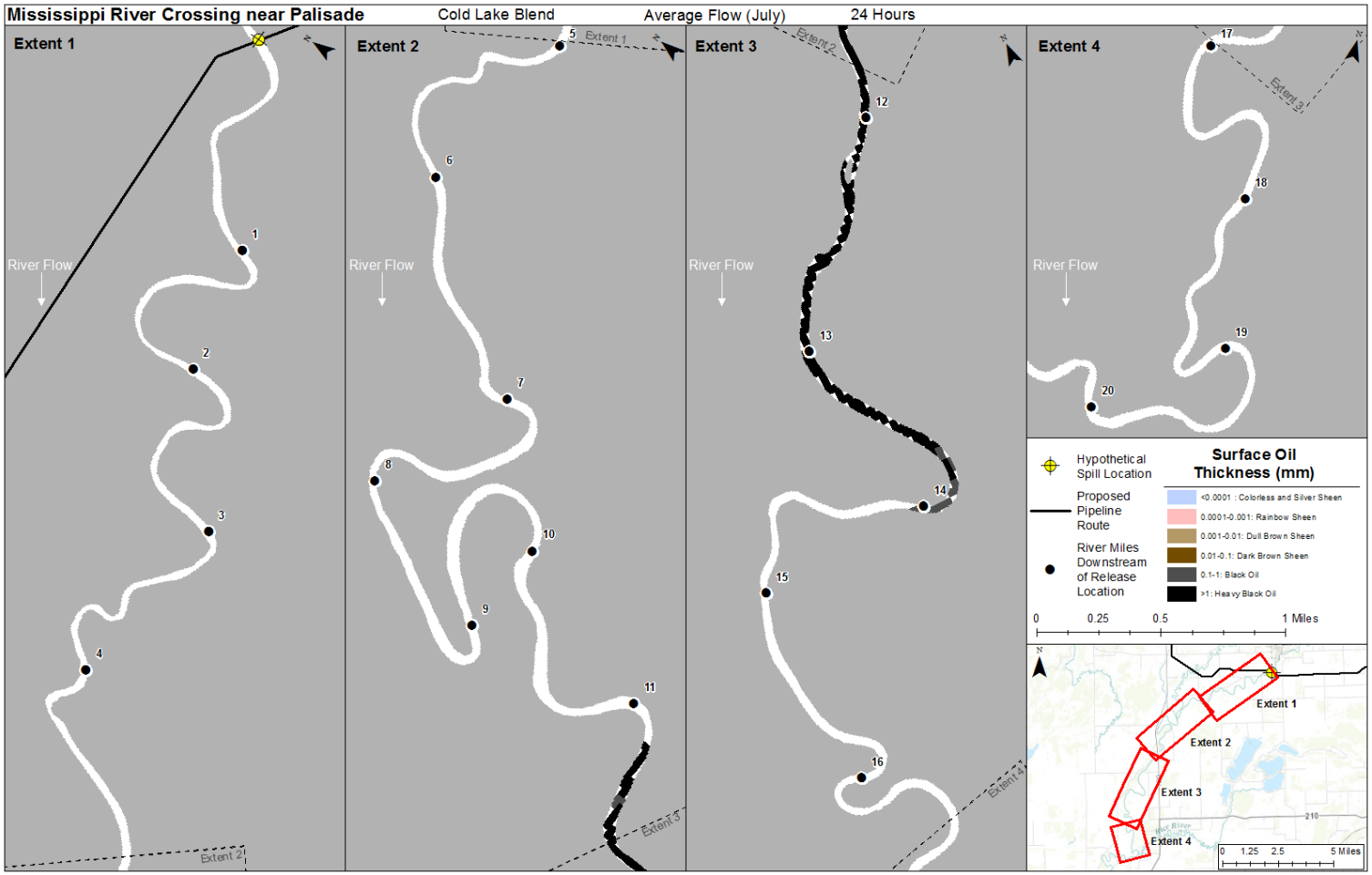


Figure 6-25 Maximum Floating Surface Oil Thickness at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

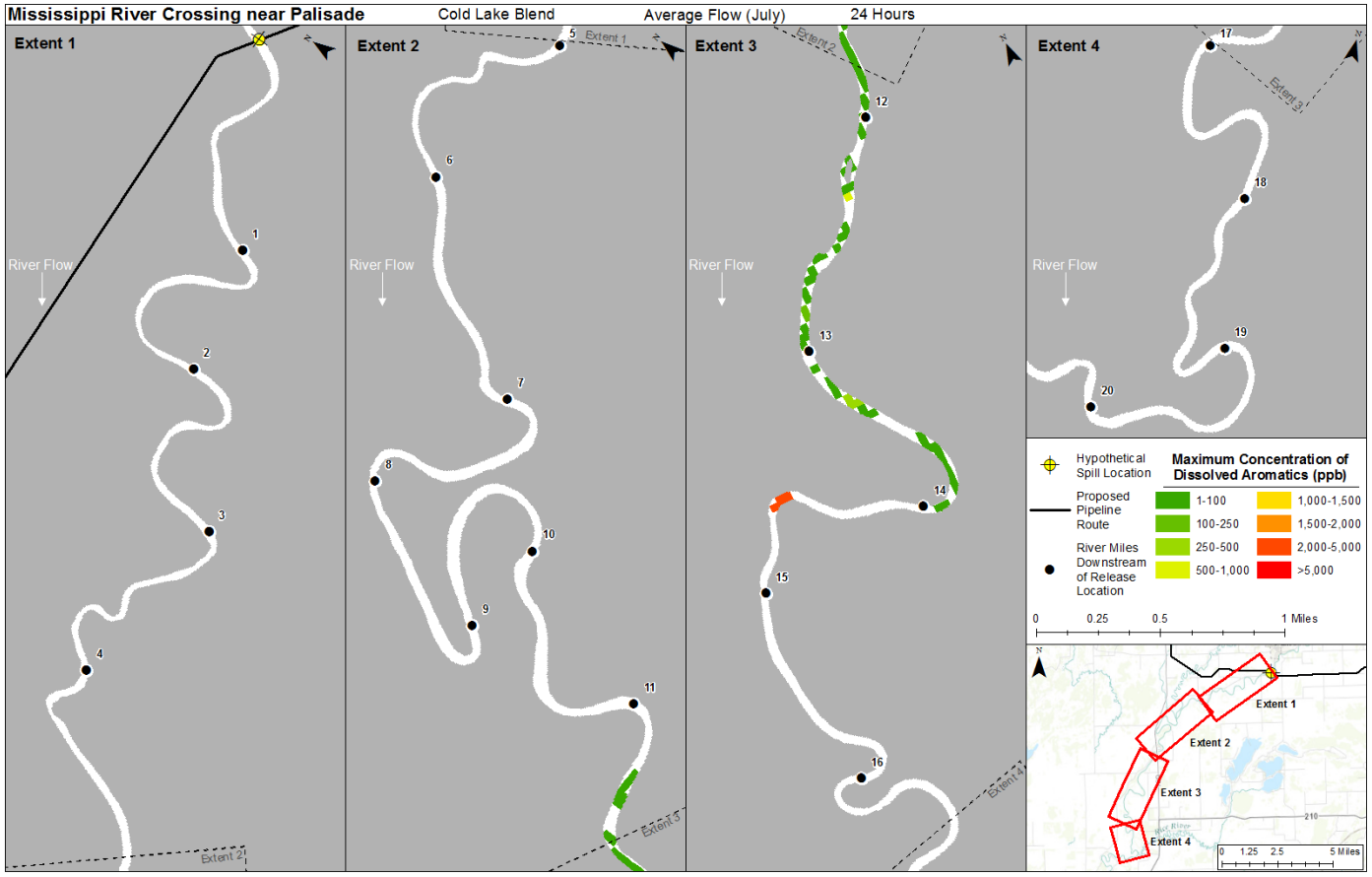


Figure 6-26 Maximum Total Dissolved Aromatic Concentration on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

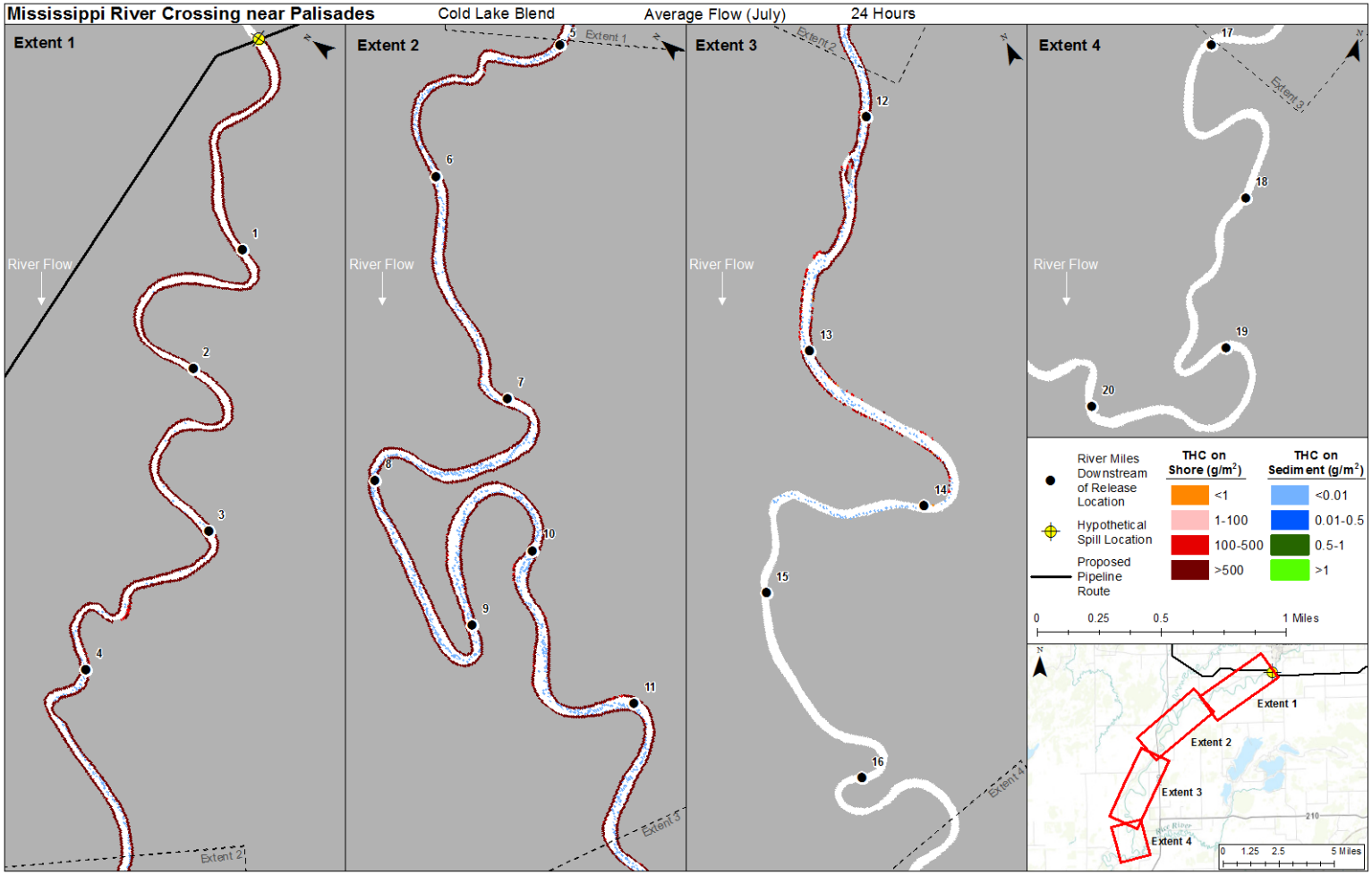


Figure 6-27 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

6.2.1.1.3 Trajectory and Fate Results for Low Flow (Winter)

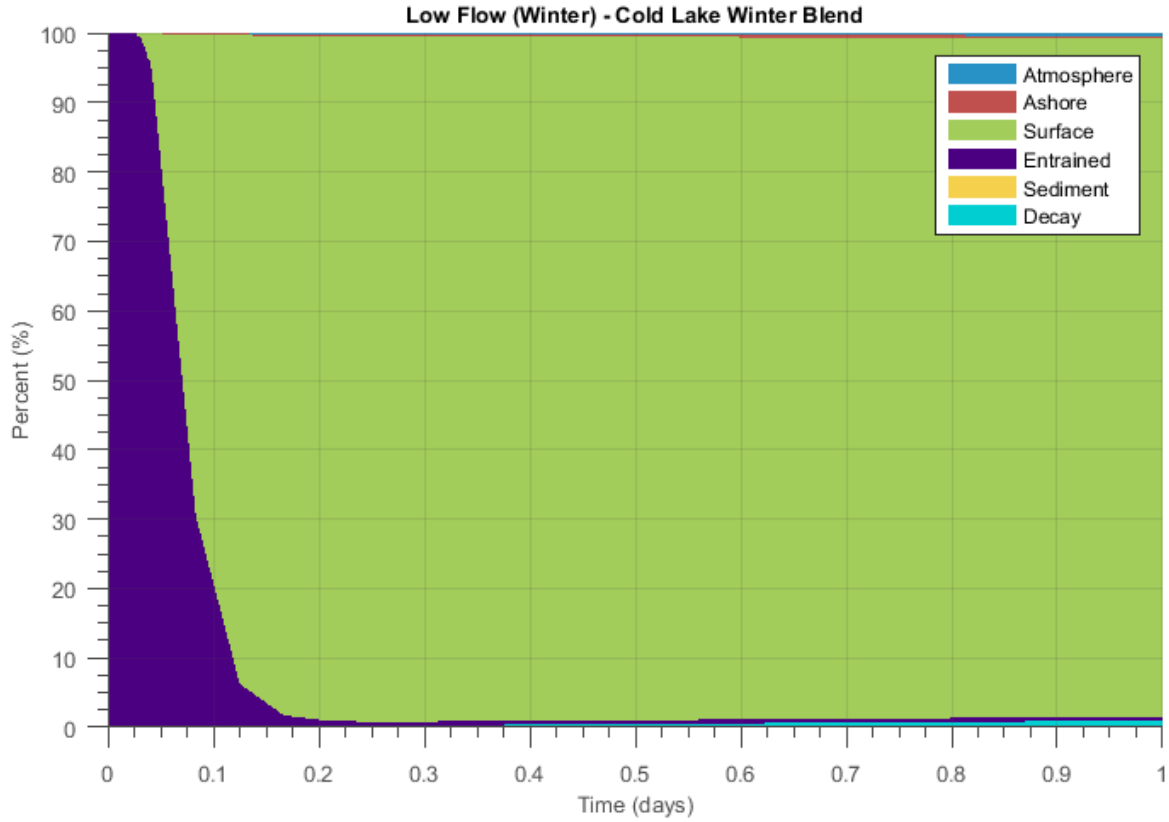


Figure 6-28 Oil Mass Balance Graph for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

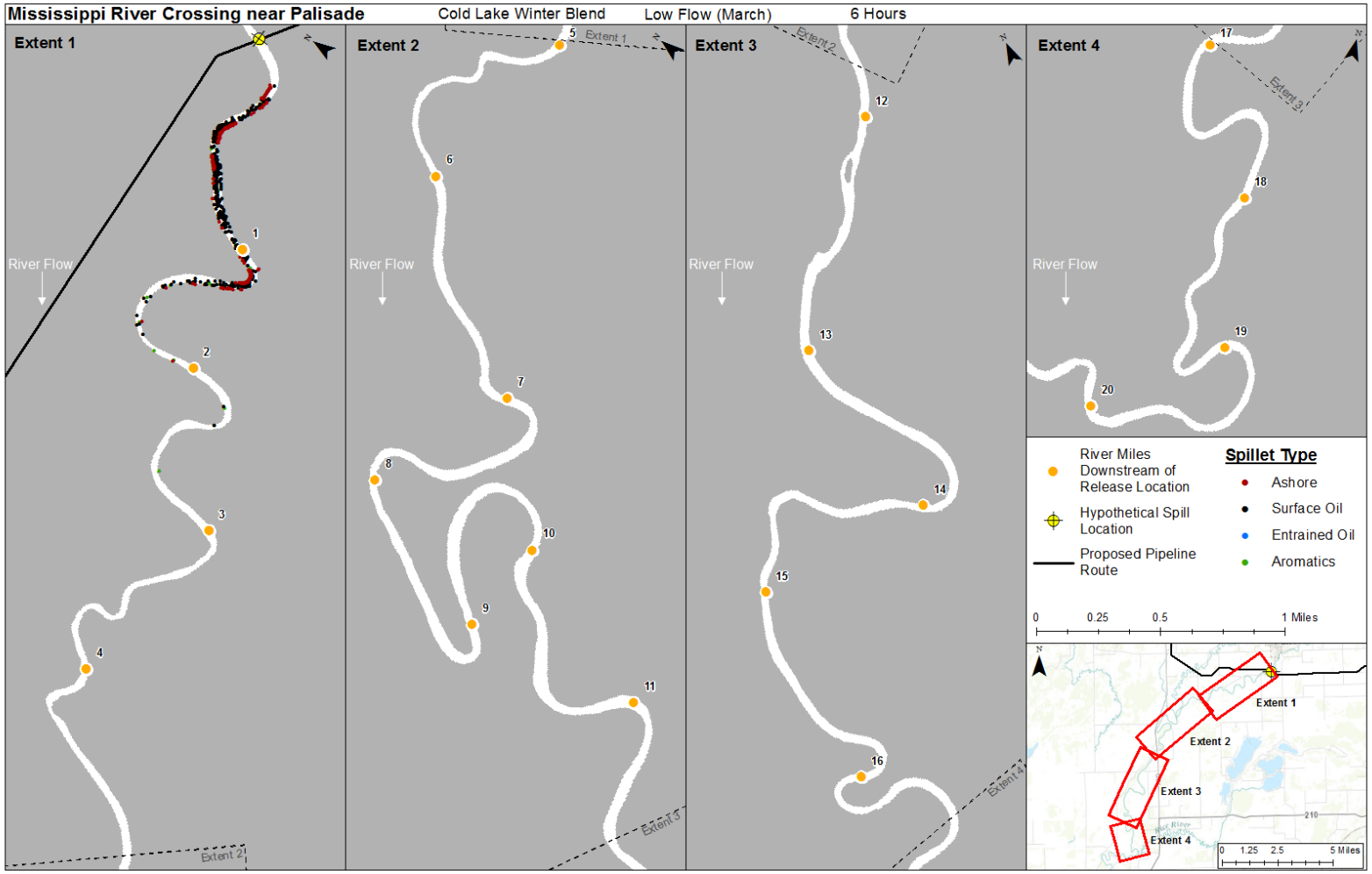


Figure 6-29 Oil Trajectory at 6 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

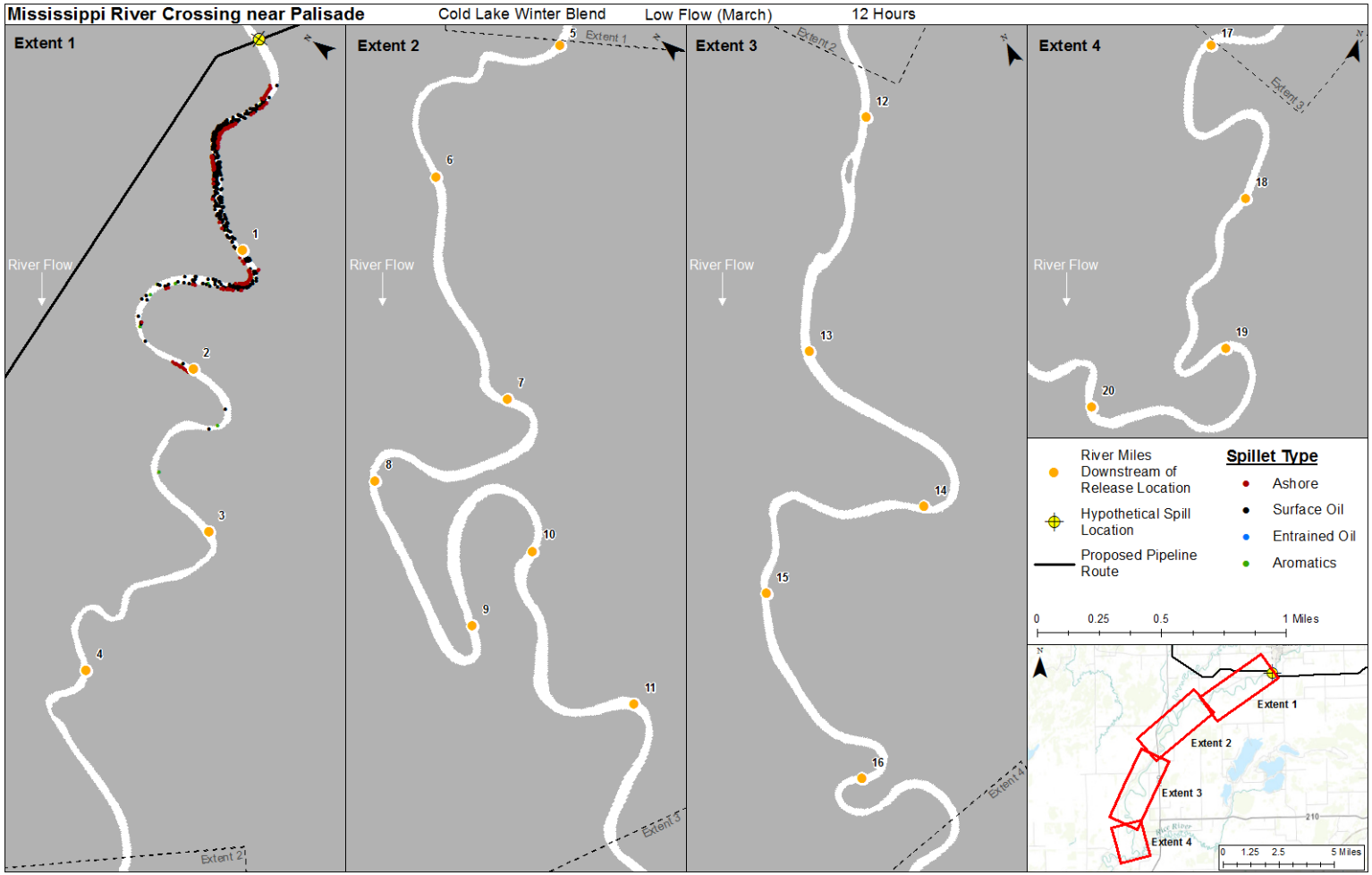


Figure 6-30 Oil Trajectory at 12 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

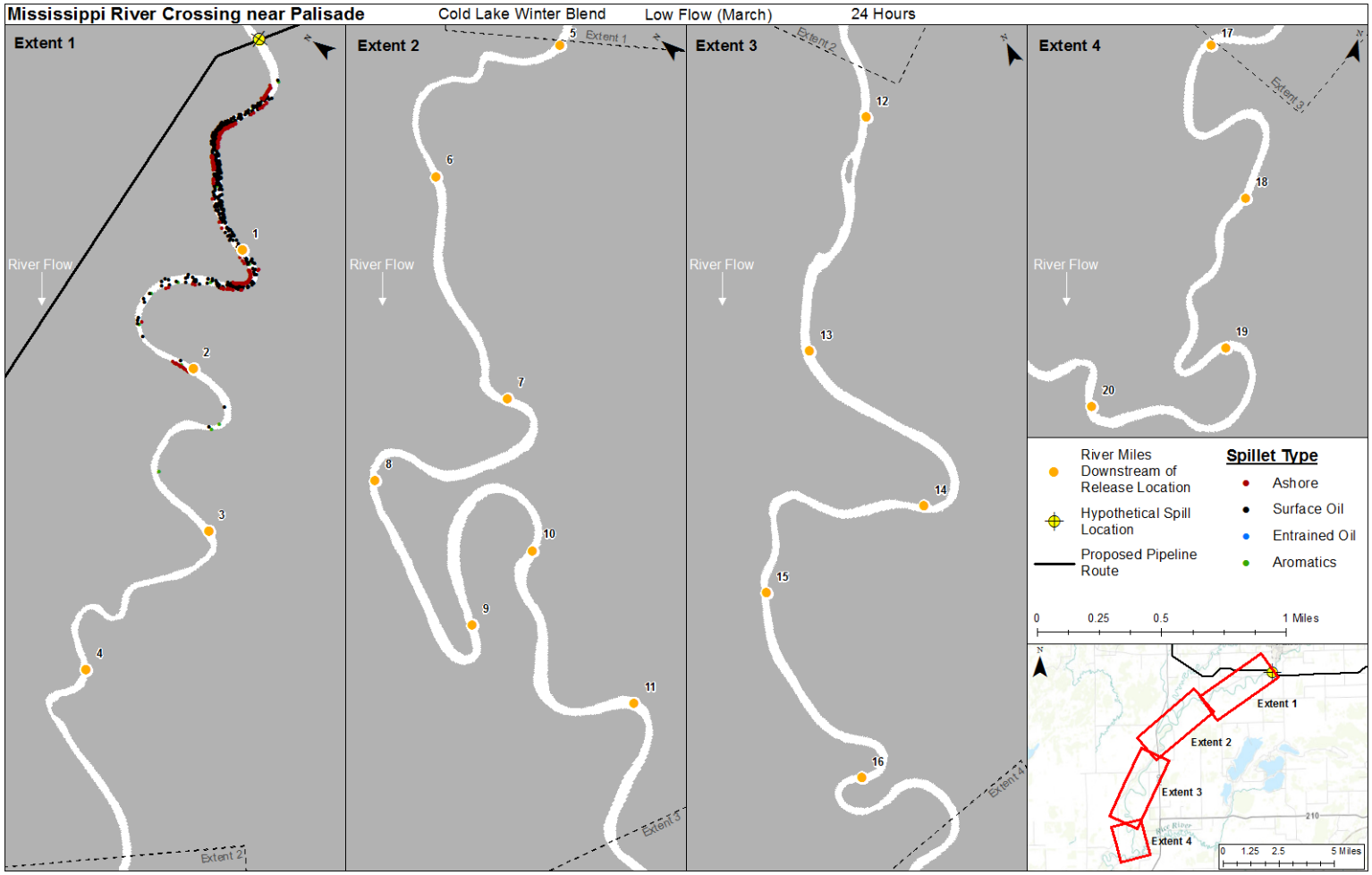


Figure 6-31 Oil Trajectory at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season



Figure 6-32 Floating Surface Oil Thickness at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season



Figure 6-33 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

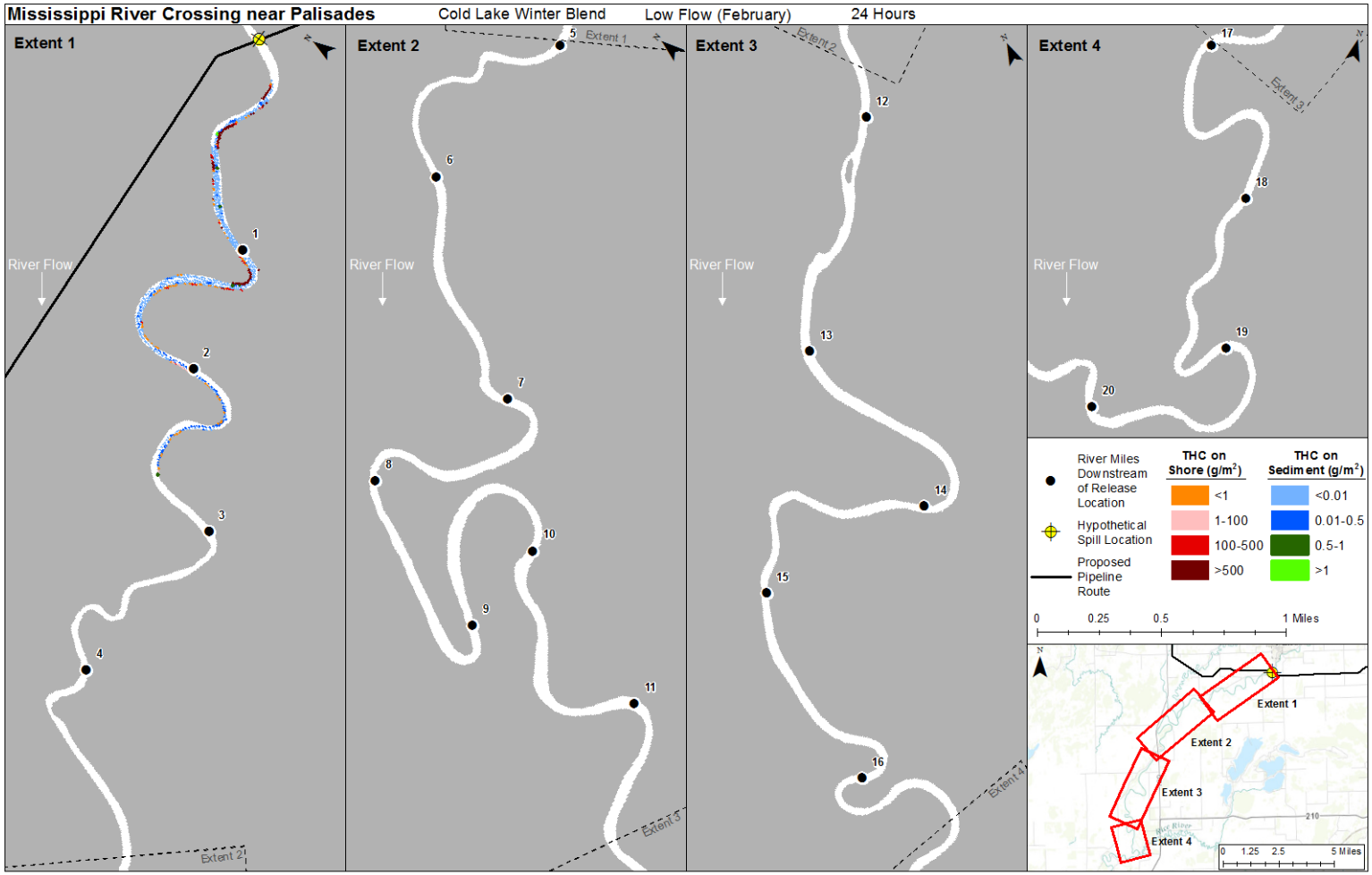


Figure 6-34 Maximum Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

6.2.1.2 Bakken Crude Scenarios

The Mississippi River at Palisade scenarios represent a low energy environment for the SIMAP analysis. Hypothetical releases of Bakken crude at the Mississippi River at Palisade resulted in the same downstream transport as the CLB. This was due to the released oil experiencing the same environmental forcing. Under high flow conditions predicted downstream transport was 4, 8, and 17.5 miles (6.4, 12.8, and 28.2 km) downstream after 6, 12, and 24 hours, respectively (Figure 6-37, Figure 6-38, and Figure 6-39). Under average river flow conditions, the release had a maximum extent of approximately 14.3 miles (23.0 km) after 24 hours (Figure 6-44, Figure 6-45, and Figure 6-46). During low river flows, the majority of the release was trapped at the ice-water interface within 1.5 miles (2.4 km) of the hypothetical release point, while the maximal extent of oil was approximately 2.8 miles (4.51 km) (Figure 6-51, Figure 6-52, Figure 6-53). Any slight differences between the downstream distance of Bakken versus CLB scenarios is the result of the effects of randomized dispersion. This does not significantly affect the downstream distance, but rather the exact location of each Lagrangian element (i.e., discretized spill) at each time step. Table 6-3 provides a summary of the mass balance information at the end of the 24-hour simulation, while Figure 6-35 provides the furthest predicted downstream extent of whole oil.

Table 6-3 Summary of the Bakken Crude (BAK) Mass Balance Information at the Mississippi River at Palisade Release Location at the End of the 24-Hour Simulation [1]

Scenario	Surface (%)	Evaporated (%)	Water Column (%)	Sediment (%)	Ashore (%)	Decayed (%)
BAK—High Flow (Spring)	35.8	52.2	<0.1	<0.1	11.4	0.6
BAK—Average Flow (Summer-Fall)	35.1	55.3	<0.1	<0.1	9.0	0.5
BAK—Low Flow (Winter)	98.7	<0.1	0.2	<0.1	0.1	1.0

NOTE:
[1] All values represent a percent of the total spilled oil

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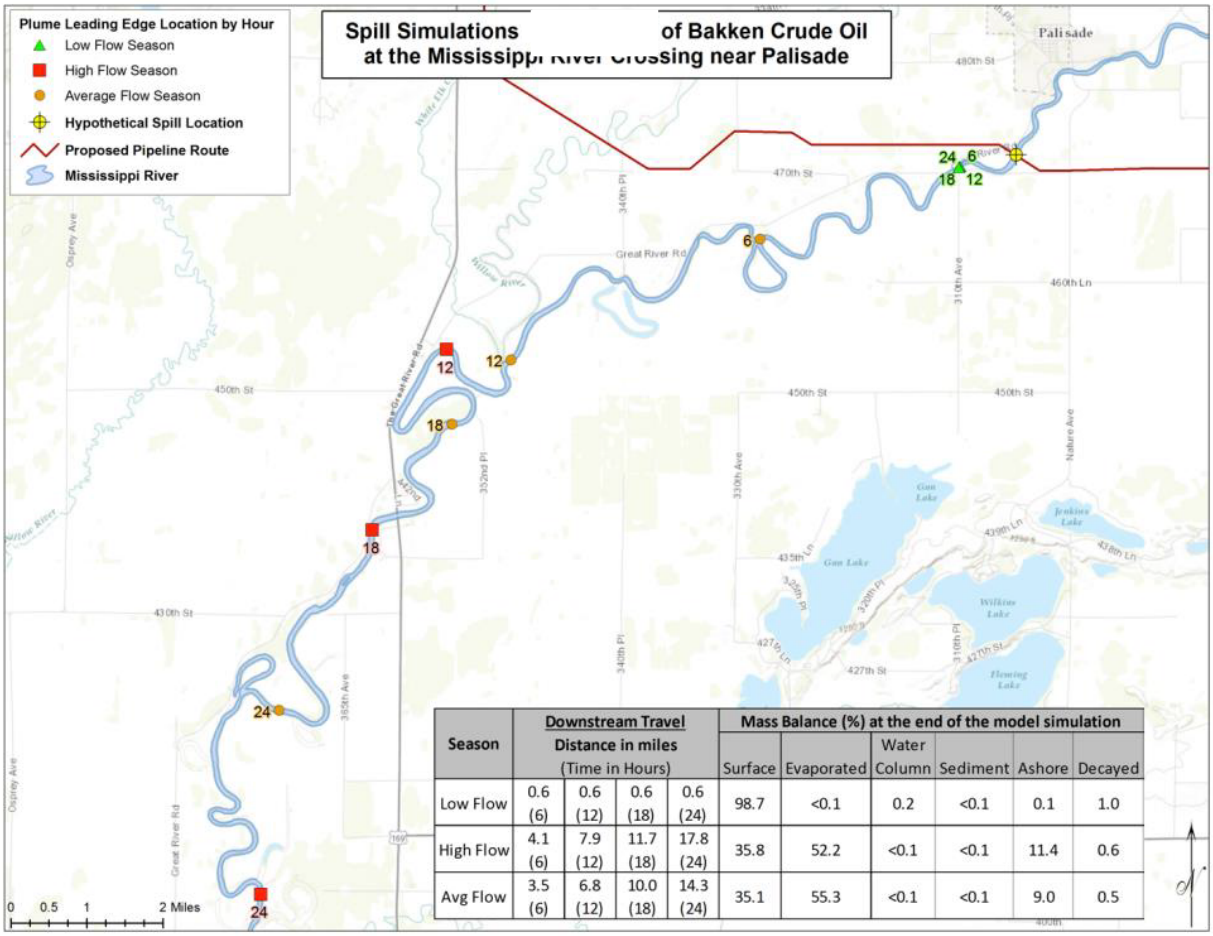

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	0.6 (6)	0.6 (12)	0.6 (18)	0.6 (24)	98.7	<0.1	0.2	<0.1	0.1	1.0
High Flow	4.1 (6)	7.9 (12)	11.7 (18)	17.8 (24)	35.8	52.2	<0.1	<0.1	11.4	0.6
Avg Flow	3.5 (6)	6.8 (12)	10.0 (18)	14.3 (24)	35.1	55.3	<0.1	<0.1	9.0	0.5

...NONPUBLIC DATA HAS BEEN EXCISED]

Figure 6-35 Predicted Downstream Transport of Bakken Crude oil at the Mississippi River at Palisade Release Location

During high and average river flow conditions, the relatively calm waters (i.e., not a lot of surface breaking disturbances) of the Mississippi River near Palisade did not entrain oil into the water column. Rather, these releases were typified by large amounts of floating oil, which formed thick surface oil slicks over much of the river (Figure 6-40 and Figure 6-47). At the end of the 24-hour simulation, floating oil thicknesses greater than 1 mm (heavy black oil) remained on the water surface. There was no floating surface oil less than 0.01 mm thick (dark brown sheen).

Extensive shoreline oiling and limited sediment oiling was observed for approximately 17.5 miles (28.2 km) of the river below the release location under high river flow conditions (Figure 6-42) and 19.2 miles (30.9 km) under average river flow conditions (Figure 6-49).

Surface oil evaporated rapidly over the 24-hour simulation (Figure 6-36, Figure 6-43, and Table 6-3). As Bakken is a much lighter crude oil with a higher volatile content than CLB, greater than 50% is predicted to evaporate over 24 hours (Table 6-3), nearly 2.5 times that of the CLB (Table 6-2). There was a low potential for Bakken entrainment into the water column due to the low winds, which did not cause surface breaking waves, and the lack of rapids, riffles, and waterfalls in this area of the Mississippi. Because of this, total hydrocarbon concentrations (i.e. whole oil in the water column) were extremely low due to the oil remaining on the surface of the water and not entrained within the water column.

The maximum concentration of dissolved aromatics was greater than 5,000 ppb in small regions within the spill extent; however, most of the dissolved aromatic concentrations were between 10 and 50 ppb (Figure 6-41 and Figure 6-48). Concentrations were higher for Bakken scenarios, when compared to the CLB scenarios, due to the higher aromatic content of the lighter Bakken oil. Of the oil that made its way into the water column, a portion did interact with SPM. Total hydrocarbon concentrations on the sediment were generally less than 0.01 g/m^2, with small segments as high as 0.5 g/m^2 (Figure 6-42 and Figure 6-49). Concentrations on the shore were generally between 100-500 g/m^2, which was lower than the CLB scenario. This is due to the lower viscosity of the Bakken, which results in thinner oiling of shorelines. Additionally, less oil would be expected to reach sediments in the Bakken releases, when compared to the CLB. The highest sediment concentrations were predicted for the high river flow scenario due to the higher concentration of TSS in the water column.

For the low river flow scenario, the hydrocarbon trajectory at the end of the 24-hour simulation extended 0.5 miles (0.8 km) from the spill location (Figure 6-53). This distance was only approximately one-third that of the CLB and was the result of the difference in oil density. Bakken is a much less dense oil and would rise through the water column more rapidly than the CLB. Because the oil spends less time in the water column, before it rises to the surface and sticks to the underside of the ice, it is transported less distance downstream. Under low river flow conditions the 100% surface coverage of ice kept the entrained oil in the water column at the ice/water interface (98.7%) (Figure 6-50 and Figure 6-54). Patchy oiling along river banks was observed, however the majority of the oil remained trapped under the ice (Table 6-2). Slightly lower amounts of oil were predicted along shorelines for Bakken, compared to CLB. Concentrations on the shore were primarily greater than 500 g/m^2 within the vicinity of the release location, with some segments downstream with concentrations less than 1 g/m^2 (Figure 6-56). A larger portion of the soluble portion of the Bakken dissolved into the water column and was transported downstream, resulting in elevated dissolved aromatic concentrations within the water column (Figure 6-55). Dissolved aromatic components traveled downstream from the initial spill location with maximum concentrations greater than 5,000 ppb in regions within the spill extent (Figure 6-55). Much larger portions of the river are predicted to experience dissolved aromatic concentrations in excess of 5,000 ppb, when compared to average or low flow scenarios. At the end of the 24-hour simulation, floating oil greater than 1 mm thick (heavy black oil) remained under the ice (Figure 6-54). There was no floating surface oil less than 0.1 mm thick (black oil). Small amounts of sediment oiling did extended down to approximately 1.2 miles (1.9

km) (Figure 6-56), although the total hydrocarbon concentrations on the sediment were generally less than 0.01 g/m^2. There was very little decay from any of the three hypothetical releases within the timeframe modeled.

6.2.1.2.1 Trajectory and Fate Results for High Flow (Spring)

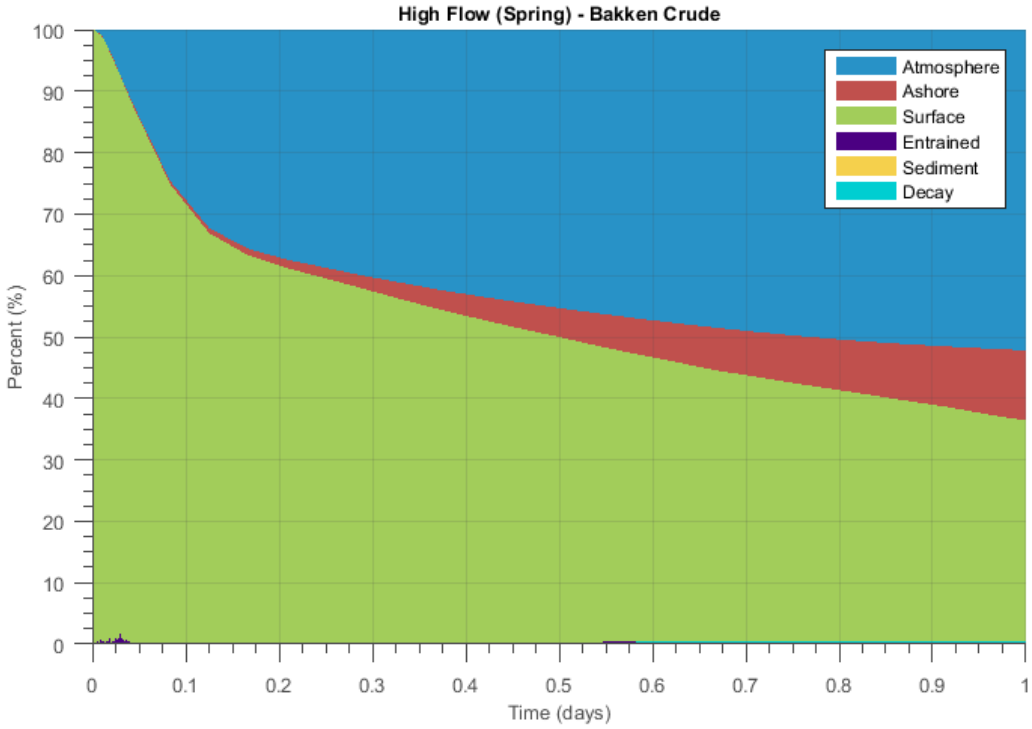

Figure 6-36 Oil Mass Balance Graph for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

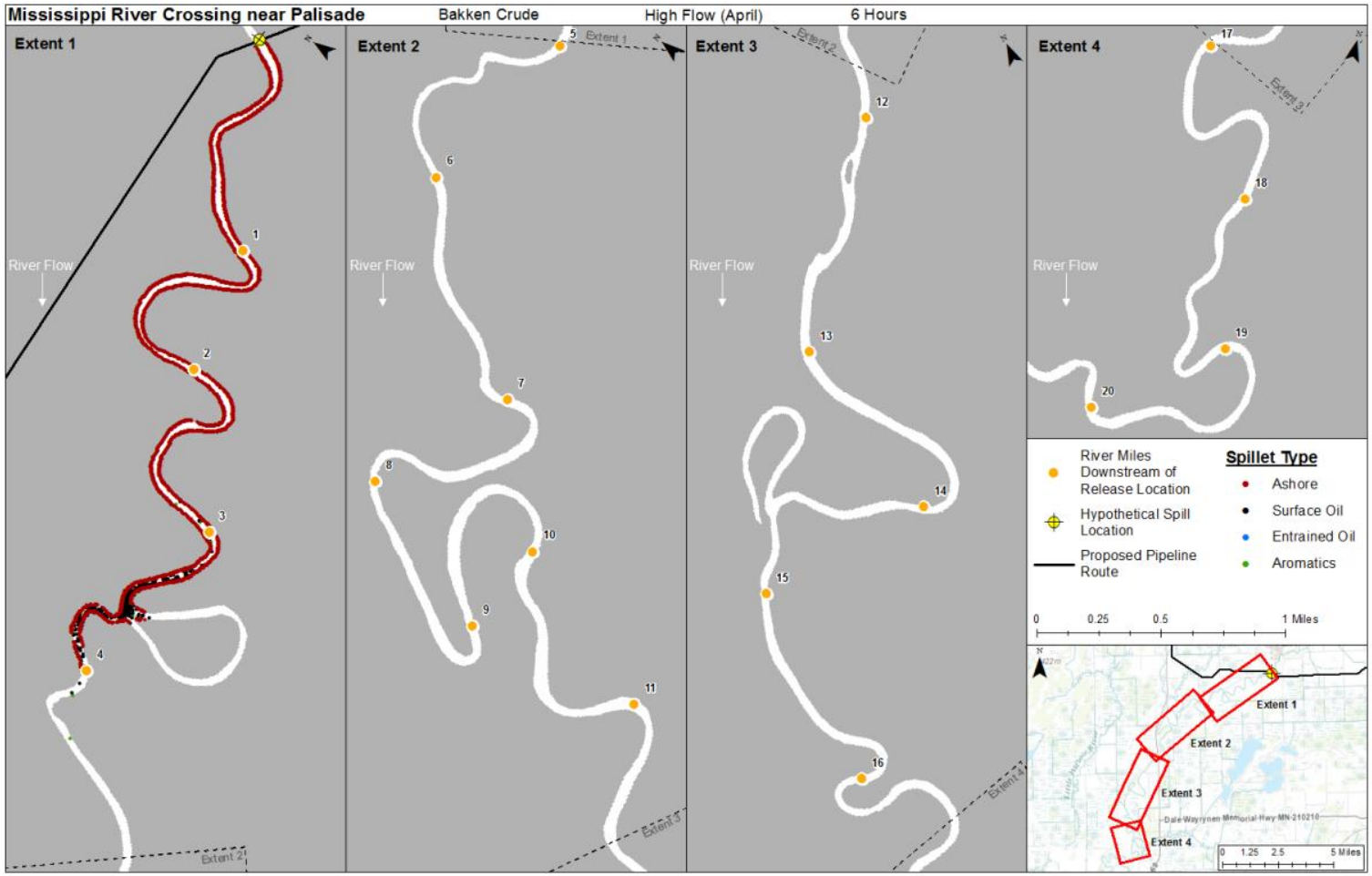

Figure 6-37 Oil Trajectory at 6 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

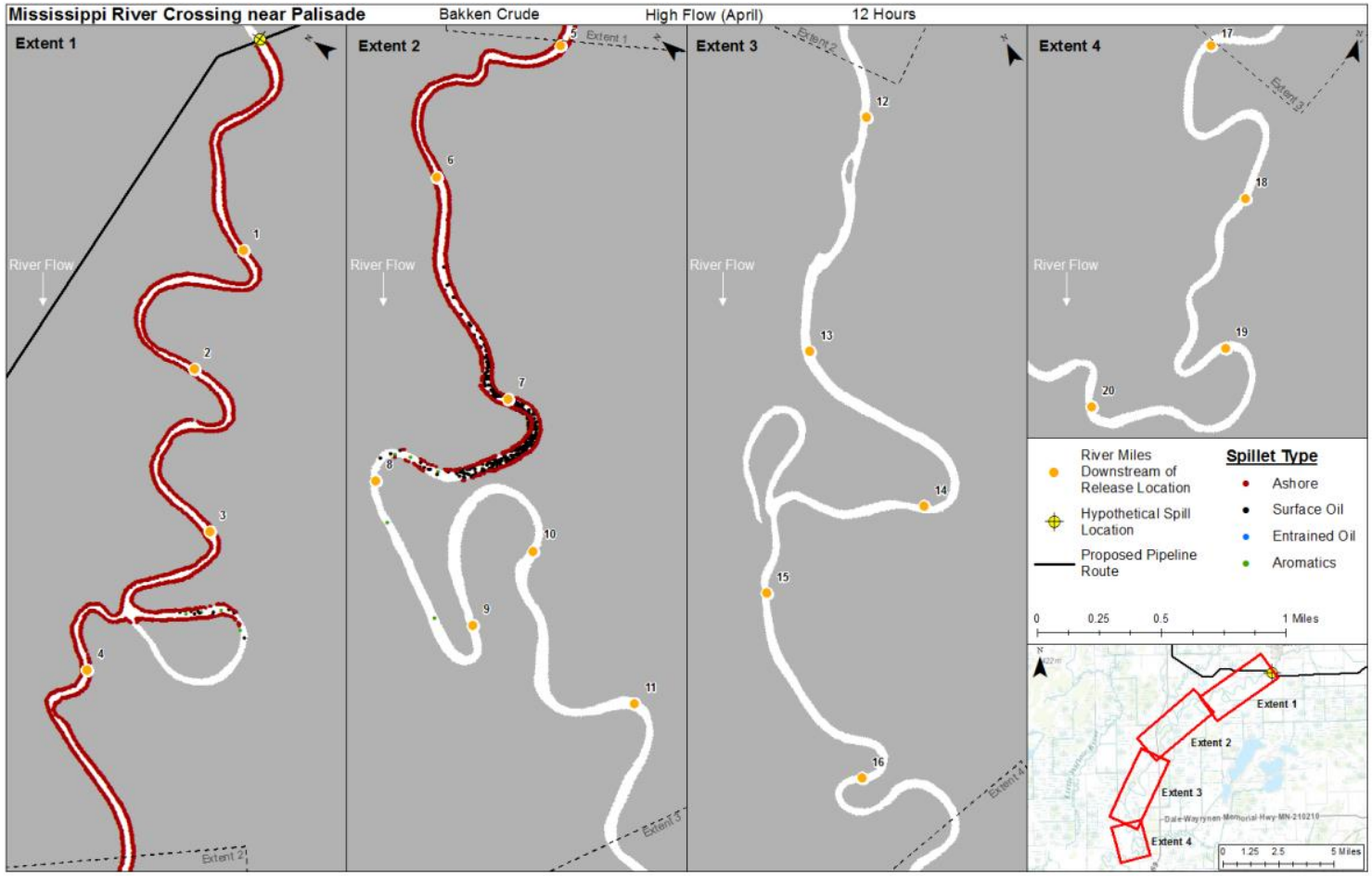

Figure 6-38 Oil Trajectory at 12 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

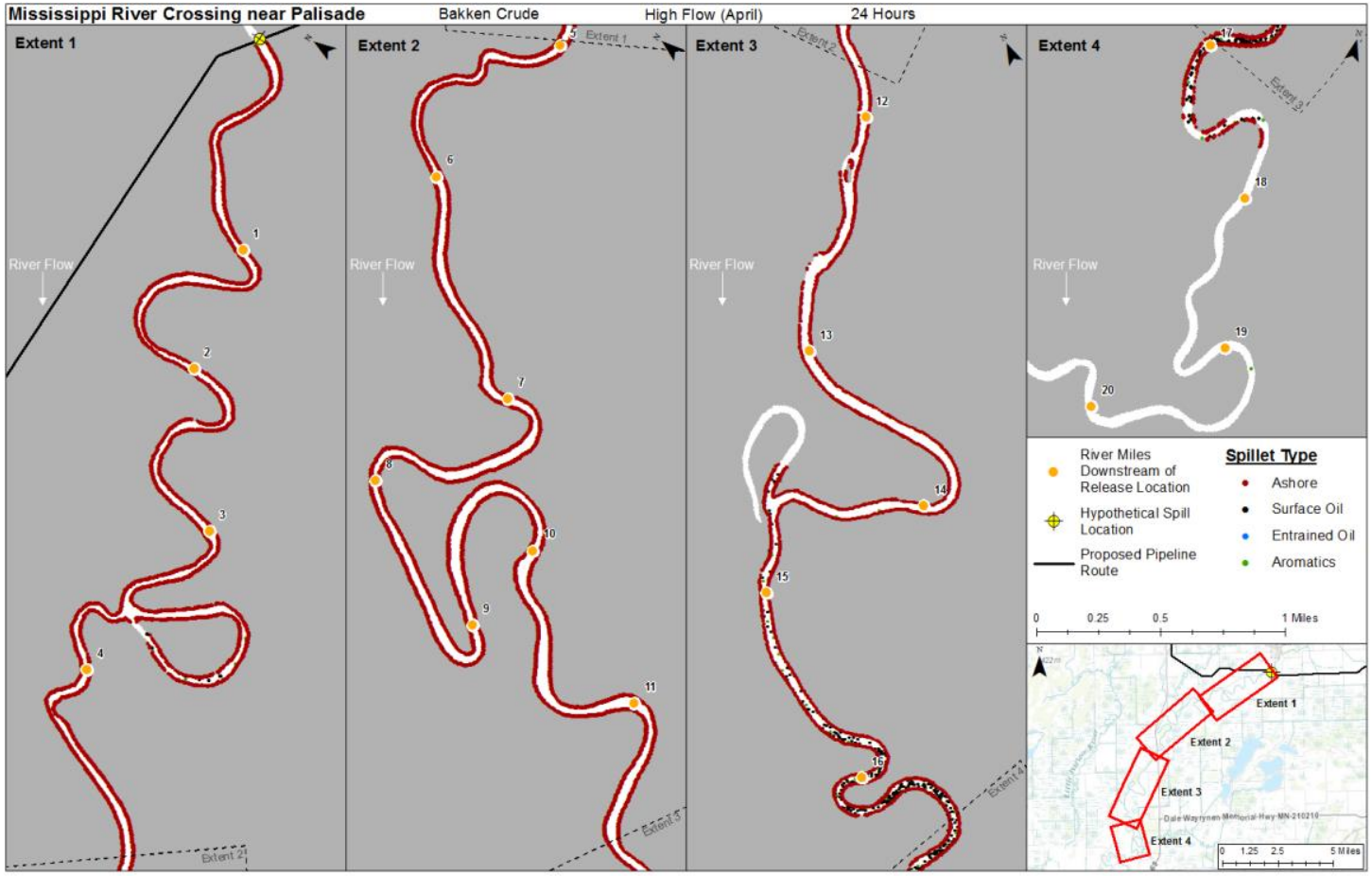

Figure 6-39 Oil Trajectory 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

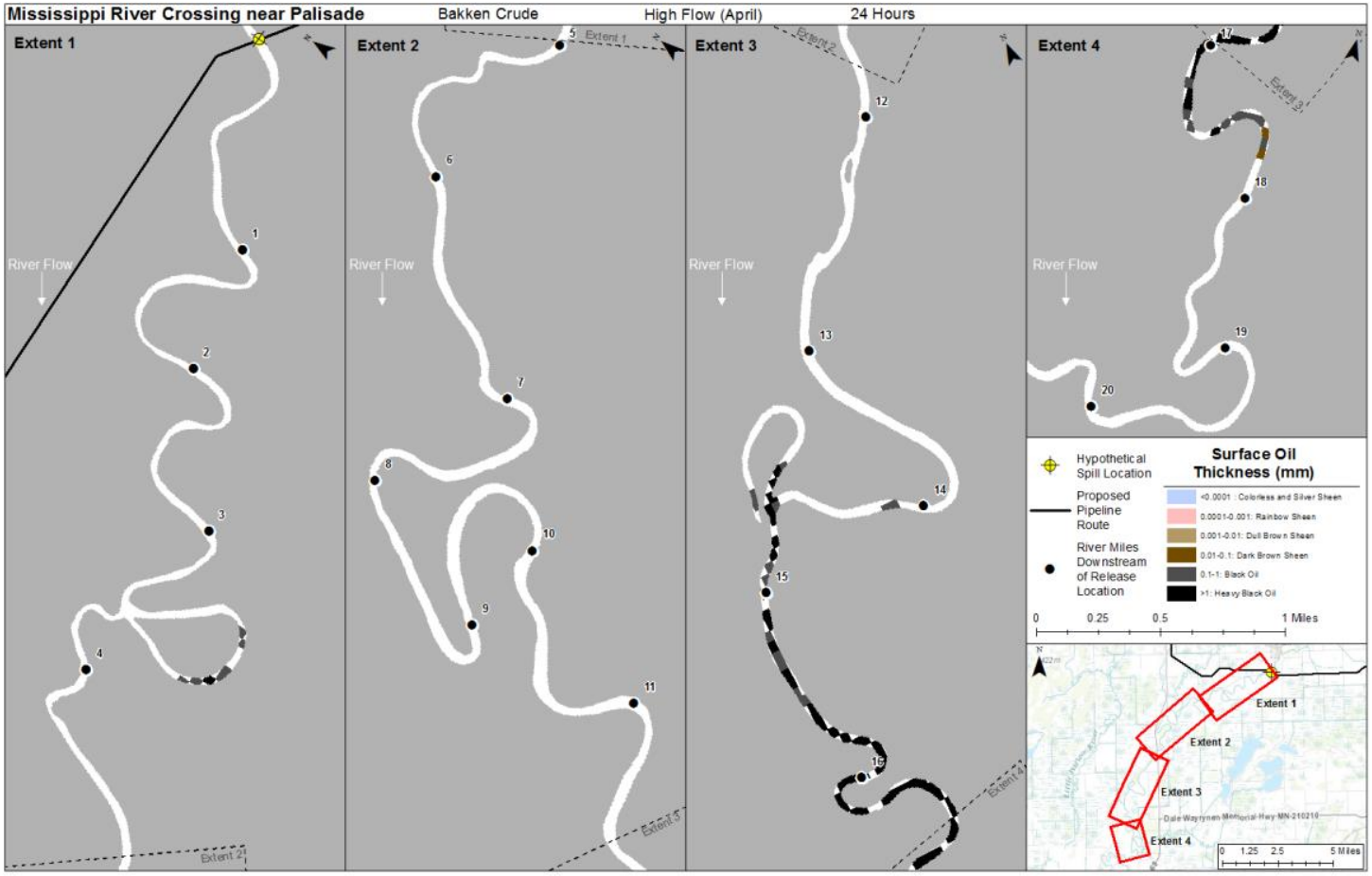

Figure 6-40 Maximum Floating Surface Oil Thickness at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

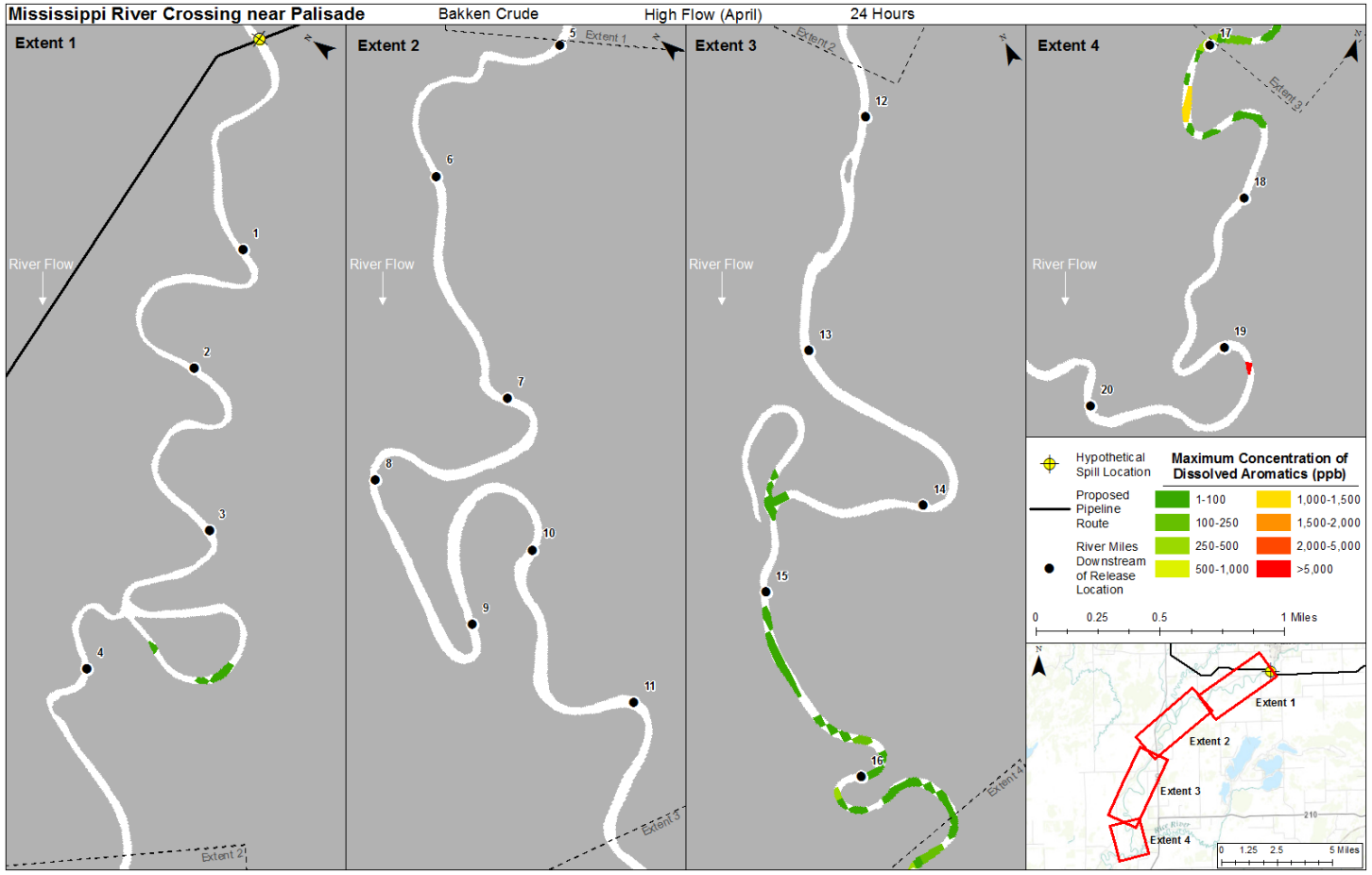

Figure 6-41 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

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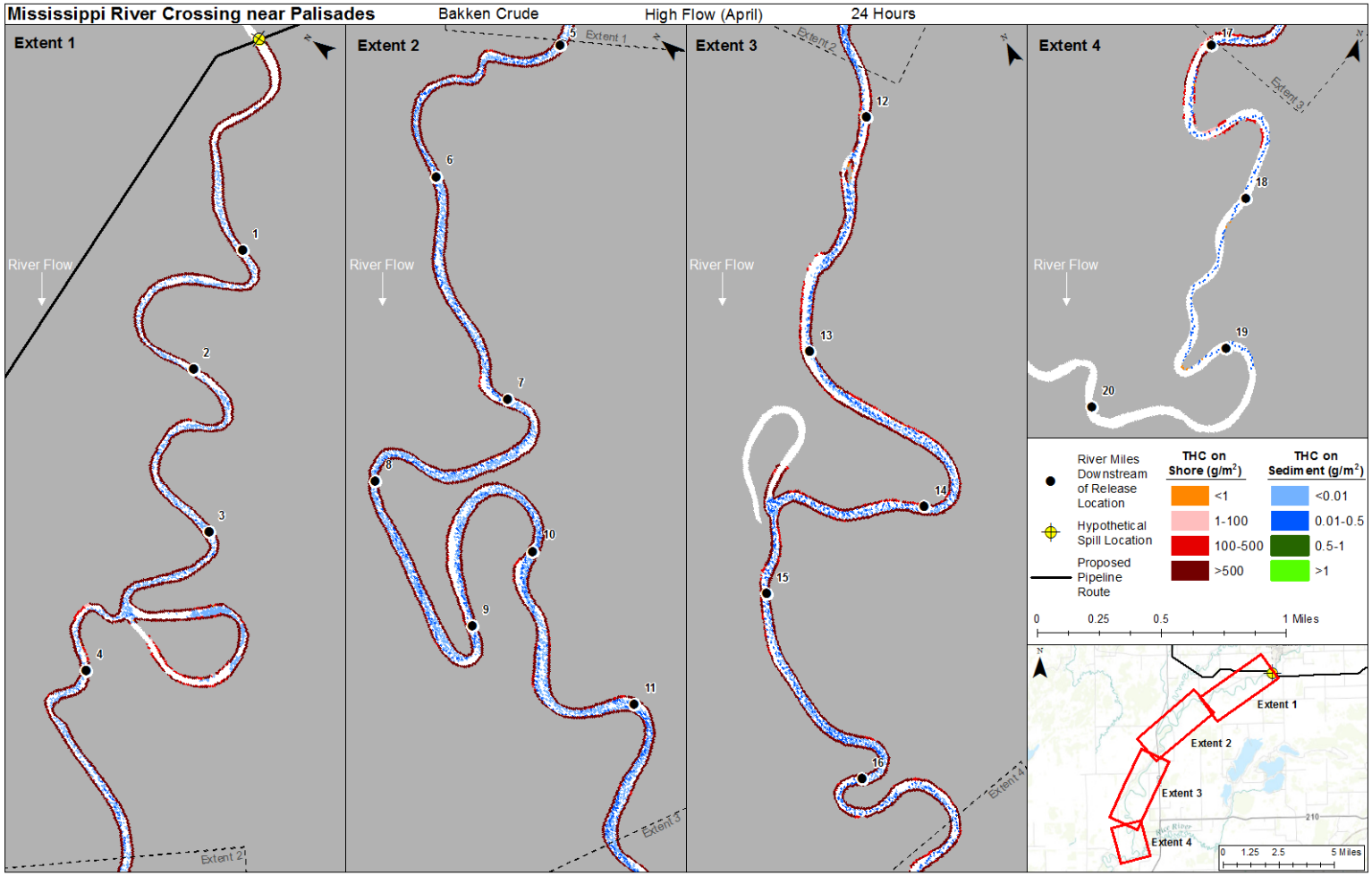

Figure 6-42 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the High Flow (Spring) Season

6.2.1.2.2 Trajectory and Fate Results for Average Flow (Summer-Fall)

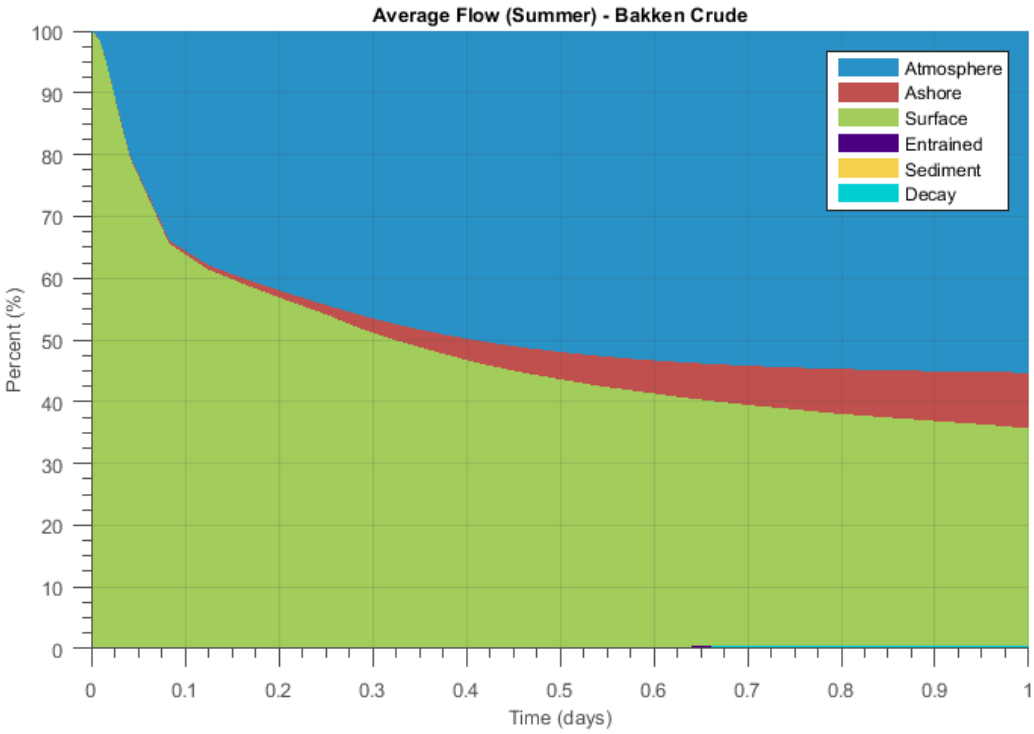

Figure 6-43 Oil Mass Balance Graph for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

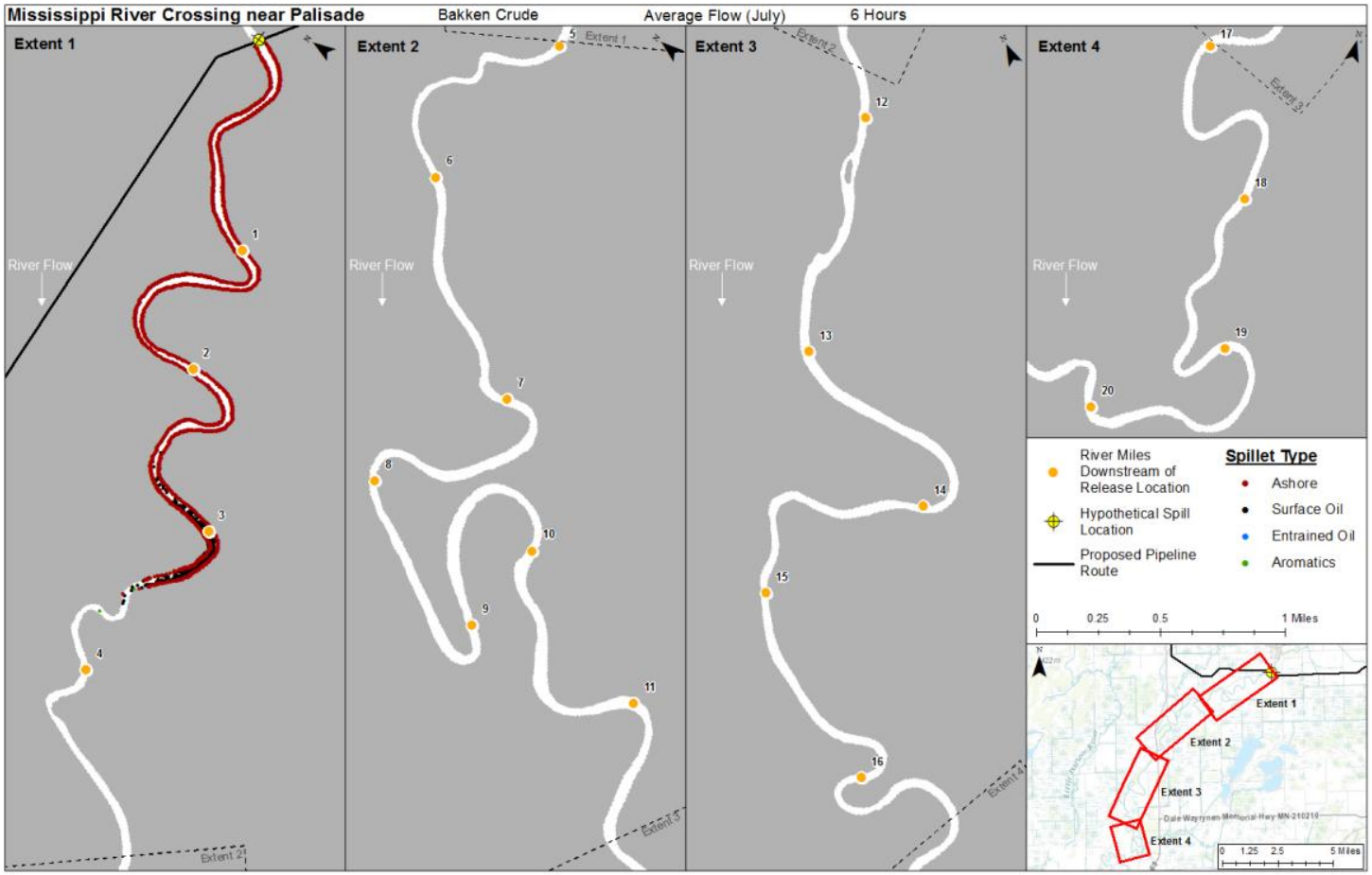

Figure 6-44 Oil Trajectory at 6 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

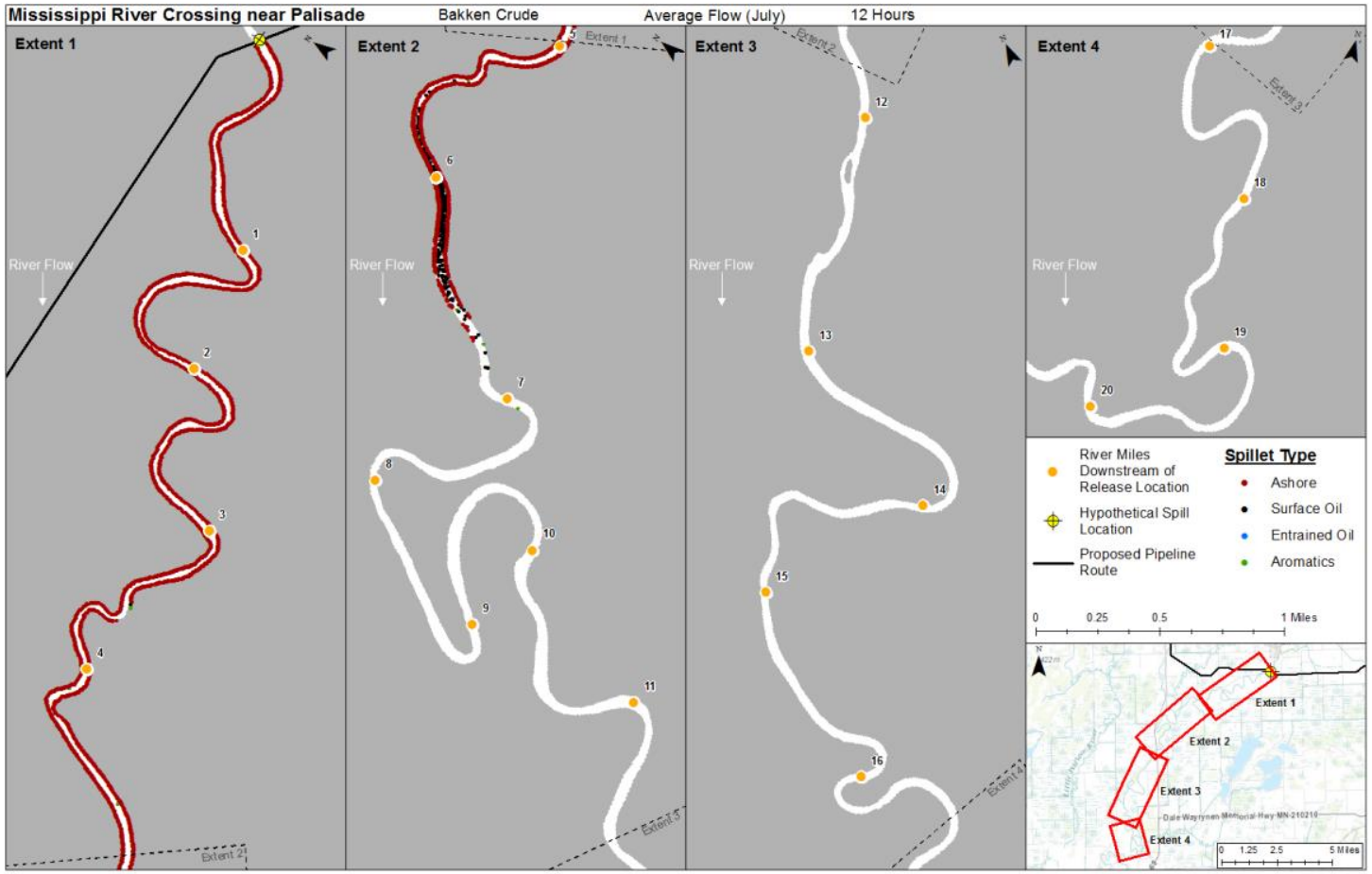

Figure 6-45 Oil Trajectory at 12 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

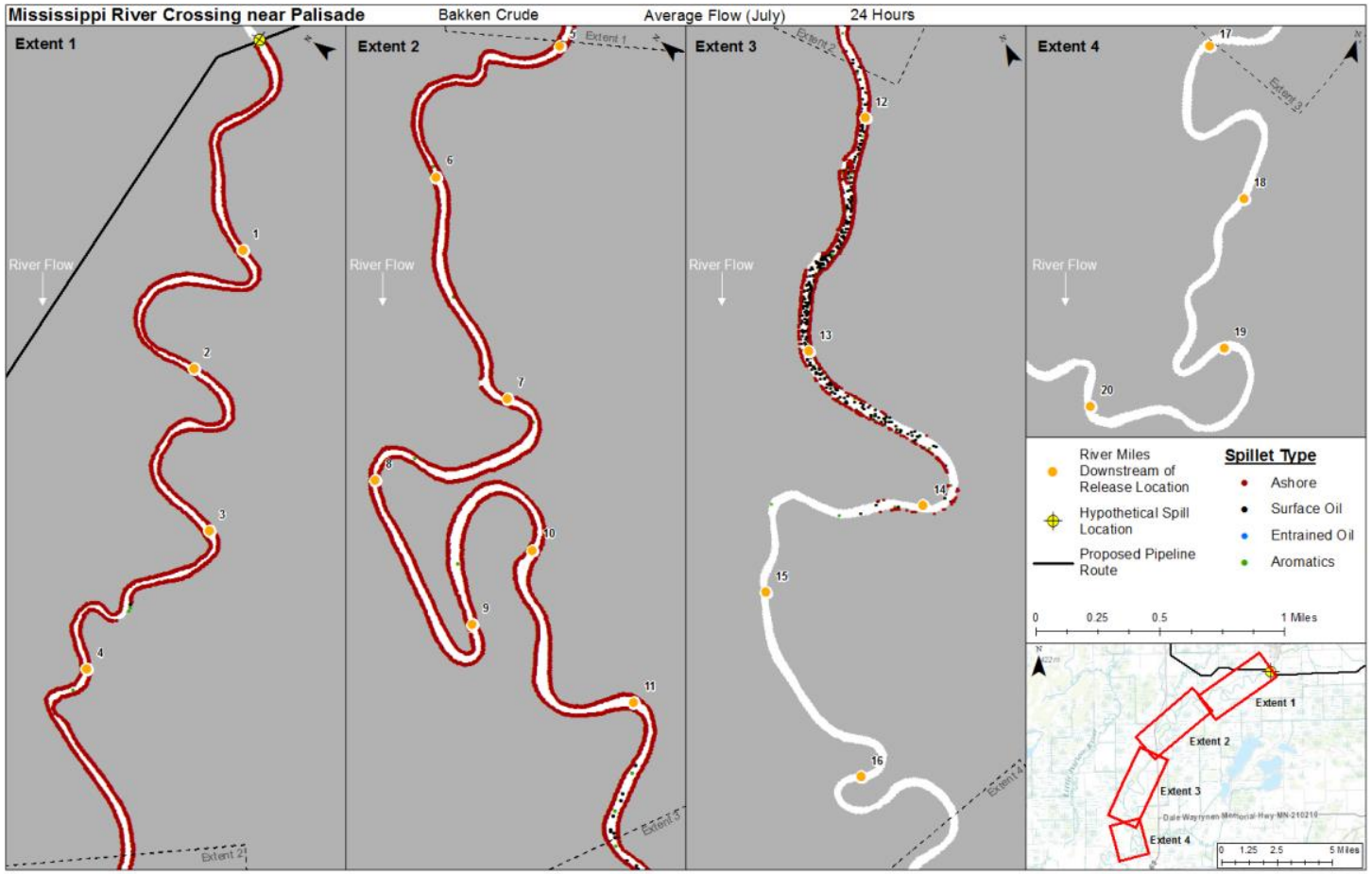

Figure 6-46 Oil Trajectory at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

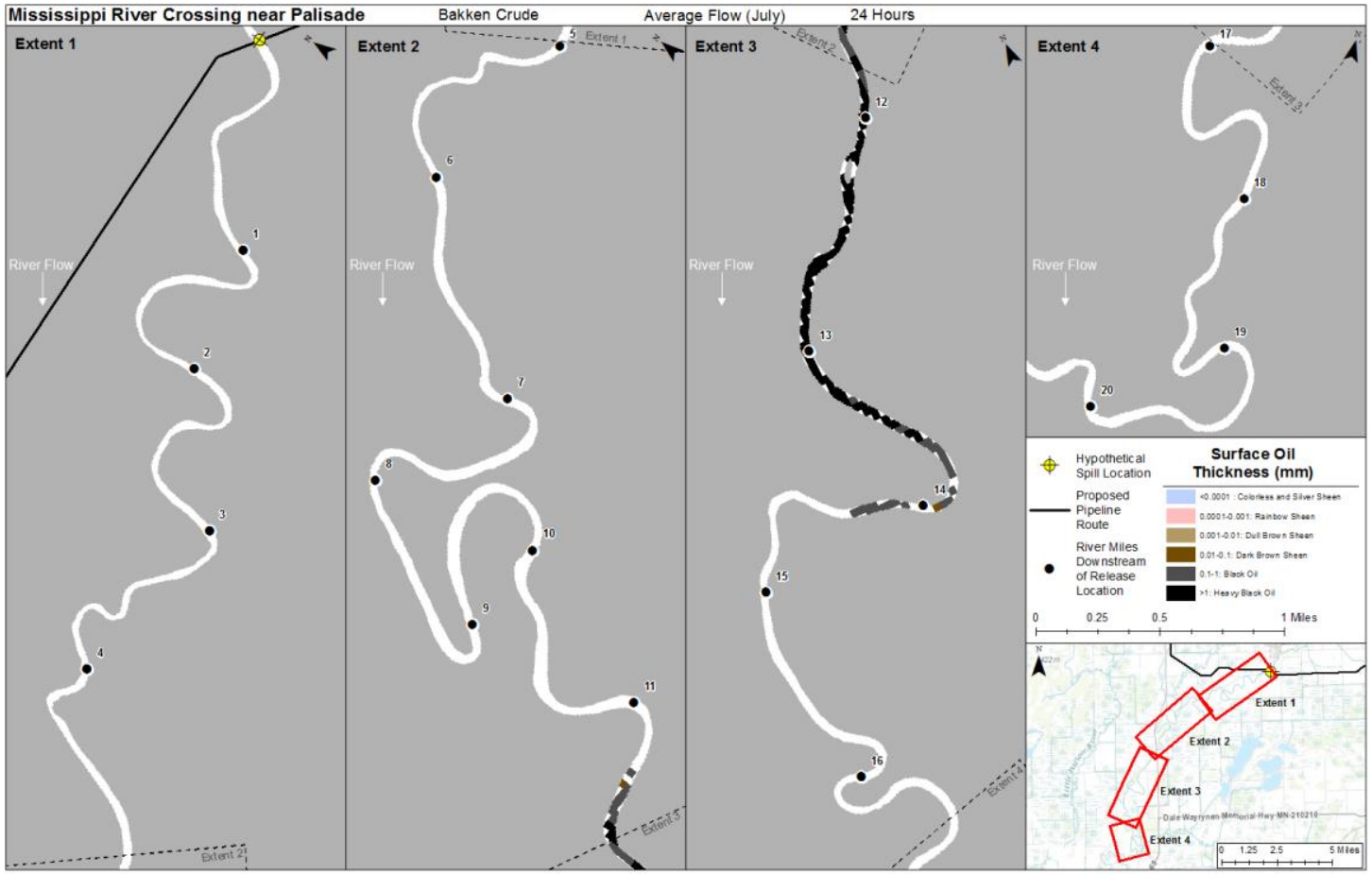

Figure 6-47 Maximum Floating Surface Oil at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade release Location During the Average Flow (Summer-Fall) Season

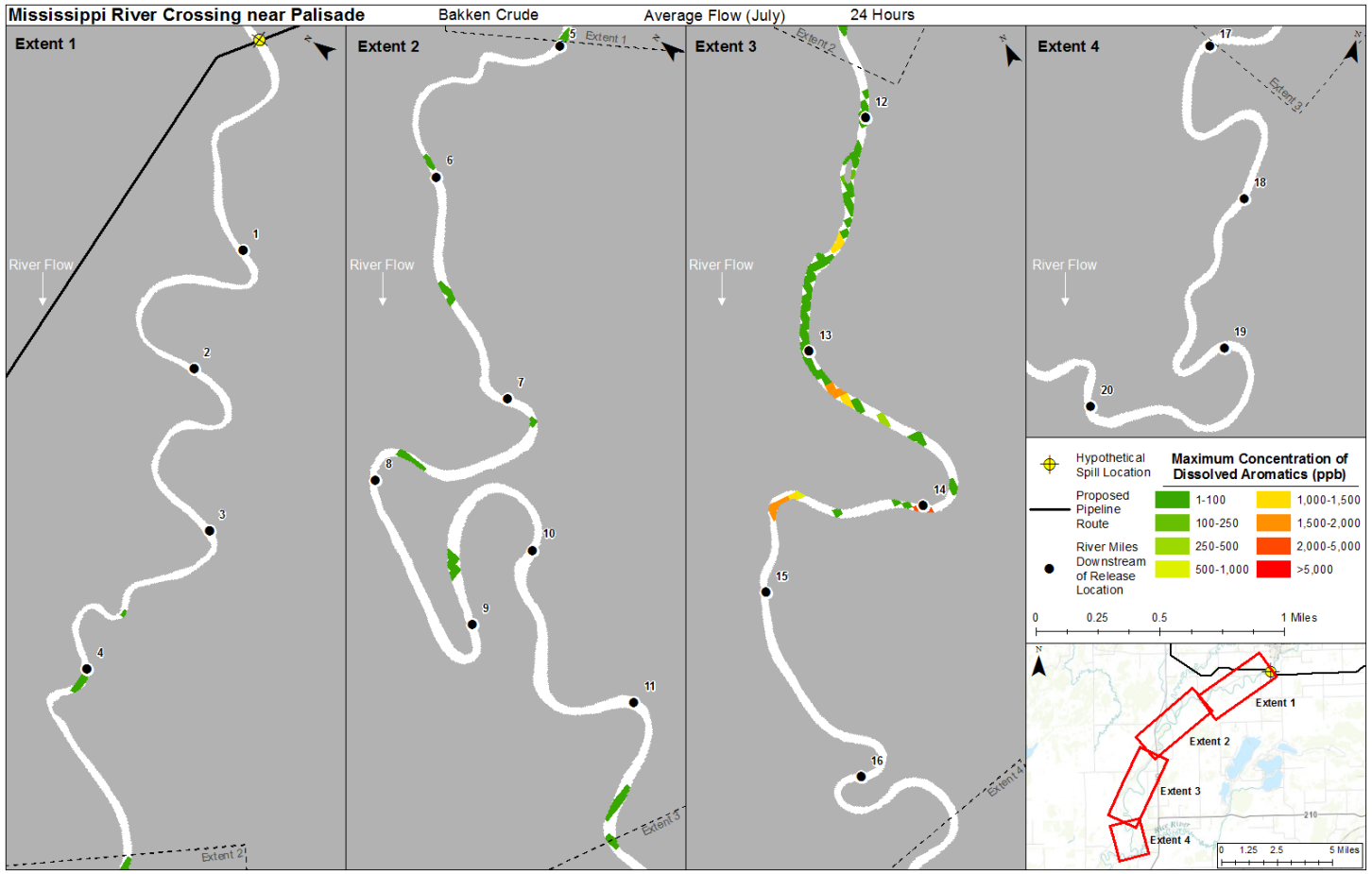

Figure 6-48 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

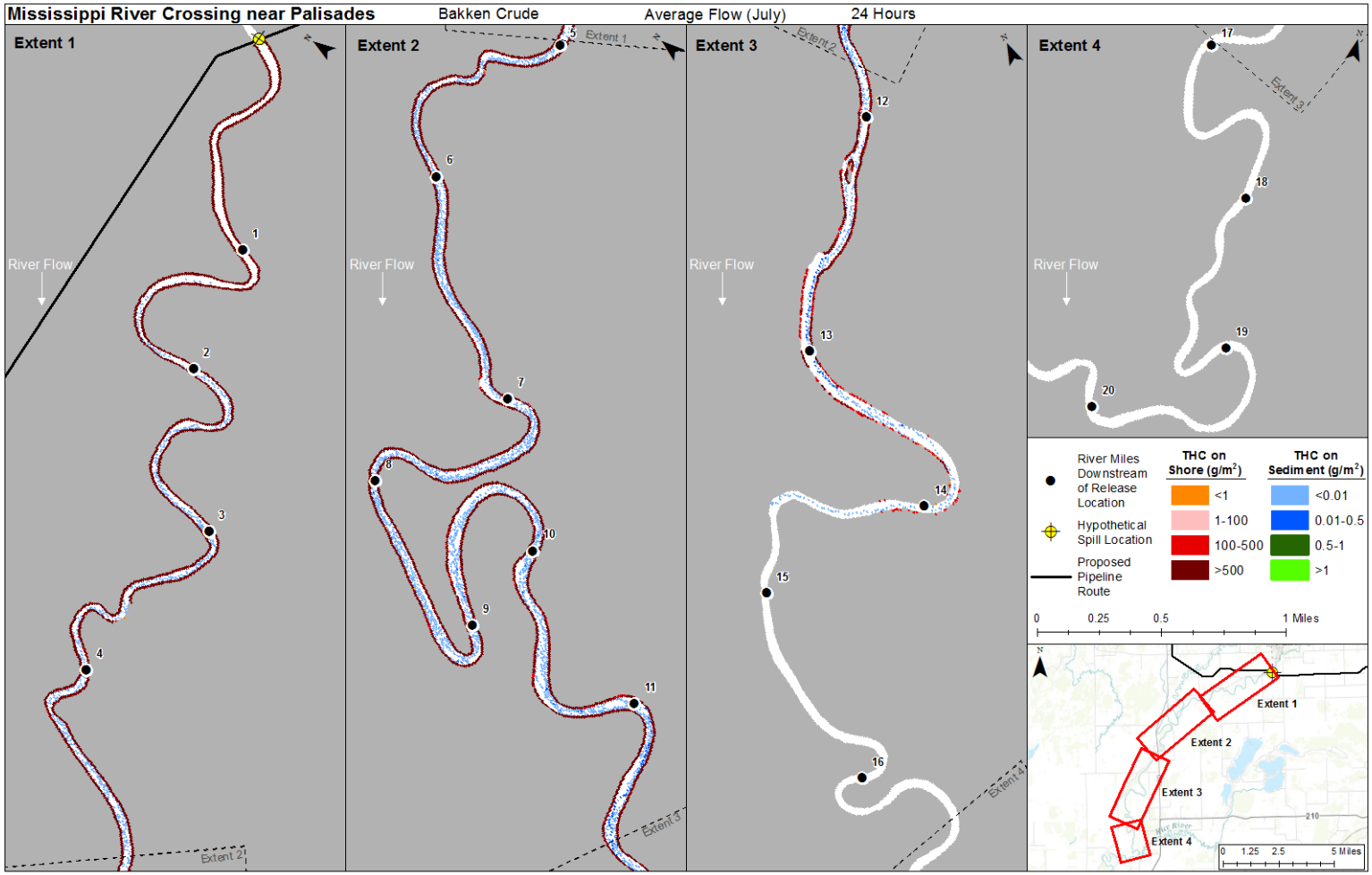

Figure 6-49 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

6.2.1.2.3 Trajectory and Fate Results for Low Flow (Winter)

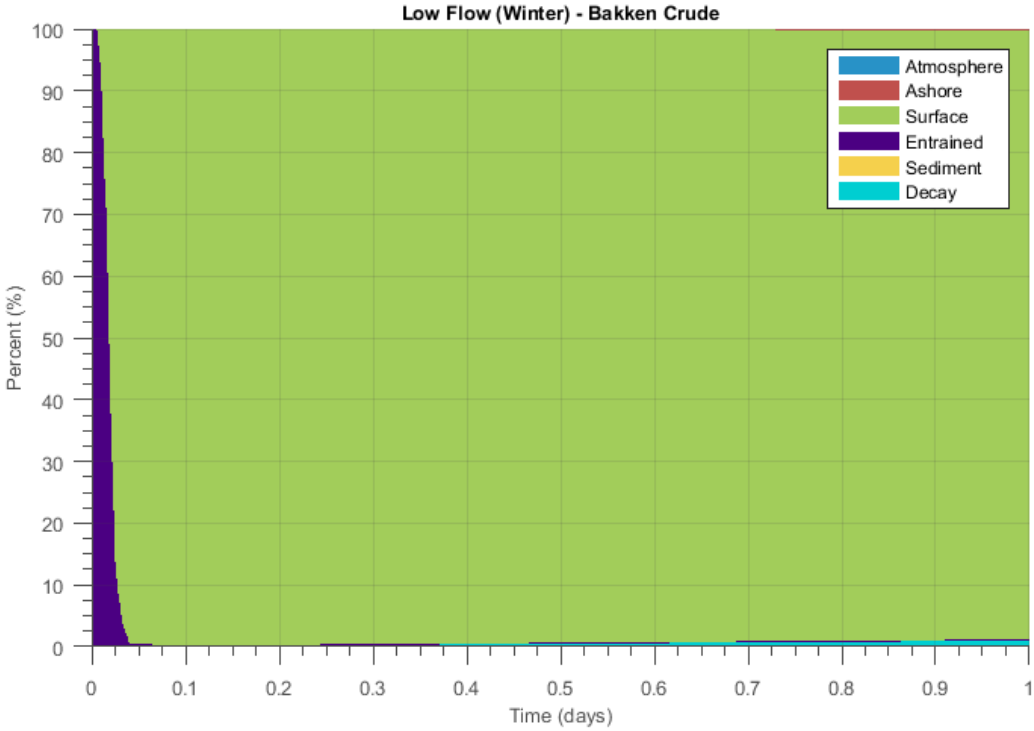

Figure 6-50 Oil Mass Balance Graph for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season



Figure 6-51 Oil Trajectory at 6 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

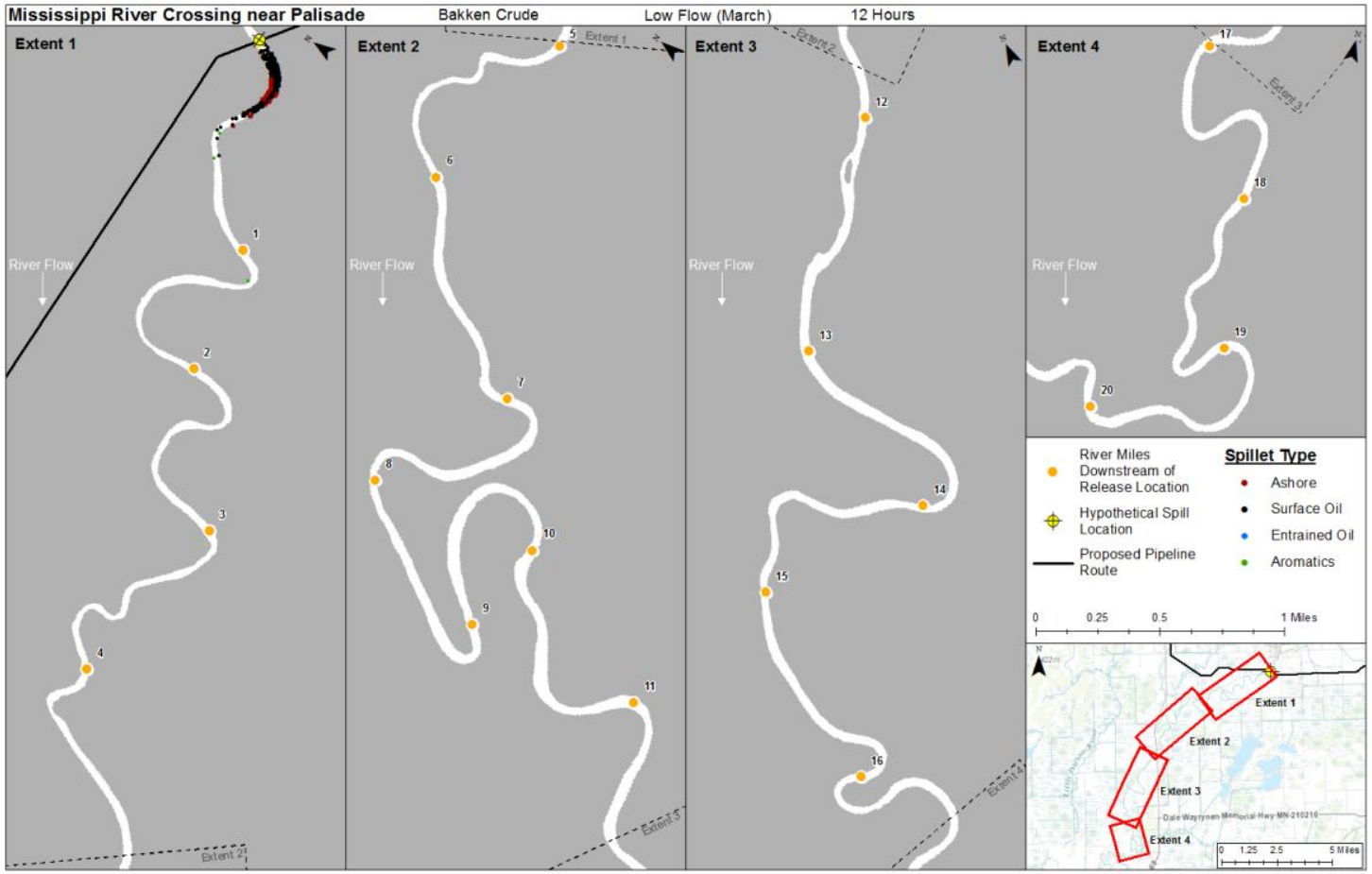

Figure 6-52 Oil Trajectory at 12 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

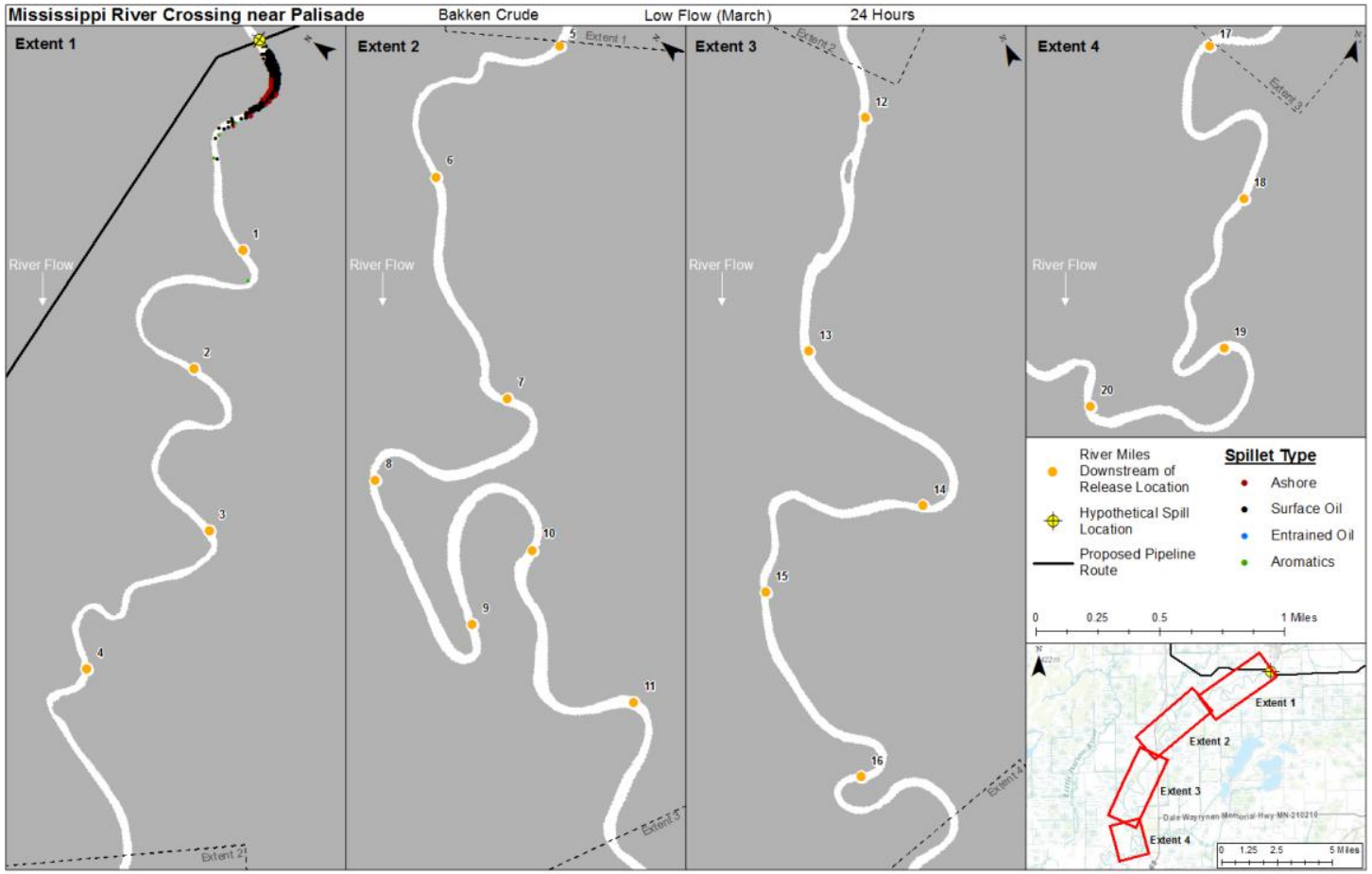

Figure 6-53 Oil Trajectory at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Trajectory and Fate Results for Modeling Locations
January 13, 2017

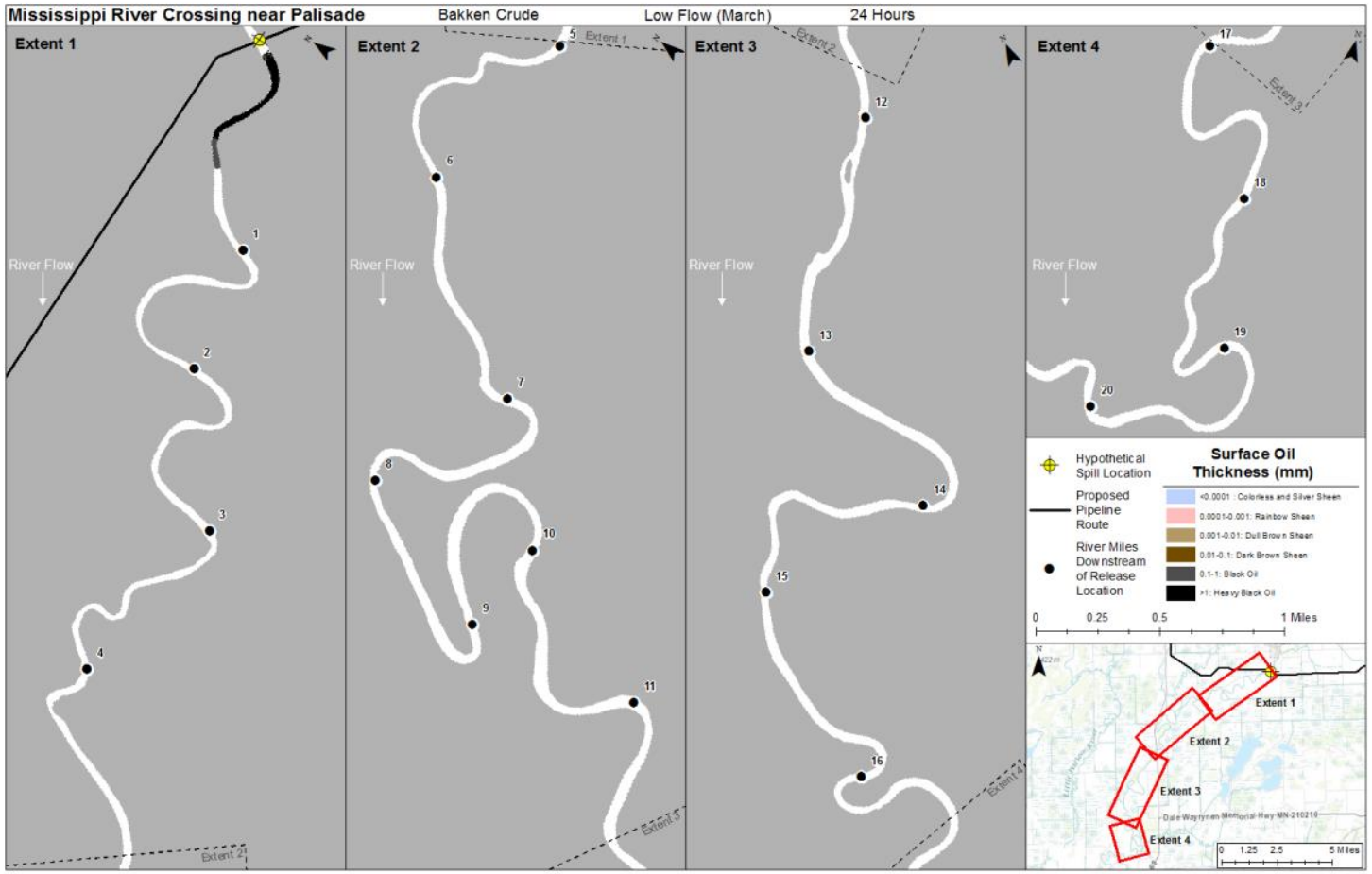

Figure 6-54 Maximum Floating Surface Oil at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Low Flow (Winter) Season

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Trajectory and Fate Results for Modeling Locations
January 13, 2017

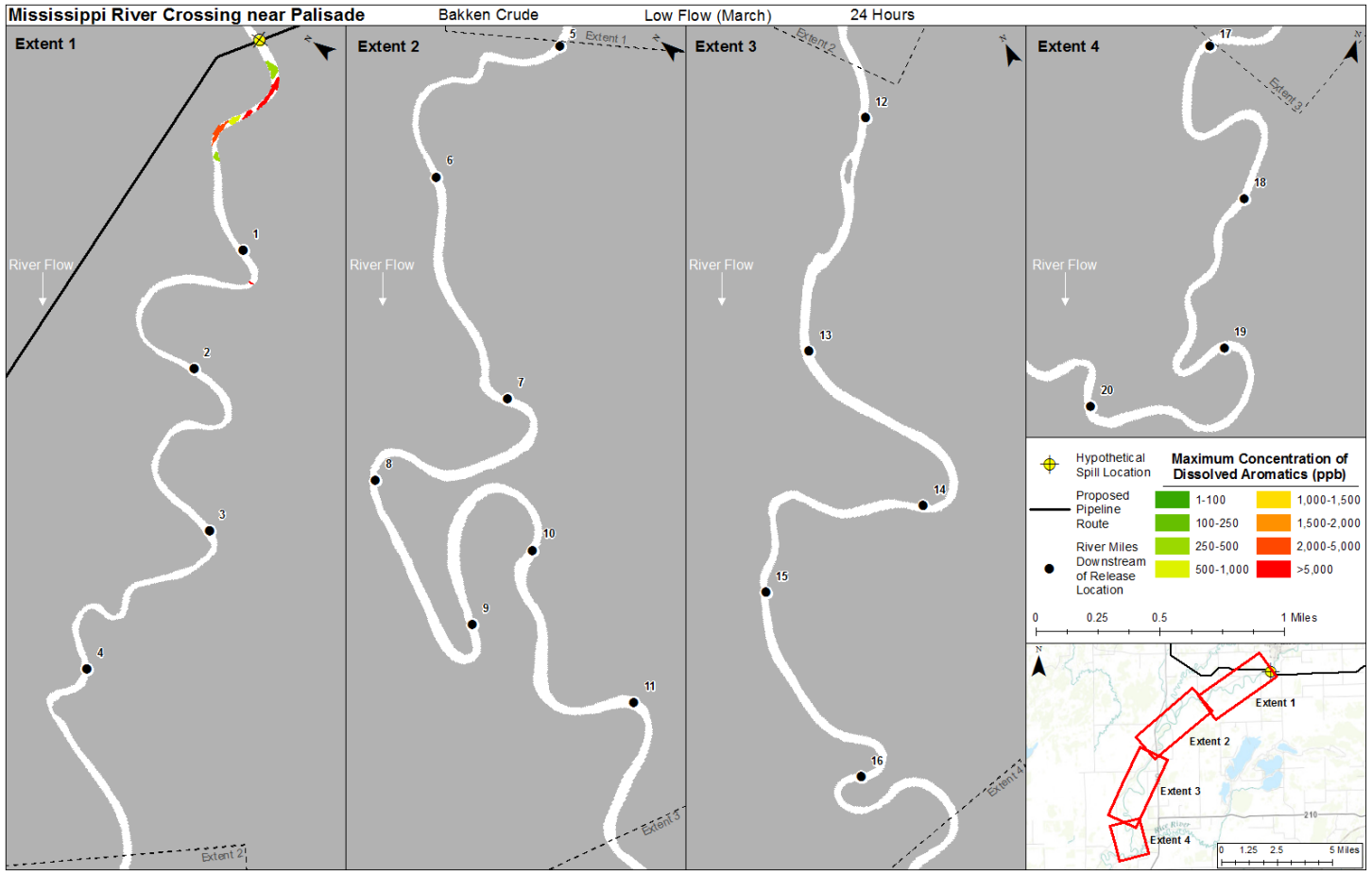

Figure 6-55 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

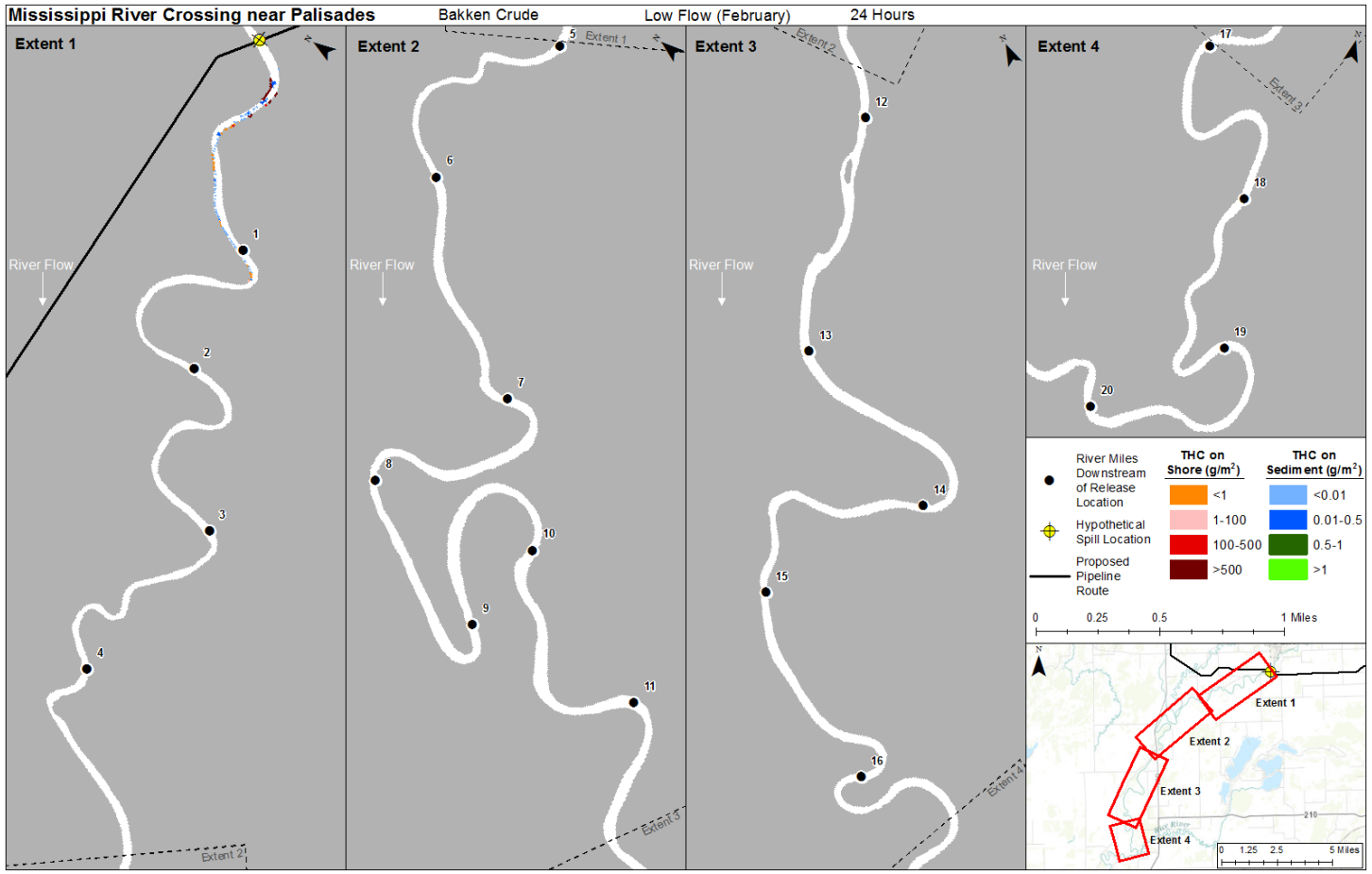

Figure 6-56 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of Bakken Crude at the Mississippi River at Palisade Release Location During the Average Flow (Summer-Fall) Season

6.2.2 Unmitigated Hypothetical Release Case 7—Mississippi River at Little Falls

The pipeline route crosses the Mississippi River approximately 4.89 miles (7.87 km) to the north of Little Falls, Minnesota, at Island Forty Eight. At this location the river is much larger, with a width of approximately 820 ft (250 m), as it travels through a relatively straight channel to the south. There are a number of wooded islands in this portion of the Mississippi River that range in size from a few hundred feet (100 m) to half a mile (0.8 km). Rather than being sinuous and marshy, like previously modeled reaches, this wide channel is lined with forested banks, passing through agricultural lands and by larger cities such as Little Falls and St. Cloud. Approximately 5.2 miles downstream of the hypothetical release location, the Mississippi River passes over the Little Falls Dam, a hydroelectric dam that is approximately 24 ft (7.3 m) tall. This concrete dam has a number of chutes or spillways that can create a tremendous amount of turbulence as water passes over top. Another 10 miles downstream, the Blanchard Dam may be found to the east of Great River Road (Rt. 24), west of Rt. 305, and at the Soo Line All-Terrain Vehicle Trail. This concrete dam is the tallest dam on the Mississippi at 46 ft (14.0 m) tall and is another hydroelectric station. The large amounts of turbulence at the dams and at the rapids downstream were modeled. Expected environmental and flow conditions used in modeling for the Mississippi River at Palisades are provided in Figures 5-41 to 5-43, and Tables 5-13 and 5-14.

6.2.2.1 Cold Lake Blend Scenarios

The Mississippi River at Little Falls scenarios represent a high energy environment with several waterfalls for the SIMAP analysis. Hypothetical releases of Cold Lake under high flow conditions resulted in oil that was transported downstream 10, 17, and 30 miles (16.1, 27.4, and 48.2 km) after 6, 12, and 24 hours, respectively (Figure 6-59, Figure 6-60, and Figure 6-61). Under average river flow conditions, the release had a maximum extent of approximately 30 miles (48.3 km) after 24 hours (Figure 6-69). During low river flows, the majority of the release was trapped at the ice-water interface within 4.0 miles (6.4 km) of the hypothetical release point, while the maximal extent of oil was approximately 5.5 miles (8.9 km) (Figure 6-76). Table 6-4 provides a summary of the mass balance information at the end of the 24-hour simulations, while Figure 6-57 provides the furthest predicted downstream extent of whole oil.

Table 6-4 Summary of the CLB (CLSB or CLWB) Mass Balance Information for the Mississippi River at Little Falls Release Location at the End of the 24-Hour Simulation [1]

Scenario	Surface (%)	Evaporated (%)	Water Column (%)	Sediment (%)	Ashore (%)	Decayed (%)
CLSB—High Flow (Spring)	37.9	19.1	4.2	0.5	37.5	0.8
CLSB—Average Flow (Summer-Fall)	31.1	20.7	2.8	0.3	44.2	0.8
CLWB—Low Flow	97.0	1.0	0.6	0.3	0.2	1.0

Table 6-4 Summary of the CLB (CLSB or CLWB) Mass Balance Information for the Mississippi River at Little Falls Release Location at the End of the 24-Hour Simulation [1]

Scenario	Surface (%)	Evaporated (%)	Water Column (%)	Sediment (%)	Ashore (%)	Decayed (%)
(Winter)						

NOTE:
[1] All values represent a percent of the total spilled oil

Trajectory and Fate Results for Modeling Locations
January 13, 2017

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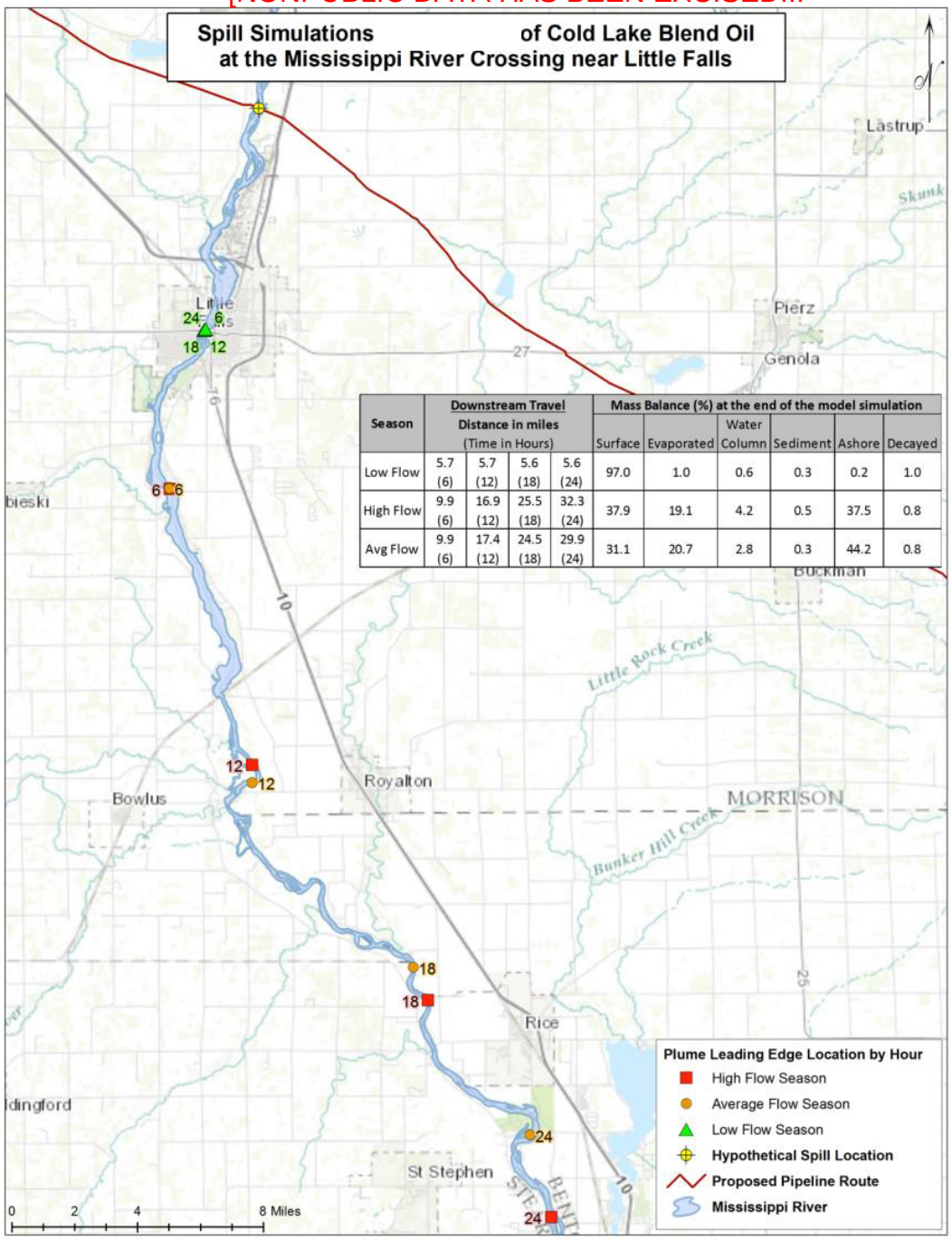

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	5.7 (6)	5.7 (12)	5.6 (18)	5.6 (24)	97.0	1.0	0.6	0.3	0.2	1.0
High Flow	9.9 (6)	16.9 (12)	25.5 (18)	32.3 (24)	37.9	19.1	4.2	0.5	37.5	0.8
Avg Flow	9.9 (6)	17.4 (12)	24.5 (18)	29.9 (24)	31.1	20.7	2.8	0.3	44.2	0.8

...NONPUBLIC DATA HAS BEEN EXCISED]

Figure 6-57 Predicted Downstream Transport of CLB Oil at the Mississippi River at Little Falls Release Location

During high and average river flow conditions, the relatively calm waters upstream and downstream of the Little Falls Dam and Blanchard Dam resulted in large amounts of floating oil, which formed thick surface slicks over much of the river (Figure 6-62 and Figure 6-70). Surface slicks for the Mississippi River at Little Falls were in general, thinner and more extensive than those of the Mississippi River at Palisade. This was the result of more rapid and turbulent river flow at Little Falls. At the end of the 24-hour simulation, floating oil thicknesses between 0.1-1 mm (heavy black oil) remained on the water surface, with localized areas exceeding 1 mm. There was no floating surface oil less than 0.01 mm thick (dark brown sheen). The presence of extensive surface slicks resulted in significant evaporation, with approximately 20% of the total release ending up in the atmosphere (Table 6-4).

Extensive shoreline oiling was observed for approximately 29 miles (46.7 km) of the river below the release location under high river flow conditions (Figure 6-64) and average river flow conditions (Figure 6-72). The concentrations of CLB on the shore were primarily greater than 500 g/m^2, with some segments between 100 and 500 g/m^2.

Mass balance information for the high and average river flow conditions, depict two points of interest approximately 0.2 and 0.6 days (4.8 and 14.4 hours) into the average and high river flow releases (Figure 6-58 and Figure 6-66). Two "humps" or increases in the mass balance were identified representing a large amount entrained oil. These increases in entrained oil were observed, as the oil passed over the Little Falls Dam and then the Blanchard Dam, along with the associated rapids downstream (Figure 6-61 and Figure 6-69). Entrained oil droplets in the water column then rose to the surface over subsequent quiescent reaches of the river, where entrained oil rose back to the surface. A depiction of the dissolved aromatic concentration and total hydrocarbon concentration within the water column at the Little Falls Dam is presented at a time when a portion of the release was above and below the dam (Figure 6-65). Above the dam, note that there are no observed total hydrocarbon concentrations, the oil is floating on the water surface. A portion of this surface oil is dissolving into the surface water column (100 ppb), but is mainly evaporating. However, immediately downstream of the dam, the total hydrocarbon concentration increases (greater than 25 ppm) and dissolved aromatic concentration within the water column increases (100–1,000 ppb), as the whole oil droplets are now in the water column where the soluble portions dissolve into the water. The total hydrocarbon concentration decreases in the water column as distance downstream of the dam increases due to the buoyant rise of whole oil droplets to the surface in the relatively quiescent waters downstream.

When oil is mixed through the water column by turbulent mixing processes such as waterfalls at dams, there is a high potential for oil-SPM interactions with the possibility of "sinking oil." Substantial oiling of the sediment was observed in both the high and average river flow scenarios, with concentrations between 0.01–0.5 g/m^2 along approximately 24 and 30 miles (38.6 and 48.2 km) of river bottom below Little Falls Dam (Figure 6-64 and Figure 6-72). In patchy and localized portions of the Mississippi River downstream of the waterfalls, sediment concentrations are predicted to exceed 500 g/m^2. However, the majority of sediment oiling is

much lower in concentration over the larger area with any amount of potential oil on the sediments. Between 0.3 and 0.5% of the CLB release is predicted to be found in the sediments under ice-free conditions. Higher sediment oiling is predicted under high river flow rates due to the increased turbulence and higher suspended sediment load within the water column. The lowest sediment concentrations and smallest areas with sediment oil were predicted for low flow conditions (Figure 6-78).

The maximum concentration of dissolved aromatics was greater than 5,000 ppb in small regions within the spill extent; however, most of the dissolved aromatic concentrations ranged between 25 and 150 ppb (Figure 6-63 and Figure 6-71). The enhanced dissolved aromatic concentrations were due to dissolution of the soluble portion of the CLWB into the water column. While this may be expected to cause higher concentrations (as observed in the Palisade case), it is important to consider that in the Little Falls scenarios, vertical mixing results in more uniform concentrations throughout the water column, as opposed to a localized or thin layer with elevated concentrations at the surface for the scenarios at Palisade.

For the low river flow scenario, the hydrocarbon trajectory at the end of the 24-hour simulation extended 4.0 miles (6.4 km) from the hypothetical release location, while the maximal extent of oil was approximately 5.5 miles (8.9 km) downstream (Figure 6-77). The downstream extent is further in this scenario than for those at Palisade due to the higher river velocity which transports oil more rapidly as it rises through the water column. In addition the water column is deeper at this release point, relative to Palisade. Finally, the CLWB has a higher density than the Bakken and therefore rises at a slower rate, being transported further downstream before sticking to the underside of the ice. Under low river flow conditions the 100% surface coverage of ice kept the entrained oil in the water column at the ice/water interface (97.0%) (Figure 6-73 and Figure 6-76). Patchy shoreline oiling along river banks was observed between miles 1 and 2 (1.6 and 3.2 km) downstream from the release point. However, the majority of the oil remained trapped under the ice (Table 6-4). Concentrations on the shore were predominantly 1–100 g/m^2, with some segments of the shoreline with values between 100–500 g/m^2 and others exceeding 500 g/m^2 (Figure 6-79).

The soluble portion of the CLWB would dissolve into the water column and be transported downstream, resulting in elevated dissolved aromatic concentrations within the water column (Figure 6-78). Dissolved aromatic components traveled downstream from the initial release location with maximum concentrations greater than 5,000 ppb in the region between 1–3 miles (1.6 to 4.8 km) of release location at hour 24.

At the end of the 24-hour simulation, floating oil under the ice had a thickness greater than 1 mm thick (heavy black oil) (Figure 6-77). There was no floating surface oil less than 0.01 mm thick (dark brown sheen). Small amounts of sediment oiling did extend down to approximately 8.5 miles (13.7 km) (Figure 6-79), although the total hydrocarbon concentrations on the sediment were generally less than 0.01 g/m^2 due to the small amount of SPM in the water column.

There was very little decay from any of the three hypothetical releases within the timeframe modeled (Table 6-4).

6.2.2.1.1 Trajectory and Fate Results for High Flow (Spring)

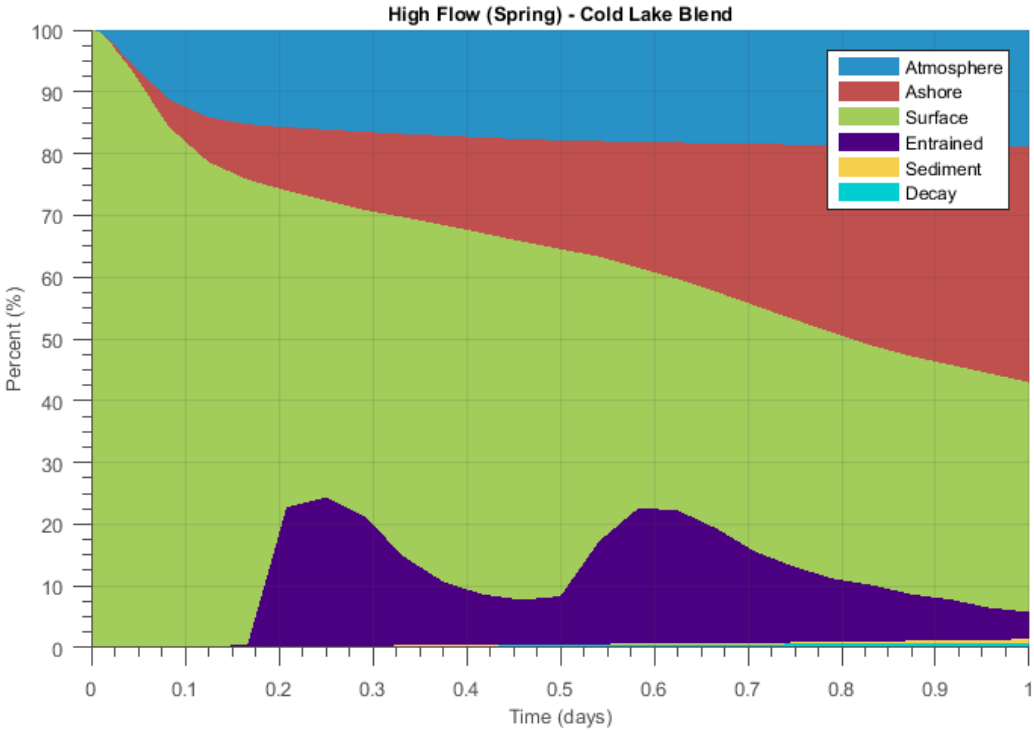

Figure 6-58 Oil Mass Balance Graph for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

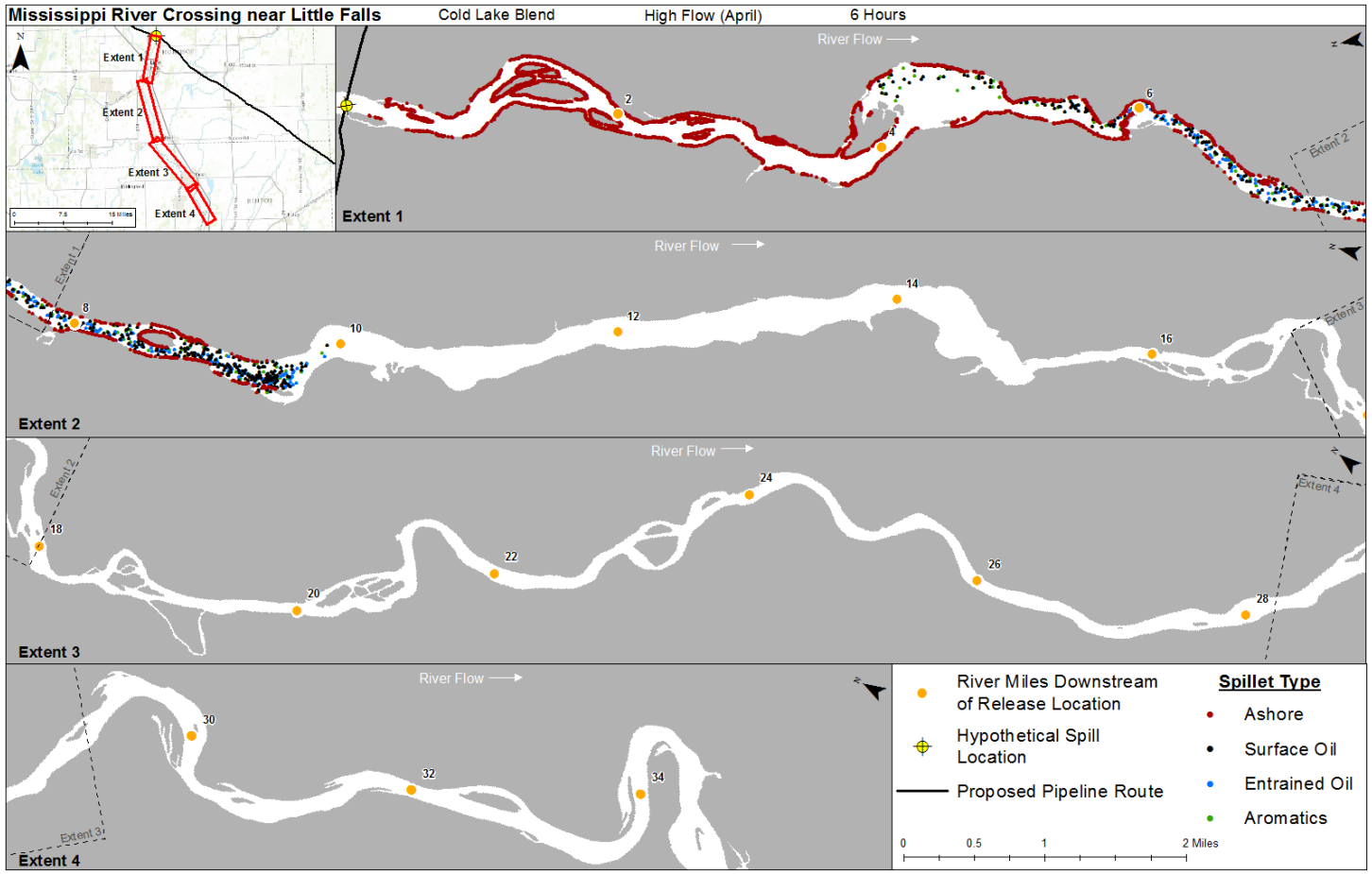

Figure 6-59 Oil Trajectory at 6 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

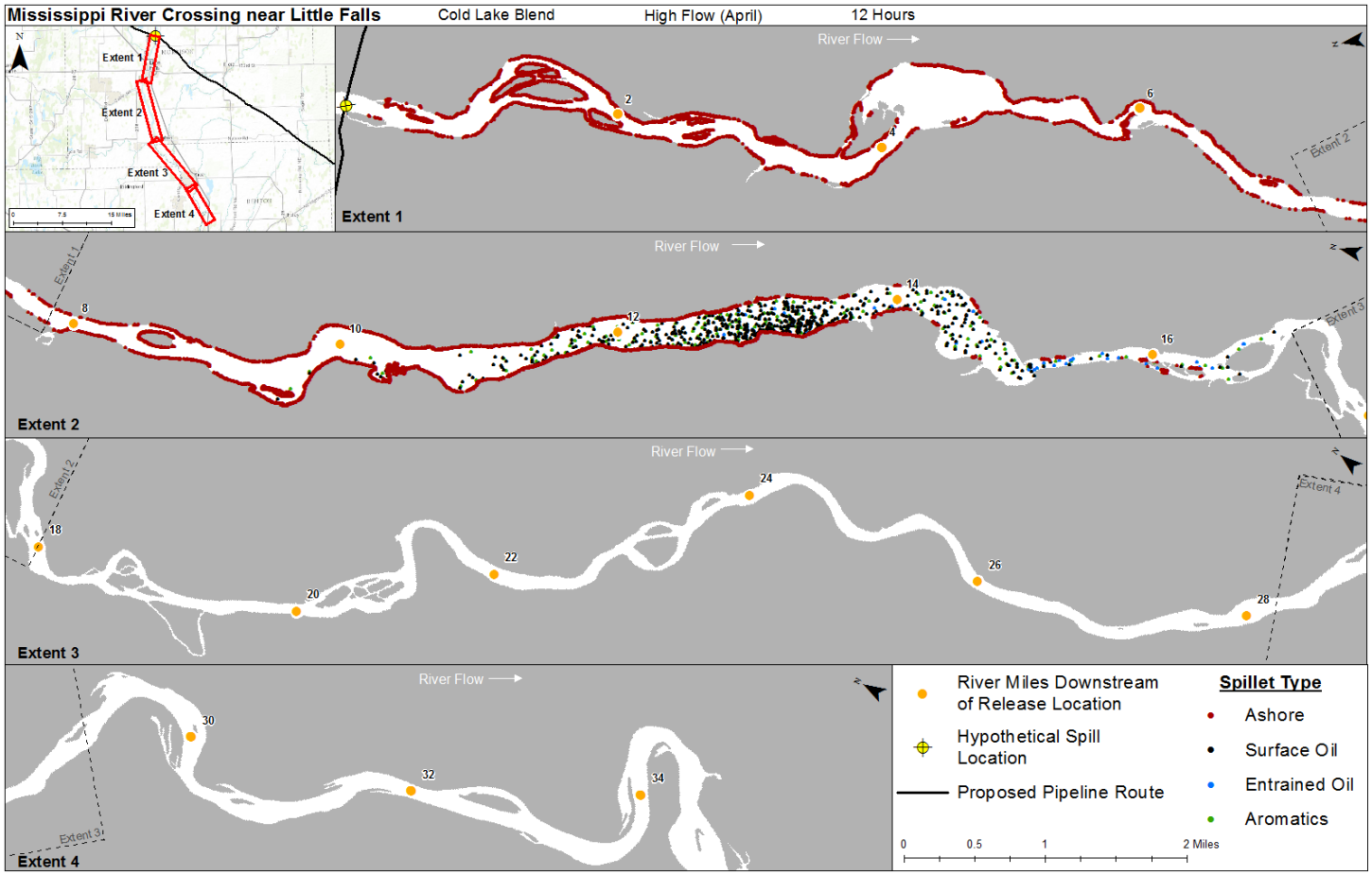

Figure 6-60 Oil Trajectory at 12 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

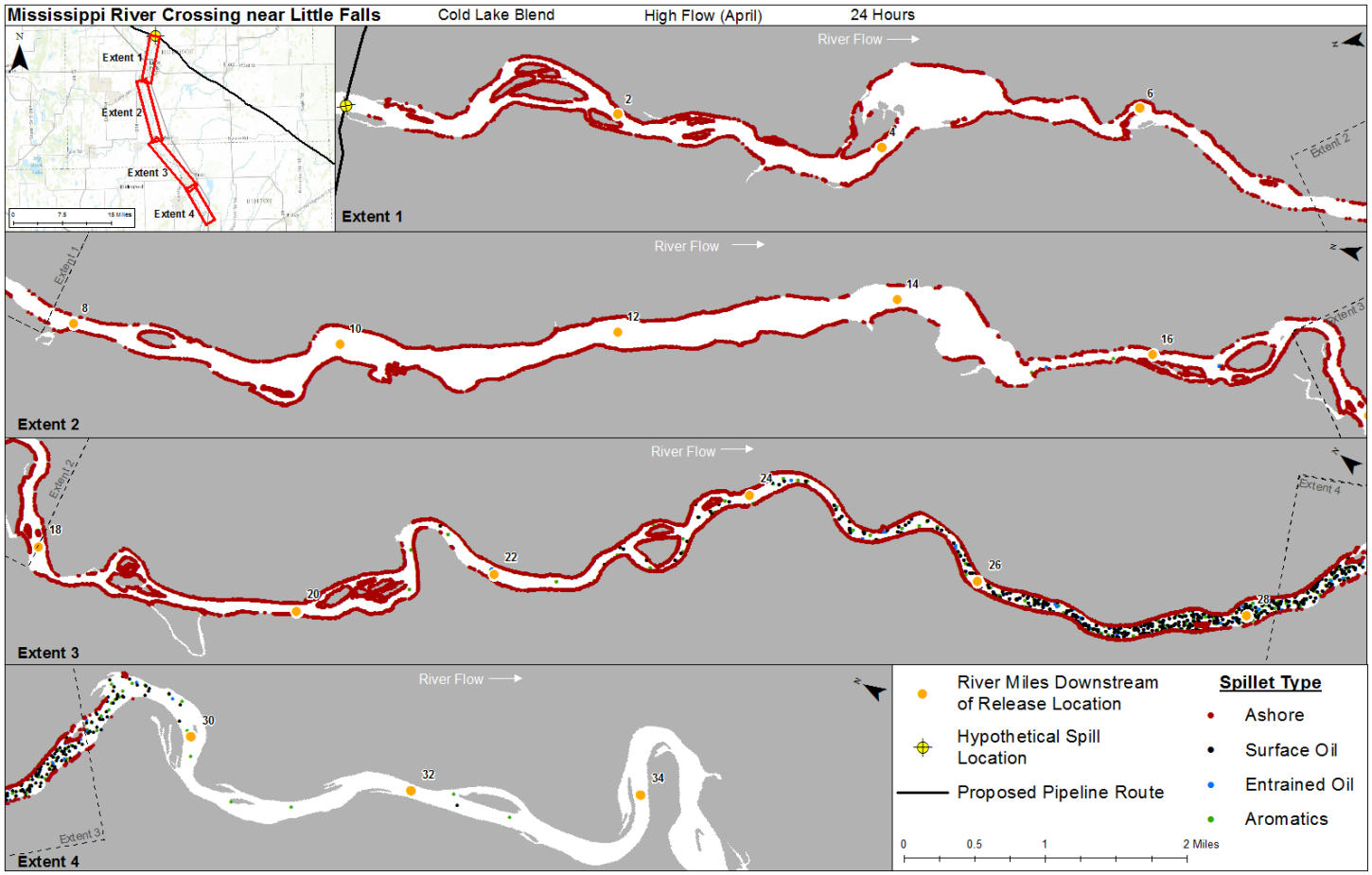

Figure 6-61 Oil Trajectory at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

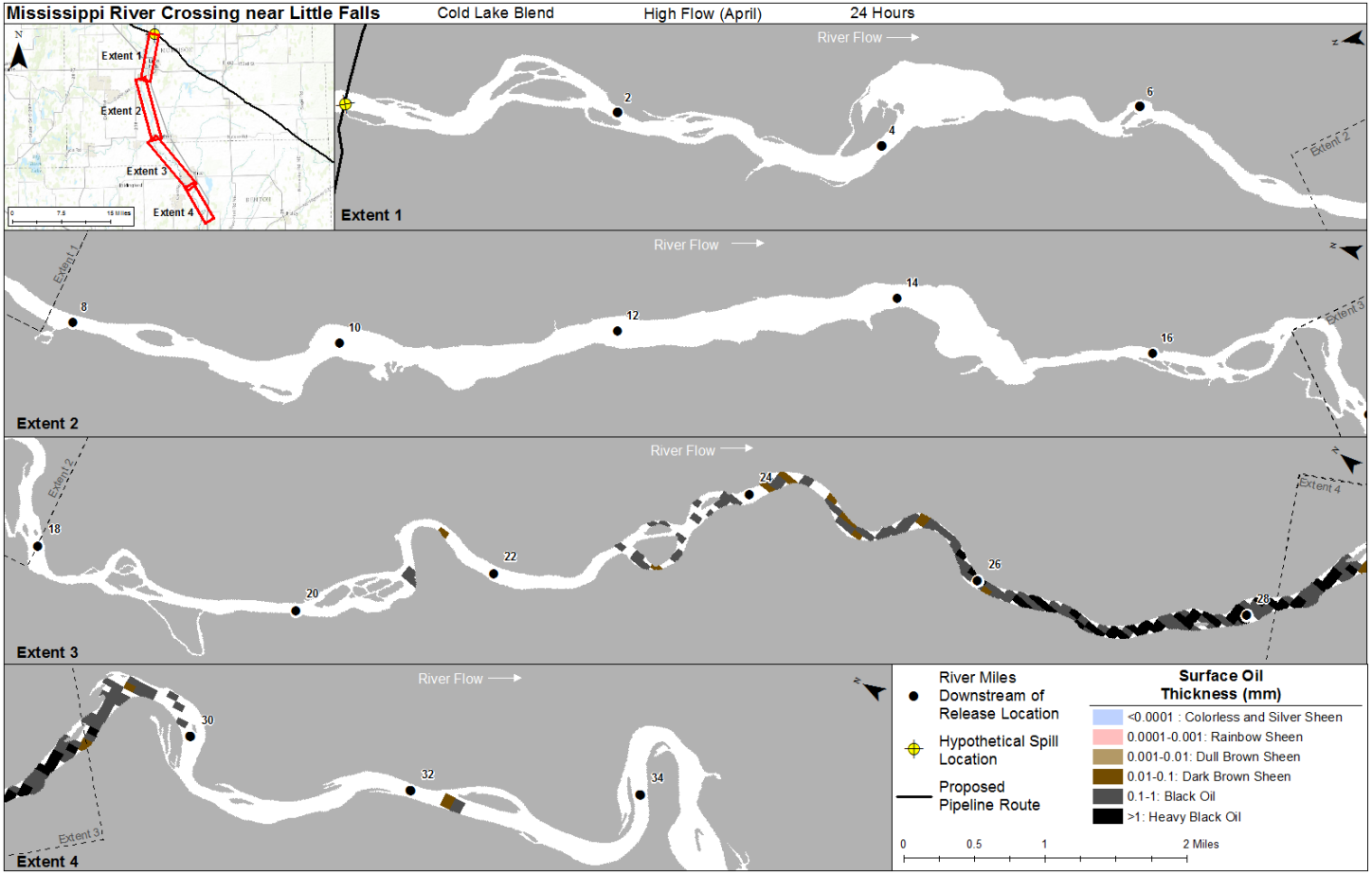

Figure 6-62 Maximum Floating Surface Oil at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

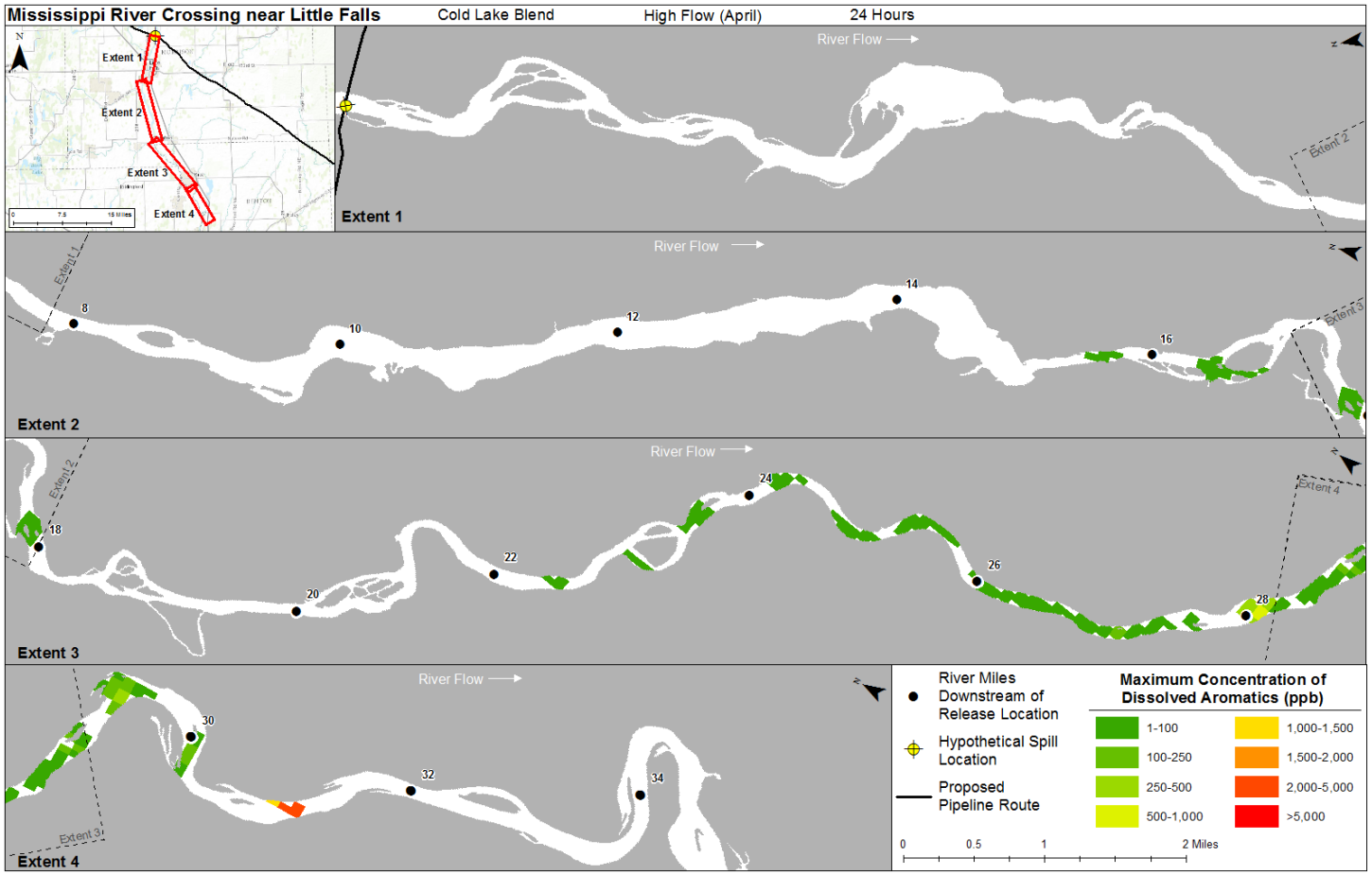

Figure 6-63 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

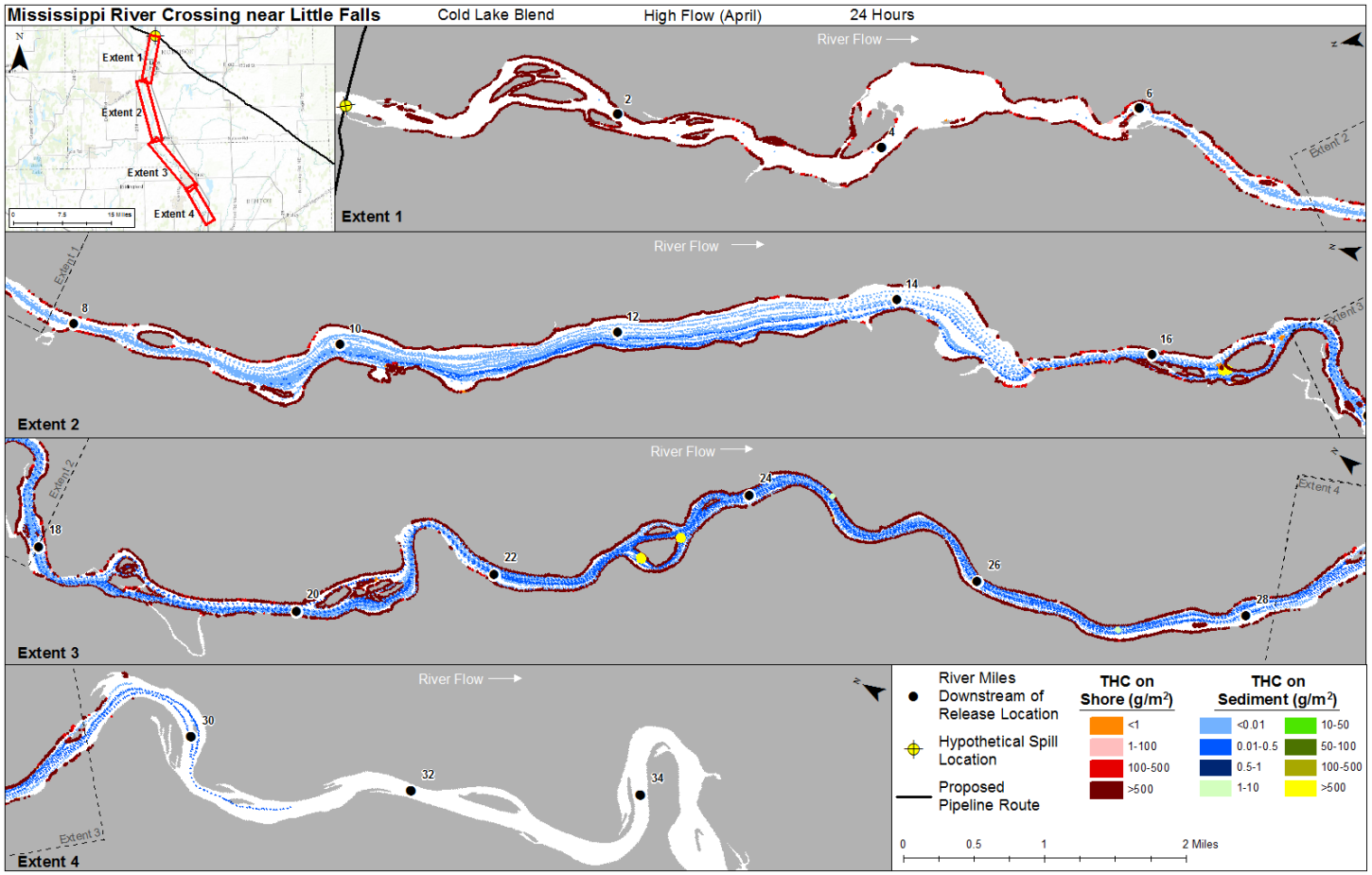

Figure 6-64 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

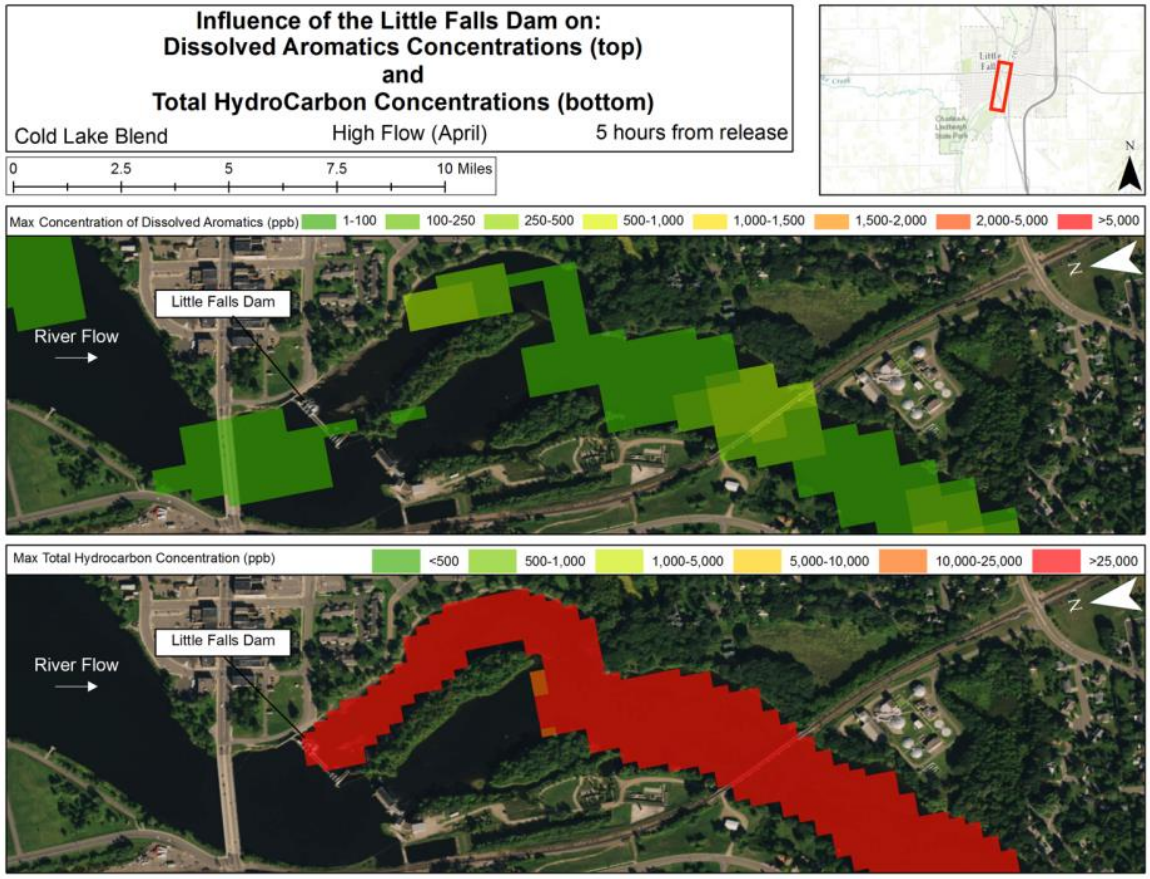

Figure 6-65 Maximum Total Dissolved Aromatic Concentration (top) and Maximum Total Hydrocarbon Concentration in the Water Column (bottom) at Little Falls Dam 24 Hours After the Release of CLB at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

6.2.2.1.2 Trajectory and Fate Results for Average Flow (Summer-Fall)

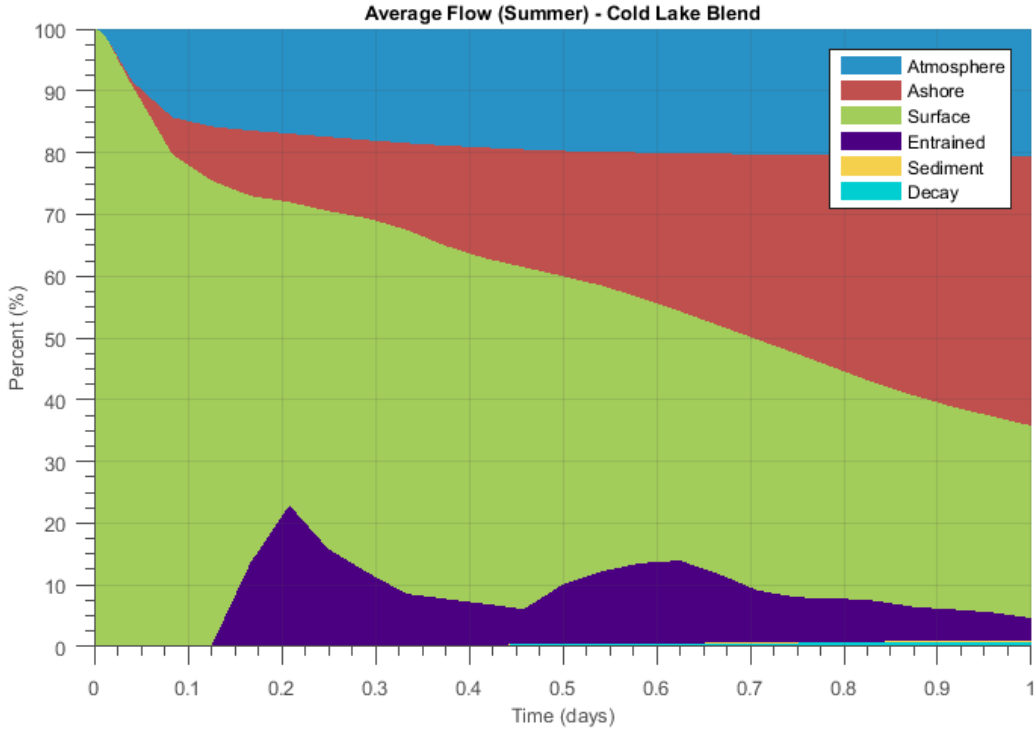

Figure 6-66 Oil Mass Balance Graph for Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

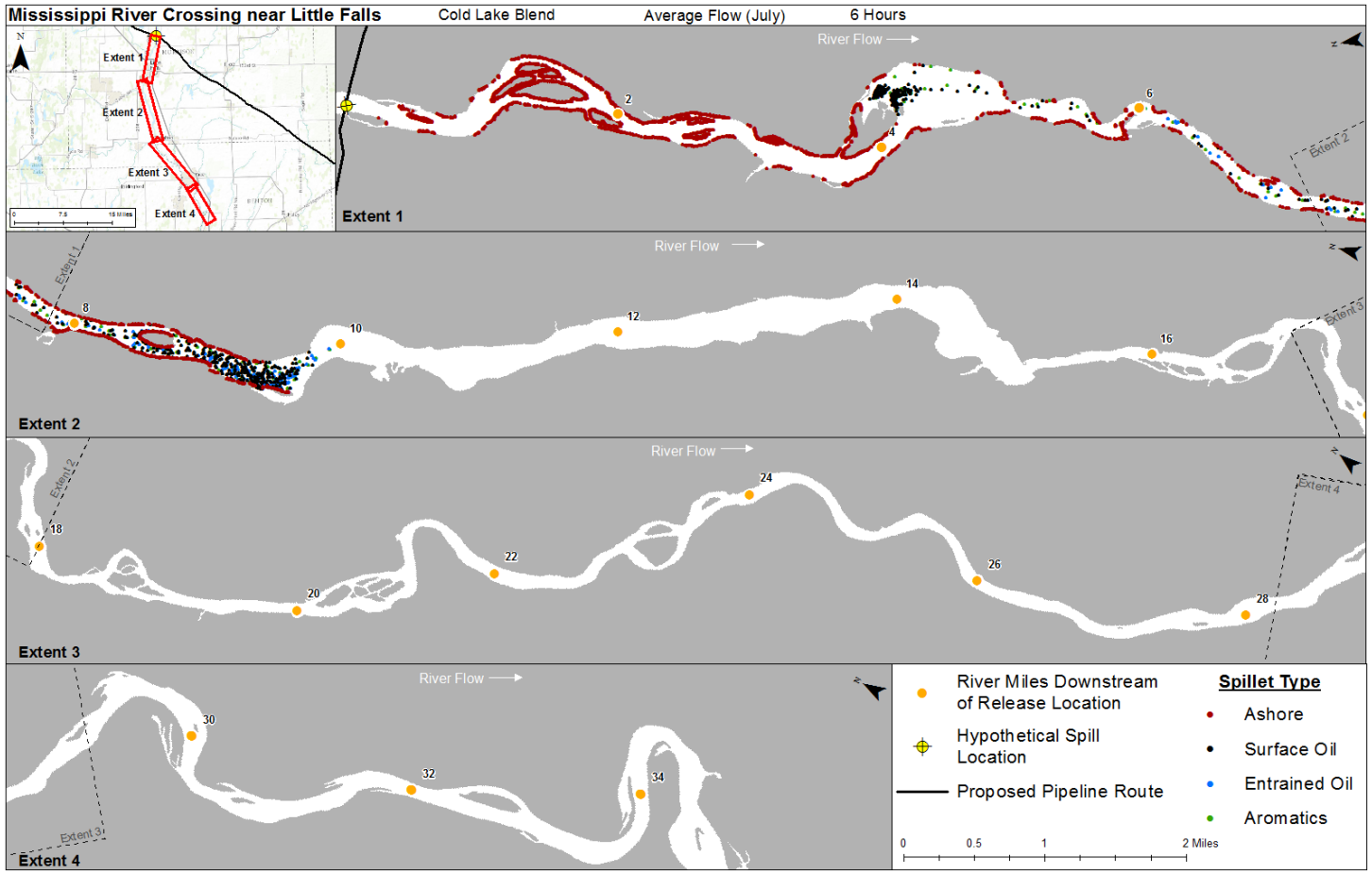

Figure 6-67 Oil Trajectory at 6 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

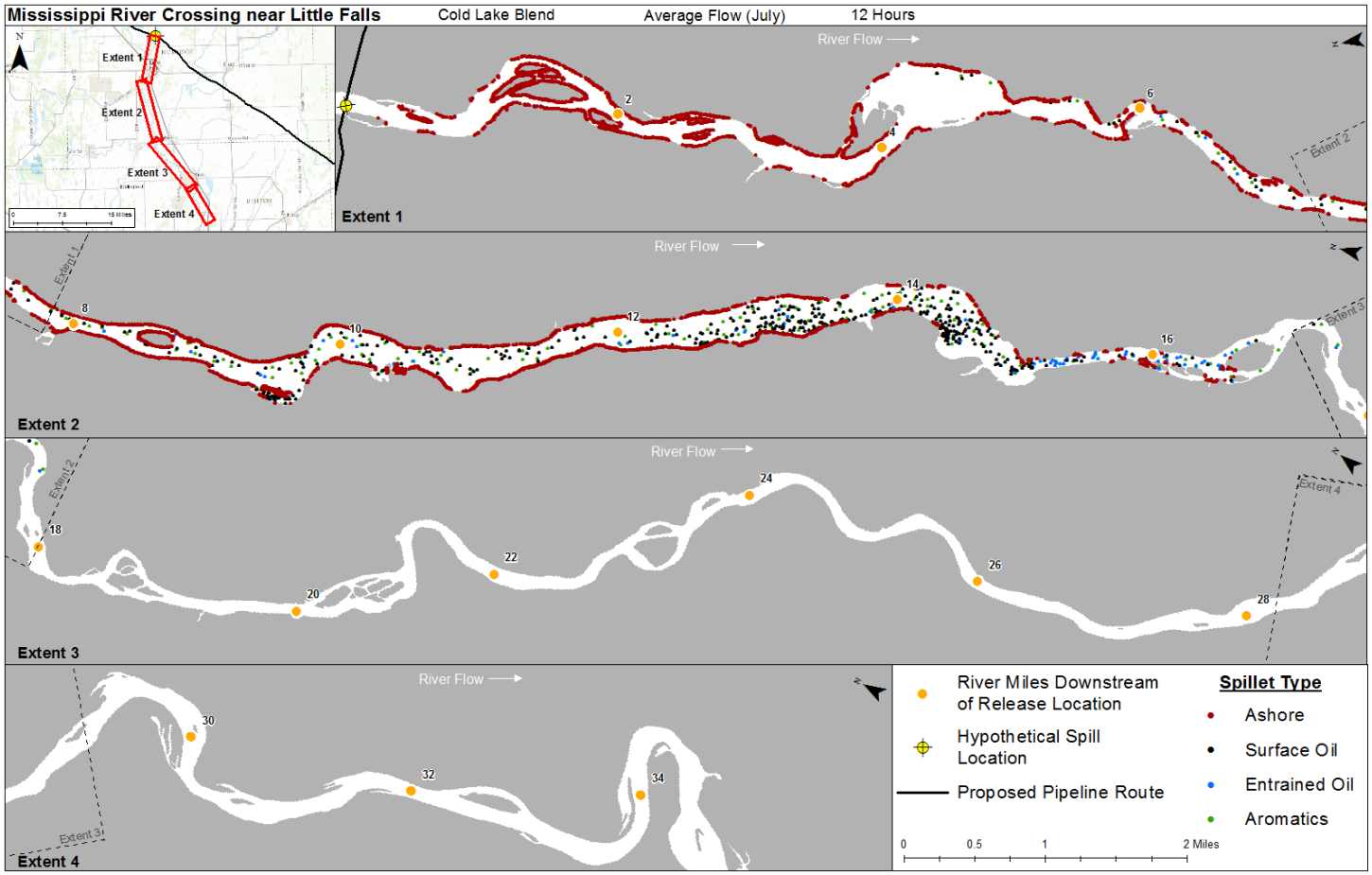

Figure 6-68 Oil Trajectory at 12 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

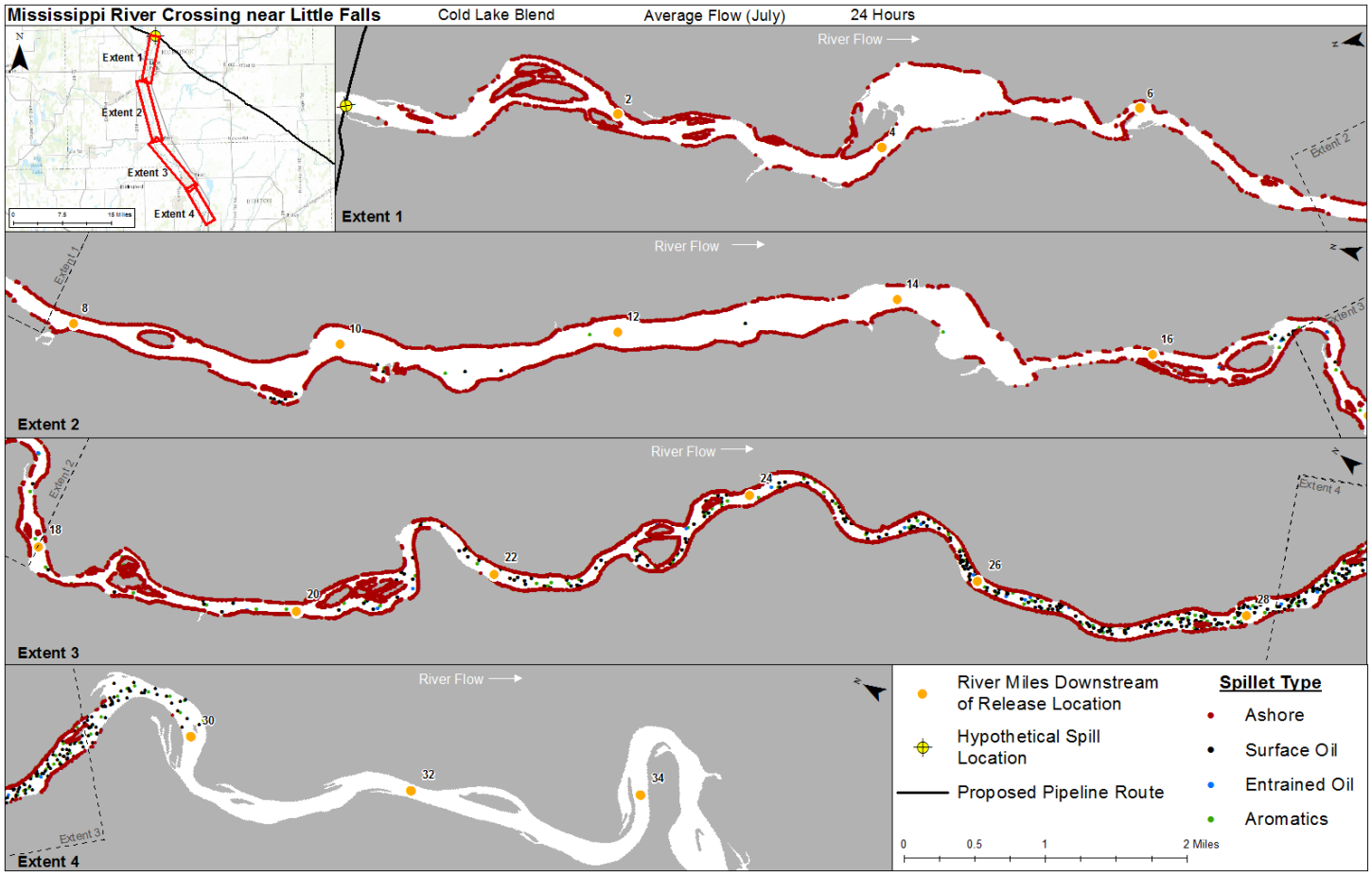

Figure 6-69 Oil Trajectory at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

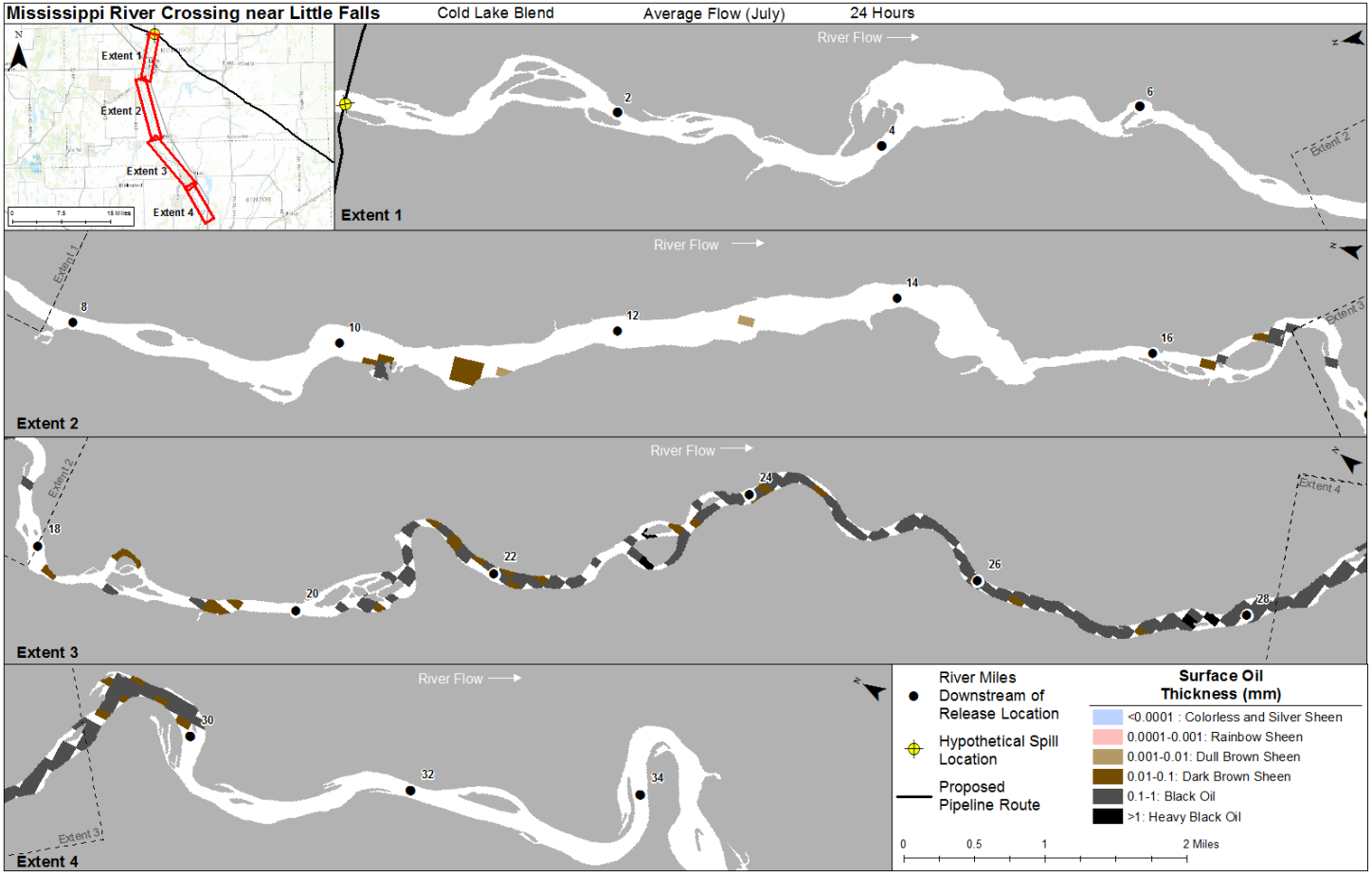

Figure 6-70 Maximum Floating Surface Oil at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

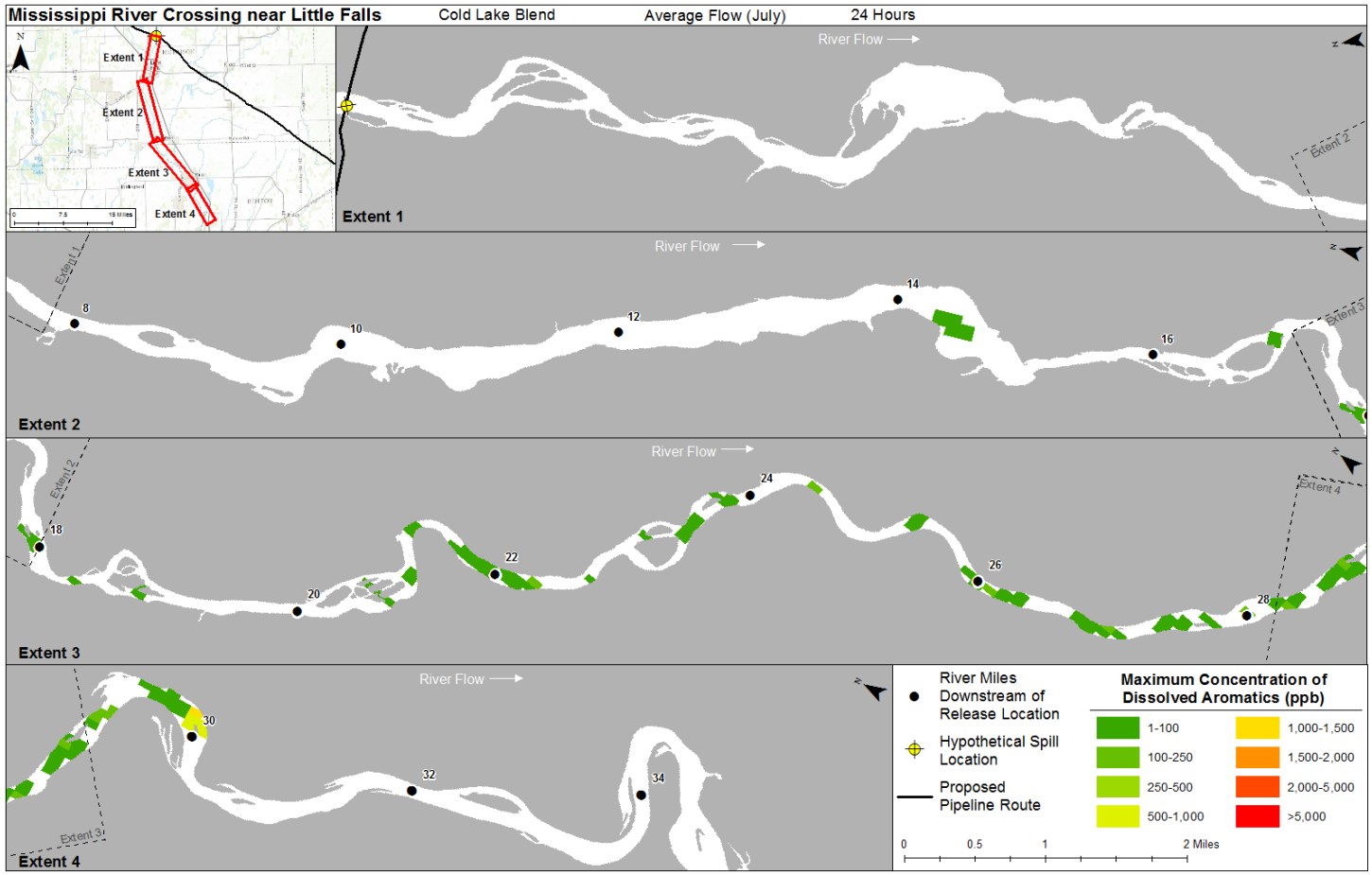

Figure 6-71 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

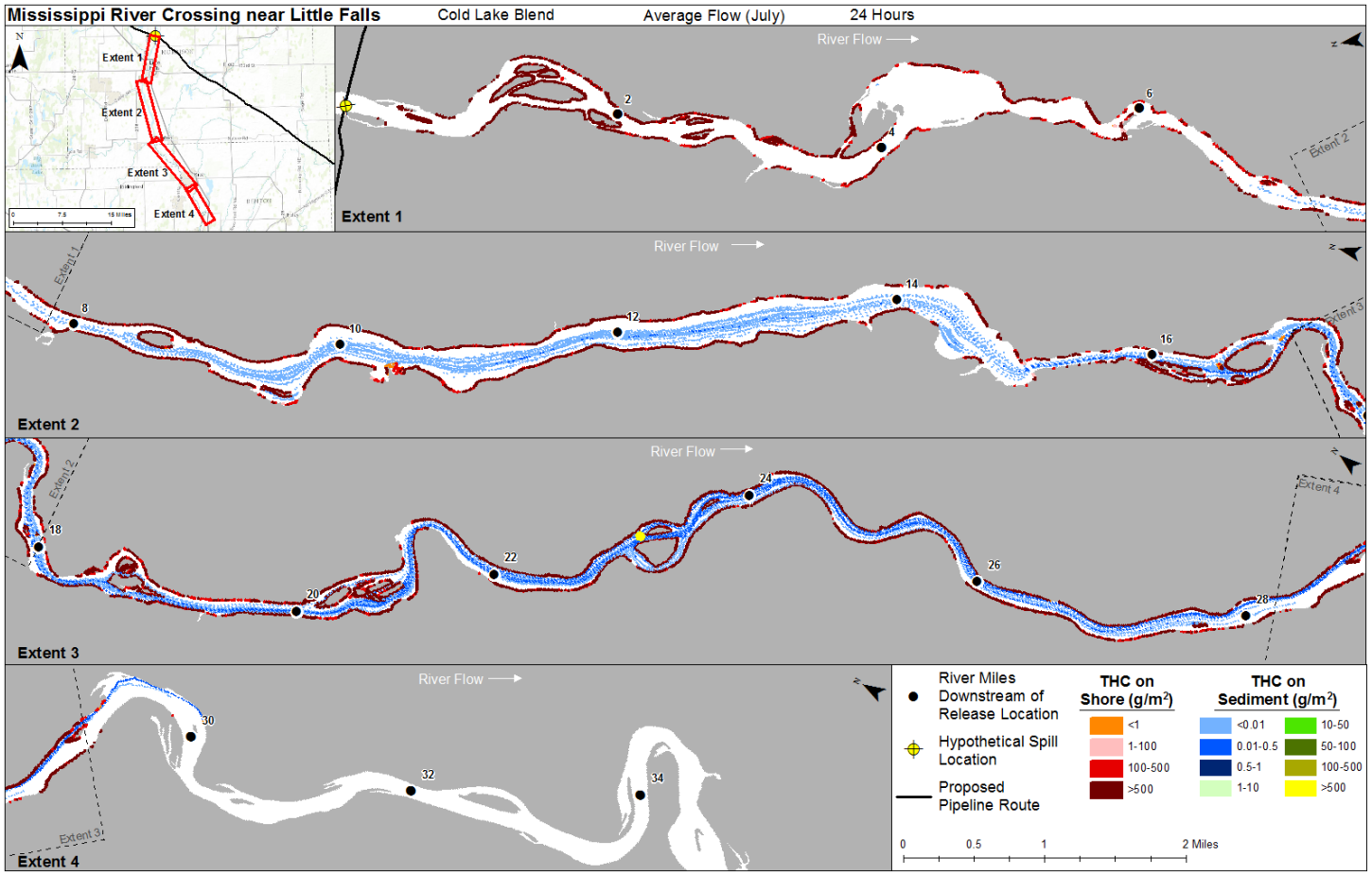

Figure 6-72 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLB at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

6.2.2.1.3 Trajectory and Fate Results for Low Flow (Winter)

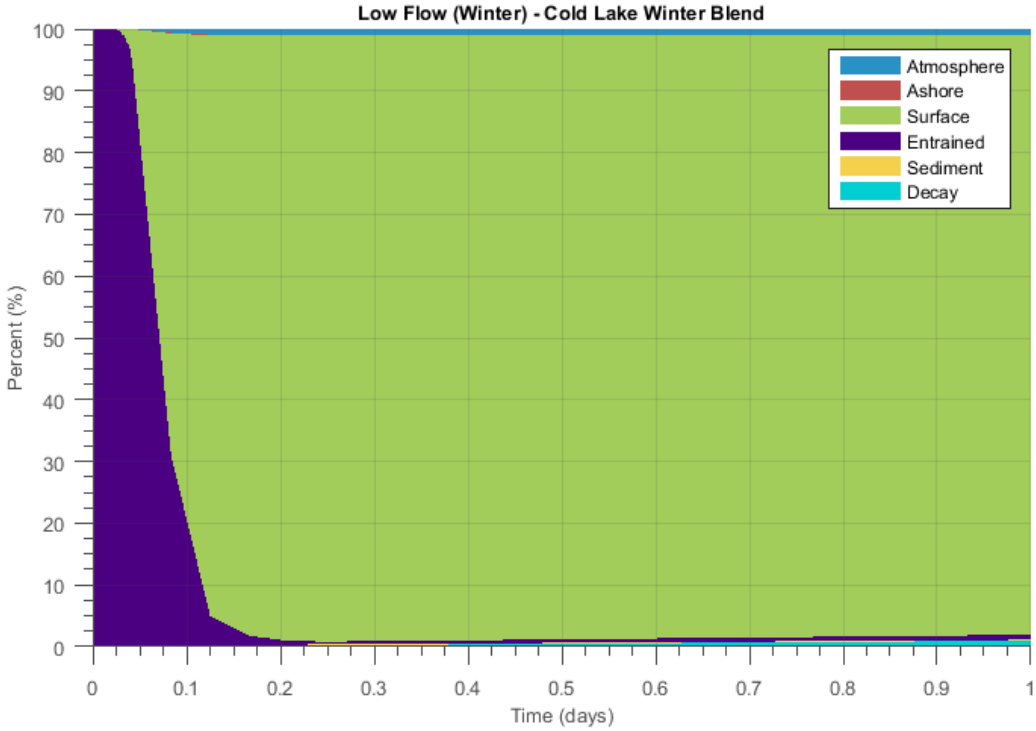

Figure 6-73 Oil Mass Balance Graph for Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

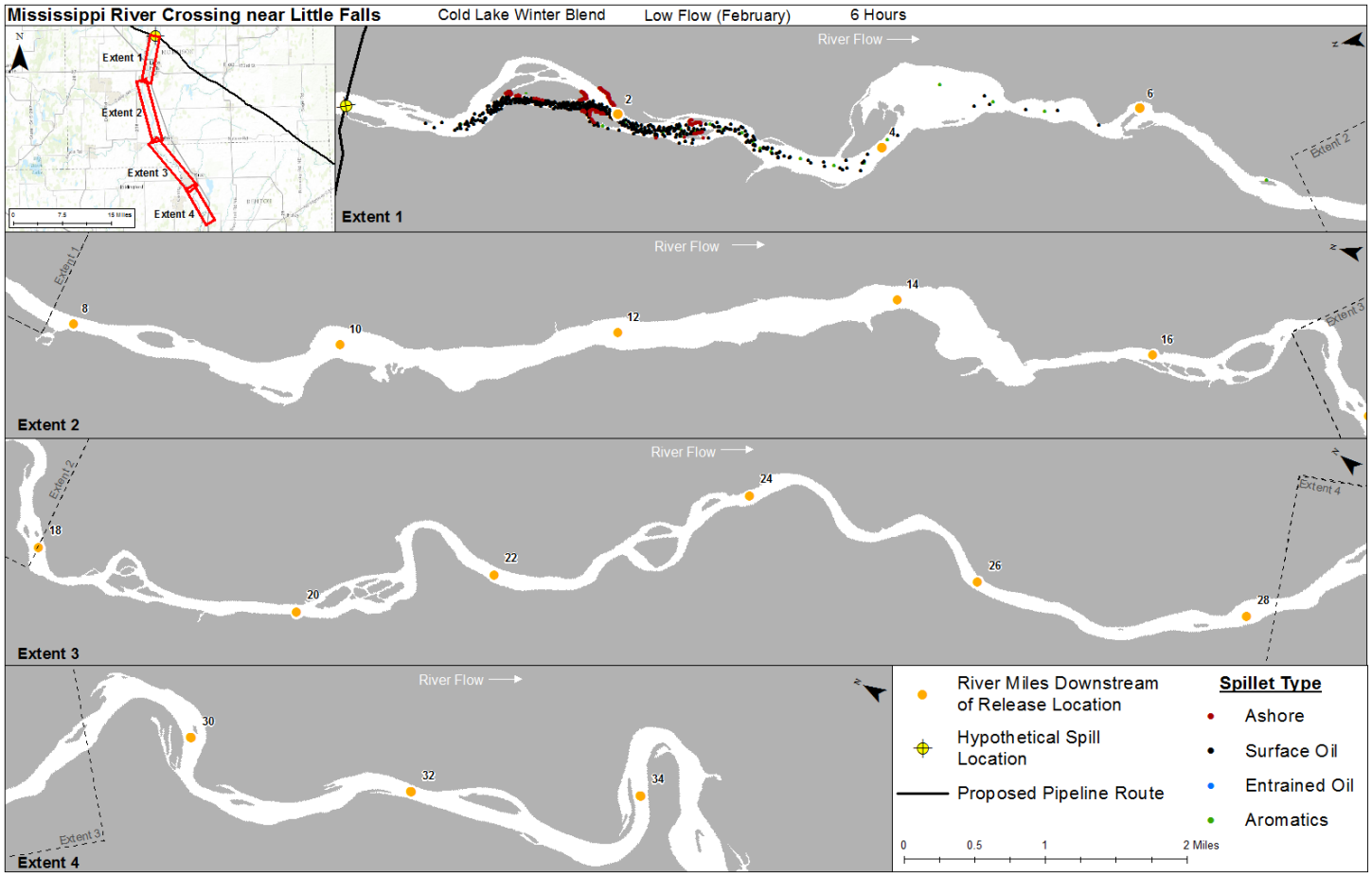

Figure 6-74 Oil Trajectory at 6 Hours for the Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

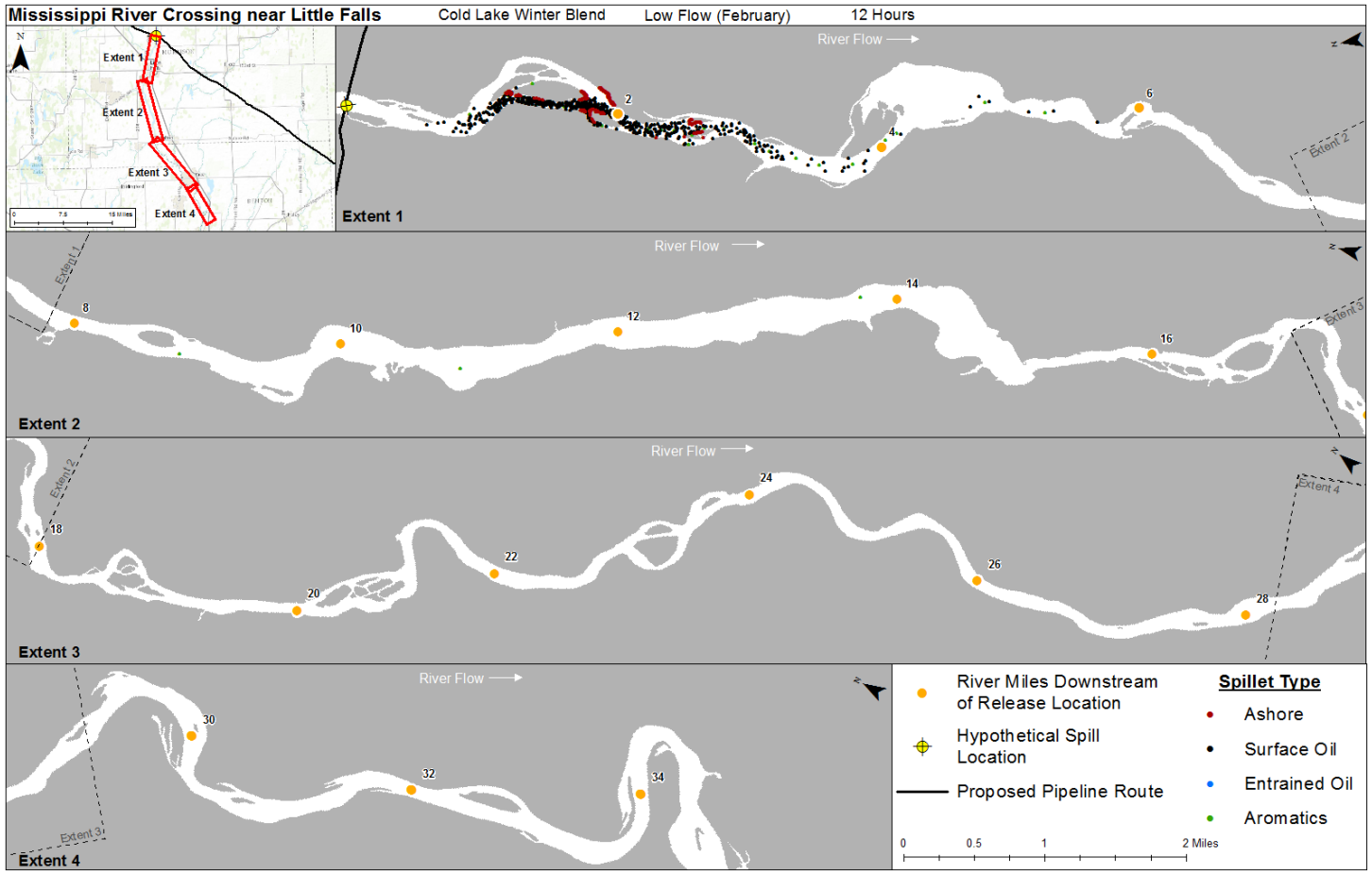

Figure 6-75 Oil Trajectory at 12 Hours for the Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

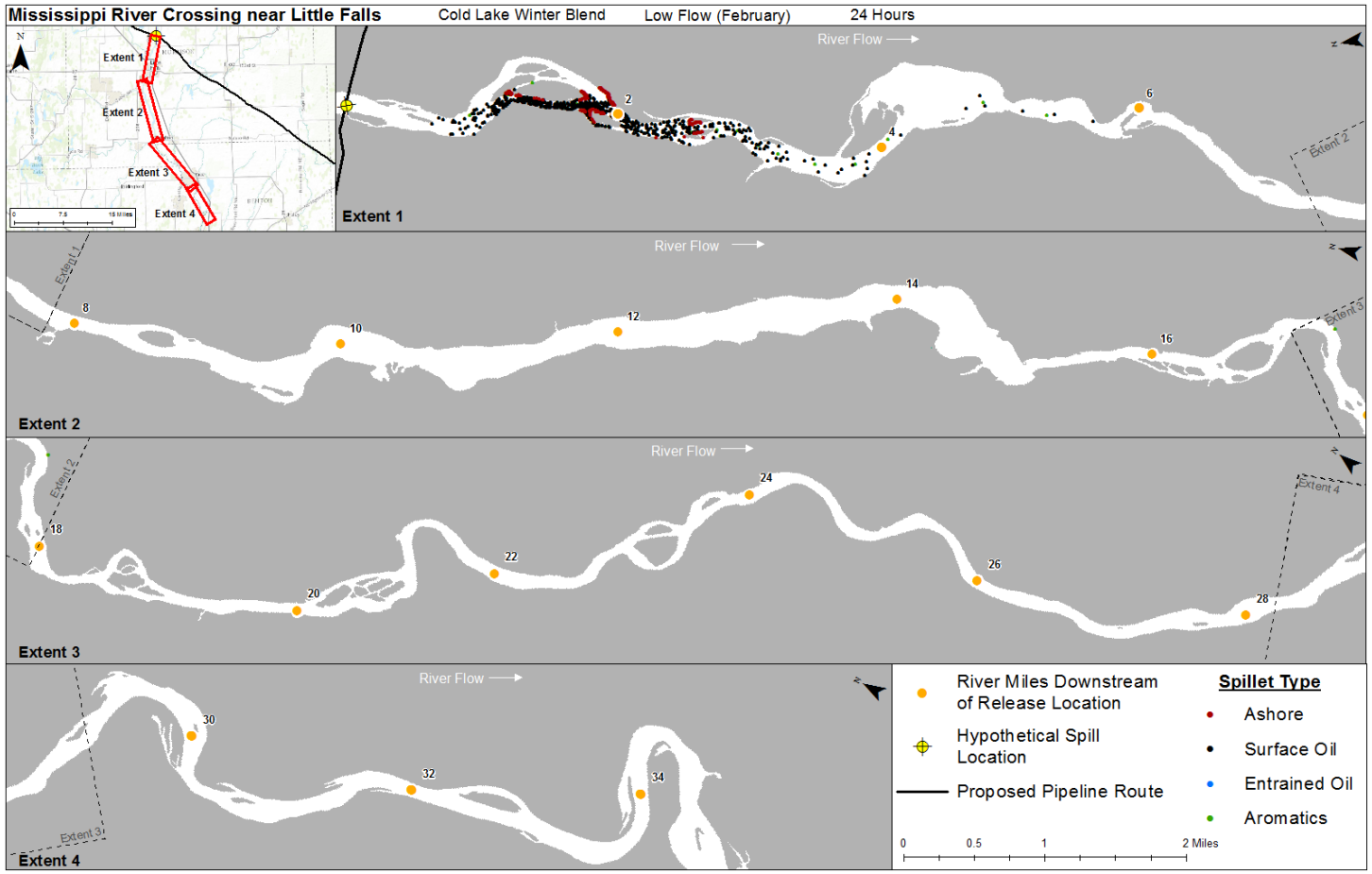

Figure 6-76 Oil Trajectory at 24 Hours for the Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

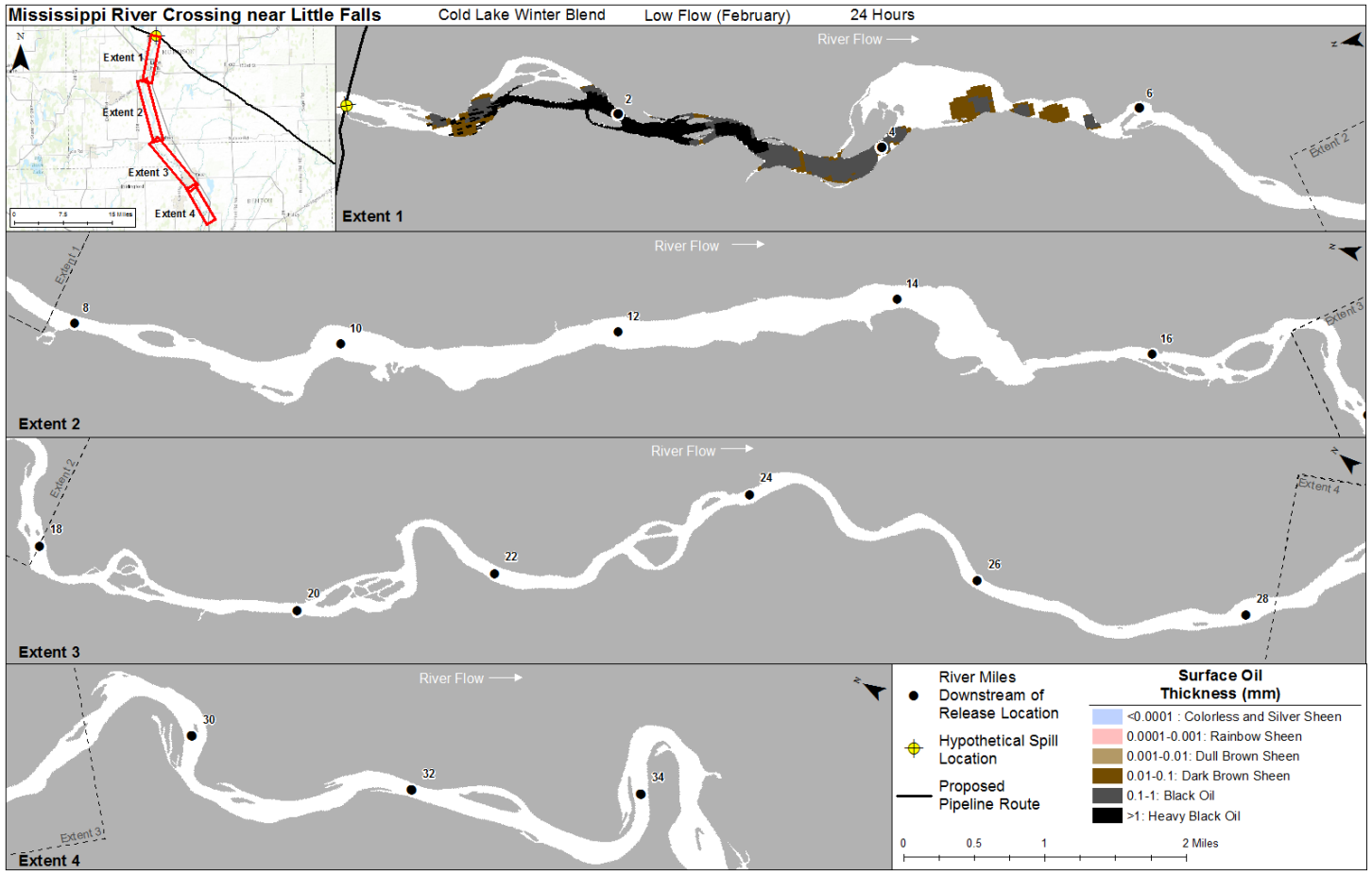

Figure 6-77 Maximum Floating Surface Oil at 24 Hours for the Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

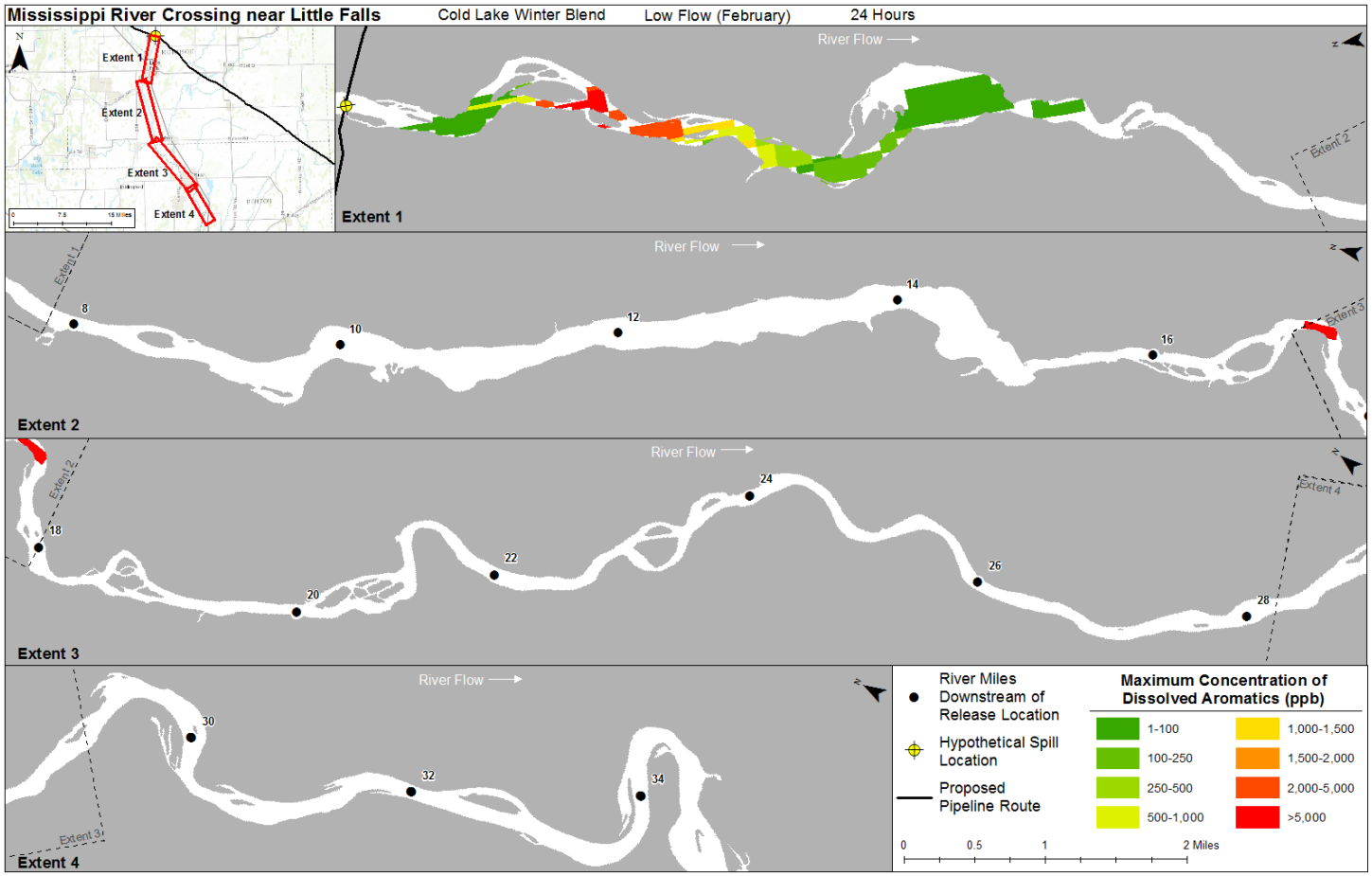

Figure 6-78 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

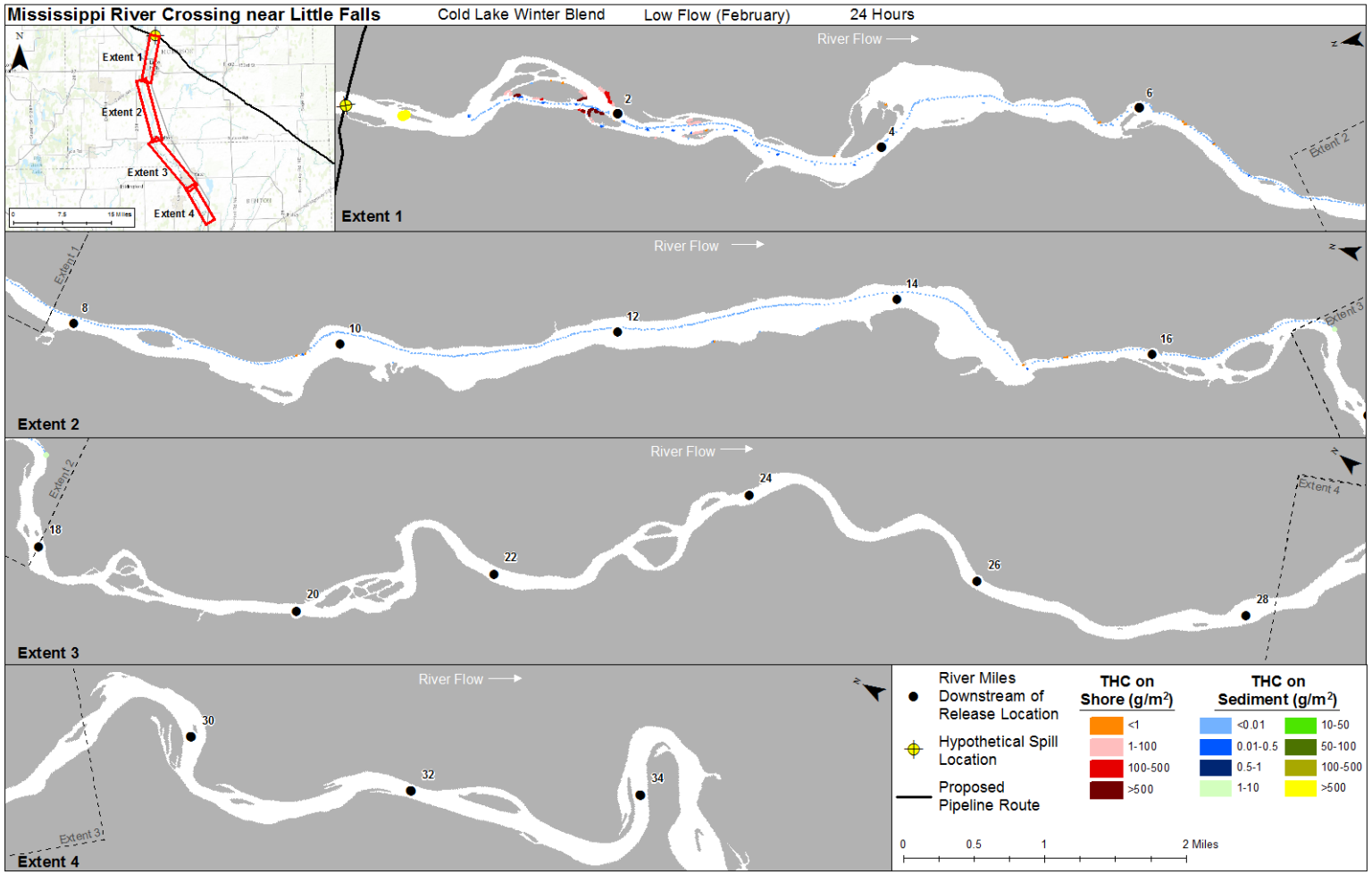

Figure 6-79 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of CLWB at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

6.2.2.2 Bakken Crude Scenarios

The Mississippi River at Little Falls scenarios represent a high energy environment with several waterfalls for the SIMAP analysis. Hypothetical releases of at the Mississippi River at Little Falls resulted in the same downstream transport as the CLB. This was due to the released oil experiencing the same environmental forcing. Under high flow conditions oil was transported downstream 9.5, 17, and 31 miles (15.3, 27.4, and 49.9 km) after 6, 12, and 24 hours, respectively (Figure 6-82, Figure 6-83, and Figure 6-84). Under average river flow conditions, the release had a maximum extent of approximately 30 miles (48.3 km) after 24 hours (Figure 6-91). During low river flows, the majority of the release was trapped at the ice-water interface within 1.5 miles (2.4 km) of the hypothetical release point, while the maximal extent of oil was approximately 2.0 miles (3.2 km) (Figure 6-98). Table 6-5 provides a summary of the mass balance information at the end of the 24-hour simulations, while Figure 6-80 provides the furthest predicted downstream extent of whole oil.

Table 6-5 Summary of the Bakken Crude Mass Balance Information for the Mississippi River at Little Falls Release Location at the End of the 24-Hour Simulation [1]

Scenario	Surface (%)	Evaporated (%)	Water Column (%)	Sediment (%)	Ashore (%)	Decayed (%)
BAK—High Flow (Spring)	21.6	51.3	8.0	<0.1	18.5	0.6
BAK—Average Flow (Summer-Fall)	17.1	54.4	6.8	<0.1	21.2	0.5
BAK—Low Flow (Winter)	97.4	<0.1	1.6	<0.1	<0.1	1.0

NOTE:
[1] All values represent a percent of the total spilled oil

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Trajectory and Fate Results for Modeling Locations
January 13, 2017

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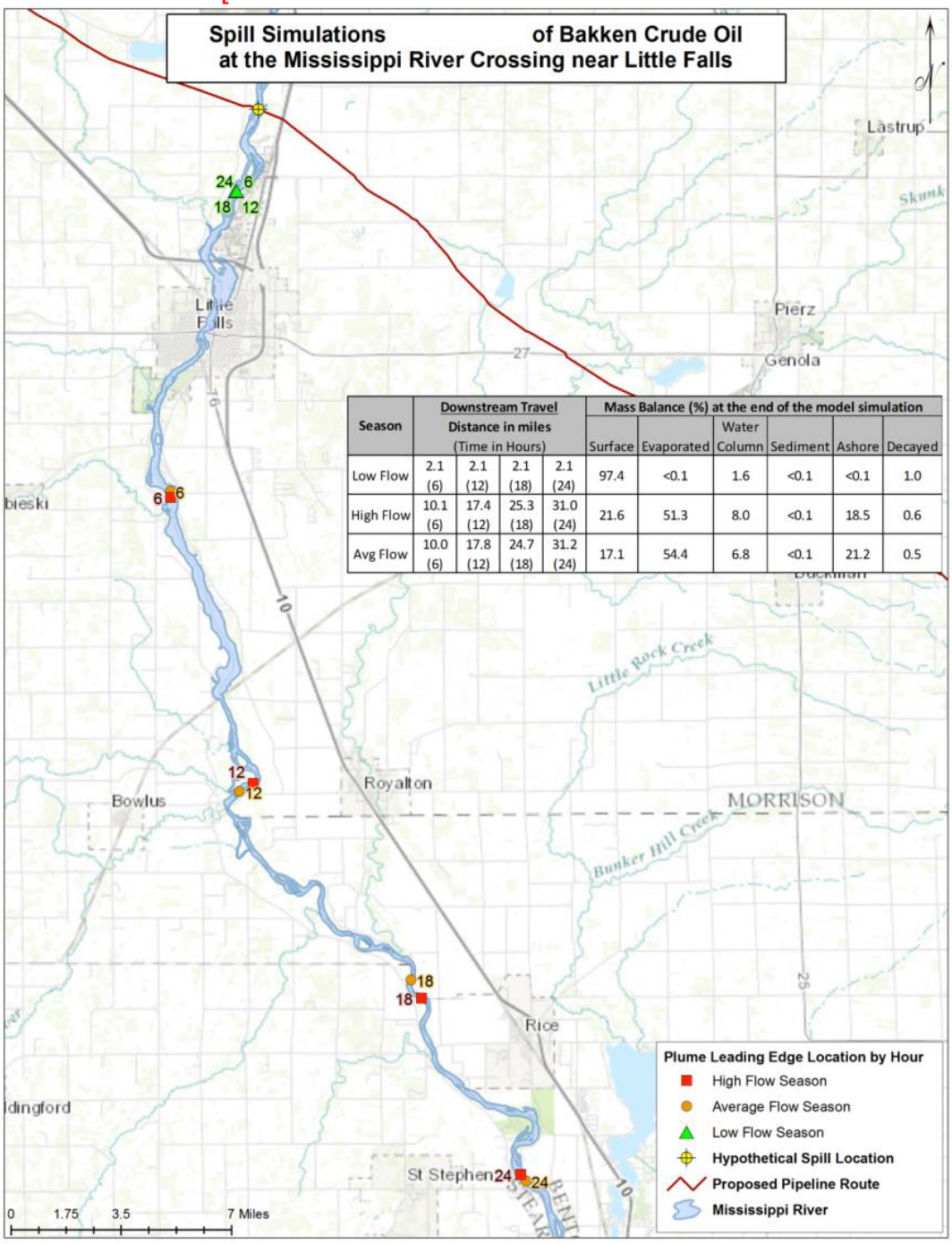

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	2.1 (6)	2.1 (12)	2.1 (18)	2.1 (24)	97.4	<0.1	1.6	<0.1	<0.1	1.0
High Flow	10.1 (6)	17.4 (12)	25.3 (18)	31.0 (24)	21.6	51.3	8.0	<0.1	18.5	0.6
Avg Flow	10.0 (6)	17.8 (12)	24.7 (18)	31.2 (24)	17.1	54.4	6.8	<0.1	21.2	0.5

...NONPUBLIC DATA HAS BEEN EXCISED]

Figure 6-80 Predicted Downstream Transport of Bakken Crude Oil at the Mississippi River at Little Falls Release Location

During high and average river flow conditions, the relatively calm waters upstream and downstream of the Little Falls Dam and Blanchard Dam resulted in large amounts of floating oil, which formed extensive surface slicks over much of the river (Figure 6-85 and Figure 6-92). Surface slicks for the Mississippi River at Little Falls were in general thinner and more extensive than those of the Mississippi River at Palisade. This was the result of more rapid and turbulent river flow at Little Falls. Additionally, for Bakken crude, slicks were thinner than CLB. At the end of the 24-hour simulation, floating oil thicknesses between 0.01 and 1 mm (dark brown sheen and black oil) remained on the water surface. There were some areas of river with floating surface oil less than 0.001 mm thick (representing colorless and silver sheens and rainbow sheens). The presence of extensive surface slicks resulted in significant evaporation, with approximately 50% of the total release ending up in the atmosphere (Table 6-5).

Extensive shoreline oiling was observed for approximately 30 miles (48.3 km) of the river below the release location under high river flow conditions (Figure 6-87) and 29 miles (46.7 km) under average river flow conditions (Figure 6-94). The concentrations of Bakken on the shore were generally 100–500 g/m^2 with nearly equal lengths of shoreline exceeding 500 g/m^2. In general, Bakken resulted in less extensive shoreline oiling than the CLB.

Similar to the CLB scenarios, Bakken crude behaved similarly over water falls. A large portion of the released oil would be entrained into the water column at both Little Falls Dam and Blanchard Dam. This would result in large increases in the THC concentration within the water column and would result in enhancements in the dissolved aromatic concentration (Figure 6-81 and Figure 6-88). Slightly lower amounts of entrained oil are found in the water column and surface oil returns more rapidly downstream of dams in the Bakken release. This is the result of the Bakken crude being less dense than CLB, which results in a larger buoyant force and a more rapid rise in velocity of Bakken oil droplets.

Oil-SPM interactions were observed with the Bakken crude oil as well, which resulted in the possibility of "sinking oil" (Figure 6-87 and Figure 6-94). Approximately 30 miles (48.3 km) of river bottom were predicted to have sediment oiling less than 0.01 g/m^2, with some localized areas experiencing 0.01–0.5 g/m^2. Below Blanchard Dam, after the second waterfall entrained oil and further mixing with SPM, some patchy and localized portions of the river bottom may have sediment concentrations between 1 and 10 g/m^2 with values as high as 10–50 g/m^2 in very small areas. In general, Bakken was more easily entrained into the water column due to its lower viscosity. However, the overall quantity of oil interacting with SPM was lower than the CLB. Less than 0.1% of the release is predicted to be found in the sediments under ice-free conditions. This is over six times lower than the predictions for CLB. Higher sediment oiling is predicted under high river flow rates due to the increased turbulence and higher suspended sediment load within the water column. The lowest sediment concentrations and smallest areas with sediment oil were predicted for low flow conditions (Figure 6-101).

The maximum concentration of dissolved aromatics was greater than 500 ppb in small regions within the spill extent; however, most of the dissolved aromatic concentrations ranged between

25 and 100 ppb (Figure 6-87 and Figure 6-94). The enhanced dissolved aromatic concentrations were due to dissolution of the soluble portion of the Bakken into the water column. While this may be expected to cause higher concentrations (as observed in the Palisade case), it is important to consider that in the Little Falls scenarios, vertical mixing resulted in more uniform concentrations throughout the water column, as opposed to a localized or thin layer with elevated concentrations at the surface for the scenarios at Palisade. Although Bakken has a higher aromatic content than Bakken, concentrations were slightly lower for Bakken than the CLB as entrained droplets rose more quickly through the water column downstream of the dams, where they formed surface slicks and evaporated more completely.

For the low river flow scenario, the hydrocarbon trajectory at the end of the 24-hour simulation extended 1.5 miles (2.4 km) of the hypothetical release point, while the maximal extent of oil was approximately 2.0 miles (3.2 km) (Figure 6-98). The downstream extent is further in this scenario than for those at Palisade due to the higher river velocity, which transported oil more rapidly as it rose through the water column. In addition the water column is deeper at this release point, relative to Palisade. However, the extent was smaller than that of the CLWB, due to the lower density and more rapid rise rate through the water column, before sticking to the underside of the ice. Under low river flow conditions the 100% surface coverage of ice kept the entrained oil in the water column at the ice/water interface (97.4%) (Figure 6-95 and Figure 6-99). Extremely patchy oiling along river banks was observed downstream from the release point, with concentrations on the shoreline less than 1 g/m^2 (Figure 6-101). Extremely small amounts of oil may be found on the sediments, with most concentrations falling less than 0.01 g/m^2.

Large portions of the soluble portion of the Bakken dissolved into the water column and was transported downstream, resulting in elevated dissolved aromatic concentrations within the water column (Figure 6-100). Dissolved aromatic components traveled downstream from the initial spill location with maximum concentrations greater than 5,000 ppb directly under the oil trapped under the ice. Much larger portions of the river are predicted to experience dissolved aromatic concentrations in excess of 5,000 ppb, when compared to average or low flow scenarios.

At the end of the 24-hour simulation, floating oil under the ice had a thickness greater than 1 mm thick (heavy black oil) (Figure 6-99). There was no floating surface oil less than 0.1 mm thick (black oil). Small amounts of sediment oiling did extend dowstream, although the total hydrocarbon concentrations on the sediment were generally less than 0.01 g/m^2 due to the small amount of SPM in the water column.

There was very little decay from any of the three hypothetical releases within the timeframe modeled (Table 6-5).

6.2.2.2.1 Trajectory and Fate Results for High Flow (Spring)

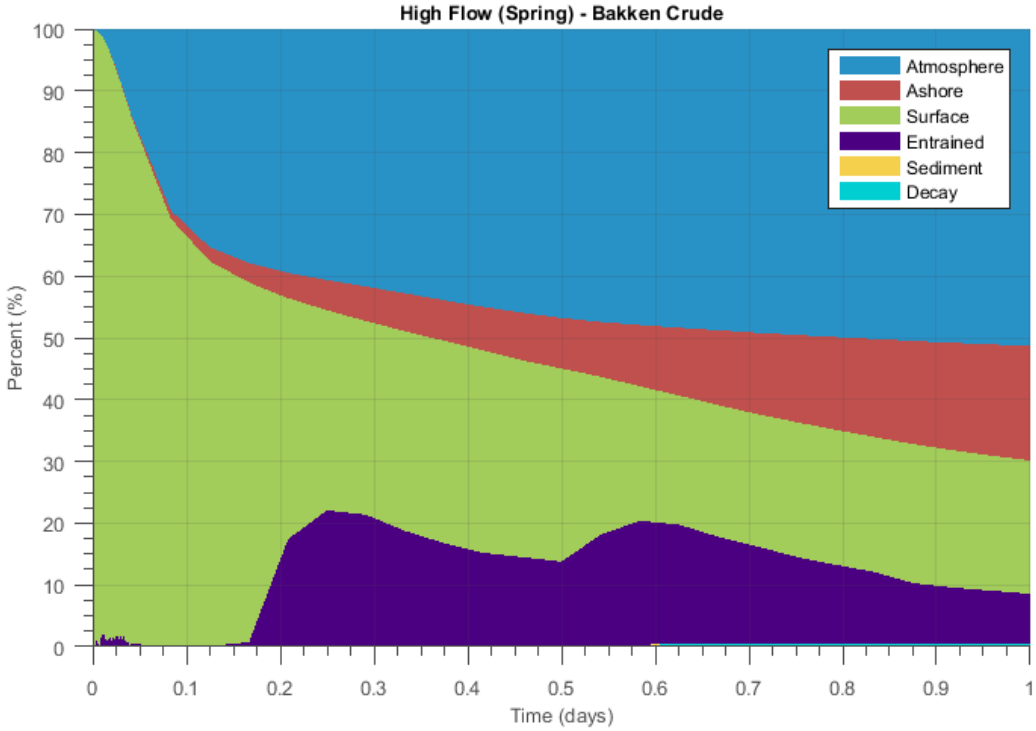

Figure 6-81 Oil Mass Balance Graph for the release of Bakken Crude at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

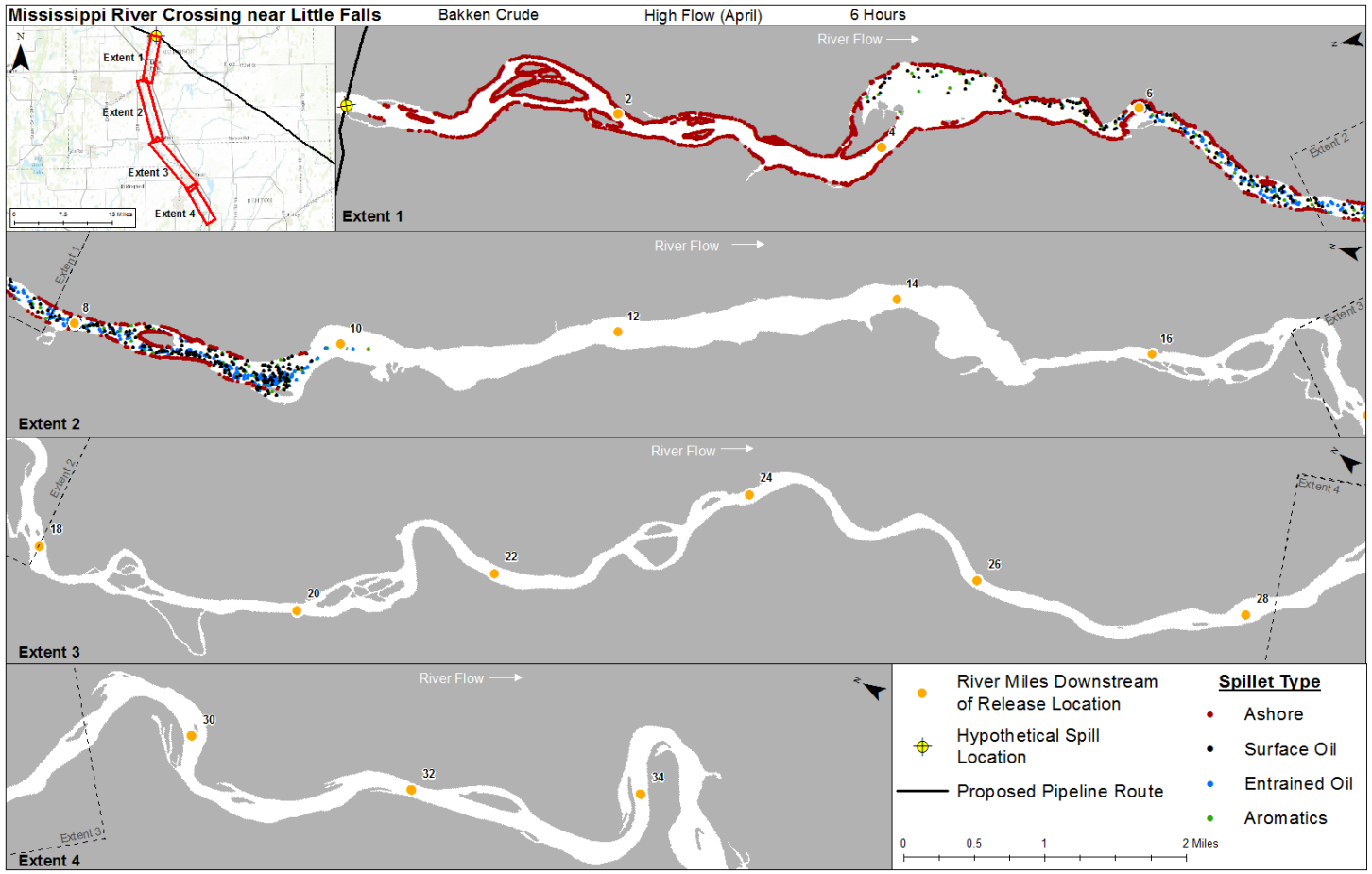

Figure 6-82 Oil Trajectory at 6 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

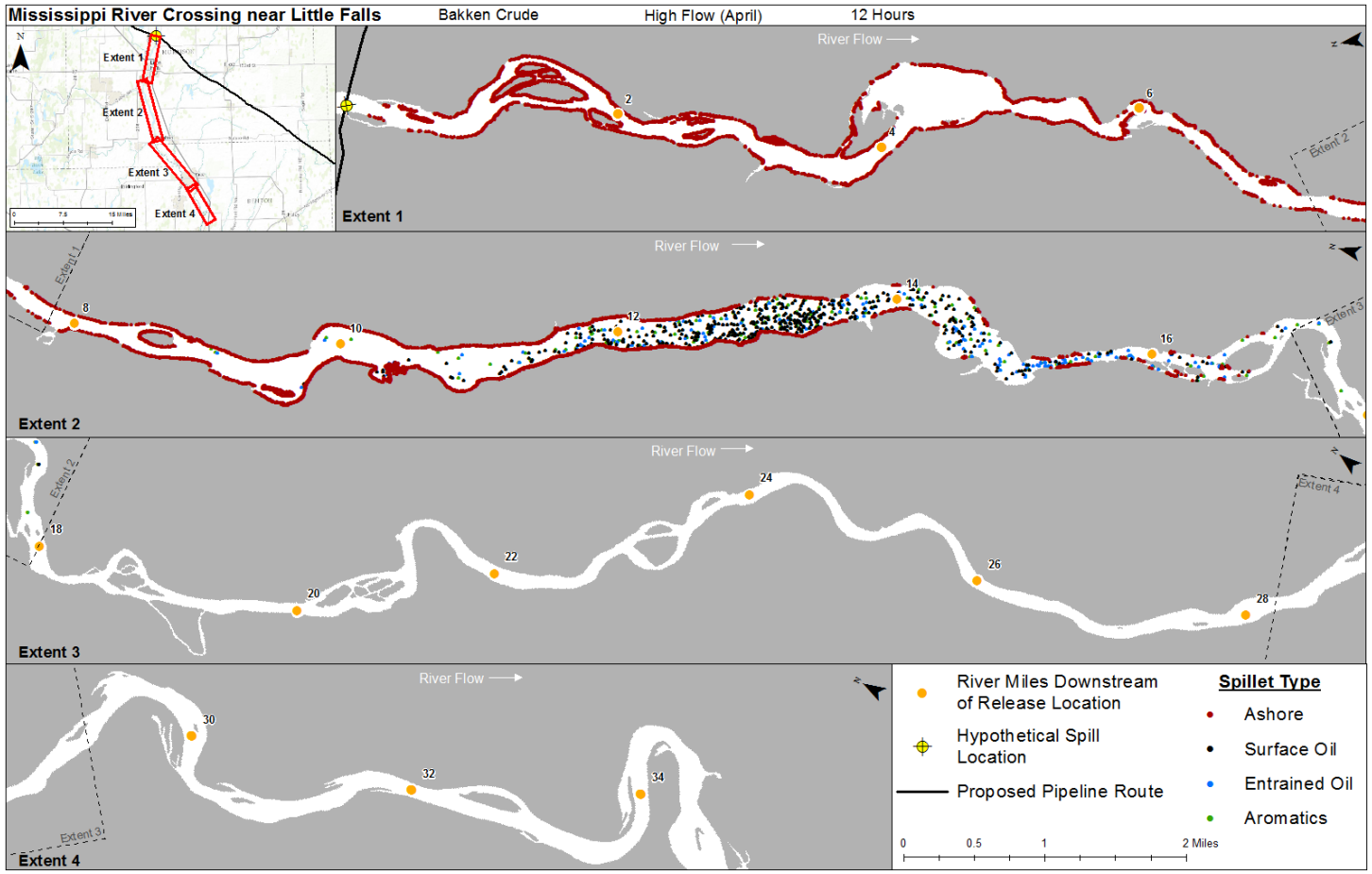

Figure 6-83 Oil Trajectory at 12 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

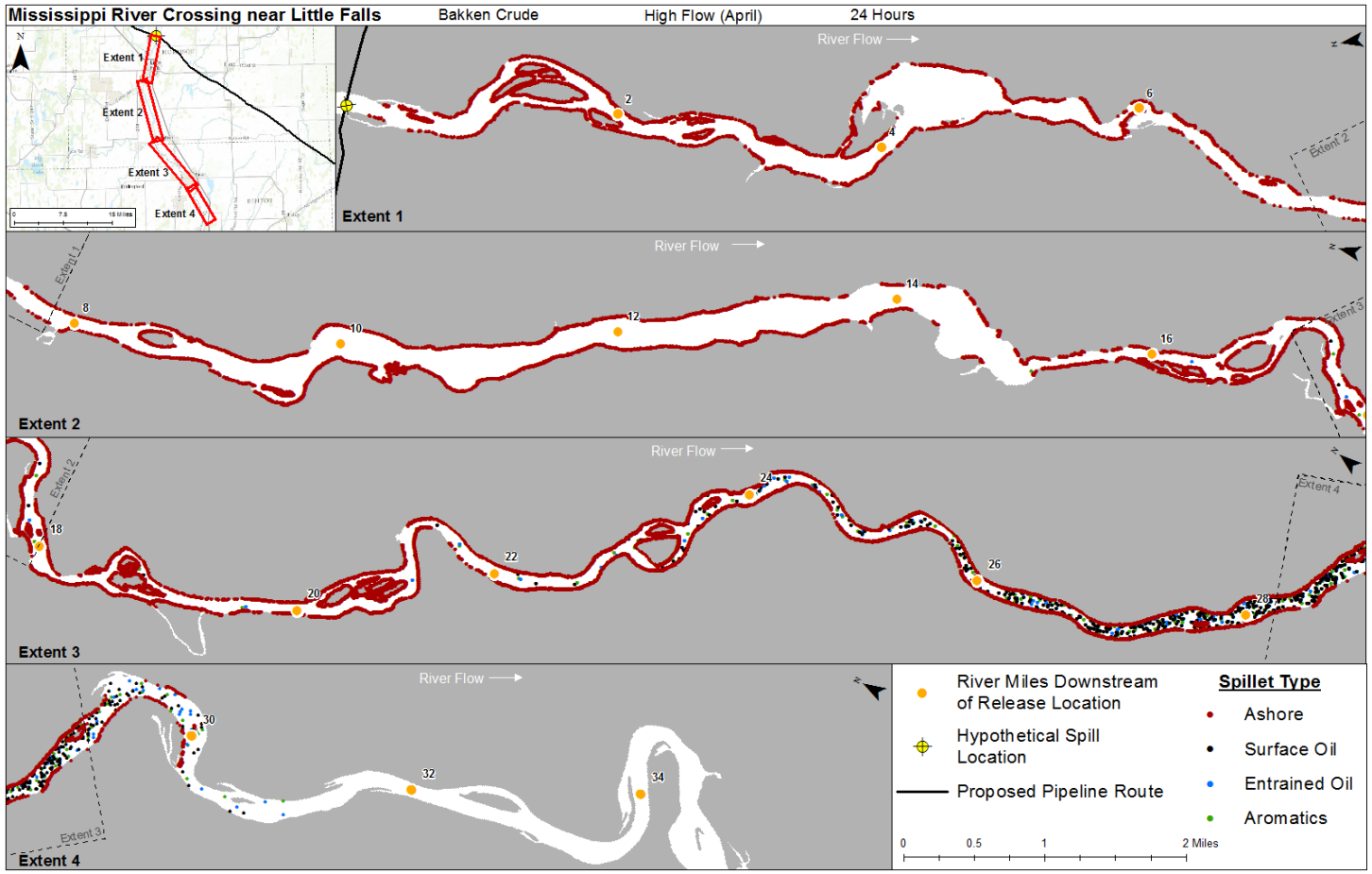

Figure 6-84 Oil Trajectory at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

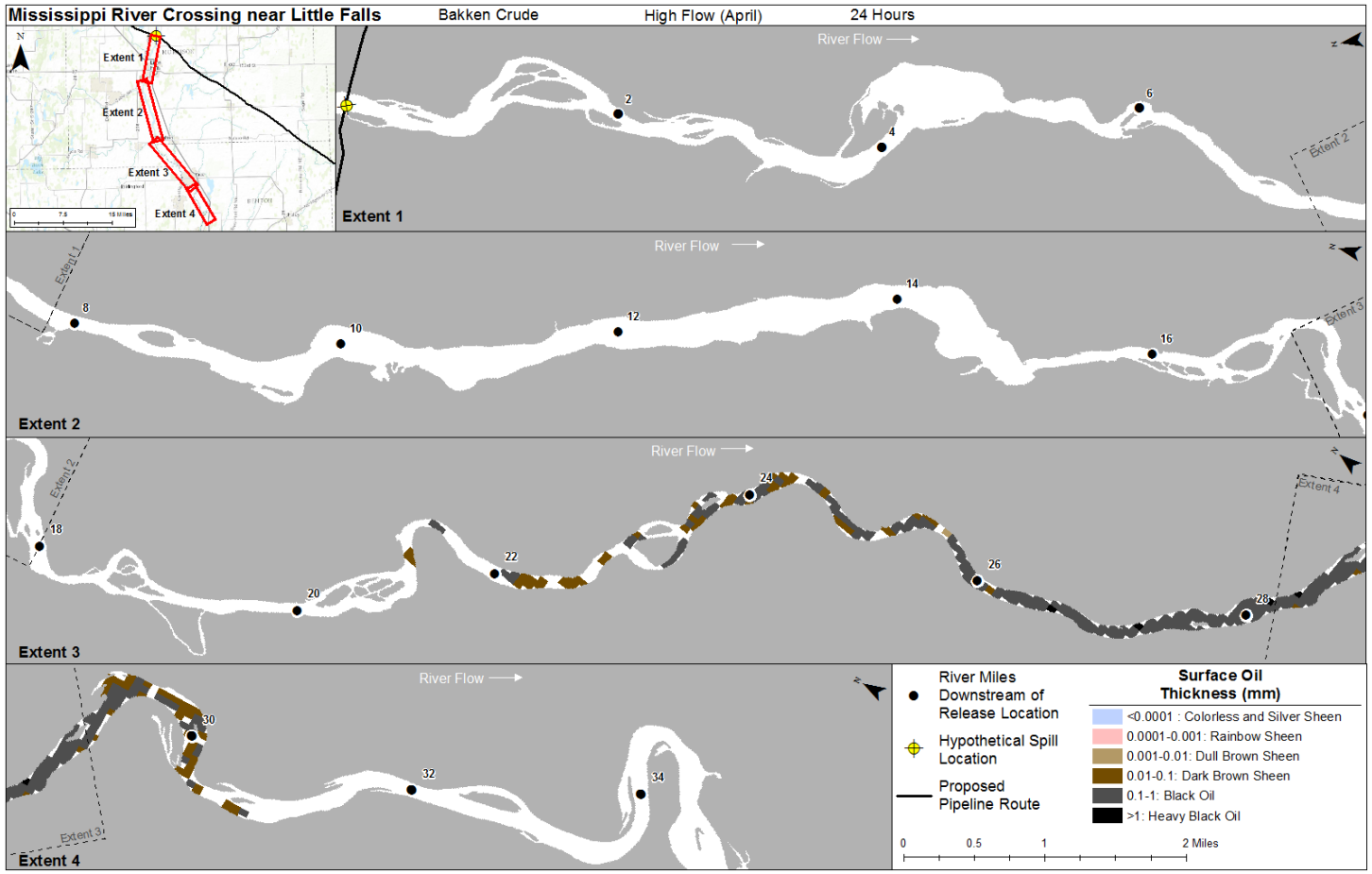

Figure 6-85 Maximum Floating Surface Oil at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location during the High Flow (Spring) Season

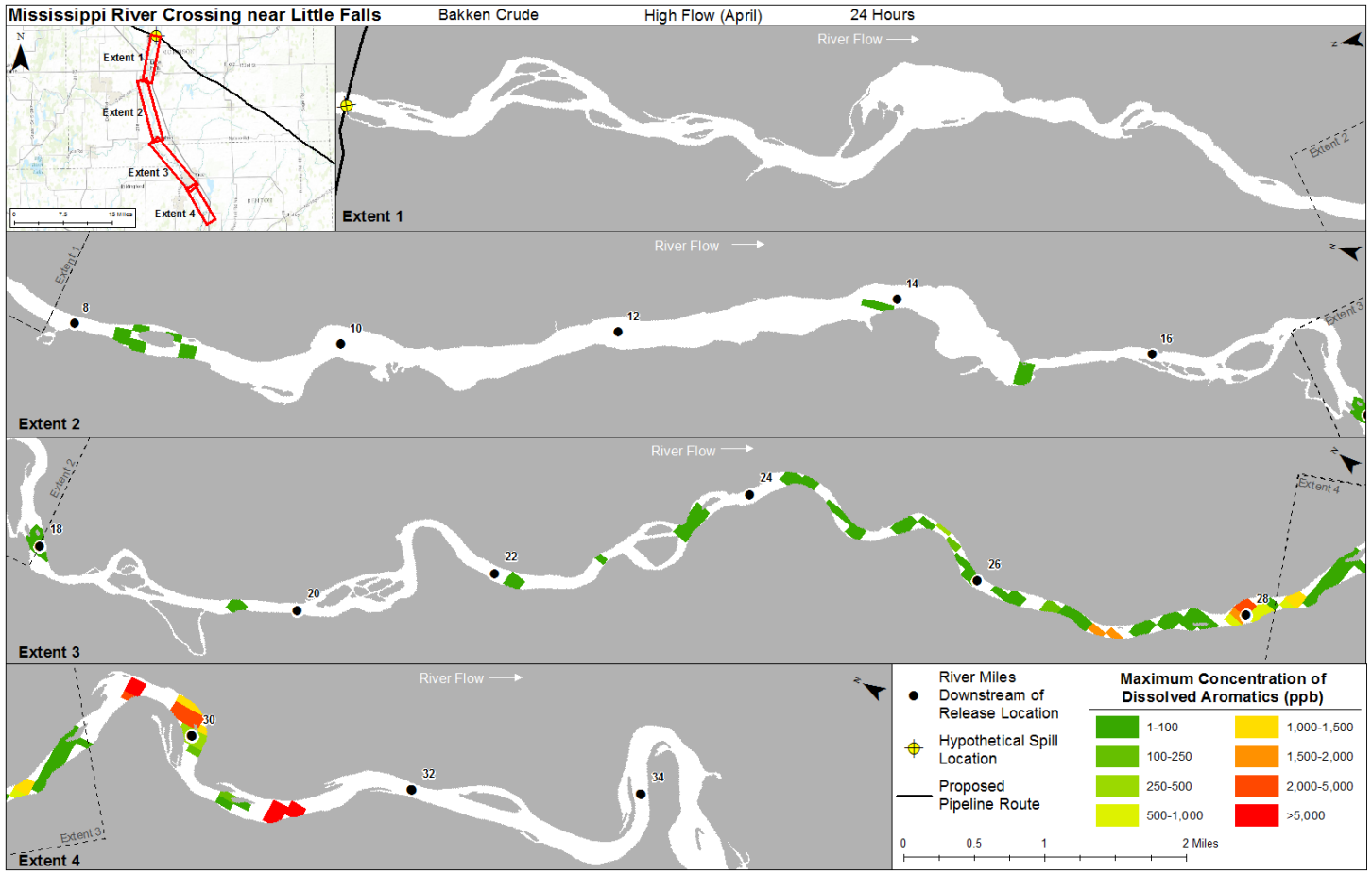

Figure 6-86 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

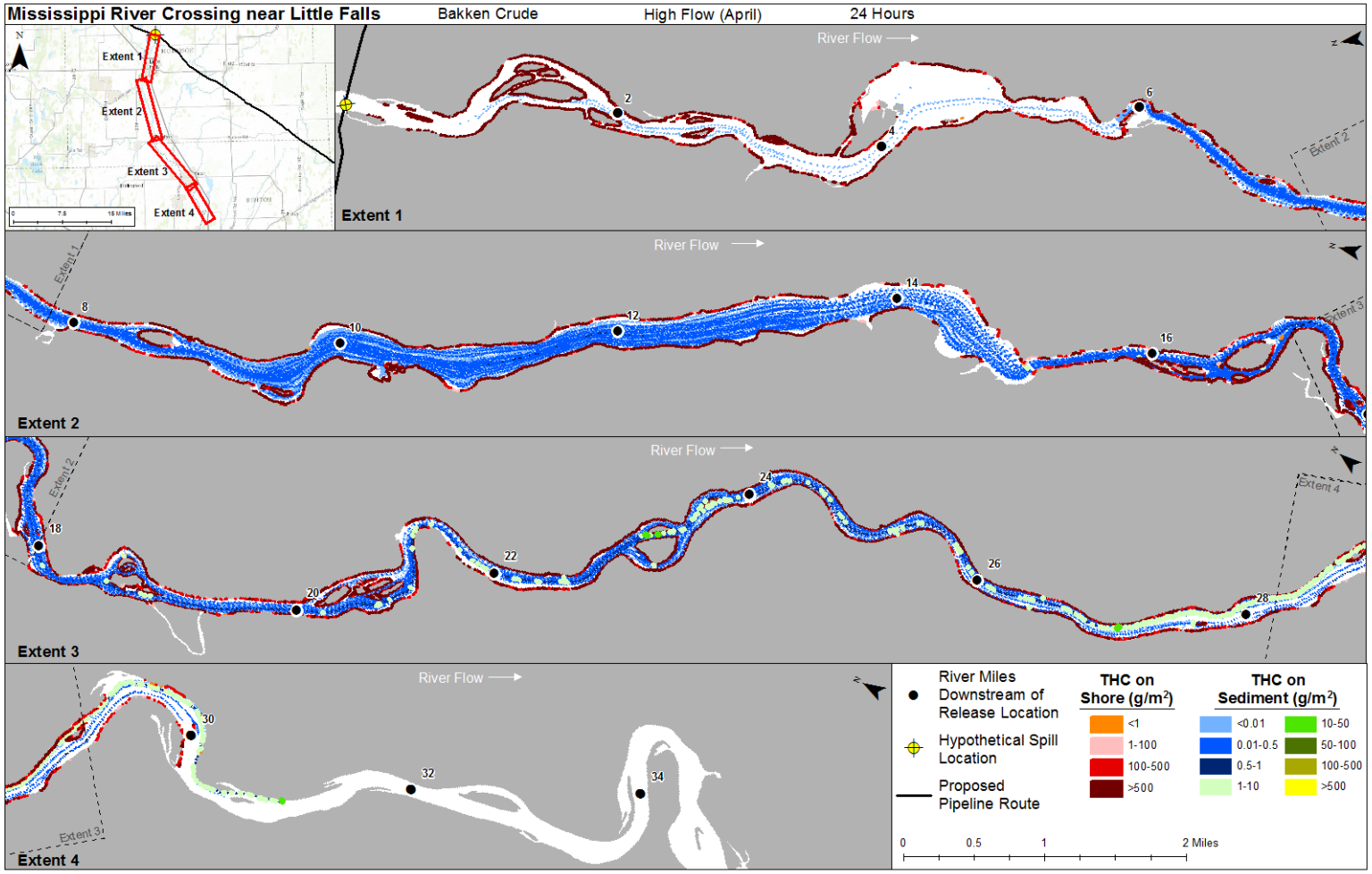

Figure 6-87 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the High Flow (Spring) Season

6.2.2.2.2 Trajectory and Fate Results for Average Flow (Summer-Fall)

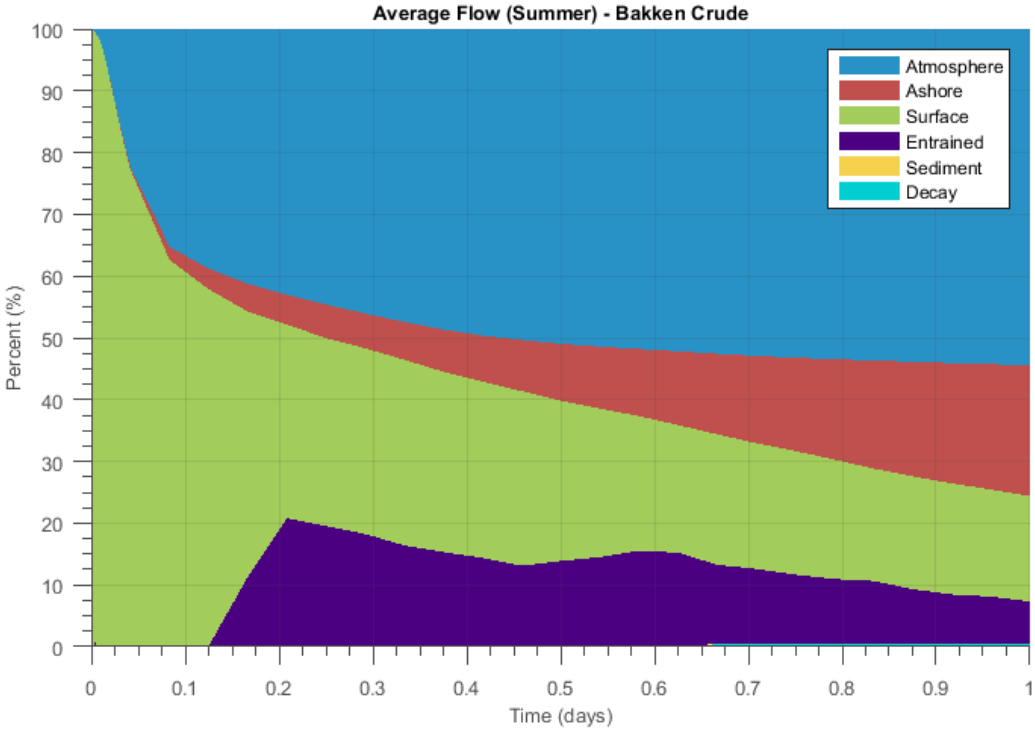

Figure 6-88 Oil Mass Balance Graph for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

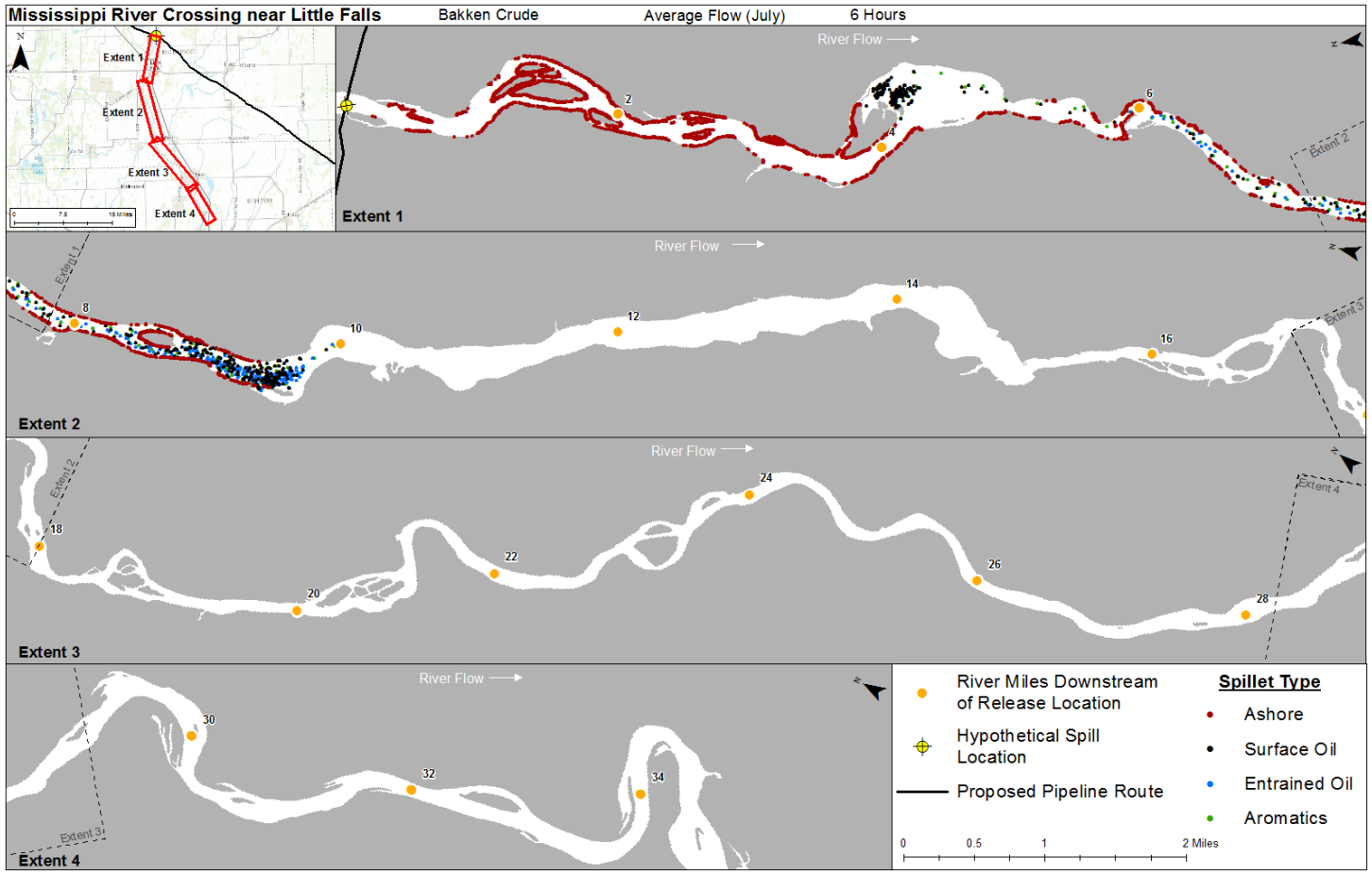

Figure 6-89 Oil Trajectory at 6 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

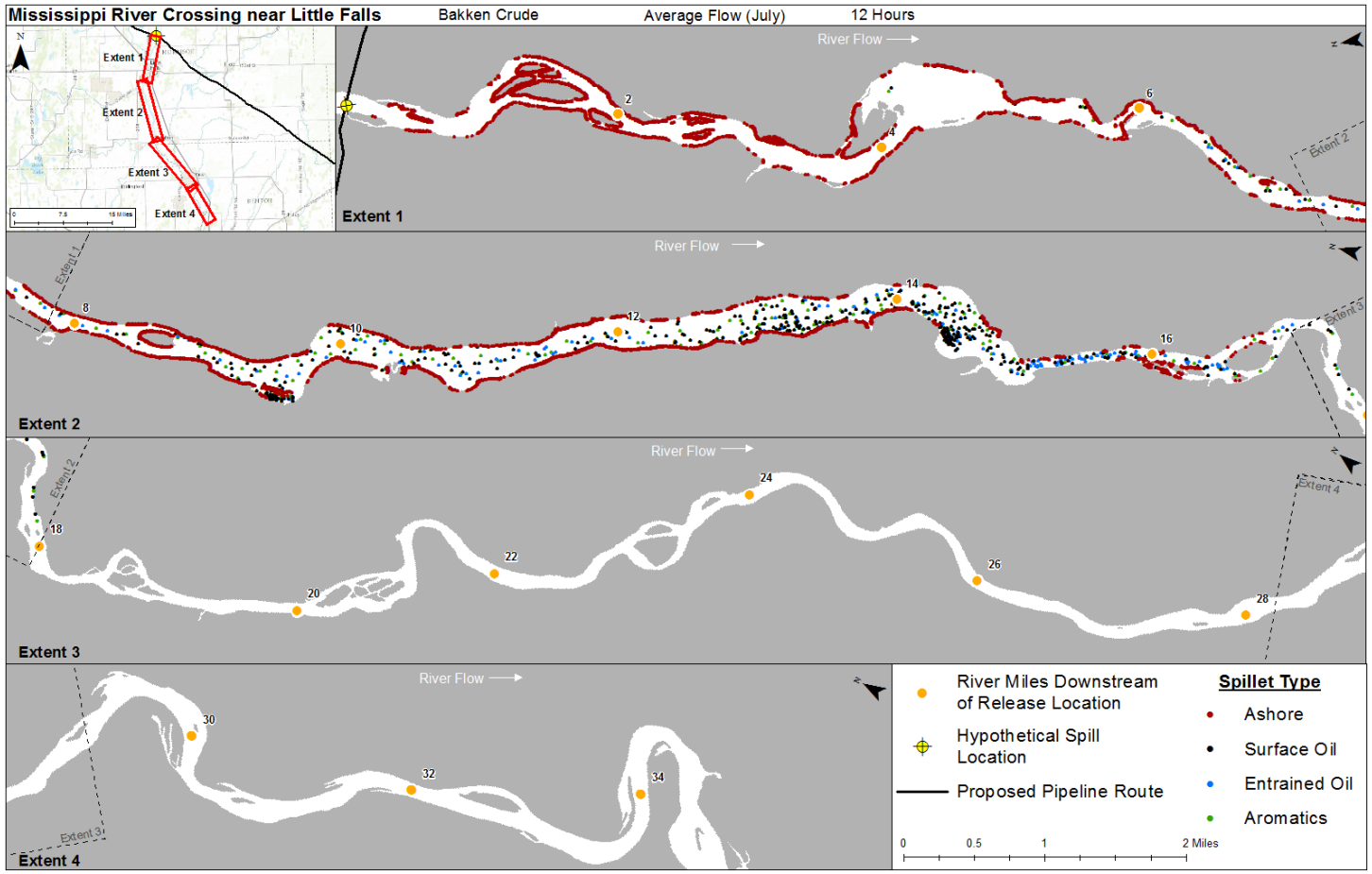

Figure 6-90 Oil Trajectory at 12 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

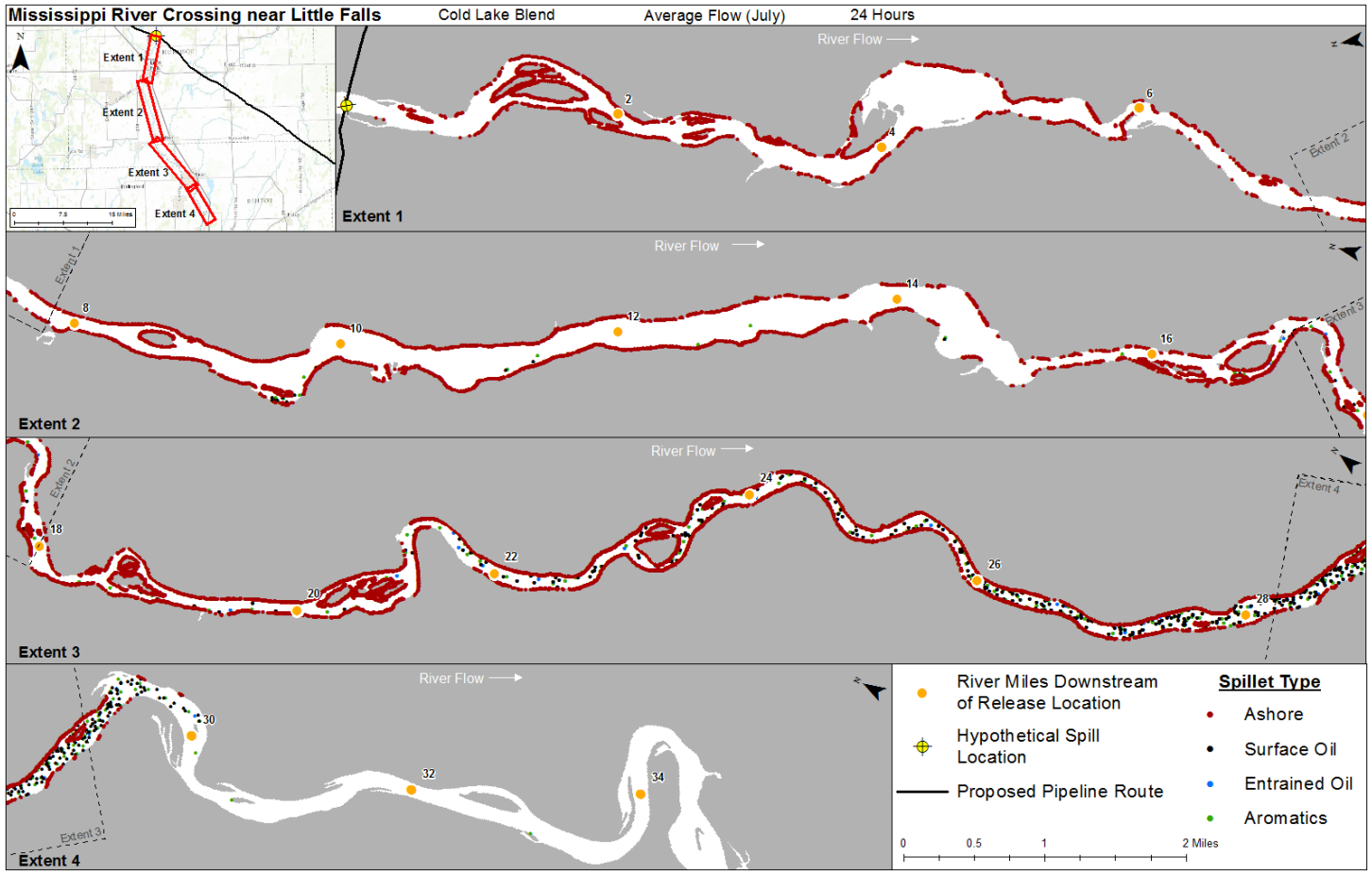

Figure 6-91 Oil trajectory at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

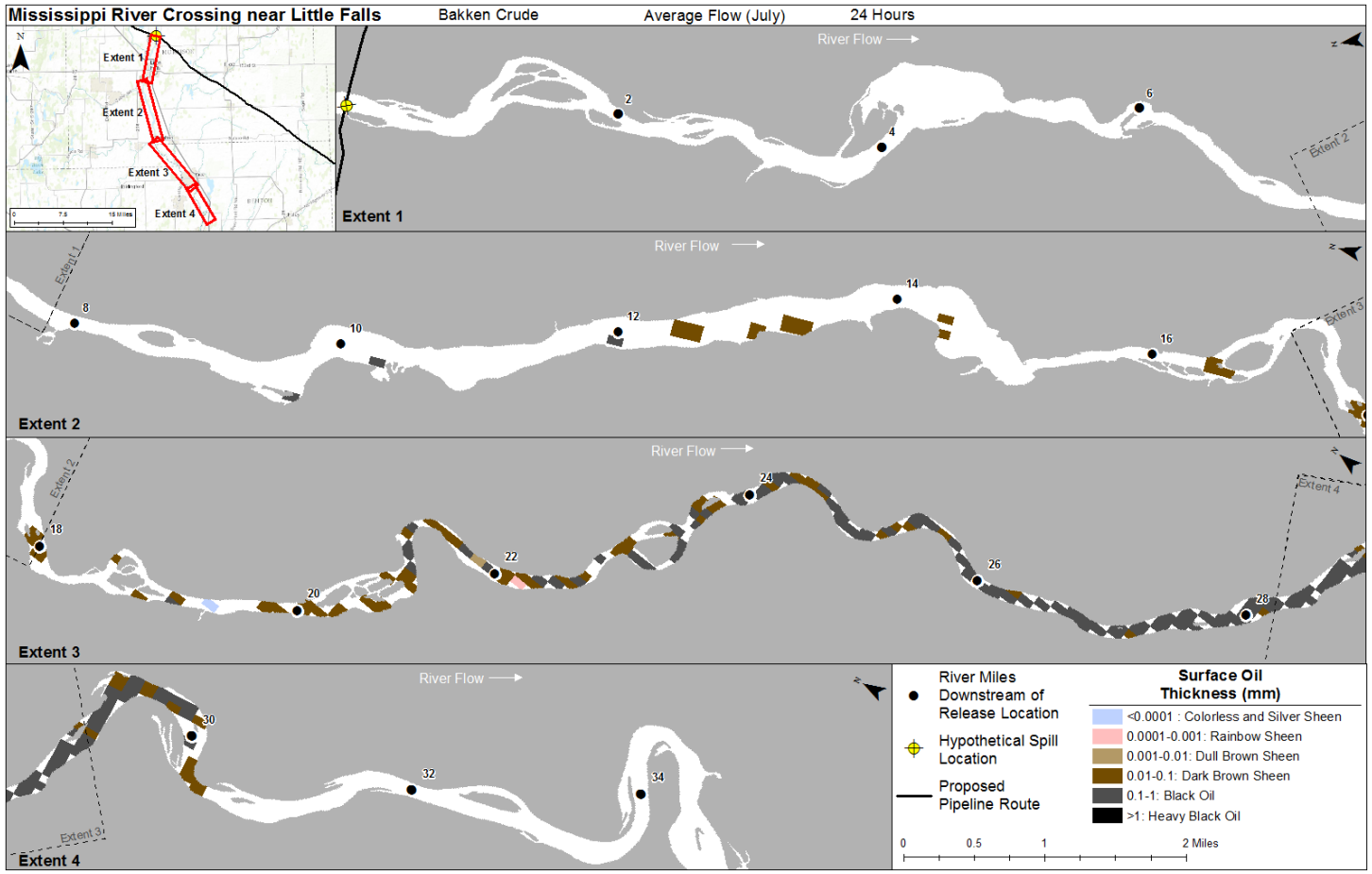

Figure 6-92 Maximum Floating Surface Oil at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season



Figure 6-93 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

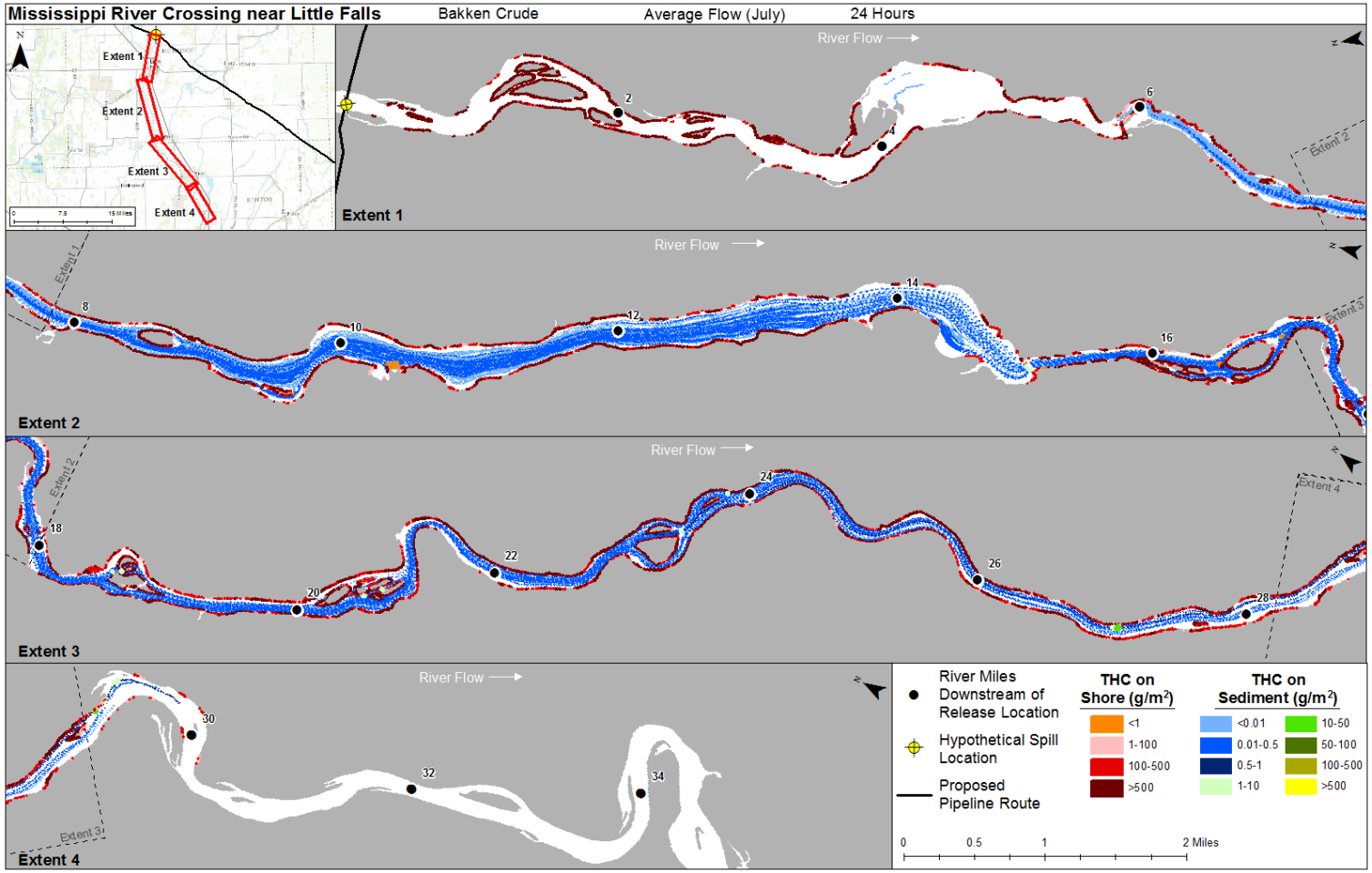

Figure 6-94 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Average Flow (Summer-Fall) Season

6.2.2.2.3 Trajectory and Fate Results for Low Flow (Winter)

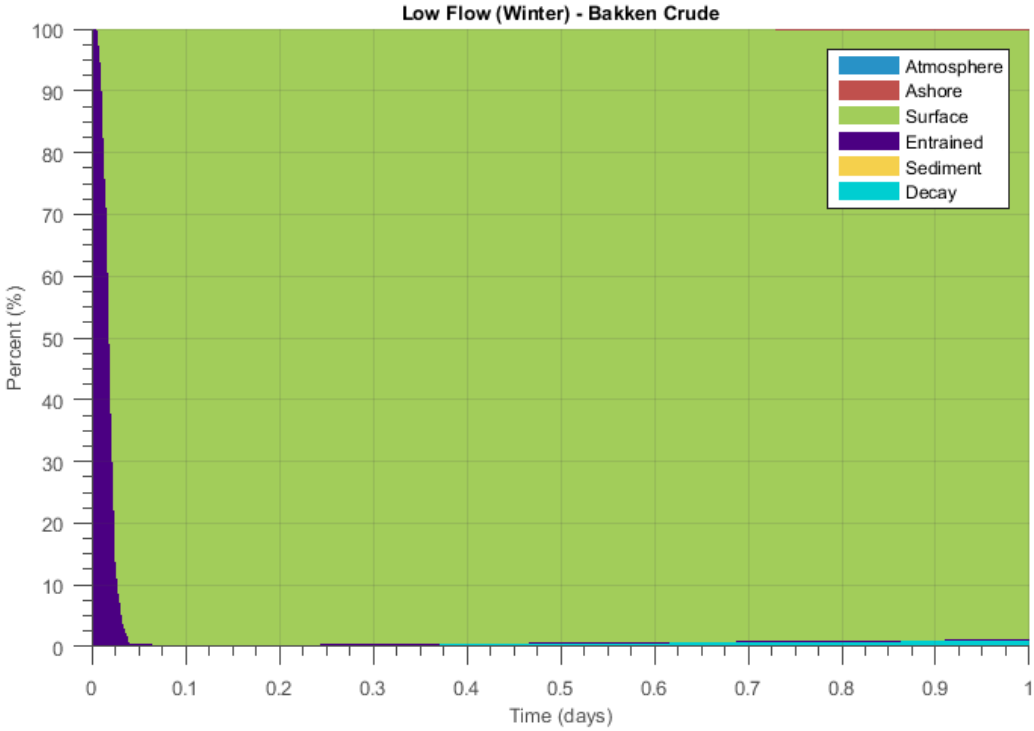

Figure 6-95 Oil Mass Balance Graph for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

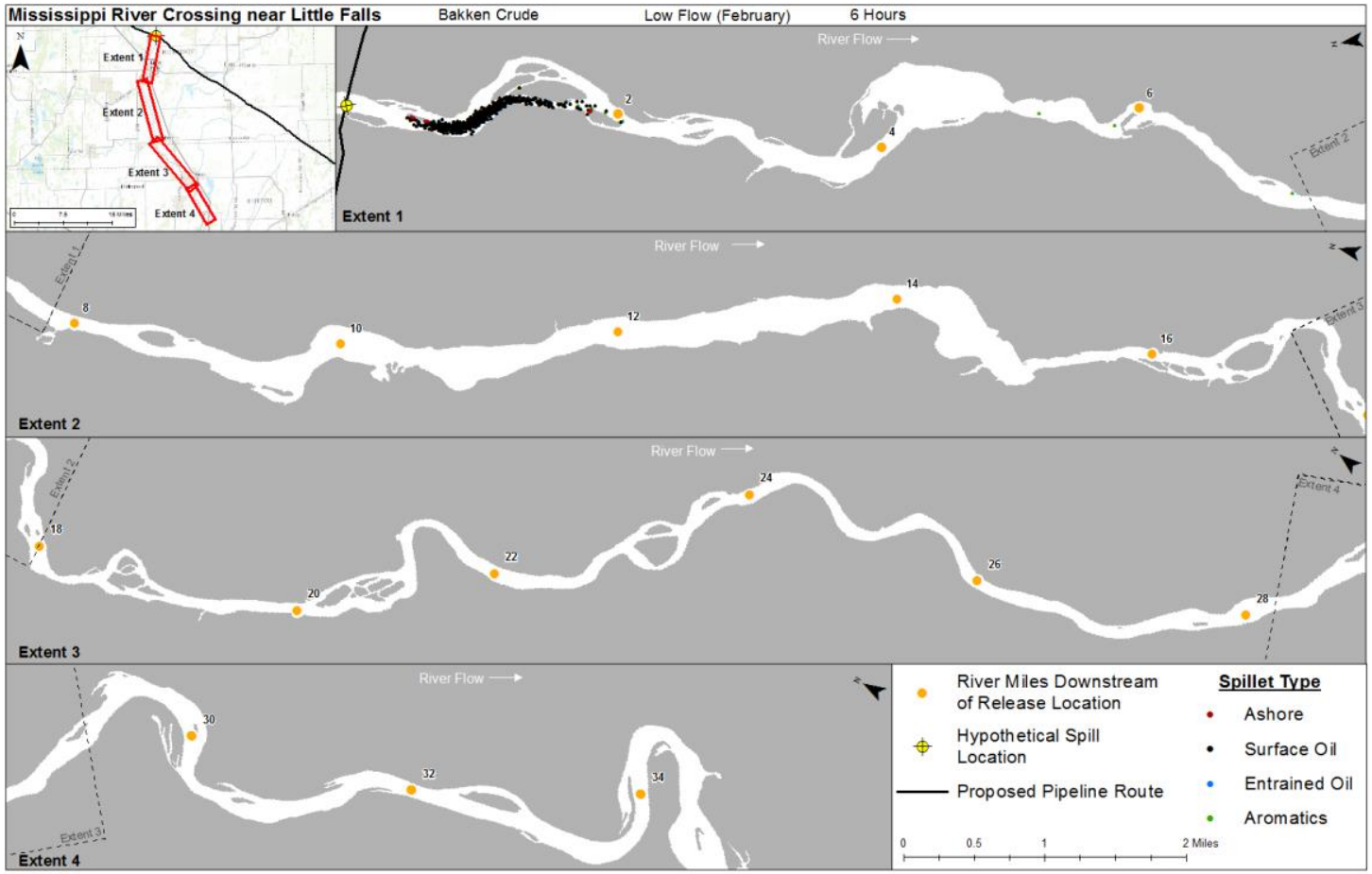

Figure 6-96 Oil Trajectory at 6 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

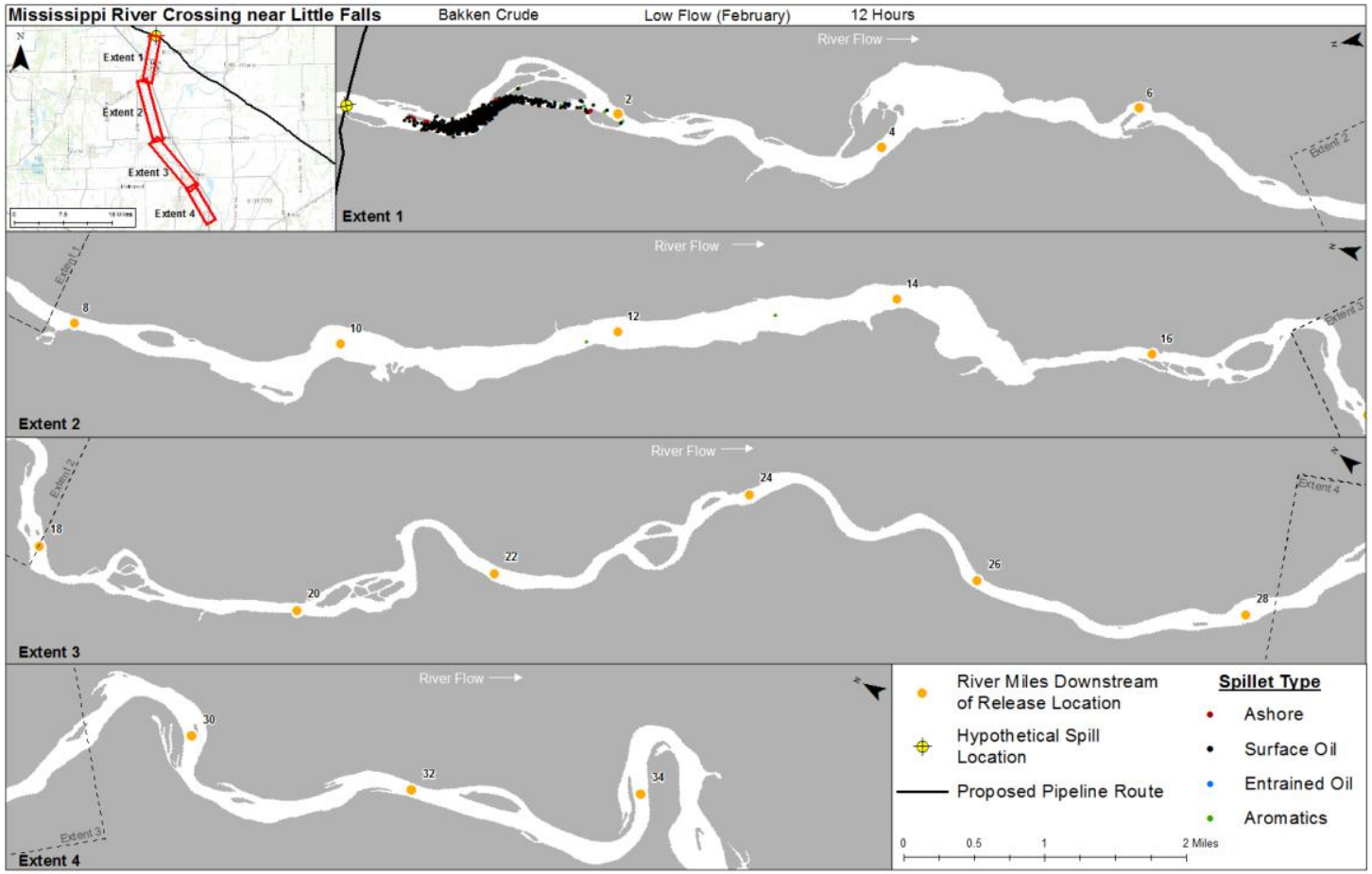

Figure 6-97 Oil Trajectory at 12 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

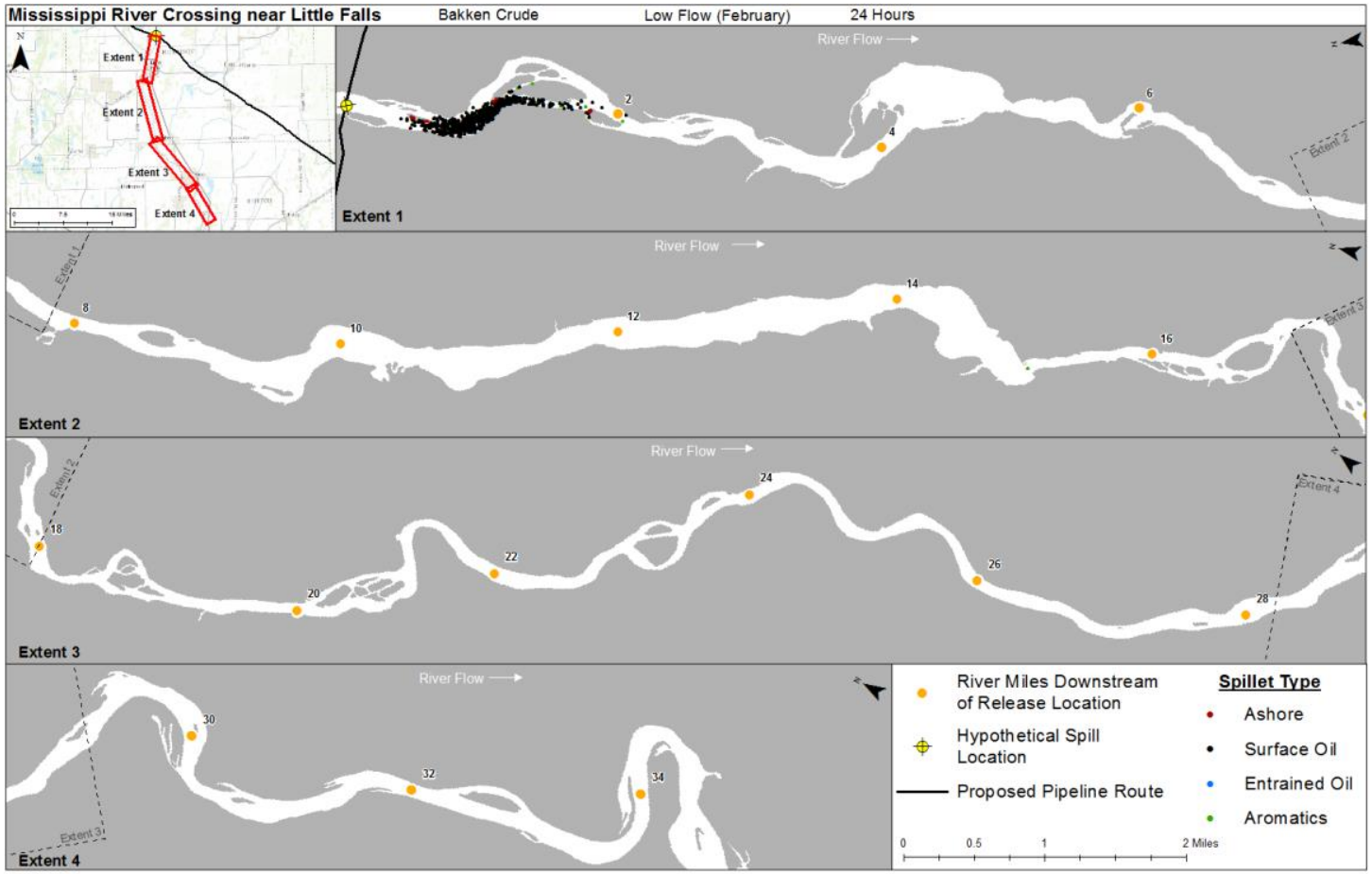

Figure 6-98 Oil Trajectory at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

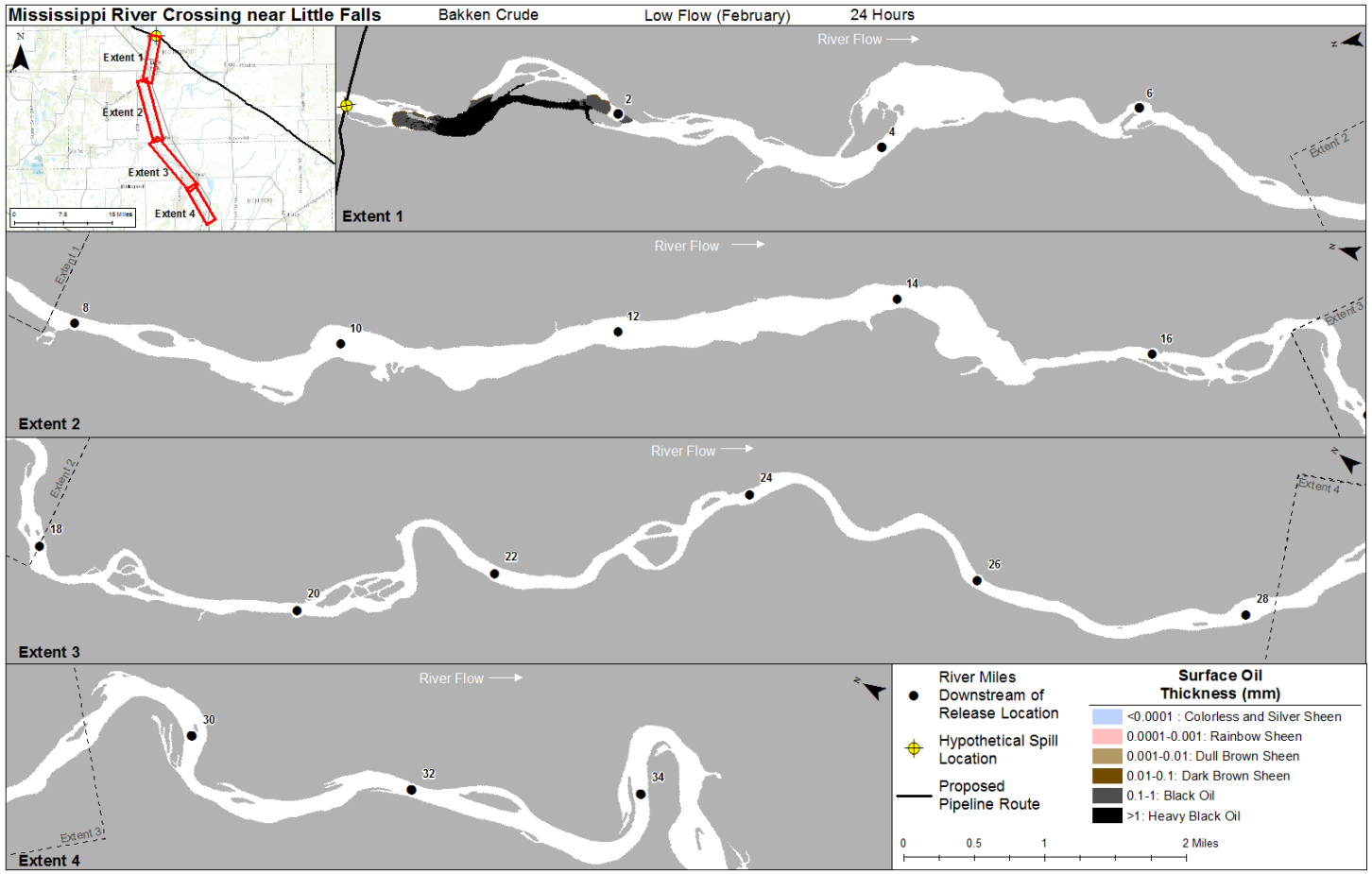

Figure 6-99 Maximum Floating Surface Oil at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

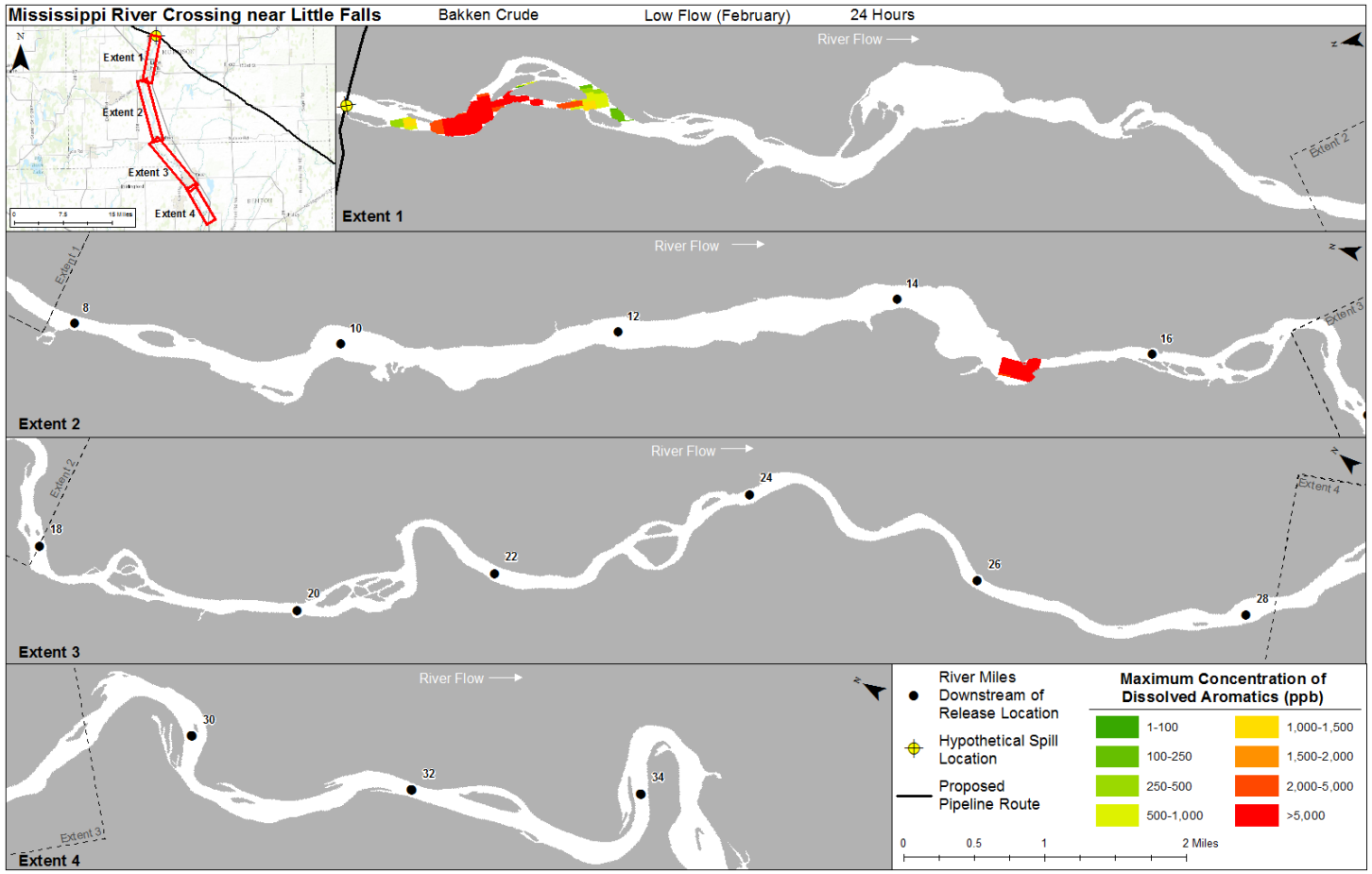

Figure 6-100 Maximum Total Dissolved Aromatic Concentration at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

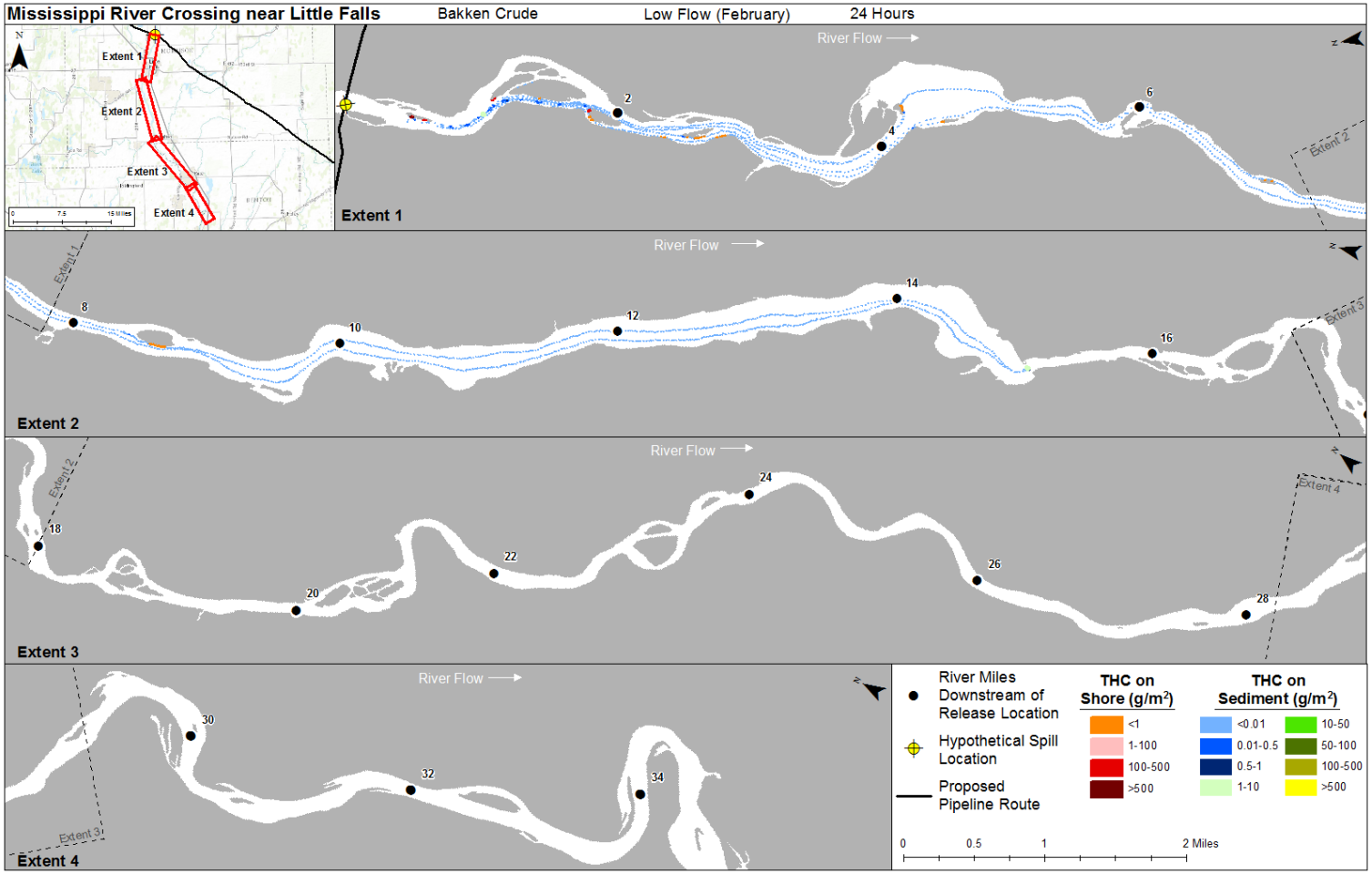

Figure 6-101 Maximum Total Hydrocarbon Mass on the Shore and on Sediments at 24 Hours for the Release of Bakken Crude at the Mississippi River at Little Falls Release Location During the Low Flow (Winter) Season

6.2.3 Summary of SIMAP Trajectory and Fate Results

In general, higher river flow resulted in further potential to oil regions downstream from the release location (Table 6-6). Modeled releases in the quiescent waters of the Mississippi River at Palisade resulted in large surface oil slicks, which resulted in large evaporative losses. Approximately 20% of the CLB and approximately 50% of the Bakken evaporated under high and average river flow conditions. Extensive shoreline oiling was also observed, with thicker shoreline oiling greater than 500 g/m^2 in CLSB scenarios, and 100–500 g/m^2 in Bakken release scenarios. Dissolved aromatic concentrations did exceed 5,000 ppb in both scenarios, due to dissolution of oil into the waters immediately below the surface slick. In general, dissolved aromatic concentrations were relatively patchy and generally lower than 100 ppb for both oil types. A small amount of sediment oiling (generally less than 0.01 g/m^2) was possible for releases at Palisade, with the highest potential under high flow conditions with larger concentrations of SPM within the water column. CLB had a higher potential to make its way to sediments, when compared to Bakken.

Table 6-6 Downstream Distance (miles) Maximum Oil Flow at the End of the Simulations

Location	Oil Type	Season / River Flow		
		Low	Average	High
Mosquito Creek	Bakken Crude	0.8	9.7	10.5
	Cold Lake Blend	0.8	3.5	3.5
Mississippi River at Ball Club (assumed grass shore type)	Bakken Crude	6.5 (6.5)	5.7 (15.9)	6.4 (23.0)
	Cold Lake Blend	1.3 (6.5)	1.3 (8.0)	1.3 (8.1)
Sandy River	Bakken Crude	6.0	9.1	12.2
	Cold Lake Blend	6.0	7.8	8.1
Shell River to Twin Lakes	Bakken Crude	1.5	13.9	21.9
	Cold Lake Blend	0.8	3.7	3.7
Red River	Bakken Crude	16.0	22.8	40.3
	Cold Lake Blend	16.0	19.2	10.5
Mississippi River at Palisade	Bakken Crude	0.6	14.3	17.8
	Cold Lake Blend	2.4	14.0	17.9
Mississippi River at Little Falls	Bakken Crude	2.1	31.2	31.0
	Cold Lake Blend	5.6	29.9	32.3

Modeled releases in the more turbulent waters of the Mississippi River at Little Falls still had large surface oil slicks, which resulted in large evaporative losses. Similar to the Palisades scenarios, under high and average river flow rates, approximately 20% of the CLB and approximately 50% of the Bakken evaporated. Extensive shoreline oiling was also observed, with thicker shoreline oiling greater than 500 g/m^2 in CLSB scenarios, and 100–500 g/m^2 in Bakken release scenarios. Dissolved aromatic concentrations did exceed 5,000 ppb in both scenarios, due to dissolution of oil into the waters immediately below the surface slick. In general, dissolved aromatic concentrations were relatively patchy and generally lower than 100 ppb for both oil types. The presence of the Little Falls Dam and Blanchard Dam resulted in large amounts of oil being entrained into the water column at the waterfalls and sections of rapids. Hydrocarbon concentrations within the water column were typically much higher after the dams, with greater than 25 ppm for THC and 250-500 ppb for dissolved aromatics. In the quiescent waters downstream, the oil resurfaced and once again formed surface slicks.

Due to the large amount of vertical mixing and the presence of suspended sediments, particularly under high flow conditions, there was a substantially higher potential for more extensive sediment oiling at Little Falls. Higher THC concentrations on sediments were predicted for CLB and mass balance results indicate that a larger portion of the total amount released was predicted to settle on the bottom after 24 hours, when compared to the Bakken scenarios. Maximum concentrations of 50 g/m^2 were predicted for Bakken, while some areas exceeded 500 g/m^2 for CLB.

For both oil types, the localized and patchy nature of sediment oiling is difficult to predict. Results are therefore helpful in indicating the potential presence of the amount of oil, rather than the exact location where it may be found, which is dynamic in time. Due to the lower viscosity of Bakken, the entrainment of oil, and ultimate oil-SPM interactions, lower level contamination (i.e., lower THC concentrations) of sediments was predicted to take place over a much larger area, when compared to the CLB. On the other hand, larger amounts of CLB were predicted to settle on the bottom, but over a much smaller areal extent, with localized patches. In all cases, it is important to note that less than 1% of the total amount of released oil (for both CLB and Bakken) was predicted to settle. In each case, the majority of the oil was predicted to oil shorelines and evaporate to the atmosphere.

Under low flow river conditions, with 100% ice coverage, the oil was predicted to rise within the first few miles downstream of the release location. The distance downstream that the oil was transported was mainly controlled by the river velocity and the density of the oils, which controlled its rise rate before reaching the ice at the surface. In general, CLB was predicted to oil slightly more areas of ice, while the Bakken was predicted to be more contained. A large portion of the soluble portion of both oils dissolved into the water column where it was transported downstream. Much larger portions of river were predicted to experience dissolved aromatic concentrations in excess of 5,000 ppb during low flow conditions with complete ice cover, when compared to average or low flow scenarios. Very limited shoreline and sediment oiling occurred in the winter scenarios, when compared to the ice free scenarios.

7.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS OF OIL RELEASES

The assessment of environmental effects of crude oil releases begins with a description of the observed and expected effects of oil on key ecological and human receptors, including how oil behaves (i.e., its fate) in terrestrial, atmospheric and freshwater environments, and how it affects associated biological resources (Section 7.1). Information in this section is informed by a number of case studies with circumstances similar to those that might be encountered in the event of an oil release from a pipeline in Minnesota. This is followed (Section 7.2) by an assessment for each of the seven modeled sites in Minnesota that were determined to be representative of most of the predominant ecological units, major hydrological features, watercourse widths, and watercourse features along the preferred and alternative routes:

- Site 1—Mosquito Creek to Lower Rice Lake (Section 7.2)
- Site 2—Mississippi River at Ball Club (Section 7.3)
- Site 3—Sandy River (Section 7.4)
- Site 4—Shell River to Twin Lakes (Section 7.5)
- Site 5—Red River (Section 7.6)
- Site 6—Mississippi River at Palisade (Section 7.7)
- Site 7—Mississippi River at Little Falls (Section 7.8)

The location of these seven sites and the spatial extent of the assessment of environmental effects are illustrated on Figure 7-1.

The assessment of each site includes a description of the environmental setting at and downstream of the hypothetical release location, and a detailed discussion of the expected environmental effects of an oil release (based on two crude oil types that provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB)) on the physical, biological and human environments; namely:

- Terrestrial receptors (i.e., soil, groundwater, terrestrial, vegetation)
- Aquatic receptors (i.e., rivers, lakes, sediment, shorelines and riparian areas, wetlands, aquatic plants, benthic invertebrates, fish)
- Semi-aquatic wildlife receptors (i.e., amphibians and reptiles, birds, semi-aquatic mammals)
- Human and socio-economic receptors (i.e., air quality, human receptors, public use of natural resources)

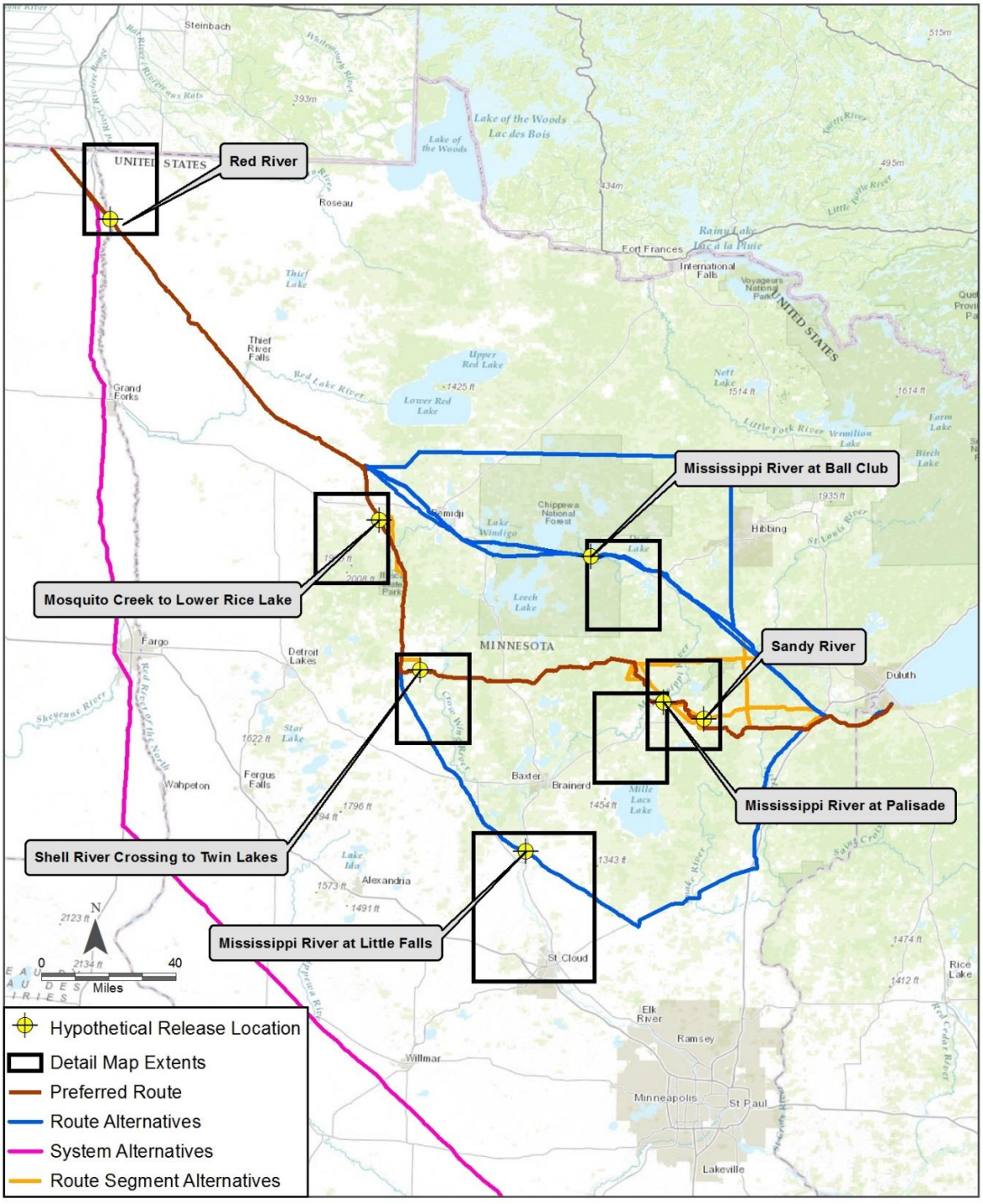

Figure 7-1 Locations of Hypothetical Release Sites and Spatial Extent of the Assessment of Environmental Effects

In addition, the potential overlap of oil releases with federally-designated (i.e., U.S. Department of Transportation [USDOT] PHMSA) HCAs and other sensitive locations not included in the USDOT PHMSA data (defined as AOIs) is included. HCAs include populated areas, unusually sensitive ecological areas, drinking water sources and commercially navigable waterways. Populated areas are broken down as high population areas (i.e., urban areas), and "other populated areas," which consist of smaller towns and villages. Ecologically-sensitive areas include imperiled species and ecological communities, threatened and endangered species, depleted marine mammals, and migratory water bird concentrations (USDOT PHMSA 2016a). The drinking water data consist of public water systems, source water protection areas, and sole source aquifers (USDOT PHMSA 2016b). Sources of these data for the environmental effects assessment are shown in Table 7-1.

Table 7-1 Sources of HCA Data

HCA Type	HCA Subtype	Source
Population Area	Other	USDOT PHMSA, 2011; 2016a; 2016b
	Other	Provided by Enbridge in 2014
	High Population	USDOT PHMSA, 2011; 2016a; 2016b
Environmentally Sensitive Area	N/A	USDOT PHMSA, 2011; 2016a; 2016b
		Provided by Enbridge in 2014
Drinking Water	N/A	USDOT PHMSA, 2011; 2016a; 2016b
		Provided by Enbridge in 2014
Commercially Navigable Waterways	N/A	USDOT PHMSA, 2011; 2016a; 2016b
		Provided by Enbridge in 2014

AOIs depict other sensitive locations where a release could have a detrimental impact. These areas include local Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks). Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website (MN Geospatial Commons 2016), USGS Protected Areas Database of the United States (PAD-US; USGS 2015), and the Minnesota Department of Transpiration (MN DOT 2016; see

Table 7-2 Sources of AOI Data

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Table 7-2 Sources of AOI Data

AOI Type	AOI Subtype	Source
Drinking Water	Surface Water Supply Management Area	MN Geospatial Commons 2016
	Water Supply Management Area	
	Wellhead Protection Areas	
Environmental	Central Region Green Infrastructure	MN Geospatial Commons 2016
	Central Region Regionally Ecological Significant Areas	
	Designated Wildlife Lakes	
	Designated Trout Stream	
	Lakes of Phosphorus Sensitivity Significance	
	Lakes with Fish-based IBI Score	
	Muskie Lakes	
	Migratory Waterfowl Feeding and Resting Areas	
	Native Plant Community	
	Native Plant Community (candidate)	
	Native Prairies	
	Potentially Undisturbed Land (Virgin Sod)	
	Regionally Significant Ecological Areas and Regional Ecological Corridors	
	Sensitive Lake Shore	
	Site of Biodiversity Significance	
	Stream Trout Lakes	
	Trout Lake Designation	
	Trout Stream Special Regulations	
	Wetland Banking Program Easements	
	Wild Rice Lake	
Protected Area	Bureau of Land Management	MN Geospatial Commons 2016; USGS 2015b
	Farm Service Agency Interest of Minnesota	
	Lake of Biological Significance	
	Military Land	
	National Forest	
	Private Conservation Land	
	Scientific and Natural Area Units	
	State Aquatic Management Area (AMA) Acquisitions	
	State Forest	
	State Park	

Table 7-2 Sources of AOI Data

AOI Type	AOI Subtype	Source
	State Wildlife Management Area	
	The Nature Conservancy	
	Wildlife Management Area	
	US NRCS Easement	
	Calcareous Fens	
Recreational	State Recreation Area	MN Geospatial Commons 2016
Tribal Lands	Tribal Lands	MN DOT 2016

An overall summary of the assessment of environmental effects of hypothetical crude oil releases at the seven representative locations is provided in Section 7.9.

7.1 REVIEW OF OBSERVED AND EXPECTED EFFECTS OF OIL RELEASES ON KEY ECOLOGICAL AND HUMAN RECEPTORS

7.1.1 Fate of Oils Released to Freshwater Environments

Crude oils and refined petroleum products are complex mixtures of hydrocarbon compounds derived from naturally occurring geological formations. When released into the environment, various weathering processes work to break down the hydrocarbons into primarily carbon dioxide and water. The rate of these weathering processes depends principally upon the type of oil (i.e., the specific mixture of hydrocarbon compounds present), the characteristics of the receiving environment (e.g., location of the release, season, and weather conditions), and the volume released, among other factors.

Individual crude oils and petroleum products are composed of differing mixtures of hydrocarbon compounds. Each has physical properties (e.g., viscosity, density, solubility) that reflect its chemical composition and affect its fate and transport once released into the environment (NRC 2003). For example, heavy oils (i.e., those with a higher percentage of heavy fractions, or high asphaltene and resin content) tend to be viscous and weather slowly because they do not readily spread into thin oil slicks, and they contain chemical constituents that resist degradation.

The high viscosity of heavy crude oil makes it difficult to pump and transport through a pipeline. Therefore, bitumen is often diluted with other petroleum products such as natural gas condensates. In addition to Bakken Crude, two of the products proposed for transport by the L3RP pipeline are CLB and CLWB. These two diluted bitumen (dilbit) petroleum products have been the subject of substantial review in the past several years.

Two recent high-profile studies of the behavior and fate of dilbits in the environment came to different key conclusions regarding their environmental fates.

The National Academies of Sciences, Engineering and Medicine (NAS 2015) formed a committee to study the relevant properties and characteristics of the transport, fate, and effects of diluted bitumen and commonly transported crude oils when released in the environment from U.S. transmission pipelines (NAS 2015). The committee concluded that:

> "In comparison to other commonly transported crude oils, many of the chemical and physical properties of diluted bitumen, especially those relevant to environmental impacts, are found to differ substantially from those of the other crude oils. The key differences are in the exceptionally high density, viscosity, and adhesion properties of the bitumen component of the diluted bitumen that dictate environmental behavior as the crude oil is subjected to weathering …" (NAS 2015).

The Royal Society of Canada likewise convened an expert panel to review the behavior and environmental effects of crude oil released into aqueous environments. The expert panel concluded that:

> "the dozens of crude oil types transported in Canada exist along a chemical continuum, from light oils to bitumen and heavy fuels, and the unique properties of each of these oil types (their chemical 'fingerprints') determine how readily released oil spreads, sinks, disperses, impacts aquatic organisms, including wildlife, and what proportion ultimately degrades in the environment. Despite the importance of oil type, the Panel concluded that the overall impact of an oil release, including the effectiveness of an oil release response, depends mainly on the environment and conditions (weather, waves, etc.) where the release takes place and the time lost before remedial operations." (Lee et al. 2015).

In this section the characteristics of light, medium, and heavy crude oils proposed for transport by the proposed L3RP pipeline are described. In addition, information is provided on how environmental factors such as season, water levels and physical processes may affect the behavior and fate of different crude oil/petroleum products if released into environments encountered by the proposed pipeline. A key objective of this section is to discuss information that will help reconcile the seemingly divergent conclusions of the two expert panels with regards to transport of dilbit products.

7.1.1.1 Oil Characteristics

CLB and CLWB crude oils are diluted bitumens with characteristic properties of density and viscosity falling in the upper range of values allowed by pipeline tariff specifications. General characteristics of CLB include an American Petroleum Institute gravity (API, a measure of how

heavy or light a petroleum liquid is compared to water) of 20.7°, a density of 0.93 at 15°C, and a sulfur content ranging between 3.6% and 4.7% (Environment Canada 2016). Similarly, CLWB has typical characteristics that include API gravity of 22.7° and density at 15°C of 0.92 (Horn 2016). Seasonal variation in environmental temperature affects the viscosity of diluted bitumen; therefore, the amount of condensate or other diluent added is adjusted through the year to meet shipping requirements. The bitumen feedstock used in CLB and CLWB remains consistent on a seasonal basis, but the CLWB contains relatively more diluent to maintain the desired viscosity characteristic during the winter months.

Bakken crude is a light sweet crude oil with an API gravity generally between 40° and 43° and a sulfur content less than 0.2 wt.%. A crude oil with less than 1 wt.% total sulfur content is referred to as being low-sulfur or sweet crude oil. A crude oil with more than 1 wt% total sulfur is referred to as being high-sulfur or sour crude oil. As such, Bakken crude oil is similar to many other light sweet crude oils produced and transported in the United States (Auers et al. 2014). The light end concentration of Bakken crude is between 3% and 9%, with 5% being the typical concentration (NDPC 2016). As a point of reference, the Energy Information Administration categorizes crude oil that has API gravity between 35° and 50° and less than 0.3 wt% sulfur as being light sweet. Bakken falls in the middle of those ranges for both properties (Auers et al. 2014).

BTEX compounds generally represent a small fraction in each of the oil products. Diluted bitumens appear to contain around 1% BTEX by weight (Zhou et al. 2015), varying principally in accordance with the properties and quantity of diluent added. Light crude oils tend to contain rather more BTEX (2 to 3% by weight, Zhou et al. 2015). Light crude oils and Bakken crude oil in particular would be expected to contain a larger fraction of both aliphatic and aromatic low boiling point hydrocarbons, and relatively less of the high boiling point and recalcitrant fractions such as resins and asphaltenes, than diluted bitumens.

The crude oil types discussed here (i.e., Bakken and diluted bitumen) represent products that exist on opposite ends of the spectrum of crude oil types commonly encountered in North America. This fact was recognized by Lee et al. (2015), but was obscured by the methodology employed by NAS (2015). The terms of reference established for the NAS committee led them to focus their evaluation of "commonly transported" crude oil types. As a result of this direction, the analysis carried out by NAS (2015) focused on the properties of Scotia Light (actually an ultralight crude or gas condensate produced in Nova Scotia, Canada, not likely to be transported by U.S. pipelines, and having API gravity 53.2°), and West Texas Intermediate (actually a light crude oil, API gravity 34.4 to 40.8), to the exclusion of the many medium and conventional heavy crude oils that allowed Lee et al. (2015) to identify diluted bitumens as belonging within a "continuum" of crude oil types.

The physical and chemical characteristics of released oils have a direct effect on their behavior and fate. Seasonal considerations and physical processes that affect the fate of released oils are also discussed in the sections below.

7.1.1.2 Seasonal Considerations for the Fate of Released Oil

The season in which a release occurs (and related freshwater levels during each season) can influence release behavior, fate, effects, and clean-up response actions. Seasonal variations in potential release behavior are addressed in this section.

Spring—Midsummer: For this analysis, the spring to midsummer is defined as the period when mid-continent streams and rivers exhibit seasonal high flow due to snow melt and drainage of temporarily stored groundwater. Water levels in ponds, lakes, and reservoirs are also seasonally high. Temperatures may range from cool to warm. The land is mostly snow-free, and biological productivity of land and water bodies is high.

Releases to land would directly affect soils and vegetation, although spreading of the released material is likely to be impeded by the vegetation. Releases to wetlands may float and spread if there is a free-water surface (as in a fen, marsh, or pond) or be absorbed if there is an abundance of vegetation or other organic matter (as in a bog). Currents, winds, and gravitational thinning forces would promote the spreading of releases that reach water bodies.

Weather, especially rapid warming periods and heavy rainfall, may cause rapid melting of snow on land and ice in rivers at this time of the year. These conditions can result in major flood flows that breach levees along larger rivers, erode river banks, and alter channels. If oil is released to a flooded area, oil could be distributed over a large area to adjacent terrestrial, wetland, and aquatic habitats that normally would not be exposed.

Late Summer—Fall: This period of the year extends from August until freeze-up of water bodies. Water levels in mid-continent streams, rivers, reservoirs, ponds, and lakes tend to be lower at this time of year than in the spring - midsummer period. Precipitation tends to be lower during the late summer and fall than in the spring - midsummer period, although strong storm events can still generate occasional flood flow periods. Oil released into water bodies will tend to remain within banks and strand along shorelines, limiting the potential for oiling of adjacent riparian, wetland, and terrestrial habitats.

Winter: Winter is the period when mid-continent water bodies are likely to be ice-covered and the land surface is likely to be frozen or covered with snow. Due to generally cold conditions, stream and river discharge may approach seasonally low levels, although periods of thaw may result in fluctuating flows. Oil released to the land generally would be slowed, although not necessarily stopped, by the snow cover. Releases reaching streams, rivers, and lakes could potentially be prevented from entering the water by snow and ice covering the water body. However, releases that penetrate ice might be more difficult to detect, contain, and clean-up.

Freeze-up and Breakup in Aquatic Environments: Freeze-up is the transitional time in the fall when streams, rivers, lakes and other water bodies begin to freeze. Breakup or spring melt is the transitional period when ice thins and breaks up, and river flows increase to freshet or flood

stage. Major floods may cause bank erosion and potentially pipeline failure, with the oil entering the river and likely being widely dispersed and difficult to contain or clean-up.

An oil release that results in oil reaching water bodies during either freeze-up or breakup may be difficult to contain, remove, and clean-up. The ice may not be strong enough to support people or equipment. In rivers, the oil may be transported several miles under the ice or in broken ice before it can be contained. Once the ice is strong enough to support people and equipment, it may be more difficult to detect the oil under the ice, and implement measures to affect rapid containment/clean-up at or near the release site.

7.1.1.3 Physical Factors Affecting the Behavior and Fate of Released Oil

The primary and shorter-term processes that affect the fate of released oil are spreading, evaporation, dispersion, dissolution, and emulsification (Payne et al. 1987; Boehm 1987; Boehm et al. 1987; Overstreet and Galt 1995). These processes contribute to the overall process of oil weathering (the physical and chemical change of released oil). Weathering dominates during the first few days to weeks of a release. A number of longer-term processes also occur, including photo-degradation, biodegradation, auto-oxidation, and sedimentation. These longer-term processes are more important in the later stages of weathering and usually determine the ultimate fate of the released oil not recovered by the clean-up program.

The chemical and physical composition of oil changes with weathering. Because of evaporation and dissolution, the effects of weathering are generally rapid (one to a few days) for hydrocarbons with lower molecular weights (e.g., gasoline, aviation gas, and diesel). Degradation of the higher weight fractions (e.g., medium and higher molecular weight components of crude oil, and bitumens in CLB and CLWB) is slower and occurs primarily through microbial degradation and chemical oxidation.

The weathering or fate of released oil depends on the oil properties and on environmental conditions, both of which can change over time.

Spreading: Spreading, either by gravity (e.g., unconfined oil on the ocean or a large lake) or by advection (e.g., oil being carried away from a release location by river flow), reduces the bulk quantity of oil present in the vicinity of the release, but increases the spatial area over which adverse effects could occur. Thus, oil in flowing systems (e.g., rivers and creeks) rather than confined systems (e.g., wetlands, ponds, and lakes) would be less concentrated in any given location, but could cause environmental effects, albeit reduced in intensity, over a larger area.

Spreading and thinning of released oil also increases the surface area of the slick, enhancing surface-dependent fate processes such as evaporation, biodegradation, photo-degradation (see below), and dissolution. Previous inland oil releases indicate, though, that the degree of spreading of oil from the release source may be constrained by natural conditions in the vicinity of the release site. For example, released oil will tend to adhere to riparian bank, lake shores,

and wetlands with which oil contact is made. On land, oil spreading is limited; but it may occur immediately once the oil reaches a water surface, and will continue to spread out into a thin film unless constrained through interactions with riparian banks, wetlands, shorelines, man-made structure, or response actions. Small amounts of crude oil can spread on water into a very thin layer ("sheen"). Sheening represents an impairment of water quality that can determine the degree of oil recovery that is required (NAS 2015).

Light crude oils such as Bakken crude are anticipated to spread more quickly due to their low viscosity relative to heavier oils such as CLB and CLWB. The spreading of oil on water may be one of the most important processes during the first hours of a release, provided the oil pour point (the temperature at which it becomes a semi-solid and loses its flow characteristics) is lower than the ambient temperature (Lee et al. 2015).

Oil Particle Aggregate Dynamics: The fate of released oil may be significantly affected by the presence of mineral or organic particulate matter in terrestrial and aquatic environments. The manner in which oil interacts with particles and its eventual transport and fate depend on the physical properties of the oil and the particles, as well as environmental conditions, including the geomorphic setting, weather, currents, and vertical mixing of the water column (Lee et al. 2011; Lee 2002).

Crude oil contacting soil will adsorb or adhere to soil particles—usually binding most strongly to particles in organic soils and less strongly to particles in sandy soils. In aquatic environments, such as rivers, floodplains, wetlands, lakes, and associated shorelines, suspended particles affect the fate and transport of released oil (Muschenheim and Lee 2002; Owens and Lee 2003; Khelifa et al. 2005a, 2005b, and 2005c; Sun and Zheng 2009; Gong et al. 2014).

Combinations of oil and particles have various names, including clay-oil flocculation (Bragg and Yang 1995), oil-mineral aggregates, and oil-suspended sediment-aggregates (Khelifa et al. 2002) depending on the type of particle involved in the interaction. The term oil particle aggregate (OPA) is a generic term that includes a wide range of particles containing both mineral sediment and organic matter in association with oil that may be retained in suspension and (or) settled out (Fitzpatrick et al. 2015). Formation of OPAs happens naturally when oil and suspended particles mix in turbulent water (Lee 2002; Muschenheim and Lee 2002; Owens and Lee 2003; Khelifa et al. 2005a; Sun and Zheng 2009; Gong et al. 2014). Major factors affecting the formation of OPA are (1) the quantity, viscosity and chemical composition of the oil; (2) the quantity, type, and surface properties of the particles; (3) the magnitude and variability in physical energy of the aquatic environment; (4) the temperature; (5) oil-water interfacial tension; and (6) (while not applicable in northern Minnesota) the salinity of the water (Lee 2002; Khelifa et al. 2002; Payne et al. 2003).

The first step to forming OPAs in the water lies with the initial breakup of a slick of oil into oil droplets. Once released into a water body with turbulence created by waves or currents, floating oil can break up into droplets and reach a stable droplet size distribution (DSD) relatively

quickly, perhaps in minutes to tens of minutes (Zhao et al. 2014a). Smaller droplets are generated when the oil-water interfacial tension is small and/or the oil viscosity is small. However, oil viscosity can increase by orders of magnitude among different types and temperatures of oils. Oil viscosity substantially increases as the temperature lowers to near oil's pour point. Further, the viscosity of a heavy crude oil or dilbit product such as CLB or CLWB is higher than that of light crude such as BAK oil (Fitzpatrick et al. 2015).

Evaporation: Evaporation is the primary mechanism for loss of low-molecular-weight constituents and light oil products. As lighter components evaporate, remaining petroleum hydrocarbons become denser and more viscous. Oil evaporation can be considerably slowed down by the formation of a "crust" or "skin" on top of the oil. This happens primarily on land where the oil layer is not agitated by water movement (Fingas 2015a). The rate of evaporation is very rapid immediately after oil release and then slows considerably (Fingas 2012). About 80% of evaporation occurs in the first few days after a release (Fingas 2015a).

Oil undergoing evaporation loses its more volatile and readily degraded components, leaving behind those components that weather more slowly. Hydrocarbons that volatilize into the atmosphere are broken down by sunlight into smaller compounds. This process, referred to as "photo-degradation," occurs rapidly in air; the rate of photo-degradation decreases as molecular weight increases.

While evaporation tends to reduce acute toxicity and result in overall mass reduction, the residual components may exhibit chronic, sublethal toxicity properties. Examples of sublethal effects observed in aquatic biota include external and internal lesions, developmental abnormalities in early-life stages, and behavioral changes in feeding and breeding. Delayed effects are also a possibility with measurable effects arising later in life or in subsequent generations (Dupuis and Ucan-Marin 2015).

Much of the light components of Bakken crude and the condensate diluent of CLB and CLWB will volatilize within the first few days of an oil release. Losses through volatilization likely are more pronounced in Bakken crude relative to CLB and CLWB.

Dispersion: Dispersion refers to the entrainment of oil droplets in the water column. The extent of oil dispersion depends on the interfacial tension between oil and water, oil viscosity, and the mixing energy that may be driven by wind and currents (Zhao et al. 2014b). The interfacial tension between the oil and water does not vary widely among oil types. The range is typically less than twofold. The mixing energy varies across environments, and over space and time in a particular environment (e.g., rivers passing over dams, and windy versus calm weather on lakes) (NAS 2015).

The DSD of oil dispersed in water plays an important role in the behavior of oil in the aquatic environment. Larger droplets are more buoyant than smaller droplets and thus rise more readily to the water surface, regardless of whether they were released underwater, or on the water

surface and entrained into the water column by turbulence. The DSD affects not only the transport but the fate and toxicity of released oil. Increasing the proportion of small droplets increases the surface area per unit mass of oil, increasing the dissolution of hydrocarbons in the water column (Reddy et al. 2012) and their potential for bioaccumulation via transport across biological membranes (NAS 2015).

It is anticipated that Bakken crude will disperse more readily than CLB or CLWB products, if released into a water body.

Dissolution: Dissolution involves the more water-soluble components of a crude oil dissolving in the water column. Dissolution is not the primary process controlling the fate of oil in the environment. More commonly, oil floats, strands on shorelines/riparian banks, or volatilizes. The range of oils (i.e., Bakken crude through to CLB and CLWB) that would be transported by the proposed pipeline is lighter than water.

Some crude oil components are water-soluble and, to the extent that dissolution does occur, it is one of the primary processes affecting the toxic effects of a release to aquatic organisms, especially in confined water bodies. The potential for dissolution decreases with increasing hydrocarbon molecular weight and decreasing water temperature. Aromatic compounds are generally more water-soluble than aliphatic compounds having the same number of carbon atoms. The BTEX compounds are among the more water soluble hydrocarbon compounds and are of particular relevance to short-term or acute toxicity to aquatic life.

Emulsification: Emulsification is the incorporation of water in oil as a colloidal suspension. During emulsification, small drops of water become surrounded by oil. External energy from wave or strong current action is needed to naturally emulsify oil. In general, heavier oils emulsify more readily than lighter oils, although recent reports suggest that diluted bitumens do not readily emulsify. The oil could remain in a slick, which could contain as much as 70% water by weight, and could have a viscosity of a hundred to a thousand times greater than the original oil. Water-in-oil emulsions often are referred to as "mousse." Emulsification is more common in large water bodies (e.g., large lakes, major rivers, and the ocean) where waves and/or currents mix the surface waters, than in smaller water bodies where this mixing energy is usually much less. The high viscosity results in a semi-solid or gel, which contributes to the persistence of the emulsified oil and makes clean-up more difficult.

Benthic Deposition/Sinking: A recent National Academies of Science, Engineering and Medicine report (NAS 2015) states that diluted bitumen products such as CLB and CLWB (dilbits), if released to a waterbody, can sink and accumulate on the underlying bed leading to difficult cleanup. Specifically, NAS (2015) states that immediately after a release, exposure to the environment begins to change released diluted bitumen through various weathering processes. The net effect is a reversion toward properties of the initial bitumen. An important factor is the amount of time necessary for the oil to weather into an adhesive, dense, viscous material. For any crude oil release, lighter, volatile compounds begin to evaporate promptly. In the case of

diluted bitumen, a dense, viscous material with a strong tendency to adhere to surfaces begins to form as a residue, creating particular challenges in those cases where the residue reaches water bodies and submerges or sinks to the bottom of a water body. The density of the residual oil does not need to reach or exceed the density of the surrounding water for this to occur, since the crude oil may combine with particles present in the water column to submerge, and then remain in suspension or sink (NAS 2015).

In essence, NAS (2015) posits that the diluent in dilbits will immediately undergo weathering leaving leftover bitumen to sink due to its inherent high density or accommodation of suspended sediments/particulates.

In comparison, a recent Royal Society of Canada study (Lee et al. 2015) indicates that a driving factor in whether or not dilbits sink is the amount of loss of the diluent following release of the product to a water body. Specifically, the density of many crude oils, including diluted bitumen products, is less than that of both fresh water (~1 g/cm^3) and sea water (~1.03 g/cm^3). Therefore, these oils will float when released onto or into water. However, bitumen by definition has a density greater than 1 g/cm^3 and, if diluent evaporates from dilbit during a release, the residual bitumen will become more dense and may become submerged or sink. Even so, oil droplets of density ~1.0 can be neutrally buoyant and remain suspended in the water column, especially if present in turbulent water such as in a rapidly flowing river or high wave energy system (Lee et al. 2015).

While the amount of diluent lost to weathering following release is critical to whether or not dilbits sink, the degree of evaporation and dissolution of diluent is poorly understood. The Royal Society of Canada report (Lee et al. 2015) further indicates that there is debate about whether 100% of the diluent component of bitumen blends can be lost by natural evaporation (Fingas 2015b) or whether the residual bitumen/heavy oil will retain some of the diluent components as intimately blended constituents, conferring novel properties on the partially weathered oil (Winter and Haddad 2014). This is particularly important for predicting if weathered dilbit will float or sink in water. The observation of evaporative mass losses of less than 20% after rigorous weathering at environmentally-relevant temperatures for dilbits nominally containing greater than or equal to 30% diluent, suggests that a substantial proportion of diluent remains intimately associated with bitumen (Lee et al. 2015).

Photo-Degradation: Photochemical processes result from exposure of released oil to sunlight, leading to cleavage and formation of covalent bonds. Oxygen is typically incorporated into the products and thus the term photo-oxidation is commonly used (NAS 2015). These oxidized products include both carbon dioxide and other oxygenated compounds (Aeppli et al. 2012). Typically, aromatic hydrocarbons are transformed more rapidly than alkanes (Garrett et al. 1998), thereby increasing the relative abundance of resins and asphaltenes in the residual oil (Aeppli et al. 2012; Prince et al. 2003). In one set of laboratory experiments, the photo-oxidation of crude oil in fresh water under direct ultraviolet irradiation showed oxidation of 5% of the

branched alkanes, 9% of the linear alkanes, and 37% of the aromatic hydrocarbons (D'auria et al. 2009; NAS 2015).

Photo-degradation of oil increases with greater solar intensity. It can be a significant factor controlling the disappearance of a slick, especially of lighter constituents, but it would be less important during cloudy days and in winter months.

Due to the relative increase in spreading and relatively higher fractions of lighter aromatic petroleum components relative to asphaltene components, Bakken crude is likely subject to increased photo-oxidation relative to CLB and CLWB.

Biodegradation: Biodegradation is the breakdown of compounds by native or introduced microorganisms. Biodegradation of oil by native microorganisms, in the hours to days following an oil release, would likely not be a significant process controlling the fate of oil in water bodies previously unexposed to oil. Although oil-degrading microbial populations are ubiquitous at low densities, a sufficiently large population must become established before biodegradation can proceed at any appreciable rate. Biodegradation is typically a long-term (weeks to years) process that reduces both the toxicity and volume of released oil.

Biodegradation can occur either aerobically or anaerobically, with aerobic processes typically occurring more rapidly and extensively. Biodegradation is accelerated in the presence of abundant oxygen and nutrients (Boufadel et al. 2010) at moderate temperature, salinity (where applicable), and reasonable oil-water interfacial surface area (Geng et al. 2014). At this time, there are no quantitative field studies on the biodegradation of releases of diluted bitumen such as CLB and CLWB, but saturates and aromatics are expected to biodegrade within weeks to years (NAS 2015).

7.1.1.4 Summary of Factors Influencing the Fate and Behavior of Released Oils

The environmental fate of released oil and oil products is controlled by many factors. Major factors affecting environmental fate include the release volume, release rate, oil temperature, terrain, receiving environment, time of year, and weather. For example, Bakken crude oil, a light, sweet crude oil, would weather differently than dilbit oils such as CLB and CLWB, in that the light ends of Bakken and the condensate diluent of CLB and CLWB would evaporate faster and dissolve to a greater degree in water than the heavier ends of Bakken and the bitumen component of CLB and CLWB.

The characteristics of the receiving environment, such as the type of land cover, soil porosity, land surface topography and gradient, type of freshwater body, particulate load in the water, presence of ice and/or snow cover on water or land, and flowing water current velocity, would affect how the release behaves. In ice-covered waters, many of the same weathering processes occur as in open water. However, ice changes the rates and relative importance of these processes (Payne et al. 1991).

The time of year when a release occurs has a major effect on the fate of crude oil. The time of year controls climatic factors such as the temperature of the air, water, or soil; depth of snow cover; presence of ice; and the depth of the active (soil frost) layer. During winter, colder air temperatures can modify the viscosity of oil so that it would spread less and potentially solidify. Temperature also affects the rate of evaporation of the volatile fraction of hydrocarbons. Frozen ground would limit the depth of penetration of any release. Weather could also affect the ability to detect, contain, or clean-up a release.

The physical and chemical processes discussed herein, which govern the fate of released oils, will drive exposure and manifest effects to ecological, land cover, and human receptors. For example, lighter oils such as Bakken tend to more readily evaporate and dissolve relative to dilbits, resulting in potential effects to biological communities residing in the water surface, column, and atmosphere, as well as result in potential inhalation exposure for human receptors. Comparatively, heavier oils such as dilbits tend to adhere to encountered riparian banks and lakeshores, resulting in marked exposure to biological communities residing there. Importantly, the specifics of any given incident will drive the fate and effects of released crude and refined petroleum products.

7.1.2 Land Cover Receptors

7.1.2.1 Air/Atmosphere

Section 109(b) of the Clean Air Act (CAA) requires that the USEPA establish National Ambient Air Quality Standards (NAAQS) "requisite to protect" public health and public welfare (40 CFR Part 50). The CAA identifies two class types of NAAQS: primary standards and secondary standards. Primary standards are limits set to protect the public health of the most sensitive populations, such as asthmatics, children and the elderly. Secondary standards are limits set to protect public welfare such as protection against visibility impairment or damage to vegetation, wildlife and structures. The CAA requires the USEPA to periodically review and, if new data indicate, update the NAAQS.

The USEPA has promulgated NAAQS for six criteria pollutants: ozone, particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and lead. Particulate matter (PM) is a term for particles in the air, such as dust, soot, smoke, and liquid droplets. Standards for PM are categorized on the size of the PM based on the aerodynamic diameter of the particle. The term PM_{10} represents particulate matter with an aerodynamic diameter less than 10 µm and $PM_{2.5}$ is PM with a diameter less than 2.5 µm.

In Minnesota, the MN PCA monitors and regulates air pollution. MN PCA is required to develop regulations, referred to as the State Implementation Plan (SIP) to outline how the areas under their jurisdiction will attain and maintain ambient air concentration levels in compliance with the NAAQS. Within their SIP, MN PCA has developed state air quality regulations under Section 7009.0800 of the Minnesota Administrative Rules. In general, the state standards mirror the USEPA

NAAQS. The primary difference is that the state has also developed ambient air quality standards for hydrogen sulfide (H_2S). In a proposed amendment to the state air quality rules published on February 29, 2016, the state has stated its intention to align their criteria pollutant standards with the current USEPA NAAQS, while retaining the H_2S standard. Long term ambient air monitoring has demonstrated that Minnesota attains compliance with all USEPA NAAQS within the counties traversed by this Project and throughout the state with the exception of a localized area in the Minneapolis-St. Paul area that is classified as nonattainment for the lead NAAQS.

The MN PCA has also worked with the Minnesota Department of Health (MN DH) to assess the health risk from air pollution beyond the NAAQS. While attainment of the NAAQS is a good overall indicator of air quality, the NAAQS do not address potential issues associated with individual chemicals or chemical species. The MN DH and MN PCA have identified a list of chemicals referred to as air toxics that cause or may cause cancer or other serious health effects or adverse environmental and ecological effects. Health Risk Values, Health-Based Values, and Risk Assessment Advice have been established as benchmarks to aid the agencies in air permitting and environmental review decisions and to prioritize air toxic emission reduction programs across the state. Chemicals for which ambient air values have been developed include BTEX and naphthalene. These are chemicals commonly found in crude oil. The standards that have been developed by MN DH represent acute (one-hour average), subchronic (13-week average), and chronic (annual average) exposures. The chronic standards define levels of increased risk to human health over the long term, or lifetime, of exposures to a specific chemical, whereas an acute standard addresses the short-term risks associated with a transient event such as an oil spill.

Crude oil is a complex mixture of organic compounds. The organic compounds, also referred to as hydrocarbons, are molecules primarily made up of carbon and hydrogen atoms. These molecules may also contain small amounts of elemental sulfur, nitrogen, and oxygen. Some metals and other trace compounds such as hydrogen sulfide also may be found in the mixture.

The number and arrangement of the carbon atoms in each compound define the physical properties of the compounds such as whether they are normally found as gases, liquids or solids and the density of the compound. Compounds with less than five carbon atoms such as methane (one carbon) and ethane (two carbons) are generally found in their gaseous form at standard conditions (also referred to as normal conditions) of temperature and pressure (e.g., conditions found near ground level in the atmosphere). Slightly larger compounds with about 5 to 10 carbon atoms (e.g., octane, which has 8 carbons) found in gasoline are liquids at standard conditions. In this range, the shorter chained compounds will readily evaporate (or volatilize) if exposed to air and are; therefore, referred to as volatile organic compounds (VOCs). Other compounds in this range are the BTEX compounds, which are generally considered toxic chemicals with Health-Based rules established by MN DH.

Organic compounds with about 11 to 20 carbon atoms can be very complex. Within this range, there is a group of compounds (including naphthalene) that are liquid or solid at standard conditions, but which will evaporate or sublimate over time. These compounds are referred to as semi-volatile organic compounds and include fuel oil and a family of chemicals referred to as PAHs. The largest hydrocarbon compounds, having 20 carbon atoms or more, can be found in products such as lube oils or asphalt. These are generally thick, viscous liquids or waxy solids under standard conditions.

Crude oil is a complex mixture of all of these classes of hydrocarbons. Depending on the geographic area or geological formation from which crude oil is recovered, the relative composition of volatile and non-volatile compounds may vary considerably. Industry classifies crude oil into three general categories (light, medium and heavy) based on a measure of density (API gravity) which reflects the chemical composition of the oil. In transitioning from light to heavy oils, the percentage of volatile organic compounds typically decreases, and the fraction of non-volatile compounds increases. Bitumen is a very heavy type of crude oil that contains very little volatile hydrocarbon. However, depending upon the type of diluent used to manufacture diluted bitumen (dilbit), the volatile content of diluted bitumen may be relatively high (i.e., similar to that of a light oil) or very low.

The physical characteristic used by the petroleum industry to classify crude oil is the specific gravity or density of the mixture. For crude oils, the density of the material is reported as a dimensionless number referred to as API gravity. API gravity has an inverse relationship with density, therefore the less dense the oil, the higher the API gravity is of the mixture. A light crude oil is a material with an API gravity greater than 31.1° (Speight 2014; Lee et al. 2015). Medium crude oils have an API gravity between 31.1° and 22.3° (Speight 2014; Lee et al. 2015). Heavy crude oils have an API gravity less than 22.3° (Speight 2014; Lee et al. 2015). For comparison, a chemical with a density equal to that of water would have an API gravity of 10°.

A crude oil with a high API gravity will generally have a high concentration of VOCs and low viscosity. Viscosity is the property that defines how easily a liquid will flow and spread out. A low viscosity liquid, such as gasoline, has low internal friction and will easily spread out into a thin film as a result of gravity. A highly viscous material like asphalt or bitumen will not readily spread. The viscosity of a material changes with temperature, with an increase in temperature resulting in a decrease in the viscosity of the material.

The high viscosity of bitumen makes it difficult to pump and transport through a pipeline. Therefore, bitumen is either heated or diluted with another petroleum product such as natural gas liquids (condensate) or synthetic oil in order to lower its viscosity. Bitumen may be diluted by 10 to 40% with a diluent in order to meet standards for pipeline transportation.

In addition to being described as a function of density and viscosity, crude oils can also be classified as being either “sweet” or “sour”. A crude oil with less than 1 wt% sulfur content is referred to as being low-sulfur or sweet crude oil. A crude oil with more than 1 wt% sulfur is

referred to as being high-sulfur or sour crude oil. Typically crude oils range from less than 0.1–5 wt% sulfur. The sulfur content is important relative to the potential perceived odor from the material and the possible emission of H_2S, a toxic gas, from an oil release.

Of the six USEPA criteria air pollutants, the pollutant most theoretically likely to be affected by a crude oil release (although not contained in the crude oil) would be ozone. Ground-level ozone is produced on hot, sunny days by a chemical reaction between VOCs and oxides of nitrogen (NOx). Volatile organic carbon compounds are released by many activities, including the use of paints and solvents. NOx emissions are released from motor vehicles, power plants, and other activities that require fuel combustion. Levels of ozone are dependent on the amount of VOCs and NOx in the air, as well as weather conditions including sunlight, temperature, and wind speed and direction. Based on the need for specific meteorological conditions and the time delay for ozone to form in the atmosphere, the more immediate concern of the local community would be the short term exposure to VOCs (including benzene), H_2S or other specific chemicals, in addition to any odors associated with the volatilization of the crude oil following a release. To better define how oil releases have affected the local air quality, a review of historical data and laboratory studies was performed.

7.1.2.1.1 Observed Effects

The following section summarizes a review of some historic oil releases and their environmental effects on local air quality (only) following the release. This section also reviews some laboratory studies that have been completed to better define environmental effects on air quality from oil releases.

> ***Exxon Valdez Release, Alaska**: A study performed by Hanna and Drivas (1993) evaluated the VOC emissions from the Exxon Valdez Oil Release. The purpose of the study was to "reconstruct the time and space variation of air concentrations from the Exxon Valdez oil spill on March 24, 1989 in Prince William Sound, Alaska." The author stated that as much as 25% of the oil may have evaporated during the first two weeks following the release and all of the VOC or BTEX compounds evaporated within a few hours. The study concluded:*
>
> 1. *Benzene, toluene, and n-hexane evaporated completely within about 12 hours of the spill, and the evaporation was primarily diffusion-limited.*
> 2. *The less volatile compounds (e.g., n-pentadecane) evaporated at a much slower, more constant rate over the first two weeks, and their evaporation was controlled primarily by mass-transfer to the air.*

The first conclusion indicates that the evaporation rate of the more volatile components was limited by the ability of the volatile compounds to travel within the layer of oil floating on the water and come into contact with the air, where they evaporated immediately. The second conclusion indicates that the evaporation of the less volatile components of the oil was limited by temperature, airflow, and the physical properties of the compounds, such as vapor pressure.

The mass-transfer process would require more time to complete than the diffusion-limited process.

Environment Canada: *Experimentation was conducted by the Emergencies Science Division of Environment Canada on crude oil evaporation (Fingas 1999). The purpose of the study was to understand the evaporation process during an oil release and to develop an oil release behavior model. Through a series of studies the author determined that up to 75% by volume of light crude oils were lost to evaporation in the first few days following a release. The value reported was 40% for a medium crude oil and 5% for a heavy crude oil. In this study, the author concluded that:*

1. *Evaporation rate of several oils with increasing wind speed shows that, unlike water, the evaporation rate does not change significantly except for the initial step over 0-level wind*
2. *Increasing area does not significantly change oil evaporation rate*
3. *Decreasing thickness does not increase oil evaporation rate*
4. *Volume or mass of oil evaporating correlates with the evaporation rate*
5. *Evaporation of pure hydrocarbons with and without wind (turbulence) shows that compounds larger than nonane and decane are not boundary-layer regulated*

The author also stated, "The fact that oil evaporation is not strictly boundary-layer regulated implies a simplistic evaporation equation will suffice to describe the process. A simple equation of the form, evaporation = constant x logarithm of time, is sufficient to describe evaporation. The following processes do not require consideration: wind velocity, turbulence level, area, thickness, and scale size. The factors found to be important to evaporation are time and temperature." Therefore, Fingas's conclusion mirrors the finding of Hanna and Drivas, that evaporation of the larger compounds in the crude oil matrix is constant based on the temperature and controlled by mass-transfer processes.

OSSA II Pipeline, Bolivia: *On January 30, 2000, a fracture developed on the OSSA II pipeline over the Rio Desaguardo in Bolivia releasing 29,000 barrels of mixed crude oil and condensate into the river during a high flow event. At the time of the release, the pipeline was carrying a heavy crude oil diluted with kerosene-range petroleum product. Studies (Henshaw et al. 2001; Douglas et al. 2002) evaluated the weathering of the crude oil over the months following the spill. Samples of raw crude oil were compared to samples of stranded oil collected along the river banks following the release.*

Douglas concluded that the light hydrocarbons (3 to 18 carbons), which includes the BTEX compounds, were almost completely removed by evaporation. The

results indicated that as much as 45% of the released oil may have evaporated. However, there are no reported data on air quality for this event.

Wabamun Lake Train Derailment, Alberta, Canada: *On August 3, 2005, a CN freight train derailed near the Village of Whitewood Sands in Alberta, Canada. Approximately 4,500 barrels of Bunker C fuel oil were released. The Bunker C fuel oil was being delivered to be utilized as asphalt stock. The Bunker C contained no BTEX and was primarily composed of non-volatile, long-chained organic compounds. A sample of the Bunker C fuel oil was collected three days after the derailment from a pool near the ruptured rail cars. A fingerprint analysis of the pooled oil indicated that the oil was identical to samples of the Bunker C fuel oil produced by the refinery from which the material originated (Hollebone et al. 2011). The lack of physical change to the oil over the three days indicates that there was minimal loss of oil constituents to evaporation.*

Trans Mountain Pipeline, Burnaby, British Columbia: *In July 2007, a backhoe accidentally struck the Trans Mountain Pipeline in Burnaby, British Columbia. A total of 1,500 barrels of Albian Heavy Synthetic crude oil blend, a type of partially upgraded heavy crude oil known as a dilsynbit, was sprayed into the air and covered surrounding streets and buildings (Trans Mountain Pipeline ULC 2014). Air quality monitoring began immediately following the incident. VOC levels declined rapidly during the clean-up efforts (Eykelbosh 2014). The residents that were evacuated in response to the spill reported various symptoms including headache, nausea, dizziness, upper respiratory tract irritation and eye irritation. No long term effects study has been completed.*

Immediately following the spill, approximately 225 people were evacuated by the fire department. More than half of the people were able to return to their homes that evening. A total of 101 people representing 42 families spent the night of the release in other accommodations away from their homes (Trans Mountain 2015).

Marshall, Michigan: *On July 26, 2010, Enbridge reported a 30-inch pipeline had ruptured near Marshall, Michigan. The break resulted in the release of an estimated 20,000 barrels of a crude oil mixture of which approximately 8,200 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013a). The pipeline was transporting Western Canadian Select and CLB crude oils. These crude oils are classified as heavy crude oils (diluted bitumens). To allow the heavy crude oil to flow through the pipeline a diluent was added to the crude oil at a concentration of about 30%.*

A review of the USEPA certified air quality ozone monitoring data collected by Michigan Department of Environmental Quality (MI DEQ) (USEPA 2016) for

southern Michigan on the day of the release and through the remainder of 2010 indicates that there were no violations of the ozone NAAQS.

Beginning on July 26, 2010 and continuing through 2012, the USEPA and Enbridge through their contractors routinely monitored the air quality throughout the project area. Initial testing was performed for VOCs, H_2S, CO, and benzene. Numerous methodologies were employed to monitor for emissions. Human health screening levels were developed and decision trees were created by the Agency for Toxic Substances and Disease Registry (ATSDR), the Calhoun County Public Health Department, and Michigan Department of Community Health (MI DCH) to determine if evacuation orders would be required (MI DCH 2014a). An initial screening level was developed by MI DCH for acute (short-term) exposure to benzene and was set at a level of greater than 200 parts per billion (ppb)at which evacuation would be recommended, if confirmed by a second test (MI DCH 2014a). Longer term, chronic screening levels were developed by MI DCH to determine when homes could be re-occupied and were set at a level of 6 ppb benzene. The 6 ppb level cited by MI DCH is a level derived by the ATSDR as an intermediate-duration inhalation Minimal Risk Level for inhalation exposures to benzene.

For comparison, in the state of Minnesota, the MN DH and MN PCA health based guidance for benzene sets an acute (short-term) exposure level of 1,000 micrograms per cubic meter, which is roughly equivalent to 320 ppb (MN DH 2016). The MN DH guidance sets a benchmark of 1.3 to 4.5 micrograms per cubic meter for longer term (chronic) exposures, which is equivalent to a range of 0.4 to 1.5 ppb (MN DH 2016)).

MI DCH prepared a report (MI DCH 2014a) assessing the extent of air contamination as monitored throughout the project period. MI DCH divided the data for 2010 into three time frame groupings:

- *Initial Response Period from July 26 through July 28, 2010*
- *Voluntary Evacuation Period from July 29 to August 17, 2010*
- *Post Evacuation Period from August 18 to December 31, 2010*

The data were primarily collected in four locations, which are identified as: 1) the Voluntary Evacuation Area (along Talmadge Creek from the release site to the confluence with the Kalamazoo River, 2) Squaw Creek Subdivision (west of the confluence of Tallmadge Creek and the Kalamazoo River about 2.5 miles downstream from the release), 3) the town of Ceresco (about 6 miles downstream from the release), and 4) Baker Estates Subdivision in Battle Creek (about 13.5 miles downstream from the release). Additional samples were also collected in the area referred to as the Oil Release Site, but no homes were located in this area.

Initial Response Period (July 26 through July 28, 2010)

During the Initial Response Period (the first three days following the release), air sampling was begun the day of the release using hand-held meters and Draeger tubes. More extensive monitoring began on the day following the release when more sophisticated monitoring was performed, which included the use of mobile field gas chromatograph monitors and the collection of Summa canister and Tedlar bag samples, which were sent to a laboratory of chemical analysis.

For VOCs, a screening level of 1,000 ppb of total VOCs was utilized by MI DCH to indicate if further chemical specific monitoring (such as benzene) might be appropriate. About half of the measured concentrations exceeded 1,000 ppb in the evacuation area, Squaw Creek Subdivision, and in Ceresco. However, VOCs were not detected in air at Baker Estates. (MI DCH 2014a). The results of the VOC monitoring during the Initial Response Period are shown in Table 7-3.

Table 7-3 Total VOC Concentrations in ppb during the Initial Response Period

Area	*Number of Measurements*	*Screening Level (ppb)*	*Range of Detections (ppb)*
Voluntary Evacuation Area	*98*	*1,000*	*ND to 120,000*
Squaw Creek Subdivision	*30*	*1,000*	*ND to 71,600*
Ceresco Area	*8*	*1,000*	*ND to 6,000*
Baker Estates Neighborhood	*2*	*1,000*	*ND*
NOTE: *ND = Not Detected*			
Source: MI DCH 2014a (Tables B-1 and B-2)			

A screening level of 60 ppb benzene was utilized by MI DCH to indicate if use of the mobile field gas chromatograph monitor was appropriate. The screening samples were collected primarily using an UltraRAE real-time monitor. Benzene was detected in concentrations up to 6,250 ppb. Exceedances of the screening level were detected in the Voluntary Evacuation Area and the Ceresco Area. The mobile field gas chromatograph was used and analyzed four samples in the Voluntary Evacuation Area during this timeframe with detections from 1.2 to 27.3 ppb recorded and no exceedances of the 60 ppb benzene screening level indicated (MI DCH 2014a). The results of the benzene monitoring during the Initial Response Period are shown in Table 7-4.

Table 7-4 Benzene Concentrations in ppb during the Initial Response Period

Area	Screening Level (ppb)	Number of UltraRAE Monitor Readings	Number of UltraRAE Monitor Readings Above Screening Level	Range of UltraRAE Detections (ppb)	Number of Field GC Monitor Readings	Number of Field GC Monitor Readings Above Screening Level	Range of Field GC Detections (ppb)
Voluntary Evacuation Area	*60*	*13*	*8*	*ND to 6,250*	*4*	*0*	*1.2 to 27.3*
Squaw Creek Subdivision	*60*	*4*	*0*	*ND*	*0*	*NA*	*NA*
Ceresco Area	*60*	*4*	*2*	*ND to 500*	*0*	*NA*	*NA*
Baker Estates Neighborhood	*60*	*1*	*0*	*ND*	*0*	*NA*	*NA*
NOTE: *NA = Not Available; ND = Not Detected*							
Source: MI DCH 2014a (Tables B-6)							

Hydrogen sulfide monitoring was also performed at these locations during these periods. A screening level of 70 ppb H_2S was established for this response. Of the four sampled areas, the screening level was only exceeded in the Voluntary Evacuation Area. During the initial response period one of four samples taken in the Voluntary Evacuation Area exceeded the screening level. (MI DCH 2014a). The results of the H_2S monitoring during the Initial Response Period are shown in Table 7-5.

Table 7-5 Hydrogen Sulfide Concentrations during the Initial Response Period

Area	Screening Level (ppb)	Number of Measurements	Number of Measurements Above Screening Level
Voluntary Evacuation Area	*70*	*4*	*1*
Squaw Creek Subdivision	*70*	*14*	*0*
Ceresco Area	*70*	*0*	*0*
Baker Estates	*70*	*0*	*0*

Table 7-5 Hydrogen Sulfide Concentrations during the Initial Response Period

Area	*Screening Level (ppb)*	*Number of Measurements*	*Number of Measurements Above Screening Level*
Neighborhood			
Source: MI DCH 2014a (Tables B-3 and B-4)			

Voluntary Evacuation Period (July 29 to August 17, 2010)

During the voluntary evacuation period 98 of 3,925 VOC measurements at all four locations indicated concentrations greater than 1,000 ppb screening level (MI DCH 2014a). The results of the VOC monitoring during the Voluntary Evacuation Period are shown in Table 7-6.

Table 7-6 Total VOC Concentrations in ppb during the Voluntary Evacuation Period

Area	*Number of Measurements*	*Number of Measurements Above Screening Level*	*Screening Level (ppb)*	*Range of Detections (ppb)*
Voluntary Evacuation Area	*2,244*	*84*	*1,000*	*ND to 568,000*
Squaw Creek Subdivision	*658*	*8*	*1,000*	*ND to 2,600*
Ceresco Area	*467*	*2*	*1,000*	*ND to 3,000*
Baker Estates Neighborhood	*556*	*3*	*1,000*	*ND to 266,000*
NOTE: *ND = Not Detected*				
Source: MI DCH 2014a (Tables B-1 and B-2)				

During the voluntary evacuation period, 64 of 2,591 samples collected using an UltraRAE real-time monitor indicated exceedances of the 60 ppb benzene screening level, with detections up to 2,200 ppb. The mobile field gas chromatograph analyzed 36 samples in the four areas during this timeframe with detections up to 17.6 ppb recorded and no exceedances of the 60 ppb benzene screening level indicated (MI DCH 2014a). The results of the benzene monitoring during the Voluntary Evacuation Period are shown in Table 7-7.

Table 7-7 Benzene Concentrations in ppb during the Voluntary Evacuation Period

Area	Screening Level (ppb)	Number of UltraRAE Monitor Readings	Number of UltraRAE Monitor Readings Above Screening Level	Range of UltraRAE Detections (ppb)	Number of Field GC Monitor Readings	Number of Field GC Monitor Readings Above Screening Level	Range of Field GC Detections (ppb)
Voluntary Evacuation Area	*60*	*1,619*	*62*	*ND to 2,200*	*24*	*0*	*ND to 17.6*
Squaw Creek Subdivision	*60*	*437*	*0*	*ND to 50*	*7*	*0*	*ND to 2.2*
Ceresco Area	*60*	*271*	*1*	*ND to 200*	*2*	*0*	*ND to 0.2*
Baker Estates Neighborhood	*60*	*264*	*1*	*ND to 250*	*3*	*0*	*ND*
NOTE: *ND = Not Detected*							
Source: MI DCH 2014a (Tables B-6)							

During the voluntary evacuation period seven of 3,175 samples exceeded the 70 ppb screening level for H_2S. All of the exceedances occurred in the Voluntary Evacuation Area (MI DCH 2014a). The results of the H_2S monitoring during the Voluntary Evacuation Period are shown in Table 7-8.

Table 7-8 Hydrogen Sulfide Concentrations during the Voluntary Evacuation Period

Area	Screening Level (ppb)	Number of Measurements	Number of Measurements Above Screening Level	Range of Detections (ppb)
Voluntary Evacuation Area	*70*	*1,747*	*7*	*ND to 112*
Squaw Creek Subdivision	*70*	*507*	*0*	*ND*
Ceresco Area	*70*	*412*	*0*	*ND*
Baker Estates Neighborhood	*70*	*509*	*0*	*ND*
NOTE:				

Table 7-8 Hydrogen Sulfide Concentrations during the Voluntary Evacuation Period

NA = Not Available; ND = Not Detected
Source: MI DCH 2014a (Tables B-3 and B-4)

Post Evacuation Period (August 18 to December 31, 2010)

In the Post-Evacuation Period 25 of 11,252 VOC measurements exceeded the 1,000 ppb screening level. Higher readings during these periods were attributed to oil recovery activities along Talmadge Creek and at Ceresco dam. (MI DCH 2014a). The results of the VOC monitoring during the Post Evacuation Period are shown in Table 7-9.

Table 7-9 Total VOC Concentrations in ppb during the Post Evacuation Period

Area	*Number of Measurements*	*Number of Measurements Above Screening Level*	*Screening Level (ppb)*	*Range of Detections (ppb)*
Voluntary Evacuation Area	*4,281*	*18*	*1,000*	*ND to 9,000*
Squaw Creek Subdivision	*1,059*	*1*	*1,000*	*ND to 1,200*
Ceresco Area	*5,149*	*5*	*1,000*	*ND to 2,800*
Baker Estates Neighborhood	*767*	*1*	*1,000*	*ND to 1,200*
NOTE: *ND = Not Detected*				
Source: MI DCH 2014a (Tables B-1 and B-2)				

A screening level of 6 ppb benzene was utilized by MI DCH in the Post Evacuation Period to indicate if long term chronic exposures may have resulted from the release. During the post evacuation period 27 of 7,377 samples collected using an UltraRAE real-time monitor indicated exceedances of the 6 ppb benzene screening level, with detections up to 9,450 ppb. The mobile field gas chromatograph was not used during this period (MI DCH 2014a). The results of the benzene monitoring during the Voluntary Evacuation Period are shown in Table 7-10.

Table 7-10 Benzene Concentrations in ppb during the Post Evacuation Period

Area	*Screening Level (ppb)*	*Number of UltraRAE Monitor Readings*	*Number of UltraRAE Monitor Readings Above Screening Level*	*Range of UltraRAE Detections (ppb)*
Voluntary Evacuation Area	*6*	*3,095*	*17*	*ND to 9,450*
Squaw Creek Subdivision	*6*	*274*	*0*	*ND*
Ceresco Area	*6*	*3,704*	*10*	*ND to 4,500*
Baker Estates Neighborhood	*6*	*304*	*0*	*ND*
NOTE: *ND = Not Detected*				
Source: MI DCH 2014a (Tables B-6)				

During the post evacuation no detections were identified for H_2S in a total of 9,977 samples recorded. (MI DCH 2014a). The results of the H_2S monitoring during the Post Evacuation Period are shown in Table 7-11.

Table 7-11 Hydrogen Sulfide Concentrations during the Post Evacuation Period

Area	*Screening Level (ppb)*	*Number of Measurements*	*Number of Measurements Above Screening Level*	*Range of Detections (ppb)*
Voluntary Evacuation Area	*70*	*3,270*	*0*	*ND*
Squaw Creek Subdivision	*70*	*921*	*0*	*ND*
Ceresco Area	*70*	*5,071*	*0*	*ND*
Baker Estates Neighborhood	*70*	*715*	*0*	*ND*
NOTE: *ND = Not Detected*				
Source: MI DCH 2014a (Tables B-3 and B-4)				

Throughout 2011, no detectable concentrations were recorded associated with the pipeline release in a total of 3,146 VOC samples taken. No detections of

benzene were monitored in a total of 2,593 UltraRAE samples and no detections of H_2S were identified in 2,968 H_2S samples (MI DCH 2014a).

Rainbow Pipeline, Alberta, Canada: *On April 29, 2011, Plains Midstream Canada ULC (ERCB 2013) reported a pipeline failure which released 28,300 barrels of light sweet crude oil from their Rainbow Pipeline in Alberta. There were no residences within 12 km (7.5 miles) of the release point. A school located in Little Buffalo, 12 km from the release, was evacuated and closed voluntarily on April 29 as a precautionary measure. The school remained closed on the following Monday, May 3. Air monitoring was performed from May 3 to May 14 at the school. The monitoring indicated no evidence of substantive risk from airborne contaminants. Three additional sites were also monitored. No exceedances of ambient air quality standards were measured.*

Silvertip Pipeline, Laurel, Montana: *On July 1, 2011, the ExxonMobil Silvertip Pipeline carrying medium sour crude oil ruptured, releasing 1,500 barrels into the Yellowstone River in Laurel, Montana (USDOT 2012). The typical concentration of VOCs in this crude oil is 142 milligrams per kilogram (mg/kg) of benzene, 1,060 mg/kg of toluene, and 2,530 mg/kg of xylenes. Samples of weathered crude oil collected four days after the release indicated that the BTEX compounds were no longer detectable (USEPA 2011). However, there is no information available regarding VOC concentrations in air.*

Mid Valley Pipeline, Mooringsport, Louisiana: *On October 13, 2014, the Sunoco Logistics Mid Valley Pipeline ruptured near Mooringsport, Louisiana releasing 4,500 barrels of light sweet crude oil. Two residences adjacent to the spill were voluntarily evacuated. Air monitoring around the perimeters of the homes showed no detectable VOC concentrations in the air six days after the release, so the residents were allowed to return home on October 19 (USEPA 2014a).*

Yellowstone River, Glendive, Montana: *On January 17, 2015, Bridger pipeline released 715 barrels of Bakken light crude oil into the Yellowstone River five miles upstream of Glendive, Montana (MT DEQ 2015a). For the seven consecutive days after the release, ambient air quality sampling indicated no elevated levels of hydrocarbon components in the city of Glendive (USEPA 2015a).*

Marshall, Michigan, and Red Deer, Alberta: *Laboratory experiments were performed by Zhou et al. (2015) to evaluate the behavior of a conventional light crude oil release (Red Deer Alberta 2012) versus a diluted heavy crude oil (diluted bitumen) release (Marshall, Michigan 2010). The study shows that diluted bitumen products have lower BTEX contents than conventional light and medium crudes, which contain 2 to 4 vol % BTEX. The study states that the volatile fraction of the*

conventional light crude oil was 30 weight percent versus 13.3 weight percent for the dilbit.

The study also evaluated the rate of evaporative loss of the volatile fraction of both the dilbit and the conventional light crude oil based on the laboratory experiment. The majority (75 to 85%) of the loss occurred within the first six hours of the test. Further continued loss occurred over the following two to seven days.

The Red Deer release resulted in strong odors that lasted for several hours. At Marshall the odor persisted for a longer period, but that may have been due to the larger size of the release and the longer duration of the actual release. The author did suggest that a secondary consideration may have been the slower release of the volatile compounds from the dilbit (Zhou et al 2015).

***USEPA and U.S. Coast Guard – Bakken Crude**: The USEPA shipped 1,675 gallons of Bakken light crude oil to Eddystone, Pennsylvania for a pilot test, which was supported by the US Coast Guard. The study goals were stated to be (USEPA 2015b):*

1. *Evaluate benzene and other VOC emissions from a discharge of Bakken oil to gain more information to support Health and Safety decisions for responders and the public*
2. *Evaluate physical properties of Bakken oil, including weathering progresses, to better predict the fate on the surface water*
3. *Evaluate recoverability of fresh and weathered Bakken oil using standard methods*

On February 11, 2015, 660 gallons of crude oil shipment was discharged into a 100 ft by 65 ft outdoor test tank filled with water. The maximum ambient temperature during the study was 34°F. The oil was allowed to sit in the tank for 24 hours while air emission information was collected. The oil was then allowed to weather an additional week. Sampling of the oil indicated that within 24 hours all of the benzene evaporated from the oil sheen. Within six hours of the initial release, all VOC readings of the ambient air above the tank were below 5 ppm. USEPA estimated that 27% of the oil was lost to evaporation within the first 24 hours. After one week, 40% of the crude oil had been lost, with the majority of the loss being assumed to be evaporation.

7.1.2.1.2 Expected Effects of Released Oils

Key findings related to the potential effects of crude oil releases to air are presented below.

Table 7-12 and Table 7-13 provide a summary of the expected environmental effects of oil releases to air. Table 7-12 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-13 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

- Crude oil is a complex mixture of petroleum hydrocarbons. These hydrocarbons may contain only a few carbon atoms or contain 20 or more carbon atoms in long-chained, complex hydrocarbon molecules. In general, shorter and less complex hydrocarbons are more volatile, which means they evaporate more readily than longer chained hydrocarbons. These shorter chained compounds are referred to as VOCs.
- The release of VOCs, such as benzene, primarily occurs within the first 24 hours of an oil release.
- Since the rate at which the volatile organic compounds, such as benzene, evaporate from an oil release does not vary greatly, the actual concentrations observed in the surrounding community will be most affected by initial concentrations of benzene in the crude oil, the actual mass of oil released, the size of the area impacted by the release due to movement of the oil plume, and weather conditions, such as winds and atmospheric stability that will impact dissipation of the evaporated chemicals.
- The evaporative loss of longer chain petroleum hydrocarbons is controlled by weather conditions, such as wind and temperature and the depth of the pooled oil.
- The areas most affected by releases from a crude oil incident to the atmosphere are in the near vicinity of the oil release site or near areas of extensive recovery operations.

Table 7-12 Environmental Effects: Air Exposures

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil chemistry—volatile compounds and BTEX	Light crude oils contain 35 to 40 wt% volatile organic compounds (less than C10) (Crude Monitor 2016). The C2 to C4 organics are 3 to 9 wt% (NDPC 2016). The total BETX concentration of light crude is 2 to 4 Vol % (Zhou et al. 2015)	Medium crude oils contain 25 to 30 wt % volatile organic compounds (less than C10) (Crude Monitor 2016). The C2 to C4 organics are less than light crude oils. The total BTEX concentration of medium crude is 1 to 3 Vol % (Zhou et al. 2015)	Heavy crude oils contain 15 to 20 wt % volatile organic compounds (less than C10) (Crude Monitor 2016). The C2 to C4 organics are minimal. The total BTEX concentration of heavy crude is 0.5 to 1.5 Vol % (Zhou et al. 2015).	Diluted bitumens may contain variable amounts of BTEX, depending upon the characteristics and amount of the diluent used. For all of the crude oil types the benzene concentration represents 10 to 15 % of the total BTEX concentration (Crude Monitor 2016).
Oil chemistry—sulfur concentration	Light sweet crude oil contains less than 0.5 wt% Sulfur. Light sour crude oil contains 0.5 to 1.5 wt% Sulfur (Zhou et al. 2015). Bakken Crude oil contains less than 0.2 wt% Sulfur and less than 1 ppm H2S. (NDPC 2016)	Medium conventional crude oil contains 1.5 to 2.5 wt % Sulfur (Zhou et al. 2015).	Heavy conventional crude oil contains 3 to 5 wt % Sulfur (Zhou et al. 2015).	The sulfur content of diluted bitumens are similar to conventional heavy crude oil, but contains a relatively low level of H2S (Zhou et al. 2015).

Table 7-13 Environmental Effects: Air

Environment Characteristic	Low	Medium	High	Other Comments
Topographical change (terrain)	An oil release in a relatively flat area will result in pooling. The release of BTEX compounds is diffusion limited, so deeper pooling will slow the release of BTEX compounds, but also results in the compounds being released in a very localized area (Hanna and Drivas 1993).	As topography provides a means to move the oil release, the pooling of the crude oil will lessen. An increase in surface area does not significantly increase the oil evaporation rate (Fingas 1999), but the released compounds will be spread over a wider area.	See medium terrain effects.	
Flow velocity of the water body	An oil release into a slow moving water body, such as a lake, will result in a slower spread of the oil with a smaller area being directly affected relative to bodies of water with higher currents. Organic compounds evaporated from the release will be concentrated in a localized area.	An increase in the velocity of the affected water body will result in increased spreading of the crude oil. An increase in the surface area of the oil sheen does not significantly increase the oil evaporation rate (Fingas 1999), but the released compounds will be spread over a wider area.	See medium velocity effects. Higher velocity stream flows may also result in additional mixing, which would bring soluble constituents such as benzene into the water column, delaying the release of the benzene to the atmosphere.	The spread of petroleum released on water, including a waterbody with a slow to no current will generally be faster than the spread of a petroleum release on land.
Temperature	Low temperatures will mostly slow the volatilization rate of the heavier organic compounds (Fingas 1999). The light ends (C_2 to C_4 organics) will flash off readily as they are gases at lower temperatures and BTEX compounds will evaporate in the first 24 hours (USEPA study 2015, Zhou et al. 2015).	Heavier organic compounds will volatilize faster (Fingas 1999) in warmer temperatures, but the loss of light ends and BTEX are constrained by diffusion through the oil matrix, more than the increase in temperature (Hanna and Drivas 1993).	See medium temperature effects. High temperatures could lead to localized increases in ground-level ozone concentrations, but monitoring data has not shown any apparent increase based on case studies. (see Marshall case study).	

Table 7-13 Environmental Effects: Air

Environment Characteristic	Low	Medium	High	Other Comments
Distance to receptors	The potential effects to humans due to atmospheric concentrations of organic compounds are greatest near the release site and in areas of oil recovery activities. Voluntary evacuation orders were made for homes within 500 meters of Talmadge Creek (Marshall Case Study) and adjacent to the release in Louisiana (Mooringsport Case Study). The evacuation orders were lifted within one to three weeks of the release.	Odors and VOC concentrations were monitored two to six miles from the release site in the Squaw Creek subdivision and the village of Ceresco along the Kalamazoo River, but benzene alert levels were not exceeded (see Marshall Case Study). A school was voluntarily evacuated 7.5 miles from a release site, but real time air monitoring determined there was no substantive risk (Rainbow Pipeline Case Study).	VOCs were first detected at the Baker Estates subdivision in Battle Creek 3 days following the oil release. The subdivision is located ~15 miles from the original release location. No alert levels were exceeded (Marshall Case Study). Air monitoring performed in Glendive, Montana (5 miles upstream of a release) did not detect any VOC or benzene in the air for the 7 days following the release. (See Yellowstone River Case Study).	
Wind speed	Calm wind conditions will retard the evaporation of heavier volatile organic compounds (Fingas 1999). The evaporation rate of the more volatile organic compounds, such as benzene are unaffected by the wind conditions, so calm conditions and stable atmospheric conditions can result in the organic compounds being retained within the vicinity of the release site and can result in elevated concentrations.	A small increase in wind will allow mixing and increase the evaporation rate of the heavier organic compounds. Beyond the initial increase in wind from calm conditions to light, the volatilization rate of the organics is temperature related (Fingas 1999, Hanna and Drivas 1993). An increase in wind speed and instability will also increase the dissipation of volatile organic compounds, such as benzene and reduce ambient concentrations.	Heavy winds do not increase the volatilization rate of the heavier organic compounds from the crude oil matrix (Fingas 1999). Heavy winds will dissipate the volatile organic compound emissions, such as benzene, reducing ambient atmospheric concentrations.	

7.1.2.2 Groundwater

7.1.2.2.1 Description

Groundwater is water below the earth's surface that occurs in a porous or fractured geologic medium. The term groundwater is generally reserved for subsurface water that occurs beneath the water table and represents fully saturated geologic media (Freeze and Cherry 1979). However, the near surface partially saturated zone—referred to as the vadose zone—can be hydraulically connected to the underlying saturated zone and, as such, can play an important role in the discussion of potential groundwater effects from oil releases.

Groundwater is important as a water resource because of its significance as a source for domestic, agricultural, and industrial water supply, and its connection (source of recharge and discharge) to surface water bodies and natural surface water features (e.g., wetlands, fens, bogs, and marshes).

An oil pipeline release could potentially affect groundwater if the oil infiltrated into the soil and water soluble constituents in the oil partitioned into groundwater. If a sufficient volume of oil is released and the hydraulic pressure is sufficient to create a downward driving force, the oil in the pore space may infiltrate and reach the water table. Once in contact with the saturated zone, the vertical migration of the oil continues until buoyancy and increasing water content impede vertical migration. Water soluble compounds in the oil in contact with groundwater may form a dissolved-phase groundwater plume. If insufficient volumes and pressures of oil are present, the partially saturated vadose zone above the water table may hold oil in place and the released oil may never reach the water table. However, water soluble compounds may still dissolve into infiltrating pore water and may migrate to the water table. In general, sands and gravels allow for faster vertical migration of oil than less permeable soils composed of silts and clays.

Groundwater containing dissolved hydrocarbons may form an elongated plume in the direction of groundwater flow. Groundwater moves slowly, generally more slowly than water in rivers or streams. Groundwater flow rate is governed by the hydraulic gradient, and by the permeability of the medium and the effective porosity of the medium containing the groundwater (Freeze and Cherry 1979). In addition, natural attenuation processes such as retardation, biodegradation, and volatilization will limit the distance that dissolved phase constituents may migrate from the source of the oil release.

7.1.2.2.2 Observed Effects

Studies of crude oil and petroleum-related constituent releases provide a basis for evaluating the potential effects of crude oil releases on groundwater. A literature review was conducted to identify information on releases to groundwater. Following are the results of the review.

Most components of oils are relatively insoluble (Wang et al. 2003). However, oil in contact with groundwater will result in some dissolution of the soluble components. Generally, aqueous-phase

solubility decreases with increasing molecular mass (and size) of the hydrocarbon molecule (Rivett 2014). The relatively low molecular weight monocyclic-aromatic components of crude oil (BTEX) are some of the more water soluble hydrocarbon components of crude oil. Crude oil also contains PAHs, composed of between two and six fused benzene rings, often with alkyl side chains of one or more carbon units in length (i.e., alkylated PAHs). PAHs have moderate (e.g., naphthalene with two rings) to very low (e.g., 5- or 6-ring PAH molecules with alkyl side chains) solubility in water. The PAHs are considered to be toxic, and those PAHs having four or more benzene rings can also be carcinogenic. Therefore, the presence of PAHs can be a source of concern, even at low concentrations. Additionally, crude oil also contains heavy fractions that include waxes, asphaltenes, and nonpolar compounds, which are functionally insoluble in water, and may have limited bioavailability.

For those constituents that are relatively water soluble, the effective dissolved phase concentration is controlled by the concentration of the constituent in the oil and its solubility in water. It has been found that the maximum dissolved concentration of a constituent of oil in contact with groundwater is proportional to the mole fraction of the constituent in the oil (this is referred to as Raoult's Law), and as a result the individual constituents do not achieve the dissolved concentration in groundwater that might be expected based upon the solubility of the pure substance in water. Individual compounds are often more soluble in oil than in water, thus they tend to remain in the oil (O'Reilly et al. 2001). Additionally, because the most soluble components constitute a relatively small percentage of the overall mass of the oil, the effective soluble concentrations are relatively low. A study that compared the calculated dissolved-phase concentrations of 69 crude oils found that benzene was the only aromatic or PAH compound tested that is capable of exceeding groundwater protection values for drinking water (O'Reilly et al. 2001). Despite the relatively limited solubility of petroleum related constituents in groundwater, BTEX, and to a lesser degree PAH, dissolution remains one of the potential concerns of an oil release on groundwater.

MN PCA (2005) states that "[v]arious natural processes control the movement of a petroleum plume and act to limit the risk exposure. These processes include dispersion, sorption to soil particles, dilution, volatilization, natural biodegradation and natural chemical degradation. Of these processes, natural biodegradation through metabolism by naturally occurring microorganisms is the primary mechanism responsible for petroleum mass reduction. For most petroleum releases, natural biodegradation will reduce toxic chemical compounds to non-toxic metabolic byproducts". Numerous multi-site studies conducted since the 1990s have presented results that indicate dissolved-phase hydrocarbon plumes (primarily BTEX) stabilize at relatively short distances from the source area (Newell et al. 1990; Rice et al. 1995; Mace et al. 1997; Groundwater Services Incorporated 1997; Newell and Connor 1998; Ruiz-Aguilar et al. 2003; Kamath et al. 2012; Connor et al. 2015). Each of these studies indicated that dissolved-phase hydrocarbon plumes are unlikely to be greater than a few hundred feet in length. Newell and Connor (1998) presented a summary of four multi-site studies that evaluated the length of dissolved-phase BTEX plumes. Based upon the combined results of 604 sites, the median plume length was reported to be 132 ft, and 90% of the plumes were less than 319 ft in length. Similarly,

Connor et al (2015) presented a summary of 10 previous multi-site investigations in which plume length was evaluated for a total of 1,320 benzene plumes. Connor et al (2015) reported a median benzene plume-length of 140 ft and a 90th percentile of 345 ft at 772 sites delineated to 10 µg/L.

Of particular relevance is a study of 217 groundwater contaminated sites in Iowa that has similar surficial geology to that of the majority of the proposed pipeline routes, characterized by Quaternary glacial deposits (Ruiz-Aguilar et al. 2003). That study indicated mean plume lengths of 193 ft and 185 ft for dissolved benzene and toluene, respectively.

Studies of historical oil releases in Minnesota provide additional insight into the potential effects of oil releases on groundwater. The following provides a focus on a few cases with particular relevance to the conditions anticipated to be associated with the proposed pipeline.

> ***Bemidji, Minnesota****: Extensive studies of a release of crude oil near Bemidji, Minnesota, provided an in-depth understanding of the behavior of crude oil in a subsurface setting with similar geology and climate to sections of the proposed Project. The release has become known as the USGS Bemidji Crude Oil Research Site and is one of the most extensive research centers for land-based hydrocarbon releases. Researchers and regulatory agency personnel have agreed to limit remediation activities and to leave the remaining oil in place to study the effects of long-term natural attenuation processes. Research at Bemidji has involved extensive investigations of multiphase flow and transport, volatilization, dissolution, geochemical interactions, microbial populations, and biodegradation with the goal of providing an improved understanding of the natural processes limiting the extent of hydrocarbon contamination.*
>
> *On August 20, 1979, approximately 10 miles northwest of Bemidji, Minnesota, the land surface and shallow subsurface were contaminated when a crude-oil pipeline burst, releasing approximately 10,700 barrels of light crude oil (specific gravity 0.837 at 23°C; Baedecker et al. 2011) onto a glacial outwash deposit (Essaid et al. 2011). The site is located in the Bagley outwash plain near Bemidji, Minnesota. The surficial aquifer is approximately 60 ft thick and consists of sand and gravel outwash overlying till. Thin, discontinuous silt layers are inter-bedded with sand near the water table (Franzi 1988). The release occurred in the recharge area of a local flow system that discharges to a small closed lake approximately 1,000 ft hydraulically down gradient (Dillard et al. 1997). The burst section of pipeline was buried 5 to 10 ft below land surface, next to a railroad ROW, and approximately 15 ft above the water table. Locally, groundwater flows to the northeast with a mean groundwater flow velocity of approximately 300 ft per year (Bennett et al. 1993). Neither man-made hydraulic stresses (e.g., pumping wells and irrigation) nor other anthropogenic sources of the compounds of interest were present at the site at the time of the release.*

Clean-up efforts undertaken immediately following the release were able to recover approximately 75% of the released oil, and the remaining 25% is estimated to have infiltrated into the sand-gravel outwash aquifer forming three separate subsurface oil bodies (Essaid et al. 2011). Additional remediation activities during 1999 – 2004 removed a further 30,000 gallons of crude oil using a pump and skim remediation method (Enbridge 2008 in Essaid et al. 2011), but researchers requested that remediation be suspended to avoid interfering with ongoing research. Researchers and regulatory agency personnel have agreed to leave the remaining oil in place to study the effects of long-term natural attenuation processes.

Some crude oil infiltrated through the unsaturated zone to the water table near the rupture site and formed what is referred to as "the North pool." The separate-phase oil in the North pool was present within the sediment pore space from the land surface down through the unsaturated zone, and to 3 to 6 ft below the water table. Oil infiltrated through the unsaturated zone to form approximately a 5-ft thick zone containing separate phase oil at and below the water table. Some of the oil flowed over the surface toward a small wetland forming another oil-infiltration area (south oil pool). Oil saturations in the sediments (the volume fraction of pore space filled with oil) range from 10 to 20% in the unsaturated zone, to 30 to 70% near the water table (Dillard et al. 1997).

Spatial differences in the physical properties and degradation of the oil over time have caused alteration of the originally uniform source. The oil is selectively losing soluble and volatile compounds through dissolution and vaporization. Annual oil-mass loss rates of the crude oil source at different locations range from 0 to 1.25%, and total accumulated losses from the original oil mass are as much as 11% (Landon and Hult 1991). Dissolution of the free-phase oil into the groundwater has resulted in the formation of a plume of aliphatic, aromatic, and alicyclic (both aliphatic and cyclic) hydrocarbons. Infiltrated crude oil moved as a separate fluid phase approximately 100 ft in the direction of groundwater flow, while the plume of dissolved hydrocarbons in the groundwater extended up to 450 ft down-gradient from the leading edge of the source (600 ft in total; Cozzarelli et al. 2001). Most of the petroleum derivatives, including both aromatic and aliphatic compounds, migrating as solutes are actively being degraded by biologically mediated processes to carbon dioxide, water, and methane (Baedecker and Cozzarelli 1991).

An additional concern at the Bemidji site is the potential mobilization of naturally occurring heavy metals or trace elements such as arsenic. As a result of the geochemical and biochemical reactions occurring during the breakdown of hydrocarbons within the plume, studies have reported arsenic concentrations within the groundwater plume of 230 µg/L compared to less than 5 µg/L in

groundwater outside the plume (Cozzarelli et al. 2015). The arsenic was found to decrease down-gradient of the plume by re-attaching to the overburden solids through adsorption or co-precipitation with iron hydroxides, leading researchers to conclude that the breakdown of hydrocarbons alters the geochemistry of the area causing the release of arsenic from the overburden materials. Long-term monitoring of arsenic mobilization, as well as other naturally occurring heavy metals, is now occurring at the site.

The Bemidji site is in a remote area with sparse population. Therefore, the potential for harmful effects to groundwater used for water supply is low. Because of the large area over which the oil infiltrated the Bemidji aquifer, about 40% of the oil is trapped in the unsaturated zone, and a considerable volume of oil is in hydrodynamic equilibrium at the water table. Both the dissolved-phase plume and crude oil in the subsurface source have evolved over time as hydrocarbon compounds have degraded and dissolved at different rates (Landon 1993). Model results have also shown that compounds with high effective solubility (i.e., benzene) and/or rapid biodegradation rates (i.e., toluene) were more depleted in the oil body than heavier compounds (Essaid et al. 2003). The existing subsurface oil body remains source of hydrocarbon components that dissolve into and can be transported with groundwater. Nevertheless, the dissolved-phase plume at Bemidji site has stabilized at 450 ft long, predominantly due to biodegradation and spatial variability of site's hydraulic properties (Franzi 1988, Baehr and Hult 1991).

***Cass Lake, Minnesota**: An additional case study is available from a site near Cass Lake, Minnesota where a leak at a crude-oil pipeline pumping station resulted in subsurface infiltration of an estimated 1,150 barrels of crude oil to the water table, and development of a corresponding plume of dissolved constituents in groundwater. Unlike the Bemidji release, which occurred in a single incident more than 35 years ago, the Cass Lake release occurred as an ongoing leak over an unknown period of time, but may date back to when the pumping station began operations in 1971, ending after it was discovered in early 2002.*

The Cass Lake site is located approximately 25 miles from the USGS Bemidji, Minnesota, research site. The glacial outwash aquifer beneath the Cass Lake site constitutes part of the Bagley outwash plain. The aquifer consists primarily of moderately well sorted fine to medium grained sand and silt with some interbedded gravel. Grey calcareous clay-rich till underlies the aquifer approximately 25 to 45 ft below the land surface. The groundwater in the glacial outwash has a high horizontal hydraulic conductivity compared to the groundwater in the till (Drennan et al. 2010; Lohman 1972). Depth to the water table generally varies with topography and is roughly 25 to 30 ft below land surface (Wenck Associates 2006 in Drennan et al. 2010). Previous work indicated

that groundwater movement in the area is generally from northwest to southeast at a velocity of approximately 85 ft per year (Drennan et al. 2010).

A dissolved plume of benzene was estimated to extend approximately 500 ft to the southeast from the source. The dissolved plume is approximately 130 feet across and extends 6 to 10 ft vertically, with the location of maximum concentration becoming deeper with distance.

A monitoring program was established to define the extent of the contamination for the site and to verify human or ecological exposure. The remedial investigation included a review of all wells within a one mile radius of the site. The review concluded that no wells exist within 0.5 mile of the site in the direction the groundwater flows, 0.5 miles being greater than 5 times the estimated extent of the plume. Therefore, no humans have been exposed to any site contamination. Monitoring wells remain in place to detect if any contamination is moving toward any water wells. The monitoring also shows that the contamination is not entering a surface water body. The nearest potential surface water is Spike Lake, 0.5 mile away, well beyond the limits of contamination.

The USGS began a research project at the site in 2007 (Drennan et al. 2010). The research is focused on the natural attenuation and biodegradation of petroleum constituents in groundwater. As part of the USGS research, additional monitoring wells were installed specifically to monitor the natural attenuation of the dissolved groundwater plume in the down gradient direction. In 2010, the USGS published "U.S. Geological Survey Scientific Investigations Report 2010-5085: Fate and Transport of Petroleum Hydrocarbons in the Subsurface near Cass Lake, Minnesota," which details the results of the 2007 research project (Drennan et al. 2010).

The small area of the Cass Lake site leak presumably resulted in oil in hydrostatic equilibrium at the water table and with a minor amount of oil in the unsaturated zone. The progression of biodegradation of oil proceeds in a quasi-sequential manner with easily degradable compounds being lost first, but more resistant classes of compounds begin degrading before complete loss of less-resistant compounds. Data for the Cass Lake site oil samples show near complete depletion of the n-alkane fraction, placing the oil in the category of "heavily degraded" (Drennan et al. 2010). The alkyl-cyclohexanes are only partially degraded, indicating that the oil has not yet reached the category of "severely degraded." As oil degradation proceeds through higher levels of severity, the soluble fraction decreases to the point where very little dissolution of compounds into the groundwater occurs. Once the oil reaches this degradation state, at an unknown time in the future, the groundwater plume is not expected to pose a risk for further expansion. In the long term, a residual fraction of heavily degraded oil

> *consisting mainly of an unresolvable complex mixture of compounds will remain in the aquifer.*
>
> *The highly degraded state of the Cass Lake oil represents one of the important findings of the study. Although the start date of the Cass Lake leak is unknown, the highly degraded nature of the Cass Lake oil suggests the leak was active for decades. The Bemidji release is known to have occurred on August 19, 1979. After more than 30 years, the released oil in some locations is less degraded than the Cass Lake samples. Three possible aspects of the Cass Lake release that may contribute to the highly degraded state of the Cass Lake oil are: (1) the leak was active for many years, (2) high recharge rates stimulate degradation, and (3) the leak occurred slowly. The geochemical and microbial data show the redox conditions are similar to the Bemidji plume, which is decades old. Thus, the Cass Lake oil leak may have been present since the pumping station first began operations in 1971.*

7.1.2.2.3 Expected Effects of Released Oils

The potential effects of crude oil releases on groundwater include infiltration of residual oil into the vadose and saturated zones. The infiltrated oil may serve as a source of dissolved-phase volatile organic compounds in groundwater which in addition may alter the geochemical character of groundwater facilitating the increased dissolution of metals and other trace elements. The potential for releases to adversely affect groundwater quality depends upon multiple factors, including hydraulic gradient, soil type, geology, seasonal conditions, oil type, and the water solubility of constituents in the oil.

When crude oil is released to the ground, it needs to displace an equivalent volume of the resident fluids (air and/or water) from the soil. To infiltrate and enter a pore space it must overcome both the capillary pressure and the hydrostatic pressure needed to displace water (referred to as pore entry pressure). The ability of the oil to enter the pores is largely a function of the pressure of the release, properties of the geologic media, and density and viscosity of the oil (ITRC 2009). If a sufficient volume of oil is present overlying a porous media, it begins to enter the unsaturated pore spaces by moving downward under the force of gravity. This can be accompanied by lateral spreading due to geologic heterogeneity. Such liquids must have a sufficiently low viscosity to move through the local surface soils and overburden to reach the groundwater.

The percentage of oil held in pore space by the formation is referred to as "residual saturation." Oil at residual saturation is functionally immobile. It is in a state where additional movement is not anticipated because the forces of gravity are balanced by the capillary pressure. The oil distribution following gravity drainage from pores is characterized by an irregular, heterogeneous distribution of disconnected ganglia. Because a small amount of oil is retained in the pore space, the ability of the crude oil to reach the groundwater is a function of the vertical distance

that the oil must travel. The residual oil in the pore space may come in contact with infiltrating water and become a source of a dissolved-phase contaminant plume.

In the case of crude oil, which is less dense than water, downward migration continues through materials that are partially saturated with water until it reaches the water table. This impedes its migration deeper due to both increasing water content and associated buoyancy forces arising from the oil-water density contrast. Near the water table crude oil and water coexist in pore space as a smear zone and the vertical equilibrium distribution is determined by capillary pressure. The magnitude of lateral spread of oil near the water table is determined principally by the subsurface geology, size of the release, as well as the properties of the crude oil (e.g., density and viscosity) (Rivett 2014).

The mobility of oil in the unsaturated zone depends primarily on several factors: (1) its saturation in the pore space relative to the other fluids, (2) the pressure (matric potential) that drives the flow of oil (driving head); (3) the vertical permeability of the unsaturated soils; and (4) the physical properties of the oil (largely viscosity and density).

The horizontal flow velocity in groundwater is a function of fluid physical properties (e.g. viscosity), the groundwater pressure gradient, and hydraulic properties of the porous media (Freeze and Cherry 1979). The equation for flow velocity (Darcy's law) may be written as follows:

$$v = k\,\mathbf{d}P/\mathbf{u}\,\mathbf{d}x$$

Where:

v = fluid flow velocity
k = intrinsic permeability of the media
dP = the applied pressure difference
dx = the thickness of the porous media
u = viscosity

Factors that modify the behavior of crude oil releases with respect to groundwater contamination include soil type, hydraulic pressure, and crude oil properties, especially the amount and solubility of BTEX compounds. More permeable soils, such as sand and gravel, will allow for relatively faster infiltration and lateral migration of crude oil than less permeable soils, such as silt and clay. Coarse-grained soils would more readily admit or absorb released oil and, therefore, would be more prone to the development of persistent hydrocarbon plumes or free product. Increased hydraulic pressure results in increased gradients and faster flow velocity. Crude oils with low viscosity would also be more readily absorbed by soils and have greater potential to reach the water table.

Because both water and oil move slowly in the pores between soil grains, the distance between the ground surface and the water table (i.e., the depth to the water table) will also affect whether the oil reaches the water table, and the time it takes to get there. Thick unsaturated

zones (greater depths to the water table) may act as a "sponge" to hold crude oil in place, more so than thin unsaturated zones with less pore volume storage. In situations where a small amount of oil is released, the soils are less permeable, or where the water table is very deep, oil may remain in the unsaturated zone and never reach the water table. At some time following termination of the release, the oil will reach a hydrostatic equilibrium and be functionally immobile (ITRC 2009). At that point dissolution and volatilization cause gradual depletion of lighter crude oil constituents, which may be accelerated by local dissolved-phase plume biodegradation (Rivett 2014). The degradation of the oil body may be relatively slow. As described in the Bemidji and Cass Lake releases, more than 30 years following the releases, oil and groundwater plumes remain in the subsurface (Essaid et al. 2011; Drennan et al. 2010).

Dissolved hydrocarbons may enter the groundwater through preferential dissolution of the soluble constituents. Light oils also typically contain higher levels of the more water soluble hydrocarbons, such as BTEX, and this also would tend to increase the potential for the development of groundwater contamination. Benzene is the primary constituent of crude oil that is capable of exceeding drinking water standards in groundwater (O'Reilly et al. 2001). Dissolved hydrocarbon plumes may move laterally; however, the lateral distance traveled is relatively short, generally less than a few hundred feet, and balanced by natural attenuation processes that reduce the concentration in groundwater over time. Natural attenuation will transform most toxic constituents of petroleum releases into non-toxic metabolic byproducts, typically carbon dioxide and water (MN PCA 2005). Numerous multi-site studies conducted since the 1990s have presented results that indicate dissolved-phase hydrocarbon plumes stabilize at relatively short distances from the source area and are unlikely to be greater than a few hundred feet in length (Newell and Connor 1998; Connor et al. 2015). The groundwater plumes resulting from the Bemidji and Cass Lake releases are reported to have traveled a maximum distance of approximately 450 ft and 500 ft, respectively.

Oil releases that affect the groundwater may also change the groundwater geochemistry as the hydrocarbons undergo biodegradation. The microbial degradation of hydrocarbons consumes oxygen and affects the reduction-oxidation (redox) state of other substances, such as sulfate, iron, and manganese present in the subsurface environment. Such redox reactions can transform iron and manganese from solid to soluble phases, and, in the process, release other trace elements that were previously bound by or co-precipitated in the solid phase. Arsenic concentrations within the hydrocarbon plume at the Bemidji site have been reported to be significantly higher than background concentrations and exceed drinking water standard, as the chemical reactions within the plume have caused arsenic to mobilize and leach out of the overburden solid phase (Cozzarelli et al. 2016). Arsenic is naturally present in soils and sediments, but is not usually a health concern unless it is mobilized by a chemical reaction and dissolves into groundwater. Arsenic released in the hydrocarbon plume is expected to reattach to aquifer sediments down-gradient from the plume, limiting the extent of the arsenic contamination in the groundwater to the approximate extent of the dissolved phase plume (Cozzarelli et al. 2016).

Key findings related to the potential effects of crude oil releases to groundwater are presented below.

- A crude oil release could potentially affect groundwater if the oil infiltrated into the soil and water soluble constituents in the oil partitioned into groundwater.
- Specific environmental conditions must be met to allow for the soluble components to reach the groundwater. The ability of a crude oil or the soluble components of crude oil to reach the groundwater is influenced by the depth to groundwater, geologic material permeability, and recharge.
- The ability of a crude oil to migrate vertically through a soil column is also influenced by the crude oil properties and release characteristics: hydraulic pressure, crude oil viscosity, crude oil density, and time.
- Dissolved hydrocarbons may enter the groundwater through preferential dissolution of the soluble constituents with benzene being the primary constituent of crude oil that is capable of exceeding drinking water standards in groundwater.
- Dissolved hydrocarbon plumes may move laterally in the direction of groundwater flow; however, the lateral distance traveled is relatively limited (generally less than a few hundred feet) and balanced by natural attenuation processes that reduce the concentration in groundwater over time and with travel distance in the aquifer.
- Crude oil releases that affect the groundwater also have the potential to change the groundwater geochemistry as the hydrocarbons undergo biodegradation. Redox reactions can transform iron and manganese from solid to soluble phases, and, in the process, release other trace elements, such as arsenic, that were previously bound by or co-precipitated in the solid phase. However, such trace elements are also likely to be removed from the dissolved phase and return to the solid phase once the groundwater emerges from the influence of the dissolved hydrocarbon plume.

Studies show that groundwater plumes of hydrocarbon compounds can persist for many years following a release of crude oil. Residual crude oil has the potential to serve as a source of dissolved phase contaminants in groundwater at concentrations above drinking water standards. However, the effects are generally restricted to low molecular weight hydrocarbons such as the BTEX compounds, and are limited to a relatively small area proximal to the release.

Table 7-14 and Table 7-15 provide a summary of the expected environmental effects of oil releases to groundwater. Table 7-14 considers the effects of specific oil characteristics or oil type on the expected type and scope of environmental effects. Table 7-15 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-14 Environmental Receptor: Groundwater

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil chemistry—soluble constituents	Light crude oils often contain relatively higher levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, depending on the oil type, but can be high (>10,000 mg/kg) in Bakken oils.	Medium crude oils often contain moderate levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, but can exceed 10,000 mg/kg.	Levels of BTEX and other relatively water soluble constituents are variable: generally low in heavy conventional oils, but variable in diluted bitumens depending upon the nature of the diluent. Levels of TPAH are variable, but typically depleted in napthalene and less than 10,000 mg/kg.	Regardless of the specific ratio of soluble constituents in the oil chemistry, benzene is the primary constituent that is typically capable of exceeding drinking water standards in groundwater (O'Reilly et al. 2001). The length of dissolved constituent plumes in exceedance of drinking water standards are generally less than a few hundred feet from the release location.
Oil properties—viscosity	Light crudes exhibit lower viscosity (1 to 5 mPa•s; NAS 2015). As a result of the lower viscosity, light oils are capable of infiltrating into soils at a relatively faster rate than higher viscosity oils.	Medium crudes have an intermediate viscosity (8 to 112 mPa•s; NAS 2015).	Heavy crudes (820 to 475,000 mPa•s) and diluted bitumens (270 to 50,000 mPa•s) weather to high viscosity (NAS 2015). The viscosity of fresh diluted bitumen is reduced by the addition of diluent, to conform to pipeline specifications.	The ability of oil to be transmitted through permeable media is inversely proportional to its viscosity. Viscosity is a function of oil chemistry. Diluted bitumens tend to display a more rapid increase in viscosity due to weathering than conventional heavy crude oils as a result of the rapid initial evaporation of some of the diluent. Viscosity also affects the residual saturation (amount of oil held within the formation). Residual saturation increases with viscosity. Recovery of released oil is facilitated if the oil is less dense and, as a result, exhibits a lower residual saturation.

Table 7-14 Environmental Receptor: Groundwater

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—density	Light crude oils typically have a low relatively specific gravity (0.78–0.88 g/mL, (Dupuis and Ucan-Marin 2015). The ability of the oil to enter the pores of a geologic medium is affected by density (ITRC 2009). Less dense fluids would be anticipated to infiltrate at a lower rate (all other factors being equal). In addition less dense fluids that migrate to the water table may spread more and penetrate the water table less due to the buoyancy effect caused by the density difference between water and oil.	Medium crude oils typically have an intermediate specific gravity compared to light and heavy crudes (Dupuis and Ucan-Marin 2015).	Heavy conventional crude oils can have density ranging of 0.88 to 1.00 g/mL, while fresh diluted bitumen will have a density less than 0.94 g/mL, increasing towards a density of 1.00 g/mL or slightly higher when fully weathered (Dupuis and Ucan-Marin 2015).	Density is directly proportional to the ability of the oil to move through a permeable material. An oil release with a relatively low density will travel faster in the subsurface than a relatively denser fluid. In addition the buoyancy will influence the distribution of oil at the soil water interface with less dense oils accumulating closer to the top of the water table and extending further into the capillary zone. Density and viscosity are correlated, so low density oils also tend to have low viscosity, whereas oils having higher density tend to have higher viscosity. High density slightly increases the ability of crude oil to flow within the overburden, but not to the extent that the higher viscosity is limiting the potential for movement.

Table 7-15 Environmental Receptor: Groundwater

Environmental Characteristic	Low	Medium	High	Other Comments
Soil permeability	Less permeable soils, such as silt and clay, will allow for relatively slower migration of crude oil than more permeable soils.	Medium-grained soil (fine sand to coarse sand) will allow for moderate oil infiltration	More permeable soils, such as sand and gravel, will allow for relatively faster migration of crude oil than less permeable soils.	Coarse-grained soils would more readily admit spilled oil, and, therefore, would be more prone to the development of persistent hydrocarbon plumes or free product. It is also noted that shallow bedrock exhibits a unique environment where permeability may be relatively low but isolated fractures may allow crude oil to be transported relatively quickly through preferential flow pathways.
Depth to groundwater	Thin unsaturated zones with less pore volume storage are more susceptible to oil migrating to the water table and potentially impacting groundwater resources.	Moderate unsaturated zones are relatively less susceptible than thin unsaturated zones.	Thick unsaturated zones are less susceptible to oil migrating to the water table. In situations where a small amount of oil is released or the water table is very deep, oil may remain in the unsaturated zone and never reach the water table.	Because both water and oil move slowly in the pores between soil grains, the distance between the ground surface and the water table (i.e., the depth to the water table) will affect whether the oil reaches the water table, and the time it takes to get there. Unsaturated zones may act as a "sponge" that hold crude oil in place. In situations where a small amount of oil is released or the water table is very deep, oil may remain in the unsaturated zone and never reach the water table.

Table 7-15 Environmental Receptor: Groundwater

Environmental Characteristic	Low	Medium	High	Other Comments
Weather conditions—temperature	Light oils remain fluid at lower temperatures and retain the potential to spread rapidly during the winter. In summer, light crude oils would also flow readily, having a greater potential to infiltrate more quickly than more viscous heavier oils.	Medium oils are slightly more viscous than light oils, and would also tend to flow readily under winter conditions. Medium crude oils would tend to flow readily under summer conditions.	Heavy oils become much more viscous at low temperatures, and as they weather. Heavy oils and diluted bitumens would have more resistance to flow than would be the case for light or medium crude oils. During the summer, diluted bitumens would flow readily.	Temperature affects both the behavior of oil in the environment, and the rate of natural attenuation processes such as volatilization and biodegradation. Key physical properties of oil such as viscosity may be sensitive to temperature. In addition, temperature plays an important role in biodegradation of hydrocarbons by affecting the physiology and diversity of the microbial community. Winter conditions such as frozen ground may greatly reduce the surficial permeability of soils inhibiting the vertical migration to groundwater.
Organic carbon content	Geologic media with low organic carbon content (e.g., clean sands and gravels) may be more prone to larger dissolved phase plumes because the constituents are not retarded by the adsorption/desorption processes.	NA	Soils containing abundant organic carbon (e.g., near surface soils and peats) may retard the transport of petroleum constituents in the subsurface.	Organic carbon can retard transport of dissolved petroleum hydrocarbon constituents reducing the potential overall distribution of these constituents in groundwater.

Table 7-15 Environmental Receptor: Groundwater

Environmental Characteristic	Low	Medium	High	Other Comments
Geochemistry	A relatively low quantity of electron acceptors such as oxygen, nitrate, iron or sulfate may limit the biodegradation processes. A low concentration of metals will limit the potential mobilization of metals in groundwater.	Moderate geochemistry is relatively less amenable to biodegradation and less susceptible to mobilization of metals than zones with an abundance of electron receptors and available metals.	An abundance of electron receptors within the dissolved plume may promote biodegradation processes. A high concentration of heavy metals and trace elements, such as arsenic, may support the potential mobilization of these constituents in groundwater.	The natural geochemistry of groundwater may influence both the natural attenuation processes and the potential dissolution of metals. Many indigenous microorganisms in groundwater and soil are capable of degrading hydrocarbon contaminants; however, this process may be rate limited by the presence of electron acceptors. The infiltrated oil may alter the geochemical character of groundwater, facilitating the increased dissolution of potentially toxic heavy metals and other trace elements such as arsenic.
Local recharge—rainfall	Low recharge will retard or delay the infiltration of soluble oil constituents towards the groundwater table, and into the groundwater.	N/A	High recharge will accelerate the infiltration of soluble oil constituents towards the groundwater table, and into groundwater.	Periods of high rainfall and high water levels could increase dissolution of soluble components of crude oil and facilitate transport to groundwater, while also reducing the time available for oil spill response activities to prevent environmental effects on groundwater quality.

Table 7-15 Environmental Receptor: Groundwater

Environmental Characteristic	Low	Medium	High	Other Comments
Release properties—driving head	The ability of an oil to penetrate a permeable geologic media is partially a function of the driving head (matric potential) exerted by the oil. A relatively small driving head would result in a low infiltration rate, all other factors being equal.	N/A	The ability of an oil to penetrate a permeable geologic media is partially a function of the driving head (matric potential) exerted by the oil. A relatively large driving head would result in a high infiltration rate, all other factors being equal.	Fluid flow velocity in a permeable media is governed by Darcy's law which relates velocity to intrinsic permeability, porosity, and applied pressure. The fluid velocity is directly proportional to the applied pressure.
Release properties—time	The volume of oil able to penetrate the subsurface is related to the rate of infiltration and time. A short time to spill response would be expected to result in a relatively smaller volume of oil in the subsurface, and lower potential for effects on groundwater.	N/A	A long time to spill response would be expected to result in a relatively larger volume of oil in the subsurface, and greater potential for effects on groundwater.	The volume of oil able to migrate vertically through a soil column is influenced by the oil infiltration rate and time. The oil volume able to penetrate the subsurface is directly proportional to the time the oil remains in contact with the geologic media. A quick and effective response to an oil release will minimize the potential for adverse effects on groundwater.

7.1.2.3 Lakes

7.1.2.3.1 Description

Lakes are defined as permanent standing water bodies surrounded by land. The water is typically fresh, although occasionally (usually in arid areas) it can be brackish or saline. Lakes may transition to wetland areas such as bogs, marshes, fens or swamps, but are differentiated by having predominantly open water, not occupied by vegetation. Such wetland areas are often peripheral or adjacent to lakes. Lakes may also transition into slowly moving river areas and can be differentiated on the basis of whether factors dominating flow are hydraulic (i.e., rivers) or wind and thermal circulation (i.e., lakes). Lakes are included in the effects assessment of land cover receptors due to their importance to aquatic and terrestrial life. They provide habitat for fish, amphibians, plants, benthic invertebrates, insects, birds, and mammals.

The effects assessment for lakes focuses on physical and chemical effects (i.e., habitat and water quality) of released, and excludes direct effects of oil on aquatic biota (e.g., aquatic plants, fish, wildlife) or sediment quality, which are considered elsewhere. Crude oil that enters a lake will generally float on the water surface. However, oil can also enter the water column as dissolved hydrocarbons or as liquid hydrocarbon in forms that range from small droplets suspended in the water column, to larger globules or other forms of oil that may re-surface, remain suspended in the water column, or sink to the bottom (Hollebone et al. 2011). Relevant petroleum exposure monitoring parameters in water include benzene, toluene, ethyl benzene and xylene (BTEX, low molecular weight and relatively volatile and water-soluble fractions that weather and biodegrade quickly), polycyclic aromatic hydrocarbons (PAHs, more persistent substances composed of two or more fused benzene rings, which are more often implicated in chronic environmental effects of hydrocarbons) and aliphatic hydrocarbons (hydrocarbon molecules that are composed of more linear, although often branched, chains of carbon atoms). More general monitoring parameters include "total" or "extractable" petroleum hydrocarbon (TPH/EPH).

7.1.2.3.2 Observed Effects

There is potential for oil released accidentally from a pipeline to reach a lake proximal to, and downgradient from, the pipeline corridor. However, releases directly to a lake appear to be rare, given that pipeline routes typically avoid lakes. A more common scenario is for oil to enter a stream or river, and then move downstream to a lake. This is supported by the literature on oil releases. Discussions of four case studies with circumstances similar to those that might be encountered in the event of an oil release from a pipeline in Minnesota are presented below.

> ***Wabamun Lake, Alberta:*** *On August 3, 2005, a train belonging to Canadian National railways derailed, releasing approximately 4,500 barrels of Heavy Fuel Oil 7013 (a Bunker C type fuel oil with a high viscosity and an initial density of about 0.99 at lake temperature) and 553 barrels of pole treating oil (Transportation Safety Board of Canada 2007). About 20% of the released heavy fuel oil*

(950 barrels) traveled overland and entered Wabamun Lake. No appreciable volume of pole treating oil entered the lake (Hollebone et al. 2011).

In the lake, the oil floated and spread rapidly over the lake surface. After a few days, strong winds and wave action dispersed the oil toward the northern, eastern, and southern shorelines, where it became entrained in macrophyte beds (Thormann and Bayley 2008; Anderson 2006). The windy conditions also resulted in mixing of the oil in the water column, with PAH and BTEX concentrations initially higher in boomed areas than Canadian water quality guidelines for protection of aquatic life, but lower than the guidelines in open water areas outside the boomed areas (Anderson 2006). While traveling overland, the oil mixed with soil and organic matter, and in the lake, OPAs formed quickly, including small tar balls, larger balls called "tar logs," submerged sheets, and large lumps. The composition of the aggregates was not static, and tar balls sometimes reformed into oil slicks (Fingas et al. 2006; Hollebone et al. 2011). The aggregates showed a variety of behaviors, including submergence, neutral buoyancy, and resurfacing (Fingas et al. 2006), with extensive tar mat formation in some nearshore areas. Behavior of oil in the lake (rapid formation of tar balls, sinking, slow degradation due to high proportions of high molecular weight components such as resins) and toxicity and persistence due to high PAH levels but low BTEX levels, was related to characteristics of the heavy fuel oil. Within four months of the release, concentrations of BTEX and PAHs were below detection in lake water (Birtwell 2008; Anderson 2006).

High initial density and viscosity, and a lack of lower molecular weight components in the heavy fuel oil distinguish this released oil from the types of crude oil and diluted bitumen products expected to be transported in the proposed pipeline.

***Marshall, Michigan:** On June 25 and 26, 2010, the Line 6B pipeline owned and operated by Enbridge ruptured, releasing approximately 20,000 barrels of heavy crude oil (NTSB 2012a). Of the released oil, approximately 8,200 barrels entered Talmadge Creek, a tributary to the Kalamazoo River, near Marshall, Michigan (NTSB 2012a). The released oil was a combination of Western Canadian Select and CLB diluted bitumens. The release occurred on the floodplain of Talmadge Creek, where wetlands are abundant (USFWS et al. 2015a). Some of the released oil traveled down Talmadge Creek to the Kalamazoo River.*

The Kalamazoo River is a meandering, low gradient river with diverse channel and floodplain features, extensive floodplain forests and wetlands, off-channel water bodies, and impoundments (Dollhopf et al. 2014). Upon entering the water, the density of the crude oil was less than that of water, and it floated, forming an oil slick that flowed downstream. The Kalamazoo River was in flood at the time of

the release, and oil was carried as far as Morrow Lake, an impoundment in the river, 36.5 miles downstream. Oil was deposited on river shoreline, riparian, and depositional areas, and also along the shores at the delta of Morrow Lake (USFWS et al. 2015a).

High river flows entrained some of the oil into the water column (resulting in submerged oil). Dam spillways may also have caused emulsification of some of the oil, and driven further oil into the water column. Over time, weathering of the lighter components and interaction of the submerged oil with suspended or shoreline/bottom sediments resulted in some of the oil sinking to the river bed in slow-moving or depositional areas of the river, particularly the upper end of Morrow Lake, a lake-like impoundment in the river. Formation of OPAs was likely promoted by the flood conditions at the time of the release, which increased turbulence and suspended sediment loads in the river, and by the turbulent mixing of water and oil (Fitzpatrick et al. 2015). The oil that reached Morrow Lake had been pre-conditioned by river transport (weathering, formation of OPAs) prior to reaching the lake.

Surface water was sampled from July 2010 through April 2012 and measured for oil-related and non-oil related chemicals. Only a very few of these measured chemicals were detected above health-protective screening levels and most of the chemicals detected at these levels were PAHs (MI DCH 2014b). It was not expected that people would be exposed to levels of these chemicals that would cause long-term health concerns.

Oil was deposited on sediments in the delta of Morrow Lake, and subsequently removed during clean-up activities.

Red Deer River, Alberta: *On June 7, 2012, approximately 2,900 barrels of light crude oil was released from a ruptured pipeline owned and operated by Plains Midstream Canada ULC, into Jackson Creek, a tributary of the Red Deer River, about 1.9 miles north of Sundre, Alberta. Floodwaters 10 times higher than the typical June flows eroded the stream bed and banks, and exposed the pipeline under the river, which then ruptured (Alberta Energy Regulator 2014). Oil travelled at least 25 miles downstream to Gleniffer Lake reservoir, where booms contained the floating oil. Dissolved hydrocarbons in river water were detected up to 5 miles further downstream during the first week post-release (Alberta Environment and Sustainable Resource Development [ESRD] 2012a).*

Hydrocarbon (BTEX, PAH, and alkanes) concentrations in water were monitored twice a day in the first week post-release, then once a day to July 12, 2012 (Alberta ERSD 2012b). Lighter weight hydrocarbons (BTEX) evaporated quickly, but some dissolved in the river water and, in the early days post-release, were

detected up to 30 miles downstream of the release location. One day post-release, benzene and toluene were detected in Gleniffer Lake, with toluene (peak of 0.0314 mg/L near the booms) above the Canadian water quality guideline for aquatic life (0.002 mg/L). BTEX and PAHs attributable to the release were detected up to nine days post-release. PAH concentrations also decreased over time and were below Canadian water quality guidelines for protection of aquatic life on all dates, except for benz(a)anthracene at three times the guideline four days post- release at several locations in Gleniffer Lake.

The main concerns for Gleniffer Lake and downstream areas were for drinking water quality, but monitoring indicated no detectable hydrocarbons in drinking water intakes (Alberta ERSD 2012b). Reports of habitat studies in Gleniffer Lake were not found. The lack of studies is likely due to concerns about lake habitat being reduced because of the low volume of the release in proportion to the volume of river (large dilution) and the high amount of weathering, related to both distance (25 miles) and type of oil released (light crude oil) upstream of Gleniffer Lake. No reports were found of oil sinking in the river or Gleniffer Lake.

Unamed Lake, Alberta: *On June 22, 2013, a break in Line 37, the Line 37 pipeline owned and operated by Enbridge Pipelines Inc., resulted in release of 1,300 barrels of synthetic light crude oil onto the pipeline ROW. The oil traveled overland to a fen, then reached a small, unnamed lake. Physical barriers were deployed to limit spreading of the oil. As part of the subsequent site assessment and remediation process, total of 137 sediment samples were collected from 64 locations between July and August, 2014. In sediment, the highest petroleum hydrocarbon concentrations were found along the northwest shoreline of the lake. Targeted sediment excavation occurred in the northwestern portion of the lake where the highest hydrocarbon concentrations were observed close to shore (Hemmings et al. 2015).*

Mayflower, Arkansas: *On March 29, 2013, a breach in the 20-in. Pegasus Pipeline operated by the ExxonMobil Pipeline Company released crude oil into a residential neighborhood in Mayflower, Arkansas (Arcadis 2014). The crude oil was identified to be Wabasca heavy crude oil (a type of diluted bitumen originating from Alberta, Canada). An emergency response action was implemented to mitigate the release, resulting in the recovery of a substantial amount of the crude oil. From the residential area, some of the oil entered a drainage way leading to a shallow drainage swale along North Main Street. From there the oil flowed east under Highway 365 and Interstate 40 (I-40) into a marsh known as Dawson Cove (Figure 1-1). Dawson Cove is separated from Lake Conway by Highway 89, with water conveyed between the cove and lake by two culverts beneath the highway (Arcadis 2014).*

Sediment samples (including both surface and subsurface samples) were collected at 53 locations within the drainage ways, Dawson Cove, and Lake Conway. Background sediment samples were collected from six distant locations in Lake Conway upstream of the generalized flow path from Dawson Cove to the Lake Conway dam and six locations in shallow ditches upstream of the primary drainage path from the residential area to Dawson Cove. A total of 125 sediment samples were collected at 34 locations in Dawson Cove. Based on the screening results, hydrocarbon concentrations in 118 of 125 sediment samples were found to be at levels that did not require further evaluation (Arcadis 2014). Seven samples had xylenes and/or isopropylbenzene above the ESV; a refined risk evaluation, indicated that at the reported concentrations, no adverse effects were anticipated for aquatic life in Dawson Cove sediment (Arcadis 2014). A total of 18 sediment samples were collected at 6 locations in Lake Conway. Based on the screening results, sediments in Lake Conway did not warrant further evaluation (Arcadis 2014).

7.1.2.3.3 Expected Effects of Released Oils

The expected effects of crude oil released into a lake are changes in water quality and effects on physical habitat quality. The further effects of these changes on sediment quality and biological components of the aquatic environment (such as fish and wildlife) are discussed elsewhere. Most crude oils float on water (i.e., they have an initial density that is less than the density of fresh water). This applies to light crude oils such as Bakken oils, as well as to heavy crude oils such as diluted bitumens, which are generally limited to a maximum density of 0.94 when shipped by pipeline. While raw bitumen may have a density that is greater than 1.0, raw bitumen would be far too viscous to pump through a pipeline. It has been suggested (NAS 2015) that diluted bitumen could weather rapidly after being released, so that changes in its properties could result in sinking. However, Lee et al. (2015) concluded that "the observation of evaporative mass losses of less than 20% after rigorous weathering at environmentally-relevant temperatures for dilbits nominally comprising greater than or equal to 30% diluent suggests that a substantial proportion of diluent remains intimately associated with bitumen". Therefore, diluted bitumen is unlikely to weather naturally to a density greater than that of fresh water within a timeframe that is relevant to oil spill emergency response operations.

A release of fresh diluted bitumen is expected to result in effects similar to those for other heavy crude oils. Diluted bitumen does not completely separate into diluent and bitumen components when released (Taylor et al. 2014; Zhou et al. 2015; Fingas 2015a). Diluted bitumen floats on water and can be stranded on shorelines. Released oil can pick up soil and organic matter from land or water, and then form OPAs, which can sink if sufficient amounts of particulate matter are incorporated in the oil particulate aggregates. A high proportion of diluent (e.g., condensate) will evaporate quickly and some will be dissolved in the water column. The residual oil components (PAHs, heavier alkanes, etc.) will degrade more slowly.

Crude oil released into a lake environment will generally spread as a slick or sheen, depending upon the ambient temperature and viscosity of the oil. Light crude oils might spread out to form very thin slicks or sheens, whereas heavy crude oils will form thicker slicks, with associated sheens. Depending upon the volume of crude oil released, the size of the water body, and weather conditions, the oil could spread out to cover the whole surface of the lake. Alternatively, strong winds might herd the released oil to the downwind side of the lake. There, the oil might be driven onto shore, and wave action might entrain some of the released oil into the water column as droplets of various sizes.

When oil comes into contact with sediment, interactions between the oil and the sediment can result in the formation of aggregates that have a density greater than that of water. Two main types of interaction occur: small droplets of oil suspended in the water can become coated with adhering fine sediment particles to form OPAs. Light crude oils with low viscosity are more readily entrained into water as small droplets than heavy crude oils. Therefore, light crude oils may be more prone to formation of OPAs than heavy crude oils. Alternatively, larger droplets, globules, or masses of oil can acquire silt, sand or gravel-sized particles as a result of interactions along shore. The resulting aggregate can also have density greater than that of the water and sink. Diluted bitumens and other heavy oils appear to be more prone to this second type of interaction with sediment particles. Importantly, however, any type of oil can sink as a result of interaction with particles that are denser than water.

The expected effects of released crude oil on water quality are often of short duration (i.e., days rather than weeks or months) because the more water soluble components of crude oil tend to evaporate within the first 24 hours of release. When dissolved in the water column, these compounds also tend to undergo biodegradation quickly (Lee et al. 2015). However, effects on physical habitat (from oil stranded on shorelines or incorporated into sediment) can last for much longer, and potentially for years if not remediated.

Table 7-16 and Table 7-17 provide a summary of the expected environmental effects of oil releases to lakes. Table 7-16 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-17 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-16 Effects of Oil on Lakes by Oil Characteristic

LAND COVER RECEPTOR: Lakes				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Comments**
Density	Light crude oils have API gravity of >31.1°.	Medium crude oils have API gravity of 22.3-31.1°.	Heavy crude oils have API gravity <22.3°, with diluted bitumens generally falling in the range of API gravity between 16 and 23°.	Oils of API gravity >10° will float on fresh water at 15 °C. Therefore, the fresh oils are all expected to float on water.
Viscosity	Light crude oils have viscosity generally in the range of 5 to 50 cP. Low viscosity oils are more likely be become entrained into the water column as small droplets, where mixing energy is high (e.g., windward shorelines).	Medium crude oils have viscosity generally in the range of 100 to 350 cP.	Heavy crude oils have viscosity generally in the range of 350 to 500 cP, although this rises rapidly with weathering. With higher viscosity, heavy crude oils are more resistant to becoming entrained into the water column as small droplets, although larger globules of oil may temporarily become submerged and re-surface.	Viscosity decreases with temperature, and increases with weathering.
Volatility	Contains a large fraction of volatile low molecular weight hydrocarbons; most prone to weathering by volatilization.	Intermediate in volatility and tendency to weather through volatilization between light and heavy crude oil.	The fraction of volatile low molecular weight hydrocarbons depends upon the oil type. Conventional heavy crude oils may have relatively low volatiles content. However, diluted bitumens contain diluent, which may (e.g., condensate) or may not (e.g., synthetic crude oil) contain a large volatile component. CLWB is an example of a diluted bitumen with a relatively large component of condensate and a volatile content similar to that of many light crude oils.	High volatility is generally correlated with low density, and low viscosity in crude oils.
Solubility in Water	Contains a large fraction of soluble low molecular weight	Intermediate in proportions of soluble low molecular weight hydrocarbons	The fraction of soluble low molecular weight hydrocarbons depends upon the oil type. Conventional heavy crude oils	Undiluted bitumen is virtually insoluble, but diluent added to bitumen contains a high

Table 7-16 Effects of Oil on Lakes by Oil Characteristic

LAND COVER RECEPTOR: Lakes				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Comments**
	hydrocarbons, and therefore can release relatively water soluble constituents to lake water, particularly if mixing energy is high and small oil droplets become entrained into the water column.	between light and heavy crude oil.	may have relatively low solubility. However, diluted bitumens (e.g., 2010 Marshall release) contain diluent, which may (e.g., condensate) or may not (e.g., synthetic crude oil) contain a large component of relatively water-soluble aromatic compounds.	fraction of soluble low molecular weight hydrocarbons.
Adhesion	Low adhesion to surfaces, and tending to weather quickly when deposited as a thin layer on exposed surfaces.	Intermediate adhesion to surfaces between light and heavy crude oil.	High adhesion to surfaces, and weathering more slowly due to greater asphaltene content than lighter crude oils.	Oil may adhere to surfaces such as substrates, debris, flora, and fauna. Heavier oils tend to be more adhesive, and to be deposited as a thicker and more persistent layer, than lighter crude oils.
Emulsification	Unlikely to occur (content of asphaltenes in light crude oil is low).	Unlikely to occur (content of asphaltenes in medium crude oil is low).	Asphaltenes are present in heavy crude oils. Conventional heavy crude oils tend to form emulsions readily. However, diluted bitumens appear to have low potential to form emulsions.	Emulsification is less likely to occur in fresh water than in salt water, even for releases of heavier oils, because there generally is not enough mixing energy to create stable emulsions.

Table 7-17 Effects of Oil on Lakes by Environmental Characteristic

LAND COVER RECEPTOR: Lakes				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Wind speed and direction	Low velocity winds may result in limited spreading or containment of oil.	Moderate velocity winds can have some ability to transport oil across lakes or to contain the oil to an area of a lake, depending on the location of the release and direction of the wind.	High velocity winds can transport oil across lakes or contain the oil to an area of a lake, depending on the location of the release and direction of the wind. High winds may also cause entrainment of oil, particularly low-viscosity oil, into the water column.	Heavy fuel oil released in Wabamun Lake in 2005 was spread by strong winds to the north, east and west shores (Anderson 2006).
Wave action	Low wave action may result in little or no dispersion of oil in water.	Moderate wave action can result in some dispersion of oil in water, particularly low-viscosity oils.	High wave action can result in substantial dispersion of oil in water, with low-viscosity oils more susceptible than high viscosity oils.	Dispersion of crude oil as small droplets into the water column can promote dissolution of more water soluble hydrocarbon constituents (promoting acute toxicity to aquatic life). It can also facilitate interactions with suspended mineral particles in the water column, leading to OPA formation and potential sinking of the aggregate.
Ice cover	Without ice cover, crude oil will spread over the water surface as a result of gravity (facilitated by low viscosity and surface tension) or wind action.	Patchy or partial ice cover will have a limited effect on oil movement on the water surface, but low temperatures will limit spreading due to increased viscosity of the oil.	Full ice cover and low temperatures will limit the ability of oil to penetrate into the water column. Snow pack on ice may also absorb and limit the spread of oil, facilitating its recovery. Oil released under the ice, or entering a lake with river flow, may spread under the ice and be difficult to track.	Ice cover will slow the spread of released oil due to the higher and surface tension induced by cold temperatures. Volatility and biodegradation rates are also reduced at low temperatures.

Table 7-17 Effects of Oil on Lakes by Environmental Characteristic

LAND COVER RECEPTOR: Lakes				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Biodegradation	Low rates of biodegradation can result in slower weathering and increased persistence of oil. Biodegradation rates are typically low when oxygen is limiting or absent. Some hydrocarbons, particularly resins and asphaltenes, are resistant to biodegradation. These substances tend to be more abundant in heavy oils than in light oils.	Moderate rates of biodegradation can increase the rate of oil weathering. Aerobic biodegradation can deplete local dissolved oxygen concentrations.	High rates of biodegradation can result in rapid weathering of oil. Aerobic biodegradation can deplete local dissolved oxygen concentrations. Light crude oils generally biodegrade more rapidly and more completely than heavier oils.	Rates of biodegradation depend on composition of the oil, temperature, dissolved oxygen concentration, and nutrient availability (Lee et al. 2015).
Temperature	At low temperatures, oil viscosity, density, and surface tension increase, and volatility of low molecular weight hydrocarbons decreases. Biodegradation rates are also low.	At moderate temperatures, oil viscosity, density, and surface tension decrease and volatility of low molecular weight hydrocarbons increases, leading to greater potential for spreading of oil. Biodegradation rates increase with increasing temperature.	At high temperatures, oil viscosity, density and surface tension are at a reduced, increasing the potential for spreading and dispersion of crude oil. Low molecular weight hydrocarbons are more volatile at high ambient temperature. Biodegradation rates are highest at high temperatures in freshwater. Some hydrocarbons, such as low molecular weight aromatic hydrocarbons, are more soluble at high temperatures (Lee et al. 2015).	Lake temperature is affected primarily by season.
Dissolved	Low oxygen	Most lakes have moderate	High oxygen environments (saturated)	Oxygen is typically not a

Table 7-17 Effects of Oil on Lakes by Environmental Characteristic

LAND COVER RECEPTOR: Lakes				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
oxygen	environments typically occur in deep zones of stratified lakes, in sediment pore water, or in winter under ice cover. Low oxygen availability limits aerobic biodegradation of oil. Anaerobic degradation of oil can occur but rates are slower than for aerobic processes.	oxygen levels (not fully saturated), especially in sub-surface waters. Oxygen levels are typically greatest near the surface due to wave action and diffusion of oxygen into the water. The rate of phytoplankton growth and degradation influences oxygen levels in the water column. Microbial degradation of crude oil could deplete the oxygen concentration in lake water.	typically occur in near-surface water, or during spring and fall overturn in dimictic lakes. The presence of phytoplankton can result in super-saturation of oxygen in daylight hours, with low oxygen concentrations occurring at night due to dark respiration.	limiting factor to biodegradation except in deep or strongly stratified aquatic environments, and there, only in the unlikely event that oil sinks into the anaerobic environment (Lee et al. 2015). However, almost any sediment can have limiting oxygen conditions, and oil in sediments can be expected to degrade slowly.
Nutrient supply	Oligotrophic lakes contain naturally low levels of nitrogen, phosphorus, and organic carbon. Low nutrient availability can limit the capacity for biodegradation (Lee et al. 2015).	Mesotrophic lakes contain moderate levels of nitrogen, phosphorus, and organic carbon that can support oil biodegradation in a lake (Lee et al. 2015).	Eutrophic lakes provide elevated levels of nitrogen, phosphorus, and organic carbon (either naturally or through human activities), which can support a high capacity for oil biodegradation in a lake (Lee et al. 2015).	Nutrient availability varies seasonally and from lake to lake. Nutrient levels are typically highest in spring and fall, at the time of overturn. Nutrients are sometimes added to oiled environments in order to stimulate microbial degradation of oil (Lee et al. 2015).

Table 7-17 Effects of Oil on Lakes by Environmental Characteristic

LAND COVER RECEPTOR: Lakes				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Suspended Solids	Low levels of suspended solids, typical in open water areas of lakes, provide a low potential for oil to interact with particles and form aggregates.	Moderate levels of suspended solids may occur in near shore areas of lakes, where sediments can be suspended from the bottom, transported from shore by overland flows, or introduced at stream inflows (e.g., during spring freshet and rain events). There is some potential for oil to interact with particles and form aggregates. These aggregates may be neutrally buoyant and enter the water column or become denser than water and sink to the bottom (Lee et al. 2015).	High concentrations of suspended solids may occur in near shore areas of lakes, where sediments can be suspended from the bottom, transported from shore by overland flows, or at stream inflows (e.g., during spring freshet and rain events). There is high potential for oil to interact with particles and form aggregates. These aggregates may be neutrally buoyant and enter the water column becoming denser than water and sink to the bottom (Lee et al. 2015).	Formation of OPAs is limited in fresh waters (i.e., at low levels of salinity). In addition, high levels of both turbulent mixing energy and suspended sediment are required in order for oil-particle interaction to be an important process in the fate of released crude oil. Hospital et al. (2016) concluded that these conditions are rarely met in the lower Fraser River and Salish Sea, and therefore they are also unlikely to be present in most inland lakes.

7.1.2.4 Rivers

7.1.2.4.1 Description

Rivers and streams can be defined as permanent flowing fresh-water bodies surrounded by land, and distinguished loosely on the basis of size (width, depth, flow volumes) and location or stream order within a watershed. They can be differentiated from permanent standing waterbodies such as lakes and ponds on the basis of whether flow is dominated by hydraulic factors (i.e., flow as in rivers and streams) or other factors such as wind or thermal circulation (i.e., water circulation as in lakes). Rivers are included in the present effects assessment of land cover receptors due to their prominence in the proposed ROW routes, their importance to aquatic and terrestrial life, and the role that they can play in transporting released crude oil away from an accidental release point. Rivers provide habitat for fish, amphibians, plants, benthic invertebrates, insects, birds, and mammals, and provide valued recreational, aesthetic, cultural, and economic values for humans.

The effects assessment for rivers focuses on observed and expected physical and chemical effects of released oil on rivers and streams. Effects of accidental crude oil releases on aquatic biota (e.g., benthic invertebrates, fish, and aquatic plants) are discussed separately. Crude oil released in rivers generally floats, interacting with shorelines as it moves downstream. Depending upon the crude oil type, a considerable amount of the released oil may escape to the atmosphere as VOCs. However, crude oil can also enter the water column as the dissolved water-soluble fraction of oil, dispersed as fine droplets, or mixed with soil or sediment as OPAs. Depending upon its interactions with suspended sediments and shoreline, crude oil may also be deposited to bed sediments in depositional areas (such effects are discussed elsewhere).

7.1.2.4.2 Observed Effects

There is potential for oil released accidentally from a pipeline to reach a stream or river, either at a pipeline crossing location, or after overland flow away from the pipeline right of way. In either case, released crude oil that reaches a watercourse can be transported downstream with the flowing water. To better understand the potential effects of oil releases on riverine resources, observed effects are compiled from four case studies where oil was accidentally released into river environments.

> ***Asher Creek, Missouri (1979)****: In August 1979, a pipeline burst, releasing approximately 9,500 barrels of unspecified domestic crude oil into Asher Creek, in southwest Missouri, during low flow conditions (Crunkilton and Duchrow 1990). A responsible party has not been identified for this incident. The creek originates in springs upstream from the release location. Information about hydrocarbon concentrations in water was not provided, but dissolved oxygen, pH, and conductivity levels in water were not changed by the release. The first site downstream from the release point was described as being "completely inundated with oil". Additional study sites were located downstream of six surface skimming siphon dams which were placed across the stream to retain floating oil*

after the release occurred (Crunkilton and Duchrow 1990). These dams were reported to contain most of the released oil. However, upstream of the dams, oil penetrated riffle substrates and coated the stream bed. Oil that entered riffle substrates due to mixing was visible for over a year (Crunkilton and Duchrow 1990). Low water volumes in these headwaters, particularly during summer at the time of the release, provided limited dilution of the oil. The first scouring floods occurred in February, six months after the release, and helped to dissipate the oil. Oil was observed as a sheen on the water surface after disturbing the substrate up to 453 days after the release at Site 2 (above the siphon dams), and up to 336 days after the release at Site 3 (below the siphon dams), but no oil was observed at other sites during the 532 day study (Crunkilton and Duchrow 1990).

***Pine River, British Columbia**: On August 1, 2000, a pipeline owned by Pembina Pipeline Corporation ruptured and released approximately 6,200 barrels of sour light crude oil, of which approximately 2,800 barrels entered the Pine River in British Columbia (BC MOE 2000a). The Pine River is fast flowing, and oil was dispersed up to 50 miles downstream. The fast flowing water allowed rapid dispersion of acutely toxic fractions of the oil into the river water. Oil was stranded and settled in depositional areas along the banks, in back eddies, and in other slow-flowing areas, as well as on organic debris and logjams (AMEC 2001 in Lee et al. 2015). Heavy rainfall later in August and September mobilized stranded oil and oil-contaminated debris and sediments; high water levels scoured some of the more heavily oiled depositional areas. Oil was recovered from the river over a period of two months, with about 91% of the released oil recovered (Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015). Most of the oil that remained unaccounted for was considered likely to be located in river sediments, or trapped in woody debris dams in the river. Some of the emergency response activities (e.g., removal of log jams and woody debris, altering of back channels, bank armoring, and presence of heavy machinery in the river) also resulted in habitat damage (Summers 2004 in Bustard and Miles 2011).*

The Pine River is an important source of drinking water for the town of Chetwynd, British Columbia, and as a result of the release, the town closed its water intake and used alternate water sources. Effects on water quality included visual and olfactory evidence of oil contaminants over a 50-mile section of river. After three weeks, hydrocarbons were still detectable chemically in water but had decreased rapidly to below British Columbia water quality guidelines due to evaporation, degradation, and natural dispersion (Lee et al. 2015). Sheen was largely restricted to back eddies and other calm areas along shorelines. The rapid decline in hydrocarbon concentrations in river water was attributed to the characteristics of the light crude oil released (rapid evaporation, dissolution, degradation, and natural dispersion).

***Marshall, Michigan**: On June 25 and 26, 2010, the Line 6B pipeline owned by Enbridge ruptured and released approximately 20,000 barrels of heavy crude oil, of which approximately 8,000 barrels entered Talmadge Creek, a tributary to the Kalamazoo River, near Marshall, Michigan (NTSB 2012a, Enbridge 2013a). The released oil was a combination of Western Canadian Select (23%) and CLB diluted bitumen (77%) (Enbridge 2013a). The release occurred on the floodplain of Talmadge Creek, where wetlands are abundant (USFWS et al. 2015a). The Kalamazoo River is a meandering, low-gradient river with diverse channel and floodplain features, extensive floodplain forests and wetlands, off-channel water bodies, and impoundments (Dollhopf et al. 2014). Oil was transported downstream in the Kalamazoo River, which was in flood at the time of the release, to Morrow Lake (an impoundment in the river 36.5 miles downstream). Oil was deposited on river shoreline, riparian, and depositional areas and along the shores at the delta of Morrow Lake (USFWS et al. 2015a), affecting approximately 40 miles of river (80 miles of shoreline and adjacent lands) (Dollhopf and Durno 2011). There was subsequent associated disturbance from oil removal efforts (removal of riparian vegetation and sediment, access road construction; Dollhopf and Durno 2011). Channel margins, backwaters, side channels, oxbows, and impoundments provided depositional areas for the oil.*

Major factors affecting OPA formation include the quantity and viscosity of the oil, oil-water interfacial tension, and chemical composition of the oil; the quantity and type suspended sediment particles; the magnitude and variability in physical energy of the aquatic environment; temperature and salinity (Fitzpatrick et al. 2015). The first step to forming OPAs lies with the initial breakup of a slick of oil into oil droplets. Once spilled into a water body with turbulence created by waves or currents, floating oil can break up into droplets. In the absence of a surfactant, smaller droplets are generated the viscosity of the oil are low. Oil viscosity can vary by orders of magnitude among different types of oil, and at different temperatures. The viscosity of a heavy crude oil or bitumen is at least 1,000 times that of light crude such as a product from the Alaska North Slope or Bakken Formation (Fitzpatrick et al. 2015). The size of the oil droplet is a very important factor in the transport and fate of the oil and its interaction with particles. Because large droplets have higher buoyancy than smaller droplets, they tend to float to the water surface, whereas smaller droplets could be driven more easily in the water column as a result of mixing energy (Fitzpatrick et al. 2015). Small droplets would only need to interact with a few, small suspended sediment particles in order to achieve neutral or negative buoyancy relative to water. Larger droplets would require considerably more interaction with suspended sediments to reach a sinking density, or could potentially split into "floating" and "sinking" portions. Particle size, amount, and type are important to the formation of OPAs. Clay-sized mineral particles are effective at forming OPAs. However, most natural waters have a range of particle sizes, which may vary with the

amount of mixing resulting from waves or currents. Particles may be smaller than the oil droplet and form a coating, or they may similar in size to the aggregate (Fitzpatrick et al. 2015). However, the practical implication of the foregoing discussion is that classical OPA formation may be insufficient to explain the behavior of crude oil that was released to the Kalamazoo River. Zhou et al. (2015) reported the results of wave tank tests that showed conventional light crude oil forming small droplets that interacted with natural river sediments at realistic concentrations to form OPAs and sink, whereas a more viscous diluted bitumen remained floating on the surface of the tank, without forming entrained droplets, and without interacting with suspended sediments or sinking.

Some features of the Kalamazoo River likely enhanced the formation, re-suspension, and deposition of OPAs. The Enbridge Line 6B pipeline release happened during a flood on the Kalamazoo River. On the basis of later measurements of suspended sediment it was inferred that the river had relatively low suspended sediment concentrations at the time of the spill (less than 100 mg/L; Fitzpatrick et al. 2015) with suspended particle sizes mainly in the silt-sized range. Water temperatures were warm. Floodwater increased turbulence in river flows, and mixing from flows over two dams may also have played a role, although OPAs and submerged oil accumulated in the first 3 miles (5 km) of river length, between the spill source and the first dam (Fitzpatrick et al. 2015). However, the importance of oil welling upwards through overburden materials from the buried pipeline to the surface, and subsequent overland flow between the failure location and Talmadge Creek has not been widely discussed. The accumulation of soil particles by liquid heavy fuel oil was considered to be an important process in the sinking behavior of that oil following the Wabamun Lake oil spill (Hollebone et al. 2011). It is possible that interactions between bulk diluted bitumen and soil particles up to sand grain size may account for some of the observed deposition of diluted bitumen to sediments in the Kalamazoo River.

Surface water samples were collected between July 2010 and April 2012 from the Kalamazoo River and Morrow Lake (MI DCH 2014b). Parent and alkylated PAHs were analyzed at various depths within the water column (USFWS et al. 2015a). Surface water analyses were conducted to evaluate potential effects on human health and on exposure of fish embryos to oil constituents. The July and August 2010 laboratory results showed that most chemical constituents were below water criteria for both the USEPA and the MI DEQ. The regulatory agencies agreed additional sampling was unnecessary.

***Red Deer River, Alberta**: On June 7, 2012, about 1.9 miles north of Sundre, Alberta, floodwaters 10 times higher than typical June flows eroded the stream bed and banks, exposing the Plains Midstream Canada ULC pipeline, which then ruptured (Alberta Energy Regulator 2014). Approximately 2,900 barrels of light crude oil*

were released into Jackson Creek, a tributary of the Red Deer River. Oil travelled at least 25 miles downstream to Gleniffer Lake reservoir, where booms contained the floating oil. Dissolved hydrocarbons were detected in river water up to 5 miles farther downstream (Alberta ESRD 2012a). Because of the high water levels at the time of the release, the majority of oil stranded in backwater areas, under trees and debris, and in highly braided river margins, and also mixed with silt and sediments well above the normal high water mark for the river (Teichreb 2014).

The main concerns were for drinking water quality, but monitoring indicated only low levels of hydrocarbons (below Health Canada guidelines for drinking water quality) at intakes along the river downstream of the Gleniffer Lake reservoir (Alberta ESRD 2012a, b). No studies were found of effects on habitat in the river. It is likely that concerns about habitat were reduced because of the small volume of released oil in proportion to the large volume of river water at flood stage (large dilution), and the type of oil released (light crude oil, which weathers quickly) (Alberta ESRD 2012a).

7.1.2.4.3 Expected Effects of Released Oils

The main effects of oil released into a watercourse are changes in water quality and changes in physical habitat. Effects vary, depending on characteristics and volume of the released oil, duration of release (instantaneous versus protracted duration), and environmental conditions within the receiving waters (current velocity, volume of river/stream channel, morphology of channel—i.e., straight versus serpentine, presence of backwaters, oxbows). Relevant oil characteristics that will directly affect the fate and effects of released oil include (but are not limited to) density, viscosity, volatility, solubility, surface tension, adhesion, and emulsification, which affect behavior of oil on water and the weathering of oil.

A release of diluted bitumen is expected to result in environmental effects similar to those observed for other heavy crude oils. Diluted bitumen does not separate into diluent and bitumen components when released (Taylor et al. 2014; Zhou et al. 2015; Fingas 2015a). Diluted bitumen floats on water and can be stranded on shorelines. If the oil first travels over land, it can pick up soil and organic matter and form OPAs in water, which can sink. OPA can form in water as well, the degree of OPA formation depending on concentrations of suspended particulates in the water column and the amount of water column turbulence. Some of the diluent (e.g., condensate) present in diluted bitumen may evaporate quickly, but diluents also contain a wide range of individual hydrocarbon compounds, and the rapid initial weathering phase of diluted bitumen samples is typically followed by a slower secondary phase.

The effects of released oil on water quality are often transient (days) because the acutely toxic components (low molecular weight hydrocarbons like BTEX, some PAHs, and some alkanes) tend to weather (evaporate) quickly, or when dissolved in the water column, degrade quickly. Higher molecular weight PAHs are less likely to be acutely toxic to aquatic life but break down slowly (over months or years), so they persist and can result in chronic effects on aquatic biota. Effects

on physical habitat (from oil stranded on shorelines and sediment) can result in habitat smothering and may last for much longer, especially where appropriate remedial actions are not taken. Soluble constituents in the deposited oil can dissolve into the water column over time resulting in ongoing toxicity to aquatic organisms. Effects of hydrocarbon contaminants on river sediments are discussed elsewhere.

Environmental characteristics affecting the behavior and fate of crude oil in watercourses include water flow, channel geometry, hyporheic flow (i.e., beneath and alongside a stream bed where there is mixing of surface waters and shallow groundwater), biodegradation, temperature, dissolved oxygen, nutrient supply, suspended sediment, and sunlight exposure. In rivers and streams, oil is predominantly transported by surface currents. River flow volume and velocity are determined by watershed size, runoff and other water inputs, river slope, and channel characteristics. Physical characteristics may range from small headwater streams with little dilution potential and boulder substrates with little depositional habitat, to higher order streams and rivers with broad floodplains, complex channel morphology and habitat, and abundant depositional areas. Water channels can be simple (e.g., artificially channelized areas) or complex, with meanders, braided areas, backwaters, shoals, and structures such as bridge supports, dams, and jetties, which will result in complex patterns of oil transport and deposition. The oil initially moves on the surface with the current. Evaporation and other weathering processes remove low molecular weight hydrocarbon fractions. Water turbulence can disperse oils that have low viscosity as fine droplets in the water column, where soluble fractions can dissolve in the water. In areas of lower turbulence (slower flows), oil droplets can coalesce and float to the surface again.

Oil can become stranded on shoreline areas, shoals, and shallow, slow-flowing areas when water levels recede. Stranded oil can be re-mobilized and flushed downstream when flows and water levels later increase. If there is a naturally high sediment load in the river (e.g., during a freshet), or if oil travels over land and picks up soil particles, OPAs can form, leading to oil deposition to sediment in slow-flowing areas.

Seasonal weather conditions also have an effect. Releases that occur during the spring freshet or high rainfall events will be rapidly transported downstream. High water levels could result in oil being deposited to riparian habitat, becoming stranded as water levels drop. Releases into ice-covered rivers during winter may be isolated initially, but travel downstream under the ice such that locating and recovering the released oil is challenging. Any residual oil that is not recovered, or oil that has been sequestered beneath the ice, may be remobilized when the ice melts and flow increases.

The effects of crude oil releases on surface water quality typically last only a short time after the release. Crude oil typically undergoes rapid initial mass loss due to weathering. Stranding along shorelines also results in removal of released oil from the water surface. Most hydrocarbons are only sparingly soluble to insoluble in water, so effects on water quality are generally short lived. Remedial activities may help speed up recovery of a water body through collection of oil.

Effects on river from oil stranded on shorelines or deposited to sediment can last for much longer, and long-term or persistent contamination of these physical habitat components can result in chronic low-level release of potentially toxic constituents of the crude oil (e.g., PAHs) back to the water column.

Table 7-18 and Table 7-19 provide a summary of the expected environmental effects of oil releases to rivers. Table 7-18 considers the effects of specific oil characteristics or oil type on the expected type and scope of environmental effects. Table 7-19 considers the effects of environmental factors on the expected types and scope of environmental effects.

Table 7-18 Effects of Crude Oil on Rivers by Oil Characteristic

LAND COVER RECEPTOR: Rivers				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Comments**
Density	Low density oils, float on water.	Intermediate in density between light and heavy oils; will float on water.	High density oils; pipeline tariffs require density to be less than 0.94. Fresh diluted bitumen will float on water.	The density of crude oil or diluted bitumen increases with evaporation of lighter components.
Viscosity	Low viscosity oils, have a high tendency to spread and disperse, both on the surface of the water, and potentially as fine droplets in the water column where mixing energy is sufficient.	Intermediate in viscosity, spreading and dispersal characteristics between light and heavy oils.	Heavy crude oils tend to be viscous. Fresh diluted bitumens have viscosity that is regulated through the addition of a diluent.	Viscosity of crude oil decreases with rising temperature, and increases as a function of weathering after release. Diluted bitumens may undergo more rapid initial weathering than conventional crude oils if the diluent is volatile (e.g., condensate). Diluted bitumens contain more diluent in winter than in summer in order to compensate for temperature effects.
Volatility	Light crude oils typically contain a large fraction of volatile (low molecular weight) hydrocarbons. These are prone to weathering by volatilization and dissolution.	Intermediate in volatility and tendency to weather through volatilization between light and heavy oils.	The fraction of volatile low molecular weight hydrocarbons depends on the oil type. Conventional heavy crude oils may have relatively low volatile content. However, diluted bitumens contain diluent, which may (e.g., condensate) or may not (e.g., synthetic crude oil) contain a large volatile component. CLWB is an example of diluted bitumen with a relatively large component of condensate and a volatile content similar to that of many light crude oils.	Evaporation of volatile components increases with temperature. As volatilization occurs, the density of the residual oil will increase. Diluted bitumen may undergo a rapid initial loss of volatiles, followed by a secondary phase of slow weathering. In contrast, light and medium conventional crude oils that contain more mid-range hydrocarbon compounds have a more gradual weathering behavior.

Table 7-18 Effects of Crude Oil on Rivers by Oil Characteristic

LAND COVER RECEPTOR: Rivers				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Comments**
Solubility	Light crude oils typically contain a large fraction of relatively water soluble (low molecular weight) hydrocarbons.	Intermediate in proportions of soluble low molecular weight hydrocarbons between light and heavy oils.	The fraction of relatively water soluble low molecular weight hydrocarbons depends on the oil type. Conventional heavy crude oils may have relatively low solubility. However, diluted bitumens contain diluent which may (e.g., condensate) or may not (e.g., synthetic crude oil) contain a large component of relatively water-soluble compounds. CLWB is an example of diluted bitumen with a relatively large component of condensate, with BTEX content similar to that of many light crude oils.	Undiluted bitumen has a very low water soluble fraction, but diluent added to bitumen contains a high fraction of soluble LMW hydrocarbons. Dissolution of the lighter fraction can increase oil density.
Adhesion	Relatively low adhesion to surfaces.	Intermediate adhesion to surfaces between light and heavy crude oil.	High adhesion to surfaces.	Oil may adhere to surfaces such as substrates, debris, flora, and fauna.
Emulsification	Unlikely to occur (content of asphaltenes in light crude oil is low).	May occur, depending upon crude oil chemistry.	Asphaltenes are present in conventional heavy crude oils, and these can have a high potential to emulsify. However, diluted bitumens, which contain very large amounts of asphaltenes, appear to have low potential to form emulsions.	Emulsification is less likely to occur in fresh water than marine, even for releases of heavier oils, because there is often not enough consistent and protracted mixing energy to create stable emulsions.

Table 7-19 Effects of Crude Oil on Rivers by Environmental Characteristic

LAND COVER RECEPTOR: Rivers				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Water Flow	Rivers in low flow condition can have exposed substrate (e.g., sandbars) or debris upon which released oil can adhere. Oil will be transported downstream at a low speed, with little dilution. Turbulence levels in the stream are also typically at low levels. Floating oil will likely remain floating, but OPAs can sink to the bottom in slow moving water.	Rivers in moderate flow conditions typically have downstream transport velocities and turbulence levels that are intermediate between low and high flow condition. In-stream features such as sandbars will typically be submerged, but the river remains within its normal banks.	Rivers in high flow conditions typically have the highest downstream transport velocities and turbulence levels within the main river channel. At high flow, the river level may exceed that of the normal banks, with flow extending laterally into riparian or floodplain areas. In these areas, there may be areas of low flow and high potential to trap floating and submerged crude oil.	High river flow conditions can result in the entrainment and virtual "disappearance" of light crude oils as they are dispersed over a large area. On the other hand, the Kalamazoo River oil spill resulted in extensive oiling of floodplain areas, as well as submergence and sinking of the heavy crude oil with subsequent accumulation in areas of quiet water such as the Morrow Lake impoundment.
Turbulence	Crude oil is likely to remain floating on the surface of rivers that have low turbulence levels, regardless of the viscosity of the oil.	Under moderately turbulent flow conditions, light crude oils may become entrained into the water as small droplets, which may then interact with suspended sediment (leading to sinking behavior). Entrainment of oil as small droplets will also promote dissolution of relatively water soluble fractions of the crude oil.	Under highly turbulent flow conditions, both light and heavy crude oils may become entrained into the water. However, the droplet size profile of heavy crude oils will tend to remain skewed towards larger droplet sizes, due to its higher viscosity and surface tension.	Turbulence can be induced in river flows as a result of slope, irregular substrate type, overall water flow, and in-stream features such as natural waterfalls or man-made weirs and dams.

Table 7-19 Effects of Crude Oil on Rivers by Environmental Characteristic

LAND COVER RECEPTOR: Rivers				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Suspended Sediment	Low concentrations of suspended sediment and turbidity typically occur in clear, small streams; in slow moving depositional areas; during low flow periods; or in streams where water inputs are dominated by groundwater. Any of these waterbodies can also experience high sediment loads during freshet flows. There is low potential for oil to interact with particles to form aggregates.	Moderate concentrations of suspended sediment and turbidity typically occur in mid-sized streams; during moderate flow periods; and in streams where inputs include some overland flow. There is some potential for oil to interact with particles and form aggregates. The aggregates may be neutrally buoyant and enter the water column, or sink.	High concentrations of suspended sediment and turbidity typically occur in low gradient rivers and large streams; in fast moving active erosional areas; in streams where there is substantial input from overland flow; and during times of high flow (e.g., spring freshet or high rainfall events). There is high potential for oil to interact with particles and form aggregates that may be neutrally buoyant or sink (Lee et al. 2015).	Geological characteristics, soil types, and land use in the surrounding watershed play large roles in determining the baseline and maximum suspended sediment concentrations in streams and rivers. The baseline may be low (i.e., clear-flowing water), moderate or high (i.e., water that is routinely muddy in appearance), but regardless of the baseline levels, suspended sediment concentrations typically peak during spring freshet and in response to high rainfall events.
Temperature	At low environmental temperatures, oil density, viscosity and surface tension are higher, and volatility of low molecular weight hydrocarbons is lower. Biodegradation rates are also limited.	At moderate temperatures, properties of density, viscosity, surface tension, volatility and biodegradation are at intermediate values.	At high environmental temperatures, oil density, viscosity and surface tension are lower, and volatility of low molecular weight hydrocarbons is higher. Biodegradation rates also tend to be higher, provided oxygen and nutrient availability are not limiting.	River temperature is affected by seasonal changes in ambient temperature, by the temperature and amount of inflowing groundwater, tributary streams and overland flow. Unshaded streams and rivers are more exposed to daily temperature fluctuations than shaded watercourses.

Table 7-19 Effects of Crude Oil on Rivers by Environmental Characteristic

LAND COVER RECEPTOR: Rivers				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Ice Cover	In winter, the ground may be snow covered, but rivers may remain open. Without ice cover, the behavior of crude oil in rivers is generally similar to its behavior in other seasons.	Moderate ice cover and low temperatures may limit the spread of crude oil in rivers, but will also pose challenges to oil spill response and recovery operations.	When there is high ice cover on a river, released oil may pool on the surface of the ice, providing an opportunity to recover the oil or limit its spread. If crude oil is released into a river below the ice, it can move under the ice surface, accumulating in hollows under the ice, and in areas of low water flow near the river margins.	Ice cover implies cold temperatures and low river flow rates, which will slow the spread of released oil due to effects on viscosity. Crude oil released beneath ice cover has limited exposure to the atmosphere, and this will force more of the low molecular weight hydrocarbon to dissolve in water than would otherwise be the case. In combination with low river flow rates, this may result in higher potential for toxicity to fish. Ice cover may impede recovery operations, leading to a secondary episode of crude oil movement in the watercourse during the spring melt period.

Table 7-19 Effects of Crude Oil on Rivers by Environmental Characteristic

LAND COVER RECEPTOR: Rivers				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Dissolved oxygen	Low oxygen environments (e.g., <5 mg/L) may occur in deep, slow moving depositional areas of rivers, or in underlying sediment pore water. Low oxygen availability limits biological communities, as well as limiting aerobic biodegradation of oil. Anaerobic degradation of oil can occur, but rates are much slower than for aerobic processes.	Many rivers are typically under-saturated with dissolved oxygen, particularly during warm periods. However, oxygen concentrations are usually adequate to support a wide variety of aquatic life, and would not be limiting to biodegradation of crude oil.	High oxygen environments (saturated to super-saturated) occur in higher gradient streams where water turbulence results in greater entrainment of oxygen. Super-saturation can also occur as a result of photosynthetic activity in streams and rivers, particularly during daylight hours in the summer. High oxygen environments can facilitate higher rates of aerobic biodegradation.	Oxygen is typically not usually a limiting factor to biodegradation of crude oil in rivers, except in deep, slow moving areas or in sediment pore-water. Biological communities are typically adapted to the prevailing oxygen regime, although still susceptible to events that deplete oxygen.
Nutrient supply (nitrogen, phosphorus, organic carbon)	Nutrient supply can be low in small streams, and can limit the capacity for microbial biodegradation of hydrocarbon residues.	Moderate nutrient availability is typical of mid-sized streams.	High nutrient availability often occurs in rivers and larger streams (as a result of both natural and anthropogenic inputs), and may support a higher capacity for microbial degradation of hydrocarbon residues.	The river continuum concept (Vanotte et al. 1980) proposes that rivers are in a constant but predictable state of development, from headwater reaches to their mouths. This has implications for biological communities, as well as abiotic factors such as nutrient supply. Nutrient levels in rivers also vary as a result of surrounding land use (sources of nutrients) and season.

Table 7-19 Effects of Crude Oil on Rivers by Environmental Characteristic

LAND COVER RECEPTOR: Rivers				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Sunlight exposure	The light environment of rivers varies in relation to a range of factors including the degree of shading (greatest in small watercourses that are overhung by trees), as well as internal factors such as the levels of suspended sediment and dissolved organic carbon in the water.	N/A	Larger watercourses may be partially shaded along their banks, but are unshaded at mid-stream. However, larger watercourses are also more likely to have higher levels of suspended sediment in the water, which may limit light transmission through the water column.	Photo-oxidation is a natural remediation process that helps to break down hydrocarbon residues into less persistent and generally less toxic compounds.
Hyporheic Flow	Stream and river beds dominated by fine-grained materials (silts and clays) have low levels of permeability to flow, and will resist entry of crude oil into the hyporheic zone.	Stream and river beds dominated by sand or sand and gravel will potentially admit hyporheic flow, but may also act as a filter bed, limiting entry of crude oil constituents to soluble components that are readily degraded by microbial processes.	Stream and river beds dominated by gravel, cobbles and boulders will readily admit hyporheic flow, and crude oil droplets may also be entrained into the hyporheic environment.	Oil entering the hyporheic zone can become trapped in the sediment by adsorption to particles and can contaminate interstitial sediment pore water. This can have implications for biota ranging from benthic invertebrates to developing fish eggs and embryos that become exposed to residual or persistent crude oil residues.

7.1.2.5 Sediment

7.1.2.5.1 Description

Sediment is defined as the weathered minerals and organic detritus that form bottom substrates in aquatic environments. Suspended sediment is not discussed here; it is included as a water quality parameter in the effects assessment for lakes and rivers. Sediment can be a repository for contaminants, including petroleum hydrocarbons. Therefore, it is included in the effects assessment of land cover receptors due to its importance to aquatic life (fish, amphibians, plants, invertebrates), birds, and mammals that depend upon it.

The dominant substrate type usually reflects the hydrological regime. The largest materials (cobbles and boulders) are typically moved only by extreme high flow events. As a result, the stable substrate in erosional environments is typically composed of cobble, boulder, and gravel which, due to their large size, have substantial pore spaces between them.

In erosional environments (moderate to high flow river systems), sediments are transported by water movement. Fine sediments (generally composed of silt, clay, fine sand and smaller organic detritus) can be suspended in the water column, while coarse sediments (coarse sand, gravel, cobble, boulder and bedrock) remain on the bottom. In depositional environments (lakes, slow flowing or deep sections of streams and rivers), fine sediments drop out of suspension and form deposits on the bottom. Substrate in depositional environments is composed primarily of fine sediments and organic matter, with small pore spaces between particles. In rivers, deposition and erosional processes can occur alternately according to flow conditions. In lakes, depositional processes are dominant, although erosional processes may prevail along exposed shorelines.

The effects assessment for sediment focuses on physical and chemical effects of released oil on sediment quality in lakes and watercourses, and excludes direct effects of oil on aquatic biota (benthic invertebrates, fish, and aquatic plants), which are discussed elsewhere. Oil released in lakes and watercourses typically remains floating on the surface, but can become stranded on the shoreline and sediment as a result of currents and wind-driven movement, or can sink when OPAs form. The oily sediment may accumulate in depositional (low flow or quiet) areas.

In water, the low molecular weight fractions of oil weather quickly, leaving behind more persistent higher molecular weight hydrocarbons, including PAHs and weathered products (e.g., tar balls, OPAs). Deposited oil can be remobilized during times of high flow or high turbulence, resulting in additional exposure of aquatic biota to the contaminants.

7.1.2.5.2 Observed Effects

There is potential for oil released accidentally from a pipeline to reach one of the many lakes and watercourses in Minnesota, where some of the oil may end up on or in the sediments. Observed effects of released oil on sediment are compiled from four case studies described below, where oil was observed to interact with freshwater sediment. These include the 2010

Marshall, Michigan release, 2005 Wabamun Lake, Alberta release, 2000 Pine River, British Columbia release, and 1979 Asher Creek, Missouri release. The case studies described below are for a variety of river and lake receptors, and oil types. Potential effects of differences in the receiving environment and oil type on the behavior and weathering patterns of released oil, and on resulting potential environmental effects are discussed.

> ***Marshall, Michigan**: On June 25 and 26, 2010 a rupture in Enbridge's Line 6B pipeline released approximately 20,000 barrels of heavy crude oil, of which approximately 8,000 barrels entered Talmadge Creek, a tributary to the Kalamazoo River, near Marshall, Michigan (NTSB 2012a, Enbridge 2013b). The released oil was a combination of Western Canadian Select (23%) and CLB diluted bitumen (77%) (Enbridge 2013a). The release occurred on the floodplain of Talmadge Creek, where wetlands are present (USFWS et al. 2015a). The Kalamazoo River is a meandering, low gradient river with diverse channel and floodplain features, extensive floodplain forests and wetlands, off-channel water bodies, and impoundments (Dollhopf et al. 2014). Oil was transported downstream in the Kalamazoo River, which was in flood state at the time of the release, to Morrow Lake (an impoundment in the river 36.5 miles downstream).*
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> *Oil was deposited on river shoreline, riparian, and depositional areas (backwaters, side channels, oxbows) and along the shores at the delta of Morrow Lake (USFWS et al. 2015a), affecting approximately 40 miles of river (80 miles of shoreline and adjacent lands) (Dollhopf and Durno 2011). There was associated disturbance from oil removal efforts such as the removal of riparian vegetation and sediment and access road construction (Dollhopf and Durno 2011). Some of the oil mixed with soil and organic matter while moving overland and, after entering the river, with suspended sediment in the water column, resulting in the formation of OPAs that submerged in some locations, especially in depositional areas. These aggregates periodically released oil globules and sheen as late as 2014 (Fitzpatrick et al. 2015). Formation of OPAs was likely promoted by the flood conditions. Based on measurements of suspended sediment at the Marshall stream gage after the release, it can be inferred that the river had relatively low suspended sediment concentrations at the time of the release, but that the floodwaters likely increased the turbulence and the presence of suspended particulate matter (Fitzpatrick et al. 2015). In addition, the high organic matter content of sediments (20% or more) resulting from the extensive floodplain wetlands along the Kalamazoo River could have contributed to OPA formation (Fitzpatrick et al. 2015). Some of the submerged oil settled in areas that became anaerobic, which would reduce the rate of biodegradation.*
>
> *About 90% of the oil entering the river was recovered in the first year. This included floating oil, stranded oil in the floodplains of Talmadge Creek and the Kalamazoo River, and submerged oil (Fitzpatrick et al. 2015). The oil weathered,*

increasing the density of the weathered diluted bitumen. In 2011, additional activities to dislodge and disperse submerged oil resulted in a small amount of additional recovery. Submerged OPAs continued to release oil from sediments in the Kalamazoo River and impoundment areas during 2011 to 2014, with surface sheens observed in impounded sections of the river (Fitzpatrick et al. 2015).

Sediment chemistry was studied in 2011, 2012, and 2013 in depositional areas of the river and in Morrow Lake (Enbridge 2014). Levels of PAHs and other oil related compounds were compared to MI DEQ sediment quality values, including threshold effect concentrations (TEC) and probable effect concentrations (PEC) adopted from USEPA standards (MacDonald et al. 2000; USEPA 2003). Numerous samples from the affected areas and also from upstream and reference areas had concentrations of individual and total parent PAHs higher than the TECs; a few samples from the affected area had concentrations higher than the PECs (Enbridge 2014). Concentrations and exceedances of screening levels decreased between 2012 and 2013 (Enbridge 2014).

Sediment toxicity was tested at the same locations as sediment chemistry during 2012 and 2013, using standard laboratory tests with the amphipod (Hyalella azteca) and larval midge (Chironomus tentans). The extent and number of samples showing toxicity decreased from 2012 to 2013 and indicated overall that toxicity was absent from most parts of the river studied (Enbridge 2014). In both years, many samples showed no toxicity, and some samples showed low levels of both toxicity (e.g., 91% survival in Hyalella and 82% survival for Chironomus) and reduced growth. Effects were similar in affected and reference areas of the river, suggesting that the effects on toxicity and growth were associated with factors other than the oil release (Enbridge 2014). Many samples from affected areas of the Kalamazoo River (i.e., the Morrow Lake headpond) contained naturally high levels of total organic carbon, which were expected to reduce bioavailability of the PAHs, many of which bind to organic carbon.

The 2013 study was a sediment quality triad study of depositional areas, bringing together information about contaminant concentrations in sediment, sediment toxicity, and benthic invertebrate communities. Using a weight-of-evidence approach with multiple lines of evidence to evaluate the ecological significance of the residual hydrocarbons in sediment, it was concluded that by 2013, spill-related hydrocarbons in sediment of the Kalamazoo River were not having adverse effects on the aquatic ecosystem (Enbridge 2014). Other findings were that one line of evidence taken alone (e.g., sediment chemistry compared to guidelines) was not enough to identify the effects on the environment, and that many factors other than, or in addition to, the oil release were affecting the aquatic environment.

***Wabamun Lake, Alberta**: On August 3, 2005, a derailed train released approximately 4,500 barrels of Heavy Fuel Oil 7013 (a Bunker C type fuel oil with a high viscosity and an initial density of about 0.99 at lake temperature) and 550 barrels of pole treating oil. About 20% of the released heavy fuel oil (950 barrels) traveled overland and entered Wabamun Lake; no appreciable volume of pole treating oil entered the lake (Hollebone et al. 2011). In the lake, the oil floated and spread rapidly over the lake surface. After a few days, strong winds and wave action dispersed the oil toward the north, east, and south shorelines, where it became entrained in the beds of emergent vegetation (Anderson 2006, Birtwell 2008).*

While traveling overland, the oil mixed with soil and organic matter, and in the lake, OPAs formed quickly, including small tar balls, larger tar "logs", submerged sheets, and large lumps (Fingas et al. 2006; Hollebone et al. 2011). The aggregates showed a variety of behaviors, including submergence, neutral buoyancy, and resurfacing (Fingas et al. 2006), with extensive tar-mat formation in some nearshore areas. The behaviors of this oil in the lake, including rapid formation of tar balls, sinking, slow weathering and degradation due to high proportions of high molecular weight components such as resins, and its toxicity and persistence, were related to characteristics of the heavy fuel oil that would not be directly comparable to most conventional crude oils or diluted bitumen.

Surface sediment (approximately the top 1 to 2 in.) from open water areas was sampled on two dates in August 2005 and analyzed for particle size, total organic carbon, BTEX, PAHs, metals, and other parameters (Anderson 2006). Results were compared with pre-release data from 2002, which had documented some existing PAH concentrations above Canadian sediment quality guidelines due to natural and anthropogenic sources, including exposed coal seams, industrial activity, fossil fuel burning, and leaching from creosote-treated structures. Sediment samples collected from open water areas in 2005 did not indicate the presence of PAHs related to the release, and PAH levels were similar to or lower than those measured in 2002 (Anderson 2006).

Laboratory toxicity tests using the amphipod Hyalella azteca and larval midge Chironomus tentans showed significant toxicity for sediments collected near the release site, but test results were difficult to interpret because test conditions were not the same for all site and control samples (e.g., samples with high sand content had higher mortality, possibly due to sandier habitats not being the preferred by the organisms, or because of the naturally low organic content and food supply in sand) (Lee et al. 2015). Growth of both species and also the aquatic worm Lumbriculus variegatus in both high- and low-sand sediments was significantly lower than in control sediments. In L. variegatus, PAH concentration was correlated with toxicity (Lee et al. 2015).

Using microcosms in the laboratory, biodegradation of oil was tested using sediment collected from Lake Wabumun, to which was added either Bunker C oil recovered from the lake or a reference light oil (Alberta Sweet Mix Blend). Tests were run at 22°C for four weeks and at 4°C for eight weeks (Foght 2006; Wang et al. 2011). Microbes in the sediment were able to degrade a substantially greater proportion of the reference oil than the Bunker C oil, which was attributed to the low proportion of low molecular hydrocarbons and the high proportion of components that do not readily biodegrade (including high molecular weight components such as resins) in the Bunker C oil.

***Pine River, British Columbia**: On August 1, 2000, a pipeline belonging to Pembina Pipeline Corporation ruptured and released approximately 6,200 bbl of sour light crude oil, of which approximately 2,800 bbl entered the Pine River in British Columbia (BC MOE 2000a). The Pine River has a moderate gradient and is swift and clear-flowing. Crude oil was dispersed up to 50 miles downstream (Lee et al. 2015). The fast flowing water allowed rapid dispersion of acutely toxic fractions of the oil into the river water.*

Oil was stranded and settled in depositional areas along the banks, in back eddies and other slow-flowing areas, and on organic debris and logjams (AMEC 2001 in Lee et al. 2015). Heavy rainfall later in August and September mobilized stranded oil, oil-contaminated debris, and sediments downstream, and high water levels scoured some of the more heavily oiled depositional areas. Over a two month period, about 91% of the released oil was recovered or accounted for. It was estimated that the equivalent of approximately 563 bbl was lost to evaporation. A further 523 bbl was unaccounted for and assumed to have been dissolved, adsorbed in soils, deposited to sediments, and/or trapped in backwaters, eddies and logjams (Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015).

Some of the emergency response activities (e.g., removal of logjams and woody debris, altering of backchannels, bank armoring, and presence of heavy machinery in the river) also resulted in habitat damage (Summers 2004 in Bustard and Miles 2011). Of note, prior to the August 2000 release, a small release of diesel fuel (151 barrels) and gasoline (187 barrels) from a tanker truck had occurred in August 1994 in the same area of the Pine River (Goldberg 2011).

Following the release in August 2000, petroleum hydrocarbons were detected chemically and seen and smelled in river water up to 50 miles downstream of the release, with sheen visible in back eddies and other calm areas along shorelines. Hydrocarbons accumulated in sediments and on organic debris (e.g., branches, leaves, and algae) that had accumulated along the shoreline, in front of logjams, and attached to sweeper logs in these calm areas (Lee et al. 2015).

Concentrations in water decreased rapidly to below British Columbia water quality guidelines due to evaporation, dissolving in water, and natural dispersion, occurrences characteristic of light crude oil (Lee et al. 2015). Analysis of semi-permeable membrane devices deployed in the Pine River indicated that two years after the release, hydrocarbons were present in water, implying that hydrocarbons from the release were leaching out of sediment into the water column (De Pennart et al. 2004), although additional sources (e.g., PAHs from coal deposits) in the watershed were also acknowledged. Observations of oil on sediment were made five years after the rupture, although the location and extent were not described (Goldberg 2006 in Bustard and Miles 2011).

***Asher Creek, Missouri**: In August 1979, a pipeline burst, releasing approximately 9,500 barrels of an unspecified type of crude oil into Asher Creek, in southwest Missouri, during low flow conditions (Crunkilton and Duchrow 1990). A responsible party has not been identified for this incident. Dissolved oxygen, pH, and conductivity levels in water were not changed by the release (no information about hydrocarbons in water was published).*

Oil that entered substrates in riffle areas due to mixing was observed for over a year post-release (Crunkilton and Duchrow 1990). The creek originates in springs 0.4 mile upstream of the release. Low water volumes in these headwaters, particularly during summer, provided limited dilution of the oil, increasing the residence time of soluble oil components in sediment (Crunkilton and Duchrow 1990). Areas downstream from surface skimming siphon dams were less severely affected and recovered more rapidly than areas where the substrate became covered with oil (Crunkilton and Duchrow 1990).

7.1.2.5.3 Expected Effects of Released Oils

The main effects of oil deposited on substrates of lakes or watercourses are changes in sediment quality and changes in physical habitat associated with weathered oil. The effects on sediment quality typically persist for months or longer because the heavier molecular weight compounds (many PAHs, resins, and asphaltenes) are slow to weather and degrade; these compounds tend to have chronic, rather than acute toxicity to aquatic biota. Effects on physical habitat (from oil stranded on shorelines and sediment (e.g., as tar balls or OPAs) can also persist, and constituents in the deposited oil can dissolve into the water column over time, resulting in ongoing toxicity to aquatic organisms.

The effects on sediment vary, depending on characteristics of both the oil and environmental conditions at the time of the release. Relevant oil characteristics include density, volatility, solubility, and adhesion, which affect behavior of oil in the aquatic system and weathering of the oil. Environmental characteristics that affect behavior and fate of the oil include water flow, hyporheic flow, dissolved oxygen, and sediment grain size.

If there is a naturally high sediment load in a river (e.g., during a freshet) or if the oil travels over land and picks up soil and organic matter before entering the water, OPAs can form. These aggregates can reach densities that are heavier than water and sink to the bottom in slower flowing areas of rivers. Temperature can affect the rate of sinking, as lower temperatures result in greater viscosity and density, and slower rates of volatilization and biodegradation (Lee et al. 2015), which can favor sinking.

In rivers and streams, there are both erosional (fast flowing) and depositional (slow flowing) areas. Oil tends to accumulate and persist in the depositional areas (inside bends of meanders, backwaters, shoals, pools). Changes in water levels and current velocity can re-suspend the oil, making it available in the water column. In erosional habitats, flushing and fast weathering processes result in faster depletion of the oil compared to the slower rates in depositional habitats, which can be exacerbated if the oil enters anoxic layers of fine sediment. Lake substrates often are predominantly fine sediments, and oil can settle or be stranded on shorelines, shallow areas, and, if the oil combines with particles, in deeper areas.

Organic carbon and pore water presence affect the bioavailability of contaminants in sediment (Enbridge 2014). Organic carbons such as humic and fulvic acids can bind contaminants and render them less bioavailable. Sediment pore water, which is the water present between the particles, can act as a pathway for exposure to dissolved contaminants for aquatic biota.

A release of diluted bitumen is expected to result in effects similar to those for other heavy crude oils. Diluted bitumen does not separate into diluent and bitumen components when released (Taylor et al. 2014; Zhou et al. 2015; Fingas 2015a). It floats on water and can be stranded on shorelines. If the oil first travels over land, it can pick up soil and organic matter, then form OPAs, which can sink, A high proportion of diluent (e.g., condensate) will evaporate quickly and some will be dissolved in the water column and degrade relatively quickly. The residual oil components (PAHs, heavier alkanes, etc.) will degrade more slowly.

Environmental standards for petroleum hydrocarbon residues in sediment are limited. Di Toro et al. (2000), Di Toro and McGrath (2000), and USEPA (2003) developed the equilibrium partitioning sediment benchmark approach that is used to assess the potential toxicity of PAHs, either as individual substances or as mixtures. The same approach has also been applied to the toxicity of fresh and weathered crude oils (Di Toro et al. 2007) and refined oil products (McGrath et al. 2005). This approach, however, demands detailed understanding of the hydrocarbon chemistry.

Empirical approaches are also helpful. Routine analytical laboratory detection limits for total petroleum hydrocarbon (TPH) in sediment typically range from about 2.5 to 15 ppm (or mg/kg). Assuming that crude oil is deposited to the surface of the sediment and mixed into a thin surface layer (less than .25 in.) of sediment that has a high water content, then the mass of oil that is deposited to sediment can roughly converted to a concentration basis in the surface sediment layer. These concentrations can then be related to likely environmental effect levels, based on a variety of studies that examined relationships between TPH concentrations in sediment and

benthic community response (Nance 1991; Rozas et al. 2000; Pettigrove and Hoffmann 2005; Anson et al. 2008).

- Crude oil deposition of less than 0.1 g/m^2 sediment would result in a surface sediment TPH concentration less than 10 ppm, and would be scarcely detectable in routine chemical analysis, and unlikely to have an ecological consequence.
- Crude oil deposition of less than 1 g/m^2 sediment would result in a surface sediment TPH concentration less than 100 ppm, and would be unlikely to result in detectable biological effects.
- Crude oil deposition of less than 5 g/m^2 sediment would result in a surface sediment TPH concentration less than 500 ppm, which could result in adverse effects to a limited number of sensitive species, but could also increase overall benthic community productivity due to an enrichment effect.
- Crude oil deposition of less than 20 g/m^2 sediment would result in a surface sediment TPH concentration less than 2,000 ppm, which would be expected to cause reduced benthic community diversity, biomass and productivity.
- Crude oil deposition of greater than 20 g/m^2 sediment would be expected to cause progressively more serious reductions in benthic community diversity, biomass and productivity.

Table 7-20 provides a summary of how oil characteristics may affect the expected type and scope of environmental effects of crude oil releases on sediment. Table 7-21 considers relationships between environmental characteristics these environmental effects.

Table 7-20 Effects of Oil on Sediment by Oil Characteristic

LAND COVER RECEPTOR: Sediment				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Comments**
Density	Low density crude oils; will float on water. Floating can keep light crude oil away from sediment, but this may change with mixing or changes in density. In the 2000 Pine River, British Columbia release, the light crude oil was well dispersed in river water.	Intermediate in density between light and heavy crude oil; will float on water. Floating can keep medium crude oil away from sediment, but this may change with mixing or changes in density.	Pipeline tariffs require density of diluted bitumen to be less than 0.94. Fresh heavy crude oil and diluted bitumen will float, but may sink with prolonged weathering, or formation of OPAs.	The density of crude oil or diluted bitumen increases with weathering. Density is correlated with viscosity, so that light oils tend to have low viscosity.
Viscosity	Low viscosity oils are readily dispersed in water by turbulence or waves. Dispersal as fine droplets can promote formation of OPAs if other conditions (e.g., suspended sediment concentration, salinity) are favorable.	Intermediate in viscosity between light and heavy crude oils. However, medium crude oils tend to remain within the "low viscosity" range.	Heavy crude oils and diluted bitumens tend to have higher viscosity, although they must still meet requirements for transport by pipeline. With increasing viscosity, and particularly when weathered, diluted bitumens may float on water but resist entrainment as fine droplets except under extremely turbulent conditions.	Crude oil viscosity increases with weathering.
Solubility	Light crude oils typically contain a large fraction of relatively water soluble low molecular weight hydrocarbons. Dissolved hydrocarbons can become adsorbed onto organic matter or suspended sediments and eventually become deposited to sediment.	Intermediate in proportions of soluble low molecular weight hydrocarbons.	The fraction of soluble low molecular weight hydrocarbons depends upon the oil type. Conventional heavy crude oils may have relatively few water soluble components. However, diluted bitumens contain diluent which may (e.g., condensate) or may not (e.g., synthetic crude oil) contain a large component of relatively water-soluble hydrocarbons.	Undiluted bitumen is a naturally highly weathered material, containing few water-soluble components. However, diluent added to bitumen may contain a large amount of relatively water soluble hydrocarbons.
Adhesion	Light crude oils have low adhesion, and form thin layers	Intermediate properties between light and heavy	Heavy conventional crude oils and diluted bitumen have high adhesion,	

Table 7-20 Effects of Oil on Sediment by Oil Characteristic

LAND COVER RECEPTOR: Sediment				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Comments**
	that may weather quickly when the contact solid surfaces.	crude oils.	and can be difficult to remove after they contact solid surfaces.	

Table 7-21 Effects of Oil on Sediment by Environmental Characteristic

LAND COVER RECEPTOR: Sediment				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Sediment grain size	Fine-grained sediments (clay, silt) may resist penetration by oil, particularly when water-saturated. However, if suspended in the water column, fine grained sediments may interact with oil droplets to form OPAs, which may be deposited to sediment in slow-moving areas of water.	Medium-grained sediments (fine to coarse sand) may resist entry of OPAs, particularly if water saturated.	Oil and OPAs can enter pore spaces between coarse-grained sediments (e.g., gravel, cobble), and can become trapped and persist. On the other hand, these sediment types are often found in areas where water currents or wave action are energetic, which can also help to flush and disperse crude oil residues.	Crude oil interactions with sediment are complex. However, long-term deposition of crude oil to sediment is most likely to occur in conjunction with OPA formation, with deposition occurring in areas of slow-moving water and soft/fine-grained sediment.
Water Flow	In slow flowing or still water, crude oil will likely remain floating at the surface. Interactions between crude oil and sediment will be dominated by interactions with shorelines, which are often coarse-grained or armored.	Rivers with moderate flows can transport oil downstream. Mixing can cause dispersion or submersion of crude oil, particularly if it has low viscosity. Crude oil that submerges is likely to re-surface. Interactions between dispersed oil droplets and suspended sediment depend upon the concentration of suspended sediment, and salinity.	Fast flowing waters are typically turbulent, increasing the likelihood of crude oil dispersion as fine droplets. These waters may or may not contain high levels of suspended sediment.	Suspended sediment levels in streams typically increase during periods of high water flow. However, not all fast-flowing streams have high levels of suspended sediment. Higher levels of salinity increase the potential for OPA formation.

Table 7-21 Effects of Oil on Sediment by Environmental Characteristic

LAND COVER RECEPTOR: Sediment				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Suspended Sediment	Low levels of suspended sediment (e.g., <10 ppm) limit the potential for oil-particle interactions and deposition of crude oil to sediment.	Medium levels of suspended sediment (e.g., 10 to 100 ppm) are also likely to limit the potential for oil-particle interactions, particularly where salinity is low.	Oil particle interactions are most likely to occur where suspended sediment levels are high (e.g., >100 ppm).	True oil-particle interactions require a combination of suspended sediment, as well as sufficient turbulence to disperse crude oil as fine droplets in the water column. Salinity also promotes these interactions.
Dissolved oxygen	Low oxygen environments may occur in lakes or deep, slow-moving depositional areas of rivers. Low oxygen availability limits aerobic biodegradation of oil. Anaerobic degradation of oil can occur, but rates are slower than for aerobic processes.		High oxygen environments (saturated or super-saturated) can occur in high gradient streams where water turbulence results in greater entrainment of oxygen. These high oxygen environments can facilitate aerobic biodegradation of crude oil that may be trapped in interstitial spaces of gravel and cobble.	Oxygen is typically a not limiting factor to biodegradation in rivers, except in deep, slow moving areas or in sediment pore water. Oxygen becomes a limiting factor to biodegradation in areas of depositional sediment. Crude oil deposited in anoxic sediment may persist indefinitely.

Table 7-21 Effects of Oil on Sediment by Environmental Characteristic

LAND COVER RECEPTOR: Sediment				
Environment Characteristic	**Low**	**Medium**	**High**	**Comments**
Hyporheic Flow (water exchange between the river and bed sediment)	Rivers are generally areas of groundwater inflow. In these areas, natural groundwater flow into the river will prevent crude oil residues from entering the hyporheic zone.	Irregular river bed surfaces can create local pressure gradients so that fine-scale interactions driven by hydrostatic pressure may draw water into the river bed, trapping small droplets of oil in the bed sediments.	In steep terrain, hyporheic flow systems may occur on river reach scales, with water entering the river bed near the start of riffles, and exiting in riffle tail pools. In arid environments, rivers may feed water into the regional groundwater flow system on an even larger scale, so that entrained oil droplets would be transported into the river bed on a larger scale.	Oil entering the hyporheic zone can become trapped in the sediment by adsorption to particles or can contaminate interstitial water. These areas are often important for benthic community production, or as spawning or juvenile rearing habitat for fish. Hyporheic flow is more likely in areas of coarse-grained sediment than fine-grained sediment. Continual flushing of the hyporheic system or periodic spate events will typically restore habitat quality.

7.1.2.6 Shoreline and Riparian Bank

7.1.2.6.1 Receptor Description

Shoreline and riparian areas are lands adjacent to lakes, ponds, streams, and rivers where soils and vegetation are strongly influenced by the presence of water and exposure stresses such as waves, flood flows, elevated water tables, scour, erosion, and sediment movement (Boak and Turner 2005). As a result, these areas frequently support a diverse set of environmental processes and associated plant communities adapted to disturbance regimes over varying spatial and temporal scales (Keddy 1982; Keddy 1983; Wilson and Keddy 1986; Gregory et al. 1991; Strayer and Findlay 2010).

Shoreline and riparian areas may have various substrate types (e.g., organic material, sand, silt, clay, gravel, cobble, rip-rap, and cement). Shoreline slopes may range from gentle inclines to steep or undercut, depending upon the prevailing hydraulic regime and landscape they occur in. Plant communities range from types characteristic of exposed beaches, rocky shorelines, and unconsolidated shorelines, to densely vegetated emergent and marsh wetlands, and forested riparian lands. Such communities contain plant species that are adapted to the various combinations of physical gradients and exposure that occur at a particular location (Keddy 1982; Keddy 1983; Wilson and Keddy 1986; Shipley et al. 1991). Communities change over time as physical conditions and competitive interactions are modified by climactic patterns and variations in disturbance stresses (Keddy and Reznicek 1986; Gaudet and Keddy 1995; Boak and Turner 2005; Strayer and Findlay 2010).

Shoreline and riparian areas provide a variety of functions that are valuable to humans. Examples of such ecosystem services include support of fish, wildlife, and non-game species; water quality buffering; flood flow dissipation; erosion protection; and aesthetic quality. Shoreline and riparian areas are often destinations for people seeking to enjoy activities such as fishing, swimming, and boating. Shoreline habitats are at risk from oil releases because of the high likelihood of being directly oiled by floating slicks, or by deposition of oiled debris, tarballs, or other oil aggregates.

Shorelines vary from place to place, based on landform, exposure, and plant community development, making classification a complex undertaking. Most classification systems are based either on the physical characteristics of the shore or on some combination of physical characteristics and vegetation (Reid and Holland 1997). In general, freshwater shoreline types can be placed into the following categories (Owens et al. 1993; NOAA and API 1994):[9]

1. Sand—sandy shorelines are areas where most particles are between 0.003 and 0.079 in. (0.075 to 2 mm) in diameter. Such shorelines may consist of one size of sand or a mixture of different sand sizes with elements of clay, silt, gravel and cobble. Often sandy shorelines

[9] Particle sizes are converted to Imperial measure based metric standards from ISO)publication 14688-1:2002, Identification and Classification of Soil.

have varying amounts of woody and other debris. Plants tolerant of disturbance may grow in areas of stable sand with adequate organic material, moisture, and nutrients.

2. Mixed Sand and Gravel—these shorelines are composed of varying amounts of sand and gravel with particle sizes ranging from 0.00079 to 2.5 in. (0.02 mm to 63.0 mm). Varying amounts of wood and other organic debris may be present. Plant communities tend to be minimal on mixed sand and gravel shorelines due to high levels of disturbance and poor water holding capacity. However some hardy plants may grow in relatively sheltered locations.
3. Gravel/Cobble—gravel shores are dominated by material with particle sizes ranging from 0.079 to 7.9 in. (2 to 200 mm). Scattered larger sized boulders, patches of sand, woody and other debris may also be present. Plant communities tend to be minimal on gravel shorelines due to high levels of disturbance and poor water holding capacity. Some hardy plants may grow in relatively sheltered locations.
4. Bedrock—bedrock shores are composed of impermeable rocky substrate that may be intact or contain cracks, fissures, and crevices. Such shores can range from vertical walls to nearly flat shelves. In most cases bedrock shorelines have limited associated biological communities and human uses, although cliff structures can provide nesting and foraging areas for birds, and some plants may grow where pits and cracks provide rooting opportunities and sufficient moisture.
5. Vegetated banks—vegetated banks are non-wetland areas occurring on mineral or organic soils at and just above the ordinary high water level. Vegetation generally consists of species found in adjacent upland communities, although specialist species such as alders, willows, and cottonwood trees may predominate. Field crops, grassland, or lawns may be present in developed areas. Many animal species use these areas for foraging, nesting, and hiding. Some animals such as swallows and muskrats may also create nests by burrowing into banks.
6. Mud/Sediment—med/sediment shorelines are composed primarily of silt and clay particles (<0.00079 in. or <0.02 mm). They may be intermixed with areas of sand and gravel and generally occur in areas of low exposure. Woody and other debris may be present. Often these areas are high in organic content and support diverse communities of plants and invertebrates.
7. Wetlands—in some locations, the shorelines of lakes, ponds, rivers, and streams are not clearly defined and the aquatic system may transition into a wetland. Depending upon the associated hydrology and plant community type, wetlands may be described as bog, marsh, fen or swamp subtypes.
8. Manmade Structures—manmade structures include shore protection surfacing such as seawalls, bulkheads, riprap revetments and groins, breakwaters and jetties, which may be constructed of rock, concrete, wood, and/or corrugated metal or plastic. Manmade structures usually have specific human use, but may have limited associated value as biological habitat.

The following summary of observed and expected effects of released oil to shoreline and riparian areas considers the non-wetland areas described above. Wetlands are addressed separately in Section 7.1.2.7.

7.1.2.6.2 Observed Effects of Oil along Shoreline and Riparian Areas

Although there are few published reports, data available from field experiments and a small number of freshwater case studies provide a basis for describing what happens to shoreline and riparian areas following a crude oil release, and for categorizing the relative sensitivity of

different shoreline types. The overall pattern in these published records is that the key determinants of oil effects to shoreline and riparian areas include the type and quantity of oil released, the type of water body affected, the shoreline type and complexity, and the vegetation community type present (Gundlach and Hayes 1978; Baca et al. 1985; Owens et al. 1987; NOAA and API 1994; Hossler et al. 2007; Michel et al. 2008).

Oil type can influence the fate of released oil because crude oils and petroleum products are composed of differing mixtures of hydrocarbon compounds. Each substance has physical properties (e.g., viscosity, adhesion, density, solubility) that reflect its chemical composition and affect its fate and transport once released into the environment (NRC 2003). Light, low viscosity oils are generally retained on shorelines only as thin layers of oil, which will also weather quite rapidly (Curl and O'Donnell 1977; Davis et al. 2004). In contrast, heavy oils tend to be viscous adhesive, so they tend to be retained on shorelines as thicker layers of oil. Heavy oils exposed to sunlight and wave action weather to form tar balls and other deposits that can be difficult to remove from shoreline rocks and sediments (Atlas 1975; Overstreet and Gault 1995; USEPA 1999; Ansell et al. 2001). Heavy oils also contain larger amounts of substances such as resins and asphaltenes, which weather slowly and render them more persistent than light oils.

The Grapevine Creek oil release in Kern County, California and the Chalk Point oil release into the Patuxent River, Maryland demonstrate the differences between oil type and persistence. The Grapevine Creek release consisted of approximately 6,200 barrels of San Joaquin valley light crude entering a small stream. Sampling data indicated that within two days of the release a majority of the oil had dissipated and over 90% of its toxic compounds were gone (Mancini et al. 1995). In contrast, the Chalk Point oil release consisted of 3,333 barrels of No. 6 heavy fuel oil that ran into Swanson Creek and the Patuxent River. In this case, sampling indicated that within the first five days of the release 39% of the oil had dissipated and the residue remained substantially toxic (NOAA et al. 2002).

The type of waterbody also influences the effects of released oil on shorelines and banks by affecting oil concentration, retention time, flushing rate, and the potential for emulsification and weathering (Baca et al. 1985; NOAA and API 1994; Overstreet and Gault 1995; Owens 2003). In general standing water bodies such as lakes and ponds will have lower physical removal, dilution and flushing rates, and slower weathering of crude oil than moving water such as rivers and streams (Baca et al. 1985; NOAA and API 1994; Overstreet and Gault 1995). In rivers and streams, higher mixing rates may also increase contact between oil and suspended sediments, promoting enhanced biodegradation rates through oil-mineral aggregate formation (Lee 2002; Owens and Lee 2003).

Differences in effect related to the water body type are illustrated by the Marathon oil release into Newton Lake, Illinois, and the tank ship MOBILOIL release into the Columbia River. The Marathon release occurred on April 27, 1985, releasing approximately 10,775 barrels of Southern Louisiana crude oil into the north end of Newton Lake in Jasper County, Illinois. The oil moved slowly along the lake surface allowing retention of most of the oil within about a mile of the

release site, although a period of high winds dispersed a small amount past the booms and several miles further south(Sauer et al. 1995; Neff et al. 1995). Shoreline oiling occurred primarily in areas near the release, where wind pushed oil toward the lake edges. In locations farther away from the release site, winds and water currents retained oil on the water surface (Sauer et al. 1995; Neff et al. 1995). In contrast, the MOBILOIL incident released over 3,900 barrels of heavy fuel oil into the Columbia River near St. Helens, Oregon on March 19, 1984. High river flows rapidly carried the oil downstream as surface and subsurface material. After 24 hours, material was detected over 50 miles downriver (Kennedy and Baca 1984). After 48 hours the oil reached 70 miles downstream and entered the convergence zone with the Pacific Ocean. Shoreline oiling above the convergence zone was related to fluctuations in river water level and much of the deposited material was rewashed into the river during subsequent high water events (Kennedy and Baca 1984).

Substrate type (e.g., grain size, mobility, organic content), substrate motility, slope and exposure, and type of vegetation can influence the effects of released oil on shoreline and riparian areas (Gundlach and Hayes 1978; Little and Scales 1987; Humphrey et al. 1993; NOAA and API 1994; Rayburn 2001; Peterson et al. 2002; Short et al. 2004; Owens et al. 2008). The degree of oil penetration into the shoreline substrate depends in large part on the permeability of the substrate (Etkin et al. 2007). There is an interaction between crude oil viscosity and average substrate pore size that determines oil retention capacity. Shoreline substrates that are water-saturated or can maintain water saturation during periods of low water level (e.g., clays, silts, and muds) are resistant to penetration by crude oil. Shoreline substrates that drain down and are porous may be penetrated by crude oil; however, light crude oils with low viscosity may be poorly retained by coarse open substrates such as gravels and cobbles, whereas heavy crude oils with higher viscosity may penetrate and be retained within such substrates. Retention of crude oil in shoreline substrates can increase the complexity and intrusiveness of the clean-up (Li and Boufadel 2010).

Sub-surface or sequestered crude oil may become physically protected from disturbance, oxygenation, and photolysis, only partially weather, and retain some degree of contamination for years (Peterson et al. 2003). Fine sands and muddy sediments have the lowest permeability of unconsolidated types and also tend to be water saturated, so oil penetration is very limited. On the other end of the scale, gravel and cobble substrates are highly permeable. Consolidated shoreline materials such as bedrock, and some manmade materials such as concrete or sheet pile, tend to be impermeable except where cracks, fissures, and other similar features occur.

The importance of shoreline exposure and slope is their effect on wave frequency, magnitude, and action (Owens et al. 1987; Little and Scales 1987; Little et al. 1993; Owens and Lee 2003; Short et al. 2004; Etkin et al. 2007). In lakes, shorelines that are exposed to prevailing summer winds (lee shores) tend to be washed by waves, while windward shorelines are generally calmer. Steep shoreline areas are usually subject to abrupt wave run-up and breaking, and even reflection in places, which enhances natural clean-up of the shoreline. Flat shoreline areas, on

the other hand, promote dissipation of wave energy farther offshore, which lets oil remain longer in the shoreline zone.

In rivers, the situation is more three-dimensional but the basic concepts still pertain. As Owens (2003) pointed out, "[g]enerally, the waters of a river move in one direction (downstream) but locally within a channel there are back eddies, whirlpools, and other dynamic hydraulic features that alter the simple unidirectional flow pattern". Once oil enters this dynamic environment, the rate of movement is primarily a function of river flow. It thus tends to be deposited along shorelines in quieter waters where velocity and turbulence decrease at a given river stage rather than along shorelines more exposed to strong currents (Kennedy and Baca 1984; Baca et al. 1985; Owens 2003).

Where dense vegetation exists at the land-water interface and released oil approaches from the water, the vegetation can provide a barrier and protect shoreline resources from contact with substantial amounts of oil. One example of this was reported following the 1988 Shell Oil release in Martinez, California. In this release, nearly 9,405 barrels of San Joaquin Valley crude oil was released into Peyton Slough and Shell Marsh. Researchers found that, in shoreline areas with vegetation, a majority of the oil was absorbed by the vegetation and did not reach soil to the landward side (Fraser et al. 1989). Similarly, shoreline oiling data from the November 2000 M/T Westchester oil release into the Mississippi River showed that along vegetated shorelines oiling occurred usually as a narrow band along the outer fringe, with little penetration into the vegetation and minimal contact with the shoreline substrates (Michel et al. 2002, 2003).

In cases where the oil reaches the shoreline from land or where waterborne oil penetrates the vegetation, shoreline plants can increase the shoreline's oil-holding capacity and oil residence time, thereby resulting in a greater duration of oiling effects than in similar un-vegetated shorelines (Gundlach and Hayes 1978; Baca et al. 1983; NOAA et al. 2002; Peterson et al. 2003; Michel and Rutherford 2013). The trapping capacity of vegetation is illustrated by the May 1983 oil release near Wilmington, North Carolina that released approximately 119 barrels of waste heavy fuel oil into the Cape Fear River (NOAA 1997). The oil affected approximately 30 miles of high-marsh type shoreline dominated by species of *Spartina, Scirpus,* and *Juncus.* Studies five months after the release found that the vegetation trapped oil along the shoreline from which it continued to seep at low tide (Baca et al. 1983). A study of the September 1969 oil release into Buzzard's Bay near West Falmouth, Massachusetts reported that oil residues persisted in the marsh vegetation along the shoreline, but not elsewhere in the release zone (Peacock et al. 2005).

The time of year of a release can influence the resulting effects to shoreline and riparian areas by determining sensitivity of affected resources and the ease of detection and clean-up. Oil released when plants are beginning to grow or reproducing result in greater damage than when plants are dormant. Oil releases in winter and under ice, however, can make detection and clean-up difficult, prolonging the period of oiling (Telford and Quam 1979; Owens et al. 2005).

7.1.2.6.3 Expected Effects of Oils on Shoreline and Riparian Areas

The expected effects of oils in shoreline and riparian areas mirror the observed effects reported in published literature. The magnitude of effects depends on three principal dimensions, namely oil type, shoreline type, and degree of exposure to physical processes

The review of case studies above indicates that in general, the lighter the oil, the more impervious the substrate, and the more exposed the site, the less will be the effect. Thus, a light oil released in a shoreline area consisting of bedrock or concrete with high exposure can be expected to have relatively minor shoreline effects, while a heavy oil released into sheltered shoreline areas with diverse wetland vegetation can be expected to have more severe effects. Assuming a release of an equivalent amount of the same type of oil, the relative sensitivity of different shoreline habitats to the oil can be generally ranked from low to high as shown below (adapted from NOAA and API 1994; Jensen et al. 1998; Peterson et al. 2003; Etkin et al. 2007):

1. Exposed rock cliffs, seawalls, and other exposed, impermeable vertical shorelines
2. Exposed bedrock shelfs, shoals, and ledges, concrete slopes, and other impermeable, non-vertical shorelines
3. Moderately exposed fine-grained sand beaches, eroding sediment scarps and banks, and other semi-permeable, shorelines
4. Moderately exposed coarse-grained sand beaches, sandy bars, sloping sand banks, and other moderately permeable shorelines
5. Moderately exposed mixed sand and gravel beaches, bars, sloping banks and other moderately to highly permeable shorelines
6. Moderately exposed gravel beaches, bars, and sloping banks; rip-rap, and other highly permeable shorelines
7. Moderately exposed soft mud and mixed mud/sand flats and other flat, semi-exposed, semi-permeable shorelines
8. Sheltered, moderately sloping rock, mud, or clay banks; rip-rap or rock rubble, vegetated bluffs and other impermeable shorelines
9. Sheltered sand/mud flats, vegetated low banks and other flat, semi-Permeable shorelines
10. Sheltered organic flats supporting marsh, swamp, and other diverse wetland shorelines

Effects of released crude oil on riparian areas are consistent with effects of released oil on wetlands, soils and terrestrial vegetation communities, as discussed elsewhere. Riparian areas are transitional between water and land, and subject to seasonal cycles of inundation and drainage that depend strongly upon site-specific conditions of hydrology, soil type and vegetation community present.

7.1.2.6.4 Summary of Oil Release Effects on Shoreline and Riparian Areas

Table 7-22 and Table 7-23 provide a summary of the expected environmental effects of oil releases to shorelines. Table 7-22 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-23 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-22 Effects of Oil on Shoreline and Riparian Areas by Oil Characteristic

Oil Characteristics	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—adhesion	Light crudes have low adhesion properties that require less intensive remediation efforts to remove oil from shoreline and riparian areas	Medium crudes have moderate adhesion properties that require more intensive remediation than light crudes, but less intensive than heavy crudes, to remove oil from shoreline and riparian areas.	Heavy crudes have high relative adhesion rates that require intensive remediation efforts to remove oil from shoreline and riparian areas. Diluted bitumens initially have similar adhesion properties, but through weathering become more adhesive than weathered conventional heavy crudes.	The adhesive properties of oils change with weathering as the more soluble and less viscous constituents evaporate to the environment. Adhesion is also related to the viscosity and persistence of oil and is specific to the particular type of crude oil.
Oil properties—viscosity	Light crudes have a low relative viscosity and are more readily disperses in aquatic environments than medium and heavy crude oils. Thus, they have a greater potential to affect larger extents of shoreline and riparian areas.	Medium crudes have a moderate relative viscosity and tendency to disperse in aquatic environments. Thus, they have a moderate potential to affect shoreline and riparian areas.	Heavy crudes have a high relative viscosity and lower tendency to disperse in aquatic environments. Diluted bitumens when fresh have lower viscosity than heavy conventional crudes; however, the viscosity of diluted bitumen increases rapidly with weathering. Heavy crudes and diluted bitumens have a lower potential to affect larger extents of shorelines and riparian areas as the released oil tends to remain aggregated, but oil is also likely to be deposited more thickly than for lighter crudes.	Viscosity of crude oils increases with weathering as low molecular weight components that act as solvents evaporate rapidly.

Table 7-22 Effects of Oil on Shoreline and Riparian Areas by Oil Characteristic

Oil Characteristics	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—persistence	Light crudes tend to be deposited more lightly, and have a lower persistence in the environment due to their more volatile constituents (i.e., low molecular weight hydrocarbons) and smaller proportions of persistent components (e.g., resins and asphaltenes). Therefore, light crude oils tend not to be persistent, and affected shoreline and riparian habitats are likely to recover quickly.	Medium crudes have a moderate relative persistence in the environment due to their mixture of volatile and non-volatile constituents. Therefore, there is a moderate potential duration of effects to shorelines and riparian areas from released hydrocarbons.	Heavy crudes and diluted bitumens are likely to be deposited more thickly, and contain larger proportions of resins and asphaltenes than lighter crude oils. Heavy crudes are therefore more persistent in the environment. Shoreline and riparian areas affected by heavy crude oils will take longer to recover than similar areas affected by lighter crude oils.	Persistence in the environment is assessed here without taking into account oil spill response, including clean-up and removal of released hydrocarbons. Oil spill response activities would enhance natural recovery, reducing although not eliminating differences related to crude oil type.

Table 7-23 Effects of Oil on Shoreline and Riparian Areas by Environmental Characteristic

Environmental Characteristics	Low	Medium	High	Other Comments
Ice cover	Ice-free conditions permit contact between released oil and shoreline/riparian areas. Recovery of hydrocarbons from open-water environments is simpler and more effective, reducing potential for crude oil contact with shorelines.	A release to the aquatic environment during spring break up creates challenging conditions for recovery efforts. Hydrocarbons are likely to contact shoreline and riparian areas. High water levels would promote entry of released oil into flooded areas and riparian zones.	A release to the aquatic environment under ice cover creates challenging conditions for recovery efforts. However, ice cover may limit crude oil contact with shorelines, and prevent contact with riparian areas. Hydrocarbons released onto ice covered aquatic environments or frozen shorelines are more easily recovered and tend to have less substantial effects to shorelines and riparian habitats.	A release under winter ice may be followed by a "secondary release" as oil that was trapped under the ice is mobilized with spring breakup and rising water levels.
Shoreline slope	Steep shorelines are usually subject to abrupt wave run-up and breaking, and even reflection in places, which enhances natural clean-up of the shoreline.	Moderate slope shorelines have intermediate risks of oil retention.	Flat or gentle slope areas promote dissipation of wave energy further offshore, letting oil remain longer in the shoreline zone. In sheltered habitats, slope is a less important factor with regard to oil effects, except that biological communities have more area to develop, and may represent more important units of habitat, where the slopes are gentle.	Shoreline slope is a factor that would be more important in large lakes than in many other freshwater habitats.

Table 7-23 Effects of Oil on Shoreline and Riparian Areas by Environmental Characteristic

Environmental Characteristics	Low	Medium	High	Other Comments
Shoreline exposure	Low energy shorelines and are sheltered from wave energy, except during unusual or infrequent events. Weathering and flushing rates are low and oil can remain adhering to the shoreline for extended periods of time. Sheltered areas also tend to have conditions conducive to development of relatively diverse biological communities making them more sensitive than locations that have greater exposure.	Medium energy shorelines have intermediate characteristics with respect to oil deposition, weathering, flushing, and retention.	High energy shorelines are regularly exposed to large waves or strong currents. The effects of oil on exposed habitats are reduced because: 1) offshore-directed currents generated by waves reflecting off hard surfaces push the oil away from the shore; 2) wave and/or current-generated forces mix and rework shoreline materials that are typically coarse-grained, removing stranded oil; and 3) organisms adapted to living in high energy settings are accustomed to short-term perturbations in the environment.	
Shoreline composition	Impermeable shorelines largely impermeable to oil except when it is able to enter crevices or fractures in rock surfaces. Impermeable shorelines tend to retain less oil, for shorter periods of time, than permeable shoreline types.	Moderate permeability shorelines have intermediate risks of oil penetration, burial, and retention.	Highly permeable shorelines tend to retain more oil and may sequester crude oil in relatively fresh form for longer periods of time. If the substrate pores are large and inter-connected, the substrate will be more permeable and allow deeper penetration and even lateral movement through capillary action.	Water saturation of shoreline substrates can prevent ingress of crude oil.

Table 7-23 Effects of Oil on Shoreline and Riparian Areas by Environmental Characteristic

Environmental Characteristics	Low	Medium	High	Other Comments
Riparian area	Watercourses occupying incised channels with narrow riparian areas present smaller surface area and lower habitat value to be harmed by retained or entrapped crude oil residues.	Watercourses having moderate riparian zones present intermediate surface area and habitat values to be harmed by retained or entrapped crude oil residues.	Watercourses having broad floodplain areas may represent important and rich habitat units, where effects may be more extensive and damaging to biodiversity than in less extensive floodplain areas.	

7.1.2.7 Wetlands

7.1.2.7.1 Description

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a vegetation community that is typically adapted for life in saturated soil conditions. Three key diagnostic environmental characteristics are therefore used to define wetlands (Environmental Laboratory 1987):

- Soils are present and are classified as hydric, possessing characteristics that are associated with reducing or anaerobic soil conditions
- Area is flooded, either permanently or periodically, with shallow water; or the soil is water-saturated to the surface at some time during the growing season of the prevalent vegetation
- Prevalent vegetation consists of macrophytes that are typically adapted to areas subject to flooding, and that have the ability to thrive in anaerobic soil conditions

Wetlands develop through the recurrent or prolonged presence of water at or near the soil surface, which greatly influences associated soil development and the types of plant and animal communities living in the soil and on its surface (Heimlich et al. 1998). Wetlands provide a variety of ecosystem services of benefit to humans, including the following functions and values that have been identified as important to the people of Minnesota (MN DNR 1997):

Table 7-24 Identified Functions and Values

Wetland Functions	Wetland Values[1]
1. Hydrologic Flux and Storage: includes ground water recharge and discharge; stream discharge and recharge; water storage, and evapotranspiration export. 2. Biological Productivity: includes primary productivity; secondary productivity; carbon storage; and carbon fixation. 3. Biogeochemical Cycling and Storage: wetlands can be a nutrient source or sink, an area for oxidation and reduction chemical transformations; an area for dentrification; and reservoirs for sediment and organic matter. 4. Decomposition: involves carbon release; mineralization; detritus output for aquatic organisms; and release of chemical compounds. 5. Community Wildlife Habitat: providing habitat for algae, bacteria, fungi, insects, invertebrates, wetland plants, fish, shellfish, amphibians, reptiles, shorebirds, waterfowl, and other wildlife. Wetlands are often critical habitat for rare and unique species enhance the diversity and resilience of plant and animal communities.	• Water supply and low flow augmentation [A] • Flood water retention [A,B] • Water quality protection [A,B,C] • Sediment control [A,C] • Wastewater treatment [B,C] • Nutrient removal [B,C] • Shoreline anchoring and erosion control [A,B,C] • Education and research [A,B,C,D,E] • Historical and archeological resources [B,E] • Open space [A,B,E] • Aesthetics [A,E] • Recreation [A,E] • Hunting and trapping [B,E] • Plant and animal refuges [E] • Threatened and endangered species habitat [E] • Crop (e.g., hay) and pasture [A,B] • Timber production [A,B] • Peat production [B,C,D] • Shrub crops (e.g., cranberry) [A,B] • Wild rice gathering/production [A,B] • Food production/aquaculture (fish, game) [B,E] • Medical product production (streptomycin) [D,E]

Table 7-24 Identified Functions and Values

Wetland Functions	Wetland Values[1]
NOTE: [1] Bracketed letters indicate influencing wetland functions identified in the first column.	
SOURCE: adapted from MN DNR 1977	

Wetlands generally include bogs, fens, marshes, swamps, and similar areas, and may be bordered by areas that are either wetter (e.g., open water or lake habitats where vegetation is no longer a dominant feature of the environment) or drier (e.g., transitional and upland areas where the water table is rarely at the ground surface, flooding is infrequent, and soils are not hydric).

Minnesota contains seven types of native wetland communities that provide the functions and values listed above to the benefit of individuals, communities, the state's citizens, and the overall integrity of land and water systems. Summary descriptions of these seven wetland communities are presented below. The focus in this section is primarily on plant community type and site hydrology.

7.1.2.7.1.1 Bogs

Bogs are nutrient-poor late-successional communities characterized by the prevalence of sphagnum mosses and ericaceous shrubs (heath family). Bogs have a raised water table relative to the surrounding landscape, and the bog water is classically isolated from deeper groundwaters because of the peat accumulation. Most water and nutrients are derived from rainfall, and bog waters are acidic (Bay 1968; Boelter and Verry 1977).

There are two general bog community types in central and northern Minnesota: forest bog and open bog (Aaseng et al. 1993; MN DNR 1997). Both types have a nearly continuous mat of moss dominated by *Sphagnum* species (especially *Sphagnum fuscum* and *Sphagnum angustifolium*), and an impoverished vascular plant flora. The ground layer is dominated by low ericaceous shrubs (e.g., Labrador tea, leatherleaf, swamp laurel, or bog-rosemary), sedges (*Carex* spp.), or cotton grasses (*Eriophorum* spp.). The forest bog community also has a tree layer dominated by black spruce.

Bogs are very sensitive to changes in hydrology and surface and peat water chemistry. Alterations to these parameters can result in shifts in species composition and associated reductions in community quality (Wilcox 1986; MA DFW 2007; Karofeld et al 2008).

Phytoplankton communities of bog pools are typically species-poor, tending to be dominated by filamentous green algae, acidophilous diatoms, and desmids (USEPA 2002a, 2002b). Algal diversity tends to be greatest in open-water areas and in systems connected to other lakes or streams (Wehr and Sheath 2003).

7.1.2.7.1.2 Fens

Fens include community types that occur on wet mineral or peat soils with seasonally standing or flowing water at the ground surface (Aaseng et al. 1993; MN DNR 1997). Fens are further divided into three sub-types according to water chemistry and associated plant community (poor fen, rich fen, calcareous seepage fen). Generally, they occur on sites too wet for significant invasion by woody species, or on sites that burn frequently. Fens share the general characteristic of a closed canopy of mid-height graminoids (grasses or grass-like plants). Dominant species include grasses (e.g., bluejoint (*Calamagrostis canadensis*, prairie cordgrass (*Spartina pectinata*), sedges (e.g., wiregrass sedge (*Carex lasiocarpa*), lake-bank sedge (*Carex lacustris*), tussock sedge (*Carex stricta*), and rushes (e.g., *Scirpus cespitosa*). Fens may have associated algal communities generally dominated by green algae, cyanobacteria, and alkaliphilous diatoms (USEPA 2002a, 2002b; Rober et al. 2013).

7.1.2.7.1.3 Marshes

Marshes are shallow-basin wetlands that develop in standing water typically in mineral soils or in relatively inorganic sediments associated with lakes, ponds, and streams (Aaseng et al. 1993; MN DNR 1997). Marsh vegetation is composed of tall, erect, rooted graminoids such as cattail (*Typha latifolia* and *T. angustifolia*), common reed grass (*Phragmites australis*), bulrush (*Scirpus* spp.), rush (*Juncus* spp.), spike-rush (*Eleocharis* spp.), and some sedges (*Cyperus* spp.). Common herbs associated with marshes include broad-leaved arrowhead (*Sagittaria latifolia*), swamp milkweed (*Asclepias incarnata*), willow-herb (*Epilobium* spp.), bulb-bearing water-hemlock (*Cicuta bulbifera*), and knotweed (*Polygonum spp.)*. Obligate aquatic plants (including *Potamogeton*, *Elodea*, *Ceratophyllum* and *Myriophyllum*) often are present in the standing water of marshes. Algal communities are also important components of marsh wetland ecosystems, contributing significantly to ecosystem primary production and nutrient retention, which improves water quality (Wehr and Sheath 2003; Rober et al. 2013). Wild rice, a commercially and culturally important species grows in some emergent marshes, and in shallow bays of lakes, generally in water less than about three feet deep, in areas with slow current, over a mucky or silty sediment, with little competition from other plants (Moyle 1944; Tucker et al. 2011).

7.1.2.7.1.4 Swamps

Shrub swamps are minerotrophic, tall-shrub communities occurring on mucks and shallow peat soils dominated either by alders (alder swamps) or willows (willow swamps) (Aaseng et al. 1993; MN DNR 1997). The major shrub species in these communities are usually alders (*Alnus* spp.), willows (*Salix* spp., and red-osier dogwood (*Cornus stolonifera*). Common understory species in the community include tussock sedges (*Carex* spp.), cattail (*Typha latifolia*), blue-joint (*Calamagrostis canadensis*), northern marsh fern (*Thelypteris palustris*), jewel-weed (*Impatiens capensis*), and mosses (e.g., *Sphagnum squarrosum*). Shrub swamps are typically non-stagnant wetlands with high levels of dissolved oxygen and soil nitrogen. Soils range from poorly drained to well drained, with most sites remaining saturated throughout the growing season.

Conifer swamps tend to develop on sites with wet mineral or poorly drained organic soils. There is often standing or barely moving water within the community (Aaseng et al. 1993; MN DNR 1997). The tree canopy is dominated by black spruces, tamaracks, or white cedars. The density of the shrub, herb, and moss layers varies greatly, depending on the density of the tree canopy, soil nutrients, and the level of the water table. Due to anaerobic conditions associated with a high water table and organic soils, trees growing in conifer swamps are shallowly rooted. The understory of the community commonly contains combinations of speckled alder, winterberry, red-osier dogwood, willow species, and mountain fly honeysuckle. On less acidic sites, groundcover includes blue-joint, cattail and jewel-weed, while more acidic sites are characterized by a continuous hummocky mat of sphagnum mosses with bog birch, leatherleaf, other ericaceous species, cinnamon fern (*Osmunda cinnamomea*), and various sedges.

Hardwood swamp forests are minerotrophic wetland communities that occur on muck and shallow peat substrates on wet sites in depressions on level to hummocky glacial lake plains, fine- and medium-textured glacial tills, and broad flat outwash plains (Aaseng et al. 1993; MN DNR 1997). Standing water, usually a result of groundwater seepage, is usually present in spring and drained by late summer. Hardwood swamps have tree canopies dominated by broad-leaved deciduous species, including black ash, paper birch, yellow birch, red maple, American elm, slippery elm, green ash, quaking aspen, or, rarely, balsam poplar. Understory vegetation may include alders, ferns, a variety of herbs, sedges and mosses. Areas of standing water will also contain populations of floating and submerged algae.

7.1.2.7.1.5 Other Related Habitat Types

Wetlands are often associated with streams, rivers and lakes, and intergrade with other recognized habitat types around these features.

Floodplain forest is a bottomland, deciduous or deciduous-conifer forest community occupying riparian areas subject to periodic over-the-bank flooding and cycles of erosion and deposition (Aaseng et al. 1993; MN DNR 1997). Floodplain forests are generally dominated by silver maple, cottonwood, black willow, American elm, green ash, and bur oak. Due to frequent flood disturbance, the understory of floodplain forest is often relatively open, with few tree seedlings and saplings. Shrubs may be a significant component, particularly where canopy gaps occur. Woody vines, including wild grape (*Vitis riparia*), poison ivy (*Rhus radicans*), and Virginia creeper (*Parthenocissus quinquefolia*), are often present in light gaps and along open channels. The herbaceous layer generally has low diversity, and contains only short-lived species or species otherwise tolerant of frequent disturbance, such as wild-rye (*Elymus virginicus*), cleavers (*Galium aparine*), sedges (*Carex* spp.) and nettles (Urticaceae).

Vernal pools are small isolated pocket wetlands that occur in depressions located within forested settings. These depressions, typically in mineral soil with an underlying impermeable clay layer, collect water in the spring from runoff and precipitation then dry out later in the year as water inputs decline below evaporation and infiltration rates (Batzer et al. 2004; Brooks 2004; Leibowitz and Brooks 2007; Palik et al. 2007; Thomas et al. 2010). Vernal pools may occur in all

forested community types but are most common in wet forest types with poorly-drained mineral soils and least common in dryer forests with generally sandier, more well drained soils (Leibowitz and Brooks 2007; Thomas et al 2010). Plants that grow in vernal pools are often tolerant of flooding, soil saturation, and drought.

7.1.2.7.2 Observed Effects of Oil on Wetlands

The effects of oil on the plants, soils, and water comprising wetlands have been evaluated in laboratory and field experiments, experimental oil releases, and case studies of accidental oil releases. These data sources span marine, freshwater, terrestrial, arctic, and temperate environments; upland and wetland vegetation; and controlled and uncontrolled settings. Most of the experimental spills and accidental oil release case studies include clean-up and remediation efforts. The body of published studies provides a framework for projecting the effects likely to result from releases of oil into different types of wetlands.

Oil affects wetlands by damaging one or more of their primary components: vegetation, soil, and water. Oil can affect wetland communities directly by blocking metabolic processes and indirectly through changing a plant's internal chemistry or by altering soil characteristics and/or water chemistry. The damage can vary considerably based on several factors. Effects vary based on the time of year, the amount of water flow through the community, water chemistry, abundance of oil, type of oil, and type of release (Michel and Rutherford 2013). The toxicity of an oil depends largely upon its content of aromatic compounds (hydrocarbons containing benzene rings), oxygenated aromatic derivatives, and aliphatic compounds (hydrocarbons without benzene rings). Lighter oils, though more acutely toxic than heavy oils, also undergo more rapid weathering leading to a reduction in toxicity. Heavy oils, while potentially having lesser acute toxicity, also weather more slowly, often resulting in longer persistence in the environment.

When released into water, oil spreads over a wide area forming a slick and immediately begins to undergo a variety of physical, chemical, and biological changes including evaporation of high volatile fractions, dissolution of water-soluble fractions, photochemical oxidation, emulsification, microbial degradation, and sedimentation. These processes are affected by temperature, wind speed, and water chemistry and may vary across different types of wetland habitats. Releases into wetlands will tend to be more confined, and the associated effects more concentrated than in open waters of large bodies of water (Shales et al. 1989). Smaller freshwater wetland environments can also be more sheltered from the effects of wind than larger lakes, resulting in lower rates of physical weathering. The effects of crude oil released to lakes are discussed in Section 7.1.2.3.

Oil that directly contacts plants can impede photosynthesis and gas exchange processes by blocking sunlight, clogging stomata, and raising internal temperature (Baker 1970; Emerson 1983; Michel and Rutherford 2013; Pezeshki et al. 2000). When these conditions are of sufficient extent and duration, the loss of metabolic processes result in a decline in vitality, and eventually, if not reversed, death. While light hydrocarbons such as gasoline, diesel fuel, gas condensates and

light crude oils can "burn" green plant tissues, resulting in tissue death and in some cases death of the whole plant, heavier crude oils may coat the plant tissues and cause death by smothering.

Changes to wetland soil or sediment characteristics that can be caused by crude oils include alterations to soil chemistry affecting nutrient availability, decreased water content due to increased repellency, and associated changes to vegetation and soil organisms (De Jong 1980; Emerson 1983; Hemmings et al. 2015). Oil flow into the soil or sediment can cause plant mortality by killing root tissues, restricting the availability of nutrients, and/or preventing regrowth from rhizomes (Corn and Copeland 2010). Because crude oil deposited in wetlands alters the microbial process, there can be a subsequent change in soil or sediment biochemistry (Nyman 1999; Mendelssohn et al. 2012). The presence of crude oil typically causes a decrease in microbial diversity and an increase in abundance of those microbes that can more readily use the carbon source available in the oil. This change in the microbial community can ultimately modify nitrogen cycling dynamics within the wetland, affecting plant growth and associated processes (Plice 1948; Ellis and Adams 1961; Greer et al. 2003).

Following a release of 30,000 barrels of crude oil into a Louisiana cypress swamp, researchers observed plant growth in affected and in unaffected control areas (Baca et al. 1985). According to the researchers:

> Comparisons of control and affected sites one year following the release showed that areas with high shading by cypress, sweetgum, and tupelo had little or no understory and very few effects were seen on the dominant woody vegetation. In addition, perennials (e.g., *Pontederia cordata*) were returning in all sunlit areas. However, floating vascular vegetation suffered significant impacts. Areas of water in the swamp once completely covered by water hyacinth (*Eichhornia crassipes*, an introduced pest) and associated nonvascular plants were devoid of any vegetation.

Following the 1972 release of approximately 160 barrels of diesel fuel into a wet meadow near Mount Baker, Washington, studies were made of the initial effects of the oil on the vegetation and of community recovery over nine years (Belsky 1982). The studies concluded that:

> Both the amount and the type of the oil in the Mt. Baker oil release were responsible for the initial impact which reduced vegetative cover from nearly 100% to less than 1% and all species except *Phyllodoce empetriformis, Carex lenticularis,* and *Rhacomitrium sudeticum* had died. The added burden of a large volume of oil (160 barrels) flowing through a small area increased the damage. The snow cover, steep terrain, and snowmelt water, on the other hand, reduced the impact of the diesel oil on the meadows. In the Mt. Baker release, oil flowed over frozen and saturated soils and contacted dormant vegetation. Most of the diesel oil flowed down the steep slope and out of the area instead of pooling for

> later absorption. In the summer a large volume of snowmelt water flushed much of the oil out of the area. Recovery of the habitat began with seed germination of *Carex nigricans* within one year, followed by seedlings of other common subalpine species two to four years later. Nine years after the perturbation 5 to 20% of the ground was covered with vegetation and the original disturbance could no longer be discerned by a casual observer.

After approximately 24 barrels of fuel oil released into a freshwater marsh along the Mill River near Northampton, Massachusetts researchers followed the growth of vegetation over four years (Burk 1977). The vegetation bad been studied the year prior to the release and, less intensively, three years previously. Following the study, researchers reported that:

> Total plant cover, total number or species, mean number of species per quadrat and the Shannon-Wiener function progressively reduced in both high and mid-marsh zones for two years after the release. Eighteen of the species found before the release were not found the following season. Perennial species generally were less affected than annual species immediately following the oil release. Some species (e.g., *Dulichium arundinaceum and Eleocharis palustris)* declined in abundance the second season following the release. Marked changes in relative abundance of the dominant species of high and mid marsh zones occurred from year to year, with *Onoclea sensibilis* more prominent in high marsh at the end of the study period than prior to the release and *Pontederia cordata* and *Nuphar variegatum* more prominent in different segments of mid-marsh. The vegetation of the high marsh and mid-marsh zones had substantially recovered by the third and fourth years. The low marsh vegetation was apparently unaffected immediately following the oil release but in succeeding years the species diversity declined and luxuriant growth of *Elodea nuttalii, Potomogeton crispus,* and *Potomogeton epihydrus* occurred.

Hutchinson and Freedman (1978) studied the effects of experimental releases of crude oil into a boreal conifer swamp using spray and point discharges. Following the study, they reported that:

> Spray releases of fresh unweathered crude oil at an intensity of 2 gallons per square yard had a general herbicidal effect, causing the death of any green tissue coming in direct contact with the oil. Death of lichens and mosses was rapid and complete. For some higher plants, a lag period (up to 4 years for some individuals of *Picea mariana*) occurred between the time of the release and the time of death. For others, death occurred during the first winter with marked effects on cover values in the spring. These effects resulted in large decreases in total plant cover and frequency at release sites. However, within a few weeks, and in subsequent years, some species developed regrowth shoots. Other species survived as underground rhizomes for a number of years prior to their reappearance above ground (i.e., *Equisetum scirpoides*). Limited seedling

> establishment by vascular plants was first observed in the fourth growing season after the release, when some sporeling establishment was also noted for several bryophyte species. No *Picea mariana* regeneration occurred in the release plots in six post-release growing seasons. Crude oil releases made in winter were found to be less damaging than equivalent summer releases in their short term biological effects and on rates of recovery and species affected. Initial observations indicate that a summer diesel oil release shows roughly equivalent toxicity to a summer crude oil release of the same intensity. Comparisons between an intensive release (53 barrels) made at one location and dispersed spray releases indicate that the former are less damaging per unit of oil, with the scale of adverse effects being related more to the area of contamination.

Racine (1994) studied the same sites 10 years later, and reported that:

> Low volume spray releases that uniformly covered the ground caused initial damage to vegetation, but after 20 years recovery of the understory vegetation was almost complete, with dramatic recovery and expansion of fruticose lichens. High volume point releases created small areas of surface oil saturation with dead vegetation and little sign of recovery, but spread out mostly below ground with little or no apparent effect on the shallowly rooted vegetation even after 15–20 years. Because winter point releases created a much greater area of surface oil, their effects were more damaging. After 15 years on the saturated surface oiled areas, only *Eriophorum vaginatum* tussocks survive and grow. At both sites with surface oil, black spruce mortality was high, with no evidence of long term recovery and with continuing chronic effects after 15 years.

Leck and Simpson (1992) studied the effects of crude oil contaminated soil on plant growth recruitment from the seed bank from two tidal freshwater wetlands along the Delaware River in New Jersey. The authors observed that:

> Oil treatment of marsh soils significantly reduced survival of *Acnida cannabina* and *Bidens laevis,* the dominant species, as well as number of species per sample and height of *B. laevis.* Total perennial seedlings, present in low numbers, also showed significant reduction with treatment. However, during the course of the study, *Peltandra virginica* recruitment and survival were not reduced by soil oil treatments and recruitment of *Sagittaria latifolia* appeared enhanced.
>
> The effect of oil on recruitment from the seed bank depends on: (a) the extent to which it covers the wetland soil thereby acting as a physical barrier to water and oxygen, (b) the extent to which it penetrates and remains in the soil thereby either coating the seeds or being toxic to them, and (c) blocking the ability of germinated seeds to reach above the soil surface.

> Oil releases can have significant short-term effects on seedling establishment and growth that may translate into long-term effects on composition. If a release were to eliminate recruitment and reproduction of annual species, we feel that species with persistent seed banks and ability to germinate throughout the growing season, such *as A. cannabina* and *B. laevis,* or perennials with widespread and summer dispersal, such as *Typha* spp. or *P. arundinacea,* could colonize gaps as they occur. Others such *as P. virginica* and *S. latifolia* with more tolerant seed/seedling characteristics may reinvade more quickly than annuals.

Lin and Mendlssohn (1996) studied the effect of south Louisiana crude oil on the dominant vegetation, *Spartina alterniflora, Spartina patens and Sagittaria lancifolia,* of three types of coastal wetlands, salt, brackish and freshwater marshes, respectively. In a greenhouse, the crude oil was applied to natural marsh sods at rates of 0, 0.88, 1.77, 3.53 and 5.30 gallons/square yard. After measuring plant growth for a year, the researchers concluded that:

> The present study clearly demonstrates that South Louisiana crude oil, when applied to the soil, significantly impairs the two *Spartina* species, while not adversely impacting *S. lancifolia.* The sensitivity is based on the effect of oil on photosynthetic rate, live and dead biomass, plant-stem density, and plant regrowth in the year following oil application. The differential oil sensitivity was partially related to differences in soil organic matter among the marsh-types. The soil organic matter played a key role in accelerating penetration and sorption of oil into the soil. The soil organic matter content, therefore, is a primary factor controlling the effects of oil releases in marshes, as initially hypothesized. Oil releases in marshes of high organic matter content may require particular concern. The plant responses observed were also related to differences in the plant sensitivities to oil.

7.1.2.7.3 Expected Effects of Oil on Wetland Community Types

The summaries below provide a general description of the type of effects that may be expected from an oil release in a given wetland type, absent clean-up, based on the wetland hydrology, soil/sediment type, plant community type. However, each oil release is different with effects that vary depending on the quantity and type of oil released, the characteristics of the affected area, the time of year and the climate/weather conditions prevailing at the time of the release.

7.1.2.7.3.1 Bog

Bogs are susceptible to oil damage due to the predominance of low stature plants with high surface area to mass ratios and shallow roots (Aaseng et al. 1993; MN DNR 1997). Plants of this type would be readily exposed to released oil. Due to the generally low topographic gradient, spongy substrate and slow-moving water, oil released into a bog would likely pool. While this would result in smothering and death of most plants it came into direct contact with, it would also limit the area affected. Subsequently, and following clean-up, vegetation in and around the release would likely be affected by altered water chemistry and nutrient availability, as well

as by residual effects of low hydrocarbon concentrations. Light oil released into a bog would likely have more severe short-term effects (due to its lower viscosity and greater tendency to spread horizontally) but less severe long-term effects than heavy oil, which would spread less, but be more persistent if not physically removed. Some plant mortality may be expected along with longer term stress and growth reductions until residual hydrocarbons in the peat and water weathered sufficiently to abate toxic stress. Medium weight oils are expected to exhibit intermediate effects consisting of some smothering and moderate toxicity damage. Changes in water chemistry from the persistence of oil or oil fractions in the bog could potentially encourage the growth of plants such as cattail and reed grass that prefer less acidic conditions and/or are tolerant of persisting hydrocarbon compounds (Werner et al. 1985; King and Coley 1985; Shales et al. 1989; Crowe et al. 2002).

7.1.2.7.3.2 Fen

The wet meadow/fen wetland types are highly susceptible to damage from released oil. Oil released to a fen (where groundwater is expected to be discharging, and the soil surface is water saturated) would spread across the surface of the wetland, contacting ground-level vegetation. Some oil would also likely be incorporated into the soil surface (Hemmings et al. 2015). For heavy oils, the combination of smothering, toxicity, and changes in water chemistry would likely result in plant mortality along with persistent inhibition of regrowth as long as un-weathered oil remains (McCown and Deneke 1972; Leck and Simpson 1992; Hemmings et al. 2015). Woody shrubs would be less likely to be affected.

7.1.2.7.3.3 Marsh

Marshes appear moderately susceptible to damage from released oil, with floating plants in proximity to the release point being more susceptible to damage than larger emergent plants with a small portion of their mass at or below the water and/or away from the oil flow path. Oiling of only the stems of emergent plants often results in limited mortality. If only the aboveground vegetation is oiled, regrowth is likely during the next growing season (Baca et al. 1985; Fraser et al 1989; Mancini et al. 1995; Michel et al. 2002, 2003).

Releases of light refined or crude oils which spread rapidly and have higher acute toxicity can result in high mortality of marsh vegetation. Effects would be more persistent in cases where oil penetrates into marsh soils (Mancini et al. 1995; Davis et al. 2004). Persistence increases with deeper penetration, soils high in organic matter, and sites that are sheltered from natural removal processes (Peterson et al. 2003; Etkin et al. 2007). Heavy oils that coat the entire plant, and particularly the leaves, have the greatest potential for widespread damage. Plants with leaves at or near the water level will be most affected by smothering, while taller plants may suffer dieback, reduced growth, or remain unharmed.

For marshes associated with lakes, less damage would be expected for releases into water or along the outside marsh fringe where natural removal processes from wind and wave exposure are more effective. In this case, plants in shallower water closer to the shore might remain protected and experience little or no damage (Fraser et al. 1989; Michel et al 2002, 2003).

Conversely, a release from shore is likely to result in the greatest exposure to crude oil residues (and correspondingly more severe effects) in the near-shore zone (Gundlach and Hayes 1978; Baca et al. 1983; NOAA et al. 2002; Peterson et al. 2003; Michel and Rutherford 2013).

7.1.2.7.3.4 Swamp

Swamps appear to be moderately susceptible to damage from crude oil exposure. In general, the predominant vegetation is woody and moderately tolerant of crude oil exposure due to the presence of bark which is protective of living tissues beneath. The slow water flow in swamps means that oil released into these systems tends to remain stagnant, limiting the area affected but prolonging contact and potentially exacerbating toxicity in the affected area (Baca et al. 1985; Shales et al. 1989). Shallow rooting structures make plants growing in these areas more susceptible to damage and long-term effects from changes in soil communities and chemistry. A release of light crude oil would likely result in death of ground cover, with less damage to shrubs and herbaceous vegetation in areas of higher relief. In the case of a release of heavy oil, mortality of herbaceous plants and smaller woody plants from smothering and toxicity would be expected, and if not remediated, potential damage to trees and larger shrubs from changes to soil and water quality and the uptake of hydrocarbons through roots and bark (Atlas 1975; Curl and O'Donnell 1977; Davis et al. 2004). Lost productivity and reduced reproduction from plants that do not die is likely (Currier 1951; Dallyn 1953; Baker 1970; Emerson 1983).

The general effects of oil released to a conifer swamp would be similar to, but somewhat more pronounced than the effects of a spill on a hardwood swamp. Black spruce appears particularly sensitive to the presence of crude oil in the root zone (Hutchinson and Freedman 1978; Racine 1994). Therefore, greater potential for tree mortality, growth suppression, and inhibition of regrowth are likely for all types of crude oils although there may be a time-lag between the initial release and mortality of larger trees. Some effects to germination and vegetative reproduction may also occur in the area of the release where seeds, tubers, and rhizomes are damaged (Burk 1977; Leck and Simpson 1992; Adam and Duncan 2002). Where oil persists in the community, regrowth is likely to be suppressed for an extended period until the oil substantially weathers and toxicity abated.

Shrub swamps appear to be moderately susceptible to damage from an oil release. While alders, willows, and dogwoods have an ability to reproduce vegetatively, their prevalent lenticels and shallow rooting habit in this community make them susceptive to intake of toxins and root damage from direct contact and dissolved hydrocarbon compounds. Short-term contact with light oils would likely result in mortality of most herbaceous plants and smaller shrubs. Larger shrubs and those on hummocks may survive but suffer reduced growth (Burk 1977; Belsky 1982; Mancini et al. 1995). Medium and heavy oils would likely cause the mortality of most plants in and around the release. Lighter oils would likely cause some mortality of herbaceous plants and small shrubs and reduced growth rates of the larger shrubs but likely not cause complete mortality except perhaps at the point of release (Atlas 1975; Curl and O'Donnell 1977; Davis et al. 2004). Some effects to germination and vegetative reproduction may also occur in

the area of the release where seeds, tubers, and rhizomes are damaged (Burk 1977; Leck and Simpson 1992; Adam and Duncan 2002).

7.1.2.7.3.5 Other Related Habitat Types

Floodplain forest wetlands appear moderately susceptible to damage from oil releases. In general, these communities are composed of larger woody vegetation that is protected by bark, limited herbaceous plants, and common natural disturbances such as flood events that can accelerate flushing, dissipation, and weathering (Currier 1951; Dallyn 1953; Baker 1970; Emerson 1983; Baca et al. 1985). The most severe effects would be from extensive releases of heavy oil. In this scenario, hydrocarbons could coat herbaceous and small woody vegetation to the point of severe stress or mortality, become incorporated into the soil, or settle in ponding areas where it could persist, causing changes to soil and water quality until the oil had substantially weathered and substantively abated in toxicity (Atlas 1975; Curl and O'Donnell 1977; Davis et al. 2004). Less severe effects would be expected for smaller releases or releases of light crude oil where the material may coat or stain vegetation, but rapidly weather. In these cases initial plant mortality may still occur, but soil incorporation or persistent changes to water quality are less likely, although residual effects may occur from portions of the light oil that do not volatilize. Some effects to germination and vegetative reproduction may also occur in the area of the release where seeds, tubers, and rhizomes are damaged (Burk 1977; Leck and Simpson 1992; Adam and Duncan 2002).

A vernal pool could present as a shallow depression in the landscape that could trap released oil during the summer, fall and winter seasons, or as a shallow standing water body in the spring. Oil released into a vernal pool in the spring would be trapped in a relatively small amount of water resulting in minimal dilution and high toxicity to aquatic life (typically insects, crustaceans, mollusks, and amphibians, but not fish), and potentially waterfowl. Crude oil residues would likely become incorporated into the soils when the pool dried up. During dry periods, released oils would collect within the pool depression without any dilution. Light petroleum oils would weather more rapidly than heavier ones but in both instances some fractions of the oil would likely be incorporated into the soil being remobilized when the pool flooded again. Regardless of timing, petroleum oils released into a vernal pool would be expected to cause mortality of herbaceous species and algae as well as shrubs and smaller trees as a consequence of capture and concentration within the pool. Some larger trees and shrubs around the edge of the pool may survive but experience decreased growth and reproduction for several years (Burk 1977; Belsky 1982; Mancini et al. 1995). Growth from seeds, tubers, and rhizomes trapped under residual heavy oil would also likely be inhibited both from oil-related chemicals and the smothering cover (Burk 1977; Leck and Simpson 1992; Adam and Duncan 2002).

7.1.2.7.4 Summary

Table 7-25 and Table 7-26 provide a description of the general relative environmental effects of different types of oil and wetland characteristics. Table 7-25 addresses the relative effects of

specific oil characteristics or oil type on wetlands, and Table 7-26 addresses the relative influence of different environmental characteristics on wetlands exposed to oil releases.

Table 7-25 Land Cover Receptor: Wetlands

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Viscosity	Low viscosity oils are more readily absorbed into plant tissues, causing acute damage. Low viscosity oils also have less tendency to adhere to plants and to persist in water and sediment resulting in relatively lower long-term chronic damage.	Intermediate effects based on specific oil constituents.	Greater tendency to adhere to plants causing smothering and greater tendency to sink and persist in water and sediment causing long-term chronic toxicity damage.	Low viscosity oils may spread over larger areas than higher viscosity oils which form thicker but less spatially extensive slicks. Viscosity is also correlated with adhesion and pour point temperature of crude oils.
Proportion of VOCs	Light crude oils generally contain relatively more VOCs, and may have greater acute toxicity to plants as a result.	Intermediate acute toxicity.	Lower acute toxicity due to crude oil chemical properties, but this may be offset by higher viscosity and greater tendency to adhere as a thicker coating on plant tissues.	Some diluted bitumens (e.g., winter blends that contain a large amount of condensate as diluent) may have similar VOC content to light crude oils.
Persistence	Light crude oils tend to have low persistence due to a predominance of chemical constituents that will readily weather, and low concentrations of relatively persistent constituents such as resins and asphaltenes	Intermediate persistence properties.	Heavy crude oils contain relatively more resins and asphaltenes than light crude oils, and these constituents tend to be persistent (i.e., are resistant to microbial and other weathering processes) in the environment.	Heavy crude oils also tend to have high viscosity, and would tend to be deposited more heavily, but over a smaller area, than lighter crude oils.

Table 7-26 Land Cover Receptor: Wetlands

Environment Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Plant type—annual, perennial, shrub, tree	Annual and perennial herbs are most sensitive to oil exposure, and particularly sensitive to light crude oils; shrubs and trees are less sensitive. Light crude oil would be less persistent than heavier crude oils, so long-term or chronic effects on wetland vegetation are less likely.	Effects of medium crude oil are likely to be intermediate between the effects of light and heavy crude oils.	Heavy crude oil is expected to be more adhesive, coating more thickly, but affecting a smaller overall area than lighter crude oils. Heavy crude oil is also likely to persist at higher concentrations in wetland soils and sediments, leading to higher potential for long-term or chronic effects on vegetation.	At low levels of exposure, oiling may kill only the green tissues of plants, with regeneration occurring in the same growing season. At higher levels of exposure, annual and perennial plants and shrubs may be killed outright, and trees may die over the course of several growing seasons.
Wetland type—bog, fen, marsh, swamp	Bogs and fens tend to lack a free water surface, and released oil will follow preferential flow paths according to site-specific topography. This can limit the spatial extent of effects, while facilitating recovery of pooled oil. Marshes and swamps typically have a free water surface that will promote the spreading of released oil, leading to effects over larger areas, and making recovery of released oil more difficult.			
Season	A crude oil release in spring (plant emergence/early growth period) would tend to result in greater mortality of small plants, new plants, and annuals, particularly if growing tips and leaves were contacted by fresh crude oil. A release later in the growing season would have less severe effects on plants where the oil was not in contact with leafy tissues. Effects to wetlands during the winter may be low, if oil can be recovered before spring thaw.			
Ground surface diversity	Hummocky or mounded conditions within a community may allow species growing in locally higher elevations to avoid direct contact with the oil. This would be particularly true in locations where much of the oil presence is transitory (e.g. bogs, fens, swamps and floodplains). Habitat such as vernal ponds formed in depressions where oil would collect are at greatest risk of damage from direct contact and chronic effects from absorption and soil contamination.			
Soil organic content	Soils with low organic content may tend to retain oil constituents for shorter time periods thus resulting in less long-term damage to resident plants. Oil may be more persistent in hydric soils and soils with higher organic matter (where oxygen may would also be limiting) leading to more chronic effects on wetland vegetation. Heavy oils would also tend to be more persistent than lighter oils.			
Wetland hydrology	Wetland habitats with moving water (e.g., marsh and swamp habitats that are marginal to rivers or lakes) allow greater flushing and weathering of released crude oil, while at the same time enhancing the spreading of oil in the environment. Stagnant or ponded areas provide little flushing and less weathering. These habitats would be at greater risk of damage from released crude oil.			

Table 7-26 Land Cover Receptor: Wetlands

Environment Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Water chemistry	Slightly alkaline habitats with high nutrient availability provide better conditions for microbial degradation of released crude oil, particularly for light crude oils that weather and undergo biodegradation more readily than heavy crude oils. More acidic, nutrient-poor habitats would be expected to exhibit slower rates of biodegradation.	Medium crude oils would be expected to exhibit biodegradation rates, and response to water chemistry conditions, intermediate between light and heavy crude oils.	Heavy crude oils tend to be recalcitrant due to their greater resin and asphaltene content. Water chemistry may have little effect on biodegradation rates for heavy crude oils.	Bogs tend to be acidic, with low nutrient availability. Marshes and swamps tend to have greater nutrient availability, but released oil may be deposited to anaerobic areas where biodegradation would be slow. Fens are minerotrophic, and groundwater seepage would tend to prevent oil from penetrating to anaerobic areas. Biodegradation potential in relation to water chemistry and wetland type is expected to improve in the order Bog < Marsh = Swamp < Fen.

7.1.2.8 Soils

7.1.2.8.1 Description

According to the Natural Resource Conservation Service (Soil Survey Staff 2003), soil is a natural material composed of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: (1) horizons or layers that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter; or (2) the ability to support rooted plants in a natural environment."

Soils are open systems that interact with the lithosphere, hydrosphere, atmosphere, biosphere, and society to perform vital ecosystem functions. Major soil functions include (Cornell University 2010):

1. Soil is a medium for plant growth or bio-materials production whereby this medium combines with the other soil functions to anchor roots, and allow for the transport of water and nutrients to the root/soil interface
2. Soil is a habitat for soil organisms, making up more than half of all life on the planet. The micro-organisms are mainly responsible for most of the bio-chemical transformations in the soil medium; whereas, the macro-organisms primarily affect physical soil transformations
3. Soil acts as a biochemical or nutrient reactor which absorbs, releases (i.e., desorbs), and transforms inorganic and biochemical compounds such as essential plant nutrients, pesticides, minerals, heavy metals, and numerous other compounds
4. Soil acts as a hydrologic buffer which stores (i.e., water holding capacity) and regulates the flow (i.e., drainage) of water in the landscape, allowing for the transport of various inorganic and biochemical compounds within and through the soil medium
5. Soil is a foundation for the physical support of structures including everything from plants to skyscrapers

There are numerous types of surface soils, the distribution and characteristics of which are broadly controlled by parent material, topography, climate, biota, and time. Although they are variable, soils typically include a common matrix of mineral and organic particles, water, and gases. This soil matrix directly supports an ecosystem that is commonly made up of microbes, invertebrates, and plants. These organisms in turn, provide a supporting foundation for an even larger ecosystem that includes animals and humans.

Soil microorganisms are an integral part of the soil and include bacteria, fungi, algae, protozoa and nematodes. As a community or assemblage, these organisms are responsible for cycling nutrients such as nitrogen, phosphorous, potassium, calcium, magnesium, iron, and sulfur, through the decomposition of organic matter, which includes oil.

The abundance and diversity of soil organisms depends on the nature of the soil and the associated plant community. A key element regulating these characteristics is the availability of active organic matter that can readily be used by microbes and invertebrates as a source of energy. In addition, oxygen, nutrients, moisture content, temperature and other climatic factors

also play important roles in soil organism community structure and abundance. Root growth is a significant contributor to soil ecosystem development. Of particular importance in microbial ecology is the zone of the soil-root interface known as the rhizosphere. The rhizosphere receives photosynthetic carbon compounds secreted from plant roots. These root secreted compounds, including organic, amino and fatty acids, carbohydrates, vitamins, nucleotides, phenolic compounds, polysaccharides, and proteins, are metabolized by surrounding microorganisms. In turn, the microorganisms mediate biochemical reactions that make nutrients available to plants. Nutrients are also made available as microbes die and decay during the cycle of immobilization and mineralization, which is strongly influenced by the carbon to nitrogen ratio. Where conditions are favorable, soil sustains a high abundance and diversity of microorganisms and invertebrates that occupy a broad and complex range of niches.

7.1.2.8.2 Observed Effects

The following case studies, primarily from temperate North American environments, provide examples of the effects that documented oil releases have had on the soil and soil organisms. In most cases, pipeline releases on land are remediated by scraping or excavating the land surface until desired clean-up targets are achieved. Additional details of some of the releases used as case studies for soils and microorganisms can be found in Stantec et al. (2012) and Enbridge (2015). Each of these releases and how they affected soil resources are described in the paragraphs below.

> ***Unknown Operator, Nipisi and Rainbow Releases, Alberta:*** *During 1970–1972, three oil releases occurred in north central Alberta, Canada near Lesser Slave Lake (Wang et al. 1998). These three releases, located at Nipisi, Rainbow and Old Peace Rivers, occurred within about two miles of one another. Little information is readily available about the Rainbow and Old Peace River releases, but the Nipisi release site has been extensively studied. The Nipisi release was one of the largest releases in Canadian history and involved over 60,000 barrels of crude oil that affected over 25 acres of predominantly bog/fen habitat. A variety of clean-up techniques, including burning, tilling, and fertilizer addition, were applied at the Nipisi site, after which it was left for research to evaluate the effectiveness of these techniques and characterize the weathering of the released oil (Wang et al. 1998).*
>
> *Twenty-five years after the releases, researchers returned to the area to assess the oiling conditions and recovery status. Substrate samples were collected from the 3 release locations: 22 samples from the Nipisi site; 9 from the Rainbow pipeline release; and 3 from the Old Peace River site. Most of the samples consisted of 100% organic materials, sphagnum peat, or a similar peat, and a few of the samples included a mineral component. Samples were grouped based on depth of collection. Surface samples were collected from the upper approximately 1.5 inches. One group of subsurface samples was collected primarily between 4*

and 16 inches below ground surface (bgs), and the second group of subsurface samples came from a depth of 16 to below 31 inches (Wang et al. 1998).

Based upon TPH levels, the surface samples were still highly contaminated (20,000–256,000 ppm) with oil, although the oil was highly weathered/degraded. The subsurface samples collected between depths of 4 to 16 inches also were still highly contaminated (10,000–165,000 ppm), but the oil was only lightly to moderately weathered/degraded. The deeper (34 to 39 inches) subsurface samples were only lightly contaminated (less than 673 ppm) with oil. The analysis indicated that the oil released on the surface had started to weather almost immediately through evaporation, but subsequent weathering through biodegradation and other weathering processes were occurring at a much slower rate. Biodegradation rates were projected to be slow because of the acidic condition of the peat, the anaerobic conditions created by the saturated ground and the relatively cool temperatures. Degradation of the subsurface oil was expected to continue and to be aided by rainfall, which would increase ground saturation and bring the oil to the surface where more aerobic conditions exist and more nutrients are available to aid in biodegradation. The researchers' determination was that the site was recovering, but that this recovery was happening slowly and would continue to happen slowly (Wang et al. 1998) on a scale of decades.

***Unknown Operator, Moose Jaw, Saskatchewan**: In January 1974, a pipeline containing crude oil broke within an active agricultural field just north of Moose Jaw, Saskatchewan. The pipe was buried 3.3 ft below the soil surface, and the asphalt-base oil (23 API gravity, 0.92 grams per centimeter cubed [g/cm^3] density) flowed underneath the frozen topsoil. The release was first detected in a ditch approximately 2,789 ft from the pipeline and later in a small pool approximately 82 ft south of the line. There was also some surface pooling closer to the release, but the majority of the oil was present as a thin lens, a fraction of an inch thick, just below the frost line at 3.3 ft in depth. Because the oil was contained, trenches were dug around the release perimeter, and an estimated 10,000 barrels of the 15,725 barrels of oil were recovered. Further remediation of the affected soil was not conducted, and in the spring of 1974 crops were planted. Fertilizer was applied to enhance the rate of oil weathering, but this was limited to the maximum rate tolerated by the crops. Monitoring of the remaining oil showed that from 1974 to 1978, there was a noticeable decrease in oil content, particularly in the 1977 fallow year when higher levels of fertilizer could be applied (De Jong 1980). The surface soil from 0 to 11.8 inches showed the greatest hydrocarbon reductions. Results of the site study provide further support for the role of microbial-mediated degradation in reducing the concentration of oil in soils, and in the recovery of the environment. According to De Jong (1980), addition of fertilizer helped compensate for the increased demand for nitrogen*

made by the microorganisms, which were most active in the surface soil where there was more oxygen.

Enbridge Line 6, Bemidji, Minnesota: *In 1979, a pipeline released approximately 10,700 barrels of light crude oil in a naturally vegetated area. The oil sprayed over an area of approximately 1.6 acres and collected in topographic depressions before infiltrating the soil and migrating to the groundwater. Although there were immediate effects from the oil on the terrestrial habitat, subsequent burning of the oil sprayed area had a much greater effect on this habitat. The area has remained relatively barren for most of the last 30 years because the soil became water repellent due to the oil contamination and possibly from the burning (Nieber 2013). Using the Water Drop Penetration Time test (Dekker 2009) to assess water repellency of the soil, researchers found that the soil within the oil spray zone ranged from slightly repellent to extremely water repellent. Where the soil was extremely water repellent, the water drops tended to evaporate from the surface before they could be absorbed into the soil. Outside the oil spray zone, the soil was water "wettable." Repellency within the oil spray zone extended to a depth of approximately 16 inches in some locations. A soil erosion survey conducted in this area found that much of the surface soil had eroded from the higher topographic points leaving them very stony. The sand eroded from these higher points was deposited in adjacent topographic depressions (Nieber 2013).*

Line 3 Glenavon, Saskatchewan: On April 15, 2007, an Enbridge Line 3 underground pipeline ruptured near Glenavon, Saskatchewan and released approximately 6,200 barrels of heavy crude oil into a slough (wetland) located in an agricultural area (SLR Consulting 2008a; Transportation Safety Board Canada 2008a). Soil located around the edges of the slough was also exposed to oil. Release response and clean-up efforts included:

- *Repair of the pipe*
- *Recovery of oil from surface water within the affected slough*
- *Deployment of booms*
- *Construction of berms to contain the oil within the immediate area of the affected slough*
- *Removal of oiled vegetation around the perimeter of the affected slough*
- *Removal of water from the affected slough that had hydrocarbon concentrations above applicable criteria, including those established in the Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life Criteria (1999, updated 2007) and/or Saskatchewan Environment*
- *Removal of contaminated sediment and soil*

Recovery of approximately 240,925 gallons (912 m^3) of the released oil was completed by April 22, 2007 (Transportation Safety Board Canada 2008a). Water and crude oil were removed from the affected slough with skimmers and

vacuum trucks. Irrigation sump lines were then used to move the collected water to an on-site above ground storage tank (AST) for temporary storage. Backhoes were used to remove contaminated sediment from the slough and to cut and remove oiled vegetation. Soil from around the edges of the slough also was removed. Contaminated vegetation, sediment and soil were transported to an off-site location for disposal (SLR Consulting 2008a).

As part of the initial Environmental Site Assessment following the release, soil samples were collected in association with four components of the response and clean-up efforts: site stratigraphy boreholes; pipeline trench repair; irrigation sump lines; and remediation of the affected slough. The collected soil samples were analyzed for BTEX, petroleum hydrocarbon fractions F1 to F4 (PHC F1-F4 {F1: C6 to C10, F2: >C10 to C16, F3: >C16 to C34, F4: C34+}), total metals, and Polycyclic Aromatic Hydrocarbons (PAHs). For soil samples not associated with the affected slough, analyses indicated that contaminant concentrations generally were below Saskatchewan Environment and CCME remedial criteria (Tier 1 Agricultural Criteria for fine grained soil; Saskatchewan Ministry of Environment 2006) with the exception of two sites associated with the irrigation sump lines. Additional excavation was conducted at these two sites, and subsequent sampling indicated that the criteria were met. Concentrations of metals for all these samples either were below CCME agricultural criteria or were consistent with background conditions (SLR Consulting 2008a). Subsequent sampling along the pipeline trench identified some locations where PAH concentrations were above remedial criteria. These areas were further excavated and, as a result, all post remediation soil samples were below CCME remedial criteria (SLR Consulting 2008b).

For the affected slough, estimates were that any remaining crude oil effects after the initial remediation efforts likely were limited to the sediment and possibly the upper 1 ft of underlying native clay soil. Additional remediation efforts were undertaken to remove sediment and native clay soil under the affected slough that had hydrocarbon concentrations exceeding applicable remedial criteria (SLR Consulting 2008b). Following additional remedial actions PAH concentrations were below CCME criteria and BTEX and F1-F4 concentrations from the base of excavation were generally non-detectable. Metals concentrations also were generally below CCME criteria and/or were consistent with conditions in nearby sloughs.

Line 37 Fort McMurray, Alberta: *On June 22, 2013, approximately 1,300 barrels of premium synthetic crude oil were released from an Enbridge Line 37 pipeline located approximately 24.9 miles southeast of Fort McMurray, Alberta, Canada (Hemmings et al. 2015). The contaminants of concern were petroleum hydrocarbon fractions (PHC) F1 to F4, BTEX, and PAH. The oil rose to the surface in*

the saturated soils and flowed overland along the pipeline ROW to a fen and eventually reached the shores of an unnamed lake. The ROW had maintained grassy vegetation, and the fen was dominated by shrubby vegetation. The release site underwent integrated remediation (see below) that was completed in October 2013. Initial remediation efforts involved targeted excavation (soil and sediment), oil skimming of surface water, treatment of surface water and groundwater, soil flushing (fen), and installation of physical barriers (hard and soft booms). Excavation within the ROW included removing affected soil at the release site and soil beyond the release point that showed visual contamination. Depth of excavation ranged from approximately 1 to 2.5 ft below grade. Approximately 7,275 tons of contaminated soil was removed from the ROW. Remediation efforts removed a majority of the released oil (approximately 93%), and natural attenuation monitoring was employed to track the weathering and effects of the remaining product (Hemmings et al. 2015).

Soils within the ROW are generally mineral soils with a minor organic component. In the fen, peat at the surface is underlain by mineral soils of various textures (silt, clay and sand). Soil samples were collected from the ROW, the fen, and the area surrounding the unnamed lake. These samples were analyzed for BTEX, PHC F1-F4, and PAHs. Concentrations of BTEX and PHC F1-F4 were higher than acceptable Alberta Environment and Sustainable Resources, Albert Tier 1 Soil and Groundwater Remediation Guidelines in many of the samples. Following initial remediation efforts (excavation), residual oil was still detected within the soils of the ROW and fen (Hemmings et al. 2015).

A biotreatability study determined that hydrocarbon degrader bacterial populations were present in the soil in sufficient numbers to allow biodegradation to occur in the presence of oxygen or under anoxic conditions. Further study of these bacterial populations indicated that they would be capable of degrading short-chain, but less able to degrade long-chain hydrocarbons. Eco-toxicological tests were then conducted to determine if residual hydrocarbons posed a risk to ecological receptors. These tests included survival and reproduction of Collembola and avoidance-response in earthworms. Tests also were conducted to assess emergence and growth of plants. Petroleum hydrocarbons did not affect adult Collembola survival or reproduction in the ROW soils, but there was significant reduction in both survival and reproduction in the fen soils (Hemmings et al. 2015). A laboratory ecotoxicity test with earthworms was conducted and the results showed earthworms avoided the petroleum hydrocarbon contaminated ROW and fen soils and showed preferential selection for the uncontaminated reference soils. This avoidance was attributed in part to the petroleum hydrocarbons and to the low soil pH (Hemmings et al. 2015). Site-specific target levels for both PCH F2 and PCH F3 that would be protective of terrestrial ecological receptors were calculated for ROW soils and fen soils. Soil

> *petroleum hydrocarbon concentrations were generally lower than the target levels, although up to 15% of the samples from the fen had petroleum hydrocarbon concentrations that exceeded the target levels. Overall conditions at the site were considered to be "improving" one year after the release, but specific statements regarding recovery status of soils were not made and monitoring at the site was still on-going (Hemmings et al. 2015).*

To understand how soil micro-organisms are affected by oil releases and how oil can be biodegraded by soil micro-organisms, several experimental release sites have been evaluated. The results of such studies are summarized below.

In 1976, at the Caribou-Poker Creek experimental release site in Alaska, for each experimental release, about 2,000 gallons of Prudhoe Bay crude oil was released on a plot 11 by 55 yards in size. Research showed that total fungal biomass decreased and heterotrophic bacterial biomass increased in the first growing season, a trend that appeared to persist for at least a decade (Garron 2007). Lindstrom et al. (1999) found no significant differences in the total bacterial numbers between uncontaminated and hydrocarbon-affected soils, but the population diversity (evenness and/or richness) was diminished in hydrocarbon-affected soils. The hydrocarbon-affected soils did have higher numbers of more oil-tolerant species when compared to uncontaminated soils.

In a study carried out from 1970 to 1971 at Tununuk Point, located on the southern tip of Richards Island, Northern Territory, Canada, light gravity sweet crude oil was applied to plots ranging in size, topography and vegetative cover in spring, summer, and winter. Oil application rates included 0.00 cm (control), 0.25 cm, 0.40 cm, 0.50 cm, 0.75 cm and 1.5 cm in thickness to simulate releases ranging up to 1,950 barrels per acre. Gossen and Parkinson (1972) found that after approximately one year, bacterial numbers and respiration rates in oil treated samples increased, relative to untreated samples.

Sexstone and Atlas (1977) also observed increases in populations of hydrocarbon-degrading soil microbes at an experimental site at Point Barrow, Alaska. Prudhoe crude oil was applied through a perforated plate to provide even coverage at concentrations of 5 L/m^2 and 12 L/m^2, simulating moderate and heavy oil releases. During the first summer following the experimental release, microbial response was limited to the surface soil (top 0.8 in. [2 cm]), but in the following year this extended to greater depths depending on the drainage characteristics of the soil. Researchers anticipated that increased numbers of heterotrophic microbes, including oil utilizers, would persist for at least a decade after the release. Sexstone et al. (1978) also found that oil released onto tundra soils infiltrated the soil, and microbes in the saturated areas showed decreased abundance. However, around the perimeter of these saturated areas, microbial numbers were higher than those found in the reference locations. At the same experimental site, Linkins et al. (1978) found evidence indicating that the organisms were actively modifying the oil and using it to support their metabolism.

Based on these data and observations, it appears that oil releases can have a large effect on both the physical and chemical characteristics of soil. With the change in conditions, certain microbial species are negatively affected, but studies also show that the microbial community is diverse and as a whole is generally able to adapt to the presence of oil and take advantage of petroleum hydrocarbons as an energy source.

7.1.2.8.3 Expected Effects of Released Oils

Soil effects resulting from a release of crude oil from a pipeline would occur as oil is dispersed into the soil vertically and horizontally through interstitial (pore) spaces. For small releases, the oil would likely be contained within the pipeline installation trench, where soil bulk densities tend to be lower. For larger and higher rate releases, oil is expected to migrate through the soil in all directions including laterally and vertically down to the groundwater table. Because oil is less dense than water, oil migrating to the water table tends to form a floating pool, although some constituents are soluble in water and would dissolve, if present (see Section 1.3.2). In addition to lateral and downward dispersal, the oil could also mound within the pipeline trench as a result of hydraulic pressure, potentially surfacing and spreading laterally across the soil surface based on topography. Once on the surface, oil would pool in low lying areas and infiltrate into the soil subsurface, migrating laterally and vertically to the groundwater table. The degree of lateral surface migration would depend on the volume of oil that reached the surface, as well as slope, ground cover, type of oil (viscosity considerations), and temperature.

Environmental effects on soil as a result of oiling are measured by the presence and concentration of oil components such as the F1-F4 fractions, the monoaromatic BTEX compounds, PAHs, and some metals (e.g., nickel and vanadium). Oil presence may modify important soil characteristics, including but not limited to nutrient availability, porosity and water repellency, and in changes to vegetation and soil invertebrate communities. The presence of oil in soil can significantly affect plant growth (De Jong 1980), and petroleum hydrocarbons can affect survival, reproduction, and presence of soil organisms (Hemmings et al. 2015).

Soil quality standards have been developed for petroleum hydrocarbon contaminants in soil, so that after remediation, the capacity of the soil to support plants and invertebrate communities, as well as various human uses (e.g., residential, agricultural or industrial land use) should be restored. At the same time, further natural recovery can occur within a reasonable timeframe. Typically, highly contaminated soil is mechanically removed and hauled to suitable landfill, composting, or recycling facilities. Excavation and hauling will typically cease at a point when the remaining contaminated soil meets standards or guidelines typically established by federal or state agencies, or at a point when continued excavation is deemed to cause more environmental harm than good. The less contaminated soil areas would then be subject to continued monitoring during a natural attenuation process until remediation objectives can be met and the site clean-up procedures can be closed.

Like any contaminant, the potential effects resulting from the introduction of crude oil into the soil matrix depends on contaminant concentration, type of oil released, the soil receiving

environment and environmental conditions such as temperature, precipitation and snow cover. When applied as a fine spray over a large area (i.e., at low concentrations), the soil may be able to absorb the oil without deleterious changes to its physical structure. The oil droplets readily adhere to the existing organic matter and have a negligible effect on the moisture content, or porosity.

Where large volumes of oil are rapidly released onto or under the ground, the oil can fill the pore spaces between soil particles. Once the soil becomes saturated with oil, both air and water are displaced. Within these highly saturated soil zones, microbial activity can be greatly impaired both by the direct toxicity of the oil and by the altered physical and chemical condition of the soil. In contrast, a suitable environment for microbes can exist around the periphery of this saturated zone, where water and air are still present with the soil. Although this peripheral zone may be suitable for the survival and growth of microbes, the abundance and diversity of organisms may be different from pre-release conditions.

Table 7-27 and Table 7-28 provide a summary of the expected environmental effects of oil releases to soils. Table 7-27 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-28 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-27 Land Cover Receptor: Soil

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Viscosity	Low viscosity allows for greater soil infiltration and migration potential.	Medium viscosity allows for an intermediate infiltration and migration potential when compared with Light and Heavy Crude.	High viscosity and density allows for less soil infiltration and migration potential.	The viscosity of fresh diluted bitumen is lowered to meet pipeline specifications through the addition of a diluent, which may (e.g., condensate) or may not (e.g., synthetic crude oil) be volatile.
Oil chemistry—BTEX	Light crude oils often contain high levels of BTEX and other relatively water soluble hydrocarbons leading to a higher potential to cause acute toxicity to plants and soil invertebrate communities.	Medium crude oils often contain moderate levels of BTEX and other relatively water soluble hydrocarbons, leading to a moderate potential to cause acute toxicity.	Heavy crude oils often contain lower levels of BTEX and other relatively water soluble hydrocarbons, leading to a lower potential to cause acute toxicity. However, diluted bitumen products often contain similar concentrations of BTEX compounds to lighter crude oil types, due to the addition of diluent.	
Oil chemistry—TPAH	Bakken Crude has proportionally more naphthalenes and alkyl naphthalenes than Alberta oil sands products (Yang et al. 2011).	Medium weight crude oil has proportionally more naphthalenes and alkyl naphthalenes than Alberta oil sands products (Fingas 2010; Yang et al. 2011).	Diluted bitumens typically have similar to lower concentrations of TPAH than light and medium crude oils, although the distribution of PAHs differs.	Low molecular weight PAHs are usually relatively depleted in bitumen from the Alberta oil sands, due to in situ weathering.
Oil chemistry—resins and asphaltenes	Light crude oils contain little in the resins and asphaltenes fraction relative to medium and heavy crude, making their lighter aliphatic and LMW aromatic components relatively bioavailable and subject to weathering.	Medium crude oils also contain relatively small fractions of resins and asphaltenes, although more than light crude oils. Medium crude oils also have good potential for biodegradation in the environment.	Heavy crude oils, and diluted bitumens in particular, contain large amounts of resins and asphaltenes. While these fractions are generally insoluble in water and of limited toxicity, they are slow to degrade and can act as reservoirs for the slow release of other more toxic hydrocarbon constituents such as LMW and medium weight PAHs.	

Table 7-28 Land Cover Receptor: Soil

Environment Characteristic	Low	Medium	High	Other Comments
Organic carbon content	Organic carbon can bind petroleum hydrocarbon residues, lowering bioavailability. Soil with low organic carbon content (<1% of soil dry weight) will poorly sequester petroleum hydrocarbons in soil, facilitating bioavailability of these released hydrocarbons.	Soil containing a moderate amount of organic carbon (1 to 6% of soil dry weight) can help to sequester released oil.	Soils containing abundant organic carbon (>6% of soil dry weight) may be less bioavailable relative to low and medium organic content soils, due to the competing effect of soil organic carbon on bioavailability.	
Soil grain size	Fine-grained soils (clay, silt) may limit oil infiltration into the subsurface.	Medium-grained soil (fine sand to coarse sand) will allow for moderate oil infiltration.	Coarse-grained sediments (gravel, cobble) will allow for rapid oil infiltration.	
Slope	Flat and low slope areas would limit the surface spreading of oil, facilitating pooling and oil infiltration.	Oil spreading will be enhanced relative to flat land soil surfaces.	Steeply sloped areas would increase surface spreading of oil.	

7.1.3 Biological Receptors

7.1.3.1 Terrestrial Vegetation

7.1.3.1.1 Description

Terrestrial vegetation consists of the communities of plant species found on land. For the purpose of this discussion; the terrestrial vegetation resource category also includes lichens and mosses. There are over 230,000 different terrestrial plants ranging from simple forms such as horsetails, and ferns to gymnosperms (including conifers) and angiosperms (flowering plants). The terrestrial vegetation growing in a particular area and time, with specific groundwater, climatic, topographic, and soil conditions, can be grouped into plant communities. Individual plant species interact with each other through competitive, symbiotic, or mutualistic biological interactions.

Plants can be classified by their growth habit (their general appearance, growth form, or architecture (USDA 2016)). The dominant growth habits are trees, shrubs, and herbaceous plants. Trees are defined as perennial, woody plants with a single stem, normally greater than 13 to 16 ft in height (USDA 2016). Shrubs are perennial, multi-stemmed woody plants that are usually shorter than the typical height identified for trees (USDA 2016). Herbaceous plants can be annual, biennial, or perennial, but do not have significant woody tissue above or at the ground (USDA 2016).

Plant communities provide critical ecosystem functions, including soil stability, nutrient availability, nutrient fixations, water retention and cycling; as well as habitat, forage, and shelter for organisms. Plants are the first level of the food chain. They conduct photosynthesis, a process that converts light energy, water, and carbon dioxide into photosynthates (i.e., sugars, starches, carbohydrates, and proteins) and oxygen (Whiting et al. 2015). Plant roots interact with soil organisms, including mycorrhizal fungi, fungal pathogens, bacteria, and invertebrates. Together plants and the soil organism community compose the soil food web. Soil organisms are key components in the degradation of organic contaminants such as oil.

7.1.3.1.2 Observed Effects

The majority of studies on the effects of oil releases on vegetation focus on wetlands, marshes, and riparian environments. There have been limited studies specifically on the effects of crude oil releases on terrestrial vegetation, and most studies have focused on tundra and artic vegetation in Alaska, Canada, and Greenland. The results of these studies on the effects on vegetation from oil releases can be applied to other northern latitude areas such as Minnesota with similar vegetation communities with respect to oil release effects. Studies on the effects of oil on terrestrial vegetation have looked at both accidental and intentional experimental releases, with varying levels of clean-up. Based on the results of the studies, the most detrimental effect on vegetation is damage to photo-synthesizing plant tissues. Other negative effects include oil permeating the soil and affecting soil microorganisms, root uptake, and soil water availability. Oil sealing the surface soil layer, and affecting soil moisture infiltration can result in

loss of vegetation through loss of soil moisture, changes in soil temperature and nutrient availability, and reductions in growth, health, and flower bud/seed development. The extent of oiling of individual species has been demonstrated to affect the degree of plant survival (Racine 1994). When an oil release is small or there is rapid remediation of the oil, many long-term effects can be avoided.

The following discussion summarizes relevant case studies on the effects of various oil types on terrestrial vegetation.

> ***Mackenzie Delta, Northwest Territories, 1970****: Wein and Bliss (1973) reported on an experimental releases conducted in northwestern Canada east of the Mackenzie Delta. The test plots were set up in five plant communities: black spruce-alder-heath; medium shrub-alder-heath; sedge-cotton grass-heath; willow-birch-heath; and sedge. Each of the plant communities are underlain by permafrost. Results of this study are applicable to areas where a release occurs in locations with an impermeable layer, frozen soils, or winter conditions. Plot sizes varied in each plant community to account for vegetation diversity and microtopography, with the black spruce-alder-heath having the largest plot (16.4 ft x 16.4 ft [5 m x 5 m]), the willow-birch-heath having the second largest plot (13.1 ft x 13. 1 ft [4 m x 4 m]), and the remaining vegetation communities having 9.8 ft x 9.8 ft (3 m x 4 m) plots. For each plot, the researchers applied Norman Wells light-gravity-sweet crude oil in either spring, summer, or winter at one of four rates. The four rates applied to the plots included: 1) control rate (0 inch.); 2) a quarter of the highest rate; 3) half of the highest application rate; and 4) the highest rate (typically the rate required to saturate the plot). The highest rate saturated the soil profile (approximately 1,300 barrels/acre for spring/winter and 1,950 barrels/acre for summer). The active layer is the portion of the soil above permafrost that thaws and freezes seasonally. In the summer this layer is deeper, which allowed a larger amount of oil to be absorbed before runoff occurred, consequently requiring a higher rate of application in the summer to saturate the soil profile. In spring and winter, the rates of application (i.e., oil thickness on the plots) were 0 in., 0.10 inch (0.25 cm), 0.20 inch (0.5 cm), and 0.39 inch (1 cm); while in the summer, the rates were 0 inch, 0.16 inch (0.4 cm), 0.30 inch (0.75 cm), and 0.59 inch (1.5 cm). In all plots, the low lying vegetation, including low shrubs, were saturated. Different temperatures of oil (194°F and -4°F) were applied in winter to see if oil would penetrate deeper into the snow cover based on oil temperature, but no statistically significant difference was observed.*
>
> *Initial effects on vegetation for the summer treatments were observed within hours of oil application on deciduous species. The initial observations included a water soaked appearance, dry tissue, and the vegetation turning brown. Effects to evergreen shrub species took several weeks. Signs of survival or regrowth were observed within weeks for some plots and species; however the regrown leaves*

tended to be thinner and larger when they grew back than control plants. In plots where the soil was saturated with oil, the vegetation showed no evidence of recovery during the treatment year. On the winter treatments plots, there was a lack or delay in spring growth compared to untreated areas.

After one growing season, plant recovery, based on ground cover of new growth, was between 20% and 55% depending upon the treatment rate, morphological and physiological differences among species, and the season of the treatment. Most of this new growth was from latent buds of dwarf shrub species and sedges. Lichens and the majority of molds showed no regrowth. The species that showed the greatest recovery were the dwarf shrubs.

The extent of effects to vegetation damage and recovery was a combination of the amount of oil applied, and the seasonality of the treatment. In general, the treatment plots with higher rates of oil application had decreased recovery comparative to the treatment plots with lower rates of oil application. Plots where the oil was applied later in the season, and after the snowfall also had decreased rates of recovery. The amount of oil and the seasonality affected how deep and how much of the oil penetrated into the soil based on the depth of the active layer and the permeability of the soil. Greater applications of oil and the deeper active layer led to the greatest effects on vegetation.

***Norman Wells, Northwest Territories, 1972**: Fresh un-weathered Norman Wells light-gravity-sweet crude oil and Arctic diesel were used in an experimental release by the researchers on a black spruce-dominated boreal forest located south of Norman Wells, Northwest Territories along the bank of the Mackenzie River (Hutchinson and Freedman 1978). The site was observed for five years after the experimental plots were treated. Follow-up studies of the same area were conducted in the early 1980s (Hutchinson 1984).*

One treatment and one control plot (32.8 ft x 32.8 ft [10 m x 10 m plots] subdivided into 25 subplots) were set up in an early succession 30- to 40-year-old post-burn area, while two treatment plots of the same size were set up in an older mature forest community that had not experienced a forest fire in more than 80 years (Hutchinson and Freedman 1978). A summer crude oil release was simulated in both communities with oil application occurring on July 5, 1972. A winter crude-oil release was simulated in the mature forest site only with oil application occurring on March 5, 1973. A simulated summer diesel oil release was conducted only in the post-burn area with oil application occurring on June 25, 1975. For each of the experimental plots, oil was sprayed evenly over the ground surface to simulate an oil release. In addition, in the post-burn area, a single-point crude oil release was simulated by pouring approximately one barrel oil onto a fixed point in the center of a 131 ft x 131 ft (40 m x 40 m) grid.

Observations on the summer crude oil sites, noted that within several days of the release, the mosses turned black, and sedges turned brown and withered. The leaves of deciduous trees developed large brown necrotic patches where they had been sprayed with the oil. Unsprayed foliage initially remained healthy and green (Hutchinson and Freedman 1978). For all sites, there was a reduction in vegetation on treated plots that varied in length and intensity. The summer simulated crude oil release was more damaging to the vegetation than the winter release. The point-release damaged less surface area per unit of oil than when the oil was sprayed on the plots, because most of the oil in the point release was absorbed by the organic matter or percolated into the soil profile. Similar effects to vegetation were observed on the diesel oil release plot as compared to the crude oil plots.

Some species recovered within a few weeks on the winter site plots. Recovery from the summer release progressed more slowly. During the study period, recovery of existing plant species occurred predominantly through re-sprouting from surviving aboveground and below ground perennating structures (e.g., shoots, rhizomes, tubers). Some shrub and perennial vascular species developed regrowth shoots within weeks of the release, but these plants died by the following spring. Successful seed establishment was not observed for at least four years post-release. Based on the cover and frequency data collected during the study, the study authors estimated that it would take a minimum of 20 post-release growing seasons to re-establish total ground cover on the treated plots.

Researchers noted that they expected the composition of the re-established vegetation community would be different from the post-release community due to the differing capacities of species to survive and recover from a release (Hutchinson and Freedman 1978). For example, coniferous tree species recovered more slowly than shrub and ground cover vegetation. Within three to four years from the experimental treatment, mosses started to recolonize the sites. Although many of the black spruce exhibited no serious short-term effects, significant mortalities of the black spruce was observed up to four years after the release, and no regeneration of this species occurred during the six years of monitoring. Similarly, no regeneration of larch was observed and no seedlings were found during the study period.

Ten years after the initiation of this study (1980), total vegetative cover and species diversity were substantially lower compared to the control sites. In some areas, the damage to the vegetation extended past the areas directly affected by the original release. The study suggests this was due to oil spreading underground. In general, plant communities affected by released oil were set back to an early stage of ecological succession (Robson et al. 2004), and both

forest types presented lower total vegetative cover and decreased species composition than neighboring unaffected areas.

***Mount Baker, Washington, 1972**: In the winter of 1972, approximately 164 barrels of No. 2 diesel fuel oil leaked out of storage tanks at the Cascade Field Station near Mount Baker, Washington. The owner of the research station was not identified. The oil inundated two subalpine meadow communities: one heather meadow and one sedge meadow. The recovery of these plant communities was studied over the following nine years (Belsky 1975; Belsky 1982). Within two growing seasons, the released oil reduced vegetative cover from 100% to 1% and killed all, but three plant species: a heather (Phyllodoce empetriformis), a sedge (Carex lenticularis), and a moss (Rhacomitrium sudeticum) (Belsky 1982). By the second growing season after the release, seedlings of Carex nigricans, a species of sedge, appeared in the wetter areas, and seedlings of other subalpine species reappeared over the next four growing seasons. After nine years, 5 to 20% of the area affected by the release was covered by seedlings, and 20% of the heather community and 10–20% of the sedge community was covered with vegetation.*

Belsky (1982) stated that the effect of the release on the meadow communities was reduced by the snow cover, steep terrain and snowmelt. Much of the oil flowed down the steep slope rather than pooling and becoming stranded, and summer snow melt helped flush much of the oil out of the area reducing the potential exposure of emerging vegetation. In addition, the timing of the release may have reduced impacts on these communities. Plants were dormant at the time of the release and the frozen ground likely helped protect underground roots. Although diesel fuel is initially more toxic to plants (Walker et al. 1978, Wein and Bliss 1973), it is comprised of relatively small chain, highly refined hydrocarbons, which tend to weather more rapidly relative to heavier oils with a higher proportion of high molecular weight PHCs. By the time plants began to emerge, the remaining oil was less toxic to the plants than it would have been at the time of the release.

***Moose Jaw, Saskatchewan, 1974**: In the winter of 1974, a pipe carrying asphalt-based oil (23 API gravity) broke north of Moose Jaw, Saskatchewan. The responsible party for the release was not identified. Approximately 15,725 barrels of oil were released. Although two-thirds of the oil was recovered from excavated trenches during the emergency response effort, an estimated 39.5 acres (159,850.83 m^2) of agricultural land was oiled. Remediation of the affected area was not conducted. Beginning in the spring of 1974, grain crops (barley, oats and wheat) were planted to study their performance as a tool for delineating the contaminated areas. Fertilizer, limited to the maximum rate tolerated by the crops, was applied to enhance the rate of oil degradation. In 1974, the results indicated that oil content over one percent (10,000 mg/kg) was associated with*

zero growth. Crop yields on the contaminated areas improved from 1975 to 1978, but were still lower than for uncontaminated areas. In 1978 total yield of wheat from the contaminated sites ranged from 620–8,010 lbs./ac (695–8,990 kg/ha) as compared to the uncontaminated areas with a total yield of 5,550 ± 1,220 lb./ac (6,230 ± 1,370 kg/ha) (De Jong 1980). Oil content and yield were negatively correlated, but there was considerable variability in the data, which was attributed, in part, to the non-uniform distribution of oil in the root zone.

***Caribou-Poker Creek, Alaska, 1976**: In a test release at the Caribou-Poker Creeks Research Watershed, approximately 48 barrels of hot Prudhoe Bay heavy crude oil (27.5 API gravity) were applied to two 0.12 acre (500 m^2) plots in an open black spruce forest. The test release was conducted by scientists with the Cold Regions Research and Engineering Laboratory (Garron 2007). One experimental release occurred in the winter (February 1976) and the other in the summer (July 1976). The oil was released through a 16 ft (5 m) wide perforated pipe located at the top of the test plots and allowed to flow downslope (Collins et al. 1994). Oil from the winter release primarily flowed under the snow and over the frozen ground and did not go below the surface until the ground thawed. By 1978, the total area covered by the winter release was approximately 807 ft^2 (75 m^2) and approximately 40% of the release area had surface oil visible (Collins et al 1994). In contrast, the soil from the summer release flowed primarily into the organic layer before spreading downslope. The summer release covered an area of approximately 3,261 ft^2 (303 m^2) and only about 10 % of that area had visible surface oil. After three years, nearly all vegetation had died in areas where oil flowed over the surface, but effects from the release were delayed where the oil was below ground and there was less vegetation mortality in these areas (Collins et al. 1994).*

The releases were conducted in open black spruce (Picea mariana) forests with a shrub understory of resin birch (Betula glandulosa), Labrador tea (Ledum decumbens), blueberry (Vacccinium uliginosum) and willow (Salix sp.). Ground cover was primarily mosses and lichens with scattered cotton grass (Eriophorum vaginatum) tussocks. Most mosses, lichens and shrubs died shortly after the initial release, but the cotton grass persisted. Based on surveys 15 years after the releases, the cotton grass appeared to have thrived following the releases (Collins et al. 1994). The response of the cotton grass was attributed to less competition from other species. The black spruce tree also experienced mortality. Surveys conducted 15 years after the releases, determined that approximately 56% of the black spruce trees on the winter plot were dead and about 38% of the black spruce trees were dead on the summer plot. No black spruce seedlings were observed in either plot, although the remaining trees were bearing cones (Collins et al. 1994). The winter oil release produce more oiled surface area and

thus had more long-term and chronic effects on the plant communities (Collins et al. 1994).

***Bemidji, Minnesota, 1979**: At this site, a Lakehead Co. pipeline released approximately 10,700 barrels of light, low-sulfur crude oil in August, 1979 (Nieber 2013, Associated Press 2014a). The oil sprayed over approximately 1.6 acres (6,500 m²) and collected in topographic depressions before infiltrating the soil into the groundwater. Clean-up efforts resulted in the capture and recovery of approximately 80% of the released oil. Following clean-up of the areas with pooled oil, the oil-sprayed vegetation was burned. The area has remained relatively devoid of vegetation for most of the last 30 years due in part to the water repellent nature of the surface soil as a result of the burning. Vegetation (species not identified) now is primarily found in topographic depressions where run-off provides sufficient water to support growth (Nieber 2013). Further inhibiting re-vegetation has been erosion of the exposed de-vegetated soil down to the rocky substrate. For this release, the delayed recovery was predominately the result of clean-up efforts (Nieber 2013).*

***Mesters Vig, Northeast Greenland, 1982**: An experimental study was conducted in northeast Greenland on the effects of North Sea (light sweet) crude and diesel oils on wet marsh, grassland, and three types of dwarf-shrub heath (Holt 1987). Plots of 10.7 ft² (1 m²) were set up in the five plant communities. In August 1982, researchers applied North Sea crude oil and diesel oil to separate plots within each of the five plant communities. To approximate a spray release, 0.06 barrels of oil was applied to each plot at an even coating of approximately 0.4 in. Monitoring of effects was conducted for the following three years after application; however, vegetative damage was evident in the first week after the oils were applied. On the crude oil plots, the leaves lost chlorophyll turning yellow or brown; on the diesel oil plots, the leaves lost chlorophyll or were shed. After three years, the total vegetative cover in each of the five plots treated with crude oil was less than prior to application treatment, with the driest sites that began with the least vegetative cover showing the least amount of recovery. The total plant cover in the sparse dry dwarf-shrub heath decreased from 40% prior to treatment to only 0.6% by the third growing season after the treatment (Holt 1987). In comparison, the total plant cover in the wet graminoid marsh decreased from 126% prior to treatment to 23% post-treatment. In addition to the decrease in cover was a reduction in species diversity. The species diversity in each post-treatment community was less than 50% when compared to the pre-treatment communities (Holt 1987). Based on percent cover after three growing seasons, the shrubs and mosses in the communities treated with crude oil showed the best recovery whereas the graminoids (grass and grass-like plants) and forbs showed very limited recovery.*

The plots treated with diesel oil also showed reductions in total cover with the drier sites experiencing the least amount of recovery. The recovery of vegetation was more limited in the diesel treated plots than the crude oil plots. Regardless of the community, shrubs and forbs showed almost no recovery after 3 growing seasons; graminoids and mosses showed some recovery, but recovery was very limited in the drier communities (Holt 1987). In both treatment groups, the wet or mesic conditions appeared to reduce the effects of the oils, which may have led to better recovery. In these wetter sites, the water may have helped protect the belowground structures (i.e., roots and rhizomes) from the oil. The toxic effects of the diesel oil were more significant and the diesel treated plots showed little or no recovery except for mosses and three species of sedge (Holt 1987).

***Tulita (Fort Norman), Northwest Territories, 1988**: Seburn et al. (1996) experimented with a crude oil release designed to simulate a small-scale subsurface pipeline rupture. The study was conducted at the Studies of the Environmental Effects of Disturbances in the Subarctic project site. The study looked at an experimental subsurface point release of approximately 21 barrels of Norman Wells light-gravity-sweet crude oil on a simulated ROW and a simulated buried pipeline trench. The ROW was cleared of trees and shrubs, but the surface vegetation and organic layer were left intact. For the simulated buried pipeline trench, essentially all of the vegetation (trees, shrubs, low-growing plants, mosses and lichens) was removed as was the surface organic soil layers (Seburn et al. 1996). The simulated pipeline trench was fertilized and seeded with an agronomic seed mix. For the study, oil was pumped into an open ended pipe that was buried about 3.3 ft deep, where it flowed to the surface covering approximately 0.17 acres. Sampling was conducted using 9.8 in x 9.8 inches (25 cm x 25 cm) quadrats located in the cleared ROW and simulated trench. After treatment, sample quadrats were classified as heavy, medium or lightly oiled, based on the amount of visible oil in each quadrat.*

The mean total plant cover in the heavily oil ROW declined from almost 75% prior the release to less than 20% a year after the release. Both the lightly oiled ROW and the unoiled ROW showed no significant changes in mean total plant cover the year after the release, but cover increased significantly in the following two years (Seburn et al. 1996). For the simulated pipeline trench, neither the heavily oiled nor lightly oiled areas showed significant changes in mean total plant cover the year after the release. By two years after the release the mean total plant cover in both the heavily and lightly oiled areas had increased significantly above pre-release levels (Seburn et al. 1996). The simulated pipeline trench had standing and flowing water on the surface that kept the soils saturated and limited how much oil could penetration into the soil, which in turn reduced the effects of the oil on the vegetation community. In addition, the soils within the

simulated pipeline trench lacked the organic soil component present in the ROW soils, which absorbed and retained the oil (Seburn et al. 1996).

In the heavily oiled ROW, cover of 16 of the total 30 plant taxa changed significantly after the release with some of these taxa completely eliminated from the study quadrants (Seburn et al. 1996). Two of the 16 taxa increased post-release. By the third year post-release, both the agronomic grasses and cotton grasses had increased significantly above pre-release levels. In the lightly oiled ROW and both the lightly and heavily oiled simulated pipeline trench, 6 or fewer taxa changed significantly after the release. A few species appeared to tolerate the oil. Except in the heavily oiled ROW, the cover of mosses increased significantly by the second or third growing season. Researches attributed the increase in mosses to the physiological adaptation where by most of these taxa do not draw water from the soil (Seburn et al. 1996). Other taxa, sedges and cotton grasses, also appeared to experience limited effects from the oil and in many situations experienced significant increases in cover. Because cotton grasses establish new root systems each year, researchers suggested that this adaptation might reduce the effects of oil that penetrates into the soil. The researchers noted that identifying effects from the oil were complicated by the clearing and trenching activities, but they attributed the more persistent changes in vegetation to the oil (Seburn et al. 1996).

***Fort McMurray Alberta, 2013**: In 2013, an Enbridge pipeline running south from Fort McMurray in northern Alberta released approximately 1,300 barrels of premium synthetic crude oil (Hemmings et al. 2015). The release occurred underground, but the oil migrated off the pipeline right-of-way into a neighboring forested area and fen. Contaminants of concern included PHC, BTEX, and PAH. An emergency response and release recovery was initiated immediately, which included remediation of soil, groundwater, and fen material. The remediation removed 93% of the oil. Remedial activities consisted of excavating visibly effected soils, sediments, and vegetation; flushing of the fen; and oil recovery from an adjacent lake. Due to the rapid response combined with natural volatilization and degradation, effects to plants, beyond the effect of the remediation operation itself, were not initially observed. However, during the on-going monitoring program the following year, stressed and dead birches were observed (Hemmings et al. 2015). An ecotoxicological assessment was completed to determine if the remaining hydrocarbons posed a risk to vegetation and other ecological receptors. The assessment used sediment and soils that remained in place after initial remediation efforts. Negative effects to shoot and root lengths for bluejoint reedgrass (Calamagrostis canadensis), and to shoot length for black spruce (Picea mariana) were observed.*

7.1.3.1.3 Expected Effects of Released Oils

The literature review on the effects of oil releases on terrestrial vegetation provides detail on what factors will play a role in determining the severity of effects. The identification of these factors is limited since the majority of the studies were conducted in northern latitudes for similar plant communities. The majority of the releases studied occurred over 30 to 40 years ago, and as such, may not reflect current clean-up methodologies.

In general, direct exposure of plants to the oil types as described in the above case studies results in direct damage to active living tissue or killing of the entire plant. The temporal extent of effects and recovery of vegetation can be a function of oil type, the mechanism of release (spray, point, or subsurface), the seasonal timing of the release, the oiling intensity, and the method of clean-up. Long-term effects to vegetation result from changes in soil moisture and nutrient availability, oil saturation in the soil reaching the roots, and changes in plant communities based on the immediate direct effects.

Holt (1987) and Hutchinson and Freedman (1978) compared the effects of diesel oil to crude oil on vegetation. Other studies evaluated one type of oil typically at various rates of application or different seasonal timing of the release. Holt found greater effects to vegetation from the initial application of diesel oil compared to crude oil. In contrast, Hutchinson and Freedman (1978), observed similar effects to vegetation from diesel oil and crude oil. The effects of a diesel oil release on subalpine meadow communities at Mt. Baker may have been limited because the release occurred during the winter and the oil had an opportunity to weather before plant emergence and because the steep topography and snow melt that helped oil flush oil from the area (Belsky 1975, 1982). None of the studies made any observation or provided any analysis in terms of effects being greater for different types of crude oils (e.g. light, medium, heavy).

The method of a release, the timing of the release (summer vs. winter), the species exposed , and the amount of oil released all combine together as factors that influence how much of the active living plant tissue is directly affected by the oil, how much of the oil penetrates to the roots, and the surface area affected. Spraying the oil on the vegetation to provide an even coating appeared to have the greatest damage to vegetation. For most of the studies, the application of oil in the summer had a greater long-term effect on vegetation recovery. Frozen or saturated soils can minimize the penetration of oils into the soil profile, allowing time for evaporation of the oil, and for spring run-off events to transport it away from the release area. The timing of the release in relation to the life stages (e.g., sprout, seedling, mature) or annual cycles of the individual plants (e.g. seeding, flowering) can affect the sensitivity of the plant, and its correspondent reproductive functions such as flowering and seed production, to released oil. For example, releases that occur before or during flowering, especially for annuals, could result in decreased seed production, and substantially decrease future vegetative cover for those species.

Vegetation communities that were lightly oiled generally experienced less change in cover and composition when compared to heavily oiled communities (Seburn et al. 1996). Effects also varied due to growth form, species morphology and physiology. For ground-level releases, trees may not show noticeable effects from the oil for months to years after the release and only if sufficient amounts of oil penetrate the soil and affected their root system. Once the root systems are affected, it can take many years for the tree component of a community to recover (Collins et al. 1994). Groundcover vegetation such as graminoids, forbs and mosses typically experience significant declines almost immediately after a release, although some species including cotton grasses and some sedge survive and increase in cover within a relatively brief period (Collins et al. 1994; Seburn et al. 1996). Vegetation that better tolerates oil releases and recovers more quickly appears to have adaptations such as annual growth of new root systems that may promote their recovery.

In most of the case studies, over time vegetation was able to recolonize disturbed areas without clean-up efforts, however, post-release vegetation typically had lower percent cover, often with shifts of dominant species and habit. New growth typically developed from root stock or rhizomes of perennial species, existing seedbanks in undisturbed soils, and unaffected vegetation that spread from undisturbed areas into disturbed areas. Recovery was dependent on soil types, vegetation community types, morphological characteristics of individual species, spring runoff, and the infiltration depth of the oil. Even though vegetative cover may recover, oil may remain present in the area. In areas where oil was not removed from the soil, vegetation typically did not recover, or only species that appeared to be oil tolerant revegetated the disturbed areas. The time to recovery is highly variable and is dependent upon both the characteristics of the release and the characteristics of the affected plant community.

7.1.3.1.4 Summary of Inland Oil Release Effects on Terrestrial Vegetation

Table 7-29 and Table 7-30 provide a summary of the expected environmental effects of oil releases to terrestrial vegetation. Table 7-29 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-30 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-29 Biological Receptor: Terrestrial Vegetation

Oil Characteristic	Low	Medium	High	Other Comments
Viscosity	Oil with low viscosity would spread more slowly and have a limited effects area which would limit effects on terrestrial vegetation.	Oil with a medium viscosity would spread at a moderate rate and have a wider effect area compared to low viscosity oil. Medium viscosity oil would have a wider area of effects than a lower viscosity oil.	Oil with a high viscosity would spread at a faster rate and could have a relatively large effects area compared to low and medium viscosity oil.	The spatial extent of oiling from overland flow would be highly dependent on the local topography.
Pour point temperature	At a temperature below pour point, oil flow from a release would be minimal, limiting effects to vegetation near the oil release site.	At a temperature at pour point, oil flow from a release would be increased, effects to vegetation would be near the oil release site and spread further out from there.	At a temperature above pour point, oil flow from a release would be greatly increased, effects to vegetation would be near the oil release site and could spread a much further distance.	
Oil release volume	Lightly oiled sites are often able to recover quickly.	Sites with increased oil volume from a release have greater effects on vegetative tissue.	Sites with high volumes typically have greater effects and increased loss of species, and vegetative cover.	The volume of oil and mechanism of release are the greatest contributing factors affecting the spatial extent of oiling.
Physical and chemical properties of the oil	Lighter refined products such as diesel fuel) while initially more toxic to plants, weathers more rapidly resulting in decreased long-term effects.		Those crude oils that are more persistent take longer to weather, stay in the ecosystem and can result in longer-term effects and recovery such as decreases in plant diversity and abundance.	Selection of remedial methods to remove oil can have a significant effect on recovery.

Table 7-30 Biological Receptor: Terrestrial Vegetation

Environment Characteristic	Low	Medium	High	Other Comments
Seasonality of release	Winter: frozen conditions can limit the penetration of oils into the soil. The amount of aboveground active living tissue in the winter is also decreased, limiting effects from oil that sprays onto vegetation.	Spring/Fall: Oil not volatilized or cleaned up can move during spring melt then seep into the soil.	Summer: In general, summer releases have the greatest effects due to the deeper active soil layer and the increased active living tissue present. Releases that occurred before seeds were produced had greater effects on the next growing season's recovery.	
Soil permeability/ moisture	Soils with low permeability include those with high moisture content, high percentage of clay, or frozen soils. These soils limit the ability of the oil to penetrate and saturate the soil limiting damaging effects on the oil on the roots, nutrient content, and soil microorganisms.	Soils with medium permeability would result in increased toxicity to terrestrial vegetation due to increased saturation of the soil by the released oil. Soil saturation with oil could also go deeper in the soil profile affecting deeper-rooted plant species.	Soils with high permeability would result in increased toxicity to terrestrial vegetation due to increased saturation of the soil by the released oil. This could result in long-term effects such as loss of deep-rooted woody vegetation, and long-term decreases in total vegetative cover and species diversity.	Mosses are sometimes able to recover quickly as they lack roots in the soil and are able to stay above the oil saturated soil.
Plant habit/ type	Herbaceous (including lichen and mosses): Effects depend on timing of the release which impacts seed production. Annual species that are unable to produce seed due to a release are frequently lost from the site. Perennial species are often able to re-sprout from below ground biomass. Lichens are often permanently affected, while mosses varied in their effects.	Shrub/sub-shrub: Surface saturation can affect the actively living tissue; however shrubs are able to recover from below ground biomass (root structure) when oil contaminants stay on the soil surface. When soils are saturated and the oil reaches the roots, effects can be long-term.	Tree: When soils are saturated with oil, long-term effects, including mortality and loss of resilience may occur. Effects to trees often take several years to be observed. Oil releases that stay on the soil surface often do not affect the taller tree species.	
Plant Species	NA	NA	NA	Certain species have been identified for

Table 7-30 Biological Receptor: Terrestrial Vegetation

Environment Characteristic	Low	Medium	High	Other Comments
				reclamation purposes due to their ability to survive and thrive in oiled environments.

7.1.3.2 Benthos

7.1.3.2.1 Description

Benthic macro-invertebrates (or more generally, aquatic invertebrates) are those invertebrates that live on or in the bottom sediments, including a wide variety of arthropods (e.g., aquatic insects, crustaceans, and others), mollusks, annelids, turbellarians, and other phyla. Functionally they are considered to be those invertebrates that live on or in the sediments and are visible to the naked eye or retained on a sieve having a mesh size of about 0.02 inches (0.5 mm, Barbour et al. 1999; Klemm et al. 1990). Sediments also support a wide variety of other, smaller, animal life forms.

Aquatic invertebrates are assessed here because of their ubiquitous importance in the aquatic food web (e.g., as processors of detritus and plant materials, and as prey items for fish), and for their value as bio-indicators and a monitoring tool for assessing the environmental effects of changes in water and sediment conditions (Barbour et al. 1999). Freshwater benthic macro-invertebrates inhabit a variety of substrates, ranging from soft sediments to large rocks, submerged woody debris, aquatic vegetation, and root masses (Klemm et al. 1990).

Because benthic macro-invertebrates are abundant in most waterbodies, relatively easy to sample and identify, tend to stay in a localized area, and have a wide range of feeding strategies and tolerance of environmental conditions, they are a common tool for monitoring health of aquatic ecosystems (Barbour et al. 1999). The use of standard sampling protocols, often based on the USEPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999), provides a consistent monitoring approach and allows statistical treatment of the data, to reliably identify adverse effects of human activities and trends over time. After identifying and counting the organisms, the data can be evaluated for abundance, diversity, evenness, species composition, dominance, and other community indices that indicate environmental disturbance, relative tolerance of the organisms present, and effects of contaminants on community structure and composition (Pontasch and Brusven 1988).

In watercourses, particular attention is paid to abundance and diversity of some orders of insect larvae in riffle habitat. Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), referred to as EPT taxa, are considered pollution sensitive, and are abundant in conditions preferred by trout and other salmonids (i.e., undisturbed rivers and streams in riffle and run areas, with high oxygen levels, and with low levels of sedimentation, organic contaminants, and nutrient enrichment). While some EPT taxa also inhabit depositional areas of lakes, rivers, and streams, other taxonomic groups (e.g., aquatic worms, midge larvae, mollusks, and crustaceans) that naturally tolerate fine sediment are usually predominant in these areas.

The effects assessment for benthic macro-invertebrates focuses on direct effects of crude oil on invertebrate communities. Oil released to water mainly remains on the surface, but it can also enter the water column (dissolved, dispersed, or as fine droplets) or be stranded on the shore and sediment. Toxicity to aquatic biota varies with the type of oil and manner of exposure, and

can be identified through water and sediment monitoring and toxicity testing. Relevant hydrocarbon monitoring parameters are BTEX (which have low molecular weight fractions that weather quickly), PAHs (which have persistent higher molecular weight fractions), and alkanes (aliphatic hydrocarbons, straight chain with varying numbers of carbon atoms). Acute toxicity is generally associated with the lower molecular weight compounds (e.g., BTEX), some PAHs such as naphthalene, and short chain alkanes (NRC 2005).

7.1.3.2.2 Observed Effects

There is potential for crude oil released accidentally from a pipeline to reach one of the many lakes, streams, or rivers in Minnesota. Oil has the potential to affect macro-invertebrates directly through acute or chronic toxicity or smothering of habitat, and indirectly by altering essential habitat characteristics). Immediately following a release, biota can be exposed to acutely toxic hydrocarbon concentrations dissolved in the water (Stalfort 1999; Poulton et al. 1997). The low molecular weight compounds (BTEX, some PAHS, and short chain alkanes) most associated with acute toxicity generally weather and disperse quickly (NRC 2003), so that concentrations in surface water are usually below levels associated with acute effects to benthic macro-invertebrates or fish within days or weeks. Oil deposited in sediment (whether stranded along shorelines, or sunken) contains PAHs that weather and degrade more slowly than the low molecular weight compounds, sometimes over a period of years, and can be associated with chronic toxicity. Indirect effects on macro-invertebrates can occur through effects on other aspects of the habitat (e.g., increase in nutrient release from sediment, increase in algal production, decrease in dissolved oxygen levels during decomposition of the oil, and decrease in decomposition of natural sources of organic matter (Crunkilton and Duchrow 1990). Over time, and as the released oil becomes increasingly weathered, biodegraded and/or dispersed, benthic macro-invertebrate communities recover. Recovery is facilitated by natural dispersal mechanisms of these organisms, such as downstream drift, and upstream movement of aerial life stages prior to egg deposition. Remediation activities can speed up the recovery process, but the habitat-associated disturbance (e.g., removal of riparian and in-water vegetation, substrate disturbance, and flow alteration) can also result in adverse effects on the benthic community.

Observed effects of released oil on benthic macro-invertebrates are compiled from seven case studies where oil was accidentally released in freshwater environments. Only one of the case studies is for a lake, reflecting the paucity of literature available on effects of oil releases in lakes and ponds, as compared to releases into rivers and streams.

> ***Asher Creek, Missouri:*** *In August 1979, a pipeline burst, releasing approximately 9,500 barrels of an unspecified type of domestic crude oil into Asher Creek, in southwest Missouri, during low-flow conditions (Crunkilton and Duchrow 1990). A responsible party has not been identified for this incident. Dissolved oxygen, pH, and conductivity levels in water were not changed by the release (no information about hydrocarbons in water was published), and oil that entered substrates in riffle areas due to mixing was observed for over a year post-release*

(Crunkilton and Duchrow 1990). The creek originates in springs 0.4 miles upstream of the release site. Low water volumes in these headwaters, particularly during summer, provided limited dilution of the oil, increasing the residence time of soluble oil components in sediment (Crunkilton and Duchrow 1990). Areas located downstream from surface skimming siphon dams were less severely affected and recovered more rapidly than areas closer to the release, where the substrate became inundated with oil (Crunkilton and Duchrow 1990).

Recovery of the benthic invertebrate community was studied between 1 and 18 months post-release (Crunkilton and Duchrow 1990), with a focus on riffle-dwelling organisms indicative of good water quality (e.g., Ephemeroptera and Plecoptera). Sampling sites were established 0.4 miles upstream (reference area) and about 1.2, 2.5, and 5.0 miles downstream of the release location. Following an initial reduction in benthic populations to 0.1% of expected density, a decrease in species diversity, and a complete loss of some mayflies and stoneflies, the community began recovering through re-colonization from upstream areas. At nine months post-release, density, diversity, and number of mayfly and stonefly taxa had recovered to levels found in the upstream reference area, but remained below the minimum values established for unpolluted Missouri streams. At 12 months post-release, a drought during August and September resulted in a decline in these metrics. At 18 months post-release, density, diversity, and number of mayfly and stonefly taxa had rebounded and were similar to values reported for unpolluted Missouri streams. Factors slowing recovery time included the additional stress of warm summer temperatures and low flows, the large volume of the release compared to the water volume of the creek at the time of the release, and the limited area upstream for providing organisms for re-colonization (the creek originates from a spring only 0.4 miles upstream of the release site).

Gasconade River, Missouri: *On December 24, 1988, a ruptured pipeline owned by Shell Oil Pipeline Corporation released approximately 20,800 barrels of intermediate sweet crude oil near Vienna, Missouri, into Shoal Creek, a tributary of the Gasconade River. Concentrations of petroleum hydrocarbons in sediment decreased rapidly in erosional areas in the months following the release, but persisted in depositional areas (Poulton et al. 1997).*

Benthic invertebrate communities in riffle and backwater areas of the Gasconade River were sampled after the release, from March 1989 to June 1990 (Poulton et al. 1997). In affected riffle habitats, total number of organisms, taxa richness, number of EPT taxa, and EPT/Chironomidae ratio recovered to levels reported in reference areas in the first summer post-release. In backwater areas, however, benthic diversity and abundance of the macro-invertebrate scrapers and shredders functional feeding groups remained diminished until the end of the

study (18 months post-release). This continued effect was attributed to residual hydrocarbon contamination in backwater slough areas despite the ongoing decline in hydrocarbon levels in sediment over that period. Although high flows and scouring increase recovery in both riffle and backwater habitats, the increased flushing potential of riffle areas likely allowed for increased weathering and flushing of oil residue, which allowed more rapid colonization of benthic invertebrate communities in the riffle habitats compared to backwater areas (Poulton et al. 1997).

Chariton River, Missouri: *On November 5, 1990, a rupture in an Amoco Oil Pipeline Corporation pipeline released approximately 2,600 barrels of light crude oil into a small tributary that flowed into the Chariton River near Ethel, Missouri. Sediment collected from depositional areas located downstream about six weeks after the release was still found to be toxic to mayflies in laboratory experiments (Poulton et al. 1998; Ort et al. 1995).*

Benthic invertebrate surveys, using artificial substrates consisting of packs of natural leaf litter, were conducted one month and one year post-release (Poulton et al. 1998). One month post-release, there were statistically significant differences between reference and affected sites in abundance and taxon richness of macro-invertebrate collector and shredder functional feeding groups, and in EPT taxon richness. One year later, differences between affected and reference sites were no longer significant for many of the metrics, except for taxon richness and overall abundance, which remained slightly lower in affected areas. The authors stated that effects observed after the release appeared to be associated with oil absorption and substrate coating, creating conditions unsuitable for successful colonization.

Cayuga Inlet, New York: *On November 3, 1997, a Conrail train derailed and released 167 barrels of diesel fuel into a first-order reach of the Cayuga Inlet, which flows into Cayuga Lake near West Danby, New York. Diesel fuel slicks escaped the containment booms and were observed on the surface of Cayuga Lake 9.6 miles downstream of the release site within twenty-four hours (Lytle and Peckarsky 2001).*

Recovery of the benthic invertebrate community was measured four times over a 15 month period at sites 0.4, 3.0 and 7.0 miles downstream of the release, and at corresponding reference sites (Lytle and Peckarsky 2001). Immediately after the release, there were statistically significant differences for taxon richness and predominant taxa at the first two sites downstream, and for density at all three sites. Short-term effects included a 90% reduction in invertebrate density at sites 0.4 and 3.0 miles downstream, and a 50% reduction in taxon richness at the site 0.4 miles downstream. The benthic community at the site 0.4 miles downstream

was dominated in autumn 1997 and spring 1998 by a riffle beetle, of the genus Optioservus, known to tolerate oil pollution. The beetle was replaced in dominance by one highly predominant mayfly species later in 1998. At the other sites, various species of mayflies were predominant. Despite the initial severity of the effect, invertebrate density and taxonomic richness at the site closest to the release recovered within a year, with re-colonization from unaffected areas. However, the authors concluded that 15 months was not long enough for complete recovery of the benthic community at the site located closest to the release, given ongoing over-representation of a single predominant taxon at this site during the study period.

***Pine River, British Columbia**: On August 1, 2000, a Pembina Pipeline Corporation pipeline ruptured and released approximately 6,200 barrels of sour light crude oil, of which approximately 2,800 barrels entered the Pine River in British Columbia (BC MOE 2000a). The Pine River is a low gradient but fast flowing river, and oil was dispersed up to 50 miles downstream. The fast flowing water allowed rapid dispersion of acutely toxic fractions of the oil into the river water. Oil was stranded and settled in depositional areas along the banks, in back eddies and other slow-flowing areas, and on organic debris and logjams (AMEC 2001 in Lee et al. 2015). Heavy rainfall later in August and September mobilized stranded oil, oil-contaminated debris, and sediments downstream, and high water levels scoured some of the more heavily oiled depositional areas. Oil was recovered from the river over a period of two months, with about 91% of the released oil being either recovered, or accounted for through volatilization (Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015). Some of the emergency response activities (e.g., removal of logjams and woody debris, altering of backchannels, bank armoring, and presence of heavy machinery in the river) also resulted in habitat damage (Summers 2004 in Bustard and Miles 2011). Prior to the August 2000 release, a small release of diesel fuel (151 barrels) and gasoline (187 barrels) from a tanker truck had occurred in August 1994 in this area of the Pine River (Goldberg 2011).*

Petroleum hydrocarbons were detected chemically, and seen and smelled in river water up to 50 miles downstream of the release, with sheen visible in back eddies and other calm areas along shorelines. Hydrocarbons accumulated in sediments and on organic debris (e.g., branches, leaves, and algae) present along the shoreline, in front of logjams, and attached to sweeper logs in these calm areas (AMEC 2001 in Lee et al. 2015). Concentrations in water decreased rapidly to below British Columbia water quality guidelines due to evaporation, dissolving in water, and natural dispersion (Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015), all of which are characteristic of light crude oil. Oil was observed to persist in some bottom substrates five years after the release (Goldberg 2006 in Bustard and Miles 2011). Analysis of semi-permeable

membrane devices deployed in the Pine River indicated that two years after the release, hydrocarbons were present in water, implying that hydrocarbons from the release were leaching out of sediment into the water column (De Pennart et al. 2004), although additional sources (e.g., road runoff, PAHs from coal deposits in the watershed) were also acknowledged.

Immediately after the release in August, total abundance of benthic macro-invertebrates declined and there were changes in community composition apparent for at least 75 miles downstream of the release (De Pennart et al. 2004). By August of 2001, relative abundance of benthic invertebrates had recovered in much of the river (De Pennart et al. 2004; Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015). Concerns were expressed about decreased food supply for fish, especially young fish during the August–November 2000 period, which was identified as a critical period leading up to overwintering (Birtwell 2008).

***Wabamun Lake, Alberta**: On August 3, 2005, a Canadian National Railway Company train derailed and released approximately 4,500 barrels of Heavy Fuel Oil 7013 (a Bunker C type fuel oil with a high viscosity and an initial density of about 0.99 at lake temperature) and 550 barrels of pole treating oil. About 20% of the released heavy fuel oil (950 barrels) travelled overland and entered Wabamun Lake. No appreciable volume of pole treating oil entered the lake (Hollebone et al. 2011). While travelling overland, the oil mixed with soil and organic matter; and in the lake, OPAs formed quickly, including small tar balls, larger tar "logs", submerged sheets, and large lumps (Fingas et al. 2006; Hollebone et al. 2011). The aggregates showed a variety of behaviors, including submergence, neutral buoyancy, and resurfacing (Fingas et al. 2006), with extensive tar-mat formation in some nearshore areas. In the lake, the oil floated and spread rapidly over the water surface. After a few days, strong winds and wave action dispersed the oil toward the north, east, and south shorelines, where it became entrained in macrophyte beds (Anderson 2006). Behavior of oil in the lake—rapid formation of tar balls, sinking, slow degradation due to high proportions of high molecular weight components such as resins, and its toxicity and persistence (due to high PAH levels but low BTEX levels—were related to characteristics of the heavy fuel oil, which would not be comparable to crude oils and diluted bitumen, given the high density of the fuel oil. Within four months of the release, concentrations of BTEX and PAHs were below detection in lake water (Birtwell 2008).*

Laboratory tests showed statistically significant toxicity to the benthic invertebrates Chironomus tentans and Hyalella azteca for sediments collected near the release site in the weeks following the release. Test results were challenging to interpret because test conditions were not the same for all site

and control samples. Samples with high sand content had higher mortality, possibly due to sandier habitats not being preferred by the organisms, or because of the naturally low organic content and food supply in sand (Lee et al. 2015). However, growth of both species and also the aquatic worm Lumbriculus variegatus in both high- and low-sand sediments was significantly less than in control sediments. For L. variegatus, PAH concentration in sediment was correlated with toxicity (Lee et al. 2015).

Marshall Michigan: *On June 25 and 26, 2010, Enbridge Line 6B pipeline ruptured and released approximately 20,000 barrels of heavy crude oil, of which approximately 8,200 barrels entered Talmadge Creek, a tributary to the Kalamazoo River, near Marshall, Michigan (NTSB 2012a; Enbridge 2013b). The released oil was a combination of Western Canadian Select (23%) and CLB (77%) diluted bitumens (Enbridge 2013a). The release occurred on the floodplain of Talmadge Creek, where wetlands are abundant (USFWS et al. 2015a). The Kalamazoo River is a meandering, low gradient river with diverse channel and floodplain features, extensive floodplain forests and wetlands, off-channel water bodies, and impoundments (Dollhopf et al. 2014). Oil was transported downstream in the Kalamazoo River, which was in flood at the time of the release, as far as Morrow Lake (an impoundment in the river 36.5 miles downstream).*

Oil was deposited on river shoreline, riparian, and depositional areas (backwaters, side channels, oxbows) of the Kalamazoo River, and in deltaic sediments of Morrow Lake (USFWS et al. 2015a), affecting approximately 40 miles of river (80 miles of shoreline and adjacent lands) (Dollhopf and Durno 2011). There was associated disturbance from remediation efforts such as removal of riparian vegetation and sediment and access road construction (Dollhopf and Durno 2011). Some of the oil mixed with soil and organic matter while moving overland, and with suspended sediment in the water column after entering the river, resulting in formation of OPAs that submerged in some locations, especially depositional areas. These aggregates periodically released oil globules and sheen as late as 2014 (Fitzpatrick et al. 2015). Formation of OPAs was likely promoted by the flood conditions. Based on measurements of suspended sediment at the Marshall stream gage after the release, it can be inferred that the river had relatively low suspended sediment concentrations at the time of the release, but that the floodwaters likely increased the turbulence and the presence of suspended particulate matter (Fitzpatrick et al. 2015). In addition, the high organic matter content of the suspended and bottom sediments (20% or more) due to the abundant wetlands along the Kalamazoo River contributed to OPA formation (Fitzpatrick et al. 2015). Some of the submerged oil settled in areas that became anaerobic, which would reduce the rate of biodegradation.

About 90% of the oil entering the river was recovered in the first year. This included floating oil, stranded oil in the floodplains of Talmadge Creek and the Kalamazoo River, and submerged oil (Fitzpatrick et al. 2015). Much of the diluent portion volatilized, which resulted in increased density of the residual weathered diluted bitumen. In 2011, additional activities to dislodge and disperse submerged oil resulted in a small amount of additional recovery. Submerged OPAs continued to release oil from sediments in the Kalamazoo River and impoundment areas between 2011 and 2014, with surface sheens observed in impounded sections of the river (Fitzpatrick et al. 2015).

Standardized surveys and other studies indicated that benthic invertebrate communities in some sections of Talmadge Creek and the Kalamazoo River were adversely affected following the release (USFWS et al. 2015a). Some of the observed effects were attributed to effects of the oiling and some to the effects of the clean-up activities. Effects attributed to clean-up activities included bank destabilization resulting from vegetation removal and the potential for resulting bank erosion associated with heavy boat traffic (Winter and Haddad 2014). In addition, heavy boat traffic associated with the clean-up was identified as the caused for crushed mussel shell observed in the oil-impacted areas (Winter and Haddad 2014).

To examine impacts and subsequent recovery, the MI DEQ conducted standard macroinvertebrate surveys in September 2010 with additional surveys in 2011, 2012, 2013, and 2014. The Michigan Procedure 51 methods (similar to USEPA Rapid Bioassessment protocols) were used, and communities were ranked as excellent, acceptable, or poor on the basis on nine community metrics. Following the 2010 survey MI DEQ found that both abundance and diversity of macroinvertebrates were impacted due to the spill and associated clean-up activities (Walterhouse 2011). Post-2010 survey data showed improvement in both the Kalamazoo River sites and Talmadge Creek with most sites returning to near baseline conditions by 2012 (Matousek 2013; Walterhouse 2012).

Benthic macro-invertebrate communities in depositional habitat were assessed at several sites in the Kalamazoo River and in reference sites in 2012 and 2013. The 2013 results were used as part of a sediment quality triad study (along with sediment chemistry and sediment toxicity data) to evaluate effects of the release in areas known to accumulate oil (Enbridge 2014). There was high variability in community metrics among the sites, with similar trends for taxon richness, diversity, and relative abundance of Chironomidae (midge larvae) and Tubificidae (oligochaete worms) at reference and affected sites; but density (organisms per m^2) was lower at the affected sites, possibly partly attributable to higher sand content in reference site substrates compared to affected sites.

Sediment toxicity was tested in 2012 and 2013 (same depositional habitat locations as sediment chemistry) using standard laboratory tests with two species of benthic invertebrates (the amphipod Hyalella azteca and larval midge Chironomus tentans). The extent and number of samples showing toxicity decreased between 2012 and 2013 and indicated overall that toxicity was absent from most parts of the river studied (Enbridge 2014). In both years, many samples from affected areas showed no toxicity and the remainder showed low levels of toxicity (e.g., 91% survival in Hyalella and 82% survival for Chironomus) and growth reduction. However, the levels of toxicity were similar in affected and reference areas of the river, indicating a background level of sediment toxicity unrelated to the oil release (Enbridge 2014). Many samples from affected areas of the Kalamazoo River contained elevated levels of organic carbon, which were expected to reduce bioavailability of the PAHs, many of which bind to organic carbon.

The 2013 study was a sediment quality triad study, bringing together information about contaminant concentrations in sediment, sediment toxicity, and benthic invertebrate communities in depositional area. Using a weight-of-evidence approach to evaluate the ecological significance of the residual hydrocarbons in sediment, the conclusion was that release-related hydrocarbons in sediment of the Kalamazoo River were not having adverse effects on the aquatic ecosystem three years post-release (Enbridge 2014).

7.1.3.2.3 Expected Effects of Released Oils

The main effects of released oil on benthic macro-invertebrates are physical smothering of benthic habitats by oil, immediate toxicity from hydrocarbon fractions such as BTEX, and longer-term toxicity from persistent hydrocarbon fractions such as PAHs or physical contact with residual oil droplets in sediment. In addition, there may be habitat damage associated with subsequent remediation. Effects persist longer in depositional areas (pools, backwaters, or deltaic sediments where rivers deposit suspended and bedload sediments), than in erosional areas (riffles and runs of rivers and streams), where oil tends to be in transit or rapidly flushed downstream. Standard laboratory toxicity tests with oiled sediments can be used to assess acute and chronic toxicity to invertebrate species. Field assessments of benthic macro-invertebrate community structure show effects in terms of abundance and diversity of benthic organisms, and can be used to assess the health and recovery of the community. Benthic invertebrate communities recover through re-colonization of affected areas, mainly by downstream drift but also by upstream migration, movement from within the substrate, and eggs laid in the water (Williams and Hynes 1976). Case studies conducted post-release typically indicate substantial recovery for benthic invertebrate communities in rivers and streams within one year, and full recovery within two or three years. Delayed recovery may be expected in depositional areas where oil deposition is heavy, if such oil is left in place.

The effects of oil releases on benthic macroinvertebrates vary depending on characteristics of the released oil and environmental conditions at the time of the release. Relevant oil characteristics related to potential for toxicity include solubility and BTEX concentration, total PAH concentrations, resin and asphaltene concentrations, and density and viscosity. These are discussed in Table 7-31. Environmental characteristics that influence the extent of effects on benthic invertebrates include organic carbon content and particle size of the sediment, water flows, and hyporheic flow, as discussed in Table 7-32. The toxicity of oil to benthic macroinvertebrates depends mainly on the extent of exposure to oil. In general, light oils, high in low molecular weight narcotic compounds such as BTEX, are more acutely lethal than medium and heavy oils. Heavy fuel oils with high proportions of three- to five-ringed alkylated PAHs have greater chronic toxicity than light oils, generally due to their high alkylated PAH levels (Lee et al. 2015). The low molecular weight BTEX and some PAHs weather and degrade more quickly than the higher molecular weight or higher alkylated PAHs, which can persist for long periods in anoxic sediments.

Table 7-31 Effects of Oil on Benthic Macroinvertebrates by Oil Characteristic

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Solubility	Contains a large fraction of soluble low molecular weight hydrocarbons like BTEX, leading to a higher potential for acute toxicity, particularly in the water column.	Intermediate in proportions of soluble low molecular weight hydrocarbons (e.g., BTEX) between light and heavy crude oil. There is a moderate potential for dissolved hydrocarbons to enter sediment pore water and for acute toxicity.	The fraction of soluble low molecular weight hydrocarbons depends on the oil type. Conventional heavy crude oils may have relatively low solubility. However, diluted bitumens contain diluent, which may (e.g., condensate) or may not (e.g., synthetic crude oil) contain a large component of relatively water-soluble aromatic compounds (e.g., BTEX). CLWB is an example of diluted bitumen with a relatively large component of condensate, with BTEX content similar to that of many light crude oils.	Soluble fractions (BTEX and low molecular weight PAHs can result in acute toxicity to organisms in the water column. However, oil that reaches substrates inhabited by benthic macro-invertebrates will have undergone some weathering, leading to lower levels of soluble hydrocarbons.
Concentration of total PAH	Among the light crude oils, Alberta sweet mixed blend crude oil has higher total PAH and proportionally more naphthalene and alkylated naphthalenes than heavier crude oils and bitumen (Yang et al. 2011).	Among the medium crude oils, Alaska north slope crude oil has higher TPAH, and proportionally more naphthalene and alkylated naphthalenes than heavier crude oils and bitumen (Fingas 2010; Zhou et al. 2015).	Diluted bitumens typically have concentrations of total PAH that are similar to or lower than many light, medium, and heavy conventional crude oils, although the PAH "fingerprint" varies (Zhou et al. 2015, Fingas 2010). There is no current evidence to suggest diluted bitumens are more toxic than conventional light or medium crude oils (Zhou et al. 2015). Diluted bitumens tend to have relatively more of the C3 and C4 alkylated PAHs, which may be more toxic and persistent, but these PAHs are less soluble in water and therefore less bioavailable. Heavy fuel oils often contain very high concentrations of PAHs.	Many PAHs are have very low aqueous solubility and accumulate in sediment, where benthic macro-invertebrates can be exposed. They do not degrade quickly and can result in chronic toxicity to aquatic biota. Total PAH levels vary from oil to oil, even within a weight class, but as a general rule, most crude oils contain approximately 1% total PAH by weight.
Concentration of resins and	Light crude oils contain very little resin and asphaltene. The light	Medium crude oils also contain little resin and asphaltene, although	Resins and asphaltenes comprise the "heavy" end of crude oils, and diluted bitumens are proportionally richer in these	Resins and asphaltenes are generally insoluble in water and thus not biologically

Table 7-31 Effects of Oil on Benthic Macroinvertebrates by Oil Characteristic

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
asphaltenes	oils weather quickly, resulting in less extensive and shorter-term effects on habitat of benthic macro-invertebrates.	more than light crude oils. Medium crude oils also have good potential for weathering and biodegradation in the environment.	components than light or medium crude oils. Their tendency to adhere to substrates and resist biodegradation results in potential to affect habitat of benthic macro-invertebrates in both depositional and erosional habitats.	available and nontoxic. They can adhere to surfaces and are slow to degrade (Lee et al. 2015), so can act as reservoirs for slow release of other more toxic hydrocarbon constituents such as PAHs.
Density and viscosity	Light crude oils have relatively low density and viscosity. Therefore, although they float and quickly re-surface when submerged, their low viscosity allows formation of small droplets under turbulent flow conditions. Such droplets readily interact with suspended sediments to form OPAs that may have a net density greater than that of the water.	Medium crude oils have intermediate density and viscosity. Therefore, while they readily float on water, they are somewhat more resistant to dispersion into flowing water as fine droplets than light crude oils.	Heavy crude oils have relatively high density (diluted bitumens are typically engineered to have a fresh density of 0.94 or less, similar to conventional heavy crude oil types). Diluted bitumens generally have lower viscosity than heavy conventional crude oils; however, density of diluted bitumen containing a volatile diluent will increase more rapidly than density of a conventional crude oil. The higher density of heavy crude oils suggests a greater tendency to sink; however, the higher viscosity of these oils reduces the likelihood that fine droplets will form in the water column and, therefore, reduces the likelihood of OPA formation.	Density and viscosity of any oil will increase as a result of weathering post-release. Any crude oil can be deposited to sediment, under the right conditions. Wave tank testing of light (Alberta Mixed Sweet Blend) and Cold Lake diluted bitumen crude oil types with natural river sediment showed that the light oil readily formed OPAs and sank, whereas the diluted bitumen remained floating (Zhou et al. 2015).

Table 7-32 Effects of Oil on Benthic Macroinvertebrates by Oil Characteristic

Environment Characteristic	Low	Medium	High	Other Comments
Sediment organic carbon content	Oligotrophic (nutrient-poor) lakes and watercourses tend to have low organic carbon content. Sediments with low organic carbon content may be more prone to toxic effects to benthic macro-invertebrate communities than those with higher organic carbon content, as the organic matter provides binding sites for PAHs and other hydrocarbons.	Freshwater environments, including many watercourses, typically contain moderate amounts of organic carbon, which can bind some of the hydrocarbon fractions, reducing toxicity to aquatic biota.	Sediments containing abundant organic carbon (e.g., eutrophic or nutrient rich lakes and depositional areas of watercourses) may be less prone to exhibiting toxic effects on benthic macro-invertebrates. The high organic carbon content in sediments of the Kalamazoo River was cited as a factor in the low observed toxicity of sediments following the 2010 Marshall release of diluted bitumen (Enbridge 2014).	Oil residues as well as specific classes of compounds such as PAHs can bind to naturally occurring organic matter, limiting hydrocarbon bioavailability and toxicity. Sediment and water flow characteristics are frequently correlated. Flowing water tends to have coarse-grained sediment with less organic matter. Slow-moving or standing water tends to have fine grained sediment, with more organic matter.
Sediment grain size	Fine grained sediments (silt and clay) occur in depositional areas, where oil tends to accumulate. Fine-grained sediments may resist entry of OPAs, although physical mixing may introduce oil into the sediments, where it may persist due to low oxygen levels and lack of water flow. These processes can result in greater or more prolonged effects on benthic macro-invertebrates.	Medium-grained sediments (fine to coarse sand) occur in moderate flow environments, pools in rivers and streams, and some lakes. There is some potential for oil to accumulate in these areas, and the sandy sediment may resist entry of OPAs. The higher load-bearing capacity of these sediments may facilitate recovery of oil without downward mixing and persistence, resulting in less prolonged effects on benthic macro-invertebrates.	Coarse-grained substrates (gravel, cobble) are typical of relatively high flow systems (riffle and run habitat of rivers and streams), where oil does not tend to accumulate. However, oil and OPAs can enter the voids in the substrate, and may persist when flushing flows are limited (Klemm et al. 1990), resulting in prolonged effects on resident benthic macro-invertebrates.	Oil persistence in sediment depends upon oxygen availability (to promote biodegradation) and irrigating water flows (to promote weathering and toxicity reduction through removal of more soluble/bioavailable constituents). Spring freshet is a major seasonal factor that can flush river sediments, leading to a rapid restoration of damaged habitat.

Table 7-32 Effects of Oil on Benthic Macroinvertebrates by Oil Characteristic

Environment Characteristic	Low	Medium	High	Other Comments
Water flow characteristics	OPAs are most likely to be deposited in areas of slow-moving or still water. The slower natural biodegradation in depositional areas results in longer term habitat and toxicity effects on benthic macro-invertebrates, and longer time to community recovery.	OPAs may be locally deposited in areas of flowing water, but then re-mobilized under higher flow conditions and re-deposited elsewhere. Benthic communities in these areas recover more quickly due to faster removal of oil and faster recolonization from surrounding aquatic areas.	OPAs are not likely to be deposited in areas of turbulent flowing water. Lower oil deposition results in fewer and shorter term effects to benthic communities.	Sediment and water flow characteristics are frequently correlated (flowing water tends to have coarser-grained sediment, with less organic carbon, and standing water tends to have finer-grained sediment, with more sediment organic carbon).
Hyporheic (subsurface) flow systems	In streams that receive strong groundwater inflows, the net water flow away from the sediment will tend to prevent oil residues from entering the sediment and the hyporheic flow system, reducing potential effects on the benthic macro-invertebrate community.	Many streams have variable interactions with groundwater, both spatially and seasonally. Water may enter and exit from the hyporheic flow system at scales ranging from less than 1 m to 100 m or more. This can result in varying influences on oil effects to benthic macro-invertebrates.	In arid environments or during dry seasons, streams may regularly "lose" water to the hyporheic and groundwater systems. Under these conditions, dissolved hydrocarbons and very fine oil droplets may be entrained into the river bed or groundwater flow systems, and be resistant to degradation in low-oxygen environments, resulting in more prolonged effects of the oil on benthic macro-invertebrates.	The persistence of crude oil residues in hyporheic flow systems is likely to be low due to fresh water inflow, which will supply oxygen, and provide a flushing flow of clean water to remove relatively water soluble/bioavailable hydrocarbons, helping to reduce toxicity effects associated with the oil.

7.1.3.3 Fish

7.1.3.3.1 Description

Freshwater fish spend some or all of their life cycle stages in streams, rivers, ponds or lakes. As a group they have important ecological and economic functions. The trophic levels freshwater fish occupy range from herbivores to top predators, and the feeding ecology of individual fish may change as they grow from juvenile to adult life stages. Fish are an important food source for mammals such as river otter (*Lontra canadensis*) and American mink (*Neovison vison*), and for birds and waterfowl such as great blue heron (*Ardea herodias*) and common merganser (*Mergus merganser*), and raptors such as osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*). Freshwater recreational fishing is a multi-billion dollar industry in North America. Traditional fisheries have been and remain an important food source for Aboriginal people, and in some locations are the basis for commercial fisheries.

Freshwater fish are often used as indicators of the health of a waterbody (Karr 1981), and fish surveys are used to determine both adverse effects and recovery from disturbance (Klemm 1993; Simon 1999). The advantages of fish for bio-monitoring are:

- Life span of fish, compared to benthic invertebrates, allows for longer term monitoring of effects
- Fish occupy multiple positions in the aquatic food web. An assemblage of fish usually includes omnivores, herbivores, insectivores, planktivores, and piscivores, allowing for monitoring across multiple trophic levels
- Fish are relatively easy to collect and identify, and depending upon the nature of the scientific analyses required, can be released unharmed
- Life history traits and environmental requirements of many fish species are relatively well known
- Many fish are important recreational and commercial species (Barbour et al. 1999; Klemm 1993)
- Fish can be one of the more sensitive indicators of water quality (Klemm 1993)

Federal and state agencies may collect fish community data as a measure of waterbody health, providing a robust record of waterbody status over time. Many states follow standard protocols for fish collection, often based on the USEPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999). Collected fish are typically identified and counted and the data may be evaluated for a variety of metrics including abundance, diversity, species composition and dominance, and indicator species.

7.1.3.3.2 Observed Effects

Oil has the potential to affect fish directly through acute or chronic toxicity and indirectly by altering essential habitat (Enbridge 2015). Some components of oil (generally low molecular weight and aromatic compounds) may be acutely toxic when dissolved in water. Other components (e.g., higher molecular weight compounds such as parent and alkylated PAHs) may cause chronic toxicity when dissolved in water (Lee et al. 2015). Oil stranded on shorelines or deposited to sediments can release hydrocarbon compounds for weeks or months after an

accidental release. Contact between floating oil and shorelines will result in oiling of sediments at the water line. In addition, given the right conditions of turbulence and suspended sediment, almost any type of crude oil can become associated with sediment particles (i.e., as OPAs) leading to the deposition of some of the released oil to sediment, where flow conditions transition from moving to still water. The physical presence of oil on or in the substrates of water bodies may disrupt habitat use by fish. Clean-up activities may also disrupt habitat through removal of oiled substrates and riparian vegetation, or physical damage such as boat groundings, propeller wash, or fording of streams by wheeled vehicles.

Observed effects of released oil on fish were compiled from several case studies where oil was released in freshwater environments.

> ***Red Deer River, Alberta:*** *On June 7, 2012, approximately 3,000 barrels of light crude oil were released from a ruptured pipeline owned by Plains Midstream Canada ULC about 1.9 miles north of Sundre, Alberta and entered Jackson Creek, a tributary of the Red Deer River. Floodwaters 10 times higher than typical June flows eroded the stream bed and banks and exposed the pipeline under the river, which then ruptured (Alberta Energy Regulator 2014). Oil traveled at least 25 miles downstream to Gleniffer Lake reservoir, where booms contained the free oil product. Dissolved hydrocarbons in river water were detected up to 5 miles farther downstream (Alberta ESRD 2012a). Low molecular weight aromatic hydrocarbons (BTEX) and some PAHs were detected in the river and lake up to 30 miles downstream of the release location in the early days post-release (Alberta ERSD 2012a). Because of the high water levels at the time of the release, the majority of stranded oil occurred well above the high water mark for the river, in back water areas, trapped under trees and debris, in highly braided river margins, and mixed with silt and sediments (Teichreb 2014). Long-term monitoring showed that PAH concentrations in edible fish tissue were below human consumption guidelines (Teichreb 2014).*

> ***Marshall, Michigan:*** *On June 25 and 26, 2010, the Line 6B pipeline owned by Enbridge ruptured and released approximately 20,000 barrels of heavy crude oil, of which 8,000 barrels entered Talmadge Creek, a tributary to the Kalamazoo River, near Marshall, Michigan (NTSB 2012a). The released oil was a combination of Western Canadian Select (23%) and CLB (77%) diluted bitumens (Enbridge 2013a). The release occurred on the floodplain of Talmadge Creek, where wetlands are abundant (USFWS et al. 2015a). The Kalamazoo River is a meandering, low gradient river with diverse channel and floodplain features, extensive floodplain forests and wetlands, off-channel water bodies, and impoundments (Dollhopf et al. 2014). Oil was transported downstream in the Kalamazoo River, which was in flood state at the time of the release, to Morrow Lake (an impoundment in the river 36.5 miles downstream).*

Oil was deposited on river shoreline, riparian, and depositional areas (backwaters, side channels, oxbows) and along the shores of Morrow Lake (USFWS et al. 2015a), affecting 80 miles of shoreline and adjacent lands. There was associated disturbance from oil removal efforts (removal of riparian vegetation and sediment, access road construction; Dollhopf and Durno 2011). Some of the oil mixed with soil and organic matter while moving overland and also with suspended sediment in the water column, resulting in formation of OPAs that submerged in some locations, especially in depositional areas, and periodically released oil globules and sheen as late as 2014 (Fitzpatrick et al. 2015). Formation of OPAs was likely promoted by the flood conditions. Based on measurements of suspended sediment at the Marshall stream gage after the release, it can be inferred that the river had relatively low suspended sediment concentrations at the time of the release, but that the floodwaters likely increased the turbulence and the presence of suspended particulate matter (Fitzpatrick et al. 2015). In addition, the high organic matter content of the suspended and bottom sediments (20 percent or more) due to the abundant wetlands along the Kalamazoo River contributed to OPA formation (Fitzpatrick et al. 2015).

About 90% of the oil released into the river was recovered in the first year. This included floating oil, stranded oil in the floodplains of Talmadge Creek and the Kalamazoo River, and submerged oil (Fitzpatrick et al. 2015). In 2011, additional activities to dislodge and disperse submerged oil resulted in a small amount of additional recovery. Submerged oil-particle aggregates continued to release oil from sediments in the Kalamazoo River and impoundment areas during 2011–2014, with surface sheens observed in impounded sections of the river (Fitzpatrick et al. 2015).

During fish and wildlife response operations conducted by the MI DNR in 2010 for some sections of Talmadge Creek and the Kalamazoo River, 42 dead fish were found, which was considered a negligible number for this time period (USFWS et al. 2015a). Abundance and diversity of fish in Talmadge Creek decreased in 2010 post-release, but had recovered during subsequent surveys. Results of surveys conducted in 2011, 2012, and 2013 suggested there were changes in species composition, perhaps related to changes in habitat following clean-up (unpublished data provided to the Trustees for review for the Draft Damage Assessment and Restoration Plan [DARP], final results pending). Preliminary results for the Kalamazoo River were less definitive than for Talmadge Creek, with some reductions in smallmouth bass (Micropterus dolomieu) in 2010, but with variable results across all sites and years (USFWS et al. 2015a).

Sublethal effects on exposed fish (condition, tissue histopathology, immunotoxicity, induction of CYP1A, and a necropsy-based assessment of

health) were evaluated by the USGS during an August 2010 fish health assessment two months post-release (Papoulias et al. 2014). There were statistically significant differences for fish captured in affected areas of the Kalamazoo River compared to reference areas, indicating that fish in affected reaches up to 27 miles downstream of the release exhibited effects consistent with crude oil exposure. Follow-up studies on this topic were not completed.

Following the release, MI DCH put cautionary fish consumption advisories in place. Their analysis of fish collected in 2010 and 2011 determined that PAH concentrations in fish tissue were below levels that would necessitate fisher closure. However, consumption guidelines remained in place due to levels of mercury and polychlorinated biphenyls (PCBs) found in the fish tissue that were not related to the crude oil release (MI DCH 2014b).

Wabamun Lake, Alberta: *On August 3, 2005, a Canadian National Railway Company train derailed and released approximately 4,500 barrels of Heavy Fuel Oil 7013 (a Bunker C type fuel oil with a high viscosity and an initial density of about 0.99 at lake temperature) and 550 barrels of pole treating oil. About 20% of the released heavy fuel oil (940 barrels) travelled overland and entered Wabamun Lake; no appreciable volume of pole treating oil entered the lake (Hollebone et al. 2011). In the lake, the oil floated and spread rapidly over the surface; after a few days, strong winds and wave action dispersed the oil toward the north, east, and south shorelines, where it became entrained in macrophyte beds (Anderson 2006). While traveling overland, the oil mixed with soil and organic matter, and in the lake, aggregates, including tar balls, larger tar "logs," submerged sheets, large lumps, tar balls that sometimes reformed into oil slicks, and a "slurry" composed of finely divided organic matter and small oil droplets, formed quickly (Fingas et al. 2006, Hollebone et al. 2011). The aggregates showed a variety of behaviors, including submergence, neutral buoyancy, and resurfacing (Fingas et al. 2006), with extensive tar mat formation in some nearshore areas. Sinking oil settled in near-shore vegetated habitats where six out of eight native fish species in Wabanum Lake spawn including lake whitefish (Coregonus clupeaformis) and northern pike (Esox lucius) (Hodson 2008; DeBruyn et al. 2007). Behavior of oil in the lake (sinking, rapid formation of tar balls, slow degradation due to high proportions of high molecular weight components such as resins) and its toxicity and persistence (due to high PAH levels but low BTEX levels) were related to characteristics of the heavy fuel oil that would not be comparable to crude oils and diluted bitumen. Ultimately, clean-up activities recovered more than 95% of the oil.*

About 100 dead fish were observed in macrophyte beds following the release, including species of minnows and adult northern pike, lake whitefish, and burbot (Lota lota) (Birtwell 2008). Although these mortalities were attributed to natural

causes, and the Alberta Sustainable Resource Development ministry concluded the release had left no short term adverse effects on fish (Transportation Safety Board of Canada 2007), Birtwell (2008) argued that the 100 fish died as a result of the release, although toxicological tests to support this assertion were not conducted.

The shoreline macrophyte beds where oil accumulated are considered important habitat for several species of fish, particularly juvenile stages (Birtwell 2008). Direct fish mortality also occurred when vegetation was removed during clean-up activities. Fish habitat was disturbed or destroyed as a direct result of oiling in the macrophyte beds and also during clean-up activities (related to trampling, low-pressure flushing, vacuuming, and dragging over substrates).

In situ studies were conducted to evaluate potential effects of oil on spawning shoals of lake whitefish and northern pike. In November 2005, four months post-release, whitefish embryos were held in egg containers installed on affected and reference area shoals; survival and prevalence of deformities typical of oil exposure were measured (Debruyn et al. 2007). In general, fish from Wabamun Lake showed high baseline rates of deformities in both reference and affected areas, reflecting historical exposure to elevated concentrations of PAHs, related to public boating on the lake and presence of coal mines and coal fired power plants in the vicinity. However, at the conclusion of the study in April 2006, hatched survivors at the affected shoals had higher rates of severe skeletal deformities (statistically significant) compared to those from the reference area. PAH concentrations measured in passive membrane samplers adjacent to the egg containers were correlated with the rates of moderate to severe deformities (Debruyn et al. 2007). Similar exposure experiments with northern pike larvae resulted in few deformities, none of which could be attributed to PAH exposure, suggesting lower uptake of or sensitivity to PAHs in this species (DeBruyen et al. 2009).

Concerns over human consumption of fish containing hydrocarbons triggered fish tissue sampling and PAH analysis for one year post-release (Sandhu et al. 2008). Although PAH levels in tissue were elevated initially, it was suggested that these concentrations posed little or no risk of adverse effects to people consuming fish six months post-release (Sandhu et al. 2008). Ten years later, the Alberta Department of Fish and Wildlife reported that walleye (Sander vitreus) introduced into Wabamun Lake had become increasingly successful and that there were healthy populations of pike and perch in the lake (Hudson 2015).

Pine River, British Columbia: *On August 1, 2000, a Pembina Pipeline Corporation pipeline ruptured and released approximately 6,200 barrels of sour light crude oil, of which approximately 2,800 barrels entered the Pine River in British Columbia*

(BC MOE 2000a). The Pine River is a low gradient river, but fast flowing, and oil was dispersed up to 50 miles downstream. The fast flowing water allowed rapid dispersion of acutely toxic fractions of the oil. Oil was stranded and settled in depositional areas along the banks, in back eddies and other slow-flowing areas, and on organic debris and logjams (AMEC 2001 in Lee et al. 2015). Heavy rainfall later in August and September mobilized stranded oil, oil-contaminated debris, and sediments downstream; and high water levels scoured some of the more heavily oiled depositional areas. About 91% of the oil was recovered from the river or accounted for through volatilization over about two months (Alpine Environmental and EBA Engineering 2001 in Lee et al 2015). Some of the emergency response activities (e.g., removal of logjams and woody debris, altering of backchannels, bank armoring, and presence of heavy machinery in the river) also resulted in habitat damage (Summers 2004 in Bustard and Miles 2011). In August 1994, a small release of diesel fuel (151 barrels) and gasoline (187 barrels) had occurred in this area of the Pine River (Goldberg 2011).

Petroleum hydrocarbons were detected chemically, and seen and smelled in river water up to 50 miles downstream of the release, with sheen visible in back eddies and other calm areas along shorelines. Hydrocarbons accumulated in sediments and on organic debris (e.g., branches, leaves, and algae) present along the shoreline, in front of logjams, and attached to sweeper logs) in these calm areas (AMEC 2001 in Lee et al. 2015). Hydrocarbon concentrations in water decreased rapidly to below British Columbia water quality guidelines due to evaporation, dissolving in water, and natural dispersion (Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015), all of which are characteristic of light crude oil. Oil was observed to persist in some bottom substrates five years after the release (Goldberg 2006, as cited in Bustard and Miles 2011). Analysis of semi-permeable membrane devices deployed in the Pine River indicated that two years after the release, hydrocarbons were present in water, implying that hydrocarbons from the release were leaching out of sediment into the water column (DePennart et al. 2004), although additional sources (e.g., road runoff, PAHs from coal deposits in the watershed) were also acknowledged.

Although not measured directly, the initial release of crude oil into the Pine River was estimated to have resulted in hydrocarbon concentrations (water-soluble fraction likely greater than 3 mg/L) high enough to kill fish within hours of the release (Birtwell 2003 in Lee et al. 2015). Over the first five days post-release, 1,637 dead fish, mostly larger, more visible individuals, were found up to 30 miles downstream (Baccante 2000 in Birtwell 2008). Most were bottom-feeding species, consisting of 64% mountain whitefish (Prosopium williamsoni), 16% slimy sculpins (Cottus cognatus), and 5% burbot. The remainder were surface feeders, consisting of bull trout (Salvelinus confluentus), rainbow trout (Oncorhynchus mykiss), and Arctic grayling (Thymallus arcticus) (Baccante 2000 in Birtwell 2008).

Accurate direct counts of fish mortalities were difficult to make, given the challenges accessing areas of the river before fish decayed or were consumed by scavengers (Hodson et al. 2011). As a result, mortality was estimated using previous estimates of fish density and assumptions of mortality ranges. The mortality estimates ranged from 15,000 to 20,100 fish over a 19 mile section of river, and from 25,000 to 250,000 over a 30 mile stretch (Goldberg 2011). Eleven days after the release, British Columbia Ministry of Environment, Lands and Parks staff biologists reported fish returning to even the most affected areas of the river from adjacent tributaries (BC MOE 2000b).

Snorkel surveys conducted prior to the release (1993, before a small release of gasoline and diesel fuel in 1994) and post-release (2000, 2005, 2006, and 2007) were used to evaluate oil effects on sport fish abundance, species richness, and recovery of the community (Goldberg 2011). Survey results from 2000 demonstrated recruitment was occurring in the first two months post-release, but with lower fish abundance than in 1993 and with suckers absent. For sections of the river surveyed in 2005, 2006, and 2007, sport fish species composition and abundance appeared to have recovered to 1993 levels. Goldberg (2011) noted that with data available for only one survey pre-release, it was not possible to evaluate the inter-annual range of abundance but concluded: "results appear encouraging in that they are, at a minimum, similar to those observed in 1993, suggesting that the fisheries resources are exhibiting on-going recovery since the 2000 pipeline rupture and 1994 spill."

There were insufficient studies to establish the nature and extent of sublethal effects on reproduction and recruitment of fish. The concentrations of PAH compounds in fish stomach contents and bile confirmed PAH exposure via the food chain (Alpine Environmental and EBA Engineering 2001 in Lee et al. 2015). Concerns were also expressed about decreased benthic macroinvertebrate abundance, which provide food, especially for young fish during the first autumn post-release, which is a critical period leading up to overwintering (Birtwell 2008).

Cayuga Inlet, New York: *On November 3, 1997, a train derailed and released 167 barrels of diesel fuel into a first order reach of the Cayuga Inlet, which flows into Cayuga Lake, near West Danby, New York. Diesel fuel slicks escaped the containment booms and were observed within 24 hours on the surface of Cayuga Lake, 9.6 miles downstream (Lytle and Peckarsky 2001). One day post-release, a fish kill of rainbow trout (Oncorhyncus mykiss), white sucker (Catostomus commersoni), blacknose dace (Rhinichthys atratulus) and darters (Etheostoma spp.) was reported, estimated at 92% of total fish abundance in the inlet (Krueger in Lytle and Pekarsky 2001). Cayuga Inlet provides spawning habitat for rainbow trout (spring spawners) and brown trout (Salmo trutta) and salmon (Salmo salar), fall spawners that were beginning their autumn run when the*

release occurred. No information about effects on spawning salmonids was provided.

Asher Creek, Missouri: *In August 1979, a pipeline burst, releasing approximately 9,500 barrels of an unspecified type of crude oil into Asher Creek, in southwest Missouri, during low flow conditions (Crunkilton and Duchrow 1990). Dissolved oxygen, pH, and conductivity levels in water were not changed by the release (no information about hydrocarbons in water was published) and oil that entered substrates in riffle areas due to mixing was observed for over a year post-release (Crunkilton and Duchrow 1990). The creek originates in springs 0.4 miles upstream of the release site; low water volumes in these headwaters, particularly during summer, provided limited dilution of the oil, which would have increased the residence time of soluble oil components in sediment (Crunkilton and Duchrow 1990). Areas located downstream from surface skimming siphon dams were less severely affected and recovered more rapidly than areas closer to the release, where the substrate became inundated with oil (Crunkilton and Duchrow 1990). Following the release, an estimated 42,000 fish were found dead along a 5 mile section of the creek (Crunkilton and Duchrow 1990).*

7.1.3.3.3 Expected Effects of Released Oils

The effects of released oil on fish depend on characteristics of the oil and environmental conditions at the time of the release. Oil characteristics that may determine the acute effects of oil on fish include tendency to disperse in water, and concentrations of relatively water soluble components in the crude oil, particularly BTEX and low molecular weight PAHs. Chronic effects of crude oil in streams, rivers and lakes would depend more upon residual levels of total PAH (TPAH) in sediment and interstitial waters. Environmental characteristics include water flows, fish species sensitivity, and geomorphic factors that could lead to crude oil deposition in sediment. Effects associated with each characteristic are described in Table 7-33 and Table 7-34.

The potential for oil releases to harm fishery resources is well established, and documented in the case studies. Effects may be acute (e.g., fish kills) or chronic, leading to reduced population density and species richness, and associated potential effects on fish consumption due to increased PAH concentrations in tissue. Habitat disturbance during cleanup activities are another source of stress to fish populations.

Table 7-33 Effects of Oil on Fish by Oil Characteristic

BIOLOGICAL RECEPTOR: Fish and Fish Habitat				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Other Comments**
Viscosity	Low viscosity oils are readily dispersed as small droplets in the water column, when water is turbulent. Partitioning of hydrocarbons from small droplets into water as dissolved hydrocarbon is rapid, leading to high potential for acute toxicity to fish.	The viscosity of medium crude oils is relatively low, so these oils are also readily entrained into the water column, facilitating the dissolution of relatively water soluble components of the crude oil.	Heavy crude oils tend to have high viscosity, making them difficult to entrain into the water column, except under very strong mixing conditions (e.g., waterfalls and rapids). The viscosity of diluted bitumen is initially depressed by the added diluent, but as this weathers away, the viscosity of the weathered crude oil increases rapidly.	The viscosity of any crude oil will increase at low temperature. Viscosity also increases as crude oils weather.
Buoyancy	Light crude oils have low density, and are highly buoyant. Oil droplets entrained into the water column will therefore tend to re-surface rapidly, rejoining a surface slick, when water turbulence decreases.	Medium crude oils have intermediate density, and will typically not weather to a density equal to or greater than 1.0.	Heavy crude oils also have relatively high density. The density of fresh diluted bitumen is required by pipeline tariffs to be less than 0.94, but will increase with weathering after being released to the environment. Diluted bitumens float on water when fresh, and are likely to adhere to shorelines long before they would weather sufficiently to become neutrally buoyant in water (i.e., reach a density of 1.0). Some refined heavy oils (e.g., heavy fuel oils) may have initial density values very close to 1.0.	Density of crude oils will increase at low temperature, and also increases with weathering. Any type of crude oil may also interact with sediment particles (ranging in size from clays to gravels) resulting in an oil-mineral aggregate that has a density greater than 1.0. This can lead to crude oil becoming deposited to sediment.

Table 7-33 Effects of Oil on Fish by Oil Characteristic

BIOLOGICAL RECEPTOR: Fish and Fish Habitat				
Oil Characteristic	**Light Crude Oil**	**Medium Crude Oil**	**Heavy Crude Oil**	**Other Comments**
Chemistry	Low molecular weight aromatic hydrocarbon compounds (e.g., BTEX and some PAHs such as naphthalene) are usually the biggest contributors to acute toxicity. These compounds are often abundant in light crude oils. Light crude oils typically contain only small amounts of highly insoluble hydrocarbon components such as resins and asphaltenes.	Medium crude oils often contain moderate levels of BTEX and other relatively water soluble hydrocarbons, leading to a moderate potential to cause acute toxicity. Synthetic crude oils originating from the oil sands of Alberta may contain only small amounts of BTEX, as well as being depleted in resins and asphaltenes as a result of processing before shipment.	Heavy crude oils and bitumens are often highly weathered, containing only small amounts of BTEX, while containing larger amounts of polar compounds (resins) and asphaltenes. However, depending upon the nature and amount of the diluent added, diluted bitumens may contain levels of BTEX that are similar to light crude oils.	Acute toxicity of crude oils generally reflects the amount of low molecular weight hydrocarbons present (e.g., BTEX). Chronic toxicity reflects the amount of TPAH present. Most crude oils contain approximately 1% TPAH. Some refined oils such as heavy fuel oils contain larger amounts of TPAH (5-6% by weight).
Persistence	Light crude oils generally weather and biodegrade rapidly, and have low persistence in the environment, except when they become deposited in anaerobic environments.	Medium crude oils also weather and biodegrade quite readily.	Heavy crude oils can be resistant to weathering. Bitumen from the Alberta oil sands represents a type of crude oil that has undergone extensive natural weathering *in situ,* before it was extracted. Therefore, diluted bitumens tend to resist further weathering and biodegradation once the diluent component has been removed. This residual crude oil can therefore become a chronic low-level source of PAHs to the aquatic environment.	Any type of crude oil can be persistent if it is deposited in an environment where oxygen is not available. However, heavy crude oils and diluted bitumens contain more resins and asphaltenes than light and medium crude oils, and as a consequence, heavy crude oils tend to biodegrade more slowly, and have higher potential to become a persistent source of chronic, low-level hydrocarbon release to the aquatic environment.

Table 7-34 Effects of Oil on Fish by Environmental Characteristic

BIOLOGICAL RECEPTOR: Fish and Fish Habitat				
Environment Characteristic	**Low**	**Medium**	**High**	**Other Comments**
Water flow characteristics (turbulence)	Crude oils will float on still water, resulting in most of the low molecular weight hydrocarbons being lost to the atmosphere, rather than becoming dissolved in the water. Conditions leading to acute toxicity to fish are unlikely to occur.	Moderately flowing water may result in the entrainment of crude oils that have low viscosity (i.e., light and medium crude oils) into the water as small droplets. This creates conditions where low molecular weight hydrocarbons can more readily dissolve into the water column, potentially leading to acute toxicity to fish. More viscous oils may resist the process of entrainment, and remain floating on the surface of the water.	Highly turbulent flow conditions, such as rapids or waterfalls, will result in the entrainment of more viscous crude oils into the water column, creating conditions where these oil types are more likely to result in acute toxicity to fish.	Within a particular watercourse, flow rates and turbulence levels vary seasonally and in response to storm events. The highest seasonal flow rates in most systems occur during spring freshet.
Volume of water flow	Low water flow rates provide little dilution potential for hydrocarbons that dissolve into the water. Therefore, episodes of acute toxicity are more likely to occur in small streams, or during seasonal periods of low water flow rate (e.g., late summer and winter).		Large rivers have high water flow rates, which will reduce the potential for episodes of acute toxicity in the event of a crude oil release. High water flow rates also occur during the spring freshet.	Information from the case studies indicates that large-scale fish kills are more likely to be observed in streams and smaller rivers than in lakes and large rivers.

Table 7-34 Effects of Oil on Fish by Environmental Characteristic

BIOLOGICAL RECEPTOR: Fish and Fish Habitat				
Environment Characteristic	**Low**	**Medium**	**High**	**Other Comments**
Fish species and life-stage sensitivity	All else being equal, large-bodied fish are typically less sensitive to acute hydrocarbon exposures than small bodied fish. In addition, warm-water fish species are less sensitive than cold-water fish species.		Highly sensitive species are typically represented by small-bodied or juvenile fish. Cold-water fish species such as salmonids (trout and whitefish) are typically more sensitive than warm-water fish species (cyprinids, catfishes and sunfishes). Egg and embryo life stages are typically more sensitive than juvenile and adult life stages.	Toxicity assessment in risk assessment is typically based upon "sensitive" receptor species and life stages, on the assumption that if these receptors are protected, then all other similar receptors will also be protected.

The extent of fish mortality after a release is influenced by the type of oil (e.g., light crude oils will become dispersed and entrained into the water column as small droplets more readily than heavy crude oils, and may contain higher concentrations of low molecular weight hydrocarbons such as BTEX), the size of the receiving water body (a proxy for how much and how quickly dissolved hydrocarbons will become diluted or dispersed to non-lethal concentrations), and the presence of additional environmental stressors that could modify toxicity (Lee et al. 2015).

Fish can be exposed to acutely toxic hydrocarbon concentrations immediately following a release due to exposure to low molecular weight hydrocarbons. These fractions weather (through volatilization and biodegradation) and become diluted over 24 to 48 hours, so fish kills are often short-term and localized, unless there is an ongoing source of oil entering a system that provides little dilution. The low molecular weight hydrocarbons responsible for most of the acutely lethal effects are BTEX, low molecular weight PAHs like naphthalene, and short-chain alkanes (NRC 2005), which produce a narcotic effect on fish.

Bioaccumulation of PAHs in fish tissue can also lead to phototoxicity, which occurs when certain PAH compounds bioaccumulated in the tissues of receptor organisms are exposed to sufficient ultraviolet (UV) light to stimulate the formation of free radicals (Sellin Jeffries et al. 2013). The free radicals so formed can rapidly result in cell and tissue death, leading to the death of the organism. This is most likely to occur near the water surface, because UV light is attenuated with increasing depth in the water column by dissolved organic matter and suspended sediments. It is also more likely to occur during the summer months because day length and light intensity are greater, and light is not reflected or blocked by snow and ice, and in organisms such as juvenile fish that are small, weakly pigmented, and occur close to the water surface during daytime hours.

There are also sublethal effects on fish related to exposure to PAHs (including alkylated PAHs), avoidance of oiled areas, changes in feeding behaviour, developmental effects of PAH exposure on fish eggs and embryos, and delayed effects of such developmental effects such as reduced cardiac fitness in fish that survive embryonic exposure to crude oil (Lee et al. 2015, Incardona et al. 2015). Sublethal effects can include immune dysfunction (e.g., reduced macrophage activities), increased incidence of liver lesions (e.g., P450 [CYP1A] enzymes activity [specific hydrocarbon receptor]; Hudson et al. 2008), and other histopathological endpoints (Higgins 2002). Sublethal effects may also include behavioral endpoints such as impaired swimming in early life stages (Lee et al. 2015). The alkylated PAHs comprise 80 to 95% of total PAHs in crude and refined oils (Wang et al. 2003). They are less soluble in water, and take longer to dissolve in water, than the low molecular weight compounds. Oil stranded on or in sediments will continue to release alkylated PAHs to the water over weeks or months, resulting in ongoing exposure of fish to elevated PAH concentrations. However, within two weeks post-release, hydrocarbon concentrations in the water usually decrease to levels below which chronic effects to fish or other aquatic life would be expected (Stantec et al. 2012, Enbridge 2015).

Most species of fish can metabolize and excrete hydrocarbons, so these compounds do not bioaccumulate in the food web. Fish can rapidly take up water soluble low molecular weight hydrocarbons and release (depurate) them from their bodies when the source is removed (Hodson 2008). However, sensitivity to oil varies considerably among species of fish, related to differences in physiology, eating habits, biology, reproductive, and habitat preferences.

Although there are general trends in the relationship between concentrations of toxic compounds in various types of oils and their toxicity to fish, considerable variability has been identified in laboratory tests and field observations (Lee et al. 2015). For example, acute toxicity tends to be greatest for light crude oils (due to the high proportion of low molecular weight hydrocarbons they contain). Chronic toxicity tends to be greater for some heavy oils (particularly heavy fuel oils due to the high proportions of alkylated PAHs they contain). However, many exceptions have been noted and no definitive relationship between toxicity and concentrations of toxic compounds has been identified (Lee et al. 2015). Other factors that influence toxicity include the proportions of other high molecular weight compounds (e.g., waxes, resins, asphaltenes) that may help to determine physical characteristics of the oil (e.g., density, viscosity) that affect the physical behavior of the oil, as well as the bioavailability of the various classes of hydrocarbon compounds within the bulk oil.

Diluted bitumens contain both diluent (which may weather and disperse quickly) and bitumen (which is low in low molecular weight compounds and tends to persist in the aquatic environment). Chronic toxicity of bitumen is expected to be similar to that of conventional crude oils, given similarity in content of high molecular weight alkylated PAHs (Lee et al. 2015).

Exposure to oil stranded in sediments and related effects on abundance of benthic macroinvertebrate prey can lead to chronic and sublethal effects on fish, including effects on reproduction, growth and survival, which result in overall reduced fish production in areas affected by the release (reviewed in Dupuis and Ucan-Marin 2015 and Lee et al. 2015).

Table 7-33 and Table 7-34 provide a summary of the expected environmental effects of oil releases to fish. Table 7-33 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-34 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

7.1.3.4 Aquatic Plants

7.1.3.4.1 Description

Fassett (1957) defined aquatic plants as those that may, under normal conditions, germinate and grow with at least their base in the water, and that are large enough to be seen with the naked eye. For practical purposes, this definition provides a focus on aquatic vascular plants, and excludes unicellular algae. Filamentous algae can form large submerged or floating mats, and some macroalgae (e.g., the stoneworts, *Chara* and *Nitella*) common in hard water systems have the appearance and form of aquatic plants, but do not produce flowers, floating, or emergent leaves. Mosses, non-vascular plants that are often found in wet places (although not necessarily submerged), will be considered to be part of wetland ecosystems (e.g., bogs), and addressed elsewhere.

Aquatic plants provide many important ecosystem services.

- Energy Flow—aquatic plants are primary producers in the aquatic food chain, converting chemical nutrients in the water and soil into plant matter (Carpenter and Lodge 1986; Dodson et al. 2000).
- Food for Waterfowl and Fish—many submerged plants produce seeds and tubers that are eaten by waterfowl and other wildlife species. Insect larvae, snails, and crustaceans also thrive in plant beds, and these in turn serve as important foods for many wildlife and fish species (Valley et al 2004; MN DNR 2010a).
- Food and Medicinal Properties for Humans—many aquatic plants have been used traditionally for food and medicinal properties by humans. Wild rice (*Zizania aquatic*) is a grass, native to North America, which is an important traditional food to native Americans, and has become commercially important as well.
- Spawning Areas and Shelter for Fish—many fish species spawn in areas where aquatic plants grow or in marshy and flooded areas in early spring. During other times of the year, aquatic plants provide rearing habitat for juvenile fish, and cover for fish of all ages (Valley et al 2004; MN DNR 2010a).
- Improve Water Clarity and Quality—aquatic plants may help to maintain water clarity, and reduce erosion, by trapping suspended sediments and limiting the re-suspension of bottom sediments and some can absorb and break down polluting chemicals (Wolverton et al. 1975).
- Aesthetic Value—many aquatic plants such as reeds, cattails, water lilies, arrowhead, and pickerelweed have flowers or leaves that can be visually appealing in aquatic landscapes (MN DNR 2016a).
- Economic Value—as a natural and in some cases managed component of many water bodies, aquatic plants support the economic value of all aquatic related activities, including but not limited to camping, wildlife observation, hunting and fishing (MN DNR 2016a).

Freshwater aquatic plants are generally limited to shallow water or wetland habitats of lake and river systems.

7.1.3.4.1.1 Non-Vascular Plants

Algae have no true roots, stems or leaves and range in size from tiny, one-celled organisms to large, multi-celled plant-like organisms. Stoneworts (e.g., *Nitella* spp. and *Chara* spp.) are

examples of algae that look much like vascular plants and may grow in similar conditions. Other algae bearing less resemblance to vascular plants are also common. Mats of filamentous algae (e.g. *Spirogyra* spp. and *Cladophora* spp.) may cover the bottom in dense blankets, form "clouds", or rise to the surface under certain conditions. Planktonic algae (phytoplankton), which consist of free-floating microscopic plants, grow throughout the well-lit surface waters of lakes, ponds, and rivers.

Aquatic moss beds occur primarily in the riverine system and in permanently flooded and intermittently exposed parts of some lacustrine systems. Mosses (e.g., *Sphagnum* spp.) are also a major structural component of true bog ecosystems. Aquatic mosses are less common than algae or vascular plants but can often dominate vegetation in lakes (Sand-Jensen et al. 1999). The dominant types found in Minnesota include genera such as *Fontinalis, Amblystegium, Fissidens*, and *Drepanocladus* (Moyle 1937).

7.1.3.4.1.2 Vascular Plants

Aquatic plants may occur at any depth within the photic zone, although light attenuation in most natural water bodies is such that the productivity of the aquatic plant community is greatest in shallow water. Most aquatic plants are angiosperms, meaning that they produce flowers that must be pollinated, which requires that they be able to produce flowers at or above the water surface. Aquatic plants that are rooted in sediments may have both submerged and floating leaves, and the form of such leaves may differ. Being supported by water, aquatic plants are often delicate or fragile, and they often occur in sheltered areas where there is little water movement. In flowing water environments, their form may be streamlined or flattened in response to water movement (Wetzel 1975). Typical submerged genera include pondweeds (*Potamogeton* spp.*),* tape grass (*Vallisneria americana)*, water milfoil (*Myriophyllum* spp.), waterweed (*Elodea canadensis*), pipeworts (*Eriocaulon* spp.), and quillworts (*Isoetes* spp.). Common floating-leaved taxa include water lilies (*Nymphaea, Nuphar*), and water shield (*Brasenia schreberi*). Dimorphic species with distinctive submerged, floating or emergent leaves include lotus (*Nelumbo lutea*), duck potato (*Sagittaria* spp.) and floating-leaf pondweed (*Potamogeton natans*).

Not all vascular plants in aquatic bed communities are necessarily rooted. Aquatic plant species that may form free-floating masses include coontail (*Ceratophyllum demersum*), bladderworts (*Utricularia* spp.), and ivy-leaved duckweed (*Lemna trisulca*). Some non-rooted plants float and are found in areas with little or no current. Examples include duckweeds (*Lemna* spp.) and watermeal (*Wolffia columbiana*).

Emergent vascular plants are those that are rooted in sediment below the water level (sometimes at considerable depth), and which project leaves into the air above the water. Examples include cattails (*Typha* spp.), rushes (e.g., *Juncus* spp.), grasses and reeds (including but not limited to wild rice, *Zizania aquatica* and reed grass, *Phragmites* sp.), sedges (e.g., *Carex* spp., *Scirpus* spp.) and others.

7.1.3.4.2 Observed Effects of Oil on Aquatic Plants

Published reports specific to the effects of released oil on freshwater aquatic plants that can grow in temperate environments absent associated spill response activities are few in number. However, the general effects of oil directly on plants and indirectly through their growing media have been reported from various sources including laboratory and field experiments, experimental oil spills, and case studies of accidental oil spills (although such studies include the associated effects of response activities). Available data sources include observed effects of oil releases in marine, freshwater, terrestrial, arctic, and temperate environments, upland and wetland vegetation, and controlled and uncontrolled settings. This body of published studies provides a framework for inferring the likely effects to aquatic plants that may result from spills of oil into different aquatic systems.

Oil that directly contacts aquatic plants in large quantity can impede photosynthesis and gas exchange processes by blocking sunlight, clogging stomata, and raising internal temperature (Baker 1970; Emerson 1983; Michel and Rutherford 2013; Pezeshki et al. 2000). In addition, toxic compounds in the oil may burn sensitive plant tissues. When these conditions are of sufficient extent and duration, the direct toxicity or indirect loss of metabolic processes may cause death of the tissues (e.g., leaves) and potentially death of the whole plant. Such "burning" effects are more marked with light oils (or gasoline) than with heavier oils while "smothering" effects are more prominent with spills of heavy oils which are thicker and relatively more persistent in the environment.

Oil which contacts plants but does not kill by smothering can cause damage through biophysical and biochemical means (Currier 1951; Dallyn 1953; Baker 1970; Emerson 1983; Shales et al. 1989; Pezeshki et al. 1998). When oil adheres to and spreads over the plant surface, toxic compounds from the oil may enter the plant through stomata, by damaging and passing through the cuticle, or by entering plant roots through the soil. The rate and extent of penetration is affected by the number of stomata, resistance of the plant cuticle or root epidermis, and the viscosity of the oil. Plants with few stomata and thicker cuticles tend to be more resistant to oil penetration. Once in the plant, petroleum compounds move through intercellular spaces then through cell walls and plasma membranes, reducing transpiration, photosynthesis, movement of materials from leaves to other tissues, and altering respiration (Currier 1951; Dallyn 1953; Baker 1970; Emerson 1983). Internal physical damage can result when cell membranes are damaged by penetration of hydrocarbon molecules, leading to leakage of cell contents (Baker 1970; Shales et al. 1989). Biochemical effects may result from inhibition of enzyme reactions by toxic components of the oil, especially PAHs and water soluble components of the oil such as the BTEX compounds which can affect submerged tissues (Baker 1970; Shales et al. 1989).

Aquatic plants may also be affected by oil indirectly through water and sediments. In addition, the presence of degradable organic matter in the oil can lead to an increase in oxygen demand which, if there is no additional aeration, may lead to oxygen depletion and anoxic

conditions associated metabolic stress on aquatic organisms including plants (Shales et al. 1989; Kennedy et al. 1992; Summers et al. 2000; Edema et al. 2008; Edema 2012).

Potential damage to aquatic plants resulting from the incorporation of oil into sediment depends on the oil type and concentration. In general, light hydrocarbons have high acute toxicity to plants but, because of their rapid evaporation and/or dissolution, generally do not reach submerged sediments in concentrations which yield acute effects. Heavier hydrocarbon fractions have less acute toxicity to plants but can submerge and affect sediments due to their greater persistence in releasing toxic compounds (Shales et al. 1989; Overstreet and Galt 1995). Low concentrations of oil incorporated into soil and sediments have also, in some limited cases, been shown to stimulate growth of individual plant species perhaps by acting as a nutrient source or stimulator of nitrogen fixing organisms (Baker 1970; Snow and Rosenberg 1975a, 1975b; Burk 1977; Lin and Mendelssohn 1996; Mollard et al. 2012).

The type of waterbody can also affect the extent and duration of oil release effects to aquatic plants as a consequence of variations in dilution factors, flushing (or lack thereof), residence time, and aquatic plant community composition. Ponds and small lakes with standing water for example will have longer residence times, lower dilution factors, less physical disturbance, and greater magnitude and duration of impacts than large lakes or rivers characterized by large water volumes, wave action, and/or flushing (Baca et al. 1983, 1985).

Through its effects on individual plants, oil can alter plant communities by selectively killing or suppressing some plant species, allowing more tolerant species to colonize affected areas and become more abundant. Oil can also alter seed production, germination, and growth rates leading to further changes in plant community composition over time as a consequence of modified reproduction abilities (McCown and Deneke 1972; Burk 1977; Leck and Simpson 1992; Nicolotti and Egli 1998; Pezeshki et al. 1998; Pezeshki et al. 2000; Adam and Duncan 2002).

Currier and Peoples (1954) completed a laboratory study regarding the toxicity of hydrocarbons (n-hexane, hexene-1, cyclohexane, cyclohexene, and benzene) on various plants including the aquatic species elodea (*Anacharis canadensis)*. With respect to the elodea, saturated solutions of all the hydrocarbons except hexane killed quickly, at least within one hour. The hexane treated shoots showed no significant injury after 20 hours of exposure to the solution. Stepwise following trials led the researchers to conclude that: "On a per cent saturation basis, the increasing toxicity series is hexane, hexene, cyclohexane, cyclohexene, benzene. However, on a concentration basis the order is just the reverse."

Snow and Rosenberg (1975a, 1975b) studied the effects of experimental oil releases on the physical, chemica1, and biotic parameters of two sub-arctic lakes. Following the studies, they observed that:

> [T]he effects of crude oil on such lakes occur in three phases. The first is a period of acute toxicity which is of short duration (~ 2 days) and overlaps with a physically deleterious phase extending to several weeks. These effects may then

> be replaced by a chronic eutrophication, i.e., acceleration in rate of nutrient supply. The relative lengths and severity of each phase will be dependent upon such factors as volume of oil, type of oil, and climate.
>
> With respect to plant growth, periphytic filamentous blue-green algae were observed to have increased following the experimental oil spill, possibly in response to the addition of crude oil to the system as a nutrient source or stimulator of nitrogen-fixing organisms.

Hellebust et al. (1975) studied an experimental release of Norman Wells crude oil into Hanna lake near Norman Wells, NWT, Canada in order to evaluate the effects of crude oil on phytoplankton, periphyton, and attached macrophytes in terms of population composition, seasonal succession, and biomass. According to the researchers:

> The presence of crude oil had no significant effects on the total phytoplankton population, nor the seasonal succession of 20 common individual species except that some growth stimulation occurred in two blue-green algae, *Oscillatoria angustissima* and *O. tenuis.* Growth inhibition of the green alga *Ankistrodesmus braunii* was most noticeable at light intensities above and below those optimal for rapid growth. These findings show that the effects of an accidental oil spill on phytoplankton may be most serious if it occurs early or late in the growth season when temperature and light conditions are suboptimal for growth.
>
> In contrast to these minor effects of crude oil on phytoplankton abundance and species composition, algae growing on periphyton traps (i.e. species which normally grow on suspended particles or on the lake bottom) were strongly inhibited by the presence of oil. A probable reason for the inhibition of periphyton growth is that these algae, in contrast to the phytoplankton, were trapped on a solid substratum that also trapped oil components. The phytoplankton cells, which are free floating or swimming, were only exposed to dissolved oil components, which did not appear to be present in sufficient concentrations, possibly due to evaporation from the surface and microbial degradation, to cause significant adverse effects.
>
> Surface contact by crude oil of sedge, horsetail, and moss populations proved to be very damaging in terms of chlorophyll loss and extensive killing of the affected shoots. However, plant parts below the water level appeared to survive well, and this allowed considerable recovery of the plants by the next growing season.

Snow and Scott (1975) studied the effect and fate of Pembina and Norman Wells and crude oils respectively on Lakes 4C and 8 near Norman Wells, NWT, Canada. The researchers partitioned the lakes using plastic sheeting then introduced the crude oil to the center of one partition in each lake at a concentration of approximately 600 L/ha. With respect to aquatic plants, Snow and Scott found:

> The development of blue-green algae on experimental substrates in the areas of the lakes treated with crude oil was most striking. Coccoid blue-green algae were mixed with a dense mat of several morphologically different kinds of filamentous algae. Achlorophyllous filaments interwoven with the algae suggested that heterotrophic fungal filaments were present, although no fruiting bodies were observed. Blue-green algae were present in the control samples, though far less abundant. It is important to note that the samplers were at no time actually in contact with the oil in either lake; therefore, whatever the nature of the growth stimulant, it was present in the water itself. These data indicate that the presence of crude oil in a lake has a potentially eutrophying effect. The only dissolved nutrient measured which showed any significant change in the water of the oil spill section of each lake when compared to levels in the control areas following the spills was total dissolved nitrogen (TDN). … An increase in TDN in the oil spill sections of the lakes could occur through two main processes: firstly, by the dissolving of nitrogen contained in the oil itself, either by physical solution or via the intermediary of microorganisms, phytoplankton, or fungi; and secondly, from increased nitrogen fixation by indigenous oil stimulated lake biota.

Burk (1977) completed a four year study of vegetation following the release of approximately 1,000 gallons of fuel oil into a freshwater marsh within the Arcadia Wildlife Sanctuary near Northhampton, Massachusetts. At the end of the study, Burk reported that:

> Total plant cover, total number of species, mean number of species per quadrat and the Shannon-Wiener function progressively reduced in both high and mid-marsh zones for two years after the spillage. Eighteen of the species found before the spill were not found the following season. Perennial species generally were less affected than annual species immediately following the oil spill. Some species (e.g. *Dulichium arundinaceum* and *Eleocharis palustris*), declined in abundance the second season following the spill. Marked changes in relative abundance of the dominant species of high and mid marsh zones occurred from year to year, with *Onoclea sensibilis* more prominent in high marsh at the end of the study period than prior to the spill and *Pontederia cordata* and *Nuphar variegatum* more prominent in different segments of mid-marsh. The vegetation of the high marsh and mid-marsh zones had substantially recovered by the third and fourth years. The low marsh vegetation was apparently unaffected immediately following the oil spillage but in succeeding years the species diversity declined and luxuriant growth of *Elodea nuttallii*, *Potamogeton crispus* and *P. epihydrus* occurred.

Bott and Rogenmuser (1978) studied the effects of No. 2 fuel oil, Nigerian crude oil, and used crankcase oil to attached algal communities from Oldman's Creek, a tributary to the Delaware River in Glouster County, New Jersey. Communities were exposed to water extracts of the oils for

five weeks during the summer and five weeks during the fall. After the treatments, the researchers reported that:

> In both experiments, No. 2 fuel oil extract reduced biomass visibly, which was confirmed by lower chlorophyll a concentrations than those of the control. Species changes also occurred; bluegreen algae became dominant and diatoms became less important in community composition. Exposure to used crankcase oil extract also depressed biomass but microscopic observations and pigment ratios indicated that changes in dominant algal types were less dramatic than those with No. 2 fuel oil exposure. Communities exposed to Nigerian crude extracts possessed biomass comparable to the control.

Kauss et al. (1973) completed a two-year field and laboratory study of the toxicity of crude oil (mixed sour blend and seven western Canadian crude oils) to phytoplankton. The site chosen for field experiments was a small, oligotrophic pond located about 500 ft from the eastern shore of Lake Huron, near Douglas Point, Ontario. At the end of the study, the researchers observed:

> Field experiments have shown that a varying response can be expected from freshwater phytoplankton exposed to crude oil pollution. The response varies from inhibition to stimulation of growth. This is probably due to the interaction of biological and physical variables. Examples of biological variables are: composition of the algal community, the relative susceptibility of individual species and the availability of oil-degrading organisms. Physical factors would include the nutrient status of the water body, conditions of wind, temperature, insolation, etc.
>
> Experiments with *Chlorella* and *Chlamydomonas* have shown that a large part of the toxicity of aqueous crude oil extracts is due to compounds which are rapidly lost by volatilization. These compounds result in decreased growth and bicarbonate uptake of algal cells. These results suggest that the major toxicity of oil spills would be of short duration (considering only the effects of water soluble components).
>
> Marked stimulation of *Chlorella* growth in some oil extracts occurred after loss of toxic compounds. This may represent bacterial contamination of the oil extracts or an actual ability to utilize certain hydrocarbons. Literature evidence suggests the latter. It is noteworthy that the extract which most stimulated growth was outboard motor oil, composed mainly of paraffinic hydrocarbons. It is unlikely that the response of *Chlorella* and *Chlamydomonas* to water soluble components of oils is representative of all freshwater algae. Indeed, *Chlorella* may well be an oil tolerant species.

Ren et al. (1994) investigated the photoinduced toxicity of crude oil constituents (fluoranthene, pyrene, and naphthalene) to duckweed (*Lemna gibba*) in a laboratory setting. The researchers

found that fluoranthene and pyrene had a linear rate of growth inhibition with a threshold of impact at 0.5 µg/ml and a 50% of inhibition growth at 16 µg/ml. Conversely, naphthalene appeared essentially nontoxic to the duckweed, perhaps as a consequence of its greater volatility. The researchers then tested whether light intensity would modify the toxicity results and found that ultraviolet light enhanced the harmful effects of the chemicals. Based on these findings, they reported that:

> It is apparent that light will significantly increase they phytotoxicity of fluoranthene, pyrene, and naphthalene. Toxicity was increased both when the plants and the chemicals were incubated together and when the chemicals were pretreated with light then incubated with plant tissue. The only region of the solar spectrum that effectively enhanced toxicity was the UV. The order of toxic strength of the PAHs was correlated with the rate of photomodification of the chemicals thought it is suggested that the chemicals have photosensitization activity in the intact form as well.

McGlynn and Livingson (1997) studied the distribution of PAHs between aquatic plants and sediments using water hyssop (*Bacopa caroliniana)* and threadleaf arrowhead (*Sagittaria stagnorum*). The researchers found that:

> The effects of sediment PAHs (greater than 10 ppm) on growth were significant for both species. New growth of *B. caroliniana* was inversely associated with sediment PAH concentrations. The biomass, old growth, and new growth of *S. stagnorum* were also inversely related to sediment PAH concentration.
>
> PAHs are assimilated by the root systems of aquatic macrophytes and that the assimilation exhibits saturation effects and the presence of PAHs in the shoots of these plants is the result of root to shoot transport. Rooted rosette monocots assimilated significantly fewer PAHs from the sediments than did rooted vittate dicots. These differences might be attributed to the lignified structure of the dicot root system, and it might be inferred that this lignification leads to a reduction of either PAH binding sites or PAH entry channels. The lake data also indicate that nonrooted plants behave quite differently from rooted plants in that their PAH loads do not seem to correlate with sediment PAH concentrations.
>
> Aquatic plants grow well at sediment PAH concentrations over 1,000 times as concentrated as the sediment PAH concentrations at which aquatic fauna exhibit toxicological effects. At low sediment PAH concentrations, aquatic plants commonly achieve PAH tissue concentrations that exceed the sediment PAH concentrations. At high sediment PAH concentrations; however, aquatic plants cease to bioaccumulate sediment PAHs.

Marwood et al. (2001) studied the effects of coal tar creosote-derived PAHs on the growth of duckweed (*Lemna gibba*) and water milfoil (*Myriophyllum spicatum*) by measuring photosynthetic activity. The researchers reported that:

> The PAHs caused a 50% growth reduction in duckweed and milfoil at concentrations of 7.2 mg/L and 2.6 mg/L respectively. The results of this study using the PAM fluorescence technique support previous studies of PAH effects on electron transport. The different responses of the various chlorophyll-*a* fluorescence parameters, when taken together, support a mechanism of PAH toxicity in which photosynthetic efficiency was impaired as a result of general damage to essential cellular components, possibly from reactive oxygen species. Based on the loss of leaf chlorophyll in plants exposed to low PAH concentrations, destruction of chlorophyll pigments is apparently an important mechanism of PAH toxicity in plants and may precede damage to the proteins of the photosynthetic apparatus.

Akapo et al. (2011) studied the morphological and anatomical effects of Forcados Mix Nigerian crude oil at concentrations ranging from 10 to 100 ppm on water lettuce (*Pistia stratiotes*). Following the study, the researchers made several observations:

> The growth of water lettuce (*Pistia stratiotes*) is retrogressively affected by crude oil, and the effect is dependent on the concentration of crude oil in environment. All physical growth parameters measured (such as number of leaves, root length, leaf area, and number of sprouts) declined during growth in the presence of crude oil. The decline was shown to be concentration dependent. The THC accumulated in the roots was greater than in the leaves for all treatment and the roots of plants exposed to various concentration of crude oil were observed to shrink and detach. Shrinking was also concentration dependent. The rate of accumulation of lead and manganese and the total hydrocarbon content (THC) was seen to be greater at low concentrations and the rate decreased as concentration increased.

Lopes and Piedade (2014) performed an experimental study on the survival and response of water hyacinth (*Eichhornia crassipes*) when exposed to Urucu light Brazilian crude oil. The study applied six different oil doses ranging from 0 to 150 mL/L and five exposure times ranging from 1 to 20 days. Results of the study showed an inverse relationship between increasing concentrations of oil and exposure times, plant survival, and the number and sizes of leaves. The factors also interacted such that the effect of both together was larger than each individually. Anatomical modifications and alterations in cell organization were also observed in plants exposed to high concentrations. The researchers concluded that:

> Dose and time of exposure are two of the most important factors controlling the effects of Urucu petroleum hydrocarbons on *E. crassipes*. While relatively low

doses of oil may cause a reduction in the number of leaves and plant biomass, high doses can even cause death of the plants. The lower dose of Urucu oil tested, 3 mL/L, did not cause significant alteration in morphology and biomass of the plants. Moderate oil doses, 12.5 and 25 mL/L, caused an increase in dead biomass and a decrease in the ratio of live/dead biomass and number of leaves. When exposed to high doses, 75 and 150 mL/L, the decline in biomass and increase in plant mortality were intensified.

7.1.3.4.3 Expected Effects of Oil on Aquatic Plants

The effects of crude oil releases on aquatic plants depend upon the type of habitat into which the oil is introduced, as well as the type of oil and quantity released. In some cases (e.g., submerged weed beds), contact between released oil and aquatic plants may be avoided altogether. However, when contact does occur, aquatic plant response to oiling depends on the amount of the plant that is oiled, the resistance of the particular plant or plant tissue to petroleum compounds, the type of oil, and the duration of contact. Contact between crude oil and unprotected green tissues can be assumed to result in tissue (e.g., leaf) death, and potentially death of the whole plant. Plant stems may be protected by waxy cuticles, bark, or multiple layers of leafy material so that contact between oil and the plant stem may not result in serious harm to the plant.

Where aquatic plants are affected by oil, some general longer-term patterns resulting in community-level effects may also be expected:

- A reduction in aquatic plant growth while exposed to oil constituents (Burk 1977; Lin and Mendelssohn 1996; McGlynn and Livingston 1997; Marwood et al. 2001; Akapo et al. 2011; Mollard et al. 2012; Lopes and Piedade 2014)
- An increase in algal biomass and shifts in community composition (Snow and Rosenberg 1975a, 1975b; Hellebust et al. 1975; Snow and Scott 1975; Bott and Rogenmuser 1978; Kauss et al. 1973)
- A reduction in the relative abundance of floating plants, and increase in abundance of submerged aquatic plants such as *Elodea, Potomogeton,* and *Ceratophyllum* (Burk 1977)
- A reduction in the relative abundance of annual plants (Burk 1977; Leck and Simpson 1992)
- A decrease in overall community diversity, with a shift in dominance to more oil-tolerant species (Snow and Rosenberg 1975a, 1975b; Hellebust et al. 1975; Snow and Scott 1975; Burk 1977; Bott and Rogenmuser 1978; Kauss et al. 1973; Lin and Mendelssohn 1996; Marwood et al. 2001)

Light refined oils with high amounts of water-soluble fractions can cause acute mortality to aquatic plants, but these oils are likely to disperse and weather rapidly so that the effects may be short-lived (NOAA and API 1994). A spill of light crude oil or refined products would be expected to result in the death of most floating plants that come into direct contact with the material. Rooted floating-leaved plants would likely suffer growth reductions and dieback for one or two growing seasons but not outright mortality (Hellebust et al. 1975; Burk 1977; Lin and Mendelssohn 1996). Algal species, aquatic mosses, and submerged plants in the vicinity of a surface oil slick, but not in physical contact with the oil on the water surface, might suffer minimal

damage from dissolved chemical constituents of the oil (Hellebust et al. 1975; McGlynn and Livingson 1997).

Heavier oils tend to coat vegetation, although the vegetation may survive if the roots are not affected (Hellebust et al. 1975; Burk 1977; Baca et al. 1985; Lin and Mendelssohn 1996). These oils can persist for longer periods and may sink under certain conditions (e.g., due to formation of OPAs). Light oils may be more prone to formation of true OPAs, due to their lower viscosity and greater tendency to form small droplets entrained in the water column under turbulent flow conditions. However, this process also enhances microbial degradation of crude oil, and light crude oils tend to be less persistent than heavy crude oils. Oil that becomes incorporated into bottom sediments might affect plant roots (NOAA and API 1994).

Algal species, aquatic mosses, and submerged plants would likely suffer little or no damage unless the oil became submerged or sank. Some algae (e.g., cyanobacteria) may experience growth increases, likely in response to alteration in the availability of key plant nutrients.

Submerged aquatic plants contacted by submerged or sinking oil could experience reductions in growth. Should the oil be extensive and/or persist for an extended period, the plants could die and the oil could impede growth of new vegetation from the sediment. Where plants are damaged but not killed, regrowth in a growing season or two is likely for perennial plants while annual plants may require longer to recover, depending upon the timing of the spill with respect to seed set, as well as seed dispersal mechanisms and the extent of representation in the existing seed bank (Baker 1971; Burk 1977; Shales et al. 1989; Pezeshki et al. 1998).

Annual plants (e.g., wild rice) may be more severely affected, likely as a consequence of oil effects to seeds, seedlings, and/or reproductive organs that disproportionately affect species that rely on seeds for yearly growth (Baker 1971; McCown and Deneke 1972; Burk 1977; Shales et al 1989; Leck and Simpson 1992; Adam and Duncan 2002).

Perennial aquatic plants appear to be at least somewhat tolerant of dissolved oil constituents (Baker 1971; Burk 1977; Kauss et al. 1973; Baca et al. 1985). Therefore, some species of perennial rooted and floating plants, may experience some growth reduction but not death where toxic water soluable factions (WSFs) are in moderate to high concentrations, or in low concentrations for extended periods of time, as could be the case where there is submerged heavy oil (Snow and Rosenberg 1975a, 1975b; Hellebust et al. 1975; Snow and Scott 1975; Bott and Rogenmuser 1978; Kauss et al. 1973). There would likely be a short-term loss of productivity from diminished photosynthetic activity and growth (Carr et al. 1997). Short term reproduction is likely to be curtailed somewhat from spills during the growing season where there are energy losses and damages to reproductive structures.

Table 7-35 and Table 7-36 provide a summary of the expected environmental effects of oil releases to aquatic plants. Table 7-35 considers the effects of specific oil characteristics or oil type on the expected type and scope of environmental effects. Table 7-36 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-35 Biological Receptor: Aquatic Plants

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Comments
Density	Light crude oils have low density, and generally float on the water surface, where they can contact floating and emergent aquatic plants, or plants in shallow water along shorelines, while weathering rapidly. Even weathered light crude oil residues will normally float on fresh water. However, the WSF of oil may enter the water column.	Medium crude oils have intermediate density, and will float on the water surface, where contact with floating and emergent aquatic plants is likely. Medium crude oils will weather more slowly than light crude oils. These oils generally have a lower WSF than light crude oils.	Heavy crude oils generally have density values lower than that of fresh water, and will float if spilled. However, as they weather, their density may increase over time so that they eventually exceed the density of fresh water. Such oils would typically have high viscosity, and will not readily become entrained into the water column as fine droplets. Heavy crudes have the lowest WSF, so little dissolution is anticipated. However, these oils can form OPAs if the oil travels over soils or is discharged into waters with high suspended sediment loads and is well-mixed. OPAs which exceed a specific density of 1 may sink.	Fresh diluted bitumens have a density that should not exceed 0.94, although density will increase and may slightly exceed the density of fresh water given sufficient exposure to the elements, or formation of OPAs. With weathering, the viscosity of diluted bitumen increases rapidly, so that it becomes increasingly resistant to the formation of small droplets in turbulent water.
Viscosity	Light crude oils have low viscosity and may readily become entrained into the water column as small droplets by breaking waves. Low viscosity oils are more readily absorbed into plant tissues, causing acute damage. However they also have a lesser tendency to adhere to plants, and are less likely to persist in water and sediment resulting in relatively lower long-term chronic damage to associated plant communities.	Intermediate environmental behavior and effects based on specific oil constituents.	Greater tendency to adhere to plants causing smothering. Higher potential to sink and be persistent in sediment causing long-term chronic toxicity damage to associated plant communities.	Diluted bitumens that contain volatile diluents (e.g., gas condensate) can have similar concentrations of low molecular weight hydrocarbons to light crude oils.
Proportion of low molecular weight VOCs	Light crude oils usually contain a larger proportion of VOCs than heavier crude oils. The VOCs (which include mono-aromatic hydrocarbons such as the BTEX compounds) are potentially damaging to plant tissues on direct contact.	Intermediate acute toxicity depending upon relative proportion of BTEX and other low molecular weight hydrocarbons.	Heavy crude oils of natural origin may contain relatively low concentrations of BTEX and other low molecular weight hydrocarbons.	Diluted bitumens that contain volatile diluents (e.g., gas condensate) can have similar concentrations of low molecular weight hydrocarbons to light crude oils.

Table 7-36 Biological Receptor: Aquatic Plants

Environmental Characteristic	Low	Medium	High	Comments
Plant growth form	Submerged forms avoid direct contact with floating crude oil on the water surface. Submerged plants may suffer some indirect damage from water column contact with WSFs.	Free-floating plants would be killed if contacted by released oil. However, these plants also disperse readily, and can reproduce quickly by vegetative means. Floating-leaved rooted plants may suffer damage to leaves from direct contact with oil at the water surface, but may avoid damage to roots and rhizomes, allowing re-growth from root systems.	Leaves of emergent plants are typically protected from contact with released crude oil, and the limited contact of oil with stems at water level may not result in plant death. Many emergent plants also have energy storage tissues in the roots, and can survive damage to above-water tissues.	Wild rice is an annual emergent plant (a type of grass). It is possible that an oil spill that occurred as shoots were emerging from the water could result in tissue or plant death. Otherwise, if a release of crude oil occurred earlier or later in the growing season, wild rice plants might not be seriously affected. Plants having thick cuticles and/or few stomata would be less sensitive to released crude oil than plants with thin cuticles and/or many stomata.
Water depth	Shallow water provides less scope for dilution of water soluble fractions of crude oil, however, plants are not particularly sensitive to the water soluble fraction. However, a large proportion of plants in shallow water may be free-floating or have floating leaves, making them more susceptible to crude oil exposure on the surface.		Deep water provides greater dilution of WSFs. Plants located in deep water are more likely to have mainly submerged growth form, which would have low exposure to crude oil on the surface.	
Water currents	Stagnant or ponded areas provide little flushing and dispersal of released crude oil or water soluble components of the oil. This may result in greater oil thickness on the water surface, and longer duration of exposure for both floating and submerged aquatic plants.		Habitats with moving water (rivers) or water circulation (large lakes) provide greater flushing and dispersal of crude oil. Although larger areas of habitat may be affected, oil slicks may be thinner, and exposure may be of shorter duration.	During the Marshall, Michigan release of heavy crude oil to the Kalamazoo River in 2010, deposition of crude oil to sediments occurred mainly in areas of still water.
Plant lifespan	Annual plants that generally rely on seed production tend to be more sensitive to the presence of oil. If seed is not set, then these plants may not be able to grow in the following season (e.g., wild rice).		Perennial plants are more resistant to damage than annual plants. Even when vegetative tissues are damaged, perennial plants can re-grow from the root system, often within the same growing season.	Many aquatic plants have several means of reproduction, including seed production, root spreading and production of new shoots from rootstock, and vegetative reproduction from plant fragments that drift into new and potentially favorable habitats.
Plant age	Young plants may be susceptible to damage because they generally have more sensitive tissues, and have fewer energy stores.	Annual plants exposed to crude oil prior to seed set may still be sensitive, if the oil exposure prevents or inhibits seed set.	Mature rooted perennial plants would be less susceptible to damage because their roots would have low exposure to released oil, and are the site of energy storage from which the plant could re-grow. Annual plants post seed set would have low sensitivity as these plants would be senescent, and dying in any case.	

7.1.3.5 Amphibians and Reptiles

7.1.3.5.1 Description

Amphibians and reptiles are considered together as a group in this study because both classes of vertebrates are ectothermic (i.e., cold-blooded) species. In Minnesota, amphibians include frogs, toads, salamanders, and newts; and reptiles include snakes, lizards, and turtles. Effects of releases from oil pipelines are typically greatest in aquatic and riparian environments (NAS 2016); given that lizards and snakes are primarily terrestrial species with little or no association with aquatic environments, this assessment focuses on amphibians and turtles.

There are three key differences between reptiles and amphibians that have implications for potential effects of hydrocarbon releases. First, amphibians have porous skin that generally requires that they inhabit areas near water or damp environments; their porous skin may also facilitate dermal absorption of contaminants, an important exposure route. Reptiles have scaly, keratinous skin or shell (i.e., turtles) that is not porous and enables them to live in arid or hypersaline environments. Second, amphibians lay eggs that do not have a thick protective membrane or shell. Their eggs are laid in aquatic environments where they may absorb dissolved contaminants. Many amphibians are also external breeders meaning sperm is expelled into the aquatic environment and swim to eggs (Vitt and Caldwell 2013). In contrast, reptilian eggs have a leathery or shell membrane, and are laid in burrows where they are less predisposed to direct contaminant exposure. Some snakes do lay live young (viviparous) in cold climates (Vitt and Caldwell 2013). Finally, amphibians hatch from their eggs as tadpoles that are entirely aquatic with rudimentary gills used for respiration underwater. These juvenile amphibians undergo metamorphosis to become adults that are semi-aquatic organisms. On the other hand, juvenile reptiles hatch as small versions of their adult counterparts and are fully independent and capable of inhabiting aquatic or terrestrial environments.

As ectothermic individuals, amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F (Obbard and Brooks 1981; Tattersall and Ultsch 2008). Most aquatic reptiles and amphibians overwinter by burying themselves in mud and sediment of shallow lakes and wetlands. However, even in northern temperate regions some amphibians (e.g., ranid frogs) remain active in underwater environments where they are dependent on respiratory gas exchanges with the aquatic environment (Tattersall and Ultsch 2008).

As a group, amphibians and reptiles are omnivorous with some species' having a diet consisting primarily of invertebrates, and some species that are more predatory/carnivorous, while others subsist to a greater degree on vegetation. Juvenile reptiles typically feed on smaller prey (plant or animal) of the same trophic order as their adult counterparts; however juvenile amphibians (e.g., tadpoles) are more herbivorous and subsist on algae in early development (Kupferberg 1997).

Amphibians and aquatic reptiles typically respond to stressors through avoidance escape behavior seeking shelter in aquatic vegetation and benthos (Licht 1986). This avoidance may result in fewer amphibians and reptiles observed being affected by hydrocarbon releases. Unlike fish that will float to the surface when dead because of their air bladder, amphibians and reptiles will likely sink to the bottom and go undetected. Frogs are also prey for many species of fish, mammals, birds, other amphibians and reptiles, which could result in rapid scavenging of amphibians in some environments post-release.

There are no federally-listed amphibian or reptile species known to occur in Minnesota (USFWS 2016). However, under Minnesota's Endangered Species Statute (MN DNR 2013) there are 2 species listed as "endangered," 4 as "threatened," and 10 as "special concern." Of the semi-aquatic amphibian and turtles considered in this receptor group, Minnesota Endangered Species include:

- Northern cricket frog (*Acris blanchardi*) Endangered
- Blanding's turtle (*Emydoidea blandingii* Threatened
- Wood turtle (*Glyptemis insculpta)* Threatened
- Spotted salamander (*Ambystoma maculatum*) Special Concern
- Great Plains toad (*Anaxyrus cognatus*) Special Concern
- Four-toed salamander (*Hemidactylium scutatum*) Special Concern
- Mudpuppy (*Necturus maculosus*) Special Concern

7.1.3.5.2 Observed Effects

A review of several hydrocarbon releases from pipelines, and one resulting from a rail car accident, provided an overview of observed effects of releases on amphibians and reptiles in similar aquatic environments (e.g., river, lakes and wetlands) to those encountered in Minnesota. This review is not exhaustive, but provides a range of observed effects on amphibians and reptiles under different environmental conditions. While some of the case studies involve releases of light or medium crude oils, the effects are taken in context of the differences in properties of the oil types and provide some contrast of the potential effects among different oil types.

> ***Exxon Bayway****: On January 2, 1990, an Exxon underwater pipeline released approximately 13,500 barrels of No 2 heating oil into the Arthur Kill waterway at the mouth of Morse Creek between New Jersey and Staten Island, New York (NOAA 1992). Initial response efforts focused on containment of the release as well as removal of the larger masses of oil. Concentrations of floating oil and mousse in the open water, primarily between Howland Hook and Fresh Kills, were collected by self-propelled skimmers. Oil concentrated and stranded above the berm on the beaches from Cedar Point to Rossville. Environmentally sensitive areas were protected with boom and skimmers that collected the larger masses of free-floating oil. By February 20, 1990, monitoring crews reported nine terrapin turtles captured and released among other affected wildlife (NOAA 1992).*

***Lakehead**: On March 3, 1991, a Lakehead Pipeline Company, Inc. owned pipeline ruptured and released over 40,000 barrels of crude oil (NOAA 1992) approximately 2 miles north of Grand Rapids. Some of the oil flowed onto the 18 in. thick ice sheets on the Prairie River. Oil formed into 8-inch deep pools on top of the ice and was also present under the ice. Vacuum trucks were used by clean-up personnel to remove the oil from the ice surface. Workers used squeegees to push the oil along the ice to a removal location. Booms were used on the river by cutting a slot through the ice cover with chainsaws. Ice that had been permeated with oil was chopped into blocks small enough to be carried away to a separate part of the river. Clean-up personnel sprayed the ice blocks with hot water to wash out the oil, which was then recovered with skimmers. Blocks that were only slightly contaminated were moved to lined holding tanks and broken up. The crushed ice was then allowed to melt to recover residual oil. There were no reports of amphibians or reptiles injured during the post-release clean-up and monitoring, though the area would have been inhabited by several species. Overall effects to fish and wildlife were reported as minimal by the MN DNR (Telegraph Herald 1991), likely due to ice-covered conditions at the time of the release.*

***OSSA II:** On January 30, 2000, an estimated 29,000 barrels of mixed heavy crude oil and diluent (density of approximately 0.8 g/mL) were released from the OSSA II pipeline, operated by Transredes S.A., at the Rio Desaguadero river crossing in Bolivia as the river was rising to peak flood conditions (Lee et al. 2001, 2002; Owens and Henshaw 2002). Due to the very high river flow and water velocity conditions, and perhaps also due to the low viscosity of the oil, which would allow it to become dispersed into the water as fine droplets, oil was found up to 230 miles downstream from the release location. For the most part, the surface oil was deposited in strips, generally 3 to 6 ft wide and up to 0.5 to 1 inch thick. Many sections of river bank had a horizontal line of oil, "a bathtub ring" where the oil was deposited and stranded indicating the water level at the time (Owens and Henshaw 2002). The response effort included more than 3,600 people that recovered the oil within three months. Wasson et al. (2000 in Owens and Henshaw 2002) reported on the wildlife effects of the release and indicated that no wildlife fatalities other than a small number of birds were observed during the extensive post-release monitoring and clean-up.*

***Tinicum:** On February 5, 2000, a Sunoco pipeline cracked in Tinicum, Pennsylvania, releasing approximately 4,575 barrels of crude oil (USFWS 2009). The pipeline rupture was located at the eastern end of the John Heinz National Wildlife Refuge and flowed onto an ice-covered freshwater impoundment (Saba and Spotila 2003). It took approximately one month for clean-up crews to recover the oil, and before that was achieved, by February 17, the ice on the impoundment started to melt in some areas exposing aquatic species to the oil. Turtles started emerging and becoming coated in oil remaining on site before recovery had been completed. Tri-state bird rehabilitation center was contracted to recover, clean and rehabilitate oiled turtles. In total, there were 19 oiled turtles captured at the site. All captured turtles were cleaned, and*

monitored for one month during which time only one turtle died from apparent crude oil inhalation (Saba and Spotila 2003). The remaining 18 turtles were used in a study, along with a control group of turtles not exposed to oil to assess effects of oil exposure on survival and behavior. No effects of oil exposure were noted and the 18 turtles released survived (Saba and Spotila 2003). In total there are 19 species of reptiles and amphibians that use the John Heinz National Wildlife Refuge, but only the 19 individuals of four species of turtles were reportedly affected by the release.

Pine River: *On August 1, 2000, a pipeline operated by Pembina Pipelines failed and released approximately 6,200 barrels of light crude oil, of which an estimated 2,800 barrels entered the Pine River 70 miles upstream of Chetwynd, British Columbia. An estimated 300 to 710 barrels remained unaccounted for following the clean-up and remediation (BC MOE 2000a). Most of the unaccounted for oil was considered to be likely entrained in sediment or debris within the river. Response measures included placing two containment systems: one approximately 14 miles downstream and a second approximately 19 miles downstream (BC MOE 2000c). The river was flowing at a low stage at the time of the release (approximately 5,680 ft^3/s measured at a station 100 miles downstream, compared to flow rates above 31,880 ft^3/s during late spring and early summer). The Pine River has a gradient of approximately 0.225% in the first 25 miles downstream from the release location, decreasing to 0.1% farther downstream. There were reports from government staff and contracted clean-up crews of oiled wildlife (all birds), but no oiled amphibians or reptiles were reported (BC MOE 2000b).*

Wabamun Lake*: On August 3, 2005, a Canadian National freight train derailed near the Village of Whitewood Sands, Alberta, releasing approximately 4,500 barrels of Bunker C fuel oil (Heavy Fuel Oil 7102; Hollebone et al. 2011) and 550 barrels of pole treating oil. An estimated 950 barrels of the Bunker C oil entered Wabamun Lake and formed a thick black slick approximately 0.5 in. thick (Wernick et al. 2009).*

While traveling overland, the oil mixed with soil and organic matter, and in the lake, OPAs formed quickly, including small tar balls, larger tar "logs", submerged sheets, and large lumps (Fingas et al. 2006; Hollebone et al. 2011). The oil-sediment complexes exhibited a variety of behaviors including submergence, neutral buoyancy, and resurfacing (Fingas et al. 2006).

No dispersions of oil in water were observed in the lake, and no mousse formation was reported in the three years following the release (Hollebone et al. 2011). Overall, the water in the open water area of the lake was reported not to be contaminated with released hydrocarbons or associated metals (Anderson 2006). This is consistent with the very low concentration of relatively water-soluble components (such as BTEX) in the released oil, and the relatively low water solubility of this heavy oil. Similarly, sediments beneath the open water portions of Wabamun Lake were reported not to have been

contaminated with petroleum hydrocarbons and were considered to be of similar quality to concentrations measured in 2002 or shortly before the release (Anderson 2006).

Clean-up activities included cutting of the vegetation and vacuum removal of submerged tar balls entrained in the reed bed detritus (Wernick et al. 2009). A two year study was conducted to assess regrowth. The study found that exposure to the oil, which was released in the late growing season, did not cause large-scale changes to these emergent plant communities (Wernick et al. 2009). Physical factors such as clean-up activities and vegetation management appeared to be responsible for reduced regrowth observed at some locations (Wernick et al. 2009; Thormann and Bayley 2008). Despite an intensive wildlife monitoring program, and a wildlife recovery center set up immediately after the release, there were no reports of amphibians or reptiles injured by the oil (TSBC 2007).The area would have been inhabited by several species of amphibians and reptiles.

***Glenavon**: On April 15, 2007, a release occurred on the Enbridge Line 3 pipeline approximately 1 mile downstream of the Glenavon pump station near Glenavon, Saskatchewan. The rupture released approximately 6,200 barrels of heavy crude oil and affected approximately 5 acres of a wetland on farmland (TSBC 2008a; SLR Consulting 2008a). Within two days of the release, approximately half of the crude oil had been recovered (Canada.com 2007a). In April 2007, surface water samples from the affected wetland exceeded applicable guidelines for hydrocarbons and total metal concentrations and background, and exceeded concentrations from nearby reference wetlands (SLR Consulting 2008a). As remediation actions, the affected surface water (approximately 1.8 million gallons) was collected and disposed in approved wastewater facilities (SLR Consulting 2008a). These activities were complete in early May 2007, and surface water samples conducted in August had concentrations below guidelines (SLR Consulting 2008a). The site was monitored for one week for exposure of wildlife to oil, and wetlands within 0.6 miles (1 km) were surveyed for any wildlife that may have been oiled initially and moved away from the release site. The only reported injured wildlife were birds (SLR Consulting 2008a); there were no reports of injured or dead amphibians or reptiles, though amphibians would have inhabited the wetland.*

***Marshall**: On July 25, 2010, Enbridge's Line 6B pipeline experienced a release in a wetland near Marshall, Michigan. Approximately 20,000 barrels of heavy crude oil containing diluted bitumen were released over a period of about 17 hours. The pipeline contained two different batches of crude oil at the time of the release. It is estimated that the released oil consisted of approximately 77% CLWB diluted bitumen and 23% Western Canadian Select, also diluted bitumen (NTSB 2012a). Of this, approximately 8,200 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013a). Talmadge Creek was flowing with higher than normal flow due to recent heavy rains. The crude oil flowed down Talmadge Creek to the confluence with the Kalamazoo River, and then into the Kalamazoo River. Due to the elevated water level, the crude oil affected*

floodplain areas on both sides of Talmadge Creek. The river was also high at the time of the release and had overflowed its banks in many areas. As a result, oil entered the floodplain areas. As water levels in the river receded, much of the crude oil flowed with the flooding water back within the banks of the Kalamazoo River, although crude oil also became stranded in hydrologically isolated areas such as depressions, cavities, burrows, and other traps within the riparian zone (Enbridge 2013a). These conditions resulted in oil being stranded in areas that would be suitable habitat for amphibians and reptiles. As a result, 106 reptiles were found dead or subsequently died during rehabilitation, and approximately 3,931 turtles and 73 amphibians were captured, treated and released (USFWS et al. 2015a). Many (over 600) of the oiled and captured turtles were recaptured at least once, which suggests that the oiling effects were relatively benign (Lee et al. 2015). The primary species affected were common map turtles (77%), snapping turtles (11%), painted turtles (6%), and eastern spiny softshell turtles (3%). Other species included common musk, Blanding's, eastern box, and spotted turtles (USFWS et al 2015 a).

***Rainbow Pipeline, Alberta, Canada**: On April 28, 2011, approximately 28,300 barrels of sweet crude oil were released from a Plains Midstream Canada pipeline into a muskeg/stagnant water area near the community of Little Buffalo in the Peace River region of Alberta. The release occurred on a hillside, and the oil flowed a half mile down the pipeline ROW and pooled in a low-lying area containing abandoned beaver ponds. The release encompassed an area of approximately 20 acres (ERCB 2013). During response activities, perimeter fencing and wildlife deterrents (including eagle kites and bear-scare canyons) were used to prevent wildlife from entering the release site (ERCB 2013). However, over the course of the following 18 months (i.e., by November, 2012) 12 amphibians (11 frogs and one toad) were found deceased (ERCB 2013). No cause-of-mortality analysis was conducted for the deceased wildlife, but it is presumed that oiling was the likely cause.*

***2011 Yellowstone River**: On July 1, 2011, flood conditions in the Yellowstone River resulted in a release from the ExxonMobil Silvertip Pipeline near Laurel, Montana. Riverbed erosion had exposed the 12 inch pipeline beneath the crossing, and debris caught on the washed-out pipeline caused excessive stress, resulting in a clean break. The failure was detected at the pipeline control center and the line was shut down within 10 minutes (USDOT 2012). Approximately 1,500 barrels of medium sour crude oil were released into the Yellowstone River (USDOT 2012). High flood flows carried the oil downstream and prevented it from settling on the river bottom. Crude oil affected primarily shorelines and banks immediately downstream of the release site (MT DEQ 2015b). A pocket of emulsified oil was found approximately 72 miles downstream, but the majority of the release effects were observed within 20 miles of the release location (USEPA 2011). Search efforts found two toads that were captured and cleaned and two additional oiled toads and one garter snake were observed, but not captured (USEPA 2011).*

***Red Deer River**: On June 7, 2012 a Plains Midstream Canada ULC (Plains) pipeline released, as a result of high water levels in the river, approximately 2,900 barrels of light crude oil into the Red Deer River downstream of Sundre, Alberta (AER 2014). The migration of visible oil was stopped by booms placed at Gleniffer Lake, but dissolved hydrocarbons continued to move downstream. This resulted in potential toxic and oiling effects upstream of the booms, and toxic effects downstream of the booms in Gleniffer Lake (Teichreb 2014). Officials with Alberta Environment indicated that effects to wildlife were minimal (Derworiz 2012). During the post-release clean-up, there were no reports of amphibians or reptiles injured and monitoring, though the area would have been inhabited by several species of amphibians and reptiles.*

***Line 37**: On June 22, 2013, unusually heavy rains resulted in ground movement that compromised the integrity of the Enbridge Line 37 pipeline, approximately 1 mile north of the terminal in Cheecham, Alberta. The resulting failure released approximately 1,300 barrels of synthetic light crude oil underground with some oil seeping to the surface where it flowed overland entering a wetland and unnamed lake (Enbridge 2013c). Initial clean-up and remediation recovered 93% of the crude oil with the remaining oil found in soils and a fen. During the post-release clean-up and monitoring, there were no reports of amphibians or reptiles injured (Focus Wildlife Canada 2013), though the area would have been inhabited by several species of amphibians, and, possibly, reptiles.*

***Mid Valley**: On October 13, 2014, an oil release from a Sunoco Logistics Partners pipeline occurred near Mooringsport, Louisiana. Approximately 4,500 barrels of sweet crude oil were released into the Miller branch of the Tete Bayou, which feeds into Caddo Lake. Although containment booms prevented the oil from entering Caddo Lake, approximately 10 miles of the creek were affected by the release. Initial media reports were that approximately 66 animals, including 30 fish, crayfish and 10 reptiles died as a result of the release (Welborn 2014a). Later media reports about one month following the release were that 486 dead animals were collected and 47 cleaned and released (Welborn 2014b). Most of the animals were crawfish and amphibians, but species and specific numbers were not provided (Welborn 2014b).*

***2015 Yellowstone River**: On January 17, 2015, a pipeline owned by Bridger Pipeline Co. released approximately 715 barrels of Bakken crude oil (estimates ranged from 300 to 1,200 barrels) into the Yellowstone River approximately 5 miles upstream of Glendive, Montana (MT DEQ 2015b). The breach in the pipeline occurred where the pipeline crossed under the river. Winter conditions resulted in extensive ice cover, but aerial patrols discovered oil as far as 25 miles downstream of Glendive, (The Guardian 2015). Booms were deployed on the ice to collect oil from the surface but winter conditions combined with thawing resulted in unsafe working conditions and only a limited amount of oil could be recovered from the river (approximately 60 barrels) (MT DEQ 2015a). There were no reports of oiled wildlife (including amphibians or reptiles) or dead fish (Stuart 2015). The Montana Departments of Natural Resources and Conservation; and Fish,*

> *Wildlife and Parks expressed concern that the most significant source of damage to the riverine system was the physical damage caused by response crews and equipment during clean-up operations.*

7.1.3.5.3 Expected Effects of Released Oils

Compared to birds and semi-aquatic mammals, effects of oil and PAHs on amphibians and reptiles is less well understood, particularly for inland freshwater species (Albers 2003; Malcolm and Shore 2003; Lee et al. 2015). Reported injuries to amphibians and reptiles from hydrocarbon releases suggest that semi-aquatic amphibians and reptiles are regularly affected species, though most likely go undetected. The extent of injuries varies and fatal injuries were more common in amphibians than in reptiles. Amphibians are generally smaller organisms than birds, mammals or even reptiles, and their propensity to seek shelter in sediment or aquatic vegetation when disturbed may result in fewer affected individuals being detected following a hydrocarbon release. Furthermore, smaller organisms are often not detected because of scavenging by predators. There are no reports of studies assessing detection or scavenging rates for amphibians. However, bird scavenging rates tend to be higher for smaller species and detection rates of individuals present lower than that of larger species (Ponce et al. 2010), and this likely would apply to other species groups as well.

There are few published studies about effects of crude oil, particularly diluted or synthetic bitumen and heavy crude oils, or hydrocarbons on amphibians and reptiles. Like other vertebrate species (i.e., mammals and birds), effects can be classified into direct physical effects, direct toxicological effects, and indirect effects. The observed effects of hydrocarbons on amphibians or reptiles are variable and likely due to differences in search effort, release environment, species present, and time of year. Generalizations about effects on amphibians and reptiles are challenging to draw based on limited research for this species group. In some case studies, reported injuries were primarily fatalities (e.g., Mid-valley release) and consisted mostly of amphibians, while in other case studies injuries were generally minor with most captured individuals treated and released (e.g., Marshall and Tinicum releases). The Mid-Valley release where most reported injuries were fatalities, consisted of light crude, whereas the Marshall release, where thousands of individuals were captured and rehabilitated, was heavy crude. The mode of action causing fatalities is challenging to determine without conducting necropsies, and the difference between the two releases could be due to difference in toxicity of the oil components or differences in the physical properties. The magnitude of effect is also difficult to interpret when estimates of population size are not available against which to compare injury rates. Based on two case studies where turtles were oiled and monitored (Marshall and Tinicum releases), the population viability of turtles is not affected by oil releases in freshwater environments.

7.1.3.5.3.1 Direct Physical Effects on Amphibians and Reptiles

Direct physical effects generally involve adhesion (i.e., oiling) of exposed individuals. For amphibians, oiling would occur primarily in the adult stage when individuals are more terrestrial and frequent the water surface and shorelines; eggs and tadpoles are generally submerged

and would not be as readily oiled. Because reptiles transition between aquatic and terrestrial environments at all life stages, oiling could affect juveniles to the same extent as adults. However, reports of injured or oiled amphibians and reptiles in case studies did not identify the age of individuals.

Saba and Spotila (2003) found that oiled adult turtles had no difference in survival or home range size than non-oiled individuals. This is consistent with reports of approximately 3,900 turtles being captured, cleaned and released following the Marshall release into the Kalamazoo River, as many individuals (n = 622) were recaptured up to five times (USFWS et al. 2015a). This recapture rate suggests that the physical effects of oiling from diluted bitumen are relatively benign (Lee et al. 2015). During the clean-up of the Marshall release 73 oiled amphibians were also captured, treated and released. Given the smaller size of amphibians and their propensity to seek shelter underwater, it is possible that oiling of frogs, toads and other amphibians would lead to individuals not being detected or recovered following a release. Oiling of amphibians and reptiles would also be limited to the active period of spring, summer and early fall as hibernating individuals buried in sediment would not be exposed to oil, as was the case in the release at the John Heinz National Wildlife Refuge where three weeks passed before ice melted and emerging turtles came in contact with the exposed oil at the water surface (Saba and Spotila 2003). One exception might be ranid frogs that are partially active underwater during the winter period. These individuals may be exposed to oil under ice of shallow lakes and rivers, if the release occurred in the winter. Oiling of reptile eggs, particularly turtles, may occur if oil permeates sandy beaches where turtles are known to dig nests to bury their eggs for incubation. Oiling of eggs may create barriers to respiration and cause the embryos to die, though distinguishing physical effects from toxic effects on eggs is difficult (Rowe and Mitchelmore 2009).

7.1.3.5.3.2 Direct Toxicological Effects on Amphibians and Reptiles

The response of amphibians and reptiles to hydrocarbon exposure has not been well studied (Albers 2003; Malcolm and Shore 2003; Lee et al. 2015). Reptiles are likely to be exposed primarily through consumption of contaminated food, direct ingestion of oil and/or inhalation of volatile hydrocarbons. These same exposure pathways would apply to amphibians that would also have higher exposure than reptiles through dermal absorption. The soft skin of amphibians would make them more susceptible to dermal exposure of dissolved hydrocarbons in the aquatic environment (Stabenau et al. 2006). Amphibian embryos have been described as slightly less sensitive to fuel oils and crude oils as fish embryos, and mortality in amphibians is most common in late-stage developing tadpoles (Albers 2003).

Studies on the effect of hydrocarbons on turtles from the John Heinz National Wildlife Refuge demonstrated that there was no difference in post-release survival, home range, or water temperature preference among exposed and non-exposed turtles (Saba and Spotila 2003). Subsequent studies reported that female snapping or painted turtles exposed to crude oil did not have lower fertility, or clutch size, but there was a measured effect on embryonic

development, though the source of the hydrocarbons is questionable because of historic site contamination (Bell 2005; Bell et al. 2006).

Studies examining the effect of petroleum hydrocarbons on hatching and growth of frog eggs found that while hatching success did not decrease in one study (Mahaney 1994), which may be attributed to the protective jelly coat of eggs, Marquis et al. (2006) noted that effects on hatching and the protective jelly coat is species-specific and not applicable to all species. Mahaney (1994) also reported that tadpole growth was also affected increasingly with higher concentrations of dissolved oil, although his study used crankcase oil, which contained a similar proportion of aromatic hydrocarbons as heavy crudes and diluted bitumens (~20%). Similarly, results from a study examining hatching success and embryo deformity rates of turtle eggs exposed to oil depended on the specific population from which individuals originated (Van Meter et al. 2006). Hydrocarbon releases into the aquatic environment that result in lower concentrations of dissolved hydrocarbons, and in PAHs, would likely result in reduced effects on egg survival and tadpole growth. Diluted bitumens have lower quantities of BTEX, USEPA priority PAHs, and total alkylated PAHs than do conventional crude oils, and have been shown to have lower or equal toxicity in zebrafish studies (NRC 2003; Zhou et al. 2015). This suggests that toxicity of diluted bitumens would have equal or lower toxicity to amphibians and reptiles adults and eggs. Moreover, evidence suggests that even light crude oil tested in experimental studies resulted in no biological effects on diamondback terrapin or snapping turtle egg survival or other biological endpoints of hatchlings after 13 months (Rowe and Mitchelmore 2009).

7.1.3.5.3.3 Indirect Effects of Oil Release on Amphibians and Reptiles

Indirect effects occur over longer term and are the result of loss of habitat, increased predation risk, or change in food abundance or availability. Loss of vegetation, and effects to local populations of algae, invertebrates or fish could have long-term effects on the survival and reproduction, and, therefore, on population abundance of amphibians and reptiles. The remedial actions taken in response to hydrocarbon concentrations exceeding guidelines from the Glenavon release likely resulted in effects to amphibian habitat, particularly where remediation activities occurred during the breeding season of species like the northern leopard frog. Wetland drainage is considered a high concern activity for this species (Environment Canada 2013). Vegetation removal and clean-up of the Wabamun release likely affected habitat for several amphibian species both as eggs, juveniles and adults, though this effect would have likely lasted only until vegetation regrowth occurred in the wetland areas the following year.

Mahaney (1994) reported that hydrocarbons from crankcase oil had a negative effect on algal growth rates. The hydrocarbon composition of crankcase oil (20% aromatic, 80% aliphatic) reported in this study is similar to heavy crude oils and diluted bitumens (Dupuis and Ucan-Marin 2015; Zhou et al. 2015), and the expected effects might be similar. However, water quality monitoring following the Wabamun Lake release indicated that water and sediment quality parameters measured in the open water portion of the lake did not indicate any contamination by hydrocarbons, and therefore algal populations were likely not affected by this release.

Table 7-37 Biological Receptor: Amphibians and Reptiles

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—buoyancy	Light crude oils typically have a low relatively density (0.78-0.88 g/mL, Dupuis and Ucan-Marin 2015) and are buoyant in freshwater aquatic environments.	Medium crude oils typically have an intermediate density compared to light and heavy crudes, and are buoyant in freshwater aquatic environments (Dupuis and Ucan-Marin 2015).	Heavy conventional crude oils can have density ranging of 0.88 to 1.00 g/mL, while diluted bitumen will have density less than 0.94 g/mL (Dupuis and Ucan-Marin 2015).	Density of crude oils will increase over time with weathering. It has been suggested (NAS 2016) that diluted bitumen will rapidly weather to a state where its density will exceed the density of fresh water. However, this conclusion is based on data from a high-temperature rotary evaporation procedure, which both accelerates weathering and drives it to an endpoint that may not be reached in a relevant period of time under more realistic environmental conditions. Lee et al. (2015) concluded that "evaporative mass losses of <20% after rigorous weathering at environmentally-relevant temperatures for dilbits nominally comprising ≥30% diluent suggests that a substantial proportion of diluent remains intimately associated with bitumen". This will mitigate against sinking behavior of diluted bitumen in fresh water. These details are further discussed in Section 7.1.2. Recovery or released oil is facilitated if the oil floats on the surface of the water. More rapid recovery of oil will result in a reduced duration of potential exposure, and will avoid contact with submerged amphibians and reptiles.
Oil properties—viscosity	Light crudes will spread rapidly on water because of their low viscosity (1 to 5 mPa•s, NAS 2016).	Medium crudes have an intermediate viscosity (8 to 112 mPa•s, NAS 2016).	Heavy crudes (820 to 475,000 mPa•s) and diluted bitumens (270 to 50,000 mPa•s) weather to high viscosity (NAS 2016). Of note, the viscosity of fresh bitumen is reduced by the addition of diluent (referred to as diluted bitumen), to conform to pipeline specifications.	Viscosity is a function of oil chemistry. Diluted bitumens tend to display a more rapid increase in viscosity due to weathering than conventional heavy crude oils as a result of the rapid initial evaporation of some of the diluent. Oil having low viscosity will rapidly spread across the water surface forming a thin and relatively uniform slick that may result in a larger area where amphibians and reptiles may be exposed to released oil. More viscous oils will spread more slowly and may exhibit thicker but patchier slicks with associated sheens. This would allow for some areas to serve as refuges for amphibians and reptiles in an aquatic system.

Table 7-37 Biological Receptor: Amphibians and Reptiles

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—adhesion	Light crudes have low adhesion and viscosity (NAS 2016) and lower quantities of oil will adhere to amphibians and reptiles exposed to released oil.	Medium crudes have an intermediate adhesion and viscosity (NAS 2016). Lower quantities of medium crude will adhere to amphibians and reptiles exposed to released oil.	Heavy crudes and diluted bitumens are highly adhesive and more viscous than light and medium crude oils. When fresh, diluted bitumens have relatively low viscosity, and would penetrate feathers. However, weathered heavy crudes may tend to adhere to amphibians and reptiles.	Properties of adhesion and viscosity may change the way that crude oil interacts with wildlife through adhering to the exterior of individuals. Light oils form thin layers on surfaces and would be more easily cleaned or removed from the skin or surface of amphibians and reptiles than heavier oils.
Oil chemistry—toxic constituents	Light crude oils often contain high levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, depending on the oil type, but can be high (>10,000 mg/kg) in Bakken oils.	Medium crude oils often contain moderate levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, but can exceed 10,000 mg/kg.	Levels of BTEX and other relatively water soluble constituents are variable: generally low in heavy conventional oils, but variable in diluted bitumens depending upon the nature of the diluent. Levels of TPAH are variable, but typically depleted in napthalenes and less than 10,000 mg/kg.	Diluted bitumens do not contain higher concentrations of either BTEX or TPAH than many conventional crude oils (Lee et al. 2015). Diluted bitumens contain the same suite of PAHs as conventional crude oils, but at different relative concentrations due to the highly weathered nature of the bitumen component, and the modifying effect of the diluent. These details are further discussed in section 7.1.2. Compared to endothermic vertebrates (i.e., birds and mammals), acute effects on amphibian and reptiles are more likely to occur through chemical toxicity of oil than physical effects of oiling. Lower proportions of toxic constituents would result in reduced potential effects on amphibians and reptiles.

Table 7-37 Biological Receptor: Amphibians and Reptiles

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—persistence	Light crude oils typically contain only small proportions of higher molecular weight components, such as resins and asphaltenes. Light crude oils generally biodegrade readily.	Medium crude oils contain variable proportions of resins and asphaltenes. Asphaltenes would be removed from synthetic medium crudes during processing of bitumen.	Heavy conventional crude oils and diluted bitumens typically contain higher proportions of resins and asphaltenes, which tend to resist biodegradation.	In general, heavy conventional crude oils and diluted bitumens would be expected to biodegrade less rapidly than light or medium crude oils. However, any oil can be persistent if deposited in an environment where there is little or no available oxygen. Increased persistence in the environment would result in a similar increase in potential exposure duration by amphibians and reptiles.

Table 7-38 Biological Receptor: Amphibians and Reptiles

Environmental Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Habitat type	Light crude oil will spread rapidly due to its low viscosity, potentially resulting in effects over a larger area in lakes and wide rivers.	Medium crude oil has low viscosity, although viscosity increases at lower temperatures, and will behave similarly to light crude oils.	Heavy crude oils have high viscosity. Diluted bitumens also have high viscosity (although reduced while fresh due to the effect of the diluent), potentially resulting in effects over a smaller area in lakes and wide rivers, due to the oil's resistance to spreading in these habitats.	Low viscosity oils will spread more rapidly, and to thinner slicks, than high-viscosity oils. As a result, low viscosity oils have a higher potential to affect a larger area of habitat, particularly open-water habitats such as lakes and wide rivers, than higher viscosity oils. At the same time, higher viscosity oils will tend to form thicker slicks than low viscosity oils. This could result in a smaller area of higher impact to habitat suitability for amphibians and reptiles compared from heavy oils compared to light oils.
Season	Light oils remain fluid at low temperature and retain the potential to spread rapidly during the winter. Light oils may penetrate cracks in ice or close to shore, allowing the oil to get beneath the ice and spread downstream. In summer, light crude oils would also flow readily and spread rapidly, having the potential to contact larger numbers of amphibians and reptiles than heavier, more viscous oils.	Medium oils are slightly more viscous than light oils, and would also tend to flow readily under winter conditions. Medium crude oils would tend to flow readily and spread rapidly under summer conditions	Heavy oils become much more viscous at low temperatures, and as they weather. Heavy oils and diluted bitumens would have more resistance to flowing or penetrating cracks in ice to reach the water surface than would be the case for light or medium crude oils. During the summer, diluted bitumens would flow readily and spread rapidly while fresh. Weathering in the first 24 to 48 hours would result in increasing viscosity and density, limiting further spreading of the oil on the water surface.	Season affects both the behavior of oil in the environment, and the types and abundance of amphibians and reptiles that could be exposed. Most amphibians and reptiles become dormant during the winter and would only be exposed to oil during the open water period when they are active. This would limit the potential for direct exposure during the winter period, though indirect effects to food and habitat may still occur from a winter release.

Table 7-38 Biological Receptor: Amphibians and Reptiles

Environmental Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Weather conditions—rainfall and water levels	Periods of high rainfall and high water levels could transport released crude oil into riparian areas, in addition to potentially increasing downstream transport distances. This would affect all crude oil types. If crude oil is transported into riparian areas, then this could increase the potential for more terrestrial species (toads and snakes) to be exposed, as well as have potential effects to nests of reptiles that burrow into riparian substrates to build their nests (e.g., turtles).			
Weather conditions—temperature	Temperature would have limited implications for effects oil on amphibians and reptiles due to their ectothermic nature (e.g., cold-blooded), which prevents these species from becoming hypothermic. Temperature would have effects on the behavior of oil in the environment (see oil characteristics table above).			
Slope	Lakes have negligible slope, and therefore the short-term distribution of crude oil on the water surface may be determined primarily by wind. Streams and rivers have slope, which determines the downstream water flow velocity, as well as influencing the turbulence of that flow. Slope therefore helps to determine the downstream transport distance for spilled oil before emergency response can be effectively applied. This can affect the types of habitat that the spilled oil could affect, as well as the numbers and types of amphibians and reptiles.			

7.1.3.6 Birds

7.1.3.6.1 Description

There are hundreds of species of birds in North America, many of which are aquatic or semi-aquatic, using wetlands, lakes, rivers, or streams as components of their habitats. The dependence of birds on aquatic habitat ranges from facultative (e.g., use of aerial habitat over water by swallows when foraging for emerging aquatic invertebrates) to obligate (e.g., use of aquatic and shoreline habitat by divers and some ducks for foraging, rearing young, and constructing nests along shorelines or on floating vegetation). This receptor group—Birds—focuses primarily on waterbirds (e.g., gulls, terns, loons), waterfowl (e.g., ducks, geese, swans), and shorebirds (e.g., sandpipers, plovers, herons, cranes) that are often intimately associated with aquatic environments, as these are the most vulnerable to releases of hydrocarbons (Albers 2003). However, members of other bird groups, such as raptors and songbirds, are also considered in this environmental effects assessment.

Birds have dietary preferences that range from piscivory (fish-eating species such as osprey, loons, mergansers) and insectivory (insect-eating species such as swallows, lesser scaup and spotted sandpiper) to omnivory (species that consume a variety of foods such as mallard) and herbivory (species that consume primarily vegetation such as Canada goose). Nesting habits of aquatic birds range from stick nests in trees located close to water (e.g., eagles, osprey, and herons), and ground-nesting species that may build nests in adjacent uplands or close to shorelines (e.g., spotted sandpiper, and lesser scaup), to species that build nests on floating vegetation as a predator avoidance mechanism, such as the horned grebe.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south, where they can find open-water habitat. Timing of migration varies among species, and is usually a function of migratory distance. Long-distance migrants depart earlier and arrive later, with more predictable migration timing, whereas short-distance migrants will arrive as soon as aquatic environments begin to open in the spring and depart only when lakes and rivers freeze in the fall. However, some aquatic birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available.

There is only one federally-listed bird in this receptor group (the piping plover, *Charadrius melodus*, Endangered, USFWS 2016) that is likely to occur in the study area (i.e., Minnesota). In addition, there are several receptor group species listed under Minnesota's Endangered Species Statutes (MN DNR 2013). These include:

- Horned grebe (*Podiceps auritus*) — Endangered
- King rail (*Rallus elegans*) — Endangered
- Wilson's phalarope (*Phalaropus tricolor*) — Threatened
- Common tern (*Sterna hirundo*) — Threatened
- Yellow rail (*Coturnicops noveboracensis*) — Special concern

- Trumpeter swan (*Cygnus buccinator)* Special concern
- Common gallinule (*Gallinula galeata*) Special concern
- Franklin's gull (*Leucophaeus pipixcan*) Special concern
- Marbled godwit (*Limosa fedoa*) Special concern
- Louisiana waterthrush (*Parkesia motacilla*) Special concern
- American white pelican (*Pelecanus erythrorhynchos*) Special concern
- Forster's tern (*Sterna forsteri*) Special concern

7.1.3.6.2 Observed Effects

A review of hydrocarbon releases from pipelines, as well as one example each for a rail car release and a release from a storage tank, provide an overview of observed effects of oil releases on birds in aquatic environments (e.g., river, lakes and wetlands) similar to those that could be encountered in Minnesota. This review is not exhaustive, but provides a range of observed effects of a variety of oil types on birds, under different environmental conditions. The case studies will provide an empirical basis from which the likely effects of oil releases on aquatic birds can be predicted, with consideration of the modifying effects of oil type, and environmental factors.

> ***Ashland Petroleum****: On January 2, 1988, a 40 year old storage tank collapsed at the Ashland Oil Facility in West Elizabeth, Pennsylvania. The tank collapse released approximately 90,500 barrels of diesel fuel, of which 23,800 barrels flowed into the Monongahela River 27 miles south of Pittsburgh, Pennsylvania. As the release moved downstream, water supplies were contaminated, resulting in the disruption of water services to riverside cities in Pennsylvania, Ohio, and West Virginia. As of January 7, 1988, only 1,900 barrels of product had been recovered (NOAA 1992). The effort to recover the oil was hindered by dams and locks along the Ohio River, ice cover, emulsification of the oil, and dispersion of the oil into the water. The Pennsylvania Game Commission assisted by volunteers set up bird cleaning programs and monitored for oiled wildlife, though efforts were hampered by weather conditions and by partial ice cover that resulted in rescue workers not being able to access areas where birds were concentrated. Waterbird and waterfowl mortality estimates ranged from 2,000 to 4,000 birds, including ducks, loons, cormorants and geese among others (Miklaucic and Saseen 1989). The high mortality was likely due to the response limitations arising from environmental conditions which prevented crews from deterring birds from oiled sites and rescuing birds that had remained in open water areas of the river (Miklaucic and Saseen 1989).*

> ***Exxon Bayway****: On January 2, 1990, an underwater pipeline released approximately 13,500 barrels of No. 2 heating oil into the Arthur Kill waterway at the mouth of Morse Creek between New Jersey and Staten Island, New York (NOAA 1992). Initial response efforts focused on containment of the release and removal of the larger masses of oil. Concentrations of floating oil and mousse in the open water, primarily between Howland Hook and Fresh Kills, were collected by self-propelled skimmers. Oil concentrated and stranded above the berm on the beaches from Cedar Point to Rossville, as well as in other natural areas. Factors resulting in the dispersal of oil beyond the berm were not*

reported, though it could have been due to tidal and wave action. Environmentally sensitive areas were protected with boom and skimmers that collected the larger masses of free-floating oil. Even though the incident occurred in January, the environment was a coastal marsh system that allows many species of aquatic birds to overwinter as a result of the open water maintained by tidal action and salt water. A total of 841 birds were reported oiled, with 691 fatalities. The most common groups were waterfowl and gulls (45% of the oiled birds each) (NOAA 1992; French McCay and Rowe 2004).

***Lakehead**: On March 3, 1991, a Lakehead Pipeline Company, Inc. owned pipeline ruptured and released over 40,000 barrels of crude oil (NOAA 1992) approximately two miles north of Grand Rapids, Minnesota. Some of the oil spread onto the 18-inch thick ice sheets on the Prairie River. Oil formed into 8 inch deep pools on top of the ice in the middle of the river and was also present under the ice. Vacuum trucks were used by clean-up personnel to remove the oil from the surface of the ice. Workers used squeegees to push the oil along the ice to a removal location. Booms were used on the river by cutting a slot through the ice cover with chainsaws. Ice that had been permeated with oil was chopped into blocks small enough to be carried away to a separate part of the river. Clean-up personnel sprayed the ice blocks with hot water to wash out the oil, which was then recovered with skimmers. Blocks that were only slightly contaminated were moved to lined holding tanks and broken up. The crushed ice was then allowed to melt to recover residual oil. There were no specific reports of oiled birds, or of the death of any birds; effects to fish and wildlife were reported as minimal by the MN DNR (Telegraph Herald 1991), likely due to ice-covered conditions at the time of the release.*

***OSSA II**: On January 30, 2000, an estimated 29,000 barrels of mixed heavy crude oil and diluent (combined density of approximately 0.8 g/mL) were released from the Transredes S.A operated OSSA II pipeline at the Rio Desaguadero river crossing in Bolivia as the river was rising to peak flood conditions (Lee et al. 2001, 2002; Owens and Henshaw 2002). Due to the very high river flow and water velocity conditions, and perhaps also due to the low viscosity of the oil which would allow it to become dispersed into the water as fine droplets, oil was found up to 230 miles downstream from the release location. For the most part, the surface oil was deposited onto river banks in strips, generally 3 to 6 ft wide and up to 0.5 to 1 inch thick. Many sections of river bank had a horizontal line of oil (a bathtub ring) where the oil was stranded, indicating the water level at the time (Owens and Henshaw 2002). The response effort included more than 3,600 people who recovered the oil within three months. Wasson et al. (2000; in Owens and Henshaw 2002) reported that few birds (in the order of tens; species not reported) were initially oiled by the release; observers did not detect additional birds in the weeks and months following the release, despite the high numbers of birds in the area.*

***Pine River**: On August 1, 2000, a Pembina Pipeline Corp. pipeline failure released approximately 6,200 barrels of light crude oil, of which an estimated 2,800 barrels entered*

the Pine River 70 miles upstream of Chetwynd, British Columbia (BC MOE 2000a). An estimated 300 to 710 barrels remained unaccounted for following the clean-up and remediation (Goldberg 2011). Most of the oil unaccounted for was considered likely to be entrained in sediment or debris in the river channel. Response measures included placing two containment systems, one approximately 14 miles downstream and a second approximately 19 miles downstream (BC MOE 2000c). The river was flowing at a low stage at the time of the release (approximately 5,680 ft^3/s measured at a station 100 miles downstream compared to flow rates above 31,880 ft^3/s during late spring and early summer) (Bustard and Miles 2011). The Pine River has a gradient of approximately 0.225% in the first 25 miles downstream from the release location, decreasing to 0.1% farther downstream (Bustard and Miles 2011).

A golden eagle and a hooded merganser were reportedly affected by the release. The eagle recovered, but the merganser was euthanized. No other birds were found by government staff or clean-up crews (BC MOE 2000b).

***Wabamun Lake**: On August 3, 2005, a Canadian National freight train derailed near the Village of Whitewood Sands, Alberta, releasing approximately 4,500 barrels of Bunker C fuel oil (Heavy Fuel Oil 7102; Hollebone et al. 2011) and 550 barrels of pole treating oil. An estimated 950 barrels of the Bunker C oil entered Wabamun Lake where it formed a thick black slick approximately 0.5 in. thick (Wernick et al. 2009). The heavy Bunker C product formed several types of aggregates including tar balls, larger tar "logs", submerged sheets, large lumps, tar balls that sometimes reformed into oil slicks, and a "slurry" composed of finely divided organic matter and small oil droplets (Fingas et al. 2006; Hollebone et al. 2011). The oil exhibited a variety of behaviors including submergence, neutral buoyancy, and resurfacing as a result of contacting and taking up foreign matter (such as mineral particles and organic debris) on its path to the lake (Fingas et al. 2006). No dispersion of oil in water was observed in the lake, and no mousse formation was reported in the three years following the release (Hollebone et al. 2011). Overall, the water in the open water area of the lake was reported to be not contaminated with released hydrocarbons or associated metals (Anderson 2006). This is consistent with the very low concentration of relatively water-soluble components (such as BTEX) in the released oil, and the relatively low water solubility of this heavy oil. Similarly, sediments beneath the open water portions of Wabamun Lake were reported not to have been contaminated with petroleum hydrocarbons and were considered to be of similar quality to concentrations measured in 2002 or shortly before the release (Anderson 2006).*

Clean-up activities included cutting of the vegetation and vacuum removal of submerged tar balls entrained in the reed bed detritus (Wernick et al. 2009). A two-year study was conducted to assess regrowth. The study found that exposure to the oil, which was released late in the growing season, did not cause large-scale changes to these emergent plant communities (Wernick et al. 2009). Physical factors such as clean-up activities and vegetation management appeared to be responsible for reduced

regrowth of vegetation observed at some locations (Wernick et al. 2009; Thormann and Bayley 2008).

Wabamun Lake is one of nine lakes in Alberta found to support western grebe colonies in 2006 (Kemper et al. 2008). The Alberta population is estimated at between 10,000 and 11,000 birds, representing approximately 10% of the North American population. The Wabamun Lake colony contains between 100 and 500 nests and is considered to be regionally important (Kemper et al. 2008). During 2001–2005, western grebes at Wabamun Lake nested in one main colony (Rich's Point), and the lowest reported number of nests was 243 in 2005. The release occurred after completion of nesting that year, killing an estimated 333 western grebes (about 69% of the adult population). A wildlife recovery center was set up immediately after the release. More than 530 oiled birds were recovered within five days after the release. Of those, 156 were either dead when recovered, or euthanized thereafter (TSBC 2007). The following summer, the resurfacing of submerged oil resulted in the oiling of additional waterfowl, though specific estimates were not provided (TSBC 2007).

In 2006, western grebes returned to nest at Rich's Point, and in addition, formed a second colony at the Ascot Beach reed bed. Together, the two sites contained 456 nests in 2006 and over 1,000 nesting adults (Kemper et al. 2008; Wollis and Stratmoen 2010). Populations at Wabamun lake followed similar trends pre- and post-release to those of the regional population (Wollis and Stratmoen 2010; AESRD and ACA 2013), suggesting that the release did not cause substantial long-term changes at this location.

***Glenavon**: On April 15, 2007, a release occurred on the Enbridge Line 3 pipeline approximately 1 mile downstream of the Glenavon pump station near Glenavon, Saskatchewan. The rupture released approximately 6,200 barrels of heavy crude oil and affected approximately five acres of a wetland on farmland (TSBC 2008a; SLR Consulting 2008a). Within two days of the release, approximately half of the crude oil had been recovered (Canada.com 2007a). The site was monitored for one week for exposure of wildlife to oil, and wetlands within 0.6 miles (1 km) were surveyed for any wildlife that may have been oiled initially and moved from the release site. Of the five birds affected (four Canada geese and one savannah sparrow), two Canada geese were euthanized, one Canada goose (which was able to fly) eluded capture and disappeared from the area, and one Canada goose and savannah sparrow were captured and transported to the Small Animal Clinic at the Western College of Veterinary Medicine. The Canada goose was successfully cleaned and considered for release, though the final action was unknown. The savannah sparrow died during clean-up (SLR Consulting 2008a). Response activities included the use of wildlife deterrents and fencing around the perimeter of the slough. The small number of birds oiled by the release was attributed to the release occurring at night when semi-aquatic birds are less likely to be active (SLR Consulting 2008a), and to mobilizing of a rapid response to avoid further exposure of birds.*

***Marshall**: On July 25, 2010, Enbridge's Line 6B pipeline experienced a release in a wetland near Marshall, Michigan. Approximately 20,000 barrels of heavy crude oil containing diluted bitumen were released over a period of about 17 hours. The pipeline contained two different batches of crude oil at the time of the release (NTSB 2012a). It is estimated that the released oil consisted of approximately 77% CLWB diluted bitumen and 23% Western Canadian Select, as well as diluted bitumen (Enbridge 2013a). Of this, approximately 8,000 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013a). During clean-up and monitoring, 52 birds were either found dead or died during attempted rehabilitation (USFWS et al. 2015a). In addition, 144 oiled birds were captured, successfully rehabilitated and released. There were approximately 140 additional birds observed oiled, but never captured. The primary species were Canada goose (75%), mallard (9%), and great blue heron (5%) (USFWS et al. 2015a). Of the birds rehabilitated and released, 127 were banded including 109 Canada geese. Between 2010 and 2015, 39 of those bands were recovered from hunters (unpublished banding data), indicating that birds survived post-release and were able to complete migration and dispersal.*

***Rainbow**: On April 28, 2011, a pipeline owned by Plains Midstream Canada released approximately 28,300 barrels of sweet crude oil into a muskeg/stagnant water area near the community of Little Buffalo in the Peace River region of Alberta. The release occurred on a hillside, and the oil flowed a half mile down the pipeline ROW and pooled in a low-lying area containing abandoned beaver ponds. The release encompassed an area of approximately 20 acres (ERCB 2013). As part of the response, wildlife mitigation measures, which included fencing and various deterrents, were implemented (ERCB 2013). Despite these measures 79 birds were reported to have died by November 2012, with most of the deaths occurring shortly after the release (i.e. within a few months). Bird species included in the reported fatalities were a mixture of approximately one-third waterfowl and two-thirds shorebirds and passerines; the particular species affected were not reported (ERCB 2013).*

***2011 Yellowstone River**: On July 1, 2011, flood conditions in the Yellowstone River resulted in a release from the ExxonMobil Silvertip Pipeline carrying medium sour crude oil near Laurel, Montana. Riverbed erosion exposed the 12-in. pipeline beneath the crossing, and debris caught on the washed-out pipeline causing stress, resulting in a clean break (i.e., a full bore rupture). The failure was detected at the pipeline control center and the line was shut down within 10 minutes (USDOT 2012). Approximately 1,500 barrels of crude oil was released into the Yellowstone River (USDOT 2012). The affected reach of the Yellowstone River has an average gradient of 0.17%. Crude oil affected primarily shorelines and banks immediately downstream of the release site (MT DEQ 2015b). According to the USEPA (2011), at least 19 oiled animals were confirmed to have been visibly oiled, including one bald eagle. Ten wildlife fatalities were reported, though no information on species or fate was provided (USEPA 2011).*

***Red Deer River**: On June 7, 2012 a Plains Midstream Canada ULC (Plains) pipeline released approximately 2,900 barrels of light crude oil into the Red Deer River downstream of Sundre, Alberta as a result of high water levels in the river that exposed the pipeline and caused structural damage (AER 2014). The migration of surface oil was stopped by booms placed at Gleniffer Lake, but dissolved hydrocarbons continued to move downstream. This resulted in potential for both toxicological and physical effects upstream of the booms, but limited potential for physical effects downstream (Teichreb 2014). As a result of the release, one Canada goose and one American crow were oiled; the animals were brought to the Medicine River Wildlife Centre where they were cleaned and treated (Derworiz 2012). Officials with Alberta Environment indicated that impacts to wildlife were minimal (Derworiz 2012).*

***Line 37**: On June 22, 2013, unusually heavy rains caused ground movement that compromised the integrity of the Enbridge Line 37 pipeline approximately 1 mile north of the terminal in Cheecham, Alberta. The resulting failure released approximately 1,300 barrels of synthetic light crude oil underground with some oil seeping to the surface where it flowed overland entering a wetland and unnamed lake (Enbridge 2013c). Initial clean-up and remediation recovered 93% of the crude oil with the remaining oil found in soils and the fen. Effects on semi-aquatic birds included two blue-winged teal found dead as a result of the release. A third teal was observed to be oiled, but may have been oiled post-mortem after predation by a fox (Focus Wildlife Canada 2013). The small number of reported oiled birds was potentially due to the low density of waterfowl and other aquatic birds in the area, but may also have been influenced by the short time required to implement spill response and mitigation measures.*

***Mid Valley**: On October 13, 2014, a Sunoco pipeline release occurred near Mooringsport, Louisiana, resulting in approximately 4,500 barrels of sweet crude oil entering the Miller branch of the Tete Bayou, which feeds into Caddo Lake. Although containment booms prevented the oil from entering Caddo Lake, approximately 10 miles of the creek were affected. Media reported that 486 dead animals were collected and 47 were cleaned and released (Wellborn 2014a). Most of the animals were crawfish and amphibians, but numbers and species were not provided. One wood duck was reportedly oiled, cleaned and released (Welborn 2014b), but this area would likely have been inhabited by shorebirds, wading birds, waterfowl, and other marsh birds.*

***Yellowstone River**: On January 17, 2015, a Bridger Pipeline LLC pipeline released approximately 715 barrels of Bakken crude oil (estimates ranged from 300 to 1,200 barrels) into the Yellowstone River approximately 5 miles upstream of Glendive, Montana (MT DEQ 2015b). The pipeline breach occurred where the pipeline crossed under the river. Winter conditions resulted in extensive ice cover, but aerial patrols discovered oil as far as 25 miles downstream of Glendive (The Guardian 2015). Booms were deployed on the ice and in areas of open water downstream to collect oil from the surface (Hirji 2015) but winter conditions combined with thawing resulted in unsafe working conditions and*

only a limited amount of oil (approximately 60 barrels, MT DEQ 2015a) was recovered from the river. There were no reports of oiled wildlife (including birds) or dead fish (Stuart 2015). The Montana Departments of Natural Resources and Conservation and Fish, Wildlife and Parks expressed concern that the most important source of damage to the riverine system was the physical damage caused by response crews and equipment during clean-up operations.

7.1.3.6.3 Expected Effects of Released Oils

The case studies in the foregoing section provide the opportunity to highlight key differences between oil releases to inland waters to those in marine environments.

The first consideration is the environment in which the releases occur. For marine releases, oil can spread and be transported by wind and currents with the potential to affect a very large area. In contrast, inland releases are almost always constrained. Releases to wetlands and small lakes (e.g., the Line 37 release) provide natural traps limiting the spread of oil and preventing damage to downstream habitats. Even releases to rivers are constrained to the river channel. River banks provide substrates where oil can strand and be retained, thereby limiting downstream migration and facilitating emergency response measures.

Secondly, the effects of an inland oil release, while potentially having severe local effects to birds, are likely to have only minor regional or population level effects unless they occur in sites where a high proportion of a species' population congregates. This is due to the redundancy provided by unaffected habitat upstream, downstream, or in unaffected nearby watersheds. As a result, only a small portion of a regional population may be exposed to oil after an inland oil release. Exceptions could occur if releases affect areas where birds are concentrated in an isolated area of open water during winter conditions (e.g., the Ashland release) or where there are breeding concentrations of birds (e.g., the Wabamun Lake release). Locations of importance to regional or continental populations of birds, such as Western Hemisphere Shorebird Reserve Network Sites or Important Bird Areas, are generally well known and potential effects of releases predicted. Thus, except in unusual circumstances, the environmental effects of oil releases on birds in inland habitats tend to be limited to small numbers of individuals than for marine oil releases. Large releases of crude oil to the marine environment have the potential to affect large numbers of individuals and species (as was the case for the Exxon Valdez oil release; Weins et al. 2013).

Hydrocarbon releases can harm birds through physical effects, acute and chronic toxicological effects, and through changes in habitat (Albers 2003; Malcolm and Shore 2003). The environmental effects of an oil release on aquatic and semi-aquatic birds will therefore depend upon the amount of oil released, the environment that the oil is released into, and the numbers and types of aquatic and semi-aquatic birds that are exposed to the oil. Secondarily, oil spill response measures will help to limit the spread of released oil and, in doing so, will reduce the potential exposure of birds. In addition, capture and rehabilitation of oiled birds may help to reduce mortality.

Detecting dead birds following a hydrocarbon release in the aquatic environment is challenging, and is known to under-represent the true number of fatalities associated with a hydrocarbon release. For example, Byrd et al. (2009) estimated that only 14.6% of carcasses along coastal (marine) beaches remained after 24 hours due to scavenging. Moreover, searchers averaged a 40% detection rate of carcasses known to be present after a single pass, and a cumulative increase to 70% detection following a second pass. Comparable statistics for inland water bodies are not available.

The following sections provide further insight into the role of oil type and environmental factors on the environmental effects of released oil on aquatic and semi-aquatic birds.

7.1.3.6.3.1 Direct Physical Effects of Oil on Birds

The most easily observed and reported effect of a hydrocarbon release on birds is physical oiling of plumage. Feathers provide aquatic birds with buoyancy and insulation. Oiling impairs both of these properties, and the added weight may affect a bird's ability to fly, affecting foraging, migration, and predator avoidance. Also, oiling often results in death from hypothermia or drowning of birds that are obligate users of aquatic habitat (Vermeer and Vermeer 1975; Jenssen 1994), particularly in cold-water environments. Smaller birds are likely to succumb to physical oiling at a faster rate than larger birds, as the surface area of smaller organisms is larger in proportion to their body mass. Body size effects would also result in greater impairment of small birds, which would require proportionally greater effort to fly with partial oiling. Lower ambient temperature will amplify the physiological effects of reduced insulation in organisms. As noted above, heat loss will also be much greater for a bird immersed in cold water than for a bird immersed in air at the same temperature (Knopper et al. 2016). A higher rate of heat loss will lead to faster onset of hypothermia and potentially death in oiled birds. A partially oiled bird might be susceptible to hypothermia if exposed to cold air or water, while the same bird might survive partial oiling if exposed to moderate or warm temperatures (Knopper et al. 2016). However, for birds such as gulls, shorebirds, and waders that have sufficient behavioral plasticity to avoid immersion in cold water when oiled, long-term survival and an ability to self-clean and recover from light to moderate oiling has been reported (Camphuysen 2011).

The effect of oil type on oiling of birds has not been directly studied, but evidence from marine studies would suggest that any oil type can be harmful. The NRDAM/CME (French et al. 1996) bases the assessment of harm to marine birds on slick thickness, with predictions of bird mortality on a threshold slick thickness of 10 µm. As heavier crude oils have higher adhesion than lighter crude oils (NAS 2016), it would be more difficult for individuals to remove heavier crude oil from feathers through preening, and could also result in greater ingestion of hydrocarbons by birds than for lighter crude oils. While it is reasonable to conclude that light oils could spread to very thin sheens (less likely to be harmful to aquatic birds) than more viscous heavy oils, it is also reasonable to conclude that a release of light oil could spread to affect a larger area and therefore affect more birds than a similar sized release of heavy oil. The exact outcome of exposure of birds to oil will depend on climate and other influences on both oil dispersion and the distribution of birds, as well as oil type.

7.1.3.6.3.2 Direct Toxicological Effects of Oil on Birds

Acute toxic effects are less common in birds and other terrestrial vertebrates that can escape from a region where oil has been released into the environment. Acute and chronic effects on birds of hydrocarbon exposure through ingestion or inhalation pathways are generally considered less serious than the physical effects of external oiling (Albers 2003). Acute toxicity of ingested hydrocarbons or inhaled hydrocarbon vapor in birds is generally the result of liver failure, narcosis and other biochemical responses (Albers 2003, 2006). Low molecular weight hydrocarbons can result in acute effects shortly after an oil release when they are in sufficiently high concentrations at the site of release (and in the ingested oil), prior to being diluted in the environment or evaporating into the atmosphere (weathering).

Direct toxicological effects on birds of hydrocarbons released to the environment are generally less significant for adult birds than physical effects described previously. Studies, generally with ducks, have shown that naturally weathered Exxon Valdez crude oil presented little potential for toxicity to wildlife species from oral ingestion (Stubblefield et al. 1995a, b). In the short term, birds are most likely to ingest hydrocarbons directly as a result of preening oiled feathers with their bills, but also through ingestion of food and incidental ingestion of sediment (Albers 2003). Ingestion of oil is seldom directly lethal, but it can cause many debilitating sublethal effects that promote death from other causes, including starvation, disease, and predation (Albers 2003, 2006). Effects include gastrointestinal irritation, pneumonia, dehydration, red blood cell damage, impaired osmoregulation, immune system suppression, hormonal imbalance, inhibited reproduction, retarded growth, and abnormal parental behavior (Albers 2003, 2006). Therefore, birds that survive external oiling without succumbing to hypothermia may be at secondary risk of death due to ingesting a quantity and mixture of hydrocarbon compounds, which can then result in multiple additional effects. Birds that survive external oil exposure may subsequently be indirectly exposed to hydrocarbons (of which the polycyclic aromatic hydrocarbons or PAHs are of greatest concern) through contaminated food, and incidental ingestion of contaminated sediment, soil or water.

During the breeding season, birds carrying hydrocarbons on their feathers are also at risk of transferring oil to their eggs. Studies examining the effect of eggshell oiling found that small quantities of oil can cause embryonic death. Effects were more pronounced for light crude oils, as they contain higher proportions of BTEX and 2-ring PAHs (Hoffman 1990), which are capable of penetrating through the eggshell and egg membrane. This is consistent with results of a study by Szaro et al. (1980) showing that weathered oils were slightly less toxic to mallard eggs than fresh oils. However, toxicity was dose-dependent through the range of 1 and 50 µL of oil per egg (Szaro et al. 1980).

7.1.3.6.3.3 Indirect Effects of Oil on Birds

Indirect effects of hydrocarbon releases to birds occur through effects to habitat or food quality or availability (Wiens et al. 2013). Because aquatic birds inhabiting inland freshwater environments are typically only present during the open-water season, their habitat requirements are seasonal during the migration and breeding period. The magnitude of effects

on breeding habitat of semi-aquatic bird species depends on their nesting behavior. Species such as gulls or terns that nest in colonies on islands, or in habitat that may be limiting (e.g., grebes nesting in reed beds) may have fewer options when seeking alternative nesting locations following a disturbance than species with greater plasticity in habitat requirements (e.g., spotted sandpiper). Where oil becomes entrained in riparian or wetland vegetation, remediation activities that include vegetation clearing could affect nesting or roosting habitat of aquatic and semi-aquatic birds (see Wabamun Lake case study).

Foraging habitat loss depends on a species foraging behavior and the fate of released hydrocarbons in the environment. Hydrocarbons collecting along shorelines and riparian bank areas would primarily affect shorebirds. Oil entrained in emergent or submerged vegetation in wetlands, deadwater areas of rivers, and shallow portions of lakes would affect waterfowl, waterbirds and wading birds (e.g., herons). However, as birds are capable of dispersing to unaffected areas to forage, effects of hydrocarbon releases would be limited to the aquatic system in which the release occurred. At a regional level, population effects would not likely be observed (Albers 2003). Indirect effects could also result from changes in food quality or abundance. Effects of hydrocarbon releases on aquatic invertebrates or fish could temporarily reduce prey availability or quality for birds.

7.1.3.6.4 Summary of Inland Oil Release Effects on Birds

Table 7-39 and Table 7-40 provide a summary of the expected environmental effects of oil releases to aquatic and semi-aquatic birds in inland environments. Table 7-39 considers the effects of specific oil characteristics or oil type on the expected types and scope of environmental effects. Table 7-40 considers the effects of environmental characteristics on the expected types and scope of environmental effects.

Table 7-39 Biological Receptor: Semi-aquatic Birds

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—buoyancy	Light crude oils typically have a low relatively density (0.78-0.88 g/mL, Dupuis and Ucan-Marin 2015) and are buoyant in freshwater aquatic environments.	Medium crude oils typically have an intermediate density compared to light and heavy crudes, and are buoyant in freshwater aquatic environments (Dupuis and Ucan-Marin 2015).	Heavy conventional crude oils can have density ranging of 0.88 to 1.00 g/mL, while diluted bitumen will have density less than 0.94 g/mL (Dupuis and Ucan-Marin 2015).	While raw bitumen has a higher density than water, diluted bitumen is less dense and limited evaporative mass loss at environmentally-relevant temperatures suggests that weathered dilbit will remain afloat as it will retain sufficient diluent to maintain a lower density ((Lee et al. 2015; see also Section 7.1.2). Recovery of released oil is facilitated if the oil floats on the surface of the water.
Oil properties—viscosity	Light crudes will spread rapidly on water because of their low viscosity (1 to 5 mPa•s, NAS 2016).	Medium crudes have an intermediate viscosity (8 to 112 mPa•s, NAS 2016).	Heavy crudes (820 to 475,000 mPa•s) and diluted bitumens (270 to 50,000 mPa•s) weather to high viscosity (NAS 2016).	Viscosity is a function of oil chemistry. Diluted bitumens tend to display a more rapid increase in viscosity due to weathering than conventional heavy crude oils as a result of the rapid initial evaporation of some of the diluent. Oil having low viscosity will rapidly spread across the water surface forming a thin and relatively uniform slick. More viscous oils will spread more slowly and may exhibit thicker but patchier slicks with associated sheens.
Oil properties—adhesion	Light crudes have low adhesion and viscosity (NAS 2016) and can be expected to penetrate the feather layer to contact skin.	Medium crudes have an intermediate adhesion and viscosity (NAS 2016). Medium crude oils also readily penetrate the feather layer to contact skin.	Heavy crudes, particularly diluted bitumens, are highly adhesive and more viscous than light and medium crude oils. Fresh diluted bitumens have relatively low viscosity, and would penetrate feathers. However, weathered heavy crudes may tend to stick to the surface of feathers without penetrating to contact the skin.	Properties of adhesion and viscosity may change the way that crude oil interacts with feathers. Light oils may more readily penetrate feathers and destroy insulation; heavy oils, particularly when weathered, may tend to adhere in a thick layer to the feather surface without immediately penetrating to the skin surface. This results in more difficult cleaning and removal of oils from feathers, greater added weight and extended duration of physical effects.
Oil chemistry—	Light crude oils	Medium crude oils	Levels of BTEX and other relatively	Diluted bitumens do not contain higher

Table 7-39 Biological Receptor: Semi-aquatic Birds

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
toxic constituents	often contain high levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, depending on the oil type, but can be high (>10,000 mg/kg) in Bakken oils.	often contain moderate levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, but can exceed 10,000 mg/kg.	water soluble constituents are variable: generally low in heavy conventional oils, but variable in diluted bitumens depending upon the nature of the diluent. Levels of TPAH are variable, but typically depleted in napthalenes and less than 10,000 mg/kg.	concentrations of either BTEX or TPAH than many conventional crude oils (Dupuis and Unca-Marin 2015; Lee et al. 2015). The characteristics of diluted bitumen are further discussed in Section 7.1.2. Acute effects on bird populations are generally caused by physical oiling, not related to the BTEX content of the oil. Chronic effects on birds of released crude oil, if any, are likely due to dietary TPAH exposure. Diluted bitumens contain the same suite of PAHs as conventional crude oils, but at different relative concentrations due to the highly weathered nature of the bitumen component, and the modifying effect of the diluent.
Oil properties—persistence	Light crude oils typically contain only small proportions of higher molecular weight components, such as resins and asphaltenes. Light crude oils generally biodegrade readily.	Medium crude oils contain variable proportions of resins and asphaltenes. Asphaltenes would be removed from synthetic medium crudes during processing of bitumen.	Heavy conventional crude oils and diluted bitumens typically contain higher proportions of resins and asphaltenes, which tend to resist biodegradation.	In general, heavy conventional crude oils and diluted bitumens would be expected to biodegrade less rapidly than light or medium crude oils. However, any oil can be persistent if deposited in an environment where there is little or no available oxygen.

Table 7-40 Biological Receptor: Semi-Aquatic Birds

Environmental Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Habitat type	Light crude oil will spread rapidly due to its low viscosity, potentially resulting in effects over a larger area in lakes and wide rivers.	Medium crude oil has low viscosity, although viscosity increases at lower temperatures, and will behave similarly to light crude oils.	Heavy crude oils have high viscosity. Diluted bitumens also have high viscosity (although reduced while fresh due to the effect of the diluent), potentially resulting in effects over a smaller area in lakes and wide rivers, due to the oil's resistance to spreading in these habitats.	Low viscosity oils will spread more rapidly, and to thinner slicks, than high-viscosity oils. As a result, low viscosity oils have a higher potential to affect a larger area of habitat, particularly open-water habitats such as lakes and wide rivers, than higher viscosity oils. At the same time, higher viscosity oils will tend to form thicker slicks than low viscosity oils. This could lead to a contrast of "more habitat and birds oiled less heavily" (lighter oils) as compared to less habitat and fewer birds oiled more heavily (heavier oils) for a spill of the same magnitude.
Season	Light oils remain fluid at low temperature and retain the potential to spread rapidly during the winter. Light oils may penetrate cracks in ice or close to shore, allowing the oil to get beneath the ice and spread downstream. In summer, light crude oils would also flow readily and spread rapidly, having the potential to contact larger numbers of birds than heavier, more viscous oils.	Medium oils are slightly more viscous than light oils, and would also tend to flow readily under winter conditions. Medium crude oils would tend to flow readily and spread rapidly under summer conditions.	Heavy oils become much more viscous at low temperatures and as they weather. Heavy oils and diluted bitumens would have more resistance to flowing or penetrating cracks in ice to reach the water surface than would be the case for light or medium crude oils. During the summer, diluted	Season affects both the behavior of oil in the environment, and the types and abundance of birds that could be exposed to spilled oil. Most aquatic birds migrate south during the winter, unless reliable open water conditions (e.g., fast-moving water where ice does not form) create access to a reliable food supply. Most northern hemisphere birds breed during the summer months, and for some species this implies colonial nesting habits. Birds may also congregate in

Table 7-40 Biological Receptor: Semi-Aquatic Birds

Environmental Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
			bitumens would flow readily and spread rapidly while fresh. Weathering in the first 24 to 48 hours would result in increasing viscosity and density, limiting further spreading of the oil on the water surface.	feeding or staging areas during seasonal migration events.
Weather conditions—rainfall and water levels	Periods of high rainfall and high water levels could transport spilled crude oil into riparian areas, in addition to potentially increasing downstream transport distances. This would affect all crude oil types. If crude oil is transported into riparian areas, then different species of birds (e.g., shorebirds and ground-feeding birds) could be exposed to the oil and its effects either through direct contact with oil, or though food chain effects as PAHs and oily residues are ingested with food and associated soil.			
Weather conditions—temperature	The survival of oiled birds could be affected by ambient temperatures, regardless of season. The primary cause of mortality in oiled birds is hypothermia caused by the loss of insulation value of oiled feathers. Birds that are in contact with cold water experience far greater thermal stress than birds that are in contact with air. Oiled birds may move onto land to reduce thermal stress. Such birds might survive for longer periods of time (providing an opportunity for capture and rehabilitation) during periods of warm weather, as compared to periods of cold weather.			
Slope	Lakes have negligible slope, and therefore the short-term distribution of crude oil on the water surface may be determined primarily by wind. Streams and rivers have slope, which determines the downstream water flow velocity, as well as influencing the turbulence of that flow. Slope therefore helps to determine the downstream transport distance for spilled oil before emergency response can be effectively applied. This can affect the types of habitat that the spilled oil could affect, as well as the numbers and types of birds.			

7.1.3.7 Semi-Aquatic Mammals

7.1.3.7.1 Description

Most North American mammals are terrestrial in nature. However, some species have evolved to use aquatic environments as facultative or obligate habitat (Vaughan et al. 2000). Species inhabiting aquatic environments are more likely to be exposed to and be affected by oil in the event of a release because oil disperses more readily in aquatic environments, and because contact with cold water results in a much higher level of thermal stress on oiled animals than exposure to air (McEwan et al. 1974; Knopper et al. 2016). Semi-aquatic species also tend to seek refuge in their aquatic environment rather than disperse over land. For example, beavers, muskrats and otters will seek refuge in lodges when threatened by predators. Therefore, semi-aquatic mammals were selected as a receptor group to focus upon for this effects assessment. The semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, but this assessment will focus particularly upon species that have a primary association with the aquatic environment such as muskrat, beaver, American mink, river otter, and the water shrew.

Among semi-aquatic mammals, moose are the least dependent on aquatic environments. Their association is based on the preferential foraging for vegetation in lakes and wetlands during the open-water season (Franzmann 1981), which would limit oil exposure to periods when hypothermia would be less severe than during the winter period. Moose are large-bodied, and would be less prone to hypothermia due to oiling of the fur than smaller mammals. The raccoon is less dependent on aquatic environments, but is associated with riparian areas, foraging on aquatic invertebrates and fish during the open-water season (Lotze and Anderson 1979). Both moose and raccoon would be expected to have the behavioral plasticity to select habitat where thermal stress would be reduced if they were to be oiled, and in addition would be able to continue to feed even when denied access to an oiled watercourse. These species are considered to have low (i.e., moose) or moderate (i.e., raccoon) sensitivity to crude oil exposure.

Other semi-aquatic herbivores in this receptor group include beaver and muskrat. These species inhabit aquatic environments year-round and overwinter in lodges located on lakes, rivers, or wetlands (Jenkins and Busher 1979; Willner et al. 1980). Both species eat a mixture of aquatic and terrestrial vegetation. American mink, North American river otter, and northern water shrews are also semi-aquatic species that forage year-round in aquatic environments, raising their young in dens along shorelines or in abandoned beaver lodges. These are primarily carnivorous species that generally eat a mixture of fish and invertebrates (Larivière 1999; Larivière and Walton 1998; Beneski and Stinson 1987). These species would have little or no opportunity to select environments where contact with water could be avoided if they were to become oiled, and similarly little behavioral plasticity to continue feeding if forced away from the aquatic environment. These species are considered to have high sensitivity to crude oil exposure.

Among semi-aquatic mammals, only the moose (Special Concern) is listed under either the federal *Species at Risk Act* or under Minnesota's Endangered Species Statutes (MN DNR 2013; USFWS 2016).

7.1.3.7.2 Observed Effects

A number of hydrocarbon oil releases from pipelines, as well as rail car and storage tank examples, provide an overview of observed effects of oil releases on mammals in aquatic environments (e.g., river, lakes and wetlands) similar to those that could be encountered in Minnesota. This review is not exhaustive, but provides a range of observed effects of a variety of oil types on semi-aquatic mammals, under different environmental conditions. The case studies provide an empirical basis from which the likely effects of oil releases on semi-aquatic mammals can be predicted, with consideration of the modifying effects of oil type, and environmental factors.

> ***Ashland Petroleum**: On January 2, 1988, a 40 year old storage tank collapsed at the Ashland Oil Facility in West Elizabeth, Pennsylvania. The tank collapse released approximately 90,500 barrels of diesel fuel, of which 23,800 barrels flowed into the Monongahela River 27 miles south of Pittsburgh, Pennsylvania. As the release moved downstream, water supplies were contaminated, resulting in the disruption of water services to riverside cities in Pennsylvania, Ohio, and West Virginia. As of January 7, only 1,900 barrels of product had been recovered (NOAA 1992). The effort to recover the oil was hindered by dams and locks along the Ohio River, ice cover, emulsification of the oil, and dispersion of the oil into the water. The Pennsylvania Game Commission assisted by volunteers set up bird cleaning programs and monitored for oiled wildlife, though efforts were hampered by weather conditions and partial ice cover that resulted in rescue workers not accessing areas where wildlife might concentrate. While bird fatalities were reported as a result of the release, there were no semi-aquatic mammals reportedly affected (Miklaucic and Saseen 1989), though there would have likely been muskrat, beaver, mink, and river otter inhabiting the aquatic environment.*

> ***Exxon Bayway**: On January 2, 1990, an underwater pipeline released approximately 13,500 barrels of No. 2 heating oil into the Arthur Kill waterway at the mouth of Morse Creek between New Jersey and Staten Island, New York (NOAA 1992). Initial response efforts focused on containment of the release and removal of the larger masses of oil. Concentrations of floating oil and mousse in the open water, primarily between Howland Hook and Fresh Kills, were collected by self-propelled skimmers. Oil concentrated and stranded above the berm on the beaches from Cedar Point to Rossville as well as in other natural areas. Factors resulting in the dispersal of oil beyond the berm were not reported, though it could have been due to tidal and wave action. Environmentally sensitive areas were protected with boom and skimmers that collected the larger masses of free-floating oil. Through February 20, 1990, monitoring crews reported 29 dead muskrats among other affected wildlife (NOAA 1992).*

***Lakehead**: On March 3, 1991, a Lakehead Pipeline Company, Inc. owned pipeline ruptured and released over 40,000 barrels of crude oil (NOAA 1992) approximately two miles north of Grand Rapids. Some of the oil spread onto the 18 in. thick ice sheets on the Prairie River. Oil formed into 8 inch deep pools on top of the ice in the middle of the river and was also present under the ice. Vacuum trucks were used by clean-up personnel to remove the oil from the surface of the ice. Workers used squeegees to push the oil along the ice to a removal location. Booms were used on the river by cutting a slot through the ice cover with chainsaws. Ice that had been permeated with oil was chopped into blocks small enough to be carried away to a separate part of the river. Clean-up personnel sprayed the ice blocks with hot water to wash out the oil, which was then recovered with skimmers. Blocks that were only slightly contaminated were moved to lined holding tanks and broken up. The crushed ice was then allowed to melt to recover residual oil. There were no reports of semi-aquatic mammals affected by the oil release; effects to fish and wildlife were reported as minimal by the MN DNR (Telegraph Herald 1991), likely due to ice-covered conditions at the time of the release.*

***OSSA II**: On January 30, 2000, an estimated 29,000 barrels of mixed heavy crude oil and diluent (combined density of approximately 0.8 g/mL) were released from the Transredes S.A operated OSSA II pipeline at the Rio Desaguadero river crossing in Bolivia as the river was rising to peak flood conditions (Lee et al. 2001, 2002; Owens and Henshaw 2002). Due to the very high river flow and water velocity conditions, and perhaps also due to the low viscosity of the oil which would allow it to become dispersed into the water as fine droplets, oil was found up to 230 miles downstream from the release location. For the most part, the surface oil was deposited in strips, generally 3 to 6 ft wide and up to 0.5 to 1 inch thick. Many sections of river bank had a horizontal line of oil (a bathtub ring) where the oil was stranded, indicating the water level at the time (Owens and Henshaw 2002). The response effort included more than 3,600 people who recovered the oil within three months. Wasson et al. (2000; in Owens and Henshaw 2002) reported on the wildlife effects of the release and indicated that no wildlife fatalities other than a small number of birds were observed during the extensive post-release monitoring.*

***Pine River**: On August 1, 2000, a Pembina Pipeline Corp. pipeline failure released approximately 6,200 barrels of light crude oil, of which an estimated 2,800 barrels entered the Pine River 70 miles upstream of Chetwynd, British Columbia (BC MOE 2000a). An estimated 300 to 710 barrels remained unaccounted for following the clean-up and remediation (Goldberg 2011). Most of the oil unaccounted for was considered likely to be entrained in sediment or debris in the river channel. Response measures included placing two containment systems, one approximately 14 miles downstream and a second approximately 19 miles downstream (BC MOE 2000c). The river was flowing at a low stage at the time of the release (approximately 5,680 ft^3/s measured at a station 100 miles downstream compared to flow rates above 31,880 ft^3/s during late spring and early summer) (Bustard and Miles 2011). The Pine River has a gradient of approximately 0.225% in the first 25 miles downstream from the release location, decreasing to 0.1% farther*

downstream (Bustard and Miles 2011). There were incidental reports of beaver, otter, and mink being affected, though no injured or oiled mammals were detected or captured during the wildlife monitoring program (BC MOE 2000b).

***Wabamun Lake**: On August 3, 2005, a Canadian National freight train derailed near the Village of Whitewood Sands, Alberta, releasing approximately 4,500 barrels of Bunker C fuel oil (Heavy Fuel Oil 7102; Hollebone et al. 2011) and 550 barrels of pole treating oil. An estimated 950 barrels of the Bunker C oil entered Wabamun Lake where it formed a thick black slick approximately 0.5 inch thick (Wernick et al. 2009). The heavy Bunker C product formed several types of aggregates including tar balls, larger tar "logs", submerged sheets, large lumps, tar balls that sometimes reformed into oil slicks, and a "slurry" composed of finely divided organic matter and small oil droplets (Fingas et al. 2006; Hollebone et al. 2011). The oil exhibited a variety of behaviors including submergence, neutral buoyancy, and resurfacing as a result of contacting and taking up foreign matter (such as mineral particles and organic debris) on its path to the lake (Fingas et al. 2006). No dispersions of oil in water were observed in the lake, and no mousse formation was reported in the three years following the release (Hollebone et al. 2011). Overall, the water in the open water area of the lake was reported to be not contaminated with released hydrocarbons or associated metals (Anderson 2006). This is consistent with the very low concentration of relatively water-soluble components (such as BTEX) in the released oil, and the relatively low water solubility of this heavy oil. Similarly, sediments beneath the open water portions of Wabamun Lake were reported not to have been contaminated with petroleum hydrocarbons and were considered to be of similar quality to concentrations measured in 2002 or shortly before the release (Anderson 2006).*

Clean-up activities included cutting of the vegetation and vacuum removal of submerged tar balls entrained in the reed bed detritus (Wernick et al. 2009). A two-year study was conducted to assess regrowth. The study found that exposure to the oil, which was released late in the growing season, did not cause large-scale changes to these emergent plant communities (Wernick et al. 2009). Physical factors such as clean-up activities and vegetation management appeared to be responsible for reduced regrowth observed at some locations (Wernick et al. 2009; Thormann and Bayley 2008).

Despite an intensive wildlife monitoring program, and a wildlife recovery center set up immediately after the release, there were no reports of semi-aquatic mammals injured by the oil, although there was considerable mortality of waterfowl (TSBC 2007). It is likely that beavers, muskrat, mink, and possibly river otters inhabit this system.

***Glenavon**: On April 15, 2007, a release occurred on the Enbridge Line 3 pipeline approximately 1 mile downstream of the Glenavon pump station near Glenavon, Saskatchewan. The rupture released approximately 6,200 barrels of heavy crude oil and affected approximately five acres of a wetland on farmland (TSBC 2008a; SLR Consulting*

2008a). Within two days of the release, approximately half of the crude oil had been recovered (Canada.com 2007a). The site was monitored for one week for exposure of wildlife to oil, and wetlands within 0.6 miles (1 km) were surveyed for any wildlife that may have been oiled initially and moved from the release site. Wildlife monitoring did not detect mammals affected by the release (SLR Consulting 2008a), though it is likely that this system provided habitat for muskrats and possibly mink. The small number of wildlife (five birds) oiled by the release was attributed to the fact that the release occurred at night, and the rapid mobilization of a response to remove oil and reduce exposure of wildlife.

***Marshall**: On July 25, 2010, Enbridge's Line 6B pipeline experienced a release in a wetland near Marshall, Michigan. Approximately 20,000 barrels of heavy crude oil containing diluted bitumen were released over a period of about 17 hours. The pipeline contained two different batches of crude oil at the time of the release (NTSB 2012 a). It is estimated that the released oil consisted of approximately 77% CLWB diluted bitumen and 23% Western Canadian Select, also diluted bitumen (Enbridge 2013a). Of this, approximately 8,000 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013a). Wildlife monitoring programs reported that 40 mammals were either found dead or subsequently died during rehabilitation (USFWS et al. 2015a). In addition, 23 oiled mammals were captured, successfully rehabilitated, and released. An unknown number of mammals are assumed to have been oiled but never found or captured. The primary species reported affected were muskrat (45%), raccoon (13%), and beaver (13%) (USFWS et al. 2015a).*

***Rainbow**: On April 28, 2011, a pipeline owned by Plains Midstream Canada released approximately 28,000 barrels of sweet crude oil into a muskeg/stagnant water area near the community of Little Buffalo in the Peace River region of Alberta. The release occurred on a hillside, and the oil flowed a half mile down the pipeline ROW and pooled in a low-lying area containing abandoned beaver ponds. The release encompassed an area of approximately 20 acres (ERCB 2013). As part of the response, wildlife mitigation measures, which included fencing and various deterrents, were implemented (ERCB 2013). Despite spill-response wildlife-mitigation measures, wildlife mortality included 11 beavers and several small rodents (ERCB 2013) during response activities up through November 2012. No cause-of-mortality analysis was conducted for the deceased wildlife, but it is presumed that oiling was the likely cause.*

***2011 Yellowstone River**: On July 1, 2011, flood conditions in the Yellowstone River resulted in a release from the ExxonMobil Silvertip Pipeline carrying medium sour crude oil near Laurel, Montana. Riverbed erosion exposed the 12-inch pipeline beneath the crossing, and debris caught on the washed-out pipeline causing stress, resulting in a clean break. The failure was detected at the pipeline control center and the line was shut down within 10 minutes (USDOT 2012). Approximately 1,500 barrels of crude oil was released into the Yellowstone River (USDOT 2012). The affected reach of the Yellowstone River has an*

average gradient of 0.17%. Crude oil affected primarily shorelines and banks immediately downstream of the release site (MT DEQ 2015b). According to the USEPA (2011), no oiling of semi-aquatic mammals was reported, though muskrats, mink, river otters, and possibly beavers likely inhabited the area.

***Red Deer River**: On June 7, 2012 a Plains Midstream Canada ULC (Plains) pipeline released approximately 2,900 barrels of light crude oil into the Red Deer River downstream of Sundre, Alberta as a result of high water levels in the river that exposed the pipeline and caused structural damage (AER 2014). The migration of surface oil was stopped by booms placed at Gleniffer Lake, but dissolved hydrocarbons continued to move downstream. This resulted in potential for both toxicological and physical effects upstream of the booms, but limited potential for physical effects downstream (Teichreb 2014). Two beavers were reported among the affected wildlife (Derworiz 2012). Officials with Alberta Environment indicated that effects to wildlife were minimal (Derworiz 2012).*

***Line 37**: On June 22, 2013, unusually heavy rains caused ground movement that compromised the integrity of the Enbridge Line 37 pipeline approximately 1 mile north of the terminal in Cheecham, Alberta. The resulting failure released approximately 1,300 barrels of synthetic light crude oil underground with some oil seeping to the surface where it flowed overland entering a wetland and unnamed lake (Enbridge 2013c). Initial clean-up and remediation recovered 93% of the crude oil with the remaining oil found in soils and the fen. No affected semi-aquatic mammals were detected (Focus Wildlife Canada 2013), though it is likely that muskrat and mink inhabited the wetland.*

***Mid Valley**: On October 13, 2014, a Sunoco pipeline release occurred near Mooringsport, Louisiana, resulting in approximately 4,500 barrels of sweet crude oil entering the Miller branch of the Tete Bayou, which feeds into Caddo Lake. Although containment booms prevented the oil from entering Caddo Lake, approximately 10 miles of the creek were affected. Media reported that 486 dead animals were collected and 47 were cleaned and released (Welborn 2014a). Most of the animals were crawfish and amphibians, but numbers and species were not provided. No semi-aquatic mammals were reportedly affected (Welborn 2014b), though this area would likely be inhabited by nutria, muskrat, river otter, beaver, and mink.*

***Yellowstone River**: On January 17, 2015, a Bridger Pipeline LLC pipeline released approximately 715 barrels of Bakken crude oil (estimates ranged from 300 to 1,200 barrels) into the Yellowstone River approximately 5 miles upstream of Glendive, Montana (MT DEQ 2015b). The pipeline breach occurred where the pipeline crossed under the river. Winter conditions resulted in extensive ice cover, but aerial patrols discovered oil as far as 25 miles downstream of Glendive (The Guardian 2015). Booms were deployed on the ice and in areas of open water downstream to collect oil from the surface (Hirji 2015) but winter conditions combined with thawing resulted in unsafe working conditions and only a limited amount of oil (approximately 60 barrels, MT DEQ 2015a) was recovered*

from the river. There were no reports of oiled wildlife (including mammals) or dead fish (Stuart 2015). The Montana Departments of Natural Resources and Conservation and Fish, Wildlife and Parks expressed concern that the most significant source of damage to the riverine system was the physical damage caused by response crews and equipment during clean-up operations (MT DEQ 2015a.

7.1.3.7.3 Expected Effects of Released Oils

The case studies presented in the foregoing section highlight some of the key factors of oil releases in aquatic environments on semi-aquatic mammals.

As previously indicated, semi-aquatic mammals are expected to be more vulnerable than terrestrial mammals since they rely on aquatic system for all or a portion of their life cycle, and releases into aquatic environments may result in oil dispersing or being transported further from the release site. Unlike waterbirds that often flock and congregate in large numbers (e.g., ducks, geese, gulls) which can be susceptible to a release, semi-aquatic mammals are typically territorial species that are more evenly distributed and have lower densities spread across suitable habitat in the landscape. Consequently for semi-aquatic mammals, the potential effects of an oil spill on regional populations are expected to be relatively low. However, there are also exceptions to low density mammal populations. Muskrats are occasionally found in high densities in wetland systems, making local populations more vulnerable to releases.

The effects of hydrocarbon releases on semi-aquatic mammals can be difficult to quantify directly because of challenges associated with detecting dead and injured individuals post-release. Bowyer et al. (2003) indicated that searching shorelines was not a reliable method of locating dead river otters following a release. This is likely a function of many semi-aquatic mammals (i.e., beavers, mink, muskrat, and otter) seeking refuge in lodges or burrows out of sight when distressed, which prevents detection. Greer et al. (2005) reported that 70 muskrats were recovered during monitoring programs following a crude oil release, but their assessment indicated that this represented less than 20% of the likely affected muskrats based on population estimates within the affected area. However, this is not likely to be the case for a large mammal such as the moose, which is more easily observed than aquatic mammals. The case studies do not provide any records of oiled or dead moose (or other ungulates) following an oil release, and it is concluded that these animals are not highly exposed to crude oil release, or highly sensitive to oiling in the event of such exposure.

Effects to semi-aquatic mammals, like other species of wildlife, are typically described in terms of three types of effects: direct physical effects, direct toxicological effects, and indirect effects through changes to habitat (e.g., land cover and food availability) (Albers 2003; Malcolm and Shore 2003; Lee et al. 2015). These three types of effects on semi-aquatic mammals are discussed below.

7.1.3.7.3.1 Direct Physical Effects on Semi-aquatic Mammals

The most frequently reported direct physical effect of a hydrocarbon release is the adhesion of oil to the fur of semi-aquatic mammals and the subsequent loss of insulation and buoyancy. This is generally considered the most adverse of effects to this receptor group (Albers 2003). Mammals rely on fur for thermal regulation, and aquatic mammals have fur that is adapted to repel water and maintain insulation under water. Loss of water repellency as a result of contact with oil and associated hypothermia can greatly reduce the survival of semi-aquatic mammals and rapidly result in death (McEwan et al. 1974; Kooyman et al. 1977; Wolfe and Esher 1981; Lipscomb et al. 1994).

Several factors affect the severity of the effects of oiling of fur. Lower ambient temperature will amplify the physiological effects of reduced insulation, because of the increased heat loss with increased temperature gradients between organisms and the ambient temperature (i.e., colder air or water temperatures). Smaller organisms (e.g., shrews) are likely to succumb to physical oiling at a faster rate than larger organisms (e.g., moose) because the surface area to volume ratio of smaller organisms is larger resulting in a greater rate of heat loss per volume, reducing body temperatures faster in smaller organisms. Exposure of an oiled animal to water also results in much greater thermal stress than exposure of the same animal to ambient air (McEwan et al. 1974; Knopper et al. 2016).

At higher temperatures, in addition to a reduced heat gradient, oil tends to weather at a faster rate, shortening the duration of insulation loss reducing the potential for adverse effects (Hurst and Oritsland 1982). However, the severity of effect also depends on the type of crude oil released. Hurst and Oritsland (1982) studied the effect of oiling on the insulation of polar bear fur using different oil types and found that thermal conductivity increased with increasing viscosity of the oils, likely due to prolonged matting of the fur by heavier oils. Weathered diluted bitumens have both high density and viscosity, and are more adhesive than other crude oils (NAS 2016). This would reduce the likelihood of unassisted wildlife survival and recovery from oiling for diluted bitumens, relative to that for lighter crude oils.

7.1.3.7.3.2 Direct Toxicological Effects on Semi-aquatic Mammals

Acute toxicity of hydrocarbons is generally the result of narcosis from exposure to certain components of oil, namely some alkanes, mono-aromatics (BTEX) and PAHs (2-ringed naphthalenes) (Dupuis and Ucan-Marin 2015). Exposure to sufficient quantities of these low molecular weight hydrocarbons typically results in acute narcotic effects shortly after an oil release. This effect is more pronounced at the site of release prior to vapors being diluted in the environment or evaporating from the water surface into the atmosphere. In semi-aquatic mammals, the more important exposure routes are direct ingestion of oil or contaminated food, and inhalation. While dermal absorption may occur, exposure is reduced by the fur of semi-aquatic furbearers, particularly for heavier oil types that would have lower potential to penetrate the fur and contact the animal's skin. Semi-aquatic mammals may ingest oil following physical oiling of their fur by grooming and cleaning themselves to remove the contaminants (McEwan et al. 1974).

The contamination of water surfaces by oil may increase the inhalation exposure to toxic components for semi-aquatic mammals that are swimming on the surface (Peterson 2001; Frost et al. 1994). Inhalation of vapors was suggested as a probable cause of interstitial pulmonary emphysema following necropsies of dead sea-otters, after the Exxon Valdez spill (Lipscomb et al. 1994). This could be of similar concern for species such as beaver, river otter, and muskrats which also spend the majority of their life cycle in water. However, the ultimate cause of death of recovered wildlife following a release is challenging as few animals are necropsied and results reported. Baker et al. (1981) reported on the death of otters near the Sullom Voe oil terminal, in the Shetland Islands, United Kingdom, following a release of Bunker C fuel oil on December 31, 1978. Heavy fuel oil (bunker C) would contain much less volatile material than most crude oils, so narcosis as a result of inhalation is unlikely to cause death; however, the heavy fuel oil would also contain much higher levels of PAHs than most crude oils (Dupuis and Ucan-Marin 2015). At least 13 otters died following the Sullom Voe release, although others presumably also died but were not detected (Baker at al. 1981). Five animals, with external oiling ranging from minor on the rump and tail, to heavy coating the entire body, were sent for post-mortem examination. The cause of death for each of the animals examined was determined to be a hemorrhagic gastro-enteropathy, presumably caused by ingestion of oil as a result of grooming. However, hypothermia was also considered to be a potential contributor to the death of these animals (Baker et al. 1981). Two dead sheep, which had been eating oil contaminated seaweed, were also examined and showed oesophageal and gastric ulceration (Baker et al. 1981).

Sublethal effects of oil exposure in mammals also occur. Schwartz et al. (2004a, 2004b) determined that exposure of mink to bunker C fuel oil, at low concentrations (500 ppm in diet) for extended periods of time, would result in immune system, systemic, and hematological responses with potential consequences for survival and reproduction in individuals. These effects may not be observed in field monitoring programs or during wildlife rehabilitation programs following a release. Similar results were also observed in studies by Mohr et al. (2008, 2010). Note, however, that bunker C oil contains different proportions of toxic hydrocarbons (e.g., less BTEX, but more PAHs; Dupuis and Ucan-Marin 2015) than diluted bitumens and conventional crude oils.

7.1.3.7.3.3 Indirect Effects of Oil Release on Semi-aquatic Mammals

Oil releases may have indirect effects on semi-aquatic mammals through effects to habitat or changes in food quality or availability. Habitat loss is more easily quantified than effects to individuals, because suitable habitat characteristics of mammals are generally well known, and effects are more easily quantified.

Indirect effects on individuals may also occur as a result of rehabilitating efforts alone. Ben-David et al. (2002) examined the survival rate of captured and rehabilitated otters exposed to oiling compared to wild otters. They found that survival was lower for captured and released otters, but the effect of oiling was not a factor because the survival rates of captured, oiled, and rehabilitated otters were similar to those captured and released without oiling (i.e., capture controls), indicating that the toxicological effect of oiling was not significant. Otters are known to

suffer from capture myopathy (Hartup et al. 1999), which would have implications for indirect effects of rehabilitation following oiling of this species, and potentially other wildlife species.

Bowyer et al. (2003) noted that following the Exxon Valdez spill, river otters had larger home ranges, lower body mass, and a less varied diet than individuals in control sites. Density of otters did not differ between sites, suggesting no population level effects occurred. However, it does suggest that otters may require larger areas to obtain sufficient food sources in areas affected by oil. Loss or degradation of habitat may lead to dispersal of individuals in search of suitable habitat, which can reduce survival through competition between immigrants and local residents, particularly in territorial species (Crawford et al. 2015).

Wolfe and Esher (1981) found that rice rat swimming behavior was affected when oil was added to swim tanks (both south Texan and empire crudes) compared to controls, and individuals avoided swimming in oiled water. The higher adhesion rate of weathered diluted bitumens and heavy crudes (NAS 2016) also requires more intensive remediation efforts that could result in more severe changes to habitat quality, though effects are typically of short to medium duration (e.g., one to two years) as was observed from the Glenavon, Rainbow, and Wabamun releases described above.

Table 7-41 and Table 7-42 provide a summary of the expected environmental effects of oil releases to semi-aquatic mammals in inland environments. Table 7-41 considers the effects of specific oil characteristics on the expected types and scope of environmental effects. Table 7-42 considers the effects of environmental factors characteristics on the expected types and scope of effects.

Table 7-41 Biological Receptor: Semi-Aquatic Mammals

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—buoyancy	Light crude oils typically have a relatively low density (0.78-0.88 g/mL, Dupuis and Ucan-Marin 2015) and are buoyant in freshwater aquatic environments.	Medium crude oils typically have an intermediate density compared to light and heavy crudes, and are buoyant in freshwater aquatic environments (Dupuis and Ucan-Marin 2015).	Heavy conventional crude oils can have density ranging of 0.88 to 1.00 g/mL, while fresh diluted bitumen will have density less than 0.94 g/mL (Dupuis and Ucan-Marin 2015).	While raw bitumen has a higher density than water, diluted bitumen is less dense and limited evaporative mass loss at environmentally-relevant temperatures suggests that weathered dilbit will remain afloat as it will retain sufficient diluent to maintain a lower density ((Lee et al. 2015; see also Section 7.1.2). Recovery of released oil is facilitated if the oil floats on the surface of the water. A more rapid recovery of oil will reduce the potential exposure duration to semi-aquatic mammals. Buoyancy of oil will also prevent contact with semi-aquatic mammals swimming submerged or foraging in the benthic environment.
Oil properties—viscosity	Light crudes will spread rapidly on water because of their low viscosity (1 to 5 mPa•s, NAS 2016).	Medium crudes have an intermediate viscosity (8 to 112 mPa•s, NAS 2016).	Heavy crudes (820 to 475,000 mPa•s) and diluted bitumens (270 to 50,000 mPa•s) weather to high viscosity (NAS 2016).	Viscosity is a function of oil chemistry. Diluted bitumens tend to display a more rapid increase in viscosity due to weathering of low molecular weight hydrocarbons associated primarily with the diluent than conventional heavy crude oils. Oil having low viscosity will rapidly spread across the water surface forming a thin and relatively uniform slick. More viscous oils will spread more slowly and may exhibit thicker but patchier slicks with associated sheens. Higher viscosity oils will have lower dispersion and generally result in smaller spatial areas where semi-aquatic mammals may come in contact with the oil. Oil viscosity also influences adhesion, which is relevant to physical oiling (see Oil Properties – adhesion below)

Table 7-41 Biological Receptor: Semi-Aquatic Mammals

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—adhesion	Light crudes have low adhesion and viscosity (NAS 2016) and can be expected to penetrate the fur to contact skin.	Medium crudes have an intermediate adhesion and viscosity (NAS 2016). Medium crude oils also readily penetrate fur to contact skin.	Heavy crudes and particularly diluted bitumens are highly adhesive and more viscous than light and medium crude oils. Fresh diluted bitumens have relatively low viscosity, and would penetrate fur. However, weathered heavy crudes may tend to stick to the surface of fur without penetrating to contact the skin.	Properties of adhesion and viscosity may change the way that crude oil interacts with fur. Light oils may more readily penetrate fur and reduce insulation; heavy oils, particularly when weathered, may tend to adhere in a thick layer to the hair without immediately penetrating to the skin surface. This results in more difficult cleaning and removal of oils from fur and extended duration of physical effects, though less potential for dermal exposure to toxic hydrocarbon components there is increased potential for ingestion (see toxicity of chemical components discussion below).
Oil properties—toxicity of chemical constituents	Light crude oils often contain high levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, depending on the oil type, but can be high (>10,000 mg/kg) in Bakken oils.	Medium crude oils often contain moderate levels of BTEX and other relatively water soluble hydrocarbons. Levels of TPAH are variable, but can exceed 10,000 mg/kg.	Levels of BTEX and other relatively water soluble constituents are variable: generally low in heavy conventional oils, but variable in diluted bitumens depending upon the nature of the diluent. Levels of TPAH are variable, but typically depleted in napthalenes and less than 10,000 mg/kg.	Acute effects on mammals are generally caused by physical oiling, not related to the BTEX content of the oil. Chronic effects on mammals of released crude oil, if any, are likely due to dietary TPAH exposure. Diluted bitumens do not contain higher concentrations of either BTEX or TPAH than many conventional crude oils (Lee et al. 2015). Diluted bitumens contain the same suite of PAHs as conventional crude oils, but at different relative concentrations due to the highly weathered nature of the bitumen component, and the modifying effect of the diluent. Additional details on the characteristics of diluted bitumen are provided in Section 7.1.2.

Table 7-41 Biological Receptor: Semi-Aquatic Mammals

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil properties—persistence	Light crude oils typically contain only small proportions of higher molecular weight components, such as resins and asphaltenes. Light crude oils generally biodegrade readily.	Medium crude oils contain variable proportions of resins and asphaltenes. Asphaltenes would be removed from synthetic medium crudes during processing of bitumen.	Heavy conventional crude oils and diluted bitumens typically contain higher proportions of resins and asphaltenes, which tend to resist biodegradation.	In general, heavy conventional crude oils and diluted bitumens would be expected to biodegrade less rapidly than light or medium crude oils. However, any oil can be persistent if deposited in an environment where there is little or no available oxygen. Persistence in the environment will directly influence the potential exposure duration of semi-aquatic mammals to oil.

Table 7-42 Biological Receptor: Semi-aquatic Mammals

Environmental Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Habitat type	Light crude oil will spread rapidly due to its low viscosity, potentially resulting in effects over a larger area in lakes and wide rivers.	Medium crude oil has low viscosity, although viscosity increases at lower temperatures, and will behave similarly to light crude oils.	Heavy crude oils have high viscosity. Diluted bitumens also have high viscosity (although reduced while fresh due to the effect of the diluent), potentially resulting in effects over a smaller area in lakes and wide rivers, due to the oil's resistance to spreading in these habitats.	Low viscosity oils will spread more rapidly, and to thinner slicks, than high-viscosity oils. As a result, low viscosity oils have a higher potential to affect a larger area of habitat, particularly open-water habitats such as lakes and wide rivers, than higher viscosity oils. At the same time, higher viscosity oils will tend to form thicker slicks than low viscosity oils. This could lead to a contrast of "more mammals oiled less heavily" with lighter oils, as compared to fewer mammals oiled more heavily with heavier oils.
Season	Light oils remain fluid at low temperature and retain the potential to spread rapidly during the winter. Light oils may penetrate cracks in ice or close to shore, allowing the oil to get beneath the ice and spread downstream. In summer, light crude oils would also flow readily and spread rapidly, having the potential to contact larger numbers of mammals than heavier, more viscous oils.	Medium oils are slightly more viscous than light oils, and would also tend to flow readily under winter conditions. Medium crude oils would tend to flow readily and spread rapidly under summer conditions.	Heavy oils become much more viscous at low temperatures, and as they weather. Heavy oils and diluted bitumens would have more resistance to flowing or penetrating cracks in ice to reach the water surface than would be the case for light or medium crude oils. During the summer, diluted bitumens would flow readily and spread rapidly while fresh. Weathering in the first 24 to 48 hours would result in increasing viscosity and density, limiting further spreading of the oil on the water surface.	Season affects both the behavior of oil in the environment, and the distribution and behavior of mammals that could be exposed to released oil. Some mammals do not use aquatic environments during the winter (e.g., moose and raccoon), while others become isolated within an aquatic system (e.g., beaver and muskrat) and would be more vulnerable to a release into an aquatic system. During the open water season, mammals have the ability to disperse from waterbodies and seek new habitat.
Weather	Periods of high rainfall and high water levels could transport released crude oil into riparian areas, in addition to potentially increasing			

Environmental Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
conditions—rainfall and water levels	downstream transport distances. This would affect all crude oil types. If crude oil is transported into riparian areas, then mammals that use terrestrial areas more (e.g., raccoons, moose) could be exposed to the oil and its effects either through direct contact with oil, or though food chain effects as PAHs and oily residues are ingested with food and associated soil.			
Weather conditions—temperature	The survival of oiled mammals could be affected by ambient temperatures, regardless of season. Mammals that are in contact with cold water experience far greater thermal stress than mammals that are in contact with air; especially for more aquatic mammal species (e.g., muskrat, beaver, otter). Some oiled mammals may avoid entering the water to reduce thermal stress. Those individuals might survive for longer periods of time during periods of warm weather as compared to periods of cold weather, providing greater opportunity for capture and rehabilitation.			
Slope	Lakes have negligible slope, and therefore the short-term distribution of crude oil on the water surface may be determined primarily by wind. Streams and rivers have slope, which determines the downstream water flow velocity, as well as influencing the turbulence of that flow. Slope therefore helps to determine the downstream transport distance for spilled oil before emergency response can be effectively applied. This can affect the types of habitat that the spilled oil could affect, as well as the numbers and types of birds.			

7.1.4 Human Receptors

7.1.4.1 Human Health

7.1.4.1.1 Description

Human health relates to the physical health and well-being of people living or using lands near the Project, and is intrinsically important to the public. Many factors may influence a community's sense of well-being, including concepts such as trust and risk perception. However, in the context of an oil release, public health concerns are focused on the potential environmental effects to health that could arise from exposure to contaminants. People want to understand how their health may be affected by oil-related contaminants in the air they breathe, the water they drink, and the food they eat.

The typical health effects associated with short-term (acute) inhalation of volatiles from crude oil (including petroleum hydrocarbons and hydrogen sulfide) are headaches, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term skin contact with oil may result in dermatitis (Solomon and Janssen 2010). The literature suggests that these acute health effects observed in residents and clean-up workers do not persist over the long-term (Eykelbosh 2014). However, relatively little has been published regarding the long-term effects of exposure to an oil release. The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans.

Crude oils are complex mixtures of thousands of PHC, and many non-petroleum compounds. To understand how crude oil may affect human health, it is necessary to assess the crude oil in terms of the various constituents, or chemicals of potential concern (COPC) that characterize its potential fate, transport, and toxicity in the environment. The primary groupings considered relevant to the assessment of human health are low molecular weight aromatics (BTEX), aliphatic and aromatic PHC fractions, PAHs, and other volatiles (including other types of organic compounds containing sulfur and nitrogen).

Higher molecular weight aliphatic and aromatic hydrocarbons (greater than C_{16}), including higher molecular weight PAHs, exhibit very low to negligible vapor pressure and are typically considered non-volatile. These non-volatile compounds are not expected in to be present in ambient air at substantive concentrations following an oil release, but they may persist in soil or sediment, affecting the biological tissue concentrations of food sources (e.g., fish). Conversely, other COPC such as BTEX and lower molecular weight hydrocarbons are highly volatile and may be relatively water soluble. While these lower molecular weight compounds are expected to be present in air and water in the short term, they are unlikely to persist as residues in sediment or biological tissues in the longer term.

7.1.4.1.2 Observed Effects

The following section summarizes a review of some historical oil releases and reported health effects. For some spills, no health effects were reported, but regulatory agencies imposed restrictions (e.g., evacuations, closure of potable water intakes, fishery closures) as a precaution to prevent exposures above levels that could be associated with health effects. These instances of regulatory restrictions are also considered relevant to the assessment of human health.

***Pine River, British Columbia**: On August 1, 2000, a failure of the Pembina Petroleum pipeline resulted in the release of approximately 6,200 barrels (985 m^3) of light crude oil. Approximately half of the released oil was estimated to have reached the Pine River (Goldberg 2011), which was experiencing low flows at the time of the release (5,700 ft^3/s at time of release versus 32,000 ft^3/s in late spring/early summer) (Bustard and Miles 2011). Of the oil that reached the Pine River, approximately 2,830 barrels (450 m^3) was later recovered (BC MOE 2000a). Following the release, the Pine River was closed to angling and area residents were advised not to use water directly from the river (BC MOE 2000b). The water intake for the water treatment plant in the Town of Chetwynd, located 68 miles (110 km) downstream of release was temporarily closed, and the use of many groundwater wells near the river was discontinued (BC MOE 2000a). The District of Chetwynd was able to resume use of the Pine River for their water supply three years later (Brown 2003).*

***Cass Lake, Minnesota**: In May 2001, during the installation of shallow groundwater monitoring wells at the Enbridge Energy Limited Partnerships South Cass Lake Pump Station in Cass Lake, Minnesota, crude oil contamination was detected in the subsurface. The site is located within the reservation environment of the Leech Lake Band of Ojibwe, and 12 residential homes and businesses, were identified within 0.6 miles of the of the site. There were concerns that the crude oil would affect domestic water-supply wells and result in human health risks. Initial groundwater samples collected in 2001 showed a maximum benzene concentration of 6,500 µg/L close to the source (Wenck Associates 2006), and a maximum benzene concentration 1,300 µg/L offsite. A contaminant plume of greater than 10 µg/L of benzene extends approximately 500 ft down-gradient from the crude oil source, 130 ft across, and vertically 6 to 10 ft (Drennan et al. 2010). Since drinking water wells were not located within 0.5 miles down-gradient of site, they were not affected by the crude oil (Natural Resources Engineering Company 2004).*

***Burnaby, British Columbia**: In July 2007, a backhoe ruptured the Trans Mountain pipeline in Burnaby, British Columbia. Heavy crude oil (diluted bitumen) sprayed 40 to 50 ft into the air for approximately 25 minutes, covering the surrounding area (TSBC 2008b). Several people were reportedly covered with oil, including emergency workers, two firefighters, and two members of the public (TSBC 2008b). Subsequent assessment classified 8 residential properties as heavily oiled, 15 as moderately oiled, and 21 as lightly oiled (TSBC 2008b). Approximately 250 people voluntarily left their homes (TSBS 2008b, Trans*

Mountain 2015). More than half of the people returned later that night and another 100 people returned the following day (Trans Mountain 2015). Residents from the most heavily oiled properties were housed in longer-term accommodations (Trans Mountain 2015). Air quality monitoring was initiated immediately after the release. Very high volatile organic compound levels were detected during the early stages of the incident, but declined rapidly as clean-up progressed (Eykelbosh 2014). Affected residents reported a number of health effects, including headaches (15%), respiratory tract irritation (8%), nausea (6%), dizziness (3%), and eye irritation (3%) (Eykelbosh 2014).

***Salt Lake City, Utah**: On June 12, 2010, approximately 800 barrels of medium crude oil were released from a Chevron crude oil transfer pipeline, spilling into Red Butte Creek in Salt Lake City, Utah. The creek flows through residential and commercial properties, affecting an estimated 600 homes and 1,800 residents (Utah Department of Health 2011).*

Environmental monitoring included both water and air sampling. Air monitoring for specific compounds (benzene, toluene, ethylbenzene, xylenes) was initiated on June 13, 2010. The highest benzene concentration in indoor air at a residential property was 1.9 µg/m^3 (0.60 ppb), while outdoor air sampling indicated a maximum benzene concentration of 1.7 µg/m^3 (0.53 ppb) (Utah Department of Health 2011). The maximum benzene concentration in water samples from Red Butte Creek was 27.6 µg/L (Utah Department of Health 2011).

A public health assessment was completed to address community health concerns related to the crude oil contaminants, specifically focusing on water and air. The public health assessment concluded that measured concentrations of crude oil components in water did not represent a health hazard to the community from ingestion or dermal absorption and that measured concentrations of volatile components in air did not have the potential to harm human health through inhalation (Utah Department of Health 2011). However, because air sampling did not begin until one day after the release, the health risk from inhalation of vapors during the minutes and hours following the release could not be determined.

In November 2010, a survey was sent to over 600 residences in the community and over 131 responses were received (Utah Department of Health 2011). Of those that responded, 23% indicated the creek ran through their backyard, and 73% said they had smelled an unusual odor in the early days of the release (Utah Department of Health 2011). Respondents answered questions about the symptoms they had experienced at the onset of the release and at the time of the survey. From the data, the most common reported symptoms were nausea, headache, irritated eyes, and anxiety (Utah Department of Health 2011). The number of people experiencing symptoms decreased from June 2010 when the release occurred through November 2010 when the public health assessment survey was distributed (Utah Department of Health 2011). There was no control group identified for the study.

***Marshall, Michigan**: On July 25, 2010, approximately 20,000 barrels of heavy crude oil containing diluted bitumen were released over a period of approximately 17 hours from Enbridge's Line 6B pipeline near Marshall, Michigan (NTSB 2012a). At the time of the release, the pipeline contained two different batches of crude oil estimated to consist of approximately 77% CLWB diluted bitumen and 23% Western Canadian Select, also a diluted bitumen (Enbridge 2013a). Of this, approximately 8,000 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013a). These two watercourses were between 25-year and 50-year flood levels at the time of the release (MI DCH 2014b). The oil was transported approximately 37 miles downstream of the release (MI DCH 2013). Approximately 41,500 people were estimated to live within 1 mile of the affected area (MI DHC 2015).*

Air monitoring and sampling activities were initiated in the area of the release on July 26, 2010, and quickly expanded to include other nearby populated areas. Approximately 24 hours after the pipeline burst, benzene concentrations of 9,600 µg/m^3 (3 ppm) were recorded close to the initial release location, at the confluence of the Talmadge and Kalamazoo Rivers (MI DCH 2015). Residents in this area had already relocated due to the odors from the released oil (MDCH 2015). The highest concentrations of benzene reported were approximately 31,900 µg/m^3 (10 ppm), observed approximately two days after the release at a location where no one was living (MI DCH 2015). Lower levels of benzene were measured at the same location or nearby on the same day, and in the days after, indicating that these air concentrations were not sustained (MI DCH 2015).

At the time of the release, the MI DCH (2014b) issued a precautionary advisory against swimming and fishing, and local health departments banned recreational use of the affected river reaches. Surface water samples (collected during July 2010–April 2012) and fish tissue samples (collected in 2010 and 2011) were submitted for analysis of crude oil constituents, particularly PAHs and certain metals, as well as other contaminants not related to crude oil (e.g., mercury and PCBs) to evaluate if the oil release, or the resulting clean-up activities, caused changes to contaminant levels in the fish (MI DCH 2014b). Oil-related and non-oil-related chemicals were measured in the surface water. Only a few chemicals (mostly PAHs) were detected above health-protective screening levels, and these exceedances occurred in only a small percentage of the surface water samples. Nickel and vanadium were not detected in fish filets, but some PAHs were detected in some filets (MI DCH 2014b). Mercury and PCB levels in fish filets were similar to those observed prior to the release (MI DCH 2014b). In June 2012, most of the river was re-opened for recreational use, and the fish consumption advisory in relation to the release was lifted.

Although there was no evidence to suggest that the oil release had contaminated groundwater resources, a precautionary bottled water advisory was issued on July 29, 2010 to allow time for well water samples to be collected and analyzed (MI DCH 2013). Approximately 168 private wells were selected for sampling based on proximity to the

release (i.e., within 200 feet of the high-water level mark from the July 2010 flood event) (MI DCH 2013). Water samples from the wells were analyzed for both crude-oil related chemicals and other chemicals. No oil-related organics above their screening levels were detected in the potable water samples (MI DCH 2013).

Sediment samples collected from the Kalamazoo River and Morrow Lake in the spring of 2011 from areas exhibiting moderate to heavy amounts of submerged oil had detectable concentrations of VOCs, PAHs, TPHs, and metals (i.e., molybdenum, nickel, and vanadium) (MI DCH 2012).

In response to concerns about acute health effects associated with the release, MI DCH collected data from health care providers and the state surveillance system, conducted a door-to-door health survey, and reviewed Poison Control Center hotline reports. Headache, nausea, and respiratory symptoms were the predominant symptoms reported by exposed individuals (MI DCH 2010).

Subsequently, a number of public health assessments were completed in relation to the release. The first addressed concerns related to submerged oil located in the sediment. The study concluded that contact with sediment containing submerged oil, tar patties, or oil sheens could cause temporary health effects such as skin irritation, which would not persist in the absence of continued exposure (MI DCH 2012). The study further concluded that repeated skin contact and accidentally eating a small amount of sediments containing submerged oil would not result in long-lasting health effects or in a higher than normal risk of cancer (MI DCH 2012).

A separate public health assessment was completed to assess potential health effects associated with drinking water from wells located along stretches of Talmadge Creek and the Kalamazoo River. Two oil-related inorganic chemicals (nickel and iron) were found in private drinking water wells, but were at concentrations that would not be expected to produce health effects. The nickel and iron were likely naturally occurring metals (MI DCH 2013). No oil-related organic chemicals were found in the samples of potable well water. Arsenic and lead, two metals not present in crude oil, were present at levels that may harm people's health (MI DCH 2013). MI DCH (2013) concluded that arsenic is a naturally occurring metal in the area and lead could be naturally occurring or be present in people's plumbing.

A third public health assessment addressed health concerns related to exposures to chemicals in surface water and fish. In its assessment, MI DCH (2014b) concluded that chemical levels found in surface water are not expected to cause long-term harm to people's health but, similar to conclusions reached for sediment, people may have temporary health effects, such as skin irritation, from contact with the oil sheen or tar globules in the water. Further, the MI DCH (2014b) concluded that oil-related chemical levels found in fish from the Kalamazoo River and Morrow Lake will not harm people's

health. However, MI DCH (2014b) did issue fish consumption guidelines because of levels of two chemicals not related to the oil release (mercury and PCBs) found in the filets.

The most recent public health assessment addressed concerns related to inhalation of volatile chemicals (MI DCH 2015). The study reviewed the air monitoring and sampling efforts completed during July 2010 through 2012. The study concluded that people experienced short-term effects associated with inhaling oil-related volatiles (headaches, nausea, respiratory discomfort and eye irritation), but that these health effects diminished or stopped once people were no longer breathing the oil-related chemicals (MI DCH 2015). Some people may have experienced anxiety, regardless of exposure (MI DCH 2015). The study further concluded the people did not breathe oil-related chemicals long enough, or at high enough levels, to cause long-term health effects (MI DCH 2015).

***Laurel, Montana**: On July 1, 2011, a break of the ExxonMobil pipeline near Laurel, Montana released an estimated 1,500 barrels of medium crude oil into the Yellowstone River, which was at the peak of a 30-year flood event at the time of the release (MT DEQ 2015c). High flows transported the oil up to 72 miles downstream, although the majority of the effects were observed within 20 miles of the release location (USEPA 2011).*

A number of public drinking water systems obtain water from the Yellowstone River, downstream of the release location. Operators of these systems were notified of the release. Monitoring and testing of the water supply systems for more than 100 contaminants did not identify any exceedances of drinking water standards. In May 2013, the MT DEQ determined that no additional sampling of the downstream public drinking water systems was necessary after tests showed contamination was below human health screening levels (MT DEQ 2013).

Several monitoring wells were installed in areas where crude oil was considered most likely to affect groundwater. Samples were obtained from these wells, as well as from over 300 private wells (MT DEQ 2015b). Crude oil-related petroleum hydrocarbons were not detected in the samples (MT DEQ 2015b). In September 2013, MT DEQ determined that petroleum hydrocarbons from the discharge were not present in groundwater and did not pose an unacceptable risk to public health (MT DEQ 2015b).

A fish consumption advisory was issued after the release as a precaution until laboratory testing could be completed (Montana Fish, Wildlife, and Parks 2011a). Fillet tissues were tested to reflect potential effects on human health from fish consumption. No petroleum hydrocarbons or oil residues were detected in any of the samples (Montana Fish, Wildlife, and Parks 2011b).

***Sundre, Alberta**: On June 7, 2012 a rupture released approximately 2,900 barrels (463 m^3) of light crude oil from the Plains Midstream pipeline into the Red Deer River downstream of Sundre, Alberta (Alberta Energy Regulator [AER] 2014). The release occurred in a*

populated area at a time of high water levels (i.e., flow in Red Deer River was ten times seasonal flow) and affected landowners and businesses more than 25 miles (40 km) downstream of the release (AER 2014).

Air monitoring, including a monitor near the release location, was initiated on June 8, 2012 and continued while clean-up activities progressed. No hydrogen sulfide or other air quality issues were detected, and no exceedances of the provincial ambient air quality objectives were reported at any time during clean-up activities (AER 2014).

Water quality monitoring of drinking water samples reported hydrocarbon concentrations below applicable guidelines (Teichreb 2014).

***Mayflower, Arkansas**: On March 29, 2013, a breach released approximately 3,190 barrels of heavy crude oil from the ExxonMobil pipeline into a residential area, resulting in the evacuation of 22 homes (ADEQ 2013a; NAS 2015). Response crews were on site within 30 minutes of detection of the release (ADEQ 2013a). Air quality monitoring in residential areas on the days after the release reported that benzene concentrations were below detection (0.05 ppm) (ADEQ 2013b). VOC concentrations of up to 29 ppm were reported on the day of the release, but had diminished to 0.2 ppm by April 2, 2013 (ADEQ 2013b). Higher levels of both benzene and VOCs were measured in work areas, and workers wore respiratory protection as specified in the health and safety plan (ADEQ 2013b; NAS 2015).*

***Mooringsport, Louisiana**: On October 13, 2014, approximately 4,500 barrels of sweet crude oil were released from the Sunoco Logistics pipeline near Morringsport, Louisiana, affecting approximately ten miles of creek (USEPA 2014b). Although oil entered the Tete Bayou, it was prevented from entering Caddo Lake, which is used for potable water.*

Continuous air monitoring was conducted under supervision of the environmental agencies. Two households temporarily relocated; however, air monitoring results indicated that no hazards were present in populated/residential areas and that detected levels would not pose a health issue to residents (USEPA 2014b; USEPA 2014a).

***Glendive, Montana**: On January 17, 2015, a rupture of the Bridger Pipeline LLC pipeline released approximately 715 barrels (30,000 gallons) of Bakken light crude oil into the Yellowstone River, approximately 5 miles upstream of Glendive, Montana (MT DEQ 2015a). At the time of the release, there was extensive ice cover, restricting recovery efforts. The City of Glendive obtains its water from the Yellowstone River.*

Soon after the release, a malodorous odor was reported to be present in the City of Glendive drinking water. As a result, the Centers for Disease Control and Prevention recommended that residents not ingest municipal water. Analysis of the water later showed elevated concentrations of VOCs, predominantly benzene exceeded the

drinking water standard of 5 ppb (MT DEQ 2015c). Despite these elevated concentrations, additional sampling and analysis of the municipal water resulted in the water supply being declared safe to drink on January 22, 2015 (i.e., one week after the release). During the ice-breakup in the river on March 14, 2015, monitoring equipment installed at the water treatment plant detected higher than normal levels of VOCs. The plant was subsequently shut down and a water conservation request was made to the City of Glendive. The water treatment plant completed the installation of an aeration system to treat VOCs and allow the plant to continue operating during the breakup. The conservation request was lifted on March 16 and no VOC detections have been made since (MT DEQ 2015a).

Ten groundwater wells were also sampled. The wells were selected based on their shallow depth and close proximity to the break. No VOCs were detected in any of the ten wells (MT DEQ 2015a).

Seven days of continuous ambient air monitoring in the City of Glendive during January 2015, following the release, showed non-detectable concentrations of VOCs, including benzene. As a result, scientists from the National Oceanographic and Atmospheric Administration Emergency Response Division concluded that the levels of contaminants were "…well below public health concern thresholds and may in fact be near background levels" (MT DEQ 2015a).

After the release, the Montana Department of Fish, Wildlife, and Parks issued a fish consumption advisory since it was confirmed that fish tissue samples showed detectable levels of PAHs. However, by the time the ice had left the river, the fish tissue samples showed no detectable concentrations in edible muscle tissue and the advisory was lifted (MT DEQ 2015a; Stuart 2015).

***Santa Barbara, California**: On May 19, 2015, a rupture of the Plains All American Pipeline near Santa Barbara, California resulted in the discharge of an estimated 2,400 barrels (101,000 gallons) of heavy crude oil, 480 barrels (20,000 gallons) of which is estimated to have reached the ocean near Refugio Beach (NAS 2015). The heavy crude oil was discharged from a heated transmission pipeline and comprised a blend of oils from four nearby platforms (i.e., it was a conventional heavy crude oil, not a diluted bitumen). As a result, 138 square miles of fishing grounds were closed to harvesting (Hamm 2015). To assess concentrations of oil related contaminants in seafood, the California Office of Environmental Health Hazard Assessment (OEHHA) developed a sampling and analysis plan that focused on concentrations of PAHs in mussels, but also included samples of finfish and invertebrates (OEHHA 2015). Elevated PAH concentrations were observed initially but were below levels of concern within six weeks of the release (OEHHA 2015).*

7.1.4.1.3 Expected Effects of Released Oils

The effects of released oil on human health will vary depending on both the characteristics of the released oil and ambient/meteorological conditions at the time of the release. While a number of oil characteristics may influence the fate and transport, oil chemistry is the strongest influence, affecting both the route of potential exposure and the longevity of exposure (i.e., short term or long term). Environmental characteristics include river flow and proximity of human receptors.

One important finding was that contamination of potable wells, while possible, appears unlikely. Of the case studies examined, surface releases of crude oil did not appear to affect potable wells. The Cass Lake, Minnesota case study considered a subsurface release of crude oil and determined that the groundwater plume was limited 500 ft beyond the oil source. Therefore, effects on groundwater quality (as a potential source of potable water) are unlikely where spill response is prompt and effective, and likely to be localized even where spill response is delayed or not effective.

The environmental effects associated with the type of oil, and characteristics of the environment in which a release occurs, are described in Table 7-43 and Table 7-44 respectively.

Table 7-43 Environmental Effects: Human Health

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil chemistry—volatiles	Light crude oils contain 35 to 40 wt % volatile organic compounds (≤C_{10}) (www.crudemonitor.ca) The higher percentage of volatiles increases the risk of short-term inhalation exposure relative to other oil types.	Medium crude oils contain 25 to 30 wt % volatile organic compounds (≤C_{10}) (www.crudemonitor.ca).	Heavy crude oils contain 15 to 20 wt % volatile organic compounds (≤C_{10}) (www.crudemonitor.ca). Diluted bitumens tend to have a lower proportion of light, volatile compounds than conventional heavy oils (NAS 2015). With the lowest level of volatile compounds, heavy crude oils would be expected to have the lowest risk of inhalation exposures. Although diluted bitumens have a lower proportion of light volatile compounds than other commonly transported crude oils, the level of concern with respect to health risk from inhalation is reportedly the same as other commonly transported crude oils (NAS 2015).	Although the risk of vapor inhalation varies by oil type, health effects associated with short term inhalation exposures have been reported for spills of light, medium and heavy oils, as indicated by the case studies.
Oil chemistry—TEX	The total BETX concentration of light crude oils is 2 to 4 wt % (Zhou et al. 2015). Light oil spills have affected surface drinking water supplies (see case studies for Pine River, BC and Glendive, Montana).	The total BTEX concentration of medium crude is 1 to 3 wt % (Zhou et al. 2015).	BTEX concentration of heavy crude oils, including diluted bitumens, is 0.5 to 1.5 wt % (Zhou et al. 2015).	BTEX are among the most volatile, soluble, and toxic of the crude oil components, with low thresholds for taste and odor in water. Increasing concentrations would be expected to increase potential for inhalation exposures and impacts to drinking water supplies.

Table 7-43 Environmental Effects: Human Health

Oil Characteristic	Light Crude Oil	Medium Crude Oil	Heavy Crude Oil	Other Comments
Oil chemistry—TPAH	Alberta sweet mixed blend crude oil has higher TPAH, and proportionally more naphthalenes and alkyl naphthalenes than oil sands hydrocarbons (Yang et al. 2011). Although PAHs were detected in fish muscle tissues following a light oil release (Glendive, Montana case study), this environmental effect appears to have been influenced by the presence of an ice cover and PAHs were not detected following ice break up.	Alaska north slope crude oil has higher TPAH, and proportionally more naphthalenes and alkyl naphthalenes than oil sands hydrocarbons (Fingas 2010; Yang et al. 2011). PAHs were not detected in fish tissues following a medium crude oil release (Laurel, Montana case study).	Diluted bitumens typically have similar to lower concentrations of TPAH than light and medium crude oils, although the distribution of PAHs differs. PAHs were found in fish tissues following spills of diluted bitumen (Marshall, Michigan case study) and heavy crude oil (Santa Barbara, California case study).	Total PAH levels in diluted bitumen appear to be similar to or lower than levels in light, medium and heavy conventional crude oils (Zhou et al. 2015). PAHs are the crude oil components most commonly found in fish and shellfish, as indicated by the case studies.
Oil chemistry—resins and asphaltenes	Light crude oils contain very little in the resins and asphaltenes fractions, making their lighter aliphatic and aromatic components relatively bioavailable, but also allowing for rapid biodegradation or weathering of these oils, reducing the potential for long-term (chronic) exposures.	Medium crude oils also contain relatively small fractions of resins and asphaltenes, although more than light crude oils. Medium crude oils also have good potential for biodegradation in the environment.	Heavy crude oils, and diluted bitumens in particular, contain large amounts of resins and asphaltenes. While these fractions are generally insoluble in water and thus non-toxic, they are slow to degrade and can act as reservoirs for the slow release of other more toxic hydrocarbon constituents such as PAHs.	Resins and asphaltenes comprise the "heavy" end of crude oils, and diluted bitumens are proportionally richer in these components than light or medium crudes.

Table 7-44 Environmental Effects: Human Health

Environment Characteristic	Low	Medium	High	Other Comments
Distance to human receptors	The potential for inhalation exposures to the general public are greatest near the release site and in areas of oil recovery activities. These exposures may result in residents leaving their homes (e.g., Burnaby, British Columbia, Marshall, Michigan, and Mayflower, Arkansas case studies). Occupants typically return to their homes within a few days to a few weeks. Reported health effects from oil spills in populated areas (such as Burnaby, British Columbia, Salt Lake City, Utah, and Marshall, Michigan case studies) included headaches, eye and respiratory irritation, and nausea.	N/A	Air monitoring performed in Glendive, Montana (five miles upstream of a release) did not detect VOC or benzene in the air at levels that would represent a health concern following the release (Glendive, Montana case study).	Although toxicological effects from short-term chemical exposure are associated with distance of human receptors from released oil, other health effects, such as anxiety and depression, may be more strongly related with an individual's perceived risk regardless of whether the individual was physically exposed (Eykelbosh 2014).
River flow	Rivers with low flow are more likely to experience laminar flow and lower velocities, reducing the opportunities for mixing and the length of watercourse exposed to oil (e.g., Mooringsport, Louisiana case study).	Rivers with moderate flows will transport oil downstream and mixing could cause dispersion or submersion of oil.	Rivers with high flows can transport oil rapidly downstream and laterally onto floodplains (e.g., Marshall, Michigan case study; Laurel, Montana case study; and Red Deer River, Alberta case study).	The further the oil is transported downstream, and the more turbulent the flow conditions, the greater the likelihood of public exposures via inhalation of VOCs and BTEX from oil and direct contact with oiled shorelines and sediment. Long-distance transport would also increase the likelihood for potable water intakes to be reached and potentially affected.

Table 7-44 Environmental Effects: Human Health

Environment Characteristic	Low	Medium	High	Other Comments
Seasonal temperature	Low ambient temperatures may reduce the rate of evaporation of VOCs in spilled crude oil. However, low temperatures may also be accompanied by "inversion" conditions in low-lying areas, reducing the rate of dispersion for vapors in air. Ice cover may restrict the amount of volatilization of the BTEX components of the oil, increasing the presence of these compounds in water (e.g. Glendive, Montana case study).	N/A	High ambient temperatures could theoretically lead to localized increases in volatile concentrations. However, "inversion" conditions are less likely and atmospheric stability is usually lower at warm temperatures, resulting in more rapid dispersion of vapors in air.	Prediction of hydrocarbon vapor concentrations in air is complex, depending upon multiple factors. Spatial heterogeneity is likely to be high. Localized exposure to high concentrations of hydrocarbon vapors in air is possible for any release, however, such exposures would be indicated by strong odors making it likely that individuals would become aware of their exposure and respond accordingly.

7.1.4.2 Land Resource Use

7.1.4.2.1 Description

Releases of oil and the subsequent activities related to clean-up and remediation have the potential to disrupt normal land and resource use activities. The nature and duration of the effects will depend on the setting and the types of land and resource use activities that could be affected. Depending on the setting, an accidental release of oil can result in injury or loss of life, short- or long-term evacuation of people living or working in the area, temporary closures of water treatment facilities and other infrastructure (including roads), and suspension of activities in outdoor parks, and recreational areas and facilities.

Land and resource use activities can also be adversely affected by oil releases as a result of closures, suspensions or other constraints on these activities that remain in place until clean-up and remediation activities have been completed and response authorities have determined that conditions are safe for resumption of land and resource activities. Examples of land and resource uses and associated activities that may be adversely affected by an accidental oil release include agricultural lands, aquaculture resources (including the harvesting of wild rice), recreational or commercial fishing, forestry and other industrial activities, outdoor recreation activities (e.g., boating, swimming, hiking, biking), recreational facilities such as parks and historical or cultural sites, and cultural use of resources (use by indigenous peoples).

7.1.4.2.2 Observed Effects

The following sections provide examples of instances where accidental releases of oil have adversely affected land and resource use activities and describe the nature and extent of those effects.

Accidental releases of oil can lead to loss of life and injuries for people engaged in land and resource use activities in proximity to the release site, particularly in cases where the oil ignites. There are relatively few situations where oil releases lead to loss of life or injury, and most of these involve accidental releases caused by construction or repair activities, typically involving refined products or light oils. For example, in 2010, two people working to repair an Enbridge pipeline at a location near Clearbrook, Minnesota were killed when leaking oil ignited (Bloomberg News 2010). In 2005, a bulldozer operator working near Lufkin, Texas was injured after he accidentally struck a crude oil pipeline operated by Sunoco Pipeline L.P.; the released oil ignited (ProPublica 2005). Near Walnut Creek, California, five workers were killed and another four were injured in 2004 when contractors accidentally struck a Kinder Morgan Energy Pipeline Partners pipeline carrying gasoline (Office of the State Fire Marshall 2004).

Accidental oil releases in populated areas and potential for adverse effects on health and safety can lead to evacuation of nearby residents or workers. The Westridge release in Burnaby British Columbia occurred in 2007 and resulted in approximately 1,500 barrels (240 m^3) of heavy synthetic crude oil being released as a result of damage to a pipeline. This resulted in 50 homes being evacuated for several nights (CBC News 2007) and residents of five houses being evacuated for four months or more until clean-up operations were completed (Raptis 2011). The

2010 Marshall pipe rupture, where 20,082 barrels (3,193 m^3) of crude oil were accidentally released and a substantial portion entered the Kalamazoo River, resulted in six houses being evacuated on the day after the release due to concerns about odor (NTSB 2012b). A voluntary evacuation notice was issued to about 50 homes four days after the release and were not lifted until 18 days after the release occurred (NTSB 2012b). In these cases, the evacuations were issued due to concerns related to public health and safety resulting from direct contact with oil (see Section 6.1.5.1).

Evacuations have also occurred when oil releases have occurred in rural settings. In 2011, the rupture of ExxonMobil's Silvertip Pipeline near Billings, Montana resulted in crude oil entering the Yellowstone River. Due to fears about a possible explosion, 140 residents of the community of Laurel were evacuated for about four hours until fumes had dissipated (O'Connor 2011). The release of crude oil from ExxonMobil's Pegasus Pipeline at a location near Mayflower, Arkansas in 2013 resulted in more than 20 homes being evacuated due to fumes and fire hazard. One year after the release, residents claimed to continue to have adverse health effects from the release (rt.com 2014).

In the case of the 2005 Lake Wabamun release in Alberta, where approximately 4,500 barrels of Bunker C fuel oil (Heavy Fuel Oil 7102) and 550 barrels of Pole Treating Oil were released as a result of a train derailment, local residents were evacuated 30 minutes after the release but were allowed back to their homes later that same day (Lake Wabamun Residents Committee 2007). As a result of the 2002 Cohasset release, 6,000 barrels of crude oil (954 m^3) were released in forested-shrub-scrub wetland in Minnesota. Potentially affected land owners were contacted immediately, and seven residents were evacuated for a period of 24 hours while 11 acres of the affected land were burned to prevent the oil from reaching the Mississippi River (NTSB 2004).

Odors associated with the 2011 Plains Midstream Canada Rainbow pipeline release in northern Alberta (approximately 28,000 barrels of crude oil) were identified as the reason for suspension of classes at the Little Buffalo School on Lubicon Cree First Nation in Cadotte Lake (Henton 2011).

Accidental releases of oil have adversely affected municipal and residential water supplies, including surface water and groundwater. In 2000, 6,200 barrels (986 m^3) of oil entered the Pine River upstream of the Town of Chetwynd, British Columbia and resulted in Chetwynd shutting down its water withdrawals from the river following the release due to concerns about oil contamination of the water supply (BC MOE 2000c). As a consequence, the Town developed an alternate water supply using groundwater (Green 2000).

Only July 29, 2010, 4 days after the Enbridge Line 6B release in Marshall, Michigan, the Calhoun County Health Department issued a precautionary Bottle Water Advisory to allow time for well water sampled to be collected and analyzed for possible contamination from the release (MI DCH 2013). Wells located more than 200 ft from the high water mark of the flood event, which included most of the municipal wells in the area, were not expected to be a risk of

contamination. The Bottled Water Advisory remained in effect until November 8, 2010 (MI DCH 2013), 105 days after the release occurred.

Following the Lake Wabamun release, the local health authority advised all residents not to use lake water for drinking purposes but advised that lake water could be used for recreational purposes (CAW/TCA 2006). The ban on use of lake water for drinking was still in place one year after the release but testing at that time determined that lake water no longer represented a threat to human health (Edmonton Journal 2007).

As a result of the Silvertip pipeline release into the Yellowstone River, the City of Billings and the community of Lockwood closed their municipal water intakes as a precautionary measure for a couple of hours after the release (Ritter 2011). Another release on the Yellowstone River in 2015 from the Bridger Pipeline resulted in the community of Glendive, Montana being unable to use water from the river for six days, with residents having to rely on bottled water (Lutey 2015; USEPA 2015a).

Accidental releases of oil have also adversely affected urban infrastructure, other than water and industrial intakes. For example, the 2007 Westridge release in Burnaby caused a section of the Barnett Highway to be closed for several days after the release (CBC News 2007).

Some of the best documented effects of oil releases on land and resource use relate to impacts on recreational resources and activities, notably beach activities and fishing. The nature of effects, such as the closure of recreational facilities (e.g., beaches) and the implementation of advisories related to swimming, boating, and fishing are usually well documented for releases in the United States because such damages are a key element of the NRDA process. Some examples of release effects on recreational resources and activities include:

- In 1996, heavy oil released from a pipeline owned by Chevron Industries into Pearl Harbor, Hawaii resulted in the USS Arizona Memorial and visitors' center being closed due to odors from the release (Kakesako et al. 1996). The visitors center was closed for four days following the release, which also resulted in closure of nearby bicycle/jogging paths for two weeks due to clean-up activities and the closure of Pearl Harbor to vessel traffic and recreational and commercial fishing and boating (Natural Resources Trustees for Pearl Harbor, Oahu, Hawaii 1999).
- The Red Butte Creek oil release resulted in the immediate closure of the creek and nearby parks, portions of which were still closed 40 days after the release (Salt Lake City no date), with clean-up operations being adjusted to accommodate two important holiday events. Red Butte Creek was declared safe for regular use by local residents two years after the release occurred (O'Donoghue 2012).
- As a result of the Marshall release, county health agencies closed 39 miles of the river system to the public for reasons of health and safety. Parts of the river were opened for public use 21 months after the event, and a Fish Consumption Advisory and a swimming advisory were also lifted at that time. Small sections of the river were subsequently closed to recreational activities for short periods of time during the following two years to allow reclamation and restoration activities to be completed (USFWS et al. 2015b).

- As a result of the Lake Wabamun release, parts of the lake were closed to swimming and boating for nearly one year, and a fish and waterfowl consumption advisory for the lake remained in place for another two years (Sherwood Park News 2008).
- Oil from the Westridge release resulted in the closure of Cates Park in North Vancouver (Woodward 2007). Some beaches were closed for 4 months after the release, and 15 kilometers of beaches eventually required remediation (Canada.com 2007b).
- The 2013 release of 600 barrels of diesel fuel (80 m^3) from a pipeline adjacent to Willard Bay, a reservoir connected to the Great Salt Lake, caused closure of some facilities in Willard Bay State Park for a period of four months (O'Donoghue and Cabrero 2013).
- In 2015, crude oil from a break in a pipeline owned by Plains All American Pipeline released into the Pacific Ocean at a location north of Santa Barbara, California (NOAA Office of Restoration 2015) and resulted in the closure of two California State Beaches for a period of up to two months (Panzar 2015).

Accidental releases of oil can adversely affect agricultural land use. In 2013, 20,600 barrels of crude oil (3,227 m^3) leaked from a Tesoro Logistics pipeline in North Dakota in the middle of a farmer's field. The affected landowner indicated that it would likely take two to three years of cleaning up the release before agricultural activities could resume and that there would be negotiations for compensation (FoxNews 2013). Clean-up activities were still underway in 2014 and, at that time, Tesoro Corp estimated that it would be another year before clean-up activities would be complete (Associated Press 2014b).

In the case of the 2008 Mt. Erie pipeline release, about 5,000 barrels (795 m^3) of crude oil affected agricultural and forested lands, and the responsible party eventually purchased 157 acres of agricultural land in the release zone (Arcadis 2011). For the Marshall release, the Michigan Department of Agriculture issued a ban on surface water withdrawals for crop or lawn irrigation, or livestock watering (NTSB 2012b). With the release from the Silvertip Pipeline occurring while the Yellowstone River was in flood, some of the released oil was deposited on cropland and pasture-land along the river (Fox News.com 2011). For the Silvertip pipeline release, farmers were advised not to use water from the river for irrigation or for stock watering (Ritter 2011). More recently, in 2015 a farmer near the Manitoba-Saskatchewan border discovered that 500 barrels (79 m^3) of oil had leaked from a Tundra Oil and Gas pipeline onto his farmland, but there is no information on the extent of damages to his agricultural operations (Dyck 2015).

Accidental releases of oil can affect industrial activities, particularly in situations where released oil enters water bodies that are used as an industrial water source.

The Wabamun release resulted in a thermal power plant having to shut down for about 40 days due to contamination of lake water that was being used to produce steam (TransAlta 2005). Clean-up operations associated with Westridge release resulted in closure of parts of Burrard Inlet for shipping and caused Shell Canada's refinery to cease operating for 11 days (Canada.com 2008).

When over 6,000 barrels of heavy Venezuelan crude oil released from the Athos I tanker entered the Delaware River in 2004, two reactors at the Salem Nuclear Power Plant were closed down for

10 days, and the Port of Philadelphia was shut down for three days (NOAA Office of Response and Restoration 2014; University of Delaware 2004;). Compensation for closing the nuclear power facilities was determined to be $33.1 million (NOAA Office of Response and Restoration 2014).

There are likely many more examples of these effects, but the details are seldom made public because claims for damages are negotiated directly between the responsible and affected parties, and the terms of the settlements are never made public.

While an accidental release of oil may affect land and resource use by Indigenous People (Canada) and Native American tribes (United States), the nature of these effects has not been well documented or reported. Where tribes and First Nations have legally established rights to harvest affected resources, responsible parties may negotiate settlements with affected parties and the terms of the settlement, including the nature and extent of damages, are not usually disclosed to the public. In the case of the Lake Wabamun release, the Paul First Nation initiated lawsuits for damages to lands and resources, as well as the effect to the residents' way of life, and ultimately received a settlement of $10 million (CBC News 2008). Under United States regulations, Indian tribes can be included as Trustees in the NRDA process when natural resources under their jurisdiction are injured (OPA 1990; 33 U.S.C. 2706b). Although tribes face multiple barriers to participation in the NRDA process (Hildreth 2011), there are some examples where tribes have been designated as trustees in an NRDA process. For example, the Nottawaseppi Huron Band of the Potawatomi Tribe (the Huron Tribe) and the Match-E-Be-Nash-She-Wish Band of the Pottawatomi Indians (the Gun Lake Tribe) were trustees involved in the NRDA process for the Marshall release (USFWS 2015b). However, in the case of the NRDA conducted for the Buzzard's Bay Oil release, the Wampanoag Tribe of Gay Head (the Aquinnah) reached a separate settlement with the Responsible Party and was not part of the final agreement (NOAA et al. 2014).

7.1.4.2.3 Expected Effects of Oil Releases

There are four factors that help determine the nature and magnitude of land and resource effects associated with an accidental petroleum release.

- The intensity of land and resource use and the potential for adversely affecting large numbers of people. Releases in densely populated or intensively used areas tend to have larger effects than releases in rural or unpopulated areas. Similarly, releases can potentially affect large numbers of people where they affect water intakes, other public infrastructure, or areas or facilities that are used for recreational or cultural purposes.
- Whether the release can be contained on land or whether the oil is able to enter a waterbody, especially a moving water body. With oil being able to spread more easily on water than on land, accidental releases into water are likely to affect a larger area and potentially affect a greater number and types of land and resource uses. The effects on land and resource use that result when a release enters a creek, river, or lake are likely to be much greater in magnitude than a release restricted to land.
- The season during which the release occurs. Releases during winter months tend to be less severe and easier to manage. Cold weather makes released oil more viscous, so it is less likely to spread and easier to contain. Also, if the surface water and ground is frozen,

released oil is less likely to spread or penetrate below frozen surfaces, so it is easier to contain and recover. However, releases from underwater pipelines in winter may present real challenges to oil collection because oil may pool underneath ice.

- The duration and invasiveness of clean-up and restoration activities. Oils that are more volatile might have a greater short-term effect (combustion leading to risk to life or odor and volatility issues leading to evacuation) but, in the longer term, may be easier to clean-up such that recovery occurs more quickly. Heavy oils, especially if they enter a water body during the summer months, tend to be more difficult to clean-up. As was observed in the case of the Marshall release, the released oil affected at least 39 miles of river bed and shoreline, and it took considerable time and effort for reclamation and restoration activities to be completed.

Table 7-45 summarizes how these factors may affect the duration and magnitude of the effects of an accidental oil release on different types of land and resource uses. In all cases, the extent of the effects will also be highly dependent on the duration of clean-up and remediation activities and the time required before response authorities have determined that land and resource use activities can be safely resumed.

Table 7-45 Summary of Expected Effects of Oil Releases on Land and Resource Uses

Effect	Oil Properties	Setting (Land/Water)	Season of Release
Loss of life and injuries	Lighter oils have greater potential for combustion	Oil releases on or in water may quickly spread and release volatile, explosive compounds, especially for lighter oils during warm seasons	Releases in winter have lower potential for effect
Evacuation	Lighter oils have greater potential for odors that cause evacuation	Oil releases on or in water may quickly spread and release volatile, explosive compounds, especially for lighter oils during warm seasons	Releases in winter have lower potential for effect
Public water supplies and other infrastructure	Lighter oils have potential for short-term effect but heavier oils may have long-term effect	Oil releases on or in water have very high potential for long-term effect	Releases in winter have lower potential for effect
Recreation	Lighter oils have potential for short-term effect but heavier oils may have long-term effect due to clean-up activities	Oil releases on or in water have very high potential to affect a greater area and to have long-term effect associated with clean-up activities	Releases in winter have lower potential for long-term effects and will affect fewer users
Agriculture	Lighter oils have potential for short-term effect but heavier oils may have long-term effect due to clean-up activities	Oil releases on or in water have higher potential to affect a greater area while releases on land may require long-term clean-up.	Releases in winter have lower potential for long-term effects and will affect fewer users

Table 7-45 Summary of Expected Effects of Oil Releases on Land and Resource Uses

Effect	Oil Properties	Setting (Land/Water)	Season of Release
Industrial activities	Lighter oils have potential for short-term effect but heavier oils may have long-term effect	Oil releases on or in water have very high potential to affect a greater number of users	Releases in winter have lower potential for long-term effects and will affect fewer users
Cultural Activities	Lighter oils have potential for short-term effect but heavier oils may have long-term effect due to clean-up activities	Oil releases on or in water have very high potential to affect a greater area and to have long-term effect associated with clean-up activities.	Releases in winter have lower potential for long-term effects and will affect fewer users

7.2 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL NEAR MOSQUITO CREEK

The proposed pipeline is expected to pass approximately 2,000 ft northeast of the head of Mosquito Creek. Mosquito Creek flows into Lower Rice Lake, which is located on tribal lands of the White Earth Reservation, and is a growing area for wild rice. Therefore, the potential for overland flow of crude oil from the release area to Mosquito Creek, and subsequent transport down Mosquito Creek to Lower Rice Lake, was investigated. The hypothetical release location is in a relatively flat forested area that gently slopes toward a homestead and agricultural and grassland habitats. The overland flow path is approximately 0.6 miles long. Agricultural drainage ditches provide a preferential flow path towards Mosquito Creek, and sections of the creek also have been channelized. Thus, Mosquito Creek can be described as a semi-natural watercourse that ranges in width from approximately 3 to 30 ft as it flows approximately 11.75 miles to the south and west before entering Lower Rice Lake. As identified in Chapter 3, Mosquito Creek is part of the Mosquito Creek Wildlife Management Area (WMA) located in the Chippewa Plains Subsection of the Northern Minnesota Drift and Lake Plains Section of the greater Laurentian Mixed Forest Province (MN DNR 2016b; MN DNR 2016c). Land cover is predominantly forest (57%) and is dominated by aspen (MN DNR 2006).

7.2.1 Description of the Freshwater Environment

At its origin, Mosquito Creek is a narrow ditch or swale (Figure 7-2). As it grows to around 30 ft in width, Mosquito Creek flows through marshy grassland and riparian bog (occasionally treed), passing through agricultural land and nature preserves before entering Lower Rice Lake. The average velocity of the Mosquito Creek changes with season, with slowest velocities (e.g., about 0.52 ft per second) expected during low flow periods in the winter, and greater velocities (e.g., about 3 ft per second) during the spring high flow period. Mosquito Creek enters Lower Rice Lake at its north end, about 0.4 miles from the lake outflow, also at the north end. A non-vegetated channel between the inflow and outflow indicates that much of the creek flow is likely to bypass the lake and report directly to the outflow. A water level control structure is

located approximately 0.64 miles downstream from the lake outflow. Lower Rice Lake is approximately 0.5 to 1 mile wide and 4.2 miles long.

Recreation, tourism and forestry are the major land uses in the area of Mosquito Creek and Lower Rice Lake (MN DNR 2016b). Although much of the land is agricultural (grassland), it does not appear to be under intensive use. Deer, bear, waterfowl, and migratory species offer hunting and trapping opportunities (MN DNR 2006; MN DNR 2016b). Being part of the Chippewa Plains, Mosquito Creek is known or expected to be home to 83 Species in Greatest Conservation Need (SGCN); these include birds (60 species), fish (4 species), insects (8 species), mammals (6 species), mollusks (2 species), and reptiles (2 species) (MN DNR 2006). Of these, 22 species are afforded federal or state endangered, threatened, or of special concern status (MN DNR 2006; MN DNR 2016d). It is foreseeable that some of these SGCN could utilize aquatic habitats along the Mosquito Creek. The area around Mosquito Creek and Lower Rice Lake is shared by White Earth Reservation, private owners, and DNR Forestry Trust lands and is populated with summer homes and Native American communities (White Earth, Pine Point/Ponsford, Naytahwaush, Elbow Lake, and Rice Lake [IAC 2012]). The Mosquito Creek WMA is complex of forest, agricultural lands and 24 emergent wetlands (MN DNR 2016b). The lower section of Mosquito Creek enters White Earth Reservation, which surrounds Lower Rice Lake (known for wild rice), and is directly downstream of the hypothetical release location.

Several access points downstream from the proposed pipeline crossing location were visited in May, 2016, to provide additional insight into baseline environmental conditions for Mosquito Creek and surrounding environments. Representative site photographs are provided in Figure 7-2 through Figure 7-5. Field observations are summarized in Table 7-46.



Figure 7-2 Mosquito Creek and Habitat Approximately 2 Miles Downstream of the Pipeline Crossing Looking Upstream



Figure 7-3 Mosquito Creek and Habitat Approximately 2 Miles Downstream of the Pipeline Crossing Looking Downstream



Figure 7-4 **Mosquito Creek and Riparian Habitat Approximately 25 Miles Downstream of the Pipeline Crossing to the West of Lower Rice Lake**



Figure 7-5 **Mosquito Creek and Riparian Habitat Approximately 55 Miles Downstream of the Pipeline Crossing to the West of Lower Rice Lake**

Table 7-46 Environmental Characteristics Observed at Selected Access Points on the Mosquito Creek in May, 2016

Access Point	Latitude Longitude	Notes
211th Avenue and Mosquito Creek approximately 2 miles downstream of pipeline crossing	47.4479 -95.3396	*Habitat Description:* both sides of road are cattle pasture and nearly level. There was no water flowing in the shallow, excavated ditch (Mosquito Creek) at the time of the field visit. An approximately 36-inch CMP culvert is under road here. Dominant vegetation is nonnative, cool season pasture grasses, with scattered small patches and groves of bur oak/aspen trees. *Wildlife observed:* bobolink, yellowthroat, ruby-throated hummingbird, gray tree frog.
County State Aid Highway 4 and Mosquito Creek approximately 25 miles downstream of pipeline crossing	47.3873 -95.6367	*Habitat Description:* this segment has a broad floodplain with a mix of shrub swamp, wet/sedge meadow and lesser amounts of wet/aspen stands on slightly higher ground. The stream has good water clarity and abundant wild celery (*Vallisneria americana*). *Wildlife observed:* barn swallow, yellow warbler, American toad, yellow throat.
Creek 132 Road and Mosquito Creek approximately 50 miles downstream of pipeline crossing	47.35421 -95.76347	*Habitat Description:* this area has a relatively narrow stream corridor amid irregular, rolling hills (glacial moraine topography). The stream has riffles and pools, as well as a relatively narrow floodplain. The invasive, nonnative reed canary grass is codominant with native plants along stream margins. The dominant vegetation in stream buffer areas is lowland hardwood forest and mesic hardwood (oak) forest with good plant species richness/quality. *Wildlife observed:* veery, yellow throat, catbird, flycatcher, hairy woodpecker *Fish & Wildlife likely to occur in vicinity:* creek chub, smallmouth bass (personal communication from angler).

7.2.2 High Consequence Area Assessment for the Mosquito Creek to Lower Rice Lake Scenario

As defined in Section 7.0, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. Sensitive AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks).

While environmentally sensitive and populated HCAs are present near the confluence of Mosquito Creek and Lower Rice Lake, modeling demonstrated that neither Bakken crude oil nor CLB floating on the surface would reach these areas under any of the seasonal flow conditions (Figure 7-6). However, AOIs are present along Mosquito Creek (Table 7-47). The locations of the HCAs and AOIs are shown in Figure 7-6.

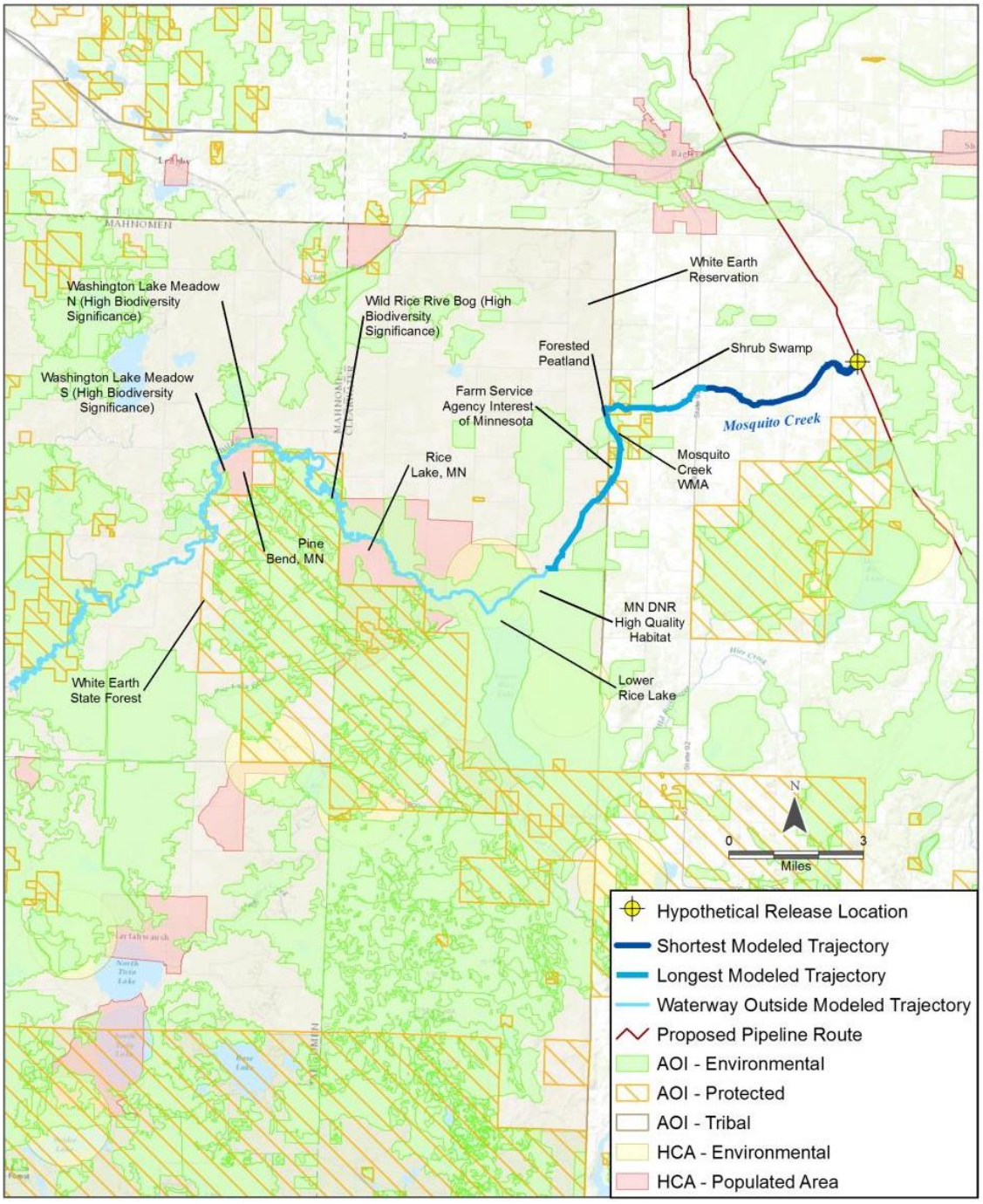

Figure 7-6 HCAs and AOIs Potentially Affected by a Crude Oil Release near Mosquito Creek

Table 7-47 Areas of Interest Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mosquito Creek to Lower Rice Lake Scenario

AOI Type	AOI Subtype	Description / Locations
Environmental	Native Plant Community (Candidate)	Forested Peatland, Shrub Swamp, Tribal Lands
Protected Area	Farm Service Agency Interest of Minnesota	N/A
	Wildlife Management Area	Mosquito Creek WMA
Tribal Lands	N/A	White Earth Reservation
NOTE: Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website, USGS Protected Areas Database of the United States and the Minnesota Department of Transportation.		

7.2.3 Selection of Key Ecological and Human Environment Receptors for Mosquito Creek to Lower Rice Lake Scenario

Taking into account the environmental characteristics of Mosquito Creek and Lower Rice Lake, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-48.

Table 7-48 Key Ecological and Human Environment Receptors for the Mosquito Creek to Lower Rice Lake Scenario

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mosquito Creek to Lower Rice Lake Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil in spring and summer-fall conditions would flow approximately 0.6 miles overland before reaching the channel of Mosquito Creek. After reaching the creek, crude oil could be transported downstream following a defined channel. Under winter conditions, the released crude oil is not predicted to reach the creek, but could be retained by snowpack over frozen ground. It is assumed that oil that remained on land would be physically remediated to established standards.	N
Groundwater	Low. In the event of an actual oil release, effects on groundwater quality after cleanup would be localized and/or negligible.	N

Table 7-48 Key Ecological and Human Environment Receptors for the Mosquito Creek to Lower Rice Lake Scenario

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mosquito Creek to Lower Rice Lake Scenario	Selected (Y/N)
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil in spring and summer-fall conditions could flow approximately 0.6 miles overland before reaching the channel of Mosquito Creek. After reaching the creek, crude oil could be transported downstream following a defined channel. Under winter conditions the released crude oil is not predicted to reach the creek, but could be retained by snowpack over frozen ground. It is assumed that oil that remained on land would be physically remediated to established standards. Terrestrial vegetation communities along the flow path would be killed or impaired, but this area would be remediated, and vegetative cover would be restored as part of the cleanup process.	N
Aquatic Receptors		
River (Mosquito Creek)	High. An assumption made in the fate modeling for this scenario is that oil released under spring or summer-fall conditions could reach Mosquito Creek via overland flow, with subsequent physical transport downstream.	Y
Lake (Lower Rice Lake)	Medium. An assumption made in the fate modeling for this scenario is that oil released under spring or summer-fall conditions could reach Mosquito Creek via overland flow, with subsequent physical transport downstream towards Lower Rice Lake. While none of the simulations indicated that floating oil would reach the lake within 24 hours, this receptor was included in the assessment due to the importance of the area to Native Americans and local residents.	Y
Sediment	High. An assumption made in the fate modeling for this scenario is that oil released under spring or summer-fall conditions could reach Mosquito Creek via overland flow, with subsequent physical transport downstream. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that oil released under spring or summer-fall conditions could reach Mosquito Creek via overland flow, with subsequent physical transport downstream. This allows potential interaction with shoreline and riparian habitat.	Y
Wetlands	High. An assumption made in the fate modeling for this scenario is that oil released under spring or summer-fall conditions could reach Mosquito Creek via overland flow, with subsequent physical transport downstream. This allows for potential interaction with riparian wetlands, and wetlands associated with Lower Rice Lake.	Y
Aquatic Plants	High. Mosquito Creek supports aquatic plant communities.	Y
Benthic Invertebrates	High. Mosquito Creek and Lower Rice Lake support benthic invertebrate communities.	Y
Fish	High. Mosquito Creek and Lower Rice Lake support fish communities.	Y
Semi-Aquatic Wildlife Receptors		

Table 7-48 Key Ecological and Human Environment Receptors for the Mosquito Creek to Lower Rice Lake Scenario

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mosquito Creek to Lower Rice Lake Scenario	Selected (Y/N)
Amphibians and Reptiles	High. Mosquito Creek and Lower Rice Lake support amphibians and reptiles.	Y
Birds	High. Mosquito Creek and Lower Rice Lake support waterfowl and other birds.	Y
Semi-aquatic Mammals	High. Mosquito Creek and Lower Rice Lake support semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. The Mosquito Creek and Lower Rice Lake area is shared by White Earth Reservation, private land owners, and MN DNR Forestry Trust lands. Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. The Mosquito Creek and Lower Rice Lake area is shared by White Earth Reservation, private land owners, and MN DNR Forestry Trust lands. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health.	Y
Public Use of Natural Resources	High. The Mosquito Creek and Lower Rice Lake area is shared by White Earth Reservation, private land owners, Mosquito Creek WMA and MN DNR Forestry Trust lands. Effects on air and water quality, or the presence of crude oil residues in the sediment, riparian or wetland habitat, could potentially disrupt public use of natural resources (e.g., wild rice harvest, drinking water supplies, hunting, fishing, recreation).	Y

7.2.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Mosquito Creek to Lower Rice Lake scenario is provided in this section. The OILMAP Land software was used by RPS ASA to simulate hypothetical releases of CLB and Bakken crude oils into Mosquito Creek and the flow of oil over land (Chapter 5.0) for a 24 hour period. A longer time period was not modeled as it was assumed that emergency response measures to prevent further downstream transport of released oil would be in place within the 24 hour period.

While OILMAP Land does provide an indication of the overland and downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column (Chapter 5.0). The ability of the OILMAP Land model system to accurately predict overland release pathways is in large part controlled by ground cover and the vertical and horizontal resolution of the elevation grid. In this scenario, a 0.6 mile flow path of predominantly grassland/herbaceous land cover (during non-winter months) or snow/ice land cover (during winter months) extended downslope to Mosquito Creek. This is a worst-case assumption for a release of crude oil near the watercourse. In the event of an

actual release, emergency response measures to prevent further possible downstream transport of oil would be expected to be in place within several hours of the release.

Based on data obtained from weather stations (Thorhult, MN and the University of Minnesota Itasca Biological Station, MN) near the hypothetical release location, long cold winters with periods of snow cover occur between October (averaging 0.5 inch) and May (averaging 0.4 inch), with maximum average coverage in February (13.7 inches). The retention of light crude oil in snow was assumed to be 20% of the snowpack depth for the Bakken crude oil, and 40% of the snowpack depth for the heavier CLWB. Elevation data used for overland flow modeling were obtained from the MN DNR (MN DNR 2014a) and have 10 ft horizontal resolution and 0.4 inch vertical resolution.

The two crude oil types provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB, heavy diluted bitumen crude oil types having higher viscosity and density). Seasonal variations in river flow velocity, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-49.

In the event of an actual release, the downstream extents of CLB and Bakken crude oil may be more similar, and the effects of CLB may extend farther downstream than predicted, with patchy coverage.

Table 7-49 Environmental and Hydrodynamic Conditions for the Three Modeled Periods at the Mosquito Creek Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	February	-11.50	4.44	0.16
Average Flow (Summer)	July	19.25	3.68	0.21
High Flow (Spring)	April	4.17	4.88	1.03
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest average flow velocity of the Mosquito Creek coincides with the spring freshet (i.e., April-June), a result of rising temperatures and snowmelt. Average flow would typically occur in summer and fall seasons. July, the month with the warmest temperature, was selected to represent the maximum amount of evaporation. The lowest flow rate occurs in winter (i.e., January-March), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3-minute period to allow for valve closure. Therefore, the release volume represents the volume of oil actively discharged in

the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum 13-minute response time to valve closure is an Enbridge standard for safe operations and leak detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown and full valve closure in the affected pipeline section. While 13 minutes is the maximum time for valve closure, this is a conservative assumption, since a response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated to be of Bakken, CLB, or CLWB crude oil.

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7.2.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectories and mass balance for Cold Lake and Bakken crude oils, under the three seasonal scenarios, is provided in Figure 7-7 and Figure 7-8, respectively. These simulations are assumed to provide bounding conditions for a release of heavy or light crude oil types. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the Cold Lake and Bakken crude oil types. The Cold Lake crude oil was assumed to be CLB for the high flow and average flow scenarios, and to be CLWB for the low flow (winter) scenario. As noted in Chapter 5.0, while OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column.

The maximum simulation duration using OILMAP Land was 24 hours, as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within that length of time. Symbols on the drawings indicate the river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Numbers other than these (e.g., 7.9) indicate the time in hours of the predicted termination of downstream transport of the released oil due to adhesion or holdup of the oil along the river banks. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, adhering to river banks, or evaporated to the atmosphere) of the released oil at relevant points in time after the start of the release.

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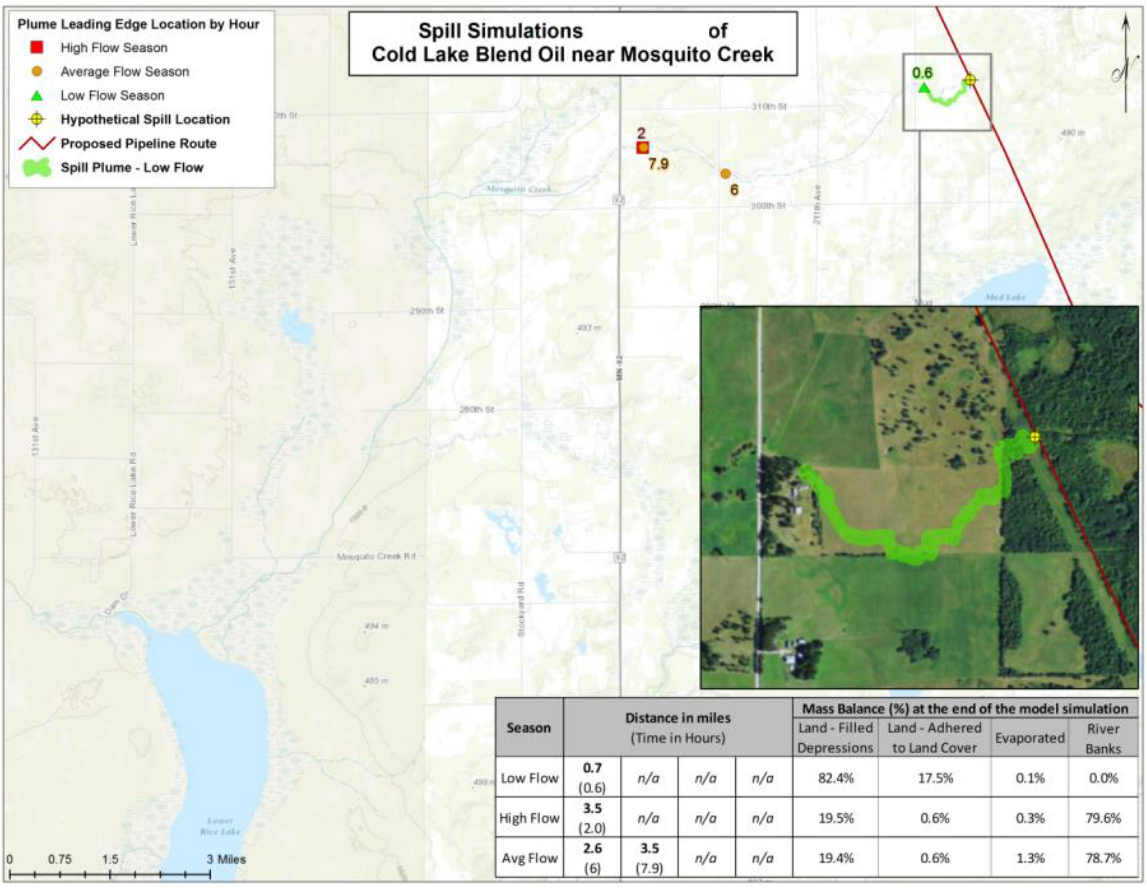

Season	Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Land - Filled Depressions	Land - Adhered to Land Cover	Evaporated	River Banks
Low Flow	0.7 (0.6)	n/a	n/a	n/a	82.4%	17.5%	0.1%	0.0%
High Flow	3.5 (2.0)	n/a	n/a	n/a	19.5%	0.6%	0.3%	79.6%
Avg Flow	2.6 (6)	3.5 (7.9)	n/a	n/a	19.4%	0.6%	1.3%	78.7%

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Figure 7-7 Predicted Downstream Transport of Cold Lake Blend Oil at the Mosquito Creek Crossing Location

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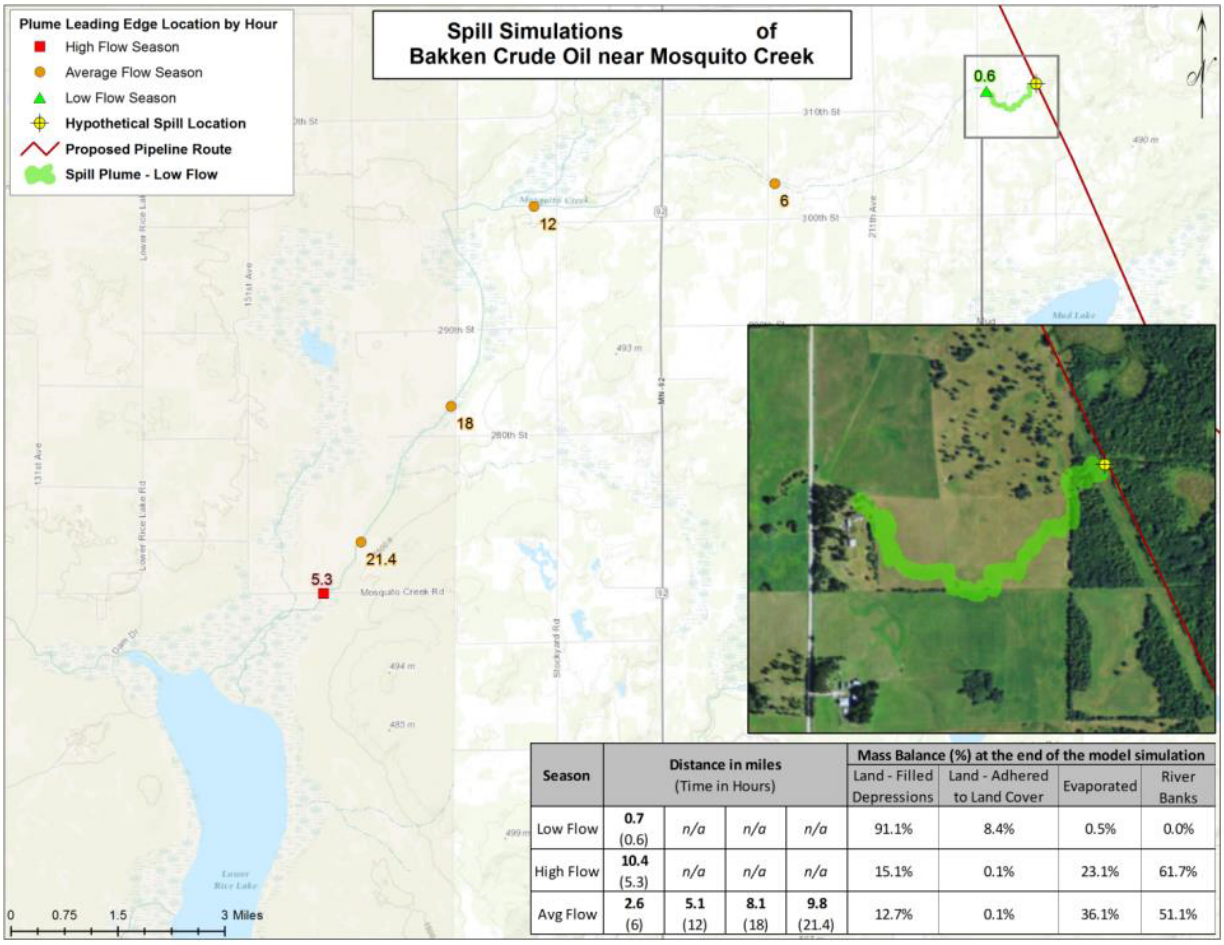

Season	Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Land - Filled Depressions	Land - Adhered to Land Cover	Evaporated	River Banks
Low Flow	**0.7** (0.6)	*n/a*	*n/a*	*n/a*	91.1%	8.4%	0.5%	0.0%
High Flow	**10.4** (5.3)	*n/a*	*n/a*	*n/a*	15.1%	0.1%	23.1%	61.7%
Avg Flow	**2.6** (6)	**5.1** (12)	**8.1** (18)	**9.8** (21.4)	12.7%	0.1%	36.1%	51.1%

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Figure 7-8 Predicted Downstream Transport of Bakken Crude Oil at the Mosquito Creek Crossing Location

7.2.5.1 Mosquito Creek to Lower Rice Lake Release During High Flow (Spring) Period

Under the high flow scenario, CLB was predicted to travel approximately 3.5 miles downstream in Mosquito Creek, with downstream transport being terminated 2 hours after the release. This is largely a result of crude oil being held up on land (20.1%) or adhering to shorelines (79.6%). Only a small amount (0.3%) of the CLB was predicted to have evaporated to the atmosphere during that period. In the event of an actual release, emergency response measures to prevent further possible downstream transport of oil would be expected to be in place within several hours of the release.

Bakken crude oil was predicted to be transported approximately 10.4 miles downstream (or approximately 1.4 miles upstream of Lower Rice Lake), with downstream transport being

terminated within 5.3 hours of the release. After 5.3 hours, approximately 23.1% of the Bakken crude oil was predicted to have evaporated to the atmosphere, with 15.2% filling depressions on land or adhered to land cover, and the remaining 61.7% predicted to be adhering to shorelines.

The release of Bakken crude oil under high flow conditions was predicted to result in shoreline oiling nearly 3 times farther downstream in Mosquito Creek than the CLB. The difference in the extent of downstream transport was primarily due to differences in shoreline retention. Because of its higher viscosity and adhesiveness, larger amounts of CLB are predicted to strand, as a thicker layer of oil on a given length of shoreline, than for the Bakken oil. Conversely, the same amount of Bakken crude oil would affect a greater length of shoreline, with a lesser thickness of oil. This result is based on the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point was oiled to its maximum holding capacity for that oil type) as oil made its way downstream. In the event of an actual release, the downstream extents of CLB and Bakken crude oil may be more similar, and the effects of CLB may extend farther downstream than presented, with patchy coverage or partial oiling of shorelines.

A larger proportion of the Bakken crude oil was predicted to evaporate to the atmosphere than was predicted for CLB. This was due in part to the lighter and more volatile character of the Bakken crude oil. In addition, the greater downstream transport of the Bakken crude oil took more time, and resulted in more water surface area with oil, both of which would allow more of the released oil to evaporate. Volatile components of the CLB would continue to evaporate after becoming stranded on the shoreline, but this process was not included within the OILMAP Land model for stranded oil.

7.2.5.2 Mosquito Creek to Lower Rice Lake Release During Average Flow (Summer-Fall) Period

Under the average river flow condition, CLB crude oil was predicted to travel up to 2.6 and 3.5 miles downstream after 6 and 7.9 hours, respectively, at which time the leading edge of the release is predicted to be 8.3 miles upstream of Lower Rice Lake (Figure 7-7). At that time, approximately 1.3% of the CLB was predicted to have evaporated to the atmosphere, 20.0% filled depressions on land or adhered to land cover, and the remaining 78.7% was predicted to be adhering to shorelines. Emergency response measures to prevent further possible downstream transport of oil would be in place within 24 hours of the release.

Bakken crude oil was predicted to travel approximately 2.6, 5.1, 8.1 and 9.8 miles downstream after 6, 12, 18 and 21.4 hours. Downstream transport was predicted to terminate 21.4 hours after the release. By that time, approximately 36.1% of the Bakken crude oil was predicted to have evaporated to the atmosphere, 12.7% filled depressions on land or adhered to land cover, and the remaining 51.1% was predicted to be retained on shorelines. Slightly more of the released CLB crude oil was predicted to evaporate under the average river flow condition than under the high river flow condition (Figure 7-7). This difference is due largely to the warmer temperatures in the summer-fall season as compared to the spring freshet, and also due to the

greater length of time, and greater surface area of water that was predicted to be oiled during the simulation.

When compared to CLB was predicted to be transported farther downstream than Bakken crude oil. This is a result of the lower overland and shoreline oil retention values for the low viscosity Bakken crude oil, when compared to the more viscous and adhesive CLB. Although not modeled here, it is expected that a medium crude oil would exhibit fate and transport properties intermediate between those of the Bakken and CLB crude oil types, with a tendency to behave more like the Bakken crude oil. This is because the viscosity and adhesiveness properties of a medium crude oil would typically be higher but more similar to those of the Bakken crude oil, than to the CLB.

7.2.5.3 Mosquito Creek to Lower Rice Lake Release During Low Flow (Winter) Period

Under the low flow conditions of winter, it was assumed that Mosquito Creek would be frozen over (100% coverage of ice), with a layer of snow on top. Therefore, a release of CLWB from the pipeline onto land could result in a release traveling over the land surface to reach the channel of Mosquito creek, but the oil would likely pool in the dry or frozen stream channel without contacting water.

Under low flow conditions, CLWB was predicted to travel approximately 0.7 miles over the land surface, within 0.6 hours of release. At that time, approximately 82.4% of the CLWB was predicted to be held up by snow or filling depressions in the land surface, with 17.5% adhering to the land cover and only 0.1% predicted to have evaporated. A considerable amount of CLWB was predicted to adhere to the land cover and be retained in depressions along due to the high holding capacity of the snow cover. With Mosquito Creek frozen over, CLWB that reached the creek would be expected to pool in the dry stream channel, or on the surface of the ice. Little evaporation was predicted to occur under winter conditions due to low air temperature which would slow evaporation, and reduced surface area due to the predicted thick retention of CLWB on the overland flow path. Evaporation was also limited by the short (0.6 hour) duration of the simulation.

Under low flow conditions, the Bakken crude oil was predicted to travel approximately 0.7 miles over the land surface, within 0.6 hours of release. At that point, approximately 91.1% of the oil was predicted to be filling depressions in the land surface, 8.4% adhering to the land cover, and only 0.5% was predicted to have evaporated. Considerably more Bakken crude oil was predicted to adhere to land cover during low flow conditions than during high or average river flow conditions, due to the holding capacity of snow cover.

7.2.6 Qualitative EHHRA for the Mosquito Creek to Lower Rice Lake Scenario

In this section the likely environmental effects of a crude oil release at the pipeline crossing location near Mosquito Creek are described. A worst case crude oil release from a main-line pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed

pipeline would carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumens such as CLB). Therefore, the following discussion describes the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7.2.3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence and sensitivity) were also considered. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-48.

7.2.6.1 Terrestrial Receptors

In spring and summer-fall seasons it is assumed that a release will flow over 0.6 miles of land downslope to Mosquito Creek, with most of the released crude oil entering the creek, rather than remaining on land. Environmental effects on soils and terrestrial vegetation are assumed to be localized to the overland flow path of the released oil. This area is limited in spatial extent, and would be remediated using conventional clean-up techniques. In the winter season it is expected that virtually all of the released crude oil would be retained in snow and fill depressions on land. This type of release would also be physically remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors are not considered further for this release scenario.

7.2.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors are most closely associated with Mosquito Creek. These receptors include creek water and sediment quality, shoreline and riparian areas, wetlands, aquatic plants (including wild rice), benthic invertebrates, and fish.

If crude oil was to enter Mosquito Creek during the spring (high flow), it is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. The distance travelled would depend upon river flow and oil type. Based on OILMAP Land simulations, light oils oil is predicted to travel father downstream than heavy oil. For heavy oil, stranding on shore would be the primary fate, with only small amounts of evaporative weathering of the oil occurring before the oil becomes stranded. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation.

The effects of crude oil releases on benthic invertebrates and fish depend on the characteristics of the released oil and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. Light oils have low viscosity relative to heavier oils. Turbulence in flowing water could potentially disperse light oil as small droplets in the water column, increasing the potential for toxic fractions of the light oil to dissolve into the water

column. As a result of the flow conditions, and the relatively small volume of flow in Mosquito Creek providing dilution to dissolved hydrocarbons, the potential for acute toxicity to fish and benthic invertebrates could be high, and greater for the light oil than for heavy oil.

As a headwater system, the volume of water flow associated with the spring freshet in Mosquito Creek is not likely to be sufficient to dilute and limit the maximum dissolved hydrocarbon concentration in water. Therefore, it is likely that acute toxicity to fish would occur in Mosquito Creek during spring flows, extending at least as far as the longest modeled trajectory, and potentially farther as dissolved hydrocarbons could continue to be transported downstream even when the surface oil slick has terminated. Toxicity to fish would also be more likely for the light crude oil than for the heavy crude oil due to the higher proportion of low molecular weight (and relatively water soluble) hydrocarbons in the light crude oil. The lower viscosity of the light crude oil, which would enhance the potential for small droplets of oil to become entrained in the water column, would also enhance the rate of hydrocarbon dissolution into water.

There would also be high potential for chronic effects of released crude oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease). Many of the fish species present in the Mosquito Creek spawn in the spring and early summer. The eggs and embryos of these species could be exposed to total PAH concentrations in the river water that could be sufficiently high to induce deformities or cause mortality. In addition the potential for phototoxicity, caused by an interaction of UV light with PAHs accumulated in fish tissues, would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. In addition the potential for phototoxicity, caused by an interaction of UV light with PAHs accumulated in fish tissues, would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. The risk of phototoxicity could be partially mitigated by periods of high concentrations of suspended sediment and dissolved organic carbon present in the water.

Entrainment of small crude oil droplets in the water column also enhances the potential for light crude oils to interact with suspended sediment particles in the water column resulting in the formation of OPAs. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water, such as oxbows and backwaters. Formation of true OPAs is less likely to occur with heavy crude oils such as diluted bitumen, as the higher viscosity of the oil precludes the ready formation of fine droplets in the water column (Zhou et al. 2015). However, heavy oils can still contact sediment particles along the shoreline, and some accumulation of both light and heavy oils in depositional areas is likely, although the precise mechanisms of deposition may vary. Neither crude oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. During the high flow spring period, while neither oil is predicted to be on the water surface beyond 10.4 miles downstream of the release location within the first 24 hours of the release, it is possible that oil

accumulated in depositional areas could mobilize over time and move farther downstream towards, and potentially into the north end of Lower Rice Lake.

For a hypothetical release under spring freshet conditions, it is likely that most aquatic plants would still be dormant or submerged, and that environmental effects on this receptor type would be minimal. However, where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants would be less vulnerable, as they would be exposed primarily to dissolved hydrocarbons, and are not considered likely to be among the more sensitive groups of aquatic biota to such exposure. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem could be oiled). However, flooded riparian areas and wetland habitats would also be exposed to the released oil, and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat.

Wild rice is an emergent aquatic plant of biological and cultural importance and occurs where Mosquito Creek enters Lower Rice Lake. Wild rice provides a food source and nesting cover for many birds, and is also harvested as a food source by people in the area. Based on the 24 hour simulations, the longest modeled trajectory during the high flow period extended 10.4 miles downstream of the releases and 1.4 miles upstream of Lower Rice Lake. This suggests that it is unlikely that released crude oil during this season would result in adverse effects to wild rice in Lower Rice Lake. However, it is possible that oil accumulated in depositional areas could mobilize with time and move farther downstream towards, and into the north end of Lower Rice Lake. This would be similar to the process that led to accumulation of diluted bitumen in the upper end of Morrow Lake following the Marshall, Michigan oil spill in 2010. The mobilization of oil that accumulates in depositional areas would be more likely to occur for the heavy crude oil which weathers more slowly and is more persistent than the light crude oil. Accumulation of crude oil in the sediment at the north end of Lower Rice Lake could be detrimental to the germination and growth of wild rice.

Crude oil released during the summer-fall (average flow) period is predicted to travel downstream, stranding on grassy and marshy banks and losing volatile components of the oil to evaporation. Results for Bakken and Cold Lake crude oil types provide bounding cases for the products likely to be carried in the pipeline. Based on a 24 hour model run, the OILMAP Land simulations indicate that crude oil could be carried between 2.6 and 9.8 miles downstream from the point of release under summer-fall average-flow conditions. For heavy oil and light oil, stranding on creek banks would be the primary fate, with only small amounts of evaporative weathering of the heavy oil and moderate amounts of weathering for lighter oils within the first 24 hour period. The lower water flow in summer-fall could result in less dilution of water soluble components in the creek as compared to spring flow. However, the lower flow rates would be accompanied by lower turbulence in the water column, and a reduced tendency for crude oil to be dispersed as fine droplets in the water column. Periodic drying of the creek headwaters during summer and fall conditions would also limit crude oil transport should a release occur

during a dry summer, as well as limiting the interaction between oil and aquatic receptors. As a result, acute lethality caused by narcotic effects on fish and benthic invertebrates are less likely during the summer-fall season than in spring. The potential for blue sac disease to harm or kill developing fish eggs and embryos is also lower, due to the timing which avoids the reproductive period for most fish species. Taking into consideration the lower river flow and turbulence, deposition of crude oil residues to sediment in areas of still water is also less likely than during the spring period. These factors would also limit the potential for downstream movement of submerged crude oil into Lower Rice Lake, and subsequent interaction with aquatic plants and wetland areas.

Under low flow winter conditions, neither of the two bounding crude oil types is predicted to enter Mosquito Creek. As such, a crude oil release in winter would not be expected to seriously affect aquatic receptors.

7.2.6.3 Semi-Aquatic Wildlife Receptors

Habitat of the Mosquito Creek downstream of the hypothetical release location supports amphibians (e.g., salamander, mudpuppy), reptiles (e.g., turtles, snakes), semi-aquatic birds (e.g., ducks, geese) and semi-aquatic mammals (e.g., muskrat, otter). Habitat along Mosquito Creek varies in quality for semi-aquatic wildlife receptors. The creek is generally narrow, with grassy, marshy or boggy banks, and flows through a corridor dominated by bog/marsh, bounded by agricultural lands. Semi-aquatic wildlife receptors (e.g., amphibians, turtles, waterfowl, muskrat, and mink) will certainly be present throughout the length of Mosquito Creek. While individuals may be affected by exposure to released oil in the immediate area of the creek during the spring freshet and the summer-fall average-flow conditions, regional populations of these animals will be robustly supported by the extensive wetland and aquatic habitats in the area. Crude oil from a hypothetical release is not predicted to enter Mosquito Creek in winter, so effects on semi-aquatic wildlife would be minimal in that season. Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.2.6.3.1 Amphibians and Reptiles

Crude oil released to the Mosquito Creek during the spring (high flow) or summer-fall (average flow) seasons is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas in the riparian floodplain. The distance travelled would depend upon river flow and oil type. Based on OILMAP Land simulations, light oils oil is predicted to travel father downstream than heavy oil. For heavy oil, stranding on shore would be the primary fate, with only small amounts of evaporative weathering of the oil occurring within the first 24 hour period. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation.

Within the oil-exposed habitats along the river that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. Turtles appear to be relatively

tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. As a result, exposure of these animals to released crude oils would be limited. After the Kalamazoo River oil release in 2010 snakes did not appear to be highly exposed to released oil. A release of light crude oil during the spring would likely have a greater effect than in summer due to the greater predicted downstream transport distance and interaction with greater areas of riparian and wetland habitats than later in the year.

Under low flow winter conditions, neither of the two bounding crude oil types is predicted to enter Mosquito Creek. As such, exposure of amphibians and reptiles in winter would not be expected. In addition, amphibians and reptiles undergo a dormancy period when temperatures drop below approximately 41 to 45°F. Therefore, even if crude oil were to reach the creek, it is unlikely that amphibians and reptiles would be materially exposed to or affected by the released oil.

7.2.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, lakes, wetlands, and riparian areas as components of their habitat, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory and herbivory. If exposed to external oiling, the ability of birds to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release. During the spring (high flow) season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Waterfowl and other semi-aquatic birds present in the affected river reach would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected as it is assumed that emergency response

measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release.

Environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude. With rising water temperatures, mortality of lightly oiled adult birds due to hypothermia becomes less likely than in the spring. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest. Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure and areas of the creek with suitable habitat, which could range from 2.6 to 9.8 miles downstream from the release point.

Under low flow winter conditions, neither of the two bounding crude oil types is predicted to enter Mosquito Creek, and most aquatic or semi-aquatic birds would have migrated away from the area for wintering habitat farther south. As such, exposure of birds to released crude oil in winter would be very limited.

7.2.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses particularly upon species that have a primary association with the aquatic environment such as muskrat and beaver (herbivores), American mink (*carnivore-piscivore*), and river otter (*piscivore*). These species are at greater risk of exposure to an oil release in water than terrestrial mammals.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along Mosquito Creek where effects may occur, and the magnitude of effects, is related to the oil type released, season and flow rate. Effects to semi-aquatic mammals relate more to the amount of time spent in the water (and consequent exposure to physical oiling) than to dietary preferences. Timely capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Based on the OILMAP Land simulations, the leading edge of the releases could range from 3.5 to 10.4 miles in extent. Animals upstream, farther downstream where there is no exposure, or occupying other nearby habitats, would likely be unaffected. Therefore, although mortality of some semi-aquatic mammals could be expected, large-scale (i.e., regional) population level effects are unlikely.

Environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude than those associated with a release during a spring freshet. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is expected to be less likely than in the spring. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil also are possible as a result of ingesting crude oil residues while grooming, or while consuming food items.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. Animals that became oiled in the winter would be likely to rapidly die as a result of hypothermia.

7.2.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs than heavier crude oils, although diluted bitumens may contain similar amounts of VOCs to light crude oils, depending upon the type and amount of diluent they contain. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release. Under spring and summer-fall conditions, most of the released CLB or Bakken crude oil is predicted to reach Mosquito Creek, spreading on land and on the water. In contrast, under winter conditions virtually all of the released crude oil is predicted to be retained in snow or fill depressions on land. Low air temperatures, as well as the relatively thick layer and limited surface area of crude oil retained in the snow pack, are expected to minimize release of volatile components to the atmosphere in winter.

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil vapor. Similarly, ATSDR (1995) report that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

The potential for VOC inhalation exposures by the public would be greatest near and downwind from the release site and near to Mosquito Creek while the released oil is on the water surface. For the most part, the areas around Mosquito Creek are sparsely populated (i.e., farms and country dwellings). The nearest HCA representing a populated area is located west of Lower Rice Lake, and not within the area identified to be potentially contacted by released oil within 24 hours of a release. One farm is located within approximately 300 ft of the overland flow path between the hypothetical point of release and the head of Mosquito Creek, and a number of other homes are located within a similar distance of Mosquito Creek, upstream of Lower Rice Lake. In the unlikely event of a crude oil release, a human fatality is highly unlikely. Most of the volatile hydrocarbons would be lost within the first 24 hours following a release of crude oil.

Residents in close proximity to the flow path would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. It is also expected that emergency response personnel would contact such residents and advise them to evacuate. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while the emergency response takes place.

No drinking water HCAs were identified along the path of the release. However, a number of homes are located along the trajectory of the overland flow path and adjacent to Mosquito Creek upstream of Lower Rice Lake. It is assumed that residents of these homes rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. Based upon case studies involving crude oil releases elsewhere, this process could take a few days to two weeks, but reports of crude oil releases affecting private wells are rare, making this an unlikely effect.

Relatively little has been published regarding the long-term effects of exposure to an oil release. Health effects observed in residents and clean-up workers in the months following an oil release generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

Effects of a crude oil release on human receptors would be generally similar for the spring (high flow) and summer-fall (average flow) seasons, except that warmer temperatures and slower river flow velocities in the summer would promote more rapid evaporation of volatile hydrocarbons in a smaller area, whereas higher river flow velocity in the spring freshet period would transport the released oil farther downstream within the first 24 hours, potentially resulting in lesser exposures, but to a larger number of people. The distance of downstream oil transport depends upon river flow rate, oil type and bank type. Based on OILMAP Land simulations of lighter oils are predicted to travel father downstream than heavier oils (Figure 7-7 and Figure 7-8). As a result, a release of the light crude oil may affect a larger number of individuals than a release of the heavy crude oil type. Both Bakken crude oil and Cold Lake diluted bitumen are expected to contain similar overall amounts of volatile hydrocarbons, so differences related to the chemical characteristics of the released oil are likely to be minor.

Recreation, tourism, forestry and agriculture are the major land uses in the area of Mosquito Creek and Lower Rice Lake. Based on the 24 hour simulations and taking release response activities into account, neither heavy nor light crude oil is predicted to move on the water surface beyond 10.4 miles downstream of the releases. However, it is possible that oil accumulated in depositional areas would mobilize with time and move farther downstream,

towards and potentially into the north end of Lower Rice Lake. Such accumulation of crude oil could potentially affect the growth and harvesting of wild rice in this area. Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities along the predicted downstream migration route would be disrupted following a release of crude oil. Under winter conditions the released crude oil would remain on land near the release location. Fisheries and public health officials typically close fisheries or issue guidance to avoid consuming fish until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with chemical constituents of released crude oil.

7.2.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to Mosquito Creek, upstream of Lower Rice Lake, have been assessed. The proposed pipeline could carry a variety of crude oil types ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB), and the discussion of expected environmental effects on receptors considers these crude oil types as bounding conditions. Potential terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors and human and socio-economic receptors were screened to identify those most likely to have interactions with released crude oil. The results of this assessment are summarized in Table 7-50.

Table 7-50 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Mosquito Creek

Receptor	Expected Environmental Effects of Released Crude Oil to Mosquito Creek	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	An assumption made in the fate modeling is that crude oil released under spring and summer-fall conditions would flow over 0.6 miles of land before reaching the headwater of Mosquito Creek, where the majority would be transported downstream. Under winter conditions released crude oil would remain on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
River (Mosquito Creek)	Both light and heavy oil would reach Mosquito Creek via overland flow under spring and summer-fall conditions, with subsequent physical transport downstream from the release location. Lighter crude oils are predicted to travel farther downstream than heavier crude oils, but would be thinner and less persistent on the water. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column, meaning potentially toxic fractions of the light oils would more readily dissolve into the water column. Under winter conditions the released crude oil would remain on land. Light oils have a larger bioavailable component to aquatic organisms.	MORE	LESS
Lake (Lower Rice Lake)	Neither heavy nor light crude oil is predicted to move on the water surface beyond 10.4 miles downstream of the releases (based on the 24 hour simulations, and taking release response activities into account). Therefore, direct effects of released crude oil on Lower Rice Lake are unlikely. However, it is possible that oil accumulated in and not recovered from depositional areas could mobilize over time and move farther downstream, into the north end of Lower Rice Lake. This phenomenon would be more likely for the more persistent diluted bitumen than for a lighter crude oil which would undergo more rapid weathering and biodegradation.	LESS	MORE

Table 7-50 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Mosquito Creek

Receptor	Expected Environmental Effects of Released Crude Oil to Mosquito Creek	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Sediment	Lighter crude oils are predicted to travel farther downstream than heavier crude oils under spring and summer-fall conditions. Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. The low viscosity of the lighter type crude oils could potentially result in a larger amount of oil entrainment as fine droplets as compared to heavier blends, resulting in the formation of OPAs, which could both sink, and enhance biodegradation. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water. The diluted bitumen crude oil type is less likely to be entrained into the water as fine droplets, and therefore true OPA formation is unlikely to occur. However, contact between the weathered diluted bitumen and shorelines is also likely to result in mixing of mineral particles into the crude oil, which could then be deposited to sediments as aggregates of oil and mineral in larger droplets or globules. If not recovered, these aggregates could move downstream with bedload until a stable depositional environment was reached, potentially in the north end of Lower Rice Lake.	LESS	MORE
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location. Lighter crude oils are predicted to travel farther downstream than heavy crude oil under spring and summer-fall conditions, but would be thinner and less persistent where they contacted shorelines and riparian habitat. For heavy oil, thicker oiling of shorelines is predicted, with shorter overall transport distance. For light oil, stranding would also be the primary fate, but considerably more of the released oil would be lost to evaporation. Flooding of riparian and wetland habitats in spring could lead to stranding of crude oils in this habitat, with heavy crude oil likely to be deposited as patties or tar balls, which would be persistent. This is in contrast to light crude oil which would be deposited as a thin layer or sheen.	LESS	MORE
Aquatic Plants	Where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants are less vulnerable. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem was oiled). Wild rice is an emergent aquatic plant of ecological and cultural importance, and occurs where Mosquito Creek enters Lower Rice Lake. Based on the 24 hour model simulations, neither heavy nor light floating crude oil is predicted to move on the water surface beyond 10.4 miles downstream of the hypothetical release point (which is approximately 1.4 miles upstream of Lower Rice Lake). The light oil is predicted to be more mobile, and would affect a larger area of habitat. However, it is also possible that heavy oil accumulated in depositional areas would mobilize with time and move farther downstream towards and into Lower Rice Lake, thus interacting with this resource.	SAME	SAME

Table 7-50 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Mosquito Creek

Receptor	Expected Environmental Effects of Released Crude Oil to Mosquito Creek	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Benthic Invertebrates	In the short-term, the low viscosity of light crude oil would result in greater potential for oil entrainment as fine droplets, as compared to heavier blends. This would enhance dissolution of low molecular weight aliphatic and aromatic hydrocarbons into water (potentially resulting in acute toxicity), in addition to promoting oil-particle interaction and potential deposition of oil to sediment. For heavy crude oil, there would be less potential for dissolution of hydrocarbons into the water, but greater long-term potential for deposition of tar balls and patties as a result of oil interaction with sediment. These could accumulate in depositional areas, resulting in chronic effects on benthic invertebrates.	MORE	LESS
Fish	Environmental effects on fish would be limited to areas affected by the released oil. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column. This would enhance the dissolution of potentially toxic fractions of the light oil into the water column. As a result, the potential for acute toxicity to fish due to narcosis would be greater for the light oil than for heavy oil. Potential chronic effects on fish eggs and embryos (i.e., blue sac disease) could also occur, but would be most likely to occur in spring and early summer, when most species spawn.	MORE	LESS
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Light crude oil is predicted to travel farther downstream under spring and summer conditions than heavy crude oil, but would be thinner and less persistent on the water. Flooding of riparian habitat and marshes in spring could lead to stranding of crude oils in this habitat. Higher potential would exist for effects to amphibians than for adult turtles (e.g., external oiling and narcotic effects similar to fish and benthic invertebrates), which appear to be somewhat tolerant of external oiling.	MORE	LESS
Birds	Light crude oil is predicted to travel farther downstream under spring and summer conditions than heavy crude oil, so environmental effects could be more spatially extensive for light crude oil types than for heavy crude oil. Cold water in the spring, in combination with greater downstream movement of released oil, suggests that environmental effects of released oil could be greatest for a light crude oil in spring. In winter few if any aquatic or semi-aquatic birds would be present. Crude oil from a hypothetical release in that season is not predicted to enter Mosquito Creek, so effects on birds would be minimal.	MORE	LESS

Table 7-50 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Mosquito Creek

Receptor	Expected Environmental Effects of Released Crude Oil to Mosquito Creek	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Semi-aquatic Mammals	Light crude oil is predicted to travel farther downstream under spring and summer conditions than heavy crude oil, so environmental effects could be more spatially extensive for light crude oil types than for heavy crude oil. Cold water in the spring, in combination with greater downstream movement of released oil, suggests that environmental effects of released oil could be greatest for a light crude oil in spring. In winter crude oil from a hypothetical release is not predicted to enter Mosquito Creek, so effects on semi-aquatic mammals would be minimal in that season.	MORE	LESS
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. Light crude oil is likely to be transported farther downstream within 24 hours than heavy crude oil. As a result, environmental effects on air quality could be more spatially extensive for light crude oil. Under winter conditions, the cold temperatures and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS
Human Receptors	Typical human health effects associated with short-term inhalation of VOCs from crude oil releases include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is unlikely. Residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most volatile hydrocarbons would be lost within 24 hours following a release. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health. Under winter conditions, cold temperatures and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS
Public Use of Natural Resources	Emergency response workers, in cooperation with public health and safety officials, would be active in notifying the public about the release, and isolating, containing and recovering released crude oil. No drinking water HCAs were identified along the path of the release. However, a number of homes are located near the flow path. In the event of a crude oil release, residents would be notified and testing would be completed to confirm the safety of private drinking water supply wells. Recreational activities would be disrupted along the predicted downstream migration route following a release of crude oil.	SAME	SAME

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Assessment of Environmental Effects of Oil Releases
January 13, 2017

7.3 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL TO THE MISSISSIPPI RIVER AT BALL CLUB

The proposed pipeline could potentially cross under the Mississippi River 1.25 miles west of Ball Club, Minnesota and 400 ft south of U.S. Highway 2. This scenario captures a hypothetical release of crude oil directly to the Mississippi River, with downstream transport from the hypothetical release point to the south and east. The river channel in this area is relatively well defined, with many oxbows, backwaters and sloughs. The river margins include extensive riparian wetlands in a wide floodplain.

The Mississippi River to the south and east of the hypothetical release location is joined by the Leech Lake River approximately 4.7 miles downstream. Below the Leech Lake River confluence, the Mississippi River deepens and the riparian marsh expands as flow moves towards White Oak Lake (MN DNR 2016e). Beyond White Oak Lake the Mississippi River flows south and then east towards Grand Rapids, Minnesota. As identified in Chapter 4, the Mississippi River near Ball Club is part of the Chippewa Plains, a subsection of the Northern Minnesota Drift and Lake Plains Section of the greater Laurentian Mixed Forest Province (MN NDR 2006).

7.3.1 Description of the Freshwater Environment

The Mississippi River near Ball Club, Minnesota flows through a forested area, but the river has a wide floodplain lined with extensive marsh and grass. The riparian marshes and numerous abandoned river segments (oxbows) downstream of the crossing are considered important but they are afforded no special protection as WMAs (MN DNR 2016e). The river channel near the hypothetical release point is about 70 ft wide. The average velocity of the Mississippi River changes with season, with slowest velocities (e.g., about 0.4 ft per second) expected during low flow periods in the winter, and greater velocities (e.g., about 1.5 ft per second) during the spring high flow period. As a result of the flow regime, sand bars are often present on the inside of river bends, and occasionally present in the river channel.

Under low and average flow conditions the main channel of the Mississippi River passes to the south of White Oak Lake, with only small marshy streams connecting them. Under high river flow conditions, more substantial hydraulic connections exist between the river and lake. White Oak Lake is 38 acres in size and approximately 16 ft deep and is bordered to the north by the communities of Zemple and Deer River. The MN DNR does not report any information about aquatic wildlife on White Oak Lake; however, in nearby Ball Club Lake, many fish species are present (e.g., northern pike, black crappie, smallmouth bass; MN DNR 2016f).

The oxbows along the Mississippi River downstream of the potential pipeline crossing location are expected to support spawning fish, mink, raccoon, otter, wood ducks, mallard, and merganser (MN DNR 2016e). Within the Chippewa Plains subsection, 83 species are considered SGCN; these include birds (60 species), fish (4 species), insects (8 species), mammals (6 species), mollusks (2 species), and reptiles (2 species) (MN DNR 2006). Of these, 22 are listed by the federal

government as endangered, threatened, or species of concern (MN DNR 2006; MN DNR 2016d). It is foreseeable that some of these SGCN would utilize aquatic habitats along the Mississippi River and White Oak Lake.

Several access points downstream from the proposed pipeline crossing location were visited in May, 2016, to provide additional insight into baseline environmental conditions for the Mississippi River downstream of Ball Club. Representative site photographs are provided in Figure 7-9 through Figure 7-12. Field observations are summarized in Table 7-51.



Figure 7-9 Mississippi River and Riparian Habitat Approximately 4.7 Miles Downstream of Pipeline Crossing Looking South (Confluence of Leech Lake River)



Figure 7-10 Mississippi River and Riparian Habitat Approximately 4.7 Miles Downstream of Pipeline Crossing Looking West (Upstream)



Figure 7-11 Mississippi River and Riparian Habitat Approximately 31 Miles Downstream of Pipeline Crossing



Figure 7-12 Mississippi River and Riparian Habitat Approximately 56 Miles Downstream of Pipeline Crossing

Table 7-51 Environmental Characteristics Observed at Selected Access Points on the Mississippi River Downstream of Pipeline Crossing Near Ball Club, MN in May 2016

Access Point	Latitude Longitude	Notes
Mississippi River #10 State Water Access Site (Boat Ramp) 4.7 miles downstream of pipeline crossing	47.3022 -93.9037	Habitat Description: At the confluence of the Mississippi and Leech Lake rivers. Broad floodplain with sedge wet/meadow, shrub swamp, and emergent marsh as the dominant plant community types. Some hardwood swamp and temporarily flooded aspen woods also present. The invasive plant Phragmites (reed grass) is common in the vicinity. Wildlife observed: yellow-bellied sapsucker, yellowthroat, green heron, tree swallow.
Mississippi River, #2 State Water Access Site (Boat Ramp) 31 miles downstream of pipeline crossing	47.6256 -93.7610	Habitat Description: River margin has good quality emergent marsh and wet/sedge meadow plant communities present. The invasive plants hybrid/narrowleaf cattail and Phragmites are common in some areas. Submergent vegetation is dominated by water celery. Floodplain forest is also present in the area. Adjacent upland areas include good quality forest dominated by aspen-birch. Wildlife observed: red-wing blackbird, yellowthroat

Table 7-51 Environmental Characteristics Observed at Selected Access Points on the Mississippi River Downstream of Pipeline Crossing Near Ball Club, MN in May 2016

Access Point	Latitude Longitude	Notes
Mississippi River at Herb Beers State Water Access Site 56 miles downstream of pipeline crossing	47.1288 -93.4051	Habitat Description: The floodplain in this area is dominated by a mix of floodplain forest and wet/sedge meadow. The invasive, nonnative reed canary grass occurs occasionally here. Floodplain transitions into terrace forest dominated by bur oak and green ash on Mississippi soils. Wildlife observed: Yellow throat, Baltimore oriole

7.3.2 High Consequence Area Assessment for the Mississippi River near Ball Club Crossing Location

As defined in Chapter 7.0, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. Sensitive AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks).

The locations of the various HCAs and AOIs near the hypothetical release location and the predicted trajectory of the floating oil are illustrated in Figure 7-13. Table 7-52 and Table 7-53 provide brief descriptions of the HCAs and AOIs for the hypothetical crude oil release location.

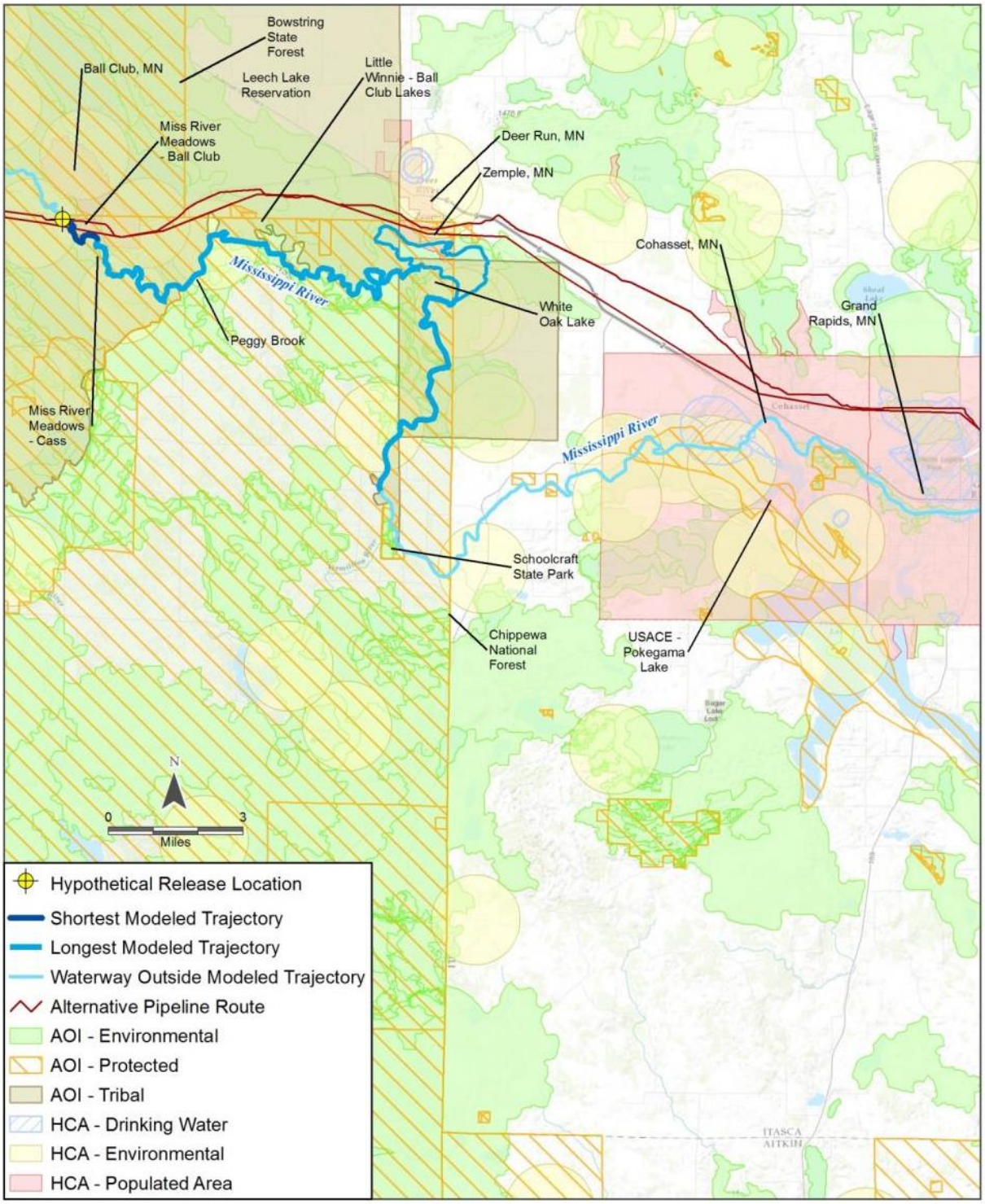

Figure 7-13 HCAs and AOIs Potentially Affected by a Crude Oil Release at the Mississippi River near Ball Club Crossing Location

Table 7-52 HCAs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mississippi River near Ball Club Crossing Location

HCA Type	HCA Subtype	Description / Locations
Environmentally Sensitive Area	N/A	N/A
Population Area	Other	Ball Club, MN Zemple, MN
NOTE: Data for the HCA analysis were obtained from the United States Department of Transportation: Pipeline and Hazardous Materials Safety Administration (USDOT PHMSA) HCA datasets plus additional HCAs compiled by Enbridge during 2010 and 2013.		

Table 7-53 AOIs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mississippi River near Ball Club Crossing Location

AOI Type	AOI Subtype	Description / Locations
Environmental	Native Plant Community (Candidate)	Little Winnibigoshish (Winnie) - Ball Club Lakes, Mississippi River Meadows - Ball Club, Mississippi River Meadows - Cass, Northern Wet Ash Swamp, Peggy Brook, Sedge Meadow, White Oak Meadows, White Oak Swamp
	Sensitive Lake Shore	White Oak Lake
	Wild Rice Lake	White Oak Lake
Protected Area	Lake of Biological Significance	White Oak Lake
	National Forest-National Grassland	Chippewa National Forest
	State Forest	Bowstring
Tribal Lands	N/A	Leech Lake Reservation
NOTE: Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website, USGS Protected Areas Database of the United States and the Minnesota Department of Transportation.		

7.3.3 Selection of Key Ecological and Human Environment Receptors for Mississippi River near Ball Club Crossing Location

Taking into account environmental characteristics of the Mississippi River near Ball Club, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-54.

Table 7-54 Key Ecological and Human Environment Receptors for the Mississippi River Near Ball Club

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mississippi River near Ball Club Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. Any oil that reaches soil would be physically remediated to established standards.	N
Groundwater	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. In the event of an actual oil release, effects on groundwater quality would be localized and/or negligible.	N
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. Any oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the cleanup process.	N
Aquatic Receptors		
Rivers (Mississippi River)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver.	Y
Lakes (White Oak Lake)	High. An assumption made in the fate modeling for this scenario is that oil released under spring conditions, could be transported downstream in the Mississippi River and enter White Oak Lake.	Y
Sediment	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. This allows potential interaction with shoreline and riparian habitat.	Y
Wetlands	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver and potential interaction with wetlands along the river and White Oak Lake.	Y
Aquatic Plants	High. Mississippi River and White Oak Lake support aquatic plant communities.	Y
Benthic Invertebrates	High. Mississippi River and White Oak Lake support benthic invertebrate communities.	Y
Fish	High. Mississippi River and White Oak Lake support fish communities.	Y
Semi-Aquatic Wildlife Receptors		
Amphibians and Reptiles	High. Mississippi River and White Oak Lake support semi-aquatic amphibians and reptiles.	Y

Table 7-54 Key Ecological and Human Environment Receptors for the Mississippi River Near Ball Club

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mississippi River near Ball Club Scenario	Selected (Y/N)
Birds	High. Mississippi River and White Oak Lake support waterfowl and other semi-aquatic birds.	Y
Semi-aquatic Mammals	High. Mississippi River and White Oak Lake support semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. The community of Ball Club, Minnesota is 1.25 miles west of the hypothetical release location. The communities of Deer River and Zemple, Minnesota are approximately 1 mile from White Oak Lake. Some homes are located along the downstream flow path for released crude oil. Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. The community of Ball Club, Minnesota is 1.25 miles west of the hypothetical release location. The communities of Deer River and Zemple, Minnesota are approximately 1 mile from White Oak Lake. Some homes are located along the downstream flow path for released crude oil. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health.	Y
Public Use of Natural Resources	High. The Mississippi River near Ball Club, Minnesota and White Oak Lake area is shared by the Leech Lake Reservation and Bowstring State Forest. Effects on air and water quality, or the presence of crude oil residues in the sediment, riparian or wetland habitat, could potentially disrupt public use of natural resources (e.g., wild rice harvest, drinking water supplies, hunting, fishing, recreation).	Y

7.3.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Mississippi River near Ball Club scenario is provided in this section. The OILMAP Land software was used by RPS ASA to simulate hypothetical releases of CLB and Bakken crude oils into the Mississippi River near Ball Club (Chapter 4.0) for a 24 hour period. A longer time period was not modeled as it was assumed that emergency response measures to prevent further downstream transport of released oil would be in place within the 24 hour period. While OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column (Chapter 5.0). No overland transport of released CLB or Bakken crude oil was modelled for this hypothetical release location, as it was assumed that released oil would directly enter the watercourse (Chapter 4.0). This is a worst-case assumption for a release of crude oil near the watercourse.

The two crude oil types provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB, heavy diluted bitumen crude oil types having higher viscosity and density). Seasonal variations in river flow velocity, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-55.

The shore type for the majority of the Mississippi River in the region of the hypothetical release is marsh. Marsh shore types have high potential to trap and retain crude oil. Because of the uncertainty around how much oil would be able to infiltrate the marshy shoreline under the seasonal flow conditions, the downstream trajectory of released oils was simulated also assuming a grass shoreline, for which oil retention capacity is lower. Both sets of results are presented here independently. It is anticipated that if an actual release were to occur, downstream oil transport would be somewhere between the two predicted downstream distances.

Table 7-55 Environmental and Hydrodynamic Conditions for the Three Modeled Periods at the Mississippi River at Ball Club Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	March	-3.61	4.51	0.12
Average Flow (Summer-Fall)	August	18.92	3.51	0.31
High Flow (Spring)	April	5.00	4.88	0.47
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest average flow velocity of the Mississippi River at Ball Club coincides with the spring freshet (i.e., April–June), a result of rising temperatures and snowmelt. Average flow would typically occur in summer and fall seasons. August, the month with the warmest temperature, was selected to represent the maximum amount of evaporation. The lowest flow rate occurs in winter (i.e., January-March), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3-minute period to allow for valve closure. The release volume therefore represents the volume of oil actively discharged in the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum 13-minute response time to valve closure is an Enbridge standard for safe operations and leak detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown, and full valve closure in the affected pipeline section. While

13 minutes is the maximum time for valve closure, this is a conservative assumption, since a response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated of Bakken, CLB or CLWB crude oil.
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7.3.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectories and mass balance for Cold Lake and Bakken crude oils, under the three seasonal scenarios and for two shore types (i.e., marsh or grass), are provided in Figure 7-14 to Figure 7-17. These simulations are assumed to provide bounding conditions for a release of heavy or light crude oil types. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the Cold Lake and Bakken crude oil types. The Cold Lake crude oil was assumed to be CLB for the high flow and average flow scenarios, and to be CLWB for the low flow (winter) scenario. As noted in Chapter 5, while OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column.

The maximum simulation duration using OILMAP Land was 24 hours, as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within that length of time. Symbols on the drawings indicate the river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Numbers other than these (e.g., 5.2) indicate the time in hours of the predicted termination of downstream transport of the released oil due to adhesion or holdup of the oil along the river banks. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, adhering to river banks, or evaporated to the atmosphere) of the released oil at relevant points in time after the start of the release.

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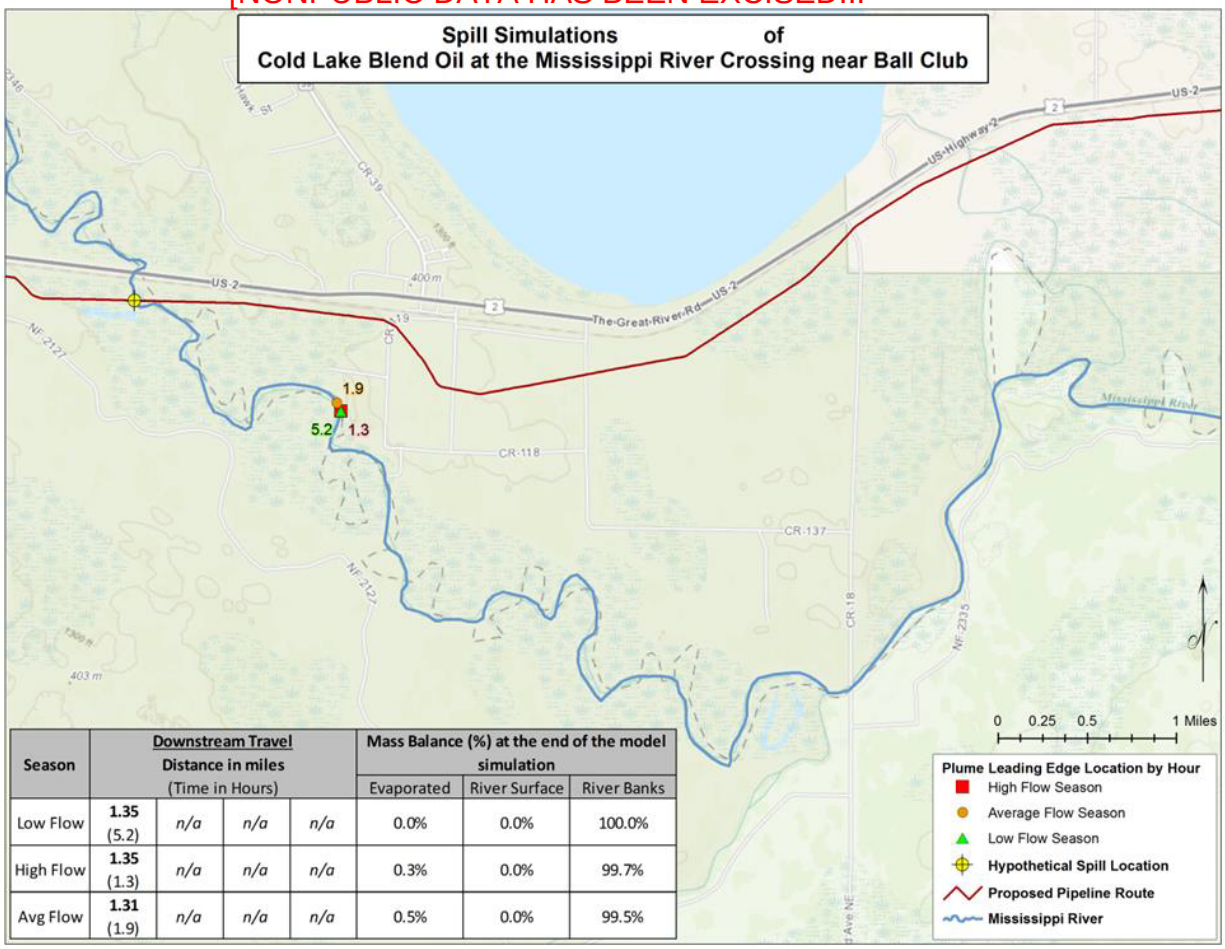

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation		
					Evaporated	River Surface	River Banks
Low Flow	**1.35** (5.2)	*n/a*	*n/a*	*n/a*	0.0%	0.0%	100.0%
High Flow	**1.35** (1.3)	*n/a*	*n/a*	*n/a*	0.3%	0.0%	99.7%
Avg Flow	**1.31** (1.9)	*n/a*	*n/a*	*n/a*	0.5%	0.0%	99.5%

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Figure 7-14 Predicted Downstream Transport of CLB Oil at the Mississippi River at Ball Club Crossing Location Assuming Marshy Shore

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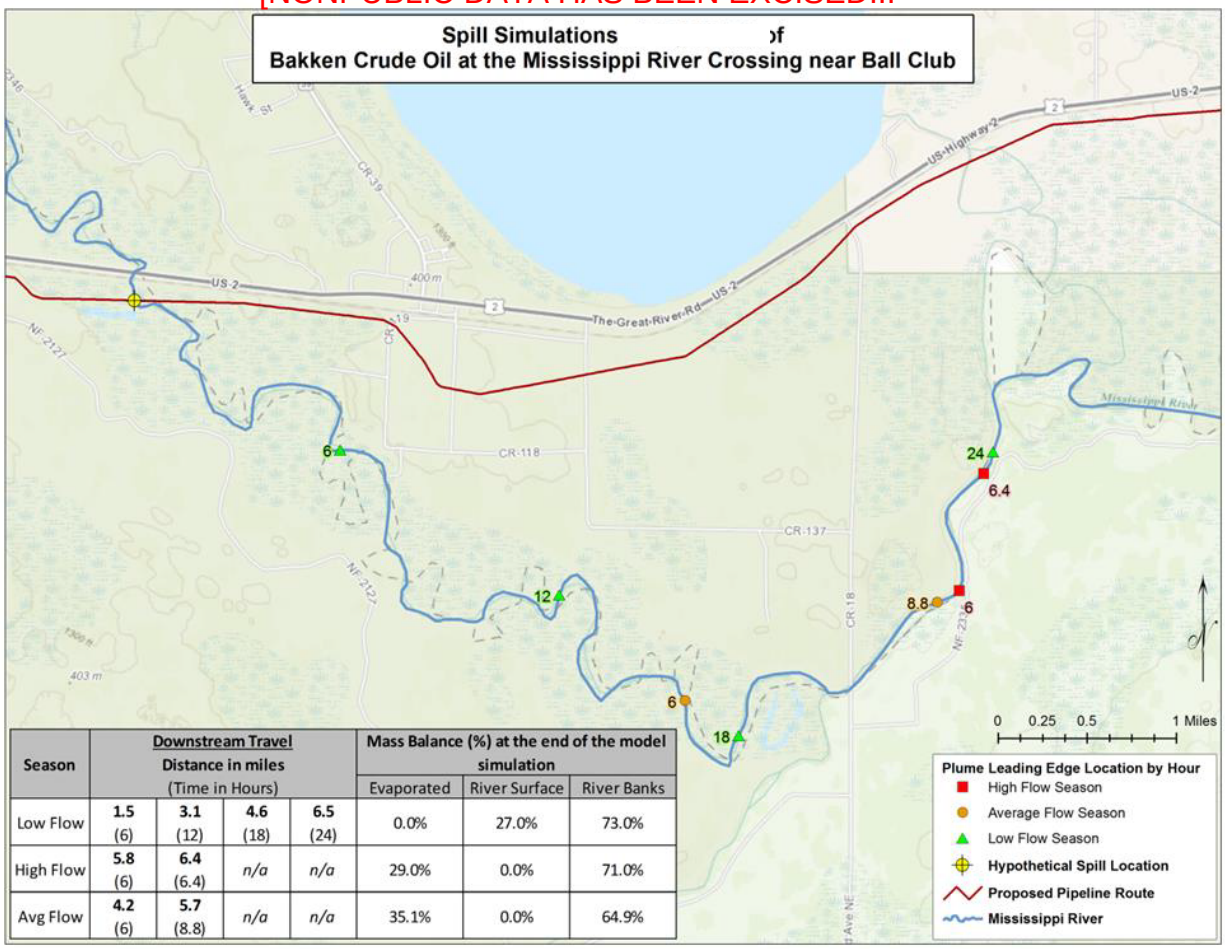

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation		
					Evaporated	River Surface	River Banks
Low Flow	**1.5** (6)	**3.1** (12)	**4.6** (18)	**6.5** (24)	0.0%	27.0%	73.0%
High Flow	**5.8** (6)	**6.4** (6.4)	*n/a*	*n/a*	29.0%	0.0%	71.0%
Avg Flow	**4.2** (6)	**5.7** (8.8)	*n/a*	*n/a*	35.1%	0.0%	64.9%

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Figure 7-15 Predicted Downstream Transport of Bakken crude at the Mississippi River at Ball Club Crossing Location Assuming Marshy Shore

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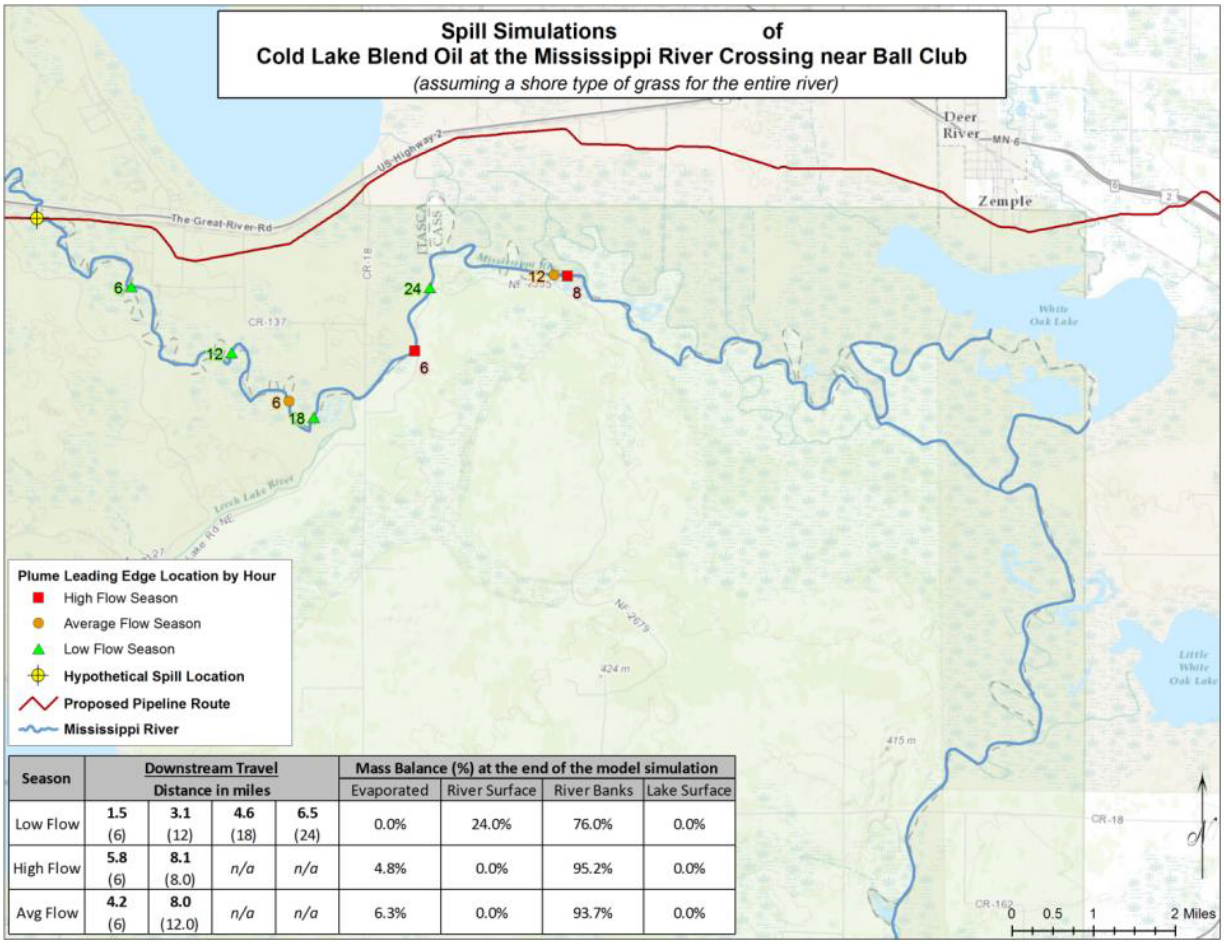

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.5 (6)	3.1 (12)	4.6 (18)	6.5 (24)	0.0%	24.0%	76.0%	0.0%
High Flow	5.8 (6)	8.1 (8.0)	*n/a*	*n/a*	4.8%	0.0%	95.2%	0.0%
Avg Flow	4.2 (6)	8.0 (12.0)	*n/a*	*n/a*	6.3%	0.0%	93.7%	0.0%

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Figure 7-16 Predicted Downstream Transport of CLB Oil at the Mississippi River at Ball Club Crossing Location Assuming Grassy Shore

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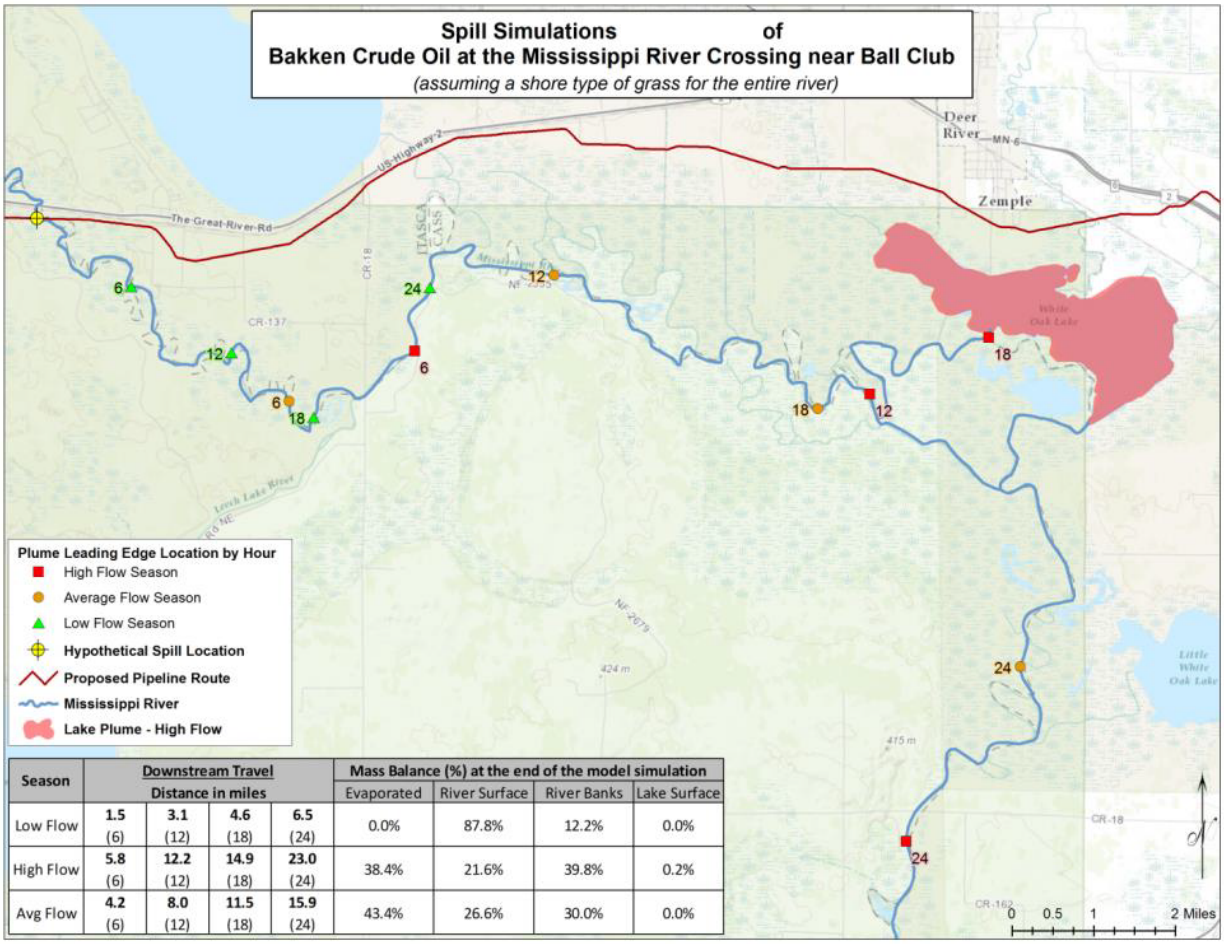

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.5 (6)	3.1 (12)	4.6 (18)	6.5 (24)	0.0%	87.8%	12.2%	0.0%
High Flow	5.8 (6)	12.2 (12)	14.9 (18)	23.0 (24)	38.4%	21.6%	39.8%	0.2%
Avg Flow	4.2 (6)	8.0 (12)	11.5 (18)	15.9 (24)	43.4%	26.6%	30.0%	0.0%

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Figure 7-17 Predicted Downstream Transport of Bakken crude at the Mississippi River at Ball Club Crossing Location Assuming Grassy Shore

7.3.5.1 Mississippi River at Ball Club Release During High Flow (Spring) Period

Under the high flow scenario and assuming a predominantly marshy shore, CLB was predicted to travel approximately 1.35 miles downstream in Mississippi River, with downstream transport being terminated 1.3 hours after the release (Figure 7-14). Almost all of the released crude oil (99.7%) was predicted to adhere to shorelines, with the balance evaporating. With the assumption of a grassy shore having less oil retention capacity, CLB was predicted to travel farther downstream (8.1 miles in 8 hours), with the majority also adhering to shorelines (Figure 7-15). It was assumed that emergency response measure to prevent further possible downstream transport of oil would be in place within 24 hours of the release.

Bakken crude oil was predicted to be transported approximately 6.4 miles downstream within 6.4 hours of a release assuming a predominantly marshy shore (Figure 7-14). At this time, approximately 29% of the Bakken crude oil was predicted to have evaporated to the atmosphere, with 71% adhering to shorelines. With the assumption of a grassy shore, Bakken crude oil was predicted to travel approximately 23 miles downstream over the 24-hour modeled period (Figure 7-15). Under these assumptions, the oil was predicted to reach and spread over the surface of White Oak Lake (1.47 square miles) to a thickness of 0.00004 inches. The Bakken crude oil was also predicted to continue to move downstream from White Oak Lake, another 6.9 miles. Approximately 39.8% of the Bakken crude oil was predicted to adhere to the shorelines of the Mississippi River and White Oak Lake, 0.2% was predicted to remain on the surface of White Oak Lake, 21.6% would remain on the river surface, and 38.4% was predicted to have evaporated into the atmosphere at the end of the 24 hour simulation. If left unmitigated, the Bakken crude oil remaining on the river surface after 24 hours could continue to move downstream, with weathering and oiling of shorelines continuing until all of the oil was removed from the water surface.

The release of Bakken crude oil under high flow conditions was predicted to result in oiling approximately farther downstream in Mississippi River than the CLB. The difference in the extent of downstream transport was primarily the result of the difference in shoreline retention. Because of its higher viscosity and adhesiveness, larger amounts of CLB are predicted to strand, as a thicker layer of oil on a given length of shoreline, than for the Bakken oil. Conversely, the same amount of Bakken crude oil would affect a greater length of shoreline, with a lesser thickness of oil. This result is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point was oiled to its maximum holding capacity for that oil type) as oil made its way downstream. In the event of an actual release, the downstream extents of CLB and Bakken crude oil may be more similar, and the effects of CLB may extend farther downstream than presented, with patchy coverage or partial oiling of shorelines.

A larger portion of Bakken crude oil was predicted to evaporate to the atmosphere than was predicted for CLB. This was due in part to the lighter and more volatile character of the Bakken crude oil. In addition, the greater downstream transport of the Bakken crude oil took more time, and resulted in more water surface area with oil, both of which would allow more of the released oil to evaporate. Volatile components of the CLB would continue to evaporate after becoming stranded on shoreline, but this process was not included within the OILMAP Land model for stranded oil.

7.3.5.2 Mississippi River at Ball Club Release During Average Flow (Summer-Fall) Period

Under average river flow conditions, and assuming a predominantly marshy shore, CLB crude oil was predicted to travel up to 1.31 miles downstream within 1.9 hours of the release at which time the downstream transport was predicted to terminate (Figure 7-14). At that time, approximately 0.5% of the released crude oil was predicted to have evaporated to the atmosphere, with the remaining 99.5% predicted to be adhering to shoreline. With the assumption of a grassy shore,

CLB was predicted to travel farther downstream (8.0 miles in 12 hours) with the majority of the release also adhering to banks (Figure 7-38).

Slightly more of the CLB crude oil was predicted to evaporate under the average river flow condition than under the high river flow condition (Figure 7-14 and Figure 7-15). This difference is due largely to the warmer temperatures in the summer-fall season as compared to the spring freshet, as well as the greater length of time and greater surface area of water that was predicted to be oiled before the end of the simulation.

Under average river flow conditions, Bakken crude oil was predicted to travel approximately 5.7 miles downstream within 8.8 hours of release, assuming a predominantly marshy shore (Figure 7-14). At this time approximately 35.1% was predicted to have evaporated to the atmosphere, with the remaining 64.9% predicted to be retained on shorelines. Under average river flow conditions, the Bakken crude oil was transported downstream at a slower velocity than under high river flow conditions, allowing more time for evaporation from the stream surface. With the assumption of a grassy shore with less oil retention capacity, Bakken crude oil was predicted to travel approximately 15.9 miles downstream over the 24-hour modeled period (Figure 7-15). The Bakken crude oil was predicted to be transported down the Mississippi River, past but not entering White Oak Lake due to low water levels, and to terminate just west of Little White Oak Lake. Approximately 30% of the Bakken crude oil was predicted to oil shorelines of the Mississippi River, 43.4% to evaporate into the atmosphere, and 26.6% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude on the river surface after 24 hours would be expected to continue downstream, with weathering and oiling of shorelines continuing until all the oil was removed from the water surface.

When compared to CLB under average river flow conditions, the Bakken crude oil was predicted to be transported farther downstream due to the lower shoreline oil retention values for the low viscosity Bakken crude oil, when compared to the more viscous and adhesive CLB. Although not modeled here, it is expected that a medium crude oil would exhibit fate and transport properties intermediate between those of the Bakken and CLB crude oil types.

7.3.5.3 Mississippi River at Ball Club Release During Low Flow (Winter) Period

Under low winter flow conditions it was assumed that Mississippi River would be frozen (100% ice coverage). It was also assumed that oil would be released directly into the river from the pipeline, which is located under the riverbed. Oil released into the water would remain in the water or be trapped under the ice. The ice cover would strongly limit or prevent evaporation to the atmosphere. Flow rates for the Mississippi River during these winter conditions result in minimum river velocities during March.

Under low river flow and assuming a predominantly marshy shore, CLWB was predicted to travel approximately 1.35 miles downstream in approximately 5.2 hours (Figure 7-14). After this time, all of the CLWB was predicted to be trapped along the river margins between the ice and the river bottom, or in hollows under the ice. With the assumption of a grassy shore with less oil retention

capacity, CLB was predicted to travel farther downstream (6.5 miles over the full 24-hour modeled period). Approximately 76% of the CLWB was predicted to be trapped along the river margins between the ice and the river bottom, or in hollows under the ice, and the remaining 24% was predicted to remain potentially mobile in the river below the ice. If left unmitigated, it is expected that the remaining CLWB would continue to move downstream until all of the oil was removed from the water.

Under low flow conditions, regardless of whether the shoreline was marshy or grassy, the Bakken crude oil was predicted to be transported approximately 6.5 miles downstream over the 24-hour modeled period. With a predominantly marshy shore, approximately 73% of the Bakken crude oil was predicted to be trapped along the river margins between the ice and the river bottom, or in hollows under the ice, with 27% remaining potentially mobile in the river below the ice at the end of the 24 hour simulation. With a grassy shore, approximately 12.2% was predicted to be trapped along the river margins between the ice and the river bottom, or in hollows under the ice, and the remaining 87.8% was predicted to remain potentially mobile in the river at the end of the 24 hour simulation. If left unmitigated, it is expected that the remaining Bakken crude in the river after 24 hours would continue to move downstream until all the oil was removed from the water.

Under winter conditions, the oil was predicted to move more slowly and to travel a shorter distance then than the average and high river flow conditions. Because the Bakken crude was released below the ice of the river, no oil was predicted to evaporate to the atmosphere.

7.3.6 Qualitative EHHRA for the Mississippi River near Ball Club

In this section the likely environmental effects of a crude oil release at the pipeline crossing location on the Mississippi River are described. A worst case crude oil release from a main-line pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed pipeline could carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). Therefore, the following discussion is based on the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7.3.3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence and sensitivity) were also considered in the analysis. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-54.

7.3.6.1 Terrestrial Receptors

For this modeling scenario, the hypothetical release of crude oil is assumed to enter into the Mississippi River with no overland flow. Environmental effects on soils, terrestrial vegetation and groundwater quality are assumed to be localized, limited in spatial extent, and readily

remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors are not considered further for this release scenario.

7.3.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors that are most closely associated with the Mississippi River at Ball Club scenario are addressed in this section. These receptors include water and sediment quality in rivers and lakes, shoreline and riparian habitat, wetlands, aquatic plants, benthic invertebrates, and fish.

Crude oil released accidentally into the Mississippi River during the spring (high flow) or summer-fall (average flow) seasons would be predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. The distance travelled would depend upon river flow, oil type and shoreline type. Based on OILMAP Land simulations, light oils oil is predicted to travel father downstream than heavy oil. Marshy shorelines are predicted to strongly limit the scope of downstream movement of crude oil, due to their high capacity to trap and retain released oil when compared to grassy shorelines (Figure 7-14 and Figure 7-15). Under high flow conditions and assuming a grassy shore (low retention), it was predicted that the Bakken crude oil could reach White Oak Lake and spread over its surface as a thin slick (0.00004 inches). For heavy oil, stranding on shore (whether marshy or grassy) would be the primary fate.

The effects of a crude oil release on benthic invertebrates and fish would depend on the characteristics of the released oil, and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. Light oils have low viscosity relative to heavier oils. Turbulence in the river water could potentially disperse light oil as small droplets in the water column, increasing the potential for toxic fractions of the light oil to dissolve into the water column. During the spring freshet, flow in the Mississippi River at Ball Club is likely to be sufficiently rapid and turbulent for such droplet formation to occur for the light crude oil, although heavy crude oil is less likely to be affected. As a result, the potential for acute toxicity to fish and benthic invertebrates could be greater for the light oil than for heavier oils.

During the spring high flow condition, the water level in the Mississippi River rises so that some of the oil transported down the river could spread over the surface of White Oak Lake. Approximately 0.2% of Bakken crude oil is predicted to be on White Oak Lake 24 hours after the release, as a very thin layer (0.00004 inches). The CLB crude oil is not predicted to reach White Oak Lake under any scenario. The large surface area of the lake would promote the rapid evaporation of volatile (and potentially water soluble) hydrocarbon constituents from the Bakken crude oil. Rapid evaporation could limit potential toxicity to fish within the lake. However, wind speeds are also potentially high during spring, so wave action on White Oak Lake could create turbulent conditions that would disperse light oil as small droplets in the water column. In

the unlikely event of a crude oil spill at Ball Club, Minnesota, narcotic effects of Bakken crude oil on fish and benthic invertebrates would be likely to occur in the Mississippi River upstream and downstream of White Oak Lake during the spring and summer-fall season. Narcosis could also occur in White Oak Lake in the spring, if water levels and flow conditions allowed the released Bakken crude oil to enter the lake.

There would also be high potential for chronic effects of released crude oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease). Many of the fish species present in the Mississippi River spawn in the spring and early summer. The eggs and embryos of these species could be exposed to total PAH concentrations in the river and lake water that could be sufficiently high to induce deformities or cause mortality. In addition the potential for phototoxicity, caused by an interaction of UV light with PAHs accumulated in fish tissues, would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. The risk of phototoxicity could be mitigated by high concentrations of dissolved oxygen content (DOC) present in the water of the Mississippi River and White Oak Lake, which would absorb and limit the penetration of UV light into the water column.

Entrainment of small crude oil droplets in the water column during the spring freshet also enhances the potential for light crude oils to interact with suspended sediment particles in the water column resulting in the formation of OPAs. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water such as sediments near the many oxbows and twists in the Mississippi, as well as slowly moving areas and backwaters in the habitats where the Mississippi connects with White Oak Lake, and in addition, White Oak Lake could provide a depositional environment where crude oil might eventually accumulate, regardless of the season when an accidental release occurred. Formation of true OPAs is less likely to occur with heavy crude oils such as diluted bitumen, as the higher viscosity of the oil precludes the ready formation of fine droplets in the water column (Zhou et al. 2015). However, heavy oils can still contact sediment particles along the shoreline, and some accumulation of both light and heavy oils in depositional areas is likely, although the precise mechanisms of deposition may vary. Neither crude oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release.

The Mississippi River and White Oak Lake support emergent, floating and submerged aquatic plants. Where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants would be less vulnerable, as they would be exposed primarily to dissolved hydrocarbons, and are not considered likely to be among the most sensitive groups of aquatic biota to such exposure. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem could be oiled). Wild rice is an emergent aquatic plant of biological and cultural importance in Minnesota, and is found in White Oak Lake. Wild rice provides a food source and nesting cover for many birds, and is also harvested as a food source by people in the area. For a hypothetical release under spring

freshet conditions, it is likely that most aquatic plants would still be dormant or submerged, and that environmental effects on this receptor type would be minimal. However, flooded riparian areas and wetland habitats would also be exposed to the released oil, and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat. In the early summer, oiling of emerging wild rice plants could lead to growth inhibition or death. Later in the summer, oiling at water level of the stems of emerged plants (deposited during spring is unlikely to affect the plants. A release of crude oil in winter would have little direct effect on aquatic plants, as they would be in a dormant state.

Crude oil released during the winter (low flow) period could potentially pool on the frozen river surface. If the release was to occur directly to the river below the ice (as is assumed in the OILMAP Land model), or if there were openings in the ice that the released oil could penetrate, the oil could travel downstream under the ice, accumulating in the narrow gap between the ice and the river sediment, or accumulating in hollows under the ice as it moved. Results provided in Section 7.2.5.3 provide bounding cases for the products likely to be carried in the pipeline. The OILMAP Land simulations indicate that crude oil could be carried 1.35 to 6.5 miles downstream from the point of release under winter low-flow conditions. For both oil types, the winter ice would effectively inhibit evaporation, while providing greater potential for dissolution into the water column during the period of lowest dilution flow. Therefore, a release in winter could cause fish mortality due to narcosis. This result would be more likely for the light crude oil, which would spread out over a larger area, facilitating release of more water soluble constituents. The heavy crude oil would tend to remain in thicker localized accumulations, and rapid release of more water soluble constituents from a thick layer of crude oil is unlikely. Fish eggs and larvae would generally not be present during the winter, so effects on these life stages due to blue sac disease are not likely, although crude oil residues in water and sediment could, if not adequately remediated, affect fish eggs and larvae in the following spawning season. Phototoxicity is not likely to occur following a release of crude oil in winter due to short day length and lower light intensity in winter, reflection and absorbance of light by snow and ice cover on the lake, and absorbance of UV light by DOC in the water beneath the ice.

Both crude oil types could be accumulated in sediment after a release in winter, and both crude oil types would be subject to re-mobilization with spring breakup of the ice, and increasing water flow rates.

7.3.6.3 Semi-Aquatic Wildlife Receptors

Habitat along the Mississippi River downstream of the hypothetical release location supports amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors), and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter). Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.3.6.3.1 Amphibians and Reptiles

Crude oil released to the Mississippi River during the spring (high flow) and summer-fall (average flow) seasons is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. The distance travelled would depend on the oil and shoreline type. The OILMAP Land simulations indicate that light oil will travel father downstream than heavy oil, with both types being retained more strongly by marshy shores, as compared to grassy shores (Figure 7-14 and Figure 7-15). Under spring (high flow) conditions and assuming a grassy shore, it was predicted that the Bakken crude oil could reach White Oak Lake and spread over its surface as a thin slick (0.00004 inches). For heavy oil, stranding on shore would be the primary fate.

Within the oil-exposed habitats along the river and lake that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. As a result, exposure of these animals to released crude oils would be limited. After the Kalamazoo River oil spill in 2010 snakes did not appear to be highly exposed to spilled oil. A release of light crude oil during the spring would likely have a greater effect than in summer due to the greater predicted downstream transport distance and interaction with greater areas of riparian and wetland habitats than later in the year.

Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms would have very little exposure to released oil moving on the water surface or within the water column.

7.3.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, lakes, wetlands, and riparian areas as components of their habitats, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory and herbivory. If exposed to external oiling, the ability of birds to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species that leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Waterfowl and other semi-aquatic birds present in the affected river and lake reach would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release.

In addition to the habitat offered by the Mississippi Rivers and its riparian habitats, White Oak Lake represent ideal habitat for a variety of aquatic and semi-aquatic bird species, including both breeding and migratory individuals. Therefore, potential for mortality of a large number (i.e., several hundred) of aquatic and semi-aquatic birds would exist, depending upon the precise circumstances and timing (e.g., spring and fall migration periods) of an accidental crude oil release. However, owing to the tremendous regional habitat resources for these birds, large-scale population-level effects are unlikely.

The environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude. With rising water temperatures, mortality of lightly oiled adult birds due to hypothermia becomes less likely than in the spring, and the temporary presence of large numbers of migrating individuals is unlikely. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest, or mortality of young birds due to direct oil exposure or the loss of a parent bird. Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure. Potential effects on aquatic and semi-aquatic birds in the fall would be similar to those in spring, although a smaller overall length of river habitat would be affected due to lower river flows. White Oak Lake is not predicted to be materially affected by a crude oil release under summer-fall conditions, and therefore substantial mortality of waterfowl and other semi-aquatic bird species in White Oak Lake is not an expected outcome in these seasons.

Under winter conditions (March), it was assumed that the Mississippi River would be frozen (100% ice cover). In addition, most waterfowl and other semi-aquatic bird species would migrate south in the winter. Therefore, a crude oil release in winter would be expected to have very limited effects on birds.

7.3.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses particularly upon species that have a primary association with the aquatic environment such as muskrat and beaver (herbivores), American mink (*carnivore-piscivore*), and river otter (*piscivore*). These species are at greater risk of exposure to an oil release in water than terrestrial mammals.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along the Mississippi River where effects may occur, and the magnitude of effects, is related to the season and river flow rate, and the type of oil released. Effects to semi-aquatic mammals relate more to the amount of time spent in the water and oil-contaminated riparian habitat (and consequent exposure to physical oiling) than to dietary preferences. Timely capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Based on the OILMAP Land simulations, the potentially affected river reach could range from 1.3 to 23 miles in extent, and could include White Oak Lake during the spring, when it is directly connected to the Mississippi River. Animals upstream, farther downstream where there is no exposure, or occupying other nearby habitats, would likely be unaffected. Therefore, although mortality of a considerable number of semi-aquatic mammals could be expected, large-scale (i.e., regional) population level effects are unlikely. Environmental effects of a crude oil release in the summer-fall period are likely to be of a magnitude similar to or lesser than those associated with a release during spring. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is less likely than in the spring. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil are possible as a result of ingesting crude oil residues while grooming, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. Animals that became oiled in the winter would be likely to rapidly die as a result of hypothermia.

7.3.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs than heavier crude oils, although diluted bitumen may contain similar amounts of VOCs to light crude oils, depending upon the type and amount of diluent they contain. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be

affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release. For the Mississippi River at Ball Club hypothetical release location, human receptors would likely be present and in proximity to the river in the community of Ball Club. Scattered farms and country homes are located at intervals along the downstream flow path, although much of the area is quite isolated. The communities of Zemple and Deer River are located north of White Oak Lake, and could potentially be exposed to hydrocarbon vapors under certain circumstances, and were identified through the HCA analysis as "other population areas".

Under the spring, high flow condition, the Mississippi River flow is expected to spread into White Oak Lake due to high water levels. Released Bakken crude oil could move out from the main river channel and into this lacustrine habitat. This behavior is identified as a possibility for the Bakken crude oil, but not for the CLB, as the more viscous oil is predicted to be more strongly retained along shorelines closer to the release point. The spreading of the released oil onto the surface of White Oak Lake would provide a large surface area, which would promote the rapid evaporation of volatile hydrocarbon constituents from the light crude oil, with potential effects on human receptors located nearby in Zemple, Minnesota. Released crude oil is not predicted to enter White Oak Lake in the summer-fall seasons, and therefore air quality effects at Zemple would be minimal. In winter, the released crude oil is predicted to remain in the upper section of the river reach, and to be confined beneath ice in the river, so effects on air quality in winter would be negligible.

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil vapor. Similarly, ATSDR (1995) report that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

The potential for VOC inhalation exposures to the public would be greatest near and downwind from the release site and near White Oak Lake, while the released oil is on the water surface. In the unlikely event of a crude oil release, residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most of the volatile hydrocarbons would be lost within the first 24 hours following a release of crude oil. It is also expected that emergency response personnel would contact such residents and advise them to evacuate. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while the emergency response takes place.

No drinking water HCAs were identified along the path of the release. However, in the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. Based upon case studies involving crude oil releases elsewhere, this

process could take a few days to two weeks, but reports of crude oil releases affecting private wells are rare, making this an unlikely effect.

Relatively little has been published regarding the long-term effects of human exposure to a crude oil release. Health effects observed in residents and clean-up workers in the months following such releases generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

Effects of a crude oil release on human receptors would be generally similar for the spring (high flow) and summer-fall (average flow) seasons. In summer, the warmer temperatures and slower river flow velocities in the summer would promote more rapid evaporation of volatile hydrocarbons in a smaller area. The distance of flow depends upon oil type and bank type: based on OILMAP Land simulations (for a 24 hour model run) lighter oils oil are predicted to travel father downstream than heavier oils, with the downstream transport distance being a function of shoreline type and oil retention capacity (Figure 7-14 and Figure 7-15). Under spring (high flow) conditions and assuming a grassy shore, Bakken crude oil was predicted to reach White Oak Lake and to spread over its surface. As a result, a release of the light crude oil could affect a larger number of individuals than a release of the heavy crude oil type.

No overland transport of released crude oil was modelled for this hypothetical release location. Infiltration of crude oil into soil and subsequently into groundwater is assumed to be negligible.

The Mississippi River near Ball Club and White Oak Lake area is shared by the Leech Lake Reservation and Bowstring State Forest. Effects on air and water quality, or the presence of crude oil residues in the sediment, riparian or wetland habitat, could potentially disrupt public use of natural resources (e.g., wild rice harvest, drinking water supplies, hunting, fishing, recreation). Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil.

7.3.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to the Mississippi River near Ball Club, Minnesota have been assessed. The proposed pipeline could carry a variety of crude oil types (ranging from very light

[e.g., Bakken crude oil] to heavy [e.g., diluted bitumen such as CLB], and the discussion of expected environmental effects on receptors is based on these crude oil types as bounding conditions. Potential terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors and human and socio-economic receptors were screened to identify those with the most likely interactions with released oil. The results of this assessment are summarized in Table 7-56.

Table 7-56 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Ball Club

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Ball Club	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	It is assumed in the model that crude oil would enter directly into the Mississippi River with no holdup of oil on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
Rivers (Mississippi River)	Both light and heavy oil would travel downstream from the release location, affecting the Mississippi River. Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, but would be thinner on the water, and less persistent where they contact shoreline habitat. Both light and heavy crude oils are predicted to travel similar travel distances under winter conditions, although more of the heavy oil would be likely to remain trapped along the edges of the rivers. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column, meaning that potentially toxic fractions of the light oils would more readily dissolve into the water column.	MORE	LESS
Lakes (White Oak Lake)	While light and heavy oil would both travel downstream from the release location in all three flow conditions, only light oil (e.g., Bakken crude oil) was identified as having the potential to enter White Oak Lake, under spring high flow conditions.	MORE	LESS

Table 7-56 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Ball Club

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Ball Club	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Sediment	Lighter crude oils are predicted to travel farther downstream than heavier crude oils in spring and summer-fall conditions, with both oil types travelling similar distances under winter conditions. Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. The low viscosity of the lighter type crude oils could potentially result in a larger amount of oil entrainment as fine droplets as compared to heavier blends, resulting in the formation of OPAs, which could both sink, and enhance biodegradation. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water such as sediments near the many oxbows and twists in the Mississippi, as well as slowly moving areas and backwaters in the habitats where the Mississippi connects with White Oak Lake. Contact between crude oil and shorelines is also likely to result in mixing of mineral particles into the crude oil, which could then be deposited to sediments as aggregates of oil and mineral in larger droplets or globules. If not recovered, these aggregates could move downstream with bedload until a stable depositional environment was reached. Low molecular weight aromatic hydrocarbons would be expected to dissolve into the water column of White Oak Lake, where they could adsorb onto suspended sediment and organic matter.	LESS	MORE
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location. Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, but would be thinner and less persistent where they contacted shorelines and riparian habitat. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet (and possible enter White Oak Lake). For heavy oil, stranding on shore would be the primary fate. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation. Flooding of riparian and wetland habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, which would be persistent. This is in contrast to light crude oil which would be deposited as a thin layer or sheen.	LESS	MORE

Table 7-56 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Ball Club

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Ball Club	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Aquatic Plants	The Mississippi River and White Oak Lake support emergent, floating and submerged aquatic plants. Where they occur, floating aquatic plants would be expected to be killed if contacted by a floating oil slick. Submerged aquatic plants would be less vulnerable. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem was oiled). However, given the extent of predicted oiling in White Oak Lake in spring, death of emergent plants from contact with crude oil, particularly the lighter crude oil type, is also possible.	MORE	LESS
Benthic Invertebrates	Environmental effects on benthic invertebrates would be limited to areas affected by the released oil. In the short-term, the low viscosity of light crude oil would result in greater potential for oil entrainment as fine droplets, as compared to heavier blends. This would enhance dissolution of low molecular weight aliphatic and aromatic hydrocarbons into water (with resulting acute toxicity), in addition to promoting oil-particle interaction and potential deposition of oil to sediment. For heavy crude oil, there would be less potential for dissolution of hydrocarbons into the water, but greater long-term potential for deposition of tar balls and patties as a result of oil interaction with sediment. These could accumulate in depositional areas, resulting in chronic effects on benthic invertebrates.	MORE	LESS
Fish	Environmental effects on fish would be limited to areas affected by the released oil. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column. This would enhance the dissolution of potentially toxic fractions of the light oil into the water column. As a result, the potential for acute toxicity to fish due to narcosis would be greater for the light oil than for heavy oil. Potential chronic effects on fish eggs and embryos (e.g., blue sac disease) could also occur, but would be most likely to occur in spring and early summer, when most species spawn. The potential for phototoxicity, caused by an interaction of ultraviolet light with PAHs accumulated in fish tissues, would be greatest in summer due to high light intensity and long day length.	MORE	LESS

Table 7-56 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Ball Club

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Ball Club	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Environmental effects on amphibians and reptiles would be limited to areas affected by the released oil. Light crude oil is expected to travel farther downstream under spring and summer conditions than heavy crude oil, but would be thinner and less persistent on the water. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. Flooding of riparian habitat in spring could lead to stranding of crude oils in this habitat. Within these habitats, oiling effects on adults, juveniles, and eggs could potentially be observed. Higher potential would exist for effects on amphibians than for turtles, which appear to be somewhat tolerant of external oiling. Dormancy of amphibians and reptiles in winter and early spring means exposure to oil released at this time of year could be negligible, and adverse environmental effects unlikely.	MORE	LESS
Birds	Mortality of oiled aquatic and semi-aquatic birds would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil (for the three flow conditions modeled), so environmental effects could be more spatially extensive for light crude oil types. During the spring high flow season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. As such, oiling of birds in White Oak Lake in spring could be the primary outcome of a release of light oil. Few birds are present in winter, so effects would be minimal in that season.	MORE	LESS
Semi-aquatic Mammals	Mortality of oiled semi-aquatic mammals would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil in all seasons, and spreading of the light crude oil into White Oak Lake is also possible under spring high flow conditions. Therefore, effects to semi-aquatic mammals could be more spatially extensive for light crude oil types. Adverse effects on mink and otter would be particularly severe in winter, due to the effects of oil in the insulating properties of fur, in combination with cold water temperatures. However, muskrat and beaver might be spared due to their lower activity levels in winter.	MORE	LESS

Table 7-56 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Ball Club

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Ball Club	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. Light crude oil is likely to be transported farther downstream within 24 hours than the heavy crude oil, and could also enter White Oak Lake under spring high flow conditions. As a result, environmental effects on air quality are predicted to be more spatially extensive for light crude oil types. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS
Human Receptors	Typical human health effects associated with short-term inhalation of VOCs from crude oil releases include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is unlikely. Residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most volatile hydrocarbons would be lost within 24 hours following a release. The communities of Ball Club and Zemple, Minnesota were identified through the HCA analysis as "other population areas". The human receptors most likely to be exposed to VOCs under this hypothetical crude oil release scenario would be located in Ball Club, or in isolated farms and country homes close to the Mississippi River, within about 5 to 10 miles of the release point. Under certain circumstances, the light crude oil could be carried farther downstream, and/or enter into White Oak Lake, resulting in potential exposure of residents of Zemple to VOCs. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS

Table 7-56 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Ball Club

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Ball Club	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Public Use of Natural Resources	Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Light crude oil is predicted to be transported farther downstream than heavy crude oil following a release, affecting a larger area and potentially interrupting public use of natural resources over a larger area. No drinking water HCAs were identified along the path of the release. However, some homes are located along the trajectory of a predicted release and could rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to the Mississippi River would result in adverse health effects to consumers of drinking water. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. In the event that the light crude oil was to enter White Oak Lake during the spring high flow season, it could affect the early development of wild rice plants, potentially affecting the productivity and utilization of this resource.	MORE	LESS

7.4 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL AT THE SANDY RIVER CROSSING

The proposed pipeline is expected to cross under the Sandy River approximately 3.4 miles northeast of McGregor, Minnesota and 0.2 miles north of Highway 210. Downstream of the proposed crossing the Sandy River passes through riparian wetlands, agricultural lands and wooded areas, as well as flowing through several lakes before it joins the Mississippi River at the northwest side of Big Sandy Lake. The main river channel at the Sandy River crossing is approximately 15 to 30 ft wide, and shows evidence of having been channelized, presumably for agricultural drainage purposes, within what was formerly a broad meandering floodplain (Chapters 3.0 and 4.0).

As identified in Chapter 4.0, the Sandy River flows through McGregor and Grayling WMAs of the Tamarack Lowlands Subsection. The subsection is a low-lying area of the Northern Minnesota Drift and Lake Plains Section within the greater Laurentian Mixed Forest Province (MN DNR 2016i). The Tamarack Lowlands is characterized by flat and rolling hills and lowland hardwood and coniferous forest cover (MN DNR 2006). The river flows about 1 mile north of populated sections of McGregor, and is about one half mile north of the airport, where it crosses Minnesota Highway 65.

7.4.1 Description of the Freshwater Environment

The Sandy River flows west through several marshy areas for approximately 6.2 miles before passing through two small lakes (Steamboat Lake and Davis Lake). Below these lakes the river turns to the northwest and becomes wider (an average of 53 ft during low flow conditions and 270 ft during high flow conditions). It then passes through Flowage Lake and Sandy River Lake before entering Big Sandy Lake, which supports considerable cottage development. A short distance below the outlet to Big Sandy Lake, the Sandy River merges with the Mississippi River (Smude 2013), which flows southwest, towards Palisade, Minnesota.

The seasonal extent or surface area of Steamboat, Davis, and Flowage lakes varies depending on river flow condition. During low and average river flow conditions, the area of Steamboat Lake is approximately 0.036 square miles, and during high river flow conditions the area is typically 0.065 square miles. During low and average river flow conditions, the area of Davis Lake is approximately 0.07 square miles, and during high river flow conditions the area is typically 0.117 square miles. During low river flow conditions, Sandy River does not join Flowage Lake until approximately 7 miles north of Davis Lake. Under high river flow conditions, the river becomes lake-like after approximately 3.5 miles.

The most common land uses in the Tamarack Lowlands Subsection are forestry, tourism, and outdoor recreation, along with some agriculture and peat mining (MN DNR 2006). Game fish include walleye, lake trout, and northern pike. Less sought-after fish include white sucker and yellow perch (MN DNR 2016j). The Tamarack Lowlands Subsection provides important wintering

areas for boreal birds in times of food shortage and is home to a predicted 69 SGCN. These include birds (51 species), fish (3 species), insects (5 species), mammals (4 species), mollusks (2 species), reptiles (4 species) and spiders (1 species) (MN DNR 2006). Of these species, 16 are afforded federal or state endangered, threatened, or of special concern status (MN DNR 2006; MN DNR 2016d). It is foreseeable that some of these SGCN could utilize aquatic habitats along the Sandy River and its associated lakes. The McGregor and Grayling Wildlife WMAs are home also to deer, mink, muskrat, white-breasted nuthatch, hairy woodpecker, sandhill crane, woodcock, sharp-tailed grouse, Canada goose, mallard, swamp sparrow, gray catbird and gray wolf (MN DNR 2006, MN DNR 2016k, MN DNR 2016l).

Several access points downstream from the proposed pipeline crossing location were visited in May, 2016, to provide additional insight into baseline environmental conditions for the Sandy River. Representative site photographs are provided in Figure 7-18 through Figure 7-21. Field observations are summarized in Table 7-57.



Figure 7-18 Sandy River and Riparian Habitat Approximately 4 Miles Downstream of Pipeline Crossing



Figure 7-19 Sandy River and Riparian Habitat Approximately 4 Miles Downstream of Pipeline Crossing



Figure 7-20 Sandy River and Riparian Habitat Approximately 19 Miles Downstream of Pipeline Crossing to the East of Sandy River Lake



Figure 7-21 Sandy River and Riparian Habitat Approximately 28 Miles Downstream of Pipeline Crossing to the North of Big Sandy Lake

Table 7-57 Environmental Characteristics Observed at Selected Access Points on the Sandy River in May 2016

Access Point	Latitude Longitude	Notes
Sandy River at Highway 65, 4 miles downstream of pipeline crossing	46.6291 -93.3174	*Habitat Description:* this crossing is an excavated ditch with very broad, flat floodplain dominated by wet/sedge meadow and shrub Swamp. Dominant plant species are lake bank sedge and several species of willow (especially pussy willow). Quality of vegetation in the area is generally good to very good. *Wildlife observed:* mallard, red-wing blackbird, American toad, warbler sp.
Sandy River at boat landing, 8 miles north of McGregor, 19 miles downstream of pipeline crossing	46.7239 -93.3036	*Habitat Description:* area is a broad flowage of the impounded Sandy River. Water clarity is very good with abundant submerged vegetation. The water edge includes emergent marsh (river bulrush abundant) that transitions into willow shrub swamp and floodplain/terrace forest. Surrounding upland areas are mesic oak forest. Vegetation quality is generally good to very good. *Wildlife observed:* American toad, mallard, Canada goose, northern oriole, hairy woodpecker.
Sandy River at Big Sandy Lake, 28 miles	46.7884 -93.3188	*Habitat Description:* at Big Sandy Lake outlet dam. Lake fringe includes relatively narrow band of emergent marsh vegetation

Table 7-57 Environmental Characteristics Observed at Selected Access Points on the Sandy River in May 2016

Access Point	Latitude Longitude	Notes
downstream of pipeline crossing		(cattail-dominated), which then transitions into a narrow band of wet meadow that includes a mix of desirable native species and invasive/nonnatives (phragmites and reed canary grass). Floodplain/terrace forest vegetation occurs along the shoreline that rises quickly from the water. *Wildlife observed:* beaver, osprey, water boatmen (Family Corixidae; aquatic insect).

7.4.2 High Consequence Area Assessment for the Sandy River, MN

As defined in Section 6.3, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks).

Under low flow conditions, floating plumes for both oil types are predicted to end before they reach Steamboat Lake, but could pass McGregor, Minnesota. Bakken crude oil was predicted to flow farther downstream than the CLB under average and high flow conditions, but both oils passed the same number of HCAs during average and high flow seasons (i.e., McGregor, Minnesota and one environmentally sensitive area, Table 7-58).

The Sandy River flows through several protected areas and environmental AOIs. Modeling demonstrated that under low flow conditions, floating oil of both types passed the same AOIs, including the McGregor 8 site of biodiversity significance, Steamboat Lake, and the Grayling Marsh and McGregor WMAs. Under average flow conditions, floating oil was predicted to pass a similar number of AOIs in addition to Davis Lake. Under high flow conditions, Bakken crude oil was predicted to pass the same AOIs and also reach Flowage Lake, which is a sensitive lake shore and wild rice lake, and Big Sandy Lake, which is military land (Table 7-59). The HCAs and AOIs are shown in Figure 7-22.

Table 7-58 HCAs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Sandy River Crossing Location

HCA Type	HCA Subtype	Description / Locations
Population Area	Other	McGregor, MN
Environmentally Sensitive Area	N/A	N/A

Table 7-58 HCAs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Sandy River Crossing Location

HCA Type	HCA Subtype	Description / Locations
NOTE: Data for the HCA analysis were obtained from the USDOT PHMSA HCA datasets plus additional HCAs compiled by Enbridge during 2010 and 2013.		

Table 7-59 AOIs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Sandy River Crossing Location

AOI Type	AOI Subtype	Description / Locations
Environmental	Sensitive Lake Shore	Flowage Lake
	Site of Biodiversity Significance	McGregor 8
	Wild Rice Lake	Steamboat Lake, Davis Lake, Flowage Lake
Protected Area	Lake of Biological Significance	Flowage Lake
	Military Land	Big Sandy Lake
	Wildlife Management Area	Grayling Marsh WMA, McGregor WMA
NOTE: Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website, USGS Protected Areas Database of the United States and the Minnesota Department of Transportation.		

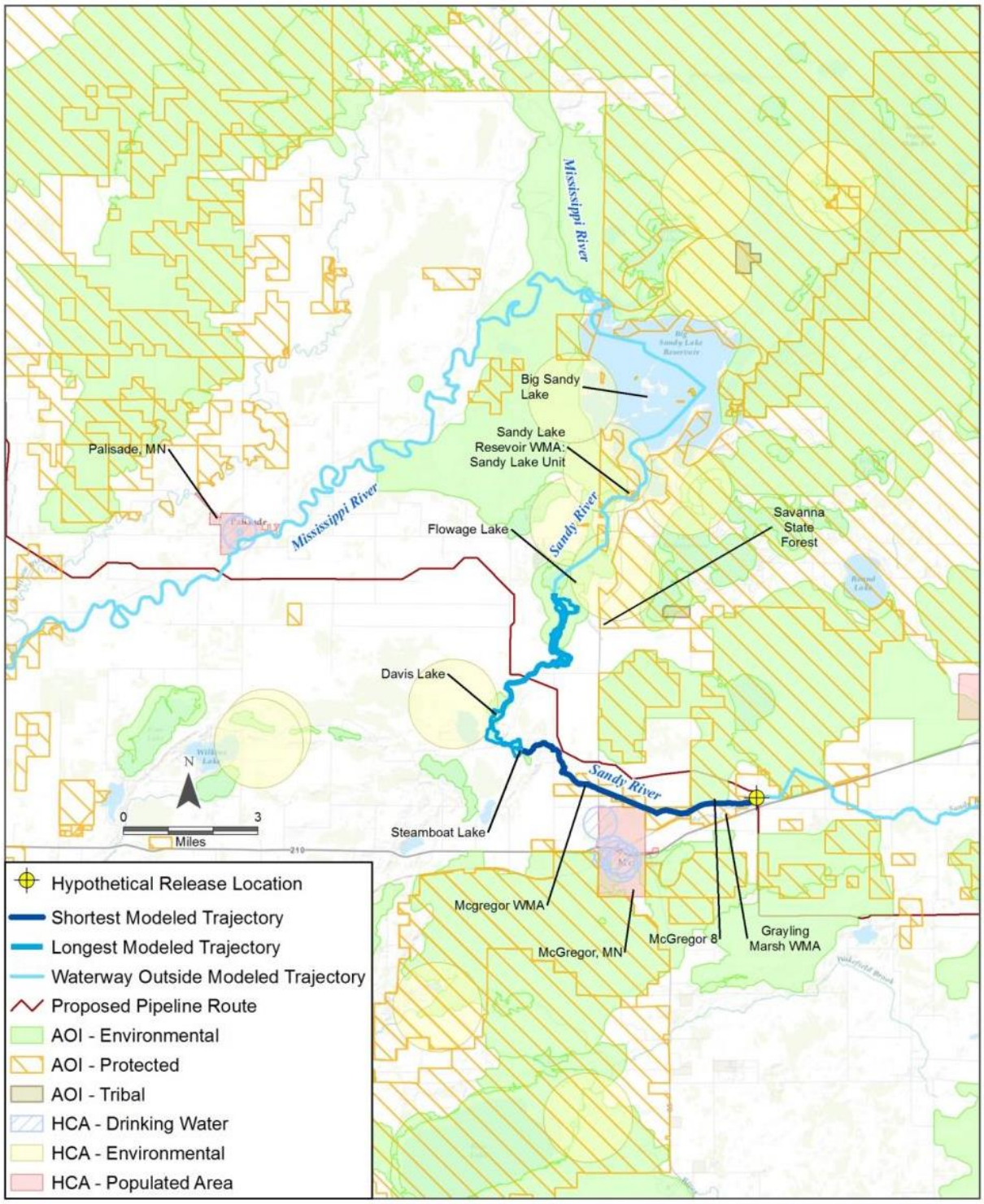

Figure 7-22 HCAs and AOIs Potentially Affected by a Crude Oil Release at the Sandy River Crossing Location

7.4.3 Selection of Key Ecological and Human Environment Receptors for Sandy River

Taking into account environmental characteristics of the Sandy River, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-60.

Table 7-60 Key Ecological and Human Environment Receptors for the Sandy River

Receptor	Relevance for Inclusion as an Environmental Receptor for the Sandy River Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River with no holdup of oil on land. Any oil that reaches soil would be physically remediated to established standards.	N
Groundwater	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River with no holdup of oil on land. In the event of an actual oil release, effects on groundwater quality would be localized and/or negligible.	N
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River with no holdup of oil on land. Any oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the cleanup process.	N
Aquatic Receptors		
Rivers (Sandy River)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River with subsequent physical transport downriver of floating oil.	Y
Lakes (Steamboat, Davis, Flowage lakes)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River with subsequent physical transport into Steamboat Lake, Davis Lake and Flowage Lake.	Y
Sediment	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River upstream of Steamboat, Davis and Flowage lakes with subsequent physical transport downriver. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River upstream of Steamboat, Davis and Flowage lakes with subsequent physical transport downriver. This allows potential interaction with shoreline and riparian habitat.	Y

Table 7-60 Key Ecological and Human Environment Receptors for the Sandy River

Receptor	Relevance for Inclusion as an Environmental Receptor for the Sandy River Scenario	Selected (Y/N)
Wetlands	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into Sandy River upstream of Steamboat, Davis and Flowage lakes with subsequent physical transport downriver and potential interaction with wetlands along the river and lakes.	Y
Aquatic Plants	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Sandy River upstream of Steamboat, Davis and Flowage lakes with subsequent physical transport downriver and potential interaction with plants. Aquatic plants are present in Sandy River and associated lakes, and riparian and wetland habitats.	Y
Benthic Invertebrates	High. The Sandy River and Steamboat, Davis and Flowage lakes support benthic invertebrate communities.	Y
Fish	High. The Sandy River and Steamboat, Davis and Flowage lakes support fish communities.	Y
Semi-Aquatic Wildlife Receptors		
Amphibians and Reptiles	High. The Sandy River and lake systems downstream of the release location support aquatic and semi-aquatic amphibians and reptiles.	Y
Birds	High. The Sandy River and lake systems downstream of the release location support a diverse bird community.	Y
Semi-aquatic Mammals	High. The Sandy River and lake systems downstream of the release location support semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. The community of McGregor, Minnesota is approximately 3.3 miles northeast the hypothetical release location. The Sandy River, Steamboat Lake and Davis Lake are also bordered by homes and used for recreational activities (e.g., hunting, fishing, boating, canoeing). Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. The Sandy River, Steamboat Lake and Davis Lake are sporadically bordered by homes and used for many recreational activities (e.g., hunting, fishing, boating, canoeing). Effects on air quality or the presence of crude oil residues in river water and riparian habitat have the potential to temporarily affect human health.	Y
Public Use of Natural Resources	High. The Sandy River, Steamboat Lake and Davis Lake are sporadically bordered by homes and used for many recreational activities (e.g., hunting, fishing, boating, canoeing). Effects on air quality, water quality, or the presence of crude oil residues in rivers, lakes and riparian habitat could potentially disrupt public use of natural resources (e.g., drinking water supplies).	Y

7.4.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Sandy River scenario is provided in this section. The OILMAP Land software was used by RPS ASA to simulate hypothetical releases of CLB and Bakken crude oils into the Sandy River (Chapter 4.0) for a 24 hour period. The maximum simulation duration using OILMAP Land was 24 hours, as it was assumed that emergency response measures to prevent farther downstream transport of released oil would be in place within that length of time. Symbols on the drawings indicate the predicted trajectory during river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice).

The two crude oil types provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB, heavy diluted bitumen crude oil types having higher viscosity and density). Seasonal variations in river flow velocity, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-61.

Table 7-61 Environmental and Hydrodynamic Conditions for the Three Modeled Periods at the Sandy River Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	March	-3.07	4.21	0.13
Average Flow (Summer/fall)	July	19.96	3.50	0.24
High Flow (Spring)	April	5.00	4.73	0.35
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest flow velocity of the Sandy River coincides with the spring freshet (i.e., April), a result of rising temperatures and snowmelt. Average flow would typically occur in summer and fall seasons. July, the month with the warmest temperature was selected to represent the maximum amount of evaporation. The lowest flow rate occurs in winter (i.e., January-March), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3-minute period to allow for valve closure. The release volume therefore represents the volume of oil actively discharged in the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum 13-minute response time to valve closure is an Enbridge standard for safe operations and leak

detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown and full valve closure in the affected pipeline section. While 13 minutes is the maximum time for valve closure, this is a conservative assumption, since a response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated of Bakken, CLB, or CLWB crude oil.
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7.4.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectory and mass balance of Cold Lake and Bakken crude oils, under the three seasonal scenarios, is illustrated in Figure 7-23 and Figure 7-24, respectively. These simulations are assumed to provide bounding conditions for a release of heavy or light crude oil types. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the Cold Lake and Bakken crude oil types. The Cold Lake crude oil was assumed to be CLB for the high flow and average flow scenarios, and to be CLWB for the low flow scenario. Details about the predicted downstream transport are provided in the following sections.

As noted in Section 7.5.3, the maximum simulation duration using OILMAP Land was 24 hours, as it was assumed that emergency response measures to prevent continued downstream transport of released oil would be in place within that length of time. Symbols on the drawings indicate the river seasonal flow condition (high corresponding to spring freshet, medium corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Numbers other than these (e.g., 16.3) indicate the time in hours of the predicted termination of downstream transport of the released oil due to adhesion or holdup of the oil along the river banks. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, adhering to river banks, or evaporated to the atmosphere) of the released oil at relevant points in time after the start of the release.

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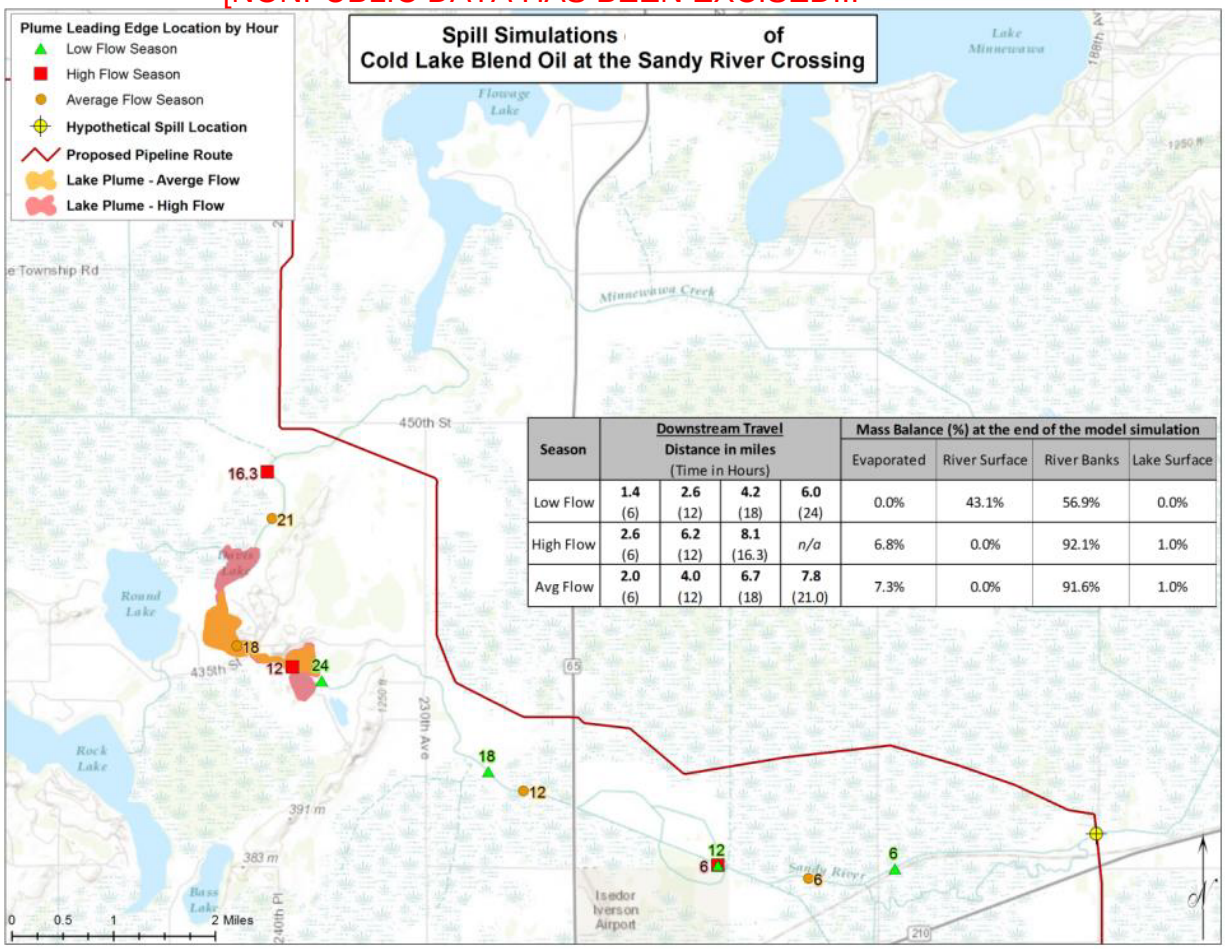

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.4 (6)	2.6 (12)	4.2 (18)	6.0 (24)	0.0%	43.1%	56.9%	0.0%
High Flow	2.6 (6)	6.2 (12)	8.1 (16.3)	n/a	6.8%	0.0%	92.1%	1.0%
Avg Flow	2.0 (6)	4.0 (12)	6.7 (18)	7.8 (21.0)	7.3%	0.0%	91.6%	1.0%

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Figure 7-23 Predicted Downstream Transport of CLB Oil at the Sandy River Crossing Location

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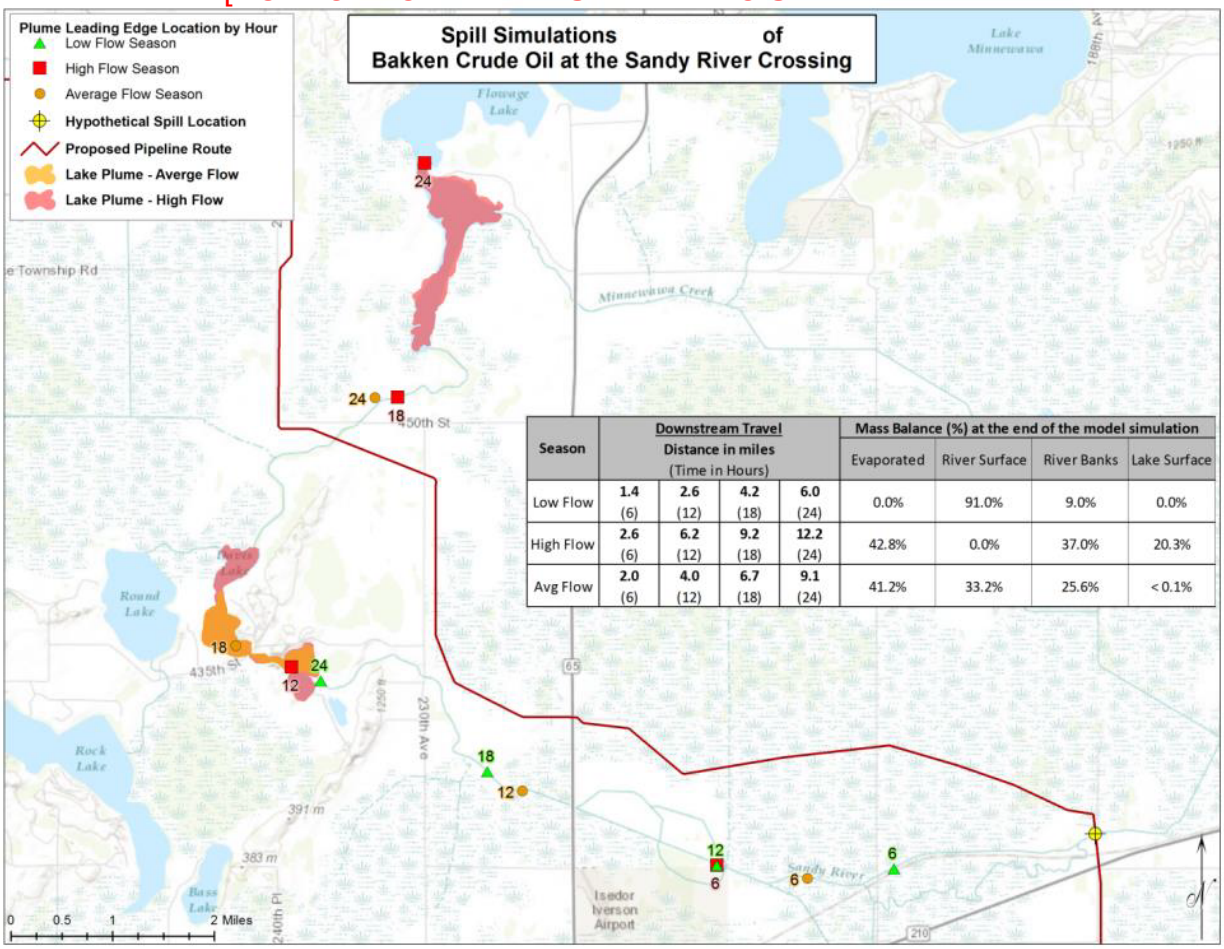

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.4 (6)	2.6 (12)	4.2 (18)	6.0 (24)	0.0%	91.0%	9.0%	0.0%
High Flow	2.6 (6)	6.2 (12)	9.2 (18)	12.2 (24)	42.8%	0.0%	37.0%	20.3%
Avg Flow	2.0 (6)	4.0 (12)	6.7 (18)	9.1 (24)	41.2%	33.2%	25.6%	< 0.1%

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Figure 7-24 Predicted Downstream Transport of Bakken Crude at the Sandy River Crossing Location

7.4.5.1 Sandy River Release During High Flow (Spring) Period

The OILMAP Land model transported oil downstream with these velocities to a point where all oil had evaporated and/or adhered to the shoreline. Under this high river flow scenario, CLB crude oil was predicted to travel a total of approximately 8.1 miles downstream, within 16.3 hours of the release. The CLB crude oil was predicted to be transported along the Sandy River, to then spread over the surfaces of both Steamboat Lake and Davis Lake (for a total area of 0.182 square miles and at a thickness of 0.004 inches [0.1 mm]), and then continue another 0.7 miles down Sandy River. Approximately 92.1% of the CLB crude oil was predicted to oil the shorelines of Sandy River, 1.0% to have spread over the surface of Steamboat and Davis lakes, and 6.8% to have evaporated into the atmosphere.

Bakken crude oil was predicted to be transported approximately 12.2 miles downstream, over the full 24-hour modeled period. The Bakken crude oil was predicted to be transported down the Sandy River, to then spread over the surfaces of both Steamboat Lake and Davis Lake (for total area of 0.182 square miles at a thickness of 0.00004 inches), and then continue another 3.5 miles in Sandy River before reaching Flowage Lake. Oil was predicted to spread very thinly (less than 0.00004 inches) over approximately 0.22 square miles of the surface of Flowage Lake. If left unmitigated, it is predicted that this spreading would continue to occur after 24 hours, covering a larger surface area of the lake. Approximately 37.0% of the Bakken crude oil was predicted to oil shorelines of Sandy River, 20.3% would have spread over the surface of Steamboat, Davis, and Flowage lakes, and 42.8% would have evaporated into the atmosphere.

Bakken crude oil was predicted to result in oiling 4.1 miles farther downstream, than the CLB crude oil (8.1 miles) under high flow river conditions. The difference in the extent of downstream transport was primarily the result of the differences in the shoreline and lake surface oil retention between the two oil types. CLB, the more viscous crude oil, would adhere to shorelines and spread as a thicker slick than the less viscous Bakken crude oil. Therefore, the same amount of Bakken would oil a greater length of shoreline and more lake surface, but at a lower slick thickness. While this result is logical, it is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point is oiled to its maximum holding capacity) as oil makes its way downstream, and the assumption that oil would spread evenly within lake. In the event of an actual release, the downstream extents of CLB and Bakken crude oils may be more similar, and the effects of CLB may extend farther downstream than presented, with patchy coverage. Due mostly to the lighter nature and higher volatile content, much more of the Bakken crude oil was predicted to evaporate (42.8%) than was predicted for the CLB crude oil (6.8%).

7.4.5.2 Sandy River Release During Average Flow (Summer-Fall) Period

Under average river flow conditions, CLB crude oil was predicted to travel a total of 7.8 miles downstream within 21 hours of the release. The CLB crude oil was predicted to be transported down the Sandy River, to then spread over the surfaces of both Steamboat Lake and Davis Lake (for total area of 0.106 square miles at a slick thickness of 0.004 inches), and then to continue another 0.7 miles down the Sandy River. Approximately 91.6% of the CLB was predicted to oil shorelines of Sandy River, 1.0% to have spread over the surface of Steamboat and Davis lakes, and 7.3% to have evaporated into the atmosphere.

Relative to the high river flow condition, the CLB crude oil was predicted to be transported a shorter distance downstream (0.3 miles). This was predominantly due to the longer duration of the scenario which allowed for more evaporation. Under both high and average flow conditions, oil was modeled to spread over the entire surface of both Steamboat and Davis lakes. However the area of the lakes was smaller in the average flow condition.

Under average river flow conditions, Bakken crude oil was predicted to be transported approximately 9.1 miles downstream over the 24-hour modeled period (Figure 7-24). The Bakken crude oil was predicted to be transported down the Sandy River, and to then spread over the surfaces of both Steamboat and Davis lakes (for total area of 0.106 square miles and at a thickness of 0.00004 inches). It was then able to continue another 2.05 miles down Sandy River. Approximately 25.6% of the Bakken crude oil was predicted to oil shorelines of Sandy River, less than 0.1% to spread over the surface of Steamboat and Davis lakes, 41.2% to have evaporated into the atmosphere, and 33.2% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, it is predicted that the remaining Bakken crude oil on the river surface would continue downstream, with weathering and oiling of shorelines continuing until all the oil is removed from the water surface.

The Bakken crude oil was predicted to be transported 3.1 miles less under summer-fall conditions when compared to the high river flow conditions. The lower river velocities of the average river flow condition prevented the oil from being transported as far downstream within the 24 hour simulation period. The Bakken crude oil evaporated less in the average flow condition (41.2 %) than the high flow condition (42.8%) due to the reduced surface area oiled. This was a result of smaller area of Steamboat and Davis lakes, and the reduced downstream transport. When compared to the CLB crude oil under average river flow conditions Bakken was transported 3 miles farther downstream before reaching the 24 hour model limit. Approximately 33.2% of the Bakken crude oil was predicted to remain on the river surface at the end of the simulation. If left unmitigated, it is predicted that the remaining Bakken crude oil on the river surface would continue downstream, with weathering and oiling of shorelines continuing until all the oil is removed from the water surface. The Bakken crude oil was able to travel farther downstream, under the same river velocities, due to differences in the shoreline and lake surface oil retention between the two oil types.

7.4.5.3 Sandy River Release During Low Flow (Winter) Period

Under winter conditions, it was assumed that the Sandy River and downstream lakes would be frozen (100% coverage of ice). It was assumed that CLWB crude oil would be released directly into the river from the pipeline under the riverbed, and that all oil would remain trapped under the ice. The ice cover would strongly limit or prevent evaporation of crude oil vapors to the atmosphere. Flow velocity for Sandy River during these winter conditions resulted in minimum river velocities during March.

Under low river flow conditions, CLWB crude oil was predicted to be transported a total of 6.0 miles downstream, over the full 24-hour modeled period. The CLWB crude oil was predicted to stop just before reaching Steamboat Lake. Approximately 43.1% of the CLWB crude oil was predicted to remain in the river below the ice, and the remaining 56.9% to have oiled the shorelines of Sandy River. Any CLWB remaining in the river after 24 hours would continue to move downstream, oiling shorelines and Steamboat Lake, if not intercepted by emergency response teams.

Relative to the high and average river flow conditions, the CLWB crude oil was predicted to be transported over a shorter distance during low river flow conditions, stopping before reaching Steamboat Lake. This was due to the reduced river velocities under the low river flow conditions.

Under low river flow conditions, Bakken crude oil was predicted to be transported a total of 6.0 miles downstream, over the full 24-hour modeled period to a point just before Steamboat Lake. Approximately 91.0% of the Bakken crude oil was predicted to remain in the river below the ice, and the remaining 9.0% to oil shorelines of Sandy River. If not intercepted by emergency response teams, the remaining Bakken crude oil in the river after 24 hours would be expected to move downstream, oiling shorelines and Steamboat Lake.

Relative to the high river flow conditions, the Bakken crude oil under low river flow was predicted to be transported 6.2 miles less downstream. Relative to the average river flow condition, the Bakken crude oil was predicted to be transported 3.1 miles less downstream. Under low river flow conditions, the shore types were assumed to be the same as the average flow condition. With the oil being transported at a slower speed, the 24 hour modeled time limit was reached at a distance that was shorter than that of the average river flow condition with oil remaining on the surface. With the Bakken crude oil below the ice of the river, no oil was allowed to evaporate from the surface. When compared to the CLWB oil under low river flow conditions, 47.9% more of the Bakken crude oil remained in the river and under the ice. This would provide only temporary storage of the oil, and oil would be expected to re-mobilize in response to changes in flow velocity, and particularly during the spring breakup of ice. This was due to the lower shoreline oil retention between the two oils. For this reason the Bakken crude oil was predicted to have greater mobility under the ice in winter.

7.4.6 Qualitative EHHRA for the Sandy River

In this section the likely environmental effects of a crude oil release at the pipeline crossing location on the Sandy River are described. A worst case crude oil release from a main-line pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed pipeline could carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). Therefore, the following discussion is based on the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7.5.3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence and sensitivity) as appropriate were also considered in the analysis. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-60.

7.4.6.1 Terrestrial Receptors

For this modeling scenario, the hypothetical release of crude oil is assumed to occur into the Sandy River, so that environmental effects on soils, terrestrial vegetation and groundwater quality are assumed to be localized, limited in spatial extent, and readily remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors are not considered further for this release scenario.

7.4.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors that are most closely associated with the Sandy River, and Steamboat, Davis, and Flowage lakes are addressed in this section. These receptors include water and sediment quality in rivers and lakes, shoreline and riparian river bank habitat, wetlands, aquatic plants (including wild rice), benthic invertebrates, and fish.

If crude oil were to enter the Sandy River during the spring (high flow) or summer-fall (average flow) periods, it would be predicted to travel downstream and then enter and partially to fully cover the surfaces of Steamboat, Davis and Flowage lakes. As it traveled, crude oil would interact with vegetation and seasonal shoreline, the amount of which would vary depending upon season and water levels. During high flow conditions, the lakes have approximately one and a half to two times greater surface area than under average or low river flow conditions. Heavier crude oils could result in plumes on Steamboat and Davis Lake with a greater thickness than expected for lighter crude oils, but this would also tend to reduce the extent of overall downstream transport. Lighter oils could also enter Flowage Lake and could be found spread very thinly.

Based on a 24 hour model run, the OILMAP Land simulations suggest that crude oil could be carried between 2.0 and 12.2 miles downstream from the point of release during spring and summer-fall periods. For heavy oil, stranding on river banks would be the primary fate, with only small amounts of evaporative weathering of the oil occurring before the oil becomes stranded. However, for light oil the primary fate is evaporation with a moderate amount expected to remain on river banks or on the surface of Sandy River (under average flow conditions) or downstream lakes (under high flow conditions). Receding waters in the lakes in late summer could lead to further stranding of oil as riparian and wetland habitats drain.

The effects of crude oil release on benthic invertebrates and fish depend on characteristics of the released oil and environmental conditions at the time of the release. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column, meaning potentially toxic fractions of the light oils would more readily dissolve into the water column. As a result, the potential for acute toxicity to fish and invertebrates is often greater for light crude oil than for heavier oils. However, Sandy River is a low-gradient watercourse, and both Steamboat and Davis lakes are small water bodies, with limited fetch (and low potential for the formation of breaking waves on their

surfaces). Therefore, both light and heavy oils are likely to float on the water surface, with low potential for turbulence to entrain oil as fine droplets into the water column.

Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. Sandy River is a small, shallow watercourse at the hypothetical release location, and even though flow in the river is unlikely to entrain small crude oil droplets into the water column, the very limited dilution provided by this river means that there is high potential for toxicity to fish and other aquatic life. While the large volume of water flow associated with the spring period freshet may dilute and limit the maximum dissolved hydrocarbon concentration in Sandy River as compared to periods of lower water flow in summer, it is unlikely that this would reduce effects to fish within the lake systems given the predicted crude oil coverage on the water surface in both seasons. As a result, narcotic effects on fish and benthic invertebrates are likely in all seasons. There would also be potential for phototoxicity, caused by an interaction of ultraviolet light with PAHs accumulated in fish tissues. This potential would be greatest in summer, due to high light intensity and long day length, and lowest in winter due to ice and snow cover, shorter day length, and lower sun angles. There would also be potential for chronic effects of released crude oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease). Many fish species spawn in the spring and early summer. The eggs and embryos of these species could be exposed to total PAH concentrations in the river water that could be sufficiently high to induce deformities or cause mortality.

The non-turbulent flow characteristics of Sandy River suggest that entrainment of crude oil as fine droplets in the water column is unlikely. Therefore, there is low potential crude oil to interact with suspended sediment particles in the water column, resulting in the formation of OPAs. However, the released oils could still contact organic matter and sediment particles along shorelines, and some accumulation of both light and heavy oils in depositional areas is likely as a result of interactions between released oil and shorelines. Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release.

For a hypothetical release under spring freshet conditions, it is likely that most aquatic plants would still be dormant or submerged, and that environmental effects on this receptor type would be minimal. However, the Sandy River to Flowage Lake system supports a wide range of aquatic plants and where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants would be less vulnerable, as they would be exposed primarily to dissolved hydrocarbons, and are not considered likely to be among the most sensitive groups of aquatic biota to such exposure. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem could be oiled). However, flooded riparian areas and wetland habitats (especially during spring periods when the lakes are at their maximum surface area) would also be exposed to the released oil,

and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat.

Wild rice is an emergent aquatic plant of biological and cultural importance in Minnesota and occurs in many areas between the predicted point of release and Flowage Lake. Wild rice provides a food source and nesting cover for many birds, and is also harvested as a food source by people in the area. Given the extent of predicted oiling in spring and summer seasons, loss of emergent plants from contact with crude oil could be expected.

Under low flow conditions, it was assumed that Sandy River and its associated lakes would be frozen (100% coverage of ice). Based on the 24 hour simulations, both bounding oil types were predicted to be transported a total of 6.0 miles downstream. More of the light oil (91%) is predicted to remain potentially mobile under the ice after 24 hours than for the heavy oil (43%), with the balance of the oils assumed to be trapped in hollows under the ice, or close to the river margins, between the ice and the river sediment. For both oil types, the winter ice would effectively inhibit evaporation, while providing greater potential for dissolution into the water column during the period of lowest dilution flow. Therefore, a release in winter could cause mortality to fish due to narcosis. This result would be more likely for the light crude oil, which remain at the ice-water interface, than for the heavy crude oil, which would tend to remain in thicker localized accumulations along the banks. Fish eggs and larvae would generally not be present during the winter. Both crude oil types could accumulate in sediment, and both would be subject to re-mobilization with spring breakup of the ice, and increasing water flow rates.

7.4.6.3 Semi-Aquatic Wildlife Receptors

Habitats along Sandy River, Steamboat Lake, Davis Lake and Flowage Lake support semi-aquatic wildlife receptors including amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), semi-aquatic birds (e.g., ducks, geese, cranes) and semi-aquatic mammals (e.g., muskrat, otter). While individual animals may be affected by exposure to released oil in the immediate area of the river, regional populations of these animals will be robustly supported by extensive wetland and aquatic habitats within the region. Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.4.6.3.1 Amphibians and Reptiles

Crude oil released to the Sandy River during the spring (high flow) and summer-fall (average flow) periods is predicted to travel downstream as it then enters and covers or partially covers the surfaces Steamboat, Davis and Flowage lakes. Within these habitats, oiling effects on amphibians (adults, juveniles, and eggs) and reptiles would be observed. Higher potential would exist for effects on amphibians (i.e., physical effects of oiling, as well as narcotic effects similar to fish and benthic invertebrates) than for adult turtles, which appear to be somewhat tolerant of external oiling. A release of light crude oil during the spring would likely have a greater effect than in summer due to the greater predicted transport distance, and interaction with more

riparian and wetland habitats than under average flow conditions. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. As a result, exposure of these animals to released crude oils would be limited.

Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms would have very little exposure to released oil moving on the water surface or within the water column.

7.4.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, lakes, wetlands, and riparian areas as components of their habitats, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory and herbivory.

If exposed to external oiling, the ability of birds to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn, this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos. Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Animals in the affected river reach and lakes would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected since emergency response measures to prevent or reduce farther possible downstream transport of oil would be in place within 24 hours of the release. Therefore, although mortality of some semi-aquatic birds is expected, large-scale population level effects are unlikely.

Environmental effects of a crude oil release in the summer period are likely to be of similar or lesser magnitude. Due to lower river flow rates, the size of the potentially affected river reach is smaller. With rising water temperatures, mortality of lightly oiled adult birds due to hypothermia becomes less likely than in the spring. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest. Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure.

In the winter months, ice cover on the Sandy River, and Steamboat, Davis and Flowage lakes, would strongly limit the opportunities for aquatic and semi-aquatic birds to occupy this habitat. In addition, released crude is predicted to remain beneath the ice cover of Sandy River and both Steamboat and Davis lakes. Therefore, adverse effects on the health of aquatic and semi-aquatic birds are not likely for a release of crude oil during the winter.

7.4.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses particularly upon species that have a primary association with the aquatic environment, such as muskrat and beaver (herbivores), American mink (carnivore-piscivore) and river otter (piscivore). These species are at greater risk of exposure to an oil release in water than terrestrial mammals.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along the Sandy River and associated lake systems where effects may occur, and the magnitude of effects, is related to the type of oil released and the season in which semi-aquatic mammal could be exposed. Effects to semi-aquatic mammals relate more to the amount of time spent in the water (and consequent exposure to physical oiling) than to dietary preferences. Timely capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Animals in areas where there is predicted to be crude oil on the surface of the Sandy River and associated lakes could be affected. Animals upstream, farther downstream where there is no exposure, or occupying other nearby habitats, would likely be unaffected. Therefore, although mortality of some semi-aquatic mammals could be expected, large-scale population level effects are unlikely. Environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude to those associated with a release during spring freshet. Due to lower river flow rates, the size of the potentially affected river reach is smaller. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is expected

to be less likely than in the spring. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while grooming, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure based on the 24 hour model run.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. Animals that became oiled in the winter would be likely to rapidly die as a result of hypothermia

7.4.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs than heavier crude oils, although diluted bitumens may contain similar amounts of VOCs to light crude oils, depending upon the type and amount of diluent they contain. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release. When crude oil is spread out as a thin layer, the rate at which the VOCs evaporate does not vary greatly with oil type. Therefore, air quality would be most affected by the initial concentration of benzene and other VOCs in the crude oil, the size of the area affected by the release, and weather conditions such as winds and atmospheric stability that will determine how quickly the VOCs disperse in air.

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil vapor. Similarly, ATSDR (1995) report that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

The community of McGregor, Minnesota was identified through the HCA analysis as an "other populated area". The OILMAP Land modeling indicated that the leading edge of released crude oil would pass approximately one mile north of McGregor, although individual farms and homes are located within 100 ft of the Sandy River, Steamboat and Davis lakes. While no drinking water HCAs were identified along the path of the release, the homes located along the trajectories of predicted releases are likely to rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. Based upon case studies involving crude oil releases elsewhere, this process could take a few days to two weeks, but reports of crude oil releases affecting private wells are rare, making this an unlikely effect.

The potential for VOC inhalation exposures to the public would be greatest near and downwind from the release site and near to the Sandy River, Steamboat, Davis and Flowage lakes while the released oil is on the water surface. In the unlikely event of a crude oil release, residents in close proximity would become aware of a strong hydrocarbon odor. Most of the volatile

hydrocarbons would be lost within the first 24 hours following a release of crude oil. It is also expected that emergency response personnel would contact residents and advise them to evacuate. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while the emergency response takes place.

Relatively little has been published regarding the long-term effects of exposure by humans to an oil release. Health effects observed in residents and clean-up workers in the months following an oil release generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

Effects of a crude oil release on human receptors would be generally similar for the spring (high flow) and summer-fall (average flow) seasons. In summer, the warmer temperatures and slower river flow velocities in the summer would promote more rapid evaporation of volatile hydrocarbons in a smaller area. In the spring freshet period, higher river flow velocity would transport the released oil farther downstream within the first 24 hours, potentially resulting in lesser exposures, but to a larger number of people. The flow modeling suggests that the light crude oil (i.e., Bakken crude oil) is likely to be transported farther downstream within 24 hours than the heavy crude oil (Cold Lake diluted bitumen). As a result, a release of the light crude oil may affect a larger number of individuals than a release of the heavy crude oil type. Both Bakken crude oil and Cold Lake diluted bitumen are expected to contain similar overall amounts of volatile hydrocarbons, so differences related to the chemical characteristics of the released oil are likely to be minor.

No overland transport of released crude oil was modeled for this hypothetical release location. Infiltration of crude oil into soil and subsequently into groundwater would be limited. During the spring freshet period, the Sandy River could be susceptible to flooding and could overtop its banks and spread into the surrounding wetlands or farmland. A release of light and medium crude oils during this period would provide a potential pathway for oil deposition to soil in low-lying areas. Light and medium crude oils would be expected to become dispersed over a large area, and are readily biodegraded, so that persistent accumulation of these oil types in riparian areas or temporarily flooded farmland is unlikely. Heavy crude oils and diluted bitumen are more likely to be deposited as thicker layers of more persistent oil, and could require more active remediation of affected areas.

The Sandy River, as well as Steamboat, Davis and Flowage lakes provide recreational opportunities (e.g., fishing, hunting, boating, swimming, bird watching) downstream of the release location. Emergency response workers, in cooperation with public health and safety

officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil.

7.4.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to the Sandy River area have been assessed. The proposed pipeline could carry a variety of crude oil types ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). The discussion of expected environmental effects on receptors is based on these crude oil types as bounding conditions. Potential terrestrial and aquatic habitats, aquatic receptors, semi-aquatic wildlife receptors, human and socio-economic receptors were screened to identify those most likely to have interactions with released oil. Potential environmental effects to these receptor groups are summarized in Table 7-62.

Table 7-62 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Sandy River

Receptor	Expected Environmental Effects of Released Crude Oil to the Sandy River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	It is assumed in the model that crude oil would enter directly into the Sandy River with no holdup of oil on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
Rivers (Sandy River)	Both light and heavy oil would travel downstream from the release location, entering the Sandy River. Lighter crude oils are predicted to travel farther downstream than heavier crude oils in spring and summer-fall conditions, but would be thinner and less persistent on the water. Both light and heavy crude oils are predicted to travel similar travel distances under winter conditions, although the heavy oil would be more likely to remain trapped along the edges of the rivers and lakes. The Sandy River is small, with a low gradient. Therefore, turbulent conditions that could entrain low-viscosity oil into the water column as fine droplets are unlikely to occur.	MORE	LESS
Lakes (Steamboat, Davis and Flowage Lake)	Both light and heavy oil would travel downstream from the release location, enter, and spread over the surfaces of Steamboat and Davis lakes, with the light crude oil also entering Flowage Lake under high flow conditions. Heavier crude oils would result in lake plumes with a greater thickness than expected for lighter crude. The lakes are small, with low fetch. Therefore, breaking waves that could entrain low-viscosity oil into the water column as fine droplets are unlikely to occur. In low flow winter conditions, neither type of crude oil was predicted to reach a lake within the 24 hour model simulation.	MORE	LESS

Table 7-62 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Sandy River

Receptor	Expected Environmental Effects of Released Crude Oil to the Sandy River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Sediment	Lighter crude oils are predicted to travel farther downstream than heavier crude oils in spring and summer conditions, with equal travel in winter months. The low mixing energy prevailing in the Sandy River system suggests that neither type of oil is likely to be entrained into the water column as fine droplets that could form OPAs. However, both oil types would interact with shoreline sediments, and the potential for oil to become absorbed into these sediments, or to sink in combination with adhering sand or silt particles, would remain. In this case, the light crude oil would be spatially more extensive, but also less persistent than the heavy crude oil. Under winter conditions, more of the heavy crude oil is predicted to become trapped along the margins of the rivers and lakes, and this oil is also likely to interact with sediment, resulting in mixing of oil and sediment. Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release.	LESS	MORE
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location. Lighter crude oils are predicted to travel farther downstream than heavier crude oils in spring and summer-fall conditions, but would be thinner and less persistent on the water. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. For heavy oil, stranding on shore would be the primary fate. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation. Flooding of riparian and wetland habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, in contrast to light crude oil which would be deposited as a thin layer or sheen. Receding waters in the lakes in late summer could lead to further stranding of oil as wetland habitat forms.	LESS	MORE
Aquatic Plants	The Sandy River and Steamboat, Davis and Flowage lakes support emergent, floating and submerged aquatic plants. Where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Lighter oils are predicted to spread more thinly and cover a larger are than heavier oils. Submerged aquatic plants would be less vulnerable. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem was oiled). However, given the extent of predicted oiling in Sandy River and associated lakes in spring and summer seasons, loss of emergent plants from contact with crude oil is to be expected.	MORE	LESS

Table 7-62 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Sandy River

Receptor	Expected Environmental Effects of Released Crude Oil to the Sandy River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Benthic Invertebrates	Environmental effects on benthic invertebrates would be limited to areas affected by the released oil. Heavy crude oil would have greater potential than light crude oil for deposition of tar balls and patties as a result of oil interaction with sediment. These could accumulate in depositional areas, resulting in chronic effects on benthic invertebrates.	LESS	MORE
Fish	Environmental effects on fish would be limited to areas affected by the released oil. The slow-moving character of the Sandy River is not likely to promote dissolution of low molecular weight hydrocarbons into the water. However, potential for toxicity to fish due to narcosis would exist for both types of oil, due to the small size of the river. Potential chronic effects on fish eggs and embryos (e.g., blue sac disease) could also occur, but would be most likely to occur in spring, when most species spawn. The potential for phototoxicity, caused by an interaction of ultraviolet light with PAHs accumulated in fish tissues, would be greatest in summer due to high light intensity and long day length.	SAME	SAME
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Environmental effects on amphibians and reptiles would be limited to areas affected by the released oil. Light crude oil is predicted to travel farther downstream under spring and summer conditions than heavy crude oil, affecting a larger area of habitat. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. Flooding of riparian habitat in spring could lead to stranding of crude oils in this habitat. Within these habitats, oiling effects on adults, juveniles, and eggs could potentially be observed. Higher potential would exist for effects on amphibians than for turtles, which appear to be somewhat tolerant of external oiling. Dormancy of amphibians and reptiles in winter and early spring means exposure to oil released at this time of year could be negligible, and adverse environmental effects unlikely.	MORE	LESS

Table 7-62 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Sandy River

Receptor	Expected Environmental Effects of Released Crude Oil to the Sandy River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Birds	Mortality of oiled aquatic and semi-aquatic birds would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil, so environmental effects to birds could be more spatially extensive for light crude oil types as it enters lake habitat downstream of the hypothetical release location. Marshy areas along the Sandy River (especially McGregor and Grayling Wildlife WMAs), Steamboat, Davis and Flowage lakes provide the highest quality habitat for nesting birds. Cold water in the spring, in combination with greater downstream movement of released oil, suggests that environmental effects of released oil could be greatest for a light crude oil in spring, and of lesser magnitude for a heavy crude oil release. Few birds are present in winter, so effects would be minimal in that season.	MORE	LESS
Semi-aquatic Mammals	Mortality of oiled semi-aquatic mammals would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil, so environmental effects could be more spatially extensive for light crude oil types. Cold water in the spring, in combination with greater downstream movement of released oil, suggests that environmental effects of released oil could be greatest for a light crude oil in spring, and of lesser magnitude for a heavy crude oil release. In winter, adverse effects on mink and otter would be particularly severe, due to the effects of oil on the insulating properties of fur, in combination with cold water temperatures. However, muskrat and beaver might be spared due to their lower activity levels in winter.	MORE	LESS
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. Light crude oil is likely to be transported farther downstream within 24 hours than the heavy crude oil. As a result, environmental effects on air quality could be more spatially extensive for light crude oil types. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS

Table 7-62 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Sandy River

Receptor	Expected Environmental Effects of Released Crude Oil to the Sandy River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Human Receptors	Typical human health effects associated with short-term inhalation of VOC from crude oil releases include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is unlikely. Residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most volatile hydrocarbons would be lost within 24 hours following a release. Light crude oil (Bakken crude oil) is likely to be transported farther downstream within 24 hours than the heavy crude oil (Cold Lake diluted bitumen). However, very few people live between Davis and Flowage lakes, and therefore the effect of this additional downstream movement in human receptors would be minimal. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	SAME	SAME
Public Use of Natural Resources	Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Light crude oil is predicted to be transported farther downstream than heavy crude oil following a release, affecting a larger area and potentially interrupting more public use of natural resources. No drinking water HCAs were identified along the path of the release. However, a number of homes are located along the trajectory of a predicted release and could rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to the Sandy River would result in adverse health effects to consumers of drinking water. However, recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route.	MORE	LESS

7.5 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL TO THE SHELL RIVER CROSSING AT TWIN LAKES, MN

The proposed pipeline route crosses the Shell River a number of times, and the hypothetical release location selected for modeling is located approximately 7.3 miles south of Park Rapids, Minnesota. This scenario captures a release of oil directly to a watercourse of medium width (70 to 120 ft) and moderately-flowing character that enters directly into the Twin Lakes. After flowing out of Lower Twin Lake, the Shell River meanders approximately 9.2 miles in a generally eastward direction before meeting the Crow Wing River, after which point the flow is generally to the south. There are 59 groundwater wells reported in the lower Shell River area, most of which are reportedly used for agricultural irrigation (MN PCA 2014). Irrigation circles are conspicuous around Park Rapids, to the east of Hubbard, and both south and east of the Twin Lakes. The presence of groundwater wells and residences with docks makes this site representative of inhabited areas that may be used recreationally, and for agriculture. In addition, this region is known to contain sensitive ecosystems. Therefore, the potential for crude oil from the release area into the Twin Lakes and subsequent transport farther down Shell River (and into Crow Wing River) was investigated. The Shell River is part of the Pine Moraines and Outwash Plains Subsection of the Northern Minnesota Drift and Lake Plains Section situated in the Laurentian Mixed Forest Province (MN DNR 2006).

7.5.1 Description of the Freshwater Environment

Upstream of the pipeline crossing location, the river channel is predominantly natural, with riparian marsh/fen/shrub swamp wetlands. Beginning approximately 2,070 ft upstream of the proposed pipeline crossing, the river enters a large wetland with bog elements. Within this area there is evidence of historical channel alteration (straightening), although below the proposed crossing the river channel appears to have reverted to a more natural channel. Approximately 3,000 ft south of the pipeline crossing, the wetland grades into Upper Twin Lake and has a conspicuous sandy outwash deposit. The open water area of Upper Twin Lake is about 4,150 ft long and 1,690 ft wide. The lake is surrounded by shrub swamp and fen, grading into marsh. Lower Twin Lake is slightly larger, being about 4,870 ft long and 1,830 ft wide, and having similar marginal wetlands. Both lakes have residential or cottage development around them but Lower Twin Lake is more intensively developed in this respect.

The Shell River is approximately 95 ft wide, approximately 1.5 ft deep, and passes through forested areas nestled between agricultural lands via a large marshy channel. The streambed is made up of loose sand and fine gravel. During the growing season much of the Shell River's streambed (33% to 40% coverage) supports macrophytes like cattails (MN PCA 2014). During the summer months, the Shell River can have low levels of dissolved oxygen, which is attributed to high water temperature and agricultural runoff (MN PCA 2014).

At the proposed crossing, the Shell River flows directly south where it reaches the Twin Lakes (Upper Twin Lake and Lower Twin Lake) about 0.6 miles downstream. The watercourse enters the

northern end of Upper Twin Lake before draining into a small reach that feeds Lower Twin Lake. The Twin Lakes cover a total area of approximately 0.75 square miles and are bounded by a number of homes with lake access. Both Upper and Lower Twin Lake have a diverse mix of aquatic plants including emergent (e.g., wild rice), floating (e.g., duckweed, waterlily) and submerged (e.g., Canada waterweed, flatstem pondweed, northern watermilfoil, coontail, and muskgrass) communities (Perleberg 2005; MN PCA 2014). Both lakes also provide habitat for numerous fish, including northern pike, walleye (a stocked species), perch, bass, and white sucker (MN PCA 2014). In addition to the recreational fishery, the bait fish industry is also well represented in the area (MN DNR 2006). The Shell River flows out of the northeastern edge of Lower Twin Lake and continues east through Huntersville State Forest, and south of Duck Lake. Here the river is wider (up to approximately 225 ft) than at the predicted release location. East of Duck Lake (which is surrounded by homes) and within the boundaries of the Huntersville State Forest and the Crow Wing Chain WMA, the Shell River merges with the Crow Wing River and flows south (MN DNR 2016g). The Shell and Crow Wing rivers provide opportunities for canoeing and fishing, with access along the river through the Huntersville State Forest (MN DNR 2016h). The average velocity of the Shell River changes with season, with slowest velocities (e.g., about 0.56 mph) expected during low flow periods in the winter, and greater velocities (e.g., about 1.2 mph) during the spring high flow period. Flow in the Shell River often exceeds the flow of the Crow Wing River (MN DNR 2016g).

The Pine Moraines and Outwash Plains is known to be home to 89 SGCN; these include birds (61 species), fish (4 species), insects (12 species), mammals (5 species), mollusks (2 species), and reptiles (4 species) (MN DNR 2006). Of these, 29 are afforded federal or state endangered, threatened, or of special concern status (MN DNR 2006; MN DNR 2016d). It is foreseeable that some of these SGCN could utilize aquatic habitats along the Shell River, Twin Lakes, and Crow Wing River.

Several access points downstream from the proposed pipeline crossing location were visited in May, 2016, to provide additional insight into baseline environmental conditions for the Shell River. Representative site photographs are provided in Figure 7-25 through Figure 7-28. Field observations are summarized in Table 7-63.



Figure 7-25 Shell River and Riparian Habitat Between Upper and Lower Twin Lakes Approximately 2 Miles Downstream of Pipeline Crossing



Figure 7-26 Shell River and Riparian Habitat Between Upper and Lower Twin Lakes Approximately 2 Miles Downstream of Pipeline Crossing



Figure 7-27 Crow Wing River and Riparian Habitat Approximately 25 Miles Downstream of Pipeline Crossing



Figure 7-28 Crow Wing River and Riparian Habitat Approximately 47 Miles Downstream of Pipeline Crossing

Table 7-63 Environmental Characteristics Observed at Selected Access Points on the Shell River near Twin Lakes, MN, May 2016

Access Point	Latitude Longitude	Notes
South Twin Lake Water Access approximately two miles downstream of pipeline crossing	46.803341 -95.034157	*Habitat Description:* broad open water/floodplain area. Fringe of open water dominated by cattail marsh with floodplain meadow (dominated by nonnative reed canary grass) and shrub swamp fringe on the outside of emergent marsh. Black willow and green ash trees, as well as red osier dogwood are common on the floodplain fringe. *Wildlife observed:* yellow-headed blackbird, Baltimore oriole, osprey, red-wing blackbird, American robin, yellow throat
Mary Brown Water site access, #5 State Water Access approximately 25 miles downstream of pipeline crossing	46.7177 -94.9293	*Habitat Description:* broad, flat floodplain in this area with good quality emergent marsh and wet/sedge meadow dominant. Shrub swamp and terrace forest occur in lesser amounts. Water clarity is good with the submergent plant wild celery common. Wildlife observed: mallard, veery
Crow Wing River, Cottingham Co. Park, #11 State Water Access Site; approximately 47 miles downstream of pipeline crossing	46.5055 -94.8074	*Habitat Description:* river banks are somewhat steep and transition into forest with a blend of floodplain forest and terrace forest. Areas farther upslope include red maple, bur oak basswood, quaking aspen and others, with a diverse shrub and ground layer. *Wildlife observed:* eastern Kingbird, yellow warbler, fly catcher

7.5.2 High Consequence Area Assessment for the Shell River at Twin Lakes, MN

As defined in Section 7.0, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. Sensitive AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks).

The locations of the various HCA (none of which are commercially navigable) and AOI near the hypothetical release location and the predicted trajectory of the floating oil are illustrated in Figure 7-29. Table 7-64 and Table 7-65 provide brief descriptions of the HCA and AOI for the Shell River hypothetical crude oil release location.

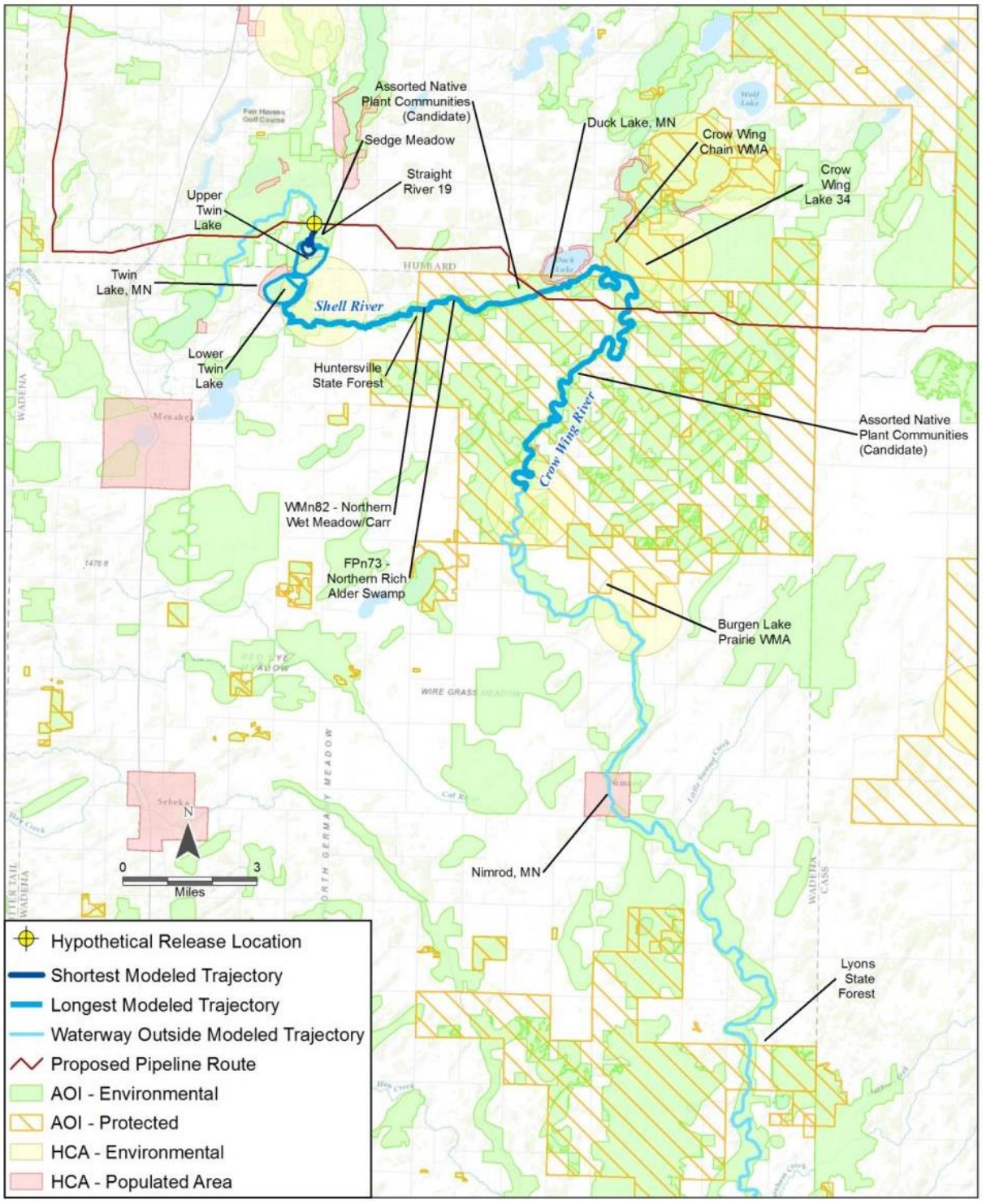

Figure 7-29 HCAs and AOIs Potentially Affected by a Crude Oil Release at the Shell River Crossing Location

Table 7-64 HCAs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Shell River Crossing Location

HCA Type	HCA Subtype	Description / Locations
Environmentally Sensitive Area	N/A	N/A
Population Area	Other	Twin Lake, MN (i.e., Lower Twin Lake) Duck Lake, MN
NOTE: Data for the HCA analysis were obtained from the United States Department of Transportation: Pipeline and Hazardous Materials Safety Administration (USDOT PHMSA) HCA datasets plus additional HCAs compiled by Enbridge during 2010 and 2013.		

Table 7-65 AOIs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Shell River Crossing Location

AOI Type	AOI Subtype	Description / Locations
Environmental	Lake of Biological Significance	Upper Twin Lake
	Wild Rice Lake	Lower Twin Lake Upper Twin Lake
	Native Plant Community (Candidate)	Sedge Meadow. Forests along Crow Wing River, Lowlands/forest along the Shell River, Northern Rich Alder Swamp, Northern Terrace Forest, Northern Wet Meadow/Carr, Upland aspen, wet meadow along river, Wet meadow along river; upland aspen/conifers
	Site of Biodiversity Significance	Crow Wing Lake 34, Straight River 19
Protected Area	State Forest	Huntersville State Forest
	Wildlife Management Area	Crow Wing Chain WMA
NOTE: Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website, USGS Protected Areas Database of the United States and the Minnesota Department of Transportation.		

7.5.3 Selection of Key Ecological and Human Environment Receptors for Shell River at Twin Lakes

Taking into account environmental characteristics of the Shell River at Twin Lakes, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-66.

Table 7-66 Key Ecological and Human Environment Receptors for Shell River at Twin Lakes

Receptor	Relevance for Inclusion as an Environmental Receptor for the Shell River at Twin Lakes Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with no holdup of oil on land. Any oil that contacted soil would be physically remediated to established standards.	N
Groundwater	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with no holdup of oil on land. In the event of an actual oil release, effects on groundwater quality would be localized and/or negligible.	N
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with no holdup of oil on land. Any oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the clean-up process.	N
Aquatic Receptors		
Rivers (Shell River and Crow Wing River)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River with subsequent physical transport downriver of floating oil.	Y
Lakes (Upper and Lower Twin Lake)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River with subsequent physical transport into the Twin Lakes system.	Y
Sediment	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with subsequent physical transport downriver. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with subsequent physical transport downriver. This allows potential interaction with shoreline and riparian habitat.	Y
Wetlands	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with subsequent physical transport downriver and potential interaction with wetlands along the river and lakes.	Y
Aquatic Plants	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Shell River upstream of Upper Twin Lake with subsequent physical transport downriver and potential interaction with plants. Aquatic plants are present in Shell River, the Twin Lakes and Crow Wing River as well as associated riparian and wetland habitats.	Y

Table 7-66 Key Ecological and Human Environment Receptors for Shell River at Twin Lakes

Receptor	Relevance for Inclusion as an Environmental Receptor for the Shell River at Twin Lakes Scenario	Selected (Y/N)
Benthic Invertebrates	High. The Shell River and Twin Lake system supports benthic invertebrate communities.	Y
Fish	High. The Shell River and Twin Lake system support fish communities.	Y
Semi-Aquatic Wildlife Receptors		
Amphibians and Reptiles	High. The Shell River and Twin Lake system supports aquatic and semi-aquatic amphibians and reptiles.	Y
Birds	High. The Shell River and Twin Lake system supports waterfowl and other semi-aquatic birds.	Y
Semi-aquatic Mammals	High. The Shell River and Twin Lake system supports semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. The community of Hubbard is located approximately 1.4 miles northeast of the hypothetical release location. The Twin Lakes and Duck Lake are ringed with homes and cottages, and are located along the downstream flow path for released crude oil. Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. The Twin Lakes are bordered by homes and used for boating, fishing, and potentially harvesting of wild rice. The Shell and Crow Wing rivers are used recreationally (e.g., hunting, fishing, and canoeing). Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health.	Y
Public Use of Natural Resources	High. The Shell River, Twin Lakes and Crow River are bordered by homes and used for many recreational activities (e.g., hunting, fishing, boating, canoeing). Effects on air quality, water quality, or the presence of crude oil residues in rivers, lakes and riparian habitat could potentially disrupt public use of natural resources (e.g., drinking water supplies).	Y

7.5.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Shell River at Twin Lakes is provided in this section. The OILMAP Land software was used by RPS ASA to simulate hypothetical releases of CLB and Bakken crude oils into the Shell River for a 24 hour period (Chapter 5). A longer time period was not modeled as it was assumed that emergency response measures to prevent further downstream transport of released oil would be in place within the 24 hour period. While OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column (Chapter 5.0). No overland transport

of released CLB or Bakken crude oil was modelled for this hypothetical release location, as it was assumed that released oil would directly enter the watercourse (Chapter 3.0). This is a worst-case assumption for a release of crude oil near the watercourse.

The two crude oil types provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB, heavy diluted bitumen crude oil types having higher viscosity and density). The environmental fate of most light, medium or heavy crude oil types that might be transported by the proposed pipeline would lie within the envelope represented by these simulations. Seasonal variations in river flow velocity, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-67.

In the event of an actual release, the downstream extents of CLB and Bakken crude oil may be more similar, and the effects of CLB may extend farther downstream than predicted, with patchy coverage.

Table 7-67 Environmental and Hydrodynamic Conditions for the Three Modeled Periods at the Shell River Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	March	-4.65	4.58	0.25
Average Flow (Summer/Fall)	August	18.61	3.52	0.35
High Flow (Spring)	April	4.04	5.05	0.54
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest average flow velocity of the Shell River coincides with the spring freshet (i.e., April-June), a result of rising temperatures and snowmelt. Average flow would typically occur in summer and fall seasons. August, the month with the warmest temperature was selected to represent the maximum amount of evaporation. The lowest flow velocity occurs in winter (i.e., January–March), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3-minute period to allow for valve closure. Therefore, the release volume represents the volume of oil actively discharged in the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum 13-minute response time to valve closure is an Enbridge standard for safe operations and leak detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown and full valve closure in the affected pipeline section. While

13 minutes is the maximum time for valve closure, this is a conservative assumption, since a response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated of Bakken, CLB or CLWB crude oil.
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7.5.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectories and mass balance for Cold Lake and Bakken crude oils, under the three seasonal scenarios, is provided in Figure 7-30 and Figure 7-31, respectively. These simulations are assumed to provide bounding conditions for a release of heavy or light crude oil types. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the Cold Lake and Bakken crude oil types. The Cold Lake crude oil was assumed to be CLB for the high flow and average flow scenarios, and to be CLWB for the low flow (winter) scenario. As noted in Chapter 5.0, while OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column.

The maximum simulation duration using OILMAP Land was 24 hours, as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within that length of time. Symbols on the drawings indicate the predicted trajectory during river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Numbers other than these (e.g., 5.5) indicate the time in hours of the predicted termination of downstream transport of the released oil due to adhesion or holdup of the oil along the river banks. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, adhering to river banks, or evaporated to the atmosphere) of the released oil at relevant points in time after the start of the release.

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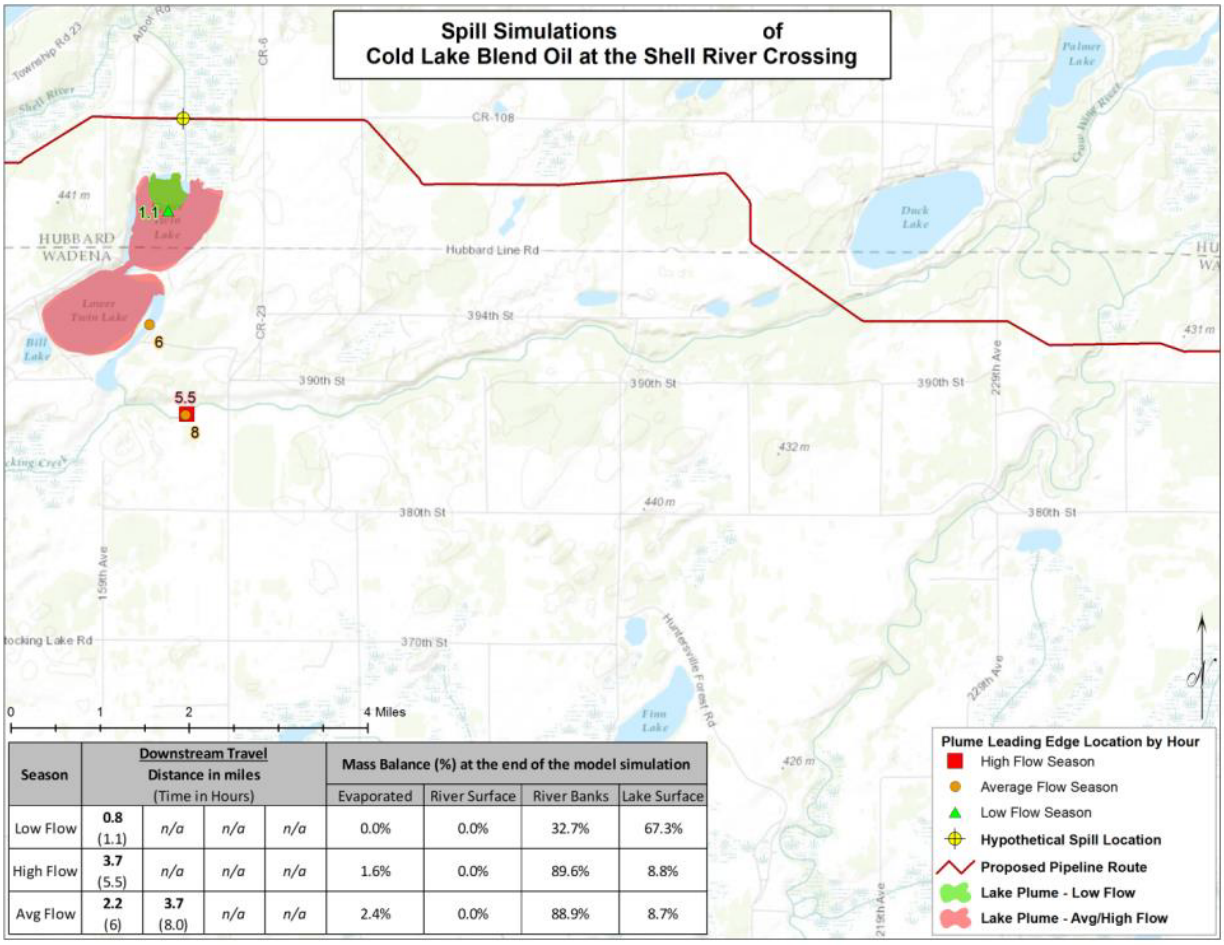

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	**0.8** (1.1)	*n/a*	*n/a*	*n/a*	0.0%	0.0%	32.7%	67.3%
High Flow	**3.7** (5.5)	*n/a*	*n/a*	*n/a*	1.6%	0.0%	89.6%	8.8%
Avg Flow	**2.2** (6)	**3.7** (8.0)	*n/a*	*n/a*	2.4%	0.0%	88.9%	8.7%

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Figure 7-30 Predicted Downstream Transport of CLB Oil at the Shell River Crossing Location

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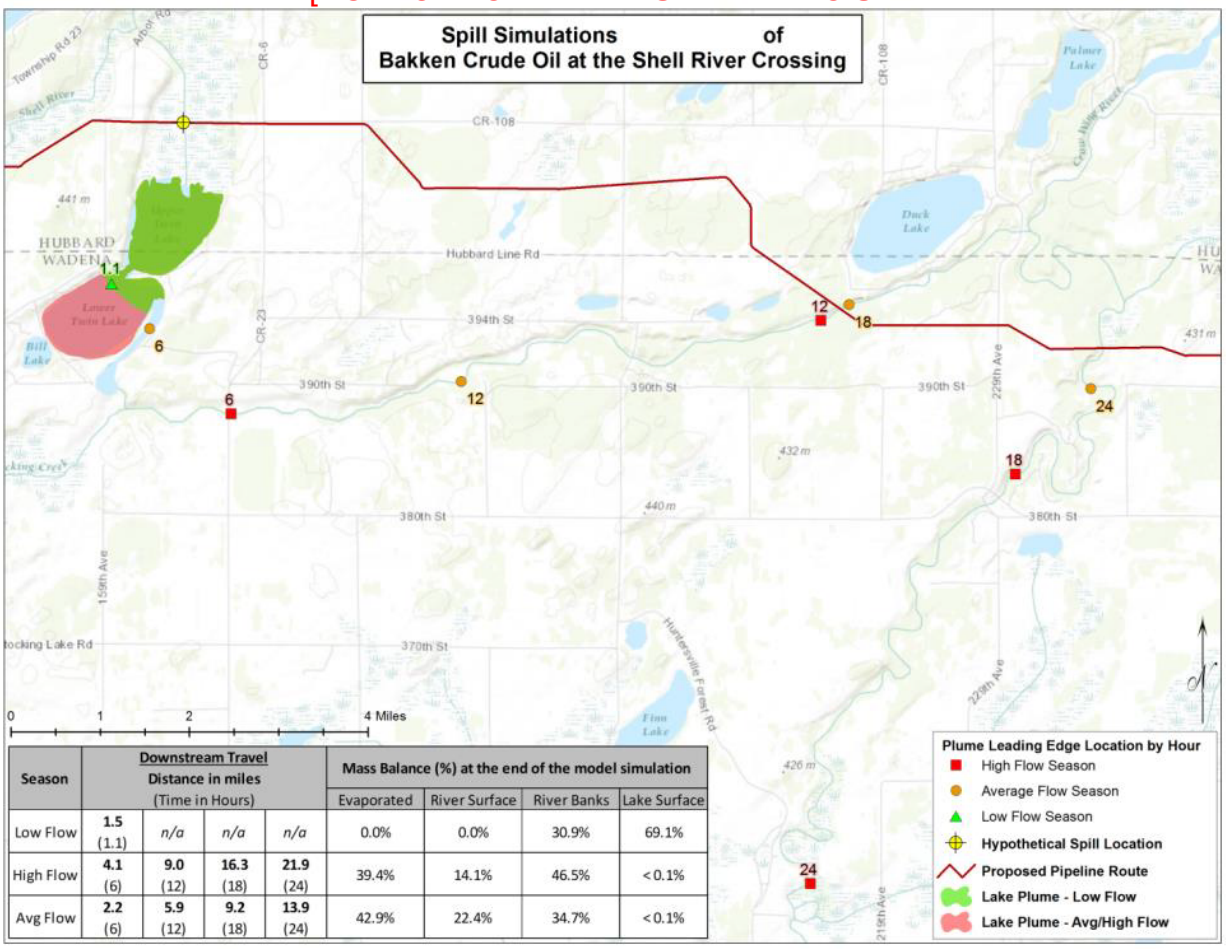

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation			
					Evaporated	River Surface	River Banks	Lake Surface
Low Flow	1.5 (1.1)	*n/a*	*n/a*	*n/a*	0.0%	0.0%	30.9%	69.1%
High Flow	4.1 (6)	9.0 (12)	16.3 (18)	21.9 (24)	39.4%	14.1%	46.5%	<0.1%
Avg Flow	2.2 (6)	5.9 (12)	9.2 (18)	13.9 (24)	42.9%	22.4%	34.7%	<0.1%

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Figure 7-31 Predicted Downstream Transport of Bakken Crude Oil at the Shell River Crossing Location

7.5.5.1 Shell River at Twin Lakes Release During High Flow (Spring) Period

Under the high flow scenario, CLB was predicted to travel approximately 3.7 miles downstream within 5.5 hours of the release (Figure 7-23). Under this scenario, CLB was predicted to be transported down the Shell River to the Twin Lakes, and then spread, covering the surfaces of both Upper and Lower Twin Lakes, a total of 0.75 square miles to a thickness of 0.004 inches. In addition, the release is predicted to continue another 1.8 miles down the Shell River below Lower Twin Lake. Approximately 89.6% of the CLB was predicted to oil shorelines, 8.8% to spread over the surface of Upper and Lower Twin Lakes, and 1.6% to have evaporated into the atmosphere.

Bakken crude oil was predicted to be transported approximately 21.9 miles downstream, over the 24-hour modeled period. The Bakken crude oil was predicted to be transported down the

Shell River, and then spread, covering the surfaces of both Upper and Lower Twin Lakes to a thickness of 0.00004 inches. The released oil was then predicted to continue another 20 miles down the Shell River and enter the Crow Wing River. Approximately 46.5% of the Bakken crude oil was predicted to oil shorelines, less than 0.1% to have spread over the surface of Upper and Lower Twin Lakes, 39.4% to have evaporated into the atmosphere, and 14.1% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude oil on the river surface would continue downstream, weathering and oiling shorelines until all the oil was removed from the water surface.

The release of Bakken crude oil under high flow conditions was predicted to result in oiling farther downstream than the CLB. The difference in the extent of downstream transport was primarily the result of differences in the shoreline and lake surface oil retention, and evaporation, between the two oil types. Both oil types were predicted to cover the surface of the Twin Lakes with a crude oil slick, but the Bakken would result in a thinner slick. The Bakken crude oil would also be deposited onto shoreline and riparian areas as a thinner layer of oil than the more viscous CLB crude oil. This result is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline up to that point was oiled to its maximum holding capacity for that oil type) as oil made its way downstream, and the assumption that oil would spread evenly within lake.

A larger proportion of the Bakken crude oil was predicted to evaporate to the atmosphere than was predicted for the CLB. This was due in part to the lighter and more volatile character of the Bakken crude oil. In addition, the greater downstream transport of the Bakken crude oil took more time, and resulted in more water surface area with oil, both of which could allow more of the released oil to evaporate. Volatile components of the CLB would continue to evaporate after becoming stranded on shoreline, but this process was not included within the OILMAP Land model for stranded oil.

7.5.5.2 Shell River at Twin Lakes Release During Average Flow (Summer-Fall) Period

Under average river flow conditions, the CLB crude oil was predicted to travel approximately 3.7 miles downstream within 8 hours of release (Figure 7-30). The CLB crude oil was predicted to be transported down the Shell River and then spread over the surfaces of both Upper and Lower Twin Lakes, a total area of 0.75 square miles to a thickness of 0.004 inches. From here the released oil is predicted to continue another 1.8 miles down the Shell River. Approximately 88.9% of the CLB crude oil was predicted to adhere to shorelines of Shell River, 8.7% to have spread over the surface of Upper and Lower Twin Lake, and 2.4% to have evaporated into the atmosphere.

Relative to the high flow condition, slightly more of the CLB crude oil was predicted to evaporate. This was mainly due to the longer time required for the CLB crude oil to move downstream due to the lower stream velocities. As a result, modeling predicted that slightly less oil might remain on the river shoreline and lake surface under the average river flow condition, as compared to the high flow condition.

Under the average flow condition, Bakken crude oil was predicted to be transported approximately 13.9 miles downstream, over the 24-hour modeled period (Figure 7-24). The Bakken crude was predicted to be transported down the Shell River and then to spread over the surfaces of both Upper and Lower Twin Lakes to a thickness of 0.00004 inches. The released oil was then predicted to continue another 12.0 miles down the Shell and Crow Wing rivers. Approximately 34.7% of the Bakken crude oil was predicted to adhere to shorelines, less than 0.1% to spread over the surface of Upper and Lower Twin Lakes, 42.9% to evaporate to the atmosphere, and 22.4% to remain on the river surface at the end of the 24 hour simulation. It was assumed that emergency response measures to prevent further possible downstream transport of surface oil would be in place within 24 hours of the release.

When compared to the CLB crude oil under average river flow conditions, Bakken crude oil was predicted to be transported farther downstream within 24 hours. It was also predicted that 22.4% of the Bakken crude oil could remain on the river surface at the end of the simulation. The Bakken crude oil was predicted to travel farther downstream than the more viscous and adhesive CLB. Although not modeled here, it is expected that a medium crude oil would exhibit fate and transport properties intermediate between those of the Bakken and CLB crude oil types, with a tendency to behave more like the Bakken crude oil. This is because the viscosity and adhesiveness properties of a medium crude oil would typically be higher and, therefore, more similar to those of the Bakken crude oil, than to the CLB.

7.5.5.3 Shell River at Twin Lakes Release During Low Flow (Winter) Period

Under low flow winter conditions, it was assumed that Shell River and Twin Lakes would be completely frozen over. It was also assumed that CLWB would be released directly into the river from the pipeline under the river bottom, and remained trapped under the ice. The ice cover would limit evaporation of crude oil vapors to the atmosphere.

Under low river flow conditions, CLWB was predicted to be transported a total of 0.8 miles downstream, within 1.1 hours of the release. The CLWB crude oil was predicted to be transported down the Shell River for 0.6 miles, and then spread under the ice of Upper Twin Lake to a thickness of 0.42 inches. The oil was predicted to spread under the ice covering an area of 0.054 square miles of Upper Twin Lake. Approximately 32.7% of the CLWB crude oil was predicted to oil shorelines of Shell River, with the remaining 67.3% spreading under the ice within the lake.

Bakken crude oil was predicted to be transported a total of 1.5 miles downstream within 1.1 hours of the release. The Bakken crude oil was predicted to be transported down the Shell River, and then spread under the ice of Upper Twin Lake to a thickness of 0.075 in. The oil was predicted to spread under the ice covering an area of 0.42 square miles including all of Upper Twin Lake and a portion of Lower Twin Lake. Approximately 30.9% of the CLWB was predicted to oil the shorelines of Shell River, and the remaining 69.1% to spread under the ice within the lake. This would provide only temporary storage of the oil, and oil would be predicted to re-mobilize in response to changes in flow velocity, and particularly during the spring breakup of ice. With the

CLWB below the ice of the river, evaporation of oil to the atmosphere would be negligible in the short-term.

When compared to the CLWB crude oil under low river flow conditions, less of the Bakken crude oil was predicted to accumulate at the river margins under the ice. This was due to the differences in shoreline oil retention between the two oils (i.e., lower viscosity and adhesion of the Bakken crude oil). For this reason the Bakken crude oil was also predicted to have greater mobility under the ice in winter.

7.5.6 Qualitative EHHRA for the Shell River at Twin Lakes

In this section the likely environmental effects of a crude oil release at the pipeline crossing location on the Shell River are described. A worst case crude oil release from a main-line pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed pipeline would carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). Therefore, the following discussion describes the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7.4.3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence and sensitivity) were also considered in the analysis, as appropriate. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-66.

7.5.6.1 Terrestrial Receptors

For this modeling scenario, the hypothetical release of crude oil is assumed to enter the Shell River with no overland flow. Therefore, environmental effects on soils, terrestrial vegetation and groundwater quality, if any, are assumed to be localized, limited in spatial extent, and readily remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors is not considered further for the Shell River at Twin Lakes scenario.

7.5.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors that are most closely associated with the Shell River at Twin Lakes scenario, namely the Shell River, Upper and Lower Twin lakes, and the Crow Wing River, are addressed in this section. These receptors include water and sediment quality in rivers and lakes, shoreline and riparian habitat, wetlands, aquatic plants, benthic invertebrates, and fish.

Crude oil released into the Shell River during the spring (high flow) or summer-fall (average flow) seasons is predicted to travel downstream, interacting with vegetation and seasonal shoreline

areas upstream of the Twin Lakes. Regardless of crude oil type, the OILMAP Land simulations indicate that crude oil would enter and spread to covers the surface of both Upper and Lower Twin lakes. Heavier crude oils would result in thicker oil slicks on the lakes than lighter crude oils. The OILMAP Land simulations (based on a 24 hour model run) indicate that the heavy crude oil could be carried approximately 1.75 miles downstream from the outlet of Lower Twin Lake (Figure 7-4-6). Much greater transport distances are possible for the light crude oil (Figure 7-24). For heavy oil, stranding on shore would be the primary fate, with only small amounts of evaporative weathering of the oil occurring within the first 24 hour period. For light oil, stranding would remain the primary fate, but considerably more of the released oil would be lost to evaporation, and the residual oil would have greater potential mobility of not contained by emergency response measures.

The effects of a crude oil release on benthic invertebrates and fish depend on the characteristics of the released oil and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. The large volume of water flow associated with the spring freshet may dilute and limit the maximum dissolved hydrocarbon concentration in the Shell River, as compared to periods of lower water flow in summer or winter. Under spring and summer-fall conditions, the spreading of the released oil onto the surface of the Twin Lakes would also provide a large surface area, which would promote the rapid evaporation of volatile (and potentially water soluble) hydrocarbon constituents from the crude oil. It is likely that this would limit effects to fish within the Twin Lakes. As a result, narcotic effects on fish and benthic invertebrates are likely to occur in the Shell River upstream of the Twin Lakes during the spring and summer-fall season, but unlikely to occur in the Twin Lakes as a result of dilution, generally low water turbulence, and rapid evaporation of volatile hydrocarbons from the lake surfaces. As a result, the potential for acute toxicity to fish and benthic invertebrates could be greater for the light oil than for heavier oils.

There would also be high potential for chronic effects of released crude oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease). Many of the fish species present in the Shell River and Twin Lakes, including northern pike (for which spawning habitat is abundant in Lower Twin Lake; MN PCA 2014), spawn in the spring and early summer. The eggs and embryos of these species could be exposed to total PAH concentrations in the river and lake water that could be sufficiently high to induce deformities or cause mortality. In addition the potential for phototoxicity, caused by an interaction of UV light with PAHs accumulated in fish tissues, would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. The risk of phototoxicity would be partially mitigated by high concentrations of dissolved organic carbon present in the water of the Shell River and Twin Lakes, which would strongly absorb and limit the penetration of UV light into the water column.

Entrainment of small crude oil droplets in the water column during the spring freshet also enhances the potential for light crude oils to interact with suspended sediment particles in the water column resulting in the formation of OPAs. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water such as sediments near the inflows to Upper and Lower Twin lakes, as well as slowly moving areas and backwaters within the Shell River and Crow Wing River system. Formation of true oil-particle aggregates is less likely to occur with heavy crude oils such as diluted bitumen, as the higher viscosity of the oil precludes the ready formation of fine droplets in the water column (Zhou et al. 2015). However, heavy oils can still contact sediment particles along the shoreline, and some accumulation of both light and heavy oils in depositional areas is likely, although the precise mechanisms of deposition may vary. Neither crude oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. During the spring, while heavy crude oil is not predicted on the water surface beyond 3.7 miles downstream of the release within the first 24 hours of the predicted release, it is possible that oil accumulated in depositional areas could mobilize over time and move farther downstream in the Shell River.

The Shell River and Upper and Lower Twin lakes support a wide range of emergent, floating and submerged aquatic plants (Perleberg 2005). Where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants would be less vulnerable, as they would be exposed primarily to dissolved hydrocarbons, and are not considered likely to be among the most sensitive groups of aquatic biota to such exposure. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem could be oiled). Wild rice is an emergent aquatic plant of biological and cultural importance in Minnesota and is abundant within the Twin Lakes. Perleberg reported in 2005 that wild rice was the most common emergent plant species in the Twin Lakes, being more abundant in Lower Twin Lake than Upper Twin Lake, and found from the shoreline to water depths of between 6 and 9 ft. Wild rice provides a food source and nesting cover for many birds, and is also harvested as a food source by people in the area. For a hypothetical release under spring freshet conditions, it is likely that most aquatic plants would still be dormant or submerged, and that environmental effects on this receptor type would be minimal. However, flooded riparian areas and wetland habitats would also be exposed to the released oil, and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat. In the early summer, oiling of emerging wild rice plants could lead to growth inhibition or death. Later in the summer, oiling at water level of the stems of emerged plants is unlikely to affect the plants. A release of crude oil in winter would have little direct effect on aquatic plants, as they would be in a dormant state.

Crude oil released during the winter (low flow) period could potentially pool on the frozen river surface. If the release was to occur directly to the river below the ice (as is assumed in the OILMAP Land model), or if there were openings in the ice that the released oil could penetrate, the oil could travel downstream under the ice, accumulating in the narrow gap between the ice and the river sediment, or accumulating in hollows under the ice as it moved. Results

provided in Section 7.4.5.3 provide bounding cases for the products likely to be carried in the pipeline. The OILMAP Land simulations indicate that light and heavy crude oil would be transported downstream from the release location, entering and spreading under the ice of the Twin Lakes over the 24 hour model run. Heavy crude oil was predicted to spread under 0.054 square miles of ice in Upper Twin Lake, to a thickness of 0.42 in. Light crude was predicted to spread under the ice of all of Upper Twin Lake and a portion of Lower Twin Lake, covering an area of 0.42 square miles to an average thickness of 0.075 in. For both oil types, the winter ice would effectively inhibit evaporation. This would provide greater potential for dissolution of relatively water soluble crude oil constituents into the water column during the period of lowest dilution flow. Also, both oil types would be predominantly trapped under the ice, remaining mobile at the interface between the lake water and the underside of the ice. Therefore, a release in winter could cause mortality to fish, due to narcosis. This result would be more likely for the light crude oil, which would spread out over a larger area, facilitating release of more water soluble constituents. The heavy crude oil would tend to remain in thicker localized accumulations, and rapid release of more water soluble constituents from a thick layer of crude oil is unlikely. Fish eggs and larvae would generally not be present during the winter, so effects on these life stages due to blue sac disease are not likely, although crude oil residues in water and sediment could, if not adequately remediated, affect fish eggs and larvae in the following spawning season. Phototoxicity is not likely to occur following a release of crude oil in winter due to short day length and lower light intensity in winter, reflection and absorbance of light by snow and ice cover on the lake, and absorbance of UV light by DOC in the water beneath the ice.

Both crude oil types could be accumulated in sediment after a release in winter, and both crude oil types would be subject to re-mobilization with spring breakup of the ice, and increasing water flow rates.

7.5.6.3 Semi-Aquatic Wildlife Receptors

Habitat of the Shell River and Upper and Lower Twin Lake area supports amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter). Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.5.6.3.1 Amphibians and Reptiles

Crude oil released to the Shell River during the spring (high flow) and summer-fall (average flow) periods is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas as it then enters and covers the surfaces of both Upper and Lower Twin Lakes. Heavier crude oils could result in lake plumes with a greater thickness than predicted for lighter crude oils (i.e., 0.004 in. vs 0.00004 in.). The OILMAP Land simulations indicate that crude oil could be carried between 3.7 and 21.9 miles downstream from the point of release, with the extent of downstream transport being in large measure a function of seasonal water flow rate as well as oil viscosity, adhesiveness, and its interactions with shoreline or riparian habitat.

Within the oil-exposed habitats along the lakes and rivers that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and have little or no association with aquatic environments. As a result, exposure of these animals to released crude oils would be limited, albeit likely greater during possible flooding of riparian areas. After the Kalamazoo River oil release in 2010 snakes did not appear to be highly exposed to released oil. A release of light crude oil during the spring would likely have a greater effect than in summer due to the greater predicted downstream transport distance and interaction with more riparian and wetland habitats than later in the year, with the river at lower flow stages.

Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms would have very little exposure to released oil moving on the water surface or within the water column.

7.5.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, lakes, wetlands, and riparian areas as components of their habitats, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory, and herbivory. If exposed to external oiling, the ability of birds to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Waterfowl and other semi-

aquatic birds present in the affected river and lake reach would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be unaffected as it is assumed that emergency response measures to prevent further possible downstream transport of oil would be in place within 24 hours of the release.

In addition to the habitat offered by the Shell and Crow Wing rivers and their riparian habitats, which include extensive wetlands, the Twin Lakes represent ideal habitat for a variety of aquatic and semi-aquatic bird species, including both breeding and migratory individuals. Therefore, potential for mortality of a large number (i.e., several hundred) of aquatic and semi-aquatic birds would exist, depending upon the precise circumstances and timing of an accidental crude oil release. However, owing to the tremendous regional habitat resources for these birds, large-scale population-level effects are unlikely.

The environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude. With rising water temperatures, mortality of lightly oiled adult birds due to hypothermia becomes less likely than in the spring, and the temporary presence of large numbers of migrating individuals is unlikely. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest, or mortality of young birds due to direct oil exposure or the loss of a parent bird. Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure. Potential effects on aquatic and semi-aquatic birds in the fall would be similar to those in spring, although a smaller overall length of river habitat would be affected due to lower river flows. It is assumed that the Twin Lakes would both be covered by a crude oil slick, and migrating birds that became oiled would be likely to die as a result of hypothermia.

In the winter months, ice cover on the Shell River, Twin Lakes, and Crow Wing River would strongly limit the opportunities for aquatic and semi-aquatic birds to occupy this habitat. As such, exposure of birds to released crude oil in winter would be very limited.

7.5.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses particularly upon species that have a primary association with the aquatic environment, such as muskrat and beaver (herbivores), American mink (carnivore-*piscivore*), and river otter (*piscivore*). These species are at greater risk of exposure to an oil release in water than terrestrial mammals. The area of the Shell and Crow Wing rivers assessed here, which includes the Twin Lakes and extensive riparian wetland areas, provides high-quality habitat for these animals.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and

indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along the Shell River where effects may occur, and the magnitude of effects, is related to the season and river flow rate, and the type of oil released. Effects to semi-aquatic mammals relate more to the amount of time spent in the water and oil-contaminated riparian habitat (and consequent exposure to physical oiling) than to dietary preferences. Timely capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Based on the OILMAP Land simulations, the potentially affected river reach could range from 3.7 to 21.9 miles in extent, and could include the Twin Lakes. Animals upstream, farther downstream where there is no exposure, or occupying other nearby habitats, would likely be unaffected. Therefore, although mortality of a considerable number of semi-aquatic mammals could be expected, large-scale (i.e., regional) population level effects are unlikely. Environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude than those associated with a release during spring. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is expected to be less likely than in the spring. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil are possible as a result of ingesting crude oil residues while grooming, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. As such, exposure of semi-aquatic mammals like muskrat and beaver in winter would be lower than expected for mammals like mink and otter. Animals that became oiled in the winter would be likely to rapidly die as a result of hypothermia.

7.5.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs than heavier crude oils, although diluted bitumen may contain similar amounts of VOCs to light crude oils, depending upon the type and amount of diluent they contain. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release.

The communities of Twin Lake and Duck Lake, Minnesota were identified through the HCA analysis as population areas. The OILMAP Land modeling indicated that the leading edge of released heavy oil would pass through Twin Lake, but that downstream transport would be limited to a short reach of the Shell River below Lower Twin Lake. In contrast the leading edge of released light oil is predicted to pass through Twin Lake, and to pass by Duck Lake, under spring

and summer-fall flow conditions. In winter, both types are predicted to remain under ice in the Twin Lakes. Lower Twin Lake has a greater number of structures than Upper Twin Lake, with the majority located on the northwestern and southwestern banks. Duck Lake, which is north of the Shell River and not expected to receive release crude oil, is surrounded by homes and cottages. In addition a number of structures are located along the banks of the Shell River and Crow Wing River, and in the unincorporated community of Huntersville along the Crow Wing.

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil vapor. Similarly, ATSDR (1995) report that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

The potential for VOC inhalation exposures by the public would be greatest near and downwind from the release site and near to the Shell River and Twin Lakes, while the released oil is on the water surface. In the unlikely event of a crude oil release, residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most of the volatile hydrocarbons would be lost within the first 24 hours following a release of crude oil. It is also expected that emergency response personnel would contact such residents and advise them to evacuate. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while the emergency response takes place.

No drinking water HCAs were identified along the path of the release. However, a number of homes are located along the trajectories of predicted releases and could rely on groundwater as a drinking water source. There are 59 groundwater wells reported in the lower Shell River (downstream of Lower Twin Lake), most of which are used for agricultural irrigation (MN PCA 2014). In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. Based upon case studies involving crude oil releases elsewhere, this process could take a few days to two weeks, but reports of crude oil releases affecting private wells are rare, making this an unlikely effect.

Relatively little has been published regarding the long-term effects of human exposure to a crude oil release. Health effects observed in residents and clean-up workers in the months following such releases generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

Effects of a crude oil release on human receptors would be generally similar for the spring (high flow) and summer-fall (average flow) seasons. In summer, the warmer temperatures and slower river flow velocities in the summer would promote more rapid evaporation of volatile hydrocarbons in a smaller area. The flow modeling suggests that the light crude oil (i.e., Bakken crude oil) is likely to be transported farther downstream within 24 hours than the heavy crude oil (Cold Lake diluted bitumen). However, for either crude oil type, the Twin Lakes represent an area where released crude oil would be expected to spread, and to affect a local population of individuals, before moving downstream as more weathered oil. As a result, a release of the light crude oil could affect a larger number of individuals than a release of the heavy crude oil type, but the difference between the crude oil types is not likely to be large for this hypothetical release example. The individuals most likely to be exposed would be located in the vicinity of the Twin Lakes. Both Bakken crude oil and Cold Lake diluted bitumen are expected to contain similar overall amounts of volatile hydrocarbons, so differences related to the chemical characteristics of the released oil are also likely to be minor.

No overland transport of released crude oil was modelled for this hypothetical release location. Infiltration of crude oil into soil and subsequently into groundwater would be limited. During the spring freshet period, the Shell River is susceptible to flooding and can overtop its banks and spread into the surrounding farmland. A release of light and medium crude oils during this period would provide a potential pathway for oil deposition to soil in low-lying areas. Light and medium crude oils would be expected to become dispersed over a large area, and are readily biodegraded, so that persistent accumulation of these oil types in riparian areas or temporarily flooded farmland is unlikely. Heavy crude oils and diluted bitumen are more likely to be deposited as thicker layers of more persistent oil, and could likely require more active remediation of affected areas.

The Shell River, Twin Lakes, and Crow Wing River provide recreational opportunities (e.g., fishing, hunting, boating, swimming, camping) at many locations downstream of the hypothetical release location. Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil. Under winter conditions the released crude oil is expected to remain in the Twin Lakes.

7.5.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to the Shell River at Twin Lakes area have been assessed. The proposed pipeline could carry a variety of crude oil types ranging from very light (e.g.,

Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). The discussion of expected environmental effects on receptors considers these crude oil types as bounding conditions.

Ecosystem components, terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors, and human and socio-economic receptors were screened to identify those most likely to have interaction with released oil. Selected receptors for qualitative assessment are highlighted in Table 7-66, discussed in detail in Sections 7.5.6.1 to 7.5.6.4, and likely environmental effects are summarized in Table 7-68.

Table 7-68 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Shell River

Receptor	Expected Environmental Effects of Released Crude Oil to the Shell River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	It is assumed in the model that crude oil would enter directly into the Shell River with no holdup of oil on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
Rivers (Shell River, Crow Wing River)	Both light and heavy oil would travel downstream from the release location, affecting the Shell River, and in some cases also extending to the Crow Wing River. Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, but would be thinner on the water, and less persistent where they contact shoreline habitat. Both light and heavy crude oils are predicted to travel similar travel distances under winter conditions, although more of the heavy oil would be likely to remain trapped along the edges of the rivers. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column, meaning that potentially toxic fractions of the light oils would more readily dissolve into the water column.	MORE	LESS
Lakes (Upper and Lower Twin Lake)	Both light and heavy oil would travel downstream from the release location, enter, and spread over the surface of the Twin Lakes. Heavier crude oils would result in surface oil slicks that would be thicker than those expected for lighter crude oils. Under winter conditions, oil could form thicker layers under the ice (0.075 to 0.42 inches for light and heavy oil, respectively) and as a consequence would spread to a lesser extent. In winter the CLWB is predicted to remain confined to the northern part of Upper Twin Lake, whereas lighter oil could flow under ice to affect all of Upper Twin Lake and part of Lower Twin Lake.	MORE	LESS

Table 7-68 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Shell River

Receptor	Expected Environmental Effects of Released Crude Oil to the Shell River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Sediment	Lighter crude oils are predicted to travel farther downstream than heavier crude oils in spring and summer-fall conditions, with both oil types travelling similar distances under winter conditions. Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. The low viscosity of the lighter type crude oils could potentially result in a larger amount of oil entrainment as fine droplets as compared to heavier blends, resulting in the formation of OPAs, which could both sink, and enhance biodegradation. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water, particularly the Twin Lakes. Contact between the weathered diluted bitumen and lake shorelines is also likely to result in mixing of mineral particles into the crude oil, which could then be deposited to sediments as aggregates of oil and mineral in larger droplets or globules. If not recovered, these aggregates could move from shoreline areas into deeper water as a result of wave action and resuspension followed by deposition. Low molecular weight aromatic hydrocarbons would also be expected to dissolve into the water column within the Twin Lakes, where they could adsorb onto suspended sediment and organic matter. Under winter conditions, more of the heavy crude oil is predicted to become trapped along the margins of the rivers and lakes, and this oil is also likely to interact with sediment, resulting in mixing of oil and sediment, or formation of oil-particle aggregates. The spring freshet is a major seasonal factor that can flush river sediments leading to restoration of damaged habitat, and dispersal of oil-particle aggregates in a way that enhances natural recovery.	LESS	MORE
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location. Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, but would be thinner and less persistent where they contacted shorelines and riparian habitat. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. For heavy oil, stranding on shore would be the primary fate. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation. Flooding of riparian and wetland habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, in contrast to light crude oil which would be deposited as a thin layer or sheen.	LESS	MORE

Table 7-68 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Shell River

Receptor	Expected Environmental Effects of Released Crude Oil to the Shell River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Aquatic Plants	The Shell River and Twin Lakes support a wide range of emergent, floating and submerged aquatic plants. Where they occur, floating aquatic plants would be expected to be killed if contacted by a floating oil slick. Submerged aquatic plants would be less vulnerable. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem was oiled). However, given the extent of predicted oiling in the Twin Lakes in spring and summer-fall seasons, death of emergent plants from contact with crude oil, particularly the lighter crude oil type, is also possible.	MORE	LESS
Benthic Invertebrates	Environmental effects on benthic invertebrates would be limited to areas affected by the released oil. In the short-term, the low viscosity of light crude oil would result in greater potential for oil entrainment as fine droplets, as compared to heavier blends. This would enhance dissolution of low molecular weight aliphatic and aromatic hydrocarbons into water (with resulting acute toxicity), in addition to promoting oil-particle interaction and potential deposition of oil to sediment. For heavy crude oil, there would be less potential for dissolution of hydrocarbons into the water, but greater long-term potential for deposition of tar balls and patties as a result of oil interaction with sediment. These could accumulate in depositional areas, resulting in chronic effects on benthic invertebrates.	SAME	SAME
Fish	Environmental effects on fish would be limited to areas affected by the released oil. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column. This would enhance the dissolution of potentially toxic fractions of the light oil into the water column. As a result, the potential for acute toxicity to fish due to narcosis would be greater for the light oil than for heavy oil. Potential chronic effects on fish eggs and embryos (e.g., blue sac disease) could also occur, but would be most likely to occur in spring and early summer, when most species spawn. The potential for phototoxicity, caused by an interaction of ultraviolet light with PAHs accumulated in fish tissues, would be greatest in summer due to high light intensity and long day length.	MORE	LESS

Table 7-68 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Shell River

Receptor	Expected Environmental Effects of Released Crude Oil to the Shell River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Environmental effects on amphibians and reptiles would be limited to areas affected by the released oil. Light crude oil is expected to travel farther downstream under spring and summer conditions than heavy crude oil, but would be thinner and less persistent on the water. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. Flooding of riparian habitat in spring could lead to stranding of crude oils in this habitat. Within these habitats, oiling effects on adults, juveniles, and eggs could potentially be observed. Higher potential would exist for effects on amphibians than for turtles, which appear to be somewhat tolerant of external oiling. Dormancy of amphibians and reptiles in winter and early spring means exposure to oil released at this time of year could be negligible, and adverse environmental effects unlikely.	MORE	LESS
Birds	Mortality of oiled aquatic and semi-aquatic birds would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil, so environmental effects could be more spatially extensive for light crude oil types. However, the Twin Lakes provide most of the highest quality habitat for aquatic and semi-aquatic birds along the predicted trajectory of a release, and numbers of birds could be high during periods of migration. As such, oiling of birds in the Twin Lakes would be the primary outcome of a release, independent of oil type. This habitat is affected equally by light and heavy crude oils under spring and summer-fall conditions. Few birds are present in winter, so effects would be minimal in that season.	SAME	SAME
Semi-aquatic Mammals	Mortality of oiled semi-aquatic mammals would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil in all seasons, so environmental effects could be more spatially extensive for light crude oil types. However, the Twin Lakes provide most of the highest quality habitat for semi-aquatic mammals, and this habitat is affected equally by light and heavy crude oils under spring and summer-fall conditions. Adverse effects on mink and otter would be particularly severe in winter, due to the effects of oil in the insulating properties of fur, in combination with cold water temperatures. However, muskrat and beaver might be spared due to their lower activity levels in winter.	MORE	LESS

Table 7-68 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Shell River

Receptor	Expected Environmental Effects of Released Crude Oil to the Shell River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. Light crude oil is likely to be transported farther downstream within 24 hours than the heavy crude oil. As a result, environmental effects on air quality could be more spatially extensive for light crude oil types. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS
Human Receptors	Typical human health effects associated with short-term inhalation of VOC from crude oil releases include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is unlikely. Residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most volatile hydrocarbons would be lost within 24 hours following a release. Light crude oil (Bakken) is likely to be transported farther downstream within 24 hours than the heavy crude oil (Cold Lake diluted bitumen). As a result, a release of the light crude oil may affect a larger number of individuals than a release of the heavy crude oil type. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS

Table 7-68 Environmental Effects Summary Table for Pipeline Crude Oil Releases to Shell River

Receptor	Expected Environmental Effects of Released Crude Oil to the Shell River	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Public Use of Natural Resources	Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Light crude oil is predicted to be transported farther downstream than heavy crude oil following a release, affecting a larger area and potentially interrupting public use of natural resources over a larger area. No drinking water HCAs were identified along the path of the release. However, a number of homes are located along the trajectory of a predicted release and could rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to the Shell River would result in adverse health effects to consumers of drinking water. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. The Twin Lakes would be the area where public use of natural resources would be most affected by a release of crude oil. While light crudes will spread further over the lakes exposing, disrupting larger areas, the greater persistence of heavy crude oil is likely to affect such use over a longer period of time than would be the case for lighter crude oil types.	MORE	LESS

7.6 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL TO THE RED RIVER

The Red River is located along the border of North Dakota and Minnesota, and flows north into Canada. The pipeline crossing is located approximately 3 miles east of Bowesmont, North Dakota and 9 miles southwest of Hallock, Minnesota. This scenario captures a hypothetical release of crude oil to the Red River with downstream transport to the north. From the hypothetical release point, the Red River flows past the communities of Pembina, North Dakota and St. Vincent, Minnesota, before crossing the border with Canada near the town of Emerson, Manitoba. For the purposes of this assessment, environmental effects outside of the jurisdiction of the United States of America are not considered.

At the proposed pipeline crossing location and downstream, the Red River is approximately 150 to 400 ft wide and drops 6 ft in elevation over 35 river miles of flow. The river occupies a well-defined sinuous channel with grassy, forested, and muddy banks nestled between predominantly agricultural lands, although the shorelines are often lined with trees. Flooding of the Red River is common in spring and can be extensive due to the generally flat topography. As identified in Chapter 3.0, the Red River is found in the Red River Prairie ecological subsection of the Prairie Parkland Province in Minnesota.

7.6.1 Description of the Freshwater Environment

The Red River flows north along a well-defined channel through predominantly agricultural lands. The average velocity of the Red River changes with season, with slowest velocities (e.g., about 1.0 mph) expected during low flow periods in the winter, and greater velocities (e.g., about 2.5 mph) during the spring high flow period. During the spring freshet, the Red River is susceptible to flooding and can overtop its banks and spread into surrounding farmland and communities.

Although the Red River is a muddy river, the water quality is high (MN DNR 2014). This is exemplified in August when millions of mayflies rise up from the water in massive hatches (MN DNR 2014). The habitats of the Red River and its tributaries support more than 70 species of fish (MN DNR 2014). The river offers easily accessible fishing opportunities for channel catfish, walleye, northern pike, smallmouth bass, sauger and lake sturgeon (MN DNR 2014). With the exception of lake sturgeon (*Acipenser fulvescens*), most fish species in the Red River are self-sustaining and do not require stocking to maintain healthy populations. The MN DNR began a stocking program to re-establish sturgeon in 1997. Several thousand lake sturgeon have since been released into the Red River basin in the hope that by the time they become sexually mature (15–20 years), dam removal and other naturalization projects will have reconnected the river to historical spawning tributaries (MN DNR 2014).

In addition to the highly valued fishery of the Red River, many bird species (e.g., wood ducks, hooded mergansers, mallard, northern shoveler, blue-winged teal and Canada goose, FWOR 2000) utilize the river and riparian habitat (e.g., oxbows) for feeding, nesting and resting. The Red River Prairie Subsection is home to 83 Species of Greatest Conservation Need (SGCN). These include amphibians (1 species), birds (54 species), fish (2 species), insects (10 species), mammals (9 species), mollusks (3 species), reptiles (3 species) and spiders (1 species) (MN DNR 2006). Of these species, 36 are afforded federal or state endangered, threatened, or of special concern status (MN DNR 2006; MN DNR 2016). It is foreseeable that some of these SGCN could utilize aquatic habitats along the Mississippi River.

Two access points downstream from the proposed pipeline crossing location were visited in September 2016 to provide additional insight into baseline environmental conditions for the Red River. Representative site photographs are provided in Figure 7-32 through Figure 7-35. Field observations are summarized in Table 7-69.



Figure 7-32 Red River and Riparian Habitat Approximately 8 Miles Downstream of Pipeline Crossing



Figure 7-33 Red River and Riparian Habitat Approximately 8 Miles Downstream of Pipeline Crossing



Figure 7-34 Red River and Riparian Habitat Approximately 30 Miles Downstream of Pipeline Crossing



Figure 7-35 Red River and Riparian Habitat Approximately 30 Miles Downstream of Pipeline Crossing

Table 7-69 Environmental Characteristics Observed at Selected Access Points on the Red River in September, 2016

Access Point	Latitude Longitude	Notes
Highway 5/Joliette Crossing approximately eight miles downstream of pipeline crossing	48.787756 -97.157182	*Habitat Description:* Vegetation is composed of floodplain forest dominated by cottonwood and sedges in the ground layer. Areas somewhat higher in elevation are dominated by terrace forest with bur oak, American elm, green ash and boxelder dominant. The ground layer is dominated by natives, including: false indigo, water pepper, cocklebur, lakebank sedge (dominant), white panicled aster, Virginia wildrye, Pennsylvania smartweed, Indian hemp and others. Nonnative plants are uncommon to rare and include reed canary grass and sow thistle. *Wildlife observed:* Crow, white-tail deer
Pembina, North Dakota Highway 59/171 approximately 30 miles downstream of pipeline crossing	48.973412 -97.238831	*Habitat Description:* Vegetation is composed of floodplain forest dominated by cottonwood trees (some of which form a supercanopy), with lakebank sedge common in the ground layer. Areas slightly higher in elevation also support terrace forest tree species, including green ash. The subcanopy consists of young trees, particularly boxelder. The shrub layer is sparse. The ground layer is dominated by natives, including: lakebank sedge (dominant), white panicled aster, Virginia wildrye, Pennsylvania smartweed, Indian hemp, water smartweed and others. Non-native plants are uncommon and include reed canary grass, burdock, stinging nettle and sow thistle.

Table 7-69 Environmental Characteristics Observed at Selected Access Points on the Red River in September, 2016

Access Point	Latitude Longitude	Notes
		Wildlife observed: American crow

7.6.2 High Consequence Area Assessment for the Red River

As defined in Section 7.0, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. Sensitive AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks). The principal HCAs include the population centers of Pembina, ND and St. Vincent, MN (Table 7-70). The Red River also flows past recreational areas, protected areas, and environmental AOIs (Table 7-71). These include water access sites and Bureau of Land Management land. The locations of the HCAs and AOI are shown in Figure 7-36.

Table 7-70 High Consequence Areas Potentially Affected by a Release of Cold Lake Blend or Bakken Crude Oil at the Red River Crossing Location

HCA Type	HCA Subtype	Description / Locations
Environmentally Sensitive Area	N/A	N/A
Population Area	Other Population Area	Pembina, ND
	Other Population Area	St. Vincent, MN
NOTE: Data for the HCA analysis were obtained from the United States Department of Transportation: Pipeline and Hazardous Materials Safety Administration (USDOT PHMSA) HCA datasets plus additional HCAs compiled by Enbridge during 2010 and 2013.		

Table 7-71 Areas of Interest Potentially Affected by a Release of Cold Lake Blend or Bakken Crude Oil at the Red River Crossing Location

AOI Type	AOI Subtype	Description / Locations
Recreational	State Land	Water Access Site
Protected Area	Bureau of Land Management	BLM Land
Environmental	US NRCS Easement	Emergency Watershed Protection Program - Floodplain Easement
	Site of Biodiversity Significance	St. Vincent 11
NOTE: Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website, USGS Protected Areas Database of the United States and the Minnesota Department of Transportation.		

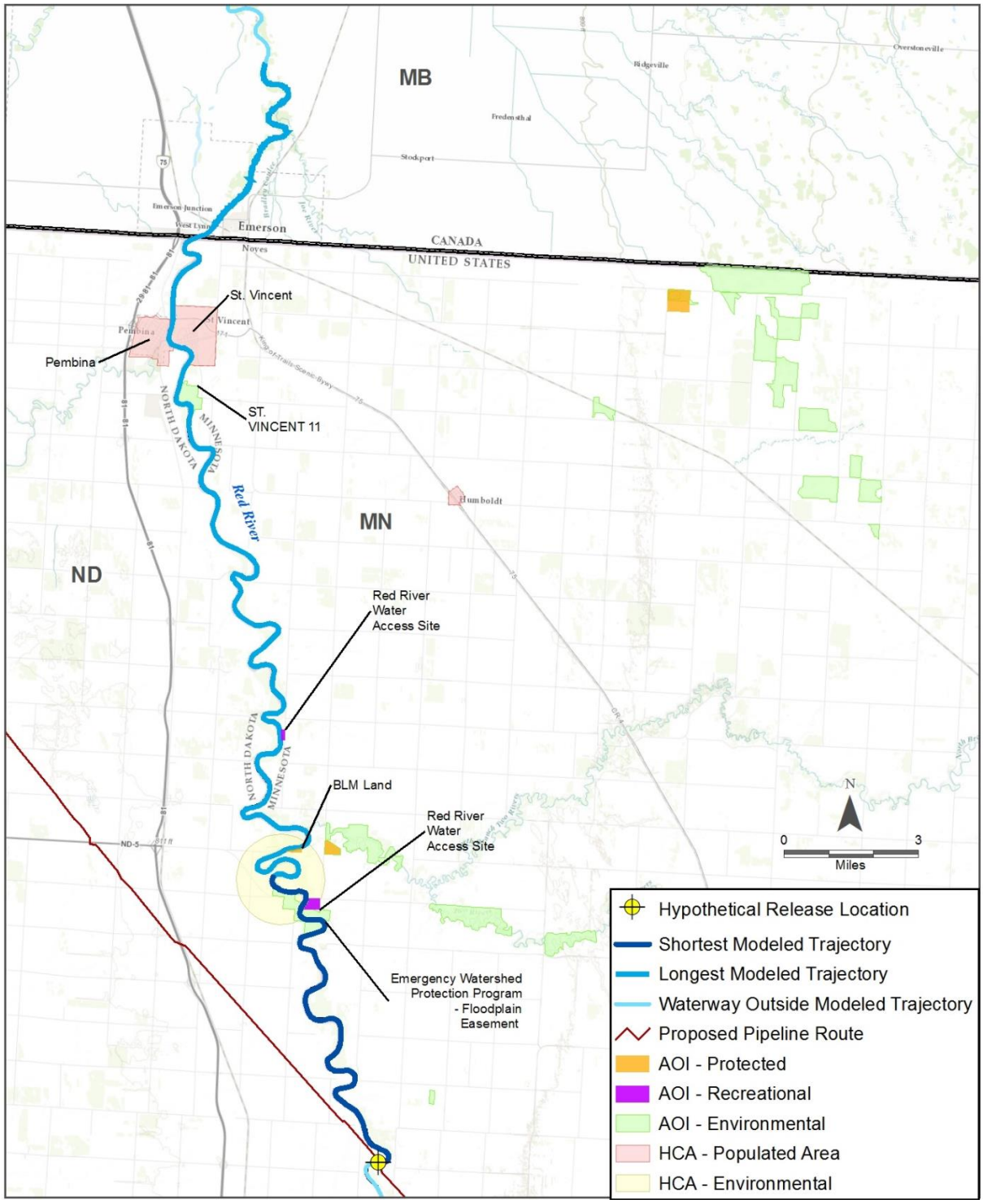

Figure 7-36 High Consequence Areas and Areas of Interest Potentially Affected by a Crude Oil Release at the Red River Crossing Location

7.6.3 Selection of Key Ecological and Human Environment Receptors for Red River

Taking into account environmental characteristics of the Red River, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-72.

Table 7-72 Key Ecological and Human Environment Receptors for the Red River

Receptor	Relevance for Inclusion as an Environmental Receptor for the Red River Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with no holdup of oil on land. In the event of an actual oil release, oil remaining on or in the soil would be physically remediated to established standards.	N
Groundwater	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with no holdup of oil on land. In the event of an actual oil release, effects on groundwater quality would be localized and/or negligible.	N
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with no holdup of oil on land. Any oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the cleanup process.	N
Aquatic Receptors		
Rivers (Red River)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with subsequent physical transport downriver.	Y
Lakes	Low. It is possible that under severe flood conditions the Red River could interact with Lake Stella (a small lake approximately 0.5 miles away from the nearest bank of the Red River). However, an assumption made in the fate modeling for this scenario is that released oil would remain in the Red River after a release.	N
Sediment	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with subsequent physical transport downriver. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with subsequent physical transport downriver. This allows potential interaction with shoreline and riparian habitat.	Y

Table 7-72 Key Ecological and Human Environment Receptors for the Red River

Receptor	Relevance for Inclusion as an Environmental Receptor for the Red River Scenario	Selected (Y/N)
Wetlands	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Red River with subsequent physical transport downriver. There is negligible to no wetland habitat in the vicinity of the predicted release trajectory.	N
Aquatic Plants	Low. The high suspended sediment load of the Red River limits light penetration and opportunities for the development of a substantial aquatic plant community.	N
Benthic Invertebrates	High. The Red River at supports a diverse benthic invertebrate community.	Y
Fish	High. The Red River supports fish.	Y
Semi-Aquatic Wildlife Receptors		
Amphibians and Reptiles	High. The Red River supports amphibians and reptiles.	Y
Birds	High. The Red River supports a diverse bird community.	Y
Semi-aquatic Mammals	High. The Red River supports semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. The communities of Pembina, ND and St. Vincent, MN are located approximately 30 miles north of the hypothetical release location. Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. The communities of Pembina, ND and St. Vincent, MN are located approximately 30 miles north of the hypothetical release location. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health.	Y
Public Use of Natural Resources	High. The Red River downstream of the crossing is shared by two public water access sites. In addition, Fort Daer Landing and Recreation Area as well as Pembina State Park are also along the trajectory of the modeled release. Effects on air and water quality, or the presence of crude oil residues in the sediment and riparian habitat, could potentially disrupt public use of natural resources (e.g., drinking water, hunting, fishing, recreation).	Y

7.6.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Red River scenario is provided in this section. The OILMAP Land software was used by RPS ASA to simulate hypothetical releases of Cold Lake Blend and Bakken crude oils into the Red River (Chapter 5.0) for a 24 hour period, or until the released crude oil reached the border between the United States and Canada. A longer time period was not modeled as it was assumed that

emergency response measures to prevent farther downstream transport of released oil would be in place within the 24 hour period. While OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column (Chapter 5.0). No overland transport of released Cold Lake Blend or Bakken crude oil was modelled for this hypothetical release location, as it was assumed that released oil would directly enter the watercourse (Chapter 3.0). This is a worst-case assumption for a release of crude oil near the watercourse.

The two crude oil types provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (Cold Lake Blend/Winter Blend, heavy diluted bitumen crude oil types having higher viscosity and density). Seasonal variations in river flow, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-73.

In the event of an actual release, the downstream extents of CLB and Bakken crude oil may be more similar, and the effects of CLB may extend farther downstream than predicted, with patchy coverage.

Table 7-73 Environmental and Hydrodynamic Conditions for the Three Modeled Periods for the Red River Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	February	-14.68	5.19	0.31
Average Flow (Summer)	August	19.78	3.98	0.44
High Flow (Spring)	April	4.02	5.05	1.02
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest average flow velocity of the Red River coincides with the spring freshet (i.e., April-June), a result of rising temperatures and snowmelt. Average flow would typically occur during summer and fall seasons. August, the month with the warmest temperature, was selected to represent the maximum amount of evaporation. The lowest flow rate occurs in winter (i.e., February), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3-minute period to allow for valve closure. The release volume therefore represents the volume of oil actively discharged in the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum

13-minute response time to valve closure is an Enbridge standard for safe operations and leak detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown and full valve closure in the affected pipeline section. While 13 minutes is the maximum time for valve closure, this is a conservative assumption, since a response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated Bakken, CLSB, or CLWB crude oil.

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7.6.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectory and mass balance of CLB and Bakken crude oils, under the three seasonal scenarios, is provided in Figures 7-6-6 and 7-6-7, respectively. These simulations are assumed to provide bounding conditions for a release of heavy or light crude oil types. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the CLB and Bakken crude oil types. The Cold Lake crude oil was assumed to be CLSB for the high flow and average flow scenarios, and to be CLWB for the low flow (winter) scenario. As noted in Chapter 5.0, while OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the modeled period, it does not quantify the amounts of oil components dissolved into the water column.

The maximum simulation duration using OILMAP Land was 24 hours, as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within that length of time. Symbols on the drawings indicate the river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Numbers other than these (e.g., 20.3) indicate the time in hours of the predicted termination of downstream transport of the released oil due to adhesion or holdup of the oil along the river banks. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, adhering to river banks, or evaporated to the atmosphere) of the released oil at relevant points in time after the start of the release.

7.6.5.1 Red River Release During High Flow (Spring) Period

Under the high river flow scenario, CLB was predicted to travel approximately 10.5 miles downstream in the Red River within 5.2 hours of the release (Figure 7-37). Beyond this point in time the model predicted that the oil would have been lost from the water surface, mainly as a result of adhesion to shoreline (95.4%), with the balance evaporating.

Bakken crude oil was predicted to be transported approximately 40.3 miles downstream within 18.5 hours of the release (Figure 7-38). The transport of floating oils was predicted to pass through

Pembina, ND and St. Vincent, MN, and into Canada. At this time, approximately 58.6% of the Bakken crude oil was predicted to adhere to shorelines and approximately 41.4% to have evaporated into the atmosphere. None of the oil was predicted to remain on the water surface after 24 hours of the release.

The release of Bakken crude oil under high flow conditions was predicted to result in oiling farther downstream than for the CLB. The difference in the extent of downstream transport was a result of the difference in the shoreline oil retention between the two oil types. Because of its higher viscosity and adhesiveness, larger amounts of CLB are predicted to strand, as a thicker layer of oil on a given length of shoreline, than for the Bakken crude oil. Conversely, the same amount of Bakken crude oil could affect a greater length of shoreline with a lesser thickness of oil, in addition to affecting a greater overall length of the river. This result is based upon the assumption of 100% shoreline oiling coverage (i.e., all shoreline was oiled to its maximum holding capacity as oil made its way downstream). In the event of an actual release, the downstream extents of CLB and Bakken crude may be more similar, and the effects of CLB may extend farther downstream than predicted, with patchy coverage.

A larger proportion of the Bakken crude oil was predicted to evaporate to the atmosphere than was predicted for the CLB. This was due in part to the lighter and more volatile character of the Bakken crude oil. In addition, the greater downstream transport of the Bakken crude oil took more time, and resulted in more water surface area with oil, both of which could allow more of the released oil to evaporate. Volatile components of the CLB would continue to evaporate after becoming stranded on shoreline, but this process was not included within the OILMAP Land model for stranded oil.

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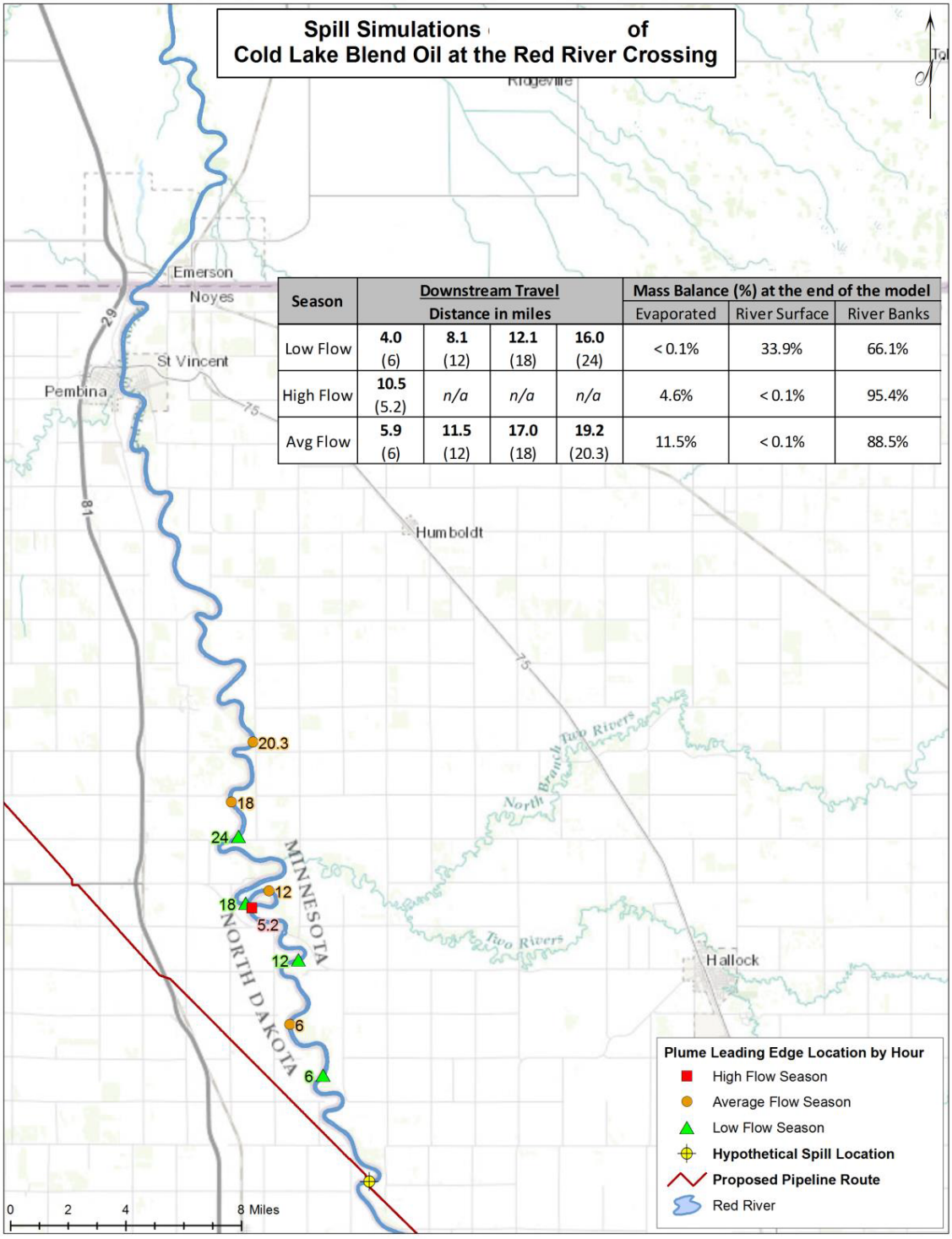

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model		
					Evaporated	River Surface	River Banks
Low Flow	**4.0** (6)	**8.1** (12)	**12.1** (18)	**16.0** (24)	< 0.1%	33.9%	66.1%
High Flow	**10.5** (5.2)	*n/a*	*n/a*	*n/a*	4.6%	< 0.1%	95.4%
Avg Flow	**5.9** (6)	**11.5** (12)	**17.0** (18)	**19.2** (20.3)	11.5%	< 0.1%	88.5%

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Figure 7-37 Predicted Downstream Transport of Cold Lake Blend Oil at the Red River Crossing Location

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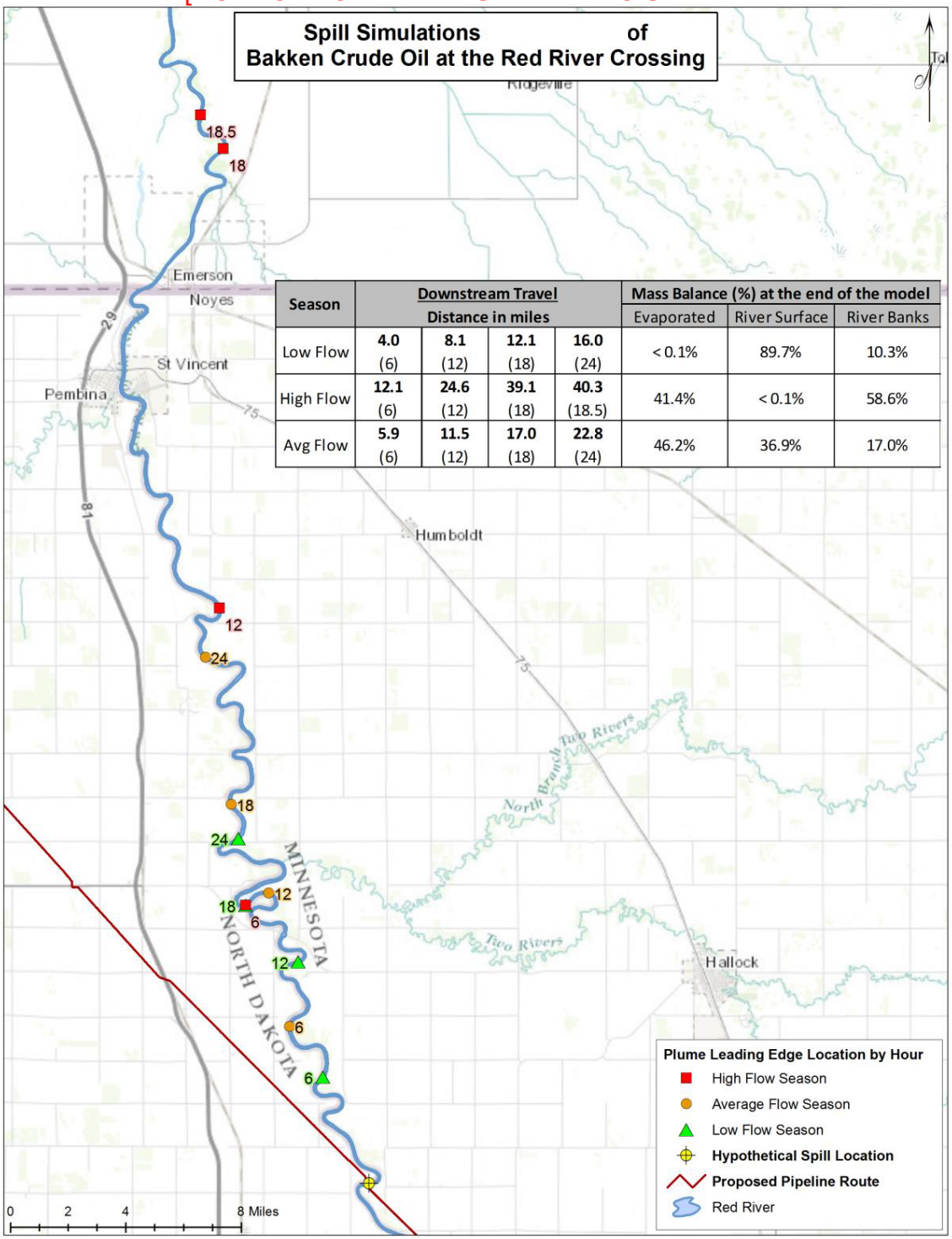

Season	Downstream Travel Distance in miles				Mass Balance (%) at the end of the model		
					Evaporated	River Surface	River Banks
Low Flow	**4.0** (6)	**8.1** (12)	**12.1** (18)	**16.0** (24)	< 0.1%	89.7%	10.3%
High Flow	**12.1** (6)	**24.6** (12)	**39.1** (18)	**40.3** (18.5)	41.4%	< 0.1%	58.6%
Avg Flow	**5.9** (6)	**11.5** (12)	**17.0** (18)	**22.8** (24)	46.2%	36.9%	17.0%

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Figure 7-38 Predicted Downstream Transport of Bakken Crude Oil at the Red River Crossing Location

7.6.5.2 Red River Release During Average Flow (Summer-Fall) Period

Under average river flow, CLB crude oil was predicted to travel up to 19.2 miles downstream, within 20.3 hours of the release (Figure 7-37). After this time, there would be little CLB on the river's surface as the model predicted that most of the released oil would have stranded along shorelines (88.5%) or evaporated (11.5%). Emergency response measures to prevent further possible downstream transport of oil would be in place within 24 hours of the release.

Under average river flow, Bakken crude oil was predicted to be transported approximately 22.8 miles downstream, over the full 24-hour modeled period (Figure 7-38). Approximately 17.0% of the Bakken crude oil was predicted to oil the shorelines of Red River, with 46.2% predicted to evaporate into the atmosphere, and 36.9% to remain on the river surface at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude oil on the river surface after 24 hours could be expected to continue downstream. The oil would continue to weather and would oil shorelines until all of the oil was removed from the water surface.

Under average flow conditions, the CLB was predicted to travel farther downstream than during high river flow condition. This is a result of less interaction between the released oil and shorelines. Under average flow conditions the stream shorelines are assumed to be a mixture of grass and mud. Under high flow conditions, with water spreading into riparian areas, shorelines of the Red River are assumed to be vegetated. As a result, it was assumed in the modeling exercise that under average flow conditions, the shorelines would hold less of the viscous CLB oil type than during high flow conditions. The muddy shoreline present under average flow conditions is assumed to be capable of retaining about 150 bbl of CLB crude oil per mile of shoreline, whereas a grassy shoreline is assumed to be capable of retaining about 1,260 bbl of CLB crude oil per mile.

Slightly more of the released CLB crude oil was predicted to evaporate under the average river flow condition than under the high river flow condition (Figure 7-37). This difference is due largely to the warmer temperatures in the summer-fall season as compared to the spring freshet, as well as the shorter length of time that the oil was free on the water surface (i.e., the simulation for the average flow period terminated after 20.3 hours compared to the shorter duration of 5.2 hours for the high flow period.

When compared to the CLB under average river flow conditions, the Bakken crude oil was predicted to be transported farther downstream before reaching the 24 hour model limit of the simulation. This difference was attributable to the lower shoreline oil retention value for the low viscosity Bakken crude oil, when compared to the more viscous and adhesive CLB. Although not modeled here, it is expected that a medium crude oil would exhibit fate and transport properties intermediate between those of the Bakken and CLB crude oil types, with a tendency to behave more like the Bakken crude oil. This is because the viscosity and adhesiveness properties of a medium crude oil would typically be higher and, therefore, more similar to those of the Bakken crude oil, than to the CLB.

7.6.5.3 Red River Release During Low Flow (Winter) Period

Under low river flow conditions, CLWB was predicted to be transported a total of 16.0 miles downstream over the full 24-hour modeled period (Figure 7-37). Approximately 66.1% of the CLWB was predicted to become trapped under ice along the margins of the Red River, with 33.9% remaining in the river below the ice at the end of the 24 hour simulation. If left unmitigated, the CLWB remaining in the Red River after 24 hours could be expected to continue to move downstream until all of the oil was trapped along the river margins, or had accumulated in fissures and hollows in the river ice. This would provide only temporary storage of the oil, and oil would be expected to re-mobilize in response to changes in flow rates, and particularly during the spring breakup of ice. With the CLWB below the ice of the river, evaporation of oil to the atmosphere would be negligible in the short-term. However, emergency response measures to prevent further possible downstream transport of oil would be in place within 24 hours of the release.

Under low river flow, Bakken crude oil was predicted to be transported approximately a total of 16.0 miles downstream over the full 24-hour modeling period (Figure 7-38). Approximately 10.3% of the Bakken crude oil was predicted to become trapped along the river margins, while the remaining 89.7% was predicted to remain in the river, below the ice, at the end of the 24 hour simulation. If left unmitigated, the remaining Bakken crude oil in the river after 24 hours would be expected to continue to move downstream, with some accumulating along the river margins and some accumulated in fissures and hollows under the river ice.

As with the CLWB, the accumulation of released Bakken crude oil under the ice would be unstable, and oil would be expected to re-mobilize in response to changes in flow rates, and particularly during the spring breakup of ice. Evaporation of the Bakken crude oil to the atmosphere would also be negligible in the short-term. Less of the Bakken crude oil was predicted to accumulate at the river margins under the ice, when compared to the CLWB under low river flow conditions. This was due to the differences in shoreline oil retention between the two oils (i.e., lower viscosity and adhesion of the Bakken crude oil). For this reason, the Bakken crude oil was predicted to have greater mobility under the ice in winter.

7.6.6 Qualitative EHHRA for the Red River

In this section, the likely environmental effects of a crude oil release at the pipeline crossing location on the Red River are described. A worst case crude oil release from a mainline pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed pipeline would carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumens such as CLB). Therefore, the following discussion describes the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7-6-3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence

and sensitivity) were also considered in the analysis. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-72.

7.6.6.1 Terrestrial Receptors

For this modeling scenario, the hypothetical release of crude oil is assumed to enter the Red River with no overland flow. Environmental effects on soils, terrestrial vegetation and groundwater quality are assumed to be localized, limited in spatial extent, and readily remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors will not be considered further for this scenario.

7.6.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors that are considered in the assessment for the Red River are river water and river sediment quality, shoreline and riparian river bank habitat, benthic invertebrates, and fish.

Crude oil released to the Red River during the spring (high flow condition) is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas in the riparian floodplain as it moves north. The distance travelled would depend upon river flow and oil type. Based on OILMAP Land simulations, light oil is predicted to travel father downstream than heavy oil. For heavy oil, stranding on shore would be the primary fate, with only small amounts of evaporative weathering of the oil occurring within the first 24 hour period. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation.

The effects of oil releases on benthic invertebrates and fish depend on characteristics of the released oil and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. Light oils have low viscosity relative to heavier oils. Turbulence in the river water could potentially disperse the light oil as small droplets in the water column, increasing the potential for toxic fractions of the light oil to dissolve into the water column. As a result, the potential for acute toxicity to fish and invertebrates would be greater for the light oil than for heavier oils. However, the large volume of water flow associated with the spring period freshet in the Red River may also dilute and limit the maximum dissolved hydrocarbon concentration in water, as compared to periods of lower water flow.

There would also be high potential for chronic effects of released crude oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease). Many of the fish species present in the Red River spawn in the spring and early summer. The eggs and embryos of these species could be exposed to total PAH concentrations in the river water that could be sufficiently high to induce deformities or cause mortality. In addition the potential for

phototoxicity, caused by an interaction of ultraviolet (UV) light with PAHs accumulated in fish tissues, would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. The risk of phototoxicity would be mitigated by high concentrations of suspended sediment present in the water of the Red River, which would reflect, scatter and absorb light, limiting the penetration of UV light into the water column.

Entrainment of small crude oil droplets in the water column also enhances the potential for light crude oils to interact with suspended sediment particles in the water column resulting in the formation of OPAs. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water, such as oxbows and backwaters. Formation of true oil-particle aggregates is less likely to occur with heavy crude oils such as diluted bitumen, as the higher viscosity of the oil precludes the ready formation of fine droplets in the water column (Zhou et al. 2015). However, heavy oils can still contact sediment particles along the shoreline, and some accumulation of both light and heavy oils in depositional areas is likely, although the precise mechanisms of deposition may vary. Neither crude oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release.

Crude oil released during the summer-fall (average flow) period is predicted to travel downstream, stranding on muddy river banks and losing volatile components of the oil to evaporation as it moves north. Results provided in Section 7.6.5 provide bounding cases for the products likely to be carried in the pipeline. The OILMAP Land simulations indicate that crude oil would be carried between 19.2 and 22.8 miles downstream from the point of release under summer-fall average-flow conditions. For heavy oil, stranding on shore would be the primary fate, with only small amounts of evaporative weathering of the oil occurring. For light oil, evaporation would be the primary fate, with a considerable amount of released oil potentially remaining on the surface of the Red River, and only a modest amount adhering to the river banks. The lower river flow in summer-fall compared to spring could result in higher concentrations of water soluble components in the river; however, along with lower flow rates, there would also be less turbulence in the water column and a reduced tendency for crude oil to be dispersed as fine droplets in the water column. As a result, and taking into consideration the relatively large size of the Red River, narcotic effects on fish and benthic invertebrates are unlikely during the summer season. Also taking into consideration the lower river flow and turbulence, deposition of crude oil residues to sediment in areas of still water is less likely during the summer season than during the spring period.

Crude oil released during the winter (low flow) period could potentially pool on the frozen river surface. If the release was to occur directly to the river below the ice (as is assumed in the OILMAP land model), or if there were openings in the ice that the released oil could penetrate, the oil could travel downstream under the ice, accumulating in the narrow gap between the ice and the river sediment, or accumulating in hollows under the ice as it moved north. Results provided in Section 7.6.5.3 provide bounding cases for the products likely to be carried in the pipeline. The OILMAP Land simulations indicate that crude oil would be carried approximately

16 miles downstream from the point of release under winter low-flow conditions. For both oil types, the winter ice would effectively inhibit evaporation, while providing greater potential for dissolution into the water column during the period of lowest dilution flow. The more viscous heavy oil would be predominantly trapped along the river margins, whereas a large fraction (about 33.9%) of the light crude oil would remain mobile at the interface between the river water and the underside of the ice. Therefore, a spill in winter could cause mortality to fish due to narcosis. This result would be more likely for the light crude oil, which would spread out over a larger area, than for the heavy crude oil, which would tend to remain in thicker localized accumulations. Fish eggs and larvae would generally not be present during the winter, so effects on these life stages due to blue sac disease are not likely, although crude oil residues in water and sediment could, if not adequately remediated, affect fish eggs and larvae in the following spawning season. Phototoxicity is not likely to occur following a release of crude oil in winter due to short day length and lower light intensity in winter, reflection and absorbance of light by snow and ice cover on the river, and absorbance of UV light by DOC in the water beneath the ice.

Both crude oil types could be accumulated in sediment, and both would be subject to re-mobilization with spring breakup of the ice, and increasing water flow rates.

7.6.6.3 Semi-Aquatic Wildlife Receptors

Habitat downstream of the hypothetical release location supports amphibians (e.g., salamander, mudpuppy), reptiles (e.g., turtles, snakes), semi-aquatic birds (e.g., ducks, geese) and semi-aquatic mammals (e.g., muskrat, otter). Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.6.6.3.1 Amphibians and Reptiles

Crude oil released to the Red River during the spring (high flow) and summer-fall (average flow) seasons is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. The distance travelled would depend on the flow conditions, as well as oil and shoreline type. The OILMAP Land simulations indicate that light oil will travel father downstream than heavy oil. A crude oil release during the summer-fall period would not be likely to have direct effects on riparian habitat and, therefore, effects on reptiles (e.g., snakes) in the riparian zone would be minimal. Downstream transport of released crude oil in summer-fall would not travel as far north as in spring (between 19.2 and 22.8 miles downstream from the point of release) meaning that possible oil-organism interactions would be fewer in this season than in spring.

Within the oil-exposed habitats along the river that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. As a result, exposure of these animals to released crude oils would be limited. After the Kalamazoo River oil spill in 2010 snakes did not appear to be highly exposed to spilled oil. A release of light

crude oil during the spring would likely have a greater effect than in summer due to the greater predicted downstream transport distance and interaction with greater areas of riparian and wetland habitats than later in the year.

Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these animals would have very little exposure to released oil moving on the water surface or within the water column.

7.6.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, wetlands, and riparian areas as components of their habitats, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory and herbivory. What they have in common is that if exposed to external oiling, their ability to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn, this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, many migratory birds would be returning to riverine habitats in Minnesota and North Dakota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Only birds in the affected river reach, which could range from 10.5 to 40.3 miles in extent, would be affected; birds upstream, farther downstream, or occupying other nearby habitats would likely be less affected as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release.

Environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude. With rising water temperatures, mortality of lightly oiled adult birds due to

hypothermia becomes less likely than in the spring. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest. Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas where birds can physically contact oil, which could range from 19.2 and 22.8 miles downstream along the Red River from the release point.

In the winter months, ice cover on the Red River would strongly limit the opportunities for aquatic and semi-aquatic birds to occupy this habitat. Therefore, adverse effects on the health of aquatic and semi-aquatic birds are not likely for a release of crude oil during the winter.

7.6.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses on species that have a primary association with the aquatic environment such as muskrat and beaver (herbivores), American mink (carnivore-piscivore) and river otter (piscivore). These species are at more likely to come into contact with an oil release in water than terrestrial mammals.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along the Red River where effects may occur, and the magnitude of effects, is related to the type of oil released, season and flow rate. Effects on semi-aquatic mammals relate more to the amount of time spent in the water (and consequent exposure to physical oiling) than to dietary preferences. Timely capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Based on the OILMAP Land simulations, the potentially affected river reach could range from 10.5 to 40.3 miles in extent. Therefore, although mortality of a considerable number of semi-aquatic mammals could be expected, large-scale (i.e., regional) population level effects are unlikely. Environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude than in spring. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is less likely. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while grooming, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. Animals that became oiled in the winter would likely die rapidly as a result of hypothermia.

7.6.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs as compared to heavier crude oils, although diluted bitumen may contain similar amounts of VOCs to some light crude oils, depending upon the type and amount of diluent. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release. The communities of Pembina, North Dakota and St. Vincent, Minnesota could potentially be exposed to hydrocarbon vapors under certain circumstances, and were identified through the HCA analysis as being "other" (i.e., smaller) population areas. Under high flow conditions in the Red River, the OILMAP Land modeling indicated that the leading edge of released Bakken crude oil could reach these urban areas in under a day. Setbacks afforded by the riparian floodplain of the river generally assure that residences are approximately 120–140 yards away from the river as it passes through Pembina and St. Vincent, although this distance would be reduced during the spring freshet. Under the winter release scenario, the ice cover is assumed to strongly limit release of volatile hydrocarbons to air.

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil vapor. Similarly, ATSDR (1995) reports that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

The potential for inhalation exposures to the public would be greatest near and downwind from the release site while the released oil is on the water surface (i.e., 3 miles east of Bowesmont, North Dakota and 9 miles southwest of Hallock, Minnesota, as well as near the Red River). There are three residences within a mile of the proposed Red River crossing location. In the unlikely event of a crude oil release, residents close to or downwind of the release trajectory would become aware of a strong hydrocarbon odor.

Most of the volatile hydrocarbons would be lost within the first 24 hours following a release of crude oil. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while emergency response takes place.

The HCA analysis did not identify drinking water intakes that could be affected downstream of the Red River crossing. Based on a search of municipal water supplies for Pembina, North Dakota and St. Vincent Minnesota, it appears that neither of these communities consistently obtains drinking water from the Red River. Rather, people in Pembina, North Dakota can

purchase drinking water from the Northeast Regional Water District (http://www.northeastregionalwater.com/index.html) and drinking water is supplied to St. Vincent by the North Kittson Rural Water company (http://www.health.state.mn.us/divs/eh/water/com/waterline/featurestories/ruralwater.html). In the unlikely event of a crude oil release, notifications would be sent to people in the area so that drinking water intakes (should there be any) could be suspended if required.

Relatively little has been published regarding the long-term effects of exposure by humans to crude oil releases. Health effects observed in residents and clean-up workers in the months following an oil release generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

Effects of a crude oil release on human receptors would generally be similar for the spring (high flow) and summer-fall (average flow) seasons. In summer, the warmer temperatures and slower river flow velocities in the summer would promote more rapid evaporation of volatile hydrocarbons in a smaller area. In the spring freshet period, higher river flow velocity would transport the released oil farther downstream within the first 24 hours, potentially resulting in effects to a larger number of people. The flow modeling suggests that the light crude oil (Bakken) is likely to be transported farther downstream within 24 hours than the heavy crude oil (Cold Lake diluted bitumen). As a result, a release of the light crude oil may affect a larger number of individuals than a release of the heavy crude oil type. Both Bakken crude oil and Cold Lake diluted bitumen are expected to contain similar overall amounts of volatile hydrocarbons, so differences related to the type of released oil are likely to be minor.

No overland transport of released crude oil was modelled for this hypothetical release location. Infiltration of crude oil into soil and subsequently into groundwater would be limited.

During the spring freshet period, the Red River is susceptible to flooding and can overtop its banks and spread into the surrounding farmland. A release of light and medium crude oils during this period would provide a potential pathway for oil deposition to soil in low-lying areas. Light and medium crude oils would be expected to become dispersed over a large area, and are readily biodegraded, so that persistent accumulation of these oil types in riparian areas or temporarily flooded farmland is unlikely. Heavy crude oils and diluted bitumen are more likely to be deposited as thicker layers of more persistent oil, and would likely require more active remediation of affected areas. Soils in the area are predominantly lacustrine clays, silts, and sands (MN DNR 2006) and these soils typically have low to medium permeability (compared to sand/gravel soils). Therefore, penetration of crude oil into flooded soils, and effects on groundwater quality (as a potential source of potable water) are unlikely.

The Red River provides recreational opportunities (e.g., fishing, hunting, boating, swimming, camping) at many locations north of the release location. Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil.

7.6.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to the Red River were assessed for both light crude oil (e.g., Bakken crude oil) and heavy crude oil (e.g., diluted bitumens such as CLB). The discussion of expected environmental effects on receptors is based on these crude oil types as bounding conditions.

Potential terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors and human and socio-economic receptors were screened to identify those with the most likely interactions with released oil. Selected receptors for qualitative assessment are highlighted in Table 7-72, discussed in detail in Sections 7.6.6.1 to 7.6.6.4, and summarized here in Table 7-74.

Table 7-74 Environmental Effects Summary Table for Pipeline Crude Oil Releases

Receptor	Expected Environmental Effects of Released Crude Oil	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	It is assumed in the model that oil would enter directly into the Red River with no hold up of oil on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
Rivers	Both light and heavy oil would travel downstream from the release location. Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, but would be thinner on the water and less persistent where they contact shoreline. Both light and heavy crude oils are predicted to travel similar travel distances under winter conditions, although the heavy oil would be likely to remain trapped along the river edges. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column, meaning potentially toxic fractions of the light oils would more readily dissolve into the water column.	MORE	LESS
Sediment	Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, with both oil types travelling similar distances under winter conditions. Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. The low viscosity of the lighter type crude oils could potentially result in a larger amount of oil entrainment as fine droplets as compared to heavier blends, resulting in the formation of oil-particle aggregates, which could both sink, and enhance biodegradation. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water. There also exists the potential for low molecular weight aromatic hydrocarbons to dissolve into the water column, as well as greater potential for deposition of hydrocarbons to the sediment. Under winter conditions, more of the heavy crude oil is predicted to become trapped along the river margins, and this oil is also likely to interact with sediment, resulting in mixing of oil and sediment, or formation of oil-particle aggregates. However, the spring freshet is also a major seasonal factor that can flush river sediments leading to a rapid restoration of damaged habitat, and dispersal of oil-particle aggregates in a way that enhances natural recovery.	LESS	MORE

Table 7-74 Environmental Effects Summary Table for Pipeline Crude Oil Releases

Receptor	Expected Environmental Effects of Released Crude Oil	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location. Lighter crude oils are expected to travel farther downstream than heavier crude oils in spring and summer conditions, but would be thinner and less persistent on the water. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. For heavy oil, stranding on shore would be the primary fate. For light oil, stranding would remain the primary fate, but considerably more of the released oil could be lost to evaporation. Flooding of riparian and wetland habitat in spring could lead to stranding of crude oils in this habitat, with heavy crude oil likely to be deposited as patties or tar balls. This is in contrast to light crude oil which would be deposited as a thin layer or sheen.	LESS	MORE
Aquatic Plants	The high suspended sediment load of the Red River limits light penetration and opportunities for the development of a substantial aquatic plant community. Therefore, effects on aquatic plant communities would be minor.	SAME	SAME
Benthic Invertebrates	Environmental effects on benthic invertebrates would be limited to areas affected by the released oil. In the short-term, the low viscosity of light crude oil would result in greater potential for oil entrainment as fine droplets, as compared to heavier blends. This would enhance dissolution of low molecular weight aliphatic and aromatic hydrocarbons into water (with resulting acute toxicity), in addition to promoting oil-particle interaction and potential deposition of oil to sediment. For heavy crude oil, there would be less potential for dissolution of hydrocarbons into the water, but greater long-term potential for deposition of tar balls and patties as a result of oil interaction with sediment. These could accumulate in depositional areas, resulting in chronic effects on benthic invertebrates.	MORE	LESS
Fish	Environmental effects on fish would be limited to areas affected by the released oil. Light oils have low viscosity relative to heavier oils and turbulence in the river water could potentially disperse the light oil as small droplets in the water column. This would enhance the dissolution of potentially toxic fractions of the light oil into the water column. As a result, the potential for acute toxicity to fish due to narcosis would be greater for the light oil than for heavy oil. Potential chronic effects on fish eggs and embryos (e.g., Blue Sac Disease) could also occur, but would be most likely to occur in spring and early summer, when most species spawn. The potential for phototoxicity, caused by an interaction of ultraviolet light with PAHs accumulated in fish tissues, would be greatest in summer due to high light intensity and long day length. However, the high turbidity of the Red River would act to limit light penetration, reducing this risk.	MORE	LESS

Table 7-74 Environmental Effects Summary Table for Pipeline Crude Oil Releases

Receptor	Expected Environmental Effects of Released Crude Oil	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Environmental effects on amphibians and reptiles would be limited to areas affected by the released oil. Light crude oil is expected to travel farther downstream under spring and summer conditions than heavy crude oil, but would be thinner and less persistent on the water. Crude oil released under ice during the winter would not contact shoreline or riparian areas, although crude oil that was not recovered could be dispersed over a large area during the spring freshet. Flooding of riparian habitat in spring could lead to stranding of crude oils in this habitat. Within these habitats, oiling effects on adults, juveniles, and eggs could potentially be observed. Higher potential would exist for effects on amphibians than for turtles, which appear to be somewhat tolerant of external oiling. Dormancy of amphibians and reptiles in winter and early spring means exposure to oil released at this time of year could be negligible, and adverse environmental effects unlikely.	MORE	LESS
Birds	Mortality of oiled aquatic and semi-aquatic birds would be limited to areas affected by the released oil. Few birds are present in winter, so effects would be reduced in that season. Released light crude oil is generally transported farther than heavy crude oil, so environmental effects could be more spatially extensive for light crude oil types. Cold water in the spring, in combination with greater downstream movement of released oil, suggests that environmental effects of released oil could be greatest for a light crude oil in spring, and of lesser magnitude for a heavy crude oil release.	MORE	LESS
Semi-aquatic Mammals	Mortality of oiled semi-aquatic mammals would be limited to areas affected by the released oil. Released light crude oil is generally transported farther than heavy crude oil, so environmental effects could be more spatially extensive for light crude oil types. Cold water in the spring, in combination with greater downstream movement of released oil, suggests that environmental effects of released oil could be greatest for a light crude oil in spring, and of lesser magnitude for a heavy crude oil release. Adverse effects on mink and otter would be particularly severe in winter, due to the effects of oil on the insulating properties of fur, in combination with cold water temperatures. However, muskrat and beaver might be spared due to their lower activity levels in winter.	MORE	LESS

Table 7-74 Environmental Effects Summary Table for Pipeline Crude Oil Releases

Receptor	Expected Environmental Effects of Released Crude Oil	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. Under winter conditions, ice cover would strongly limit or prevent evaporation of crude oil vapors to the atmosphere.	MORE	LESS
Human Receptors	Typical human health effects associated with short-term (acute) inhalation of VOCs from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is not expected. Residents in close proximity would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most volatile hydrocarbons would be lost within 24 hours following a release. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health. Under the winter release scenario, ice cover is assumed to strongly limit release of volatile hydrocarbons to air. Other population area HCAs were identified along the path of the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route.	MORE	LESS
Public Use of Natural Resources	Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Light crude oil is predicted to be transported farther downstream than heavy crude oil during the first 24 hours following a release, affecting a larger area. However, the heavy crude oil would form thicker and more persistent deposits where it contacted shoreline and riparian areas. This conclusion is independent of the type of crude oil that could be released.	SAME	SAME

7.7 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL TO THE MISSISSIPPI RIVER AT PALISADE

The proposed pipeline could potentially cross underneath the Mississippi River approximately one mile south of Palisade, Minnesota and immediately east of Route 10. This scenario captures a hypothetical release of crude oil directly to the Mississippi River, with downstream transport to the south and west. The Mississippi River near the release point is relatively flat and contains many oxbows, many of which are known areas of interest for recreational uses of the river (MN DNR 2016m). The Mississippi River passes through mixed farmland and state forest as it flows towards Aitkin, Minnesota. The town of Aitkin is protected from potential floods by a diversion channel, which would presumably be carrying some of the flow of the Mississippi River during the spring freshet period, although not necessarily at other times of the year. As identified in Chapter 4.0, the Mississippi River crosses through the Tamarack Lowlands, a low-lying subsection of the Northern Minnesota Drift and Lake Plains Section that is part of the greater Laurentian Mixed Forest Province.

7.7.1 Description of the Freshwater Environment

The Mississippi River near Palisade, Minnesota flows to the south and west along a winding channel through terrain that is largely flat. The river has a well-defined channel, although there are numerous oxbows and side channels that, depending upon river flow, may or may not be hydraulically connected to the main channel. The river channel near the hypothetical release point is about 180 to 200 ft wide. The banks are mainly forested (ranging from a narrow riparian strip of trees, to extensive woodland on some oxbow peninsulas). Land use outside of the immediate floodplain is mainly agricultural on both sides of the river. Low lying areas of the Mississippi River are subject to flooding (MN DNR 2016m); there are only a few residences in close proximity to the river, and these appear to be predominantly associated with farms.

Downstream of the hypothetical release location, and north of Aitkin, Minnesota, is a spillway and flood diversional channel that transmits water from the Mississippi River upstream of Aitkin, to a point on the same river downstream of Aitkin, a distance of approximately 5.8 miles. The entrance to the flow diversional channel appears to be a passive spillway, with a constriction at the entrance so that water would pass through a narrows approximately 50 ft wide. When the river is in flood stage, some of the water would pass through the spillway, where there would be turbulent flow. However, none of the modeled crude oil release trajectories was predicted to reach the entrance of the flow diversion channel within 24 hours of a hypothetical release event. The average velocity of the Mississippi River changes with season, with slowest velocities (e.g., about 0.74 mph) expected during low flow periods in the winter, and only slightly greater velocities (e.g., about 1 mph) during the spring high flow period.

The vegetative communities in the river oxbows include speckled alder, willows, bog birch, ferns, tall asters, sedges, and wildflowers. Some of the oxbows are covered by forest; others appear to be maintained at an earlier successional stage, possibly due to disturbance caused by periodic flooding. The still waters of the oxbows provide pond and marsh habitat suitable for muskrat, as well as providing spawning and rearing habitat for fish such as northern pike (MN DNR 2016n). Muskrat, beaver, otter, turtles, herons, hawks, osprey, and eagles are commonly observed along the river (MN DNR 2016n).

In this stretch of the Mississippi River, northern pike, walleye, bass and muskellunge are abundant (MN DNR 2016n; MN DNR 2010b). The Tamarack Lowlands Subsection provides important wintering areas for boreal birds in times of food shortage and is home to a predicted 69 SGCN. These include birds (51 species), fish (3 species), insects (5 species), mammals (4 species), mollusks (2 species), reptiles (2 species), and spiders (1 species) (MN DNR 2006). Of these species, 16 are afforded federal or state endangered, threatened, or of special concern status (MN DNR 2006; MN DNR 2016d). It is foreseeable that some of these SGCN could utilize aquatic habitats along the Mississippi River.

The Mississippi River crosses through portions of the Waukenabo State Forest, and sections of land owned by the Bureau Land Management (BLM). The most common land uses in the Tamarack Lowlands Subsection are forestry, tourism, and outdoor recreation, agriculture, and peat mining (MN DNR 2006).

Several access points downstream from the proposed pipeline crossing location were visited in May, 2016, to provide additional insight into baseline environmental conditions for Mississippi River and surrounding environments. Representative site photographs are provided in Figure 7-39 through Figure 7-42. Field observations are summarized in Table 7-75.



Figure 7-39 Mississippi River and Riparian Habitat Approximately 5 Miles Downstream of Pipeline Crossing



Figure 7-40 Mississippi River and Riparian Habitat Approximately 5 Miles Downstream of Pipeline Crossing



Figure 7-41 Mississippi River and Riparian Habitat Approximately 30 Miles Downstream of Pipeline Crossing



Figure 7-42 Mississippi River and Riparian Habitat Approximately 61 Miles Downstream of Pipeline Crossing

Table 7-75 Environmental Characteristics Observed at Selected Access Points on the Mississippi River in May 2016

Access Point	Latitude Longitude	Notes
County Road 10 approximately 3.5 miles east of US Hwy 169 and 5 miles downstream of proposed pipeline crossing	46.709591 -93.484909	*Habitat Description:* River banks are approximately 10 ft high and relatively steep in most areas. Vegetation adjacent to river channel is a mix of floodplain forest (silver maple, cottonwood dominant) with floodplain wet/sedge meadow. Sandbar willow is common in some areas adjacent to the stream channel. The invasive, nonnative reed canary grass occurs occasionally here. *Wildlife observed:* American robin, Baltimore oriole
Mississippi River at Aitkin state water access site, just north of Aitkin, approximately 30 miles downstream of proposed pipeline crossing	46.5424 -93.7131	*Habitat Description:* Plant communities in the vicinity of this location include floodplain forest (silver maple-box elder) and terrace forest (bur oak, elm, green ash). Herbaceous vegetation is generally dominated by natives (especially sedges), but the invasive, nonnative reed canary grass occurs occasionally. *Wildlife observed:* blue jay
Mississippi River at Highway 6 state water access site; 5 miles north of Crosby at southwest corner of bridge and approximately 61 miles downstream of pipeline crossing.	46.5435 -93.9564	*Habitat Description:* River bank is relatively steep and approximately 10-15 ft high. Floodplain forest is present in the lowest areas adjacent to the river. However, due to the high banks of the river, much of the adjacent vegetation is terrace forest (mesic to dry-mesic oak forest with aspen) on sandy soils. *Wildlife observed:* crow, blue jay

7.7.2 High Consequence Area Assessment for the Mississippi River near Palisade Crossing Location

As defined in Section 7.0, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. Sensitive AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks).

Under low and average flow conditions, floating plumes of CLB and Bakken crude oil are not predicted to pass HCAs. However, under high flow conditions, floating plumes of both oil types are predicted to pass through habitat that has been identified as an environmentally sensitive area (Table 7-76). The Mississippi River downstream of Palisade also flows through several protected areas and environmental AOIs (Table 7-77). As with the HCAs, floating plumes of CLB and Bakken crude oil under low flow conditions are not predicted to pass the AOIs. However, under average and high flow conditions, both oil types are predicted to pass BLM lands and the

Waukenabo State Forest (Table 7-77). The locations of the HCAs and AOIs are shown in Figure 7-43.

Table 7-76 HCAs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mississippi River near Palisade Crossing Location

HCA Type	HCA Subtype	Description / Locations
Environmentally Sensitive Area	N/A	N/A
NOTE: Data for the HCA analysis were obtained from the USDOT PHMSA HCA datasets plus additional HCAs compiled by Enbridge during 2010 and 2013.		

Table 7-77 AOIs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mississippi River near Palisade Crossing Location

AOI Type	AOI Subtype	Description / Locations
n/a	N/A	N/A
Protected Area	Bureau of Land Management	BLM Land
	State Forest	Waukenabo State Forest
NOTE: Data for the AOI analysis were derived from multiple datasets provided on the MN Geospatial Commons website, USGS Protected Areas Database of the U.S., and the MN Department of Transportation.		

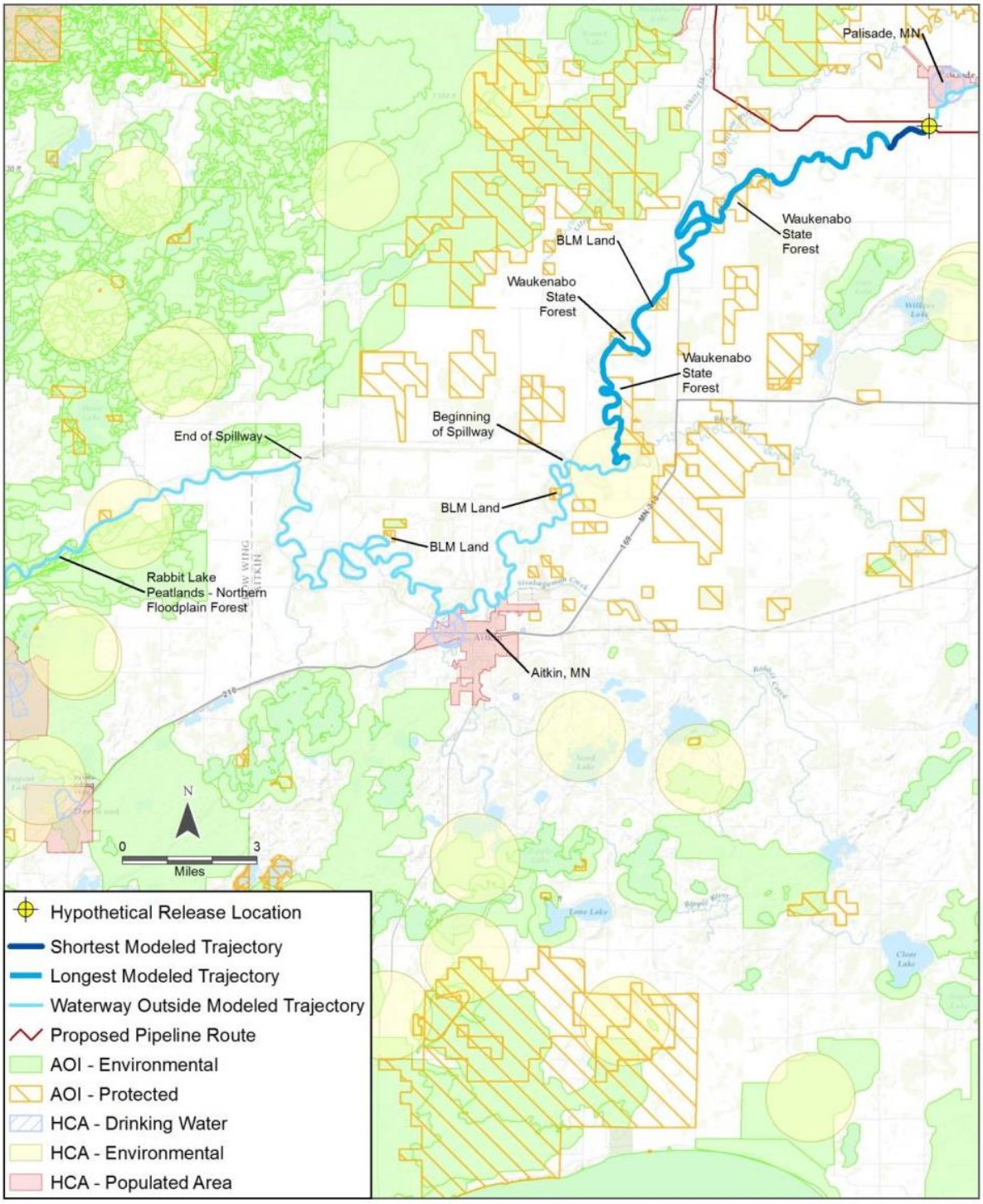

Figure 7-43 HCAs and AOIs Potentially Affected by a Crude Oil Release at the Mississippi River near Palisade Crossing Location

7.7.3 Selection of Key Ecological and Human Environment Receptors for Mississippi River near Palisade Crossing Location

Taking into account environmental characteristics of the Mississippi River near Palisade, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-78.

Table 7-78 Key Ecological and Human Environment Receptors for the Mississippi River near Palisade

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mississippi River near Palisade Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. Any oil that reaches soil would be physically remediated to established standards.	N
Groundwater	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. In the event of an actual oil release, effects on groundwater quality would be localized and/or negligible.	N
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. Any oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the cleanup process.	N
Aquatic Receptors		
Rivers (Mississippi River)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver.	Y
Lakes	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. There is no relevant lacustrine habitat in the vicinity of the predicted release trajectory.	N
Sediment	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. This allows potential interaction with shoreline and riparian habitat.	Y
Wetlands	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver and potential interaction with wetlands along the river and oxbows.	Y

Table 7-78 Key Ecological and Human Environment Receptors for the Mississippi River near Palisade

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mississippi River near Palisade Scenario	Selected (Y/N)
Aquatic Plants	High. Mississippi River supports aquatic plant communities.	Y
Benthic Invertebrates	High. Mississippi River supports benthic invertebrate communities.	Y
Fish	High. Mississippi River supports fish communities.	Y
Semi-Aquatic Wildlife Receptors		
Amphibians and Reptiles	High. Mississippi River supports amphibians and reptiles.	Y
Birds	High. Mississippi River supports waterfowl and other birds.	Y
Semi-aquatic Mammals	High. Mississippi River supports semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. The community of Palisade, Minnesota is approximately one mile north of the hypothetical release location. Some homes are located along the downstream flow path for released crude oil. Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. The community of Palisade, Minnesota is approximately one mile north of the hypothetical release location. Some homes are located along the downstream flow path for released crude oil. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health.	Y
Public Use of Natural Resources	High. The Mississippi River near Palisade, Minnesota is shared by the Waukenabo State Forest. The drinking water intake for Palisade is upstream of the hypothetical release location so effects on water quality for residences in the area are not expected. Effects on air and water quality, or the presence of crude oil residues in the sediment, riparian or wetland habitat, could potentially disrupt public use of natural resources (e.g., drinking water supplies, hunting, fishing, recreation).	Y

7.7.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Mississippi River near Palisade, Minnesota scenario is provided in this section. The Mississippi River channel downstream from the hypothetical release location is characterized by low gradient and relatively flat water. The flood diversion channel with its dam and spill way has the potential to result in localized turbulence that could entrain crude oil, should it be released and transported downstream that far. Unlike OILMAP Land, the SIMAP fate and transport modeling software can quantify the amount of crude oil that is likely to become entrained into or

dissolved in the water column, or deposited to sediments as a result of the turbulent conditions (Chapter 4 and 5). To shed additional light on this potential, SIMAP was used to simulate hypothetical releases of CLB and Bakken crude oils into the Mississippi River downstream of Palisade, Minnesota (and also at Little Falls, Minnesota). Like the OILMAP Land model, SIMAP also provides an indication of the downstream extent of oiling and mass balance of oil within the 24 hour modeled period. A longer time period was not modeled as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within the 24 hour period.

The two crude oil types used in this analysis provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB, diluted bitumen crude oil types having higher viscosity and density). Seasonal variations in river flow velocity, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-79.

Table 7-79 Environmental and Hydrodynamic Conditions for the Three Modeled Periods at the Mississippi River at Palisade Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	March	-3.19	4.78	0.33
Average Flow (Summer)	July	20.19	3.95	0.38
High Flow (Spring)	April	5.03	5.24	0.47
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest average flow rate of the Mississippi River downstream of Palisade coincides with the spring freshet (i.e., April-June), a result of rising temperatures and snowmelt. Average flow would typically occur in summer and fall seasons. July, the month with the warmest temperature, was selected to represent the maximum amount of evaporation. The lowest flow rate occurs in winter (March), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3-minute period to allow for valve closure. The release volume therefore represents the volume of oil actively discharged in the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum 13-minute response time to valve closure is an Enbridge standard for safe operations and leak detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown, and full valve closure in the affected pipeline section. While 13 minutes is the maximum time for valve closure, this is a conservative assumption, since a

response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated of Bakken, CLB, or CLWB.
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7.7.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectories and mass balance for Cold Lake and Bakken crude oils, under the three seasonal scenarios, is provided in Figure 7-37 and Figure 7-38. These simulations are assumed to provide bounding conditions for a release of heavy or light crude oil types, respectively. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the Cold Lake and Bakken crude oil types. The Cold Lake crude oil was assumed to be CLB for the high flow and average flow scenarios, and to be CLWB for the low flow (winter) scenario. The maximum simulation duration using SIMAP was 24 hours, as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within that length of time.

Symbols on the drawings indicate the river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, evaporated to the atmosphere, dissolved in the water column, deposited to sediment, adhering to river banks, or decaying through photo-oxidation and biodegradation) of the released oil at relevant points in time after the start of the release.

7.7.1.1 Mississippi River at Palisade Release During High Flow (Spring) Period

Under the high flow scenario CLB was predicted to travel downstream in the Mississippi River approximately 4, 8, and 18 miles after 6, 12, and 24 hours, respectively (Figure 7-44). By 24 hours after the hypothetical release, almost all of the released crude oil (71.3%) was predicted to remain on the surface of the Mississippi River, with 19.7% evaporating and 8.1% adhering to shorelines. Less than 1% was predicted to break down through photo-oxidation and biodegradation. Negligible amounts (less than 0.1%) of the heavy oil were predicted to mix in the water column, or deposit to sediment (Figure 7-44).

Bakken crude oil was predicted to follow a similar downstream transport pattern as CLB (Figure 7-45). By 24 hours after the hypothetical release, most (52.2%) of the Bakken crude oil was predicted to have evaporated, with 35.8% remaining on the river surface, approximately 11.4% adhering to shorelines, and less than 1% broken down through photo-oxidation and biodegradation. Negligible amounts (less than 0.1%) of the Bakken crude oil were predicted to mix within the water column or deposit to sediment (Figure 7-45).

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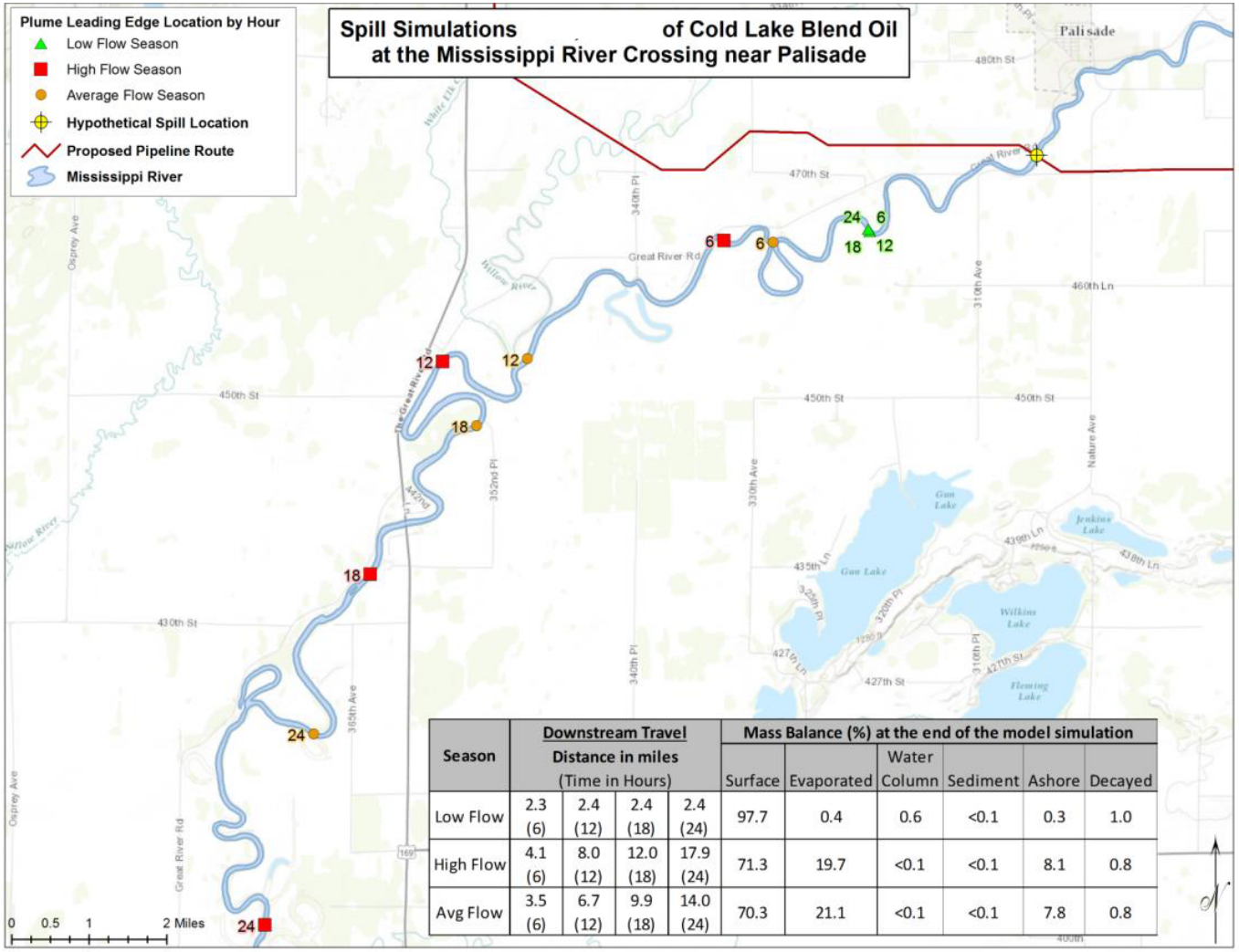

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	2.3 (6)	2.4 (12)	2.4 (18)	2.4 (24)	97.7	0.4	0.6	<0.1	0.3	1.0
High Flow	4.1 (6)	8.0 (12)	12.0 (18)	17.9 (24)	71.3	19.7	<0.1	<0.1	8.1	0.8
Avg Flow	3.5 (6)	6.7 (12)	9.9 (18)	14.0 (24)	70.3	21.1	<0.1	<0.1	7.8	0.8

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Figure 7-44 Predicted Downstream Transport of CLB Oil at the Mississippi River near Palisade, MN

LINE 3 REPLACEMENT PROJECT:
ASSESSMENT OF ACCIDENTAL RELEASES: TECHNICAL REPORT

Assessment of Environmental Effects of Oil Releases
January 13, 2017

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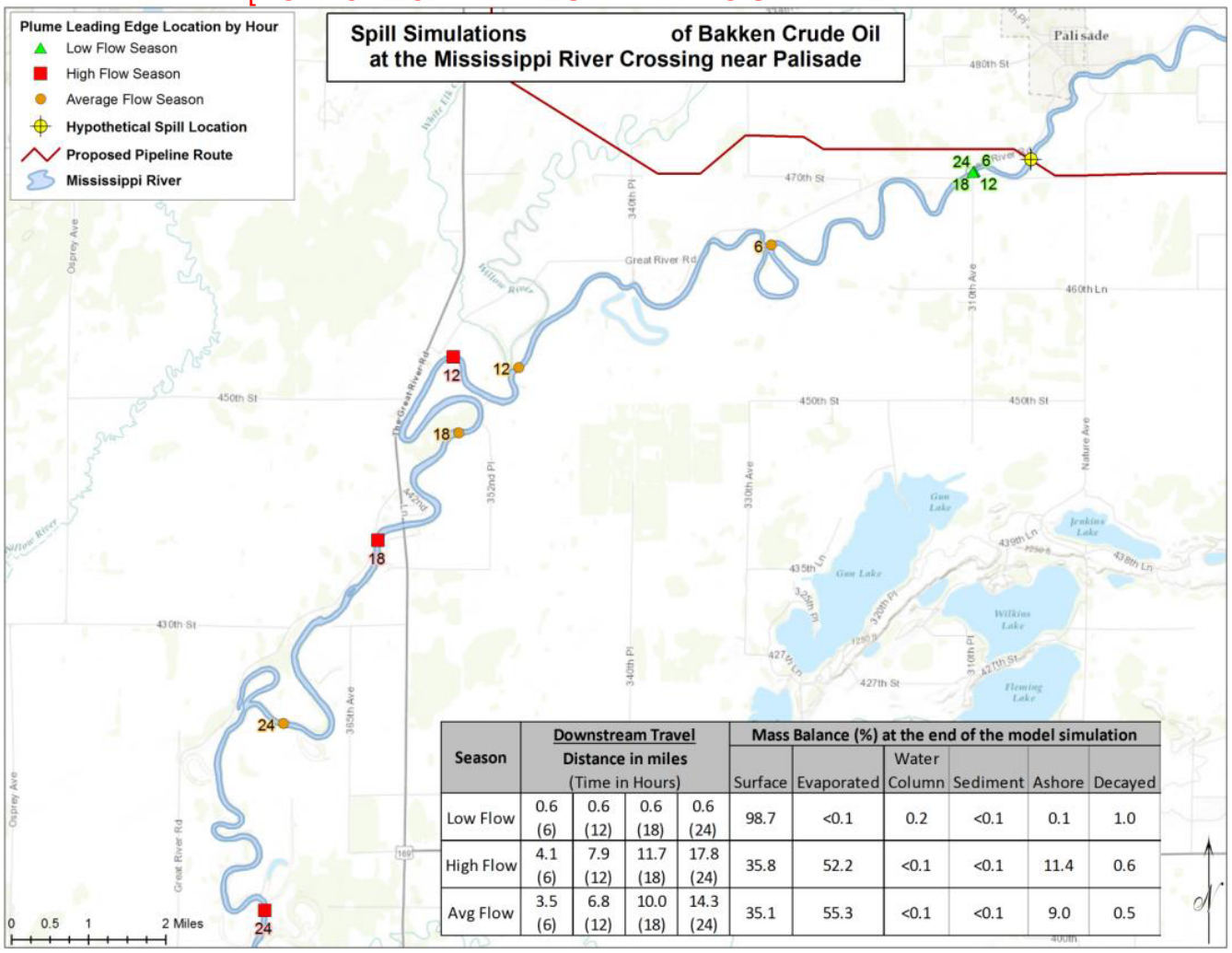

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	0.6 (6)	0.6 (12)	0.6 (18)	0.6 (24)	98.7	<0.1	0.2	<0.1	0.1	1.0
High Flow	4.1 (6)	7.9 (12)	11.7 (18)	17.8 (24)	35.8	52.2	<0.1	<0.1	11.4	0.6
Avg Flow	3.5 (6)	6.8 (12)	10.0 (18)	14.3 (24)	35.1	55.3	<0.1	<0.1	9.0	0.5

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Figure 7-45 Predicted Downstream Transport of Bakken Crude Oil at the Mississippi River near Palisade, MN

This pattern of mass balance for both oil types is the result of the oil properties and relatively calm waters (i.e., not a lot of surface breaking disturbances) of the Mississippi River during high and average river flow conditions. Both oil types were predicted to float on the water surface. Owing to the calm water conditions, negligible amounts of either crude oil type were predicted to entrain into the water column. These hypothetical releases were typified by large amounts of floating oil, which are predicted to form thick surface oil slicks downstream from the release. At the end of the 24-hour simulation, floating CLB and Bakken crude oil were predicted to have a thickness greater than 0.04 inches on the water surface, with none of the slick predicted to be less than 0.0004 inches. As a result of the extensive surface oil slicks, oil floating on the river was predicted to evaporate rapidly over the 24-hour simulation. If left unmitigated, both oil types remaining on the river surface after 24 hours could continue to move downstream, with weathering and oiling of shorelines continuing until all of the oil was removed from the water surface.

The potential for entrainment of CLB and Bakken crude oil into the water column was predicted to be low due to the low wind speeds which did not cause surface breaking waves, and the low water velocities, lack of rapids, riffles, and waterfalls in this area of the Mississippi river. Natural weathering resulted in increased viscosity of the CLB, which would further reduce the likelihood of potential entrainment into the water column. Because of this, THCs in the water column were predicted to be extremely low due to the oil remaining on the surface and not entraining within the water column.

Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the CLB and Bakken crude oil were predicted to be between 1 and 100 ppb. However, brief pulses of concentrations between 2,000 and 5,000 ppb, or greater than 5,000 ppb, were predicted to occur within 24 hours after the release in extremely limited spatial and temporal extents within the Mississippi River for CLB and Bakken crude oil, respectively.

Of the oil that made its way into the water column, a portion could interact with (i.e., become adsorbed to) suspended sediments. For CLB, THCs on the bed sediments were predicted to be generally less than 0.01 g/m^2, with small areas where deposition could be as high as 1 g/m^2. For Bakken crude oil, total hydrocarbon concentrations on the bed sediment were generally predicted to be less than 0.01 g/m^2, with small areas as high as 0.5 g/m^2 (Chapter 6.0).

For the hypothetical CLB release, retention of crude oil along shorelines resulted in predicted values that were generally greater than 500 g/m^2. In contrast, for the Bakken crude oil, shoreline retention values generally ranged from 100 to 500 g/m^2. This difference is due to the greater viscosity and adhesiveness of the CLB crude oil, which results in thicker oiling of shorelines as compared to the Bakken crude oil. Extensive shoreline oiling but limited sediment oiling was predicted for approximately 18 miles of the river, below the release location, under high river flow conditions. The highest sediment concentrations were predicted for the high river flow scenario due to the higher concentration of TSS in the water column. Less oil was expected to reach sediments in the Bakken releases, when compared to the CLB. In the longer term, if not

recovered by emergency response personnel, crude oil that was initially deposited along shorelines could subsequently be deposited to bed sediments, in combination with silt and sand originating from the shoreline contact.

7.7.5.1 Mississippi River at Palisade Release During Average Flow (Summer–Fall) Period

Under the average flow scenario, CLB was predicted to travel downstream in the Mississippi River approximately 4, 7, and 14 miles after 6, 12, and 24 hours, respectively (Figure 7-44). By 24 hours after the hypothetical release, most of the released crude oil (70.3%) was predicted to remain on the surface of the Mississippi River, with 21.1% evaporating, 7.8% adhering to shorelines, and less 1% broken down through photo-oxidation and biodegradation (Figure 7-44). Negligible amounts (less than 0.1%) of the heavy oil were predicted to mix in the water column or deposit to sediment (Figure 7-44).

Bakken crude oil was predicted to follow a similar downstream transport pattern to CLB (Figure 7-45). Most of the Bakken crude oil (55.3%) was predicted to evaporate, with 35.1% remaining on the river's surface, 9% adhering to shorelines, and less than 1% broken down through photo-oxidation and biodegradation. Negligible amounts (less than 0.1%) of the lighter crude oil were predicted to mix within the water column or deposit to sediment (Figure 7-45).

This pattern of mass balance for both oil types is the result of the oil properties and relatively calm waters (i.e., not a lot of surface breaking disturbances) of the Mississippi River during high and average river flow conditions. Both oil types were predicted to float on the water surface. Owing to the calm water conditions, negligible amounts of either crude oil type were predicted to entrain into the water column. These hypothetical releases were typified by large amounts of floating oil, which formed thick surface oil slicks. At the end of the 24-hour simulation, floating CLB and Bakken crude oil were predicted to have a thickness greater than 0.04 inches on the water surface, with none of the slick predicted to be less than 0.0004 inches. As a result of the extensive surface oil slicks, oil floating on the river was predicted to evaporate rapidly over the 24-hour simulation. If left unmitigated, both oil types remaining on the river surface after 24 hours could continue to move downstream, with weathering and oiling of shorelines continuing until all of the oil was removed from the water surface.

The potential for entrainment of CLB and Bakken crude oil into the water column was predicted to be low due to the low wind speeds which did not cause surface breaking waves, and the low water velocities, lack of rapids, riffles, and waterfalls in this area of the Mississippi river. Natural weathering resulted in increased viscosity of the CLB, which would further reduce the likelihood of potential entrainment into the water column. Because of this, total hydrocarbon concentrations in the water column were predicted to be extremely low due to the oil remaining on the surface and not entraining within the water column.

Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the CLB and Bakken crude oil were predicted to be between 1 and 100 ppb. However, brief pulses of concentrations between 2,000 and 5,000 ppb, or 1,000 and 5,000 ppb, were predicted to

occur within 24 hours after the release in extremely limited spatial and temporal extents within the Mississippi River for CLB and Bakken crude oil, respectively.

Of the oil that made its way into the water column, a portion could interact with suspended sediment. For CLB, total hydrocarbon concentrations on the bed sediment were generally less than 0.01 g/m^2, with small areas as high as 1 g/m^2. For Bakken crude oil, THCs on bed sediment were predicted to be generally less than 0.01 g/m^2, with small areas as high as 0.5 g/m^2.

For the hypothetical CLB release, retention of crude oil along shorelines resulted in predicted values that were generally greater than 500 g/m^2. However, overall the concentrations were predicted to be lower than under high flow conditions. In contrast, for the Bakken crude oil, shoreline retention values generally ranged from 100 to 500 g/m^2. This difference is due to the greater viscosity and adhesiveness of the CLB crude oil, which results in thicker oiling of shorelines as compared to the Bakken crude oil. Extensive shoreline oiling but limited sediment oiling was predicted for approximately 14.5 miles of the river, below the release location, under average river flow conditions. In the longer term, if not recovered by emergency response personnel, crude oil that was initially deposited along shorelines could subsequently be deposited to bed sediments, in combination with silt and sand originating from the shoreline contact.

7.7.1.2 Mississippi River at Palisade Release During Low Flow (Winter) Period

Under the low flow scenario CLWB was predicted to travel downstream in the Mississippi River approximately 2.5 miles within the 24 hour model simulation (Figure 7-44). By 24 hours after the hypothetical release, almost all of the released crude oil (97.7%) was predicted to remain on the surface of the Mississippi River (under ice), with approximately 1% broken down through biodegradation, and less than 1% evaporating, mixing in the water column, or adhering to shorelines (Figure 7-44). Negligible amounts (less than 0.1%) of the heavy oil were predicted to evaporate or deposit to sediment (Figure 7-44).

Under the low flow scenario Bakken crude oil was predicted to travel 0.5 miles downstream in the Mississippi River within the 24 hour model simulation (Figure 7-45). This distance is approximately one-fifth that of the CLWB and is the result of the difference in oil density: Bakken crude oil is less dense than CLWB and would be expected to rise through the water column more rapidly after a release than the CLWB. As a result, lighter oils would spend less time in the water column than heavier oils, travel a lesser distance downstream, and rise to the surface and adhere to the underside of the ice more quickly. By 24 hours after the hypothetical release, almost all of the released crude oil (98.7%) was predicted to remain on the surface of the Mississippi River (under ice), with approximately 1% broken down through biodegradation (Figure 7-45), 0.2% dispersed in the water column, and 0.1% adhering to shoreline. Negligible amounts (less than 0.1%) of the light oil were predicted to evaporate or deposit to sediment (Figure 7-45).

Where CLWB was predicted to adhere to the shoreline, concentrations were generally greater than 500 g/m^2, with some areas less than 1 g/m^2. The soluble portion of the CLWB was predicted to dissolve completely into the water column and be transported downstream. This was a

conservative prediction reflecting the fact that ice cover would strongly limit or prevent the evaporation of volatile hydrocarbons, but also maximizing the potential release of soluble hydrocarbons to the water column.

Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the CLWB were predicted to be between 1 and 500 ppb. However, brief pulses of concentrations greater than 5,000 ppb were predicted to occur within 24 hours after the release in extremely limited spatial and temporal extents (generally within 1 mile of the release). At the end of the 24-hour simulation, floating oil greater than 0.04 inches thick was predicted to remain on the water surface (beneath the ice), with none of the slick predicted to be less than 0.0004 inches thick.

The soluble portion of the Bakken crude oil was also assumed to dissolve completely into the water column, and was predicted to be transported downstream resulting in elevated dissolved aromatic hydrocarbon concentrations in the water column in some areas. Maximum soluble hydrocarbon concentrations greater than 5,000 ppb were predicted to occur within 24 hours after the release in extremely limited spatial and temporal extents (the first 0.75 miles downstream of the hypothetical release). At the end of the 24-hour simulation, floating oil greater than 0.04 inches thick was predicted to remain on the water surface (beneath the ice), with none of the slick predicted to be less than 0.0004 inches thick.

Where sediment oiling was predicted occur, total hydrocarbon deposition to the bed sediment was generally predicted to be less than 0.01 g/m^2. Patchy oiling of Bakken crude oil was also predicted along shoreline of the Mississippi River near the release site, but most of the oil was predicted to remain trapped under the ice. Slightly lower amounts of Bakken crude oil were predicted along shorelines as compared to CLWB.

7.7.6 Qualitative EHHRA for the Mississippi River near Palisade

In this section the likely environmental effects of a crude oil release at the pipeline crossing location on the Mississippi River are described. A worst case crude oil release from a main-line pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed pipeline could carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). Therefore, the following discussion is based on the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7.7.3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence and sensitivity) were also considered in the analysis. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-78.

7.7.6.1 Terrestrial Receptors

For this modeling scenario, the hypothetical release of crude oil is assumed to enter the Mississippi River with no overland flow. Environmental effects on soils, terrestrial vegetation, and groundwater quality are assumed to be localized, limited in spatial extent, and readily remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors are not considered further for this release scenario.

7.7.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors that are most closely associated with the Mississippi River at Palisade scenario are addressed in this section. These receptors include water and sediment quality in rivers, shoreline and riparian habitat, wetlands, aquatic plants, benthic invertebrates, and fish.

Crude oil released into the Mississippi River during the spring (high flow) or summer-fall (average flow) seasons is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. Based on SIMAP simulations, CLB crude oil and Bakken crude oil were predicted to follow the same downstream transport pattern (each predicted to reach approximately 18 miles downstream 24 hours after a release) and form slicks of similar thickness (generally between 0.0004 and 0.04 inches). However, a greater amount of CLB is predicted to remain on the surface of the Mississippi River after 24 hours as compared to Bakken crude oil (i.e., approximately 70% vs. 36%), while a greater amount of Bakken crude oil is predicted to evaporate as compared to CLB (i.e., approximately 55% vs. 20%). During spring (high flow) and summer-fall (average flow) seasons, both oil types are predicted to have similar amounts adhering to shorelines (i.e., between 8 and 11%), and negligible amounts of either oil type are predicted to mix into the water column or deposit to sediment (i.e., less than 0.1%).

The effects of a crude oil release on benthic invertebrates and fish would depend on the characteristics of the released oil, and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. The potential for entrainment of CLB and Bakken crude oil into the water column during high and average river flow conditions was predicted to be low due to the low wind speeds, which did not cause surface breaking waves, and the lack of rapids, riffles, and waterfalls in this area of the Mississippi River. Natural weathering resulted in increased viscosity of the CLB, which further reduced the likelihood of potential entrainment into the water column. Because of this, total hydrocarbon concentrations (i.e., whole oil in the water column) were extremely low due to the oil remaining on the surface and not entrained within the water column. Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the CLB and Bakken crude oil were predicted to be between 1 and 100 ppb. However, brief pulses of concentrations between

1,000 and greater than 5,000 ppb were predicted to occur within 24 hours after the release in extremely limited spatial and temporal extents within the Mississippi River. These areas of high concentration would be expected to move down the river with the flowing water, so that a transient pulse of relatively high exposure to dissolved aromatic hydrocarbon concentrations would be followed by exposure to much lower concentrations.

French McCay (2002) proposed a benchmark lethal concentration (LC50) value of 224 ppb (µg/L) for sensitive aquatic species exposed indefinitely to total aromatic hydrocarbons from crude oil. For species of average sensitivity, a threshold of 1,869 ppb was reported. Given exposure of shorter duration (i.e., less than one day), a considerably higher concentration (perhaps two to three times higher) would be required in order to result in the death of even sensitive species. Therefore, the predicted transient exposure concentrations for dissolved aromatic hydrocarbon compounds in the river water could result in acute lethality to fish that are sensitive or have average sensitivity to hydrocarbons. With these modeled concentrations, lethality could also be expected in isolated areas of the Mississippi within the release trajectory where high concentrations of dissolved aromatic hydrocarbon persist over a period of several days or longer. However, the majority of predicted dissolved aromatic concentrations were much less than 500 ppb.

Of the oil that made its way into the water column, a portion could interact with suspended particulate matter. Where oil is predicted to deposit to sediment, the highest sediment concentrations were predicted for the high river flow scenario due to the higher concentration of TSS in the water column. Slightly less oil was expected to reach sediments in the Bakken releases, when compared to the CLB. The highest sediment concentrations were predicted for the high river flow scenario due to the higher concentration of TSS in the water column. For CLB, total hydrocarbon concentrations in sediment were generally less than 0.01 g/m^2, with small segments as high as 1 g/m^2. For Bakken crude oil, THCs on the sediment were generally less than 0.01 g/m^2, with small segments as high as 0.5 g/m^2.

With limited mixing of crude oil into surface river bed sediments to a depth of less than 0.25 inch, crude oil deposition of less than 0.1 g/m^2 is likely to be undetectable, and without any ecological consequence. Crude oil deposition to sediment of less than 1 g/m^2 would result in sediment hydrocarbon concentrations that would be less than 100 ppm (mg/kg). These low concentrations would also be unlikely to result in significant environmental effects on fish, benthic invertebrates, or other aquatic life. As a result, based on the SIMAP model results, the potential for acute toxicity to fish and benthic invertebrates is expected to be low, and similar for both the Bakken and CLB crude oil types.

The potential for chronic effects of released crude during high and average river flow oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease) is expected to be generally low. While the eggs and embryos of these species could be exposed to total PAH concentrations in the river water that could be sufficiently high to induce deformities or cause mortality, these areas of limited and transitory. The potential for blue sac

disease would be greatest for a crude oil release in winter or during the spring freshet, as such crude oil could be dispersed into side-channel and oxbow habitat that is important for spawning fish such as northern pike. While local accumulations could result in adverse effects on developing fish eggs and embryos in the first season following an accidental crude oil release, it is not likely that such effects would persist beyond one year, and effects would occur in only a limited area of the river. Therefore, at the scale of the Mississippi River in Minnesota, it is not likely that such effects would be detectable at a population level.

The potential for phototoxicity caused by an interaction of UV light with PAHs accumulated in fish tissues would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. The risk of phototoxicity would be mitigated by high concentrations of suspended sediment and DOC present in the water of the Mississippi River, which would absorb and limit the penetration of UV light into the water column.

The Mississippi River supports emergent, floating and submerged aquatic plants. Where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants would be less vulnerable, as they would be exposed primarily to dissolved hydrocarbons (which is limited in high and average flow conditions), and are not considered likely to be among the most sensitive groups of aquatic biota to such exposure. For a hypothetical release under spring freshet conditions, it is likely that most aquatic plants would still be dormant or submerged, and that environmental effects on this receptor type would be minimal. However, flooded riparian areas and wetland habitats in oxbows would also be exposed to the released oil, and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat. A release of crude oil in winter would have little direct effect on aquatic plants, as they would be in a dormant state.

During low flow winter conditions, if the release was to occur directly to the river below the ice (as is assumed in the SIMAP model), or if there were openings in the ice that the released oil could penetrate, the oil could travel downstream under the ice, accumulating in the narrow gap between the ice and the river sediment, or accumulating in hollows under the ice as it moved. Results provided in Section 7.7.5.3 provide bounding cases for the products likely to be carried in the pipeline. The SIMAP simulations indicate that heavy crude oil could be carried 5 times farther downstream than light oil (i.e., 2.5 miles vs 0.5 miles from the point of release) under winter low-flow conditions, although this is due to the assumption that the heavy crude oil would only rise slowly through the water column. In reality, with the assumed failure mechanism of a full bore pipeline rupture, it is likely that both types of crude oil would well up from the river bed with a certain amount of momentum, along with entrained river bed muds. Both types of crude oil would probably behave more similarly, near the point of release, than the SIMAP simulation suggests. At the end of the 24-hour simulation, floating oil of both types is predicted to have a thickness between 0.0004 and 0.04 in. at the water surface (beneath the ice). For both oil types, the winter ice would effectively inhibit evaporation. The soluble portion of the CLWB was

predicted to dissolve completely into the water column and be transported downstream. Maximum dissolved aromatic hydrocarbon concentrations greater than 500 ppb were predicted in limited regions within the release extent. However, brief pulses of concentrations greater than 5,000 ppb were predicted to occur 24 hours after the release in extremely limited spatial and temporal extents for CLWB (generally within 1 mile of the release) and Bakken crude oil (generally within 0.75 miles of the release). As noted above, short-term exposure to these concentrations of dissolved aromatic hydrocarbons from crude oil could result in mortality of fish species.

7.7.6.3 Semi-Aquatic Wildlife Receptors

Habitat along the Mississippi River downstream of the hypothetical release location supports amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors), and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter). Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.7.6.3.1 Amphibians and Reptiles

Crude oil released to the Mississippi River during the spring (high flow) or summer-fall (average flow) seasons would be predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. Based on SIMAP simulations, CLB crude oil and Bakken crude oil were predicted to follow the same downstream transport pattern (each predicted to reach approximately 18 miles downstream 24 hours after a release) and form slicks of equal thickness between 0.0004 inches and greater than 0.04 inches. However, a greater amount of CLB is predicted to remain on the surface of the Mississippi River after 24 hours as compared to Bakken crude oil (e.g., approximately 70% vs. 36%), while a greater amount of Bakken crude oil is predicted to evaporate as compared to CLB (e.g., approximately 55% vs. 20%). During spring (high flow) and summer-fall (average flow) seasons, both oil types are predicted to have similar amounts adherence to shorelines (e.g., between 8 and 11%) and negligible amounts (less than 0.1%) of either oil type are predicted to mix within the water column or deposit to sediment.

Within the oil-exposed habitats along the river that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. As a result, exposure of these animals to released crude oils would be limited. After the Kalamazoo River oil spill in 2010, snakes did not appear to be highly exposed to spilled oil. A release of light crude oil during the spring would likely have a greater effect than in summer due to the greater predicted downstream transport distance and interaction with greater areas of riparian and wetland habitats than later in the year.

Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms would have very little exposure to released oil moving on the water surface or within the water column.

7.7.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, lakes, wetlands, and riparian areas as components of their habitat, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory, and herbivory. If exposed to external oiling, the ability of birds to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release. During the spring (high flow) season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Waterfowl and other semi-aquatic birds present in the affected river reach would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release.

The Mississippi River below Palisade, Minnesota would provide excellent habitat for a variety of waterfowl species, as well as fish-eating raptors, and other species such as kingfisher, herons and shorebirds. The environmental effects of a crude oil release in the summer-fall period are likely to be of similar or lesser magnitude. With rising water temperatures, mortality of lightly oiled adult birds due to hypothermia becomes less likely than in the spring, and the temporary presence of large numbers of migrating individuals is unlikely. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest, or mortality of young birds due to direct oil exposure or the loss of a parent bird.

Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure. Potential effects on aquatic and semi-aquatic birds in the fall would be similar to those in spring, although a smaller overall length of river habitat would be affected due to lower river flows. Mortality of waterfowl and other semi-aquatic bird species would occur, and would likely be similar to effects that were reported following the release of crude oil to the Kalamazoo River in 2010. While the death of these birds would be a serious environmental effect locally, given the length of the Mississippi River in Minnesota, and the abundance of other wetland, lake, river and riparian habitat in the region and state, longer-term population-level effects on semi-aquatic birds are not likely to be observed.

Under winter conditions (March), it was assumed that the Mississippi River would be frozen (100% ice cover). In addition, most waterfowl and other semi-aquatic bird species would migrate south in the winter. Therefore, a crude oil release in winter would be expected to have very limited effects on birds.

7.7.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses particularly upon species that have a primary association with the aquatic environment such as muskrat and beaver (herbivores), American mink (carnivore-piscivore) and river otter (piscivore). These species are at greater risk of exposure to an oil release in water than more fully terrestrial mammals. The Mississippi River below Palisade, Minnesota, would provide excellent habitat for muskrat and beaver, as well as fish-eating mammals such as American mink and river otter, and incidental omnivorous mammals such as raccoon.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along the Mississippi River where effects may occur, and the magnitude of effects, is related to the season and river flow rate, and the type of oil released. Effects to semi-aquatic mammals relate more to the amount of time spent in the water and oil-contaminated riparian habitat (and consequent exposure to physical oiling) than to dietary preferences. Timely capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During high and average flow conditions, and based on SIMAP simulations, CLB crude oil and Bakken crude oil were predicted to follow the same downstream transport pattern (each predicted to reach approximately 18 miles downstream 24 hours after a release) and form slicks of equal thickness between 0.0004 in. and greater than 0.04 in. Both oil types are predicted to have similar amounts of adherence to shorelines (e.g., between 8 and 11%) and only very little

amounts of both types of oil are predicted to mix within the water column or deposit to sediment (e.g., less than 0.1%).

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Animals upstream, farther downstream where there is no exposure, or occupying other nearby habitats, would likely be unaffected. Therefore, although mortality of a considerable number of semi-aquatic mammals could be expected, large-scale (i.e., regional) population level effects are unlikely. Environmental effects of a crude oil release in the summer-fall period are likely to be of a magnitude similar to or lesser than those associated with a release during spring. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is less likely than in the spring. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil are possible as a result of ingesting crude oil residues while grooming, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure. While the death of these animals would be a serious environmental effect locally, given the length of the Mississippi River in Minnesota, and the abundance of other wetland, lake, river and riparian habitat in the region and state, longer-term population-level effects on semi-aquatic mammals are not likely to be observed.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. Animals that became oiled in the winter would be likely to rapidly die as a result of hypothermia.

7.7.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs than heavier crude oils, although diluted bitumen may contain similar amounts of VOCs to light crude oils, depending upon the type and amount of diluent they contain. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release. For the Mississippi River at Palisade scenario, the community of Palisade, Minnesota (population less than 200 as reported in the census of 2010) is located approximately one mile north of the hypothetical release location. Depending upon the wind direction at the time of a hypothetical crude oil release, receptors in Palisade might or might not be exposed to odor in the first few hours and days. A small number of human receptors would likely also be present in closer proximity to the river, between the hypothetical release location and the downstream extent of the oil trajectory. These individuals would have variable exposure to VOCs and odor, depending upon their location and prevailing wind speed and direction in the event of a crude oil release.

Based on SIMAP simulations, CLB crude oil and Bakken crude oil were predicted to follow similar downstream transport patterns (each predicted to reach approximately 18 miles downstream within 24 hours of a release), and to form slicks of similar thickness during the spring (high flow) or

summer-fall (average flow) seasons. However, a greater amount of Bakken crude oil (greater than 50%) is predicted to evaporate within 24 hours as compared to CLB crude oil (approximately 20%). Therefore, the effects of a release of Bakken crude oil on air quality would be greater than the effects of a release of CLB.

If a crude oil release was to occur in winter, and to be confined below ice on the river, very little of the volatile hydrocarbon present in the oil would be released to the atmosphere as VOCs. Most would be forced to dissolve into the river water, moving downstream, or remain associated with the liquid crude oil at locations where this oil accumulated until spring breakup. At that time, it is likely that the remaining crude oil would be dispersed downstream along the river, although the residual volatile hydrocarbon content and effects on air quality would be lower than the effects described here for a release during the spring freshet.

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil vapor. Similarly, ATSDR (1995) report that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

The potential for VOC inhalation exposures to the public would be greatest near and downwind from the release site while the released oil is on the water surface. In the unlikely event of a crude oil release, residents in close proximity would become aware of a strong hydrocarbon odor. Most of the volatile hydrocarbons would be lost within the first 24 hours following a release of crude oil. It is also expected that emergency response personnel would contact such residents and advise them to evacuate. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while the emergency response takes place.

The drinking water intake for Palisade, Minnesota is upstream of the hypothetical release location so effects on water quality for residences in the area are not expected. In addition, no drinking water HCAs were identified along the path of the release. However, in the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. Based upon case studies involving crude oil releases elsewhere, this process could take a few days to two weeks, but reports of crude oil releases affecting private wells are rare, making this an unlikely effect.

Relatively little has been published regarding the long-term effects of human exposure to a crude oil release. Health effects observed in residents and clean-up workers in the months following such releases generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure

to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

No overland transport of released crude oil was modelled for this hypothetical release location. Infiltration of crude oil into soil and subsequently into groundwater is assumed to be negligible.

The Mississippi River downstream from the hypothetical release location crosses through patches of the Waukenabo State Forest and sections of land owned by the BLM. This section of the Mississippi River is also frequented by recreational users for canoeing, fishing and other purposes. Effects on air and water quality, or the presence of crude oil residues in the sediment, riparian or wetland habitat, could potentially disrupt public use of natural resources (e.g., drinking water supplies, hunting, fishing, recreation). Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil.

7.7.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to the Mississippi River near Palisade, Minnesota have been assessed. The proposed pipeline could carry a variety of crude oil types (ranging from very light [e.g., Bakken crude oil] to heavy [e.g., diluted bitumen such as CLB], and the discussion of expected environmental effects on receptors is based on these crude oil types as bounding conditions. Potential terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors and human and socio-economic receptors were screened to identify those with the most likely interactions with released oil. The results of this assessment are summarized in Table 7-7-6.

Table 7-80 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Palisade

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Palisade	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	It is assumed in the model that crude oil would enter directly into the Mississippi River with no holdup of oil on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
Rivers (Mississippi River)	Both light and heavy oil would travel downstream from the release location, affecting the Mississippi River. Lighter crude oils and heavier crude oils are predicted to follow the same downstream transport pattern (each predicted to reach approximately 18 miles downstream within 24 hours after a release), and form slicks of similar thickness (between 0.0004 inches and greater than 0.04 inches). During spring (high flow) and summer-fall (average flow) seasons, a greater amount of CLB is predicted to remain on the surface of the Mississippi River after 24 hours as compared to Bakken crude oil (e.g., approximately 70% vs. 36%). However, both oil types are predicted to have similar amounts adherence to shorelines (e.g., approximately 8% for the CLB and 9-11% for the Bakken). Negligible amounts of either crude oil type are predicted to mix within the water column or deposit to sediment. In winter, simulations indicate that heavy crude oil could be carried farther downstream than lighter oil (i.e., 2.5 miles vs. 0.5 miles from the point of release), but this may be due to assumptions in the model. Overall, the SIMAP simulations indicate similar effects of both crude oil types on the aquatic habitat of the Mississippi River at Palisade, Minnesota.	SAME	SAME
Sediment	In all three seasons, both oil types are predicted to have very little mixing within the water column or deposition to sediment (e.g., less than 0.1%). Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. Where deposition is predicted, a slightly higher concentration of CLB is predicted in sediment than for Bakken crude oil. However, neither is predicted to be deposited to sediments at concentrations that would seriously affect aquatic life.	SAME	SAME

Table 7-80 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Palisade

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Palisade	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location, affecting the Mississippi River. Lighter crude oils and heavier crude oils are predicted to follow the same downstream transport pattern (each predicted to reach approximately 18 miles downstream within 24 hours after a release), and form slicks of similar thickness (between 0.0004 inches and greater than 0.04 inches). During spring (high flow) and summer-fall (average flow) seasons, both oil types are predicted to have similar amounts adherence to shorelines (e.g., approximately 8% for the CLB and 9-11% for the Bakken). Flooding of riparian and wetland habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, which would be persistent. This is in contrast to light crude oil which would be deposited as a thin layer or sheen. In winter, simulations indicate that heavy crude oil could be carried farther downstream than lighter oil (i.e., 2.5 miles vs. 0.5 miles from the point of release), but this may be a function of assumptions inherent in the model, and these distances are expected to be more similar should a release occur. Overall, the SIMAP simulations indicate that slightly more of the Bakken crude oil might strand on shorelines or in riparian areas (9-11%) than would be the case for CLB (approximately 8%), although the CLB crude oil type would tend to be more persistent in such areas.	SAME	SAME
Aquatic Plants	The Mississippi River supports emergent, floating and submerged aquatic plants. Based on SIMAP simulations for spring and summer-fall conditions, CLB crude oil and Bakken crude oil were predicted to exhibit similar downstream transport patterns, and to form slicks of similar thickness. Where they occur, floating aquatic plants would be expected to be killed if contacted by a floating oil slick. Submerged aquatic plants would be less vulnerable. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem was oiled).	SAME	SAME
Benthic Invertebrates	Environmental effects on benthic invertebrates would be limited to areas affected by the released oil. In all three seasons, both oil types are predicted to have very little mixing within the water column or deposition to sediment (e.g., less than 0.1%). Neither the light nor the heavy oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release. Where deposition is predicted, a slightly higher concentration of CLB is predicted in sediment than for Bakken crude oil. However, neither is predicted to be deposited to sediments at concentrations that would seriously affect aquatic life such as benthic invertebrates.	SAME	SAME

Table 7-80 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Palisade

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Palisade	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Fish	Environmental effects on fish would be limited to areas affected by the released oil. In spring and summer-fall conditions, both light and heavy oil are predicted to follow the same downstream transport pattern (i.e., reach approximately 18 miles downstream within 24 hours after a release). The potential for entrainment of CLB and Bakken crude oil types into the water column during high and average river flow conditions was predicted to be low. Because of this, predicted total aromatic hydrocarbon concentrations in the water column were generally low due to the oil remaining on the surface and not entrained within the water column. The maximum concentration of dissolved aromatics from both oil types was locally greater than 1,000 to 5,000 ppb, but suggested a transient exposure of less than 24 hours duration. This concentration range and duration of exposure could result in acute lethality to sensitive aquatic species, and species with average sensitivity to hydrocarbons. In winter, Bakken Crude oil is predicted to travel 0.5 miles downstream in the Mississippi River within the 24 hour model simulation, a distance that is approximately one-fifth that of the distance traveled by CLWB. The predicted maximum soluble hydrocarbon concentration of both oil types is greater than 5,000 ppb in limited areas (within 1 mile of the release location) and transient exposures would be expected within their release extent.	SAME	SAME
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Environmental effects on fish would be limited to areas affected by the released oil. In spring and summer-fall conditions, both light and heavy oil are predicted to follow the same downstream transport pattern (i.e., reach approximately 18 miles downstream within 24 hours after a release). During spring (high flow) and summer-fall (average flow) seasons, both oil types are predicted to have similar amounts of adherence to shorelines (e.g., approximately 8% for the CLB and 9-11% for the Bakken). Flooding of riparian and wetland habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, which would be persistent. This is in contrast to light crude oil which would be deposited as a thin layer or sheen. Within these habitats, oiling effects on adults, juveniles, and eggs could potentially be observed. Higher potential would exist for effects on amphibians than for turtles, which appear to be somewhat tolerant of external oiling. Dormancy of amphibians and reptiles in winter and early spring means exposure to oil released at this time of year could be negligible, and adverse environmental effects unlikely.	SAME	SAME

Table 7-80 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Palisade

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Palisade	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Birds	Mortality of oiled aquatic and semi-aquatic birds would be limited to areas affected by the released oil. Both light and heavy crude oil types are predicted to travel similar distances, and both would form slicks of similar thickness. During the spring high flow season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. Few birds are present in winter, so effects would be minimal in that season.	SAME	SAME
Semi-aquatic Mammals	Mortality of oiled semi-aquatic mammals would be limited to areas affected by the released oil. Both light and heavy crude oil types are predicted to travel similar distances, and both would form slicks of similar thickness. Adverse effects on mink and otter would be particularly severe in winter, due to the effects of oil in the insulating properties of fur, in combination with cold water temperatures. However, muskrat and beaver might be spared due to their lower activity levels in winter.	SAME	SAME
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. Light crude oil is expected to travel a similar distance downstream under spring and summer conditions as heavy crude oil. As a result, environmental effects on air quality are predicted to be spatially similar for light crude oil types. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS

Table 7-80 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Palisade

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Palisade	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Human Receptors	Typical human health effects associated with short-term inhalation of VOCs from crude oil releases include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is unlikely. Residents in close proximity would become aware of a strong hydrocarbon odor. Most volatile hydrocarbons would be lost within 24 hours following a release. The human receptors most likely to be exposed to VOCs under this hypothetical crude oil release scenario would be located in homes located close to the Mississippi River, within about 18 miles of the release point. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	SAME	SAME
Public Use of Natural Resources	Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Both light and heavy crude oil types are predicted to travel similar distances, and both would form slicks of similar thickness, potentially interrupting public use of natural resources over a similar area. No drinking water HCAs were identified along the path of the release. However, some homes are located along the trajectory of a predicted release and could rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to the Mississippi River would result in adverse health effects to consumers of drinking water. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route.	SAME	SAME

7.8 EXPECTED ENVIRONMENTAL EFFECTS OF LARGE RELEASES OF CRUDE OIL TO THE MISSISSIPPI RIVER AT LITTLE FALLS

The proposed pipeline would cross underneath the Mississippi River five miles north of Little Falls, Minnesota. As the Mississippi River flows south from the hypothetical release site, it passes through Little Falls, through the Little Falls electric generation dam, through Zebulon Pike Lake (an 8 mile long reservoir) and through another electric generation dam (Blanchard Dam). A number of islands and riparian habitats are part of this reach of the Mississippi River. This scenario captures a release of crude oil directly to the Mississippi River, with downstream transport from the hypothetical release point to the south through a large population center, as well as a high energy physical environment with several waterfalls. The average gradient of the Mississippi River in this section is greater than at other assessed locations, including both the effects of dams, and relatively narrow sections of the river where flow is confined and faster than in wider reaches. As identified in Chapter 3, the Mississippi River forms the western boundary of the Anoka Sand Plain Subsection of the Minnesota and Northeast Iowa Morainal Section of the Eastern Broadleaf Forest Province (MN DNR 2006).

7.8.1 Description of the Freshwater Environment

The Mississippi River near Little Falls flows south along a broad channel (approximately 800 ft across) with numerous islands (MN DNR 2016o). The river banks are typically steep and well defined. Immediately downstream of the hypothetical release site, the Mississippi River flows by Belle Prairie County Park and an island called Island 48. From here the Mississippi River passes Roscoe Island, Island 50, the confluence of Little Elk River, and then narrows and becomes turbulent prior to flowing over the Little Falls electrical generation dam. Directly south of this dam the Mississippi River bends sharply around Mill Island and flows south where it is fed by the Swan River.

The Zebulon Pike Lake reservoir begins downstream of Little Falls dam, and terminates at the Blanchard electrical generation dam about 8 miles south. Numerous parks (i.e., Le Bourget Park, James Green Park, Maple Island Park, Mill Park and the much larger Charles A. Lindbergh State Park) are associated with the reservoir. The McDougall WMA and the Charles A. Lindbergh State Park provide recreational opportunities such as hunting, trapping, hiking, cross-country skiing, snow shoeing, and wildlife watching (MN DNR 2016p; MN DNR 2016q). The banks of the Mississippi River are mainly forested, with residences and agricultural lands on either side. Below the Blanchard dam, the river channel continues to wind, with occasional islands and narrow sections, as it continues generally south toward the cities of Sartell, Sauk Rapids and St. Cloud, Minnesota.

Excellent fishing opportunities for smallmouth bass, walleye, northern pike, and muskellunge are available along this stretch of the Mississippi River (MN DNR 2016o). This section of the Mississippi River and surrounding riparian areas also provide habitat for mallard, teal, wood duck, mergansers, goldeneye, and Canada goose (MN DNR 2016r). The Anoka Sand Plain Subsection

also provides open grasslands for sandpiper, nesting songbirds and grazing ungulates (elk, deer) and is home to 97 SGCN (MN DNR 2006; MN DNR 2016p; MN DNR 2016r). These include amphibians (1 species), birds (56 species), fish (3 species), insects (9 species), mammals (8 species), mollusks (9 species), reptiles (8 species), and spiders (3 species) (MN DNR 2006). Of these species, 37 are afforded federal or state endangered, threatened, or of special concern status (MN DNR 2006; MN DNR 2016d). It is foreseeable that some of these SGCN could utilize aquatic habitats along the Mississippi River.

Several access points downstream from the proposed pipeline crossing location were visited in May 2016, to provide additional insight into baseline environmental conditions for the Mississippi River near Little Falls. Representative site photographs are provided in Figure 7-46 through Figure 7-49. Field observations are summarized in Table 7-81.



Figure 7-46 Mississippi River and Riparian Habitat Approximately 5 Miles Downstream of Pipeline Crossing, Above the Little Falls Dam



Figure 7-47 Mississippi River and Riparian Habitat Approximately 5 Miles Downstream of Pipeline Crossing, Above the Little Falls Dam



Figure 7-48 Mississippi River and Riparian Habitat Approximately 28.75 Miles Downstream of Pipeline Crossing



Figure 7-49 Mississippi River and Riparian Habitat Approximately 53.1 Miles Downstream of Pipeline Crossing, at Clearwater, Minnesota

Table 7-81 Environmental Characteristics Observed at Selected Access Points on the Mississippi River in May 2016

Access Point	Latitude Longitude	Notes
4th Avenue Landing State Water Access Site 5 miles downstream of proposed pipeline crossing	45.9811 -94.3624	*Habitat Description:* site is upstream of dam in Little Falls. Shoreline is well-defined due to relatively stable water levels behind dam. Shoreline is gradual to abrupt, with most banks being less than 10 ft high. Terrace forest trees (Elm - green ash) are most common in vicinity of this site. The non-native, invasive Siberian elm is occasional in area. *Wildlife observed:* mallard
Mississippi Co Park State Water Access Site 28.75 miles downstream of proposed pipeline crossing	45.7266 -94.2231	*Habitat Description:* river banks are approximately 5-10 ft high in this area with silver maple floodplain forest on the lowest areas and islands. Terrace forest (elm-ash) begins approximately 15-20 ft above river level. Plant communities are generally moderate to good quality in areas observed. *Wildlife observed:* catbird, Canada goose, yellowthroat *Fish & Wildlife likely to occur in vicinity:* walleye, smallmouth bass, wood duck

Table 7-81 Environmental Characteristics Observed at Selected Access Points on the Mississippi River in May 2016

Access Point	Latitude Longitude	Notes
Clearwater State Water Access Site 53.1 miles downstream of proposed pipeline crossing	45.4195 -94.0424	Habitat Description: river banks are generally about 15-20 ft high in this area with the river banks being relatively steep-sided, but stable and vegetated. Terrace forest on first terrace above river is dominated by hackberry, silver maple, green ash, and American elm. The shrub layer and herbaceous vegetation is composed of a mix of native and nonnative species. Fish & Wildlife likely to occur in vicinity: walleye, smallmouth bass, wood duck

7.8.2 High Consequence Area Assessment for the Mississippi River near Little Falls Crossing Location

As defined in Section 7.0, HCAs include populated areas, drinking water source areas, ecologically sensitive areas, and commercially navigable waterways. Sensitive AOIs include Minnesota drinking water management areas, native plant communities, sensitive lake shores, recreational areas, tribal lands, and protected areas of several types (e.g., national forests, military lands, state parks).

Under low, average and high flow conditions, the stretch of the Mississippi River downstream from the hypothetical release location passes through several HCAs, as well as protected areas and drinking water AOIs (Table 7-82 and Table 7-83, respectively). The locations of the HCAs and AOIs are shown in Figure 7-50.

Table 7-82 HCAs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mississippi River near Little Falls Crossing Location

HCA Type	HCA Subtype	Description / Locations
Environmentally Sensitive Area	N/A	N/A
Population Area	Other	Little Falls, MN Rice, MN
Drinking Water	Wellhead Protection Area	Little Falls, MN
NOTE: Data for the HCA analysis were obtained from the USDOT PHMSA HCA datasets plus additional HCAs compiled by Enbridge during 2010 and 2013.		

Table 7-83 Table 7-8-3: AOIs Potentially Affected by a Release of CLB and Bakken Crude Oil at the Mississippi River near Little Falls Crossing Location

AOI Type	AOI Subtype	Description / Locations
Drinking Water	Surface Water Supply Management Area	Saint Cloud, MN
	Water Supply Management Area	Little Falls, MN
Protected Area	Bureau of Land Management	BLM Land
	Private Conservation Land	Sensitive Ground Water - Limit
	State Park	Charles A. Lindbergh State Park
	State Wildlife Management Area	McDougall WMA, Michaelson Farm WMA
	The Nature Conservancy	McDougall Homestead

NOTE:

Data for the AOI analysis were derived from multiple datasets provided on the Minnesota Geospatial Commons website, USGS Protected Areas Database of the United States and the Minnesota Department of Transportation.

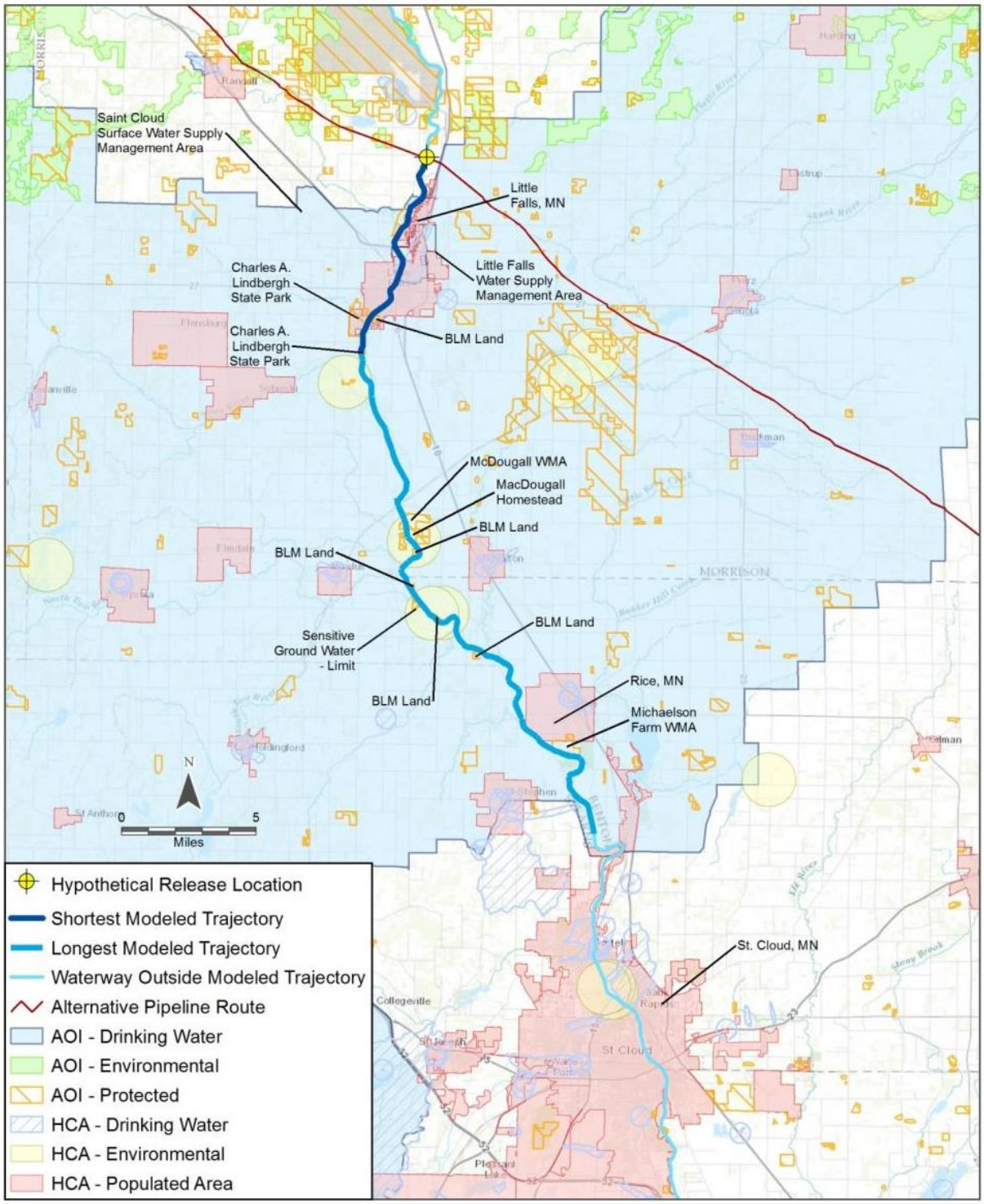

Figure 7-50 HCAs and AOIs Potentially Affected by a Crude Oil Release at the Mississippi River near Little Falls Crossing Location

7.8.3 Selection of Key Ecological and Human Environment Receptors for Mississippi River near Little Falls Crossing Location

Taking into account environmental characteristics of the Mississippi River near Little Falls, the potential interactions of released crude oil with key ecological and human environment receptors were screened to identify key receptors for the subsequent environmental effects analysis. The rationale and results of this screening step are provided in Table 7-84.

Table 7-84 Key Ecological and Human Environment Receptors for the Mississippi River near Little Falls Crossing Location

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mississippi River near Little Falls Scenario	Selected (Y/N)
Terrestrial Receptors		
Soils	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. Any oil that reaches soil would be physically remediated to established standards.	N
Groundwater	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. In the event of an actual oil release, effects on groundwater quality would be localized and/or negligible.	N
Terrestrial Vegetation	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with no holdup of oil on land. Any oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the clean-up process.	N
Aquatic Receptors		
Rivers (Mississippi River)	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver.	Y
Lakes (Zebulon Pike Lake)	Low. Zebulon Pike Lake is a reservoir approximately 8 miles south of Little Falls and bounded by the Little Falls Dam on the north and the Blanchard Dam on the south. While considered a lake, there is no relevant lacustrine habitat. This stretch of the Mississippi River is similar to other stretches.	N
Sediment	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. This allows potential interaction and/or deposition of crude oil residues to sediments.	Y
Shoreline and Riparian Areas	High. An assumption made in the fate modeling for this scenario is that released oil would enter directly into the Mississippi River with subsequent physical transport downriver. This allows potential interaction with shoreline and riparian habitat, especially associated with the many islands within the river.	Y
Wetlands	Low. An assumption made in the fate modeling for this scenario is that released oil would enter directly into Mississippi River with subsequent physical transport downriver. There is little to negligible wetland habitat in the vicinity of the predicted release trajectory.	N

Table 7-84 Key Ecological and Human Environment Receptors for the Mississippi River near Little Falls Crossing Location

Receptor	Relevance for Inclusion as an Environmental Receptor for the Mississippi River near Little Falls Scenario	Selected (Y/N)
Aquatic Plants	Low. Substantial aquatic plant community development is unlikely in the high energy environments of this stretch of the Mississippi River.	N
Benthic Invertebrates	High. The Mississippi River supports benthic invertebrate communities.	Y
Fish	High. The Mississippi River supports fish communities.	Y
Semi-Aquatic Wildlife Receptors		
Amphibians and Reptiles	High. Mississippi River supports amphibians and reptiles.	Y
Birds	High. Mississippi River supports waterfowl and other birds.	Y
Semi-aquatic Mammals	High. Mississippi River supports semi-aquatic mammals.	Y
Human and Socio-Economic Receptors		
Air Quality	High. From the hypothetical release site, the Mississippi River runs through the community of Little Falls, Minnesota (5 miles south) and is bordered by a number of homes. The Mississippi River also passes near the population center of Rice, Minnesota, which is along the downstream flow path for released crude oil. Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns.	Y
Human Receptors	High. Effects on air quality or the presence of crude oil residues in aquatic and riparian habitat have the potential to temporarily affect human health. Drinking water for the communities of Little Falls and Rice is drawn from groundwater sources by city owned and operated wells. Therefore, the water supplies for residents of Little Falls and Rice are not likely to be affected by a release.	Y
Public Use of Natural Resources	Downstream of the hypothetical release site the Mississippi River flows through the Zebulon Pike Lake reservoir, numerous parks (i.e., Le Bourget Park, James Green Park, Maple Island Park, Mill Park, and the much larger Charles A. Lindbergh State Park) and the McDougall and Michaelson Farms WMA. These locations provide a number of recreational opportunities. Effects on air and water quality, or the presence of crude oil residues in the sediment or habitat, could potentially disrupt public use of natural resources.	Y

7.8.4 Modeled Conditions at the Release Location

A description of key modeling assumptions for the environmental effects analysis for the Mississippi River near Little Falls, Minnesota scenario is provided in this section. The Mississippi channel in this area is characterized by a variety of slow moving to moderately flowing sections, with occasional riffle sections, and dams with potential overflow and tailrace sections. This high energy environment has the potential to result in localized turbulence that may entrain crude oil.

Unlike OILMAP Land, the SIMAP fate and transport modeling software can quantify the amount of crude oil that is likely to become entrained into or dissolved in the water column, or deposited to sediments as a result of the turbulent conditions (Chapter 4 and 5). To shed light on this potential entrainment or dissolution, SIMAP was used to simulate hypothetical releases of CLB and Bakken crude oils into the Mississippi River downstream of Little Falls, Minnesota. Like the OILMAP Land model, SIMAP provides an indication of the downstream extent of oiling and mass balance of oil within the 24 hour modeled period. A longer time period was not modeled as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within the 24 hour period.

The two crude oil types provide bounding cases for oils that range from light (e.g., Bakken crude oil having low viscosity and density) to heavy (CLB/CLWB, heavy diluted bitumen crude oil types having higher viscosity and density). Seasonal variations in river flow velocity, temperature, wind speed, and snow and ice cover were all considered at the release location. A summary of key variables is provided in Table 7-85.

Table 7-85 Environmental and Hydrodynamic Conditions for the Three Modeled Periods at the Mississippi River near Little Falls Crossing

Season	Month	Air Temperature (°C)	Wind Speed (m/s)	Average River Velocity (m/s)
Low Flow (Winter)	February	-8.33	4.30	0.46
Average Flow (Summer-Fall)	July	22.06	3.47	0.60
High Flow (Spring)	April	7.06	4.85	0.74
NOTE: A velocity of 1 m/s is equivalent to 2.25 miles per hour.				

The highest average flow velocity of the Mississippi River near Little Falls coincides with the spring freshet (i.e., April), a result of rising temperatures and snowmelt. Average flow would typically occur in summer and fall seasons. July, the month with the warmest temperature, was selected to represent the maximum amount of evaporation. The lowest flow rate occurs in winter (February), and was typified by freezing conditions and probable ice cover on water.

The crude oil release volume was calculated as a full bore rupture, with a maximum time to response in the pipeline Control Center of 10 minutes, followed by a 3 minute period to allow for valve closure. Therefore, the release volume represents the volume of oil actively discharged in the period of time required to detect and respond to the event (taking into consideration the pipeline diameter, pipeline shutdown time, pipeline design flow velocity), followed by the volume of oil lost due to drain-down of the elevated segments of pipeline. The maximum 13 minute response time to valve closure is an Enbridge standard for safe operations and leak detection. This includes the combination of identification of the rupture, analysis of the pipeline condition, pipeline shutdown, and full valve closure in the affected pipeline section. While 13

minutes is the maximum time for valve closure, this is a conservative assumption, since a response through to valve closure is expected to occur in less than 13 minutes in a full bore rupture leak scenario. Based on these assumptions, the site-specific hypothetical release volume was estimated of Bakken, CLB, or CLWB crude oil.
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7.8.5 Summary of Predicted Downstream Transport of Bakken and Cold Lake Crude Oils

A summary of the predicted downstream trajectories and mass balance for Bakken and Cold Lake crude oils, under the three seasonal scenarios, is provided in Figure 7-51 and Figure 7-52. These simulations are assumed to provide bounding conditions for a release of light and heavy crude oil types, respectively. The fate of most types of crude oil, if released, would lie within the envelope of predictions for the Bakken and Cold Lake crude oil types. The Cold Lake crude oil was assumed to be CLB for the high flow and average flow scenarios, and to be CLWB for the low flow (winter) scenario. The maximum simulation duration using SIMAP was 24 hours, with intervals at 6 and 12 hours. These times were chosen for modeling purposes only as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within that length of time.

Symbols on the drawings indicate the river seasonal flow condition (high corresponding to spring freshet, average corresponding to summer-fall conditions, and low corresponding to winter flow under ice). Numbers associated with the symbols indicate the predicted location of the leading edge of the released oil in the river after 6, 12, 18 or 24 hours. Tables inserted within the Figures also provide information on the mass balance (i.e., oil remaining on the surface of the river, evaporated to the atmosphere, dissolved in the water column, deposited to sediment, adhering to river banks, or decaying through photo-oxidation and biodegradation) of the released oil at relevant points in time after the start of the release.

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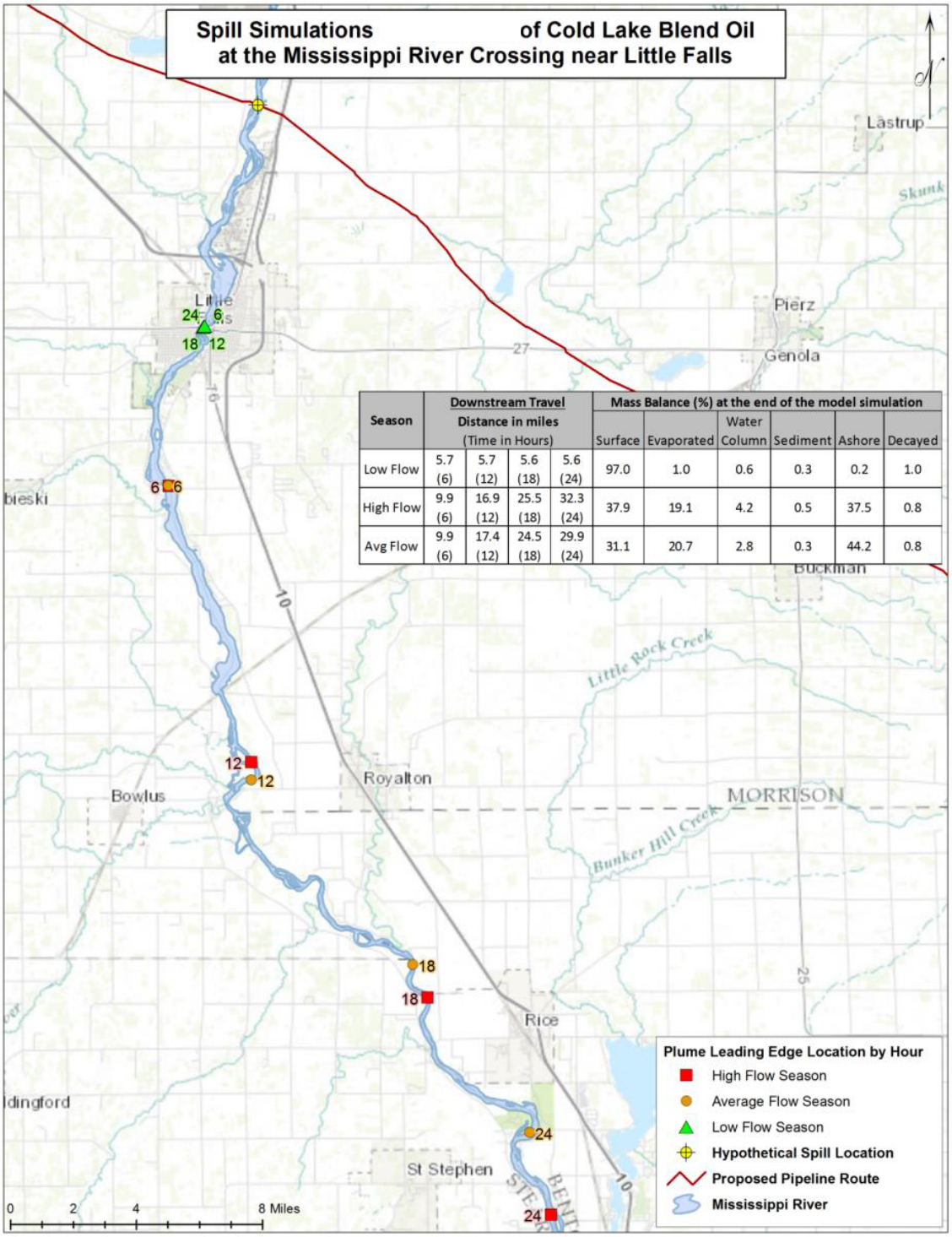

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	5.7 (6)	5.7 (12)	5.6 (18)	5.6 (24)	97.0	1.0	0.6	0.3	0.2	1.0
High Flow	9.9 (6)	16.9 (12)	25.5 (18)	32.3 (24)	37.9	19.1	4.2	0.5	37.5	0.8
Avg Flow	9.9 (6)	17.4 (12)	24.5 (18)	29.9 (24)	31.1	20.7	2.8	0.3	44.2	0.8

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Figure 7-51 Predicted Downstream Transport of CLB Oil at the Mississippi River near Little Falls

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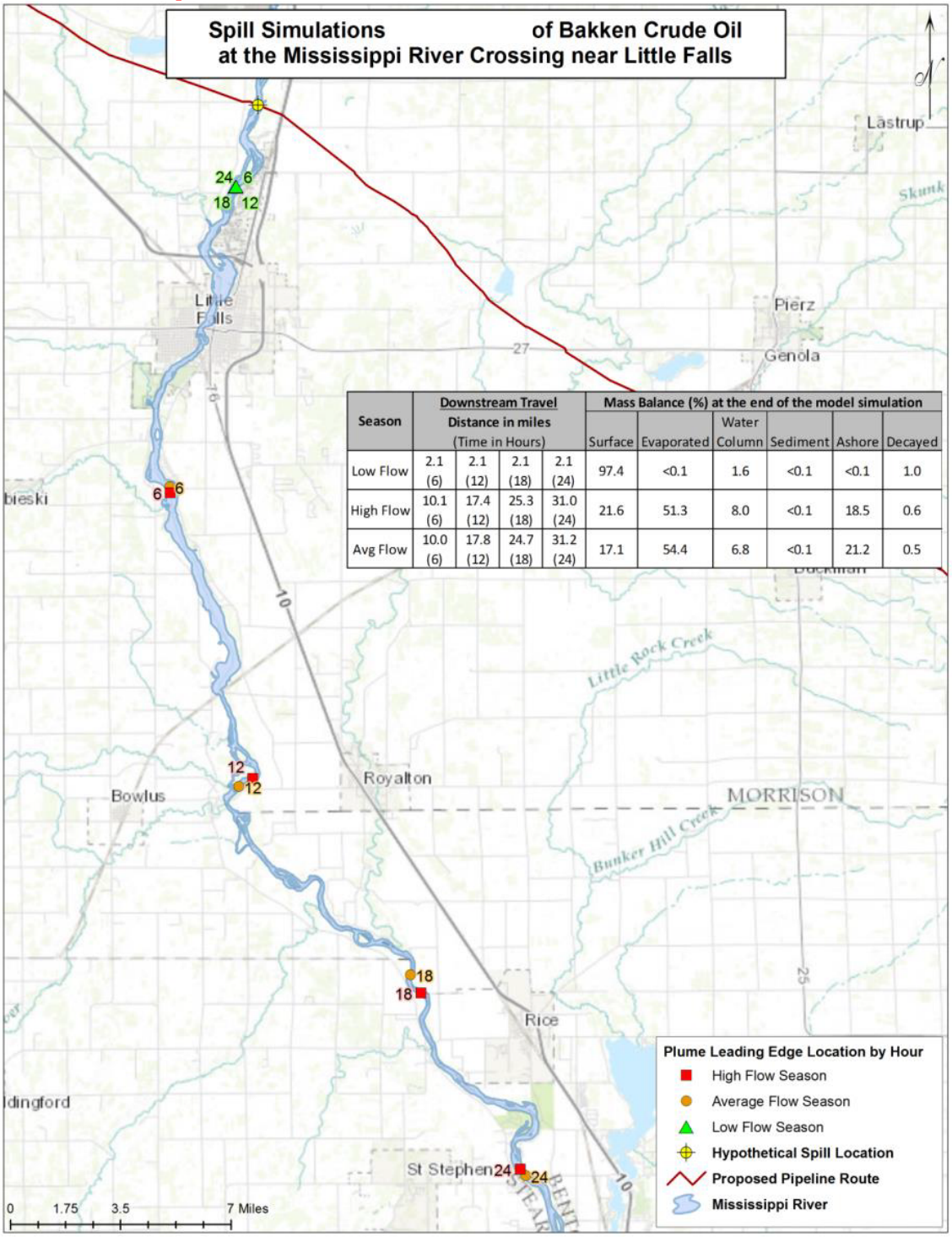

Season	Downstream Travel Distance in miles (Time in Hours)				Mass Balance (%) at the end of the model simulation					
					Surface	Evaporated	Water Column	Sediment	Ashore	Decayed
Low Flow	2.1 (6)	2.1 (12)	2.1 (18)	2.1 (24)	97.4	<0.1	1.6	<0.1	<0.1	1.0
High Flow	10.1 (6)	17.4 (12)	25.3 (18)	31.0 (24)	21.6	51.3	8.0	<0.1	18.5	0.6
Avg Flow	10.0 (6)	17.8 (12)	24.7 (18)	31.2 (24)	17.1	54.4	6.8	<0.1	21.2	0.5

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Figure 7-52 Predicted Downstream Transport of Bakken Crude Oil at the Mississippi River near Little Falls

7.8.5.1 Mississippi River near Little Falls Release During High Flow (Spring) Period

Under the high flow scenario, CLB was predicted to travel 10, 17, 26, and 32 miles downstream in the Mississippi River after approximately 6, 12, 18 and 24 hours(Figure 7-51). By 24 hours after the hypothetical release, a portion of the released crude oil (37.9%) was predicted to remain on the surface of the Mississippi River, with 19.1% evaporating, 37.5% adhering to shorelines, and approximately 4.2% mixing in the water column. Less than 1% was predicted to deposit to sediment or be broken down through photo-oxidation and biodegradation (Figure 7-51).

Bakken crude oil was predicted to follow the same general downstream transport pattern as CLB (Figure 7-52). By 24 hours after the hypothetical release, most of the Bakken crude oil was predicted to evaporate (51.3%), with 21.6% remaining on the river surface, 18.5% adhering to shorelines, and 8% mixing in the water column. Negligible amounts (less than 0.1%) of the Bakken crude oil were predicted to deposit to sediment and less than 1% was predicted to be broken down through photo-oxidation and biodegradation (Figure 7-52).

Two key events were predicted to affect the mass balance of the crude oil approximately 4.8 and 14.4 hours (0.2 and 0.6 days) after the hypothetical release of CLB and Bakken crude. These events were predicted to occur as the releases passed over the Little Falls and Blanchard Dams, along with the associated rapids downstream (Chapter 6.0). At these locations, it was predicted that there would be substantial entrainment of crude oil into the river water. Entrained oil droplets in the water column are predicted to rise to the surface over subsequent quiescent reaches of the Mississippi River. Above the Little Falls dam, predicted total hydrocarbon concentrations in the river water were very low, as the oil would be floating on the surface, with volatile hydrocarbons mainly evaporating to the atmosphere. However, downstream of the Little Falls Dam, the dissolved aromatic hydrocarbon concentration in the water column is predicted to increase, as oil droplets forced into the water column enable the soluble portion to dissolve into the water. The total hydrocarbon concentration in the water column was predicted to decrease as the release moves downstream of the dam, due to the buoyant rise of whole oil droplets to the surface in the relatively quiescent waters downstream. This process was predicted to be repeated at the Blanchard Dam. More Bakken crude oil is predicted to be entrained than the CLB.

At the end of the 24 hour simulation, the thickness of the floating CLB was predicted to range from 0.004 to 0.04 in. on the water surface, with localized areas possibly exceeding 0.04 in. Slicks of Bakken crude oil were predicted to be generally thinner overall, but by the end of the 24-hour simulation, floating oil thicknesses between 0.004 and 0.04 in. could exist. Colorless and silver sheens and rainbow sheens that are less than 0.00004 in. could also remain in some areas. As a result of the predicted areal extent of the surface oil slicks, oil floating on the river was predicted to evaporate rapidly over the 24 hour simulation.

Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the CLB and Bakken crude oil were predicted to be between 1 and 100 ppb. However, brief pulses

of concentrations between 1,000 and 5,000 ppb for CLB, or 1,000 and greater 5,000 ppb for Bakken crude oil, were predicted to occur within 24 hours after the release, but in extremely patchy and localized extents within the Mississippi River.

Extensive shoreline oiling was predicted for CLB and Bakken crude oil for approximately 29 or 30 miles of the river below the release location under high river flow conditions. The concentrations of CLB on the shore were predicted to be primarily greater than 500 g/m^2, with some segments between 100 and 500 g/m^2. In contrast, concentrations of Bakken crude oil on the shore were predicted to be generally lower, and range from 100-500 g/m^2 but with nearly equal lengths of shoreline exceeding 500 g/m^2. In general, Bakken resulted in less extensive shoreline oiling than the CLB.

When oil is mixed through the water column by turbulent mixing processes such as waterfalls at dams, there is a high potential for dissolved oil to interact with (i.e., to become adsorbed to) suspended sediments, or for suspended sediments to interact with small crude oil droplets suspended in the water (i.e., for oil-particle aggregates to form). Under the high flow scenario for CLB, substantial oiling of the bed sediment was predicted along approximately 24 miles of river bottom below Little Falls Dam, with concentrations between 0.01 and 0.5 g/m^2. In patchy and localized portions of the Mississippi River downstream of the waterfalls, sediment concentrations are predicted to exceed 500 g/m^2. However, over the larger area, the majority of sediment oiling is predicted to be much lower in concentration. In terms of Bakken crude oil, approximately 30 miles of river bottom were predicted to have sediment oiling less than 0.01 g/m^2, with some localized areas experiencing 0.01–0.5 g/m^2. Below Blanchard Dam, after the second waterfall, entrained oil and further mixing with suspended particulate matter, some patchy and localized portions of the river bottom may have sediment concentrations between 1 and 10 g/m^2 with values as high as 10–50 g/m^2 in very small areas. In general, Bakken was more easily entrained into the water column due to its lower viscosity. However, the overall quantity of oil interacting with suspended sediments was lower than the CLB.

7.8.5.2 Mississippi River near Little Falls Release During Average Flow (Summer–Fall) Period

Under the average flow scenario, CLB was predicted to travel approximately 10, 17, 25, and 30 miles downstream in the Mississippi River after 6, 12, 18 and 24 hours (Figure 7-51). By 24 hours after the hypothetical release, a portion of the released crude oil (31.1%) was predicted to remain on the surface of the Mississippi River, with 20.7% evaporating, 44.2% adhering to shorelines and 2.8% mixing in the water column. Less than 1% was predicted to deposit to sediment or be broken down through photo-oxidation and biodegradation (Figure 7-51). Bakken crude oil was predicted to follow the same general downstream transport pattern as CLB (Figure 7-52). By 24 hours after the hypothetical release, the majority of Bakken crude oil was predicted to evaporate (54.4%), with 17.1% remaining on the river surface, 21.2% adhering to shorelines and 6.8% mixing in the water column. A negligible amount (less than 0.1%) of the Bakken crude

oil was predicted to deposit to sediment and less than 1% was predicted to be broken down through photo-oxidation and biodegradation (Figure 7-52).

As described for the spring freshet, as the hypothetical releases pass over the Little Falls and Blanchard Dams (4.8 and 14.4 hours after the hypothetical release), it was predicted that there would be substantial entrainment of crude oil into the river water. Entrained oil droplets in the water column are predicted to rise to the surface in subsequent quiescent reaches of the Mississippi River. Above the Little Falls Dam, predicted total hydrocarbon concentrations in the river water were very low, as the oil would be floating on the surface. However, downstream of the Little Falls Dam, the dissolved aromatic hydrocarbon concentration in the water column is predicted to increase, as oil droplets forced into the water column enable the soluble portion to dissolve into the water. The total hydrocarbon concentration in the water column was predicted to decrease as the release moves downstream of the dam, due to the buoyant rise of whole oil droplets to the surface in the relatively quiescent waters downstream. This process was predicted to be repeated at the Blanchard Dam. More Bakken crude oil is predicted to be entrained than the CLB.

During average river flow conditions, the relatively calm waters upstream and downstream of the Little Falls Dam and Blanchard Dam was predicted to result in large surface slicks over much of the river. At the end of the 24-hour simulation, floating CLB thicknesses ranged between 0.004 and 0.04 in. on the water surface, with localized areas exceeding 0.04 inches. Bakken crude oil slicks were generally thinner than CLB, and by the end of the 24-hour simulation, floating oil thicknesses between 0.004 and 0.04 in. (but in some areas less than 0.00004 in. representing colorless and silver sheens and rainbow sheens) could remain. As a result of the large surface oil slicks, oil floating on the river was predicted to evaporate rapidly over the 24 hour simulation.

Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the CLB and Bakken crude oil were predicted to be between 1 and 100 ppb. However, brief pulses of concentrations between 500 and 1,500 ppb for CLB, and between 500 and greater than 5,000 ppb for Bakken crude oil, were predicted to occur 24 hours after the release, and in extremely patchy and localized extents within the Mississippi River.

Extensive shoreline oiling was predicted for CLB and Bakken crude oil for approximately 29 or 30 miles of the river below the release location under high river flow conditions. The concentrations of CLB on the shore were predicted to be primarily greater than 500 g/m^2, with some segments between 100 and 500 g/m^2. In contrast concentrations of Bakken crude oil on the shore were predicted to be generally lower, and range from 100-500 g/m^2 but with nearly equal lengths of shoreline exceeding 500 g/m^2. In general, Bakken resulted in less extensive shoreline oiling than the CLB.

When oil is mixed through the water column by turbulent mixing processes such as waterfalls at dams, there is a high potential for dissolved oil to interact with (i.e., to become adsorbed to) suspended sediments, or for suspended sediments to interact with small crude oil droplets

suspended in the water (i.e., for OPAs to form). Under the average flow scenario for CLB, substantial oiling of the bed sediment was predicted along approximately 30 miles of river bottom below Little Falls Dam, with concentrations between 0.01 and 0.5 g/m^2. In patchy and localized portions of the Mississippi River downstream of the waterfalls, sediment concentrations are predicted to exceed 500 g/m^2. However, the majority of sediment oiling is much lower in concentration over the larger area with any amount of potential oil on the sediments. In terms of Bakken crude oil, approximately 30 miles of river bottom were predicted to have sediment oiling less than 0.01 g/m^2, with some localized areas experiencing 0.01–0.5 g/m^2. Below Blanchard Dam the second waterfall is predicted to entrain and further mix the oil with suspended sediment; as a result, some patchy and localized portions of the river bottom may have sediment concentrations between 1 and 10 g/m^2 with values as high as 10–50 g/m^2 in very small areas. In general, Bakken was more easily entrained into the water column due to its lower viscosity. However, the overall quantity of oil interacting with suspended sediment was lower than the CLB.

7.8.5.3 Mississippi River near Little Falls Release During Low Flow (Winter) Period

Under the low flow scenario, CLWB was predicted to travel downstream in the Mississippi River approximately 5.5 miles at all four of the time points (6, 12, 18 and 24 hours) (Figure 7-51). As a result, the oil release would not encounter either of the waterfalls created by the two dams. By 24 hours after the hypothetical release, almost all of the released crude oil (97.0%) was predicted to remain on the surface of the Mississippi River (i.e., at the ice/water interface). Very little of the released crude oil was predicted to evaporate or undergo degradation within 24 hours. Less than 1% of the release was predicted to mix into the water column (i.e., little or no entrainment), adhere to shore lines, or deposit to sediment (Figure 7-51). Where CLWB was predicted on the shorelines, oiling was patchy between 1 and 2 miles downstream from the release point. Concentrations of CLWB on the shore were predicted to be predominantly in the range of 1 to 100 g/m^2, with some segments of the shoreline between 100 and 500 g/m^2, and others exceeding 500 g/m^2.

Under the low flow scenario Bakken crude oil was predicted to travel downstream in the Mississippi River approximately 2.1 miles at all four of the time points (6, 12, 18 and 24 hours) (Figure 7-52). This distance is less than that of the CLWB and is the result of the difference in oil density. Bakken crude oil is less dense than CLWB and would be expected to rise through the water column more rapidly after a release than the CLWB. As a result, lighter oils are predicted to spend less time in the water column than heavier oils, travel a lesser distance downstream, and rise to the surface and adhere to the underside of the ice more quickly. By 24 hours after the release, almost all of the released crude oil (97.4%) was predicted to remain on the surface of the Mississippi River (i.e., at the ice/water interface). Very little of the released crude oil was predicted to evaporate or undergo degradation within 24 hours. Approximately 1.6% of the release was predicted to mix into the water column (Figure 7-52). Negligible amounts (less than 0.1%) of the Bakken crude oil are predicted to deposit to sediment, evaporate, or adhere to shoreline (Figure 7-52). Under low flow conditions the 100% surface coverage was with ice was

predicted to keep the entrained oil in the water column at the ice/water interface. Extremely patchy oiling along river banks was predicted downstream from the release point, with concentrations on the shoreline less than 1 g/m^2. Extremely small amounts of oil could be found on the sediments, with most concentrations falling less than 0.01 g/m^2. The soluble portion of the CLWB was predicted to dissolve into the water column and be transported downstream, resulting in elevated dissolved aromatic concentrations within the water column. By 24 hours after the hypothetical release, dissolved aromatic components were predicted to travel downstream from the initial release location with maximum concentrations greater than 5,000 ppb in the region between 1 and 3 miles of release location. Bakken crude oil was predicted to have maximum concentrations of dissolved components greater than 5,000 ppb directly under the oil trapped under the ice. Much larger portions of the river are predicted to experience dissolved aromatic concentrations in excess of 5,000 ppb, when compared to average or high flow scenarios.

At the end of the 24-hour simulation, both types of floating oil under the ice had a predicted thickness greater than 0.04 in. THCs on the bed sediment were generally less than 0.01 g/m^2 for both CLWB and Bakken crude oil due to the small amount of suspended sediment in the water column.

7.8.6 Qualitative EHHRA for the Mississippi River near Little Falls

In this section, the likely environmental effects of a crude oil release at the pipeline crossing location on the Mississippi River are described. A worst case crude oil release from a main-line pipeline, such as described here, would be an unlikely event (Chapter 4.0). The proposed pipeline could carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). Therefore, the following discussion is based on the likely environmental effects of a crude oil release on relevant ecological and human environment receptors (identified in Section 7.8.3), using the predicted geographic extent of effects of released Bakken or CLB crude oil types over the 24 hour simulations as bounding conditions. Effects of season (including temperature, river flow conditions, and receptor presence/absence and sensitivity) were also considered in the analysis. The rationale supporting the effects analysis, based on case studies describing the effects of crude oil releases on the various ecological and human environment receptors, was provided in Section 7.1 and Table 7-84.

7.8.6.1 Terrestrial Receptors

For this modeling scenario, the hypothetical release of crude oil is assumed to enter into the Mississippi River with no overland flow. Environmental effects on soils, terrestrial vegetation and groundwater quality are assumed to be localized, limited in spatial extent, and readily remediated using conventional clean-up techniques. The environmental effects of a crude oil release on land cover receptors are not considered further for this release scenario.

7.8.6.2 Aquatic Receptors

The aquatic environmental and ecological receptors that are most closely associated with the Mississippi River at Little Falls scenario are addressed in this section. These receptors include water and sediment quality in the river, shoreline and riparian habitat, benthic invertebrates, and fish.

Crude oil released into the Mississippi River during the spring (high flow) or summer-fall (average flow) seasons is predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. Based on SIMAP simulations, CLB and Bakken crude oil were predicted to follow the same downstream transport pattern. Each oil type is predicted to reach approximately 30 miles downstream within 24 hours after a release. In sections of the river above and below the Little Falls Dam and Blanchard Dam, large amounts of floating oil are predicted. CLB thickness was predicted to range from 0.004 to 0.04 in. on the water surface, with localized areas possibly exceeding 0.04 inch Bakken crude oil slicks were predicted to have the same thicknesses (between 0.004 and 0.04 inch), although in some areas less than 0.00004 inch could remain.

The effects of a crude oil release on benthic invertebrates and fish would depend on the characteristics of the released oil, and environmental conditions at the time of the release. Acute toxicity to fish is commonly, but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons (particularly mono-aromatic hydrocarbons, some low molecular weight PAHs, and short-chain aliphatic hydrocarbons) are sufficiently high to cause acute toxicity due to narcosis. The potential for entrainment of CLB and Bakken crude oil into the water column during high and average river flow conditions was predicted to be high, particularly as the crude oil passes the Little Falls Dam, and then the Blanchard Dam, along with the associated rapids downstream. Based on SIMAP simulations, most of the dissolved aromatic concentrations associated with the Cold Lake Blend and Bakken crude oil under spring and summer conditions were predicted to be between 1 and 100 ppb. However, brief pulses of concentrations between 500 and 1,500 ppb for CLB, and between 500 and greater than 5,000 ppb for Bakken crude oil, were predicted to occur 24 hours after the release, but in extremely patchy and localized extents of the Mississippi River.

French McCay (2002) proposed a benchmark lethal concentration (LC50) value of 224 ppb (µg/L) for sensitive aquatic species exposed indefinitely to total aromatic hydrocarbons from crude oil. For species of average sensitivity, a threshold of 1,869 ppb was reported. Given exposure of shorter duration (i.e., less than one day), a considerably higher concentration (perhaps two to three times higher) would be required to result in the death of even sensitive species. Therefore, the predicted transient exposure concentrations for dissolved aromatic hydrocarbon compounds in the river water could result in acute lethality to sensitive fish species, or to species that have average sensitivity to hydrocarbons. However, the majority of predicted dissolved aromatic concentrations were less than 500 ppb. Therefore, the potential for toxicity to fish would be greatest in the areas downstream of the two dams, with lower potential elsewhere.

Some of the entrained crude oil in the water column could interact with suspended particulate matter leading to the deposition of crude oil to sediment. Under the average flow scenario for CLB, substantial oiling of the bed sediment was predicted along approximately 30 miles of river bottom below Little Falls Dam, with concentrations between 0.01 and 0.5 g/m^2 with concentrations of Bakken crude oil less than 0.01 g/m^2, but with some localized areas experiencing 0.01-0.5 g/m^2. In patchy and localized portions of the Mississippi River downstream of the waterfalls, sediment concentrations are predicted to exceed 500 g/m^2 for CLB (but with limited spatial and temporal extent) and between 1 and 10 g/m^2 (but as high as 10–50 g/m^2 in very small areas) for Bakken crude oil.

With limited mixing of crude oil into river bed sediments to a depth of less than 0.5 in., crude oil deposition of less than 0.1 g/m^2 is likely to be undetectable and without any ecological consequence. Crude oil deposition to sediment of less than 1 g/m^2 would result in sediment hydrocarbon concentrations that would be less than 100 ppm (mg/kg). These low concentrations would also be unlikely to result in significant environmental effects on fish, benthic invertebrates, or other aquatic life. Crude oil deposition to sediment of greater than 50 g/m^2 would be expected to cause reduced community diversity, biomass and productivity. As a result, based on the SIMAP model results, the predicted crude oil deposition to sediments is not expected to be toxic to benthic invertebrates. Any such effects would be of short duration and limited to patchy areas within the trajectory of the oil release. Adverse environmental effects on benthic communities are more likely for CLB crude oil types rather than Bakken crude oil.

The potential for chronic effects of released crude oil on fish eggs and embryos (i.e., induction of deformities or mortality collectively termed blue sac disease) under high and average river flow conditions is expected to be low. While the eggs and embryos of these species could be exposed to total PAH concentrations in the river water that could be sufficiently high to induce deformities or cause mortality, these areas are of limited spatial extent and transitory. The potential for blue sac disease would be greatest for a crude oil release in winter or during the spring freshet, as crude oil could be dispersed into side-channel and oxbow habitat that is important for spawning fish. While local accumulations could result in adverse effects on developing fish eggs and embryos in the first season following an accidental crude oil release, it is not likely that such effects would persist beyond one year, and effects would occur in only a limited area of the river. Therefore, at the scale of the Mississippi River in Minnesota, it is not likely that such effects would be detectable at a population level.

The potential for phototoxicity caused by an interaction of UV light with PAHs accumulated in fish tissues would be greatest for a crude oil release in summer due to high light intensity and long day length. Small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish) are most susceptible to phototoxicity. The risk of phototoxicity would be partially mitigated by high concentrations of suspended sediment and DOC present in the water of the Mississippi River, which would absorb and limit the penetration of UV light into the water column.

During low flow winter conditions, if the release was to occur directly to the river below the ice (as is assumed in the SIMAP model), or if there were openings in the ice that the released oil could penetrate, the oil could travel downstream under the ice, accumulating in the narrow gap between the ice and the river sediment, or accumulating in hollows under the ice as it moved. Results provided in Section 7.8.5.3 provide bounding cases for the products likely to be carried in the pipeline. The SIMAP simulations indicate that heavy crude oil could be carried farther downstream than light oil (i.e., 5.5 miles vs. 2.1 miles from the point of release) under winter low-flow conditions. At the end of the 24 hour simulation, floating oil of both types is predicted to have a general thickness greater than 0.04 inches beneath the ice. For both oil types, the winter ice would effectively inhibit evaporation. Bakken crude oil is less dense than CLWB and would be expected to rise through the water column more rapidly after a release than the CLWB. As a result, light oil would spend less time in the water column than heavier oil, and is predicted to have less dissolution into the water column during the period of lowest dilution flow than heavier oil.

Based on SIMAP simulations run for 24 hours, most of the dissolved aromatic concentrations associated with the CLWB were predicted to be between 1 and 500 ppb and within the first 1 to 3 miles downstream of the hypothetical release site. However, areas having dissolved aromatic hydrocarbon concentrations greater than 5,000 ppb were predicted to occur within this 24 hour period for both crude oil types. Short-term exposure to these concentrations of dissolved aromatic hydrocarbons from crude oil could result in mortality of fish species, particularly under the winter, low flow condition.

7.8.6.3 Semi-Aquatic Wildlife Receptors

Habitat along the Mississippi River downstream of the hypothetical release location supports amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors), and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter). Details on predicted environmental effects for amphibians and reptiles, birds and mammals are provided below.

7.8.6.3.1 Amphibians and Reptiles

Crude oil released to the Mississippi River during the spring (high flow) or summer-fall (average flow) seasons would be predicted to travel downstream, interacting with vegetation and seasonal shoreline areas. Based on SIMAP simulations, CLB crude oil and Bakken crude oil were predicted to follow the same downstream transport pattern (each predicted to reach approximately 30 miles downstream 24 hours after a release). In sections of the river above and below the Little Falls and Blanchard dams, large amounts of floating oil are predicted with slicks between 0.004 and 0.04 in. on the water surface. A greater amount of CLB is predicted to remain on the surface of the Mississippi River after 24 hours compared to Bakken crude oil (e.g., approximately 31 to 38% vs. 17 to 22%).

Within the oil-exposed habitats along the river that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. There is little or no relevant wetland habitat in the vicinity of the predicted release trajectory, so exposures would likely be limited to shorelines and riparian habitats. Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is not likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. As a result, exposure of these animals to released crude oils would be limited.

Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms would have very little exposure to released oil moving on the water surface or within the water column.

7.8.6.3.2 Birds

Aquatic and semi-aquatic birds are those that use rivers, lakes, wetlands, and riparian areas as components of their habitat, particularly for nesting and feeding. These birds belong to a variety of guilds including but not limited to waterfowl, divers, gulls and terns, raptors, shorebirds, waders, and some songbirds. They have a variety of dietary preferences, including piscivory, insectivory, omnivory and herbivory. If exposed to external oiling, the ability of birds to maintain body temperature may be compromised, leading to death as a result of hypothermia. Even if they survive their initial exposure to crude oil, the exposure may require an increase in metabolic rate to survive. In turn, this may compromise other life functions such as reproduction or growth. Birds that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues while preening or attempting to clean and restore the normal properties and functions of feathers. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs, resulting in death of developing embryos.

Unlike many other vertebrate receptors, aquatic bird species in the northern temperate zone are nearly all seasonal migrant species which leave their summer (and often breeding) habitat in the fall for wintering areas farther south where they can find open-water habitat. However, some birds (e.g., Canada goose) will opportunistically remain in freezing conditions if there is reliable open water (e.g., immediately downstream of the two dams) and a source of food available). Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release. During the spring (high flow) season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. With cold water temperatures prevailing, aquatic and semi-aquatic birds contacted by crude oil are likely to die as a result of hypothermia. Waterfowl and other semi-aquatic birds present in the affected river reach would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release.

Some areas of the Mississippi River below Little Falls, Minnesota would provide excellent habitat for a variety of waterfowl species, as well as fish-eating raptors, and other species such as kingfisher, herons and shorebirds. The environmental effects of a crude oil release in the spring and the summer-fall period are likely to be of similar magnitude. With rising water temperatures, mortality of lightly oiled adult birds due to hypothermia becomes less likely than in the spring, and the temporary presence of large numbers of migrating individuals is unlikely. However, in the early summer, environmental effects could include egg mortality due to transfer of oil from the feathers of lightly oiled adult birds in the nest, or mortality of young birds due to direct oil exposure or the loss of a parent bird. Chronic adverse effects on the health of birds that survive their initial exposure to crude oil are also possible as a result of ingesting crude oil residues while preening, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure. Potential effects on aquatic and semi-aquatic birds in the fall would be similar to those in spring, although a smaller overall length of river habitat would be affected due to lower river flows. While the death of these birds would be a serious environmental effect locally, longer-term population-level effects on semi-aquatic birds are not likely to be observed given the length of the Mississippi River in Minnesota, and the abundance of other wetland, lake, river and riparian habitat in the region and state.

Under winter conditions (March), it was assumed that the Mississippi River would be frozen (100% ice cover). In addition, most waterfowl and other semi-aquatic bird species would migrate south in the winter. However, some birds (e.g., Canada goose, eagles) will opportunistically remain in freezing conditions if there is reliable open water and a source of food available. Areas of the Mississippi near the Little Falls and Blanchard Dam could provide these areas of open water. Timely capture and rehabilitation of oiled birds may help to mitigate the environmental effects of a crude oil release. A crude oil release in winter would be expected to have very limited effects on birds.

7.8.6.3.3 Semi-aquatic Mammals

While the semi-aquatic mammal species found in Minnesota include terrestrial species such as moose and raccoon, this assessment focuses particularly on species that have a primary association with the aquatic environment such as muskrat and beaver (herbivores), American mink (carnivore-piscivore), and river otter (piscivore). These species are at greater risk of exposure to an oil release in water than more fully terrestrial mammals.

Effects to semi-aquatic mammals are typically described in terms of direct physical effects (e.g., hypothermia due to loss of insulation), direct toxicological effects (e.g., gastro-enteropathy caused by ingestion of crude oil residues while grooming oiled fur or ingesting food), and indirect effects caused by changes to habitat (e.g., land cover and food availability). The spatial extent along the Mississippi River where effects may occur, and the magnitude of effects, is related to the season and river flow rate, and the type of oil released. Effects to semi-aquatic mammals relate more to the amount of time spent in the water and oil-contaminated riparian habitat (and consequent exposure to physical oiling) than to dietary preferences. Timely

capture and rehabilitation of oiled mammals may help to mitigate the environmental effects of a crude oil release.

During the spring (high flow) season, with cold water temperatures prevailing, semi-aquatic mammals contacted by crude oil are likely to die as a result of hypothermia. Animals upstream, farther downstream where there is no exposure, or occupying other nearby habitats, would likely be unaffected. Therefore, although mortality of a considerable number of semi-aquatic mammals could be expected at a local scale, large-scale (i.e., regional) population level effects are unlikely. Environmental effects of a crude oil release in the summer-fall period are likely to be of a magnitude similar to or lesser than those associated with a release during spring. With rising water temperatures, mortality of lightly oiled semi-aquatic mammals due to hypothermia is less likely than in the spring. Chronic adverse effects on the health of semi-aquatic mammals that survive their initial exposure to crude oil are possible as a result of ingesting crude oil residues while grooming, or while consuming food items. However, as in the spring, effects are expected to be limited to areas of oil exposure. While the death of these animals would be a serious environmental effect locally, longer-term population-level effects on semi-aquatic mammals are not likely to be observed given the length of the Mississippi River in Minnesota, and the abundance of other wetland, lake, river and riparian habitat in the region and state.

In the winter months, muskrat and beaver are likely to reduce their activity levels, although American mink and river otter would remain active. Animals that became oiled in the winter would be likely to rapidly die as a result of hypothermia.

7.8.6.4 Human and Socio-Economic Receptors

Crude oils are complex mixtures of hydrocarbon compounds. Light crude oils typically contain more VOCs than heavier crude oils, although diluted bitumen may contain similar amounts of VOCs to light crude oils, depending upon the type and amount of diluent they contain. Air quality in the vicinity of a crude oil release, and along the downstream corridor, would be affected by the release of VOCs (such as benzene, which is often used as an indicator substance) primarily within the first 24 hours of an oil release.

Based on SIMAP simulations, CLB and Bakken crude oil were predicted to follow the same downstream transport pattern, with each predicted to reach approximately 30 miles downstream 24 hours after a release. As a result, both oil types are predicted to pass through the community of Little Falls, Minnesota (population of approximately 8,500 people) and pass along the western border of the community of Rice, Minnesota (population of approximately 1,275 based on 2010 census).

Typical human health effects associated with short-term (acute) inhalation of volatiles from crude oil include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain. Short-term or repeated skin contact with crude oil may result in dermatitis. The case studies (Section 7.1) do not reveal any instances of human fatality as a result of inhalation of crude oil

vapor. Similarly, ATSDR (1995) report that there are no known instances of human fatality as a result of inhalation of vapor from fuel oils, which would be comparable to light crude oils.

If a crude oil release was to occur in winter, and to be confined below ice on the river, very little of the volatile hydrocarbon present in the oil would be released to the atmosphere as VOCs. The potential for VOC inhalation exposures to the public would be greatest in the spring and summer-fall seasons, near and downwind from the release site, while the released oil is on the water surface. In the unlikely event of a crude oil release, nearby residents would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most of the volatile hydrocarbons would be lost within the first 24 hours following a release of crude oil. It is also expected that emergency response personnel would contact such residents and advise them to evacuate. Actual or potential exposure to crude oil vapor may result in residents leaving, or being advised to leave their homes for a period of time while the emergency response takes place.

Drinking water for the communities of Little Falls and Rice is drawn from groundwater sources by city owned and operated wells. Therefore, the water supplies for residents of Little Falls and Rice are not likely to be affected by a release. In addition, no drinking water HCAs were identified along the path of the release. However, in the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. Based upon case studies involving crude oil releases elsewhere, this process could take a few days to two weeks, but reports of crude oil releases affecting private wells are rare, making this an unlikely effect.

Relatively little has been published regarding the long-term effects of human exposure to a crude oil release. Health effects observed in residents and clean-up workers in the months following such releases generally do not persist over the long term (Eykelbosh 2014). The International Agency for Research on Cancer (IARC 1989) has determined there is "limited evidence of carcinogenicity" of crude oil in experimental animals and "inadequate evidence of carcinogenicity" of crude oil in humans. Although toxicological effects from short-term exposure to volatile hydrocarbons are reversible when exposure is reduced, other health effects such as anxiety and depression may occur, and may persist, regardless of whether the individual was physically exposed to hydrocarbons.

No overland transport of released crude oil was modelled for this hypothetical release location. Infiltration of crude oil into soil and subsequently into groundwater is assumed to be negligible.

Downstream of the hypothetical release site, the Mississippi River flows through the Zebulon Pike Lake (reservoir), and past several parks (e.g., Le Bourget Park, James Green Park, Maple Island Park, Mill Park, and Charles A. Lindbergh State Park), as well as the McDougall and Michaelson Farms WMAs. These locations provide a number of recreational opportunities. Effects on air and water quality, or the presence of crude oil residues in the sediment or habitat, could potentially disrupt public use of natural resources (e.g., drinking water supplies, hunting, fishing, recreation).

Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Recreational activities would be disrupted following a release of crude oil along the predicted downstream trajectory of the release. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil.

7.8.6.5 Summary and Conclusions

Expected environmental effects to key ecological and human environment receptors after a hypothetical large crude oil release to the Mississippi River near Little Falls, Minnesota have been assessed. The proposed pipeline could carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). The discussion of expected environmental effects on receptors is based on these crude oil types as bounding conditions. Potential terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors and human and socio-economic receptors were screened to identify those with the most likely interactions with released oil. The results of this assessment are summarized in Table 7-86.

Table 7-86 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Little Falls

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Little Falls	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Terrestrial Receptors			
Soils	It is assumed in the model that crude oil would enter directly into the Mississippi River with no holdup of oil on land. In the event of an actual oil release, any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.	SAME	SAME
Groundwater		SAME	SAME
Terrestrial Vegetation		SAME	SAME
Aquatic Receptors			
Rivers (Mississippi River)	Both light and heavy oil would travel downstream from the release location, affecting the Mississippi River. In spring and summer, both light (Bakken) and heavy (CLB) crude oil types are predicted to display similar downstream transport patterns. Both are predicted to reach approximately 30 miles downstream within 24 hours after a release, and to form slicks of similar thickness (between 0.004 inches and greater than 0.04 inches). During spring (high flow) and summer-fall (average flow) seasons, relatively more of the CLB is predicted to remain on the surface of the Mississippi River after 24 hours (31 to 38% vs. 17 to 22%), adhere to shorelines (37.5 to 44.2% vs 18.5 to 21.2%) and deposit to sediment (0.5% vs <0.1%). However, slightly more of the less viscous Bakken crude oil is predicted to mix and dissolve into the water column as compared to the CLB (e.g., approximately 6.8 to 8% vs 2.8 to 4.2%). In winter, simulations indicate that CLWB could be carried slightly farther downstream than the Bakken oil (i.e., 5.5 miles vs. 2.1 miles from the point of release), but the area affected by the highest dissolved aromatic hydrocarbon concentrations in water would be slightly larger for the Bakken oil than for the CLWB.	MORE	LESS
Sediment	In all three seasons, slightly more of the CLB is predicted to deposit to sediment than Bakken crude oil (e.g., approximately 0.5% vs <0.1%). In patchy and localized portions of the Mississippi River downstream of the waterfalls, sediment concentrations are predicted to exceed 500 g/m^2 for CLB (but with limited extent) and between 1-10 g/m^2 (but as high as 10-50 g/m^2 in very small areas) for Bakken crude oil. Contact between the weathered diluted bitumen and shorelines is also likely to result in mixing of mineral particles into the crude oil, which could then be deposited to sediments as aggregates of oil and mineral in larger droplets or globules. If not recovered, these aggregates could move downstream with bedload until a stable depositional environment was reached.	LESS	MORE

Table 7-86 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Little Falls

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Little Falls	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Shoreline and Riparian Areas	Both light and heavy oil would travel downstream from the release location, affecting the Mississippi River. Both Bakken and CLB crude oil types are predicted to exhibit similar downstream transport patterns (each predicted to reach approximately 30 miles downstream within 24 hours after a release). During spring (high flow) and summer-fall (average flow) seasons, a greater amount of CLB is predicted to adhere to shorelines (i.e., 37.5 to 44.2% for CLB vs. 18.5 to 21.2% for Bakken) 24 hours following the hypothetical release. Flooding of riparian habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, which would be persistent, in contrast to light crude oil which would be deposited as a thin layer or sheen.	LESS	MORE
Benthic Invertebrates	In all three seasons, slightly more of the CLB is predicted to deposit to sediment than Bakken crude oil (e.g., approximately 0.5% vs <0.1%). In patchy and localized portions of the Mississippi River downstream of the two waterfalls, sediment concentrations are predicted to exceed 500 g/m^2 for CLB (but with limited extent) and between 1-10 g/m^2 (but as high as 10-50 g/m^2 in very small areas) for Bakken crude oil. Crude oil deposition to sediment of >50 g/m^2 would be expected to cause reduced community diversity, biomass and productivity. As a result, based on the SIMAP model results, the potential for crude oil deposition to sediments that would be toxic to benthic invertebrates is expected to be low. However, adverse environmental effects on the benthic community could be seen in patchy and localized areas of the Mississippi River, albeit briefly. Contact between the weathered diluted bitumen and shorelines is also likely to result in mixing of mineral particles into the crude oil, which could then be deposited to sediments as aggregates of oil and minerals in larger droplets or globules. If not recovered, these aggregates could move downstream with bedload until a stable depositional environment was reached. However, neither of the bounding oil types is predicted to be deposited to sediments at concentrations that would seriously affect aquatic life.	SAME	SAME

Table 7-86 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Little Falls

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Little Falls	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Fish	Environmental effects on fish would be limited to areas affected by the released oil. In spring and summer-fall conditions, both light and heavy oil are predicted to reach approximately 30 miles downstream within 24 hours after a release. On average, about twice as much of the Bakken crude oil type was predicted to dissolve into the water than was predicted for the CLB. The maximum concentration of dissolved aromatics from both oil types was locally greater than 1,000-5,000 ppb, but suggested a transient exposure of less than 24 hours duration. This concentration range and duration of exposure could result in acute lethality to sensitive aquatic species and species with average sensitivity to hydrocarbons. In winter, the effects of the Bakken crude oil on fish were also predicted to be slightly more severe than was the case for CLB.	MORE	LESS
Semi-Aquatic Wildlife Receptors			
Amphibians and Reptiles	Both light and heavy oil would travel downstream from the release location, affecting the Mississippi River. Lighter crude oils and heavier crude oils are predicted to follow the same downstream transport pattern (each predicted to reach approximately 30 miles downstream within 24 hours after a release), and form slicks of similar thickness (between 0.004 inches and greater than 0.04 inches). Flooding of riparian habitats in spring could lead to stranding of crude oils in these habitats, with heavy crude oil likely to be deposited as patties or tar balls, which would be persistent, in contrast to light crude oil which would be deposited as a thin layer or sheen. Within these habitats, oiling effects on adults, juveniles, and eggs could potentially be observed. Higher potential would exist for effects on amphibians than for turtles, which appear to be somewhat tolerant of external oiling. Dormancy of amphibians and reptiles in winter and early spring means exposure to oil released at this time of year could be negligible, and adverse environmental effects unlikely.	SAME	SAME
Birds	Mortality of oiled aquatic and semi-aquatic birds would occur in areas affected by the released oil. Both light and heavy crude oil types are predicted to travel similar distances, and both would form slicks of similar thickness. During the spring high flow season, many migratory birds would be returning to riverine and lacustrine habitats in Minnesota, or migrating through these areas on their way to breeding habitats farther north. Few birds are present in winter, so effects would be lower in that season.	SAME	SAME

Table 7-86 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Little Falls

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Little Falls	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Semi-aquatic Mammals	Mortality of oiled semi-aquatic mammals would be limited to areas affected by the released oil. Both light and heavy crude oil types are predicted to travel similar distances, and both would form slicks of similar thickness. Adverse effects on mink and otter would be particularly severe in winter, due to the effects of oil in the insulating properties of fur, in combination with cold water temperatures. However, muskrat and beaver might be spared due to their lower activity levels in winter.	SAME	SAME
Human and Socio-Economic Receptors			
Air Quality	Effects on air quality have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality in the vicinity of the oil release would be most affected within the first 24 hours of an oil release. CLB crude oil and Bakken crude oil were predicted to follow the same downstream transport pattern, with each predicted to reach approximately 30 miles downstream 24 hours after a release. However, considerably more of the Bakken crude oil is predicted to evaporate to the atmosphere within 24 hours than is the case for the CLB. Both oil types are predicted to pass through the community of Little Falls, Minnesota and pass along the western border of the community of Rice, Minnesota. As a result, environmental effects on air quality are predicted to be spatially similar for both crude oil types, although slightly more severe for the Bakken crude oil. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	MORE	LESS
Human Receptors	Typical human health effects associated with short-term inhalation of VOCs from crude oil releases include headache, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain; fatality is unlikely. Nearby residents would become aware of a strong hydrocarbon odor that would alert them to the presence of a hazard. Most volatile hydrocarbons would be lost within 24 hours following a release. The human receptors most likely to be exposed to VOCs under this hypothetical crude oil release scenario would be located in homes located close to the Mississippi River about 30 miles downstream from the release point (e.g., Little Falls, Minnesota). Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs, in addition to constraining the area of effects.	SAME	SAME

Table 7-86 Environmental Effects Summary Table for Pipeline Crude Oil Releases to the Mississippi River at Little Falls

Receptor	Expected Environmental Effects of Released Crude Oil to the Mississippi River at Little Falls	Relative Effect	
		Light Crude Oil	Diluted Bitumen
Public Use of Natural Resources	Both light and heavy crude oil types are predicted to travel similar distances, and both would form slicks of similar thickness, potentially interrupting public use of natural resources over a similar area. Downstream of the hypothetical release site the Mississippi River flows through the Zebulon Pike Lake reservoir and past several (i.e., Le Bourget Park, James Green Park, Maple Island Park, Mill Park, and the much larger Charles A. Lindbergh State Park) and the McDougall and Michaelson Farms WMA. The leading edge of both oil types is predicted to extend beyond these locations. Effects on air and water quality, or the presence of crude oil residues in the sediment or habitat, could potentially disrupt public use of natural resources. Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Drinking water for the communities of Little Falls and Rice is drawn from groundwater sources by city owned and operated wells. Therefore, the water supplies for residents of Little Falls and Rice are not likely to be affected by a release. In addition, no drinking water HCAs were identified along the path of the release. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to the Mississippi River would result in adverse health effects to consumers of drinking water. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route.	SAME	SAME

7.9 SUMMARY

The assessment of environmental effects of oil releases began with a description of the observed and expected effects of oil on key ecological and human receptors, including how oil behaves (i.e., its fate) in terrestrial, atmospheric and freshwater environments and associated biological resources (Section 7.1). This section was followed by a detailed assessment of expected environmental effects for each of seven sites that are representative of most of the predominant ecological units, major hydrological features, watercourse widths, and watercourse features along the preferred and alternative routes in Minnesota (Sections 7.2 to 7.8). These sections were informed by detailed fate and transport modeling of hypothetical releases of very light (e.g., Bakken crude oil) and heavy (e.g., diluted bitumen such as CLB) crude oils (Chapter 6.0), as well as the information provided in Section 7.1. A brief summary of these components is provided below.

7.9.1 Summary of Predicted Fate and Downstream Transport of Bakken and Cold Lake Crude Oils

The OILMAP Land software was used to simulate hypothetical releases at five of the seven hypothetical release sites: Site 1—Mosquito Creek to Lower Rice Lake; Site 2—Mississippi River at Ball Club; Site 3—Sandy River; Site 4—Shell River to Twin Lakes; and Site 5—Red River. While OILMAP Land does provide an indication of the downstream extent of oiling and mass balance of oil within the 24 hour modeled period, it does not quantify the amounts of oil components dissolved into the water column. However, the SIMAP fate and transport modeling software can quantify the amount of crude oil entrained into or dissolved in the water column, as well as deposited to sediments. Due to the possibly turbulent nature of the Mississippi River near at Palisade, Minnesota (Site 6) and near Little Falls, Minnesota (Site 7) that would promote dissolution and deposition of released oil, SIMAP was used to simulate hypothetical releases of Bakken crude oils and CLB into the Mississippi River at these two hypothetical release sites. Like the OILMAP Land model, SIMAP also provides an indication of the downstream extent of oiling and mass balance of oil within the 24 hour modeled period. A longer time period was not modeled with either software as it was assumed that emergency response measures to prevent or reduce further downstream transport of released oil would be in place within the 24 hour period.

The fate and downstream transport of released oil in each scenario was largely determined by flow conditions (i.e., high flow coinciding with the spring freshet; average flow during summer or fall; low flow in winter typified by freezing conditions and probable ice cover on water) and oil type. At the end of the 24 hour simulation and under high flow conditions, Bakken crude oil as compared to CLB was predicted to evaporate more, have a greater or equal proportion remaining on the river surface (or lake), and to travel farther downstream. However, in the event of an actual release, the downstream extents of Bakken crude oil and CLB may be more similar. Bakken crude oil as compared to CLB was also predicted to spread more thinly on the water surface and to adhere less to river banks. Similar fate and transport of these two oils were

typically predicted under average flow conditions, but evaporative losses could be greater in summer due to hotter ambient temperatures. Under low flow conditions, the downstream extents of Bakken crude oil and CLB were predicted to be similar, but shorter, than under average and high river flow conditions. Ice cover on rivers and lakes during winter would strongly limit or prevent evaporation to the atmosphere of both oil types.

A more detailed summary of the fate and downstream transport of released oil at the seven sites is provided in Section 6.

7.9.2 Summary of Expected Environmental Effects

For all seven sites, expected environmental effects to terrestrial receptors, aquatic receptors, semi-aquatic wildlife receptors and human and socio-economic receptors were screened to identify those most likely to have interactions with released crude oil. The proposed pipeline could carry a variety of crude oil types ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). The discussion of expected environmental effects on receptors considers these crude oil types as bounding conditions.

A comparative summary by site and receptor in terms of which crude oil type is predicted to have more severe effects is shown in Table 7-87. Further details for the receptor groups (i.e., aquatic receptors, semi-aquatic wildlife, human and socio-economic receptors) are provided in sections below. Overall, the effects of a release of light crude oil compared to heavy crude oil are expected to be more or equal. In some cases, a similar magnitude of effect is expected. For sediment and shoreline and riparian areas, lighter oil is expected to have less of an effect than heavier oil. For the other receptors (river and lakes, quality, aquatic plants, benthic invertebrates, fish, amphibians and reptiles, birds and semi-aquatic mammals, and air quality, human receptors and public use of natural resources), lighter oil is expected to have a more of an effect, or an equal effect, when compared to heavier oil. Similarities in the magnitude of effects were more apparent when fate and trajectory were modeled using SIMAP.

Table 7-87 Comparative Analysis of Which Crude Oil Type is Predicted to Have More Severe Effects by Site and Receptor

Receptor	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Aquatic Receptors							
Rivers	Bakken	Bakken	Bakken	Bakken	Bakken	Same	Bakken
Lakes	CLB	Bakken	Bakken	Bakken	N/A	Same	N/A
Sediment	CLB	CLB	CLB	CLB	CLB	Same	CLB
Shoreline and Riparian Areas	CLB	CLB	CLB	CLB	CLB	Same	CLB
Aquatic Plants	Same	Bakken	Bakken	Bakken	Same	Same	N/A
Benthic Invertebrates	Bakken	Bakken	CLB	Same	Bakken	Same	Same
Fish	Bakken	Bakken	Same	Bakken	Bakken	Same	Bakken
Semi-Aquatic Wildlife Receptors							
Amphibians and Reptiles	Bakken	Bakken	Bakken	Bakken	Bakken	Same	Same
Birds	Bakken	Bakken	Bakken	Same	Bakken	Same	Same
Semi-aquatic Mammals	Bakken	Bakken	Bakken	Bakken	Bakken	Same	Same
Human and Socio-Economic Receptors							
Air Quality	Bakken	Bakken	Bakken	Bakken	Bakken	Bakken	Bakken
Human Receptors	Bakken	Bakken	Same	Bakken	Bakken	Same	Same
Public Use of Natural Resources	Same	Bakken	Bakken	Bakken	Same	Same	Same

NOTES:
Site 1—Mosquito Creek to Lower Rice Lake; Site 2—Mississippi River at Ball Club; Site 3—Sandy River; Site 4—Shell River to Twin Lakes; Site 5—Red River; Site 6—Mississippi River at Palisade; Site 7—Mississippi River at Little Falls

7.9.2.1 Terrestrial Receptors

With the exception of the Mosquito Creek to Lower Rice Lake scenario, where overland flow was predicted between the point of release and the point of oil entry to a water body, it was assumed in the other six scenarios that crude oil would enter directly into a water body (i.e., Mississippi River, Sandy River, Shell River, Red River) with no holdup of oil on land. In all scenarios and with both types of modeled oil, in the event of an actual oil release any oil on land would undergo prompt and effective remediation. Residual effects on plant communities, soil or groundwater quality are unlikely.

7.9.2.2 Aquatic Receptors

The effects of a crude oil release on benthic invertebrates and fish depends on the characteristics of the released oil and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons are sufficiently high to cause acute toxicity due to narcosis. Turbulence in river/lake waters could potentially disperse light oil as small droplets in the water column, increasing the potential for toxic fractions of the light oil to dissolve into the water column. During the spring freshet, areas of water flow in rivers could be sufficiently rapid and turbulent for such droplet formation to occur for the light crude oil, although heavy crude oil is less likely to be affected. As a result, the potential for acute toxicity to fish and benthic invertebrates could be greater for the light oil than for heavier oils. In lakes, rapid evaporation of volatile (and potentially water soluble) hydrocarbon constituents from the Bakken crude oil would be expected. Rapid evaporation could limit potential toxicity to fish within the lake.

Chronic effects of released crude oil on fish eggs and embryos could also result from the release of crude oils. The eggs and embryos of these species could be exposed to total PAH concentrations in river and lake water that could be sufficiently high to induce deformities or cause mortality. In addition the potential for phototoxicity would be greatest for a crude oil release in summer due to high light intensity and long day length, especially for small fish that are lightly pigmented or transparent (i.e., embryos, larval and juvenile fish).

Entrainment of small crude oil droplets in the water column during the spring freshet could also enhance the potential for light crude oils to interact with suspended sediment particles in the water column resulting in the formation of oil-particle aggregates. Such aggregates may subsequently be preferentially deposited in areas of still or slowly moving water. Heavy oils too can contact sediment particles along the shoreline, and some accumulation of both light and heavy oils in depositional areas is likely, although the precise mechanisms of deposition may vary. Neither crude oil type is likely to reach a density greater than that of the water and sink directly to the sediment within the first few days following release.

Where they occur, floating aquatic plants would be expected to be killed if contacted by an oil slick. Submerged aquatic plants would be less vulnerable, as they would be exposed primarily to dissolved hydrocarbons, and are not considered likely to be among the most sensitive groups of aquatic biota to such exposure. Emergent aquatic plants are generally quite tolerant of moderate exposure to floating oil (such that a portion of the stem could be oiled). For a hypothetical release under spring freshet conditions, it is likely that most aquatic plants would still be dormant or submerged, and that environmental effects on this receptor type would be minimal. However, flooded riparian areas and wetland habitats would also be exposed to the released oil, and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat.

During the winter (low flow) period if the release was to occur directly to the river below the ice (as is assumed in the OILMAP Land and SIMAP model), or if there were openings in the ice that the released oil could penetrate, the oil could travel downstream under the ice accumulating in the narrow gap between the ice and the river sediment, or accumulating in hollows under the ice as it moved. For both oil types, the winter ice would effectively inhibit evaporation, while providing greater potential for dissolution into the water column during the period of lowest dilution flow. Therefore, a release in winter could cause fish mortality due to narcosis. This result would be more likely for the light crude oil, which would spread out over a larger area, facilitating release of more water soluble constituents. The heavy crude oil would tend to remain in thicker localized accumulations, and rapid release of more water soluble constituents from a thick layer of crude oil is unlikely. Fish eggs and larvae would generally not be present during the winter, so effects on these life stages are not likely, although crude oil residues in water and sediment could, if not adequately remediated, affect fish eggs and larvae in the following spawning season. Both crude oil types could be accumulated in sediment after a release in winter, and both crude oil types would be subject to re-mobilization with spring breakup of the ice, and increasing water flow rates.

7.9.2.3 Semi-Aquatic Wildlife Receptors

Habitat at the seven hypothetical release sites supports amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors) and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter). Within the oil-exposed habitats along rivers and lakes that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed. Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms

would have very little exposure to released oil moving on the water surface or within the water column.

If exposed to external oiling, the ability of birds and mammals to maintain body temperature may be compromised, leading to death as a result of hypothermia. Birds and mammals that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues during preening/grooming or ingesting food, and birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs. Waterfowl and other semi-aquatic birds and mammals present in the affected rivers and lakes would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release. Timely capture and rehabilitation of oiled birds and mammals may help to mitigate the environmental effects of a crude oil release.

7.9.2.4 Human and Socio-Economic Receptors

Effects on air quality from a release of crude oil have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality and subsequent human exposure to VOCs in the vicinity of the oil release would be most affected within the first 24 hours. Light crude oil is expected to travel a similar distance downstream under spring and summer conditions as heavy crude oil. As a result, environmental effects on air quality are predicted to be spatially similar for light and heavy crude oil types. Under winter conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs and human exposure, in addition to constraining the area of effects.

Emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release. Some homes located along the trajectory of a predicted release could rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to the any of the modeled rivers/creeks/lakes would result in adverse health effects to consumers of drinking water. Recreational activities would be disrupted following a release of crude oil along the predicted downstream migration route. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors for contact with constituents in the oil.

8.0 REVIEW OF ENVIRONMENTAL RECOVERY FOLLOWING RELEASES OF OIL

8.1 INTRODUCTION

Ecosystem and human environments experience numerous types of disturbances, including natural phenomena such as fire and flooding, and anthropogenic disturbances, including chemical and crude oil releases, mining, and industrial and urban development. The ability of a system to recover from disturbance is a complex phenomenon, dependent upon numerous intrinsic and extrinsic factors including the condition of the initial system, resistance and resiliency of the initial system prior to disturbance, and its inherent variability. The rate of recovery is largely dependent on the severity of the disturbance, its areal extent, and its duration.

Since various components of a system will recover at different rates, the selection of recovery endpoints and length of time can yield different results. It is therefore recommended that recovery endpoints be reflective of critical ecological function or important human relevance. Timeframes to determine if recovery from human disturbances has occurred need to be considered in the same context as natural recovery rates. Otherwise, it may be incorrectly determined that recovery from human disturbances has not occurred when, in fact, it is occurring but requires more time.

EERA requested that Stantec conduct a review of existing literature, supported with case studies, to evaluate the process of recovery from a crude oil release in a variety of environments and ecosystems. The review was prepared in support of the permitting process for the L3RP. Specifically, the Commission has requested information concerning the effects of potential crude oil releases along the preferred and alternate pipeline routes on the natural and human environment (Chapter 7.0), as well as the ability of these systems to recover from the effects of a crude oil release.

This chapter reviews current information on the recovery of natural and human environments from effects of crude oil releases. For biophysical environments, the ability of key groups of biota and key receptors to recover, the timeframe for recovery, and the factors affecting recovery rates are addressed. For human environments, the processes by which human use and socio-economic conditions recover following crude oil releases and the factors influencing recovery are addressed.

The recovery of both natural and human environments is considered based on the climatic conditions, ecosystems, and communities that exist in Minnesota, through which the pipelines will pass. When information was available, case studies from Minnesota and similar environments are considered to supplement the review of historical oil releases. Although broad generalizations cannot be drawn from a single event, case studies provide significant data that, in combination

with existing literature, can help regulators and operators gain a more comprehensive understanding of the effects of crude oil releases and recovery of various environmental media.

It is important to note that within this document, the term "recovery" refers to the recovery of the natural and human environments that occurs after emergency response and clean-up of a crude oil release. It does not refer to the collection and removal of crude oil from the environment, which is a common use of this term in the spill response literature.

8.2 APPROACH

8.2.1 Goals and Objectives

The overall goal of this recovery review is to provide an overview of the current science and information related to the recovery of the natural (i.e., biophysical) and human environments following crude oil releases. This report focuses on terrestrial and freshwater habitats in continental and temperate North American climates, as well as on recovery of human uses and socio-economic conditions pertinent to the region. An extensive literature review was conducted for this report, and case studies in the upper Midwest and portions of Canada were identified to address the ability of both human and natural environments to recover from severe release events. Additional case studies from other areas are cited when recovery details are relevant.

While the majority of pipeline incidents[10] tend to be relatively small with a median release volume of three barrels, these smaller releases also tend to cause few effects and almost half (47%) are contained completely on the operator's property (PHMSA 2016). Most have limited effects on the environment; therefore, very little information about recovery is publicly documented for the majority of pipeline releases. Most of the available literature is based the recovery from very large releases with severe, and sometimes widespread, effects. While these types of releases are uncommon, they do tend to be documented for regulatory purposes and, in certain instances, have resulted in scientific research that has been published in peer-reviewed journals.

Specific objectives of the recovery section are to:

- Provide a recovery assessment specific to freshwater and terrestrial releases from ecoregions similar to Minnesota
- Update the recovery assessment with information not available at the time of previous reviews
- Address specific recovery topics, including:

[10] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

- Those key receptors and groups for the natural environment for which ecological recovery was specifically studied and which may be present in the area of the two proposed projects
- How different approaches to emergency spill response, habitat restoration, and environmental rehabilitation can affect rates of recovery
- How biota respond and recover from crude oil releases
- Perspectives on how human socio-economic conditions recover following crude oil releases

8.2.2 Scope and Organization

To understand how systems recover from crude oil releases, an understanding of the physical and chemical properties of crude oil is needed (Section 8.2.3.1), as well as a general description of fate and behavior of crude oils in various environmental media (Section 8.2.3.2). Recovery from crude oil release effects is then examined for a variety of environmental receptors (Sections 8.3.1 to 8.3.7), as well as recovery of human communities from socio-economic effects (Section 8.3.8). Findings are summarized in Section 8.5.

8.2.3 Factors Affecting Recovery

8.2.3.1 Physical and Chemical Properties of Crude Oil

Crude oil is a complex mixture of petroleum hydrocarbons and its composition varies widely, depending on its origin and processing. Created from organic matter, crude oil is primarily composed of carbon and hydrogen, with smaller amount of other elements. These hydrocarbons vary in molecular weight, form, and length, and include paraffins, aromatics, cycloalkanes, alkenes, and other compounds. The differences in the structure of these compounds as well as their relative proportion within each crude oil account for the crude oil's physical and chemical characteristics.

From an environmental perspective, BTEX are of particular interest. These lightweight aromatic petroleum hydrocarbons are highly volatile and relatively water soluble, making them mobile within the environment but their environmental persistence is lower than many other petroleum hydrocarbons. Heavy molecular weight petroleum hydrocarbons, such as asphaltenes, have low volatility, are much less soluble, and are more environmentally persistent. Consequently, understanding how these hydrocarbons interact with the environment is important for understanding recovery.

Light crude oils are characterized by their high proportion of lightweight hydrocarbons, with few heavy constituents. Light crude oils typically have AP) gravities greater than 31.1, indicating that they will float on water[11] in the event of a release, which would facilitate clean-up (Lee et al. 2015). Light crude oils contain a smaller fraction of heavy molecular weight compounds than

[11] Fluids with API values greater than 10 float on the water's surface, while fluids with API gravities less than 10 will sink.

lower value API crude oils and have a low viscosity. As a result, they form a thin sheen across the surface of water that provides more surface area to the environment, thus enhancing weathering processes such as evaporation, dispersion, and photodegradation.

Medium crude oils generally have API gravities ranging from 22.3 to 31.1 (Lee et al. 2015). Environmental processes (e.g., spreading, evaporation and emulsification) will be intermediate in comparison to lighter and heavier crude oils.

Heavier crude oils have a higher proportion of heavy molecular weight compounds (e.g., asphaltenes) than light and medium crude oils. Heavy crude oils typically have API gravities less than 22.3 (Lee et al. 2015).

Diluted bitumen is one type of blended heavy crude oil[12]. Diluted bitumen crude oils from Canada generally have API gravities above 20 API, indicating that they will float on the surface of water (Crude Monitor 2016). Because diluted bitumens are heavy oils, they are more viscous than either medium or light crude oils and will spread over land and across the water's surface more slowly, reducing the affected area in a given period of time compared to lighter oils. Like other crude oils, diluted bitumen can form emulsions (i.e., water-in-oil mixtures). Due to the greater proportion of heavy molecular weight compounds and their affinity to organic materials, diluted bitumen emulsions tend to incorporate sediments. The resulting oil-water-sediment material tends to be more stable and has longer environmental persistence than light crude oil emulsions.

Several case studies presented in this report feature fuel oil and Bunker C Oil releases. These are extremely heavy oils that can have substantially different effects than crude oils transported by pipelines. However, these case studies are presented in this report where information to recovery is relevant.

8.2.3.2 Environmental Fate and Behavior of Crude Oil

Once released into the environment, crude oil is subject to a number of physical processes and chemical transformations, including evaporation, emulsification, dissolution, photodegradation, and biodegradation (Prince et al. 2003; Fingas 2015) (Section 7.1.2). These weathering processes are present regardless of release location. Additional details regarding environmental fate and behavior of crude oil are discussed in Section 7.1.

8.2.3.3 Species Resistance

Species differ in their ability to resist disturbance. For a crude oil release, species resistance depends on multiple factors including the species sensitivity to exposure to petroleum

[12] Definitions of a "heavy oil" vary within the industry. For this report, heavy oils refer to those crude oils with API values less than 23 but more than 10. Raw bitumen is an extremely heavy crude oil with API value of 10 or less.

hydrocarbons, life stage, and behaviors that may increase or decrease the exposure of the organism. While effects of petroleum hydrocarbons were discussed in the previous chapter, the severity of effects and the areal extent of the effects can strongly influence the rate of recovery of the environment.

8.2.3.4 Species Resiliency

Numerous factors, such as life history strategies and the presence of nearby, unaffected populations that can recolonize an affected area, influence how quickly a species may recover from a crude oil release (i.e., the species' resiliency). While life history strategies for all species are not discretely divided into two independent groups, the "r" and "K" strategies are useful descriptors used by scientists to discuss population dynamics and characteristics.

Species that exhibit "r" strategies ("r strategists) produce a large quantity of offspring, resulting in an initial exponential growth in the local population. The success of these species relies on their biotic potential or maximum reproductive capacity (r) (Rafferty 2016a). Other characteristics of "r" strategists include short gestation periods, small body size, fast maturation rates, short life spans, and little individual parental investment. Some examples of "r" strategist species include certain annual grasses and forbes (including those that are often those considered invasive and noxious weeds); some insects (e.g., mosquitos, cockroaches); some bird species (e.g., house sparrows); and small mammals (e.g., mice).

The life history traits that characterize "r" strategists allow these species to exploit disturbed, less crowded, and sometimes unstable ecological niches (Rafferty 2016a). Therefore, they typically are not highly adapted to their environment since the environments they inhabit often change or are disrupted in some way. To succeed in these highly variable environments, it is crucial that "r" strategists are able to reproduce quickly and in great numbers to allow for the highest probability of continued future generations of offspring. Another advantage of large numbers of offspring in a temporary and unstable environment is the ability to respond opportunistically and to quickly claim untapped resources, such as nutrients and sunlight. However, after population booms, populations of "r" strategists begin to decline rapidly due to overcrowding or competition with more specialized species (Rafferty 2016a).

Species that exhibit "K" life history strategies ensure survival of their offspring by focusing on quality rather than quantity. Key characteristics of "K" strategists include fewer offspring, extended gestation periods, long life spans, large body size, and extensive parental investment. These species invest time in their individual offspring rather than relying on large numbers to increase the chance of survival and reproduction. "K" strategists utilize longer maturation periods and have the ability to transfer knowledge and skills to their young, which is needed to survive to adulthood and ultimately produce future generations (Rafferty 2016b). Populations that are "K" strategists fluctuate depending on the carrying capacity (K) of their local environment, resulting in stable biological communities and long term population growth (Rafferty 2016b). Because "K" strategists have evolved in relatively stable environments, "K"

strategists may require longer periods to recover from disruptive changes to the environment, compared to "r" strategists. Examples of "K" strategists include many types of woody vegetation (e.g., redwood trees), certain birds (e.g., hawks, eagles), and large mammals (e.g., bears, humans).

8.2.4 Defining Recovery

Definitions of ecological recovery have evolved substantially over the last few decades within both regulatory and scientific contexts. Much of this evolution derives from advances in ecological knowledge based on the successes and failures of ecological remediation (Jackson and Hobbs 2009).

Historically, definitions of recovery include a central concept regarding a return of the ecosystem or a particular resource or human use to some desirable system state roughly equivalent to its pre-disturbance conditions. Since pre-disturbance (baseline) conditions often have not been quantitatively assessed prior to a release, definitive conclusions regarding recovery are difficult to achieve.

More recently, the definition of recovery has meant a return to the conditions that would have prevailed had the crude oil release not occurred, while recognizing the need to take into account spatial and temporal variability in natural ecosystems, as well as the influence of natural and man-made factors other than the release. Current perspectives from the scientific literature and regulatory context attempt to define appropriate and practical objectives of recovery and active remediation to re-establish the ecosystem functions that provide valuable ecological goods and services. This current perspective focuses less upon comparison with baseline conditions than identifying measures to assess recovery in terms of desired ecosystem function.

8.3 RECOVERY BY VALUED ECOSYSTEM COMPONENT

8.3.1 Groundwater

Groundwater often is an important resource for agriculture, public, industrial, and private water supplies. In Minnesota, groundwater supplies derived from aquifers account for about 75% of the drinking water and almost 90% of agricultural water supplies (MN DNR 2016).

Water beneath the land surface occurs in two principal zones: the unsaturated zone and the saturated zone beneath it. When the unsaturated zone is porous, consisting of materials such as sands and gravels, water from precipitation can percolate through the unsaturated zone and recharge the groundwater in the saturated zone. The top of the saturated zone is the water table. The saturated zone consists of groundwater filling the pores and crevices in soil, sand, gravel, or rock. Not all groundwater located within saturated zones is located within an aquifer.

Aquifers are defined as water-bearing porous soil or rock strata that yield water at rates sufficient to support human uses. Consequently, a saturated layer of clayey soil does not meet the definition of an aquifer. Well intakes are located below the water table and within saturated aquifer material where the water pressure is great enough to allow water to enter wells, thus permitting groundwater to be withdrawn for use (MN DNR 2016).

Aquifers are broadly classified into two categories, unconfined and confined. Unconfined aquifers are the saturated portions of the upper soil profile located above a confining layer. The upper surface of an unconfined aquifer is in direct contact with the atmosphere through porous materials. In contrast, confined aquifers are separated from the atmosphere by a confining layer, consisting of a very slowly permeable or rock layer (aquitard). Confining layers severely impede downward movement (percolation) of infiltrated water. Water in these aquifers is under pressure and, in a well, will rise above the top of the aquifer.

Aquifers differ in their susceptibility to surface contamination due to a variety of factors such as the depth to groundwater and the presence of a confining layer. Across the United States, the depth to the groundwater is highly variable. Groundwater depth can range from zero when it is immediately below the land surface to hundreds, even thousands of feet deep. In Minnesota, groundwater is generally close to the land surface, typically within a few tens of feet in much of the state (MN DNR 2016).

The presence or absence of a confining layer is a critical factor that affects an aquifer's vulnerability to surface contamination. Confined aquifers are protected by one or more relatively impermeable layers (such as clay) that limit the vertical movement of water and contamination. An unconfined aquifer has no overlying impervious layer to separate it from the surface contamination. Shallow, unconfined aquifers are considered to be vulnerable to surface contamination, whereas deep, confined aquifers have a comparatively low susceptibility to surface contamination.

Crude oil releases from pipelines do not commonly affect groundwater resources. The PHMSA maintains a pipeline incident database that contains detailed information on all reportable historical pipeline incidents[13]. On a national basis, PHMSA incident data indicate that only a small fraction (approximately 4%) of reportable incidents affected groundwater[14]. When groundwater resources were affected, approximately 77% of those releases required groundwater remediation activities (PHMSA 2016). For the State of Minnesota, PHMSA data

[13] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[14] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

indicate that groundwater is affected by 13% of the reported releases, with 50% of those releases requiring remediation (PHMSA 2016). Differences between the national and regional statistics appear to be related to a higher proportion of shallow, unconfined aquifers in the Minnesota region compared to other regions of the U.S. Nevertheless, only 0.4% of releases affected actual drinking water resources in states crossed by the SPP and L3RP (i.e., only a fraction of surface and groundwater resources are used as drinking water supplies) (PHMSA 2016).

8.3.1.1 Recovery of Groundwater Following a Crude Oil Release

8.3.1.1.1 Permeability of Soils to Crude Oil

Once crude oil is released into the environment, the attributes of the release site, including the groundwater characteristics, will determine how quickly the crude oil may penetrate into the soil; how far it may move vertically within the soil and subsoils; and the degree that the crude oil fills the interstitial spaces within the soil and between subsoil particles in the unsaturated layer. Effects to soil and groundwater generally are slow to develop, allowing time for emergency response and clean-up actions to mitigate potential effects. If clean-up activities do not completely remove the crude oil, the residual crude oil and constituents that dissolved from the crude oil may migrate downwards through the unsaturated layer to reach groundwater. Since petroleum hydrocarbons can adhere more strongly to soil particles with a higher organic carbon content, the mobility of the residual crude oil through the unsaturated layer is largely controlled by the composition of the unsaturated layer and the depth of the unsaturated layer (i.e., the distance between surface soil and groundwater). Factors such as the depth of the aquifer and presence of intervening layers of confining materials (e.g., horizontal layers of clay, silt, slate, granite) may reduce the potential for groundwater contamination. In general, the movement of crude oil in soils and subsoils is limited.

The surface area of crude oil in contact with groundwater, duration of contact with groundwater, and the concentration of water soluble constituents (e.g., benzene) within the crude oil are critical factors that determine if a plume of petroleum hydrocarbons may be formed in the groundwater and how large the plume becomes. In their examination of over 600 petroleum hydrocarbon releases, Newell and Connor (1998) found that residual oil acts as a source for groundwater contamination and that recovery occurred (e.g., groundwater plumes stabilized or decreased in size) when the residual petroleum hydrocarbons from the original release site were removed. Consequently, the timeliness and efficacy of clean-up activities in removing crude oil strongly affects the extent of impacts to groundwater and rates of recovery.

8.3.1.1.2 Chemical, Physical, and Biological Attenuation Factors

Groundwater recovery can be governed by a number of important natural environmental fate processes including chemical (adsorption), physical (volatilization, dilution, chemical attenuation), and biological (biodegradation) processes. Collectively, these environmental fate processes that stabilize or remove hydrocarbons from the environment are referred to as natural attenuation. *Biodegradation* is generally the most significant natural attenuation process and

occurs when microbes digest petroleum hydrocarbons, converting hydrocarbons into small amounts of water and gases. Native microbial populations may bloom and biodegrade petroleum hydrocarbons in groundwater. *Sorption* causes contaminants to adhere to soil particles, but does not destroy the contaminants. Sorption reduces the rate that petroleum hydrocarbons can migrate through soils and subsoils. *Dilution* decreases contaminant concentrations as they migrate through the medium and mix with clean groundwater. *Evaporation* changes liquids to gas and can be a significant means of reducing release volume, as well as removing many of the most concerning compounds (i.e., BTEX) from the soil. However, evaporation rates are reduced when the exchange of gases is limited, so evaporation at the soil surface will be greater than evaporations at increasing depth within the soil horizon. *Chemical reactions*, including complexation and abiotic transformation, can stabilize and convert hydrocarbons into less harmful forms (USEPA 2016).

Because of natural attenuation, dissolved hydrocarbon plumes tend to stabilize within tens to hundreds of feet from the source release (Newell and Connor 1998; Connor et al. 2015). Although natural attenuation rates depend on site-specific physical, chemical, and biological subsurface environment characteristics, nationwide investigations of over 1,300 historical petroleum release sites found that the migration of dissolved constituents typically stabilizes within approximately 425 feet of the point of release. Furthermore, this analysis found that approximately 94% of BTEX plumes studied were either stable or shrinking (Connor et al. 2015). Natural attenuation stabilizes and reduces the concentrations of many petroleum hydrocarbons compounds, including BTEX (MN PCA 2005).

> ***Enbridge Crude Oil Pipeline, Bemidji, Minnesota:*** *The Bemidji release is the sentinel study that vastly increased the scientific understanding of natural attenuation processes. In 1979, a pipeline released approximately 10,700 barrels of crude oil near Bemidji, Minnesota. Initial clean-up efforts removed approximately 8,200 barrels (75% of the original volume) and an unquantified volume was lost to the atmosphere to volatilization. There was a substantial volume of crude oil that remained in the soils and subsoils after clean up. The release occurred in an area of very sandy soils with shallow groundwater. Since the release occurred within a state forest with few environmental receptors (e.g., drinking water intakes, populated areas) in close proximity to the release site, the State of Minnesota, the USGS, and Enbridge collectively agreed to monitor effects of crude oil and its dissolved constituents on groundwater. As part of this research initiative, these agencies and Enbridge agreed that further clean up and remediation of the site (i.e., treatment of contaminated soils and subsoils) would not be undertaken at that time. Seventeen years after the release, natural attenuation had limited the movement of the hydrocarbon plume to 650 ft in length, compared to groundwater movement of 1,640 ft (Delin et al. 1998).*

Natural attenuation is influenced by a number of factors including soil type, depth to groundwater, electron receptors, nutrient availability, and temperature. Rates of natural

attenuation depend upon the subsurface temperature and presence of electron receptors that are utilized by the microbes to degrade petroleum hydrocarbons. Oxygen, used for aerobic respiration, can result in much higher reaction rates compared to anaerobic (anoxic) reactions that depend on electron acceptors, such as nitrate, ferric iron, sulfate, or carbon dioxide (listed from strongest to weakest). As the more preferred electron receptors are consumed (e.g., oxygen, nitrate), the oxidation-reduction (redox) potential of the groundwater decreases over time. Consequently, many remediation activities focus on supplementing oxygen and nitrogen to maintain and enhance rates of natural attenuation.

> ***Enbridge South Cass Lake Pumping Station, Minnesota****: A subgrade leaking flange at the Cass Lake pumping station in north-central Minnesota was discovered in 2002. An estimated 1,143 barrels of crude oil were present at the groundwater table, and the dissolved phase plume (>10 ppb benzene) extended 500 ft downgradient (Drennan et al. 2010). Because the oil resided under a gravel-covered yard at Cass Lake, enhanced surface recharge was suspected as a factor accelerating degradation (Drennan et al. 2010). To further accelerate groundwater recovery, a bioventing groundwater remediation system[15] was installed in 2014. Monitoring data following just three months of operation suggest biodegradation was being enhanced with increased oxygen, decreased carbon dioxide, and increased temperature in the unsaturated zone (AECOM 2015).*

8.3.1.1.3 Removal of Residual Crude Oil

If crude oil is allowed to remain in the soils and subsoils following a release, the residual oil can act as a source of dissolved constituents that contribute to the formation of a groundwater plume. Natural attenuation processes slow the movement of dissolved petroleum hydrocarbons in groundwater. Eventually, the petroleum hydrocarbon plumes stabilize when an equilibrium is reached between dissolved petroleum products entering the plume and the degradation of hydrocarbons along the groundwater's leading edge.

The movement of groundwater plumes has been studied extensively. Newell and Connor (1998) summarized data from petroleum hydrocarbons throughout the U.S. Their analysis concluded that the removal of the source of petroleum hydrocarbons was one of the most critical variables in groundwater recovery, allowing plumes to stabilize and eventually begin to shrink.

If crude oil remains in the environment, weathering and the natural attenuation process will continue to degrade the remaining crude oil. Concentrations of straight-chained hydrocarbons and simple aromatics will diminish with time, leaving a small volume of crude oil composed of complex, multi-ringed petroleum hydrocarbons that can be extremely persistent.

[15] The purpose of the bioventing groundwater remediation system, consisting of three bioventing wells installed to depths of 24 ft below grade as well as eight total vapor monitoring points, was to oxygenate and degrade petroleum compounds in subsurface soils (AECOM 2015).

> ***Enbridge Crude Oil Pipeline, Bemidji, Minnesota****: Bekins et al. (2005) analyzed soil cores 25 years after the Bemidji release and found substantial biodegradation of the n-alkane fraction had occurred through methanogenesis. While weathering of the crude oil has decreased the mobility and capacity of the residual oil to liberate soluble contaminants into the groundwater, weathering continues to remove light- and medium-weight petroleum hydrocarbons, leaving behind a crude oil that is increasingly persistent and less susceptible to natural attenuation.*

8.3.1.2 Factors Affecting Recovery

Rapid and effective emergency response containment and clean up can substantially accelerate recovery by limiting the amount of crude oil available to affect groundwater, and by reducing hydrocarbon concentrations to levels where natural attenuation processes can more readily complete the recovery.

Failure to remove residual oil at the release site is the most significant factor impeding the recovery of groundwater. If left in place, residual oil at the release site can represent an ongoing source for the dissolved plume, potentially for many decades. Vertical fluctuations in the water table also can impede recovery by increasing the amount of oiled substrate in the saturated and unsaturated layers (i.e., smear zone thickness).

When accelerated rates of recovery are desired, active remediation or enhanced bioremediation can be implemented. Selection of remediation technology depends on the remedial objectives, affected media (e.g., soil, saturated and unsaturated layers, groundwater characteristics), and the physical and chemical properties of the petroleum hydrocarbon (e.g., crude oil volatility, crude oil transmissivity [i.e., its mobility within the pores and interstitial spaces of the subsoils and underlying lithology], concentrations of soluble petroleum hydrocarbons with the crude oil).

Active remediation can involve the installation of a mechanical system where recovery wells are used to volatilize certain petroleum hydrocarbons and extract the resulting gases (e.g., soil vapor extraction), inject airflow to volatilize petroleum hydrocarbons below the water table (e.g., air sparging), or extract the affected groundwater and/or crude oil (e.g., skimming, pump-and-skim). A multi-phase extraction[16] system involves the simultaneous extraction of volatilized petroleum hydrocarbons from the unsaturated layer, groundwater, and crude oil where it has pooled on the surface of the water table.

Soil vapor extraction often is used to remediate contaminants that are within the saturated layer. The selection of a soil vapor extraction system must consider the volatility of the residual petroleum hydrocarbon (i.e., vapor pressure of the residual petroleum hydrocarbon), ability of the crude oil to desorb from the soil (i.e., Henry's Law), and soil type (course-grained versus fine-

[16] Multi-phase extraction—a generic term for technologies that extract VOCs from soil vapor and groundwater, simultaneously (USEPA 1999).

grained). Crude oil that is weathered and adsorbed to fine-grained soils (e.g., silt, clay) is not a good candidate for soil vapor extraction.

Extraction of crude oil from the unsaturated zone where the crude oil has filled the pores between subsoil particles is conducted through pumping, skimming, or multi-phase extraction techniques. Pumping extracts groundwater from a well and the water can be treated and disposed of, if contaminated from the crude oil. Since crude oil tends to float, groundwater is extracted by pumping and then oil is skimmed from the surface of the extracted groundwater. As described above, multi-phase extraction methods remove product from the unsaturated layer, the groundwater surface, and the saturated layer. Selection of these methods rely upon the ability of the crude oil and its dissolved constituents to move through the spaces within the soil and subsoil structure as the crude oil is conveyed to a recovery well (i.e., transmissivity).

Crude oil transmissivity is considered a better metric than measurements of in-well thickness of oil for assessing if oil is recoverable (i.e., mobile) (ITRC 2009). Crude oil transmissivity is dependent upon the soil type, crude oil physical properties (e.g., density, viscosity), crude oil saturation (i.e., percentage of pore space occupied by crude oil), and thickness of the mobile crude oil in the formation. In general, transmissivity is higher for light crude oils (e.g., Bakken crude oil) and lower for heavy crude oils (e.g., diluted bitumen). As crude oils weather, they become more viscous and dense and therefore have lower transmissivity. ITRC (2009) identified a practical minimum crude oil transmissivity range (0.1 to 0.8 square ft per day [ft^2/d]) to help determine if the oil can be feasibly recovered hydraulically.

As the extraction process progresses, the process becomes less efficient as the crude oil saturation reaches residual levels, the crude oil becomes hydraulically disconnected (i.e., present as disconnected globules within the pores), or is immobilized by capillary forces within the pore space.

> ***Enbridge Crude Oil Pipeline, Bemidji, Minnesota****: In 1999, the State of Minnesota mandated active remediation for the Bemidji release site with the objective of reducing crude oil in all monitoring wells to only a "sheen". A pump-and-skim extraction system was used from 1999 through 2003 and approximately 700 barrels of crude oil were removed during that time. Despite the removal of a substantial volume of residual crude oil, the regulatory agency requirement was not met because the residual oil continued to create a sheen from water extracted from certain monitoring wells. Further, the crude oil thickness decreased locally near the pumping wells during pumping, but there was little effect on surrounding monitoring wells as crude oil thickness rebounded following system shutdown (Delin and Herkelrath 2014).*

Enhancements of natural attenuation processes also can be considered to accelerate groundwater recovery. Typically, natural attenuation enhancements involve increasing the availability of electron acceptors, such as oxygen and nitrate. Bioventing, where ambient air is

injected or extracted at low flow rates, is used to supplement and replenish oxygen for microbial respiration in the vadose zone. Biosparging (a process where compressed air is injected at low flow rates below the water table) is used to increase dissolved oxygen levels in the groundwater to enhance biodegradation. Sulfate amendments also have been used to enhance biodegradation rates in anaerobic environments.

8.3.1.3 Groundwater Summary

The vast majority of terrestrial crude oil releases do not affect groundwater resources. National statistics demonstrate that only 1.36% of releases required groundwater remediation, and 0.17% of the releases adversely affected drinking water, whether groundwater or surface water (PHMSA 2016). In the Upper Midwest, the presence of shallow unconfined aquifers increases groundwater vulnerability compared to other parts of the US. In Minnesota and surrounding states, PHMSA data indicate that groundwater is affected by 9.7% of the pipeline releases, with 71% of those same releases requiring remediation (PHMSA 2016).

Effects and the subsequent need for groundwater recovery can be substantially reduced by minimizing the duration that crude oil is in contact with the groundwater. Previous reviews of petroleum hydrocarbon releases concluded that the removal of the residual oil at the release site was the most important factor for initiating recovery (Newell and Connor 1998).

When a petroleum hydrocarbon plume is formed, recovery of groundwater can occur through natural attenuation, but may take decades to achieve. Petroleum hydrocarbon plumes move more slowly than the groundwater due to adhesion to soil particles and natural attenuation processes. As a result, the length of petroleum hydrocarbon plumes generally is tens to hundreds of feet. A compilation of studies evaluating 600 sites (Newell and Connor 1998) found most petroleum hydrocarbon plumes were stabilized or decreasing, indicating recovery (Newell and Connor 1998). Human intervention through enhanced natural attenuation or by active remediation procedures can accelerate rates of groundwater recovery from decades to years.

8.3.2 Soils

The Natural Resource Conservation Service (Soil Survey Staff 2003) defines soil as a natural body consisting of "solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: i) horizons or layers, that are distinguishable from the initial [bedrock] material as a result of additions, losses, transfers, and transformations of energy and matter; or ii) the ability to support rooted plants in a natural environment."

Ecosystem functions provided by soils (Coleman et al. 1998; Doran and Parkin 1994) include:

- Accepting, storing, and releasing water to plants, streams and subsoils
- Accepting, storing, and processing nutrients, making them available to plants and other organisms

- Supporting and sustaining root growth
- Maintaining viable soil biotic habitat
- Responding to management and resisting degradation

The soils in the region crossed by the two proposed pipelines are generally characterized by glacial till and sandy soils. The materials deposited through direct and indirect glacial action provide the parent material for the soils in this region. Glacial till is an unsorted mixture of material ranging from very fine clay to stones and boulders. During glacial retreat (i.e., melt), large amounts of water were released, which washed the till, removing fine particles. The remaining sands and gravel materials were then sorted, forming glacial outwash sediments. These materials were collected in low-lying areas (sometimes for long time periods), forming lacustrine deposits that settled in lakes. Lacustrine deposits range from sand and gravel at beaches to clayey substrate near the center of a lake. During the glaciation and melting periods, wind transported soil particles (i.e., silt and clay) to other areas, where the particles were deposited on older till or bedrock (i.e., weathered and fresh) (Anderson et al. 2001).

A crude oil release on glacial till would not migrate quickly through soil media due to the low permeability of the material. Conversely, a crude oil release on sandy and gravelly soils consistent with glacial outwash, would migrate more quickly due to the higher porosity of the material. Similarly, crude oil released on clayey deposits (i.e., toward the center of the lacustrine deposits) would not migrate through the soil as quickly as crude oil released on sandy and gravelly deposits (i.e., on lake beaches). Migration of crude oil released on loess deposits would depend on the bulk density of the soil and whether the medium contained moisture (Wang and Shao 2009).

There are numerous types of surface soils, the distribution and characteristics of which are broadly controlled by parent material, climate, biota, and time. Although they are variable, soils typically include a common matrix of air, water, and organic and inorganic (mineral) particles that vary in size and shape. This soil matrix commonly supports an ecosystem of microbes and invertebrates. These organisms, in turn, provide a supporting foundation for an even larger ecosystem of plants and animals.

8.3.2.1.1 Soil Microorganisms

Soil microorganisms, an integral part of soil, primarily consist of bacteria, actinomycetes, fungi, algae, protozoa, and nematodes. This assemblage is responsible for cycling nutrients, such as nitrogen, phosphorous, potassium, calcium, magnesium, iron, and sulphur, through the decomposition of organic matter. Certain microorganisms (e.g., bacteria) also have the ability to use petroleum products as a food supply, decomposing crude oil to carbon dioxide and water (Jensen 1975; Rowell 1975; Watts et al. 1982).

However, the smaller soil organisms tend to contribute disproportionately more to the overall abundance of metabolic activity within the soil and often form symbiotic relationships with plants.

The abundance, diversity, and resiliency of soil organisms are dependent on the nature of the soil and the associated plant community. Reproduction rates and sensitivity to petroleum hydrocarbons can allow some species to proliferate more quickly and consume petroleum hydrocarbons compared to other species (Brezeszcz et al. 2016). These characteristics can determine how quickly the soil ecosystem can recover when exposed to crude oil. For example, Rowell (1975) found microbes began to degrade crude oil in several types of mineralized soils in Alberta within 1 to 3 days after application of crude oil at a concentration of 5% by weight. A key element regulating these characteristics is the availability of active organic matter that can readily be used as a source of energy and carbon. In addition, nutrients, moisture content, temperature, and other climatic factors play important roles (Rowell 1975; Dibble and Bartha 1979).

While an important component of the soil, soil invertebrates are not easily quantified in the field and, as a result, there is little information about their response to crude oil releases. Consequently, the following sections focus on the recovery of the soil ecosystem. Terrestrial plant recovery, which is closely related to soil recovery, is discussed in Section 8.3.3.

Review of recent national PHMSA pipeline incident data[17] shows that almost half of reportable pipeline incidents resulted in soil contamination (PHMSA 2016)[18]. The majority of releases include soil remediation involving 100 cubic yards of soil or less, and only 3% of releases reported to PHMSA require soil remediation of 10,000 cubic yards or more (PHMSA 2016).

8.3.2.2 Recovery of Soils and Soil Microorganisms following a Crude Oil Release

Recovery of soils and soil organisms is strongly influenced by the volume of the release, as well as by the type of crude oil. Large, concentrated releases tend to result in a larger initial effect on a localized area, which leads to slower recovery (Wang et al. 1998). Large volume releases also can create hydraulic head pressure that may allow crude oil to penetrate deeper into the soil, where crude oil degradation is generally slower and recovery can be prolonged, than a small volume of crude oil.

The physical and chemical characteristics of the crude oil determine how the oil moves through soils, its toxicity to soil organisms, and how readily the crude oil can be degraded by microbial organisms. Low viscosity crude oils do not flow easily and adhere to soil particles, limiting their ability to penetrate into the soil and subsoils (Rowell 1975; Raymond et al. 1976; Vanloocke et al. 1979). Crude oils that contain a greater portion of straight-chained hydrocarbons (paraffins) will

[17] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[18] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

degrade more quickly than branched hydrocarbon chains or aromatic hydrocarbons (Volk 1980). Soluble aromatics metabolize more quickly than non-soluble aromatic hydrocarbons (Volk 1980; Fedorak and Westlake 1981).

Evaporation of crude oil at or near the ground surface can quickly reduce the volume of crude oil, particularly with lighter crude oil products, but other weathering processes (e.g., photodegradation) tend to occur more slowly (Wein and Bliss 1973; Wang et al. 1998). Weathering processes occur more slowly in colder environments or in soils that are acidic, low in nutrients, or anoxic (Sparrow and Sparrow 1988; Wang et al. 1998).

The topography of a release site is also an important factor, along with release size. Flat and relatively flat terrain tends to confine the crude oil to a relatively small, contiguous, and easily defined area. In steep terrain, the same volume of crude oil may move farther from an initial release site, compared to relatively flat terrain. Similarly, a precipitation event or snow melt can result in a larger affected area, but can lessen effects and accelerate recovery (Collins et al. 1994).

Clean-up and remediation efforts, including removal of contaminated soil and efforts to enhance biodegradation rates, generally can accelerate site recovery, although some methods such as *in situ* burning can negatively affect soil recovery (De Jong 1980; SLR Consulting 2008a; Nieber 2013). Both bioremediation (using microorganisms) and phytoremediation (using plants) are appropriate remediation options, especially at sites where a short growing season and low temperatures prevent rapid degradation of petroleum products through other weathering processes. See Section 7.1 for further discussion regarding weathering processes.

> ***Unknown Operator, Nipisi Pipeline Release, Alberta****: In 1970, Nipisi Pipeline released approximately 60,000 barrels of crude oil and affected over 25 acres of predominantly bog/fen habitat (Wang et al. 1998). Initial treatments included burning, tilling, or fertilizer additions. After the initial remediation treatment, no further reclamation activities occurred and the site was designated a scientific research area to study subsequent recovery rates of peat bog/fen habitat. After 25 years, surface and subsurface soil core samples in affected areas were analyzed to determine which clean-up method was most effective, and document changes in residual oil after 25 years. Results found no differences between the initial treatments. Core samples revealed that crude oil near the soil surface (depth: 0–1.6 inches) had been significantly weathered, whereas subsurface samples (depth: 4–16 inches) showed very little weathering. There were limited petroleum hydrocarbons at depth (depth: 31–39 inches). Beyond the surface of the peat bog, soil conditions were anoxic and the bog experienced negligible flushing of groundwater through recharge. Water levels did fluctuate vertically within the bog with seasonal precipitation. Researchers believe that the limited amount of crude oil weathering that was observed in the 4–16 inch*

samples was attributable to restricted natural attenuation processes, including volatility, photodegradation, and dissolution. Since groundwater movement was quite slow, researchers hypothesized that vertical penetration was related to the amount of organic content, grain size, and "chromatographic" processes that allowed lighter hydrocarbons to migrate deeper into the peat than if the water levels had been stable (Wang et al. 1998). While recovery is occurring, the colder temperatures at this latitude also may be responsible for slow recovery at the site.

Soil microorganism activity plays a role in the biodegradation of crude oil and promotes recovery of both the biological function and matrix of the soil (Ellis and Adams 1961). Historical efforts to reclaim agricultural soils contaminated with petroleum hydrocarbons included enhancing aerobic conditions by increasing the population of soil microorganisms through fertilization and cultivation, seeding with microorganisms, or removal of crude oil by burning (Schwendinger 1968). Subsequent research has shown that some of these practices can reduce rates of soil recovery, particularly if applied inappropriately. Fertilization and cultivation (when feasible) typically increase biodegradation rates, particularly when degradation has depleted oxygen and nutrient levels in the soil. When done improperly, soil tilling can severely disrupt the soil structure, leading to increased compaction, increased erosion, and lower productivity. Seeding with microorganisms has had mixed success but is becoming a more sophisticated science as scientists identify which microbes or microbial communities degrade petroleum hydrocarbons most efficiently (Brezeszcz et al. 2016).

***Unknown Operator, Crude Oil Pipeline, Moose Jaw, Saskatchewan**: In January 1974, a pipeline failure occurred north of Moose Jaw, Saskatchewan. The pipe was buried 3.3 ft below the soil surface and the diluted bitumen (API gravity 23) flowed underneath the frozen topsoil and into a ditch that was 2,289 ft from the pipeline break. Some surface pooling also occurred close to the release point, but the majority of the crude oil was present as a thin lens, a fraction of an inch thick (several millimeters), just below the frost line. Of the total 15,720 barrels that were released, an estimated 10,060 barrels were recovered. No exact estimate of the crude oil remaining could be made as an unknown amount of crude oil was removed from the site in the form of contaminated snow. Some crude oil was likely lost by volatilization (De Jong 1980). Further remediation of the affected soil was not conducted and, in the spring of 1974, crops were planted. Fertilizer was applied to enhance the rate of crude oil weathering but was limited to the maximum rate tolerated by the crops. From 1974 to 1978, monitoring demonstrated an appreciable decrease in crude oil content within the soil, particularly in the 1977 fallow year when higher levels of fertilizer were applied (De Jong 1980). The surface soil (0 to 1.2 inches) showed the greatest hydrocarbon reductions. The study provided further support for the role of microbes in reducing the concentration of crude oil, and the recovery of the environment. The addition of fertilizer helped compensate for the increased demand for nitrogen*

made by the microorganisms that were most active in the surface soil where there was more oxygen (De Jong 1980).

Burning can be counterproductive for recovery of soil productivity since burning can create anaerobic conditions and incomplete burning can create a hydrophobic (i.e., resisting or repelling water) soil surface, substantially slowing the biodegradation of crude oil (Chapelle 1999; Cozzarelli and Baehr 2003; Nieber 2013). In some cases, crude oil contaminated soils can become hydrophobic, so soil tilling can be an effective remediation strategy to break the surface tension, allowing water to penetrate, as well as oxygenating the soil. Current strategies to enhance biodegradation of petroleum hydrocarbons generally focus on providing sufficient oxygen and nutrients to enhance microbial growth, while minimizing effects on terrestrial vegetation.

***Enbridge Crude Oil Pipeline, Bemidji, Minnesota**: During this 10,700-barrel release in 1979, crude oil sprayed over an area of approximately 1.6 acres and collected in low-lying areas before infiltrating the sandy soil and contacting shallow groundwater. Initial clean-up efforts removed approximately 8,200 barrels (75% of the original volume). Much of the remaining oil was retained in the surface and subsurface soils. Although there were immediate effects of the oil release on terrestrial habitat, subsequent removal of topsoil, and burning of that topsoil had a greater effect. Fire affects the chemical properties of soil organic matter through heating of soil organic matter and associated rapid losses of nitrogen availability. Nitrogen availability is a limiting factor for growing plants and other vegetation. Hydrophobic compounds may also be formed from heating of the soil and contribute to soil hydrophobicity (the ability of soil to repel water), which is commonly observed following a fire. Intense fires (greater than 750°F) may reduce or consume soil organic matter which holds sand, silt, and clay particles together, reducing overall soil structure (Kennard et al. 2016).*

The area that was disturbed and burned has remained relatively barren for most of the last 30 years due to the combined effects of lack of topsoil and burning that have made the soil hydrophobic(Nieber 2013). Using the Water Drop Penetration Time test to assess the soil's water repellency, researchers found that the soil within the crude oil spray zone ranged from slightly water repellent to extremely water repellent. Where the soil was extremely water repellent, water drops tended to evaporate from the surface before they could be absorbed into the soil. Repellency within the crude oil spray zone extended to a depth of approximately 16 in. in some locations. Outside the crude oil spray zone, the soil was water "wettable" (Nieber 2013). While hydrophobic soils and topsoil stripping have limited recovery in certain areas, the vast majority of the soils affected by the crude oil and its overland flow have recovered to support vegetation comparable to surrounding areas, particularly in low lying wetland areas.

Within the crude oil release literature, recovery of the soil matrix is usually associated with the reduction in petroleum hydrocarbon concentrations and resulting increased capacity to support an abundance and diversity of microbes, plants, and invertebrates. From a regulatory perspective, soil has recovered when the concentration of crude oil has been reduced below an established soil quality standard or guideline. According to the MN PCA risk-based site evaluation guidance, the residential soil reference value for benzene is 6.0 ppm and the industrial soil reference value for benzene is 10.0 ppm (MN PCA 2009, 2012). Many soil-based organisms have a high tolerance to petroleum hydrocarbons. Therefore, the recovery of the soil-based organisms usually is complete long before petroleum hydrocarbon reduction in the soil is achieved (Borja et al. 2010).

> ***Enbridge Line 3 Glenavon, Saskatchewan****: On April 15, 2007, approximately 6,230 barrels of crude oil were released as a result of a rupture on Enbridge's Line 3. Spill response and clean-up efforts for Enbridge's Line 3 release included removal of crude oil from surface water and vegetation. Crude oil was removed from a slough where hydrocarbon concentrations were above applicable criteria (e.g., Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life Criteria, 1999, updated 2007). Water and crude oil were removed from the affected slough using skimmers and vacuum trucks. Approximately 5,740 barrels of crude oil were recovered by April 22, 2007 (Transportation Safety Board Canada 2008). Contaminated vegetation, sediment, and soil were transported to an off-site location for disposal (SLR Consulting 2008a).*
>
> *Soil samples were collected in association with four components of the response and clean-up efforts: site stratigraphy[19] boreholes; pipeline trench repair; irrigation sump lines; and remediation of the affected slough. Soil samples were analyzed for BTEX, certain petroleum hydrocarbons, total metals, detailed salinity, and CCME PAHs. For soil samples not associated with the affected slough, contaminant concentrations generally were below the remediation criteria set by Saskatchewan Environment and the CCME. Concentrations of metals for samples either were below CCME agricultural criteria or were consistent with background conditions (SLR Consulting 2008a).*
>
> *After the initial remediation efforts in the affected slough, the effects on soil were largely limited to sediment in the slough and possibly the upper one foot of underlying native clay soil (SLR Consulting 2008b). Additional remediation efforts were undertaken to remove contaminated sediment and native clay soil under the affected slough where hydrocarbon concentrations exceeded applicable remedial criteria (SLR Consulting 2008b). Following this remedial action, PAH*

[19] Stratigraphy refers to how geological materials are vertically layered, usually as observed through soil cores taken from bore holes. For example, the stratigraphy from a well bore might be: loamy soil (0 to 2 ft bgs); sand (2 to 10 ft bgs); clay (10 to 15 ft bgs); and gravel (15 to 30 ft bgs).

concentrations were below CCME criteria and BTEX and petroleum hydrocarbon concentrations from the base of the excavation were generally non-detectable. Metal concentrations also were generally below CCME criteria and/or were consistent with conditions in nearby sloughs.

***Enbridge Line 37 Fort McMurray, Alberta**: In the Line 37 pipeline release in 2013, synthetic crude oil (approximately 750 barrels) released from the pipeline rose to the surface in the saturated soils, flowed overland along the pipeline ROW to a fen, and then reached the shores of an unnamed lake. Initial remediation efforts involved targeted excavation (soil and sediment), crude oil skimming of surface water, treatment of surface water, groundwater soil flushing (fen), and installation of physical barriers (hard and soft booms). Excavation within the ROW included removing affected soil at the release site and soil beyond the release point that showed visual contamination. Depth of excavation ranged from approximately 1 to 2.5 ft below grade. Approximately 7,275 tons of contaminated soil was removed from the ROW. Remediation efforts removed a majority of the released crude oil (approximately 93%), and natural attenuation monitoring was employed to track the weathering and effects of the remaining product (Hemmings et al. 2015).*

Soils within the ROW are generally mineral soils with a minor organic component. In the fen, peat at the surface is underlain by mineral soils of various textures (e.g., silt, clay and sand). Soil samples were collected from the ROW, the fen, and the area surrounding the unnamed lake. These samples were analyzed for BTEX, straight-chained petroleum hydrocarbons, and PAHs. Concentrations of BTEX and straight-chained petroleum hydrocarbons were higher than acceptable guidelines in many of the samples. Following initial remediation efforts (excavation), residual oil was still detected within the soils of the right-of-way and fen (Hemmings et al. 2015).

A biotreatability study determined that hydrocarbon-degrading bacterial populations were present in the soil in sufficient quantities to allow biodegradation to occur in the presence of oxygen or under anoxic conditions. Further study of these bacterial populations indicated that they would be capable of degrading short-chain hydrocarbons, but less able to degrade long-chain hydrocarbons.

Ecotoxicological tests were then conducted to determine if residual hydrocarbons posed a risk to ecological receptors. These tests included survival and reproduction of Collembola (small wingless soft-bodied hexapods that live in soil) and avoidance response in earthworms. Tests also were conducted to assess emergence and growth of plants, the results of which are discussed in Section 8.3.3. Petroleum hydrocarbons did not affect adult Collembola survival or

> *reproduction in the ROW soils, but there was significant reduction in both survival and reproduction in the fen soils (Hemmings et al. 2015). Earthworms avoided the contaminated soils from both the ROW and fen and showed preferential selection for the uncontaminated reference soils. This avoidance was attributed in part to the petroleum hydrocarbons and to the low soil pH. Site-specific target levels for petroleum hydrocarbons that would be protective of terrestrial ecological receptors were calculated for right-of-way soils and fen soils. Soil concentrations were generally lower than the target levels, although up to 15% of the samples from the fen had petroleum hydrocarbon concentrations that exceeded the target levels. Overall conditions at the site were considered to be "improving," but specific statements regarding recovery status of soils were not made and monitoring at the site was still on-going (Hemmings et al. 2015).*

Petroleum hydrocarbon releases in wetlands (e.g., bogs and fens) in northern portions of North America exhibit slower remediation activity due to a decreased rate of biodegradation of subsurface crude oil in anaerobic environments, acidic conditions, and cooler temperatures, as well as a lack of nutrients in wetlands for petroleum hydrocarbon-degrading microbes and bacteria. Additionally, intense fire can limit nutrients in the soil (nitrogen); however, adding fertilizer can aid in soil nutrient and microbe recovery.

8.1.1.1 Factors Affecting Recovery

Spill response and remediation of crude oil-contaminated soils can minimize the effects of crude oil on soils, as well as accelerate recovery (Hemmings et al. 2015; SLR Consulting 2008b). Top soil stripping followed by topsoil replacement can quickly restore the productivity of affected areas. Bioremediation (using microorganisms) and phytoremediation (using plants) are appropriate remediation options, especially at sites where a short growing season and low temperatures prevent rapid degradation of petroleum products through other weathering processes. In contrast, in situ burning of oiled soil reduces the microbial community and can leave a water-repellent residue that further inhibits microbial recolonization and biodegradation (Essaid et al. 2011; Nieber 2013; Kennard et al. 2016).

Environmental conditions that affect the weathering of crude oil can impede or enhance recovery. Topography that promotes flushing of crude oil from a site following precipitation events or snow melt can accelerate recovery (Collins et al. 1994). Cold temperatures restrict evaporative losses, microbial activity, and biodegradation (Wein and Bliss 1973). Low nutrient availability restricts microbial activity and biodegradation (Sparrow and Sparrow 1988). Higher oxygen levels in the soil promote aerobic degradation, but degradation also occurs under anaerobic conditions (Essaid et al. 2011).

8.3.2.3 Soil and Soil Microorganism Summary

Effective clean up and remediation of crude oil-contaminated soils are important factors in accelerating recovery of soils and, in turn, soil biota and vegetation. Remediation of crude oil-contaminated soils can be accelerated by adding fertilizer to increase the nitrogen content of the environment, which increases microbial activity and aids the productivity of petroleum hydrocarbon-degrading microbes and bacteria. Although crude oil releases in the terrestrial environment have the potential to cause immediate effects to soil structure and microorganisms, the microbial community can readily adapt and decompose crude oil. This decomposition, along with evaporation and photodegradation, contributes to the weathering processes that reduce the concentration of oil and oil constituents and facilitates recovery.

Other factors also strongly influence initial effects to soil and subsequent recovery. In general, large volumes of released crude oil will cause more damage to the soil and greater changes to the abundance and diversity of microorganisms compared to small releases. The greater initial damage subsequently requires longer times for adaptation and recovery. Environmental conditions supporting weathering, such as warm temperatures and presence of oxygen, lead to more rapid soil recovery.

8.3.3 Vegetation

8.3.3.1 Terrestrial Vegetation

Plants tend to dominate the visible terrestrial landscape. Using photosynthesis, plants convert solar energy and carbon dioxide into carbohydrates and oxygen and form the primary food source for terrestrial life. Healthy plant communities provide numerous ecosystem services that include:

- Supporting: soil formation and stabilization, nutrient fixation and cycling, primary production
- Provisioning: food, fresh water, fuel wood, fiber, medicines, and biochemical
- Regulating: climate, soil temperature, and moisture
- Providing: cultural, spiritual and religious, recreation, aesthetic, and educational value (World Resource Institute 2003)

Terrestrial plant recovery is influenced by many of the same factors that determine the effects of a crude oil release on soils and their recovery. This section specifically addresses the recovery of terrestrial plants from effects of a crude oil release. While releases off the operator's property

often may affect vegetation, only 2.5% of pipeline incidents reported to PHMSA[20] resulted in the need for active vegetation remediation[21] (PHMSA 2016).

8.3.3.1.1 Recovery of Terrestrial Plants following a Crude Oil Release

Many factors that influence the effects of released crude oil and associated recovery of terrestrial plants are closely related to the recovery of soils following a release (Section 8.3.2). In general, the recovery of oil-affected soils varies from a few weeks to decades. The rate of recovery for vegetation depends on the sensitivity of the affected species; the severity of the release and the amount of physical contact of vegetation with the crude oil; and the rate of reproduction and proximity of unaffected seed sources. Factors that impede or accelerate weathering processes of crude oil such as volatilization, photodegradation, or natural biodegradation affect the rate of both soil and plant recovery (Belsky 1982; Wang and Fingas 1997).

Recovery is expected to be slower under colder climatic conditions as lower temperatures affect the length of growing seasons, rate of crude oil weathering, and biological activity that supports biodegradation. Snow cover and shorter winter days also affect the rate of photodegradation.

An experiment was conducted on two areas of permafrost vegetation in central Alaska, which were sprayed with crude oil to determine recovery rates following the use of fertilizers and bacteria to aid reclamation processes (Racine 1994). Following the initial spraying, crude oil was located below the ground surface and on top of the permafrost. In areas where a low volume of crude oil was sprayed on the vegetation, the oil initially covered the ground, which caused initial damage to vegetation. Following 20 years of recovery, understory vegetation had almost recovered. However, in areas where a high volume of crude oil was sprayed, the release created small areas of oil-saturated ground surface, which exhibited little sign of recovery. While the crude oil spread below the ground surface, it had little or no apparent effect on the shallow-rooted vegetation above the migrating oil, even after 15 to 20 years. Both sites exhibited high, long-term mortality of black spruce after 15 years. Remediation efforts included in-situ application of fertilizers and bacteria to aid in recovery in place of excavation methods. Recovery was rapid for areas with less saturated crude oil where lichens, mosses, and shrubs all showed good recovery after 20 years.

[20] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[21] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

While this experiment demonstrated how severity of oiling affects vegetation recovery rates, the observed rates of recovery may be slower than expected in the Minnesota region. Racine's (1994) experiment was conducted in central Alaska where crude oil weathering processes would be slower and growing conditions harsher than in Minnesota due to latitude and the presence of permafrost. Permafrost is defined as locations where soil temperatures are continuously below 32 degrees Fahrenheit for two or more years. In addition to colder soil temperatures that would reduce the rate of vegetative growth, permafrost would reduce growth by limiting availability of soil moisture to vegetation within the root zone. Permafrost also would greatly reduce natural attenuation processes that are affected by temperature (e.g., volatilization, biodegradation). In Alaska, 80% of the state is affected by permafrost, including the study site. While Minnesota has soils that can freeze to depths of 60 inches or more, frozen soils are considered seasonal and therefore, are not considered permafrost (World Meteorological Organization 2016). Consequently, vegetation in Minnesota is likely to recover more quickly from crude oil exposure than that observed in central Alaska, even though the sites share many of the same species such as black spruce, lichens, and mosses.

Plants recover from crude oil exposure through both the regrowth of surviving structures, such as roots and buds, and recolonization from the surrounding unaffected areas. A study conducted in the Northwest Territories, Canada, cited by Racine (1994), indicated vegetation that was oiled during the summer exhibited greater damage than vegetation that was oiled in winter (Hutchinson and Freedman 1978).

The rate of recovery can be influenced by precipitation and runoff events that can remove crude oil from the affected area. In regions with high snowpack and good drainage, oil can be flushed out of the area by large volumes of snowmelt water. This effect can lead to rapid recovery of habitat and seed germination within a year (Collins et al. 1994; Belsky 1982).

Historical efforts to promote plant recovery on agricultural soils contaminated with petroleum hydrocarbons often have involved increasing the population of soil microorganisms. Efforts to increase soil microorganisms have included fertilization and cultivation to produce more aerobic conditions or seeding with microorganisms (Schwendinger 1968). Even in areas where soils support the natural weathering of the crude oil, the sudden availability of organic compounds from the crude oil may promote microbial growth. As discussed in Section 8.3.2, the addition of fertilizers, including oxygen-releasing compounds, and tilling of the soil can help maintain microbial activity and thus promote the biodegradation of the crude oil and the recovery of the plant community.

Like soil microbes, plants also can play an important role in promoting the degradation of soil contaminants. Phytoremediation is a technique that utilizes plants to biodegrade contaminants from the soil and improve soil structure. Plants infiltrate soil with their roots, releasing nutrients and supporting growth of indigenous microbes throughout the soil profile. Active revegetation through seeding and planting following remediation can be an important factor influencing terrestrial plant recovery.

At the community level, while plant communities that experience substantial effects may recover quickly, the recovery of a plant community may take an altered trajectory and regress to an earlier successional stage. Early successional plant communities are characterized by more disturbance-tolerant species, often including plants considered invasive and noxious weeds (Robson et al. 2004). While affected plant communities may recover quickly and regain their ecological function, productivity, and abundance, returning to a diversity state prior to the release without intervention can take years to decades.

Robson et al. (2004) examined the differences in terrestrial plant communities between uncontaminated sites and sites affected by crude oil releases located in Saskatchewan, Canada. Although this study did not focus specifically on recovery endpoints, it did examine some of the factors that influence the recovery process. Differences in total vegetative cover and species diversity between oiled and uncontaminated sites were attributed to the tolerance of different species to crude oil, soil disturbance, and low soil fertility. Oiled sites had substantially more early successional species that were self-pollinating or reproduced solely by seed (Robson et al. 2004). The authors noted that species composition and abundance were affected by distance to undisturbed habitat, which may serve as an important seed source.

The following case studies provide examples of terrestrial plant recovery from oil releases. Where the information is available, these examples describe the recovery status of the plant community, time to recovery, and influence of the release characteristics and the environment on the recovery. Although broad generalizations cannot be drawn from a single event, case studies provide important information that, in combination with existing literature, can help regulators and operators gain a more comprehensive understanding of the effects of oil releases on terrestrial plants and recovery.

> ***Unknown Operator, Mt. Baker, Washington****: In March and early April of 1972, 164 barrels of No. 2 Fuel Oil were released near Mt. Baker, Washington, inundating 2 subalpine meadow communities. Because subalpine communities have limited growing seasons and relatively thin soils compared to low elevation plant communities, subalpine plant communities may be particularly vulnerable to disturbance. Prior to the release, vegetative plant cover was 80 to 100%. Two growing seasons after the release, plant cover was reduced to only 1%. Recovery of the subalpine plant community was studied over the following nine years (Belsky 1975; Belsky 1982).*
>
> *Only one species of sedge and one species of heather survived the initial release. Seedlings of black alpine sedge (Carex nigricans) appeared on the bare soil after one growing season, and other subalpine species returned over the next two to four years although the plant community remained measurably affected. After 9 years, subalpine ground cover was between 5 and 20%, and plant abundance and diversity remained low. However, the researchers stated that the original disturbance was no longer discernable by a casual observer.*

Recovery of a subalpine plant community from the release can be facilitated by the type of fuel, the topography of the area, and the time of the release. Although diesel fuel is initially more toxic to plants (Walker et al. 1978;, Wein and Bliss 1973), it is predominantly composed of relatively small chain hydrocarbons, which weather more rapidly than complex ringed hydrocarbons found in higher concentrations in crude oils. The snow cover and frozen ground that was present at the time of the release prevented adsorption of the fuel by the soil, and much of the contact with the product was to dormant vegetation (Belsky 1982). In the spring, a large volume of snowmelt water and the steep terrain combined to flush much of the fuel out of the area, further limiting the subsequent exposure to the emerging vegetation.

***Unknown Operator, Crude Oil Pipeline, Moose Jaw, Saskatchewan**: In January 1974, approximately 39.5 acres of agricultural land were affected by a release of crude oil (API gravity 23) from a pipeline in Moose Jaw, Saskatchewan. Approximately 15,700 barrels were released, of which approximately 10,100 barrels were recovered from trenches dug around the contaminated area. Crops were planted to study their performance as a tool for delineating the contaminated areas. Fertilizer was applied to enhance the rate of biodegradation, but application rates were limited to the maximum levels tolerated by the crops. Oil was observed to have affected the soil both vertically (depth) and horizontally.*

The results of the study indicated that soils with an oil content greater than 1% were associated with zero growth during the first growing season in 1974 following the release. The correlation between low yields and oil concentrations may have been influenced by late seeding in 1974. The crop did not mature and total above ground yields were obtained (De Jong 1980). The study continued through 1978 with different crops planted each year. With the exception of 1977 in which the oil-contaminated area was left fallow, De Jong (1980) noted that areas of poor growth were correlated with areas of greater oil content.

De Jong (1980) also observed in areas unaffected by oil contamination, that poor germination and growth of vegetation were caused by soil disturbance from large equipment used during clean-up activities. Use of the equipment resulted in poorly-filled trenches and boreholes, subsoil on the surface, and soil compaction.

At the end of the study, some residual contamination remained in 7 of 9 soil borings at depths from soil surface to 47 inches and ranged between 0 and 5% of soil volume. Oil contamination greater than 0.5% soil volume affected soil water uptakes at deeper soil depths.

Crop yields in oil contaminated areas remained lower than those from non-contaminated areas. Grain yield and soil moisture data for contaminated soil cores during the 1978 growing season indicated yields decreased by approximately 161 pounds/acre (lbs./ac). For comparison, yields of non-contaminated soil cores indicated yields decreased approximately 71 lbs./ac for each centimeter decrease in soil water uptake. Decreased yields at the oil contaminated sites were influenced by reduced availability of nitrogen in the soil and reduced water uptake by the crops (De Jong 1980). Key factors discussed by the authors contributing to microbial degradation of oil included adequate soil moisture, nutrients (i.e., nitrogen), and subsurface soil temperature.

***Enbridge Crude Oil Pipeline, Bemidji, Minnesota**: This 1979 pipeline release sprayed 10,700 barrels of crude oil over an area of approximately 1.6 acres. The released oil collected in topographic depressions before infiltrating into the soil and groundwater.*

While there were immediate effects from the oil on the terrestrial vegetation (e.g., trees sprayed by oil), the long-term effects to vegetation were localized and were the result of topsoil stripping without replacement and in-situ burning of the oil. While these methods were considered appropriate at the time, the portions of cleared and burned area have remained relatively devoid of vegetation for most of the last 30 years due in part to the burning of the crude oil and the development of water repellent surface soil. The lack of revegetation also left the soil prone to surface erosion, and the remaining rocky substrate further inhibited the rate of revegetation. The majority of the site was not stripped of topsoil and soil was not burned in place, and the herbaceous vegetation appears to be relatively comparable to the surrounding ROW, particularly in the low-lying wetland areas (H. Tillquist, pers. comm.).

Fire can affect the chemical properties of soil organic matter through heating of soil organic matter and the associated rapid losses of nitrogen in the areas where the soil has been burned. Lack of nitrogen is a limiting factor for growing plants and other vegetation. Hydrophobic polymers formed during the soil heating/burning can result in soil hydrophobicity. Intense fires (greater than 750°F) also may reduce/consume soil organic matter that holds sand, silt, and clay particles together, reducing overall soil structure (Kennard et al. 2016).

Because the site was used as a research site to investigate the long-term effects of an oil release, remediation to hydrophobic soils has not been conducted. According to Delin (H. Tillquist, pers. comm.), the addition of fertilizers, shallow tilling, and where absent, topsoil replacement, would likely result in the reestablishment of the vegetative community.

> *Factors influencing recovery at this site included landscape position (topography and microtopography), as well as the degree of water repellency. Vegetation is relatively dense in topographic depressions where run-off has provided sufficient water to support growth, but quantitatively, it has not completely recovered outside of these depressions (Nieber 2013).*

8.3.3.1.2 Factors Affecting Recovery

Factors that contribute to accelerated weathering of crude oil and soil recovery also contribute to terrestrial plant recovery. These factors include warm temperatures, evaporation, photodegradation, flushing, and microbial activity (Wein and Bliss 1973; Belsky 1982; De Jong 1980). Cold temperatures and shorter growing seasons reduce the rate of microbial activity and evaporative losses, thus limiting the potential biodegradation of the crude oil and subsequent terrestrial plant recovery (Wein and Bliss 1973; De Jong 1980). Higher nutrient availability supports plant growth and can accelerate microbial activity stimulated by the crude oil, further promoting oil degradation and terrestrial plant recovery (De Jong 1980; Robson et al. 2004).

Crude oil in soils can reduce available nitrogen and affect water uptake, impeding terrestrial plant recovery (De Jong 1980). In some cases, the effect of crude oil and remediation on the plants renders the soil prone to erosion and other physical forces. Under these circumstances, the damage may be more permanent where the soil layer is significantly disturbed (Essaid et al. 2011; Nieber 2013).

Water from storm events or snow melt can act to transport the crude oil, especially on sloped ground, thus flushing oil out of the soil and naturally attenuating oil concentrations (Collins et al. 1994; Belsky 1982). Resulting decreased hydrocarbon concentrations in the soil can accelerate plant recovery.

Crude oil releases occurring at or near periods of plant dormancy can result in less severe effects and subsequently aid recovery (Belsky 1982).

Early successional species that are self-pollinating or reproduce solely by seed are important early colonizers following a crude oil release. Undisturbed habitat nearby can function as a seed source for these species and thus accelerate recovery (Robson et al. 2004).

Clean-up activities that compact and/or disturb soils can slow terrestrial plant recovery (De Jong 1980). Burning of oil after a release can damage both plant roots and buds, reduce the microbial community, and leave a water repellent residue on the soil surface that further inhibits crude oil weathering and terrestrial plant recovery (Essaid et al. 2011; Nieber 2013). Recovery can be prolonged for sites that do not undergo remediation and terrestrial plant restoration (Nieber 2013).

8.3.3.1.3 Summary of Terrestrial Vegetation

Terrestrial plants are an integral part of the soil food web and effects to and recovery of soils are closely related to terrestrial plant recovery. The case studies presented for both terrestrial plants and soils describe a recovery process and indicate that plant communities are able to recover from the effects of a crude oil release. Environmental conditions that enhance weathering of oil and/or bulk transport and attenuation in the soil are key factors to accelerating the recovery of the plant community. Factors that contribute to weathering, soil recovery, and subsequent terrestrial plant recovery include oil type, temperature, nutrient availability, soil moisture, evaporation, photodegradation, flushing, and microbial activity. The interaction of these variables can be complex and needs to be evaluated on a site-specific basis following a release. Disturbance related to remediation activities can result in additional effects to terrestrial vegetation, further delaying recovery. See Section 8.5 for further details. Therefore, remediation efforts should focus on minimizing soil disturbance, soil compaction, and disruption of root masses, if possible, allowing affected plant communities to recover naturally.

8.3.3.2 Wetland and Riparian Vegetation

Wetland and riparian vegetation is associated directly with or exists in the proximity of wetland or open water habitats. Wetland plants can range from fully aquatic species to those species such as red maple (*Acer rubrum*) that grow across a wider range of habitats, including seasonally inundated and seasonally saturated areas. Riparian vegetation grows along the banks of watercourses and waterbodies and can include both wetland and non-wetland communities.

Wetland and riparian communities provide a variety of functions that support both natural and human environments. These functions include, but are not limited to, wildlife and fisheries habitat, groundwater exchange, shoreline stabilization, flood and storm surge reduction, and water quality protection through the uptake of excess nutrient and toxins. Wetlands are distinguished from dry lands (uplands) by ground or surface water that is present for a sufficient period of time to saturate the soil and support a prevalence of vegetation adapted to these wet conditions. Wetlands can be closely associated with marine, riverine, or lentic (e.g., ponds and lakes) systems or they may form in isolated basins or on slopes away from obvious sources of surface water. In wetland classification systems such as the National Wetland Inventory (NWI) (Cowardin et al. 1979), vegetation, soils, and hydrology play key roles in defining the wetland type. Although hydrology, soils, and vegetation are intricately tied together, vegetation is often the wetland focal point because it is readily visible and changes in plant communities can be easily observed.

8.3.3.2.1 Recovery of Wetland and Riparian Vegetation Following a Crude Oil Release

Many of the same factors that influence the initial effects of a crude oil release also can influence the recovery of wetland and riparian vegetation. The type of oil, release volume, time of year, and environmental conditions at the time of the release will influence the rate of recovery (Hoff et al. 1993; Lin and Mendelssohn 1996). Because of its viscosity, crude oil can coat vegetation and inhibit respiration. Light, soluble, and highly volatile constituents within crude oils

can be toxic to plants, particularly herbaceous vegetation (Michel and Rutherford 2013). Plants tend to be less sensitive to petroleum hydrocarbon toxicity compared to animals. Most release volumes from pipelines are small and contained entirely within an operator's property. Consequently, the effects on vegetation are often minimal with nominal periods for recovery. In the unlikely event of a very large, widespread release, effects on vegetation can be severe and recovery periods may be long.

Similar to terrestrial vegetation, the time of year when a release occurs can strongly influence the type and extent of effects of crude oil releases on vegetation, as well as the time it can take for plant communities to recover. A crude oil release that occurs during or just prior to senescence (i.e., seasonal quiescence of vegetation) will have less of an effect on vegetation and recovery should occur more quickly (Michel and Rutherford 2013; Pezeshki et al. 2000). Senescence, including leaf drop in many plants, occurs prior to the onset of dormancy when most, if not all, biological processes within a plant cease until the next growing season. If leaf drop has occurred, there is less surface area exposed to oiling and, under dormant conditions, the plant does not experience the same metabolic or reproductive effects that it does during the growing season.

Other aspects of the initial crude oil release and the environment in which the release occurs also can influence the recovery period. If a crude oil release only coats the aboveground portion of a plant, recovery can occur within a single growing season. In contrast, if the crude oil penetrates into the soil, recovery often takes three to five years, or potentially longer (Mendelssohn et al. 2012). Environmental influences such as the flow and movement of water, whether from natural or anthropogenic activities, can advance or potentially hinder recovery. The natural stream flow, tidal action, and wakes created by boat traffic were attributed to helping flush oil from a contaminated marsh along the Delaware River from the Panamanian Tank Vessel Grand Eagle release in 1984 (Michel and Rutherford 2013). Flood events that occur concurrently with an oil release, such as in the Enbridge Line 6B release near Marshall, Michigan, can result in oil becoming stranded in larger areas and areas beyond annual flood levels (USFWS et al. 2015a). Flooding can help to flush oil from affected areas, but oil stranded above typical flood stages can remain for longer periods if it is not cleaned up, and can slow vegetation recovery and reestablishment (Michel and Rutherford 2013).

Physiology and reproductive strategy of vegetation affect how readily plants can recover from a crude oil release or other environmental disturbances. For example, rhizomes, which store starches and proteins, provide plants with an energy source and, in some species, act as an alternate means of reproduction that allow plants to survive and more readily recover following a crude oil release (Lin and Mendelssohn 1996). Annual species tend to be particularly susceptible to the initial effects of an oil release but can be the first to reestablish if there is an available seed source near the release location (Michel and Rutherford 2013). Recovery time also is influenced by the wetland community type (e.g., forested, scrub-shrub, emergent). If the root zone is unaffected by crude oil or clean-up activities, vegetation can begin to rebound within a single growing season from the direct oiling effects (Rood and Hillman 2013).

Oil spill response methods on vegetation can either impede or accelerate recovery depending on how the methods are employed and the type of vegetation affected. The recovery period for historical wetland mitigation can take decades if the vegetation is removed during remediation efforts (USACE 2010), while current techniques avoid disturbing wetland vegetation to the extent practical. The potential for adverse effects was also observed in the Texaco (Anacortes Refinery) 1991 Fidalgo Bay release in Puget Sound, Washington. After the release of 5,000 barrels of North Slope crude oil in a salt marsh, researchers followed the recovery of woody saltwort (*Salicornia virginica* [*Salicornia depressa*]) to study the influences of the oil release and subsequent clean-up methods (Washington Department of Fish and Wildlife et al. 2004). The recovery of woody saltwort density in treatment areas that employed flushing with low-pressure, ambient temperature seawater lagged only slightly behind the control areas. The treatments that involved oil removal with a high-powered industrial vacuum and manual clean up and where the surface was trampled by foot traffic, took an additional three months to reach control densities. In addition, the below-ground biomass of woody saltwort was lower, possibly indicating that these plants were stressed and/or there was damage to the below-ground root system (Hoff et al. 1993).

When clean-up activities are not employed, recovery results can be highly variable. In the absence of clean up, recovery of wetland and riparian vegetation is influenced by the scale and severity of the release event, including the volume of released oil, the plant community involved, and other environmental factors. Following a release from a Plains Midstream pipeline into the Red Deer River, Alberta, recovery occurred quickly in a relatively exposed habitat along the riverbanks (AER 2014). Further details regarding this release and vegetative recovery are discussed below as a case study.

In contrast, prolonged recovery occurred at Buzzards Bay, Massachusetts, and Chalk Point, Maryland, which involved saltmarsh and brackish marsh communities, respectively. In September 1969 and October 1974, two separate No. 2 Fuel Oil releases from tank barges (*Florida* [4,500 barrels] and *Bouchard 65* [180 to 870 barrels], respectively) into Buzzards Bay caused extensive plant mortality (Costa 2013). Without clean up or remediation, salt marsh plants had not fully recovered after nearly 40 years based on stem density and biomass estimates. Factors contributing to persistent oil effects from these releases included the type of oil (No. 2 Fuel Oil), high tides that stranded the oil in the marsh where it penetrated into the organic soils, the sheltered setting of the affected marsh, a lack of oil clean up and remediation activities, and amount of oil that remained in the environment (Michel and Rutherford 2013). Similar to the Buzzard Bay releases, the Chalk Point release occurred on April 7, 2000 and involved the release of 3,330 barrels of a No. 6 and No. 2 fuel oil mixture into a brackish marsh along the Patuxent River from a pipeline going into nearby Chalk Point Power Generating Station (Michel and Rutherford 2013). The heavily oiled area in the interior of the marsh was left untreated (due to limited access) and seven years later, the oil showed little evidence of weathering due to the nature of the released products. No. 2 and No. 6 fuel oils consist largely of complex, heavy molecular weight hydrocarbons that are resistant to weathering and biodegradation. The slow weathering in the interior of the marsh was attributed to slow physical

removal processes, oil type, and low oxygen availability (Michel et al. 2009). Although vegetation within the marsh exhibited some growth, plant density and height were less than what was observed in unaffected areas.

Although the literature is limited regarding the functional recovery of temperate wetland and riparian vegetation following a crude oil release, information from traditional wetland restoration provides insight into the recovery process. Herbaceous wetlands, especially freshwater emergent marshes and wet meadows, have successfully been created or restored (NRC 2001). Other wetland community types are more difficult to replicate or restore because of complex species assemblages (e.g., sedge meadows, fens) or specific requirements for groundwater or surface water flows (Minkin and Ladd 2003; NRC 2001). In these cases, wetlands and riparian areas may recover some ecological functions even though the area may revert to another state (Minkin and Ladd 2003).

The initial and potentially long-term effects of crude oil releases on wetland and riparian vegetation are influenced by a variety of environmental and biological conditions, as well as the amount of oil in a given location, the physical and chemical characteristics of the oil, and the methods used to clean up the release.

The following case studies from temperate North American environments provide examples of the effects these releases had on the vegetation and the vegetation's subsequent recovery. The following case studies describe several remediation approaches and environmental factors that can accelerate or impede recovery of wetland and riparian vegetation following an oil release.

> ***Enbridge Line 4 Cohasset, Minnesota****: On July 4, 2002, an underground pipeline located west of Cohasset, Minnesota, ruptured and released approximately 6,000 barrels of crude oil in a large wetland complex (NTSB 2004). Approximately 2,574 barrels of crude oil were recovered. Because of concerns that the oil contamination would spread with forecasted rain, the decision was made to burn the oil in place (NTSB 2004). The in-situ burn was estimated to have consumed approximately 3,000 barrels of crude oil. The affected wetland was described as a peat wetland complex with naturally occurring forested and scrub-shrub components. The crude oil release occurred in the pipeline ROW, which was dominated by herbaceous vegetation, including devil's beggartick (Bidens frondosa), bluejoint reedgrass, and broad-leaf cattail (USFWS et al. 2005). After the vegetation in and adjacent to the release site was burned, temporary mat roads were constructed to allow access for heavy equipment. Burned trees were cut and removed, and oiled peat and debris were excavated to a depth of approximately three ft.*
>
> *In total, approximately 11 acres of wetlands were affected by the initial crude oil release and remediation activities. Following remediation, wetland restoration efforts included re-establishing site topography and vegetation. Disturbed*

surfaces within the wetland were re-contoured to create pit and mound microtopography and some seeding with native wildflowers and grasses was conducted. Emergent plants, unrooted cuttings (shrubs and trees), and tree seedlings were installed. As of 2005, the affected site was a mix of emergent vegetation and open water habitat. Although the site was dominated by cattails, other species such as broad-leaved arrowhead (Sagittaria latifolia), water plantain (Alisma subcordatus), duckweed (Lemna minor), sedges, and rushes also were becoming established. The presence of duckweed is often considered an indicator of good water quality since it is among the most sensitive of aquatic plants (Wang 1986). Because of changes to the site including the removal of the peat substrate from the affected area, it is unlikely that the peat wetland will fully revert to its previous condition, but instead will provide emergent wetland habitat (USFWS et al. 2005).

Canadian National Railway Company, Wabamun Lake Oil Release, Alberta: *On August 3, 2005, a Canadian National Railway Company railroad incident involving a release of 4,400 barrels of heated Bunker C Oil (a very high density oil) and 554 barrels of pole treating oil flowed across lawns adjacent to the railway and into Wabamun Lake. The Bunker C Oil was still warm when released due to being recently heated for loading into railcars and was therefore less viscous than the oil would have been at ambient temperature. As it flowed overland and into the lake, the Bunker C Oil picked up sediment, debris, and water that changed the behavior of the oil once it entered Wabamun Lake (Hollebone et al. 2011). Strong winds and wave action dispersed the oil-water-sediment mixture across the lake.*

These oil-water-sediment mixtures quickly formed neutrally-buoyant tarballs[22] that were observed moving up and down through the water column. Not long after the release, the submerged and sunken tar balls were seen along the shoreline and in shallow water. Some of the submerged oil-water-sediment material also formed relatively large patties and logs. Even after initial clean-up efforts, tar balls were commonly observed along the vegetated shoreline (Hollebone et al. 2011). Tar balls on and around the vegetation continued to move laterally in the water column and release oil during the course of their movements. Those tar balls in contact with and adhering to shoreline vegetation also continued to release oil. In February 2007, tar balls were still observed within shoreline vegetation and adhering to roots of shoreline vegetation (Hollebone et al. 2011).

The vegetated shoreline of Wabamun Lake is dominated by softstem bulrush (Schoenoplectus tabernaemontani) and broad-leaf cat-tail (Typha latifolia)

[22]Bunker C Oil is extremely heavy and viscous. Therefore, formation of neutrally and negatively buoyant tar balls and emulsions is more likely than with other crude oils.

(Wernick et al. 2009). Because of the location of the release and the wind direction at the time, much of the oil became trapped in the softstem bulrush beds along the lakeshore. During clean-up efforts, the oiled softstem bulrush was cut manually or with mechanical weed cutters, either just below the waterline or just above the sediment. The sediments were then flushed and/or vacuumed (Thormann and Bayley 2008; Wernick et al. 2009). The selected method of treatment was based on accessibility and the perceived sensitivity of the area to disturbance. In general, areas that were accessible from shore were cut manually. Those areas inaccessible from shore and considered to be particularly sensitive to disturbance were cut primarily using reed cutters (Thormann and Bayley 2008). Low-pressure flushing was used to remove oil from sediment and vegetation, and vacuuming was used to remove remaining tarballs.

Studies that followed the softstem bulrush beds recovery concluded that the Bunker C Oil itself had no long-term effects on the biomass, cover, height, or seedhead production of the softstem bulrush (Thormann and Bayley 2008). However, the clean-up efforts did have a substantial negative effect on rhizome density and biomass (Thormann and Bayley 2008). Researchers concluded that clean up treatment applied to some of the study site substantially disturbed or damaged plant rhizomes resulting in decreased biomass (Thormann and Bayley 2008). The same authors concluded that the richness and cover of submerged aquatic plants had not been affected by the release or subsequent clean-up treatments (Thormann and Bayley 2008).

When comparing two of the monitoring sites, researchers concluded that the difference in the aboveground biomass of softstem bulrush potentially could be attributed to water depth, wind and wave exposure, and the intensity of the clean-up treatment. In general, monitoring sites with shallower water depth, regardless of the degree of oiling or intensity of treatment, had a greater biomass of softstem bulrush. The difference in biomass in shallower water was attributed to increased rates of seed germination, seedling growth, and rhizome survival and re-growth (Thormann and Bayley 2008). Because the water level in Wabamun Lake rose approximately 1.3 ft from 2005–2007, it is uncertain whether some of the deeper areas will successfully recolonize.

***Plains Midstream, Red Deer River, Alberta**: On June 7, 2012, between approximately 1,000 and 3,000 barrels of light crude oil released into the Red Deer River in Alberta. The release was caused by high floodwaters that eroded the riverbed and banks, exposing the 12-inch Rangeland South Pipeline within the river, resulting in a rupture. The flood eroded the west bank of the river and exposed the line, thereby creating the break in the pipeline (AER 2014).*

Following the release, researchers identified three areas along the river floodplain to assess the release effects on vegetation and the potential for natural recovery (Rood and Hillman 2013). In consultation with Alberta Environment and Sustainable Resource Development, two of these areas received no remedial clean up, and the third only had limited vegetation removed during clean-up efforts in order to study vegetation recovery rates. Balsam poplar (Populus balsamifera), sandbar willow (Salix exigua), and wolf willow (Elaeagnus commutata) dominated the floodplain areas along the Red Deer River. Researchers tagged and measured hundreds of saplings of these three species in the study areas. The degree of crude oil coating on the saplings was variable. Initially, the coating was oily and readily transferable but, after two weeks, weathering of the oil made the coating tacky and more difficult to remove. After approximately four weeks, the coating was chalky and dark as a result of oxidation and heavily coated leaves fell off the saplings. Staining on the stems, as well as the surrounding rock and gravel substrate, gradually faded and by the end of the summer, some of the staining had almost completely disappeared.

During the course of the summer, stem measurements showed that those saplings that were heavily oiled grew more slowly, but did produce new shoots from the stems and suckers. Researchers also observed new seedlings sprouting from the roots in oil-coated river banks and on contaminated gravels and sands. In both of these instances, this new growth was characterized as "extensive." Researchers noted that because the saplings grew on raised surfaces, they were more exposed to wind and sun, where accelerated weathering of the released crude oil, specifically evaporation and oxidation, likely occurred. They also noted that the effects of oiling of these woody riparian species were temporary and that the plants rebounded by the end of the same growing season. Based on their observations, their recommendations for future releases would be to remove only heavily coated vegetation, limiting site disturbance and minimizing potential introduction and establishment of invasive species.

***Enbridge Line 37 Fort McMurray, Alberta**: On June 22, 2013, during the Enbridge Line 37 release, 1,300 barrels of synthetic crude oil were released from the pipeline, rose to the surface in the saturated soils, and flowed overland along the pipeline ROW to a fen, eventually reaching the shores of an unnamed lake. The release site underwent integrated remediation that was completed in October 2013 and involved targeted excavation (soil and sediment), oil skimming of surface water, treatment of surface water and groundwater, soil flushing (fen), and installation of physical barriers (hard and soft booms). Activities specifically conducted in the fen included flushing, installation of a sand bag weir to assist with collection of the treatment water, and installation of an Aquadam to divert up gradient surface water. In addition, approximately 92.6 tons of affected surface vegetation was removed, though the root mats were left in place. Remediation efforts removed a*

majority of the released crude oil (approximately 93%), and natural attenuation monitoring was employed to track the weathering and effects of the remaining product (Hemmings et al. 2015).

While monitoring of the wetland in 2014 identified additional areas of stressed and dead vegetation that was not observed in 2013, the overall vegetative cover of the release site had improved. In 2014, 10 to 20% of the vegetation within the sampled plots were showing signs of stress or were dead. Two wetland community vegetation plots were sampled. Stressed and dead vegetation generally was limited to leaves on individual plants and to a few dead young white birches (Betula papyrifera). There were no patches of dead vegetation observed. Because the vegetation beyond the release site did not show comparable signs of stress, it was presumed that the effects observed in the release area were attributable to the crude oil.

An ecotoxicological assessment was completed to determine if the remaining hydrocarbons posed a risk to ecological receptors, including vegetation. The assessment used sediment and soils that remained in place after initial remediation efforts and plant species, including black spruce (Picea mariana), bluejoint reedgrass (Calamagrostis canadensis), and northern wheatgrass (Elymus lanceolatus). Endpoints measured for plants were seedling emergence, shoot and root lengths, and dry mass. Seedling emergence and growth were unaffected in the tests with lake sediments. Bluejoint reedgrass shoot and root lengths showed a negative effect in tests using soils from the ROW and fen. Black spruce also showed a negative effect for shoot lengths, but seedlings showed an increase in emergence. Although bluejoint reedgrass seedling emergence was not affected in tests with the fen soils, there were statistically significant effects on the species' growth that were attributed to the residual petroleum hydrocarbons. Additional monitoring of stressed vegetation and soil contamination levels conducted in 2015 will be used to assess the health of the wetland and determine if additional remediation is necessary (Hemmings et al. 2015).

Analyses of the case studies indicate that vegetation recovery is affected by several factors: 1) amount and type of crude oil released; 2) ambient temperature that affects weathering and biodegradation rates; 3) remediation or treatment methods (e.g., flushing, excavation, in-situ burning); 4) type of ecosystem (e.g., wetland, lake, stream); and 5) water depth. Warmer temperatures can accelerate recovery, whereas releases that occur in colder environments can take longer to show recovery signs due to a shorter growing season. Remediation methods can differ depending on the environment (e.g., wetland, fen, stream) and can affect the recovery timeframe. Burning can decrease the amount of oil, but it also can create hydrophobic and sterilized soils, which decrease rates of vegetation recovery. Excavation of the released

crude oil can accelerate recovery, but soil disturbance may cause greater harm in some sensitive environments.

8.3.3.2.2 Factors Affecting Recovery of Wetland and Riparian Vegetation

Environmental factors that increase the weathering process can benefit the recovery of vegetation. Weathering of oil-contaminated soils (and associated effects on vegetation) occurs slowly because of low flushing, high organic content, and lack of oxygen (Michel et al. 2009; Michel and Rutherford 2013). These include degree of exposure of the vegetative community, which influences evaporation and photodegradation, and natural flushing by stream flows, waves, or tides (ESRD 2012; Michel and Rutherford 2013). In lentic environments, wind and wave action can drive released crude oil into fringing wetland communities, increasing effects and impeding subsequent recovery of these areas (Thormann and Bayley 2008). In lotic environments, flood conditions can disperse released crude oil into riparian habitats over a wider area than during normal flows and, depending on the success of clean-up activities, can slow subsequent recovery of these areas (USFWS et al. 2015a). Consequently, properly employed use of low-pressure flushing and vacuuming of residual crude oil can remove oil from the environment and, therefore, can be effective remediation techniques.

Crude oil releases that occur during the dormant season can result in faster rates of vegetation recovery than plants affected during active growing seasons. Dormant plants are less biologically active and may have less leaf surface area potentially exposed to oiling (Michel and Rutherford 2013; Pezeshki et al. 2000). Emergent wetland community types dominated by herbaceous and annual vegetation generally recover faster than forested communities (USACE 2010; USFWS et al. 2005). Vegetation often can begin to reestablish quickly from undisturbed root masses and existing seed banks. Forested communities and other late successional vegetation communities may take longer to recover completely from a crude oil release or subsequent clean-up activities than emergent or early successional communities (USFWS et al. 2005; USACE 2010). For example, when mature forest stands are cut or burned following a release as part of remediation activities, it may take several decades for this community to recover to the forested successional stage.

High release volumes that smother or otherwise cause substantial dieback of large areas of vegetation can delay recovery (Michel and Rutherford 2013). Additionally, clean-up activities that damage root masses and remove surface soil can delay recovery (Thormann and Bayley 2008; Wernick et al. 2009; USFWS et al. 2005; Hoff et al. 1993). Lack of clean up in heavily oiled areas, especially when active growing portions of vegetation have been heavily coated and root masses are affected by crude oil, also can delay recovery (Michel and Rutherford 2013; Corn and Copeland 2010).

Natural attenuation of crude oil can be an effective approach in areas with light to moderate oiling or where clean-up activities have removed the bulk of the released product (ESRD 2012; Hemmings et al. 2015). Natural attenuation may be the preferred recovery choice compared to active clean up where removal of existing natural seed banks and root masses could delay re-

establishment of vegetation or potentially expose a natural community to invasive species (Rood and Hillman 2013). The potential effects of leaving crude oil in place needs to account for potential effects to water quality, fisheries, and wildlife in the area. Localized remediation of heavily oiled vegetation that focuses on vegetation removal with minimal root disturbance can accelerate recovery (Hemmings et al. 2015; Hoff et al. 1993; Thormann and Bayley 2008). Remediation must be carefully implemented since surface soil removal and subsequent changes in hydrology can prevent reestablishment of the original wetland types (USFWS et al. 2005).

8.3.3.2.3 Summary of Wetland and Riparian Vegetation Recovery

Wetland and riparian vegetation support numerous functions and values for both the natural and human environment. Effects to these communities from a crude oil release can subsequently affect the functions they support, such as wildlife and fisheries habitat, shoreline stabilization, and water quality. Depending on the degree of oiling and species susceptibility, some species of vegetation show little or no response, while others may die back, at least temporarily, or may show other signs of stress. The effects to and recovery of vegetation following a crude oil release will vary depending on the type and amount of product released, type and intensity of response activities, time of year, weather conditions, soil characteristics, and vegetation type.

The information reviewed here demonstrates a relationship between the type and intensity of remediation efforts and the recovery of affected vegetation communities. In some instances, vegetation communities can recover naturally without active remedial efforts as was seen with the Red Deer River study in Alberta. With other releases, such as the Cohassett and Lake Wabamun releases, additional clean-up activities are needed to reduce further effects within the environment. The information from the case studies, other literature, and general wetland restoration literature suggests that the greater the magnitude and severity of disturbances resulting from a crude oil release, the longer it will take a wetland or riparian community to recover. This includes recovery of the vegetation and the functional capacity of the community. Nevertheless, the case studies and other literature demonstrate that wetland and riparian vegetation do recover from a crude oil release. Remediation techniques can strongly affect vegetation recovery so the effects of clean-up activities and the selection of remedial procedures should be appropriate to the site-specific circumstances.

8.3.4 Terrestrial and Semi-Aquatic Wildlife

Wildlife includes a wide range of terrestrial, semi-aquatic, and aquatic species—including birds, mammals, reptiles, and amphibians-that occupy nearly every type of natural, human-altered, or human-created environment. Semi-aquatic wildlife, such as amphibians and waterfowl, are closely associated with aquatic habitats for most or some portion of their life cycle. Terrestrial species are principally land-dwelling and may use aquatic habitats for limited purposes or periods. For example, North American species of the deer family (*Cervidae*) are terrestrial species, but visit aquatic habitats for water, food, and cover. Similarly, the bald eagle

(*Haliaeetus leucocephalus*) carries out most aspects of its life on or over land, but forages principally in or near aquatic habitats.

Wildlife species are valued as part of the natural environment, as well as for their cultural and economic importance. Federal and state laws place value on wildlife due to its aesthetic, ecological, educational, recreational, and scientific value. Wildlife-related recreational activities, including hunting, fishing, and wildlife watching (i.e., observing and photographing), involve millions of people and contribute upwards of several billion dollars annually to individual state economies (U.S. Department of the Interior, USFWS, and U.S. Department of Commerce, U.S. Census Bureau 2011).

Injury and mortality of wildlife from a crude oil release can stimulate public concern and sympathy. This is particularly true when larger charismatic species (e.g., eagles and otters) are affected or when releases with potential population-level effects occur. From the public's perspective, the protection and rescue of animals becomes the expected focal point of a release. Rehabilitation of oiled wildlife is a common element of modern crude oil spill response.

Notwithstanding the level of public concern, based on the PHMSA pipeline incident database[23], most releases are small[24], are often within the operator's facilities, and wildlife species may not be present at the time of the release. Small numbers of wildlife may be affected by releases and often their recovery is undocumented. Active wildlife remediation programs are generally associated with the large, widespread releases and, consequently, are only reported in 0.4% of releases (PHMSA 2016).

8.3.4.1 Recovery of Wildlife Following a Crude Oil Release

Determining recovery of wildlife populations following a crude oil release is contingent upon identifying specific effects and defining recovery from those effects. Determining a return to baseline conditions is difficult to assess because pre-release population data for wildlife species often do not exist, exhibit wide variability, or are of questionable accuracy. Long-term studies necessary to make such an assessment typically are not conducted.

In contrast to population-level recovery, the recovery of individual animals affected by a crude oil release is well documented. Animals captured quickly following oiling and properly treated can survive and, in many cases, be returned to the wild. The success of these wildlife rehabilitation efforts in freshwater environments was demonstrated following the John Heinz

[23] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[24] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

Wildlife Refuge, the Exxon Mobile Silvertip, and the Enbridge Line 6B crude oil releases (ARCADIS 2011; Enbridge 2012; Saba and Spotila 2003).

As noted above, population-level effects and recovery, particularly in the freshwater and terrestrial environments, are not well documented. Information taken mostly from better documented incidents in marine environments indicates that populations recover (Pearson and Fleece 2014; Kingston 2002). An individual's vulnerability to a crude oil release (presence of the individual within the affected area, behavioral avoidance, and sensitivity to contact with oil) may determine whether an individual organism may be affected by an oil release. The magnitude of the crude oil release, including the volume of oil released, type of oil released, and areal extent of the release, may influence how many individual organisms may be affected. A species biology (i.e., its life history strategies) will influence the resiliency of a population following a crude oil release. Species that are short lived, high fecundity, and early maturity ("r" strategists), may be able to recovery more quickly from the loss of individuals within a population than longer-lived organisms with low fecundity and longer maturation ("K" strategists). Scientific literature concludes that, despite the loss of multiple individuals, some populations may be substantially affected, while others will show minimal effects (Stantec et al. 2012a).

In general, species with long life spans and low annual reproduction take longer to recover, but other aspects of a species' biology may have a strong overriding influence (Stantec et al. 2012a). For example, turtles generally have long life spans, but appear not to be as affected by crude oil releases as birds and mammals, and can recover relatively quickly (for further explanation, see Saba and Spotila 2003, and the John Heinz Wildlife Refuge crude oil release case study below). Species resistance and resiliency to disturbance are determined by intrinsic factors (e.g., a species sensitivity to petroleum hydrocarbons) as well as extrinsic factors (e.g., the ability of the environment to recover and provide suitable habitat). Ecological measures, such as patchiness of the environment, the proximity and mobility of nearby populations available to recolonize, the mobility of a species, and population fecundity measures, all contribute to the ability of wildlife to recover from effects.

Interpretation of a wildlife population's recovery status can sometimes result in contradictions (Wiens et al. 2004). Since assessment of population recovery is highly dependent upon the selection of endpoints and the variability of the species prior to an event, different researchers may draw different conclusions regarding species recovery for the same release. Consequently, agreement on regulatory endpoints early in the clean-up phase is important.

In addition to a species' biology, the magnitude of the event on a population can affect how quickly it can recover. For example, two years after the *Exxon Valdez* oil release, sea otter populations in Prince William Sound had begun to increase, with the exception of the Knight Island population. The sea otter population at Knight Island experienced the highest exposure to the released oil and subsequent mortality. Two years following the release, sea otter populations at this location had not significantly increased (Bodkin et al. 2002).

Timely and effective spill clean-up can reduce potential effects on wildlife (Sellers and Miller 1999). Successful cleaning and rehabilitation can help the recovery of both affected individuals and affected populations. In addition to clean up, the use of temporary wildlife deterrents (e.g., bald eagle decoys, scarecrows, noise making devices) and exclusion fences at release sites also may reduce contamination of individuals and associated risks to populations (Enbridge 2013; Plains Midstream Canada 2012; SLR Consulting [Canada] Ltd. 2008).

The following case studies provide examples of the effects releases had on wildlife and the recovery process. Although broad generalizations cannot be drawn from a single event, case studies provide substantial data that, in combination with existing literature, can help regulators and operators gain a better understanding of the effects of oil releases and recovery of various environmental media. As discussed in Section 8.1, the number of releases that have occurred within natural environments and climates similar to Minnesota and that include recovery information is limited. Therefore, these case studies include releases from a broader temperate region of North America. However, even with inclusion of these additional case studies, the information on wildlife recovery in freshwater and terrestrial environments is limited.

> ***Ashland Oil Company, Storage Tank Release, Ashland, Pennsylvania****: On January 2, 1988, an Ashland Oil Company fuel storage tank at the Floreffe terminal site collapsed, releasing approximately 92,430 barrels of diesel fuel (CHMR et al. 1990). Of the estimated volume of released fuel, approximately 16,790 barrels entered a sewer line and eventually reached the Monongahela River. An estimated 70% of the fuel reached the Monongahela River within 2 hours of the release, and the remaining 30% of the fuel reached the river in the next seven hours before a plug was placed in the sewer. Waterfowl, principally mallards, were killed during the first few days following the release, with mortality estimated at 2,000 waterfowl by the Pennsylvania Game Commission. Most of the birds killed were characterized as semi-domesticated because they had remained in the area and had not migrated the preceding fall. In the spring following the fuel release, mallards breeding along approximately 25 miles of the Monongahela River below the release site had reduced nesting success with their first clutch of eggs compared to upstream reference locations. However, mallards in the stretch below the release site did successfully produce second clutches of eggs during the breeding season (CHMR et al. 1990). In the following year, breeding mallards showed no apparent residual effects from the oil release, indicating the species had recovered. Researchers indicated that because mallards have a high rate of reproduction, population-level effects from the diesel release likely were limited and short-term.*

> ***Sunoco, John Heinz Wildlife Refuge, Pennsylvania****: On February 5, 2000, approximately 4,770 barrels of crude oil leaked from a Sunoco pipeline adjacent to the John Heinz Refuge in Philadelphia, Pennsylvania (Saba and Spotila 2003). The crude oil flowed into an approximately 146-acre non-tidal freshwater*

impoundment within the refuge. The impoundment was ice covered at the time of the release, which helped to slow the initial flow of oil. As a result of warming temperatures and clean-up activities, the ice began to melt and turtles that had been hibernating within the impoundment began to surface and became contaminated with crude oil. A fence was erected to prevent additional oiling of turtles and other wildlife.

Oiled turtles were captured and taken to a rehabilitation facility to recover. Oiled turtles included 4 painted turtles (Chrysemys picta), 2 snapping turtles (Chelydra serpentina), 12 red-eared slider turtles (Trachemys scripta), and 1 red-bellied turtle (Pseudemys rubriventris) (Saba and Spotila 2003). The oiled turtles were cleaned and rehabilitated with 18 of the 19 turtles surviving. The researchers noted that these turtles may have had higher survival rates compared to other animal groups commonly affected by crude oil releases, such as seabirds and fur-bearing mammals, because oil does not adhere as readily to their shells and skin as it does to the fur and feathers of these other animals. In addition, other species ingest crude oil during the process of preening or grooming, a behavior limited in turtles due to their restricted flexibility. Crude oil ingestion by turtles is therefore limited to accidental ingestion of oil contaminated water and prey, which likely reduces effects from oil exposure (Saba and Spotila 2003).

In a monitoring study, radio-transmitters were placed on the oil-exposed turtles and two other groups of turtles to study the potential effects of crude oil exposure and subsequent rehabilitation. Because of the small sample size of oil-exposed and rehabilitated turtles, researchers captured 16 additional turtles near the release site that were classified as possibly exposed to crude oil. Thirty-two turtles from locations at least 0.6 mile from the release site were collected and treated as control specimens (not exposed to the crude oil release). Transmitters were placed on each of the 66 turtles to track their movements, record body temperatures, and assess potential survival and behavioral differences among the three groups. Researchers found that all of the rehabilitated turtles acted normally when released (Saba and Spotila 2003). This study found no differences in survival, home range, or temperature preference among the three study groups. This suggests that with rehabilitation, turtles can survive and recover from crude oil exposure.

***Canadian National Railway Company, Wabamun Lake Oil Release, Alberta**: On August 3, 2005, a Canadian National freight train derailed near the Village of Whitewood Sands, Alberta, releasing approximately 4,500 barrels of Bunker C Oil (Heavy Fuel Oil 7102; Hollebone et al. 2011) and 550 barrels of pole treating oil). An estimated 950 barrels of the Bunker C Oil entered Wabamun Lake where it formed a thick black slick approximately 0.5 inch thick (Wernick et al. 2009). While travelling overland, the oil mixed with soil and organic matter and, in the lake,*

OPAs formed quickly, including small tar balls, larger tar "logs", submerged sheets, and large lumps (Fingas et al. 2006; Hollebone et al. 2011). The heavy Bunker C Oil formed several types of aggregates including tar balls, larger tar "logs", submerged sheets, large lumps, tar balls that sometimes reformed into oil slicks, and a "slurry" composed of finely divided organic matter and small oil droplets (Fingas et al. 2006; Hollebone et al. 2011). The oil-sediment complexes exhibited a variety of behaviors including submergence, neutral buoyancy, and resurfacing as a result of contacting and taking up foreign matter (such as mineral particles and organic debris) on its path to the lake (Fingas et al. 2006).

Not long after the initial release, the submerged and sunken tar balls were seen along the shoreline and in shallow water. Even after initial clean-up efforts, tar balls were still commonly observed along the vegetated shoreline (Hollebone et al. 2011). Tar balls in and around the vegetation continued to move laterally in the water column releasing oil during the course of their movement. Consequently, oil continued to be released and adhere to shoreline vegetation. Tar balls were still observed almost 2 ½ years later (February 2007) within shoreline vegetation, including roots (Hollebone et al. 2011).

The oil release occurred after the western grebe nesting period and efforts were made to prevent oil from entering their primary nesting area (AESRD and ACA 2013). Most of the birds affected by the release were adults. Approximately 368 western grebes (76% of this population) were affected. Of the 368 affected birds, 333 were found dead or were subsequently euthanized, and 35 were cleaned and released.

Prior to 2006, there had been a single breeding colony of western grebes at Wabamun Lake, but in 2006, a second breeding colony was established. The original western grebe colony had been present on Wabamun Lake for over 20 years with relatively stable reproduction since 2001 (AESRD and ACA 2013). However, the year following the oil release (i.e., 2006), the Wabamun Lake western grebe population nearly doubled, but in 2007 it dropped below the estimated pre-release population levels. The population level continued to fluctuate over the next several years, and in 2011 the population dropped to its lowest level in 10 years (AESRD and ACA 2013).

The literature is unclear as to what lasting effects, if any, the oil release might have had on this western grebe population and the observed fluctuation in population levels. Determining such lasting effects is complicated by other important influences on the lake habitat. Erickson (2010) noted that three of the largest populations of western grebes in Alberta, including Wabamun Lake, had shown consistent declines for 9 years and suggested that these declines potentially were the result of increased lakeshore development. In 2009, four

years after the release, water level increases in Wabamun Lake, reduced the extent and density of bulrushes (Schoenoplectus tabernaemontani) and caused some of the western grebes to shift nesting locations from bulrushes to cattails (Typha spp.) (Wollis and Stratmoen 2010).

***Enbridge Line 6B, Marshall, Michigan**: On July 25, 2010, Enbridge's Line 6B pipeline experienced a release in a wetland near Marshall, Michigan. Approximately 20,000 barrels of heavy crude oil containing diluted bitumen were released over a period of approximately 17 hours. Approximately 8,200 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013). Wildlife monitoring programs reported 40 mammals were either found dead or they subsequently died during rehabilitation (USFWS et al. 2015a). In addition, 23 mammals were captured due to oiling, and were successfully rehabilitated and released. An unknown number of mammals are assumed to have been oiled but never found or captured. The primary species affected were muskrat (45%), raccoon (13%), and beaver (13%) (USFWS et al. 2015a).*

During clean up and monitoring, 52 birds were found dead or died during attempted rehabilitation (USFWS et al. 2015a). In addition, 144 oiled birds were captured, successfully rehabilitated and released. Approximately 140 birds that were observed to be oiled were never captured. The primary species were Canada goose (75%), mallard (9%), and great blue heron (5%) (USFWS et al. 2015a). Of the birds that were rehabilitated and released, 127 were equipped with leg bands including 109 Canada geese. Between 2010 and 2015, 39 of those bands were recovered from hunters (unpublished banding data), indicating that some birds survived post-release and subsequent migrations.

Additionally, 106 reptiles were found dead or subsequently died during rehabilitation, and approximately 3,900 turtles and 73 amphibians were captured, treated and released (USFWS et al. 2015a). The primary species affected were common map turtles (77%), snapping turtles (11%), painted turtles (6%), and eastern spiny softshell turtles (3%). Other species included common musk, Blanding's, and eastern box and spotted turtles.

***Enbridge Line 37, Fort McMurray, Alberta**: On June 22, 2013, approximately 1,300 barrels of synthetic crude oil were released from an underground pipeline located approximately 24.9 miles southeast of Fort McMurray, Alberta, Canada (Hemmings et al. 2015). The crude oil saturated nearby soil and flowed overland along the pipeline ROW to a fen where it eventually reached the shores of an unnamed lake. Just over a month after the release, the effects on wildlife were characterized as minimal. Nevertheless, the release site underwent remediation to reduce effects to other environmental receptors and remediation was completed four months after the release. Remediation efforts removed a majority*

> *of the crude oil (approximately 93%) and natural attenuation monitoring was employed to track the degradation of the remaining product. To reduce potential exposure of wildlife to the crude oil, wildlife deterrents were deployed and an exclusion fence erected (Enbridge 2013).*
>
> *A rigorous analysis of wildlife effects and subsequent recovery from this release is not provided in available literature, but information suggests that exposed wildlife is recovering. In 2014, wildlife, including boreal chorus frogs (Pseudacris maculata) and wood frogs (Lithobates sylvaticus), were using the previously oiled area. Researchers assessed that habitat suitability was moderate to high for wetland-dependent species based on the vegetation cover, shallow water, and availability of prey for species, such as the red-sided garter snake (Thamnophis sirtalis parietalis) and American mink (Neovison vison) (Hemmings et al. 2015). In a subsequent ecological risk assessment at the site, it was determined that the potential health risks to birds and mammals were negligible, with the exception of the mallard duck (Anas platyrhynchos). Although some risk was predicted for mallard ducks, the site did not have sufficient habitat to support a duck population and, therefore, effects related to growth, reproduction, and survival of ducks were not anticipated (Hemmings et al. 2015).*

Wildlife can be adversely affected by a release of hazardous material. However, the degree of severity is dependent on several factors.

In case studies involving heavy crude oil releases (e.g., Enbridge Line 6B, Marshall, Michigan), injuries were generally minor with most captured individuals being treated and released. Conversely, case studies consisting of light crude oil releases were where most reported injuries were fatalities.

Case studies illustrate that long term effects to wildlife can be reduced by swift spill response, remediation efforts, and effective rehabilitation techniques. Additionally, the type of wildlife affected is a major factor in the susceptibility of exposure to a release of crude oil. For example, turtles are less susceptible and respond better to rehabilitation than most mammals or birds, as crude oil cannot adhere to their skin and shell as well as it can to feathers and fur needed for buoyancy and thermoregulation.

8.3.4.2 Factors Affecting Recovery

The degree of exposure and a species' biology are the two principal factors affecting the degree and rate of recovery. A species reproductive strategy plays an integral role in how quickly populations will be able to recover from a crude oil release. Species that exhibit "r" reproductive strategies typically recover at much faster rates than do "K" strategists. Species that exhibit "r" strategies produce a large number of offspring, have short gestation periods, and have fast maturation rates. These characteristics are more adapted for fluctuating and unstable

environments, including contaminated areas. Conversely, "K" strategists do not recover as well from contaminated environments as they typically have fewer offspring, longer gestation periods, and slower rates of maturation (Rafferty 2016a,b; Reser 2016).

Rapid and effective clean-up also can limit wildlife exposure to released crude oil, thus minimizing effects and accelerating recovery (AESRD and ACA 2013; Hemmings et al. 2015). Once individual wildlife are exposed to oil, rapid and effective rehabilitation efforts can accelerate the recovery of these animals (ARCADIS 2011; Enbridge 2012; Saba and Spotila 2003).

The body type, behavior, and other aspects of a species' biology can reduce crude oil effects and, as a result, accelerate recovery (Saba and Spotila 2003). For example, reptiles may be less susceptible to oil fouling than birds and mammals because they lack fur and feathers where crude oil can be trapped and affect buoyancy and thermoregulation. Species with high reproductive rates typically recover quickly following a crude oil release (CHMR et al. 1990).

Large release volumes potentially can adversely affect more habitat and more individuals slowing subsequent recovery processes (Sellers and Miller 1999). The time and specific location of a release can also be important. Releases that occur when animals are concentrated in an area (e.g., nesting periods) can result in more oiled individuals and, therefore, slower recovery of the population (CHMR et al. 1990; Sellers and Miller 1999). Instinctive behaviors, such as site fidelity, that deter animals from leaving oiled areas also can result in higher rates of oiling and delays to subsequent recovery (Esler 2000).

8.3.4.3 Summary of Wildlife Recovery

There is limited information available on the recovery of wildlife related to freshwater and terrestrial crude oil releases compared to that for marine releases. Much of the data about releases in freshwater and terrestrial environments relates to effects rather than remediation and recovery. Freshwater and terrestrial wildlife release effects typically are tracked by the number of individuals oiled, the number treated, and the number of mortalities. This type of information typically is collected during the initial weeks or months following a release. Long term comparisons with local, unaffected populations are typically unavailable. Even when these data are collected, population-level effects are difficult to clearly distinguish due to a number of factors such as the availability of pre-release population information, the timeframe of monitored events, and separating crude oil release effects on wildlife from other environmental influences. Natural fluctuations in population levels and natural or anthropogenic changes to habitat unrelated to a crude oil release can make it difficult to determine when a population has recovered from the effects of a release (Hemmings et al. 2015).

Evidence from the case studies presented and the more robust literature for marine wildlife indicate that wildlife populations can recover from release effects, although recovery may take several years. Recovery is generally faster in species that reproduce quickly with large litters (i.e.,

species that exhibit "r" reproductive strategies), as opposed to species that take longer to reach reproductive maturity, and have low fecundity rates (i.e., species that exhibit "K" strategies).

The most important element affecting the recovery of wildlife populations following a crude oil release is limiting the proportion of affected individuals within the population and their habitat. Limiting mortality, particularly in species with long life spans and low reproductive rates, is important in wildlife recovery. Timely and effective clean-up efforts that reduce the number of oiled individuals can benefit population recovery. In addition, rehabilitation of oiled individuals can successfully treat the affected individual as well as benefit the affected population.

8.3.5 Surface Waters

Surface waters in Minnesota include freshwater habitats that range from lakes and ponds to wetlands, rivers, and streams. Fens and peat bogs are discussed in Section 8.3.2. These habitats and the quality of water in them play a vital role in sustaining aquatic and terrestrial ecosystems, as well as health, economic, and social values vital to humans. Surface waters within rivers, lakes, and wetlands provide many beneficial functions to organisms and humans (Postel and Carpenter 1997), including:

- Habitat for wildlife and fisheries by providing areas for spawning, feeding, and foraging
- Nutrient cycling
- Purification of water by filtering, degrading or diluting pollutants
- Fresh water used as a source for potable use, irrigation, industry, and recreation
- Transportation routes for boats and ships
- Hydroelectric power generation

Crude oil releases can affect surface water quality and disrupt the services provided by surface water. Although the physical, chemical, and biological responses within the surface water and associated sediment are closely integrated, this section will focus on the quality of surface water, how it can be affected by a crude oil release, and the rate of recovery if such effects occur. For surface water, recovery is typically quantified by measuring hydrocarbon concentrations. Regulators generally consider recovery complete when water quality standards protective of human health and the environment are met. Other sections within this report address the response and recovery of the sediment (Section 8.3.6) and freshwater biota, including benthic macroinvertebrates (Section 8.3.7) and fish (Section 8.3.7).

National pipeline incident data[25] shows that approximately 6.2% of pipeline incidents affect surface water. Of those incidents, 40% require active remediation[26] (PHMSA 2016). Surface water that is used as a drinking water resource is infrequently affected, accounting for 0.16% of historical releases (PHMSA 2016).

8.3.5.1 Recovery of Surface Waters Following a Crude Oil Release

This section reviews factors that influence recovery, including release volume, weathering, clean-up efforts, weather conditions, and waterbody characteristics. Collectively, these factors influence how surface waters recover from a crude oil release.

For lotic waters (streams and rivers), the volume of the release coupled with the stream's discharge[27] are the most important factors influencing effects and subsequent recovery (Enbridge 2015). These factors, combined with stream velocity, seasonal hydrology, channel morphology, currents, and sediment load, can strongly influence crude oil behavior and its resultant effects (Stantec et al. 2012b; Lee et al. 2015). Higher stream volume helps to dilute the released crude oil, enhancing the rate of recovery of surface water. The stream discharge is influenced by the time of year, with lower volumes often occurring during the summer and early fall (Crunkilton and Duchrow 1990; Enbridge 2015).

Environmental conditions associated with certain times of the year also can influence how rapidly a release might spread. The flow and spread of crude oil across the surface of water can be slowed by cold temperatures and ice and can subsequently reduce the overall affected area (Saba and Spotila 2003). The undulating and uneven underside of ice can trap crude oil released into surface waters, which can reduce the downstream transportation of crude oil, localizing effects and facilitating clean up.

Effective and timely response and clean-up efforts reduce the extent of crude oil contamination and can accelerate recovery (Guiney et al. 1987). Following an Ozark Pipeline System 9,520-barrel crude oil release in Asher Creek, Missouri in 1979, areas protected with surface skimming siphon dams were less severely affected and recovered more rapidly than unprotected areas where the substrate became inundated with crude oil (Crunkilton and Duchrow 1990). Lee et al. (2015) characterized clean-up of oil products as very effective for light oils and effective for medium crude oils, provided efforts are initiated soon after the release. Heavy crude oils do not

[25] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[26] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

[27] Discharge is the volume of water moving down a stream or river per unit time, usually expressed in cubic feet per second (USGS 2015).

readily disperse in water, and have a lower proportion of low molecular weight hydrocarbons that quickly evaporate.

In the absence of effective spill response, heavy crude oils can form emulsions consisting of water, particulate matter in the water column and bottom sediments, especially during turbulent flow conditions. These emulsions eventually can approach or exceed the density of water. Depending on water temperatures and velocities, these emulsions can sink and rise in the water column and may become trapped in bottom substrates. Weathering reduces the amount of soluble hydrocarbons over time, and clean-up activities can help limit the extent of the affected area and the hydrocarbon concentrations within the surface water (Stantec et al. 2012a; Enbridge 2015).

Environmental factors that enhance weathering will accelerate recovery. For example, biodegradation[28] typically increases with increasing temperature. Higher ambient temperatures also can reduce the crude oil's surface tension allowing oil to spread out, thereby increasing the surface area available for evaporation and microbial activity (Lee et al. 2015).

Although high flow conditions typically result in a large affected area and the potential for increased dispersion of crude oil into the water column, greater flows also serve to dilute oil concentrations (Stantec et al. 2012b). Modeling conducted for the Enbridge Northern Gateway Project predicted that the water quality of larger rivers would recover more quickly than smaller watercourses because there is a larger volume of water to dilute the crude oil, limiting the dissolved hydrocarbon concentrations (Enbridge 2015; Stantec et al. 2012b). This concept is supported by crude oil releases on both the Plains Midstream pipeline (Red Deer River) and the ExxonMobil Silvertip pipeline (Yellowstone River) where high stream discharge volume appeared to have helped dilute the crude oil (ARCADIS 2011; ESRD 2012). High flow rates are not always beneficial and can cause negative effects, such as turbulent flows, which affect the fate and behavior of crude oil released to surface waters by increasing dispersion, introducing sediment and debris into the crude oil, and facilitating the formation of water-in-oil emulsions. Turbulent flows most often occur in watercourses with steep gradients, high-velocity flows, boulder or cobble substrates, or where man-made structures such as overflow dams exist (Enbridge 2015; Lee et al. 2015).

Because small ponds and wetlands experience less water exchange than continually flowing streams, recovery rates of water quality in these water bodies are often slower because there is less dilution and flushing (Enbridge 2015). Depending upon the surface area and hydrodynamics of relatively static water systems, flushing of crude oil from lakes also can be slow, particularly when compared to lotic systems (Stantec et al. 2012b). Dilution in lentic (e.g., lakes, ponds) settings helps accelerate recovery.

[28] Biodegradation is a natural process of microbial transformation of chemicals, such as oil under aerobic or anaerobic conditions; oil biodegradation usually requires nutrients, such as nitrogen and phosphorus; transformation may be complete, producing water, carbon dioxide and/or methane, or incomplete, producing partially-oxidized chemicals (Lee et al. 2015).

As discussed above, crude oil effects on surface waters are influenced by the environmental setting, as well as the behavior of the oil on and within the surface waters. The following case studies present oil releases that affected surface waters and the subsequent recovery process. Because only a small body of information is available on surface water effects of oil releases and recovery in freshwater environments that are similar to those in Minnesota, additional case studies from temperate North America are included. Although broad generalizations cannot be drawn from a single event, case studies provide important information that, in combination with existing literature, can help regulators and operators gain a more comprehensive understanding of the effects of crude oil releases and recovery of various environmental media.

> ***Ozark Pipeline System, Asher Creek, Missouri****: Recovery of Asher Creek following an Ozark Pipeline System crude oil release of 9,520 barrels in August 1979 was impeded by low stream flow volume (Crunkilton and Duchrow 1990). This release occurred near the stream headwaters, and as a result, there was less contributing stream flow than locations further downstream. During the initial phase of this release, stream discharge volume was limited and water turnover[29] was slow. This increased the residence time of soluble oil compounds and resulted in loss of much of the macroinvertebrate community (Crunkilton and Duchrow 1990). When flow volumes were increased during spring flood events, they helped scour and dissipate residual oil in aquatic sediments and contributed to the recovery of the surface water and associated aquatic organisms.*
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> ***Laurel Pipe Line Company, Roaring Run Creek, Pennsylvania****: High flow volumes have been shown to enhance recovery rates, as demonstrated by a release of 1,310 barrels of aviation kerosene by the Laurel Pipe Line Company into Roaring Run Creek in Cambria County, Pennsylvania on October 16, 1982. The continuous supply of uncontaminated water from an upstream location contributed to recovery of water quality in less than two months (Guiney et al. 1987). Other factors contributing to the recovery of this system included a rapid clean-up response (Guiney et al. 1987).*
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> ***Advanced Fuel Filtration Systems, Inc., East Walker River, California****: On December 30, 2000, a tanker truck operated by Advanced Fuel Filtration Systems, Inc. overturned on State Route 182 north of Bridgeport, California, and released approximately 86 barrels of No. 6 Fuel Oil (Higgins 2002). Much of the released oil entered the East Walker River. Following the release, three surface water sampling events were conducted and samples were collected from seven locations (one control and six impact sites) and analyzed for PAHs. The PAH constituent analysis determined that the PAHs detected in the water samples were connected specifically to this event. Total PAHs were highest during the initial sampling effort*

[29] The turnover rate for water was calculated from the estimated volume of the wetted channel and stream discharge (Crunkilton and Ducrow 1989).

(January 2001) and in sampling locations located approximately 6.4 and 10 miles downstream of the release site that had the highest total PAH concentrations (Higgins 2002). Three months after the release (March 2001), the total PAH concentrations at the six impact sites had decreased, but two sites remained above the threshold effects levels for certain fish species. By the May 2001 sampling event (approximately 19 weeks post-release), total PAH levels at all of the affected sites had decreased to near background concentrations analyzed at the control site (Higgins 2002).

***Enbridge Line 6B Marshall, Michigan**: In July 2010, a pipeline rupture released approximately 20,000 barrels of diluted bitumen oil into Talmadge Creek and the Kalamazoo River in Marshall, Michigan. In July 2010, the Calhoun County Public Health and Kalamazoo County Health and Community Services Department banned recreational use of the Kalamazoo River. In August, these two organizations also banned the use of surface waters for irrigation and the watering of livestock (NTSB 2012). The MI DCH also issued swimming and fish consumption advisories for the Kalamazoo River (MI DCH 2014).*

Clean-up efforts began almost immediately, including installing oil sorbent and containment booms and using oil skimmers and vacuum trucks to recover the oil. By August 2010, clean-up efforts included excavation and removal of contaminated soil, sediment, vegetation, and debris. Recovery of submerged oil included more active methods such as sediment agitation, sediment traps, and sheen management (USFWS et al. 2015). As part of the NRDA process, a group of federal and state agencies, as well as local First Nation representatives (the Trustees), assessed the effects of this release, effectiveness of clean-up efforts, and potential options to compensate for effects (USFWS et al. 2015).

Between July 2010 and April 2012, surface water data were collected from the Kalamazoo River and Morrow Lake (MI DCH 2014). Chemical analyses were conducted for oil constituents such as PAHs and alkylated PAHs, at different depths within the water column (USFWS et al. 2015). Surface water analyses were conducted to evaluate potential human health effects, as well as potential exposure of fish embryos to the oil constituents. The July and August 2010 sample results showed that most chemical constituents were below human health water criteria for both the USEPA and the MI DEQ. Surface water sampling conducted from 2011 to 2012 detected only a few of the monitored chemicals (primarily PAHs) above health-protective screening levels (MI DCH 2014). Based upon sample results, it was determined that PAH concentrations were not high enough to adversely affect fish embryos (USFWS et al. 2015). In June 2012, most of the Kalamazoo River was reopened to recreation, and the MI DCH lifted its advisories and fish consumption guidelines, although people were advised to follow fish consumption guidelines in effect prior to the release.

***Plains Midstream Red Deer River, Alberta**: On June 7, 2012, between 1,000 and 3,000 barrels of light crude oil were released into the Red Deer River about 1.9 miles north of Sundre, Alberta (ESRD 2012). The release was caused by vertical stream scour that exposed a pipeline that failed under the excessive outside forces caused by high floodwaters. The river's discharge was about 10 times the seasonal flow prior to the release (AER 2014). Crude oil reached Gleniffer Lake (also known as Dickson Dam Reservoir) located approximately 24.9 miles downstream of the release site. Sampling between the release site and Gleniffer Lake indicated that the majority of the hydrocarbons had been transported to the lake. Booms placed on Gleniffer Lake effectively contained the free oil product, limiting further downstream migration. Contained oil was hauled offsite by Plains contractors (AER 2014).*

The lighter weight hydrocarbons that had dissolved in the water column continued downstream. Low levels of these dissolved hydrocarbon components were found approximately 30 miles downstream near the city of Red Deer (ESRD 2012). Five to nine days later (June 12 and 16, 2012), monitoring showed a "marked" decrease in hydrocarbon concentrations at all sample locations. Drinking water plant sampling concentrations dropped to below detection limits at all sampling locations by June 14, and all concentrations prior to this date were well below applicable Health Canada drinking water guidelines (0.005 ppm for benzene, 0.024 ppm for toluene, 0.0024 ppm for ethylbenzene and 0.3 ppm for xylenes) (ESRD 2012). The ESRD (2012) report stated that this decrease indicated that hydrocarbon concentrations had been diluted by input from the Red Deer River, and by the recovery of surface water.

Monitoring showed that BTEX decreased over time and by June 16 (less than 10 days after the release), BTEX concentrations were below detectable limits (ESRD 2012, Teichreb 2014). With the exception of toluene that exceeded protection of aquatic life guidelines for a few days but never Federal drinking water guidelines, examination of petroleum hydrocarbon concentration data from locations downstream of the city of Red Deer did not exceed Federal water quality guidelines [30] for petroleum hydrocarbons (ESRD 2012). One month after the release (early July 2012), BTEX levels continued to be below detection levels with two exceptions. One sample location in Gleniffer Lake near the Carefree Resort marina had a short-term period of detection between June 24 and 28, 2012, and was highly localized as evidenced by non-detectable concentrations of petroleum hydrocarbons at nearby sites. This area was undergoing

[30] Concentrations of dissolved petroleum hydrocarbons downstream of Gleniffer Lake were below the most sensitive applicable water quality guidelines for all parameters with the exception of toluene. Toluene frequently exceeded the protection of aquatic life guideline during the initial days of monitoring, but did not exceed applicable Health Canada drinking water guidelines downstream of Gleniffer Lake (ESRD 2012).

decommissioning at the time of the peak and thus was not open to recreational boating. Investigations into the cause of the peak were conducted, but no plausible explanation was found (ESRD 2012). A second small peak occurred on July 2, 2012, at the sample location near the Gleniffer Lake Resort, which may have been caused by recreational boat activity during the Canada Day holiday, but this could not be confirmed. This peak was also short-term and localized (ESRD 2012).

PAHs also were monitored post-release and, while they were initially detected in surface water from Gleniffer Lake downstream to the city of Red Deer. Concentrations decreased over time. The majority of samples after June 16 showed PAHs to be below detection limits (ESRD 2012). Although occasional detections of PAHs were found, they were very random in nature with no clear connection to the June 7, 2012 release.

***Enbridge Line 37, Fort McMurray, Alberta**: During this 2013 event, synthetic crude oil released from the pipeline rose to the surface in the saturated soils and flowed overland along the pipeline right-of-way to a fen and eventually reached the shores of an unnamed lake. Contaminants of concern in this event were certain petroleum hydrocarbon fractions, BTEX, and PAHs (Hemmings et al. 2015). Remediation efforts at the unnamed lake involved removing free product using barrel skimmers and sediment excavation in the northwest corner of the lake where the highest concentrations of certain petroleum hydrocarbons were documented. Approximately 118 cubic yards of sediment were excavated to a depth of 4 inches. Site remediation also involved installation of physical barriers (hard and soft booms), targeted soil excavation within the ROW, soil flushing within the affected fen, removal of oiled vegetation, and treatment of surface water and groundwater. Contaminated oily water, slurry, and sludge were collected in vacuum trucks and taken off-site for disposal or treated at an on-site water treatment facility. The effective containment and recovery of crude oil resulted in the collection of 93% of the released oil and contributed to the subsequent recovery of surface water.*

Surface water sampling occurred at the unnamed lake, at up-gradient and down-gradient waterbodies, and, when water was present, within the pipeline ROW. During initial response efforts, benzene, toluene, ethylbenzene, and certain petroleum hydrocarbon concentrations were above the applicable surface water guidelines within the affected area. However, approximately two months after the release, these contaminant concentrations were below applicable guidelines (Hemmings et al. 2015). Monitoring results from 2014 determined that contaminant levels continued to be below applicable guidelines.

Releases of oil have the potential to affect surface water adversely. Effects can vary in degree of severity depending on several factors, including the type and quantity of oil released, and timeliness of spill response. Heavier oils (e.g., Bunker C Oil, diluted bitumen) do not dissolve or naturally attenuate as quickly as a lighter crude oil due to their higher concentrations of high molecular weight compounds (e.g., asphaltenes). Lighter crude oils are composed of lighter hydrocarbons such as BTEX compounds and alkanes, which evaporate quickly and are relatively biodegradable. High levels of BTEX compounds can be toxic to humans and aquatic life if water quality thresholds are surpassed. Additionally, the quantity of crude oil released is a major factor in determining effects as it largely dictates how much area and aquatic wildlife may be affected. The case studies demonstrate that effects to surface waters can be mitigated by timely spill response efforts, including the placement of sorbent and containment booms and use of surface skimmers and vacuum trucks. Remediation can also occur naturally through processes such as natural attenuation, evaporation, and weathering.

8.3.5.2 Factors Affecting Recovery

Rapid and effective response to a release of crude oil can reduce the severity and extent of the effects to surface water, thereby accelerating its recovery (Guiney et al. 1987; Hemmings et al. 2015). Remediation practices that can accelerate the rate of surface water recovery include removal of oil, clean-up of oil-contaminated surfaces such as sediment and vegetation, and treatment of surface water (Guiney et al. 1987; Hemmings et al. 2015).

Environmental factors such as warm temperatures that enhance crude oil weathering also promote surface water recovery (Lee et al. 2015).

The type of oil released can influence the rate of recovery. Lighter oils typically weather more readily and more completely than heavier oils (Lee et al. 2015).

However, the fate, effects, and subsequent recovery from a crude oil release depend primarily on the effectiveness of emergency response and the environmental conditions in which the release takes place (Lee et al. 2015). Larger surface waterbodies typically recover more quickly than smaller waterbodies because the crude oil is more rapidly diluted in the larger volume of water (Anderson 2006; ESRD 2012). The volume and turbulence associated with high flows in rivers and streams can increase the dilution of crude oil and accelerate surface water recovery (ESRD 2012; Enbridge 2015).

Large release volumes typically result in greater area and severity of effects and, thus, slow the recovery of surface waterbodies (Crunkilton and Duchrow 1990). The time of year when a release occurs can impede recovery if the release occurs near or during a period of low flow (Crunkilton and Duchrow 1990).

8.3.5.3 Surface Water Summary

Freshwater resources include lakes, ponds, wetlands, rivers, and streams. These waterbodies are important for both the diverse assemblages of species they support and their associated human use. Released crude oil that enters a freshwater aquatic habitat can negatively affect water quality and the ecosystem that it supports. The fate and behavior of oil in surface waters is dependent on a number of factors that include the volume of the release, the type of oil, and the nature of the receiving environment. When crude oil enters surface water, it rapidly spreads out over the surface, but wind, waves, current, air temperature, and other conditions strongly influence the potential for dispersion, weathering, and sedimentation.

As demonstrated by the case studies described here, it is common for the recovery of surface water to be rapid and complete within weeks to months following the crude oil release. Recovery within larger lotic systems can occur very quickly, sometimes within a few days (e.g., Red Deer River and Silvertip Pipeline oil releases). The volume of crude oil released is often small compared to the receiving waterbody, and the higher flows can dilute the released oil. Smaller stream systems, such as Asher Creek, where the release volume was large compared to the size of the waterbody, and lentic systems such as the lake affected by the Fort McMurray release, may take longer to recover. Water quality recovery still can occur within a few months, particularly when clean-up and remediation efforts are employed. Emergency response and clean-up activities can help limit both the severity and extent of the effects of the release on surface water quality and promote the resulting recovery.

8.3.6 Aquatic Sediments

Aquatic sediments are the mineral substrate (e.g., sand, gravels, cobbles) and organic matter deposited into a waterbody by water, air, or ice. Sediments provide habitat for aquatic organisms, such as aquatic invertebrates, and are an integral part of aquatic ecosystems. The composition of aquatic sediments strongly influences the associated macroinvertebrate community (e.g., coarser substrates associated with higher flows have a very different macroinvertebrate community than fine-grained sediments in lower energy depositional substrates). Aquatic sediments also function as spawning habitat for many species of fish and the rearing habitat for larval or juvenile life stages for a variety of species. Additionally, many species of aquatic plants, such as water-lilies (*Nymphaea* spp.) and smartweeds (*Persicaria* spp.), use aquatic sediments as germination and rooting substrate. Like terrestrial soils, aquatic sediments function to accept, store, and process nutrients, making them available to plants and animals.

While aquatic sediment is often thought of as fine-grained material such as silt, clay, and sand, it may include coarse-grained mineral substrates such as gravel, cobble, boulders, and bedrock. The composition of aquatic sediment within a watershed or individual waterbody depends on factors such as channel slope, geologic history, and land use patterns. In some watersheds, fine-grained particles may dominate the sediment, while in other systems, these smaller particles may

be essentially absent. Lakes and ponds generally contain sediment that has accumulated from external sources over extended periods of time and may be a legacy of glacial processes. Sediment in ponds and lakes also may be the result of more recent processes such as inputs from streams and rivers, wind and wave erosion, or nearshore transport (littoral drift) in larger waterbodies.

There are several generalizations regarding patterns of sediment deposition in aquatic ecosystems. In rivers, coarse-grained sediment (e.g., gravel, cobble, boulders) is typically present in high-velocity turbulent habitats, while sediments in low-velocity habitats are often fine-grained (e.g., silt, sand, clay) and may have high organic carbon concentrations. In the inner portion of meander bend, the water moves more slowly and fine-grained materials settle out of the water column creating deposits of sediment (areas of deposition). In contrast, in the outside of these bends, water moves more quickly, allowing water to transport more sediment, and can scour sediments from bedrock or substrates too large for transport. In some cases, especially in large riverine systems, substrates in the center of the channel may consist of coarse-grained substrates, while those on the margins are fine-grained as a result of secondary circulation patterns (Hey 1983).

For lakes, factors that influence sediment deposition patterns and grain size composition include basin size, lake depth, lake surface area, and lake age (Horne and Goldman 1994). The length of open water where wind may blow (i.e., fetch) is an important determinant in the kinetic energy profile for nearshore environments on lakes and other standing waterbodies. Substrates along windswept shorelines in large lakes typically are coarse-grained, while substrates in sheltered embayments typically are fine-grained. Sediments often exist in aquatic ecosystems as a patchwork mosaic of substrate types. These patterns contribute to resource partitioning that controls the distribution and abundance of aquatic organisms. For example, some benthic spawning fish use coarse-grained substrates, while others use sand (Welcomme et al. 2006).

8.3.6.1 Recovery of Aquatic Sediments Following a Crude Oil Release

For aquatic sediments, recovery is measured by hydrocarbon concentrations and contaminant levels in sediments decreasing to a point where they meet sediment quality standards or meet risk-based objectives in assessments, such as the sediment quality triad.[31] Other sections in this report address the response and recovery of sediment-associated species, including benthic macroinvertebrates (Section 8.3.7) and fish (Section 8.3.7).

Many factors influence the recovery of aquatic sediments from crude oil, including oil properties, weathering, emergency response, site-specific conditions, and environmental conditions. Most crude oils, including heavy crude oils such as diluted bitumen, are less dense than water and will float. Initial effects to sediment occur along shorelines due to oil stranding. If not removed from

[31] Sediment quality triad (SQT)—chemistry to measure contamination, bioassay to measure toxicity, in situ biological assessment to measure effects [i.e., benthic community alteration]) (Chapman 1990).

the environment, crude oil on the water's surface will undergo weathering processes such as evaporation, dispersion, emulsification, or contact with suspended sediment in the water.

These processes may increase the specific gravity of the released crude oil to a point that it becomes neutrally or negatively buoyant and submerges. Specifically, as the volatile lightweight hydrocarbons within crude oil evaporate, the remaining oil will consist of an increasingly larger proportion of non-volatile heavy molecular weight hydrocarbons that have a strong affinity to suspended sediments, particularly those with a high organic content. As the density of the remaining product increases, the residual material may submerge or sink (Fingas 2015).

Crude oil's tendency to bind tightly with suspended or benthic sediments helps reduce the residual oil's toxicity by decreasing its availability to organisms even when ingested (bioavailability). Heavy molecular weight PAHs that weather more slowly are resistant to biodegradation, but they also are not generally as toxic as lower molecular weight hydrocarbons (Prince et al. 2003). In combination, these factors contribute to the magnitude of sediment contamination and effects which, in turn, influences the duration of recovery of aquatic sediments.

The site-specific characteristics of the receiving environment also may influence the recovery of aquatic sediments. For example, the 2010 Enbridge Kalamazoo River pipeline release occurred during a spring flooding event. The Cold Lake diluted bitumen (i.e., heavy oil) that was released had an average API gravity of 21.0 and floated on the water initially (Crude Monitor 2016). However, extreme turbulence due to the flooding, extremely high sediment loads, suspended debris, as well as the presence of a roller dam, created oil-water-sediment emulsions ladened with debris. These emulsions became negatively buoyant, resurfacing, and re-sinking, and eventually settling out in depositional areas. During the clean-up of this release, river sediments were physically removed to allow recovery of the affected river segment.

Weathered oil-particulate aggregates may settle to the bottom sediments, where clean-up is more difficult than collection of crude oil from the water's surface. The amount of unrecovered oil and the proportion of complex PAHs in the submerged sediment influence the biodegradation rates that lead to recovery.

The recovery of aquatic sediments affected by crude oil will progress at different rates depending on the types of aquatic habitat and environmental conditions. In general, high energy habitats, such as riffles in rivers and wave-swept shorelines in lakes, tend to recover rapidly in comparison to low energy habitats such as backwaters in rivers, large surface water impoundments, or wetland sloughs (Poulton et al. 1997). This is attributed to several physical, chemical, and biological processes. These habitat types differ substantially in terms of sediment retention times. Riffles have a near continuous supply of turbulent flow from upstream, resulting in the transport, dispersal, and dilution of released product. Low energy environments have lower rates of flushing, and sediments in these locations may be both high in organic content and

anoxic. Anaerobic biodegradation of crude oil generally is acknowledged to be a less efficient process than aerobic biodegradation (Prince et al. 2003).

The case studies and other supporting literature discussed below describe several remediation approaches and environmental factors that can accelerate or impede recovery of aquatic sediments following a crude oil release. These case studies are primarily from lotic (streams and rivers) habitats because there is little available sediment recovery literature from oil releases in lentic (ponds and lakes) habitats. Case studies are ordered chronologically as practices have evolved from previous experience within the oil and gas industry. As illustrated in Attachment A, the number of petroleum hydrocarbon releases with recovery information within the geographic region similar to Minnesota was very limited. The case studies below include incidents from a broader temperate region of North America. Stantec et al. (2012a) and Enbridge (2015) provide additional descriptions of some of these sediment case studies, including incident details and recovery information. Although broad generalizations cannot be drawn from a single event, case studies provide significant data that, in combination with existing literature, can help regulators and operators gain a more comprehensive understanding of the effects of releases of petroleum hydrocarbons and the subsequent recovery of various environmental media.

> ***Laurel Pipe Line Company, Roaring Run Creek, Howell's Run, and North Branch of Little Conemaugh River, Pennsylvania****: On October 16, 1982, approximately 1,310 barrels of aviation kerosene was released from a Laurel Pipe Line Company pipeline. The release affected multiple streams, including Roaring Run Creek, Howell's Run, and the North Branch of Little Conemaugh River. Clean-up operations for this incident included booming and vacuuming of the kerosene, and resulted in recovery of approximately 760 barrels of the released material.*
>
> *The aviation kerosene saturated sediments downstream of the release site, resulting in contaminated sediments with high concentrations of petroleum hydrocarbons. Recovery information on the affected area indicated that water chemistry recovered in less than two months. While sediment hydrocarbon concentrations remained elevated for 14 months after the release, hydrocarbons were no longer detected in sediments after 21 months (Guiney et al. 1987). Factors contributing to the recovery of this system included the rapid clean-up response, and a continuous supply of uncontaminated water from upstream of the release site (Guiney et al. 1987).*
>
> ***Shell Pipe Line Company, Gasconade River, Missouri****: On December 24, 1988, a Shell Pipe Line Company pipeline ruptured releasing approximately 20,760 barrels of crude oil into Shoal Creek, a tributary of the Gasconade River which eventually reached the Missouri River. Clean-up operations for this incident were conducted for a month following the release and recovered approximately 50% (10,380 barrels) of the released crude oil. Sediment quality was studied for 18 months after the release (Poulton et al. 1997). Sampling conducted by the Missouri*

Department of Natural Resources during the first months after the incident showed rapid recovery of aquatic sediments in fast flowing stream reaches, and were comparable to unaffected sites within six months following the incident. In contrast to fast flowing stream reaches, crude oil had accumulated in backwater areas and took longer to recover to background conditions. While some backwater sites reached background concentrations in 15 to 18 months, other sites had not reached background levels (defined as a range of total petroleum hydrocarbons between 30 ppm [detection limit] and 80 ppm) when the study was concluded 18 months after the release. Spring floods that flushed and scoured the sediments within the stream bed were thought to increase the rate of recovery of aquatic sediment quality.

***St. Lawrence River, Quebec**: This 1999 experimental oil treatment was conducted in a freshwater wetland along the shoreline of the St. Lawrence River in St. Croix de Lotbinière, Quebec. The experiment involved the intentional release of 0.8 barrels of crude oil into each of the four blocks of vegetation wetland plots (Hodson et al. 2002). A weathered medium crude oil was applied to vegetated wetland plots to examine the effects of nutrient enrichment (bioremediation) and plant growth (phytoremediation) on sediment recovery. The experiment examined a biomarker of exposure (a liver enzyme known as cytochrome p450) in trout as an indicator of remediation success (Hodson et al. 2002). After 15 months, sediments showed an approximate 80% reduction in petroleum hydrocarbons, which corresponded with similar reductions in biomarker activity in the trout. Reductions in hydrocarbons were attributed to weathering of volatile components and flushing due to tidal and wave action. It also is possible that clean sediment deposited through littoral drift and erosion contributed to hydrocarbon reductions.*

***Enbridge Line 3 Glenavon, Saskatchewan**: On April 15, 2007, Enbridge's Line 3 pipeline released an estimated 6,230 barrels of heavy crude oil into a slough (wetland) located on agricultural land near Glenavon, Saskatchewan (SLR Consulting 2008b). Approximately 5,740 barrels were recovered from the release (TSBC 2008). Emergency response efforts included repair of the pipeline, recovery of surface oil from the slough, removal of affected vegetation from the perimeter of the slough, and removal of affected surface water. Remediation included excavation of affected sediments from the slough that had PAH concentrations that exceeded freshwater sediment criteria set by the CCME. Subsequent sampling of sediments conducted in May through September 2007 indicated hydrocarbon concentrations were below the remedial criteria established for the site. In September and October, reclamation of both the slough and riparian zones commenced after the remedial criteria were met. The reclamation program consisted of contouring the site to match surrounding topography;*

relieving shallow soil compaction from equipment; and topsoil replacement, cultivation, and bank seeding of the slough (SLR Consulting 2008b).

***Enbridge Line 6B Marshall, Michigan**: In July 2010, Enbridge's Line 6B pipeline released approximately 20,000 barrels of crude oil near Marshall, Michigan over a period of approximately 17 hours. At the time of the release, the pipeline contained two different batches of crude oil estimated to consist of approximately 77% CLWB diluted bitumen and 23% Western Canadian Select crude oil (NTSB 2012). Of this, approximately 8,200 barrels reached Talmadge Creek and the Kalamazoo River (Enbridge 2013).*

As described previously, the combination of extreme turbulence due to the flooding, water flow over a dam, and mixing of the released crude oil with suspended particulates in the water column formed oil-water-sediment aggregates ladened with debris. As a result, in the weeks following the incident, OPAs became submerged in some locations, especially low energy depositional areas. Surface oil was removed during the clean-up operations, and submerged oil was removed through targeted dredging of contaminated sediments. To monitor the effects and recovery of the residual oil in sediments, Enbridge completed a weight-of-evidence SQT analysis in 2013 that incorporated sediment contaminant chemistry, sediment toxicity, and macroinvertebrate community analysis. These three lines-of-evidence were reviewed together to determine whether significant ecological effects remained, and whether there was evidence of sediment recovery. The macroinvertebrate results from this analysis, as well as other studies[32], are further reviewed in Section 8.3.7.

The SQT analysis focused on sediments in depositional areas of the Kalamazoo River where residual submerged oil was present. Talmadge Creek sediments lacked sufficient accumulations of oil to be included in the study. Taking into account the sediment chemistry results, sediment toxicity, and the macroinvertebrate community results, the SQT analysis concluded the recovery to pre-release conditions was well advanced, and residual oil was not having a significant adverse effect on the aquatic ecosystem.

***Enbridge Line 37 Fort McMurray, Alberta**: On June 22, 2013, approximately 1,300 barrels of synthetic crude oil was released from the Enbridge Line 37 pipeline. The released crude oil rose to the surface in the saturated soils and flowed overland along the pipeline ROW to a fen, eventually reaching the shores of an unnamed lake.*

[32] Other studies include MI DEQ Procedure 51, which consists of separate qualitative evaluations of the macroinvertebrate community, fish community, and habitat quality. These protocols can be used to assess the existing condition of Michigan's wadeable streams and rivers as well as detect spatial and temporal trends (MI DEQ 2016).

> *Remediation of the affected area was carefully planned to minimize effects to the sensitive fen and lake environment. Initial remediation efforts focused on removal of crude oil from the surface of the lake and wetland, removal of affected soil, and targeted removal of sediment from the lake during a period of low water. The initial remediation removed 93% of the released crude oil.*
>
> *A human health and ecological risk assessment was conducted on the remaining oil to develop site-specific remediation targets and inform subsequent monitored natural attenuation. For lake sediments, a net environmental benefit approach was used to determine if the remaining sediment posed a negligible environmental risk. Leaving the remaining oil in place was determined to be less detrimental to the overall ecosystem than additional disturbance of the lake. As of the date of this report, monitored natural attenuation is ongoing to confirm that remediation objectives are being met (Hemmings et al. 2015).*

The above case studies focused on the recovery of aquatic sediments following very large petroleum hydrocarbon incidents. Despite the volumes released, aquatic sediments in the affected watercourses and waterbodies recovered fully in most cases. The only exceptions to full recovery were in studies where monitoring was terminated after short periods (e.g., 18 months), such as the study on the Gasconade River. The case studies demonstrated that sediment recovery may differ based on: 1) incident circumstances (e.g., quantity of crude oil, type of oil, flooding); 2) remediation activities and regulatory thresholds; and 3) the type of affected environment (e.g., stream velocity, sediment characteristics).

8.3.6.2 Factors Affecting Recovery

Human intervention to protect sensitive habitats and reduce the amount of affected sediments can speed the rate of recovery (Hemmings et al. 2015). Freshwater sediments in high energy habitats tend to recover more rapidly than low energy habitats due to the increased flushing and weathering of crude oil (Guiney et al. 1987; Poulton et al. 1997; Higgins 2002). Episodic flood events in rivers and wind-generated wave energy in lakes can mobilize sediments and disperse contamination (Poulton et al. 1997; Hodson et al. 2002). In some circumstances, this physical agitation can increase weathering of crude oil by restoring aerobic metabolic processes.

Some constituents of crude oil (e.g., asphaltenes) are particularly resistant to weathering and, if not removed from the environment, may persist in sediment for decades, slowing recovery (Prince et al. 2003). Weathering of oil in poorly oxygenated (anoxic) sediments relies on anaerobic processes that are less efficient than aerobic processes and can prolong recovery (Prince et al. 2003). Dredging has been used to accelerate sediment recovery. Regulators and industry have effectively worked together to evaluate site-specific conditions at the release site to determine effective remediation strategies that address the net environmental benefit. In some cases, the use of heavy equipment many cause greater environmental harm than allowing natural attenuation to occur.

8.3.6.3 Summary of Aquatic Sediment Recovery

Aquatic sediments are an important habitat component of freshwater systems, providing substrate that is utilized by both macroinvertebrates and fish for habitat, reproduction, and feeding. Crude oil releases that reach freshwater environments may affect aquatic sediments, especially riverbanks and lake shorelines. Timely and effective emergency response can reduce effects and recovery time. If crude oil is not removed from the environment, weathering will increase the oil's density. Under certain circumstances, oil-water-particulate aggregates may form with suspended sediment and debris, which can then sink to the substrate surface.

Following a crude oil release, monitoring the recovery of aquatic sediments is important to restore ecological function. Recovery can be assessed using a variety of techniques including comparison of petroleum hydrocarbon concentrations in sediment compared to sediment quality guidelines; recovery of the benthic macroinvertebrate communities; or risked-based weight-of-evidence approach.

Recovery of aquatic sediments is a fairly rapid process in high energy habitats where flushing and an accelerated weathering process can occur. In low energy habitats, recovery may take longer, especially when crude oil is incorporated with finer grain sediments that may be anoxic. Fast, effective response to oil releases in the freshwater environment can minimize effects to sediment. In some circumstances, human intervention measures can be used to facilitate sediment recovery; however, it is important to consider the net environmental benefits before major interventions are initiated.

8.3.7 Aquatic Biota

Aquatic biota are often used to monitor the ecological health of aquatic ecosystems, including effects and recovery from crude oil releases. In streams and rivers, time to recovery varies with waterbody size and habitat type, but recolonization usually begins soon after the release with full or substantial recovery within one year. The type of oil and volume released also affect recovery of aquatic biota. Depending on the species, recolonization can occur through a combination of downstream drift, upstream and downstream migration, migration from within the substrate, and aerial sources.

The primary factors accelerating recovery include utilization of clean-up techniques that minimize crude oil penetration into substrates, dilution and degradation of oil by higher flows, and the presence of individuals in nearby unaffected reaches. Recovery may be impeded by residual crude oil contamination, habitat alterations, and supplemental environmental stressors such as low flow and drought conditions during the recovery process.

8.3.7.1 Aquatic Vegetation

Aquatic plants are defined as those that live in freshwater, brackish, or saltwater environments. Many species of aquatic plants such as water-lilies (*Nymphaea* spp.), broad-leaf cattail (*Typha*

latifolia), and smartweeds (*Persicaria* spp.) use aquatic sediments as germination and rooting substrate. Other aquatic plants grow in the water column such as green algae (*Selenastrum* capricornumtum) or along the surface of slow moving water such as duckweed (Lemna minor). Aquatic communities provide diverse ecological functions that support both natural and human environments, including providing wildlife and fisheries habitat, shoreline stabilization, flood and storm surge reduction, and water quality protection through the uptake of excess nutrients and toxins.

8.3.7.1.1 Recovery of Aquatic Vegetation Following a Crude Oil Release

Many factors influence the recovery of aquatic vegetation from a crude oil release, including the resiliency of the species affected, the type of oil and its properties, weathering, and emergency response. Release volume, time of year, and environmental conditions at the time of the release also can influence the rate of recovery (Hoff et al. 1993; Lin and Mendelssohn 1996). For example, high energy habitats such as riffles in rivers and wave-swept shorelines in lakes tend to recover rapidly in comparison to low energy habitats such as backwaters in rivers, large surface water impoundments, or wetland sloughs (Poulton et al. 1997). High energy habitats can scour crude oil from sediments, help break up and disperse crude oil, and create aerobic conditions that help to facilitate the biodegradation of crude oil.

Most crude oils, including heavy crude oils such as diluted bitumen, are less dense than water and therefore will initially float on the water's surface. Crude oils may physically coat the surface of aquatic vegetation on or near the water surface. Over time and if clean-up is not complete, crude oil present on surface water eventually may submerge through a combination of weathering processes such as evaporation, dispersion, emulsification, or contact with particles in the water column or sediment. These weathering processes reduce the concentrations of volatile and water soluble compounds, including some that are toxic to aquatic plants. As crude oil weathers, the composition of the remaining material becomes dominated by heavy molecular weight hydrocarbons (e.g., asphaltenes). These residual compounds tend to be more resistant to biodegradation, have a higher affinity to sediment, and are not generally as toxic to aquatic vegetation as lower molecular weight hydrocarbons (Prince et al. 2003).

The resiliency of aquatic vegetation to a crude oil release depends on the sensitivity of the plant species, the time of year when the release occurs, the recovery rate of surface water and sediments used by the aquatic plants, and the proximity of nearby plant communities that can help recolonize the affected area. For example, both green algae and duckweed are relatively sensitive to many water soluble contaminants, but their ability to reproduce quickly with many offspring allows algae and duckweed populations to recover quickly once water quality improves.

Physiology and reproductive strategies can affect how readily plants recover from a crude oil release or other environmental disturbance. For example, some plants have rhizomes, which are shallow horizontal roots that allow plants to reproduce asexually as an alternative means of reproduction. Softstem bulrush (*Schoenoplectus tabernaemontani*) and cattails are common

aquatic plants with rhizomes. In the event of a crude oil release, rhizomes may allow plants to survive and more readily recover following a crude oil release (Lin and Mendelssohn 1996). While annual species tend to be susceptible to the initial effects of a crude oil release, these species are frequently among the first to reestablish themselves if there is an available seed source near the release site (Michel and Rutherford 2013).

The time of year when a release occurs can substantially influence the type and extent of effects to vegetation, as well as the time it can take for aquatic plant communities to recover. A crude oil release that occurs during or just prior to senescence (i.e., seasonal quiescence of vegetation) will have fewer initial effects on vegetation and a more rapid recovery than releases during the active growing season (Michel and Rutherford 2013; Pezeshki et al. 2000). Senescence, including leaf drop in many aquatic plants, occurs prior to the onset of dormancy when biological processes within a plant cease until the next growing season. There is less surface area exposed to oiling if leaf drop has already occurred, and the plant does not experience the same metabolic or reproductive effects under dormant conditions as during the growing season.

Other environmental processes such as the flow and movement of water, whether from natural or anthropogenic activities, can advance or potentially hinder recovery. Natural stream flow, tidal action, and wakes created by boat traffic were attributed to helping flush oil from a contaminated marsh along the Delaware River from the Panamanian tank vessel *Grand Eagle* in 1984 (Michel and Rutherford 2013). Flood events can occur simultaneously with crude oil releases, such as in oil releases from oil well pad sites (e.g., Missouri and Yellowstone rivers in 2014 near Trenton, North Dakota; Platte and Big Thompson rivers in Colorado, 2013); pipeline releases (e.g., Bridger's Poplar Pipeline in Yellowstone River, Montana, 2015; ExxonMobile's Silvertip pipeline in Yellowstone River, Montana, 2011; Enbridge's Line 6B near Marshall, Michigan, 2010); and home heating oil releases (e.g., homes in Grand Forks during 1997 Red River flood, North Dakota) can result in oil becoming stranded over large areas. These flood events resulted in the oiling of aquatic, terrestrial, and riparian vegetation. While flooding can help to flush oil from affected areas, it can also strand oil above normal water levels where it can remain for longer periods if it is not cleaned up. The stranding of oil can slow vegetation recovery and reestablishment (Michel and Rutherford 2013).

Emergency response methods can either facilitate or impede recovery of aquatic vegetation recovery depending on how the methods are employed and the type of vegetation affected (Section 8.4). Rates of aquatic vegetation recovery are improved when techniques selected for crude oil removal account for the sensitivity and reproductive strategies of the affected vegetation (e.g., reduce disturbance to rhizomes), reduce soil/sediment disturbance to the extent practical, and ensure clean-up is timely and effective. When regulators determine that clean-up techniques may cause net environmental harm, recovery results can be variable. In the absence of clean up, recovery is influenced by the type and severity of effects on aquatic plants, magnitude of the area affected, the type of aquatic plant community, and other environmental factors (e.g., water flow, water quality, time of year.).

***Enbridge Line 4 Cohasset, Minnesota**: In 2002, an underground pipeline located west of Cohasset, Minnesota, ruptured and released approximately 6,000 barrels of crude oil in a large wetland complex (NTSB 2004). Because of concerns that the oil contamination would spread with forecasted rain, the decision was made to burn the oil in place (NTSB 2004). After the vegetation in and adjacent to the release site was burned, temporary mat roads were constructed to allow access for heavy equipment.*

Approximately 11 acres of wetlands were affected by the initial crude oil release and remediation activities. Following remediation, wetland restoration efforts included reestablishing site topography and vegetation. As of 2005, the affected site was a mix of emergent vegetation and open water habitat. Although the site was dominated by cattails, other species such as broad-leaved arrowhead (Sagittaria latifolia), water plantain (Alisma subcordatus), duckweed (Lemna minor), sedges, and rushes also were becoming established.

***Canadian National Railway Company, Wabamun Lake Oil Release, Alberta**: On August 3, 2005, approximately 4,400 barrels of heated Bunker C Oil and 554 barrels of pole treating oil were released as a result of a Canadian National Railway Company train derailment near Wabumun Lake, Alberta, Canada. Wabumun Lake is approximately 32 square miles in size and supports extensive beds of bulrush and cattails along its shoreline and in shallow areas.*

The railway company did not respond promptly to the release, did not have an emergency response plan, and their clean-up efforts were not highly effective. They eventually pleaded guilty to failing to take reasonable measures to confine, clean up, and remedy the release.

As the Bunker C and pole treating oils flowed overland toward the lake, the oils adsorbed to sediment and vegetative debris, and combined with water. The resulting oil-sediment-matter mixture was more dense than the initial oil that sank in water (Hollebone et al. 2011). The authors also noted the oil-sediment-vegetable matter conglomeration was 500 to 50,000 times more viscous than Bunker C Oil, which greatly reduced the possibility of the oil breaking into smaller particles (Hoolebone et al. 2011). Strong winds and wave action transported the oil-sediment-vegetative debris mixture across the lake, forming neutrally and negatively buoyant tar balls[33].

[33] Bunker C Oil is extremely heavy and viscous. Therefore, formation of neutrally and negatively buoyant tar balls and emulsions is more likely than with other crude oils.

Not long after the initial release, submerged tar balls were seen along the shoreline and in shallow water, as well as dispersed among the emergent shoreline vegetation (Hollebone et al. 2011). Some of the submerged oil-sediment-vegetative matter mixtures formed relatively large mats and logs. Tar balls on and around the vegetation continued to move laterally in the water column and release oil during the course of their movements. Those tar balls in contact with and adhering to shoreline vegetation continued to release oil. In February 2007, tar balls were still observed within shoreline vegetation and adhering to roots of shoreline vegetation (Hollebone et al. 2011).

The shoreline of Wabamun Lake is dominated by softstem bulrush (Schoenoplectus tabernaemontani) and broad-leaf cattail (Typha latifolia) (Wernick et al. 2009). Much of the oil became trapped in the softstem bulrush beds along the lakeshore. During clean-up efforts, the oiled softstem bulrush was cut manually or with mechanical weed cutters. The sediments were then flushed and/or vacuumed (Thormann and Bayley 2008; Wernick et al. 2009). In general, areas that were accessible from shore were cut manually. Those areas inaccessible from shore and considered to be particularly sensitive to disturbance were cut primarily using reed cutters (Thormann and Bayley 2008).

In post-release studies that followed the softstem bulrush beds, it was determined that the oil itself did not negatively affect the species, but clean-up efforts did have a substantial negative effect on rhizome density and biomass. Based on study results, it appeared that the oil had no measurable negative long-term effects on the biomass, cover, height, or seedhead production of the softstem bulrush (Thormann and Bayley 2008).

In general, monitoring sites with shallower water depth, regardless of the degree of oiling or intensity of treatment, had a greater biomass of softstem bulrush. The difference in biomass in shallower water likely could be attributed to increased rates of seed germination, seedling growth, and rhizome survival and re-growth (Thormann and Bayley 2008). The researchers also concluded that the richness and cover of submerged aquatic vegetation was not affected by the release or subsequent clean-up treatments (Thormann and Bayley 2008).

8.3.7.1.2 Factors Affecting Recovery of Aquatic Vegetation

Aquatic vegetation can recover from crude oil releases. Species that reproduce quickly with numerous offspring can recover quickly once clean-up has occurred. Aquatic plants that use rhizomes to reproduce also can recover quickly, provided that the root zone is not overly disturbed and the clean-up occurs prior to substantial toxicological effects to the roots. Crude oil releases occurring during a season when vegetation is dormant, when there is less biological activity and less leaf surface area, may recover more quickly than a release during the active growth period (Michel and Rutherford 2013; Pezeshki et al. 2000).

Remediation of heavily oiled vegetation that focuses on vegetation removal with minimal root disturbance (e.g., cutting and removal of vegetative matter above the water surface without disturbing the root zone) can accelerate recovery (Hemmings et al. 2015; Hoff et al. 1993; Thormann and Bayley 2008). The removal of existing natural seed banks and disturbance of root masses delay the re-establishment of vegetation or potentially expose a natural community to invasive species (Rood and Hillman 2013).

Properly employed use of low-pressure flushing and vacuuming of residual crude oil can be effective remediation techniques. Natural flushing by stream flows, waves, or tides can benefit the recovery of vegetation (ESRD 2012; Michel and Rutherford 2013).

Under certain circumstances, natural attenuation may be an available remediation strategy, particularly in areas sensitive to disturbance. Natural attenuation of crude oil includes the physical weathering of oil by evaporation, photodegradation, and dispersion, as well as biodegradation of oil by bacteria. Natural attenuation can be an effective approach in areas with light to moderate oiling, where clean-up activities have removed the bulk of the released product, or where clean-up activities are likely to result in greater environmental harm than allowing natural attenuation to occur (ESRD 2012; Hemmings et al. 2015).

Previous releases have shown that recovery may be slower than expected under certain circumstances. High release volumes that cause substantial dieback of large areas of vegetation can delay recovery due to reduced asexual reproduction and distance to unaffected seed sources (Michel and Rutherford 2013). Clean-up activities, including use of heavy equipment, that inadvertently damage root masses and remove aquatic sediments, can also delay recovery (Thormann and Bayley 2008; Wernick et al. 2009; USFWS et al. 2005; Hoff et al. 1993). Incomplete clean up in heavily oiled areas, especially when the vegetation has been heavily coated and root masses are affected, also can delay recovery (Michel and Rutherford 2013; Corn and Copeland 2010).

8.3.7.1.3 Summary of Aquatic Vegetation Recovery

Effects to aquatic vegetation communities from a crude oil release can subsequently affect the functions they support, including wildlife and fisheries habitat, shoreline stabilization, and water quality. Depending on the resistance and resiliency of the aquatic plants, some species may show little or no response to crude oil while others die back, at least temporarily, or show other signs of stress or impairment. The effects to and recovery of aquatic vegetation following an oil release vary, depending on the type and amount of product released, type and intensity of response activities, time of year relative to plant dormancy, weather conditions, aquatic sediment characteristics, and vegetation type.

There is a limited amount of information about the effects and recovery of freshwater aquatic vegetation from crude oil releases compared to marine releases. The information that is available shows that the type and intensity of remediation efforts does have a strong influence on the subsequent recovery of affected vegetation communities. While vegetation communities

can recover through natural attenuation following some releases, remedial action is often needed to prevent further spread of the released crude oil, and reduce additional contamination of the environment.

Recovery of vegetation from a crude oil release is contingent upon many factors, some of which cannot necessarily be anticipated at the time of the release or during the subsequent remedial efforts. The information from the case studies and general restoration literature suggest that the greater the intensity and extent of disturbance resulting from a crude oil release, response, and remediation activities, the longer it will take aquatic vegetation to recover. This includes recovery of the aquatic vegetation and the functional capacity of the community. Overall, the case studies and other literature demonstrate aquatic vegetation can recover, provided remediation techniques appropriate to the circumstances are used.

8.3.7.2 Benthic Macroinvertebrates

Aquatic invertebrates are an assemblage of taxa that live at least part of their life cycle in an aquatic habitat. Benthic macroinvertebrates are further defined as those individuals living in or on bottom substrate and that are large enough to be seen without magnification. In freshwater environments, the main taxonomic groups of benthic macroinvertebrates include insects, annelid worms, mollusks, flatworms, and crustaceans. These macroinvertebrates can be found on a variety of benthic substrates from soft sediments to large rocky substrate, submerged woody debris, aquatic vegetation, and root masses (Klemm et al. 1990).

Macroinvertebrates have a number of important roles in aquatic food webs, including the digestion of organic material and recycling of nutrients. They serve as a conduit of energy flow from organic matter to vertebrate populations (Madsen and Nightengale 2009). This energy transfer is critical for smaller forested stream ecosystems that may derive the majority of their energy budgets from terrestrial sources such as leaf and needle litter (Allan and Castillo 1995; Vannote et al. 1980). Although benthic macroinvertebrates themselves have little commercial value, they are an important food source for recreational and commercial fish species.

Benthic macroinvertebrates are widely used for monitoring the ecological health of aquatic ecosystems, including effects and recovery from crude oil releases. The merits of these organisms as test subjects include ease of sampling and identification, high site fidelity, sessile life stages, complex life cycles, variable positions in the food web, relatively high abundance in most aquatic habitats, variable susceptibility to environmental stressors, and importance as a food source for commercial and recreational fish species (Barbour et al. 1999). Macroinvertebrate data are regularly collected by federal and state agencies as a measure of waterbody health and these data can provide a robust record of waterbody status over time.

8.3.7.2.1 Recovery of Benthic Macroinvertebrates Following a Crude Oil Release

Recovery of macroinvertebrate communities can be influenced by many factors, including the type of habitat(s) affected by a release, species life history (reproductive strategy, life stage,

habitat preferences), sensitivity of the species, and timing of the incident in relation to these factors.

Benthic macroinvertebrates recolonize affected stream or riverine environments by four main routes: downstream drift, upstream migration, migration from within the substrate, and aerial sources including oviposition (egg laying). Williams and Hynes (1976) studied these recolonization mechanisms in an Ontario stream and found that 4.1% of recolonization was from drift, 28.2% was from aerial sources, 19.1% was from migration from substrate, and 18.2% was from upstream migration. This study illustrates the importance of all methods of recolonization for macroinvertebrates and the potential influence of season, flow, and life history on recolonization. Other studies also report drift as the most important mechanism of recolonization, although the other mechanisms are usually not studied (Wallace 1990). Wallace (1990) also reports that drift may be less important than aerial sources for small streams where there is less of an upstream source of colonists and that headwater taxa generally have lower drift rates than those in larger streams.

Wallace (1990) defines macroinvertebrate recovery as "the reestablishment of community structure to within the range expected over the annual cycle within a particular habitat prior to the initial disturbance." Studies on recovery of macroinvertebrates need to take into account that aquatic environments are dynamic systems and there is little long-term evidence to suggest that benthic macroinvertebrate communities approach equilibrium conditions (Wallace 1990).

The case studies described below followed recovery of benthic macroinvertebrates from oil releases. These case studies are primarily from lotic (streams and rivers) habitats because there is little available macroinvertebrate recovery literature from oil releases in lentic (ponds and lakes) habitats. Impoundments, pools, and backwaters in lotic systems can have similar habitat features and communities to lentic systems and some of the same factors influencing recovery may apply.

The number of incidents with freshwater aquatic invertebrate recovery information from petroleum releases within the geographic region most similar to Minnesota was limited. Therefore, these case studies include incidents from a broader temperate region of North America. Stantec et al. (2012a) and Enbridge (2015) provide additional descriptions of some of these macroinvertebrate case studies, including incident details and recovery information specific to the scope and objectives of their analysis.

A common theme in the evaluation of recovery of macroinvertebrate populations and communities is the importance of one or more reference sites. Macroinvertebrate communities are typically diverse, complex, and subject to a high degree of variability. Therefore, the selection of an appropriate reference site with similar flow and habitats to the affected sites is an important aspect for making a recovery determination. When reference sites do not meet these criteria, the confirmation of recovery can be confounded.

For similar reasons, studies should rely on multiple metrics to determine if recovery of the macroinvertebrate community is occurring. Due to high natural variability, reliance on a single metric is much less reliable than a weight-of-evidence approach.

> ***Ozark Pipeline System, Asher Creek, Missouri**: This incident occurred in August 1979 when a 22 inch diameter pipeline constructed in 1949 ruptured along its longitudinal seam, releasing approximately 9,520 barrels of crude oil into Asher Creek in southwest Missouri. Asher Creek is a small stream with low flows that limited the dispersal and dispersion of the large volume release of crude oil. The benthic macroinvertebrate community was sampled for 18 months after the event (Crunkilton and Duchrow 1990). This study followed macroinvertebrate density, diversity, and the number of taxa of mayfly (Ephemeroptera) and stonefly (Plecoptera) over time.*
>
> *Initial sampling found that the site directly downstream of the release site was most affected. The study monitored species density, diversity, and mayfly/stonefly taxa over time and compared these community metrics with reference site metrics. Recovery occurred within nine months, and the re-colonization of affected stream reaches included organisms normally associated with unpolluted waters. A drought in August and September (about one year after the incident) caused macroinvertebrate metrics to decline, but diversity and mayfly/stonefly taxa rebounded approximately six months later following increased flows. Similar trends were seen in reference sites indicating recovery at the affected stream sites. It should be noted that additional environmental stressors were likely affecting aquatic macroinvertebrates within the region. For 11 months after the release, species diversity indices and the number of mayfly/stonefly taxa in reference sites were less than the minimum values established for unpolluted Missouri streams (Crunkilton and Duchrow 1990).*
>
> *Factors impeding recovery time included: 1) the additional stress of warm summer temperatures and low flows, 2) the large volume of the crude oil compared to the volume of the creek at the time of the incident, and 3) the origination of the creek from a spring only 0.4 miles upstream of the release site, which limited the abundance and diversity of upstream macroinvertebrates available for re-colonization.*
>
> *The primary contributing factor accelerating recovery was the scouring spring floods, which the authors believe flushed residual crude oil from the area and promoted additional species recruitment. Consistent spring flows and numerous riffles in the creek also promoted recovery by increasing turbulence and maintaining dissolved oxygen concentrations near saturation levels, both of which helped weather and degrade the released oil.*

This study also found that siphon dams and absorbent materials used in the emergency response phase retained floating, insoluble oil fractions and were valuable in protecting stream substrate in downstream areas. Areas protected from oil inundation below these dams recovered faster than unprotected areas.

Tennessee Experimental Pond Trials: *Experimental trials in Tennessee ponds were undertaken to quantify effects of oil releases on macroinvertebrates. The trials were conducted for four months starting with the addition of synthetic crude oil in July 1981 (Cushman and Goyert 1984). Different levels (i.e., 0.375, 0.075, 0.015 ppm) of synthetic crude oil were applied to the ponds to examine effects on and recovery of the macroinvertebrate community. Recovery in the species diversity, number of taxa, and total abundance were apparent three months following the application. An increase in the numbers of some chemical-tolerant species was also observed at some treatment levels. Macrophytes (aquatic vegetation, excluding photosynthetic algae and plankton) were found to mediate some effects on macroinvertebrates at lower treatment levels (e.g., 0.015 ppm).*

Laurel Pipe Line Company, Roaring Run and Howell's Run, Pennsylvania*: On October 16, 1982, a pipeline released approximately 1,310 barrels of -kerosene by Laurel Pipe Line Company into Roaring Run and Howell's Run near Ebensburg, Pennsylvania (Guiney et al. 1987). Clean-up operations recovered approximately 66% of the kerosene within the first 2 weeks. Acute effects included large reductions of macroinvertebrates in the reaches of both creeks.*

The study was initiated within one month of the incident and followed the macroinvertebrate recovery for over a year. Sampling indicated recovery of the macroinvertebrate community had begun by the following spring and, after a year, recovery was nearly complete with a high species diversity index.

Major factors that accelerated the recolonization process in the streams in this case study included the immediate and effective clean-up activities, uncontaminated flow from upstream of the release site that aided in dilution, and the drift of benthic organisms from upstream areas for recolonization. Recovery was delayed in some of the upstream sites directly below the release due to drought conditions. Sediment hydrocarbons were elevated for up to 14 months after the incident and authors reported these elevated concentrations could have slowed recolonization. However, after 21 months, no additional kerosene hydrocarbons were detected. The authors concluded that "Biological recovery appeared complete after only 12 months."

Yellowstone Pipeline Company, Wolf Lodge Creek, Idaho: *This incident occurred on June 4, 1983, when a Yellowstone Pipeline Company pipeline released approximately 595 barrels of unleaded gasoline into Wolf Lodge Creek, Idaho (Pontasch and Brusven 1988). Macroinvertebrate sampling sites were set up in riffle stream sections following the incident, with riffles sampled 17 days post-release and then at weekly and monthly intervals for 16 months.*

Although there were immediate effects from the release on the creek's macroinvertebrate community, community metrics documented a progression of recovery with time. Macroinvertebrate densities at the impact sites were not significantly different than reference sites 7 months after the release, and species richness was not significantly different after 16 months. The study also found that macroinvertebrates with higher drift densities, like mayflies and chironomids, rapidly recolonized the impact sites while stoneflies and caddisflies with low drift densities colonized more gradually. A bulldozer was used to agitate stream bed sediments to release hydrocarbons one month after the incident, but it is unclear from this study what additional effects this clean-up technique had on the macroinvertebrate community.

Shell Oil Company, Gasconade River, Missouri*: A Shell Oil Company pipeline released approximately 20,760 barrels of crude oil into Shoal Creek, a tributary of the Gasconade River near Vienna, Missouri on December 24, 1988. Clean-up operations occurred between December 1988 and January 1989 consisting of absorbent booms, surface oil removal, and pumping from backwater areas. Macroinvertebrate sampling occurred in July and October 1989, and in January, March, and June of 1990. Macroinvertebrate sampling occurred in both riffle and backwater areas of the Gasconade River during the two summers after the incident (Poulton et al. 1997).*

In riffle habitats, the study found that the total number of organisms; taxa richness; number of mayfly (Ephemeroptera spp.), stonefly (Plecoptera spp.), and caddisfly (Trichoptera spp.) (EPT) taxa; and EPT/Chironomidae ratio had recovered to reference levels after seven months. Authors noted that spring floods reduced the abundance and diversity of macroinvertebrates at both reference and impact areas, and the high flows and scouring may have contributed to subsequent recovery in riffle habitats. The flows in the riffle habitats contributed to weathering and flushing of oil residue, allowing more rapid colonization and faster recovery in these habitats.

In contrast, benthic diversity and the scrapers and shredders functional feeding groups in the backwater areas remained diminished until the end of the study at 18 months post-release. These backwater areas would have experienced far less scouring from high stream flows. Authors attribute the slower recovery of benthic

invertebrates in backwater areas to residual hydrocarbon contamination, despite an overall decline in hydrocarbon levels during the study period.

***Amoco, Chariton River, Missouri**: On November 5, 1990, a pipeline owned by Amoco released approximately 2,620 barrels of crude oil into a small tributary and then into the Chariton River near Ethel, Missouri. One month after the release, the abundance and taxa richness of collector and shredder functional groups and taxa richness of EPT from control and impact sites differed significantly indicating crude oil had affected the macroinvertebrate community.*

After one year, differences between impact and reference sites were no longer statistically significant with the exception of slightly lower taxa richness and overall abundance in the impact areas. The recovery of certain macroinvertebrates (i.e., filtering collectors) downstream of the oil release and the changes in a downstream community metric between sampling periods also suggested partial recovery after one year. The authors state that the effects to benthic biota observed after the release appeared to be associated with oil sorption and substrate coating, creating conditions unsuitable for successful colonization.

***Yellowstone Pipeline Company and Conoco, Flathead Reservation, Montana**: The Yellowstone Pipeline released approximately 100 barrels of refined fuel into Camas Creek on the Flathead Reservation in Sanders County, Montana in the winter of 1993.*

Macroinvertebrates were severely affected as a result of direct and indirect toxicity and the diversion of the stream channel during clean-up activities, which resulted in reduced flows at sampling stations downstream of the release. The affected area was characterized by low EPT taxa abundance and richness.

The benthic community underwent progressive spatial recovery. Fifteen months after the incident, the taxa richness and EPT Index at the site closest to the release site approached levels observed at the upstream reference site. Sites farther downstream exhibited only partial recovery after 15 months, but authors noted that based on the observed recovery rate, the benthic community in the affected reach would likely recover (Van Derveer et al. 1995).

***Consolidated Railways, Train Derailment, Cayuga Inlet, New York**: This release occurred on November 3, 1997, when a Consolidated Railways train derailed and released 167 barrels of diesel fuel into the Cayuga Inlet stream near West Danby, New York. Aquatic macroinvertebrate sampling occurred for 15 months after the derailment (Lytle and Peckarsky 2001).*

Researchers measured various macroinvertebrate community metrics and documented recovery during the 15-month study period. The authors concluded that the initial effects on benthic macroinvertebrates during the first 3 months were severe and that these effects extended up to 3.1 miles downstream. Despite the initial severity of the effects, macroinvertebrate density and taxonomic richness recovered within a year (Lytle and Peckarsky 2001).

The 15-month study period was not considered long enough to document full recovery for all community metrics because some sample sites immediately below the release site were dominated by a single taxa. The researchers speculated that the recovery time was potentially prolonged by lingering contamination during the initial colonization period and by the winter conditions that followed. Colonization from downstream macroinvertebrate drift and aerial recolonization of adults was mostly limited to the growing season following the incident (Lytle and Peckarsky 2001).

***Olympic Pipeline Company, Whatcom Creek, Washington**: On June 10, 1999, the Olympic Pipeline released approximately 5,640 barrels of unleaded gasoline into Hannah Creek that subsequently flowed into Whatcom Creek in Bellingham, Washington (Madsen and Nightengale 2009). The gasoline was ignited, causing a fire that burned over 26 acres of riparian trees and vegetation. Aquatic life in a 3-mile stretch of Whatcom Creek was affected. The fuel release and subsequent fire had direct and indirect effects on the water quality of Whatcom Creek, including: 1) the direct effects from the fuel release (introduction of PAHs); and 2) the indirect effects from the burn that resulted in reduced shade (resulting in increased temperatures and decreased dissolved oxygen) and reduced ground cover adjacent to Whatcom Creek (resulting in increased sediment loading, fecal coliform, and other pollutants).*

Following clean-up, a number of restoration projects were implemented to restore stream habitat that was affected by the fuel release and subsequent runoff from burned areas. Macroinvertebrates were monitored for five years after the incident and again in 2007 (eight years after the incident) to assess recolonization and recovery. Sampling seven days after the release and associated fire showed almost complete loss of the macroinvertebrate community, but after four months, macroinvertebrates had rapidly populated sampling sites. Initial colonizers were mayfly species that tend to be more tolerant of poor water quality conditions than other aquatic invertebrates. Fourteen months after the incident, community metrics for benthic invertebrates (e.g., taxa richness, B-IBI scores, presence of stonefly taxa, EPT taxa richness) in Whatcom Creek had returned to pre-event levels at most sites.

***Enbridge Line 6B Marshall, Michigan**: In July 2010, a pipeline released approximately 20,000 barrels of diluted bitumen oil into Talmadge Creek that subsequently flowed into the Kalamazoo River near Marshall, Michigan. Clean-up efforts began almost immediately, including installing oil sorbent and containment booms and using oil skimmers and vacuum trucks to recover the oil. By August 2010, clean-up efforts included excavation and removal of contaminated soil, sediment, vegetation, and debris. Recovery of submerged oil included more active methods such as sediment agitation, sediment traps, and sheen management (USFWS et al. 2015a).*

Following the release, the MI DEQ conducted standard macroinvertebrate surveys in September 2010 with subsequent surveys in 2011, 2012, 2013, and 2014 to examine effects and recovery. A final synthesis of data will be prepared by MI DEQ following surveys in 2015 and 2016.

The survey methods followed MI DEQ Procedure 51 (MI DEQ 2008), which is a rapid, qualitative biological and habitat survey for assessing resource status in wadeable streams and rivers. Procedure 51 preferentially samples gravel, cobble, and boulder substrates in riffle/run habitats, but other lower flow habitats may also be sampled. Metrics used in this procedure include total number of taxa, total number of mayfly taxa, total number of caddisfly taxa, total number of stonefly taxa, percent mayfly composition, percent caddisfly composition, percent contribution of the dominant taxa, percent composition of isopods, snails, and leeches, and percent surface dependent macroinvertebrates (MI DEQ 2008). These individual metrics are used to calculate a total community score for a site, which falls into one of three community ratings defined in Procedure 51 guidance: "Excellent," "Acceptable," and "Poor."

Following the 2010 survey, MI DEQ found that both abundance and diversity of macroinvertebrates were affected by the release and by the associated clean-up activities (Walterhouse 2011). Data from 2011 and 2012 surveys showed that most of the Procedure 51 community scores were increasing for the Kalamazoo River sites. The one exception was the control site where the score decreased slightly due to a lack of stoneflies in 2012. Results for Talmadge Creek also showed improvement post-2010. The total number of taxa at the affected sites in the Kalamazoo River and Talmadge Creek increased over time, with most sites returning to near baseline conditions by 2012 (Matousek 2013; Walterhouse 2012). Matousek (2013) noted a shift in species composition at Talmadge Creek compared to upstream control site due to the presence of more open habitat following response activities that was attributed to the removed trees and shrubs and thereby allowed more sunlight to reach the stream by opening the vegetative canopy. Based on initial survey data in the Final DARP, the NRDA Trustees conclude: "After showing initial impacts, the data generally indicate

trends toward recovery with trends interrupted during periods when additional oil recovery efforts occurred" (USFWS et al. 2015).

Enbridge also evaluated potential chronic effects of residual oil in the Kalamazoo River using a weight-of-evidence SQT approach (Enbridge 2014). The sediment quality triad approach included assessment of benthic macroinvertebrate field samples, sediment chemistry, and bioassays to assess sediment contamination from areas where effects were expected based on poling and depositional setting.

The study found that taxa richness and diversity in affected areas of the Kalamazoo River were not different from upstream reference locations. Density was lower in the affected areas, but this result may have been confounded by sandier substrate conditions at reference sites compared to affected sites. Incorporation of the sediment chemistry and toxicity data from the SQT approach also showed no discernible pattern between the observed and predicted sediment toxicity and the benthic community indices, suggesting recovery to pre-event conditions is well advanced. Benthic invertebrate density was not correlated with predicted PAH toxicity. Biodiversity was not affected by the release.

Enbridge (2014) also evaluated the Procedure 51 data collected through 2012 by MI DEQ. Based on their review, it was concluded that it was not possible to detect effects of the release conclusively in the Procedure 51 evaluations and, by 2011, the community ratings were consistent with pre-release conditions. These conclusions were supported by: 1) highest quality macroinvertebrate community being present at the impact site closest to the release site; 2) lowest score of all sampled stations in 2012 being located at the reference site; and 3) the lower scores being located at the site furthest from the release site in an area of poor habitat where there were potential additional effects from the Battle Creek wastewater treatment plant and other system stressors.

8.3.7.2.2 Factors Affecting Recovery

The rate of recovery of aquatic macroinvertebrate populations and communities is governed by multiple factors including the resistance and resiliency of the species, including the presence of nearby macroinvertebrate populations that can help recolonize the affected area; time of year that the release occurs; the volume released and the type of petroleum product released; water movement through the physical habitat (e.g., lentic versus lotic system, riffles versus backwaters, flushing flows); other environmental stressors; and the speed and efficacy of clean up.

After a crude oil release, macroinvertebrate communities closest to the release recovered faster than less affected areas downstream because they are closest to unaffected upstream reaches

of the stream or river that are a source of recolonization by drift (Enbridge 2014; Van Derveer et al. 1995). Headwaters streams with minimal upstream macroinvertebrate habitat to contribute to recolonization by drift may be slower to recover (Crunkilton and Duchrow 1990). Macroinvertebrates that have higher drift densities, like mayflies and chironomids, rapidly recolonize affected sites (Guiney et al. 1987; Pontasch and Brusven 1988).

Timing of the release in relation to typical macroinvertebrate colonization periods may affect recovery. If a release occurs during or after the species' dispersal period, macroinvertebrates may not recolonize the affected area until the following season, thereby delaying recovery (Lytle and Peckarsky 2001; Poulton et al. 1997).

In general, aquatic macroinvertebrates recover more quickly from small scale events that are not persistent in the environment and that do not substantially disrupt the physical habitat. Consequently, the speed and efficacy of containment and use of appropriate clean-up activities can limit the spatial extent of a release and its effects, and facilitate recovery of the aquatic macroinvertebrate communities. The use of absorbent booms and dams enhances recovery and reduces the amount of crude oil that is available to weathering, thereby limiting the potential for submerged crude oil and associated effects to sediments and accelerating recovery (Crunkilton and Duchrow 1990). A large volume of crude oil in relation to stream volume can increase recovery time (Crunkilton and Duchrow 1990).

The physical action and dilution caused by swift flowing waters help disperse crude oil from aquatic habitats and can accelerate weathering of released oil. Flows from upstream areas also provide a source of benthic colonizers via downstream drift that enhances macroinvertebrate recruitment (Crunkilton and Duchrow 1990; Guiney et al. 1987; Poulton et al. 1997). Riffle areas of streams and rivers recover faster than slower flowing or backwater areas because greater flows in riffles provide oxygen to degrade crude oil and contribute to flushing, allowing for faster recolonization time (Crunkilton and Duchrow 1990; Poulton et al. 1997).

It is important to have one or more reference sites when evaluating recovery since confounding environmental factors which are independent of the release event, can facilitate or slow recovery. Environmental stressors such as low flows and high summer temperatures can delay recovery (Crunkilton and Duchrow 1990; Guiney et al. 1987). Anthropogenic environmental stressors (e.g., altered flow regime, habitat alterations) unrelated to the release may further impede recovery (Enbridge 2015). Changes in stream habitat due to removal of riparian vegetation during the response to a release or subsequent clean-up activities may influence macroinvertebrate abundance, species composition, and subsequent recovery (Matousek 2013).

Recovery of macroinvertebrates may also be impaired by persistence of crude oil or anthropogenic actors. For example, substrate oiling or residual hydrocarbon contamination in sediment may slow recovery (Guiney et al. 1987; Poulton et al. 1998). This includes slow flowing or

backwater areas that contain finer sediment with residual contamination that does not weather as quickly as riffle areas (Crunkilton and Duchrow 1990; Poulton et al. 1997).

8.3.7.2.3 Benthic Macroinvertebrate Summary

Aquatic macroinvertebrates represent an extremely diverse range of organisms that fulfill many critical ecological functions within the aquatic environment. Benthic macroinvertebrates are important components of aquatic food webs and are prey items for recreationally and commercially important fish species. Macroinvertebrates are often used to monitor the ecological health of aquatic ecosystems, including effects and recovery from crude oil releases.

Effects to macroinvertebrate communities following a release can be substantial and include physical oiling and smothering of organisms, acute or chronic toxicity to organisms, and altering essential habitat by both the release and subsequent clean-up activities. Recovery of benthic macroinvertebrates from these effects is well documented in freshwater lotic environments across a wide geographic area. While macroinvertebrate recovery from lentic systems (e.g., lakes, ponds) is not as well documented, the case study from the Tennessee pond trials demonstrates that macroinvertebrates do recover from crude oil releases.

In streams and rivers, time to recovery varies with watercourse size and habitat type. Recolonization usually begins soon after the release with full or substantial recovery often within one year. Recolonization occurs through a combination of downstream drift, upstream migration, migration from within the substrate, and aerial sources. The initial extent of effects to macroinvertebrate and subsequent recovery is strongly related to the magnitude of the release volume compared with the volume of the receiving waterbody. Smaller streams that receive high volume releases experience both a greater effect and longer recovery time.

The primary factors accelerating recovery include utilization of clean-up techniques that minimize crude oil penetration into substrates, dilution and degradation of oil by higher flows, and the recruitment of individuals from adjacent unaffected reaches. Recovery may be impeded by the presence of residual crude oil, habitat alterations, and environmental stressors such as low flow and drought conditions that may occur during the recovery process. The selection of an appropriate reference site with similar flow and habitats to the affected sites is an important aspect for making a recovery determination. Given the inherent variability of macroinvertebrates and sensitivity to other environmental stressors that can confound results, multiple reference sites may assist with the confirmation of recovery.

8.3.7.3 Fish and Fish Habitat

Freshwater fish spend the majority of their life cycle in freshwater streams, rivers, ponds, and lakes. These fish occupy many trophic levels within a food web and are often the top predators in freshwater systems. They are an important food source for semi-aquatic mammals such as river otter (*Lontra canadensis*) and American mink (*Neovison vison*); wading birds and waterfowl such as great blue heron (*Ardea herodias*) and common merganser (*Mergus merganser*); and

raptors such as osprey (*Pandion haliaetus*) and American bald eagle. Recreational freshwater fishing is a multi-billion dollar industry in North America and traditional fisheries have been (and remain) an important food source for native people.

Freshwater fish are often used as indicators of the health of a waterbody (Karr 1981). Fish surveys are often used to assess both effects and recovery from disturbance (Klemm 1993; Simon 1999). The advantages of using fish for biomonitoring include:

- Longer life span of fish compared to macroinvertebrates allows for improved monitoring for potential long-term effects
- Fish occupy multiple positions in the aquatic food web, and a fish assemblage usually incorporates omnivores, herbivores, insectivores, planktivores, and piscivores, allowing for monitoring across multiple trophic levels
- Fish are relatively easy to collect and identify and can be released unharmed
- Life history traits and environmental requirements of most fish species are relatively well known
- Many fish are important recreational and commercial species (Barbour et al. 1999)
- Fish can be one of the more sensitive indicators of water quality (Klemm 1993)

Fish community data are regularly collected by federal and state agencies as a measure of waterbody health and these data can provide a robust record of waterbody status over time. Standard protocols for fish collection exist in many states and are often based on the USEPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999). Collected fish are typically identified and counted, and analyses of data are used to determine population and community metrics such as abundance, diversity, species composition and dominance, indicator species, and similarity indices.

National PHMSA pipeline incident data[34] show that approximately 1.2% of releases affect fish[35] (PHMSA 2016).

8.3.7.3.1 Recovery of Fish and Fish Habitat Following a Crude Oil Release

Similar to the recovery of benthic macroinvertebrates, recovery of fish communities can be influenced by many factors including the sensitivity to petroleum hydrocarbons; species life history (reproductive strategy, life stage, habitat preferences); presence of nearby unaffected populations from which recruitment can occur; types of habitats affected by a release; timing of a release in relation to these other factors; and the speed and efficacy of clean-up activities.

[34] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[35] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

Fish differ in their sensitivities to petroleum hydrocarbons. Salmonids, including trout, salmon, and whitefish, are among the most sensitive aquatic species. Because of this known sensitivity, trout larvae, the most sensitive life stage, are often used to evaluate water quality. Life history traits can also affect both exposure and recovery. Kubach et al. (2011) speculated that the slower observed recovery time for species such as flat bullhead (*Ameiurus platycephalus*) and northern hogsucker (*Hypentelium nigricans*) following a release was due to relatively slow growth and longer time to reproductive maturity for these species.

The presence of nearby unaffected fish populations either upstream or downstream of an affected area can facilitate recovery. Where fish populations have been reduced by a petroleum release or associated clean-up activities, these areas can be recolonized quickly through the downstream and upstream migration of fish from unaffected areas. Unaffected tributaries adjacent to release sites also can be an important refuge for fish and a pathway for recolonization (Kubach et al. 2011). Habitat fragmentation disrupts the ability of fish to easily move between areas of suitable habitat and this loss of habitat connectivity can impede recruitment into affected areas. Kuback et al. (2011) found that less fragmented streams recovered faster than fragmented streams and rivers. Another process to facilitate recovery is through fish stocking (Guiney et al. 1987).

Recovery determinations are complicated by the availability of suitable reference habitats for comparison to the impact sites (USFWS et al. 2015a). Without suitable reference sites to account for natural variability and confounding environmental factors, it can be difficult to clearly ascertain whether full recovery has occurred.

The following case studies have been selected as examples of fish and fish habitat recovery from crude oil releases and describe time to recovery and influences of oil release characteristics and environmental conditions on effects and subsequent recovery. As noted earlier, the number of releases with recovery information within the geographic region most similar to Minnesota was limited. Therefore, these case studies include releases from other similar temperate regions of North America. Additional descriptions of some of these releases as case studies for fish and fish habitat can be found in Stantec et al. (2012a) and Enbridge (2015).

With the exception of Lake Wabamun, these case studies are from lotic (flowing water) habitats because there is little available literature from lentic (stationary water) habitats. Nevertheless, impoundments, pools, and backwaters in lotic systems can have similar habitat features and communities to lentic systems and share some of the same factors influencing recovery.

> ***Laurel Pipe Line Company, Roaring Run and Howell's Run, Pennsylvania****: On October 16, 1982, a pipeline released approximately 1,310 barrels of kerosene by Laurel Pipe Line Company into Roaring Run and Howell's Run near Ebensburg, Pennsylvania (Guiney et al. 1987). Following the release, a fish survey by the Pennsylvania Fish Commission indicated fish populations at least four miles downstream of the release had been killed. Electrofishing surveys were initiated*

seven months after the release and again one year after the incident. Results of these surveys indicated the fish population had recovered with the reappearance of diverse assemblages and drastic increases in abundance. An abundance of young-of-the-year sunfish and minnows also indicated successful breeding was occurring.

This study found that the major factors accelerating recolonization included the immediate and effective clean-up activities; uncontaminated flow from upstream of the release site that aided in dilution; and natural recruitment of fish from unpolluted portions of the watershed. The authors concluded that "biological recovery appeared complete after only 12 months."

***Colonial Pipeline Company (Colonial), Reedy River, South Carolina**: On June 26, 1996, a Colonial pipeline released approximately 22,800 barrels of No. 2 Fuel Oil (diesel) into the Reedy River near Fork Shoals, South Carolina (Kubach et al. 2011). Approximately 94% of the released oil was recovered within 12 days of the rupture.*

Initial surveys of fish showed near complete mortality up to 23 miles downstream of the release site (Rankin et al. 1996, Glover 1996 as cited in Kubach et al. 2011). Electrofishing techniques were used from August 1996 (2 months post-release) through October 2005 (52 months post-release) to evaluate recovery of the fish community. Authors used "non-metric multidimensional scaling ordination to evaluate change in fish assemblage structure among sites, and determine the degree of recovery in assemblage structure." The results showed that by 52 months post-release, the assemblage groups in the impact and reference sites reached their greatest similarity, indicating recovery. The authors found that recovery occurred fastest at the sites closest to the release site (16 months). This was attributed to these sites being closest to undisturbed reaches upstream of the release site where fish were available for recolonization. The three sites farthest downstream from the release site were slower to recover. The slower recovery was attributed to habitat fragmentation caused by anthropogenic barriers (dams/ponds), as well as depletion of the macroinvertebrate community as a food source for fish, resulting from the diesel release.

Olympic Pipeline Company, Whatcom Creek, Washington: The Olympic pipeline incident occurred on June 10, 1999, releasing approximately 5,640 barrels of unleaded gasoline into Hannah Creek, which then flowed into Whatcom Creek in Bellingham, Washington (Madsen and Nightengale 2009). The release ignited, killing three children, and burning approximately 25 acres of riparian vegetation along the Whatcom Creek corridor (Madsen and Nightengale 2009).

After the release and resulting fire, over 100,000 dead salmon, trout, lamprey, and crayfish were documented. The stream was recovering in 2000 and 2001 with Chinook salmon (Oncorhynchus tshawytscha) spawning in the burn zone. While the number of anadromous Chinook salmon, coho salmon (Oncorhynchus kisutch), and steelhead trout returning to the creek was lower post-incident compared to pre-incident, Madsen and Nightengale (2009) presented fish stocking and return data that correlated the reductions in stocking with post-incident declines in these same fish populations. The authors concluded that the decrease in these species was attributed to reduced stocking for these species rather than the potential effects of the release and fire.

Restoration projects were conducted after the release, including restoring fish habitat. These projects included construction of backwater areas and reconfiguration of the stream channel to include large woody debris, meanders, pools, backwaters, and more complex habitats in the former channelized stream. Since the incident, more consistent flows from an upstream dam have been maintained during the spawning season, and the physical habitat and water quality have been maintained or improved by the emergency response and restoration projects. The authors concluded that, "while the fire may have temporarily reduced spawning success, it seems unlikely that it is responsible for the observed decline in adult returns."

***Advanced Fuel Filtration Systems, East Walker River, California**: This release occurred on December 30, 2000, when a tanker truck operated by Advanced Fuel Filtration Systems overturned north of Bridgeport, California and released approximately 86 barrels of No. 6 Fuel Oil into the East Walker River. Fish mortality from oil exposure was observed, with 21 dead fish were recovered during clean up. Fish surveys were conducted in the fall of 2001, approximately nine months after the event. Fish survey results were compared to results of regional annual fish surveys conducted in California and Nevada in 1999, considered to reference sites for the affected area. The survey data showed that rainbow trout, brown trout (Salmo trutta), and mountain whitefish were present in affected reaches, but fish density was below the average for reference sites and most fish captured were adults.*

The authors theorized that residual No. 6 Fuel Oil had caused toxicity to early life stages of these salmonid species, resulting in low numbers of juvenile fish (Hampton et al. 2002). Water quality data support this hypothesis. Concentrations of certain PAHs in water samples from the affected area did exceed threshold levels for trout embryo mortality for one month after the release and sub-lethal effect concentrations for at least three months after the release. After five months, PAH levels no longer exceeded effect thresholds and were not considered to pose a threat to fish.

Data from affected area were collected in 2001 and were compared to 1999 regional data. Differences in fish density and age-class structure based on spatial and temporal variation were not addressed. As this report does not include data on subsequent surveys after 2001, no additional information on the recovery of the fish population from the oil release was available.

***Canadian National Railway Company, Wabamun Lake, Alberta**: On August 3, 2005, a Canadian National railroad incident involving the release of 4,400 barrels of heated Bunker C Oil (a very high density oil) and 554 barrels of pole treating oil flowed across lawns adjacent to the railway and into Wabamun Lake. Direct mortality of fish was reported immediately following the oil release. Transportation Safety Board of Canada (TSBC 2007) reported that dead fish were observed after the release, but attributed the low fish abundance to natural causes. Birtwell (2008) argued that approximately 100 fish collected after the release died as a result of the release, although there were no toxicological tests to support this assertion.*

Fish population dynamics were not studied following the incident. However, because of concerns that a large spawning shoal used by lake whitefish (Coregonus clupeaformis) had been oiled by the release, several in situ studies were conducted that evaluated the exposure of eggs and larval fish. Studies were conducted to examine the pattern, frequency, and severity of deformities in lake whitefish and northern pike (Esox lucius) larvae incubated in situ at impact sites versus reference sites. Although the studies showed very high variability, Hodson (2008) concluded in his review of the studies that the data were sufficient to determine that the quality of the spawning habitat of whitefish and pike in Lake Wabamun was negatively affected for up to 20 months by the oil released in August 2005 (Debruyn et al. 2007; Hodson 2008; DeBruyn et al. 2009).

***Enbridge Line 6B, Marshall, Michigan**: In July 2010, a pipeline released approximately 20,000 barrels of diluted bitumen oil into Talmadge Creek and the Kalamazoo River in Marshall, Michigan. Following the release, no fish kills were observed by state biologists (Winter et al. 2012) and only 42 fish were found dead during the response effort in 2010 (USFWS et al. 2015). The Trustees concluded in the DARP that this was a negligible number of fish for this time period (USFWS et al. 2015a).*

Preliminary results from the MI DNR show that after initial reductions in fish abundance and diversity in Talmadge Creek in 2010, these metrics were recovering during subsequent surveys. Some changes in species composition were noted and may be related to changes in habitat following clean up (i.e., a wider and shallower stream with less cover). Preliminary results for the Kalamazoo River were less definitive with some reductions in smallmouth bass (Micropterus

dolomieu) in 2010, but overall results were variable across all sites and years (USFWS et al. 2015). The DARP does not offer further analysis of effects to fish or recovery for the Kalamazoo River.

8.3.7.3.2 Factors Affecting Recovery

Oiling of spawning habitat may affect fish reproduction and delay recovery (Debruyn et al. 2007; Hodson 2008). Some species (e.g., trout) may be more vulnerable to initial effects of a release, while others may be more susceptible to long-term effects because of their association with the sediment (e.g., suckers) (Goldberg 2011; Higgins 2002). Long-lived fish species with slower growth and later reproduction may take longer to recover than other species (Kubach et al. 2011).

The presence and proximity of fish for recolonization in unaffected reaches and tributaries adjacent to the release site can accelerate recovery, as can successful reproduction in the affected waterbody (Goldberg 2011; Guiney et al. 1987; Kubach et al. 2011; Madsen and Nightengale 2009). The immediate and effective clean-up of the release can reduce effects of exposure to crude oil and increases the rate of recovery (Guiney et al. 1987). Additionally, clean flows from upstream that dilute and degrade hydrocarbons can improve water quality and enhance recovery (Guiney et al. 1987).

Post-release restoration efforts and maintained flows during spawning periods can improve fish habitat in previously degraded streams and accelerate recovery (Madsen and Nightengale 2009). Stocking of fish in the affected waterbody can also promote recovery (Madsen and Nightengale 2009; Guiney et al. 1987).

The removal of woody debris and log jams during clean-up operations can negatively affect fish habitat and stream structure (Bustard and Miles 2011). Effects to stream geomorphology and riparian vegetation can influence fish assemblage structure and subsequent recovery (USFWS et al. 2015a). Natural and anthropogenic barriers to fish movement can impede fish recolonization and recovery (Kubach et al. 2011).

8.3.7.3.3 Fish and Fish Habitat Summary

Freshwater fish are important components of aquatic food webs and occupy many trophic levels, which can vary by species or life stage. Recreational freshwater fishing is a multi-billion dollar industry in North America, and traditional fisheries remain an important food source for native people. Freshwater fish are often used to monitor the ecological health of aquatic ecosystems, including effects and recovery from crude oil releases.

Effects to fish following a petroleum hydrocarbon release can be substantial and may include acute or chronic toxicity, alteration of habitat by physical oiling and habitat disturbance resulting from clean-up activities. Recovery of freshwater fish populations after a crude oil release is well documented in freshwater lotic environments. While there are fewer studies on the recovery of freshwater fish recovery in lentic systems, the case study information from Wabamun

Lake does support recovery. Lentic habitats and communities have some similarities to lotic impoundments, pools, and backwaters, and some of the same factors influencing recovery may apply.

In streams and rivers, recolonization usually begins soon after the petroleum hydrocarbon incident with substantial recovery within one year. Complete recovery of fish assemblages may take several years. Some community metrics, such as species richness, relative abundance, and ecological function, may recover more quickly while others, such as overall abundance and community similarity, may take longer.

The primary factors accelerating recovery of fish populations include immediate and effective clean up, restoration of stream habitats, natural flushing of the system, and recolonization of fish from adjacent unaffected areas. Impediments to recovery include habitat alteration resulting from the removal of riparian vegetation, woody debris and log jams, the presence of physical barriers that limit fish movement and recolonization, species life history, and oiling of spawning habitat. The selection of suitable reference areas is critical for making sound determinations of recovery as part of any recovery study.

8.3.7.4 Summary for Aquatic Biota

The recovery of an aquatic community from the effects of a crude oil release depend on the physical and chemical characteristics of the oil, the extent that the oil penetrates the substrate, size and flow characteristics of the stream, the speed and efficacy of clean up, time of year, and tolerance of stream organisms (Crunkiton and Duchrow 1990). Several studies attribute stream discharge and flushing as the major factors accelerating recolonization and recovery (Crunkilton and Duchrow 1990; Guiney et al. 1987; Lytle and Peckarsky 2001). This factor has implications for stream size with smaller streams recovering more slowly and releases occurring during low flow conditions potentially having greater effects. In addition, the timing of a release in comparison to the life history stage of affected organisms can be an important influence on initial recovery as some macroinvertebrate life stages are unable to recolonize an effected area (Lytle and Peckarsky 2001; Wallace 1990). Recovery determinations were also influenced by the suitability of reference habitats for comparison (Enbridge 2015; Matousek 2013).

8.3.8 Socio-Economics

Crude oil releases can affect people from a financial and emotional perspective. For large releases that affect a large area, local and regional economies may be affected, sometimes for an extended period. Individuals, groups, and entire communities can be affected in different ways.

While effects to emotional well-being, cultural values, sense of community, and other important human emotional values can occur, determining if recovery from these release effects occurred is subjective and difficult to quantify objectively. As a result, literature on recovery of human

emotional values is limited. Consequently, this report acknowledges this importance, but focuses on recovery of socio-economic conditions that can be more easily quantified and for which sufficient literature and case studies exist.

The majority of crude oil releases occur during maintenance activities, inside transport or storage facilities, or in locations removed from businesses and homes. These small and isolated releases are generally cleaned up without substantial socio-economic damage or inconvenience and are often reported and documented in agency databases with little public attention.

> ***Marathon, Albion, Illinois****: A Marathon pipeline release occurred on August 10, 2008, near Golden Gate in Wayne County, Illinois. The pipeline released approximately 5,000 barrels of crude oil (more than 3,260 barrels of the crude oil were recovered), affecting agricultural and forested land and some wetlands. Containment and clean-up activities commenced immediately after the release and restoration was completed within about one month (Arcadis 2011). The entire process occurred quickly and received little press coverage. The quick response and lack of concern was later attributed to the release occurring in a sparsely populated area, the lack of evacuations or fire, and the preparedness of emergency responders who had simulated a hypothetical oil release from this pipeline only a year earlier (Wells 2008b).*

Socio-economic effects that affect more than a few individuals generally occur in populated areas where people's lives and livelihoods may be affected. Releases in populated areas can cause people to evacuate their homes, disrupt social services, require a large influx of clean-up workers, and affect employment and business activity. Based on recent national incidents reported to PHMSA[36,37], approximately 24% of reported incidents have occurred within populated areas (PHMSA 2016). Evacuations occurred in 2.3% of releases with an average evacuation of 101 evacuees per incident (PHMSA 2016). Such releases can result in heightened media attention, a substantial public record, and increased research. Data gathered from these large events adds to the scientific knowledge base, can provide insight into the effects that a large-scale crude oil release can have on individuals and communities, and how efforts to address and mitigate those effects during spill response have evolved.

[36] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

[37] The majority of PHMSA reportable pipeline incidents since January 2002 are small (3 barrels or less) and almost half of the PHMSA-reported pipeline incidents occur completely within operator-owned facilities (47%). Of those releases that were not contained completely within the operator's property, the median release volume was 20 bbl, again indicating that small releases are the most common and very large releases are uncommon (PHMSA 2016).

Review of media reports, published literature, and case studies suggests that the socio-economic damages resulting from crude oil releases can be discussed within three general categories: 1) disruptions of daily life and associated economic burdens; 2) loss of use of natural resources; and 3) loss of income and commercial activity. These three categories of socio-economic effects and their recovery are examined in more detail in the following sections.

8.3.8.1 Development of Socio-Economic Spill Response Elements

In 1969, the Union Oil release in Santa Barbara showed that the U.S. lacked adequate resources to respond to releases and that federal law provided insufficient mechanisms for providing individual and public compensation for oil releases (Easton 1972; Miller 1999; Clarke and Hemphill 2002; Mai-Duc 2015). Other notable oil releases since that time include the Texaco Oklahoma off Cape Hatteras, North Carolina (1971); the Corinthos in the Delaware River near Marcus Hook, Pennsylvania (1975); the Argo Merchant off Nantucket, Massachusetts (1976); and the Hawaiian Patriot near Honolulu, Hawaii (1977). In response to these releases, as well as concerns from the general public, environmental groups and other public organizations, Congress passed a number of laws, including:

- National Oil and Hazardous Substances Pollution Contingency Plan (1968)
- Clean Water Act (1972)
- Trans-Alaska Pipeline Authorization Act (1973)
- Deep Port Act (1974)
- Outer Continent Shelf Lands Act Amendments (1978)
- Hazardous Liquid Pipeline Act (1979)

States also passed laws and oil transporters developed programs for safety and spill response preparedness, communication, and compensation.

> ***Ashland Oil, West Elizabeth, Pennsylvania****: In January 1988, Ashland Oil's storage tank near West Elizabeth, Pennsylvania collapsed during filling, releasing approximately 92,860 barrels of diesel fuel into a containment area and the Monongahela River. Ashland Chairman John Hall immediately went to the site, took responsibility for the release, and instituted an aggressive clean-up effort including open communications and outreach to affected persons and businesses. According to after-action reports, Ashland's cooperative relationship with federal officials overseeing the effort and stakeholders greatly contributed to the effectiveness of the overall response (Miklaucic and Saseen 1989; Randle and Reinhardt 2014). As a result, 77% of the people interviewed following clean up thought that Ashland had done a good to excellent job with the clean-up (Trauth et al. 1988).*
>
> *In terms of the community's socio-economic well-being, Ashland's response included providing advance payments to communities in anticipation of incurred costs and proactively attempting to contact individuals and businesses that*

might have claims. Ashland representatives noted that many individuals and businesses that could have filed a claim chose not to do so; some did not because the losses were intangible and others did not because they had simultaneously benefitted and suffered losses (Trauth et al. 1989).

***Exxon Valdez Crude Oil Release, Prince William Sound, Alaska**: Although the 1989 Exxon Valdez crude oil release in Prince William Sound, Alaska was a marine oil release, the incident marked a sentinel moment that defined public perceptions of both the effects and recovery of human and natural environments to crude oil releases. The Exxon Valdez event made it clear that the country still did not have adequate resources, planning, or compensatory mechanisms in place to address a major marine oil release. From a socio-economic perspective, Exxon's response to the release was vastly different to Ashland Oil's efforts a year earlier.*

Exxon was slow to address the release's socio-economic effects on local communities and its dealings with residents often appeared uneven and unfair. Increases in population due to the influx of emergency responders, limitations on spill response resources, inadequate communication, and discrepancies in how residents were involved in the spill response led to negative community perceptions (Impact Assessment Inc. 1990, 2001).

The negative community perceptions that developed following the Exxon Valdez release have been referred to as a "corrosive community"—a community characterized by uncertainty, ambiguity, psychological isolation, division, and a general sense of anger, frustration, and betrayal of those responsible to properly carry out their responsibilities (Fall et al. 2001; Gill 2007; Picou 2009). These feelings were reinforced and prolonged by the reliance on litigation as the primary avenue for compensation. Litigation stress became a secondary trauma to the socio-economic stress, further damaging the affected communities and greatly delaying the start of recovery such that it became disconnected from the environmental recovery (Picou et al. 2004; Picou and Martin 2007).

Because both the magnitude of effects from the Exxon Valdez release and subsequent recovery of the human and natural environments were controversial and highly publicized, the event helped provide the impetus to reexamine the state of oil spill prevention, response, and clean up (NOAA 2016). In response to the release, Congress passed the Oil Pollution Act in 1990. The Act is now the primary domestic legislation and associated regulations for addressing oil releases.

Other federal laws, such as the Clean Water Act and the Outer Continental Shelf Lands Act, contain provisions that pertain to oil releases, as do a variety of local, state, and federal tort laws. However, with respect to socio-economics, Oil Pollution Act 90 established a specific legal framework that sets out both damage and loss liabilities and a claims process for providing compensation for such injuries. This regulatory framework guides relationships between a

responsible party and resource agencies and provides affected individuals and groups a clearer legal basis for obtaining compensation when direct negotiation is unavailable or found lacking (Nichols 2010; Ryan 2011).

Following the Exxon Valdez crude oil release, oil producers and transporters took additional steps to develop comprehensive frameworks for response planning and compensation , and obtain a better understanding that crude oil releases are both technical and social disasters (Clarke and Hemphill 2002; Webler and Lord 2010; Webler et al. 2010). Spill response plans now include mechanisms that are designed to rapidly address the socio-economic disruptions that can occur following a crude oil release. These mechanisms help reduce disruptions, and facilitate recovery of communities. As a result, responsible parties have been doing an increasingly better job understanding, supporting, and compensating individuals and communities affected by oil releases.

> ***Enbridge Line 6B, Marshall, Michigan****: In July, 2010, approximately 20,000 barrels of diluted bitumen oil were released out of Enbridge's Line 6B pipeline near Marshall, Michigan. The company followed Ashland's proactive approach. Pat Daniel, Enbridge President, traveled to the site immediately, took responsibility, and began setting mechanisms in place to address both the environmental and social elements of the disaster (Iltan and McCarthy 2010).*
>
> *Enbridge brought in public affairs staff and community agents, and set up centers where members of the community could obtain information, assistance with practical matters, and financial support (Enbridge 2010a). Releases of information were coordinated and consistent, and Enbridge maintained contact with local agencies. Enbridge contracted land agents to work with property owners and businesses to address access, nuisance, and other operational issues. An Enbridge spokesman noted: "The intent from the onset always has been if anyone has a legitimate concern they could file a claim and the intent was to avoid litigation" (Christenson 2015).*
>
> *For its part, the USEPA implemented a community involvement plan to promote communication between Incident Command operations and members of the public and to involve members of the public in activities and decisions relating to the clean-up (Weston 2011). Enbridge participated in many of the public and stakeholder meetings as a part of the Incident Command structure. The overall effort operated cooperatively—local media played a large role in disseminating messages with information on the evacuation, clean-up efforts, and emergency resources. Federal, state, and local agencies held town hall meetings to respond to residents' concerns and Enbridge worked directly with those affected to address damages and compensation (Lisabeth 2012). For example, to address concerns about property values, Enbridge instituted a home purchase program*

for households located within 200 feet of the shoreline in affected areas (Enbridge 2010b).

General natural resource damages relating to the Line 6B oil release were addressed through a NRDA process led by the USFWS. Enbridge started addressing lost use of the Kalamazoo River by constructing five river access locations for the public while the damage assessment was ongoing. This was part of an agreement between Enbridge and the State of Michigan to address resource damages. The company subsequently also agreed to remove a dam, and restore several miles of impounded river in addition to providing 300 acres of wetlands. Enbridge also funded restoration of three creek areas, improvements to several inland lakes, a savannah restoration program, a turtle nest protection program, and two tribal cultural projects (USFWS et al. 2015). The compensatory agreement was achieved without litigation and followed cessation of remediation activities relatively closely.

Viewed as a whole, Enbridge's efforts to address socio-economic elements of the oil release, in conjunction with the USEPA community involvement plan, were generally successful. Pat Daniel's initial efforts were later used as a case study by the Harvard Business Review on effective leadership (Seijts and Watson 2012). There were some protests about pipelines and fossil fuels, political viewpoints sometimes were expressed in the media, litigation was not completely avoided, and some individuals were not completely satisfied with their compensation. However, it appears that the lack of communication and development of a "corrosive community", described following the Exxon Valdez release, did not develop and compensation was worked out in a timely manner. Enbridge managed to address most socio-economic issues directly and disagreements that were litigated did not appear to cause substantial strain on the community or impede a return to residents' pre-spill ways of life (Christenson 2015; Davis 2015).

8.3.8.2 Recovery of Various Socio-Economic Effects Following a Crude Oil Release

8.3.8.2.1 Disruptions of Daily Life

Crude oil releases have the potential to disrupt people's daily lives and cost them money while the release is being cleaned up and the environment restored. For small releases and releases in isolated areas, the disruption and costs may be negligible. Examples might include a closed road, increased traffic and noise, or an increased demand on limited municipal services. For larger releases, such as the ones making national news, the disruption and costs may be substantial. In these cases, adequate access to affected areas and resources can be challenging. People in the vicinity of a release may need to leave their homes, board their animals, or be required to have clean-up crews and equipment crossing or staged on their

property. In some cases, these nuisances may persist for a considerable period of time, costing the affected families money, as well as the quiet use and enjoyment of their property.

To address the costs and nuisances that people in affected communities may experience as a consequence of a crude oil release, responsible parties have established units within their spill response teams to deal specifically with community issues. In most cases following a sizeable release, the responsible party will set up an office or community center where affected people can come for support in finding housing, paying bills, and obtaining other daily life resources. Agents within these offices also address matters of nuisance and land use through payments for access easements, property damages, and lost use. The intent of these actions is to reduce the inconvenience to affected households by avoiding straining household finances, paying landowners for the use of their property, and compensating for damages. Some states have established laws addressing oil releases that include provisions for the state to relocate people affected by a release, if necessary, and charge the responsible party for the costs plus fees (Knauf and Reichhart 2010). In most cases, however, responsible parties prefer to address matters of compensation directly, outside a formal claims process.

With private land and resource owners and users, compensation arrangements are negotiated and implemented cooperatively and can occur relatively quickly. The claim system may be administered either directly by the company or indirectly through a third-party administrator. The terms of such settlements are typically not made public. When managed this way, the compensation process can be efficient. However, when those affected cannot reach a financial agreement with the company responsible for the release, final resolution of compensation may move into the court system, and this process can be adversarial and lengthy. Several case studies serve to illustrate how the claims process can work.

> ***Chevron, Red Butte, Utah**: In 2010, Chevron's Red Butte incident released approximately 800 barrels of crude oil near Salt Lake City, Utah. As of September 9, 2010 (three months later), Chevron had reported that they recovered 778 barrels of the released crude oil. Chevron took responsibility, committed to pay for damages and expenses, set up a claims process, and notified residents of their ability to seek compensation (Foy 2010). Chevron paid most claims directly; however, a class action lawsuit was filed by 66 landowners, who argued that they did not receive adequate compensation. The lawsuit was not settled until 2015 (Fox 13 News 2015).*
>
> ***Exxon Silvertip Pipeline, Laurel, Montana**: In July 2011, Exxon's Silvertip pipeline under the Yellowstone River near Laurel, Montana burst and released 1,000 barrels of crude oil. As a result, 140 people were evacuated from their homes and numerous farm animals were temporarily relocated. Exxon established a claims process to compensate those evacuated for lodging, food, boarding, property and environmental damage, and other expenses incurred from the release*

> *(Reuters 2011). Most people seemed satisfied with the process, although three lawsuits seeking damages were filed against Exxon and remain unsettled.*
>
> ***Exxon Pegasus Pipeline, Mayflower, Arkansas**: In March 2013, Exxon's Pegasus pipeline in Mayflower, Arkansas failed, releasing around 5,000 barrels of diluted bitumen crude oil. Residents of 22 homes were evacuated and temporarily housed in hotels with expenses paid by Exxon (Hasemyer 2015). A class action lawsuit filed by some residents seeking damages also remains unsettled.*

For larger releases, compensatory efforts can be complex. As described above, Enbridge's community response to their 2010 Line 6B release included not only payment of claims for relocation costs, but also purchase of homes from owners in proximity to the release who wished to relocate permanently. A limited number of lawsuits were filed against Enbridge, with only one currently remaining unsettled.

8.3.8.2.2 Loss of Income and Commercial Activity

Crude oil releases and the associated clean-up activities may lead to individual losses of income, as well as changes in local commercial activity. For example, releases on agricultural land can result in damages to crops and future lost productivity (Inoni et al. 2006). Releases in areas of resource harvesting can lead to a loss of income from blocked access and reduced catches (Pulsipher et al. 1999; Impact Assessment Inc. 2013). Releases in commercial areas may lead to forced business closures and/or lessened demand for goods and services due to decreased travel and tourism or a tendency for local residents to stay away (Tourism Economics 2011). Compensation for losses of income and commercial activity typically are paid directly through a claims process.

Some economic activity generated by clean-up related expenditures may partially offset some losses of commercial activity, particularly in increased demand for lodging and other services, as well as increased business for supply companies (Killian 2010; Aldy 2014; Tankersly 2014; Masunaga and Panzar 2015; Davis 2015). However, a vast majority of reports regarding the overall consequences of crude oil releases on wages, income, and business activity are negative (McDowell Group 1990; Pulsipher et al. 1999; Garza-Gil et al. 2006; Impact Assessment 2013).

Oil Pollution Act 90 requires the party or parties responsible for causing an oil release to pay damages to all injured parties and remediate the release. Under OPA 90, damages are defined as:

1. Natural Resources—Damages for injury to, destruction of, loss of, or loss of use of natural resources, including the reasonable costs of assessing the damage, which shall be recoverable by a United States trustee, a State trustee, an Indian tribe trustee, or a foreign trustee.

2. Real or Personal Property—Damages for injury to, or economic losses resulting from destruction of real or personal property, which shall be recoverable by a claimant who owns or leases that property.
3. Subsistence Use—Damages for loss of subsistence use of natural resources, which shall be recoverable by any claimant who so uses natural resources which have been injured, destroyed, or lost, without regard to the ownership or management of the resources.
4. Revenues—Damages equal to the net loss of taxes, royalties, rents, fees, or net profit shares due to the injury, destruction, or loss of real property, personal property, or natural resources, which shall be recoverable by the Government of the United States, a State, or a political subdivision thereof.
5. Profits and Earning Capacity—Damages equal to the loss of profits or impairment of earning capacity due to the injury, destruction, or loss of real property, personal property, or natural resources, which shall be recoverable by any claimant.
6. Public Services—Damages for net costs of providing increased or additional public services during or after removal activities, including protection from fire, safety, or health hazards, caused by a discharge of oil, which shall be recoverable by a State, or a political subdivision of a State.

Under *Oil Pollution Act* 90, a party responsible for causing an oil release is under an affirmative duty to set up a claims procedure and process claims for damages. Damages may be payable to individuals, businesses, or government entities. Two examples serve to illustrate how the required claims process can operate.

> ***BP, Deepwater Horizon, Gulf of Mexico****: Shortly after its 2010 Deepwater Horizon crude oil release in the Gulf of Mexico, BP established 31 field offices with 500 field adjusters to handle claims for damages including loss of income and commercial activity (Gulf Oil Spill Litigators 2010). The company also established a 20 billion dollar trust fund and appointed an administrator to handle additional claims relating to natural resource damages, state and local response costs and individual compensation (McDonell 2012). In March 2012, BP settled a class action lawsuit covering other individuals and businesses affected by the release. BP's total expenditures for compensation were estimated at approximately 20 billion dollars, which the company had set aside in the Trust Fund (Fahey and Kahn 2012).*
>
> ***Chevron, Willard Bay, Utah****: On March 18, 2013, a pipeline owned by Chevron Pipeline Company leaked approximately 500 barrels of diesel fuel into wetlands adjacent to Willard Bay, a reservoir connected to the Great Salt Lake (USEPA 2014). The release caused temporary closure of the Willard Bay State Park. The North Marina and campground at Willard Bay remained closed through May and June, 2013 (UDEQ 2011). The campground reopened on July 22, 2013, once a fence had been constructed to keep the public out of the contaminated area (O'Donoghue and Cabrero 2013). A year later, as part of its settlement agreement, Chevron agreed to pay $500,000 for lost-use damages at the park and campground (UDEQ 2011).*

8.3.8.2.3 Lost Use of Natural Resources

Crude oil releases may damage or restrict access to natural resources that community residents, Indian tribes and visitors use for various purposes. Examples of such lost uses include closure of recreation areas or access points, restrictions on hunting, fishing, and gathering, reductions in harvestable fish, wildlife and plant populations, and changes in the visual landscape. Responsible parties compensate individuals and communities who experience lost use of natural resources in two different ways.

When lost resource use is suffered by a single entity such as a landowner, parties responsible for the release now typically try to provide compensation directly to those affected using a claims process or through agents assigned to communicate with property owners and other individuals to address their unique situations.

When lost resource use is a general public matter, compensation is generally provided through the NRDA process for larger releases, and through similar state proceedings for smaller releases (Ryan 2011). As described by NOAA in its guidance documents (Huguenin et al. 1996):

> "A major goal of the *Oil Pollution Act* of 1990 is to make the environment and public whole for injury to or loss of natural resources and services as a result of a discharge or substantial threat of a discharge of oil (referred to as an "incident"). This goal is achieved through returning injured natural resources and services to the condition they would have been in if the incident had not occurred (otherwise referred to as "baseline" conditions), and compensating for interim losses from the date of the incident until recovery of such natural resources and services through the restoration, rehabilitation, replacement, or acquisition of equivalent natural resources and/or services."

In accordance with the *Oil Pollution Act* 90, when an oil release occurs, designated representatives of federal agencies, state agencies, Indian tribes, and, in limited instances, foreign governments having affected resources under their jurisdiction form a "Trustee Council." The Council members begin by completing a pre-assessment to determine if trustees have the jurisdiction to pursue restoration under *Oil Pollution Act* 90, and, if so, whether it is appropriate to do so. If damages to resources under their jurisdiction are expected to continue and feasible restoration alternatives exist to address such damages, trustees may proceed with the NRDA process. The process then proceeds through injury assessment, calculation of damages, evaluation of potential restoration actions, and restoration planning and implementation. In most cases, these steps are taken cooperatively with the party responsible for the release. At the end of the NRDA, one or more compensatory projects are implemented to address losses incurred by the public between the time of the oil release and the time when affected resources have recovered back to approximately their pre-spill condition (baseline). The following case studies illustrate how the natural resource damage compensation can work.

***Enbridge Line 4, Cohasset, Minnesota**: After Enbridge's Line 4 ruptured near Cohasset, Minnesota, on July 4, 2002, releasing approximately 6,000 barrels of crude oil, the NRDA Trustees, which included the United States of America, the State of Minnesota and the Leech Lake Band of Ojibwe, invited Enbridge to participate in a cooperative NRDA process and Enbridge agreed. In June 2003, the Trustees provided Enbridge with a recommended process for completing the NRDA requirements and associated restoration. A memorandum of understanding between the Trustees and Enbridge related to the NRDA and restoration process was signed in May 2004. A draft restoration plan and environmental assessment was submitted in August 2005 (USFWS et al. 2005). In 2008, the Draft Restoration Plan and Environmental Assessment became the basis for a Consent Decree negotiated between the Trustees and Enbridge Energy Limited Partnership (United States District Court District of Minnesota 2009). Under the decree, Enbridge committed to finance and perform the substantial scope of work identified in the Restoration Project Implementation and Monitoring Work Plan. In addition to funding the restoration projects identified in the Implementation and Monitoring Work Plan, Enbridge was also directed to make payments in the amount of $16,300 for outstanding unreimbursable assessment costs and costs to be incurred for monitoring the performance of the restoration work. Of this, $12,200 was to be paid to the U.S. Government, $1,400 to the State of Minnesota, and $2,700 to the Leech Lake Band of Ojibwe. The court approved the Consent Decree in January 2009. No administrative penalty was issued to Enbridge.*

***Chevron, Red Butte, Utah**: In 2010, Chevron's Red Butte incident released approximately 800 barrels of crude oil near Salt Lake City, Utah. As of September 9, 2010 (three months later), Chevron had reported that they recovered 778 barrels of the released crude oil. Following the incident, Chevron entered into negotiations with the city and the Utah Department of Environmental Quality regarding damages. In September 2011, the parties reached a settlement on released crude oil. The settlement included a payment of $1.0 million to Salt Lake City for lost use, which included environmental and social effects (Utah Water Quality Board 2011). The State of Utah received a $3.5 million settlement, which included a $0.5 million civil penalty and $3.0 million for a waterfowl project and mitigation projects to enhance and protect waterways that may have been affected by the released crude oil (Salt Lake City 2012). The settlement agreement also specified amounts that Chevron would pay to Salt Lake City and the State of Utah for expenses associated with clean up, remediation, and restoration. Chevron paid $1.3 million to the University of Utah for additional remediation and restoration, and $900,000 as compensation to third parties affected by the release.*

> ***Enbridge Line 6B, Marshall, Michigan****: When Enbridge's Line 6B released approximately 20,000 barrels of diluted bitumen oil near Marshall, Michigan in July 2010, a NRDA Council was formed by the State of Michigan, the United States Department of the Interior (though the USFWS and Bureau of Indian Affairs), the U.S. Department of Commerce (through NOAA), the Nottawaseppi Huron Band of Pottawatomi Indians (the Huron Tribe), and the Match-E-Be-Nash-She-Wish Band of Pottawatomi Indians (the Gun Lake Tribe) (USFWS 2015b). The pre-assessment phase of the NRDA process began in November 2010. Enbridge initially cooperated in the NRDA Council's efforts and then, starting in 2013, focused on damage compensation negotiations through the State of Michigan. At that point, the state negotiations and NRDA process ran parallel paths. On May 13, 2015, Enbridge agreed to a partial settlement for resource damages with the State of Michigan that included development of five river access locations, removal of the dam in Ceresco, Michigan, restoration of several miles of impounded river, and provision of 300 acres of wetland compensation (MI 37th Circuit Ct 2015). In June 2015, Enbridge reached agreement with the NRDA Trustees regarding the remaining resource damages at issue (Enbridge 2015). Details of the agreement were presented in the Trustees' October 2015 Final DARP (USFWS et al. 2015b). The additional compensation included funding for restoration of three creek areas, improvements to several inland lakes, a savannah restoration program, a turtle nest protection program, and two tribal cultural projects. The total estimated cost of the two compensation packages was estimated at 66.9 million dollars (Williams and Brush 2015; USFWS et al. 2015b).*

When looking at these recent case studies, it is apparent that the current NRDA process contrasts markedly with the process used to come to final resolution and recovery of the socio-economic environment from past events such as the Exxon Valdez crude oil release. The information summarized in Stantec et al. (2012a) suggested that for the Exxon Valdez crude oil release, full "recovery" of the socio-economic environment was still underway, even though the biophysical environment had largely recovered. Because it took 19 years to resolve outstanding legal claims with the Exxon Valdez crude oil release, this extended litigation process delayed the perceived recovery of the socio-economic environment. This process also perpetuated the misconception that the socio-economic environment is extremely slow to recover from a crude oil release. In addition, the presence of lawyers in small Alutiiq villages following the Exxon Valdez crude oil release likely served to intensify the actual social effects and masked more subtle and culturally unique responses to the crude oil release (Picou 2009; Wooley 1995). By comparison, settlements for recent releases such as Line 4, Red Butte Creek, Line 6B, and even Deepwater Horizon, while to some degree adversarial, were much more direct and efficient, with most damage claims being closed within several years of the clean-up.

8.3.8.3 Factors Affecting Recovery

While recovery time is partly a consequence of release size and complexity, decisions made by parties involved in a crude oil spill response can greatly affect the means and timeframe that an affected community needs to recover. The influence of various decisions plays out by affecting each of the three resource categories: daily life and associated economic burdens, lost use of natural resources, and loss of income and commercial activity, as discussed in the previous section. In general, more rapid recovery is encouraged by actions that are proactive about addressing the possibility of a release, fully recognize the people who are affected, address effects quickly and evenly, are respectful, and are sensitive to the fact that response actions can also cause damage. On the other hand, actions that delay responses, increase damages, neglect the social environment, and/or create adversarial relationships tend to increase recovery time. These actions can be considered in terms of two general categories: operational and response.

Operational actions are those that can be carried out before a release occurs to increase the likelihood that a release is detected and recognized rapidly, and to better prepare the responsible party, oversight agencies, and local communities once a release is identified. Acting in this manner means assuming that a release has occurred when monitoring data suggests one is possible, rather than assuming that one has not.

Response actions involve oil transporters developing detailed response and resourcing plans for sensitive areas along their routes, practicing the plans, and ensuring plan coordination with agency and community emergency units. The process of developing emergency response plans serves as a "heads-up" about the potential for releases and other risks associated with a pipeline. They are also a very useful method of educating parties about the design measures being taken to reduce release probabilities and risks, the monitoring system that is in place, and the procedures that would be implemented should an event occur. Having the public involved in the development of the response plans helps incorporate the unique and special circumstances of every community in the plans (Perkins and Bullock 2014).

Detailed, area-specific emergency response plans are even more effective when shared and practiced with community officials, public emergency response officials, and contracted emergency responders. Such coordination can typically be achieved by periodically conducting spill simulation exercises (Aurand and Coelho 2004; Enbridge 2015; Rayburn et al. 2004). Public involvement in these exercises also provides a means of demonstrating corporate understanding of the unique characteristics and concerns of the communities along a pipeline route, as well as the proponent's commitment to response plans that are functional, viable and up-to-date.

By limiting the release of crude oil, planning well, and promoting efficient, coordinated responses, responsible parties can reduce damages, involve the affected community, and promote socio-economic recovery. With respect to operational matters, one can consider the

differences between Marathon's pipeline release near Albion, Illinois and Enbridge's Line 6B release near Marshall, Michigan.

> ***Marathon, Albion, Illinois****: As described above, in spite of releasing nearly 6,000 barrels of crude oil, Marathon's Albion pipeline rupture received little notice (Wells 2008a, 2008b). The lack of attention was attributed in part to occurrence in a relatively isolated location. The other reason appeared to be good preparation and an efficient response. When Marathon operators noted a sudden pressure drop, they assumed a leak had occurred, shut down the pipeline, and sent a field crew to investigate (Arcadis 2011). When the field crew identified a leak, they notified the company emergency response unit which immediately responded with equipment and 250 personnel. Marathon responded according to a prepared plan that was rehearsed with emergency responders only a year earlier (Wells 2008b). Marathon's caution, preparedness, and rapid response appear to have reduced environmental damages and social disruption and facilitated rapid recovery.*
>
> ***Enbridge 6B, Marshall, Michigan****: In the case of the 2010 Enbridge Line 6B approximately 20,000 barrel diluted bitumen oil release, damages from the release could have been reduced if monitors in Enbridge's control center had responded to a pressure drop in the pipe as a release. Instead, they assumed it was a column separation and ignored operating guidelines stating that "[i]f an operator experiences pressure or flow abnormalities or unexplainable changes in line conditions for which a reason cannot be established within a 10-minute period, the line shall be shut down, isolated, and evaluated until the situation is verified and/or corrected" (NTSB 2012). The pipeline was restarted twice and the rupture remained undetected for 17 hours.*
>
> *Enbridge, the state of Michigan and the local community were also not prepared to respond to a release. The NTSB accident report noted several contributing factors including "Enbridge's failure to identify and ensure the availability of well-trained emergency responders with sufficient response resources" and "insufficient public awareness and education" (NTSB 2012). The state of Michigan was similarly unprepared. One first responder noted: "when we got a call that there was an oil release we expected to see an overturned truck or something like that. Half the river was black. My staff had never been trained for this type of event" (Brooks 2014). While Enbridge's community response was extensive (as noted above) and well received, the release damages and community disruption could have been reduced through a little caution, better preparation and coordination, and better resource planning. Fewer damages would have resulted in less disruption and a shorter period for socio-economic recovery.*

Once a release occurs, response actions taken by the responsible party, oversight agencies, and affected communities can also influence the extent of damage and disruption and, by association, the length of time to recovery. Rapid, efficient responses that consider tradeoffs with different clean-up techniques are able to address the social elements of the disaster in a timely manner and attempt to avoid adversarial situations in settling claims. Responses that take contrary actions tend to increase environmental damages and community disruption with associated longer recovery times. Response effectiveness for socio-economic elements can be measured in minimization of damages, communication effectiveness, and the fairness and timeliness of compensatory and damage payments.

Minimization of damages involves both damages relating to the natural environment in which the community is based, as well as damages to the daily life and economy of the community. The more damages are avoided, the less recovery is required by the community and the faster recovery can occur. Natural resource damages can be reduced by being prepared but it is also important to implement the plans rapidly and efficiently. This means effective and respectful communications, appropriate deployment of resources, and a sensitivity to the tradeoffs between different sorts of clean-up techniques and the damages that those techniques themselves can cause. To address this latter element, researchers and spill responders have developed and implemented a Net Environmental Benefits approach where various parties involved in a spill response can evaluate tradeoffs and provide guidance regarding suggested response techniques that consider the specific resources affected (Efroymson et al. 2003). Various government agencies and companies have been involved in developing the process and workshops have been held in many different areas around the country (Rayburn et al. 2004; Aurand and Coelho 2004). The concept is that better understanding of resources in specific locations that may be affected will result in more focused and resource-sensitive approaches, thereby helping to reduce damages and enhancing the rate of recovery.

From a community standpoint, minimization of adverse effects on the socio-economic environment includes taking immediate actions that can lead to safe and effective means of removing people, their pets and other important possessions from immediate harm. It also includes providing for individuals' needs for as long as it is required, before they can safely return to their homes and businesses and getting them home or back to work as soon as possible. Such actions can include such things as establishing temporary shelters, providing food and water, providing health care, setting up claims centers, making temporary financial resources available, and proactively following up with those individuals who have been dislocated. To the degree that responsible parties and other spill responders can rely upon local sources of materials, supplies, and labor, associated expenditures can also help reduce the economic disruption and establish a foundation for more rapid recovery. People affected by a crude oil release want and deserve to have responsible parties care about and address their well-being. When that occurs, damages can be reduced and recovery is promoted. When it does not, as in the Exxon Valdez case, animosity can linger for decades.

Effective communication with affected communities is also an important element of spill response that can either impede or enhance recovery. It is important that the Incident Command and local officials establish a communications center that will issue routine updates on the status of the release, answer questions about the release, and inform people about when they will be able to resume normal activities. Ineffective communications can damage the relationship between the responsible party, government agencies and the public, creating suspicion and ill will, and impeding community recovery. For example, communication issues were identified as a hindrance to recovery related to health effects resulting from the Enbridge Line 6B Marshall, Michigan release (Eykelbosh 2014). Eykelbosh noted that the lack of health specialists with social media skills who could effectively communicate technical issues in a proactive manner meant that activists were able to influence public opinion unduly with false or misleading information. Her analysis suggested that the recovery process, especially in the early stages following a release, can be hampered by ineffective, overly technical communication. In contrast, she noted that Kinder Morgan's Trans Mountain Pipeline 1,520-barrel crude oil release in Burnaby, British Columbia in 2007 was an example of effective communication of risk to the media and concerned citizens (Eykelbosh 2014). It involved using town hall meetings and identification of monitoring and remediation endpoints that were simple for the public to understand. In addition, communication following the Burnaby 2007 oil release included early and ongoing reporting of air quality and other potential health related effects using data that could be understood by the public.

Implementation of effective and timely procedures for compensating private parties for damages is also a key to the recovery process. Timely payments, through direct compensation and programs/mechanisms that promote social support and community resilience, can help address the mental health and household loss/inconvenience effects of a release, reduce damages and support recovery (Eykelbosh 2014). The differences between the Deepwater Horizon release and the Exxon Valdez crude oil release are a good example of this. Deepwater Horizon was over four times as large as the Exxon Valdez crude oil release and affected portions of four states. Yet, nearly all damage claims had been settled in five years. In contrast, following the Exxon Valdez crude oil release, the drawn out legal battles and delays in reaching a final settlement in the form of punitive damages meant that final resolution was not achieved 20 years after the release. Some authors addressing the Exxon Valdez crude oil release observed that "The inability of the legal system to produce a timely resolution to damages experienced by survivors of the Exxon Valdez oil release has actually resulted in a secondary disaster which may be more significant than the Exxon Valdez oil spill" (Picou and Martin 2007). Enbridge's Line 6B release, though substantially smaller than either Exxon Valdez or Deepwater Horizon, was still one of the largest inland releases in U.S. history. Its damages were also settled in approximately five years.

As summarized above, the published record of oil releases that have occurred during the past 50 years provides some clear lessons. Cautious transport operations and prevention are of utmost importance. When releases occur, communities do recover, and how releases are responded to when they happen can greatly influence the extent of damages and the time it

takes a community to recover. Failure to be prepared, failure to implement effective response and recovery actions in a timely manner, and delays in settling damages or NRDA claims can extend recovery of the socio-economic environment beyond recovery of the biophysical environment. This delayed recovery results from a lack of compensation to make affected parties whole, lingering ill will toward the responsible party and/or poor perceptions regarding environmental conditions. On the other hand, when oil transporters, government, and communities are prepared and work together effectively, disruptions, damages, and resentment can be reduced and managed so socio-economic recovery can be achieved as rapidly as possible.

8.3.8.4 Summary of Socio-Economic Effects and Community Recovery

Review of literature, media reports, and case studies regarding oil releases over the past 50 years clearly illustrates that clean up and oil recovery technologies have improved over the past decades. Human communities can and do recover from the socio-economic effects caused by oil releases. The speed and efficacy of spill response can limit the severity and the area affected by a release, which facilitates recovery rates.

People responding to releases now are better trained, better organized, and have better technology at their disposal than what existed at the time of the Union Oil and Ashland releases. There is a much better understanding on the part of oil transporters and government agencies that oil releases are human and ecological disasters, and that an effective response must immediately and directly address the people affected. The Exxon Valdez crude oil release, while studied in depth and often cited, is not a good example of the present status of crude oil release response efforts, potential socio-economic effects, or how compensation processes are carried out. The Exxon Valdez crude oil release occurred prior to most governing legislation being enacted. Modern day spill responses by oil transporters, regulators, and researchers have over 25 years of technological improvements, field studies, and training to utilize.

Crude oil releases affect people in a community in a variety of ways and not all individuals or businesses may be completely satisfied with how the effects are addressed. However, the experiences demonstrated by the recent case studies indicate that socio-economic environments can and do recover after a crude oil release, and that the current regulatory framework usually results in recovery within two to five years. Within this framework, full community socio-economic recovery for a given release seems to occur when each of the following effect categories applicable in a particular location has been addressed.

Restoration of daily life activities and reimbursement of spill-related household costs is a critical part of recovery. This part of recovery is partially dependent on applicable regulations and involves completion of efforts to restore the natural biophysical environment and ecosystem to conditions required by regulations and clean-up endpoints. Once infrastructure (e.g., buildings, roads, water intakes) and the residential environment (e.g., recreational areas, agricultural land) have been returned to a safe and functional state, day-to-day socio-economic activities can

return to near normal. This means that affected residents may return to their homes, and municipalities and companies can return to withdrawing water for public and private consumption or can access an alternate source of water. Tourists and recreationists can resume visiting the area. This stage of recovery can be achieved relatively quickly, usually within one to two years. The duration of recovery will depend partly on the effectiveness of the response process which can be greatly enhanced by having a robust spill contingency planning and preparedness regime that includes an effective and community-based response.

The second measure of the recovery of the socio-economic environment relates to the return of ecological functionality for affected land and resources. This means that individuals and communities are able to return to land and resource use, including harvesting activities, as they existed prior to the release, without having to worry about the effects of residual oil. For example, a release on agricultural land could be cleaned up the first year, but the return to planting and harvesting may be delayed for another year or two while the land recovers from the release and the effects of remediation on yields diminish. Also, the return to commercial and traditional fishing may be delayed for several years until fish populations recover and issues related to fish contamination and other food safety concerns have been addressed. This stage of recovery is especially important for communities that are dependent on aquatic resources for food and employment.

The third measure of recovery of the socio-economic environment involves restoring the well-being of individuals and communities adversely affected by the release through financial compensation for damages. Full recovery of the socio-economic environment is only possible once the affected parties perceive that recovery has occurred and that adequate compensation has been paid. However, the timing of this event will depend on the processes by which compensation is negotiated and provided, and whether or not extended litigation occurs. While final payment of compensation marks the formal completion of the recovery process for the socio-economic environment, there may still be some unresolved issues for both communities and individuals. These issues may relate to ongoing (pre-spill) social issues, longer term problems from having release responders living in small communities, and community angst from delays in implementing the emergency response plans or in communicating the risks and issues. In addition, within communities, there can be perceptions that there are winners and losers. These issues and perceptions may lead to longer term resentment. Widespread negative publicity through sensationalized press coverage can also extend the recovery timeframe in ways that are difficult to predict even though full compensation may have been paid (Wooley 1995; Wooley 2002). These residual effects for individuals can extend beyond completion of the formal socio-economic recovery process for the community as a whole.

8.4 RESPONSE AND REMEDIATION

Emergency response, clean up, and post-release activities can mitigate the extent of environmental effects and influence the course of recovery from a crude oil release. This section

assesses the relationships between emergency response and remediation to petroleum releases and how they can influence ecosystem recovery.

In general, published articles and case studies illustrate that post-response recovery is enhanced when responsible parties are well prepared in advance, the initial response is organized, communication during the emergency response is timely and effective, the response adapts well to changing conditions, and attention is paid to tradeoffs between oil removal and environmental damage. Consistent with this pattern, response efforts have improved substantially over the past decades, reflecting the increase in attention paid by oil producers, transporters, and other parties to improve preparedness. Preparedness can include proactive information gathering, analysis and database development, mock response exercises, communication and coordination with local emergency response officials, and alignment with regional planning efforts. Calls for continued efforts along these lines are common and are likely to be implemented given the interest by responsible parties, regulators, and local citizens to minimize the likelihood of a crude oil release and its potential consequences (Fingas 2014 2014; Fingas 2015; Lee et al. 2015).

For the purposes of discussion within this section, terms are used as follows:

- Response: Emergency activities to achieve two goals, containment and clean up
- Containment: Activities designed to contain released crude oil and prevent it from moving farther (especially into sensitive areas) and to facilitate crude oil collection and removal
- Clean up: Active collection and removal of crude oil and oiled materials from the environment
- Recovery: Return of an ecosystem or environmental receptor to some desired state that provides similar ecosystem benefits following disturbance (See Section 8.2)
- Remediation: Physical, chemical, or biological processes applied post-clean up to reduce any residual crude oil
- Rehabilitation: Collection of oiled wildlife to clean the crude oil from the individual, return it to health and, ideally, release it back into the environment
- Restoration: Activities carried out to promote the return of natural resources affected by a crude oil incident to the condition that would have existed if the event had not occurred (baseline condition)

Natural attenuation and compensatory restoration are also terms that are widely used. Natural attenuation refers to various physical, chemical, and biological processes that occur without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in the environment (USEPA 1999). Compensatory restoration refers to action taken to reimburse for interim losses of natural resources and services that occur from the date of the incident until recovery is deemed complete (French et al. 1996).

8.4.1 Response

Numerous authors have discussed how the early historical practice of using heavy earthmoving equipment, even in sensitive areas such as marshes, can substantially delay recovery (e.g.,

review in Stantec et al. 2012). The lessons learned from these historical incidents have led modern response strategies to target preventing crude oil from reaching sensitive environments, and make informed decisions concerning heavy equipment use. There has been a growing interest within the industry regarding how timely and appropriate response approaches can enable and accelerate recovery. Current practice focuses on the following variables that can either impair or enhance recovery (Dollhopf and Durno 2014; Jones and Plourde 2011; Lindstedt-Siva 1999; Purnell and Zhang 2014; Stevens and Aurand 2008):

- Preparedness—Are the responsible party and regulatory agency staff trained in the Incident Command Structure, a formalized, uniform response framework used throughout the U.S.? Is response staff knowledgeable, trained, and capable of deploying a variety of response techniques? Have they participated in previous responses or drills? Is there sufficient staff with the appropriate skill sets available? Is the proper equipment available and in sufficient amounts? Can personnel and response equipment be immediately deployed to release sites? Has advance planning been carried out? Do responders have knowledge of the type of oil released and environmental resources in proximity to the affected area?
- Cooperation and communication—Has the responsible party initiated its emergency response plan, including the notification of federal, state, and local authorities, as appropriate? Has the responsible party involved in the response coordinated with local responders to create trust and respect? Can the parties work together and is there a willingness to communicate so that prompt, efficient, and appropriate actions can be taken?
- The role of the public and press—Do the responsible party and regulatory agencies communicate clearly and routinely with the public? Is there sufficient trust with interested stakeholders that meaningful discourse can occur? Have personal or political agendas or the threat of legal action led to decisions that might contribute to longer recovery?
- Flexibility and willingness to learn—Does the Incident Command (i.e., response managers) apply knowledge from other responses and adjust tactics during a response to address changing conditions and different resource types?
- Understanding of trade-offs and the net environmental benefits of different approaches—Does the Incident Command consider whether response activities in certain areas may cause more environmental damage and lead to longer recovery than allowing natural recovery?

The importance of these response variables is apparent when contrasting incidents prior to the advent of the *Oil Pollution Act* of 1990 (OPA 1990) with more recent releases. As summarized in the 1999 International Oil Spill Conference report:

> Prior to the Exxon Valdez spill, RPs [responsible parties], federal agencies, and individual states tended to plan independently for responses. When a spill occurred, each found that the others' plans were inadequate or incompatible with its own. The result was confusion and recrimination, creating an impression in the public's eyes that chaos reigned (Lindstedt-Siva 1999, p.15).

The *Oil Pollution Act* 1990 required industry and government to produce contingency plans to help guide activities in the event of future incidents. Since the passage of *Oil Pollution Act* 1990,

efforts at emergency preparedness planning and collaborative efforts, such as joint planning sessions and response exercises, have been widely implemented within the industry (Aurand and Coelho 2004; Enbridge 2015a; Rayburn et al. 2004). As a result, responses to crude oil releases have become more efficient and adaptive, with much better prospects for reduced environmental damages and more rapid recovery (Aurand and Coelho 2004; Enbridge 2015a; Rayburn et al. 2004).

Reports from the 2010 Enbridge Marshall Incident Commander, for example, show that the incident response was organized, adapted to changing conditions, and attempted to "balance between cleaning a riverine environment and minimizing adverse effects to the ecosystems and/or changing river dynamics" (Dollhopf and Durn 2011). The U.S. Coast Guard reports regarding the 2010 Deepwater Horizon release also illustrate how responders to that event were well prepared and modified the Incident Command System structure to provide for better communication, better understanding of local field conditions, and better congruence between response actions and ecosystem sensitivity (Jones and Plourde 2011, USCG 2011).

8.4.2 Remediation

Remediation involves active human intervention to remove contaminants from environmental media following initial response efforts. For crude oil releases, the environmental media requiring remediation are often soil and groundwater (PHMSA 2016). The contaminants are remediated through engineered means or through enhancement of biological processes, usually applying some combination of microorganisms, nutrient additions, oxygenation, and phytoremediation (i.e., use of plants to promote biodegradation).

8.4.2.1 Engineered Remediation

Engineered remediation uses chemical and physical processes to address crude oil trapped in the unsaturated zone, oil at the water table, or a dissolved plume of contaminants. Techniques include hydraulic removal (e.g., pumping, skimming), volatilization (e.g., soil vapor extraction or air sparging), or a combination of approaches (e.g., multi-phase extraction).

For example, at the Enbridge 1979 Bemidji release site, a pump-and-skim system was installed and operated from 1999 to 2003 and removed approximately 724 barrels of the estimated 1,760 to 1,990 barrels of crude oil that remained following the initial clean-up responses (Delin and Herkelrath 2014). The remedial effort was expected to decrease the time to recovery by substantially reducing the amount of residual crude oil remaining for degradation through natural attenuation (Cozzarelli et al. 2001; USGS 1998).

At the Enbridge Cass Lake site, approximately 1,143 barrels of crude oil were released (discovered in 2001). To mitigate groundwater effects, a bioventing system was installed in 2014. After just three months of operation, monitoring data suggest the rate of biodegradation was

enhanced with increased oxygen, decreased carbon dioxide, and increased temperature in the vadose zone (AECOM 2015).

8.4.2.2 Bioremediation

Bioremediation has been studied by microbiologists since the 1940s, but it did not become broadly considered as a viable technology for crude oil clean up until the Exxon Valdez incident in 1989. In the years since Exxon Valdez, bioremediation has become a better developed and more broadly understood technology that can be considered and applied in many different circumstances. As Wilson and Jones (1993) noted, the bioremediation approach "has advantages over thermal and some physio-chemical techniques in terms of cost and because the soil as a living system suitable for plant growth is not destroyed."

Bioremediation should be considered within the context of biodegradation, a naturally occurring process whereby bacteria or other microorganisms alter and break down organic molecules into other substances, eventually producing fatty acids, carbon dioxide, and water. There are hundreds to thousands of species of bacteria, archaea, and fungi that can degrade petroleum and these oil-degrading microorganisms are ubiquitous throughout the world. While the microorganisms capable of petroleum hydrocarbon degradation may only represent a small proportion of the entire microbial community in the area affected by crude oil, bioremediation accelerates biodegradation through supplementing microbial populations, stimulating existing microbial populations, or manipulating the contaminated media using techniques such as aeration, nutrient augmentation, or temperature control to enhance growth of microbial populations (Lee and Merlin 1999).

Phytoremediation is a type of bioremediation using plants, their associated root/soil microorganisms, and agricultural practices (e.g., nutrient amendments, tilling) to accelerate the removal or degradation of environmental contaminants (Frick et al. 1999; White Jr. et al. 2006). Phytoremediation manipulates natural synergistic relationships among plants, microorganisms, and the environment without intensive engineering techniques or excavation. Intervention by phytoremediation is carried out to establish or augment an appropriate plant-microbe community at the site or to implement agronomic techniques (e.g., tillage, fertilizer application) to enhance natural degradation or containment processes (Frick et al. 1999). Phytoremediation acts primarily by promoting the growth of microbes, including petroleum hydrocarbon degraders, within the root zone. Soil in proximity to the plant roots supports as much as one to two orders of magnitude more microbes than unvegetated soil (Kamath et al. 2004; Robson et al. 2004; Siciliano and Germida 1998). Plants infiltrate soil with their roots, releasing nutrients and supporting growth of indigenous microbes throughout the soil profile, which is more effective than the addition of nutrients without plant growth.

Perhaps the largest bioremediation effort ever undertaken was in response to the 1989 Exxon Valdez event. After the event, a substantial portion of the crude oil floated ashore and was stranded in areas where physical washing and collection of crude oil from the environment were

difficult. A portion of the deposited oil also moved into the subsurface, often due to wave and tidal actions. Based on prior research and response-related testing, fertilizer additions were used on shoreline areas starting in 1990. Results showed that the fertilizer treatments resulted in total losses of petroleum hydrocarbon as high as 1.2% per day (Atlas and Hazen 2011). By 1992, only 1.3% of the initially oiled shoreline had detectable amounts of crude oil (Atlas and Hazen 2011; Pritchard et al. 1992).

Since the Exxon Valdez, additional smaller-scale bioremediation efforts also have taken place in various locations, and techniques have been tested using laboratory and field experiments to validate observations at other crude oil releases, and test new methods (Venosa et al. 1996). For example, research at a contaminated land farm site indicated that as much as 70% of the oil contamination can be degraded over the course of three years with enhanced phytoremediation using Plant Growth Promoting Rhizobacteria (PGPR) (Gurska et al. 2009). This includes degradation of high molecular weight hydrocarbons in the lube oil and crude oil range. Other studies have shown that it is possible to adapt these phytoremediation systems to other sites by utilizing site-specific PGPR-enhanced phytoremediation. A series of experimental studies were carried out in a wetland along the south shore of the St. Lawrence River to evaluate the influence of nutrient enrichment and plant growth on crude oil degradation rates. These studies documented results similar to the land farm site (Greer et al. 2003; Venosa et al. 2002; Venosa and Zhu 2003).

Research carried out from 1994 through 1999 "[d]emonstrated that the application of fertilizers stimulated the activities of indigenous hydrocarbon-degrading and denitrifying bacteria, and the presence of crude oil either enhanced or had no detrimental effect on these activities. As a remediation strategy, the application of fertilizers to a wetland shoreline following a crude oil release would promote the growth of indigenous plants and their associated microbial flora, resulting in increased metabolic activity and the potential for increased oil degradation activity" (Venosa and Zhu 2003).

8.4.3 Rehabilitation

Rehabilitation includes activities that can be undertaken to protect wildlife from harm that have come into contact or may come into contact with the released product. There are numerous proactive measures that can be implemented (e.g., deterrents, ex-closures, relocation) to keep wildlife from contacting crude oil that has been released into the environment. Despite efforts, individuals still may become oiled, most often in the immediate aftermath of a release. Rehabilitation involves the capture, cleaning, medical treatment (if necessary), and release into unaffected areas. For the most severe cases, rehabilitation takes place in a special facility, though lightly oiled and uninjured animals may be cleaned in the field and released. Planning, training, experience, and networks of wildlife rehabilitators have improved and expanded considerably over the past several decades such that, depending on site conditions, a vast majority of captured individuals survive the experience and are released as discussed below.

Perhaps the largest wildlife rescue and rehabilitation effort in freshwater environments that has been conducted to date took place in response to Enbridge's Line 6B release near Marshall, Michigan in July 2010. Approximately 20,000 barrels of crude oil was released and 8,200 barrels entered Talmadge Creek and the Kalamazoo River (Enbridge 2013). Active wildlife response activities were initiated on July 28, 2010, and concluded on October 2, 2011. This effort included the care and overwintering of 463 animals.

Additional wildlife captures and in-river relocations were made in 2013 to inspect, clean (when necessary), and remove individuals from areas where active oil dredging was occurring.

Between the initiation of wildlife response activities in 2010 and the conclusion of dredge activities (December 31, 2013), a total of 14,053 individual animals had been collected and 13,543 (96.4%) survived (Enbridge 2014). An additional 157 turtles that were hatched during captivity were released. Survival rates were highest for amphibians, crustaceans, and turtles, and lowest for mammals (Table 8-1).

Table 8-1 Enbridge Line 6B Pipeline Release—Wildlife Response Summary from July 28, 2010, to December 31, 2013

Category	Individuals	Dead on Arrival	Died in Care	Euthanized	Released	In Care	Survival (%)
Birds	196	25	27	0	144	0	73.5%
Mammals	72	34	15	0	23	0	31.9%
Turtles	5,605	26	74	5	5,479[1]	21	98.1%
Snakes	23	4	2	1	16	0	69.6%
Amphibians	893	0	0	0	893	0	100.0%
Fish	6,715	290	0	0	6,425	0	95.7%
Crustaceans	549	5	2	0	542	0	98.7%
Total	14,053	384	120	6	13,522	21	96.4%

NOTE:
[1] Does not include 157 turtle hatchlings born in the wildlife center and released during 2011 and 2012.

Long-term studies evaluating the post-release survival of animals rehabilitated during the Enbridge Line 6B wildlife response are underway. Although complete quantitative analysis is not yet complete, data show that numerous turtles were recaptured over the course of four years and the successful captive reproduction from oiled female turtles suggest positive long-term survival results.

Wildlife rehabilitators have reported similar success from crude oil releases into freshwater and marine environments. Saba and Spotila (2003) reported on the Sun Pipeline Corporation crude oil pipeline release of approximately 4,800 barrels in the John Heinz National Wildlife Refuge in Pennsylvania in 2000. After tracking 66 rehabilitated turtles, the authors concluded that, "[r]ehabilitation of oil exposed freshwater turtles is effective in restoring these animals to normal behavior in nature." Golightly et al. (2002) studied the behavior and survival of a small set of western gulls after rehabilitation from the offshore 1997 Torch Operating Company crude oil release in south-central California. Approximately 170 barrels were released and 78 bbl recovered. All oiled and rehabilitated birds survived until their transmitters failed (127 to 235 days). Dunne and Miller (2007) studied the post-release survival of oiled, rehabilitated waterfowl from multiple release events throughout the U.S. using data from the USGS Bird Banding Laboratory and concluded that "contact with oil and subsequent rehabilitation is not an indicator of reduced post-release survivability in mallards and Canada geese, and that release location has a significant effect on longevity." More recently, Ziccardi et al. (2011) examined the behavior and survival of rehabilitated surf scoters oiled during the offshore 2007 cargo ship *Cosco Busan* (operated by Fleet Management Ltd.) event, which released 1,260 barrels of heavy fuel oil in San Francisco Bay. While survival rate estimates for the oiled birds were lower than for other non-oiled groups, the authors noted that the results exhibited, "possibly stronger effects based on captivity and/or rehabilitation versus overt effects of oiling." While Russell et al. (2003) correctly pointed out that each species may respond differently to the stress of being oiled, captured, and rehabilitated and the handling of animals at a given facility can influence survival, the overall rehabilitation goal of releasing healthy animals that can survive in the wild is being realized.

8.4.4 Restoration

When a release of crude oil or other contaminants occurs, the condition of the environment prior to the release is considered a "baseline" for evaluation of damages resulting from the event. The loss of ecosystem services, or "injury," reduces conditions below the baseline and then, as the crude oil is cleaned up, the affected ecosystem services begin to recover naturally (Figure 8-1). Restoration attempts to reduce the magnitude and duration of the injury by hastening the recovery of affected resources back to baseline conditions through active human intervention activities (French et al. 1996; OPA 1990).

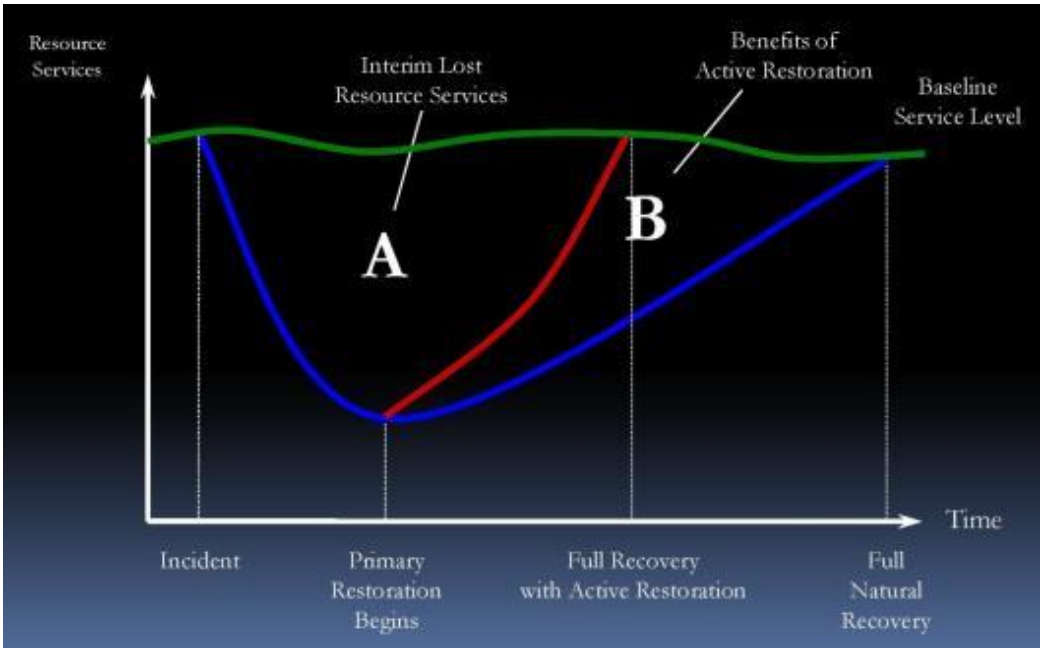

Figure 8-1 General Model of Ecosystem Service Loss Following a Petroleum Hydrocarbon Release

Examples of human intervention activities that can hasten recovery include removing contaminated soil and backfilling areas with appropriate soils, sediments, or other materials; seeding and planting disturbed habitats; treating invasive species; stocking fish or other species; augmenting soil mycorrhizae; and installing wildlife or fish habitat structures. The specific measures selected in a particular case are determined by the type, location, and abundance of resources affected.

During the Line 6B spill response in Michigan, Enbridge employed a variety of restoration techniques with the intent of reducing damages and the time necessary for affected areas to recover. Some of the techniques implemented included backfilling scraped and excavated areas, seeding and planting with native species, and controlling the spread of invasive species. Five years after the release, monitoring data submitted to the MI DEQ indicate that affected wetland areas are showing a comparable level of quality and function to similar unaffected areas and appear reasonably consistent with environmental conditions without crude oil disturbance (Enbridge 2015b, 2015c, 2016a, 2016b). Enbridge also provided multiple compensatory restoration projects, including removal of a dam, creation of 300 acres of wetlands, and construction of five recreation sites (USFWS et al. 2015a).

At Enbridge's 2002 Cohasset release site in Minnesota where 6,000 barrels of crude oil were released with 2,574 barrels recovered, wetland restoration efforts included reestablishing site

topography and vegetation. Disturbed surfaces within the wetland were re-contoured to create pit and mound micro-topography; native wildflowers and grasses were seeded; emergent plants, unrooted cuttings (shrubs and trees) and tree seedlings were planted; and the area was treated to control the spread of invasive plants. Although removal of peat soil caused the site to be wetter than before the release, it is now a functional marsh-type wetland following restoration (USFWS et al. 2005). Enbridge also provided for the restoration of 30 acres of forested and scrub-shrub wetland and the retrofit of 10 school buses for particulate emission reductions as compensatory projects (USFWS et al. 2005).

Resource enhancement can also be conducted in conjunction with restoration efforts, raising the level of ecological function above baseline and providing greater service benefits. Following a 2003 release of approximately seven barrels of No. 6 Fuel Oil from its B.L. England Generating Station in Cape May, New Jersey, Conectiv Energy restored the area by replacing damaged invasive vegetation with native species. Project reports indicated that at the end of the first growing season, development of planted vegetation was progressing throughout most of the project area with vegetative cover by native species averaging 41% for the site, representing approximately half of the total 80% native vegetative cover required to be deemed successfully restored (Pfeifer and Hess 2005). The improved community diversity above baseline conditions provided greater benefits to marsh animals such as fiddler crabs, diamondback terrapins, egrets, butterflies, mummichog, and humans. Conectiv Energy restored additional habitat adjacent to the damaged area as a compensatory project to increase the benefits to marsh ecosystem services (Pfeifer and Hess 2005).

8.4.5 Summary

While recovery cannot eliminate the damages caused by a release of crude oil and associated response activities or achieve a full restoration of exactly what existed before a crude oil release, reports from past release events suggest that it can reduce the overall amount and extent of damages and substantially reduce the time necessary for natural resource recovery to occur. The remaining loss of ecosystem services can then be addressed through compensatory restoration (as identified by the applicable regulatory agency) to address interim losses (i.e., reduced ecosystem functions and human use of the resources during the time it takes the resources to recover).

8.5 DISCUSSION

When possible, the case studies selected for review of recovery of environmental receptors in the physical, biological and human environments focused on crude oil releases that occurred within the same or similar climatic conditions, ecosystems, and communities as those found in Minnesota. In some cases, recovery from releases in other regions was discussed to offer greater breadth of information on factors that influence recovery rates.

For biological and physical environments, the ability of environmental receptors to recover, the timeframe for recovery, and the factors affecting recovery rates were examined. For human environments, the processes by which human use and socio-economic conditions recover following crude oil releases and the factors influencing recovery also were addressed.

The case studies that were reviewed generally were large releases since these releases are better documented due to the severity or magnitude of the event. As the majority of pipeline releases tend to be relatively small with a median volume of three barrels (PHMSA 2016), the effects are expected to be less than for large releases and rates of recovery are expected to be more rapid.

8.5.1.1 Physical Environment

The recovery of the physical environment (e.g., surface water, groundwater, soil) from a crude oil release is determined by numerous factors including site-specific environmental conditions at the time of the release, the environmental material that is affected, the severity and areal extent of the release, the type of oil released, the speed and efficacy of emergency response, and methods for clean-up and site remediation.

8.5.1.1.1 Surface Water

The rate of recovery of surface water is measured by the rate at which petroleum hydrocarbons are removed from the environment, as well as the ability of the surface water to support aquatic life and meet drinking water standards protective of human health and the environment.

Based on PHMSA pipeline incident statistics[38], the vast majority of crude oil releases do not affect surface water resources. Even though 47% of pipeline releases occur completely within the operator's property, there were only 2.7% of hazardous liquid pipeline incidents that required surface water remediation and only 0.2% of the incidents that affected drinking water resources (PHMSA 2016).

Factors that accelerate the recovery of surface waters include:

- Prompt and efficient emergency response to remove crude oil from the environment
- Warm temperatures, sunlight, and nutrient availability to facilitate weathering and biodegradation
- High flow rates in rivers and inflow in ponds and lakes that dilute crude oil and flush the affected area of petroleum hydrocarbons
- Large waterbody size, which contributes to dilution of crude oil and crude oil constituents

[38] Incidents must be reported to PHMSA if the incident results in one or more of the following consequences: 1) a release of 5 gallons or more, 2) death or serious injury necessitating hospitalization, 3) fire or explosion not intentionally set by the operator, or 4) property damage of $50,000 or more (49 CFR 195.50).

8.5.1.1.2 Groundwater

For groundwater, the rate of recovery varies depending primarily on the amount of crude oil in the environment; the vulnerability of the groundwater (e.g., unconfined and confined aquifers); the physical and chemical characteristics of the crude oil; and attributes of the groundwater (e.g., oxygen and nutrient availability, microbial populations, physical, and chemical composition of the aquifer materials).

Based on PHMSA pipeline incident statistics, the vast majority of terrestrial crude oil releases do not affect groundwater resources. Even though 47% of pipeline releases occur completely within the operator's property, there were only 3% of hazardous liquid pipeline incidents that required groundwater remediation, and only 0.2% of the incidents that affected drinking water resources (PHMSA 2016).

Although contaminated groundwater may take decades to recover, petroleum hydrocarbon plumes tend to move slower than groundwater and generally move only tens of hundreds of feet (as opposed to thousands of feet). A review of petroleum hydrocarbon groundwater plumes throughout the U.S. found that the plume size was stable or shrinking at the majority of sites examined, indicating groundwater resources recover from petroleum hydrocarbon contamination (Newell and Connor 1998). The removal of residual oil from the environment is critically important for recovery of groundwater resources.

8.5.1.1.3 Soil

As discussed above, many pipeline incidents occur completely within the operator's property and most are small in volume (three barrels or less). Based on PHMSA statistics, pipeline incidents that occurred off the operator's property are small (20 barrels), and the majority of releases require soil remediation involving 100 cubic yards of soil or less. Only 3% of releases reported to PHMSA require soil remediation of 10,000 cubic yards or more (PHMSA 2016)

The speed of soil recovery is primarily related to release volume, type of oil released, the soil type, and the speed and efficacy of emergency response. While crude oil releases can adversely affect soils, there are a number of environment fate processes that can facilitate soil recovery. For example, microbial biodegradation, in combination with other environmental fate mechanisms, such as evaporation and photodegradation, facilitate the recovery of soils. In Minnesota, microbial biodegradation may be slower than more temperate areas with warmer soil temperatures, but remediation techniques that oxygenate and fertilize soils can be used to enhance soil recovery rates.

8.5.1.2 Terrestrial Ecosystems

Similar to the physical environment, the recovery of the biological environment from a crude oil release is determined by numerous factors including site-specific environmental conditions at the time of the release, the types of environmental receptors affected, the severity and areal

extent of the release, the type of oil released, the speed and efficacy of emergency response, and methods for clean-up and site remediation.

8.5.1.2.1 Terrestrial Vegetation

In general, the recovery of plants is closely associated with the recovery of affected soils, though vegetation may also be directly affected by direct contact (oiling) or toxicological processes. Other factors accelerating the recovery of plants include the presence of nearby vegetation populations that act as sources for seeds and the use of active clean up and recovery strategies (e.g., removal of coated vegetation, reseeding, fertilization of soils). The timing of the release also is important as areas that are affected during periods of dormancy tend to recover more quickly. Recovery of terrestrial plants is variable and dependent on the severity and areal extent of effects, the recovery of soils, the techniques used during emergency response and clean up, and the successional stage of the community.

National pipeline incident data indicate that only 2.5% of pipeline incidents reported to PHMSA resulted in the need for active vegetation remediation (PHMSA 2016).

8.5.1.2.2 Terrestrial Biota

Terrestrial wildlife, including birds, mammals, and reptiles, may be affected in the event of a crude oil release. Recovery of wildlife depends upon the susceptibility, behaviors, and physical traits of the species affected. For example, case studies found that reptiles recovered more quickly from oiling compared to birds and mammals; this is attributed to the lack of fur or feathers that crude oil can adhere to, which helps reduce adverse effects due to physical contact. While individual organisms differ in their susceptibility and may experience adverse effects, effects to wildlife populations are influenced by life history strategies. The loss of multiple individuals may substantially affect some populations, while others may show minimal effects.

Active wildlife remediation programs are generally associated with the large, widespread releases and, consequently, are only reported in 0.4% of releases (PHMSA 2016).

Historical releases have demonstrated that individual animals, if captured and treated quickly following oiling, can survive and often be returned to the wild. If emergency response is prompt and strategies to reduce effects to wildlife (e.g., use of wildlife deterrents) are employed, recovery can be rapid. Active wildlife remediation programs are generally associated with the large, widespread releases and, consequently, are only reported in 0.4% of releases (PHMSA 2016).

8.5.1.3 Aquatic Ecosystems

The recovery of the aquatic ecosystem from a crude oil release is determined by numerous factors including site-specific environmental conditions at the time of the release, subsequent water flows through the affected area, the environmental media affected, the types of environmental receptors affected, the severity and areal extent of the release, the type of oil

released, the speed and efficacy of emergency response, and methods for clean-up and site remediation.

8.5.1.3.1 Aquatic Biota

Aquatic ecosystems directly and indirectly support a myriad of organisms including aquatic and riparian vegetation, fish, amphibians, benthic invertebrates, birds, and mammals. Crude oil releases can have substantial effects on surface water and the ecosystems it supports. As described above in Section 8.5.1.1, Physical Environment, the recovery of surface waters is measured by the rate at which petroleum hydrocarbons are removed from the environment, as well as the biological recovery of organisms that rely on the affected surface water.

Factors facilitating the recovery of aquatic ecosystems closely mimic the factors affecting recovery of surface waters, including:

- Prompt and efficient emergency response to remove crude oil from the environment
- Warm temperatures and nutrient availability to facilitate weathering and biodegradation
- Presence of upstream populations of fish, wildlife, and invertebrates to facilitate recolonization
- High flows in rivers and inflow in ponds and lakes, which dilute crude oil and flush the affected area of hydrocarbons
- Large waterbody size, which contributes to dilution of crude oil and crude oil constituents

National PHMSA pipeline incident data show that approximately 1.2% of crude oil releases affect fish (PHMSA 2016).

In general, effects to aquatic ecosystems tend to be temporary and localized in extent. While rates of aquatic ecosystem recovery are variable, recovery in flowing systems can begin to occur soon after the release event as the crude oil is flushed from the system. Recovery in stationary or slow moving waters may take longer as recovery may be more dependent upon weathering and other degradation processes, rather than flushing flows.

8.5.1.4 Human Environment

Since the late 1960s and the emergence of the environmental movement, great strides have been made through the passing of laws and programs for safety and release preparedness, communication, and compensation. Three measures of socio-economic recovery from a crude oil release are: 1) restoration of daily life activities and monetary reimbursement; 2) the return of ecological functionality of affected land and resources; and 3) restoration of the well-being of individuals and communities adversely affected by a release through financial compensation for damages. Review of literature and case studies demonstrate that communities recover from socio-economic effects, and the speed and efficacy of spill response can limit the severity of effects to human uses and the area affected by a release, which facilitate recovery rates.

Based on recent national incidents reported to PHMSA, approximately 24% of reported incidents have occurred within populated areas (PHMSA 2016). Evacuations occurred in 2.3% of releases with an average evacuation of 101 evacuees per incident (PHMSA 2016).

8.5.1.5 Summary

Recovery rates are affected by numerous factors, including:

- Condition of the environment prior to disturbance, including natural variability and climatic conditions that can affect recovery rates
- Severity and spatial extent of the disturbance, including the type of crude oil; amount of residual crude oil left after initial response and clean up; and the persistence of residual crude oil in the environment
- Environmental conditions that affect crude oil evaporation and degradation rates (e.g., temperatures, nutrient and oxygen availability, sunlight)
- Resiliency and resistance of the ecosystem. Broadly, a species sensitivity to chemical exposure and its life history strategy (e.g., "r" or "K" strategists) can strongly influence the population's ability to withstand and recover from an oil release
- Proximity and mobility of nearby populations that can help quickly re-establish affected populations
- Speed and efficacy of emergency response and clean up

This review demonstrates that recovery of abiotic and biotic ecosystem components occurs after a crude oil release, though the timeframes for recovery are variable due to a variety of factors, as described above. Environmental conditions within the affected area, the types of environmental media and receptors affected, the severity and areal extent of the release, and the speed and efficacy of emergency response and clean up are major factors that affect the timeframes for recovery., Some very broad generalizations can be made about recovery rates from large crude oil releases as summarized in Table 8-2.

Table 8-2 Generalized Recovery Rates of Environmental Receptors After a Crude Oil Release with Significant Effects

Environmental Receptor	Unassisted Recovery Rates	Recovery Rates with Remediation	References
Terrestrial soil & vegetation	Months to years	Days to several years	Belsky 1982; De Jong 1980; Hemmings et al. 2015; Nieber 2013; Sparrow and Sparrow 1988; Wang et al. 1998; Wein and Bliss 1973
Terrestrial "r" strategists (species that tend to be short lived, reproduce quickly, abundant, and high mobility)	Months to several years	Weeks to months	Belsky 1982; Belsky 1975; CHMR et al. 1990; Robson et al. 2004

Table 8-2 Generalized Recovery Rates of Environmental Receptors After a Crude Oil Release with Significant Effects

Environmental Receptor	Unassisted Recovery Rates	Recovery Rates with Remediation	References
Terrestrial "K" strategists (species that are relatively long lived, slow to maturity, low reproduction rates)	Years to decades	Months to years	Bodkin et al. 2002; Hemmings et al. 2015; Saba and Spotila 2003; Stantec et al. 2012a
Surface water	Hours to days	Hours to days	Brown 2015; Hirji 2015.
Groundwater	Decades	Years to decades	Delin and Herkelrath 2014; Newell and Conner 1998
Aquatic sediments	Years to decades	Months to years	Fingas 2015; Guiney et al. 1987a; Hemmings et al. 2015; Poulton et al. 1997
Aquatic biota "r" strategists	Weeks to years	Weeks to months	Crunkilton and Duchrow 1990; Cushman and Goyert 1984; De Pennart et al. 2004; Lytle and Peckarsky 2001; Pontasch and Brusven 1988; Wallace 1990
Aquatic biota "k" strategists	Years to decades	Months to years	Goldberg 2011; Guiney et al. 1987a; Kubach et al. 2011
Socio-economic	Years to decades	Months to years	Arcadis 2011; Clarke and Hemphill 2002; Fall et al. 2001; Webler et al. 2010
Public perception (local)	Years to decades	Years to decades	Wooley 2002; Wooley 1995

9.0 SUMMARY AND CONCLUSIONS

As part of the route permitting process for L3RP, the DOC-EERA was directed to complete an environmental review. The review was required to include an assessment of large releases of crude oil, including the probability of such events, modeling of crude oil releases, and an assessment of the potential corresponding environmental effects. Pinhole leaks, which were identified as a concern by regulators and the public, are discussed in a separate report.

To complete this assessment, a number of factors and aspects have been discussed in this report, including:

- How a large release of crude oil might occur and the likelihood of such a release (i.e., a threat assessment and failure frequency analysis for the pipeline segments at each of the seven representative locations)
- Likely trajectory and fate (i.e., behavior) of unmitigated large releases (assuming no emergency responses within the first 24 hours) of several types of crude oil under different geographic, environmental, and seasonal conditions
- Range of potential effects that an unmitigated large release of crude oil may have on the natural and human environment
- Potential and timing for the recovery of the natural and human environments following a large release of crude oil, including how cleanup and remediation can influence recovery

Scientific studies and monitoring have documented that the effects of exposure to large releases of crude oil on freshwater and terrestrial ecosystems are adverse, and that human uses in the areas of a release can be negatively affected (Chapters 7.0 and 8.0). However, as discussed below, the extent and significance of these effects will depend on many factors, including the type and amount of crude oil, the sensitivity of the receptor to crude oil exposure, seasonal and environmental conditions, physical conditions such as river flow rates and shoreline types, and biological conditions such as shoreline or wetland vegetation cover.

While effects of exposure to crude oil can be adverse, incident records from past pipeline operations, as well as analyses of failure frequencies for the seven representative locations, demonstrate that a large release from a new and modern pipeline such as L3RP would be unlikely. Modern pipeline design includes a wide range of measures to reduce the likelihood of an oil release, including pipeline design, to directly address higher risk segments of the ROW; technical specifications for pipeline materials; construction techniques such as deeper burial in higher risk segments or HDD under watercourses; operational and emergency protocols for pipelines and pump stations; ongoing monitoring and inspection of pipelines; and preventive maintenance.

Further, pipeline operators such as Enbridge, are required to prepare emergency response plans, demonstrate response preparedness through regular inspections of response equipment, and regularly conduct drill exercises for hypothetical oil releases. As a result, if a release were to

occur, emergency responders would be prepared and response actions would be taken swiftly (i.e., within hours) to help reduce immediate and long-term effects on the natural and human environment. Site remediation and restoration methods have advanced substantially over the past two decades, and would help reduce long-term effects on the biophysical and human environment and facilitate recovery of affected receptors.

As described in Chapter 8.0, evidence from actual oil releases demonstrates that biophysical and human receptors will recover following exposure to released crude oil, although the timeframes for recovery can vary. Effective clean-up of a release, combined with appropriate remediation and restoration methods will enhance recovery.

In reality, if an oil release were to occur, Enbridge would be expected to respond to the release within a matter of hours. Accordingly, the modeling of unmitigated large releases of crude oil constitutes an unlikely scenario for the proposed pipeline. As a result, the predicted trajectories, fates, and effects described here represent worst case scenarios.

In this chapter, results from the report are summarized with respect to:

- What is the likelihood of a large release of crude oil?
- How do different types of crude oil behave?
- How do seasonal flows and climate conditions influence possible outcomes?
- How do shoreline vegetation and water body types influence possible outcomes?
- What are the effects of crude oil exposure for various receptors?
- Will these receptors recover and how quickly?

9.1 WHAT IS THE LIKELIHOOD OF A LARGE RELEASE OF CRUDE OIL?

The primary purpose of this report is to provide quantitative and qualitative information regarding the risk of a crude oil release from the proposed L3RP. Risk is defined most concisely as the "chance of loss". Accordingly, in the context of the risk associated with the operation of the L3RP pipeline, the term "risk" is used as a joint expression of chance (the annual probability of incurring a rupture in the L3RP pipeline), and loss (the consequences associated with such a rupture). The failure frequency analysis (Chapter 4.0) focuses on identifying potential threats for the seven representative locations along the proposed L3RP pipeline. For those threats that have the potential to contribute to the overall failure probability at each representative location, the annual probability (frequency) that a large release of crude oil will occur was assessed.

To address the probability of a large crude oil release, quantitative estimates of rupture frequency were determined for each of the seven representative locations. In linear infrastructure such as pipelines, the probability of failure over a given time period is proportional to segment length, with longer segments being associated with greater probabilities. Therefore, given that each of the seven representative sites were associated with river crossings, the length of the pipeline segment that was considered in the failure frequency analysis was established through a high resolution analysis of outflow and overland spill modeling for each modeled

location. Full-bore rupture release scenarios were modeled in OILMAP Land as multiple individual releases at intervals of 32.8 ft (10 m) inland from each side of each river crossing. The model characterized site-specific local topography and land cover using a release volume specific to each crossing to determine whether spill plumes could reach the water body by means of overland flow. The length of pipeline defined by endpoints located inland from each river bank, over which the spill plume from a hypothetical full bore rupture could impact the water body (either directly, or by means of overland flow), was termed the "potential impact segment". The total length of the potential impact segment was the basis of estimating failure probability at each of the seven representative locations.

Having established the potential impact segment at each of the seven representative sites, quantitative estimates of rupture frequency for these segments were made, based on a two-step analysis. The first step involved a Threat Assessment in which the relevant threats for each impact segment were identified. As part of the Threat Assessment, approaches for quantifying threat-specific rupture frequency were selected, giving consideration to the threat attribute data, as well as best practice methodologies. Using these approaches, threat-specific quantitative estimates of rupture frequency were then generated for each potential impact segment in the second step of the analysis—the Frequency Analysis.

Potential threats to the L3RP that were examined included: external corrosion, internal corrosion, stress corrosion cracking, manufacturing defects, construction defects, equipment failure, third party damage, incorrect operations, weather related and outside force, and other threats. The threat assessment examined each of these potential threats to the specific segments of the L3RP in proximity to the seven representative locations, taking into account the design, materials, and construction and operational attributes for the pipeline.

The threat assessment showed that with the exception of "stress corrosion cracking" and "other threats", all of the remaining potential threats for the seven representative locations contributed to overall failure frequency. These potential threats were included in the quantitative assessment of failure frequency for that potential impact segment. Equipment failure (which addresses the failure of non-pipe components such as valves or equipment within pump stations) was not included in the failure frequency analysis, as none of the potential impact segments considered for the seven representative locations included non-pipe components.

To be consistent with the assessment of full bore ruptures in the consequence analysis, the frequency analysis focused on the occurrence of ruptures (as opposed to smaller leaks) within the potential impact segment. Based on the guidance provided in the Threat Assessment, the frequency analysis estimated rupture frequency for each of the seven representative locations using optimal approaches for each threat. These approaches included:

- Methods based on Industry Incident Data—PHMSA Hazardous Liquids Database, 2010-2015 (threats assessed using this method included manufacturing defects, construction defects and incorrect operations)

- Methods based on mechanistic, reliability approaches (external corrosion, internal corrosion, and third party damage)
- Site-specific evaluation of hydrotechnical and geotechnical hazards (weather related and outside forces)

The annual probability values, as well as the average annual return periods (defined as the inverse of the annual probability values) for each of the potential impact segments are summarized below:

Table 9-1 Annual Probability of Rupture and Average Return Period within the Potential Impact Segment for Each of the Seven Potential Impact Segments

Site Number	Annual Probability of Rupture	Average Return Period (yr)
	L3RP	L3RP
1—Mosquito Creek	3.402×10^{-06}	293,945
2—Mississippi River at Ball Club	3.961×10^{-07}	2,524,615
3—Sandy River	1.939×10^{-06}	515,730
4—Shell River	4.388×10^{-06}	227,894
5—Red River	2.781×10^{-06}	359,583
6—Mississippi River at Palisades	2.527×10^{-06}	395,726
7—Mississippi River at Little Falls	2.287×10^{-06}	437,254

As noted above, for linear infrastructure, such as pipelines, the likelihood of incurring a failure at some point along a pipeline segment increases as the length of the segment that is being considered increases. This is reflected in the above results, with the longest potential impact segment (the 2,543 ft-long segment associated with the Shell River crossing), having the greatest probability of failure.

The annual likelihood of a large crude oil release occurring within the seven potential impact segments for L3RP ranges from 4.388×10^{-06} to 3.961×10^{-07}. These failure frequencies are equivalent to average annual return periods from 227,894–2,524,615 years. Based on these values, large releases of crude oil from the proposed L3RP at any of the seven sites evaluated are considered to be unlikely.

9.2 HOW DO DIFFERENT TYPES OF CRUDE OIL BEHAVE?

Crude oils and refined petroleum products are complex mixtures of many thousands of different hydrocarbon compounds derived from naturally occurring geological formations. Each has

physical and chemical properties (e.g., viscosity, density, solubility, volatility) that reflect its composition and affect its transport and fate, once released into the environment (NRC 2003).

When released into the environment, various weathering processes work to break down the hydrocarbons into primarily carbon dioxide and water. The rate of these natural weathering processes depends principally upon the type of crude oil (i.e., the specific mixture of hydrocarbon compounds present), and the characteristics of the receiving environment (e.g., location of the release, season, and weather conditions).

A range of product types are expected to be shipped in the L3RP pipeline, including heavier crude oils such as diluted bitumen and lighter crude oils such as Alberta Light Sweet Crude. To account for the differences in the types of crude oil that could be transported and the range of behaviors these oils would have within the environment, both a light crude oil (i.e., Bakken Crude) and two different blends of a single heavy crude oil (i.e., CLB) were considered in the risk analyses. The latter type of crude oil has a chemical composition that varies throughout the year, and was represented in the modeling as CLSB and CLWB. These two types of crude oil (Bakken Crude and CLB) represent products that exist within the spectrum of crude oil types commonly encountered in North America (Lee et al. 2015).

CLB is a diluted bitumen (often referred to as dilbit) with density and viscosity values that are in the upper range of values allowed by pipeline tariff specifications (typically less than 0.94 g/cm^3 at 15°C); both the modeled CLSB and CLWB have a density of approximately 0.92 g/cm^3 (Environment Canada 2016; Horn 2016). Because seasonal variations in environmental temperature affects the viscosity of diluted bitumen, the amount of condensate or other diluent added to the bitumen feedstock is adjusted through the year to meet shipping requirements to maintain the desired viscosity required for pumping. In turn, this also affects the density and viscosity of the crude oil, and the amount of soluble and volatile hydrocarbons present, which can result in slightly different behaviors.

Bakken crude is a light sweet crude oil with a sulfur content less than 0.2 wt.%; it is similar to many other light sweet crude oils produced and transported in the United States (Auers et al. 2014). The light end concentration of Bakken crude is between 3 and 9%, with 5% being typical (NDPC 2016). The Bakken crude oil used for modeling in this study had a density of 0.82 g/cm^3.

The time of year when a release occurs can have an important effect on the fate of crude oil due to differences in the temperature of the air, water, or soil; presence and depth of snow cover; presence and percent coverage of ice on water surfaces; and the depth of the active soil layer. During winter, cold air temperatures can increase the viscosity of released crude oil (i.e., make it thicker) so that it would spread more slowly, and potentially solidify. Temperature also affects the rate of evaporation of the volatile fraction of hydrocarbons; less of these fractions will evaporate, and will do so more slowly in colder temperatures than warmer temperatures. Frozen ground can limit the depth of penetration of any release. Variations in

weather can also affect the ability of responders to detect, contain, or clean up a release (e.g., ice, torrential rains or flood events can make recovery of crude oil more challenging).

A large number of physical and chemical processes govern the fate of released crude oils (Figure 9-1). These same processes drive the potential for exposure and the types of effects that can occur to ecological, land cover, and human receptors.

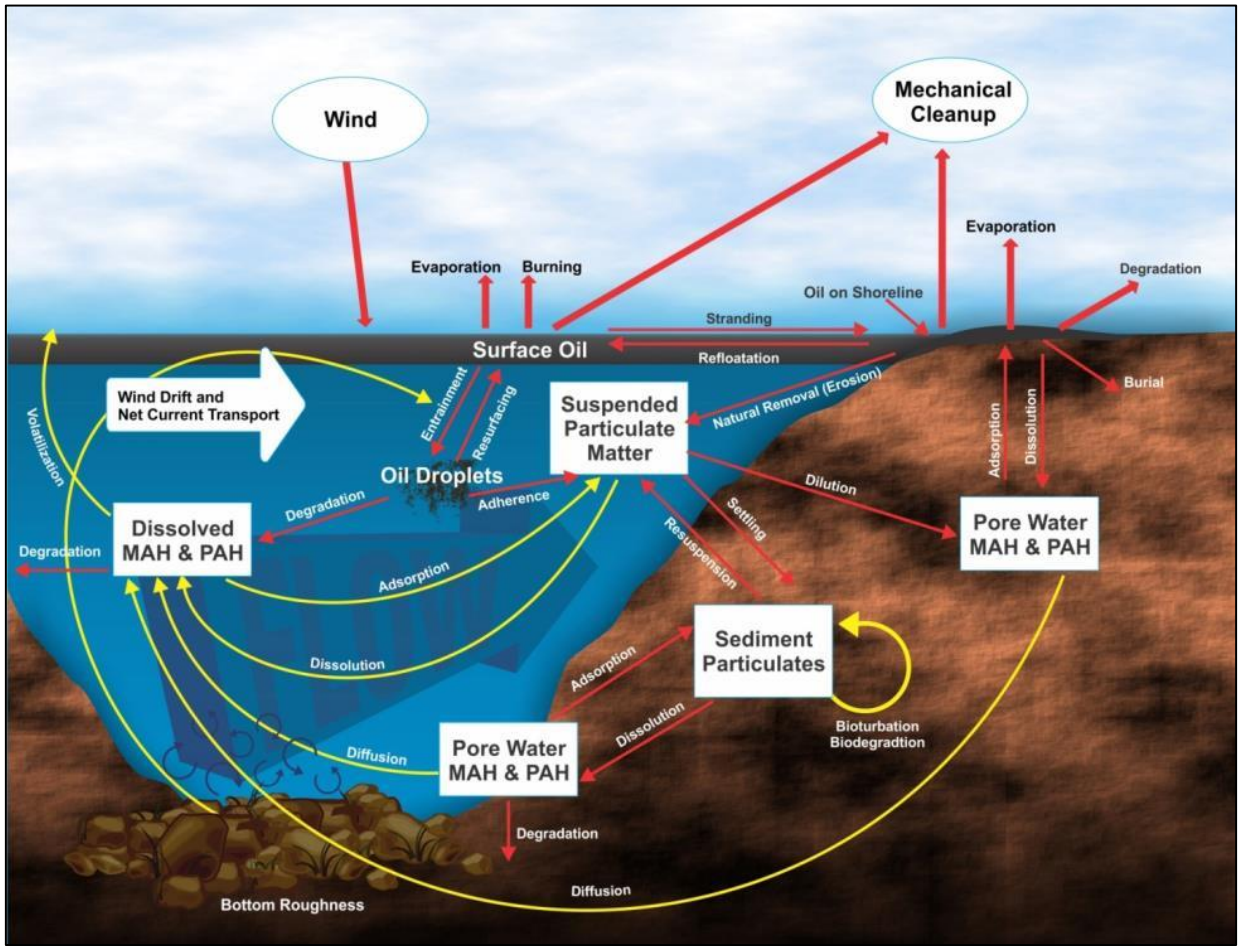

Figure 9-1 Crude Oil Fates Processes in Lakes and Rivers (Horn 2016)

Differences in the varying weathering processes for Bakken crude oil and CLB are summarized below:

Process	Comparison of Types of Crude Oil (Bakken, CLB and CLWB)
Spreading	Light crude oils such as Bakken are anticipated to spread more quickly due to their relatively low viscosity, when compared to heavier crude oils such as CLB.
Oil particle aggregation (binding of oil to sediment particles)	Any crude oil (including Bakken and CLB) can form OPAs, as they tend to adsorb to mineral and, especially, organic particles that are within the water column. The dispersion of crude oil into the water column as fine droplets, where it can interact with suspended sediment particles, is a necessary first step in this process for the formation of typical OPAs.
Evaporation	Losses through volatilization are greater in lighter crude oils such as Bakken, relative to CLB, as the composition of lighter crudes includes a larger proportion of volatile compounds.
Dispersion	Bakken crude will disperse more readily into the water column, when compared to CLB, due to its low viscosity and, therefore, the low amount of energy required to entrain this crude oil. This has implications for the potential formation of OPAs, as well as for the dissolution of relatively water soluble constituents of hydrocarbon and potential toxicity to aquatic life.
Dissolution	Bakken has a higher potential for dissolution, when compared to CLB, due to a larger percent composition of soluble lighter ends and lower viscosity. Due to the larger amount of condensate added, CLWB has more soluble compounds than CLSB.
Emulsification	In general, heavier crude oils emulsify more readily than lighter crude oils, although recent reports suggest that diluted bitumens do not readily emulsify (Fingas 2015).
Benthic deposition or sinking	Crude oils (including diluted bitumens) rarely weather sufficiently in the natural environment to result in a density greater than 1.0, so they tend to remain floating on the water surface unless other factors further modify the density. Formation of OPAs is the process most likely to result in released crude oil achieving a density (in combination with entrained or adhering mineral particles) that is greater than 1. The formation of an OPA and the density of the aggregation depends on a number of factors including the viscosity and density of the crude oil; the salinity and mixing energy available in the water body; and the concentration of suspended sediment present. Oil that strands along shorelines can also contact and bind to coarser sediment particles (e.g., sand and gravels) resulting in an aggregation that can sink if it enters the water body.
Photo-degradation	Bakken is likely subject to increased photo-oxidation relative to CLSB and CLWB. Diluted bitumens contain more resins and asphaltenes than lighter crude oils, and these hydrocarbons tend to be more resistant to weathering through photo-degradation.
Biodegradation	Accelerated in the presence of abundant oxygen and nutrients and at moderate temperatures; saturates and aromatics are expected to biodegrade within weeks (straight-chained aliphatics) to years (highly branched aliphatics to multi-ringed aromatics). Diluted bitumens contain more resins and asphaltenes than lighter crude oils, and these hydrocarbons tend to be more resistant to weathering through biodegradation.

Lighter crude oils such as Bakken tend to more readily evaporate, disperse and dissolve relative to diluted bitumen (diluent notwithstanding), resulting in a greater potential for toxic effects to the atmosphere, as well as biological communities residing in lakes and rivers. In addition, volatile compounds may result in potential inhalation exposure for human receptors.

Heavier crude oils tend to adhere to vegetation and soils along riparian banks and lakeshores that are within the predicted trajectory of an oil release, and tend to expose biological receptors that inhabit these areas. In general, heavier crude oils are more persistent and, as a result, may expose receptors over a longer period of time, relative to lighter crude oils.

Importantly, the specifics of any given incident will drive the fate and effects of released crude oil and refined petroleum products. Swift and effective containment of released crude oil, as well as cleanup, remediation and restoration will help to reduce the scale and magnitude of adverse effects (Lee et al. 2015). The influence of seasonal flows, climate condition, water body type and shoreline vegetation on the outcomes of a large release of crude oil is discussed below.

9.3 HOW DO SEASONAL FLOWS AND CLIMATE CONDITIONS INFLUENCE POSSIBLE OUTCOMES?

The downstream transport and fate of released crude oil is largely determined by river flow conditions and the type of crude oil. Three seasonal periods were considered in the modeling for L3RP: high river flow, coinciding with the spring freshet; average river flow, during summer or fall; and low river flow in winter, typified by freezing conditions and probable ice cover on the water surface.

Under high river flow conditions, the maximum downstream transport of released crude oil was predicted. Bakken crude oil is predicted to evaporate more, have a greater or equal proportion remaining on the river surface (or lake), and travel farther downstream, as compared to CLB. However, in the event of an actual release, it is expected that the downstream extents of both crude oils may be more similar, although the distribution of diluted bitumen may be patchier than light crude oils. Light oils such as Bakken crude oil are predicted to spread more thinly on the water surface with less adhering to riverbanks than heavy oils.

As a result of lower water velocities during average river flow conditions, both types of crude oil are predicted to travel a shorter distance downstream than during high flows. The fate of both crude oils during average flow conditions would be similar to those described for high flow conditions. However, evaporative losses could be greater in summer due to hotter ambient temperatures, or more comparable due to the lower surface area and the resulting reduction in evaporative surface due to less downstream transport. Evaporative losses would typically be higher for light crude oils such as Bakken, when compared to heavier crude oils such as CLB.

Under low river flow conditions, the predicted downstream extents of Bakken crude oil and CLWB was much less than during either the high flow or average flow period for most sites. The tendency for shorter downstream distances during the low flow period (i.e., winter) reflects the lower velocity of water in streams during the winter period, as well as adhesion to the undersurface of the ice (in SIMAP modeled cases). Ice cover on rivers and lakes during the winter would strongly limit or prevent evaporation to the atmosphere for both types of crude oil.

There was one exception in predicted downstream transport. Modeling for the Mississippi at Ball Club for both types of crude oil indicates that downstream transport was similar among all seasonal flows due to the large amount of shoreline oil retention.

As the primary objective of the modeling was to assess the trajectory, fate and effects of large releases of crude oil from a worst case perspective, only one of the seven representative locations (i.e., Mosquito Creek) included substantial overland flow of crude oil. The Mosquito Creek location was not a water crossing, but rather required overland flow to a seasonally variable, upper portion of the creek. At all other locations, overland flows of released crude oil and associated effects were generally not modeled because environmental effects of land releases of crude oil on soils, terrestrial vegetation and groundwater quality are limited in spatial extent (i.e., local), and readily remediated using conventional cleanup techniques (i.e., a release to land, or overland flow, is not a worst case event). Therefore, the environmental effects of a crude oil release on land cover receptors were not considered further in this assessment.

9.4 HOW DO SHORELINE VEGETATION AND WATERBODY TYPES INFLUENCE POSSIBLE OUTCOMES?

As noted above, differences in the downstream travel of crude oil are strongly influenced by river flow conditions (water volumes and resulting water velocity) and crude oil type. However, the type and density of shoreline vegetation and the waterbody type(s), also influence the downstream movement of crude oil.

Light crude oils such as Bakken would be expected to travel further downstream than the CLB due primarily to differences in shoreline oil retention. Larger amounts of CLB are predicted to strand as a thicker layer of oil on a given length of shoreline, than for the Bakken crude oil. Conversely, the same amount of Bakken crude oil could affect a greater length of shoreline, with a lesser thickness of oil.

As described in Chapter 5.0, the rate of oil loss to adhesion and puddle formation depends primarily on the physical characteristics of the land surface (vegetation type, land cover, slope) and the physical characteristics of the released product. Wetlands, including woody and herbaceous wetlands, have the highest oil retention values, followed by deciduous, evergreen and mixed forest (Table 5-1). Shrubland, grasslands and herbaceous cover, row crops and bare soil and rock have the lowest oil retention values. When comparing oil types, heavy crude oil will adhere more thickly to each of these surfaces than light crude oil (Table 5-2).

The type of water body and the associated river (or lake) flow conditions also affect the speed and distance that released crude oil may travel. The surface area of a water body and degree of mixing (e.g., turbulence or wave energy, especially sites such as waterfall or rapids) directly affects the rates of evaporation, dispersion (entrainment), dissolution, and photo-oxidation of released crude oil on the water surface, as well as the extent of spreading before crude oil reaches a shoreline or wetland (where adhesion could occur).

For the types of water bodies considered in this assessment, watercourses with well-defined channels and higher river flow rates tended to carry crude oil further and faster than sinuous and slower moving watercourses of a similar width and depth. This reflects not only the greater water velocity and volumes in well-defined water channels, but also the types of shorelines (i.e., typically dominated by shrublands, grass and herbaceous cover and bare substrates) and the lower oil retention value for these types of shorelines. In contrast, sinuous water courses have slower water flows and are typically associated with wetlands and riparian forests which have a high oil retention value.

As noted for the Mississippi River at Little Falls site, when crude oil releases move over turbulent water (e.g., rapids, tailraces, weirs or waterfalls), there could be substantial entrainment of crude oil into the water column. Entrained oil droplets in the water column would rise to the surface in downstream quiescent reaches of the watercourse. Downstream from the turbulent water areas, the dissolved aromatic hydrocarbon concentrations in the water column would increase, as the soluble portion of oil droplets forced into the water column dissolve into the water. Light oils such as Bakken crude oil that are exposed to such turbulent conditions would typically result in higher amounts of dissolved hydrocarbons in the water column, than would be the case for heavy crude oils such as CLB. Volatilization of the soluble compounds from the water would occur, as well as biodegradation.

When crude oil is mixed through the water column by turbulent mixing processes, there is also increased potential for small oil droplets that are suspended in the water column to interact with suspended sediments (i.e., the formation of oil-particle aggregations). This process is strongly influenced by the amount of suspended particulate matter in the water column. When diluted bitumen products (e.g., CLB) are dispersed in the water column and weather, they tend to adsorb to mineral and, especially, organic particles more than lighter crude oils. However, when diluted bitumen is on the water surface or along shorelines, natural weathering processes can actually increase the viscosity of heavy oils to a point where entrainment becomes less likely. Without this crude oil being in the water column, interactions between oil and suspended particulate matter may be reduced.

9.5 WHAT ARE THE EFFECTS OF CRUDE OIL EXPOSURE?

Overall, the effects of a release of light crude oil are expected to be similar to the effects of a heavy crude oil release, although at the level of the various ecological and human environment receptors, either type of crude oil may be predicted to have more or less spatially extensive or

severe effects. For example, for sediment, shoreline and riparian areas, lighter crude oil is often predicted to have less severe but more spatially extensive effects than heavier crude oil, due to its lower viscosity and adherence to shoreline substrates and riparian vegetation. For the other receptors (e.g., river and lake habitat, aquatic plants, benthic invertebrates, fish, amphibians and reptiles, birds and semi-aquatic mammals, air quality, human receptors, and public use of natural resources), the relative magnitude of effects of lighter and heavier crude oils are variable, depending upon site-specific conditions, and also depending upon whether acute or chronic effects are being considered.

9.5.1 Aquatic Receptors

The effects of a crude oil release on benthic invertebrates and fish depend on the characteristics of the released crude oil and environmental conditions at the time of the release. Acute toxicity to fish is commonly but not always observed in association with crude oil releases, and is an indicator that, at least briefly, concentrations of dissolved hydrocarbons in the water column are sufficiently high to cause acute toxicity due to narcosis. Where water flow in rivers is sufficiently rapid and turbulent to entrain crude oil as small droplets in the water, the potential for acute toxicity to fish (including eggs and embryos) and benthic invertebrates could be greater for the light crude oil than for heavier crude oils. There is also potential for phototoxicity from a crude oil release in summer due to high light intensity and long day length, especially for small fish that are lightly pigmented or transparent.

Where they occur, floating aquatic plants would be expected to be killed if contacted by a crude oil slick. Submerged aquatic plants would be less vulnerable, as their exposure to dissolved hydrocarbons would be brief, and they are not considered to be among the most sensitive groups of aquatic biota. Mortality of aquatic and riparian vegetation could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat.

During the winter (low flow) period, if a release of crude oil occurred onto the ice, the ice layer, as well as absorption of crude oil by snow, could substantially reduce the exposure of aquatic environments to oil. However, if crude oil was released directly to the river below the ice, or crude oil travelled along the ice surface and penetrated openings in the ice, the crude oil could travel downstream under the ice, accumulating in the narrow gap between the ice and the sediment along the river bank, or accumulating in hollows under the ice. For both types of crude oil, the winter ice would effectively inhibit evaporation, while providing greater potential for dissolution into the water column during the period of lowest dilution and water flow (i.e. lower volume of water moving through the river channel). Mortality of fish due to narcosis could occur and would be more likely for the light crude oil. The heavy crude oil would tend to remain in thicker localized accumulations, and rapid dissolution is less likely. As fish eggs and larvae would generally not be present during the winter, adult fish would be most affected. However, if crude oil residues in water and sediment remained, they could affect fish eggs and larvae in the following spawning season. Both crude oil types could be accumulated in sediment after a

release in winter, and both crude oil types would be subject to re-mobilization with spring breakup of the ice, and increasing water flow rates.

9.5.2 Semi-Aquatic Wildlife Receptors

Amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors) and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter) are present in many areas along the proposed pipeline route. If amphibians (adults, juveniles, or eggs) are directly exposed to crude oil, oiling effects, including mortality, could occur. Mortality of turtles is less likely, as these species appear to be relatively tolerant of external crude oil exposure. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. During the winter (and likely up until April when winter ice is gone), amphibians and reptiles undergo a winter dormancy period and, as a result, would have a limited potential for exposure during the winter to released crude oil moving on the water surface or within the water column.

If exposed to external oiling, the ability of birds and mammals to maintain body temperature may be compromised, leading to death as a result of hypothermia. Birds and mammals that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues during preening/grooming or ingesting food. Birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs. Waterfowl and other semi-aquatic birds and mammals present in the affected rivers and lakes would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats would likely be less affected, as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of crude oil would be in place within 24 hours of the release. Timely capture and rehabilitation of oiled birds and mammals may help to mitigate the environmental effects of a crude oil release.

9.5.3 Human and Socio-Economic Receptors

Effects on air quality from a release of crude oils have the potential to temporarily disrupt human use and occupancy patterns. Light crude oils typically contain more VOCs than heavier crude oils, although the VOC content of diluted bitumen may be similar to that of light crude oil, depending on the type and quantity of diluent used in its manufacture. Air quality and subsequent human exposure to VOCs in the vicinity of the release of crude oil would be most affected within the first 24 hours of the oil release. In the event of an actual release, emergency response workers, in cooperation with public health and safety officials, would be active in isolating, containing and recovering released crude oil, as well as notifying the public about the release.

Light crude oil is typically expected to travel a similar or greater distance downstream under spring and summer conditions than heavy crude oil. As a result, environmental effects on air quality are predicted to be spatially similar for light and heavy crude oil types. Under winter

conditions, cold temperatures, ice cover and absorption of crude oil into snow pack would strongly limit emissions of VOCs and human exposure, in addition to constraining the area of effects.

Some homes located along the trajectory of a predicted release could rely on groundwater as a drinking water source. In the event of a crude oil release, people would be notified and testing of wells would be completed to confirm the safety of the water supply. It is unlikely that a crude oil release to any of the modeled rivers/creeks/lakes would result in adverse health effects to consumers of drinking water. Where surface water is used as a source of water supply, the operators of such systems would be notified immediately upon the detection of a release, so that the situation could be monitored. Unprotected drinking water intakes in the path of a crude oil release would be temporarily closed until it was confirmed that the surface water was safe as a drinking water source.

Recreational activities would be disrupted following a release of crude oil along the predicted downstream trajectory of the release. Fisheries regulators and public health officials typically close fisheries until it is confirmed through monitoring that fish consumption is not a threat to public health. This standard approach is an effective mitigation strategy to protect human receptors from contact with constituents in the crude oil.

9.6 WILL RECOVERY OCCUR?

The recovery of biophysical and human receptors from exposure to crude oil is affected by numerous factors, including:

- Condition of the environment prior to disturbance, including natural variability and climatic conditions that can affect recovery rates
- Severity and spatial extent of the disturbance, including the type of crude oil
- Amount of residual crude oil left after initial response and clean up
- Persistence of residual crude oil in the environment
- Environmental conditions that affect evaporation and weathering of crude oil (e.g., temperatures, nutrient and oxygen availability, sunlight)
- Resiliency and resistance of the ecosystem (broadly, a species' sensitivity to chemical exposure, as well as its life history strategy, can strongly influence the population's ability to withstand and recover from a crude oil release)
- Proximity and mobility of nearby populations that can help quickly re-establish affected populations
- Speed and efficacy of emergency response and clean up
- Use of remediation and restoration measures (if required)

As discussed in Chapter 8.0, recovery of abiotic and biotic ecosystem components occurs after a crude oil release, although the timeframes for recovery are variable due to a number of factors. Environmental conditions within the affected area, the types of environmental media and receptors affected, the severity and areal extent of the release, and the speed and

efficacy of emergency response and cleanup are major factors that affect the timeframes for recovery.

9.7 CONCLUSIONS

The proposed L3RP will be built and operated to the standards for new and modern pipelines. The design, material specifications, construction methods, and operational protocols, including inspection and preventative maintenance, will help to reduce the likelihood of a crude oil release. Based on the failure frequency analyses for the seven representative locations, a large release of crude oil from the L3RP is considered unlikely.

While a large release of crude oil is unlikely, when freshwater or terrestrial ecosystems and human uses are exposed to a release of crude oil, effects are adverse. The significance of these effects can range from minor on local and regional receptor populations or uses, to substantial on a major portion of the exposed receptor population or uses. The significance of the effects of a crude oil release on a receptor will depend strongly on:

- Receptor itself in terms of its vulnerability to exposure to crude oil, and its sensitivity, if it is exposed to crude oil
- Type and volume of crude oil released
- Timing and location of the release relative to seasonal occurrences and locations of sensitive receptors and uses
- Climatic and site conditions at the time of the release
- Ability of responders to contain the release
- Speed, type and extent of cleanup, remediation, and restoration activities

This report assessed potential effects of an unmitigated large release of crude oil. In the unlikely event of an actual release of crude oil, swift and effective emergency response and cleanup measures would help reduce the extent of effects and help promote recovery of the affected receptors. Similarly, remedial actions and habitat restoration measures, as appropriate, would help further reduce many of the expected effects, while also aiding in recovery of freshwater and terrestrial environments, as well as human uses.

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ATTACHMENT A

Line 3 Replacement Project: Assessment of Potential Pinhole Release

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Abbreviations and Acronyms

API	American Petroleum Institute
AS	air sparge
bbl	barrels
bpd	barrels per day
BTEX	benzene, ethyl benzene, toluene, and xylene
CLB	Cold Lake Bitumen
CPM	computational pipeline monitoring
DOC-EERA	Minnesota Department of Commerce - Energy Environmental Review and Analysis
ft^2	square foot
GAC	granular activated carbon
gpm	gallons per minute
HSSM	hydrocarbon spill screening model
L3RP	Line 3 Replacement Project
LNAPL	light non-aqueous phase liquids
MPCA	Minnesota Pollution Control Agency
MWI	Minnesota Well Index
NWI	National Wetlands Inventory
PAH	polycyclic aromatic hydrocarbons
PHAST	Process Analysis Software Tool
PHMSA	Pipeline and Hazardous Materials Safety Administration

PWI	Public Waters Inventory
SCADA	supervisory control and data acquisition
SCC	stress-corrosion cracking
SVE	soil vapor extraction
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Enbridge is proposing to construct the Line 3 Replacement Project (L3RP), an oil pipeline replacement project, in the state of Minnesota. Enbridge is seeking the review and ultimate approval of the Project by the Minnesota Public Utilities Commission (Commission). The Commission has authorized Minnesota Department of Commerce, Energy Environmental Review and Analysis (DOC-EERA), in coordination with the Minnesota Department of Natural Resources (MDNR) and the Minnesota Pollution Control Agency (MPCA), to prepare an Environmental Impact Statement (EIS) for the Project.

DOC-EERA and coordinating agencies requested information relating to accidental pinhole releases and the potential effects of these releases on groundwater.

1.2 DEFINITION OF PINHOLE RELEASE

It is important to note that there is no formal industry definition for a pinhole release per relevant standards (CSA Annex E or API 1130) and the definitions of "pinhole release" as it relates to pipeline management are many and varied in the literature. Definitions are commonly based upon either subjective observation or numerical criteria based upon engineering estimates such as diameter of a theoretical breach or flow rate. In many instances in the literature the term "pinhole" is used without a specific definition. For context, a review of several industry relevant definitions of pinhole release is provided below.

Since 2001, United States Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) incident reports have included "pinhole" as an option for classifying the type of leak. The term "pinhole" is not defined in the incident instruction form for hazardous liquids (PHMSA, 2014). However the corresponding PHMSA incident form for gas distribution systems defines a pinhole leak as:

> "… a leak that is hard to see with the naked eye characterized as being a small hole made as by a pin."

Alternately, the PHMSA documentation on material/weld failures includes the following definition:

> "… a small, unwelded area extending through the entire thickness of the weld (PHMSA 2014)."

Several authors have defined pinhole releases in terms of numerical criteria. As part of an independent engineering assessment performed on the Keystone XL pipeline risk assessment, a

pinhole was defined as a "1/32-inch hole" for the purposes of modeling a pinhole leak rate (Battelle 2014).

Similarly, in the reporting of spills related to safety and environmental performance of oil pipelines, the European oil pipeline management group CONCAWE, defines a pinhole in terms of dimension as:

> "… less than 2 mm x 2 mm" (CONCAWE 2011)

Alternately, authors have also attempted to quantify a pinhole leak in terms of flow rate and likelihood to be detected. As part of the risk assessment of the Keystone XL pipeline project, a numerical model was used to estimate the rate of a slow oil leak that may go undetected for extended periods of time (Exponent, 2013). Based upon the assumptions made in the modeling analysis (discussed in detail in Section 2.3 of this report), a leakage rate of 0.035 bpd could theoretically infiltrate until discovered by inspection tools or investigative excavations.

For the purposes of this document, a pinhole release is defined "as a slow and small leak of crude oil from the proposed pipeline, or its remote facilities (e.g., pump station valves) that might not be immediately detected by the leak detection systems". The definition seeks to highlight the nature of a small release that may go undetected for a longer period of time and to provide a direct contrast with a large release or full bore rupture. An understanding of the limitations of the leak detection systems and a quantification of the rate of release anticipated to be encountered during a pinhole release is integral to this definition. The assessment of pinhole leaks will address leak detection monitoring, the nature (including rate of release), occurrence, and probability of pinhole leaks.

1.3 PURPOSE AND SCOPE

The purpose of this document is to provide an assessment of the risk of a pinhole oil release from the proposed L3RP. Risk is defined as the product of the likelihood of an adverse event occurring and the corresponding consequences that may result. In the context of a pipeline, the adverse event is the potential release of a hazardous liquid such as crude oil and the corresponding consequence is the potential for receptors to experience adverse effects as a result of exposure to the oil.

1.4 OVERVIEW OF THE ASSESSMENT

To promote increased understanding of the issues associated with accidental pinhole releases, the assessment of pinhole leaks considers, as an integrated whole, topics that describe the potential for a pinhole release to occur, the characteristics of the release and the potential consequences that may occur.

The proposed scope of work includes:

- An assessment of the potential characteristics of pinhole releases, including anticipated frequency, potential causes, size, rate of release, and maximum release volume and likely detection methods (Section 2.0.)
- The fate and transport of released hydrocarbons in the environment (e.g., factors affecting migration, movement in the unsaturated zone; movement in the saturated zone; and fate and transport of dissolved hydrocarbons in groundwater) (Section 3.0)
- Identification of potentially sensitive receptors proximal to the proposed project route and its alternatives, including: wells, surface water, calcareous fens, source water protection areas, and drinking water supply management areas (Section 4.0)
- An assessment of susceptibility of groundwater based upon the typical hydrogeologic regimes that will be traversed by the project (Section 5.0)
- The ability of groundwater to recover from the effects of a release, including an understanding of how emergency response, remediation, cleanup, natural processes and restoration can promote recovery (Section 6.0)
- A review of available case studies relevant to pinhole releases and their potential effect on the environment (Section 7.0).

Each of these topics is discussed in more detail below.

2.0 CHARACTERISTICS OF PINHOLE RELEASES

Pipelines currently under construction incorporate new tools, technologies, and strategies to protect the public and the environment. Modern pipelines are designed and constructed to rigorous standards that meet or exceed government regulations. Materials are selected and tested prior to and during manufacturing to meet quality criteria. Welds made to a pipeline section during construction are tested using X-ray or ultrasonic methods. Soil-side corrosion is prevented using a combination of external coatings that are subject to quality control/inspection before and after backfill, and cathodic protection systems that are continuously monitored. Internal corrosion is prevented by maintaining strict tariff limits on trace sediment and water; and by either flowing the pipeline rapidly enough to prevent these materials from accumulating, or by executing periodic cleaning programs to remove any accumulated matter that could cause corrosion.

Operating pipelines are equipped with sophisticated, computerized leak-detection monitoring systems and control systems that provide continuous, real-time information and are augmented with routine inspections and aerial patrols of rights-of-way. Inspection is supplemented with the periodic use of inline inspection tools capable of measuring the size, frequency, and location of small changes in pipeline walls.

Refer to the Assessment of Accidental Releases: Technical Report – Chapter 4.0 (Stantec/RPS/Dynamic Risk Assessment Systems 2016) for a detailed discussion of potential threats and a systems and protocols that are anticipated for the L3RP project.

This section describes the characteristics of potential pinhole releases (as defined above) including: potential causes, rate of release, volume, length of time until detection and anticipated frequency.

2.1 CHARACTERISTICS OF CRUDE OIL

The assessment of the risk of a pinhole oil release from L3RP is strongly influenced by the seasonal conditions, environmental setting and type of oil. A range of crude oils will be carried by the proposed pipeline. Different types of crude oil exhibit differences in chemical make-up, density and viscosity. The range of product types expected to be shipped in the L3RP may range from light crude oils such as those in the Bakken crude oil and Alberta Light Sweet Crude categories, to heavy oils such as conventional heavy crude oils and diluted bitumen products. The physical and chemical characteristics of light and heavy crude oils are quite different, although the characteristics of diluted bitumens are very similar to those of heavy conventional crude oils (Zhou et al. 2015). The physical characteristics of two example crude oils (i.e., Bakken, a light conventional crude oil, and Cold Lake Bitumen (CLB), a diluted bitumen) are discussed below. These two crude oils represent a range of product types that could be shipped in L3RP.

CLB is a diluted bitumen with a high viscosity and density, falling in the upper range of characteristic values allowed by the pipeline tariff specifications for Enbridge (typically less than 0.94 g/cm^3 at 15°C). This product generally exhibits mid-range density and viscosity characteristics for the range of diluted bitumen products. Seasonal variations in environmental temperatures affect the viscosity of the diluted bitumen, which directly affects the ability to pump the fluid through the pipeline. To address this, the amount of diluent added to CLB is varied throughout the year to attain a viscosity that meets shipping requirements. The largest amount of diluent is added to the bitumen during winter to reduce the viscosity to a level suitable for shipping at low temperatures. As a consequence, the density, viscosity, and aromatic content of CLB changes throughout the year. During the winter months, CLB has a lower density and viscosity and a greater aromatic content, when compared to the summer months. As the chemical and physical characteristics of the CLB will vary seasonally, a summer blend and winter blend were considered in the assessment of pinhole leaks.

Bakken crude oil is produced in North Dakota, Montana, and the bordering Canadian provinces of Manitoba and Saskatchewan. Bakken is a light crude oil with an American Petroleum Institute (API) gravity generally between 40 and 43° a sulfur content less than 0.2% by weight, low density, low viscosity, and a high aromatic content.

The physical properties of the three crude oils are shown in Table 2-1.

Table 2-1 Physical Properties of Typical Crude Oils to be Shipped in the L3RP Pipeline

Oil Property	Bakken Crude	Cold Lake Winter Blend	Cold Lake Summer Blend
Oil type	Crude	Emulsion	Emulsion
Minimum slick thickness (µm)	0.1	10.0	10.0
Surface tension (dyne/cm)	27.3	27.1	27.1
Pour point (°C)	-55.0	-45.0	-45.0
API gravity (°)	41.80	22.69	20.73
Density (g/cm^3) at 16°C	0.81650	--	--
Density (g/cm^3) at 15°C	--	0.91770	0.92950
Viscosity (cP) at 10°C	3.88	--	--
Viscosity (cP) at 15°C	--	150.0	342.0
Viscosity (cP) at 30°C	2.49	--	--
NOTES: µm = micrometer; dyne/cm = dynes per centimeter; g/cm^3 = grams per cubic centimeter; °C = degrees Celsius; cP = centipoise			
SOURCE: Stantec/RPS/Dynamic Risk Assessment Systems 2016			

2.2 POTENTIAL THREATS TO INTEGRITY

The following briefly summarizes the potential threats to the integrity of the L3RP as it relates to a potential pinhole leak. Refer to the *Assessment of Accidental Releases: Technical Report—Chapter 4* (Stantec/RPS/Dynamic Risk Assessment Systems 2016) for a detailed threat assessment based upon the approach described in American Society of Mechanical Engineers (ASME) Code B31.8S.

During the operational life of pipelines, malfunctions have occurred due to material failures (e.g., pipeline corrosion or defects in materials), vandalism, equipment failure, third-party damage or natural events. The following processes are identified as the principal potential causes of pinhole releases. These processes may occur alone or combine to result in a pinhole leak.

- Corrosion. Metal loss caused by corrosion is the most common cause of leaks that can be readily detected in the pipelines that have been in service for many years. Corrosion is caused by chemical reactions (oxidation and reduction; i.e., "rusting") that physically alter the metal and result in local areas of weakness. Underground pipelines are typically constructed of carbon steel. These materials may be subject to a variety of corrosion mechanisms in underground environments including: external corrosion, internal corrosion, and stress-corrosion cracking (SCC) (Beavers et al. 2006). The most common result of

corrosion on underground pipelines is uneven metal loss over localized areas (covering a few to several hundred square inches).
  - External Corrosion. External surfaces of a pipeline may undergo corrosion influenced by environmental factors such as soil chemistry, microbes, presence of corrosive materials or films, and/or stray electrical currents.
  - Internal Corrosion. Corrosion on the internal wall of a pipeline can occur when the pipe wall is exposed to corrosive materials. The nature and extent of the corrosion damage that may occur are functions of the concentration and particular combinations of these various corrosive constituents within the pipe, as well as of the operating conditions of the pipeline (e.g., temperature).
  - Stress Corrosion Cracking. SCC is a cracking of a material produced by the combined action of corrosion and tensile stress. A characteristic of SCC is the development of groups of longitudinal surface cracks in the body of the pipe that link up to form long, shallow flaws. In some cases, the growth and interconnection of the stress-corrosion cracks produce flaws that are of sufficient size to cause leaks
- Manufacturing Defects. Anomalies, imperfections, flaws or defects that arise during the manufacturing of the product. Typically major manufacturing defects are screened out during integrity testing procedures.
- Construction Defects. Anomalies, imperfections, flaws or defects of construction origin, including handling, transportation, fabrication, excavation and construction.
- Equipment Failure. A failure of a pipeline component or device other than the pipe and fittings such as valves, flanges, and gaskets. This usually results in a release that is contained on company property, typically not resulting in injury to the public or adverse effects to the environment.
- Third Party Damage. Damage to the pipeline that is caused by outside parties or forces other than naturally occurring events. This can include mechanical damage caused by machinery working in the right-of-way, as well vehicle or equipment contact, vandalism, sabotage or terrorism.
- Incorrect Operation. Incorrect operations failure is defined in the context of pipeline transmission infrastructure as failures that have causal factors that are related to design, as well as operation and maintenance procedures. Includes a release or failure resulting from incorrect actions by a company or contract personnel. Examples of incorrect operations that may lead to a release include inadvertent actions (e.g., improperly setting a valve, improper performance of routine maintenance, inappropriately reacting to a condition on the pipeline).
- Geotechnical / Hydrotechnical Forces. Naturally occurring events capable of causing damage include a release or failure resulting from earth movement, earthquakes, landslides, subsidence, lightning, heavy rains/floods, washouts, flotation, mudslides, scouring, temperature, frost heave, frozen components, high winds or similar natural causes.
- Other Threats. These include incidents whose cause is unknown, or where investigation into the cause has been exhausted and the final judgment as to the cause remains unknown, or where a cause has been determined which does not fit into any of the main cause categories listed above.

While leak detection systems are capable of identifying many releases, they may not immediately detect a slow and small leak of crude oil from a pipeline (PHMSA 2016). Given that leak detection technology has limitations in detecting small leaks, protocols for the management and operation of modern pipelines have focused upon prevention of pinhole leaks within the pipeline and the system components.

Management processes include measures associated with pipeline design and construction that help to reduce the potential for, and effects of pinhole releases, such as:

- Material specifications for the pipe and components
- Methods for review and verification of the pipeline design, and engineering quality control
- Quality assurance measures to verify that construction materials used for the pipelines comply with or exceed the requirements of Code of Federal Regulations (CFR), Part 195
- Multiple levels of inspections to confirm the pipeline's integrity through the milling, transportation, and installation processes
- Design processes such as Intelligent Valve Placement
- Construction methods to reduce potential for incidents (e.g., variable minimum burial depths specific to land use types; burial depths under water crossings; variable construction techniques such as horizontal directional drilling or open cuts under roads and water crossings)
- Inspection and testing to verify the integrity of the pipelines before commissioning

Pipeline operations also employ an array of measures to avoid or reduce the risk of an accidental pinhole release and maximize the effectiveness of the emergency response (Stantec/RPS/Dynamic Risk Assessment Systems 2016). These include:

- Conducting routine aerial and ground based monitoring
- Maintaining cathodic protection to reduce corrosion
- Utilizing internal pipeline inspection technology to identify potential pipeline integrity anomalies
- Continuous monitoring through supervisory control and data acquisition (SCADA) systems
- Systems and processes for detection of pipeline leaks and malfunctions
- Use of a state of the art control center manned 24 hours a day/7 days a week to monitor and react in the event that anomalies in the operation of the pipeline are detected
- Installation and operation of remotely controlled pipeline valves
- Use of redundant monitoring and response equipment

2.3 RATE OF RELEASE

For the purposes of this assessment, a pinhole release is defined as a slow and small leak of crude oil from a pipeline or its remote facilities (e.g., pump station valves) that might not be immediately detected by the leak detection systems. An understanding of the limitations of the leak detection systems and a quantification of the rate of release anticipated to be encountered during a pinhole release is integral to this definition. In practice, a leak that continues for a long period of time would be unlikely because the rate of the leak would be expected to exceed the rate of infiltration, quickly fill the trench and appear at the surface where it would be discovered through visual surveillance.

The breach size and pipeline pressure are the primary factors that determine the leak rate (U.S. Department of State (USDOS 2014). Larger leaks are typically rapidly detected because they trigger alarms from components of the leak detection system, or are identified through visual inspections (Shaw et al. 2012). Where a leak of crude oil is below the limits of the detection

system, the released oil would likely remain within or near the pipeline trench where it can be contained and remediated after discovery.

For example, automated internal leak detection systems based on computational pipeline monitoring (CPM) are limited to the accuracy of the metering (1% accuracy of the flow rate is considered good) (Shaw et. al 2012). The proposed transmission rate for the L3RP is 760,000 barrels per day (bpd). Based upon these data only, the anticipated leak detection capabilities based on computational monitoring at the maximum rate of 760,000 bpd for the L3RP line would be approximately 222 gallons per minute (gpm) or 7,600 bpd with an anticipated response time of a few minutes (Stantec/RPS/Dynamic Risk Assessment Systems 2016). Actual pipeline leak detection systems accuracy is dependent on the pipe parameters and installed instrumentation (Shaw et al. 2012).

A release rate for L3RP approaching the CPM detection limit (e.g., would quickly fill the more permeable trench materials and reach the ground surface where it would be anticipated to be reported in several hours to days through volume reconciliation or visual observation. Additionally, to achieve a rate of release approaching 1% would require a breach in the pipeline that would be significantly larger than a pinhole. The potential effects of larger releases are discussed in detail in the Assessment of Accidental Releases: Technical Report (Stantec/RPS/Dynamic Risk Assessment Systems 2016).

However, a pinhole release may potentially continue undetected for longer periods of time resulting in a release of sufficient volume and allowing for sufficient transport time to affect groundwater. The issues surrounding rate of release and fate and transport of pinhole releases were qualitatively assessed during the independent engineering assessment of the Keystone XL Pipeline Risk Assessment (Exponent 2013). Exponent is a science and engineering consulting firm that was commissioned to provide third-party independent environmental review of a specific set of issues identified by the U.S. Department of State (DOS) in consultation with the U.S. Department of Transportation, PHMSA and the U.S. Environmental Protection Agency that relate to the Keystone XL Project. A review of the independent engineering assessment methodology was performed at the request of DOC-EERA and is presented below.

The potential scale of infiltration of oil and dissolved constituents and subsequent contamination of groundwater from a pinhole release was evaluated by Exponent using a numerical hydrocarbon spill screening model (HSSM) developed for U.S. EPA (Weaver et al. 1994). HSSM is a screening model that includes a variety of chemical and hydrologic processes, and is based upon a simplified conceptualization of an oil release. The model simulates vertical oil flow and transport from the ground surface to the water table due to gravity and capillary forces. The oil is then simulated to float and spread radially in the capillary fringe, thereby forming an oil lens (or layer). Additionally, HSSM simulates dissolution of chemical constituents of the oil into the groundwater and migration of the dissolved phase contaminant plume.

As part of the screening analysis for the Keystone XL pipeline, HSSM was used to estimate the rates of a pinhole release for a flat terrain condition. The leak calculations are intended to

provide insights into the potential transport and fate of oil spilled from the pipeline. Simulations with HSSM are an illustrative and simplified screening-level calculation and should not be relied upon for final risk determinations, emergency and/or environmental planning/response actions.

HSSM was used in the Keystone XL assessment to estimate the maximum steady-state leak rate (i.e., where infiltration is equal to leak rate out of the pipeline) per area of trench floor. Leak rates higher than the maximum steady-state infiltration rate would eventually fill the pore-space in the trench backfill at a rate equal to the difference between the infiltration rate and the leak rate. Leaks lower than the steady state infiltration rate may go undetected until discovered through means other than remote monitoring or visual inspection (e.g., scheduled maintenance or excavation inspections).

The results from HSSM simulations show that the maximum leakage rate of oil that can be vertically infiltrated through permeable sand is approximately 0.21 gallons per day (gpd) or 0.005 bpd/square ft (ft^2), meaning that for every square foot of trench floor, 0.21 gallons is predicted to infiltrate through that unit area in one day if there is a pinhole leak in the pipeline. The area of the spill footprint on the bottom of the trench (i.e., infiltration site) affects the total anticipated rate of infiltration.

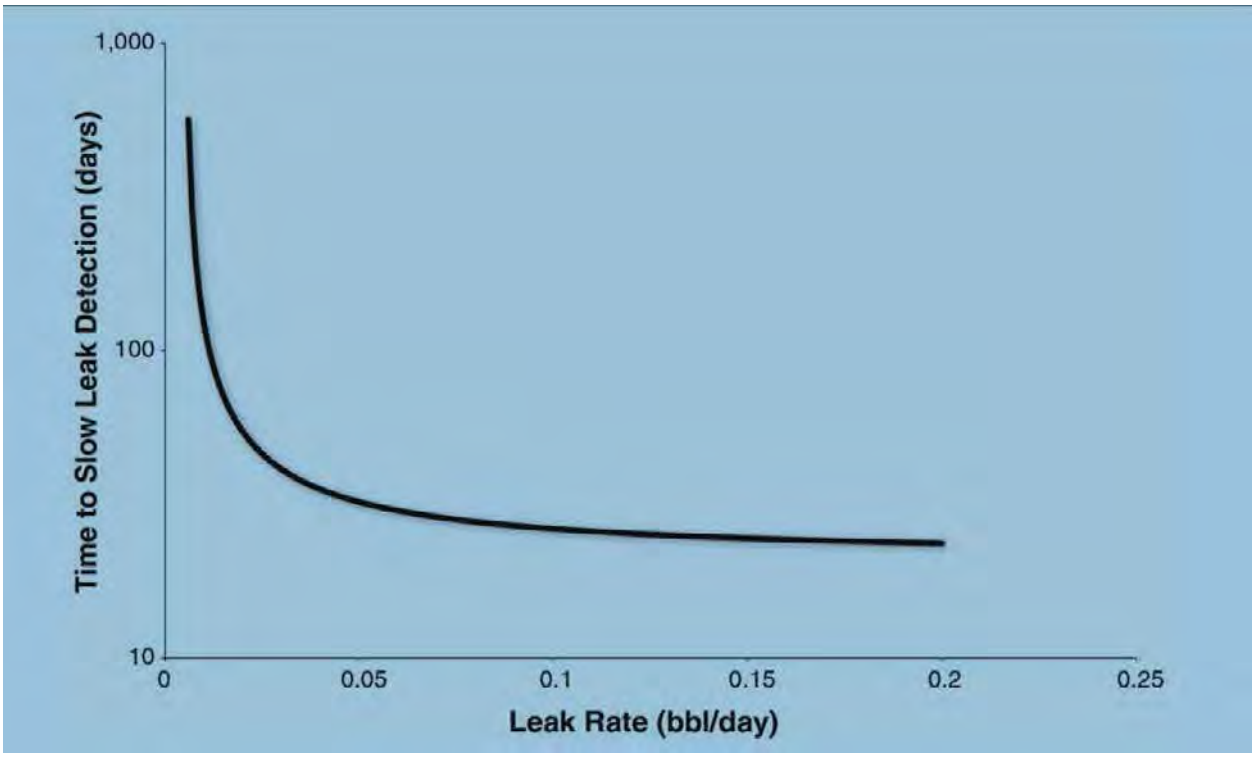
To provide a sense of scale for a small leak that could go undetected, Exponent conducted further analyses assuming infiltration occurs over a 3-ft diameter circle of trench floor; 3 ft was selected to coincide with the approximate maximum diameter of the pipe. However, the geometry and area of the spill footprint could be highly variable. If lateral movement of the oil through the trench backfill occurred, the area of the infiltration zone would increase, which would increase the volume of oil that could be infiltrated. These factors could result in higher leak volumes that may not come to the surface and, therefore, not be detected by inspection. Conversely, the vertical case considered for this analysis, rather than the lateral flow scenario, is also conservative in that the infiltration rate would be greater for a given area due to the assumed larger driving head.

For instance, a circular footprint of trench floor with a diameter of 3 feet has an area of approximately 7 ft^2, which would correspond to a total infiltration rate of:

$$7\ ft^2 \times 0.21\ gpd = 1.5\ gpd$$

Thus, a leakage rate over the 3-ft diameter circle of 1.5 gpd could theoretically infiltrate indefinitely without surfacing because the infiltration rate is equal to the leak rate.

A similar process was used to estimate the time required for the oil to reach the ground surface at rates above the steady state infiltration rate. Figure 2-1 shows potential leak rates and the associated estimated time to detection.



SOURCE: Exponent 2016

Figure 2-1 Time to slow leak detection as a function of leak rate for various slow leak rates based on a 3-ft diameter circular infiltration footprint

Modeling of theoretical subsurface transport suggest that a low-volume release could go undetected as it migrates up to the surface, or as it travels along the bottom of the pipe trench. However, in practice, leaks with rates equal to or below the infiltration rate are unlikely because the flow rate for even a very small hole (1/32 in.) would be expected to be as much as two orders of magnitude higher than the infiltration rate.

As part of an independent engineering assessment performed on the Keystone XL pipeline risk assessment, a leak rate for a pinhole, defined as a 1/32-in. hole, was estimated using Process Analysis Software Tool (PHAST) (Battelle 2013). Based upon the modeling, a calculated leak rate of 28 bpd was estimated. The pinhole leak rate, 28 bpd, is almost three orders-of-magnitude greater than the maximum infiltration rate into permeable sand over the assumed area described previously under the developed HSSM scenario. This suggests that a leak from a pinhole release would quickly migrate to the surface and be discovered through visual surveillance and/or odor reports.

Visual and odor reports are provided by third parties (i.e., landowners, farmers, etc.) and from the pipeline operator's aerial and ground line patrols. For example, Enbridge typically conducts

patrols every two weeks on its entire system. Therefore, a pinhole release that goes undetected indefinitely along the pipeline is unlikely; rather it would migrate to the surface and be reported.

2.4 ESTIMATED RELEASE VOLUME

A release below leak detection thresholds, should it occur, releases a small amount of oil at a time and therefore, may not be detected immediately. Based on an analysis of estimated release rates defined in Section 2.3, leak detection systems (including patrol), and estimated response times, the following table was developed to evaluate the total volume of oil that may result from a pinhole release:

Table 2-2 Estimated Potential Release Volumes Prior to Detection

Description	Rate	Time		Total Volume of Product Before Detection	
	bpd	Days	Minutes	Barrels	Gallons
1% [1]	7,600	0.083	120	633	26,600
0.5% [1]	1,750	2	2,880	3,500	147,000
0.1% [1]	760	14	20,160	4,900	205,800
1/32 in. pinhole	28	28	40,320	784	32,928
Equivalent infiltration rate	0.035	1,825	2,628,000	64	2,683

NOTE:
[1] Percentage of pipeline throughput based upon 760,000 bpd.

The total volume that may result from a spill is a combination of the following:

- Size of breach
- Pipeline pressure
- Fluid properties (temperature and viscosity)
- Time to detect leak
- Time to shut down pipeline and isolate leak after detection
- Pipeline diameter
- Distance between isolation valves
- Effectiveness of the isolation

Once the leak is suspected, the operator shuts down the operating pumping units and closes the nearby valves to isolate the leak. These actions eliminate the force that will maintain pressure on the pipeline that would continue the leak.

The response time between initiation of the spill event and the response is an important factor in controlling the total volume of oil released and preventing potential impacts to the environment. The following describes the various processes that control the elapsed time between the release start and detection.

First, most releases ranging in magnitude from small to medium (up to 1,000 barrels [bbl]) would occur on construction sites or at operations and maintenance facilities. At these locations, spill response typically would be quick because of the presence of local staff and contractors and often mitigation systems, such as secondary containment, are employed. Quick containment and clean-up is expected to reduce surface oil spreading and its potential infiltration into the ground.

Second, large releases are detected quickly. SCADA sensors are designed to automatically detect leaks large enough to produce noticeable changes in pipeline pressure and flow rates. The sensors have a monitoring threshold because operating variables for pipelines (e.g., give several examples such as pressure) normally fluctuate within a working range. The SCADA system, in conjunction with CPM or model-based leak detection systems are designed to detect leaks to a level of approximately 1% of the pipeline flow rate.

For releases below the automated leak detection system threshold complementary leak detection methods are also employed, along with a public awareness program, to detect the presence of leaks within the system. The CPM system is the primary method to detect leaks. In cases where a leak under detection limit of the CPM system were to occur, the use of local sensors and SCADA, extended volume balance calculations and other methods of detection such as visual surveillance, third party and employee reports are utilized to detect leaks. The speed of detection and total leakage depends on various factors, including conditions surrounding the release, surveillance frequency, and third party reporting. It is estimated that a leak near the threshold of 1% of throughput would prompt a response in the pipeline Control Center of a conservative time of 120 minutes.

SCADA systems, in conjunction with CPM or model-based leak detection systems are capable of detecting a leak relatively rapidly (i.e., within minutes) if the rate is greater than the detection threshold. Computer-based, non-real time, accumulated gain/loss volume trending also is used to assist in identifying low rate or seepage releases below the 1% by volume detection thresholds. The lower the rate the longer it would be anticipated to see the gain/loss trends. It is conservatively estimated that a leaks of 0.5% and 0.1% of throughput would prompt a response in the pipeline of 2 and 14 days, respectively.

Smaller leaks may be identified by observing pooled oil outside the pipeline or by observing environmental patterns such as stressed vegetation. The pipeline operators typically conduct aerial or ground patrols every two weeks on its entire system. For smaller releases it was conservatively estimated that the time from initial release to discovery may take up to 2 cycles of patrol or 28 days total.

Finally, releases at a rate below the threshold for infiltration would not be anticipated to be observed at the surface. In this case discovery would be anticipated to be identified through inline inspection tools or an investigatory excavation. The pipeline operators typically conduct inline inspection every two years on its entire system.

For additional context, as part of a larger study on the application and effectiveness of leak detection systems, Shaw et al. (2012) on behalf of PHMSA performed an analysis of time to shut down for hazardous liquid releases identified as originating on the right-of-way over an 18 month period between January 2010 and July 2012. Time to shut down the pipeline is taken to mean that pumping has ceased and the upstream and downstream block valves have been shut to isolate the section of pipeline containing the release. The review of the incident data showed the following for 197 incident reports:

- 47 (24%) of the incident reports had identical dates and times for the incident identification and the shutdown. This results in zero minutes to shut down the pipeline.
- For 68 (34%) of the incident reports the elapsed time to shut down could be calculated using the initial identification and the report shutdown.
- No shutdown time was reported for 66 (33%) of the incidents. Not all pipelines are shutdown as a result of a release.
- For 12 (6%) shutdown date and times provided it was not possible to compute the time taken to shut down because of the date and time values recorded.
- Ignoring zero minute shutdowns, the shortest shutdown time was 1 minute and the longest calculated shutdown time was 44 hours and 30 minutes.
- 8 of the 68 reports where a time to shut down could be calculated had a shutdown time longer than 1 hour.
- 27 of the 68 reports had a shutdown time between 15 minutes and 40 minutes.
- 32 of the 68 reports had a shutdown time between 1 minute and 14 minutes.

The results of this study validate the conservative nature of the estimated discovery times presented in Table 2-2.

2.5 FREQUENCY

Analysis of historical pipeline incident data was conducted to understand frequency of historical releases with respect to pipelines in Minnesota, the Upper Midwest Region and the United States.

The PHMSA incident and mileage reports were analyzed to show the distribution of historical spill volumes, incident causes and frequencies of crude oil pipeline incidents contained in the PHMSA database. Although the results are not a direct indicator of the nature of possible incidents that could occur in association with the proposed L3RP because the majority of the pipelines spills reviewed were of older vintage pipelines, they can provide insight into what could potentially occur with respect to spill volume, incident cause, and incident frequency.

Characteristics of Pinhole Releases
January 13, 2017

PHMSA collects information on reportable[1] pipeline incidents. This information is available to the general public. Information collected for each incident includes the following:

- Date of each reportable incident
- Type of hazardous liquid associated with the pipeline involved in the incident
- Volume of hazardous liquid spilled in the incident
- Part of the pipeline system from which the spill occurred
- Diameter of the hazardous liquid pipeline involved in the incident
- Cause of the incident

The total mileage, type of hazardous liquid transported, and the diameter of pipelines in operation in the United States are also collected.

PHMSA incident and mileage data for the period from January 2002 through December 2015 were considered to be the most applicable to this report. Data prior to January 2002 had different reporting requirements and may not provide additional useful information. Prior to 2002, PHMSA required reports of hazardous liquid releases of greater than or equal to 2,100 gallons (50 bbl). As of 2002, PHMSA required reports of hazardous liquid releases of greater than or equal to 5 gallons (0.1 bbl). Therefore PHMSA data prior to 2002 likely understate the actual number of incidents and lead to over estimates of average spill volumes. All reported database incidents are counted, even if the information was incomplete or unspecified ("blank" or "Unknown", "Miscellaneous", and "Other").

As this assessment of pinhole leaks study focuses on the proposed pipeline and associated facilities (e.g., pump station valves) and excludes facilities that would typically have secondary containment, the historic incident data was subdivided to allow historic spill volumes and incident causes from the mainline pipe to be assessed separately from discrete elements such as pumping stations, breakout tanks, valves and other associated equipment. In addition, the PHMSA the data set, which includes incidents from hazardous liquid pipelines, can be filtered to include only crude oil pipeline incidents.

Table 2-3 is a summary of hazardous liquid pipeline incidents reported to PHMSA for the period January 2002 through December 2015 and shows the incident breakdown by pipeline system element (mainline pipe, tanks, valves, and other discrete equipment items associated with pumping stations or pipeline systems). The Project's location (Minnesota) is relatively flat, colder and more rural than the majority of U.S. pipelines, which are clustered primarily in Oklahoma, Texas, the Great Lakes area, and along the East, West, and Gulf coasts. Therefore, the data set was further evaluated to show breakdown incidents by region, represented by Minnesota, North Dakota and Wisconsin, and by Minnesota, separately.

[1] Reportable releases meets the criteria in 49 CFR §195.50. Hazardous liquid releases during maintenance activities are not to be reported if the spill was less than 5 barrels, not otherwise reportable under 49 CFR §195.50, did not result in water pollution as described by 49 CFR §195.52(a)(4), was confined to company property or pipeline right-of-way, and was cleaned up promptly. Any spill of 5 gallons or more to water during a maintenance activity is required to be reported.

Table 2-3 Summary of Crude Oil Pipeline Incidents, 2002 through 2015

Description	Number of Incidents		
Crude Oil Pipeline incidents	United States	Region (ND, MN, WI)	Minnesota
Crude oil mainline pipe incidents	591	44	20
Crude oil pipeline, equipment incidents (not mainline pipe)	1,227	93	41
Crude oil pipeline system, unspecified elements	641	45	19
Total crude oil pipeline incidents	2,459	182	80

For pipeline components, including the body of the pipeline itself and associated equipment, there were 2,459 reported crude oil incidents out of a total of 5,290 incidents in the entire hazardous liquid pipeline database for the time period referenced. Of the crude oil incidents in Table 2-3, 591 incidents were associated with the body of the pipeline or the welds connecting mainline pipe sections. Also, 641 incidents were reported in such a way (such as with blank data fields) that it is not clear if they were associated with the mainline pipe of a pipeline or with a discrete element.

The PHMSA data also include information on the pipelines in service in each calendar year since 2004. This information includes the pipeline length, the commodity transported, the pipeline diameter, the installation year, and the number of breakout tanks associated with the pipeline. This information was used to determine the incident rate per mile-year of pipeline.

A summary of crude oil pipeline incidents as reported to PHMSA from January 2002 through December 2015, including spill volume and incident frequency is presented in Table 2-4 and Table 2-5, and Figure 2-2 and Figure 2-3. Table 2-4 and Figure 2-2 summarizes the data for crude oil pipeline and its components. Table 2-5 and Figure 2-3 summarizes the mainline pipe. This is the section of the infrastructure most relevant to a slow and small leak of crude oil from that might not be immediately detected by the leak detection systems due to the remote location and underground construction.

Table 2-4 Historic Incident Summary, Onshore Crude Oil Pipeline, and Reported Elements

Item	United States	Region (ND, MN, WI)	Minnesota	Unit
	Value	Value	Value	
January 2002–December 2015	14	14	14	Years of data
Total Incidents	2459	182	80	Reported incidents
Pipeline Mileage	730,690	64,999	28,163	Mile-years
Incident Rate per Mile-Year	0.00337	0.00280	0.00284	Reported incident per mile-year

Table 2-4 Historic Incident Summary, Onshore Crude Oil Pipeline, and Reported Elements

Item	United States	Region (ND, MN, WI)	Minnesota	Unit
	Value	Value	Value	
Maximum Incident Volume Reported (bbl)	49,000	20,600	6,000	Barrels
Median Incident Volume Reported (bbl)	3	3	2	Barrels
Average Incident Volume Reported (bbl)	220	341	226	Barrels
0–50 barrels	81%	80%	88%	Percentage of incidents
50–1,000 barrels	16%	14%	6%	Percentage of incidents
>1,000 barrels	3%	6%	6%	Percentage of incidents

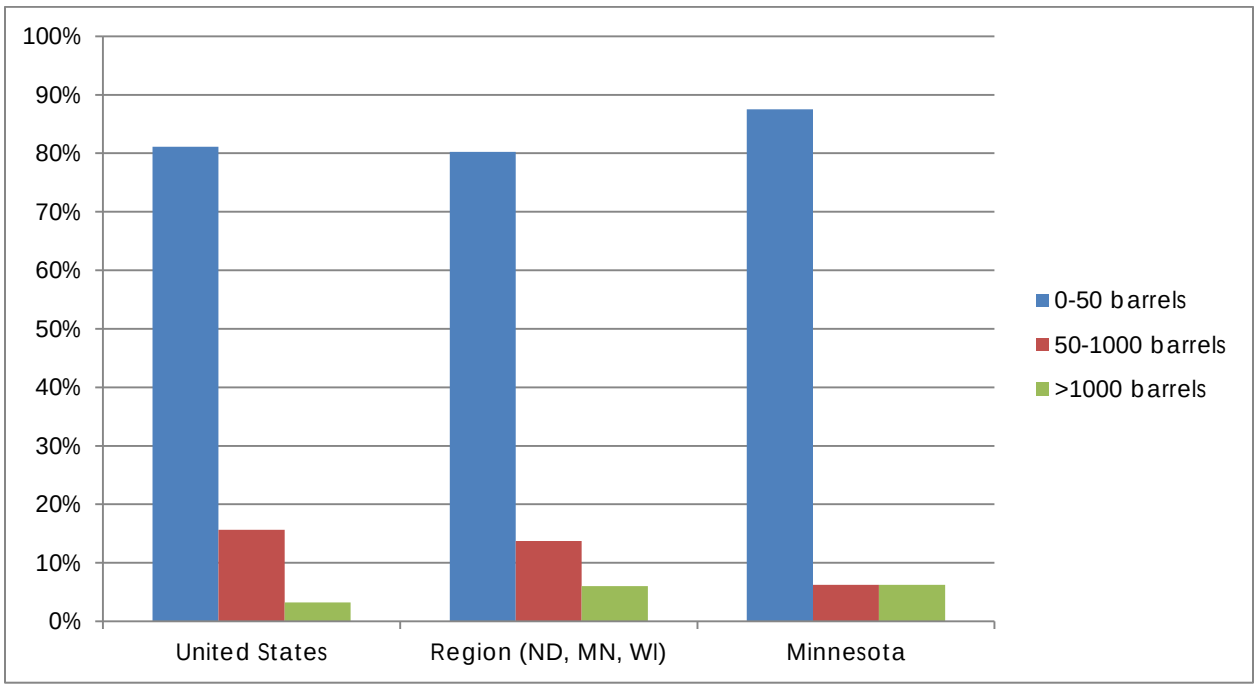


Figure 2-2 Frequency of Releases by Volume, Onshore Crude Oil Pipeline, and Reported Elements

Table 2-5 Historic Incident Summary, Onshore Crude Oil Mainline Pipe

Item	United States	Region (ND, MN, WI)	Minnesota	Unit
	Value	Value	Value	
January 2002–December 2015	14	14	14	Years of data
Total Incidents	591	44	20	Reported incidents
Pipeline Mileage	730,690	64,999	28,163	Mile-years
Incident Rate per Mile-Year	0.00081	0.00068	0.00071	Reported incident per mile-year
Maximum Incident Volume Reported	31,322	20,600	6,000	Barrels
Median Incident Volume Reported	20	45	5	Barrels
Average Incident Volume Reported	437	1,203	794	Barrels
0–50 barrels	63%	50%	65%	Percentage of incidents
50–1,000 barrels	30%	30%	15%	Percentage of incidents
>1,000 barrels	7%	20%	20%	Percentage of incidents

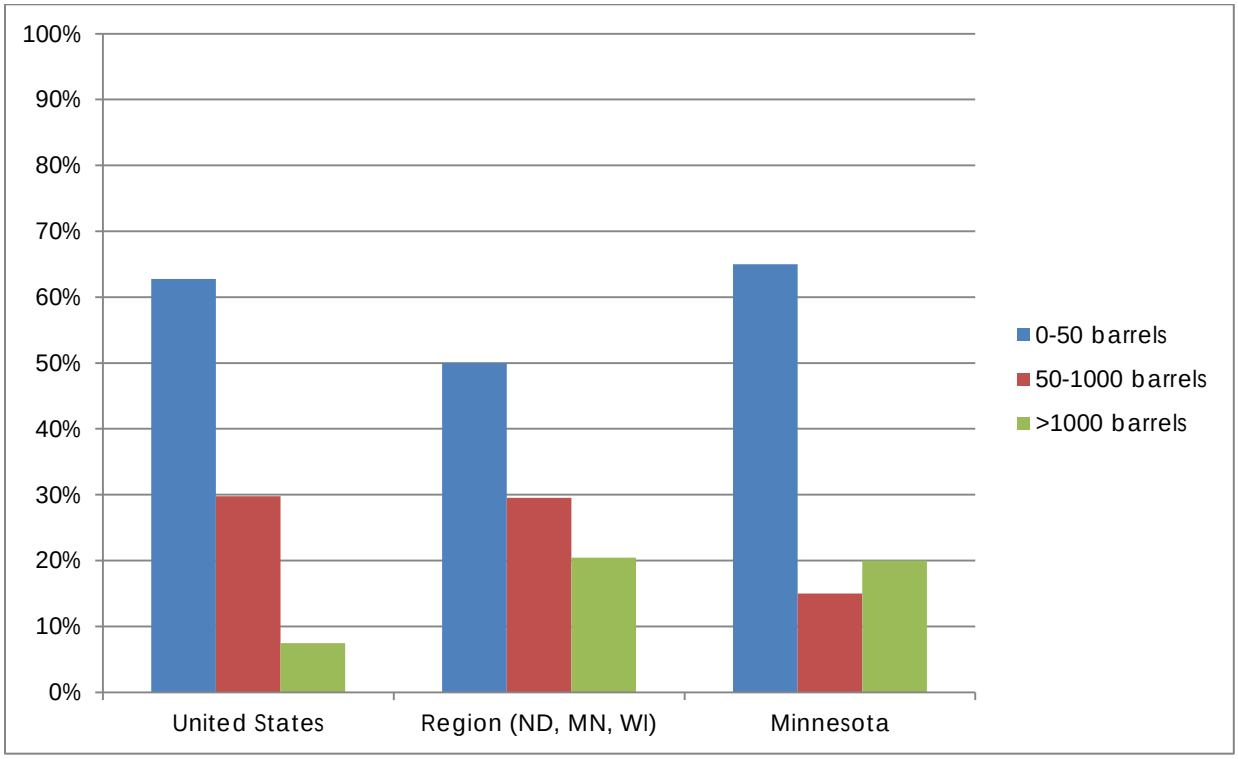


Figure 2-3 Frequency of Releases by Volume, Mainline Pipe

The summaries indicate that spill volumes from the mainline pipe tend to be larger than spills from discrete elements and that the majority of the releases are less than 1,000 barrels.

3.0 FATE AND TRANSPORT OF HYDROCARBONS IN THE ENVIRONMENT

3.1 INTRODUCTION

Crude oil consists of complex mixtures of organic chemicals that exist as a separate phase when mixed with water and are less dense than water. These two characteristics: (1) immiscibility (or inability to mix with water without substantial external mixing energy) and (2) density difference, strongly influence the fate of a crude oil in the environment. When released into the subsurface, oil has a tendency to migrate downward through materials that are partially saturated with water until they reach the water table, which impedes (but not completely prevents) their migration deeper due to both increasing water content and associated buoyancy forces arising from the oil-water density contrast. The magnitude of lateral spread of oil near the water table is determined principally by the subsurface geology, size of the release, as well as the properties of the crude oil (e.g., density, viscosity and interfacial tensions).

As is discussed in this section, many factors affect how a pinhole leak of crude oil will be transported horizontally and laterally within the subsurface materials. Other factors will influence the distribution of crude the movement of crude oil within the subsurface materials and ground water. A variety of processes will deplete the crude oil naturally, including dissolution, vaporization and local biodegradation. Plume expansion continues until a relatively stationary condition is reached, whereby the flux of dissolved components from the remaining oil is balanced by the mass removed through natural attenuation processes in the aquifer. Together, these various processes and factors tend to limit the spatial extent of crude oil contamination, Field investigations at over 600 petroleum hydrocarbon release sites indicate that the migration of dissolved constituents typically stabilize within tens to hundreds of feet from the source area for the crude oil.

3.2 FUNDAMENTAL CONCEPTS OF CRUDE OIL TRANSPORT

The mobility of the various fluids and gases present (oil, water and air) in a porous or fractured geological medium is governed largely by the relative percentage of the pore space occupied by each fluid. In the unsaturated zone, the pore spaces between soil grains are only partially filled with water. The rest of the pore space is filled with air. The water in the pore spaces coats the soil grains and is held there by capillary pressure (the same forces that cause water to soak up into a sponge or paper towel).

When crude oil is released to the ground, it needs to displace an equivalent volume of the resident fluids (air and/or water). For the oil to enter a pore space, it must overcome the

capillary pressure, as well as the pressure needed to displace water (referred to as pore entry pressure).

If a sufficient volume of oil is present, it begins to enter the unsaturated pore spaces by moving downward under the force of gravity. This can be accompanied by lateral spreading due to geologic heterogeneity. However, due to the capillary pressure and presence of water and air trapped in dead end pores, the air and or water are never completely displaced. As more oil is released, it gradually forces oil into continuous linked pore spaces and migrates away from the release point in the direction of lower pressure. The permeability of the trench materials in comparison to the native soils may influence the transport of oils in the subsurface. Typically the principal direction of transport is downward in permeable sediments under the force of gravity; however, in a pinhole release within a pipeline trench where the native soils are less permeable then the trench fill material, oil may preferentially follow the path of least resistance filling the relatively higher permeability materials within the trench. For a buried pipe, this could result in filling of the pipe trench and ultimately surface expression of the oil. Lateral migration of the oil along the length of the pipeline could occur within the trench, which could extend the time until surface expression of the leaking oil occurs.

Following the termination of a release, not all of the oil drains from the formation. Similar to how water behaves in the unsaturated zone, oil migration in the subsurface leaves behind a trail of residual oil in the form of disconnected droplets. The unsaturated soil acts like a sponge that holds the crude oil in place. The percentage of pore space that contains oil held by the formation, referred to as residual saturation, is functionally immobile. Following gravity drainage, the oil within the pore space is characterized by an irregular, disconnected and heterogeneous distribution.

Residual saturation values depend upon the geological media properties, the physical properties of the crude oil, (viscosity and interfacial tensions) and the nature of the oil exposure (e.g., the residual saturation may vary with the initial saturation, and also with the type of soil in which the oil release occurred). If only a small volume of oil is released, as in a small pinhole release, the migration will cease within the partially saturated zone as mass is immobilized within soil pores due to the retention capacity of the capillary forces. For larger releases with sufficient volume to overcome the residual soil retention capacity, the oil will continue to migrate either upwards until it reaches the ground surface or downwards toward the underlying water table where the pressures are balanced by the buoyancy of the water.

The mobility of oil in the unsaturated zone depends primarily on several factors: (1) its saturation in the pore space relative to the other fluids, (2) the pressure that drives the flow of oil (i.e., the driving head); (3) the permeability of the unsaturated soils; (4) the density and viscosity of the oil and (5) the distance of travel (e.g., distance to ground surface or depth to the water table).

If the oil in the formation is below its residual saturation concentration, it is not able to move. Oil movement is resisted by capillary forces (the oil pore entry pressure or water displacement pressure). The oil needs to exceed the lower threshold of residual saturation for it to form a contiguous phase that is mobile, thereby overcoming the retention capacity of the capillary

forces. As the saturation of the oil in the pore space increases, the (so-called) relative permeability of the formation with respect to the oil also increases. Oil, present in the formation r, migrates along a tortuous path preferentially following the path of least resistance.

If the release is sufficiently large to exceed the residual saturation, and the pressure is high enough to drive the oil in the pore space, the oil body may migrate. More permeable soils, such as sand and gravel, will allow for relatively faster migration of crude oil than less permeable soils, such as silt and clay. Migration may occur upward through the more permeable sediments of the trench until it reaches the ground surface or, if the oil release is balanced by gravity driven infiltration, it may slowly infiltrate into the soils and, if not mitigated, may reach the water table.

Because both water and oil move slowly in the pores between soil grains, the distance between the ground surface and the water table (i.e., the depth to the water table) will also affect whether the oil reaches the water table, and the time it takes to get there. Thicker unsaturated zones (greater depths to the water table) act as a thicker “sponge” that holds more crude oil in place than thinner unsaturated zones with less pore volume storage. In situations where just a the soils are less permeable, or the water table is very deep, a release of a small amount of crude oil may remain in the unsaturated zone and never reach the water table.

Once in contact with the saturated zone, the vertical migration of the oil continues until buoyancy and increasing water content impede vertical migration. Oil begins to spread laterally at the capillary fringe unless sufficient oil elevation head exists for it to displace water and penetrate below the water table. In such a case, vertical oil penetration will continue until the pressure head is balanced by the upwards forces of buoyancy and capillary pressure, which are together referred to as either pore entry pressure or water displacement pressure. The resulting oil body will then continue to migrate laterally following the water table down hydraulic gradient and radially due to oil mounding above the water table (creating an oil head gradient) in response to the resisting forces.

At the water table, where oil can more easily push the water from the formation into the capillary fringe, oil will mound in response to resistance from buoyancy and pore entry pressures. Lateral migration will occur in response to the gravitational forces for this mounded oil enhancing the gradient laterally. The lateral migration and growth of the oil body will continue until the driving force from the release dissipates or is balanced by the formation capillary pressures and the oil pore entry pressure or water displacement pressure at the leading edges. The greater the density difference between oil and water, the stronger the buoyancy forces and less vertical penetration of the oil and greater lateral spread. At the leading edges, oil reaches residual saturation, becomes discontinuous and is immobilized by capillary forces under ambient groundwater flow conditions leading to dispersed and disconnected oil in the formation. At this point, dissolution and volatilization cause gradual depletion accelerated by local dissolved-phase plume biodegradation.

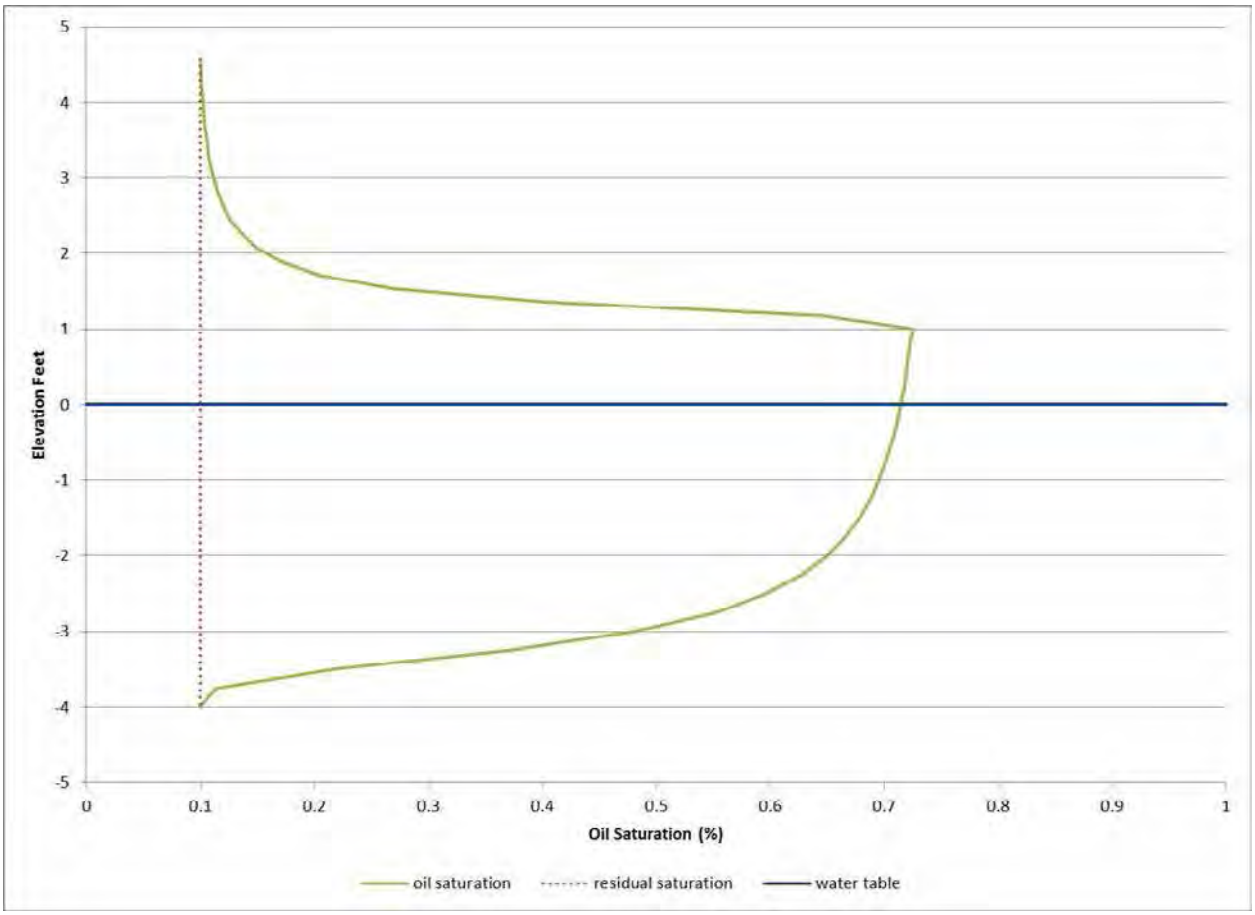
3.3 FACTORS AFFECTING CRUDE OIL DISTRIBUTION

Scientists originally conceptualized oil migration in porous media as a continuous 'pancake' layer floating on the water table. This conceptualization incorrectly assumed oil migration to the water table and lateral spread along the capillary fringe forming a continuous layer of complete saturation of the pore space by oil. The oil body was assumed to float on the water table as a separate continuous layer, and correlated directly to the thickness observed in monitoring wells (or some fraction of this observed oil thickness in wells with several theoretical and semi-empirical relations developed relating this difference). This earlier understanding failed to fully recognize the controls of capillary forces and could greatly over-predict both the amount of oil within the subsurface (particularly in fine-grained strata [Huntley and Beckett 2002]), as well as the amount of potentially recoverable oil.

A closer approximation of the oil saturation distribution is based on the capillary pressures of the various liquid phases and the development of functions that relate fluid contents of the porous media to capillary pressures (Farr et al. 1990; Lenhard and Parker 1990a, b). The oil saturation profile at the water table interface is predicted to approximate the shape of a shark fin within an unconfined aquifer under equilibrium conditions (Figure 3-1).

Oil type and release mode may also influence oil distribution in the subsurface. For a catastrophic release such as a pipeline rupture, oil elevation heads will initially be large and dissipate quickly. For an on-going leaking pipeline, there may be a constant elevation head that drives the migration of the oil. A longer term release with a constant pressure head will continue to overcome the resistance of capillary pressure and buoyancy, and drive the oil deeper in the formation with less lateral spread than for a similar volume of released oil from a catastrophic release.

Oil viscosity also affects timeframes for stabilization of the crude oil plume. For a limited volume release, an oil of high viscosity leads to slower migration and increased timeframes for that oil to reach hydrostatic equilibrium. Highly viscous crude oils may move very slowly through the subsurface and take years to reach equilibrium (Oostrom et al. 2006).



NOTE: simulated with LDRM model
SOURCE: Charbeneau 2014

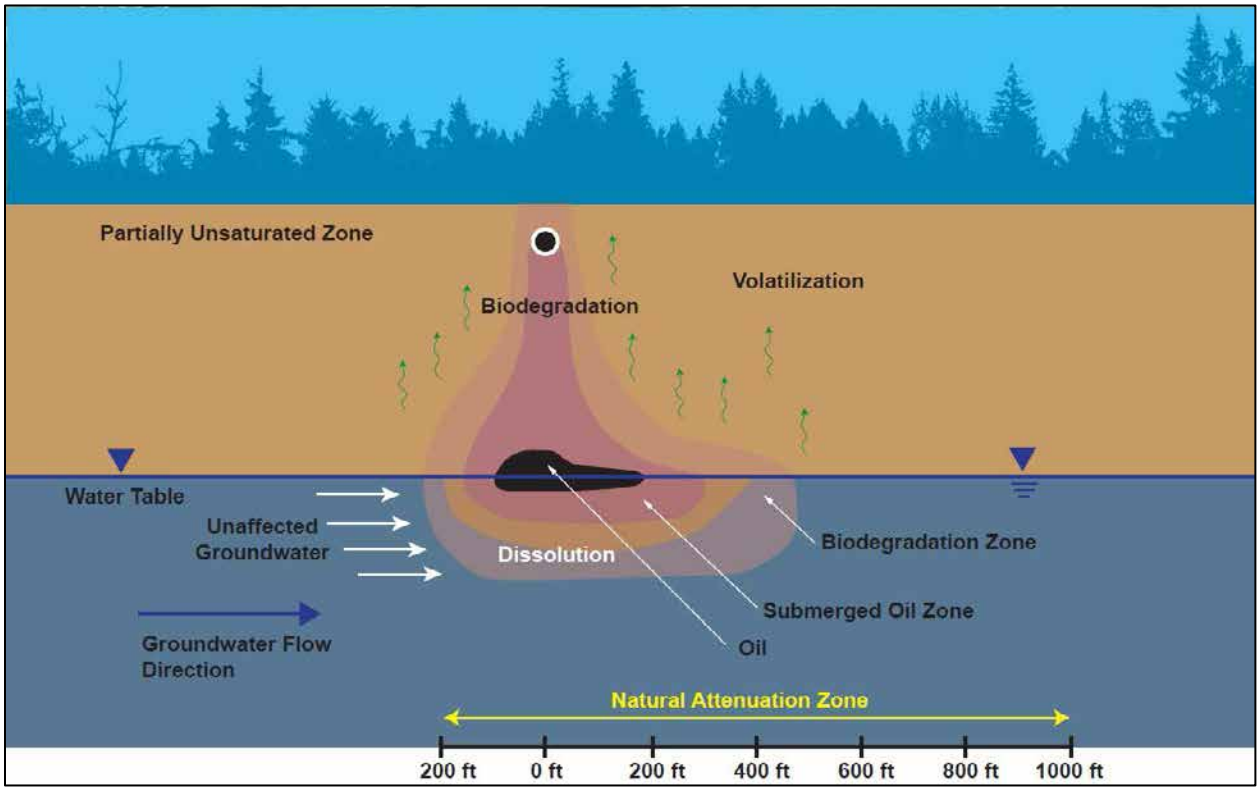
Figure 3-1 Theoretical Distribution of Oil at the Water Table in a Homogeneous Unconfined Sand Aquifer

3.4 CRUDE OIL FATE IN THE SUBSURFACE

Upon release of crude oil to the subsurface environment, depletion of the oil will continue naturally by a range of processes that include dissolution, vaporization and local biodegradation in the unsaturated and saturated zone (Figure 3-2). Collectively these processes result in mass transfer away from the oil release (ITRC 2009b; Johnson et al. 2006; Lundegard and Johnson 2006).

Once released to the subsurface, the oil may dissolve into groundwater or evaporate into the soil vapor. In the former, the process of dissolution creates a dissolved-phase plume in groundwater, whereas the latter creates a vapor-phase plume above the water table. This section discusses these mass transfer processes and the fate and transport of the respective

plumes that are produced. This includes the role of natural attenuation in their management and risk mitigation.



SOURCE: Modified from ASTM 2006

Figure 3-2 Subsurface Oil Fate Processes

3.4.1 Volatilization

Volatilization is the phase change from liquid to gas by which some of the smaller molecules leave the liquid phase of the crude oil and move into the atmosphere or the air in the soil pore spaces. This process is driven by the vapor pressure (volatility) of the various components of the crude oil. Crude oil contains VOCs that can vaporize during and after release in the subsurface, leading to the development of a vapor-phase in the partially saturated zone (Christophersen et al. 2005; Molins et al. 2010). Volatilization is less important for heavier oils. Key controlling parameters (vapor pressure, Henry's Law constant and diffusion coefficient) are sensitive to temperature and decrease at low temperature. This causes vapor generation and migration to be sensitive to temperature profiles in the shallow subsurface that may vary over a large range between summer and winter. Vapor generation and migration are more likely to occur on the ground surface than in the shallow subsurface where temperatures are generally cooler.

In the early phases of a crude oil release, volatilization can be the primary mechanism for release of smaller molecules. Crude oil exposed to air may lose approximately 20% of its volume by evaporation in a few hours, and 30% of its volume within a day (Fingas 2011); however, in the subsurface these processes may act more slowly. Volatilization will continue throughout the soil column where crude oil has been dispersed on the surfaces of soil grains, provided the pore spaces of the soil are not filled with water or oil to the point of inhibiting air flow. Diffusive VOC transfer across the largely immobile, water-saturated capillary fringe may be slow in either direction (Davis et al. 2004; Werner and Höhener 2001). The capillary fringe may contain air-filled pore spaces, but these spaces may be physically disconnected and effectively restrict gas and vapor diffusion. Fluctuation in the water table may increase vertical mixing and can enhance volatilization by increasing the contact area between the contaminated groundwater and gas phase.

Vapor-phase contaminants are attenuated by physical-chemical mechanisms such as dilution, diffusion, atmospheric emission and partitioning into pore water, but also by sorption and biodegradation (Rivett et al. 2011). For many petroleum constituents, biodegradation may lead to substantial natural attenuation of vapor (Grathwohl et al. 2001; Lahvis et al. 2013; USEPA 2013), as exemplified by studies on petroleum hydrocarbon light non-aqueous phase liquids (LNAPLs) such as gasoline, diesel, kerosene, crude oil and others (Christophersen et al. 2005; Molins et al. 2010).

3.4.2 Dissolution

Oil trapped in the subsurface will lose mass over time due to dissolution. Soluble components are transferred from the oil to flowing groundwater infiltrating through the vadose, or unsaturated, zone or in the saturated zone and a dissolved-phase plume may develop. Dissolution rates and hence source zone longevity is influenced by:

- Oil composition
- Distribution and saturation
- Oil-water contact area
- Groundwater velocity
- Molecular diffusivity of the oil chemicals in water
- Non-equilibrium dissolution effects
- Enhanced dissolution due to biodegradation of dissolved components (Garg and Rixey 1999)

Even though crude oil has a low solubility in water, when oil comes in contact with water, some compounds from the oil will dissolve into the water. The lightest components of crude oil (benzene, ethyl benzene, toluene, and xylene (sometimes referred to collectively as BTEX)), are the most soluble components of crude oil and among the most readily degraded and volatilized. Crude oil also contains medium weighted hydrocarbons called “polycyclic aromatic hydrocarbons” or PAHs. PAHs have moderate to very low solubility in water. Crude oil also contains heavy fractions that include waxes, asphaltenes, and nonpolar compounds which do not readily dissolve in water.

Dissolution of the soluble compounds in the crude oil happens relatively slowly because it takes place only where the oil is in direct contact with the slowly moving groundwater. This direct contact takes place primarily below the water table, where groundwater moves underneath the greatest accumulation of oil. Groundwater moves much more slowly than water in rivers or lakes. Even in very permeable deposits, such as sand and gravel, groundwater typically moves less than one foot per day. The plume of dissolved hydrocarbons will move even more slowly than the groundwater flow because of natural attenuation processes.

The solubility of crude oil components varies with time as the more soluble components preferentially dissolve into water, causing the remaining fractions to change. In crude oils, the light-end hydrocarbons will preferentially dissolve from the free phase oil. Medium and heavy hydrocarbons are sparingly soluble to practically insoluble and more persistent. Regardless of the type of crude oil, as the soluble components of the crude oil dissolve, the remaining residual oil is less soluble and more persistent than the source oil. Dissolution of the oil may require many thousands of pore volumes of water to be flushed through a source, with substantial variation in timescale possible due to variation in oil composition and effective solubility of components (Thornton et al. 2013).

Over a period of time, when crude oil is in contact with groundwater, dissolved crude oil constituents will enter the groundwater column, forming a contaminant plume that will move in the direction of groundwater flow. Vertical migration of contamination into groundwater is extremely limited, and is much less than horizontal migration. Where deeper aquifers are present and separated from the water table aquifer by impermeable layers, the deeper aquifers will not be affected.

Over a relatively short distance, the dissolved hydrocarbon plume will reach an equilibrium state and expand no farther as the flux of dissolved components from the remaining oil is balanced by the mass removed through attenuation processes in the aquifer (Section 3.4.4). Field investigations at over 600 petroleum hydrocarbon release sites indicate the migration of dissolved constituents typically stabilize within tens to hundreds of feet from the source area (Newell and Connor 1998; Connor et al. 2015). Over time, the contaminant plume will begin to reduce due to natural biodegradation.

3.4.3 Direct Biodegradation of Crude Oil

Biodegradation of crude oil source zones via microbial activity in the aqueous phase and vapor phase is well documented and discussed further below. In addition, direct biodegradation of the portion of the oil that does not volatilize or dissolve into groundwater has been also demonstrated to occur (e.g., Stout and Lundegard 1998). Several laboratory studies have shown that rates of mineralization of target constituents have exceeded the measured rates of aqueous-phase partitioning. These studies propose various mechanisms for bacteria to enhance biodegradation of the crude oil constituents. In general, biodegradation is not occurring within the crude oil itself, but rather at the oil-water interface through enhanced bio-activity (e.g., enzyme secretion and microbial attachment at oil-water interface). Laboratory studies confirm

that biodegradation of petroleum does occur in some situations and environments; however, they also point to circumstances that would reduce or eliminate biodegradation (e.g., toxicity).

3.4.4 Natural Attenuation of Dissolved-Phase Plumes

While dissolution fundamentally controls the duration of inputs to dissolved-phase plumes, the plume size and composition is predominantly controlled by natural attenuation in the aquifer. There has been substantial interest over the past two decades in monitored natural attenuation as a management strategy for contaminated groundwater (API 1998; ASTM 1998; EA 2000; Wiedemeier et al. 1995, 1997). This has provided a comprehensive body of evidence on the theoretical basis and practical site implementation of this approach for dissolved plumes originating from petroleum sources (Rivett and Thornton 2008; Wiedemeier et al. 1999).

Natural attenuation includes all of the of physical, chemical, and biologic processes that act without human intervention to reduce the mass, toxicity, mobility, and volume of crude oil in soil and groundwater (USEPA 1999). Natural attenuation takes place in the unsaturated zone, at the water table, and in groundwater, through the processes of biodegradation, dispersion, adsorption to soil particles, and volatilization. Whether in soil or groundwater, the processes involved in natural attenuation are the same, although the relative importance of individual processes could vary by location. Of these processes, biodegradation through metabolism by naturally occurring microorganisms is generally considered to be the primary mechanism responsible for petroleum mass reduction in the subsurface soil and groundwater (MPCA 2005).

The composition of the dissolved-phase plume that develops immediately down gradient of a release source is closely linked to the chemical composition of the crude oil and its evolving dissolution (and vaporization) characteristics. Preferential dissolution of the more soluble and volatile components of the crude oil will lead to plumes that are often dominated by BTEX components (Bowers and Smith 2014; Thornton et al. 2013). However, the less soluble and typically more biodegradable aromatic hydrocarbons such as toluene, ethylbenzene and xylenes often develop dissolved-phase plumes that are restricted to the source area.

In terms of plume size and duration, the plume expansion period is short compared with the length of time most residual crude oil remains in the subsurface. Plume expansion continues until a relatively stationary condition is reached, whereby the flux of dissolved components from the remaining oil is balanced by the mass removed through attenuation processes in the aquifer.

Natural attenuation will reduce most toxic constituents of petroleum releases into non-toxic metabolic byproducts, typically carbon dioxide and water (MN PCA 2005). Numerous multi-site studies conducted since the 1990s have presented results that indicate dissolved-phase hydrocarbon plumes stabilize at relatively short distances from the source area and are unlikely to be greater than a few hundred feet in length (Newell and Connor 1998; Connor et al. 2015).

3.4.4.1 Biodegradation

Many organic compounds in oils can be biodegraded by naturally-occurring subsurface microorganisms (Rivett and Thornton 2008). Microbially-mediated reactions occur, whereby organic compounds are metabolized, often to innocuous by-products, such as carbon dioxide, methane, and water. Electron acceptors used to support biodegradation include dissolved oxygen, nitrate and sulfate in pore water, and mineral oxidants such as manganese and iron-oxides present as grain coatings. Once those electron acceptors are depleted, fermentation (biochemical breakdown) of organic compounds may occur with the ultimate production of methane. Aerobic biodegradation (using oxygen as an electron acceptor) and anaerobic biodegradation (using other electron acceptors) typically occurs concurrently in groundwater plumes.

3.4.4.2 Dispersion

Dispersion is the process by which soluble hydrocarbons spread out vertically and laterally, reducing their concentration. This enhances the effects of other natural attenuation processes, such as biodegradation.

3.4.4.3 Adsorption

Adsorption slows the movement of oil in the subsurface. Adsorption is a chemical process where hydrocarbon compounds are electro-chemically attracted to the electrically charged surfaces of soil grains—particularly organic material in the soil. The extent to which adsorption slows the movement of dissolved hydrocarbons with respect to the velocity of the groundwater in which they are dissolved is called the retardation coefficient. Typical retardation coefficients for BTEX compounds are in the range of three to five, meaning they migrate three to five times slower than groundwater.

3.4.4.4 Volatilization

Volatilization is the transfer of mass from the liquid phase to the gas phase, as discussed in Section 3.4.1. This process may occur directly from the oil phase to the gas phase, but it also occurs between the dissolved phase and the vapor phase. Volatilization will continue throughout the soil column, provided the pore spaces of the soil are not filled with water or oil to the point of inhibiting air flow. Diffusive transfer across the largely immobile, water-saturated capillary fringe may be slow in either direction (Davis et al. 2004; Werner and Höhener 2001). The capillary fringe may contain air-filled pore spaces that may be physically disconnected from each other, thereby effectively restricting gas and vapor diffusion. Fluctuation in the water table may increase vertical mixing and can enhance volatilization by increasing the contact area between the contaminated groundwater and the gas phase.

4.0 NATURAL RESOURCE AND WATER SUPPLY MAPPING

At the request of DOC-EERA, the following natural resource and water supply areas have been identified within 1,000 ft of the center line (2,000 ft corridor) of the proposed L3RP Project and the route alternatives:

- Streams, wetlands, and lakes
- Calcareous fens
- Trout streams
- Wells
- Wellhead protection areas
- Drinking water supply management areas
- Surface water intakes

The location and proximity of these resources to the project were reviewed using spatial analysis tools in ArcGIS. Maps and tables identifying the natural resource and water supply features within 1,000 ft of the L3RP Project are included as Attachment A. A detailed assessment of environmental effects of oil releases on ecological and human receptors is presented in *Assessment of Accidental Releases: Technical Report—Chapter 7* (Stantec/RPS/Dynamic Risk Assessment Systems 2016).

4.1 STREAMS, WETLANDS AND LAKES

Surface water bodies, including stream wetlands and lakes, within 1,000 ft of the proposed route center line were identified in the National Wetlands Inventory (NWI; U.S. Fish and Wildlife Service) and Public Waters Inventory (PWI; MDNR 2016).

Based upon the assessment 3,913 wetlands, 88 streams, and 57 lakes (basins) were identified within 1,000 ft of the proposed right of way. Maps and tables identifying the surface water features within 1,000 ft of the L3RP Project are included as Attachment A

4.2 CALCAREOUS FENS

Three calcareous fens were identified, one each in Marshall, Pennington and Polk counties, within 1,000 ft of the proposed route center line in a data set derived from the National Heritage "Biotics" Database (MDNR 2016a). Maps and tables identifying the calcareous fens within 1,000 ft of the L3RP Project are included as Attachment A.

4.3 TROUT STREAMS

Nine state designated trout streams were identified that intersect the 2,000-ft proposed route corridor (MDNR 2016b). Maps and tables identifying the state designated trout streams within 1,000 ft of the L3RP Project are included as Attachment A.

4.4 WELLS

Water wells located within 1,000 ft of the L3RP Project and route alternatives (omitting monitoring wells, observation wells and abandoned wells) were identified using the MWI (MDH 2016), Based upon the analysis the following observations are made:

- 224 total wells were identified
- 201 of the 224 total wells were identified as domestic wells
- 3 of the 224 total wells were identified as exploratory well
- 8 of the 224 total wells were identified as irrigation wells
- 3 of the 224 total wells were identified as exploratory well
- 6 of the 224 total wells were identified as other or were not identified
- 2 of the 224 total wells were identified as scientific investigation wells
- 4 of the 224 total wells were identified as test wells

Maps and tables identifying the water wells within 1,000 ft of the L3RP Project are included as Attachment A.

4.5 WELLHEAD PROTECTION AREAS

Three Wellhead Protection Areas were identified that intersect the corridor within 1,000 ft of the proposed pipeline center line (MDH 2016b). Maps and tables identifying the wellhead protection areas within 1,000 ft of the L3RP Project are included as Attachment A.

4.6 DRINKING WATER SUPPLY MANAGEMENT AREAS

Three Drinking Water Supply Management Areas were identified that intersect the corridor within 1,000 ft of the proposed pipeline center line (MDH 2016b). Maps and tables identifying the wellhead protection areas within 1,000 ft of the L3RP Project are included as Attachment A.

4.7 SURFACE WATER INTAKES

One hundred and ninety-one total (27 active) surface water intakes were identified that intersect the corridor within 1,000 ft of the proposed pipeline center line (MDH 2016b). Maps and tables identifying the surface water intakes within 1,000 ft of the L3RP Project are included as Attachment A.

5.0 POTENTIAL ENVIRONMENTAL EFFECTS

5.1 GROUNDWATER SUSCEPTIBILITY TO HYDROCARBON CONTAMINATION

5.1.1 Aquifers

An aquifer is a geologic unit (or a combination of geologic units) that is capable of yielding usable quantities of water. Aquifers are typically composed of thick, laterally continuous deposits of permeable sand, gravel, or bedrock that is composed of permeable sandstone or limestone, or is highly fractured. Portions of geologic units that are not capable of yielding usable quantities of water generally are termed "aquitards" and are either too thin to accommodate wells or are composed of low-permeability materials, such as silt, clay, or crystalline bedrock. Unlike geologic units, aquifers and aquitards are not typically given formal names, but are often referred to by the geologic units that comprise them.

5.1.1.1 Glacial Aquifers

Unconsolidated permeable glacial deposits and recent alluvial deposits are the most important groundwater source along the proposed L3RP route. These deposits are typically near the ground surface, and consist primarily of glacial sand and/or gravel outwash, ice-contact deposits, or sand and gravel alluvium that was deposited along existing streams. Most glacial aquifers are classified as "surficial aquifers" because the groundwater table is located in these near surface deposits. The surficial glacial aquifers vary in thickness from a few feet to over 300 ft, and can produce water up to 3,000 gallons per minute or more, depending on the thickness and extent of the saturated deposits and the permeability of the aquifer materials.

Surficial glacial aquifers receive recharge by infiltrating precipitation and snow melt. Perched wetland deposits may also provide some minor additional recharge. Groundwater in the surficial glacial aquifers generally flows from upland areas (e.g., topographic highs) to lakes and streams. Many lakes and streams near the proposed route and its alternatives are in direct hydraulic connection with the surficial glacial aquifers and the open water of these features is typically at the same elevation as the water table. Groundwater from surficial aquifers discharges to lakes and rivers, where some water evaporates. Evapotranspiration from plants is also a mechanism of discharge.

In some locales near the proposed route and its alternatives, there may be "buried" glacial aquifers. Buried glacial aquifers are unconsolidated, permeable sand and gravel deposits that are separated from the ground surface or from overlying surficial glacial aquifers by a laterally continuous layer of lower permeability silt and/or clay that functions as an aquitard. Buried glacial aquifers are typically "confined" (i.e., the water pressure is above the aquitard base) and, in some cases, wells that are installed in buried glacial aquifers flow freely without pumping.

Flowing wells are most commonly encountered where a buried glacial aquifer is near a river because the ground surface is at a lower elevation near rivers. Buried glacial aquifers are recharged primarily by downward leakage through the aquitard. Discharge from these aquifers often takes place by upward leakage in the vicinity of rivers.

Surficial aquifers are an important source of groundwater throughout the region crossed by the proposed route and its alternatives, and can provide adequate water volumes to supply municipalities and irrigation systems. Surficial aquifers generally yield good quality water. However, there may be naturally occurring constituents, such as iron and manganese, at concentrations above secondary drinking water standards (i.e., levels that affect taste, color, and odor but not human health). In some areas, there may also be naturally high levels of constituents such as arsenic (MPCA 1999).

Glacial aquifers, and particularly surficial glacial aquifers, can be affected by surface activities, including industrial and agricultural land use, due to the relatively shallow depth of the water table and the relatively coarse texture of the material in the overlying unsaturated zone. The most common anthropogenic contaminant in glacial aquifers near the proposed routes is nitrate, which originates as fertilizer applied to agricultural fields and leaches into the groundwater system. Nitrate and other agriculturally derived contaminants are classified as "non-point source pollutants" because of their widespread use near portions of the proposed route and its alternatives. Nitrate persists in glacial aquifers for a long time because of the naturally low levels of organic material or sulfides that are able to "denitrify" nitrate.

5.1.1.2 Cretaceous Aquifers

Fine sandstone and shale of Cretaceous age are present in two areas that are traversed by the proposed route in Cass and Aitkin counties. These rocks, which are likely the stratigraphic equivalent of the Dakota Sandstone (present in southwestern Minnesota), are typically 200 to 350 ft below ground surface, and are overlain by glacial deposits. Because they are thin and of relatively low permeability, the Cretaceous aquifer near the proposed route and its alternatives yields only domestic quantities of water (i.e., 10–25 gallons per minute) and is used only in a few rural locations. The water quality of the Cretaceous aquifer is typically poor compared to glacial aquifers and has naturally elevated levels of total dissolved solids (particularly sodium, potassium and chloride) as well as undesirable levels of boron, sulfate, fluoride, molybdenum and iron in some areas (MPCA 1999).

5.1.1.3 Precambrian Aquifers

The proposed route and its alternatives are located over Precambrian aquifers consisting of undifferentiated granite, greenstone, and slate from central Minnesota to the northwest and Proterozoic meta-sediments from central to eastern Minnesota. These aquifers can yield limited supplies of water to rural domestic and livestock wells, where fractures, faults, and weatherized zones provide porosity and permeability. Wells in these aquifers are generally completed at depths ranging from 30- to 400-feet and generally yield between 1 and 25 gallons per minute.

5.1.2 Groundwater Susceptibility Evaluation Methods

Subsurface soil characteristics and the depth to the water table along the proposed L3RP route and its alternatives in Minnesota were evaluated. Statewide mapping of water-table aquifer vulnerability and depth to water table was utilized to evaluate the susceptibility of water table aquifers in the vicinity of the Project. The water table aquifer vulnerability map (MDA, 2015) assigns aquifer vulnerability ratings of high, medium, or low based on the composition of surficial materials. The vulnerability ratings are based on upon guidance from the Geologic Sensitivity Project Workgroup (DNR, 1991) and are defined as follows:

- Low: Water moving vertically will reach the aquifer within several decades to more than a century
- Medium: Water moving vertically will reach the aquifer in years to decades
- High: Water moving vertically will reach the aquifer within hours to years

Vulnerability ratings were assigned to geologic material types as follows:

- Low: Till Plain
- Medium: Supraglacial Drift Complex, Lacustrine, Peat
- High: Alluvium, Outwash, Ice Contact, Terrace, Bedrock, Sand and Gravel

The L3RP route and its alternatives were divided into one-mile segments and the vulnerability rating from the map was extracted at the midpoint of each segment. Based on professional judgment, lacustrine materials were considered low vulnerability in this analysis. Lacustrine deposits are typically composed of fine-grained sediments and such deposits have low permeability.

Depth to the water table was also taken into account in evaluating the susceptibility of water table aquifers. Depth to water table information from the Minnesota Hydrogeology Atlas (DNR, 2016) was extracted the midpoint of each one-mile project section. Project sections with a water table depth greater than 40 ft below ground surface were considered to have low susceptibility regardless of the geology. Based on professional judgment, in areas where the water table is 40 ft deep or deeper, a combination of release response and natural physical processes would make it unlikely that oil would migrate all the way down to the water table. Even for higher permeability deposits, such as sand and gravel, this is likely the case because these unsaturated deposits require large pore entry pressures to develop in order for downward migration to progress.

5.1.3 Groundwater Susceptibility Evaluation Results

From a total of 340 Project segments analyzed for the L3RP route, 137 have low susceptibility, 79 have medium susceptibility, 96 have high susceptibility, and 28 were unclassified due to lack of available data. Low -susceptibility water table aquifers are present across over 40% of the proposed L3RP route. A similar evaluation was performed for the route alternatives and are shown on Table 5-1, along with the proposed L3RP route.

Table 5-1 Summary of Groundwater Susceptibility L3RP Project Route

Route Alternative	1-Mile Linear Segment Aquifer Susceptibility Rating				
	Low	Medium	High	Unclassified	Total
L3RP Route	137	79	96	28	340
RA-03AM-L3	130	68	111	36	345
RA-06-L3	140	141	89	47	417
RA-07-L3	83	101	157	48	389
RA-08-L3	93	117	134	42	386
RSA-05-L3	11	6	7	0	24
RSA-10-L3	12	0	1	0	13
RSA-15-L3	5	0	16	0	21
RSA-21-L3	14	57	7	31	109
RSA-22-L3	27	61	17	39	144
RSA-23-L3	0	30	9	31	70
RSA-27-L3	0	13	4	13	30
RSA-28-L3	0	1	0	7	8
RSA-31-L3	0	4	2	9	15
RSA-33-L3	0	1	2	1	4
RSA-34-L3	0	0	3	3	6
RSA-35-L3	0	2	2	0	4
RSA-37-L3	36	35	8	4	83
RSA-42-L3	4	0	0	5	9
RSA-43-L3	3	0	0	5	8
RSA-44-L3	4	7	0	8	19
RSA-45-L3	4	5	0	10	19
RSA-46-L3	4	0	0	0	4
RSA-49-L3	2	7	0	3	12
RSA-51-L3	1	1	2	0	4
RSA-52-L3	0	1	1	0	2
RSA-53	83	101	160	48	392
RSA-Blandin-L3	0	6	1	1	8
RSA-White Elk Lake-L3	0	16	0	1	17
SA-04-L3	50	173	22	4	249

A complete set of figures displaying the groundwater susceptibility assessment are presented in Attachment B.

5.2 SURFACE WATER SUSCEPTIBILITY

For the purpose of this assessment, it is predicted that 28 bpd (estimated release rate from 1/32 in. hole; refer to Section 2.3) of crude oil would be released from a pinhole leak. Assuming that leak detection systems identify the leak within 100 days, it is estimated that 2,800 barrels (bbl) could be released before the leak was detected.

A release of crude oil to the environment from a pinhole leak in the proposed pipeline could occur underground, with subsequent transport into aquatic systems, should riverine and lacustrine habitats be nearby.

The proposed pipeline would carry a variety of crude oil types, ranging from very light (e.g., Bakken crude oil) to heavy (e.g., diluted bitumen such as CLB). An assessment of the fate and transport of a worst case release at seven representative river systems in Minnesota (i.e., hypothetical release directly to a water body) was conducted (Chapters 5 and 6 of the *Assessment of Accidental Releases: Technical Report* [Stantec, RPS, Dynamic Risk Assessment Systems 2016]). This report also included an assessment of expected environmental effects of these releases (Chapter 7 of the *Assessment of Accidental Releases: Technical Report* [Stantec, RPS, Dynamic Risk Assessment Systems 2016]), as well as a review of the potential and timing for the recovery of the physical, biological, and human environments following a large release of oil (Section 8.0).

The fate and downstream transport of released oil in a water body is largely determined by flow conditions (i.e., high flow coinciding with the spring freshet; average flow during summer or fall; low flow in winter typified by freezing conditions and probable ice cover on water) and oil type. In general, lighter crude oils such as Bakken crude oil is predicted to evaporate more and to travel equal or farther distances downstream than heavier crude oils such as CLB. Bakken crude oil is also predicted to spread more thinly on the water surface and to adhere less to river banks than Cold Lake Blend. Evaporative losses of both oil types would be greater in summer due to hotter ambient temperatures. Under low flow conditions, the downstream extents of released oils would be similar, but shorter than under spring and summer conditions. Ice cover on rivers and lakes during winter would strongly limit or prevent evaporation to the atmosphere of both oil types.

Overall, the effects of a release of light crude oil compared to heavy crude oil on human and ecological receptors are expected to be similar in overall magnitude, while varying in specific details. For sediment, shoreline and riparian areas, light oil is expected to have less of an effect than heavier oil. However, for other receptors (river and lakes, quality, aquatic plants, benthic invertebrates, fish, amphibians and reptiles, birds and semi-aquatic mammals, and air quality, human receptors and public use of natural resources), lighter oil is expected to have similar or potentially more serious effects, when compared to heavy oil. The overall impact of an oil spill, including the effectiveness of an oil spill response, depends mainly on the environment and conditions (weather, waves, etc.) where the spill takes place and the time lost before remedial operations (Lee et al. 2015).

5.3 WETLANDS, FENS AND PEATLANDS SUSCEPTIBILITY

The fate and downstream transport of released oil would be largely determined by flow conditions of water bodies (i.e., high flow coinciding with the spring freshet; average flow during summer or fall; low flow in winter typified by freezing conditions and probable ice cover on water) and oil type. Oil that reaches soil would be physically remediated and vegetative cover would be restored as part of the clean-up process. Soil would be physically remediated to established standards (Stantec et al. 2016).

Flooded riparian areas and wetland habitats (e.g., fens and peatlands) could also be exposed to released oil, and if not properly remediated, crude oil residues could kill plants in these areas. This could affect the biological integrity and productivity of the habitat, and potentially lead to erosion and further damage to the habitat. In the early summer, oiling of emerging wild rice plants could lead to growth inhibition or death. Later in the summer, oiling at water level of the stems of emerged plants is unlikely to affect the plants. A release of crude oil in winter would have little direct effect on aquatic plants, as they would be in a dormant state (Stantec et al. 2016).

Wetlands, fens and peatlands are also home to amphibians (e.g., frogs, salamander), reptiles (e.g., turtles, snakes), birds (e.g., ducks, geese, shorebirds, raptors), and semi-aquatic mammals (e.g., muskrat, beaver, mink and otter). Within the oil-exposed habitats that support amphibians (adults, juveniles, and eggs), oiling effects including mortality would be observed (Stantec et al. 2016). Turtles appear to be relatively tolerant of external crude oil exposure, and although these animals are likely to become oiled, mortality of turtles as a result of this exposure is less likely. Reptiles like lizards and snakes are primarily terrestrial species and are less intimately associated with aquatic environments. Amphibians and reptiles undergo a winter dormancy period when temperatures drop below approximately 41 to 45°F. At this time, amphibians and turtles typically bury themselves in river bottom substrates or other similar habitats. Therefore, during the winter (and likely up until April or May when winter ice is gone), these organisms would have very little exposure to released oil moving on the water surface or within the water column (Stantec et al. 2016).

If exposed to external oiling, the ability of birds and mammals to maintain body temperature may be compromised, leading to death as a result of hypothermia (Stantec et al. 2016). Birds and mammals that survive external oiling may experience toxicological stresses as a result of ingesting crude oil residues during preening/grooming or ingesting food, and birds can also transfer potentially lethal quantities of crude oil residue from their feathers to the external surface of eggs. Waterfowl and other semi-aquatic birds and mammals present in the affected rivers and lakes would be most affected. Animals upstream, farther downstream, or occupying other nearby habitats, would likely be less affected as it is assumed that emergency response measures to prevent or reduce further possible downstream transport of oil would be in place within 24 hours of the release. Timely capture and rehabilitation of oiled birds and mammals may help to mitigate the environmental effects of a crude oil release (Stantec et al. 2016).

6.0 RECOVERY OF GROUNDWATER FROM THE EFFECTS OF A RELEASE

Because oil spill detection and response times are much faster than the times required for an oil spill to develop hydrocarbon plumes and for those plumes to travel toward receptors, spill countermeasure plans and associated cleanup actions should be effective at protecting groundwater resources. Containment, recovery, and clean-up actions would be undertaken to reduce the effects on human health and the environment. Measures would be specific to the affected receiving environment and include consideration of local sensitivities such as human health, public safety, priority ecosystem values, weather, and other site-specific considerations. Without treatment or physical removal, crude oil could be a long-term source of groundwater contamination. For this reason, release recovery efforts aim to reduce potential for groundwater contamination by removing pooled oil and affected surface materials as quickly as possible, and as deeply as needed to remove oil so that aquifers are not affected.

6.1 REMEDIATION TECHNOLOGIES

After initial recovery efforts are complete and immediate risks to human health addressed, longer term remedial technologies can be implemented. Corrective remedial actions must be reviewed and approved by the United States Environmental Protection Agency (USEPA) or MPCA prior to execution of the selected technology. Remedial technologies would be chosen based upon the volume of the release, environmental setting, regulatory clean-up objectives and potentially affected receptors.

6.1.1 Ex-Situ Technology

6.1.1.1 Soil Excavation

Soil excavation consists of removal and disposal of soil that contains oil from a release by using earth moving equipment. Soil is transported by a licensed waste hauler to an approved disposal or treatment facility. During excavation activities, soils are either screened in the field with portable instruments or submitted to a laboratory for analytical testing. Field screening or laboratory testing may indicate when cleanup standards have been achieved. Soils substantially below the groundwater table are not typically excavated due to dewatering and stability requirements. After excavation is complete, clean material is used to fill the excavation and return the area to pre-excavation conditions.

Soil excavation would be effective for the cleanup of the majority of pinhole leaks. Excavation is typically confined to the pipe trench backfill and immediately adjacent materials. Excavation would also be effective in sensitive areas with shallow groundwater or where groundwater may discharge to seeps or surface water. Excavation can be more difficult during cold weather if the ground is frozen. Excavation is typically limited to soils above bedrock.

6.1.1.2 Skimmer Systems

Skimmer systems consist of recovery wells equipped with skimmer pumps designed to remove oil that floats on the groundwater table. Skimmer pumps have intakes that float at the oil-groundwater interface. The intakes are designed to only allow oil to enter the pump. The recovered oil is then pumped to a holding tank. Skimmer pumps can be installed in numerous wells to remove oil over small or large areas. The pumps are controlled from a central location. Periodic maintenance of the pumps and intakes is required.

Skimmer systems are effective in sensitive areas with shallow groundwater and areas with deeper groundwater. These systems can be installed when the ground is frozen and in bedrock. These systems would not typically be installed for pinhole releases contained within the pipe trench backfill materials, but could be installed if a release were to extend beyond the limits of the trench to the groundwater table.

6.1.1.3 Pump and Treat Systems

Pump and treat systems consist of recovery wells installed within affected areas that are equipped with pumps for removing oil and groundwater if oil has dissolved into groundwater. Multiple wells can be connected to a central control building. Oil and water are separated prior to disposal. The recovered oil is typically sent to a holding tank. Groundwater is processed through one or more treatment systems to remove constituents of concern that dissolved into the groundwater. Common treatment technologies include air stripper systems (in which air is pumped through the water to volatize dissolved oil) and granular activated carbon (GAC) tanks. Groundwater is pumped through the GAC tanks and dissolved oil is adsorbed onto the carbon surface. The used carbon is taken to an approved disposal facility. After the groundwater is treated, it may then be re-injected into the subsurface or discharged into the local municipalities' sanitary sewer system.

Pump and treat systems are effective for long-term containment of groundwater contamination in sensitive areas with shallow groundwater and areas with deeper groundwater. They typically require operation over several years because mass removal via pump and treat systems is relatively slow. These systems can be installed when the ground is frozen and in bedrock.

6.1.1.4 Multi-Phase Extraction Systems

Multi-phase extraction systems consist of wells that are installed within the affected area if constituents of concern from the oil have dissolved into groundwater. These are called multi-phase systems because they simultaneously extract soil vapor, oil and groundwater. Multiple wells can be connected to a central control building. A vacuum is applied to the wells to extract soil vapor, oil and groundwater from the area affected by a release. Oil and water are separated prior to disposal. The recovered oil is typically sent to a holding tank. Groundwater is processed through one or more treatment systems as discussed in the section on pump and treat systems. The soil vapor may be treated to remove the volatilized oil.

Multi-phase extraction systems are effective in sensitive areas with shallow groundwater and areas with deeper groundwater. These systems can be installed when the ground is frozen and in bedrock. These systems would not typically be installed for pinhole releases contained within the pipe trench backfill materials, but could be installed if a release were to extend beyond the limits of the trench.

6.1.1.5 Air Sparge/Soil Vapor Extraction Systems

Air sparge (AS)/soil vapor extraction (SVE) systems consist of wells that are installed within the affected area if oil has dissolved into groundwater. Multiple wells can be connected to a central control building. These systems consist of a combination of wells installed below the groundwater table. The AS wells are used to pump air into groundwater in the area affected by a release. The SVE wells, which are installed above the groundwater table, are used to extract soil vapor. The AS wells are used to volatilize dissolved constituents within the groundwater into the soil vapor above the groundwater table. Simultaneously, soil vapor is extracted through the SVE wells. The soil vapor may be treated to remove the volatilized constituents.

AS/SVE systems are effective in sensitive areas with shallow groundwater and areas with deeper groundwater. These systems can be installed when the ground is frozen and in bedrock. These systems would not typically be installed for pinhole releases contained within the pipe trench backfill materials, but could be installed if a release were to extend beyond the limits of the trench.

6.1.2 In-Situ Technology

6.1.2.1 Chemical Treatment

Chemical treatment commonly consists of using compounds that release oxygen into groundwater. The oxygen enhances the breakdown of oil dissolved in groundwater into harmless end products. The oxygen releasing compounds can be added to groundwater through wells or temporary injection points. Periodic testing of groundwater is performed to assess the effectiveness of the treatment.

Chemical treatment is effective in sensitive areas with shallow groundwater and areas with deeper groundwater. This approach can be taken when the ground is frozen and in bedrock. This approach would not typically be selected for pinhole releases contained within the pipe trench backfill materials, but could be used if a release were to extend beyond the limits of the trench.

6.1.2.2 Biodegradation

Naturally occurring microbes feed upon oil and have been shown to not only limit how far the effects of a release can extend, but also reduce the amount of oil dissolved in groundwater. Once the majority of the released oil has been recovered, biodegradation is a common

approach for managing residual effects of a release. These processes can be allowed to progress naturally, an approach called natural attenuation, or the natural processes can be enhanced by adding oxygen releasing compounds or other nutrients. If nutrient enhancement is used, then the nutrients can be added to groundwater through wells or temporary injection points. Periodic testing of groundwater is performed to assess the effectiveness of the natural degradation.

This approach is acceptable in sensitive areas with shallow groundwater and areas with deeper groundwater. It may not be an option if wells are used for water supply, in areas where groundwater may discharge to seeps, or surface water is located within a few hundred feet of the oil release.

6.1.3 Physical Barriers and Hydraulic Containment

Subsurface physical barriers or hydraulic containment may be installed to protect sensitive receptors or influence the flow direction of oil dissolved in groundwater. The barriers can consist of:

- Sheet piling or slurry walls to form physical barrier
- Extraction wells to form hydraulic containment
- Permeable reactive barriers that can be used to direct groundwater flow to an area where materials have been installed below the groundwater table that will treat the groundwater as it passes through them

These approaches may require active operation, treatment of groundwater and periodic groundwater monitoring.

These approaches are most effective in areas with shallow groundwater. Excavation to install slurry walls or reactive barriers and driving sheet piling can be more difficult during cold weather if the ground is frozen, and are generally limited to soil above bedrock. These approaches would not typically be selected for pinhole releases contained within the pipe trench backfill materials, but could be used if a release were to extend beyond the limits of the trench and had the potential to affect a sensitive area.

7.0 CASE STUDIES

Cases studies were identified to provide a historical context for pinhole releases. A review of available case studies relevant to pinhole releases and their potential effect on the environment was performed, with a focus on case studies most relevant to conditions in Minnesota.

Two relevant case studies for L3RP are discussed, a release of crude oil from a pipeline system near Bemidji, Minnesota and a release of crude oil near Cass Lake, Minnesota. While these releases are not classified as a pinhole releases, the studies provide a great deal of insight into the potential effects of a release into a northern Minnesota environment. In particular, the well-

studied cases document how oil moves in the subsurface under geologic and climatic conditions similar to some of the areas the proposed Project will cross.

Additionally, since 2001, PHMSA incident reports have included "pinhole" as an option for classifying the type of leak. It is noted that PHMSA definition of a pinhole leak is subjective (refer to Section 1.1) and may include leaks that are generally considered to be larger than a pinhole as defined in this report. The PHMSA database categorized eight releases in Minnesota as "pinhole releases" of petroleum related products during the period from 2001 to 2015. Information requests were submitted to the MPCA for each of the eight pinhole releases. Summaries describing the quantity released, impacts to the environment, and remediation efforts, where available, are provided in Section 7.3. A case study location map is provided as Figure 7-1.

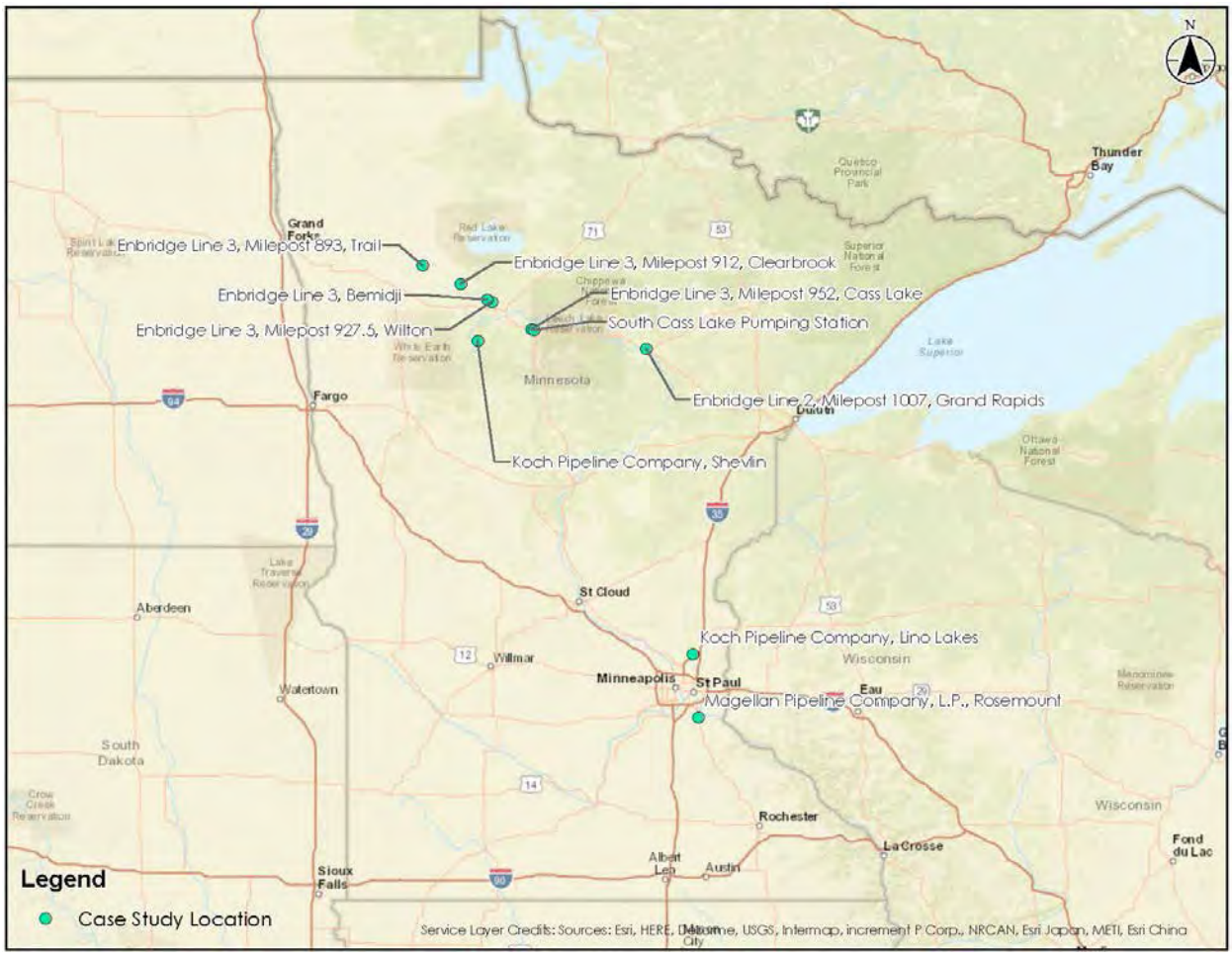


Figure 7-1 Case Study Location Map

7.1 ENBRIDGE ENERGY, LIMITED PARTNERSHIPS' LINE 3, BEMIDJI, MINNESOTA

The Bemidji release is the sentinel study that vastly increased the scientific understanding of natural attenuation processes. In 1979, Enbridge's Line 3 released approximately 10,700 barrels of crude oil near Bemidji, Minnesota. Initial clean-up efforts removed approximately 8,200 barrels (75% of the original volume) and an unquantified volume was lost to the atmosphere to volatilization. There was a substantial volume (up to approximately 2,500 barrels) of unrecovered crude oil that remained in the soils and subsoils after clean-up. The release occurred in an area of very sandy soils with shallow groundwater. The water table ranges from near land surface to approximately 36 feet below the land surface. Since the release occurred within a state forest with few environmental receptors (e.g., drinking water intakes, populated areas) in close proximity to the release site, the State of Minnesota, the U.S. Geological Service, and Enbridge collectively agreed to monitor effects of crude oil and its dissolved constituents on groundwater. As part of this research initiative, these agencies and Enbridge agreed that further cleanup and remediation of the site (i.e., treatment of contaminated soils and subsoils) would not be undertaken at that time. Seventeen years after the release, natural attenuation had limited the movement of the hydrocarbon plume to 650 feet in length, compared to groundwater movement of 1,640 ft (Delin et al. 1998).

7.2 SOUTH CASS LAKE PUMPING STATION, MINNESOTA

A subgrade leaking flange at the Cass Lake pumping station in north-central Minnesota was discovered in 2002. An estimated 1,143 barrels of crude oil were present at the groundwater table (approximately 26 to 28 ft below ground surface), and the dissolved phase plume (greater than 10 ppb benzene) extended 500 ft downgradient (Drennan et al. 2010). Because the oil resided under a gravel-covered yard at Cass Lake, enhanced surface recharge was suspected as a factor accelerating degradation (Drennan et al. 2010). To further accelerate groundwater recovery, a bioventing groundwater remediation system was installed in 2014. Monitoring data following just three months of operation suggest biodegradation was being enhanced with increased oxygen, decreased carbon dioxide, and increased temperature in the unsaturated zone (AECOM 2015).

7.3 PHMSA REPORTED PINHOLE RELEASES

A search of the PHMSA release database identified eight releases in Minnesota classified as "pinhole" releases of petroleum products that occurred during the period from 2001 to 2015. A description of the available case studies is provided below.

7.3.1 Enbridge Line 3, Milepost 952, Cass Lake, Minnesota

On March 20, 2012 Enbridge pipeline maintenance (PLM) personnel discovered historical contamination near a PLIDCO repair fitting during a routine maintenance dig along Enbridge's

Line 3 crude oil transmission pipeline at milepost 952 near Cass Lake, Minnesota. Upon evaluation of the PLIDCO repair fitting and site conditions and a review of historical documentation, it was determined that residual contamination was from the historical leak identified in 1973. Approximately 5900 cubic yards of contaminated soil caused by the historical leak was removed from the site and disposed of at an off-site facility (AECOM 2012). Groundwater monitoring wells indicated the presence of dissolved benzene ranging from non-detect to 89 micrograms per liter (µg/L). The water table was located approximately 5 to 22 feet below ground surface. Despite the relatively old age of the release, dissolved benzene in groundwater was limited to approximately 250 ft in length (AECOM 2012).

7.3.2 Enbridge Line 3, Milepost 893, Trail, Minnesota

Crude oil on the surface was observed and reported by a railroad engineer on April 14, 2003 approximately 16.5 miles upstream of the Clearbrook Terminal. Enbridge immediately shut down five lines in the vicinity of the discovered release and mobilized a response crew to the incident area. The source of the release was identified as a failed girth weld on the Line 3 pipeline. An estimated 125 barrels of crude oil were estimated to have been released (Natural Resources Engineering 2003). Crude oil on the surface was contained and removed via vac truck and subsurface soils containing residual oil were excavated. The water table was located approximately 1.5 ft below ground surface. Approximately 2,500 cubic yards of soil containing residual crude oil were excavated and treated off site. Subsequent investigation indicated the site did not pose additional risk to human health or the environment (Natural Resource Engineers 2003). The MPCA issued a case closure letter on July 17, 2003 (MPCA Spill Number 58832).

7.3.3 Enbridge Line 2, Milepost 1007, Grand Rapids, Minnesota

A subgrade pinhole leak was encountered during maintenance excavation of a 26-in. pipeline near the City of Grand Rapids, Minnesota in February, 2004. An estimated 714 barrels of crude oil were estimated at the groundwater table located approximately 36 to 45 ft below ground surface (Natural Resources Engineering 2005), and the dissolved phase plume (greater than 10 ppb benzene) extended approximately 200 ft down gradient of the free phase crude oil body and was approximately 500 ft in length total (AECOM, 2013). Analysis of natural attenuation parameters indicated that conditions were acceptable to promote natural attenuation of petroleum related constituents in groundwater (AECOM 2013). To further accelerate groundwater recovery, an oil recovery system was installed. Groundwater monitoring data following the discovery of the release indicated that the dissolved phase plume was limited in extent and relatively stable (AECOM 2013). The active remediation soil and groundwater remediation and natural attenuation processes resulted in significant reduction in dissolved phase constituents, most notably benzene by 2012. The MPCA issued a case closure letter on July 16, 2013 (MPCA Spill Number 17922).

7.3.4 Enbridge Line 3, Milepost 927.5, Wilton, Minnesota

Crude oil on the ground was observed and reported by an individual at milepost 927.5 near the City of Wilton, Minnesota on October 20, 2006 (MPCA Spill Number 68260). Enbridge immediately mobilized a response crew to the incident area. The source of the release was identified as a failed weld. An estimated five barrels of crude oil were estimated to have been released (Barr Engineering 2008). The pipeline was excavated and repaired on October 21, 2006. Approximately 727 cubic yards of soil contain residual crude oil were excavated and treated off site. Subsequent investigation indicated the water table was located at a depth of approximately 10 to 15 ft below ground surface and a dissolved phase plume (greater than 10 ppb benzene) approximately 140 to 200 ft in length was identified (Barr 2008). Analysis of natural attenuation parameters indicated that natural attenuation was expected to decrease dissolved benzene concentrations in shallow groundwater (Barr 2008). The MPCA issued a case closure letter on November 12, 2008.

7.3.5 Enbridge Line 3, Milepost 912, Clearbrook, Minnesota

An Enbridge employee identified oil in a ditch on November 13, 2007. Upon excavation of the site, it was determined that two pinhole leaks had occurred on the long seam of Line 3 at milepost 912. The leak was isolated and a tight fitting sleeve was put on as a temporary repair until plans could be made to cut the section out for further investigation. An estimated two barrels of crude oil was released. The MPCA issued a case closure letter on December 10, 2008 (MPCA Spill Number 71592).

7.3.6 Magellan Pipeline Company, L.P., Rosemount, Minnesota

An in-line inspection of a 10.75-in. diameter gasoline pipeline identified a location requiring repair on January 11, 2014. The pipeline had already been shutdown to facilitate completion of the inspection. Upon excavation for repair, the pipeline was found to have a "low rate" release. The release was located at milepost 0.29 of the pipeline (referred to as #3-10" Pine Bend to Rosemount Line) in Rosemount, Minnesota. According to the PHMSA incident report the cause of the rerelease was external corrosion and the pipeline was installed in 1957. The pipeline was repaired and approximately 50 cubic yards of soil was "rehabilitated" (MPCA Spill Number 89107).

7.3.7 Koch Pipeline Company, Lino Lakes, Minnesota

A release occurred during hydrostatic testing of a crude oil pipeline on September 25, 2014 near Lino Lakes in Anoka County, Minnesota (MPCA Spill Number 91343). Loss of pressure during hydrostatic testing indicated a release which was confirmed via excavation along the pipeline. Specifically, the release occurred near milepost 218 of the Loop 7 segment of the pipeline referred to as Minnesota Pipe Line 2. The release location was within a jurisdictional wetland that was dry at the time of the release. The cause of the test failure was identified as a manufacturing defect. The release included an estimated 2,000 gallons of hydrostatic test water

and 88 to 165 gallons of crude oil. A total of 915 tons of impacted soil was excavated for off-site disposal (Barr 2015a). The excavation encountered perched groundwater at approximately 5–6 ft below grade (Barr 2015a). The perched groundwater was reportedly separated from the uppermost aquifer by a clay layer that is present from 15 to 40 ft below grade. Residual petroleum impacts were not identified and an evaluation of potential soil, groundwater and vapor receptors identified minimal risks (Barr 2015a). The MPCA granted Site closure on February 26, 2016.

7.3.8 Koch Pipeline Company, Shevlin, Minnesota

Crude oil on the ground was observed by Koch Pipeline Company L.P. (KP) staff at the Itasca Pump Station on December 18, 2014 located near the town of Shevlin in Clearwater County, Minnesota (MPCA Spill Number 91983; PHMSA Report Number 20150021). The pipeline control center was notified and the pipeline was shut down. The source of the release was determined to be a pinhole leak in a suction line at the station. It was estimated that approximately 20 barrels of crude oil was released. Approximately 320 cubic yards of impacted soil was excavated for off-site disposal (Barr 2015b). Subsequent investigations delineated the extent of impacts. It was estimated that the deepest contamination at the site reached a confining layer at approximately 22 ft below grade. Groundwater was not encountered at the Site and based on County Well Index records the groundwater elevation at the site was estimated to be more than 80 feet below grade (Barr 2015b. Given the low potential for impacts to reach the water table it was concluded that remaining soil impacts above the MPCA Soil Leaching Values (SLVs) were not of concern (Barr 2015b). The MPCA granted Site closure on September 3, 2015.

8.0 CONCLUSIONS

Pipeline releases in general are uncommon and pinhole releases historically have occurred infrequently. The calculated incident rate per mile-year for the on-shore mainline crude oil pipeline is 0.00081, 0.00068, 0.00071 in the United States, upper Midwest region, and Minnesota, respectively for the period from January 2002 to December 2015. Additionally, of the 80 total releases reported in Minnesota during this period, 11 have been classified as pinhole releases in the PHMSA database of reportable pipeline incidents.

The potential for pinhole leaks to occur in newer pipelines and the potential impact of releases has been reduced through the use of new tools, technologies, and strategies to protect the public and the environment. Modern pipelines are designed and constructed to rigorous standards that meet or exceed government regulations. Materials are selected and tested prior to and during manufacture to meet quality criteria and all welds made to a pipeline section during construction are tested using X-ray or ultrasonic methods. Soil-side corrosion is prevented using a combination of external coatings that are subject to quality control/inspection before and after backfill, and cathodic protection systems that are continuously monitored. Internal corrosion is prevented by maintaining strict tariff limits on trace sediment and water; and by either flowing the pipeline rapidly enough to prevent these materials from accumulating, or by

executing periodic cleaning programs to remove any accumulated matter that could cause corrosion. Operating pipelines are equipped with sophisticated, computerized leak-detection monitoring systems monitoring and control systems that provide continuous, real-time information and are augmented with routine inspections and aerial patrols of rights-of-way. Inspection is supplemented with the periodic use of inline inspection tools capable of measuring the size, frequency, and location of small changes in pipeline walls.

Pinhole leaks in pipelines rarely go undetected for long periods of time. Most pinhole releases (greater than 28 bbls per day) of crude oil would fill the more permeable trench materials in a relatively short time and reach the ground surface, where they would be reported in several hours to, at most days, through CPM, volume reconciliation and/or visual observation. While unlikely to occur, a very small leak rate (e.g., less than 0.035 bpd or 1.5 gpd) could potentially continue undetected for longer periods of time resulting in a release of sufficient volume and allowing for sufficient transport time to affect groundwater. However, conclusions from other reports indicate that a release as small as 1/32-in. would result in a release of 28 bpd (nearly three orders of magnitude higher than 0.035 bpd) (Battelle, 2014). Therefore it is unlikely that a pinhole release as low as 0.035 bpd would occur. This is further evidenced by the relative scarcity of pinhole releases in the PHMSA database of reportable pipeline incidents and the case studies presented that indicate releases pinhole releases were discovered relatively quickly through observation of crude oil at the surface.

Surficial aquifers would be most susceptible to effects of a crude oil release in areas where the water table is within 40 ft of the ground surface and unsaturated zone soils are permeable enough to allow oil to migrate down to the water table. However, even in a scenario where crude oil from a release migrates to the water table and soluble hydrocarbons dissolve into the groundwater, the distance that a plume of dissolved hydrocarbons will move from the site of the release will be reduced by natural processes. Field investigations at over 600 petroleum hydrocarbon release sites indicate the migration of dissolved constituents typically stabilize within tens to hundreds of feet from the source area.

After emergency response and remediation activities remove contaminated soil, natural attenuation would reduce the maximum movement of a plume of dissolved hydrocarbons to a distance on the order of a few hundred feet.

Assessment of water table aquifers along the L3RP project route and its alternatives shows that very-low- or low-susceptibility water table aquifers are present across approximately 62% of the L3RP route. Where high-susceptibility areas are located along the proposed route, potential impacts to water supplies are limited because water quality in the water table aquifer tends to be degraded by fertilizers, herbicides, and pesticides from agricultural applications and is not typically used for water supply.

In the event of a crude oil release, a wide variety of techniques are available to contain, capture, and remove released oil. Initial remediation activities can include excavating affected soil and pumping out oil that is accumulated at the water table. If groundwater was affected by

a crude oil release, monitoring would be conducted to document the movement of dissolved hydrocarbons in the groundwater and the activity of natural attenuation processes. If monitoring indicated that a plume of dissolved hydrocarbons had the potential to reach a nearby downgradient water supply or sensitive environment, then additional remediation techniques are available to mitigate impacts to groundwater and slow or stop the movement of the plume.

Given the generally low-susceptibility of surficial aquifers along the Project route and its alternatives and the ability of release response, remediation, and natural attenuation to limit the movement of dissolved hydrocarbons in groundwater, the Project is expected to result in no effects or localized effects on groundwater if a small release of crude oil were to occur.

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ATTACHMENT A

ATTACHMENT A
Natural Resource and Water Supply Summary Tables and Figures
Line 3 Replacement Project Preferred Route

Table 1
Line 3 Replacement Project
Public Waters Inventory Streams Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Approximate Milepost [a]	Kittle Name (Kittle Number)	Crossed by the Centerline	Miles Within the Corridor [b]
Middle Red	Kittson	802.00	Red River (H-026)	Yes	0.39
Middle Red	Kittson	804.00	Red River (H-026)	No	0.44
Middle Red	Kittson	806.00	Unnamed Creek (H-026-011-001)	Yes	0.86
Middle Red	Marshall	828.00	Tamarac River (H-026-019)	No	0.10
Middle Red	Marshall	829.00	Tamarac River (H-026-019)	Yes	2.09
Middle Red	Marshall	829.00	Tamarac River (H-026-019)	No	0.03
Middle Red	Marshall	829.00	Tamarac River (H-026-019)	No	0.23
Snake	Marshall	836.00	Middle River (H-026-021-004)	Yes	0.65
Snake	Marshall	843.00	Snake River (H-026-021)	Yes	0.80
Snake	Marshall	843.00	Snake River (H-026-021)	No	0.06
Snake	Marshall	847.00	Unnamed Creek (H-026-021-010)	Yes	0.41
Red Lake	Pennington	864.00	Red Lake River (H-026-030)	Yes	1.11
Red Lake	Pennington	866.00	Unnamed Creek (H-026-030-030)	Yes	0.47
Red Lake	Pennington	870.00	Unnamed Creek (H-026-030-028)	Yes	0.58
Clearwater	Red Lake	875.00	Clearwater River (H-026-030-019)	Yes	0.52
Clearwater	Clearwater	902.00	Unnamed Creek (H-026-030-019-007-007)	Yes	0.58
Clearwater	Clearwater	903.00	Unnamed Creek (H-026-030-019-007-007)	No	0.31
Clearwater	Clearwater	903.00	Unnamed Creek (H-026-030-019-007-007)	No	0.20
Clearwater	Clearwater	904.00	Lost River (H-026-030-019-007)	Yes	0.50
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005-001)	Yes	0.35
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005-001)	Yes	0.35
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005-001)	Yes	0.35
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005)	Yes	0.52
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005)	Yes	0.52
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005)	Yes	0.52
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005-001)	No	0.21
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005)	No	0.21
Clearwater	Clearwater	907.00	Unnamed Creek (H-026-030-019-007-005)	No	0.32
Clearwater	Clearwater	D913.9	Unnamed Creek (H-026-030-019-007-005-002)	No	0.16
Clearwater	Clearwater	D922.2	Clearwater River (H-026-030-019)	Yes	0.59
Clearwater	Clearwater	D924.1	Walker Brook (H-026-030-019-029)	No	0.00
Clearwater	Clearwater	D924.2	Walker Brook (H-026-030-019-029)	Yes	0.60
Clearwater	Clearwater	D925.3	Unnamed Creek (H-026-030-019-029-001)	Yes	0.41

Table 1
Line 3 Replacement Project
Public Waters Inventory Streams Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Approximate Milepost [a]	Kittle Name (Kittle Number)	Crossed by the Centerline	Miles Within the Corridor [b]
Mississippi Headwaters	Clearwater	D936.9	Unnamed Stream (M-164)	Yes	0.81
Mississippi Headwaters	Clearwater	D937.2	Unnamed Stream (M-164)	No	0.04
Mississippi Headwaters	Clearwater	D937.3	Unnamed Stream (M-164)	No	0.01
Mississippi Headwaters	Clearwater	D937.8	Mississippi River (M)	No	0.06
Mississippi Headwaters	Clearwater	D937.9	Mississippi River (M)	Yes	0.29
Mississippi Headwaters	Clearwater	D937.9	Mississippi River (M)	Yes	0.29
Mississippi Headwaters	Clearwater	D937.9	Mississippi River (M)	Yes	0.29
Mississippi Headwaters	Clearwater	D938.1	Mississippi River (M)	No	0.03
Mississippi Headwaters	Clearwater	D942.6	LaSalle Creek (M-163)	No	0.29
Mississippi Headwaters	Hubbard	D942.9	LaSalle Creek (M-163)	Yes	1.03
Mississippi Headwaters	Hubbard	D943.6	LaSalle Creek (M-163)	No	0.06
Crow Wing	Hubbard	D959.1	Unnamed Creek (M-096-035-002-004-000.5)	Yes	0.31
Crow Wing	Hubbard	D960.6	Unnamed Creek (M-096-035-002)	Yes	0.41
Crow Wing	Hubbard	D971	MAJ_02036	No	0.12
Crow Wing	Hubbard	D971.1	Straight River (M-096-035-002-002)	Yes	0.46
Crow Wing	Hubbard	D973.5	Unnamed Stream (M-096-035-004)	Yes	0.48
Crow Wing	Hubbard	D978.3	Unnamed Stream (M-096-035-004)	Yes	0.54
Crow Wing	Hubbard	D980.6	Unnamed Stream (M-096-035)	Yes	0.54
Crow Wing	Hubbard	D980.7	Unnamed Stream (M-096-035-003)	No	0.16
Crow Wing	Hubbard	D981.5	Unnamed Stream (M-096-035)	No	0.13
Crow Wing	Hubbard	D982.2	Unnamed Stream (M-096-035)	Yes	0.38
Crow Wing	Wadena	D988.1	Unnamed Stream (M-096-035)	Yes	0.49
Crow Wing	Wadena	D990.2	Crow Wing River (M-096)	Yes	0.49
Pine	Cass	D1014.2	Pine River (M-106)	Yes	0.45
Pine	Cass	D1023.2	Blind Lake Creek (M-106-014-002)	Yes	0.41
Pine	Cass	D1030.7	Unnamed Stream (M-106-004-003-001)	No	0.15
Pine	Cass	D1033.4	Daggett Brook (M-106-004)	No	0.28
Pine	Cass	D1033.7	Daggett Brook (M-106-004)	No	0.32
Pine	Cass	D1033.9	Daggett Brook (M-106-004)	No	0.12
Pine	Cass	D1034.2	Daggett Brook (M-106-004)	Yes	0.47
Pine	Cass	D1034.7	Daggett Brook (M-106-004)	No	0.24
Pine	Cass	D1038.1	Spring Brook (M-106-004-002-001)	Yes	0.36
Pine	Cass	D1038.2	MAJ-070115782_A	No	0.00

Table 1
Line 3 Replacement Project
Public Waters Inventory Streams Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Approximate Milepost [a]	Kittle Name (Kittle Number)	Crossed by the Centerline	Miles Within the Corridor [b]
Prairie-Willow	Cass	D1044.8	Unnamed Stream (M-117-012)	Yes	0.48
Prairie-Willow	Cass	D1046.4	Unnamed Stream (M-117-012)	No	0.31
Prairie-Willow	Aitkin	D1050.2	Unnamed Stream (M-117-012-002)	Yes	0.60
Elk-Nokasippi	Aitkin	D1064	Unnamed Stream (M-117-001)	Yes	1.23
Prairie-Willow	Aitkin	D1065.3	Willow River (M-117)	No	0.24
Prairie-Willow	Aitkin	D1065.6	Willow River (M-117)	Yes	0.67
Prairie-Willow	Aitkin	D1065.6	Willow River (M-117)	No	0.28
Prairie-Willow	Aitkin	D1069.1	Mississippi River (M)	No	0.17
Prairie-Willow	Aitkin	D1069.5	Mississippi River (M)	Yes	0.39
Prairie-Willow	Aitkin	D1078.8	Sandy River (M-120)	Yes	0.66
Kettle	Carlton	D1101.4	Kettle River, West Branch (M-050-046-035)	Yes	0.40
Kettle	Carlton	D1107.4	Heikkila Creek (M-050-046-036)	Yes	0.57
Kettle	Carlton	D1111.1	Kettle River (M-050-046)	Yes	0.52
Kettle	Carlton	D1115.6	Moose Horn River, West Fork (M-050-046-029-020)	Yes	0.47
Kettle	Carlton	D1117.1	King Creek (M-050-046-029-023)	Yes	0.37
Kettle	Carlton	D1117.7	Unnamed Stream (M-050-046-029-023-002)	No	0.19
Kettle	Carlton	D1119.3	Park Lake Creek (M-050-046-029-027)	Yes	0.78
Kettle	Carlton	D1120.5	Moose Horn River (M-050-046-029)	Yes	0.50
Beartrap-Nemadji	Carlton	D1125	Blackhoof River (S-001-003)	Yes	0.83
Beartrap-Nemadji	Carlton	D1125	Unnamed Stream (S-001-003-028)	No	0.11
Beartrap-Nemadji	Carlton	D1125.2	Unnamed Stream (S-001-003-029)	Yes	0.27
Beartrap-Nemadji	Carlton	D1136.2	Unnamed Stream (S-001.5-007)	Yes	1.05

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Mileposts for features not crossed by the centerline are interpolated based on the closest centerline milepost.

b Total miles of PWI stream segment(s) crossed by the 2000-ft-wide corridor.

Table 2
Line 3 Replacement Project
Summary of Waterbodies Crossed by the Proposed Centerline
and within the 2,000-ft-wide Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Centerline [a]				Miles Within the 2,000-ft-wide Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Middle Red	**7**	**17**	**15**	**39**	**2.8**	**3.9**	**6.1**	**12.8**
Kittson	2	5	9	16	0.4	0.8	3.1	4.3
Marshall	5	12	6	23	2.4	3.2	3.0	8.6
Snake	**3**	**9**	**-**	**12**	**1.5**	**3.5**	**-**	**5.0**
Marshall	3	9	-	12	1.5	3.5	-	5.0
Red Lake	**5**	**8**	**19**	**32**	**1.1**	**2.4**	**7.4**	**10.9**
Pennington	5	5	11	21	1.1	1.5	5.2	7.9
Red Lake		3	8	11	-	0.9	2.2	3.1
Clearwater	**19**	**39**	**27**	**85**	**6.5**	**13.0**	**6.5**	**26.0**
Red Lake	6	-	4	10	1.8	-	1.7	3.5
Polk	2	2	11	15	0.8	0.9	4.0	5.7
Clearwater	11	37	12	60	3.9	12.1	0.8	16.8
Eastern Wild Rice	-	**2**	**-**	**2**	-	**0.1**	**-**	**0.1**
Clearwater	-	2	-	2	-	0.1	-	0.1
Mississippi Headwaters	**14**	**5**	**5**	**24**	**2.9**	**2.1**	**0.6**	**5.6**
Clearwater	12	5	3	20	2.1	2.1	0.3	4.5
Hubbard	2	-	2	4	0.8	-	0.3	1.1
Crow Wing	**21**	**2**	**12**	**35**	**4.7**	**0.9**	**5.3**	**11.0**
Hubbard	19	1	5	25	3.8	0.5	1.1	5.3
Wadena	2	-	3	5	1.0	-	0.7	1.7
Cass	-	1	4	5	-	0.4	3.5	4.0
Pine	**11**	**1**	**8**	**20**	**3.3**	**0.4**	**0.8**	**4.5**
Cass	11	-	7	18	3.3	-	0.8	4.1
Crow Wing	-	1	1	2	-	0.4	0.0	0.4
Leech Lake	**2**	**-**	**5**	**7**	**0.1**	**-**	**0.2**	**0.2**
Cass	2	-	5	7	0.1	-	0.2	0.2
Prairie-Willow	**22**	**17**	**31**	**70**	**5.9**	**5.9**	**5.7**	**17.6**
Cass	3	1	6	10	0.6	0.4	0.8	1.8
Aitkin	19	16	25	60	5.3	5.5	4.9	15.7
Elk-Nokasippi	-	**6**	**1**	**7**	-	**2.7**	**0.1**	**2.7**
Aitkin	-	6	1	7	-	2.7	0.1	2.7
Kettle	**9**	**15**	**4**	**28**	**3.7**	**3.4**	**1.3**	**8.4**
Carlton	9	15	4	28	3.7	3.4	1.3	8.4
Beartrap-Nemadji	**8**	**7**	**2**	**17**	**1.9**	**2.7**	**0.7**	**5.3**
Carlton	8	7	2	17	1.9	2.7	0.7	5.3
St. Louis	**1**	**5**	**-**	**6**	**0.8**	**1.6**	**-**	**2.3**
Carlton	1	5	-	6	0.8	1.6	-	2.3
Grand Total [c]	**122**	**133**	**129**	**384**	**35.1**	**42.6**	**34.6**	**112.3**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Centerline [a]				Acres Within the 2,000-ft-wide Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/Riverine	Total [d]
Middle Red	**0.1**	**<0.1**	**<0.1**	**0.1**	**15.9**	**4.2**	**11.8**	**31.9**
Kittson	0.1	<0.1	<0.1	0.1	12.5	4.2	11.2	27.9
Marshall	<0.1	-	<0.1	<0.1	3.5	-	0.6	4.1
Snake	**0.1**	**0.2**	**<0.1**	**0.4**	**120.5**	**43.9**	**0.6**	**165.0**
Marshall	0.1	0.2	<0.1	0.4	120.5	43.9	0.6	165.0
Grand Marais-Red	**<0.1**	**-**	**<0.1**	**<0.1**	**7.2**	**-**	**0.1**	**7.4**
Marshall	<0.1	-	-	<0.1	6.8	-	-	6.8
Pennington	<0.1	-	<0.1	<0.1	0.4	-	0.1	0.5
Red Lake	**0.4**	**0.2**	**0.1**	**0.7**	**146.4**	**64.0**	**25.3**	**235.7**
Pennington	0.4	0.2	0.1	0.7	141.0	61.2	25.1	227.3
Red Lake	<0.1	<0.1	<0.1	<0.1	5.4	2.7	0.3	8.4
Clearwater	**2.7**	**3.0**	**0.1**	**5.8**	**574.5**	**793.0**	**39.5**	**1407.0**
Red Lake	0.6	<0.1	<0.1	0.7	123.6	25.4	18.1	167.2
Polk	1.1	0.6	<0.1	1.7	211.4	150.9	2.9	365.2
Clearwater	1.0	2.4	0.1	3.5	239.5	616.6	18.5	874.6
Eastern Wild Rice	**0.5**	**0.9**	**<0.1**	**1.4**	**156.5**	**250.1**	**1.5**	**408.1**
Clearwater	0.5	0.9	<0.1	1.4	156.5	250.1	1.5	408.1
Mississippi Headwaters	**0.6**	**0.5**	**<0.1**	**1.1**	**171.9**	**272.5**	**9.9**	**454.3**
Clearwater	0.3	0.3	<0.1	0.5	86.5	190.6	0.8	277.8
Hubbard	0.3	0.2	<0.1	0.6	85.5	81.9	9.1	176.5
Crow Wing	**1.6**	**5.0**	**0.3**	**6.9**	**541.0**	**1384.8**	**142.8**	**2068.6**
Hubbard	0.9	2.4	0.2	3.5	355.6	703.4	116.7	1175.7
Wadena	0.3	0.8	0.1	1.2	84.1	201.1	24.2	309.3
Cass	0.4	1.8	<0.1	2.2	101.3	480.3	1.9	583.5
Pine	**1.5**	**1.8**	**0.2**	**3.6**	**446.9**	**758.8**	**198.9**	**1404.6**
Cass	1.4	1.8	0.2	3.3	395.2	723.4	180.9	1299.5
Crow Wing	0.1	<0.1	0.1	0.2	51.7	35.4	18.0	105.1
Leech Lake	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**21.6**	**4.8**	**4.2**	**30.6**
Cass	<0.1	<0.1	<0.1	<0.1	21.6	4.8	4.2	30.6
Prairie-Willow	**3.0**	**8.0**	**0.2**	**11.2**	**904.3**	**2668.9**	**76.8**	**3650.0**
Cass	<0.1	0.4	<0.1	0.4	15.8	148.9	16.3	181.0
Aitkin	3.0	7.6	0.2	10.7	888.5	2520.0	60.5	3469.0
Elk-Nokasippi	**0.2**	**2.6**	**<0.1**	**2.8**	**101.8**	**596.3**	**4.6**	**702.7**
Aitkin	0.2	2.6	<0.1	2.8	101.8	596.3	4.6	702.7
Kettle	**2.3**	**5.0**	**<0.1**	**7.3**	**166.0**	**1949.3**	**3.5**	**2118.9**
Aitkin	-	0.1	-	0.1	-	16.8	-	16.8
Carlton	2.3	4.9	<0.1	7.2	166.0	1932.6	3.5	2102.1
Beartrap-Nemadji	**<0.1**	**2.6**	**<0.1**	**2.6**	**20.6**	**578.6**	**11.0**	**610.3**
Carlton	<0.1	2.6	<0.1	2.6	20.6	578.6	11.0	610.3
St. Louis	**<0.1**	**0.2**	**0.1**	**0.3**	**5.2**	**114.6**	**4.1**	**124.0**
Carlton	<0.1	0.2	0.1	0.3	5.2	114.6	4.1	124.0
Grand Total [d]	**13.0**	**30.1**	**1.1**	**44.2**	**3400.4**	**9483.8**	**534.7**	**13418.9**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed centerline.

b Total acres of NWI within the 2000-ft-wide corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project
Public Waters Inventory Wetlands and Basins Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed	County	Type	Miles Crossed by the Centerline [a]	Acres Within the Corridor [b]
Red Lake	Pennington	Wetland	0.15	50.32
Clearwater	Clearwater	Wetland	-	2.22
		Basin	-	22.81
Eastern Wild Rice	Clearwater	Basin	0.09	33.08
Mississippi Headwaters	Hubbard	Basin	-	9.59
Crow Wing	Hubbard	Basin	0.18	94.25
		Wetland	0.15	42.50
Crow Wing	Wadena	Basin	-	0.06
Pine	Crow Wing	Wetland	-	4.70
Pine	Cass	Basin	0.18	181.37
		Wetland	0.01	15.81
Leech Lake	Cass	Basin	-	18.34
Prairie-Willow	Cass	Basin	-	15.33
Prairie-Willow	Aitkin	Basin	-	29.39
Elk-Nokasippi	Aitkin	Basin	-	10.76
Beartrap-Nemadji	Carlton	Wetland	-	14.12
		Total:	**0.77**	**544.64**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide corridor.

Table 5
Line 3 Replacement Project
Listed Calcareous Fens within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Approximate Milepost [a]	Fen Name	Crossed by the Centerline [b]	Within the Corridor
Snake	Marshall	844.8	Viking 18	N/A	Yes
Red Lake	Pennington	853.7	Norden 18		Yes
Clearwater	Polk	894.2	Gully 30		Yes

Listed Calcareous Fens Data Source: https://gisdata.mn.gov/dataset/biota-nhis-calcareous-fens. This data set is a GIS point shapefile derived from the Natural Heritage "Biotics" Database

a Mileposts for features not crossed by the centerline are interpolated based on the closest centerline milepost.

b This data set contains a point for each calcareous fen; the actual calcareous fen boundary (polygon) as defined by the Minnesota Department of Natural Resources (MDNR) is not included in this data set. As such, this data set can only be used as a high level screening tool. A MDNR Fen Management Plan is expected to be required for Gully 30.

Table 6
Line 3 Replacement Project
Trout Streams Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Approximate Milepost [a]	Kittle Name (Kittle Number)	Crossed by the Centerline	Miles Within the Corridor [b]
Mississippi Headwaters	Hubbard	D942.9	LaSalle Creek (M-163)	Yes	1.05
Crow Wing	Hubbard	D971.1	Straight River (M-096-035-002-002)	Yes	0.46
Pine	Cass	D1038.1	Spring Brook (M-106-004-002-001)	Yes	0.20
Kettle	Carlton	D1117.1	King Creek (M-050-046-029-023)	Yes	0.37
Kettle	Carlton	D1117.7	Unnamed Stream (M-050-046-029-023-002)	No	0.19
Beartrap-Nemadji	Carlton	D1125	Unnamed Stream (S-001-003-027.8)	No	0.11
Beartrap-Nemadji	Carlton	D1125	Blackhoof River (S-001-003)	Yes	0.83
Beartrap-Nemadji	Carlton	D1125	Unnamed Stream (S-001-003-028)	No	0.11
Beartrap-Nemadji	Carlton	D1125.2	Unnamed Stream (S-001-003-029)	Yes	0.27

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Mileposts for features not crossed by the centerline are interpolated based on the closest centerline milepost.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide corridor.

Table 7
Sandpiper Pipeline Project
Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
Middle Red	Marshall	Monitoring	92 139 290 388 434 476 519	7
		Other	431	1
Snake	Marshall	Abandoned	128 130	2
		Domestic	593	1
		Monitoring	508 517	2
Grand Marais-Red	Marshall	Domestic	365	1
Red Lake	Pennington	Domestic	361 775 825 941	4
Clearwater	Clearwater	Domestic	20 208 328 444 489 520 595 619 728 760 766 783 868 943 948 969	16
		Monitoring	45 282 820	3
		Other	360	1
	Red Lake	Domestic	848	1

Table 7
Sandpiper Pipeline Project
Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
Mississippi Headwaters	Clearwater	Abandoned	159	1
		Domestic	373 513 796	3
	Hubbard	Domestic	80 250 521 605 729 744 864 869 928	9
		Irrigation	942	1
Crow Wing	Cass	Domestic	325 545	2
	Hubbard	Abandoned	5 35 170 231	4
		Domestic	62 81 84 252 288 296 310 352 382 385 411 415 436 447 466 470 512 513 558 567 568 574	49

Table 7
Sandpiper Pipeline Project
Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
Crow Wing	Hubbard	Domestic	592 597 607 640 642 646 657 675 679 690 695 716 718 726 761 767 774 811 848 849 870 898 903 953 957 975 976	
		Irrigation	160 215 293 357 406 497 914	7
		Observation	349 456 460	3
		Other	181 527	2
		Test Well	447 551 789	4

Table 7
Sandpiper Pipeline Project
Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
Crow Wing	Hubbard	Test Well	984	
	Wadena	Abandoned	550	1
		Domestic	138 463 620 774	4
Pine	Cass	Domestic	108 189 190 253 295 336 349 451 520 534 540 575 615 667 686 702 708 714 778 779 784 823 829 832 861 866 883 891 899 901 935 960 962 970 970 972	39

Table 7
Sandpiper Pipeline Project
Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
Pine	Cass	Domestic	977 978 998	
		Other	979	1
		Scientific Investigation	377	1
	Crow Wing	Domestic	296 553 927	3
Leech Lake	Cass	Scientific Investigation	375	1
Prairie-Willow	Aitkin	Abandoned	801	1
		Domestic	275 279 281 298 316 322 326 332 391 591 660 674 707 750 789 809 816 830 849 862 943 952 988	23
	Cass	Domestic	728	1
Elk-Nokasippi	Aitkin	Domestic	565 662 782 803	4
Kettle	Carlton	Abandoned	275	1
		Domestic	251 283	16

Table 7
Sandpiper Pipeline Project
Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
Kettle	Carlton	Domestic	370 401 497 552 554 591 595 603 619 630 839 936 950 990	
		Exploration	484 824 951	3
Beartrap-Nemadji	Carlton	Unknown	380	1
		Abandoned	929	1
		Domestic	116 186 272 289 470 500 569 582 611 724 727 748 750 806 821 881 891 948 997	19
St. Louis	Carlton	Abandoned	644 672	2
		Domestic	139 304	6

Table 7

Sandpiper Pipeline Project

Wells within the 2,000-ft-wide Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Number of Wells
St. Louis	Carlton	Domestic	339 866 894 959	

Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

a – Municipal wells are not included in the data source.

Table 8
Line 3 Replacement Project
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Centerline and within the 2,000-ft-wide Corridor in Minnesota

Watershed	County	Approximate Milepost [a]	Name	Miles Crossed by the Centerline [b]	Acres Within the Corridor [c]
Clearwater	Red Lake	886.0	Oklee 2 WHPA	-	40.73
			Oklee DWSMA	0.61	138.75
Crow Wing	Hubbard	D966.5	Sundsruds Court WHPA	-	0.56
			Sundsruds Court DWSMA	0.59	172.00
St. Louis/ Beartrap-Nemadji	Carlton	D1133.5	Wrenshall 1 WHPA	0.07	15.73
			Wrenshall DWSMA	0.57	138.98

DWSMA Data Source: *https://gisdata.mn.gov/dataset/water-drinking-water-supply*
WHPA Data Source: *https://gisdata.mn.gov/dataset/water-wellhead-protection-areas*

a Mileposts for features not crossed by the centerline are interpolated based on the closest centerline milepost.
b Total miles of DWSMA and WHPA crossed by the centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide corridor.

Table 9
Line 3 Replacement Project
Surface Water Intakes Within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Permit Type	Permit Status	Total
Middle Red	Kittson	General Permit Authorization	Inactive	4
	Marshall	General Permit Authorization	Inactive	12
		General Permit Authorization	Active	1
Snake	Marshall	General Permit Authorization	Inactive	9
		General Permit Authorization	Active	1
		Individual Permit	Inactive	2
Red Lake	Pennington	General Permit Authorization	Inactive	8
		Individual Permit	Inactive	2
	Red Lake	General Permit Authorization	Inactive	1
Clearwater	Clearwater	General Permit Authorization	Active	2
		General Permit Authorization	Inactive	35
		Individual Permit	Inactive	5
	Polk	General Permit Authorization	Inactive	3
		Individual Permit	Inactive	2
	Red Lake	General Permit Authorization	Inactive	4
		General Permit Authorization	Active	7
		Individual Permit	Inactive	2
Eastern Wild Rice	Clearwater	General Permit Authorization	Inactive	9
		Individual Permit	Inactive	2
Mississippi Headwaters	Clearwater	General Permit Authorization	Inactive	13
		Individual	Inactive	2
	Hubbard	General Permit Authorization	Inactive	14
Crow Wing	Cass	Individual Permit	Inactive	1

Table 9
Line 3 Replacement Project
Surface Water Intakes Within the 2,000-ft-wide Corridor in Minnesota

Watershed Name	County	Permit Type	Permit Status	Total
Crow Wing	Hubbard	General Permit Authorization	Inactive	20
		Individual Permit	Inactive	7
		Individual Permit	Active	16
	Wadena	Individual Permit	Active	1
Beartrap-Nemadji	Carlton	General Permit Authorization	Inactive	1
		Individual Permit	Inactive	2
St Louis	Carlton	General Permit Authorization	Inactive	1

Source Data: MNDNR Permitting and Reporting System





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 1

Line 3 Replacement Project

Enbridge

Kittson County, Minnesota

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Source: Z:\Clients\E_H\Enbridge\SPP_L3\ArcGIS\2016\07\ENG_Data_Request\ENG_Data_Deliverable_L3R.mxd
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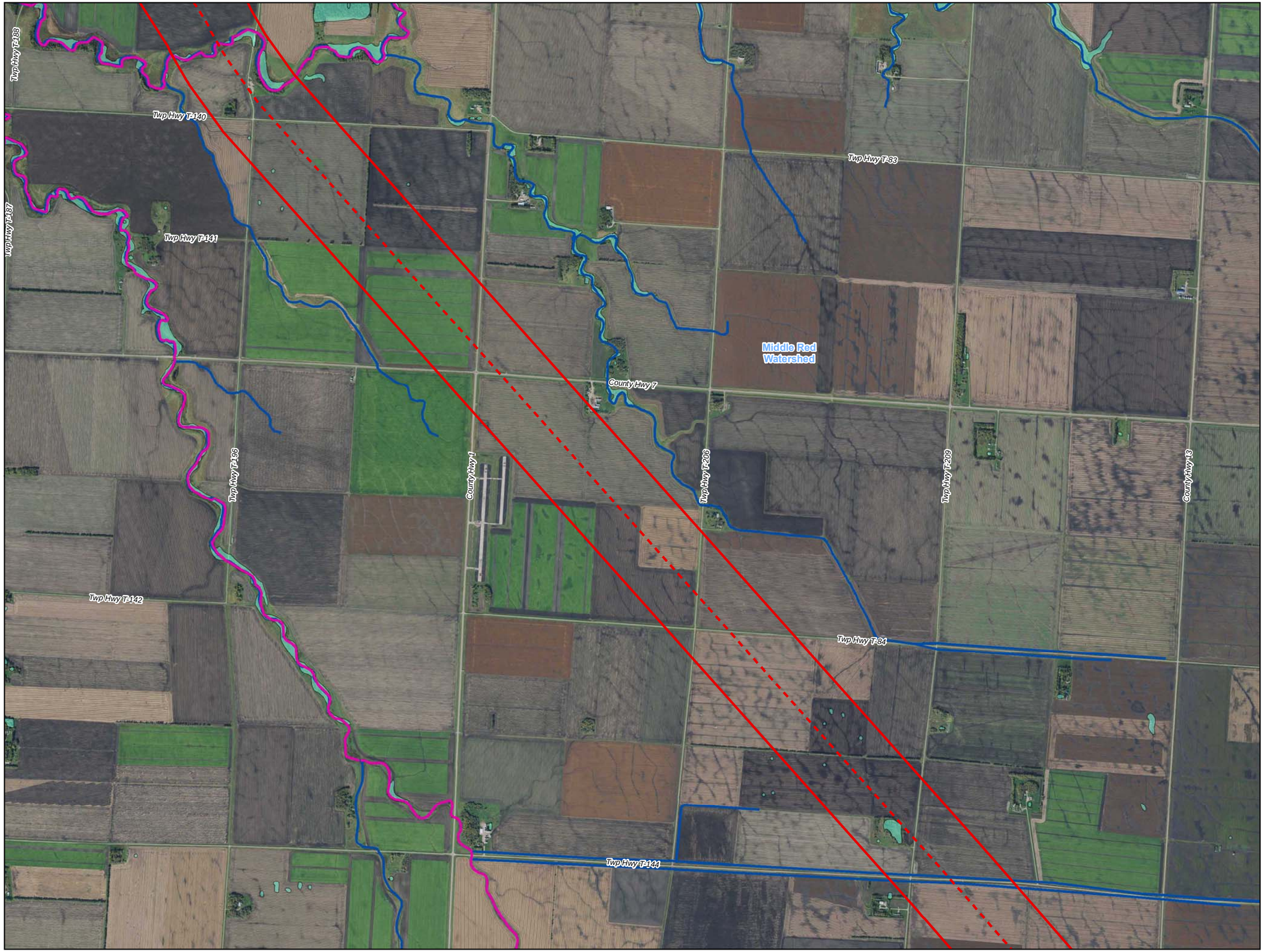



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
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- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
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- PWI Basin
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- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 2

Line 3 Replacement Project

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Kittson County, Minnesota

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0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
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- PWI Basin
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- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 3

Line 3 Replacement Project

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Kittson County, Minnesota

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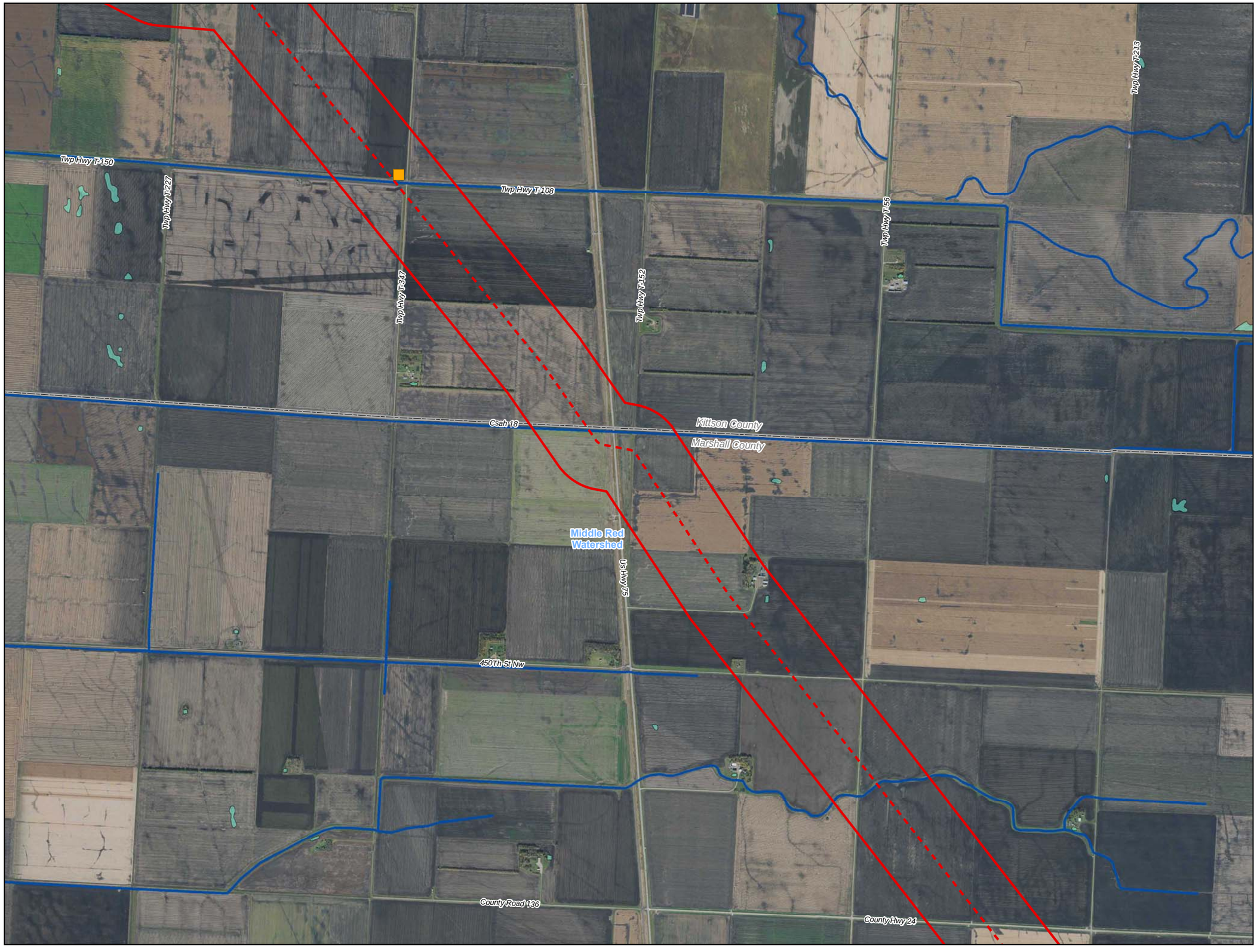



0 1,000 2,000 Feet

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N W E S

- Line 3 Replacement Milepost
- Water Well
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- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
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- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 4

Line 3 Replacement Project

Enbridge

Marshall County, Minnesota

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Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 5

Line 3 Replacement Project

Enbridge

Marshall County, Minnesota

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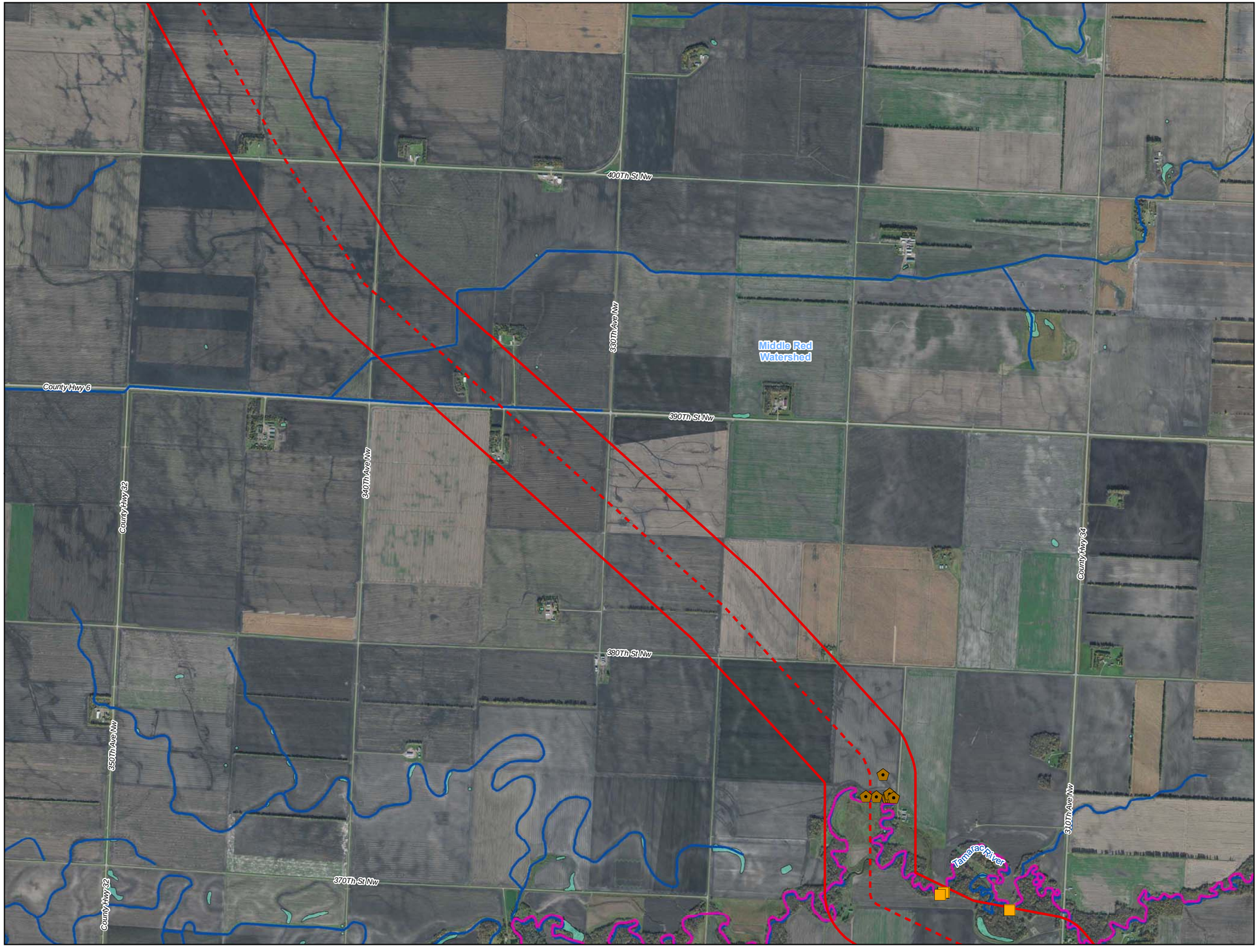



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 6

Line 3 Replacement Project

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Marshall County, Minnesota

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0 1,000 2,000 Feet

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N W E S

- Line 3 Replacement Milepost
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- Calcareous Fen
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- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 7

Line 3 Replacement Project

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Marshall County, Minnesota

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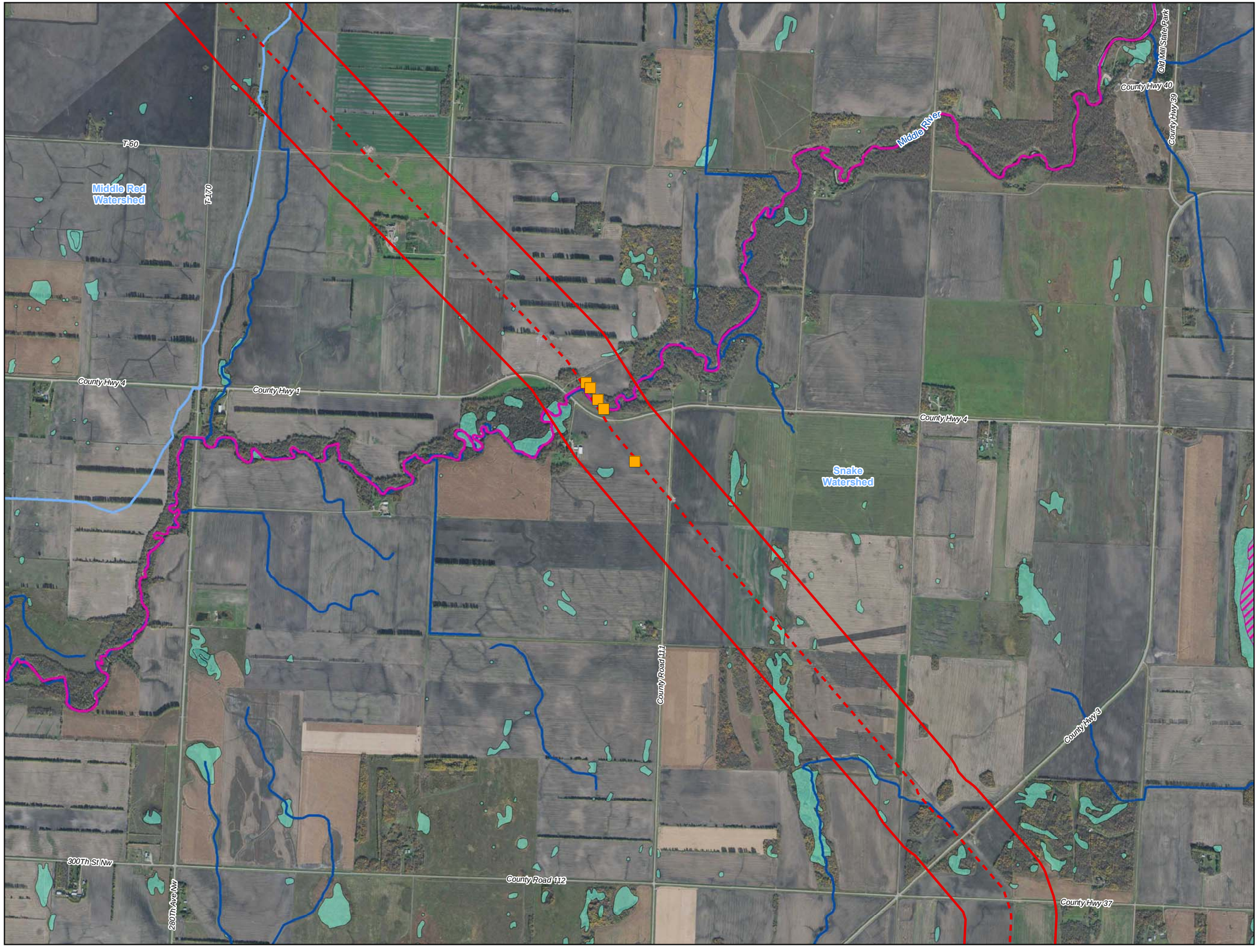



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 8

Line 3 Replacement Project

Enbridge

Marshall County, Minnesota

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Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
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- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 9

Line 3 Replacement Project

Enbridge

Marshall County, Minnesota

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Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 10

Line 3 Replacement Project

Enbridge

Marshall County, Minnesota

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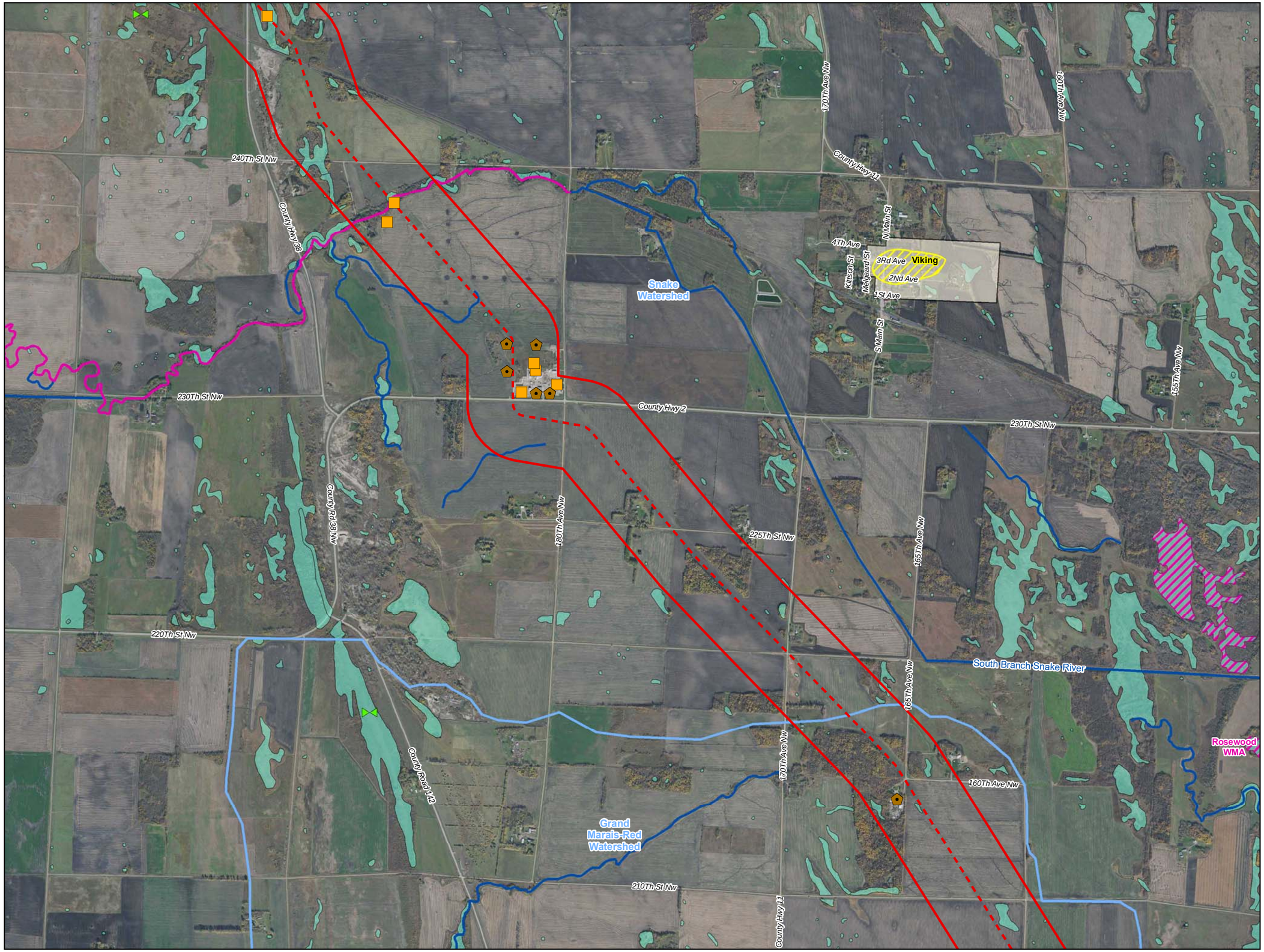



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 11

Line 3 Replacement Project

Enbridge

Marshall County, Minnesota

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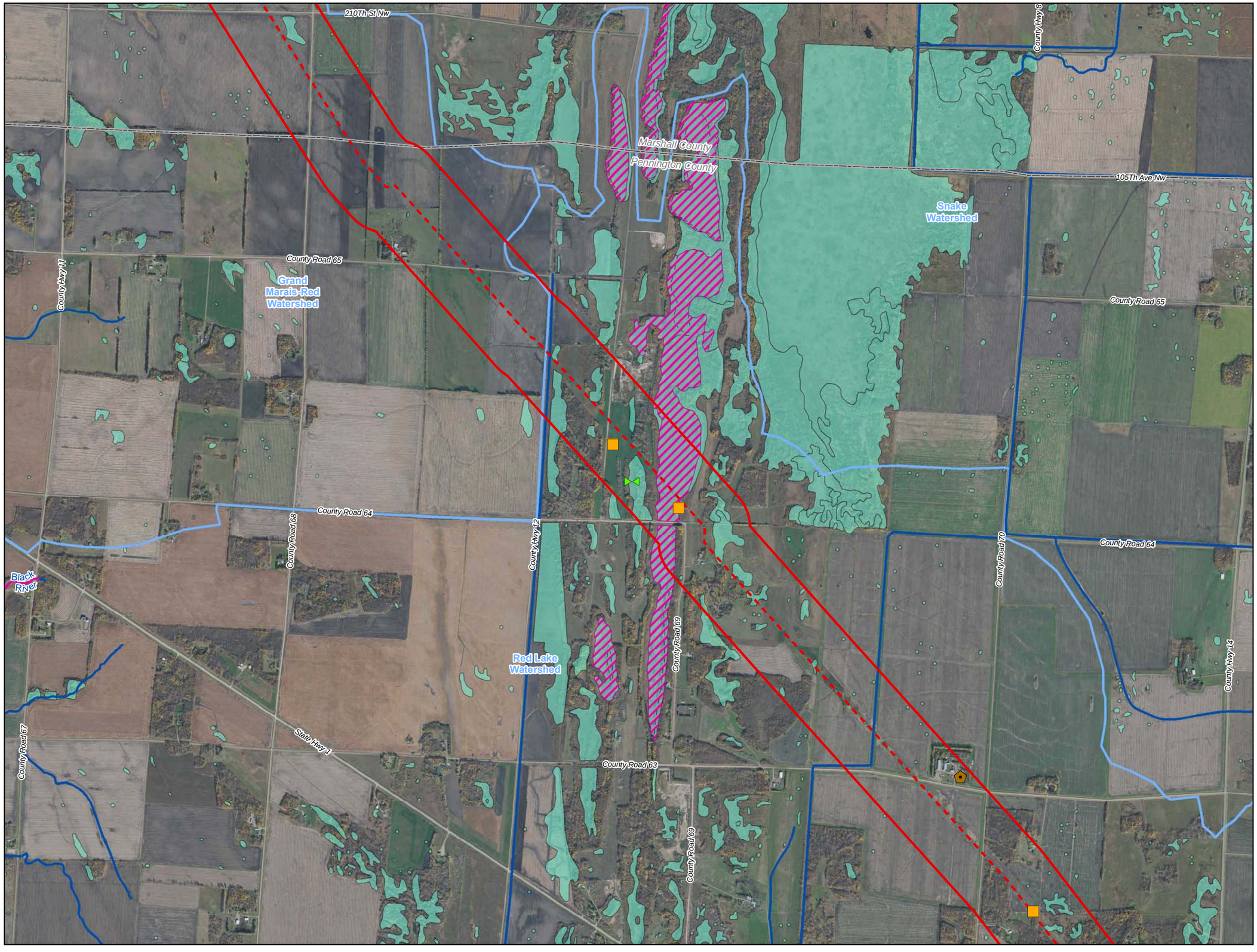



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 12

Line 3 Replacement Project

Enbridge

Pennington County, Minnesota

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0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 13

Line 3 Replacement Project

Enbridge

Pennington County, Minnesota

ENBRIDGE

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0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 14

Line 3 Replacement Project

Enbridge

Pennington County, Minnesota

ENBRIDGE

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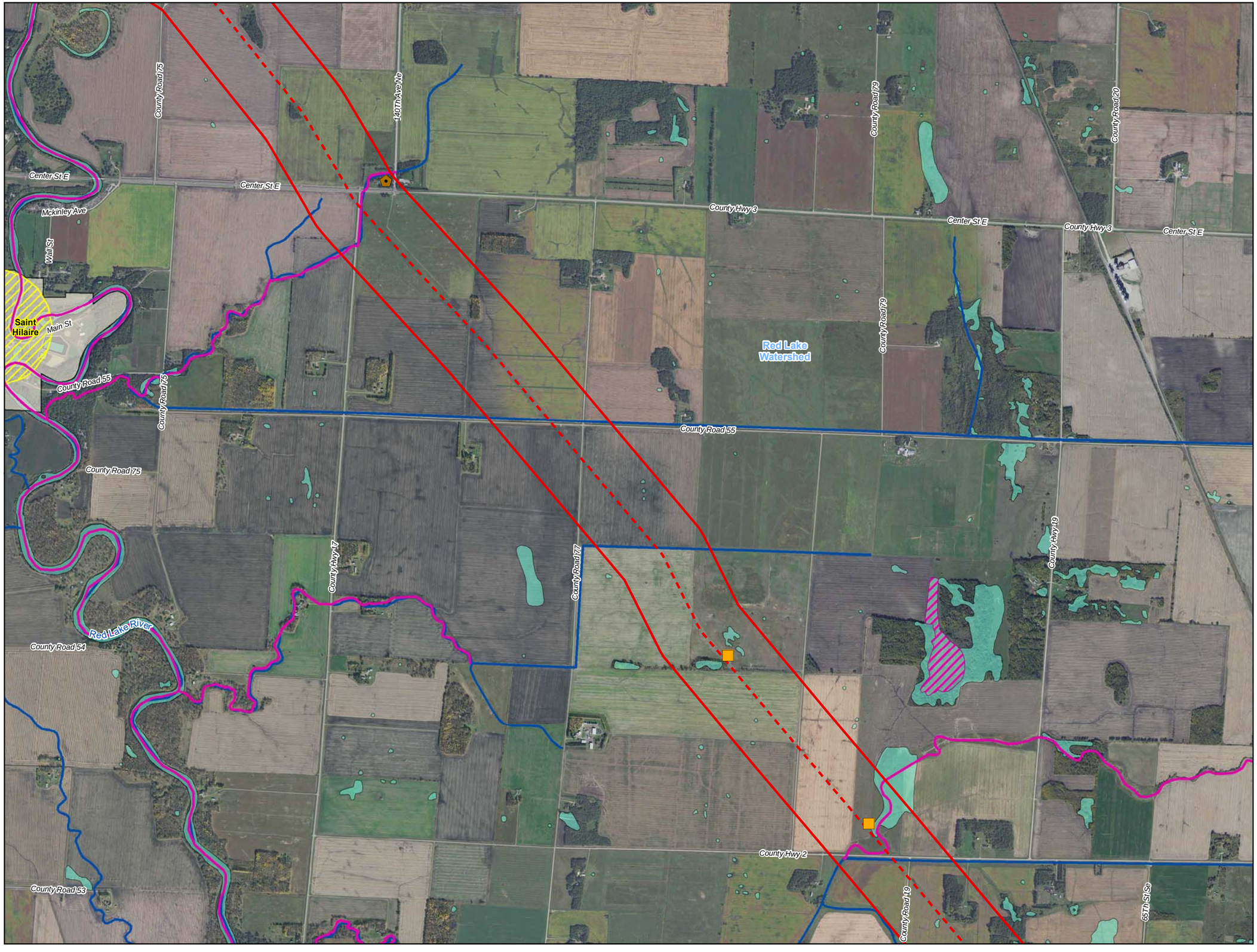



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 15

Line 3 Replacement Project

Enbridge

Pennington County, Minnesota

ENBRIDGE

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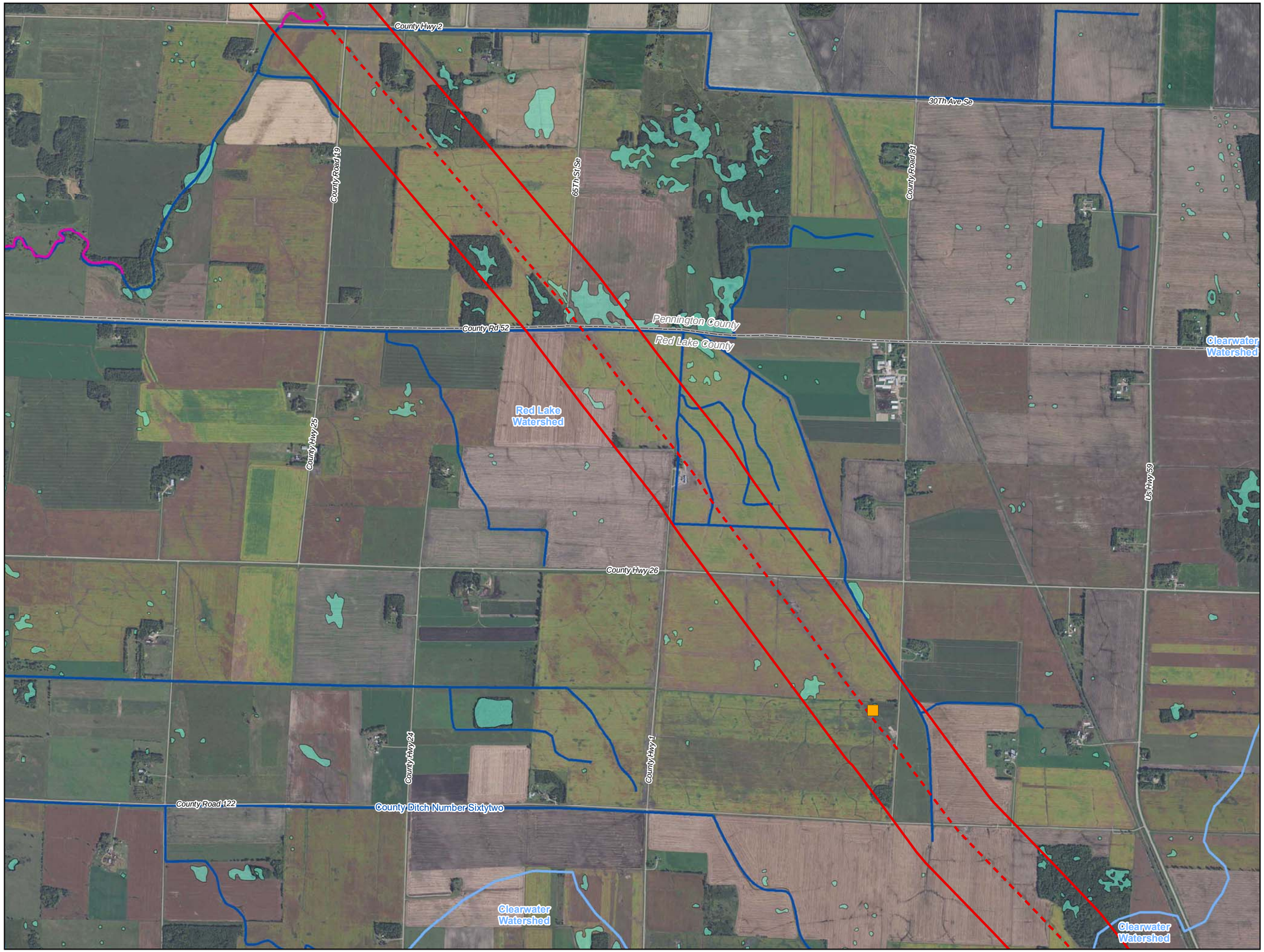



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 16

Line 3 Replacement Project

Enbridge

Red Lake County, Minnesota

ENBRIDGE

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0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 17

Line 3 Replacement Project

Enbridge

Red Lake County, Minnesota

ENBRIDGE

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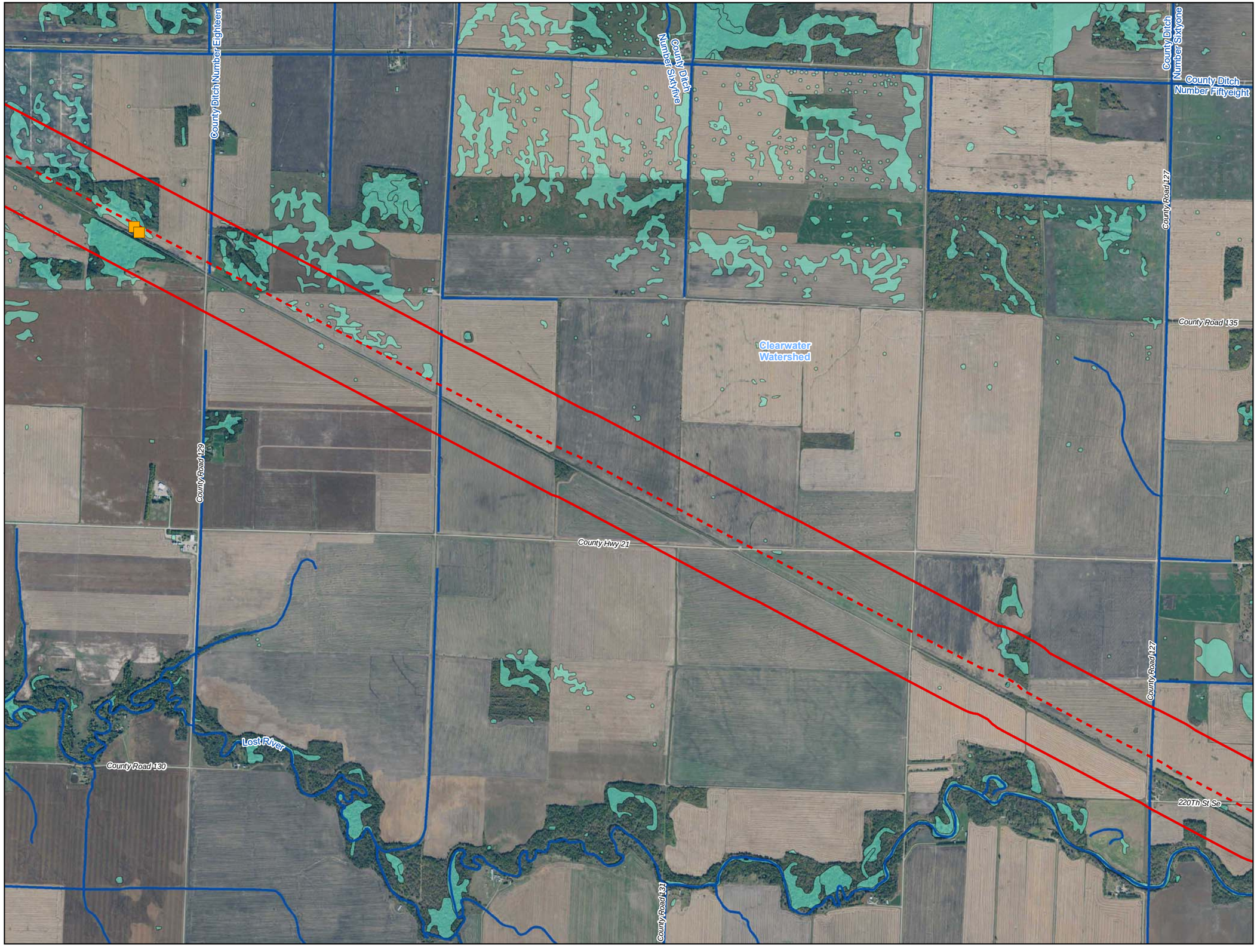



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 18

Line 3 Replacement Project

Enbridge

Red Lake County, Minnesota

ENBRIDGE

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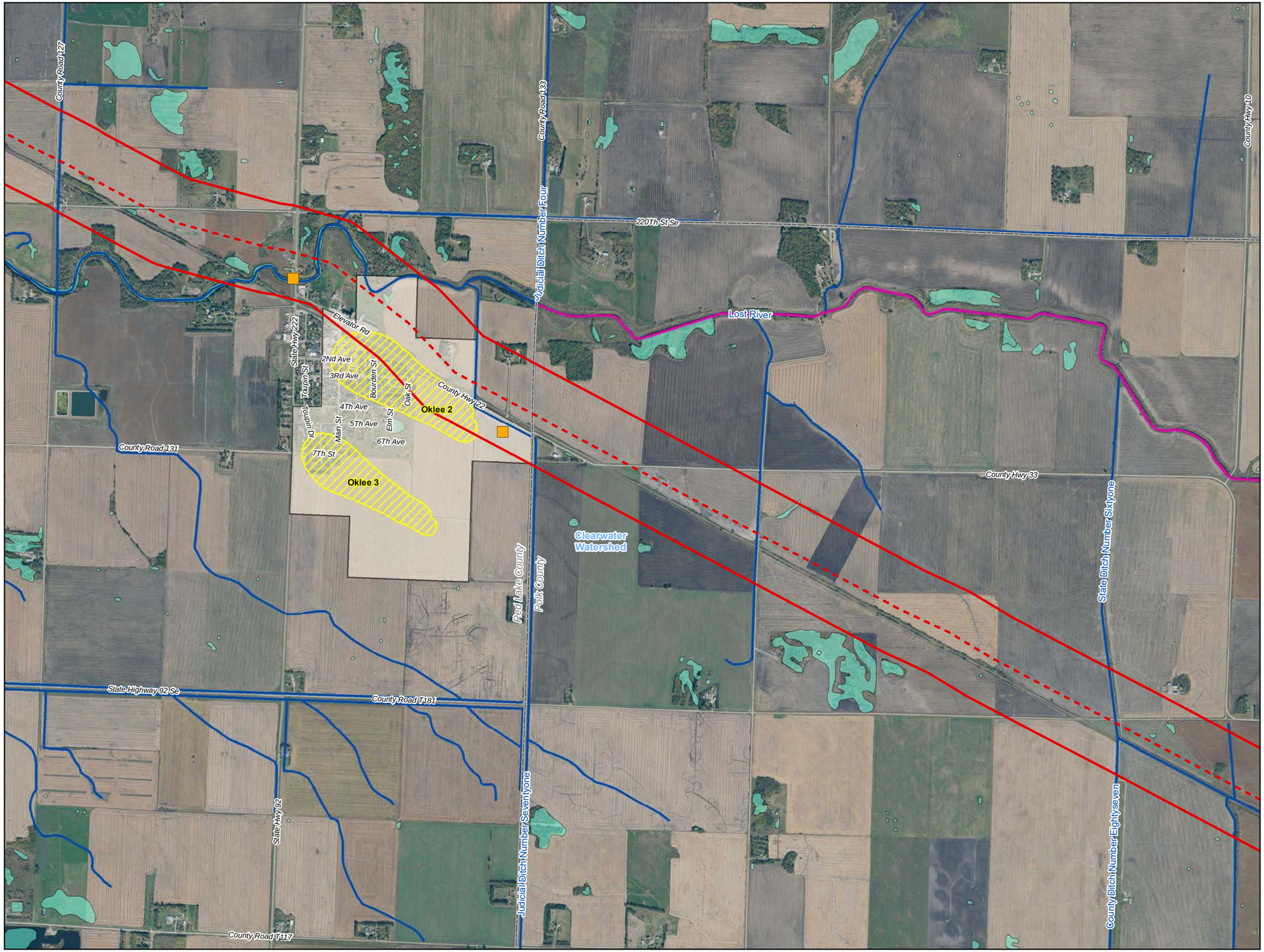



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 19

Line 3 Replacement Project

Enbridge

Red Lake County, Minnesota

ENBRIDGE

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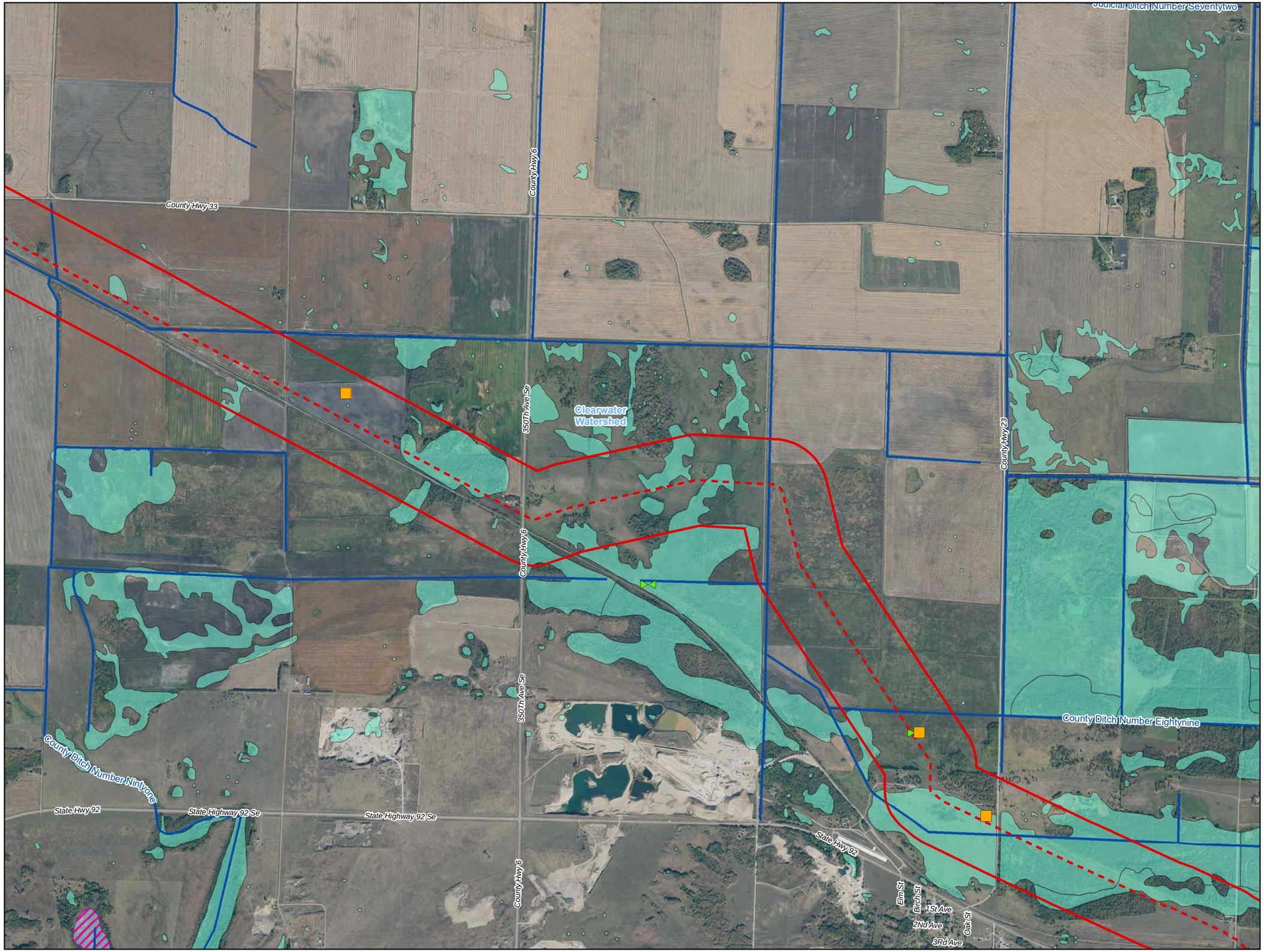



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 20

Line 3 Replacement Project

Enbridge

Polk County, Minnesota

ENBRIDGE

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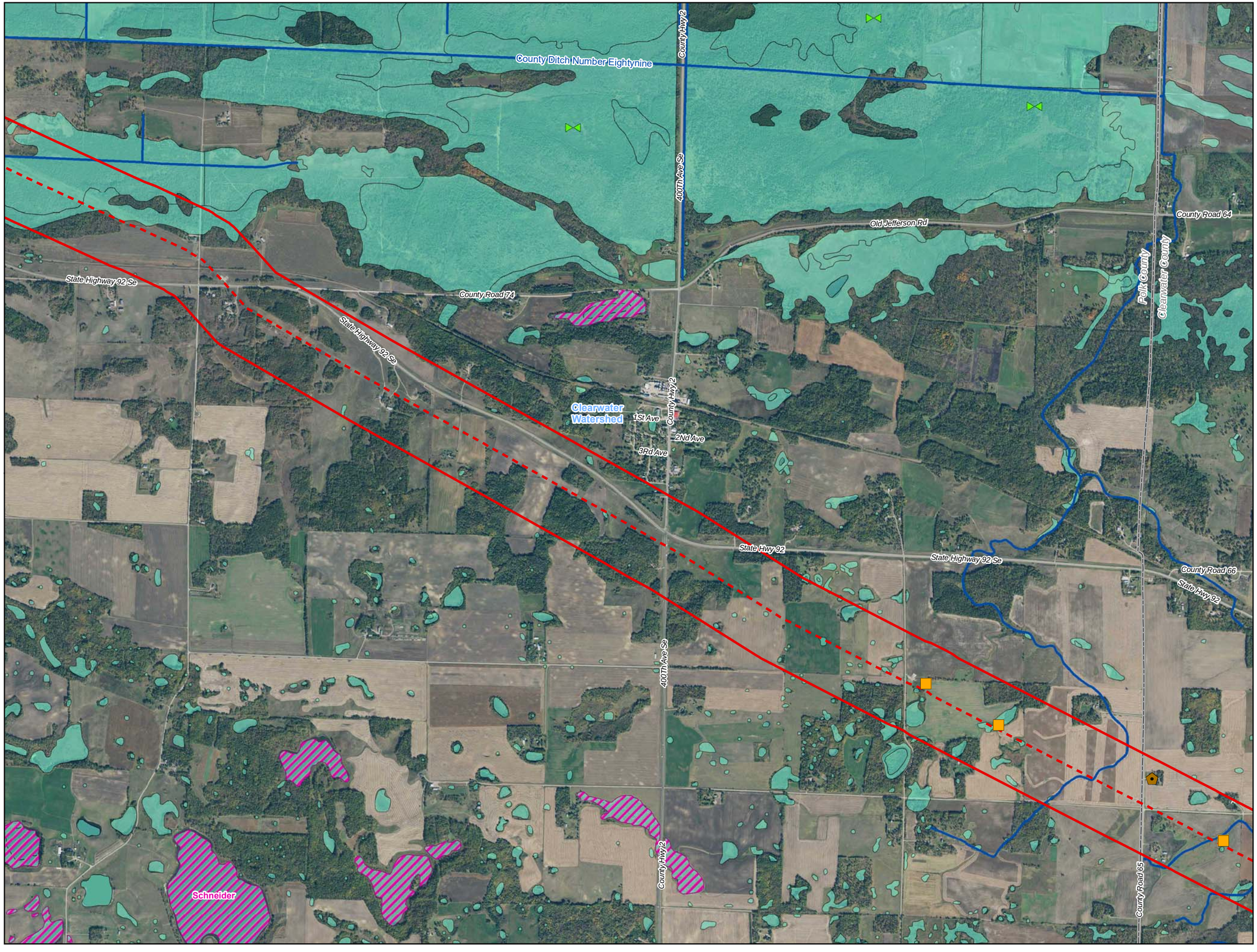



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 21

Line 3 Replacement Project

Enbridge

Polk County, Minnesota

ENBRIDGE

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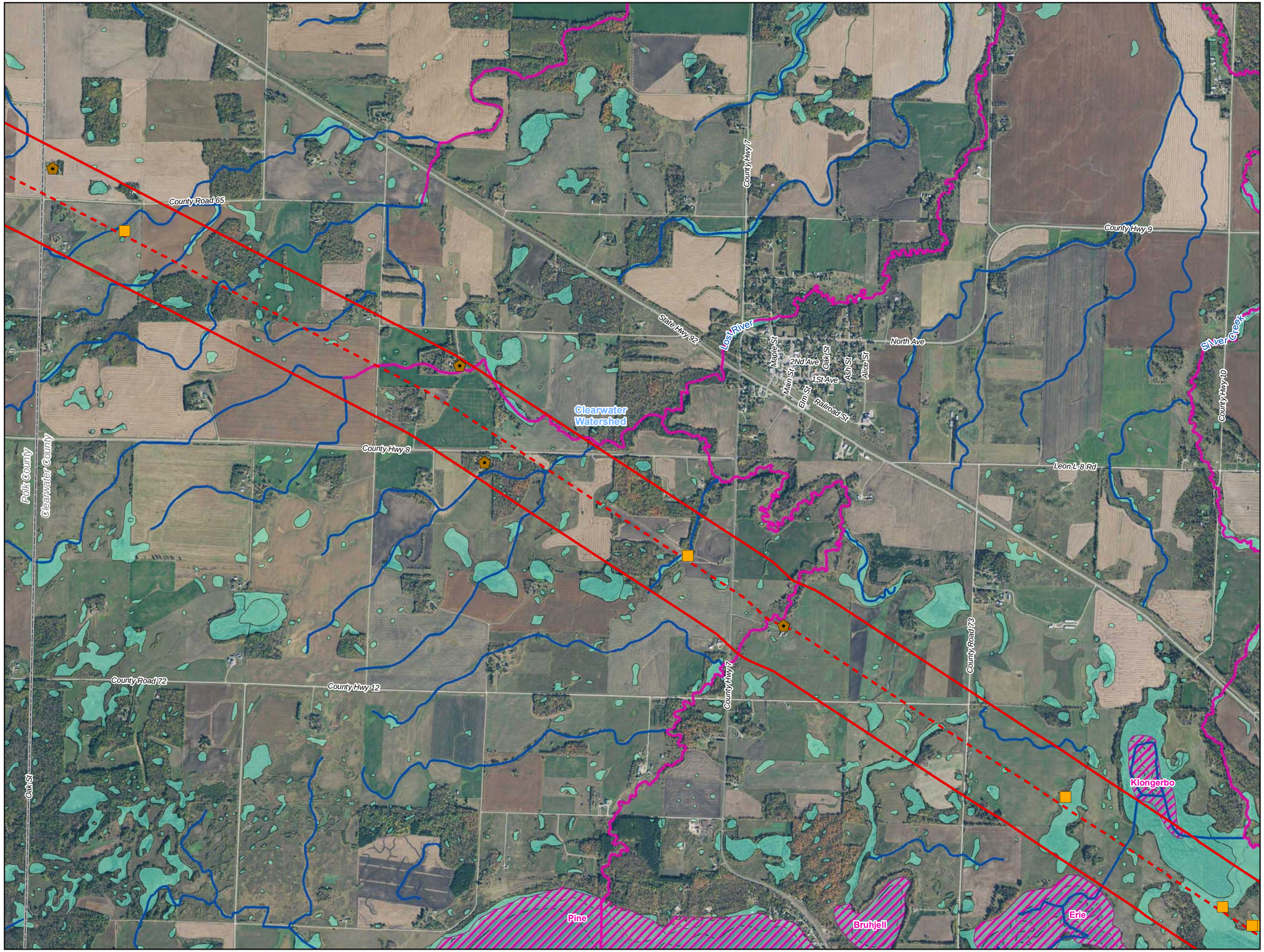



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 22

Line 3 Replacement Project

Enbridge

Clearbrook County, Minnesota

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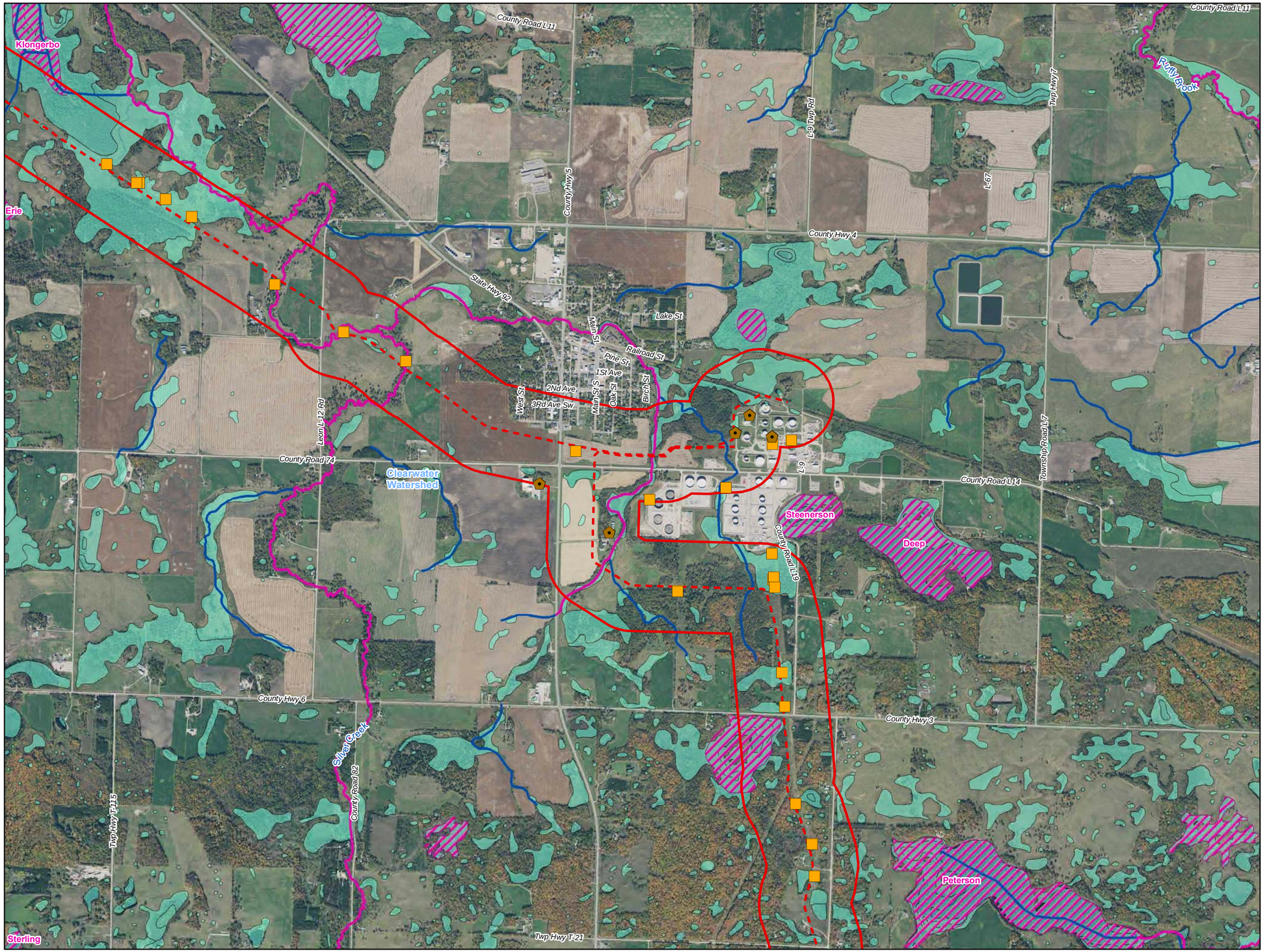



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 23

Line 3 Replacement Project

Enbridge

Clearbrook County, Minnesota

ENBRIDGE

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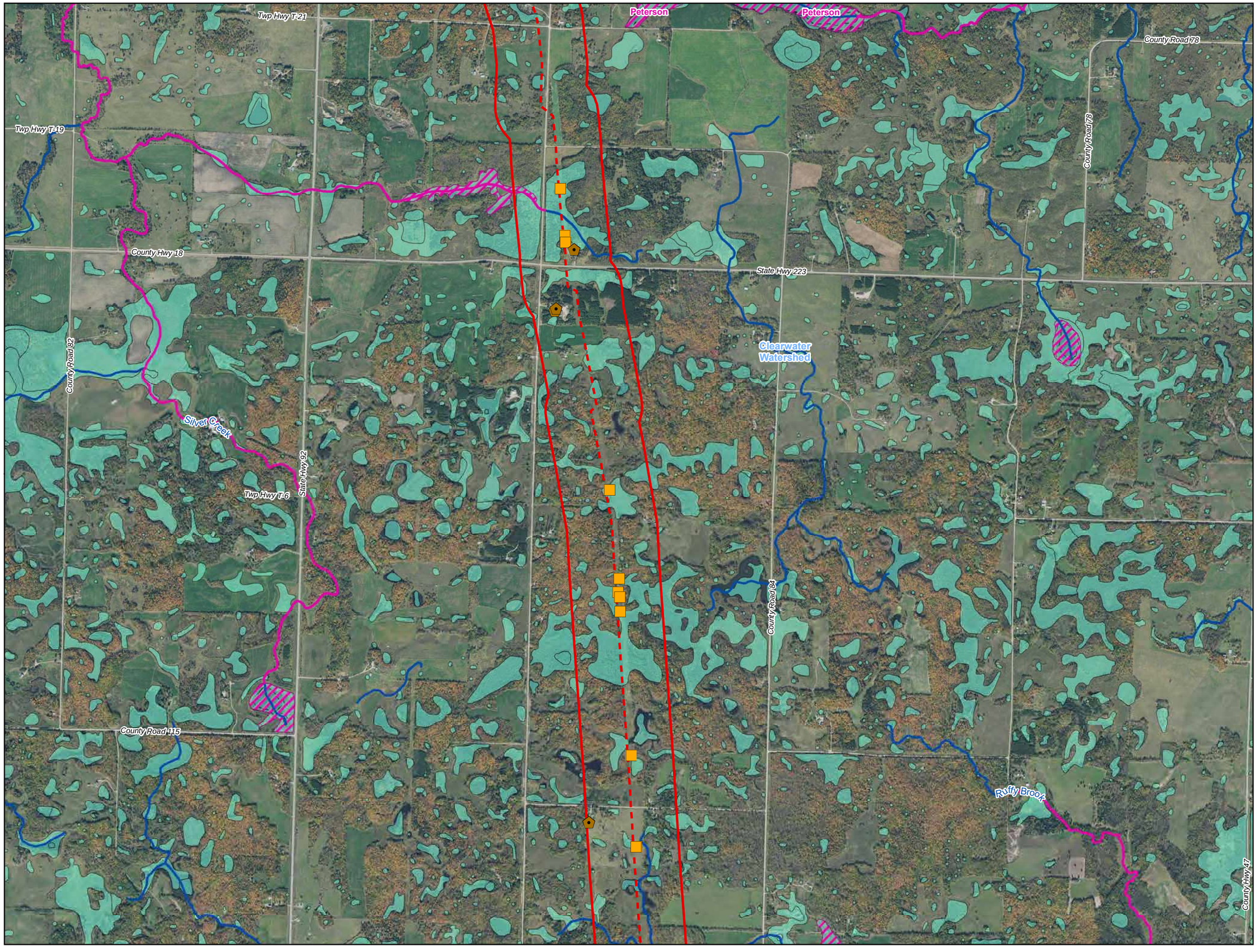



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 24

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

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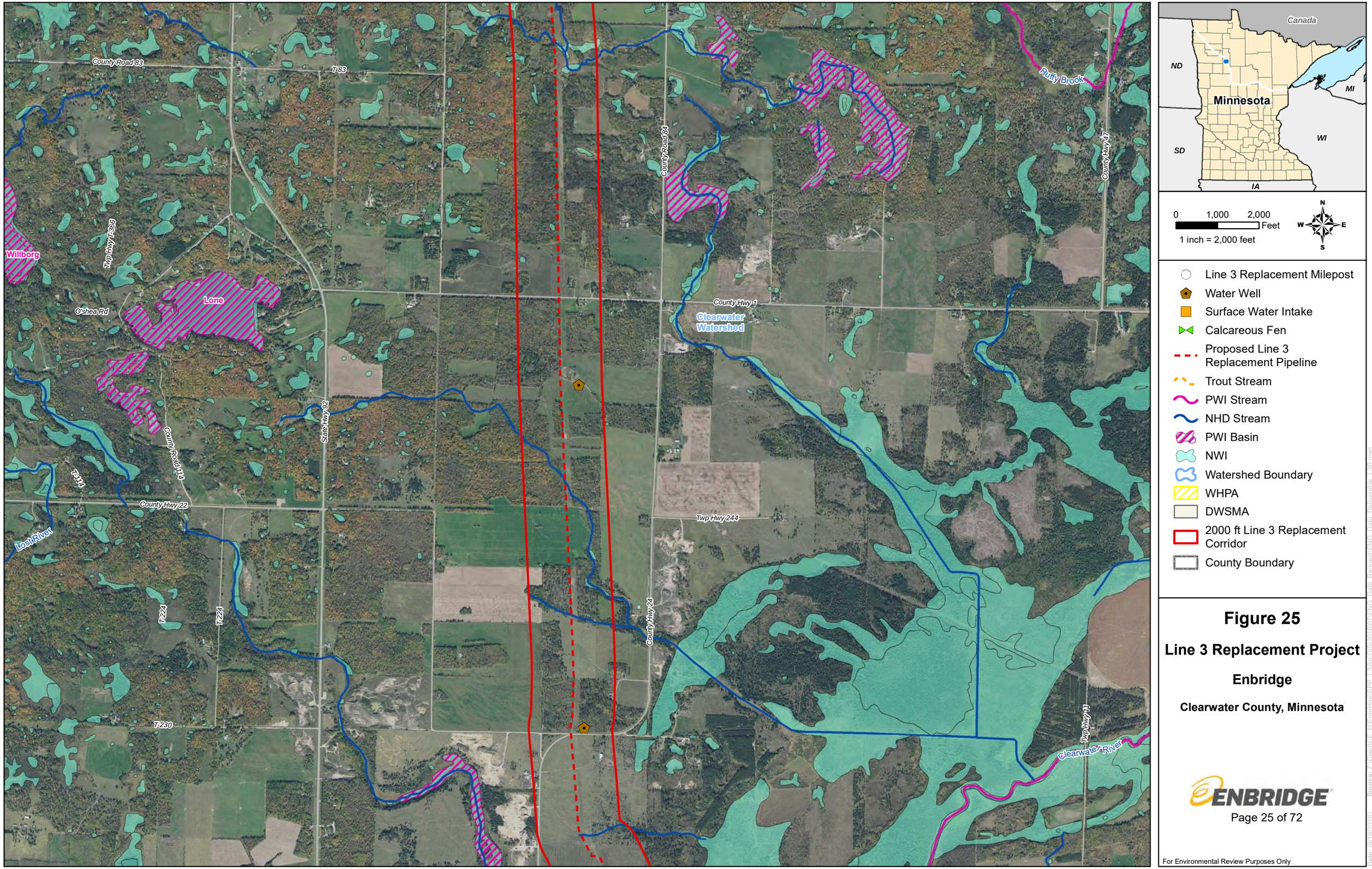

Figure 25

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

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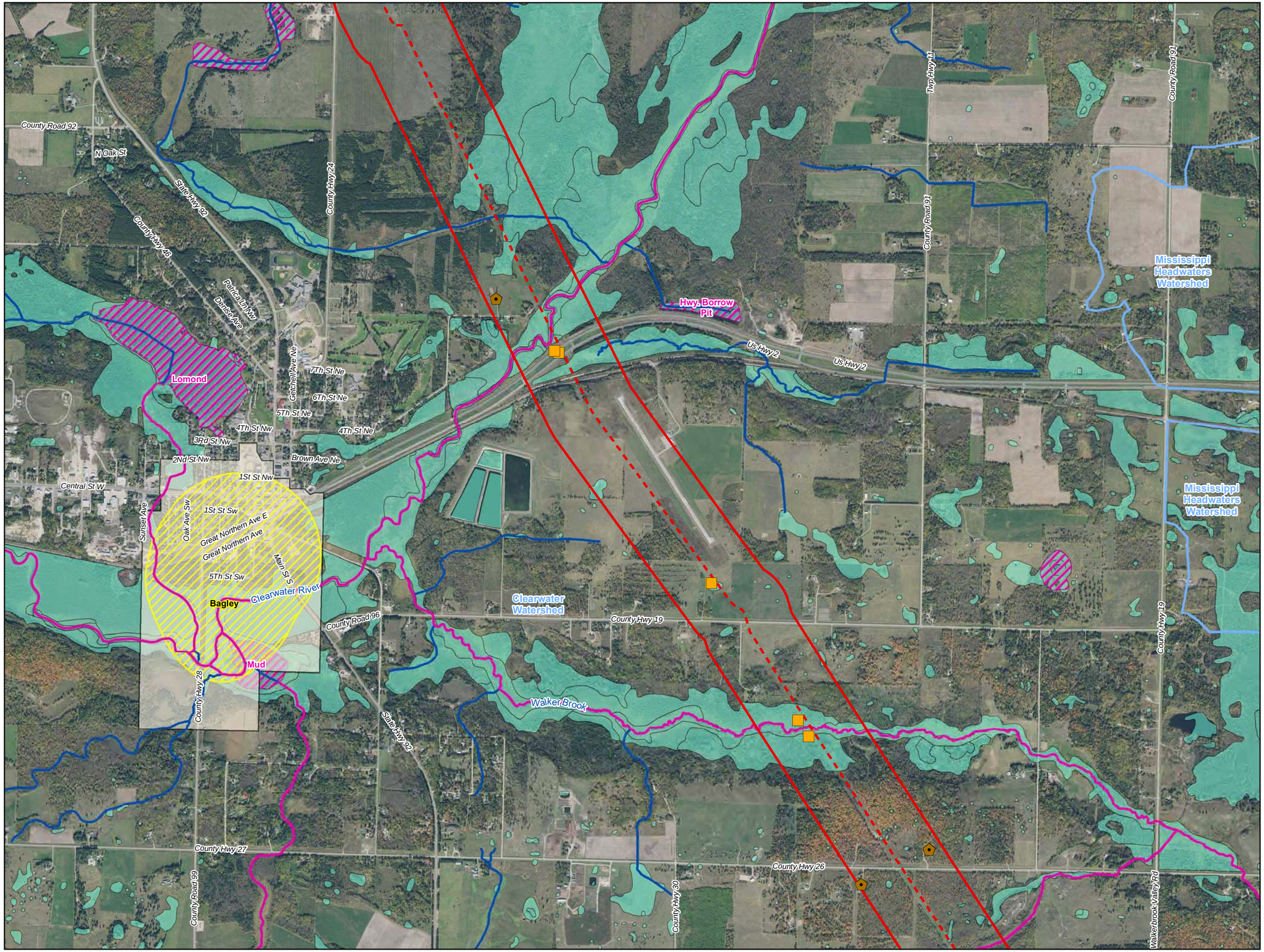



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 26

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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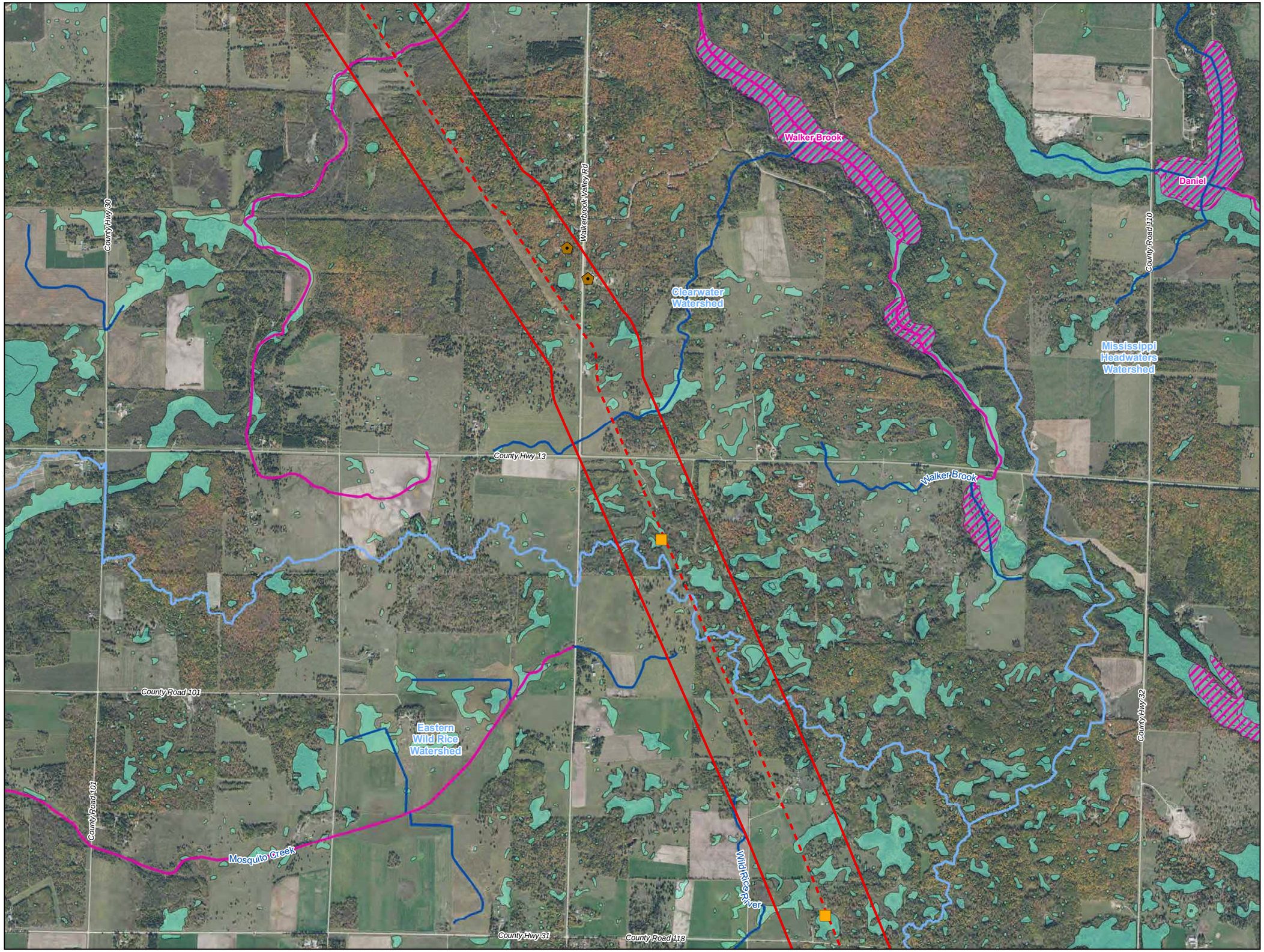



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 27

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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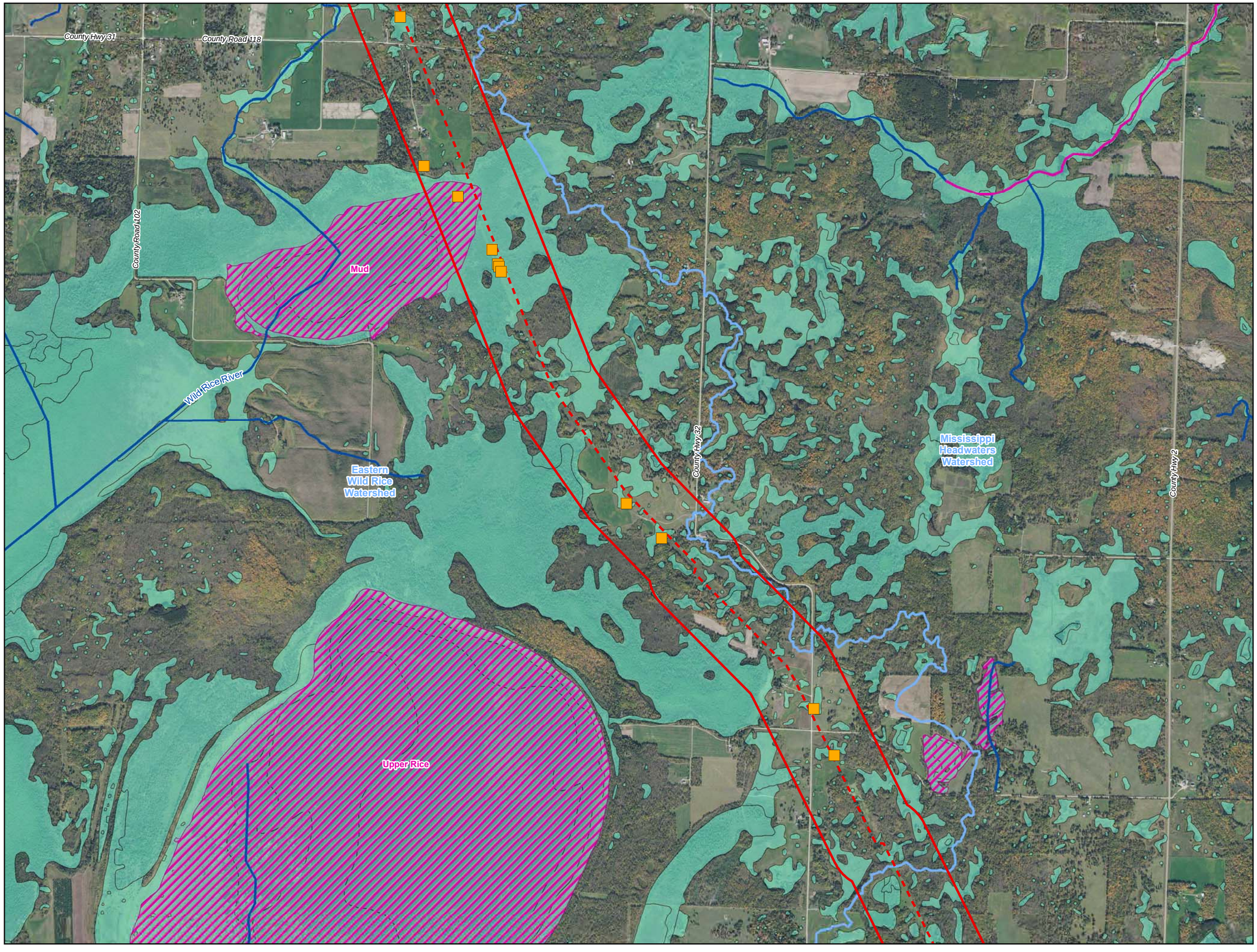



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 28

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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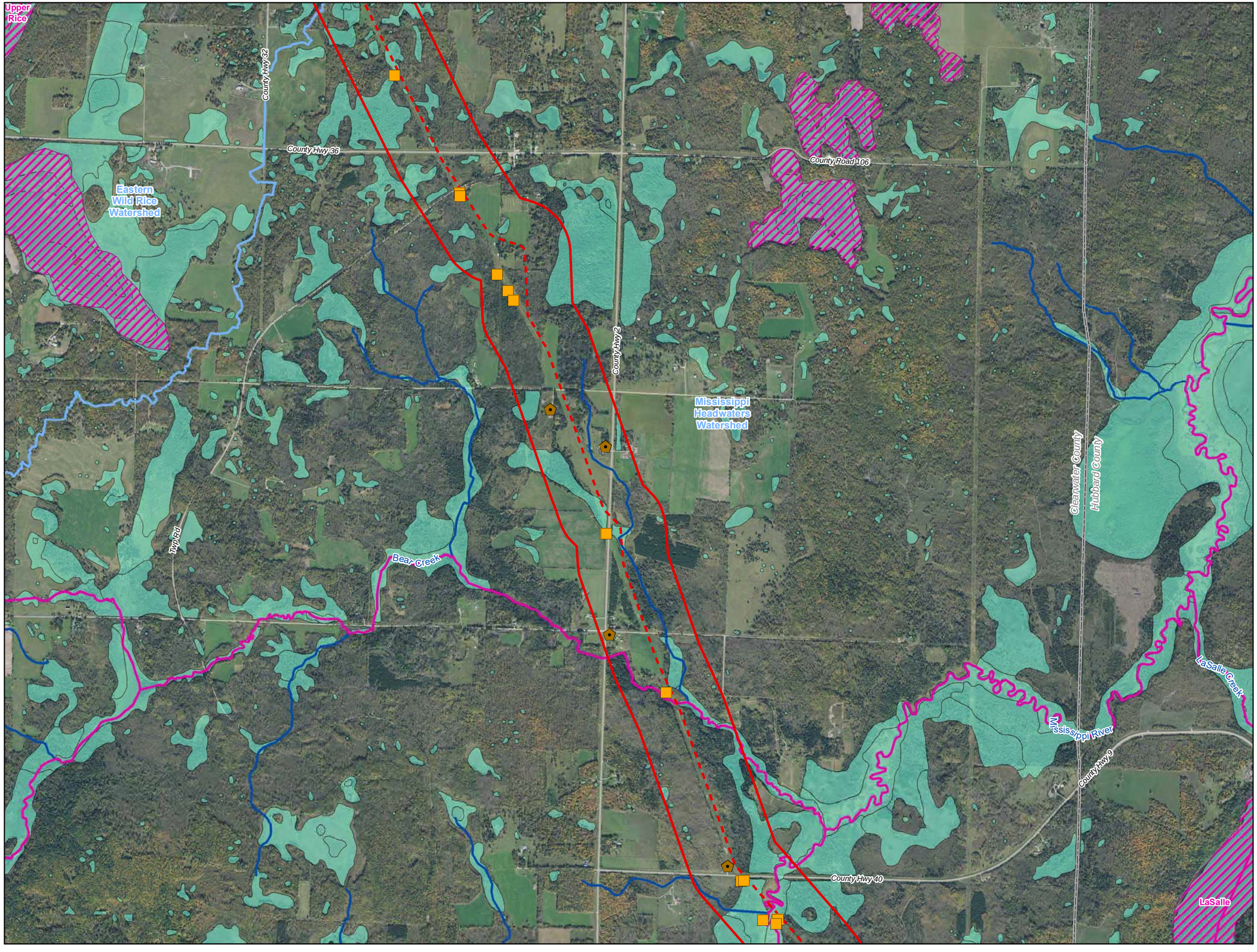



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 29

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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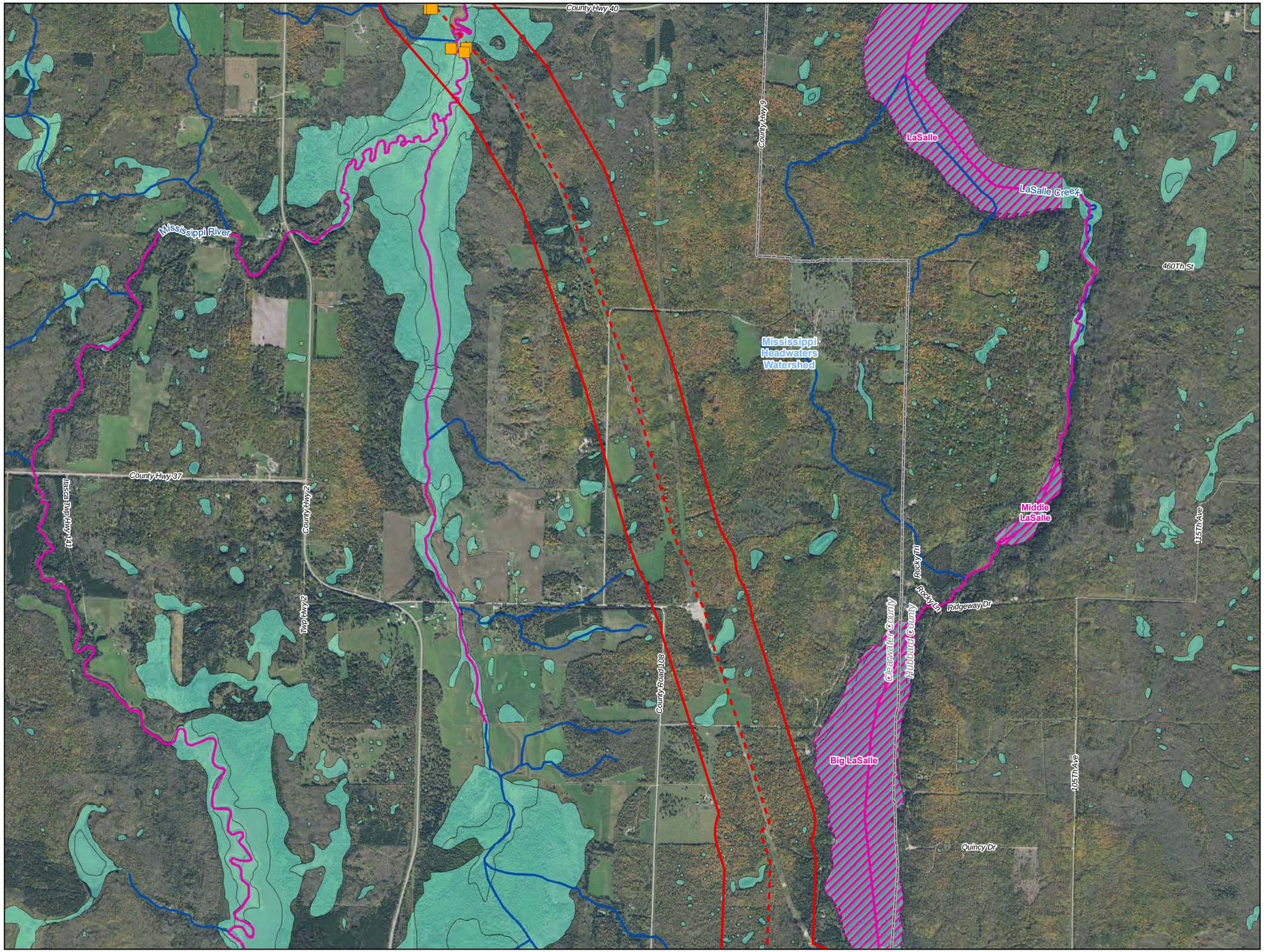



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 30

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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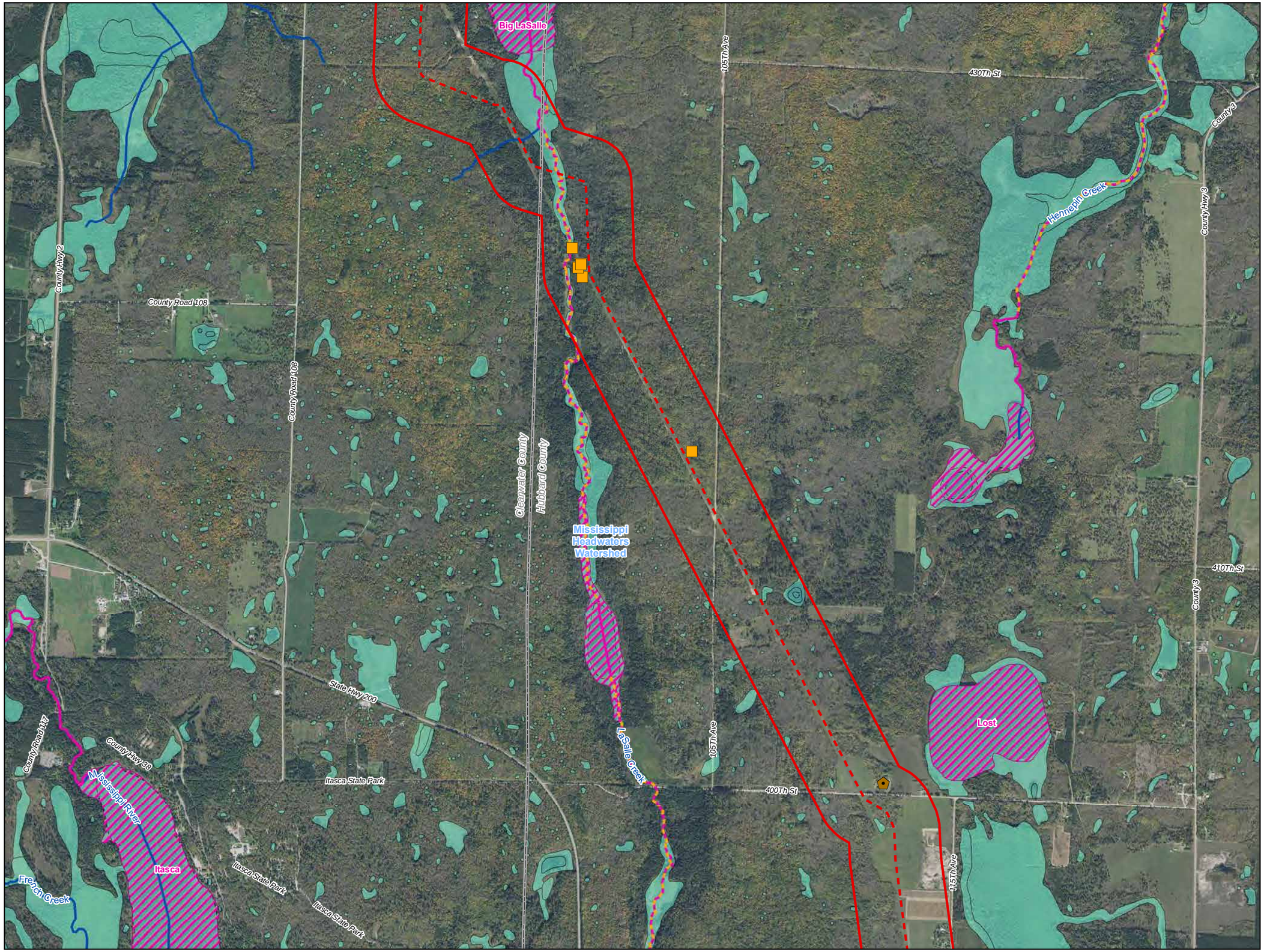



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 31

Line 3 Replacement Project

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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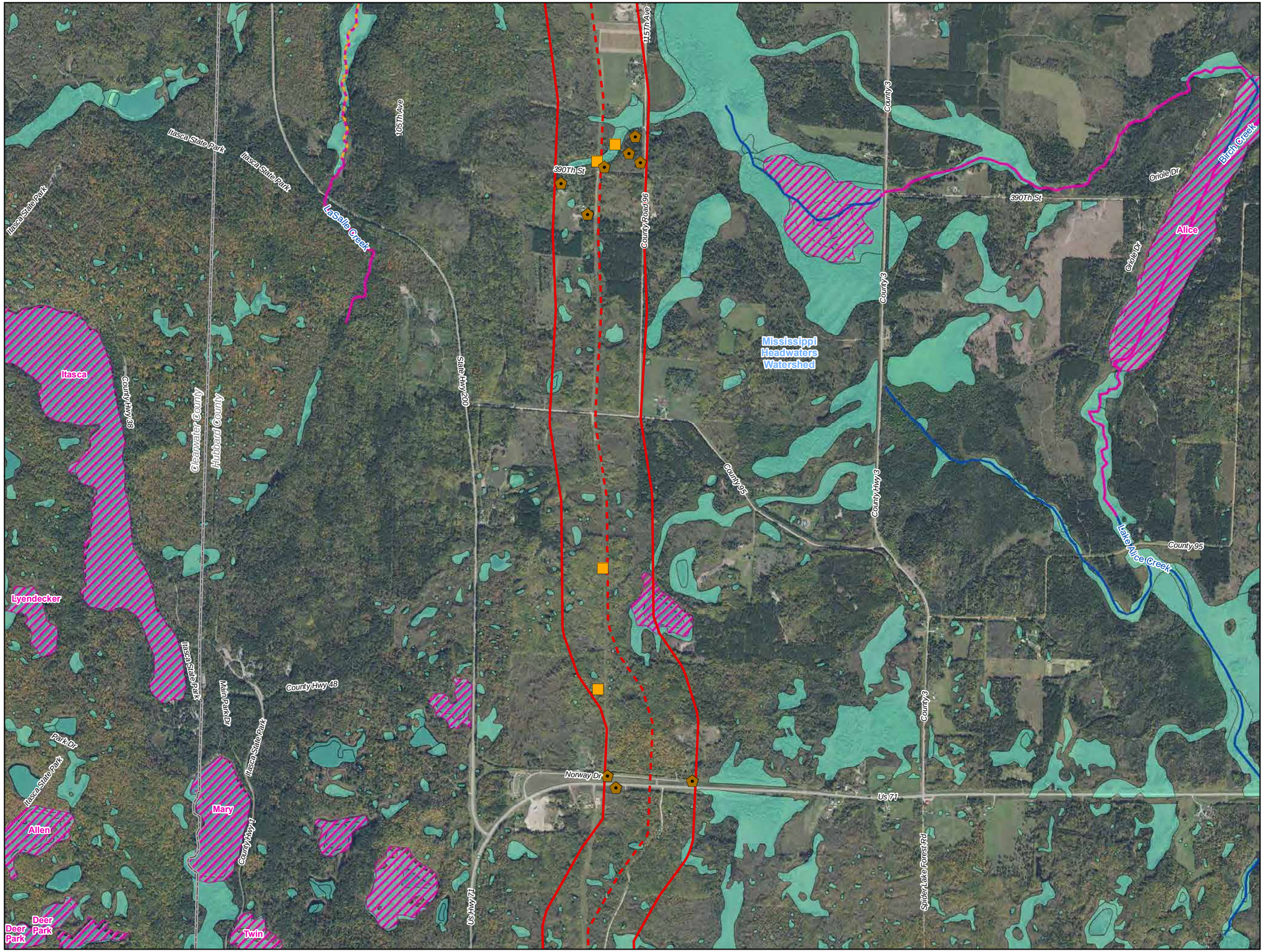



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 32

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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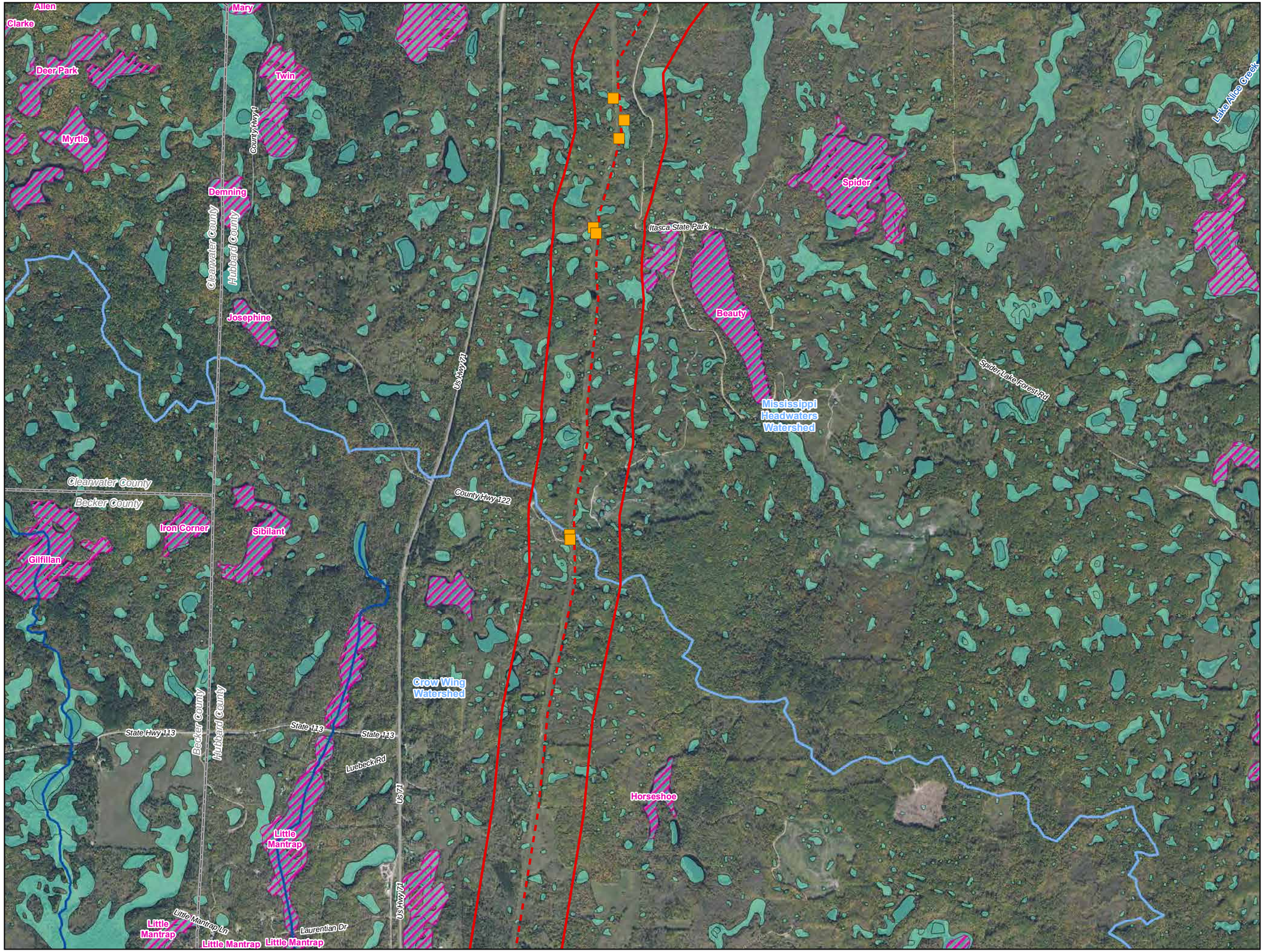



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 33

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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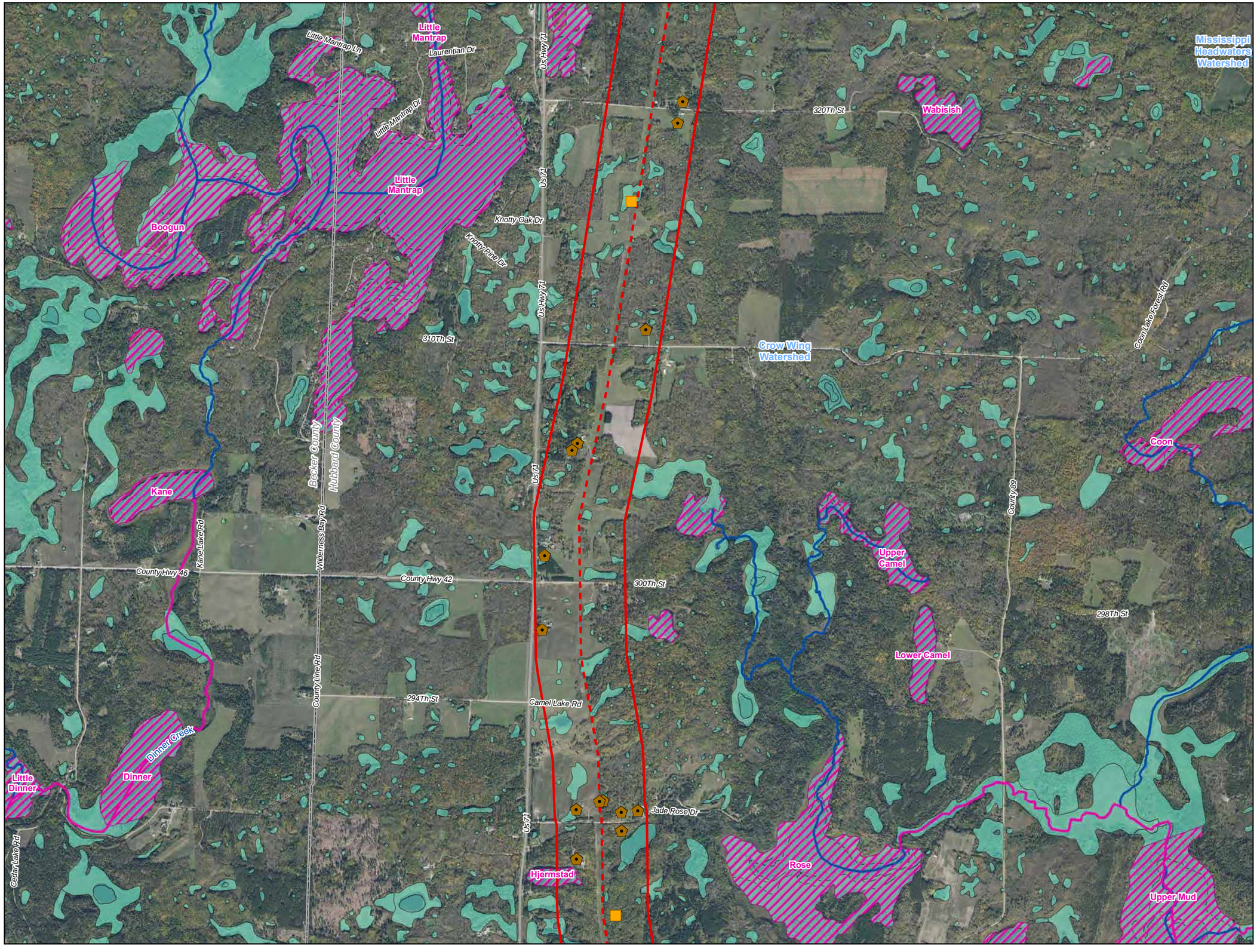



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 34

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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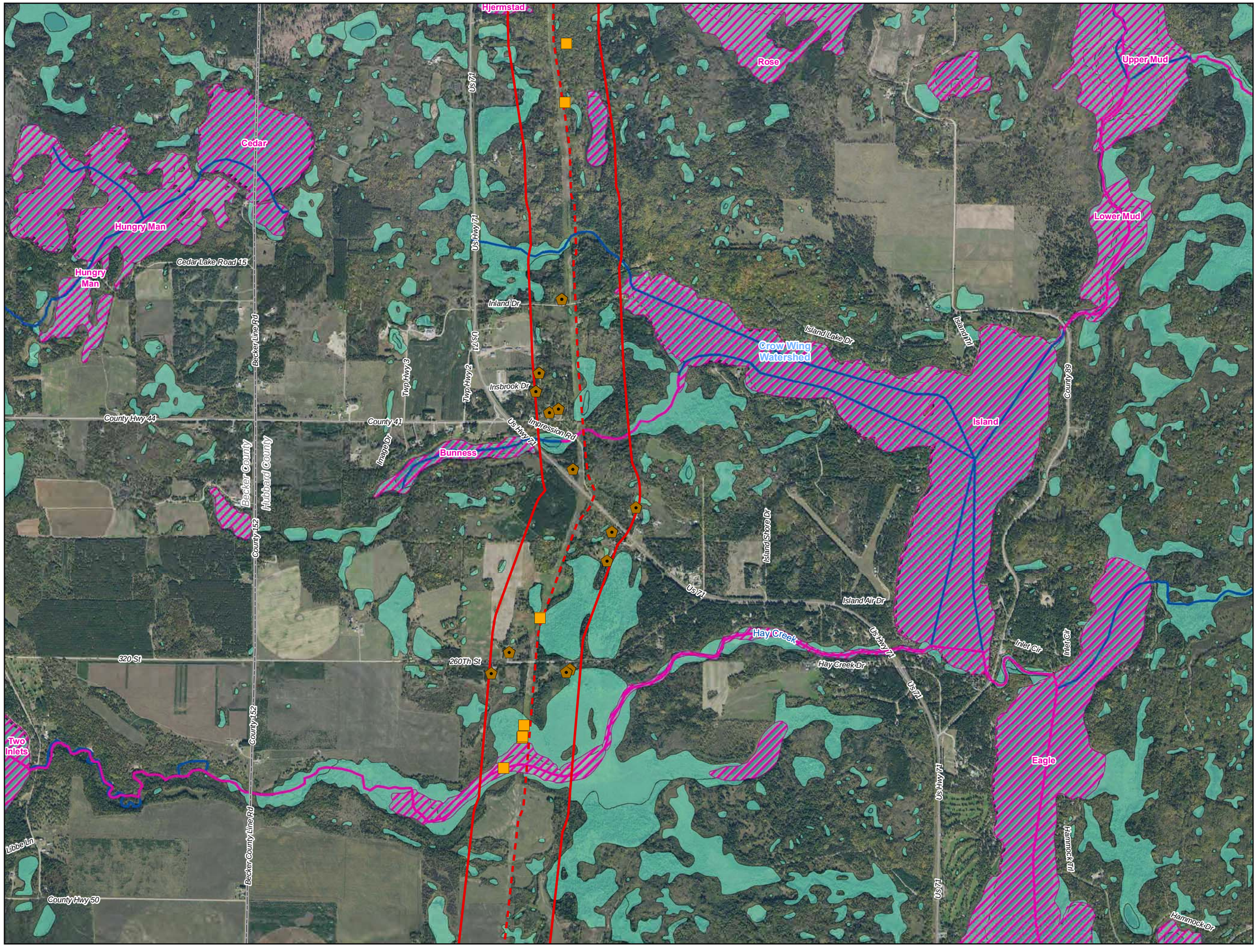



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 35

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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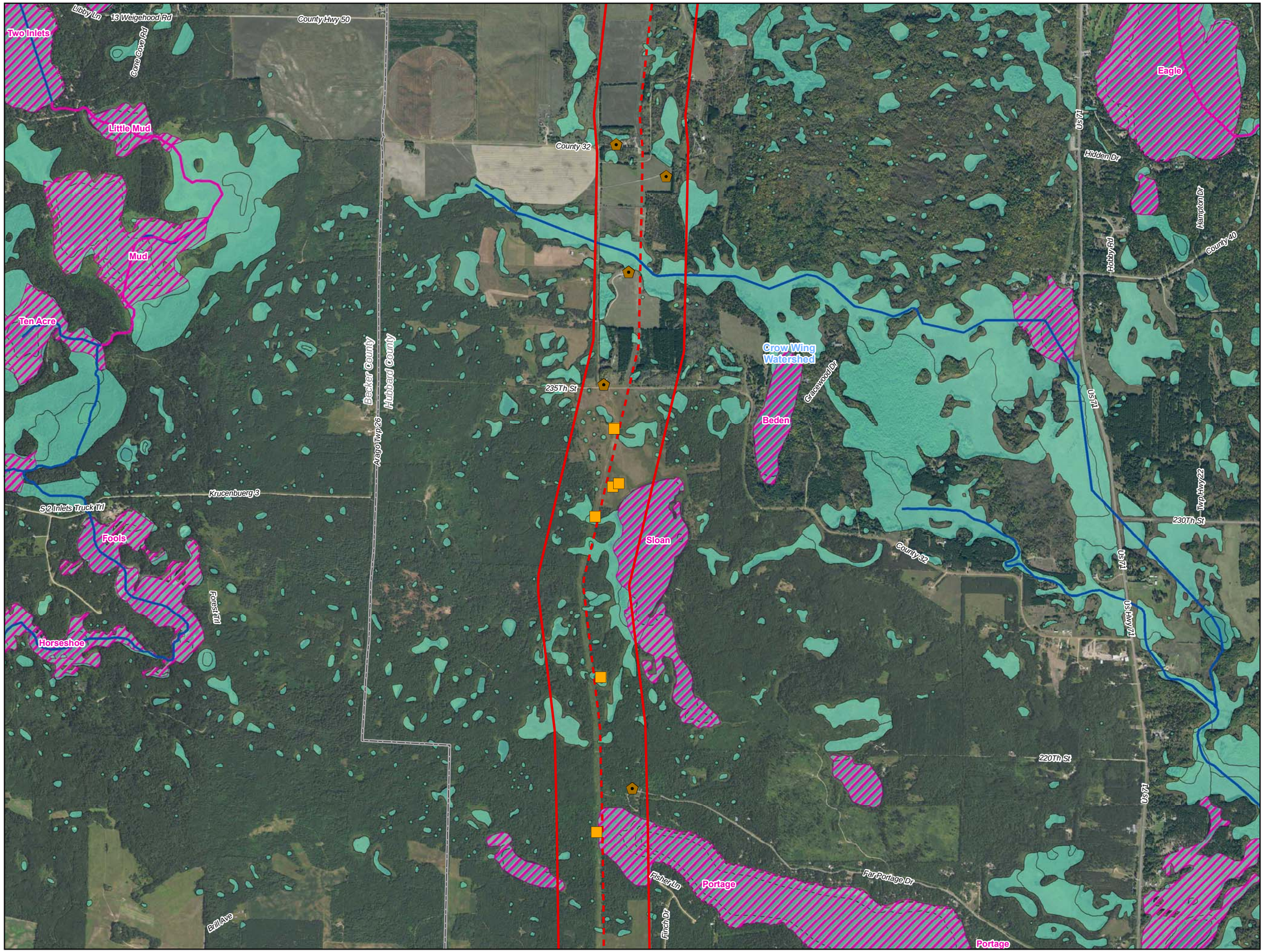



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 36

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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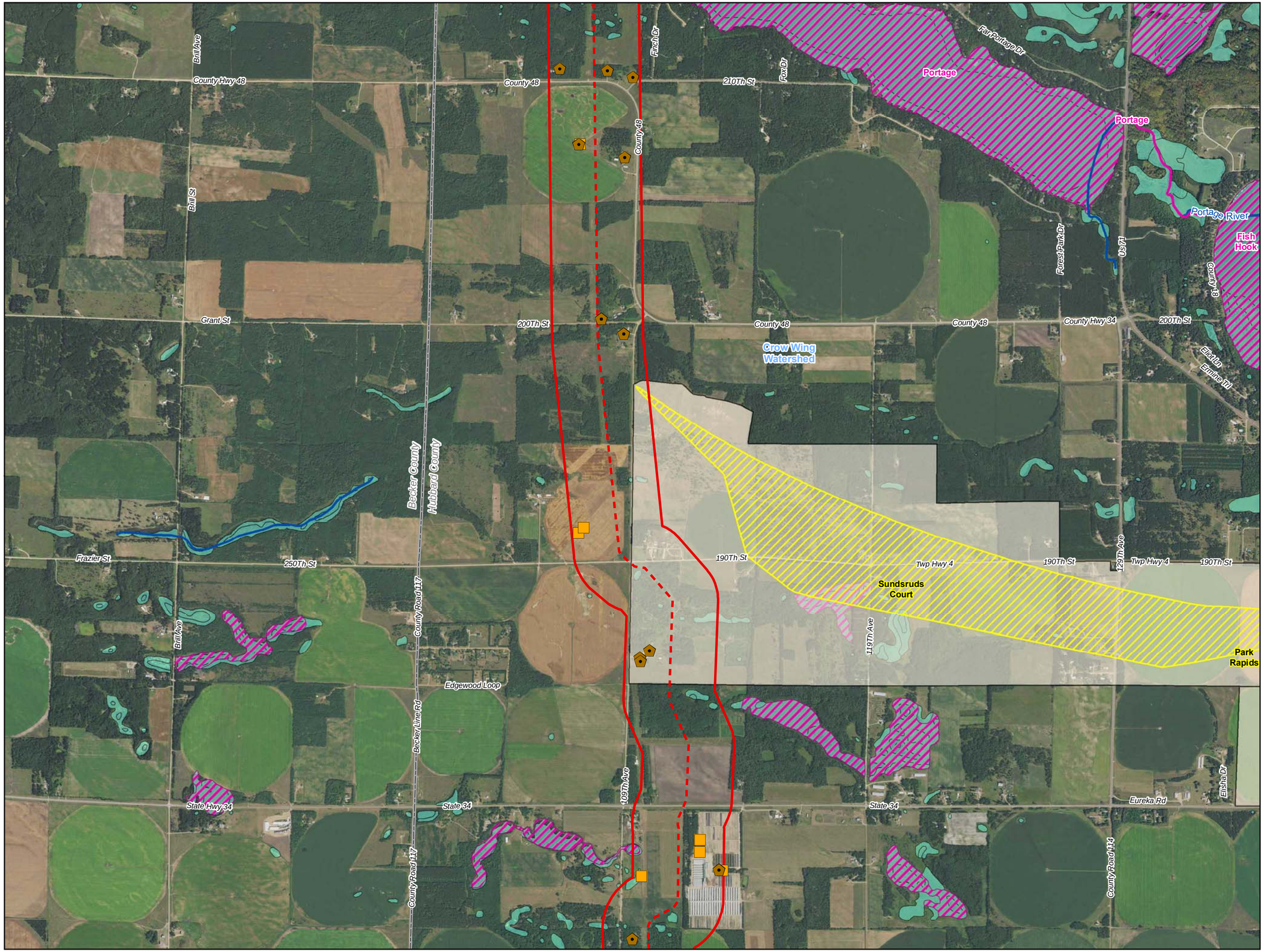



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 37

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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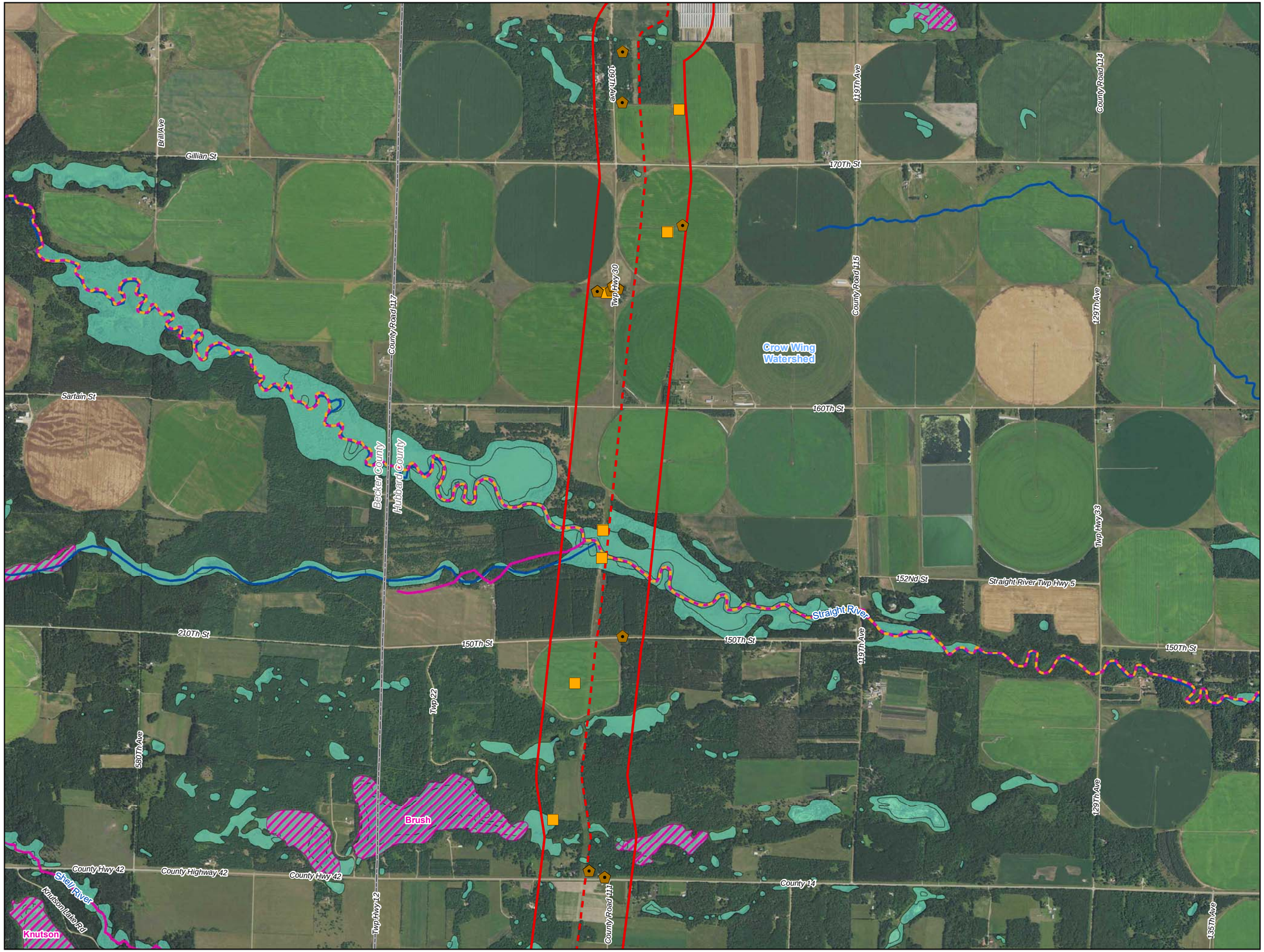



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 38

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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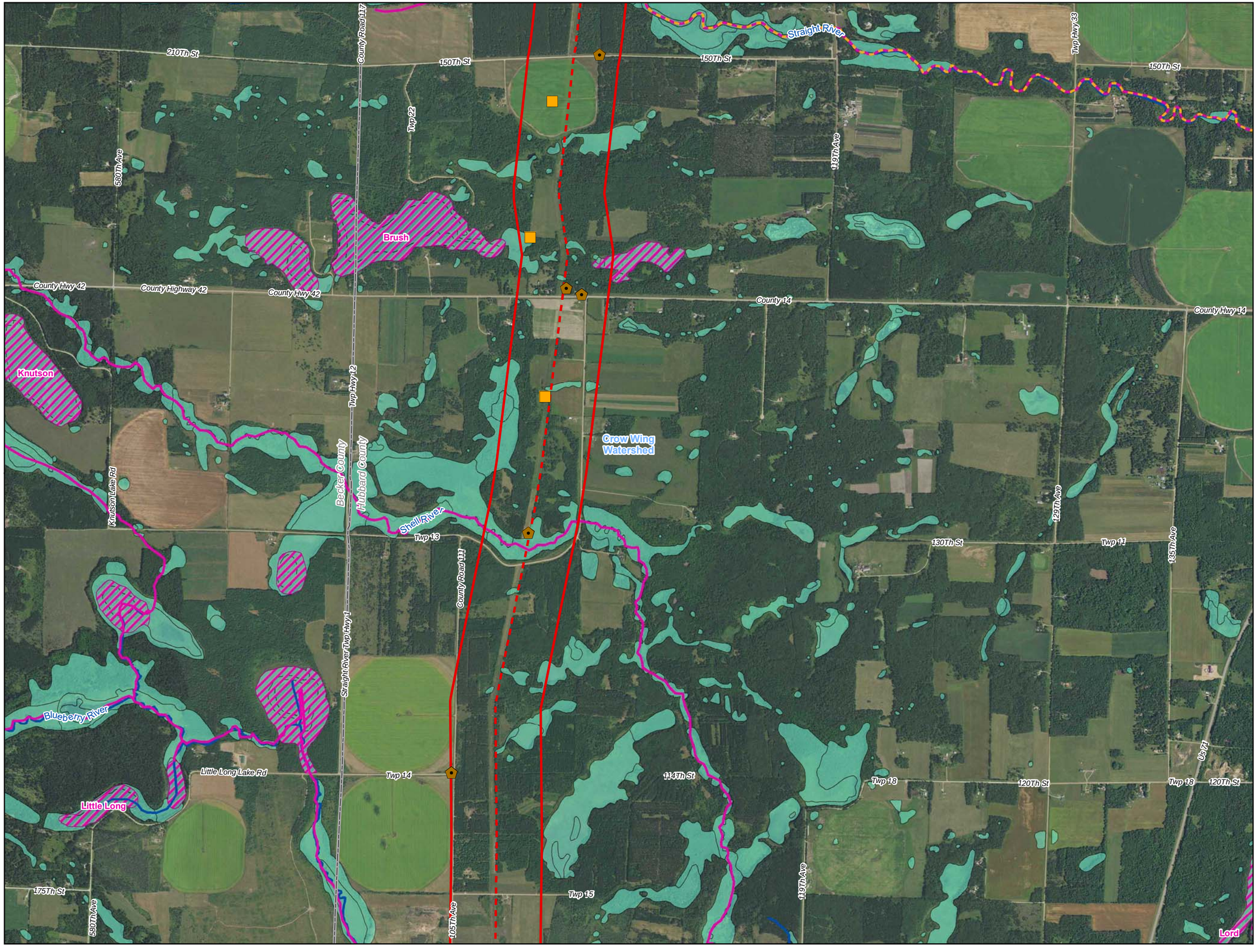



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 39

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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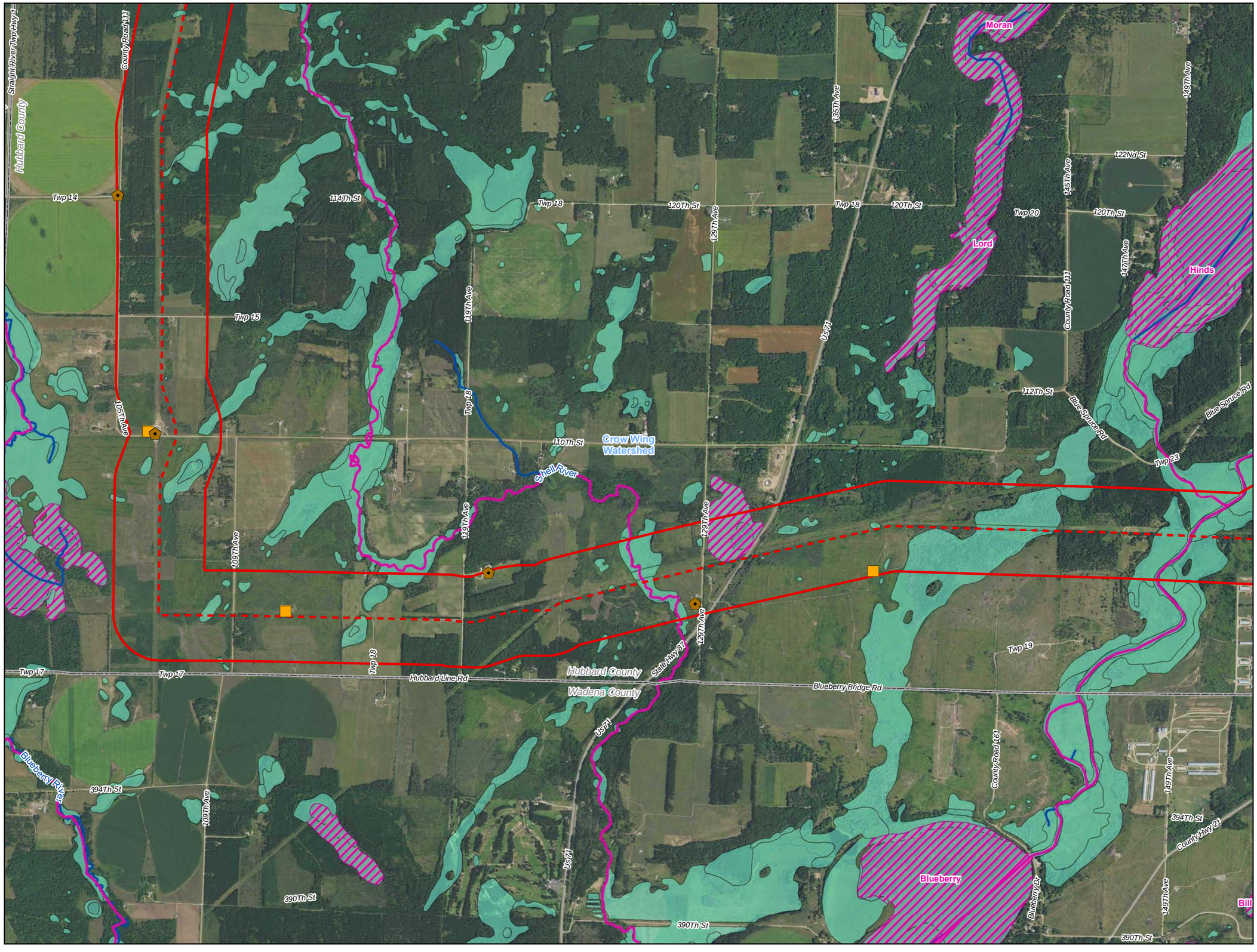



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 40

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

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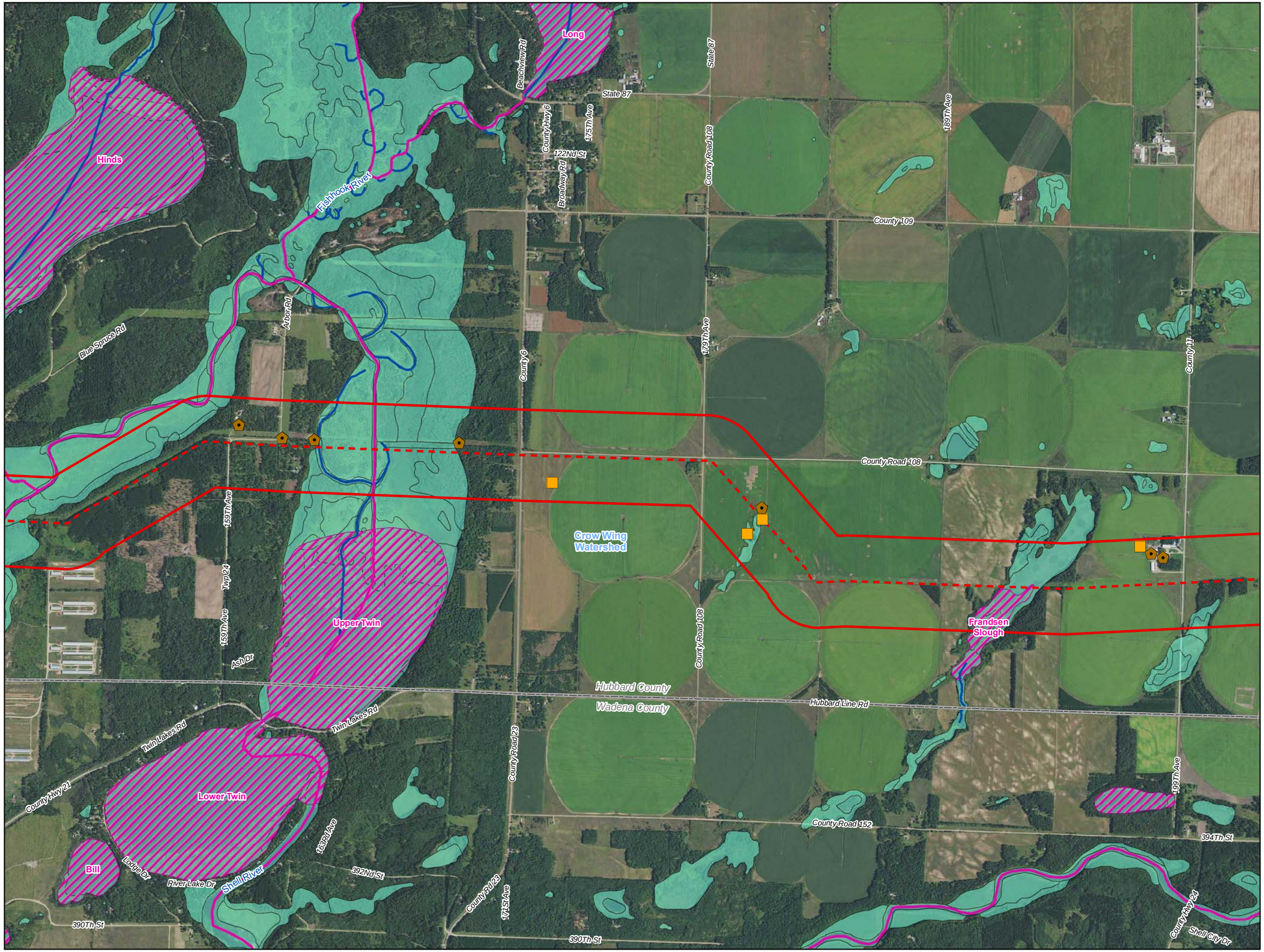



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 41

Line 3 Replacement Project

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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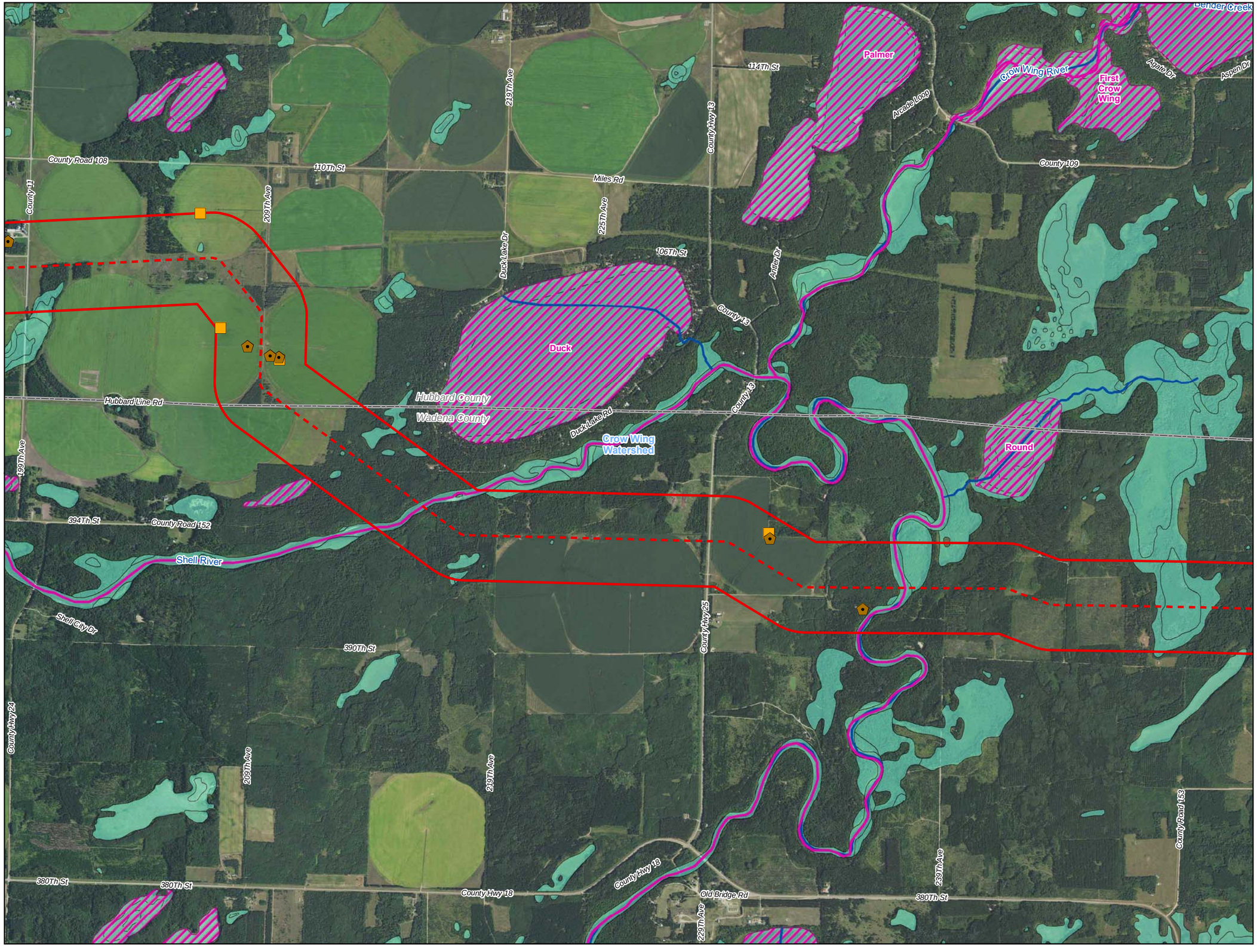



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 42

Line 3 Replacement Project

Enbridge

Wadena County, Minnesota

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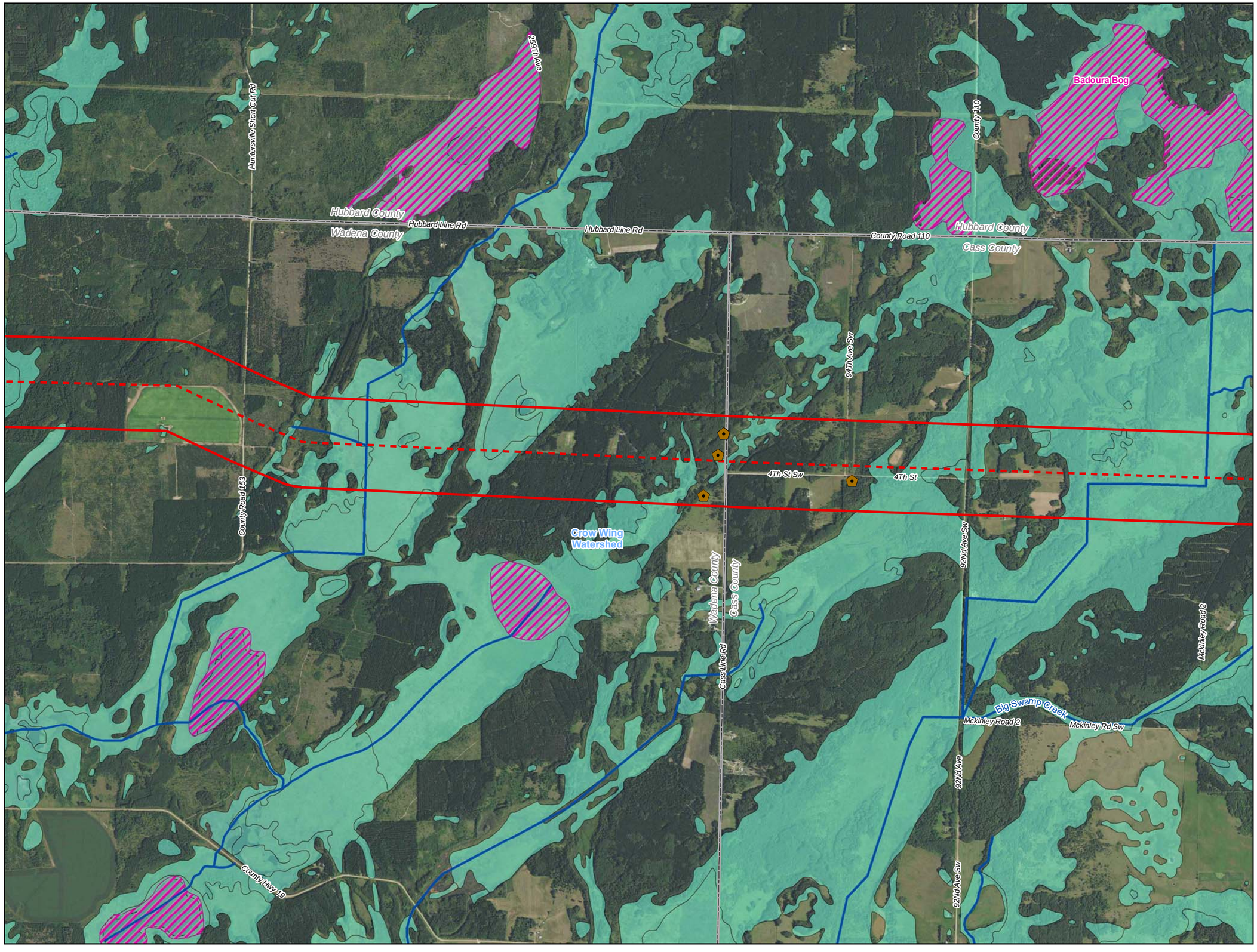



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 43

Line 3 Replacement Project

Enbridge

Wadena County, Minnesota

ENBRIDGE

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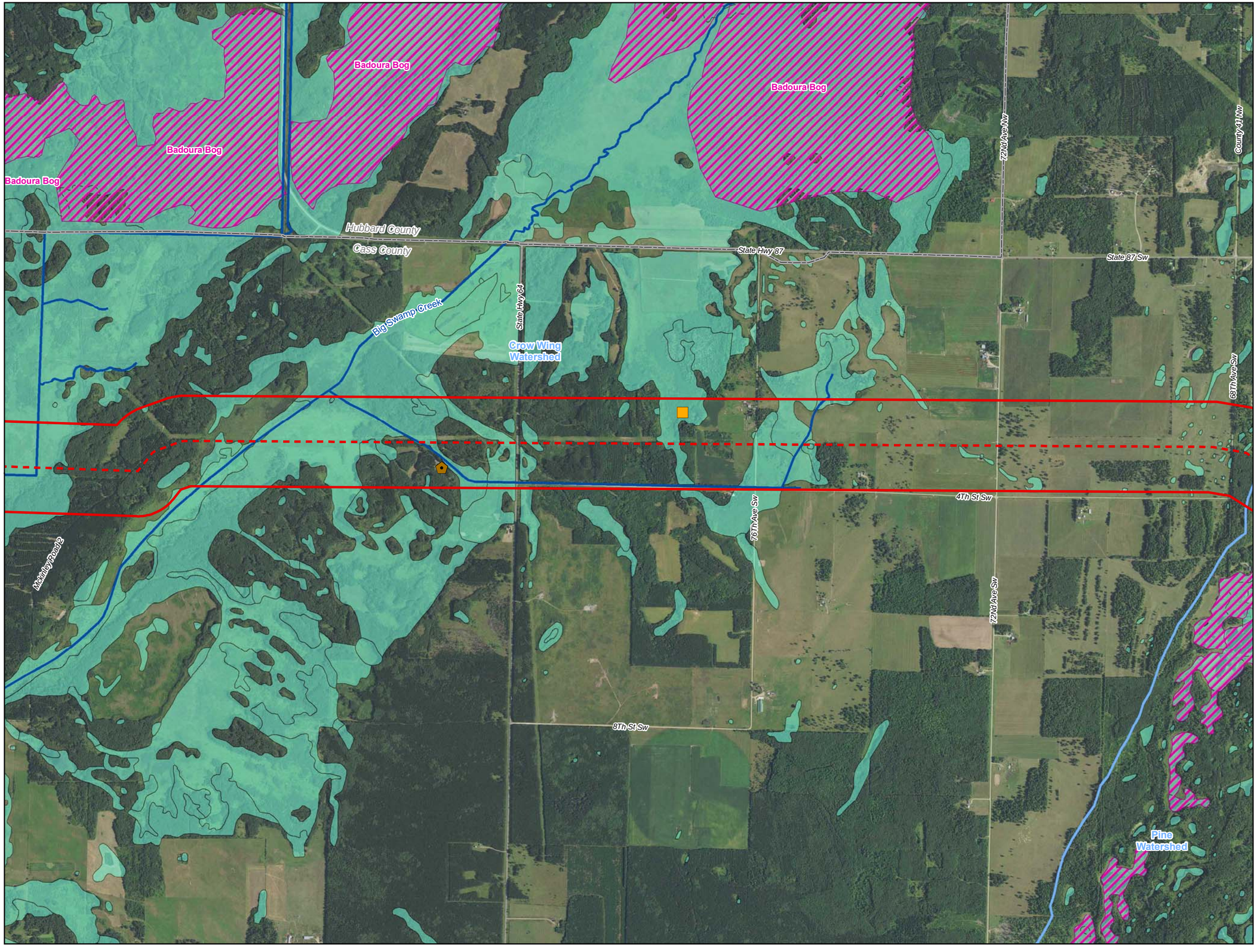



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 44

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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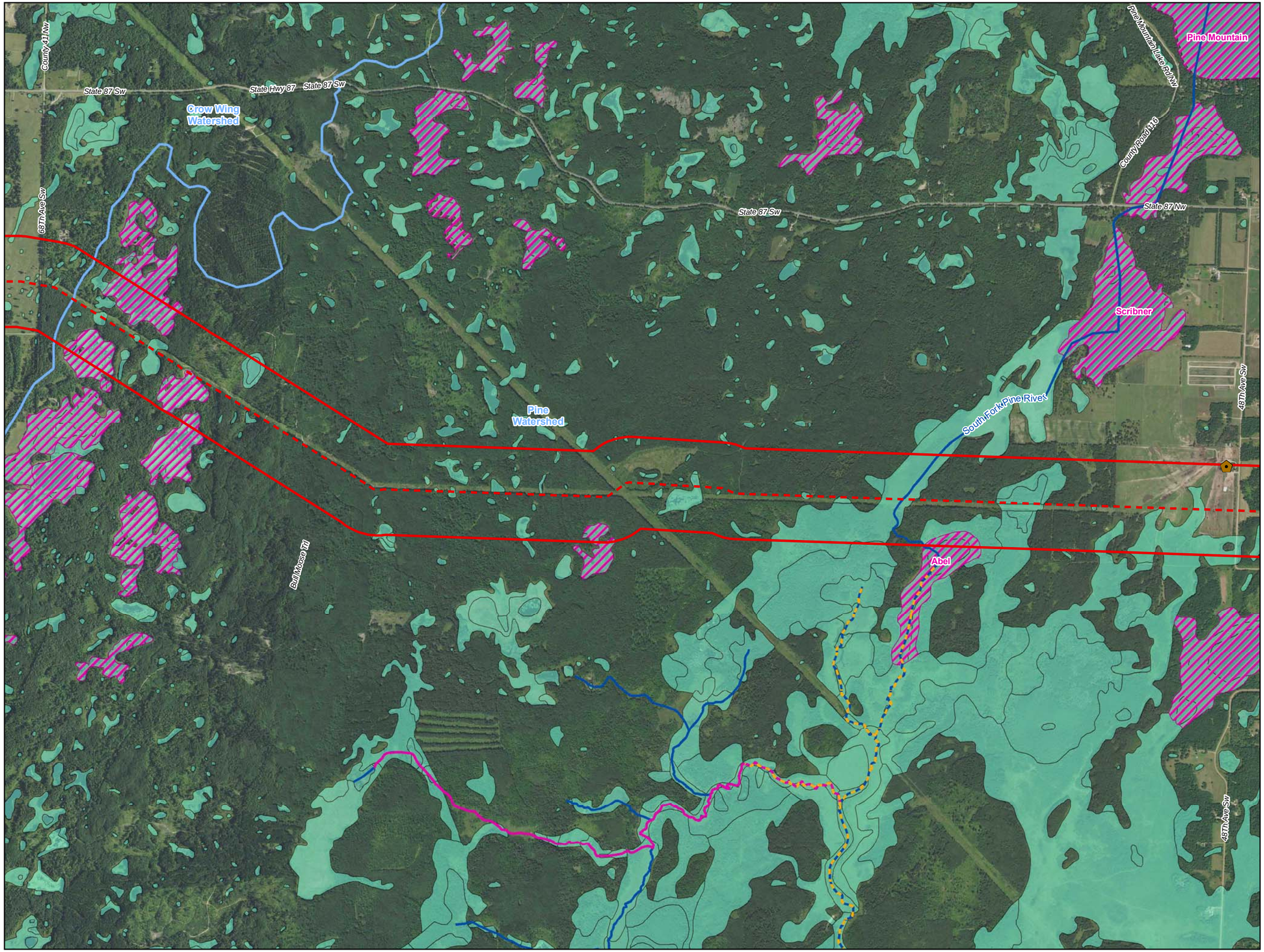



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 45

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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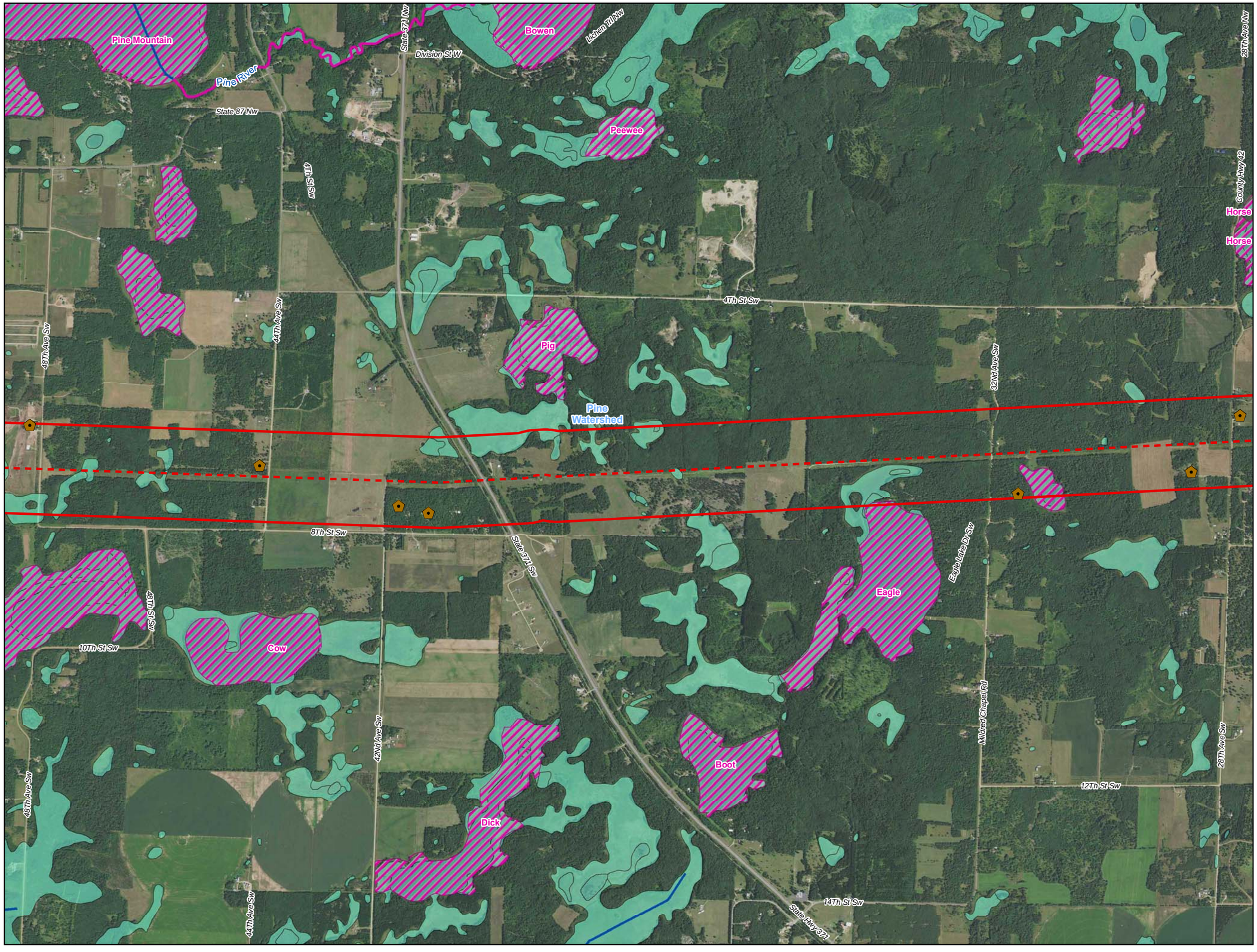



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 46

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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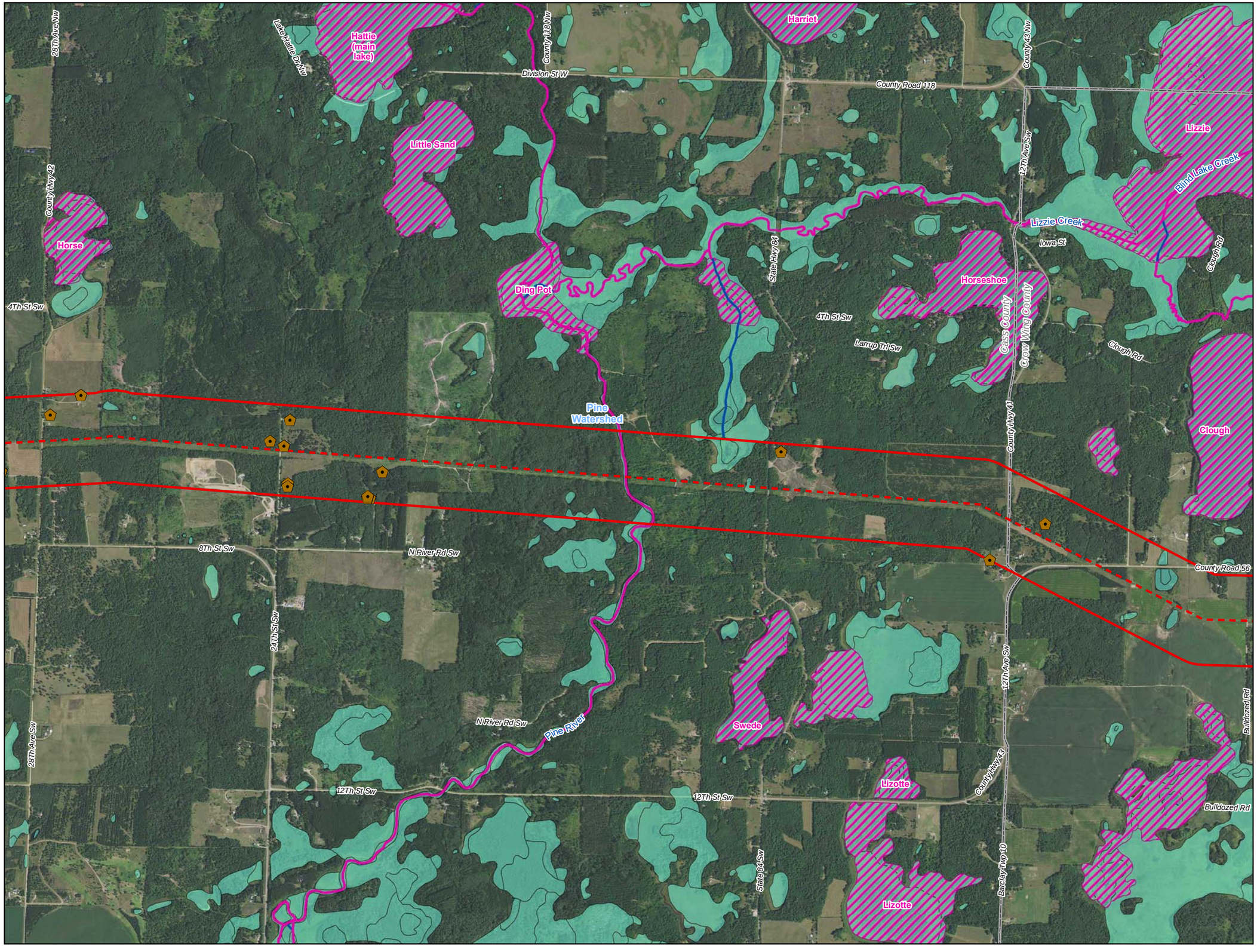

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 47

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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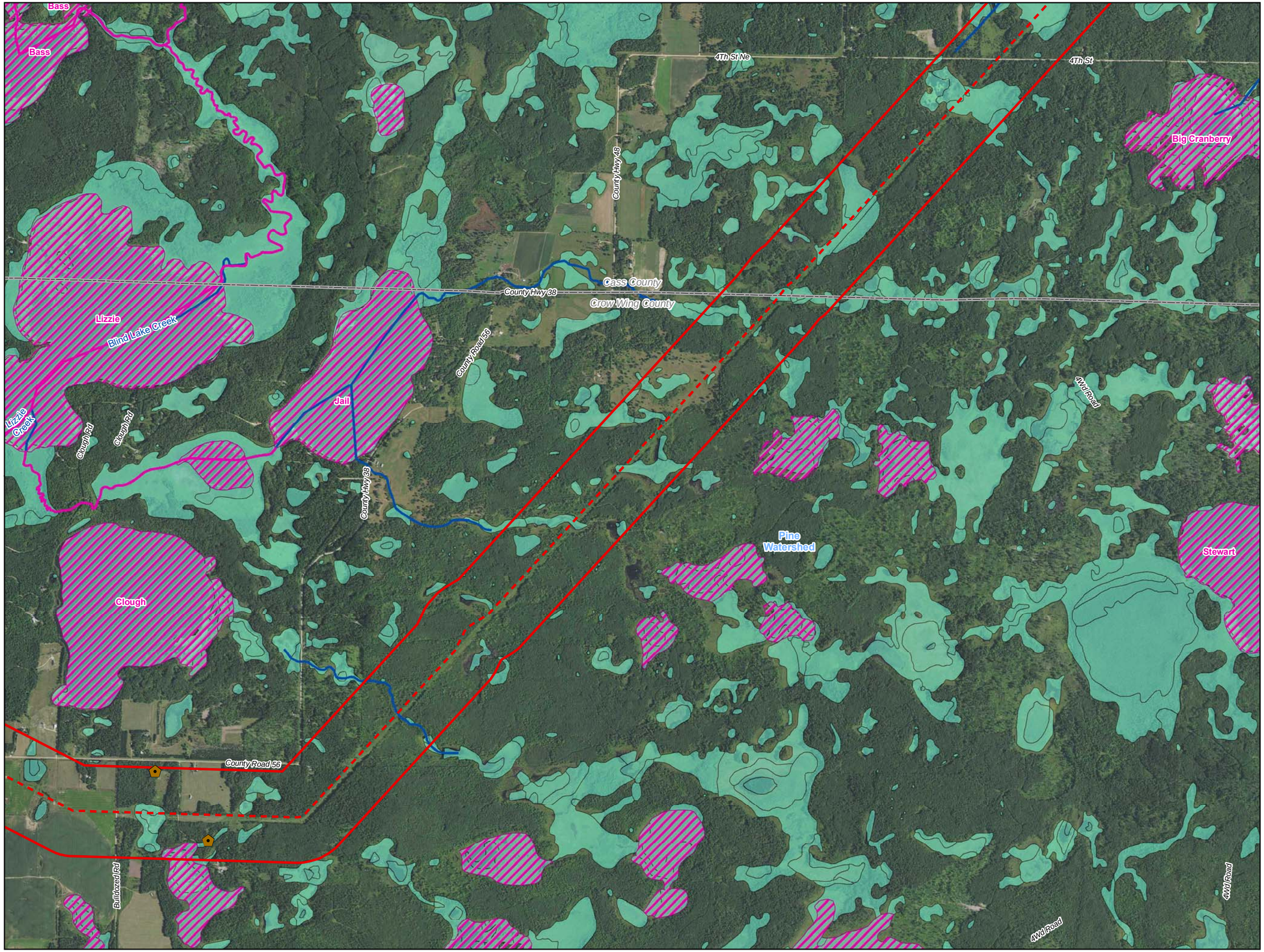



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 48

Line 3 Replacement Project

Enbridge

Crow Wing County, Minnesota

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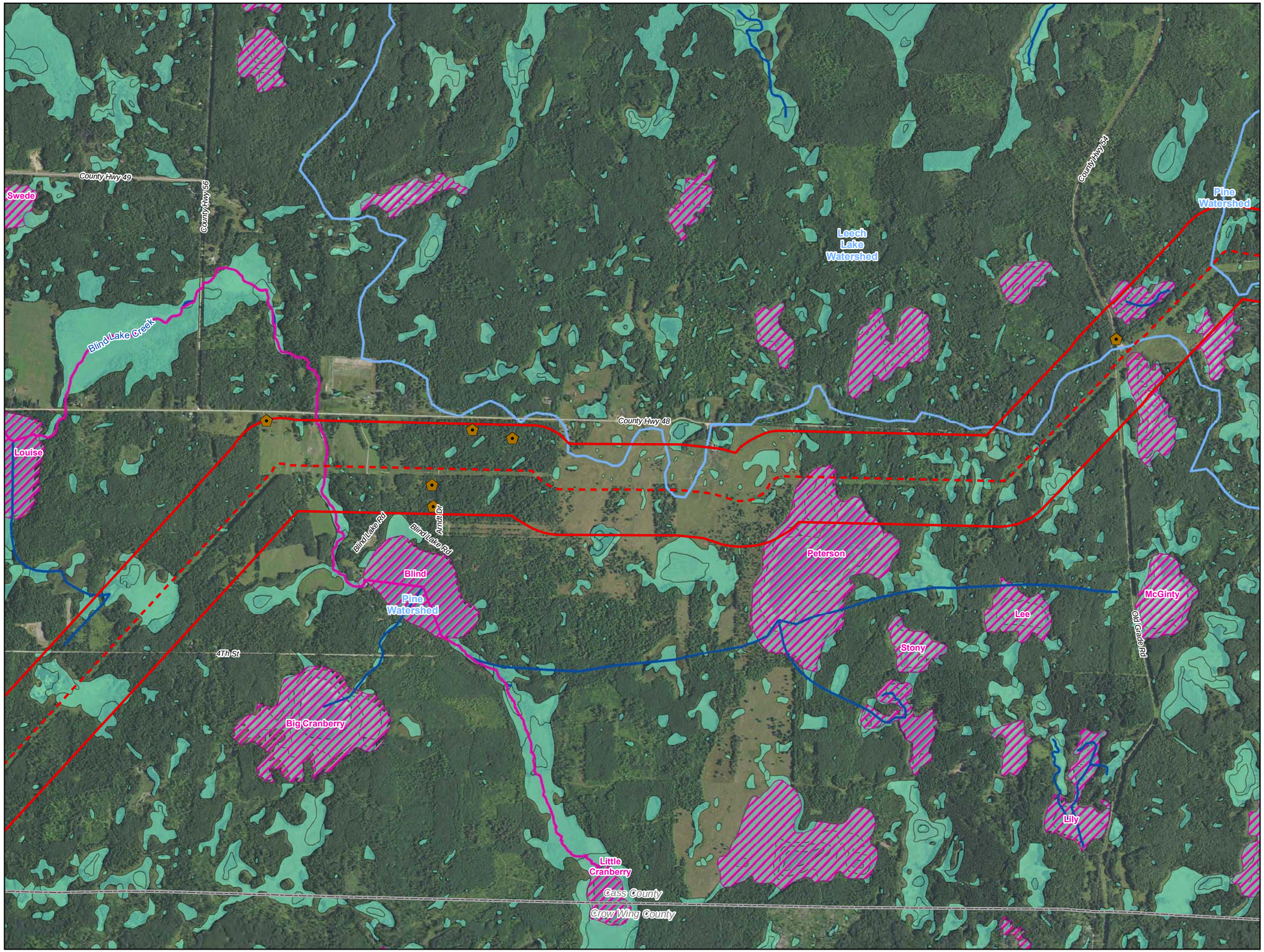



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 49

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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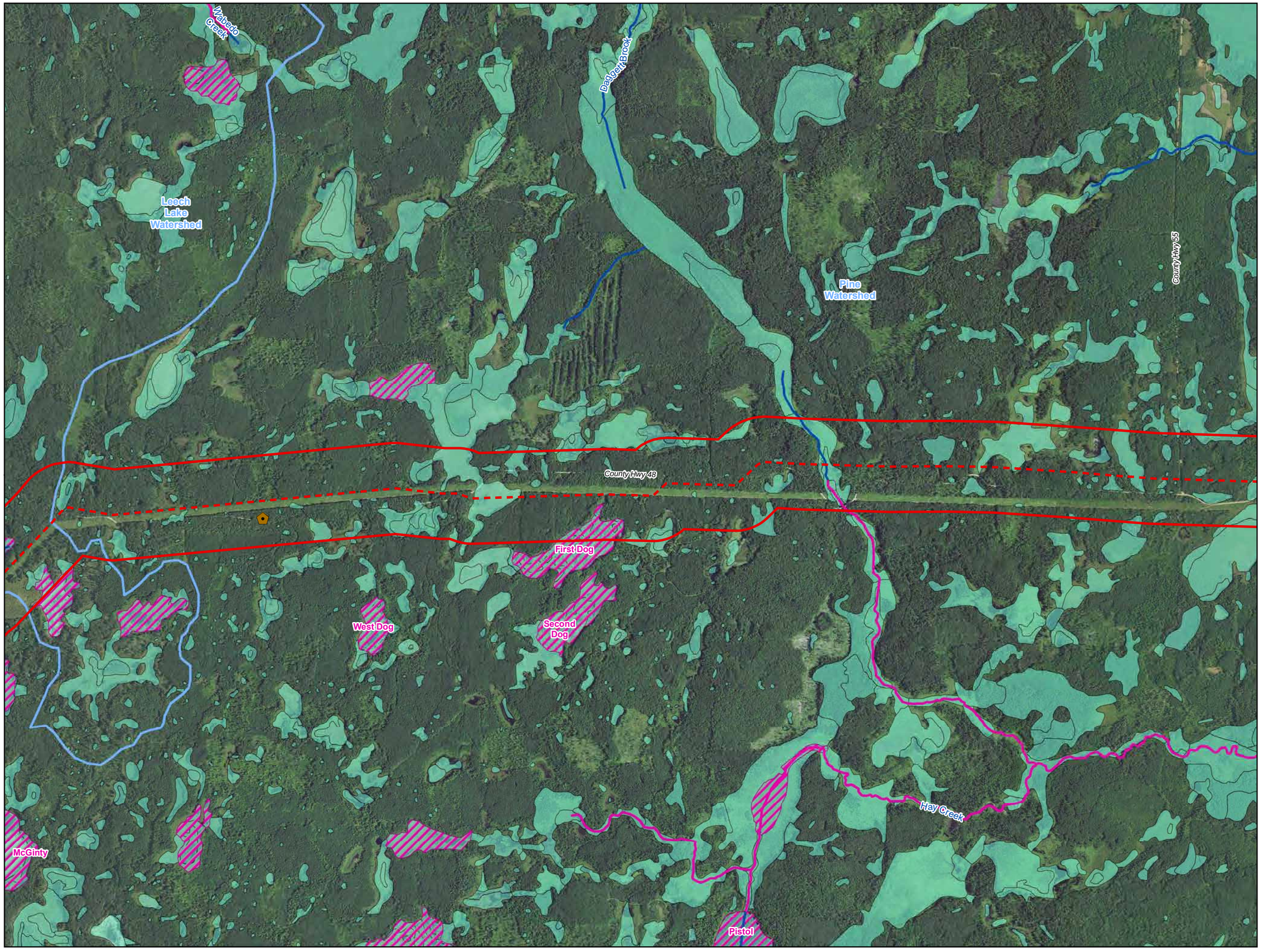



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 50

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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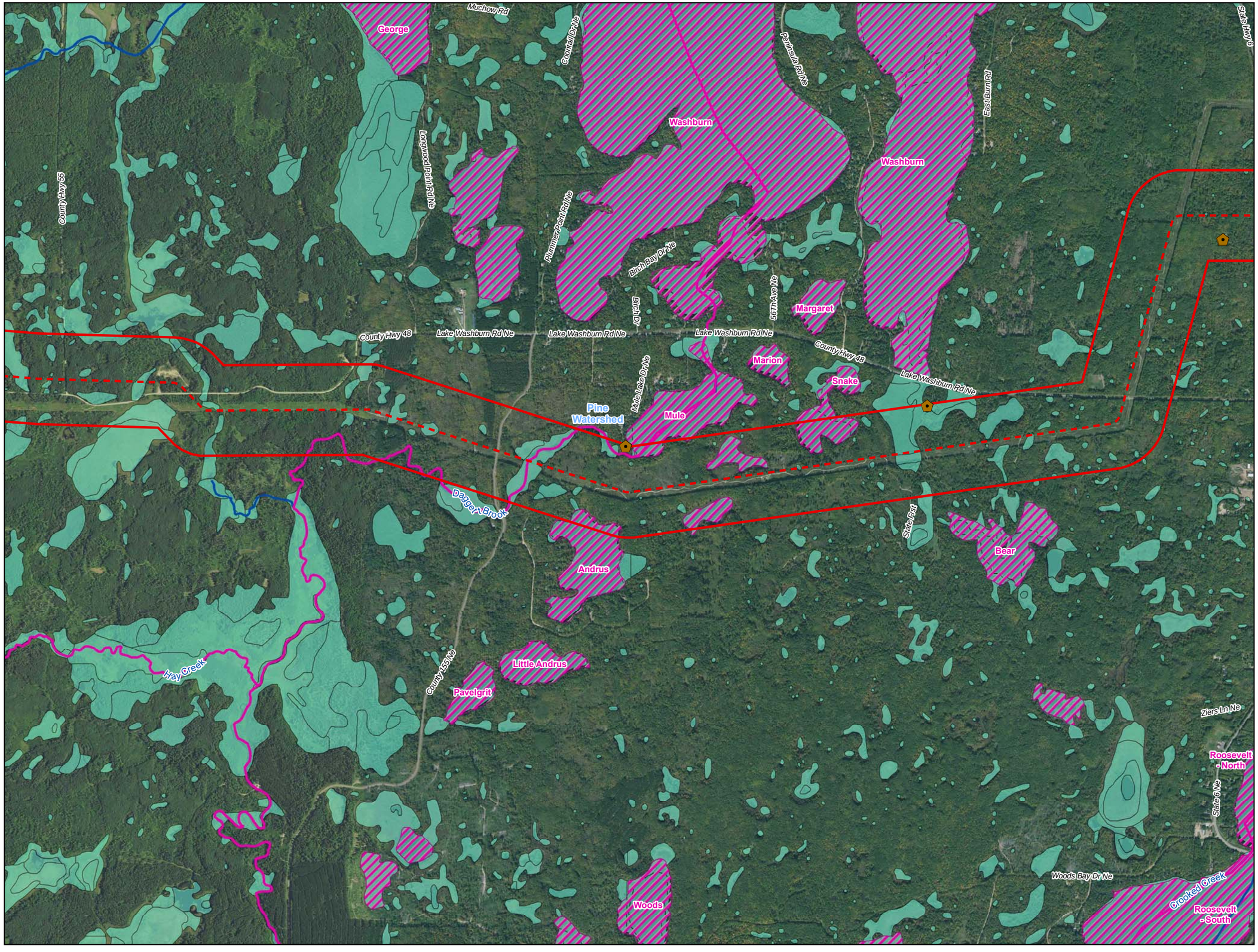



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 51

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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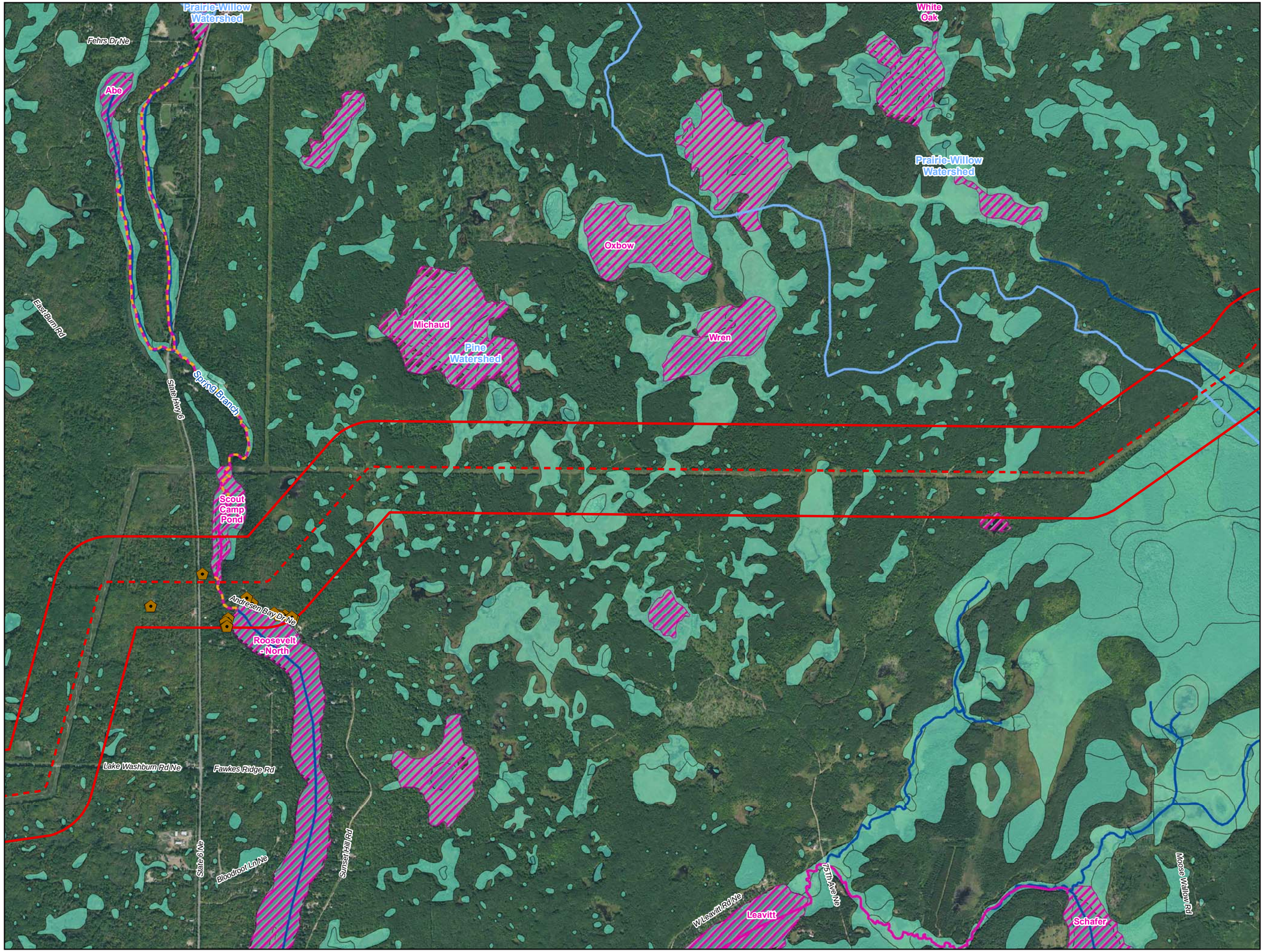



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 52

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

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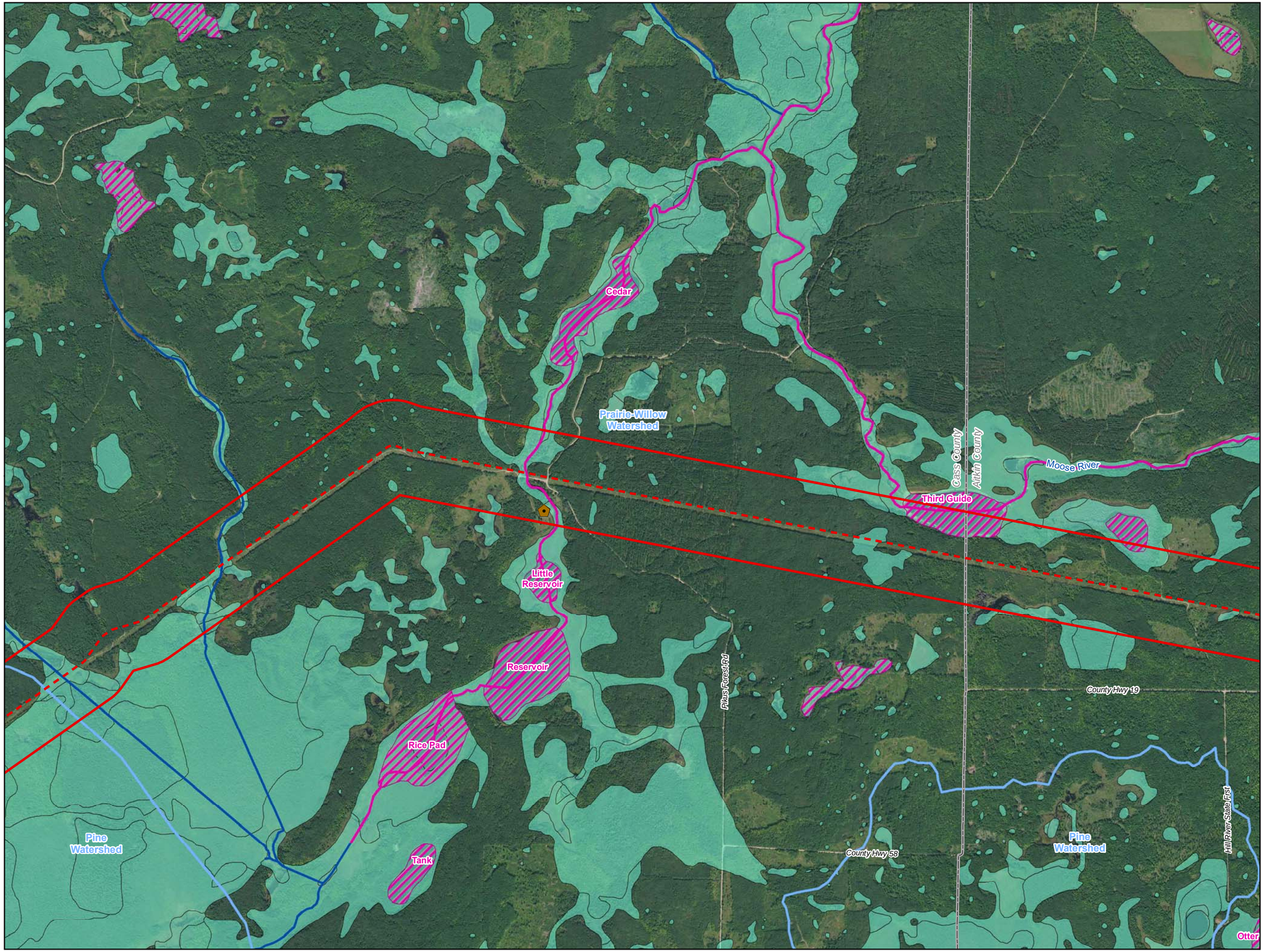



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 53

Line 3 Replacement Project

Enbridge

Cass County, Minnesota

ENBRIDGE

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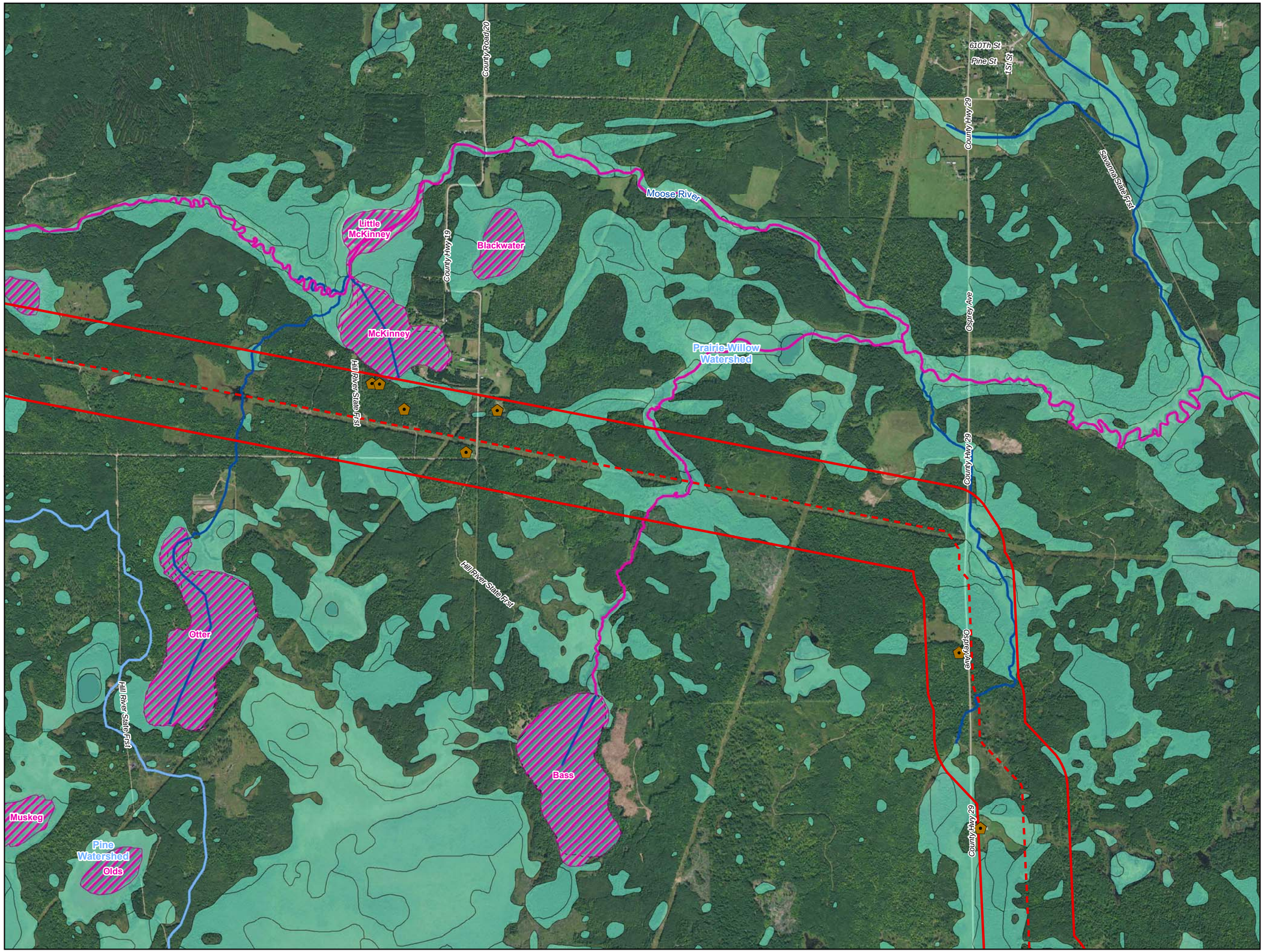



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 54

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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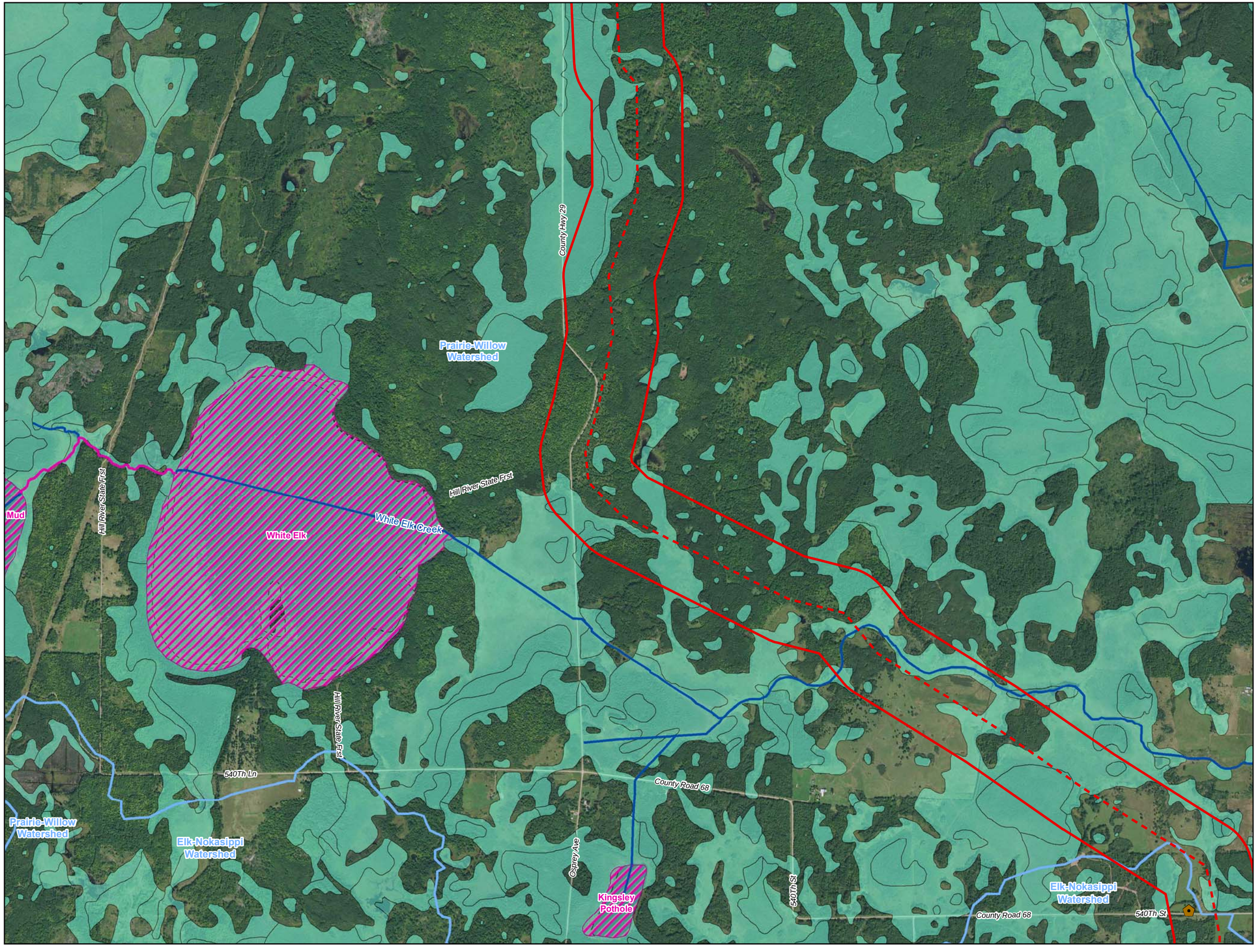



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 55

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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White Elk Creek
540Th St
County Road 68
540Th Ln
Prairie-Willow Watershed
525Th Ln
Hill River State Trl
U S Highway 169
Elk-Nokasippi Watershed
510Th Ln
Packer
Sitas
West
Baker
East
Waukenabo



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 56

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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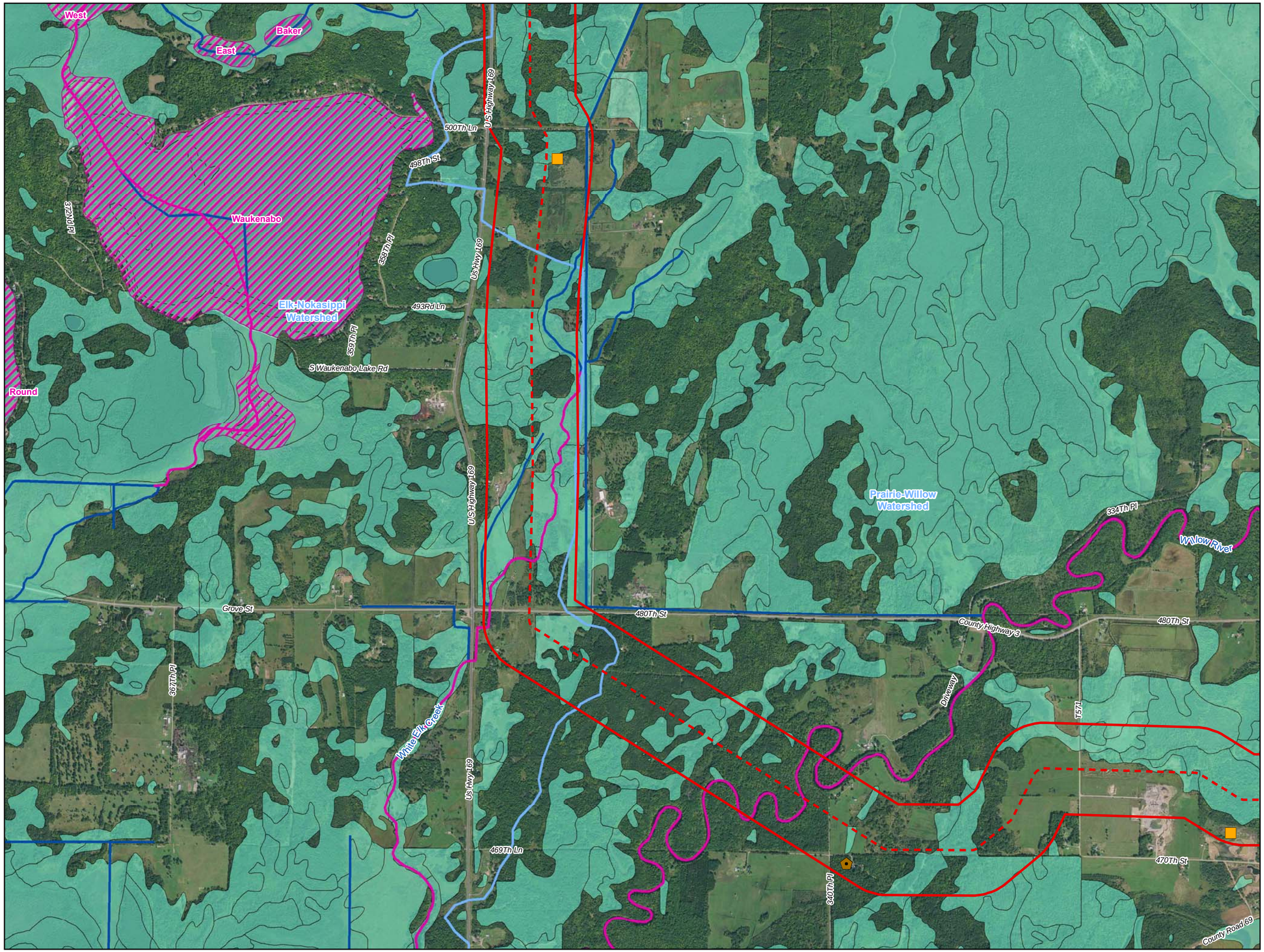



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Line 3 Replacement Milepost
- Water Well
- Surface Water Intake
- Calcareous Fen
- Proposed Line 3 Replacement Pipeline
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 57

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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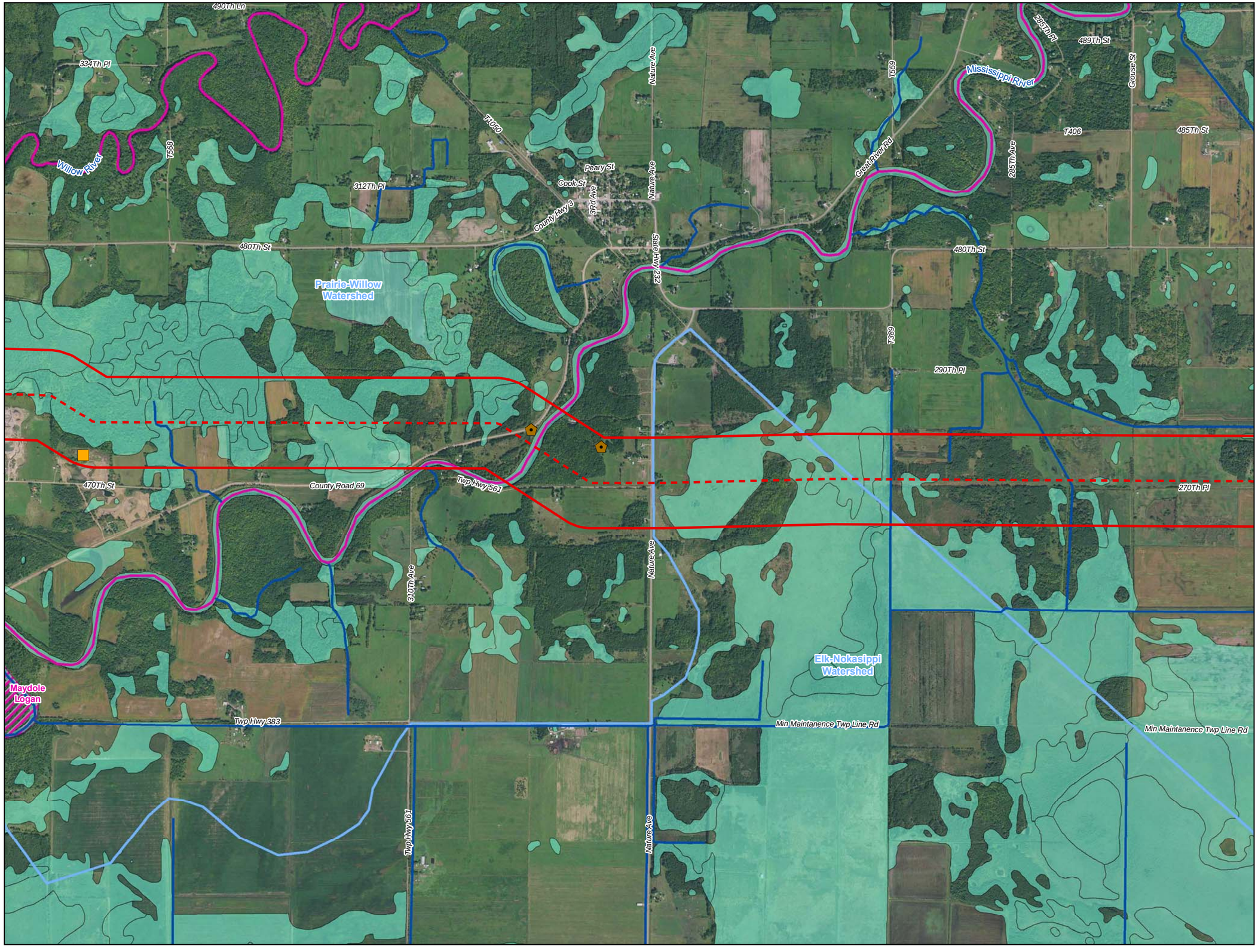
Source: Z:\Clients\E_H\Enbridge\SPP_L3ARC\GIS\2016\07\ENG_Data_Request\ENG_Data_Deliverable_L3R.mxd

Date: (9/16/2016)





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- PWI Basin
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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 58

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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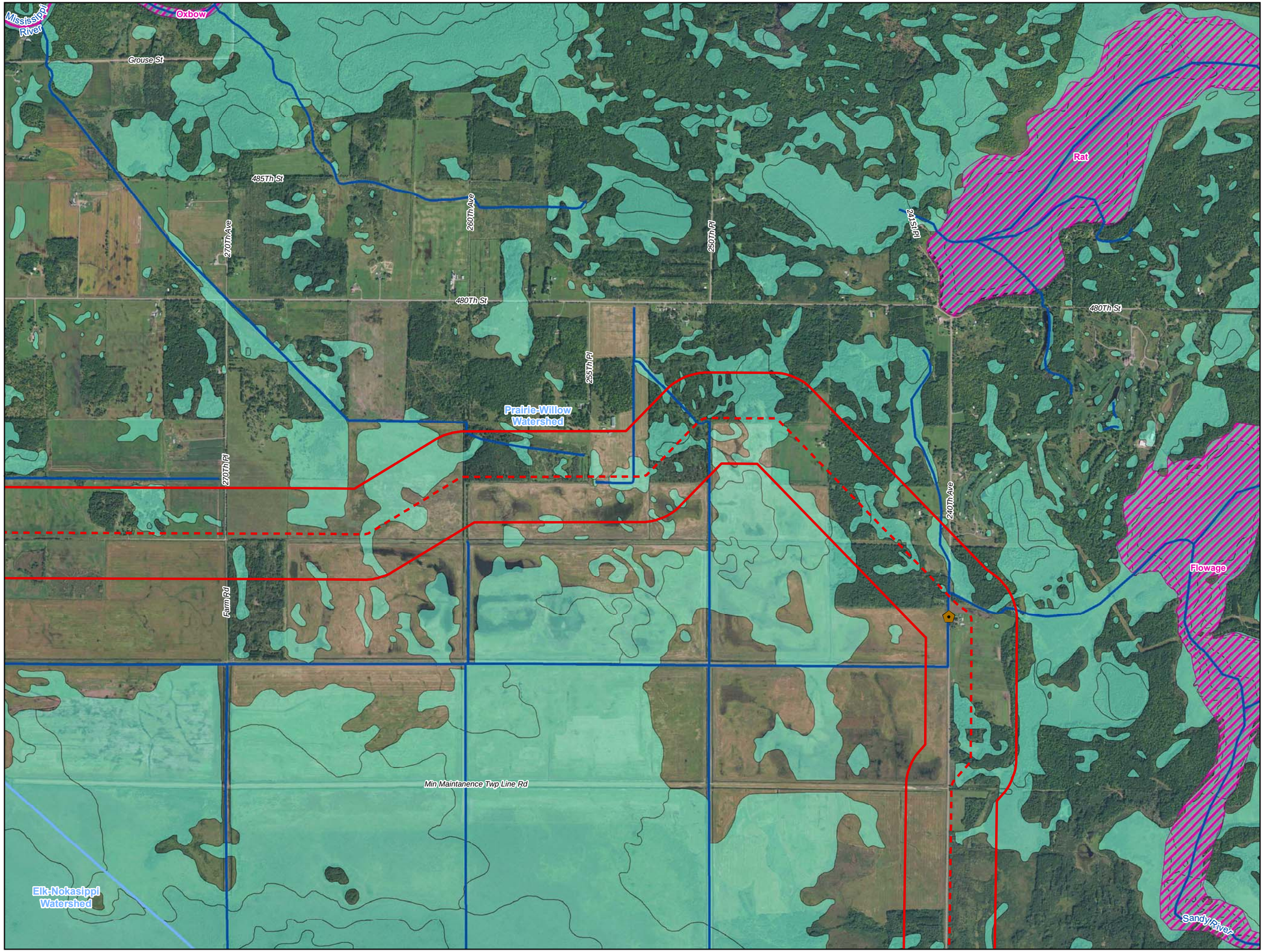
Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

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- Water Well
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- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 59

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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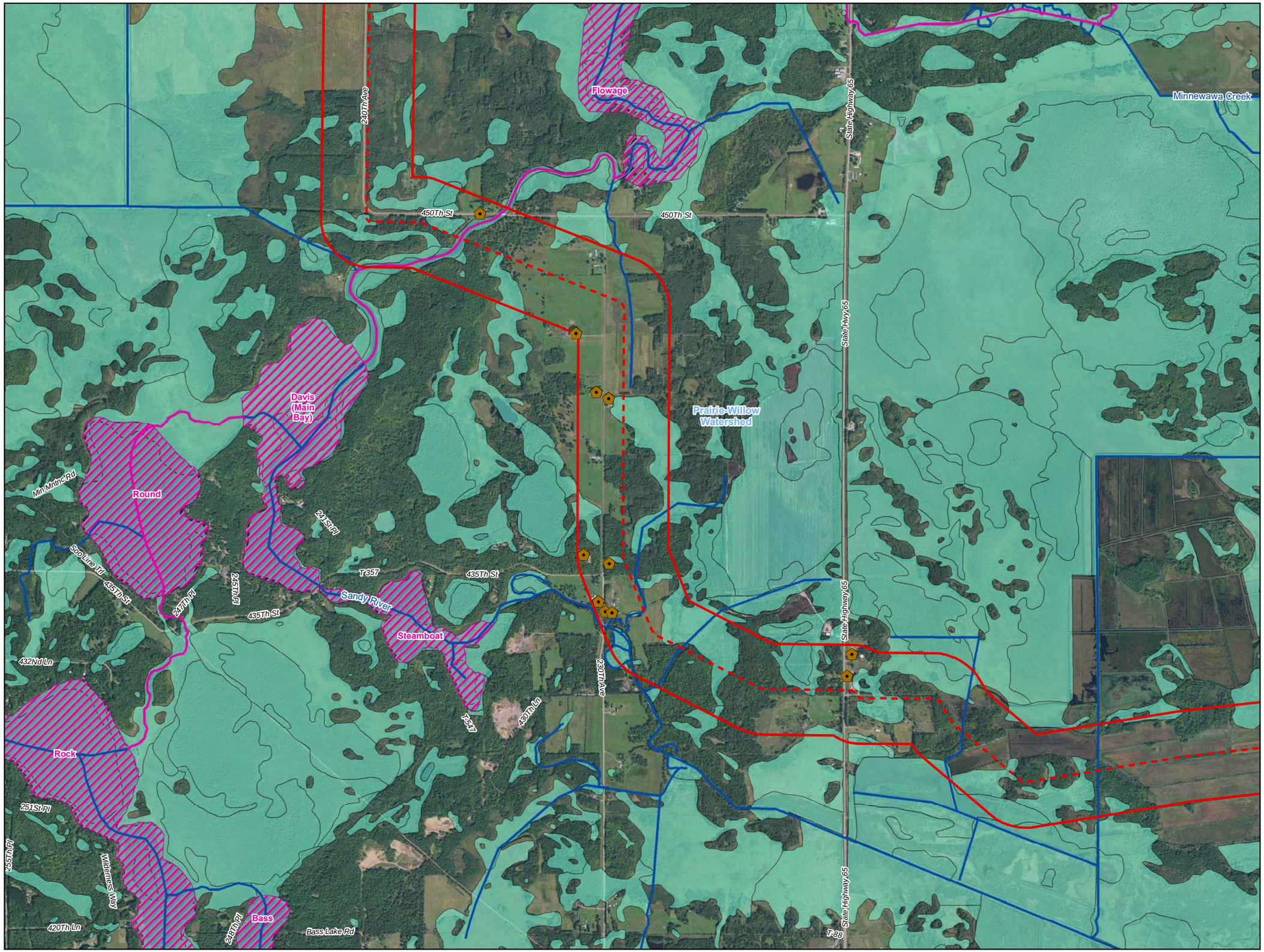
Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

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- NWI
- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 60

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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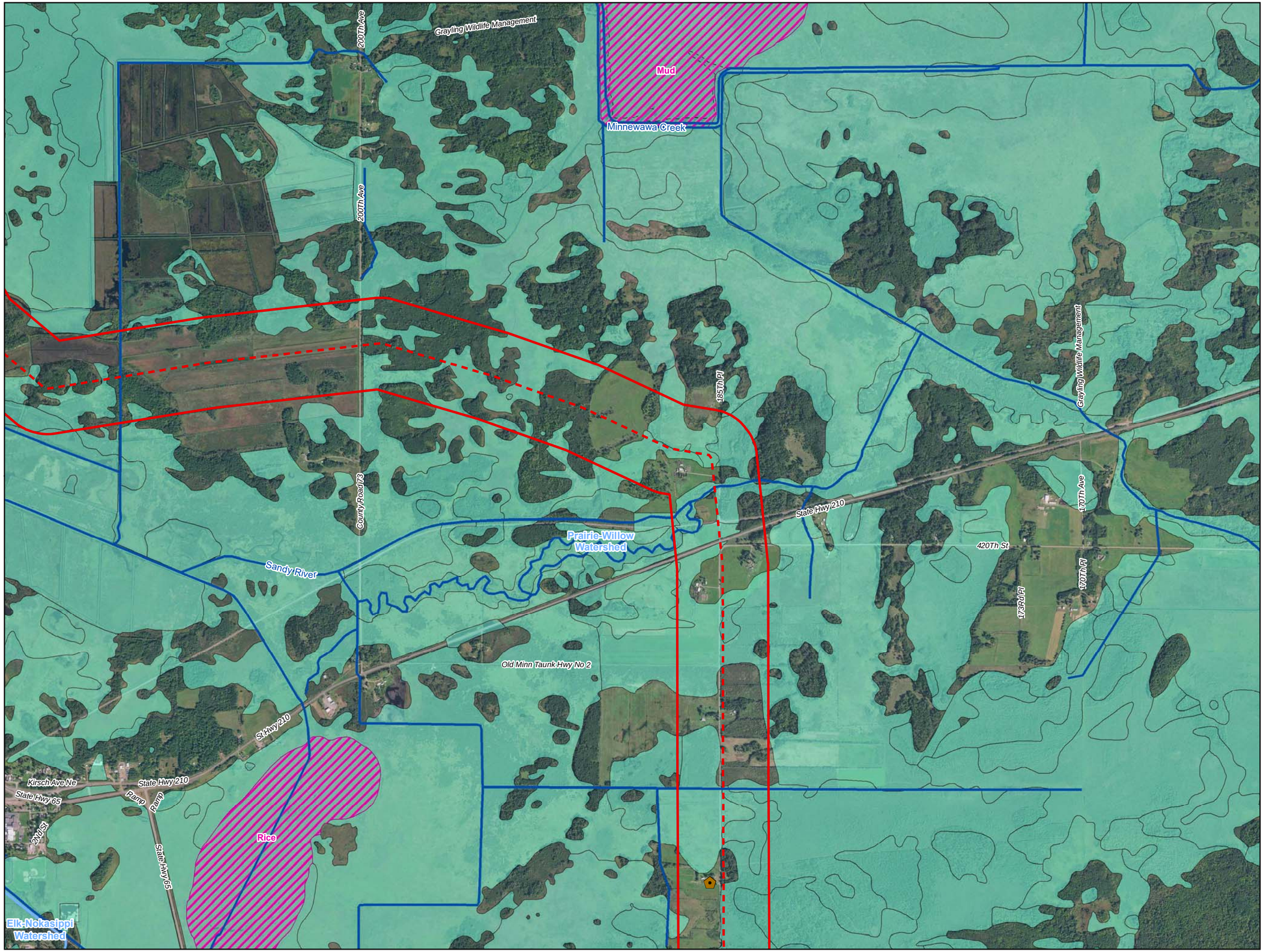
Source: Z:\Clients\E_H\Enbridge\SPP_L3A\ArcGIS\2016\07\ENG_Data_Request\ENG_Data_Deliverable_L3R.mxd
Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

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- Water Well
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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 61

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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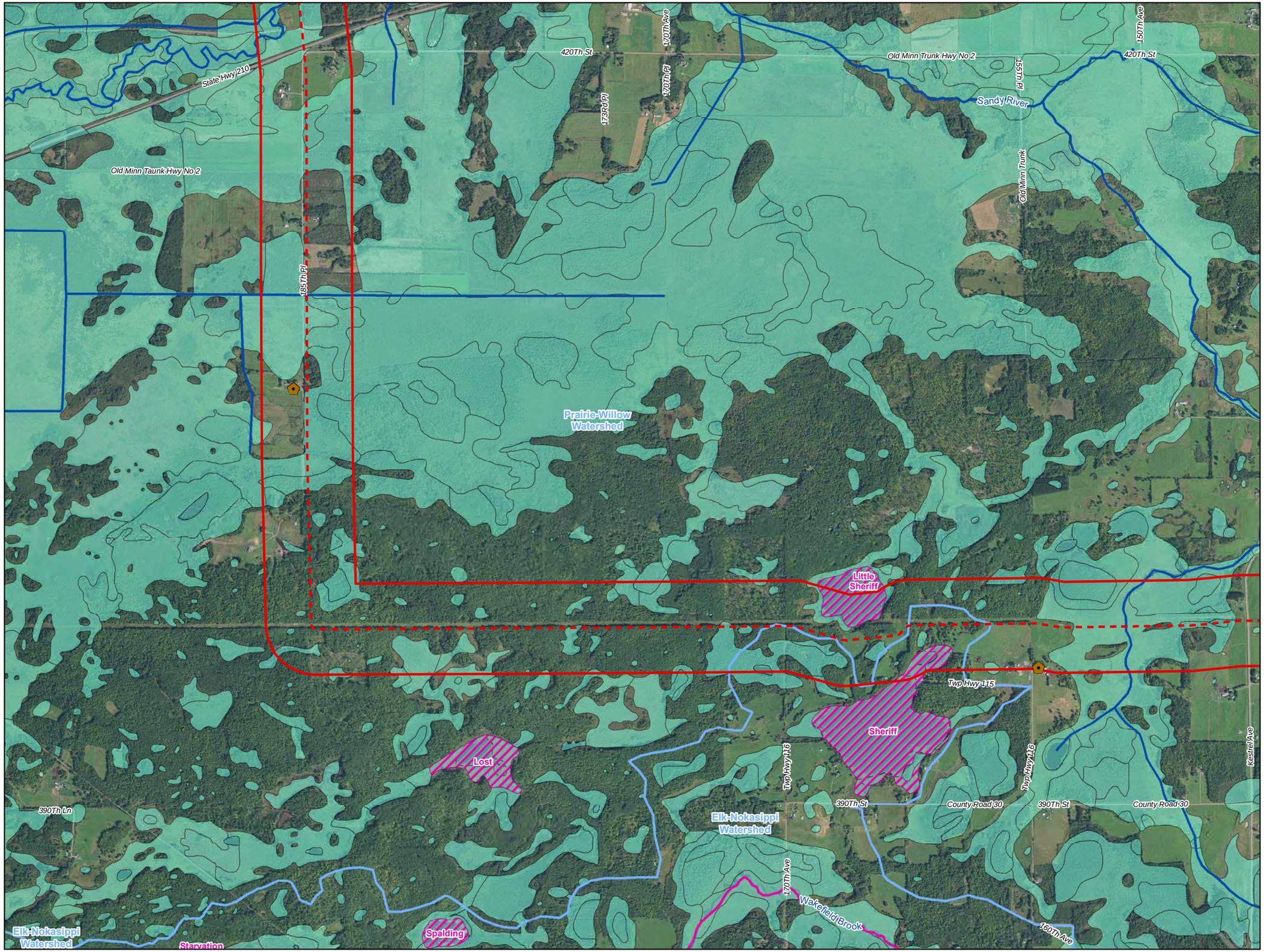
Source: Z:\Clients\E_P\Enbridge\SPP_L3rArcGIS\2016\ENG_Data_Request\ENG_Data_Deliverable_L3R.mxd

Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

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- Water Well
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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 62

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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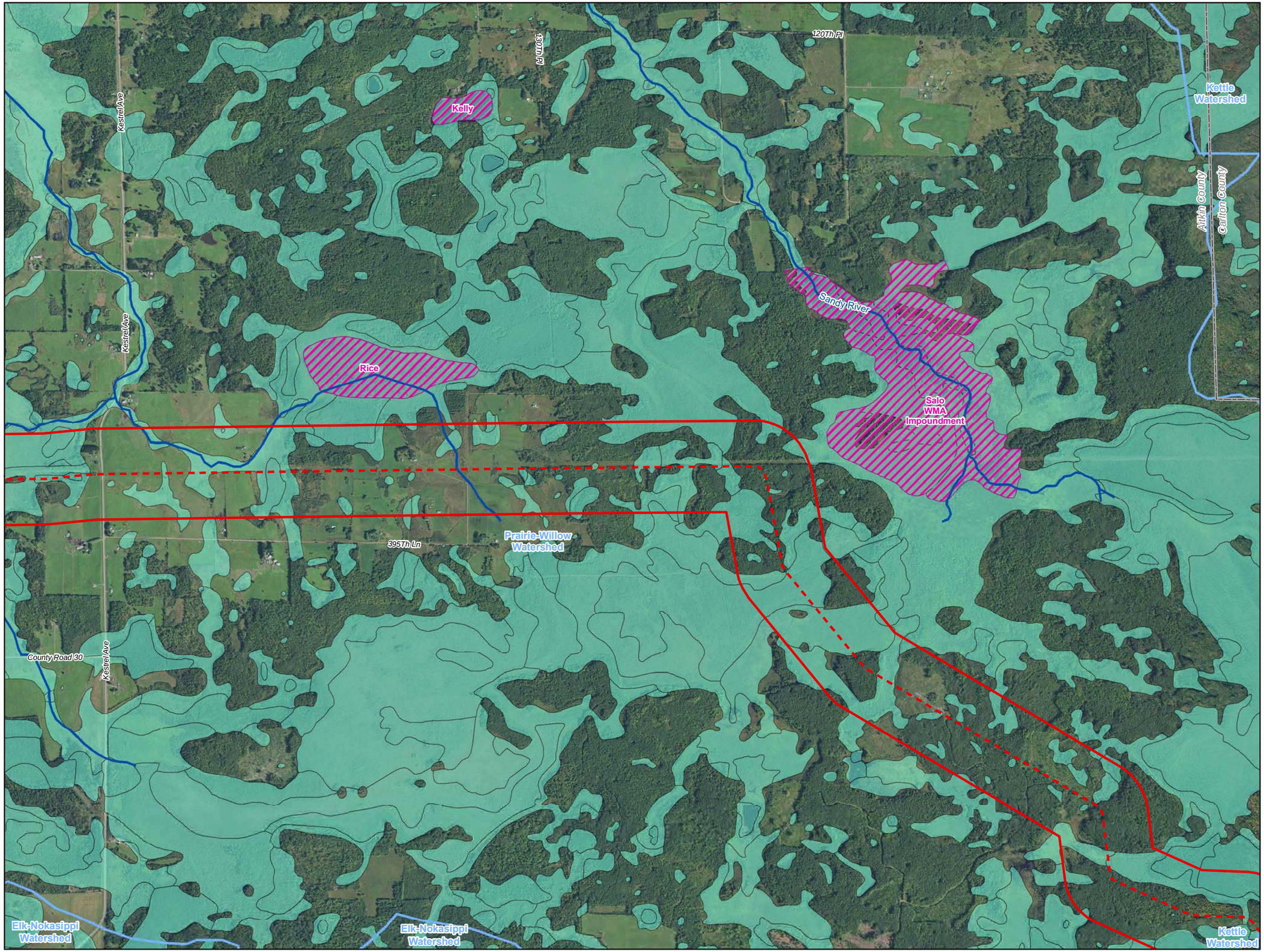



0 1,000 2,000 Feet

1 inch = 2,000 feet

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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 63

Line 3 Replacement Project

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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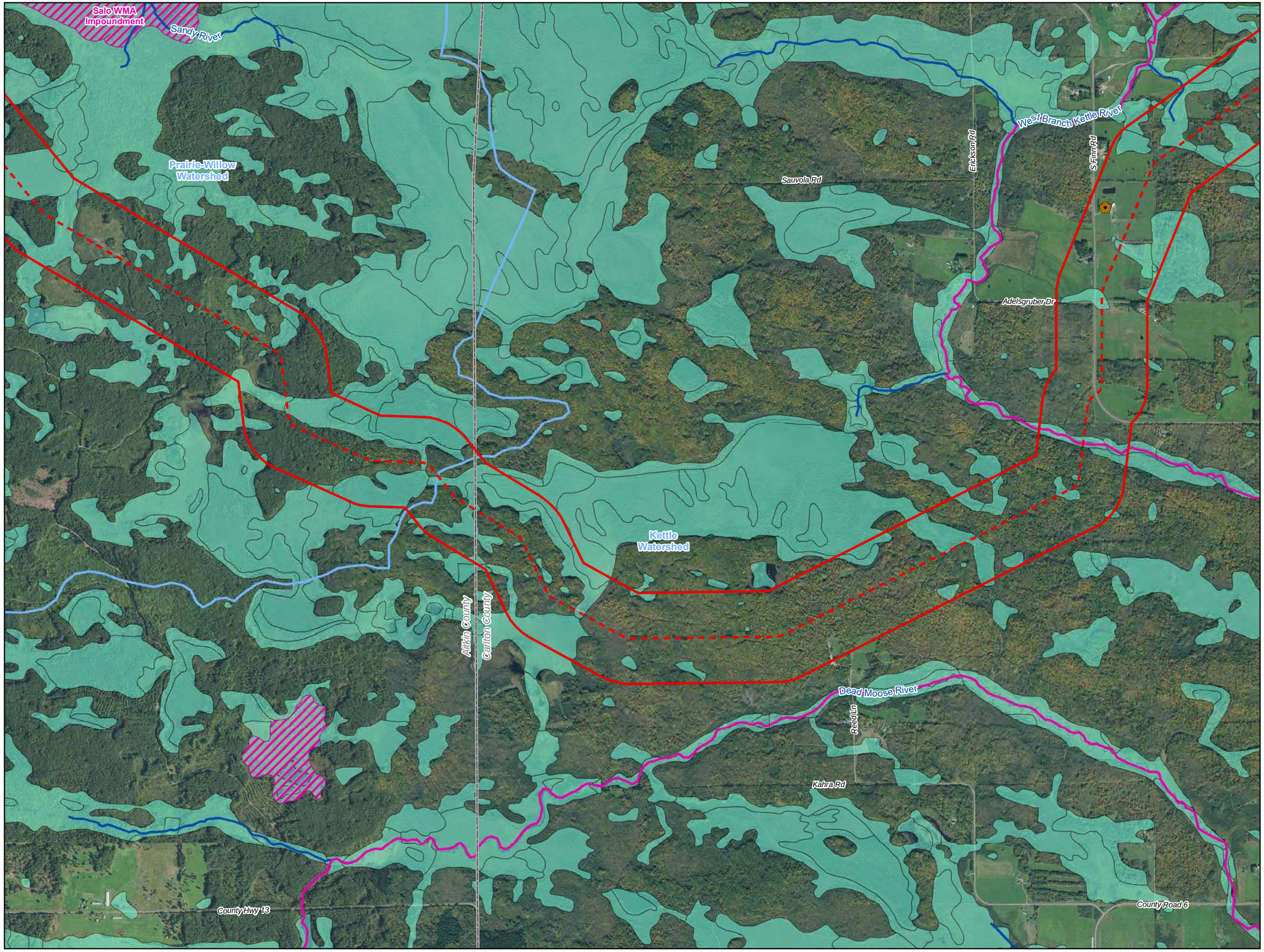
Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

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- Water Well
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- Watershed Boundary
- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 64

Line 3 Replacement Project

Enbridge

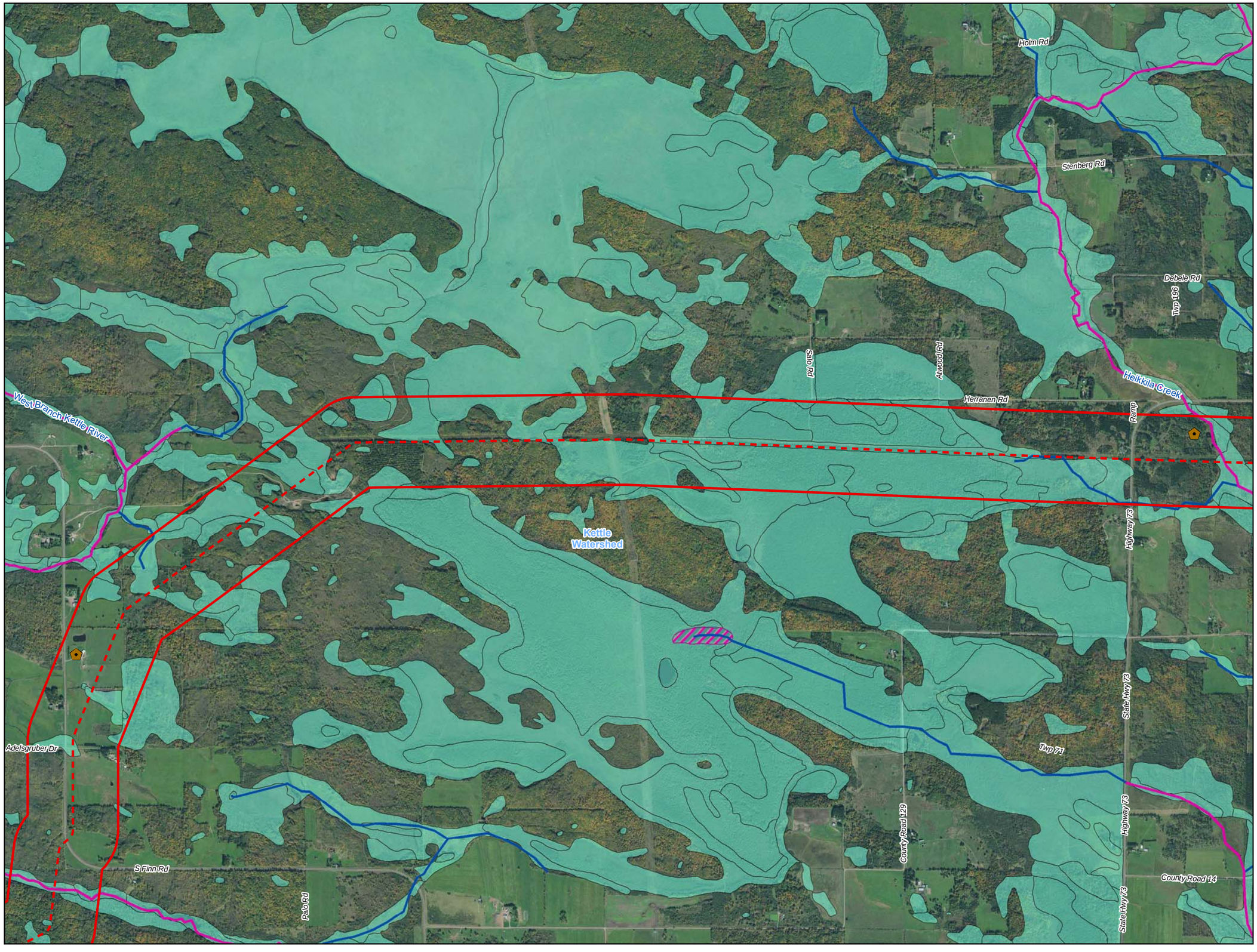
Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\SPP_L3\ArcGIS\20160707\ENG_Data_Request\ENG_Data_Deliverable_L3R.mxd

Date: (9/16/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 65

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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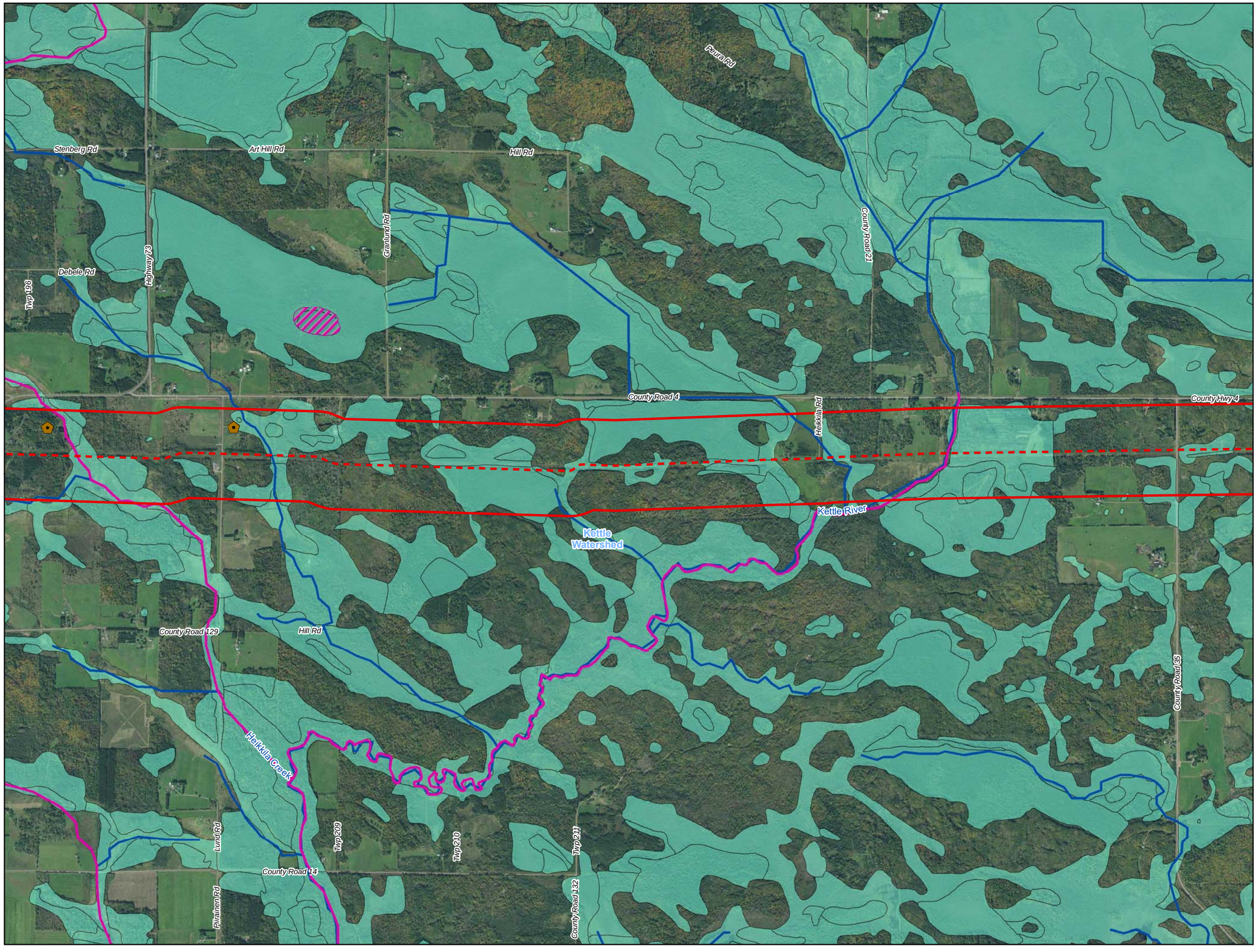
Date: (9/16/2016)





0 1,000 2,000 Feet

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N W E S

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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 66

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

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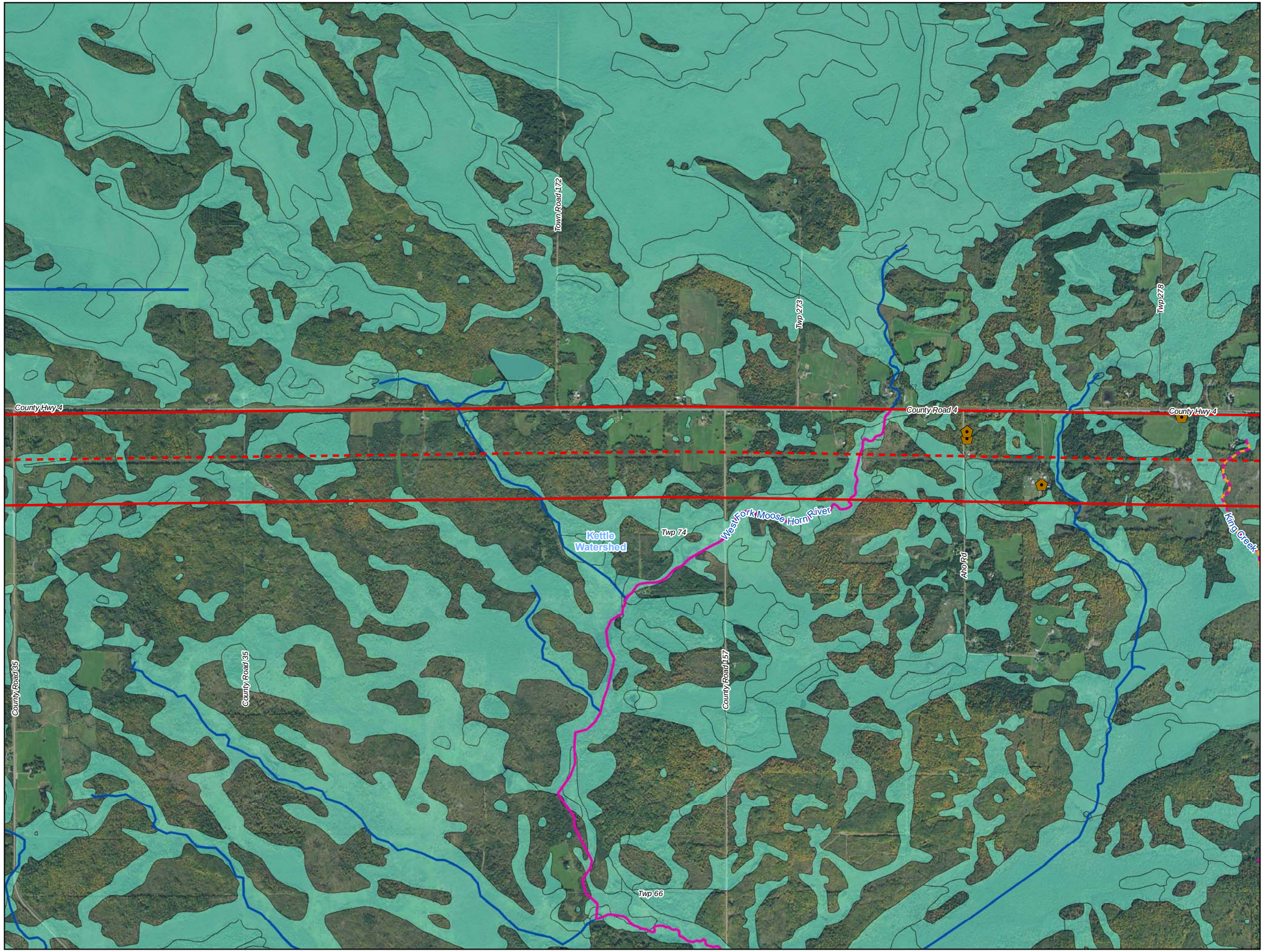
Source: Z:\Clients\E_H\Enbridge\SPP_L3\ArcGIS\20160607\ENG_Data_Request\ENG_Data_Deliverable_L3R.mxd

Date: (9/16/2016)





0 1,000 2,000 Feet

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N W E S

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- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 67

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Date: (9/16/2016)

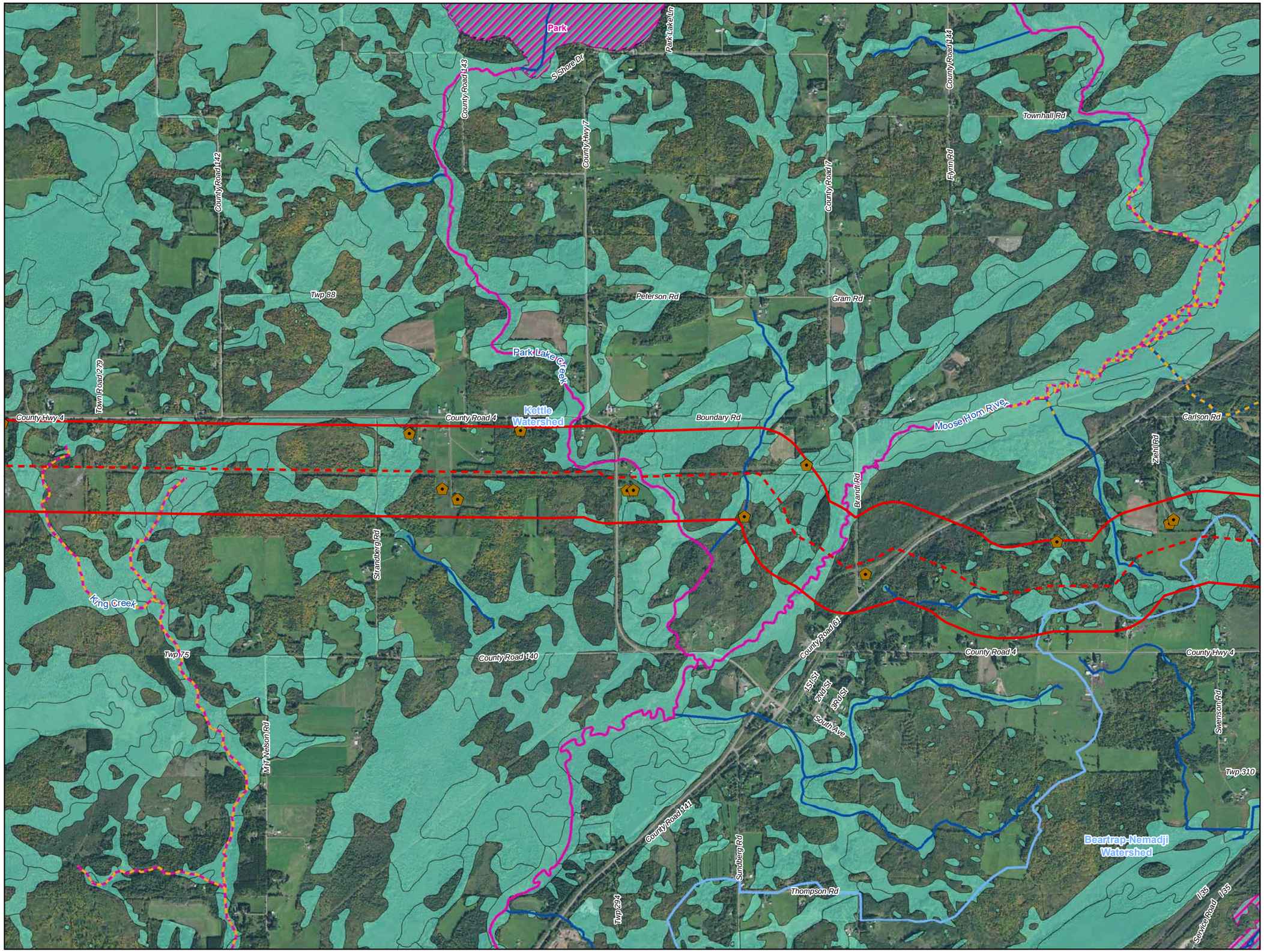

Figure 68

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

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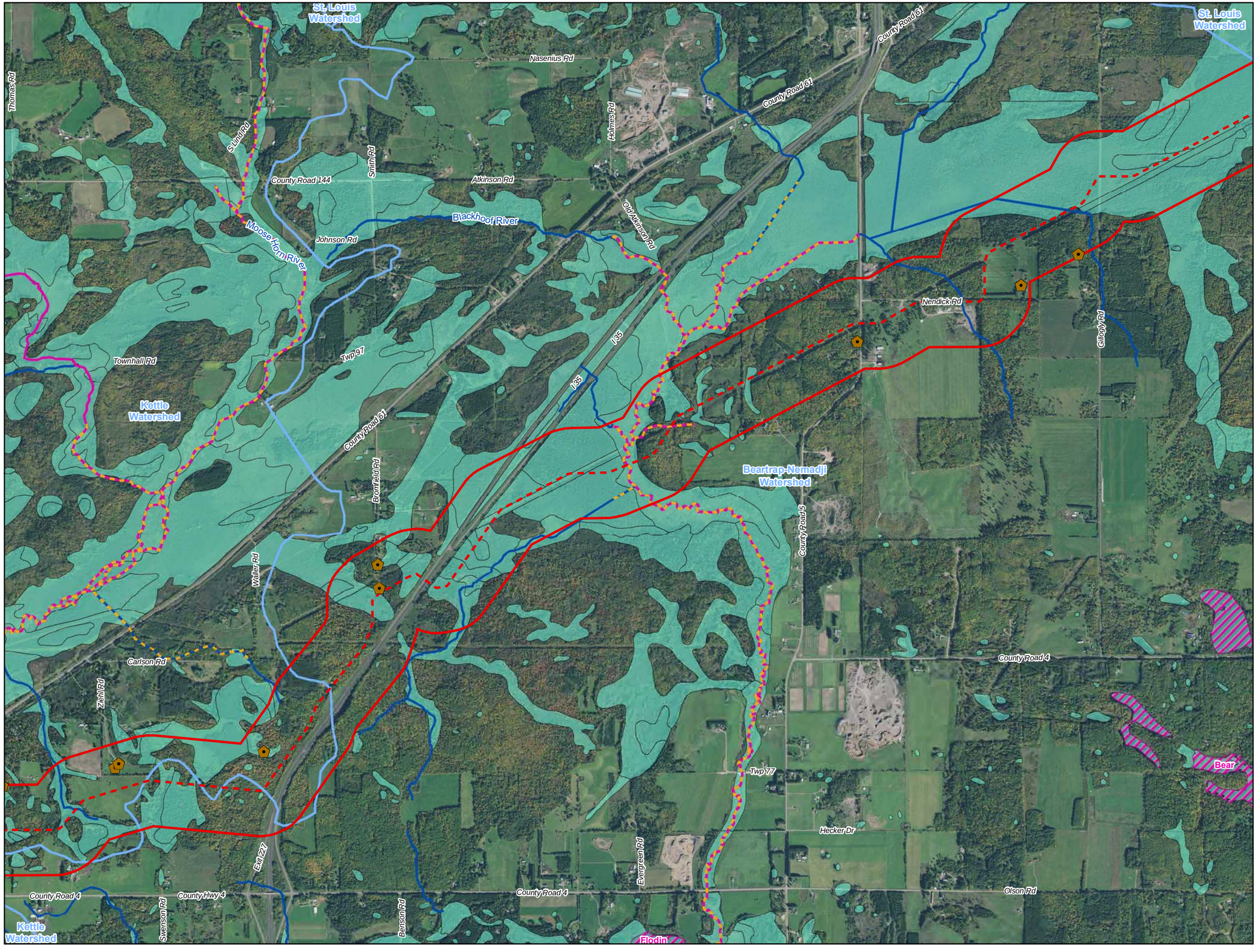



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- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 69

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

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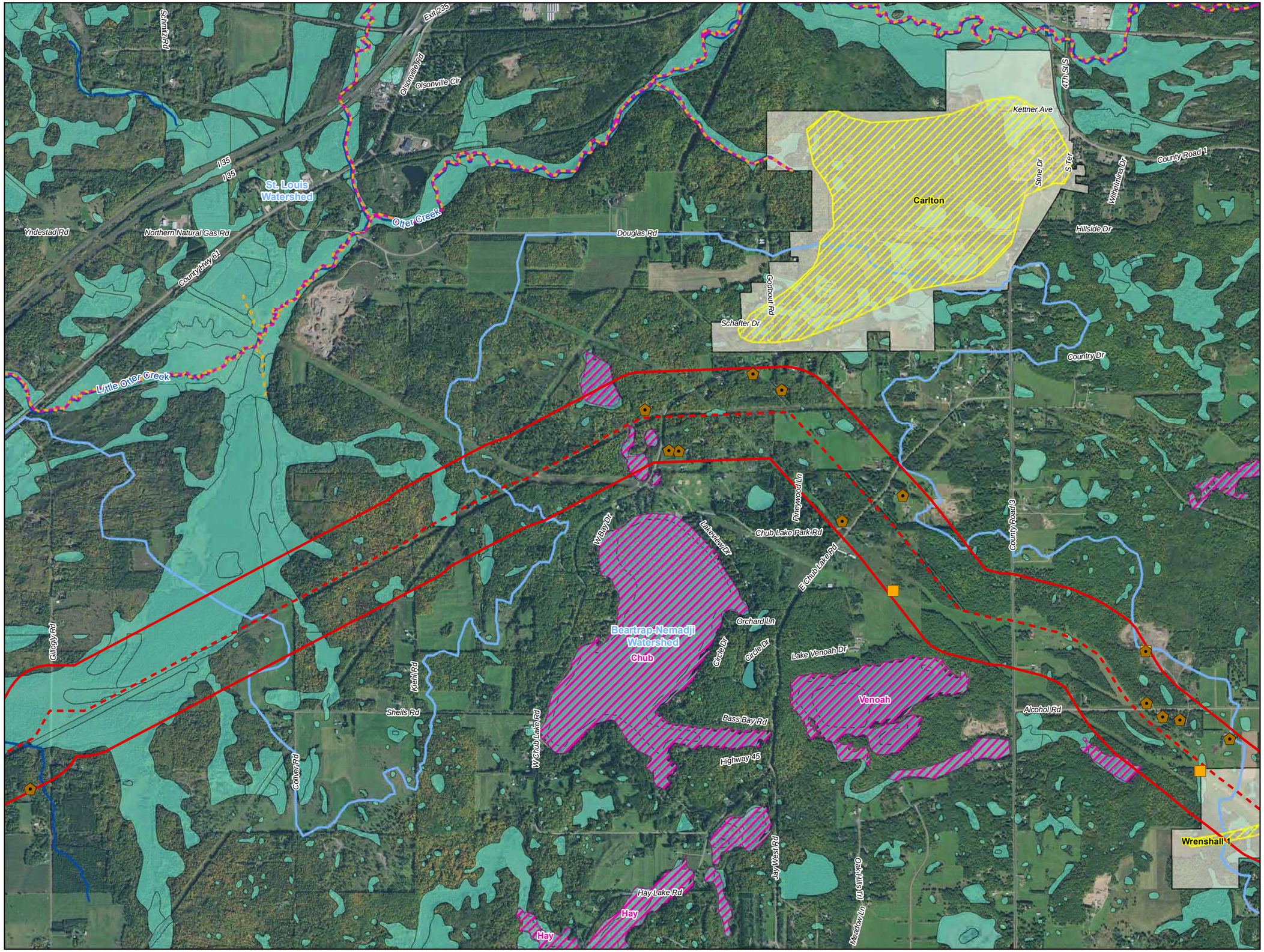
Date: (9/16/2016)





0 1,000 2,000 Feet

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N W E S

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- Calcareous Fen
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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 70

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

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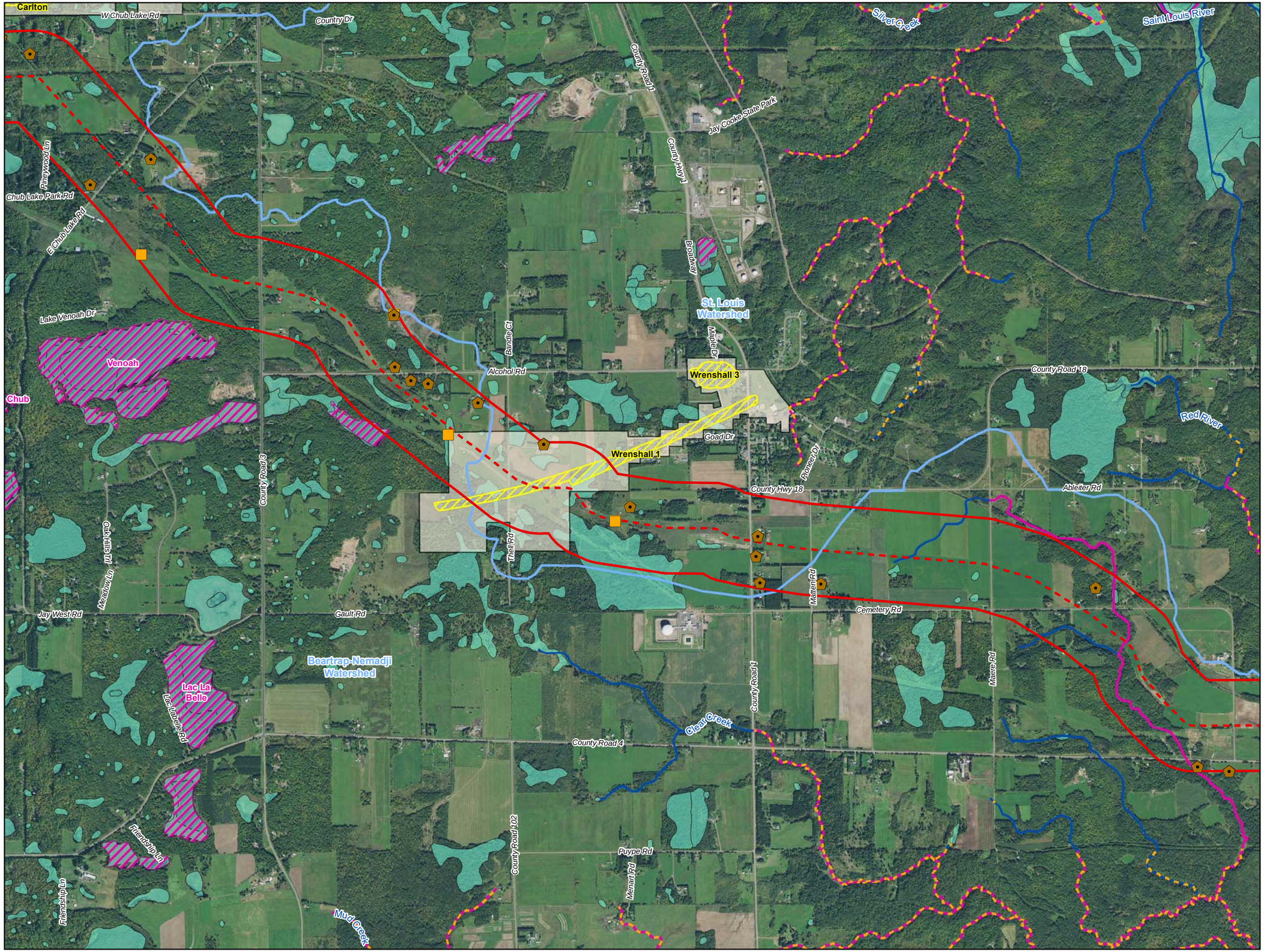
Date: (9/16/2016)





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- WHPA
- DWSMA
- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 71

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

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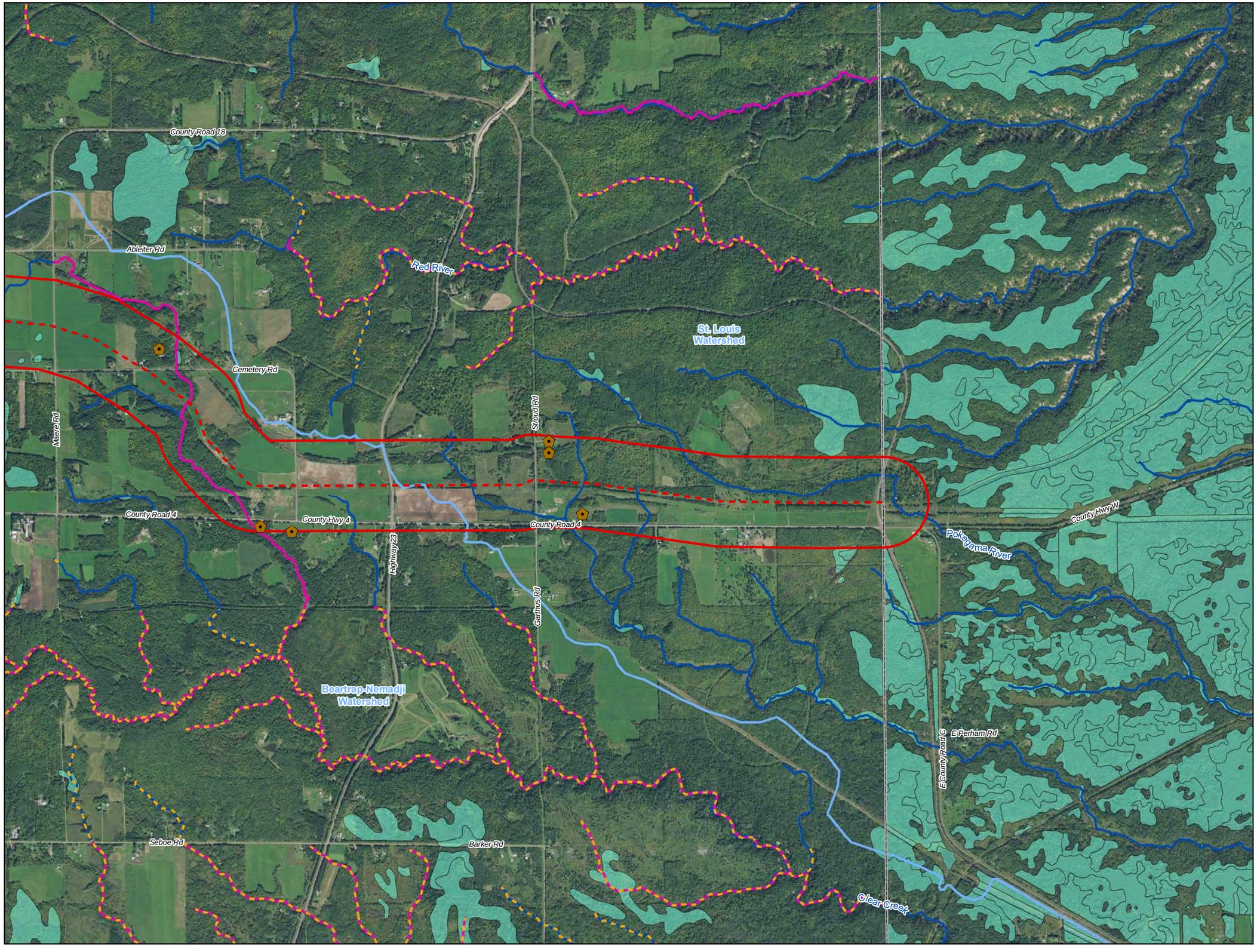
Date: (9/16/2016)





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- 2000 ft Line 3 Replacement Corridor
- County Boundary

Figure 72

Line 3 Replacement Project

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Date: (9/16/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project System Alternative (SA)-04

DRAFT

Table 1
Line 3 Replacement Project – SA-04-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed System Alternative Centerline and within the 2,000-ft-wide System Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed System Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide System Alternative Corridor** [b]
Bois De Sioux	**2**	**1.1**
Traverse	2	1.1
Mustinka	**5**	**3.8**
Stevens	2	2.3
Traverse	3	1.5
Pomme De Terre	**4**	**2.0**
Stevens	4	2.0
Chippewa	**3**	**1.8**
Chippewa	1	0.6
Stevens	1	0.8
Swift	1	0.5
Middle Minnesota	**2**	**2.7**
Blue Earth	1	1.5
Nicollet	1	1.2
Le Sueur	**5**	**6.1**
Blue Earth	2	1.9
Waseca	3	4.2
Upper Cedar	**3**	**2.1**
Freeborn	-	0.6
Mower	3	1.5
Grand Total [c]	**24**	**19.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed system alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide system alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – SA-04-L3
Summary of Waterbodies Crossed by the Proposed System Alternative Centerline and within the 2,000-ft-wide System Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed System Alternative Centerline [a]				Miles Within the 2,000-ft-wide System Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Bois De Sioux	**1**	**2**	**1**	**4**	**0.5**	**1.1**	**0.3**	**1.8**
Traverse	1	2	1	4	0.5	1.1	0.3	1.8
Mustinka	**3**	**12**	**13**	**28**	**1.1**	**7.8**	**7.6**	**16.5**
Traverse	2	5	11	18	1.0	3.9	5.9	10.7
Stevens	1	7	2	10	0.1	3.9	1.8	5.8
Pomme De Terre	**1**	**6**	**-**	**7**	**0.7**	**3.5**	**0.1**	**4.4**
Stevens	1	6	-	7	0.7	3.5	0.1	4.4
Chippewa	**5**	**29**	**1**	**35**	**2.2**	**20.0**	**0.3**	**22.6**
Chippewa	1	7	-	8	0.6	4.4	0.3	5.2
Stevens		2	1	3	-	2.5	-	2.5
Swift	4	20	-	24	1.7	13.1	-	14.8
Hawk-Yellow Medicine	**-**	**3**	**16**	**19**	-	**2.0**	**10.2**	**12.2**
Chippewa	-	2	1	3	**-**	1.4	0.9	2.3
Kandiyohi	-	1	15	16	-	0.6	9.3	10.0
South Fork Crow	**-**	**-**	**11**	**11**	-	**0.1**	**6.3**	**6.4**
Kandiyohi	-	-	1	1	**-**	0.1	0.7	0.7
Renville	-	-	10	10	-	-	5.6	5.6
Lower Minnesota	**-**	**3**	**20**	**23**	**-**	**1.7**	**12.7**	**14.5**
Nicollet	-	-	6	6	-	-	4.0	4.1
Renville	-	-	1	1	-	-	0.5	0.5
Sibley	-	3	13	16	-	1.7	8.1	9.8
Middle Minnesota	**1**	**5**	**7**	**13**	**1.4**	**7.0**	**5.1**	**13.5**
Blue Earth	-	4	-	4	**-**	5.7	-	5.7
Le Sueur	1	1	-	2	0.5	0.6	-	1.2
Nicollet	-	-	7	7	0.9	0.6	5.1	6.6
Le Sueur	**4**	**13**	**3**	**20**	**4.3**	**9.1**	**2.7**	**16.1**
Blue Earth	2	3	2	7	2.4	3.2	1.8	7.4
Freeborn	-	1	1	2	-	0.5	0.4	0.9
Waseca	2	9	-	11	1.9	5.4	0.4	7.8
Shell Rock	**-**	**2**	**6**	**8**	-	**1.2**	**3.3**	**4.5**
Freeborn	-	2	6	8	**-**	1.2	3.3	4.5
Upper Cedar	**3**	**3**	**3**	**9**	**1.4**	**2.8**	**3.3**	**7.6**
Freeborn	-	1	1	2	**-**	1.4	2.4	3.8
Mower	3	2	2	7	1.4	1.4	1.0	3.8
Grand Total [c]	**18**	**78**	**81**	**177**	**11.8**	**56.3**	**52.0**	**120.1**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed system alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide system alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – SA-04-L3
Summary of USFWS National Wetlands Inventory Crossed by the System Alternative Proposed Centerline and within the 2,000-ft-wide System Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed System Alternative Centerline [a]				Acres Within the 2,000-ft-wide System Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Bois De Sioux	**0.3**	**-**	**-**	**0.3**	**56.4**	**-**	**6.9**	**63.3**
Traverse	0.3	-	-	0.3	56.4	-	6.9	63.3
Mustinka	**0.3**	**-**	**0.1**	**0.4**	**80.8**	**9.0**	**6.9**	**96.7**
Stevens	0.2	-	-	0.2	43.3	5.6	2.0	50.8
Traverse	0.1	-	-	0.2	37.5	3.5	5.0	45.9
Pomme De Terre	**0.5**	**-**	**0.1**	**0.5**	**156.7**	**0.1**	**44.0**	**200.8**
Stevens	0.5	-	0.1	0.5	156.7	0.1	44.0	200.8
Chippewa	**1.1**	**0.2**	**-**	**1.3**	**222.4**	**45.7**	**8.2**	**276.2**
Chippewa	0.3	0.1	-	0.3	68.9	17.1	-	86.0
Stevens	-	-	-	0.1	6.2	-	0.2	6.4
Swift	0.7	0.2	-	0.9	147.3	28.5	8.0	183.8
Hawk-Yellow Medicine	**0.6**	**-**	**-**	**0.6**	**100.1**	**1.7**	**-**	**101.8**
Chippewa	-	-	-	-	11.0	0.3	-	11.2
Kandiyohi	0.6	-	-	0.6	89.1	1.4	-	90.5
South Fork Crow	**0.6**	**-**	**-**	**0.6**	**142.3**	**-**	**-**	**142.3**
Kandiyohi	0.4	-	-	0.4	81.8	-	-	81.8
Renville	0.2	-	-	0.2	60.5	-	-	60.5
Lower Minnesota	**0.6**	**-**	**0.2**	**0.8**	**159.1**	**-**	**58.3**	**217.4**
Nicollet	-	-	-	-	40.2	-	-	40.2
Renville	0.1	-	-	0.1	49.3	-	0.4	49.7
Sibley	0.4	-	0.2	0.7	69.6	-	57.9	127.5
Middle Minnesota	**1.0**	**0.4**	**0.1**	**1.4**	**151.2**	**123.4**	**52.3**	**327.0**
Blue Earth	0.9	-	-	0.9	116.7	5.9	0.2	122.8
Le Sueur	0.1	0.1	0.1	0.3	9.2	50.1	46.0	105.3
Nicollet	-	0.2	-	0.2	25.3	67.5	6.2	98.9
Le Sueur	**0.7**	**-**	**-**	**0.7**	**175.1**	**31.3**	**3.2**	**209.6**
Blue Earth	0.5	-	-	0.5	126.0	16.8	-	142.9
Freeborn	-	-	-	-	0.2	-	-	0.2
Waseca	0.2	-	-	0.2	48.8	14.4	3.2	66.5
Shell Rock	**-**	**-**	**-**	**-**	**2.0**	**-**	**-**	**2.0**
Freeborn	-	-	-	-	2.0	-	-	2.0
Upper Cedar	**-**	**-**	**-**	**0.1**	**11.1**	**2.3**	**5.5**	**18.9**
Freeborn	-	-	-	-	2.8	-	0.9	3.7
Mower	-	-	-	-	8.3	2.3	4.6	15.2
Grand Total [d]	**5.6**	**0.6**	**0.5**	**6.7**	**1257.1**	**213.5**	**185.5**	**1656.0**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed system alternative centerline.

b Total acres of NWI within the 2000-ft-wide system alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – SA-04-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed System Alternative Centerline and within the 2,000-ft-wide System Alternative Corridor in Minnesota

Watershed / County	Miles Crossed by the System Alternative Centerline [a]		Acres Within the System Alternative Corridor [b]	
	Wetlands	Basins	Wetlands	Basins
Mustinka	-	**0.1**	**-**	**25.8**
Stevens	-	0.1	-	25.8
Pomme De Terre	-	**-**	**-**	**66.0**
Stevens	-	-	-	66.0
Chippewa	-	**-**	**-**	**14.2**
Chippewa	-	-	-	14.2
Hawk-Yellow Medicine	**-**	**-**	**11.0**	**0.7**
Chippewa	-		11.0	
Kandiyohi	-	-	-	0.7
Lower Minnesota	-	**0.3**	**-**	**63.0**
Sibley	-	0.3	-	63.0
Middle Minnesota	**-**	**-**	**11.0**	**-**
Nicollet	-	-	11.0	-
Le Sueur	**0.2**	**-**	**24.0**	**-**
Waseca	0.2	-	24.0	-
Grand Total [c]	**0.2**	**0.3**	**46.0**	**169.7**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the system alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide system alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5 Line 3 Replacement Project – SA-04-L3 Wells within the 2,000-ft-wide System Alternative Corridor in Minnesota[a]				
Watershed Name	**County**	**Well Type**	**Distance from Centerline (feet)**	**Total Number of Wells**
Bois De Sioux	Traverse	Domestic	432	1
Mustinka	Traverse	Domestic	252	2
			611	
	Stevens	Domestic	482	3
			422	
			133	
Pomme De Terre	Stevens	Domestic	551	7
			757	
			839	
			95	
			444	
			167	
			802	
Chippewa	Stevens	Domestic	457	3
			884	
			992	
		Irrigation	706	1
	Swift	Domestic	532	7
			862	
			658	
			638	
			62	
			381	
			368	
		Industrial	591	1
		Irrigation	385	2
			910	
		Observation	717	1
	Chippewa	Domestic	384	1
Hawk-Yellow Medicine	Kandiyohi	Abandoned	998	2
			730	
		Domestic	732	8
			442	
			253	
			69	
			715	
			549	
			707	
			201	
		Other	69	1
South Fork Crow	Kandiyohi	Domestic	863	2

South Fork Crow (cont.)	Kandiyohi (cont.)	Domestic (cont.)	531	2 (cont.)
		Test Well	861	2
			866	
	Renville	Domestic	748	1
Hawk-Yellow Medicine	Renville	Domestic	868	2
			873	
South Fork Crow	Renville	Domestic	84	10
			84	
			532	
			672	
			39	
			39	
			716	
			644	
			45	
			382	
		Irrigation	583	1
Lower Minnesota	Renville	Domestic	561	2
			685	
	Sibley	Domestic	825	11
			208	
			700	
			166	
			997	
			44	
			274	
			291	
			861	
			476	
			11	
		Unknown	123	1
	Nicollet	Domestic	255	6
			804	
			856	
			840	
			57	
			605	
		Other	785	1
		Unknown	16	9
			869	
			825	
			905	
			801	
			982	
			891	

Lower Minnesota (cont.)	Nicollet (cont.)	Unknown (cont.)	810	9 (cont.)
			617	
Middle Minnesota	Nicollet	Domestic	82	13
			996	
			801	
			355	
			530	
			636	
			937	
			601	
			944	
			633	
			522	
			239	
			397	
		Unknown	36	10
			428	
			327	
			976	
			436	
			666	
			42	
			486	
			530	
			861	
	Le Sueur	Domestic	1	1
		Monitoring	288	1
	Blue Earth	Domestic	391	9
			444	
			825	
			705	
			484	
			50	
			907	
			362	
			278	
		Irrigation	764	1
Le Sueur	Blue Earth	Domestic	683	12
			240	
			619	
			654	
			550	
			854	
			999	
			547	
			747	
			201	

Le Sueur (cont.)	Blue Earth (cont.)	Domestic (cont.)	713	12 (cont.)
			756	
		Test Well	52	1
	Waseca	Domestic	998	6
			553	
			404	
			184	
			500	
			329	
	Freeborn	Domestic	946	5
			641	
			784	
			873	
			190	
		Test Well	690	1
Shell Rock	Freeborn	Domestic	870	3
			185	
			622	
Upper Cedar	Freeborn	Domestic	593	4
			98	
			673	
			712	
Shell Rock	Freeborn	Domestic	923	1
Upper Cedar	Freeborn	Domestic	618	1
	Mower	Abandoned	366	7
			85	
			938	
			404	
			398	
			320	
			338	
		Domestic	304	13
			703	
			682	
			946	
			669	
			932	
			62	
			755	
			424	
			280	
			897	
			335	
			663	
		Irrigation	654	2
			615	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

[a] Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – SA-04-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed System Alternative Centerline and within the 2,000-ft-wide System Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the System Alternative Centerline [b]	Acres Within the System Alternative Corridor [c]
Hawk-Yellow Medicine	Kandiyohi	1454+00	Raymond 5 DWSMA	-	0.1
Le Sueur	Blue Earth	2903+00	Eagle Lake DWSMA	-	26.2
Upper Cedar	Mower	3970+00	Lyle WHPA	0.5	138.2
		3972+00	Lyle DWSMA	0.8	182.3

DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest system alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the system alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide system alternative corridor.

Table 7
Line 3 Replacement Project – SA-04-L3
Surface Water Intakes within the 2,000-ft-wide System, Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Mustinka	Stevens	Individual Permit	Inactive	1
Pomme De Terre	Stevens	Individual Permit	Active	1
			Inactive	2
Chippewa	Stevens	Individual Permit	Active	2
	Swift	Individual Permit	Active	6
			Inactive	2
Lower Minnesota	Sibley	Individual Permit	Inactive	1
Middle Minnesota	Le Sueur	Individual Permit	Inactive	1
	Blue Earth	Individual Permit	Active	4
			Inactive	2
Le Sueur	Blue Earth	Individual Permit	Inactive	3
	Waseca	General Permit Authorization	Inactive	2
Upper Cedar	Freeborn	Individual Permit	Inactive	1
	Mower	Individual Permit	Active	2

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Alternative (RA)-03AM

DRAFT

Table 1
Line 3 Replacement Project – RA-03AM-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Crow Wing	**6**	**5.7**
Wadena	5	4.7
Todd	1	1.0
Redeye	**3**	**3.0**
Wadena	3	3.0
Long Prairie	**2**	**2.1**
Todd	2	2.1
Elk-Nokasippi	**3**	**2.5**
Morrison	3	2.5
Platte-Spunk	**3**	**3.0**
Morrison	3	3.0
Rum	**7**	**9.3**
Morrison	1	0.6
Benton	3	6.7
Mille Lacs	3	2.1
Snake	**12**	**8.7**
Kanabec	7	5.9
Pine	5	2.8
Kettle	**5**	**6.9**
Pine	3	1.7
Carlton	2	5.1
Grand Total [c]	**41**	**41.2**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RA-03AM-L3
Summary of Waterbodies Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Crow Wing	**6**	**5**	**4**	**15**	**5.1**	**3.0**	**2.0**	**10.1**
Wadena	1	1	1	3	0.9	0.6	0.3	1.7
Todd	5	4	3	12	4.2	2.4	1.7	8.3
Redeye	**5**	**3**	**4**	**12**	**3.9**	**3.0**	**1.9**	**8.9**
Wadena	5	3	4	12	3.9	3.0	1.9	8.9
Long Prairie	**2**	**3**	**2**	**7**	**2.2**	**1.2**	**1.1**	**4.4**
Todd	2	3	2	7	2.2	1.2	1.1	4.4
Elk-Nokasippi	**4**	**3**	**1**	**8**	**2.6**	**2.4**	**0.5**	**5.5**
Morrison	4	3	1	8	2.6	2.4	0.5	5.5
Platte-Spunk	**3**	**6**	**6**	**15**	**2.5**	**4.0**	**6.9**	**13.4**
Morrison	3	6	6	15	2.5	4.0	6.9	13.4
Rum	**5**	**9**	**6**	**20**	**5.9**	**8.1**	**4.5**	**18.5**
Morrison	-	1	3	4	-	2.6	1.8	4.3
Benton	2	3	-	5	3.5	2.6	0.3	6.4
Mille Lacs	3	5	3	11	2.4	2.9	2.5	7.8
Snake	**10**	**3**	**7**	**20**	**7.4**	**1.6**	**2.8**	**11.9**
Mille Lacs	-	1	-	1	-	0.5	-	0.5
Kanabec	6	1	5	12	5.2	0.7	2.0	7.9
Pine	4	1	2	7	2.2	0.4	0.8	3.5
Kettle	**5**	**15**	**7**	**27**	**7.3**	**10.9**	**4.7**	**22.9**
Pine	3	13	6	22	2.3	9.1	4.3	15.7
Carlton	2	2	1	5	5.0	1.8	0.4	7.2
Grand Total [c]	**40**	**47**	**37**	**124**	**36.9**	**34.2**	**24.4**	**95.6**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RA-03AM-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Alternative Proposed Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Crow Wing	**1.3**	**1.9**	**-**	**3.3**	**457.0**	**764.4**	**18.2**	**1239.6**
Hubbard	-	-	-	-	0.4	---		0.4
Todd	0.4	0.7	-	1.2	190.8	269.6	5.0	465.5
Wadena	0.9	1.2	-	2.1	265.7	494.8	13.2	773.7
Redeye	**1.0**	**2.2**	**-**	**3.2**	**240.3**	**588.3**	**1.5**	**830.0**
Wadena	1.0	2.2	-	3.2	240.3	588.3	1.5	830.0
Long Prairie	**0.6**	**1.4**	**0.1**	**2.1**	**182.1**	**384.9**	**47.5**	**614.6**
Morrison	-	0.3	-	0.3	32.3	81.7	35.8	149.7
Todd	0.6	1.2	-	1.8	149.9	303.2	11.8	464.8
Elk-Nokasippi	**0.9**	**1.7**	**0.2**	**2.7**	**269.6**	**568.6**	**70.0**	**908.3**
Morrison	0.9	1.7	0.2	2.7	269.6	568.6	70.0	908.3
Platte-Spunk	**2.1**	**0.3**	**-**	**2.5**	**568.6**	**254.4**	**39.5**	**862.6**
Morrison	2.1	0.3	-	2.5	568.6	254.4	39.5	862.6
Rum	**3.0**	**0.1**	**0.1**	**3.2**	**934.7**	**219.4**	**21.9**	**1176.0**
Morrison	1.8	-	-	1.8	489.3	61.3	2.5	553.1
Benton	0.3	0.1	-	0.4	119.9	107.0	3.4	230.3
Mille Lacs	0.9	0.1	-	1.0	325.5	51.1	16.0	392.7
Snake	**1.9**	**0.7**	**0.1**	**2.7**	**829.2**	**480.0**	**41.6**	**1350.8**
Mille Lacs	0.1	-	-	0.1	31.8	5.0		36.8
Kanabec	0.7	0.5	0.1	1.3	422.9	287.3	39.1	749.2
Pine	1.0	0.2	-	1.3	374.6	187.8	2.5	564.9
Kettle	**2.4**	**6.0**	**0.1**	**8.5**	**716.6**	**1861.3**	**98.1**	**2676.0**
Pine	2.2	2.7	0.1	5.0	630.0	850.1	97.1	1577.2
Carlton	0.2	3.4	-	3.6	86.7	1011.1	1.0	1098.8
Grand Total [d]	**13.2**	**14.4**	**0.6**	**28.2**	**4198.1**	**5121.3**	**338.4**	**9657.8**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route alternative centerline.

b Total acres of NWI within the 2000-ft-wide route alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RA-03AM-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed / County	Miles Crossed by the Route Alternative Centerline [a]		Acres Within the Route Alternative Corridor [b]	
	Wetlands	Basins	Wetlands	Basins
Crow Wing	**0.4**	**0.1**	**81.4**	**29.1**
Todd	0.4	0.1	74.4	27.2
Wadena	-	-	7.0	1.9
Redeye	**-**	**-**	**9.1**	**-**
Wadena	-	-	9.1	-
Long Prairie	**-**	**-**	**20.6**	**0.1**
Todd	-	-	1.5	0.1
Morrison	-	-	19.1	
Elk-Nokasippi	**-**	**-**	**13.4**	**9.5**
Morrison	-	-	13.4	9.5
Platte-Spunk	**-**	**-**	**40.6**	**-**
Morrison	-	-	40.6	-
Snake	**-**	**-**	-	**2.1**
Kanabec	-	-	**-**	2.1
Kettle	**-**	**-**	**2.1**	**62.5**
Pine	-	-	2.1	62.5
Grand Total [c]	**0.4**	**0.1**	**167.2**	**103.2**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the route alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RA-03AM-L3
Summary of Trout Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Crow Wing	**2**	**2.5**
Wadena	2	2.5
Redeye	**1**	**0.5**
Wadena	1	0.5
Snake	**1**	**0.4**
Pine	1	0.4
Kettle	**-**	**0.1**
Carlton	-	0.1
Grand Total [c]	**4**	**3.5**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RA-03AM-L3
Wells within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Crow Wing	Wadena	Abandoned	386	1
		Domestic	81	15
			587	
			676	
			117	
			137	
			545	
			626	
			818	
			940	
			111	
			351	
			461	
			680	
			811	
			711	
		Irrigation	596	5
			825	
			283	
			190	
			763	
Redeye	Wadena	Abandoned	910	1
		Domestic	463	21
			596	
			432	
			386	
			982	
			299	
			652	
			364	
			301	
			528	
			589	
			597	
			779	
			682	
			553	
			472	
			576	
			912	
			365	
			530	

Redeye (cont.)	Wadena (cont.)	Domestic (cont.)	929	21 (cont.)
		Irrigation	88	6
			149	
			828	
			426	
			658	
			560	
		Test Well	937	1
Crow Wing	Wadena	Abandoned	451	6
			188	
			870	
			4	
			315	
			839	
		Domestic	476	9
			464	
			503	
			260	
			532	
			326	
			726	
			763	
			130	
		Industrial	198	1
		Irrigation	649	6
			813	
			849	
			762	
			989	
			134	
		Test Well	297	1
	Todd	Abandoned	103	15
			105	
			131	
			129	
			13	
			29	
			8	
			42	
			40	
			81	
			3	
			85	
			243	
			15	
			21	

Crow Wing (cont.)	Todd (cont.)	Domestic	968	3
			146	
			299	
Long Prairie	Todd	Abandoned	53	3
			48	
			58	
		Domestic	338	7
			162	
			74	
			766	
			355	
			397	
			333	
		Monitoring	907	6
			752	
			379	
			720	
			351	
			383	
		Scientific Investigation	590	2
			728	
	Morrison	Domestic	956	5
			657	
			924	
			144	
			142	
Elk-Nokasippi	Morrison	Abandoned	741	1
		Domestic	421	23
			126	
			476	
			330	
			716	
			554	
			174	
			293	
			219	
			604	
			764	
			613	
			768	
			500	
			990	
			423	
			826	
			383	
			807	
			639	

Elk-Nokasippi (cont.)	Morrison (cont.)	Domestic (cont.)	537	23 (cont.)
			169	
			87	
		Exploration	868	22
			43	
			70	
			73	
			71	
			389	
			25	
			308	
			3	
			270	
			17	
			41	
			223	
			202	
			184	
			5	
			2	
			47	
			27	
			51	
			940	
			319	
		Irrigation	264	3
			476	
			229	
		Unknown	962	16
			982	
			559	
			637	
			649	
			590	
			663	
			612	
			677	
			778	
			692	
			777	
			863	
			772	
			875	
			875	
Platte-Spunk	Morrison	Abandoned	978	1
		Domestic	323	22
			308	

Platte-Spunk (cont.)	Morrison (cont.)	Domestic (cont.)	255	22 (cont.)
			992	
			627	
			577	
			798	
			775	
			279	
			140	
			279	
			431	
			450	
			506	
			810	
			928	
			856	
			186	
			586	
			152	
			315	
			814	
		Irrigation	357	2
			237	
		Other	396	1
		Unknown	961	1
Rum	Morrison	Domestic	93	11
			463	
			355	
			529	
			380	
			361	
			102	
			155	
			843	
			530	
			905	
	Benton	Domestic	636	10
			958	
			281	
			801	
			325	
			144	
			203	
			708	
			693	
			441	
	Mille Lacs	Abandoned	504	7
			791	

Rum (cont.)	Mille Lacs (cont.)	Abandoned (cont.)	263	7 (cont.)
			547	
			751	
			274	
			805	
		Domestic	64	16
			395	
			445	
			595	
			99	
			236	
			304	
			38	
			182	
			507	
			640	
			345	
			279	
			278	
			309	
			952	
		Monitoring	414	14
			417	
			379	
			453	
			399	
			407	
			444	
			587	
			576	
			746	
			431	
			497	
			499	
			503	
Snake	Mille Lacs	Domestic	824	3
			602	
			514	
	Kanabec	Abandoned	908	9
			114	
			253	
			271	
			203	
			241	
			132	
			163	
			91	

Snake (cont.)	Kanabec (cont.)	Domestic	213	98
			394	
			774	
			510	
			431	
			914	
			339	
			325	
			426	
			691	
			413	
			245	
			169	
			634	
			642	
			906	
			824	
			158	
			27	
			21	
			337	
			615	
			892	
			372	
			338	
			834	
			138	
			211	
			564	
			201	
			256	
			824	
			270	
			553	
			722	
			431	
			342	
			355	
			96	
			438	
			271	
			471	
			222	
			892	
			258	
			420	
			237	

Snake (cont.)	Kanabec (cont.)	Domestic (cont.)	171	98 (cont.)
			114	
			99	
			716	
			232	
			879	
			740	
			107	
			246	
			179	
			957	
			573	
			474	
			882	
			913	
			430	
			382	
			233	
			221	
			950	
			21	
			530	
			306	
			931	
			956	
			553	
			381	
			328	
			624	
			433	
			729	
			492	
			131	
			755	
			302	
			739	
			162	
			365	
			117	
			280	
			186	
			686	
			115	
			847	
			126	
			151	
			519	

Snake (cont.)	Kanabec (cont.)	Domestic (cont.)	704	98 (cont.)
			109	
			262	
			171	
		Irrigation	913	1
		Monitoring	199	7
			224	
			164	
			252	
			584	
			258	
			172	
		Observation	272	1
		Test Well	1	7
			178	
			4	
			407	
			622	
			951	
			57	
		Unknown	6	5
			315	
			288	
			27	
			159	
	Pine	Abandoned	448	9
			498	
			430	
			547	
			882	
			737	
			775	
			717	
			820	
		Commercial	136	1
		Domestic	734	22
			422	
			148	
			913	
			978	
			960	
			739	
			915	
			758	
			101	
			19	
			420	

Snake (cont.)	Pine	Domestic	659	22 (cont.)
			518	
			131	
			528	
			64	
			227	
			354	
			444	
			613	
			699	
		Monitoring	889	16
			671	
			459	
			481	
			632	
			493	
			446	
			540	
			579	
			864	
			772	
			783	
			727	
			535	
Kettle	Pine	Abandoned	474	2
			736	
		Domestic	528	19
			504	
			955	
			907	
			753	
			373	
			397	
			808	
			424	
			44	
			45	
			304	
			173	
			64	
			85	
			711	
			644	
			695	
			315	
Snake	Pine	Monitoring	894	2
			904	

Kettle	Pine	Domestic	976	21
			784	
			477	
			418	
			223	
			138	
			512	
			338	
			172	
			617	
			615	
			272	
			740	
			826	
			472	
			510	
			788	
			315	
			994	
			214	
			589	
	Carlton	Abandoned	166	6
			543	
			605	
			643	
			648	
			601	
		Domestic	829	36
			212	
			518	
			593	
			563	
			361	
			942	
			885	
			162	
			925	
			367	
			322	
			492	
			870	
			715	
			410	
			201	
			743	
			902	
			870	

Kettle (cont.)	Carlton (cont.)	Domestic (cont.)	117	36 (cont.)
			233	
			372	
			225	
			194	
			769	
			303	
			265	
			564	
			129	
			515	
			668	
			498	
			444	
			663	
			123	
		Exploration	773	2
			613	
		Other	789	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

[a] Municipal wells are not included in the source data.

Table 7
Line 3 Replacement Project – RA-03AM-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Route Alternative Centerline [b]	Acres Within the Route Alternative Corridor [c]
Rum	Mille Lacs	1718+00	Milaca WHPA	1.0	196.8
		1722+00	Milaca DWSMA	1.6	350.7
	Mille Lacs	1863+00	Bock WHPA	-	18.7
		1864+00	Bock DWSMA	-	40.2
Snake	Kanabec	1963+00	Ogilvie WHPA	-	32.5
		1964+00	Ogilvie DWSMA	-	75.1
Kettle	Pine	2462+00	Hinckley WHPA	0.3	93.9
			Hinckley DWSMA	0.8	183.7
	Carlton	3017+00	Moose Lake WHPA	-	19.9
		3022+00	Moose Lake DWSMA	0.4	103.3

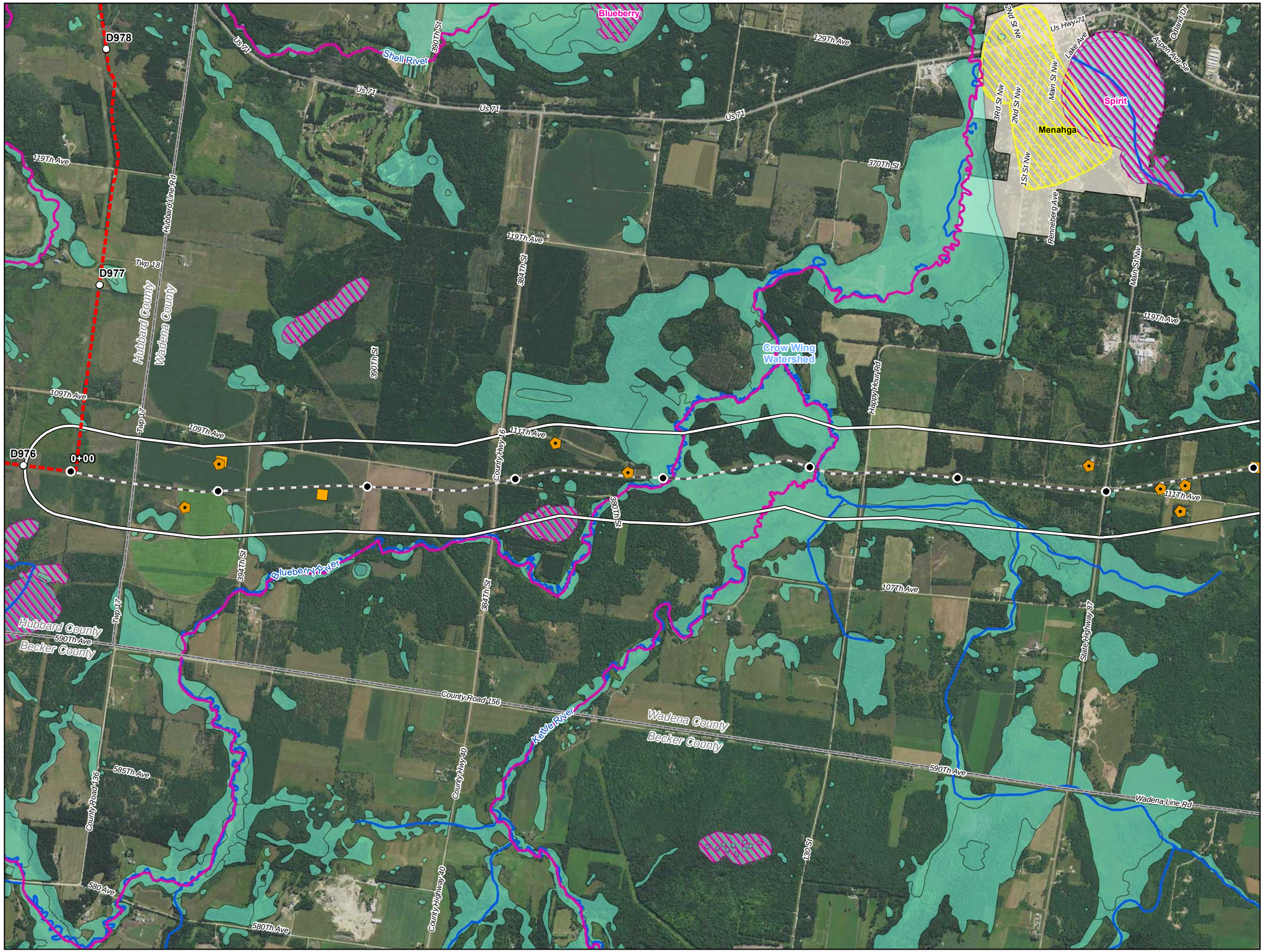
DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

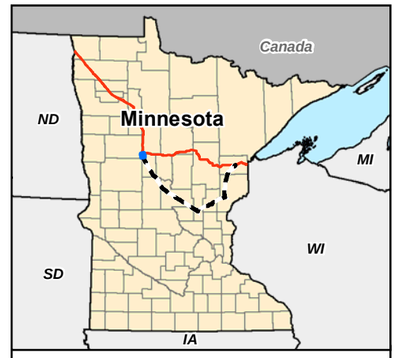
a Stationing for features not crossed by the centerline are interpolated based on the closest route alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the route alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide route alternative corridor.

Table 8
Line 3 Replacement Project – RA-03AM-L3
Surface Water Intakes within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Crow Wing	Wadena	General Permit Authorization	Inactive	4
		Individual Permit	Active	4
			Inactive	2
Redeye	Wadena	General Permit Authorization	Inactive	13
		Individual Permit	Active	6
		Individual Permit	Inactive	6
Crow Wing	Wadena	General Permit Authorization	Inactive	10
		Individual Permit	Active	9
		Individual Permit	Inactive	3
	Todd	General Permit Authorization	Inactive	2
Long Prairie	Todd	General Permit Authorization	Inactive	5
		Individual Permit	Active	1
		Individual Permit	Inactive	3
	Morrison	General Permit Authorization	Inactive	3
Elk-Nokasippi	Morrison	Individual Permit	Active	3
		Individual Permit	Inactive	3
Platte-Spunk	Morrison	Individual Permit	Active	3
		Individual Permit	Inactive	3
Rum	Mille Lacs	Individual Permit	Inactive	1
Snake	Kanabec	Individual Permit	Active	3
	Pine	Individual Permit	Active	1
Kettle	Pine	Individual Permit	Inactive	3

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Wadena County, Minnesota

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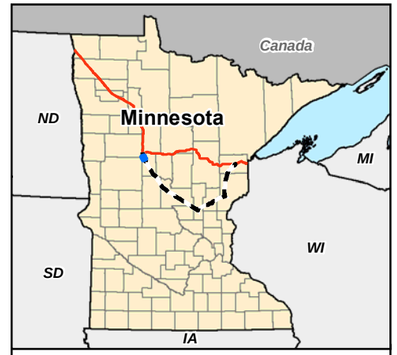

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- Alternative Stationing
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Wadena County, Minnesota

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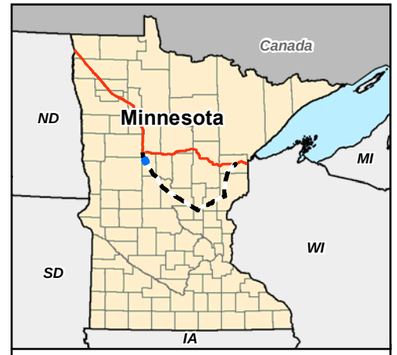

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- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 3

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Wadena County, Minnesota

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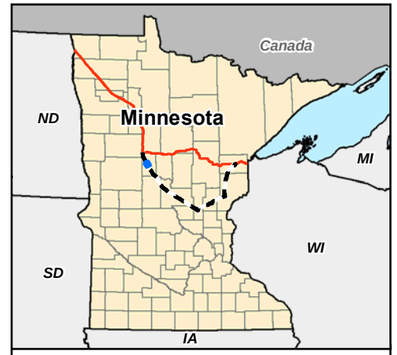

0 1,000 2,000 Feet

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- Alternative Stationing
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- PWI Basin
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- WHPA
- DWSMA
- County Boundary

Figure 4

Line 3 Replacement Project

RA-03AM-L3

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Wadena County, Minnesota

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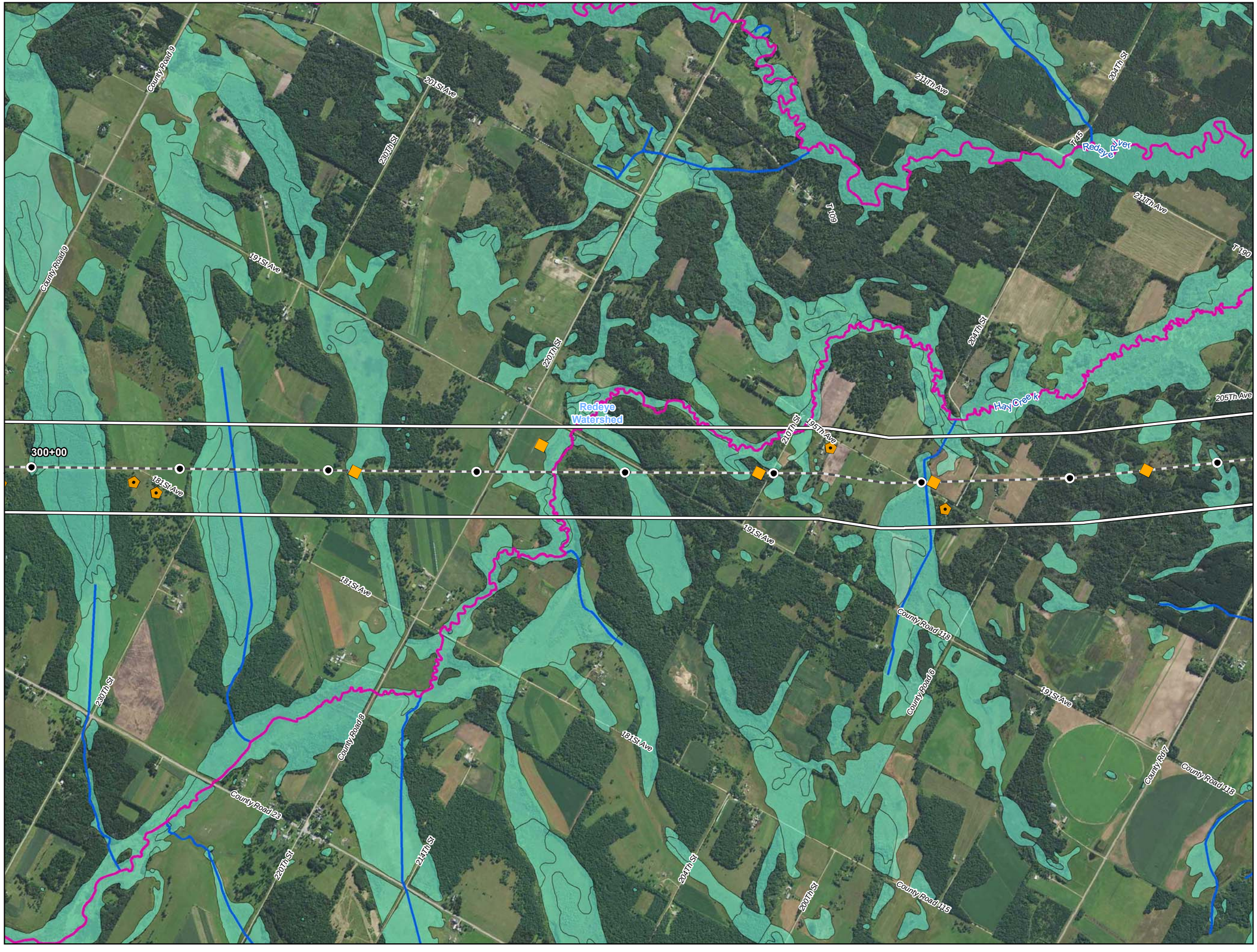

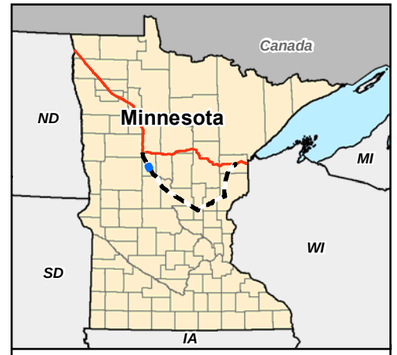

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- PWI Basin
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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 5

Line 3 Replacement Project

RA-03AM-L3

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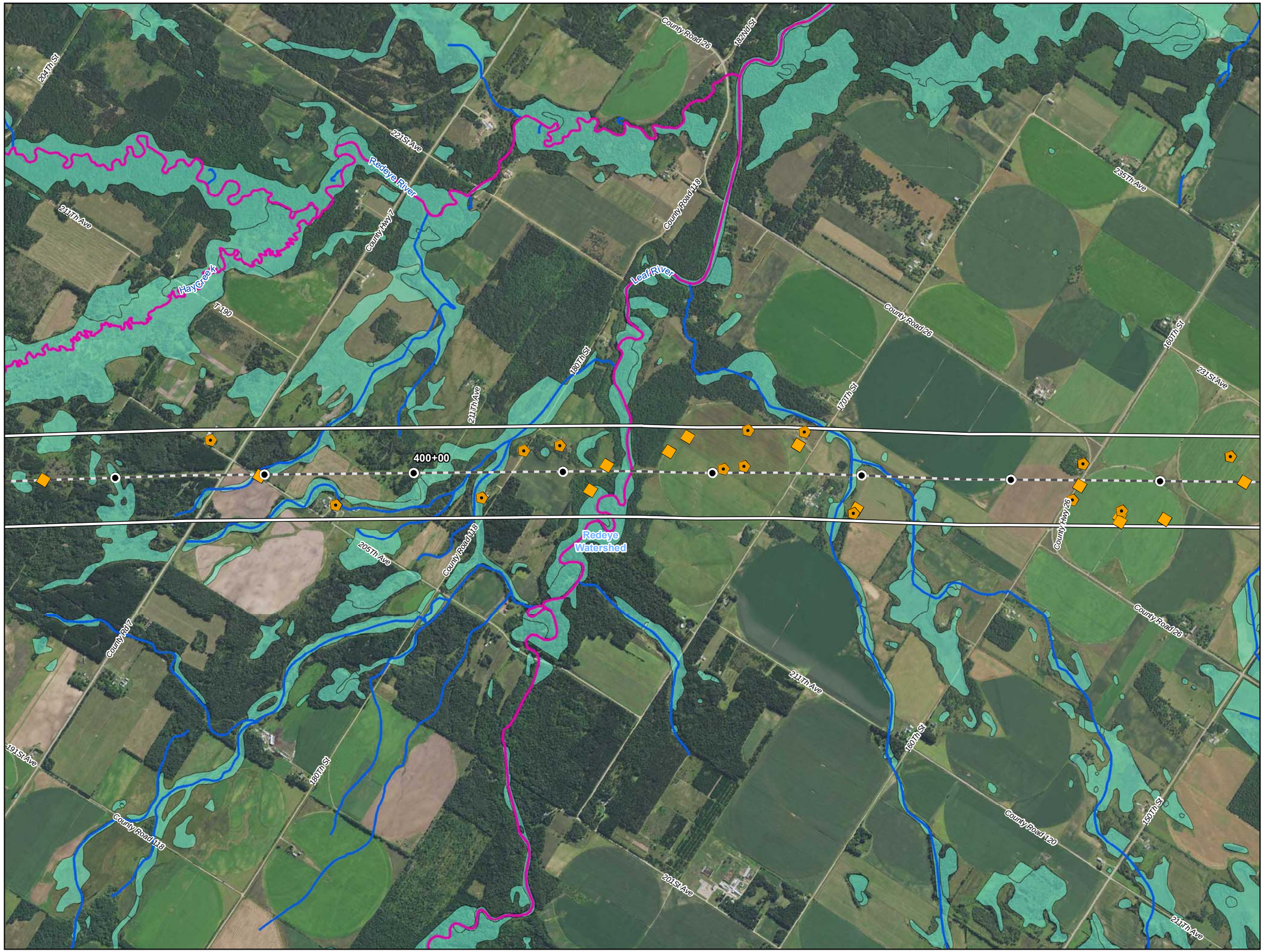

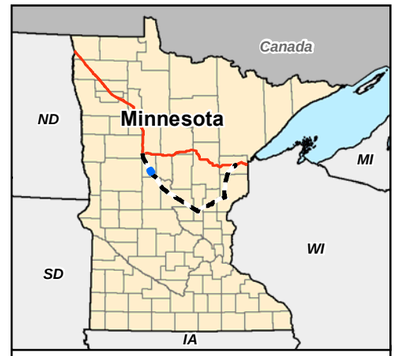

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- DWSMA
- County Boundary

Figure 6

Line 3 Replacement Project

RA-03AM-L3

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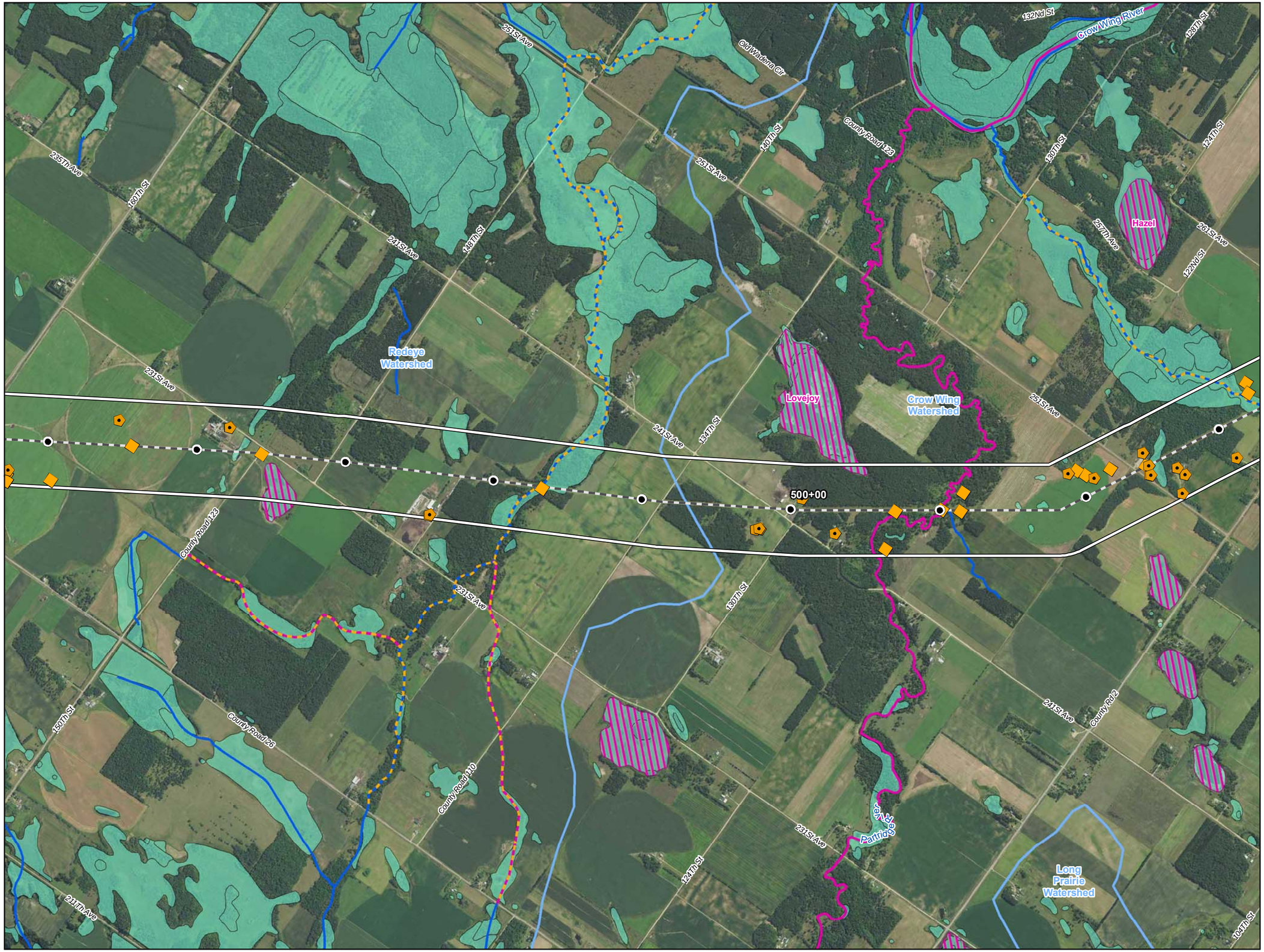

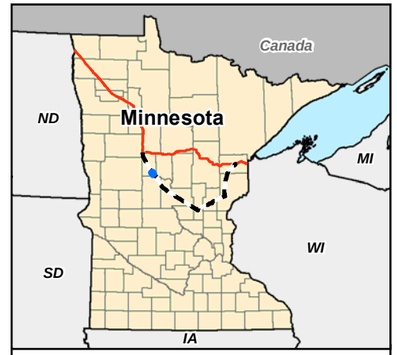

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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 7

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Wadena County, Minnesota

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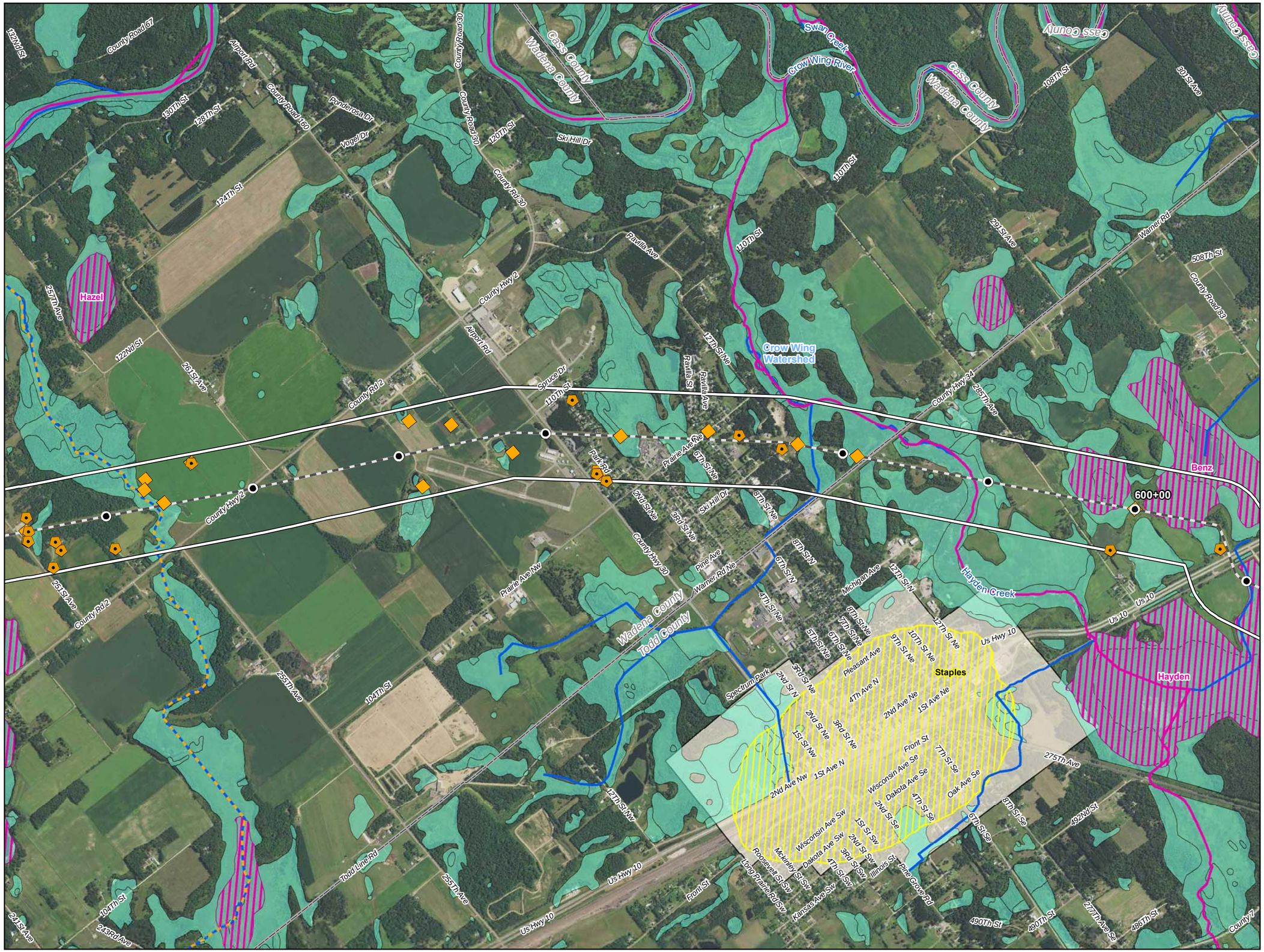

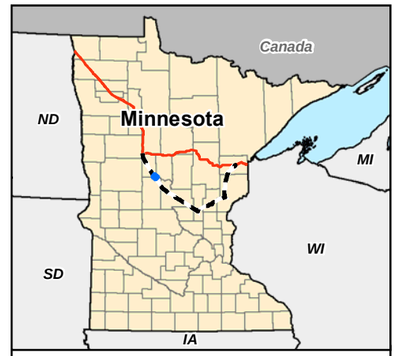

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Figure 8

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Wadena County, Minnesota

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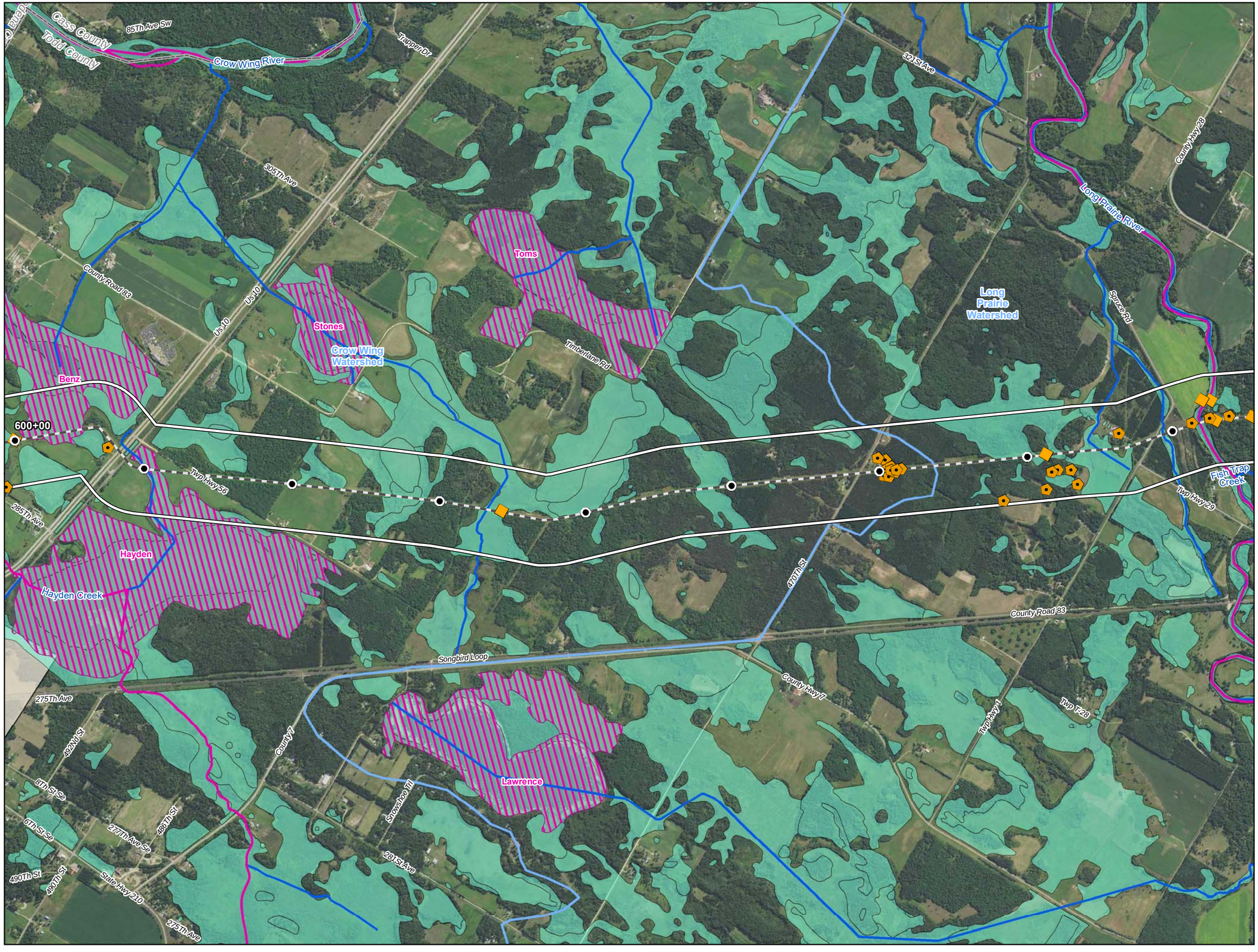

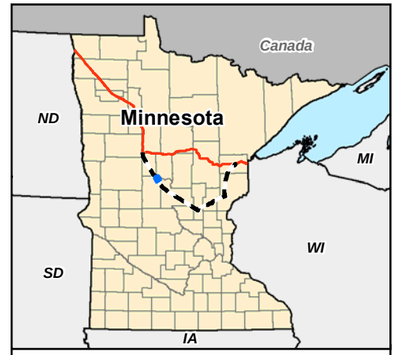

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- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 9

Line 3 Replacement Project

RA-03AM-L3

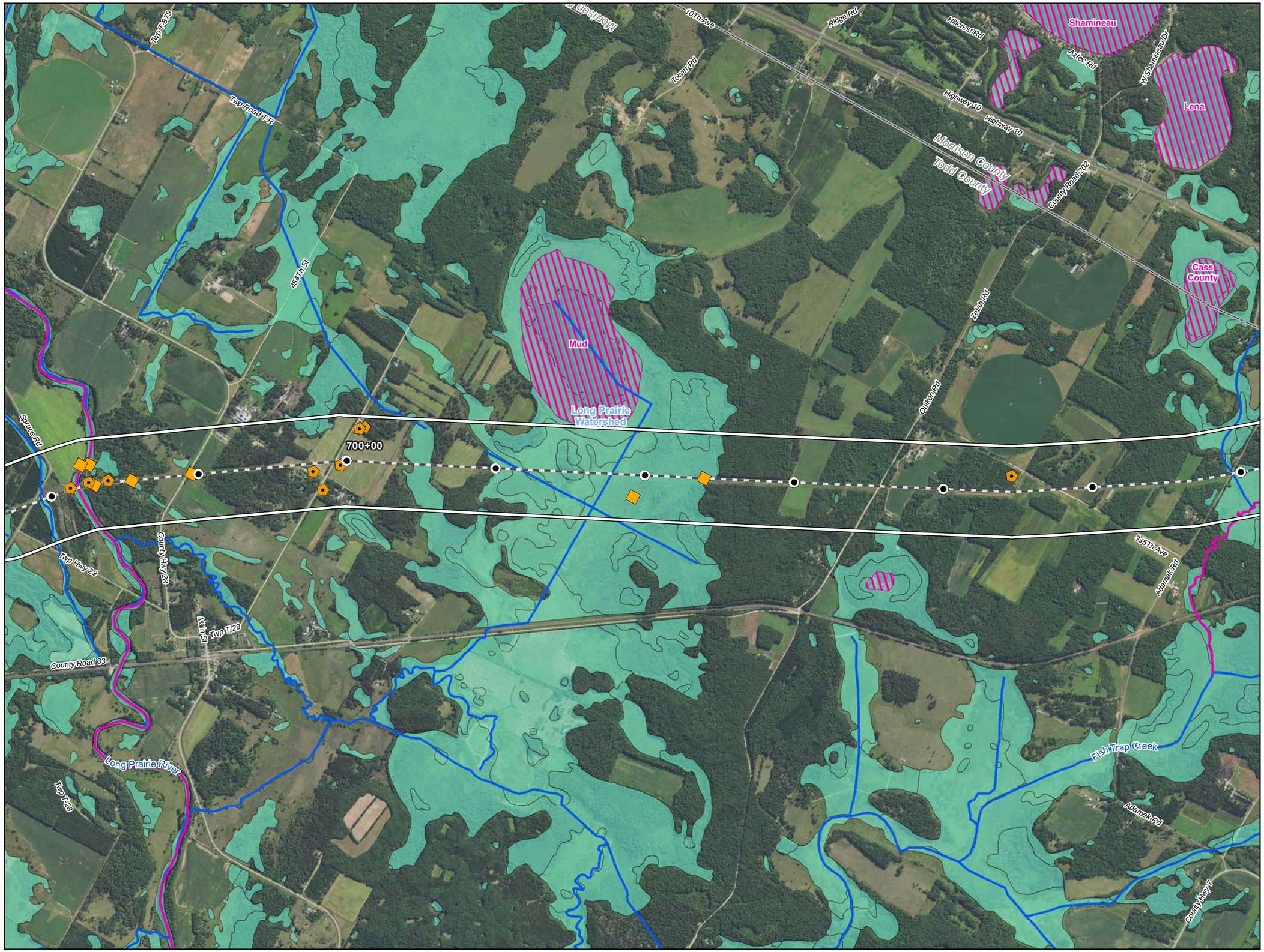
Enbridge

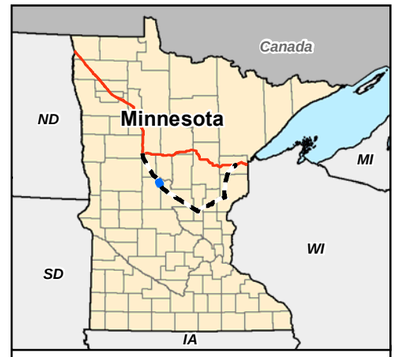
Todd County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 10

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Todd County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd
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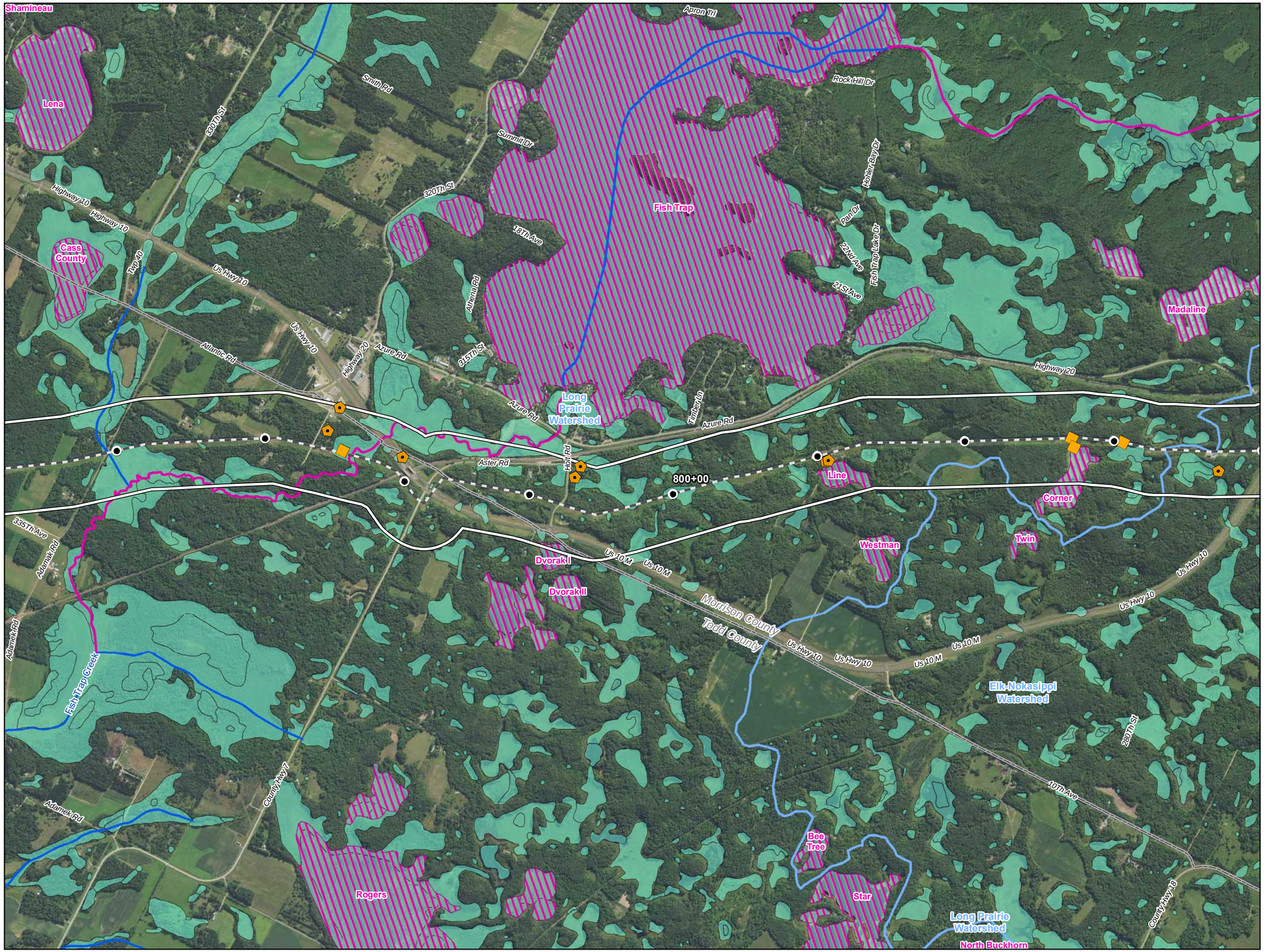

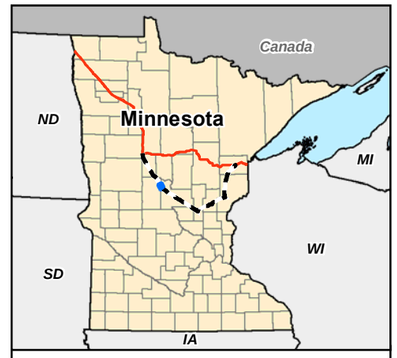

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 11

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_FR\EnbridgeLine_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)

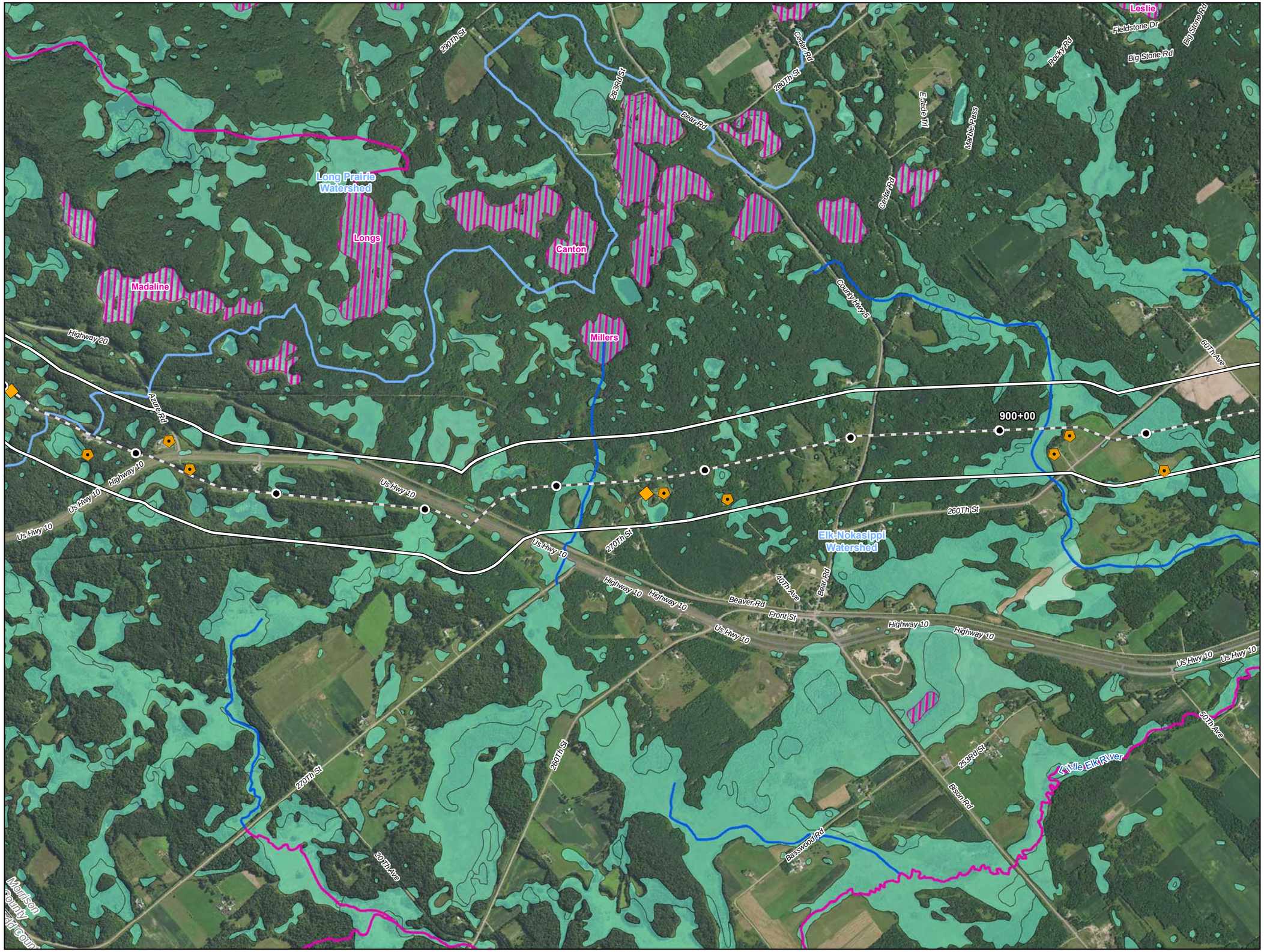

Figure 12

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd
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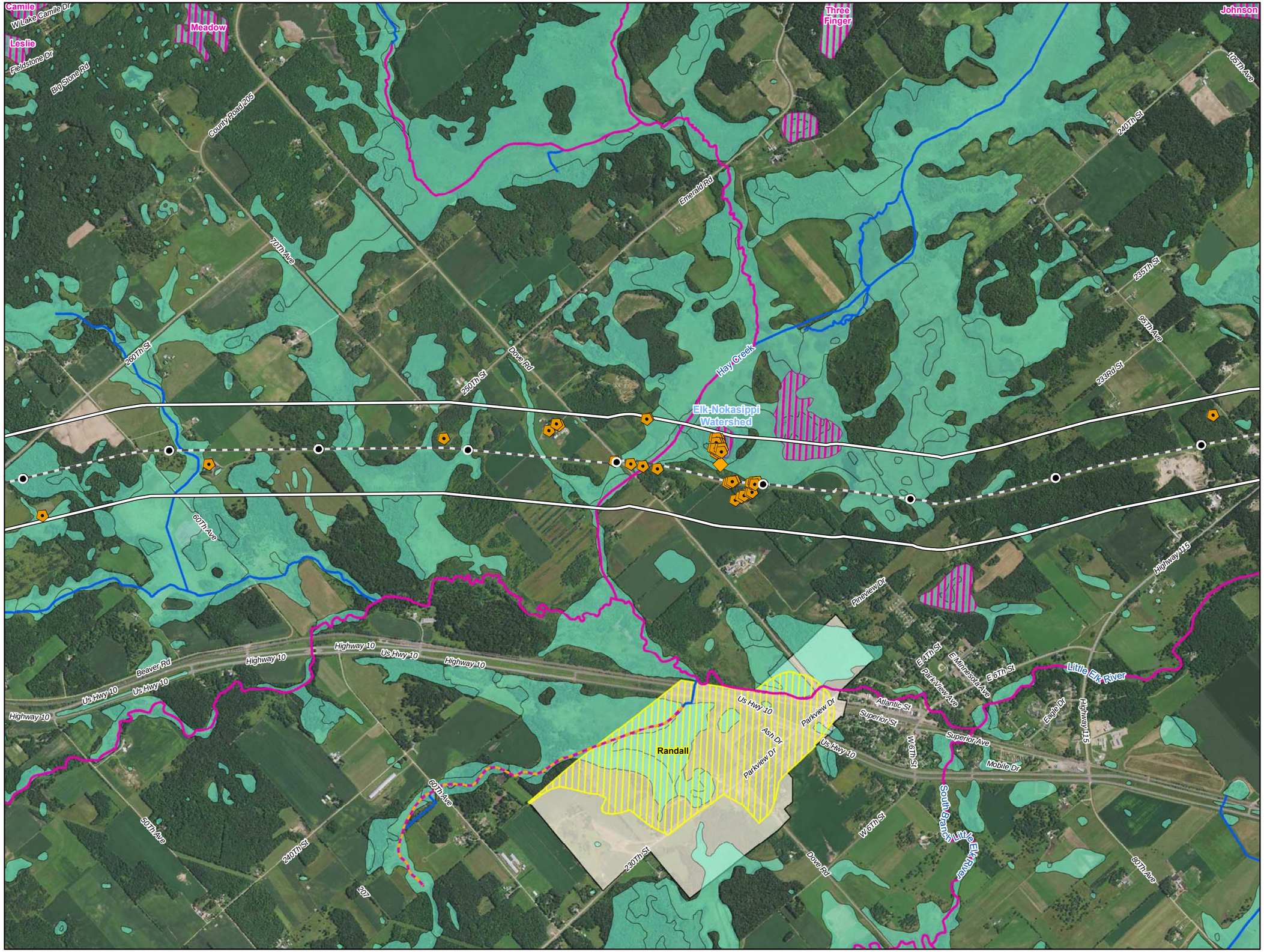

Figure 13

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

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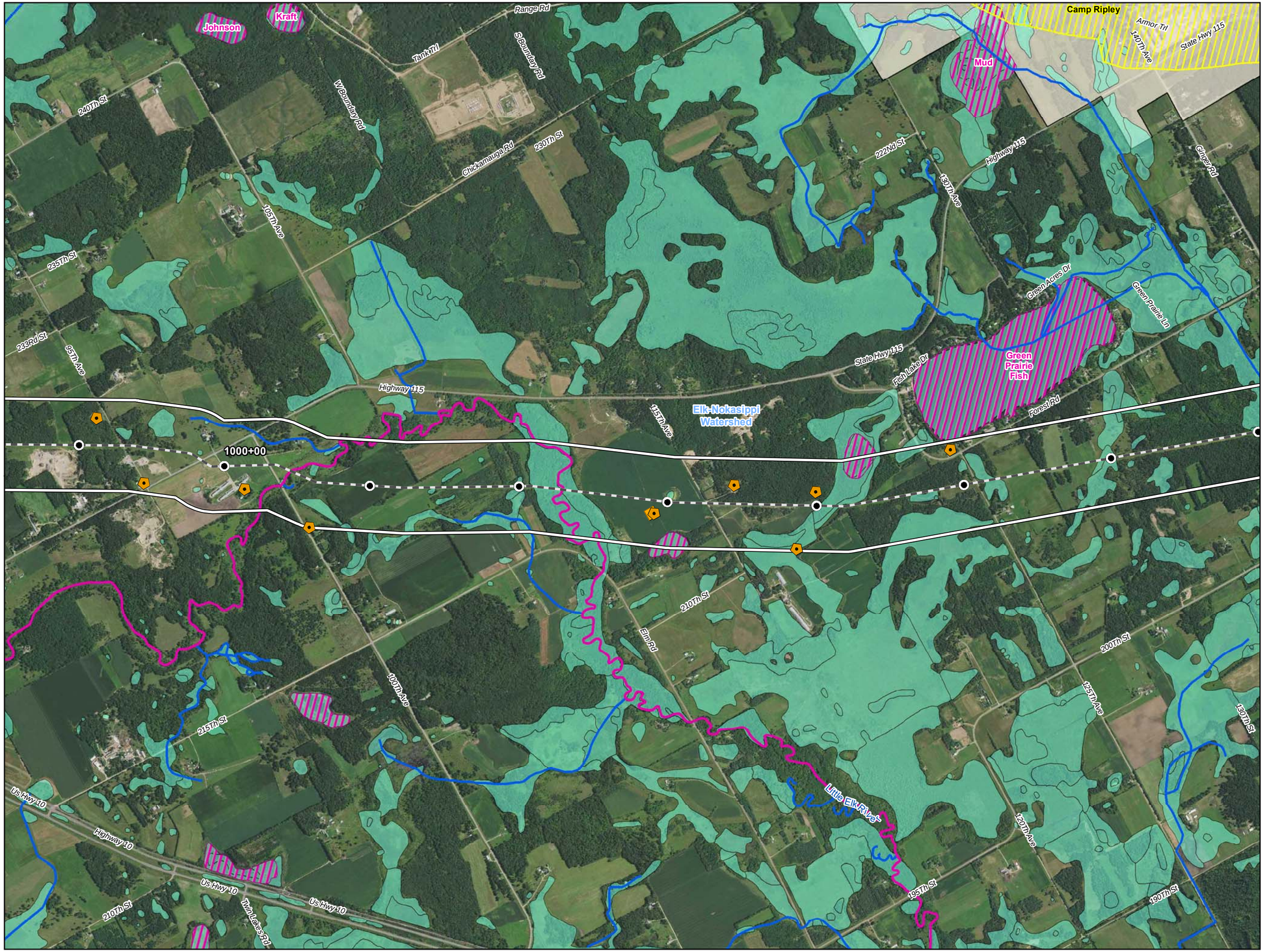
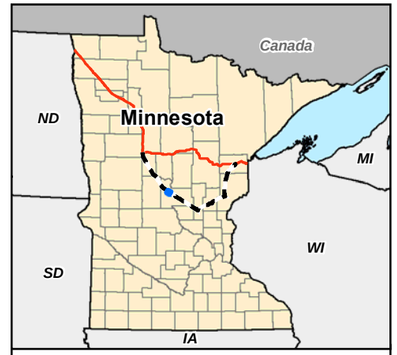
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 14

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

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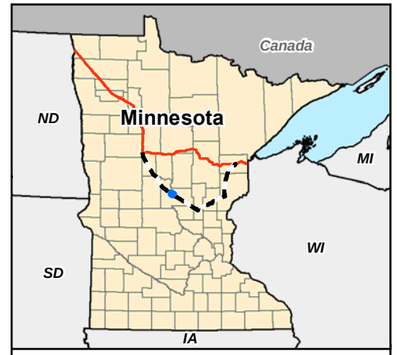
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 15

Line 3 Replacement Project

RA-03AM-L3

Enbridge

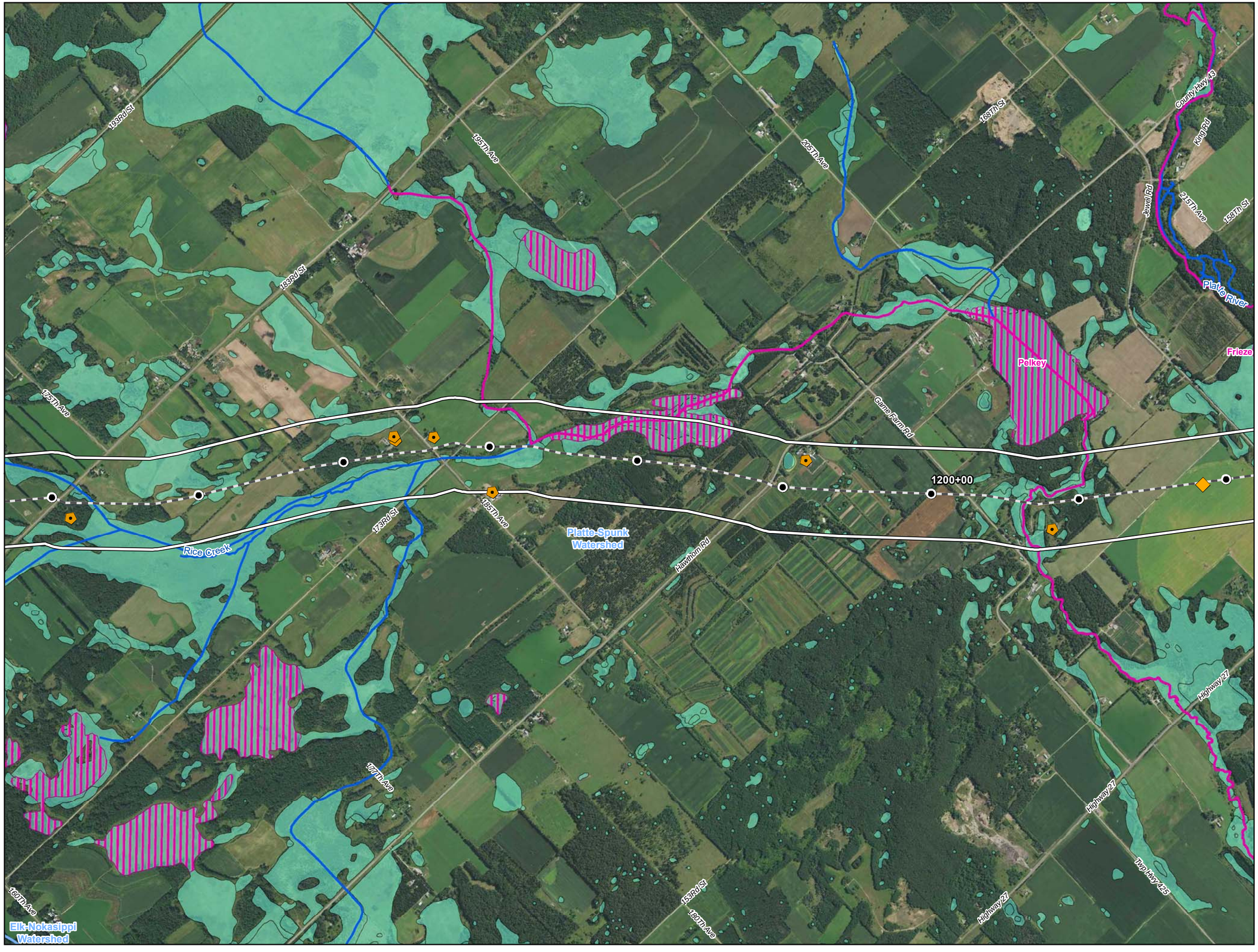
Morrison County, Minnesota

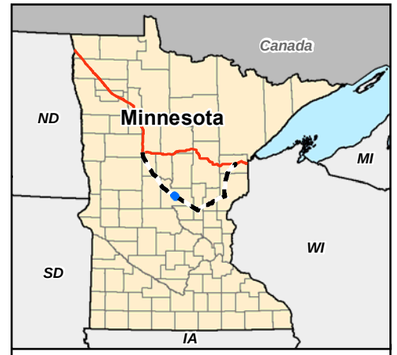
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_FH\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 16

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

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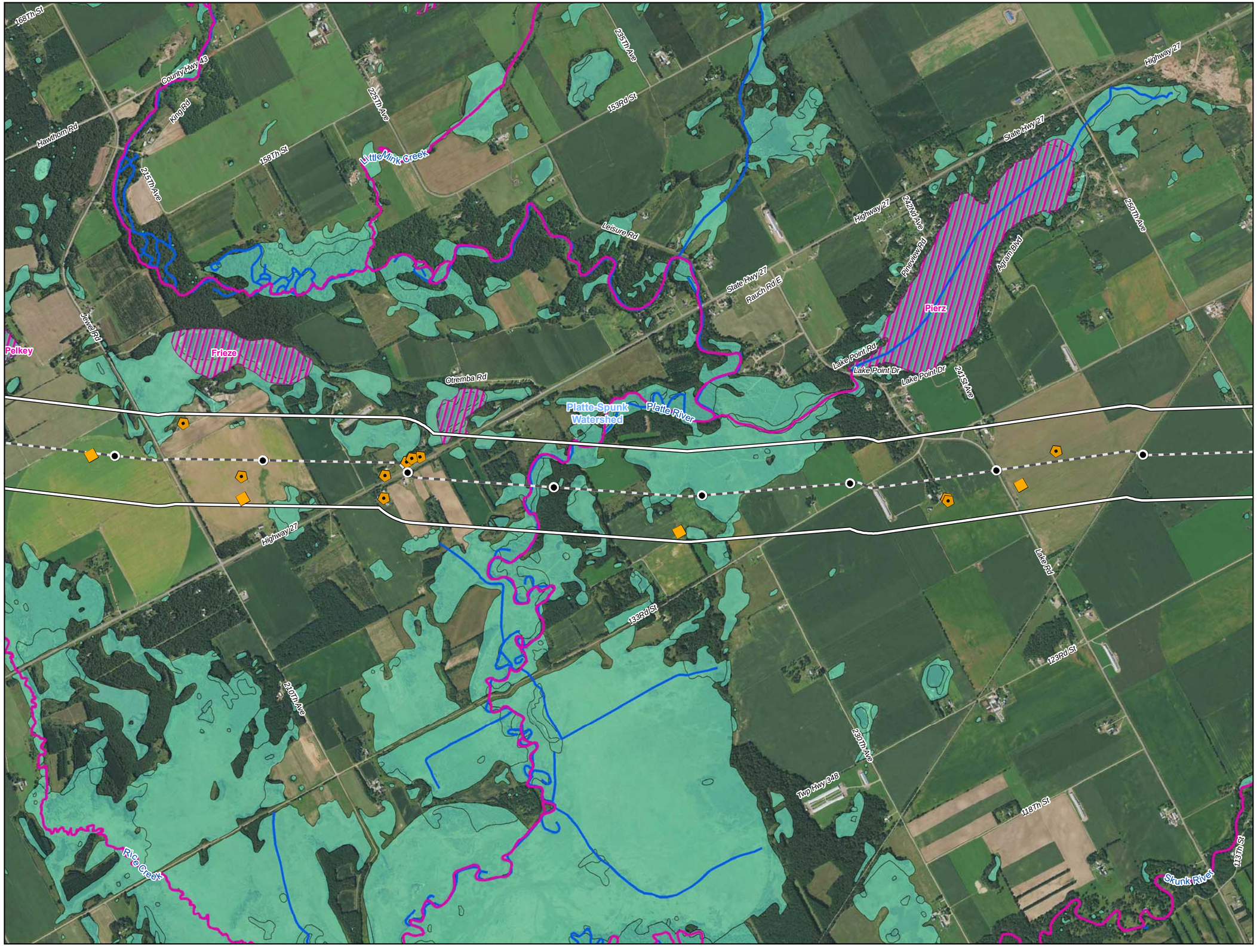
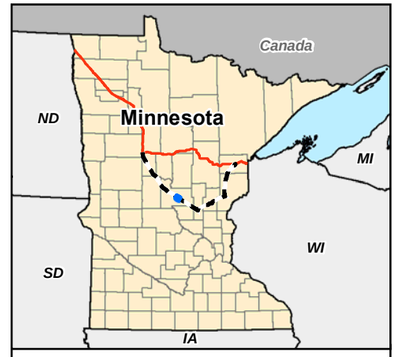
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 17

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

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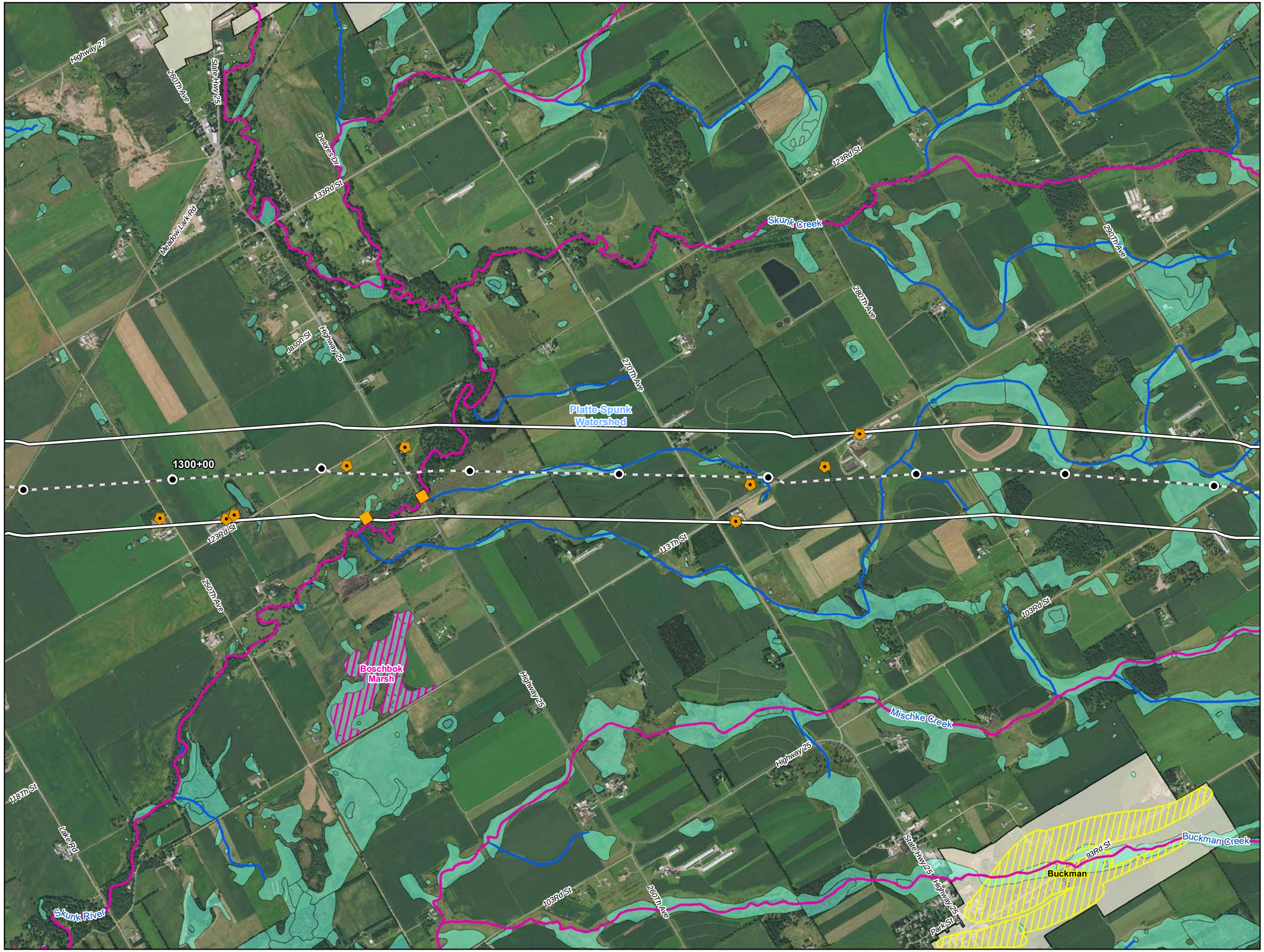
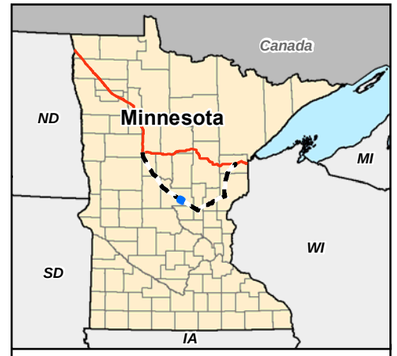
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 18

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

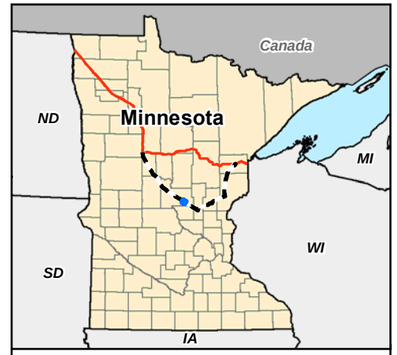
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\20161010\Pinhole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 19

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

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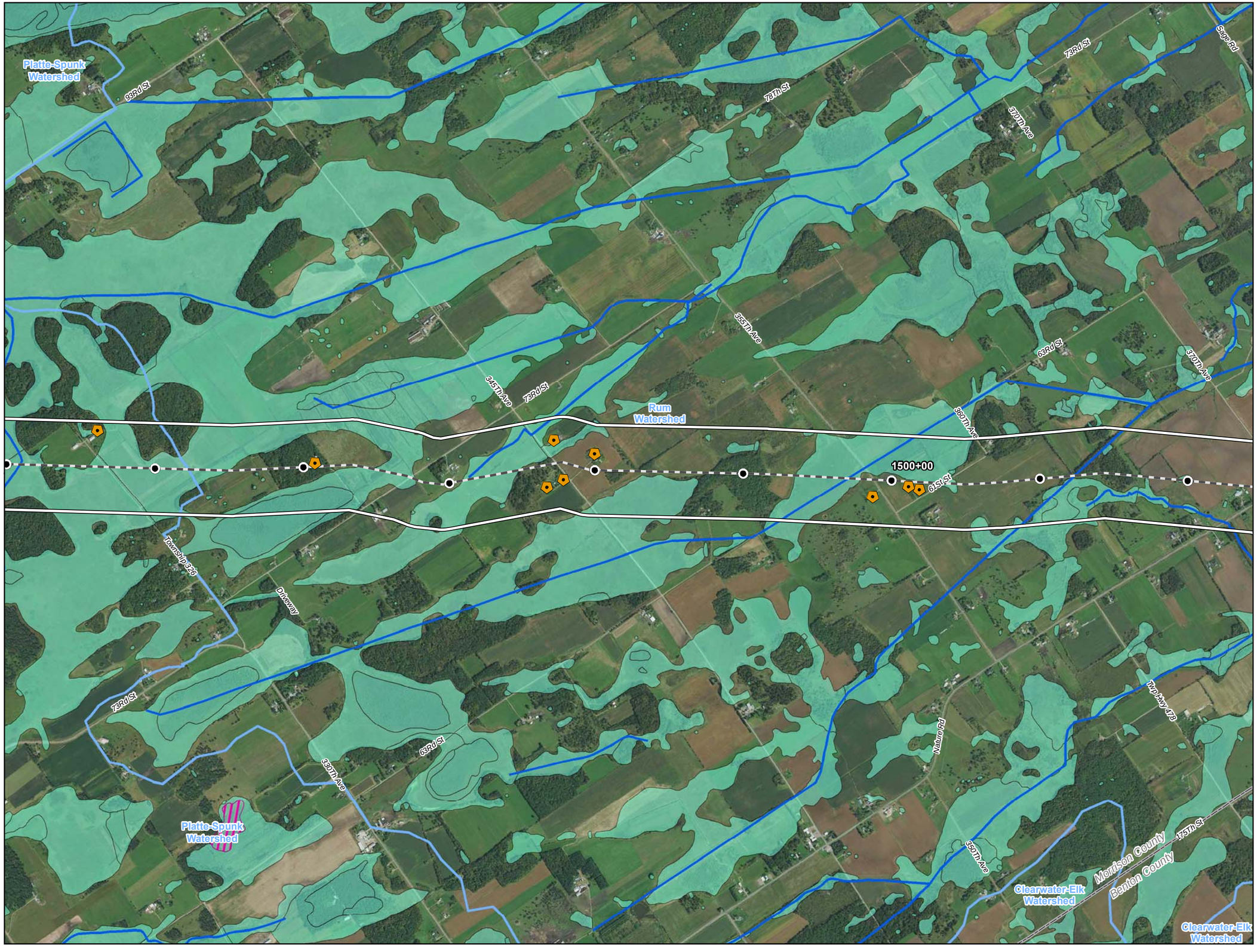

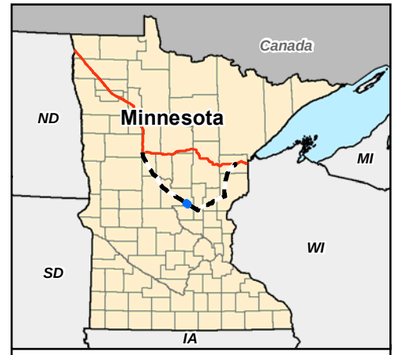

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 20

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Morrison County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\EnbridgeLine_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

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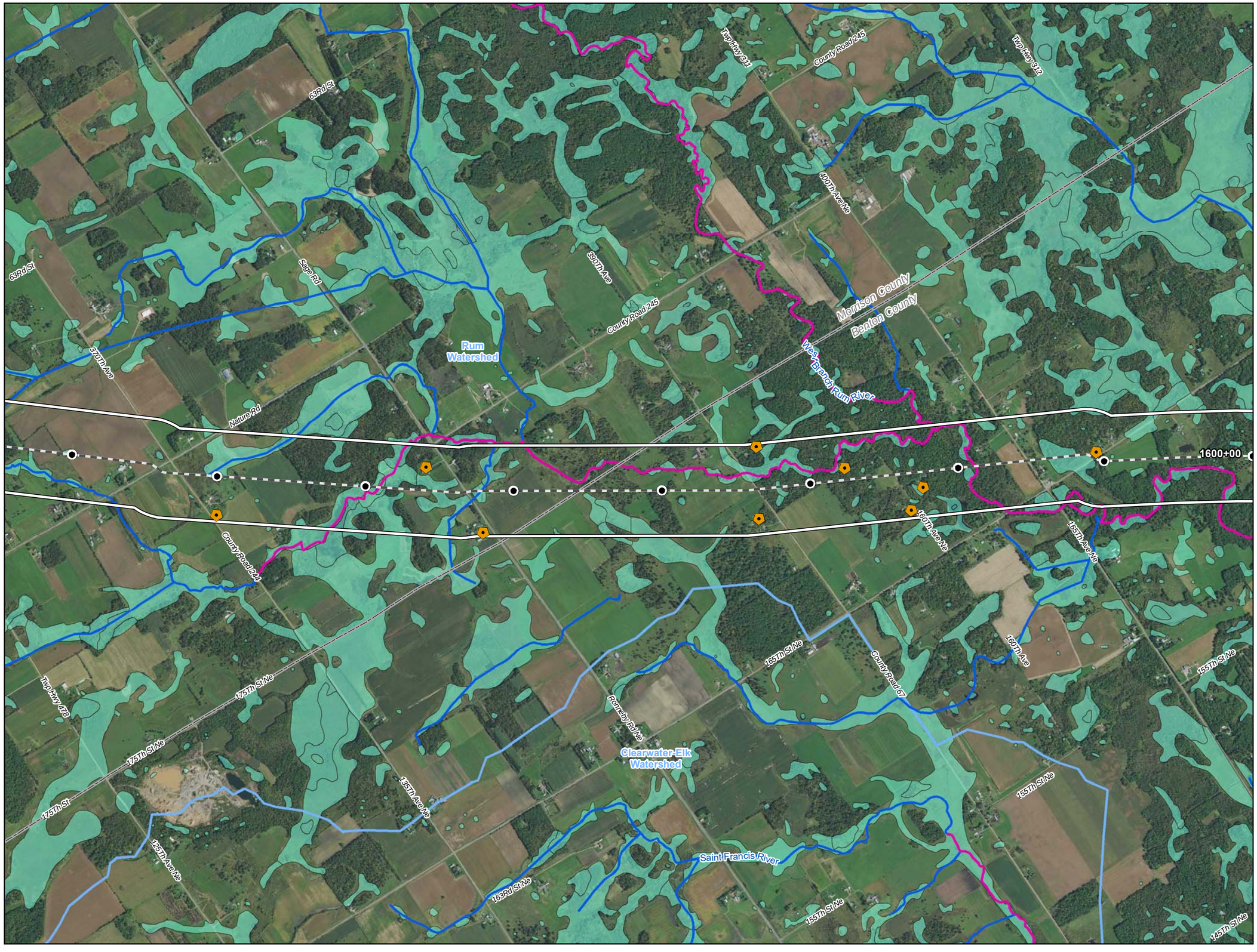
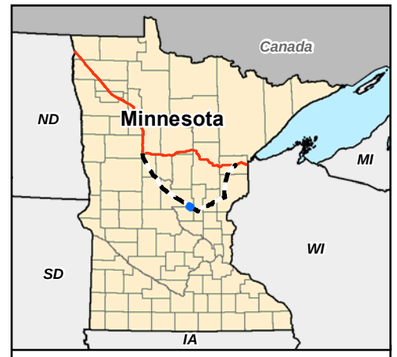




0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 21

Line 3 Replacement Project

RA-03AM-L3

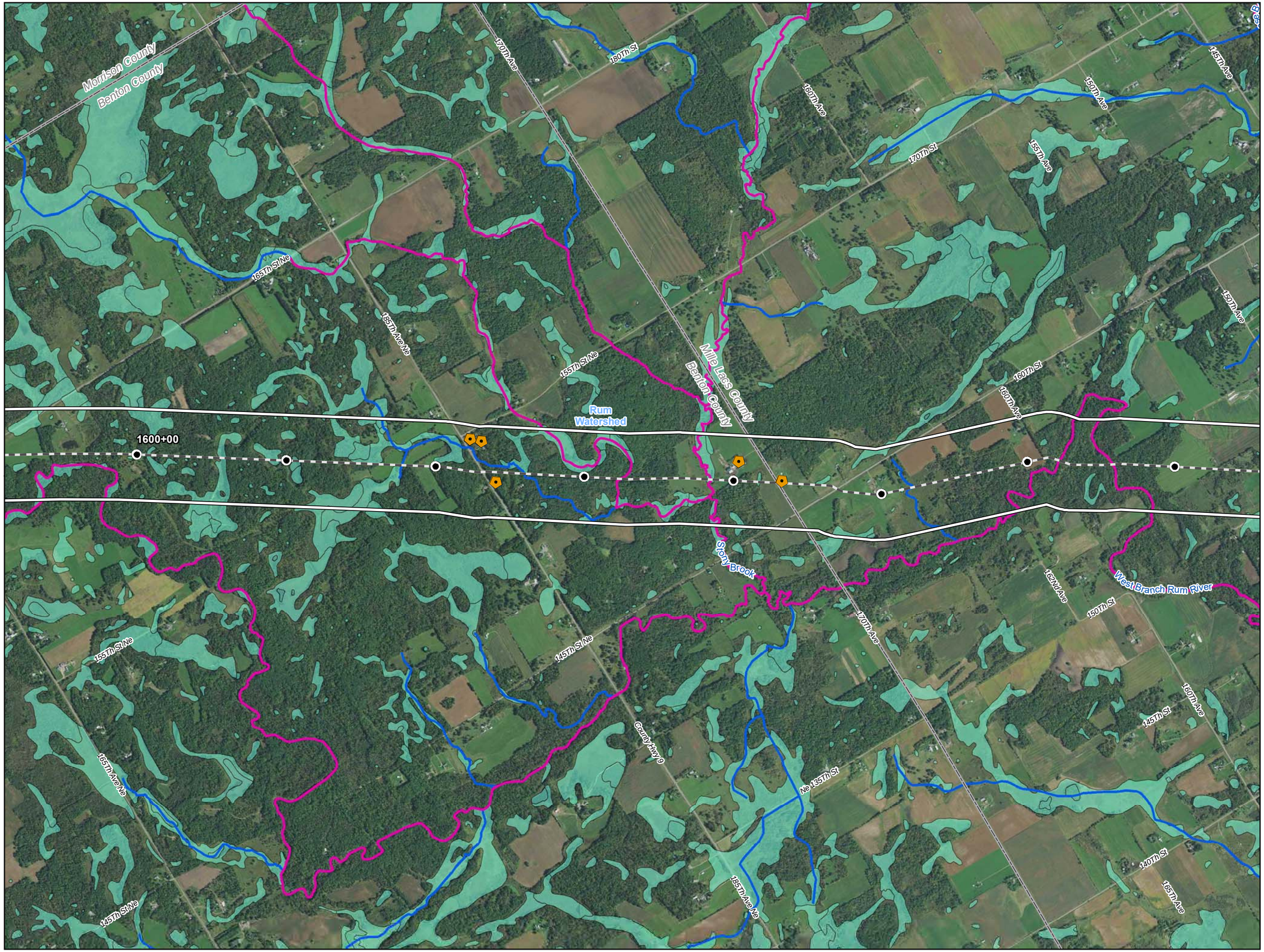
Enbridge

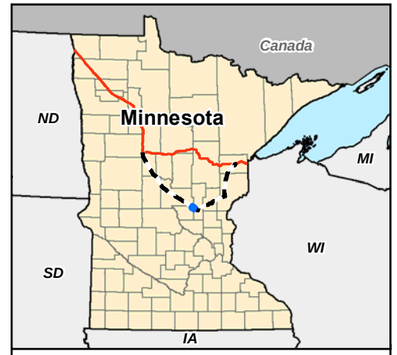
Benton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Date: (10/18/2016) Source: Z:\Clients\E_H\EnbridgeLine_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 22

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Benton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)

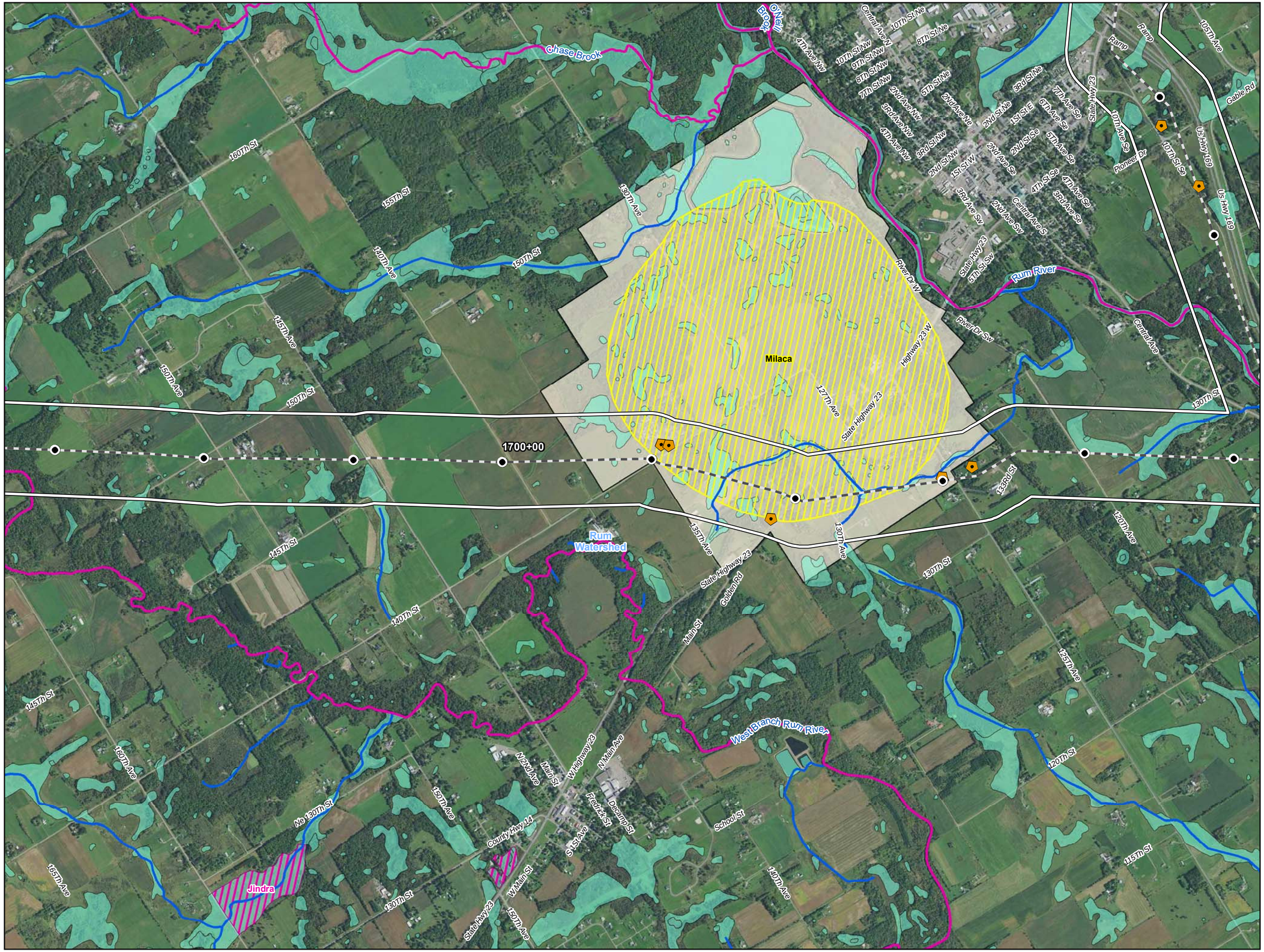


Figure 23

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Mille Lacs County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

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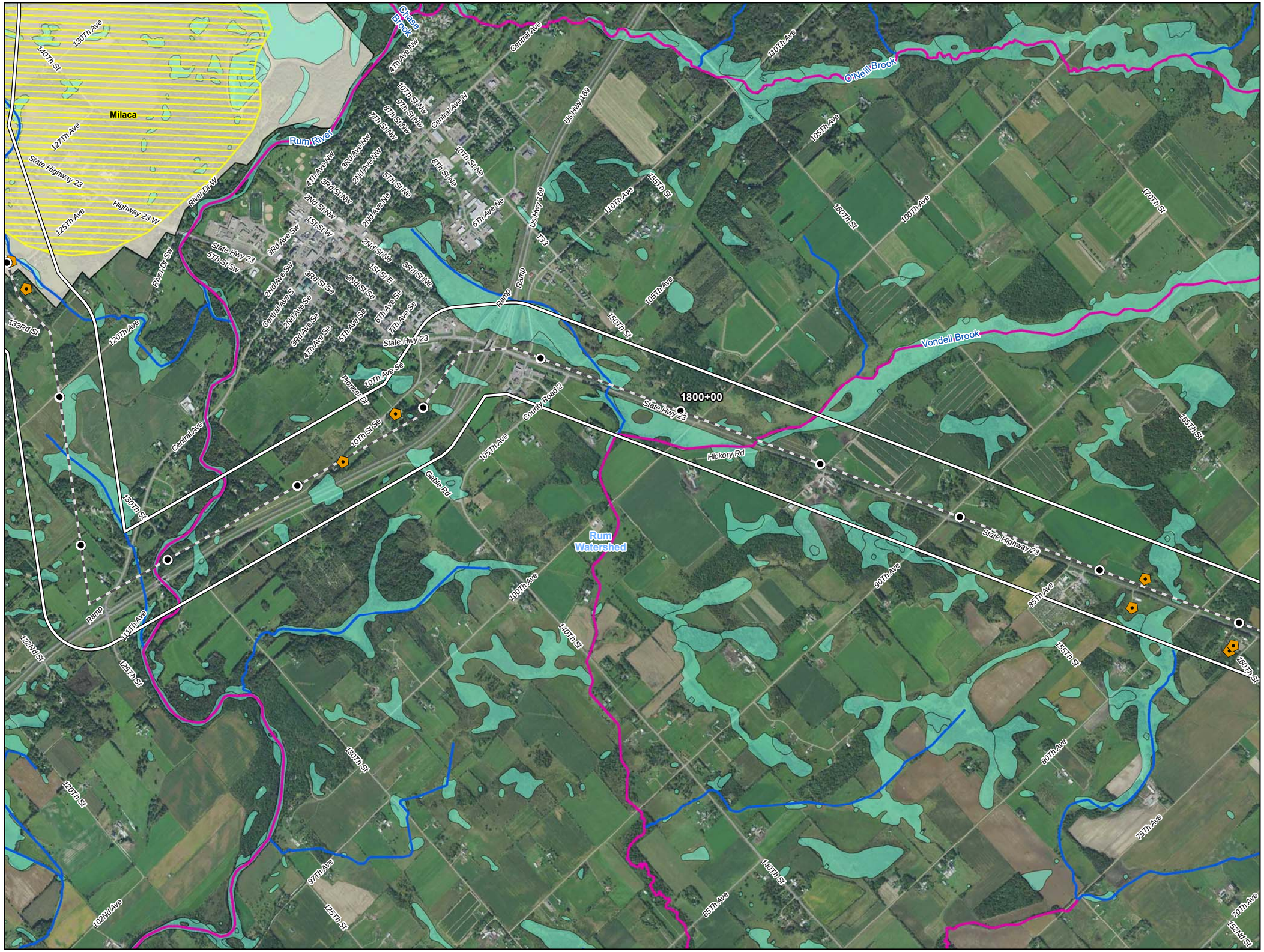
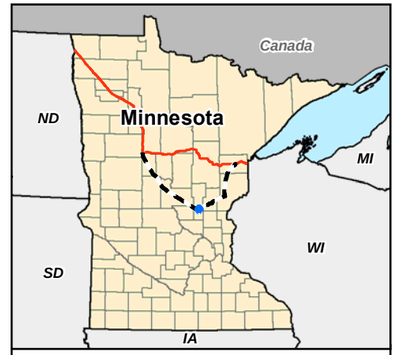




0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 24

Line 3 Replacement Project

RA-03AM-L3

Enbridge

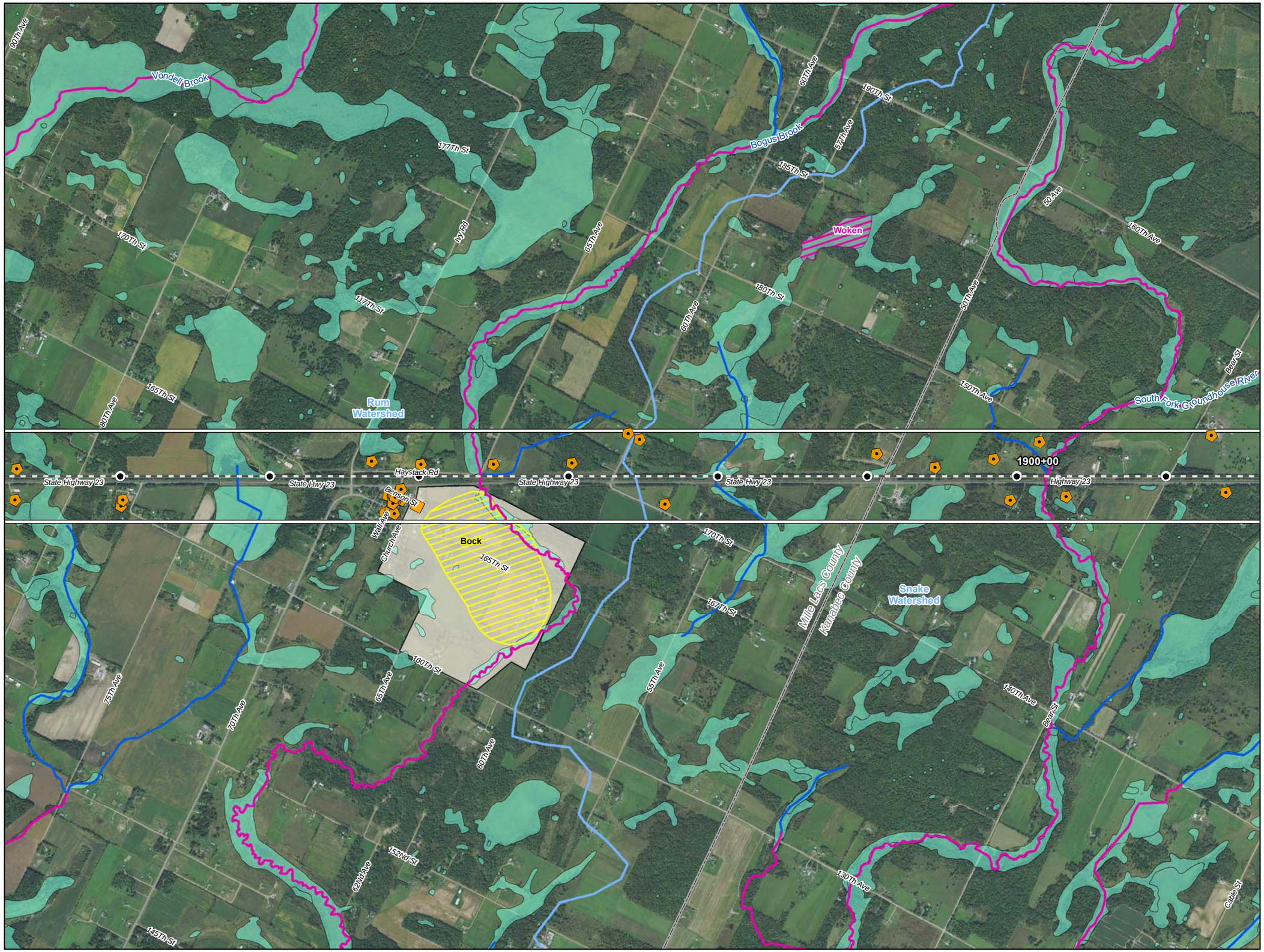
Mille Lacs County, Minnesota

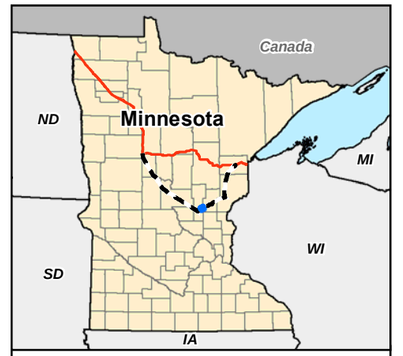
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\01\Pinhole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 25

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Mille Lacs County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

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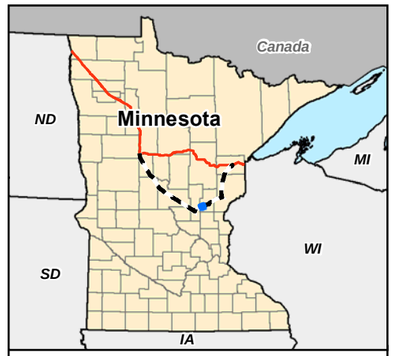

0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 26

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Kanabec County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd
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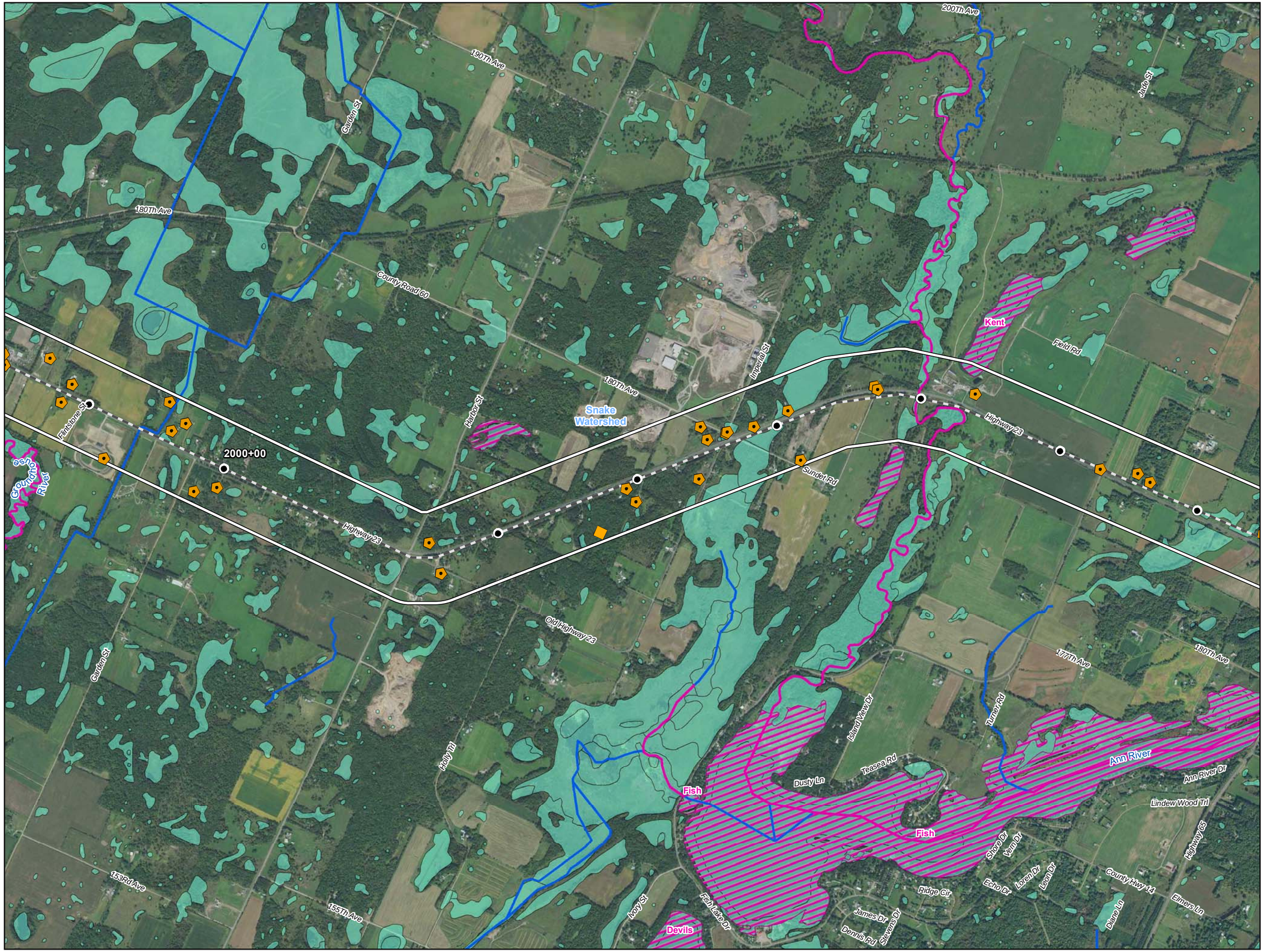


- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 27

Line 3 Replacement Project

RA-03AM-L3

Enbridge

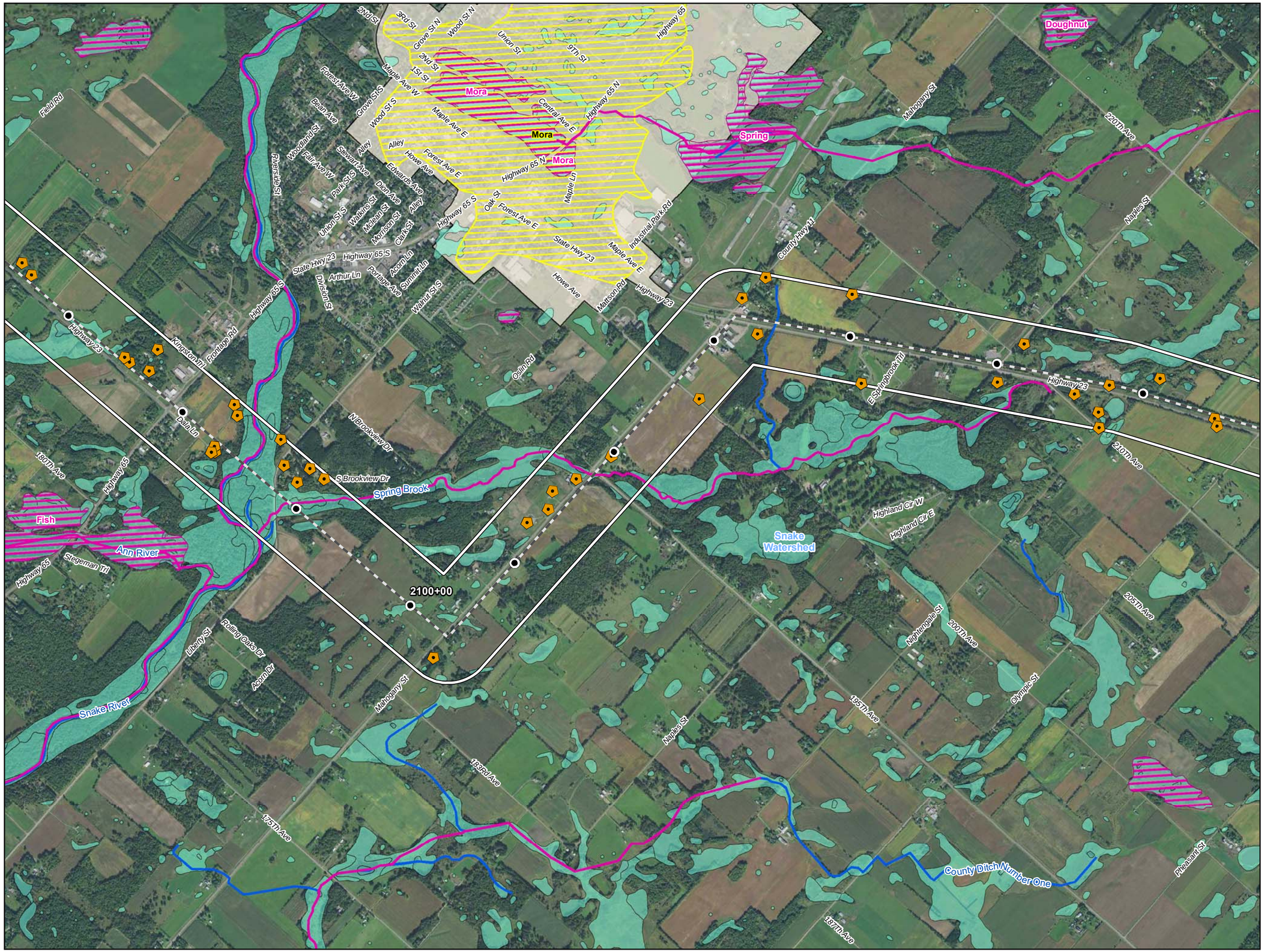
Kanabec County, Minnesota

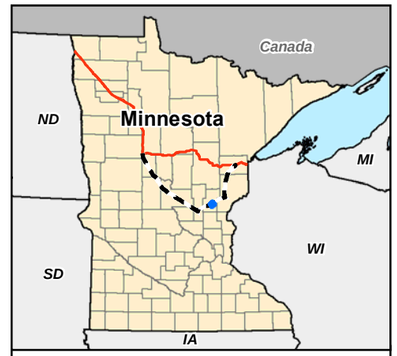
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 28

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Kanabec County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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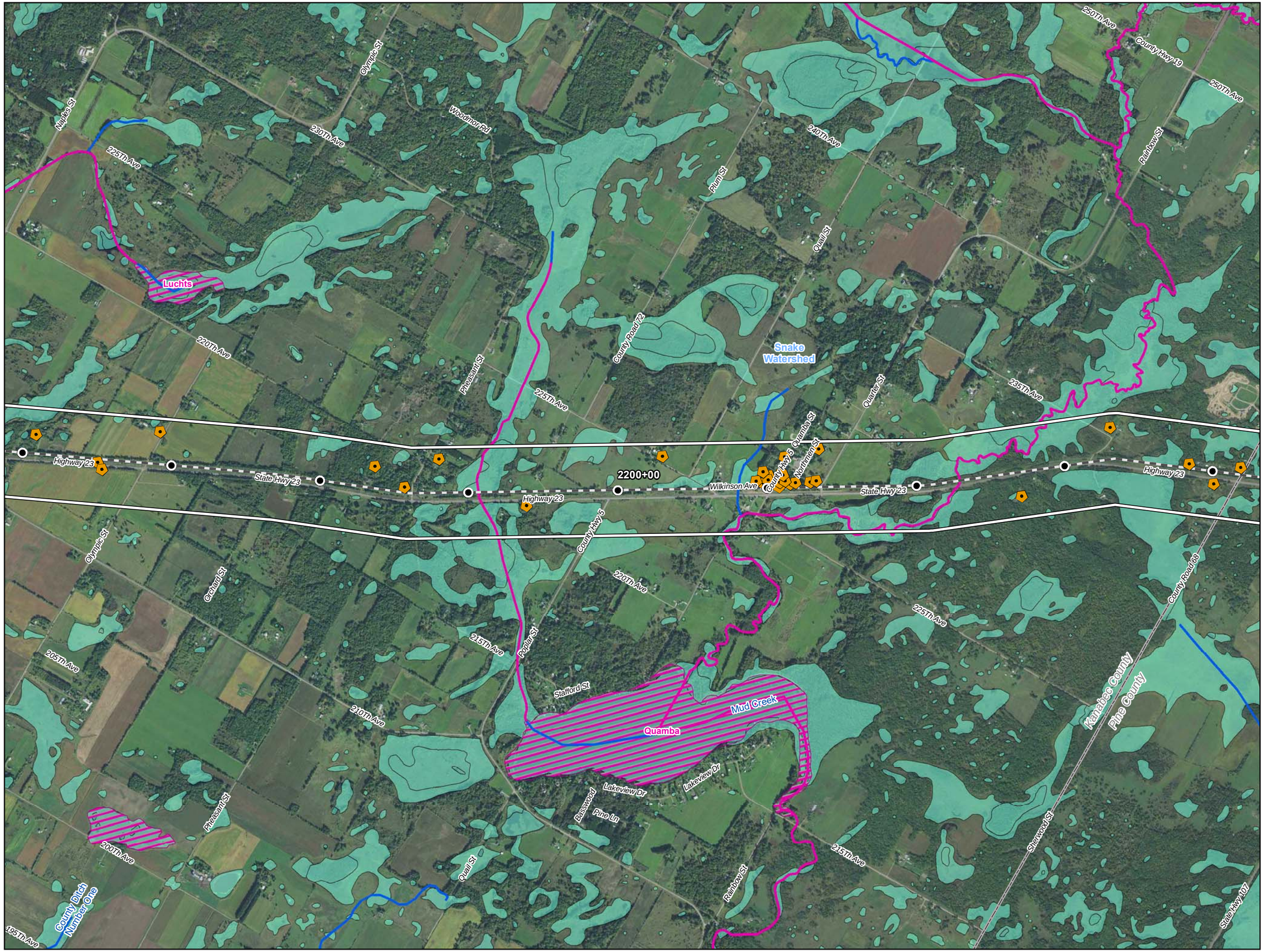
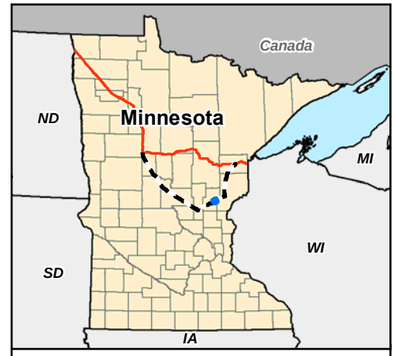
Date: (10/18/2016)





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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 29

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Kanabec County, Minnesota

ENBRIDGE

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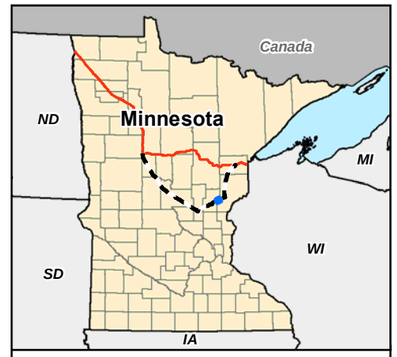
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
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- Alternative Centerline
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 30

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Pine County, Minnesota

ENBRIDGE

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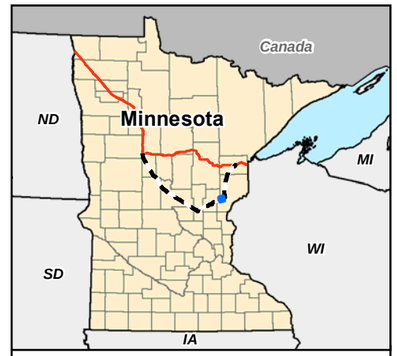
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 31

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Pine County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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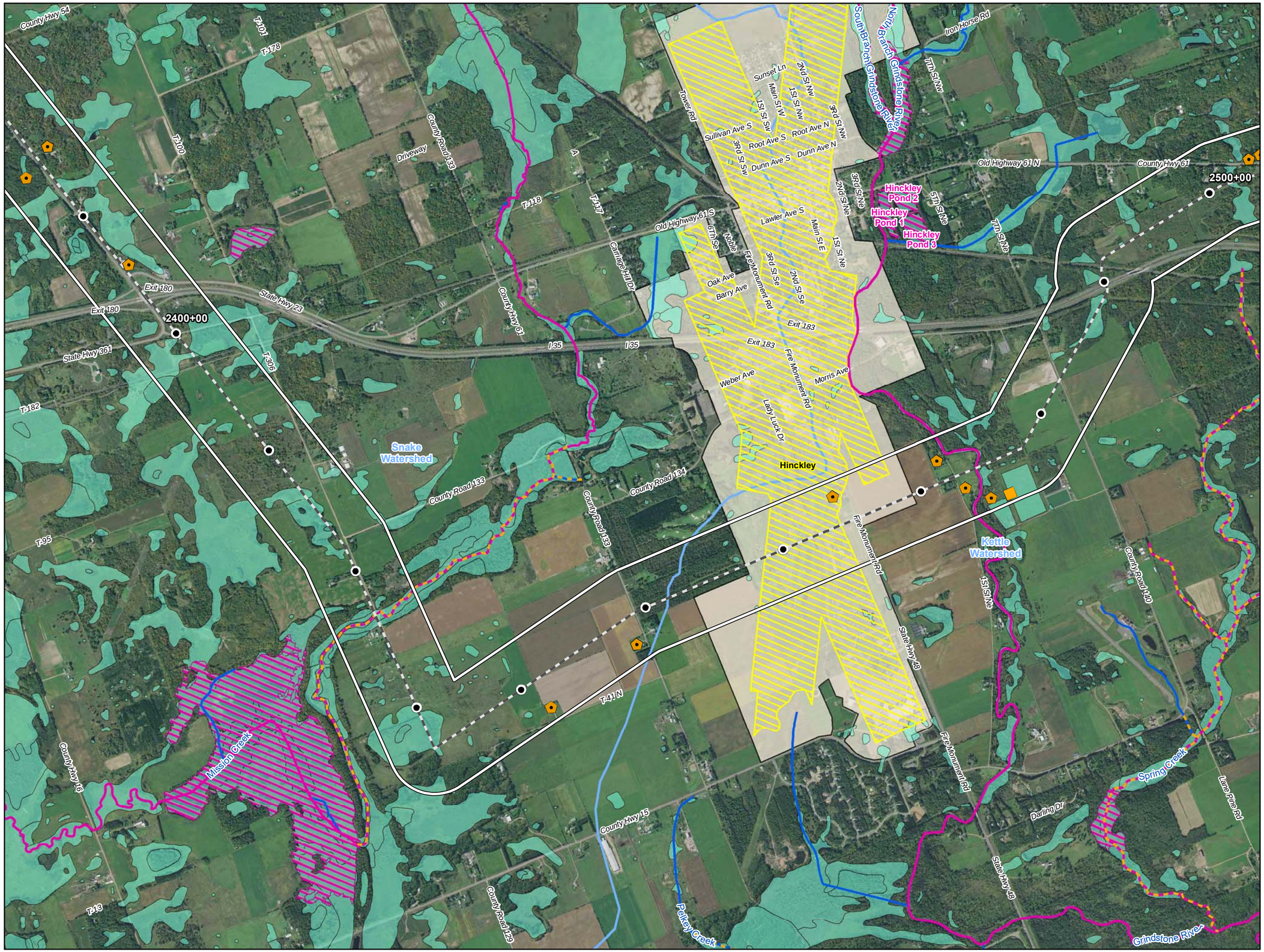
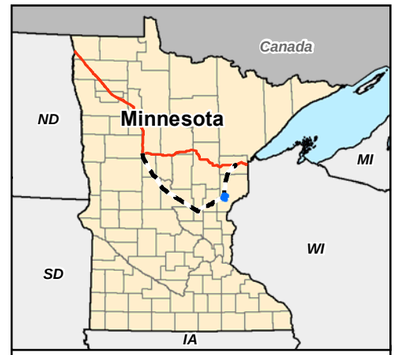
Date: (10/18/2016)





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- Trout Stream
- PWI Stream
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- PWI Basin
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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 32

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Pine County, Minnesota

ENBRIDGE

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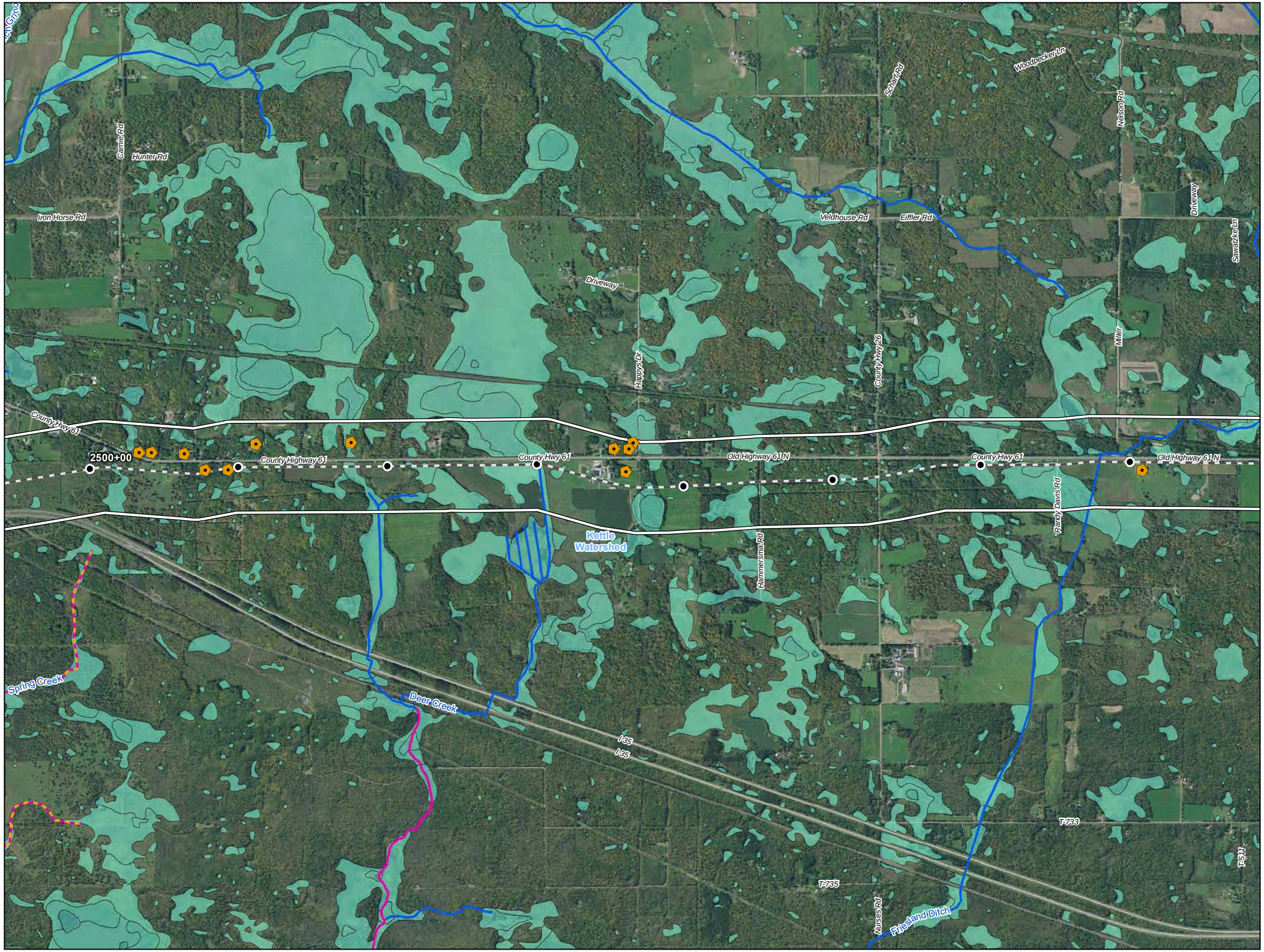
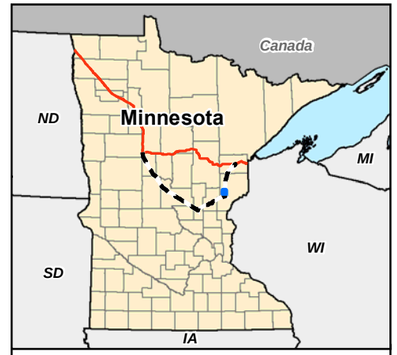
Date: (10/18/2016)





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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 33

Line 3 Replacement Project

RA-03AM-L3

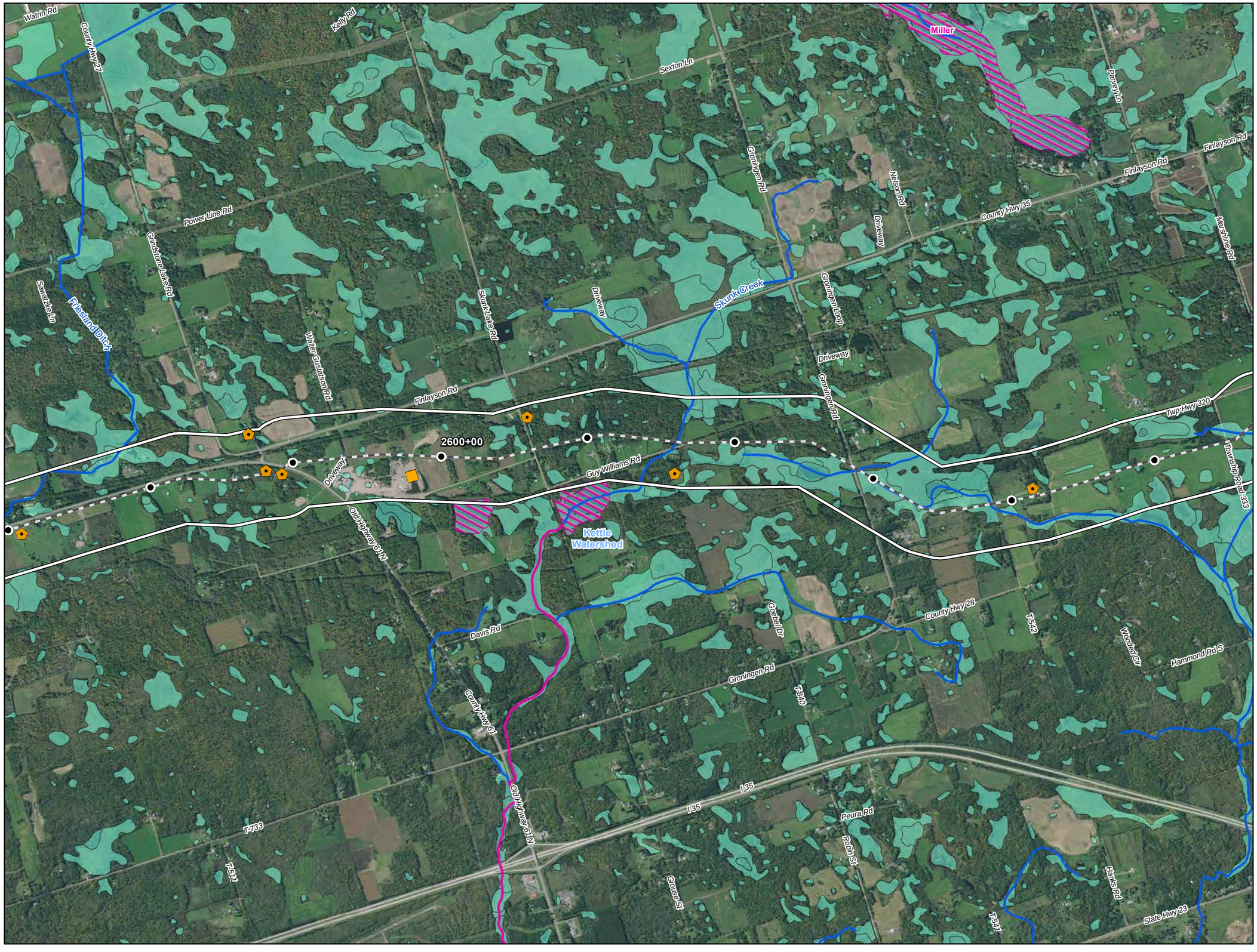
Enbridge

Pine County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd
Date: (10/18/2016)





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- DWSMA
- County Boundary

Figure 34

Line 3 Replacement Project

RA-03AM-L3

Enbridge

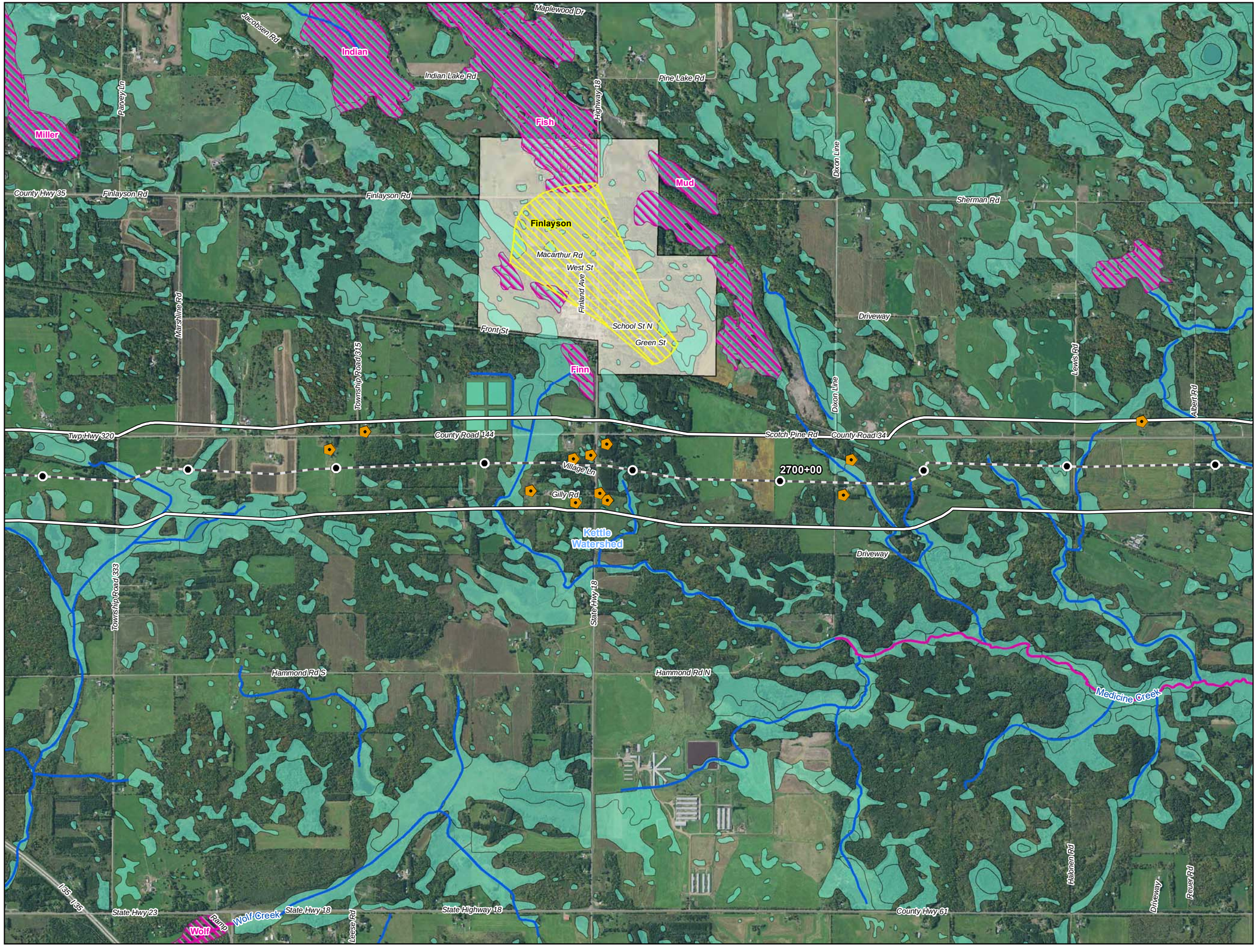
Pine County, Minnesota

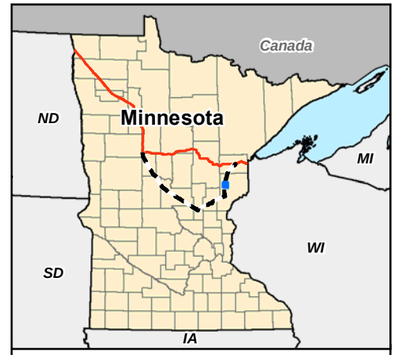
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)





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- DWSMA
- County Boundary

Figure 35

Line 3 Replacement Project

RA-03AM-L3

Enbridge

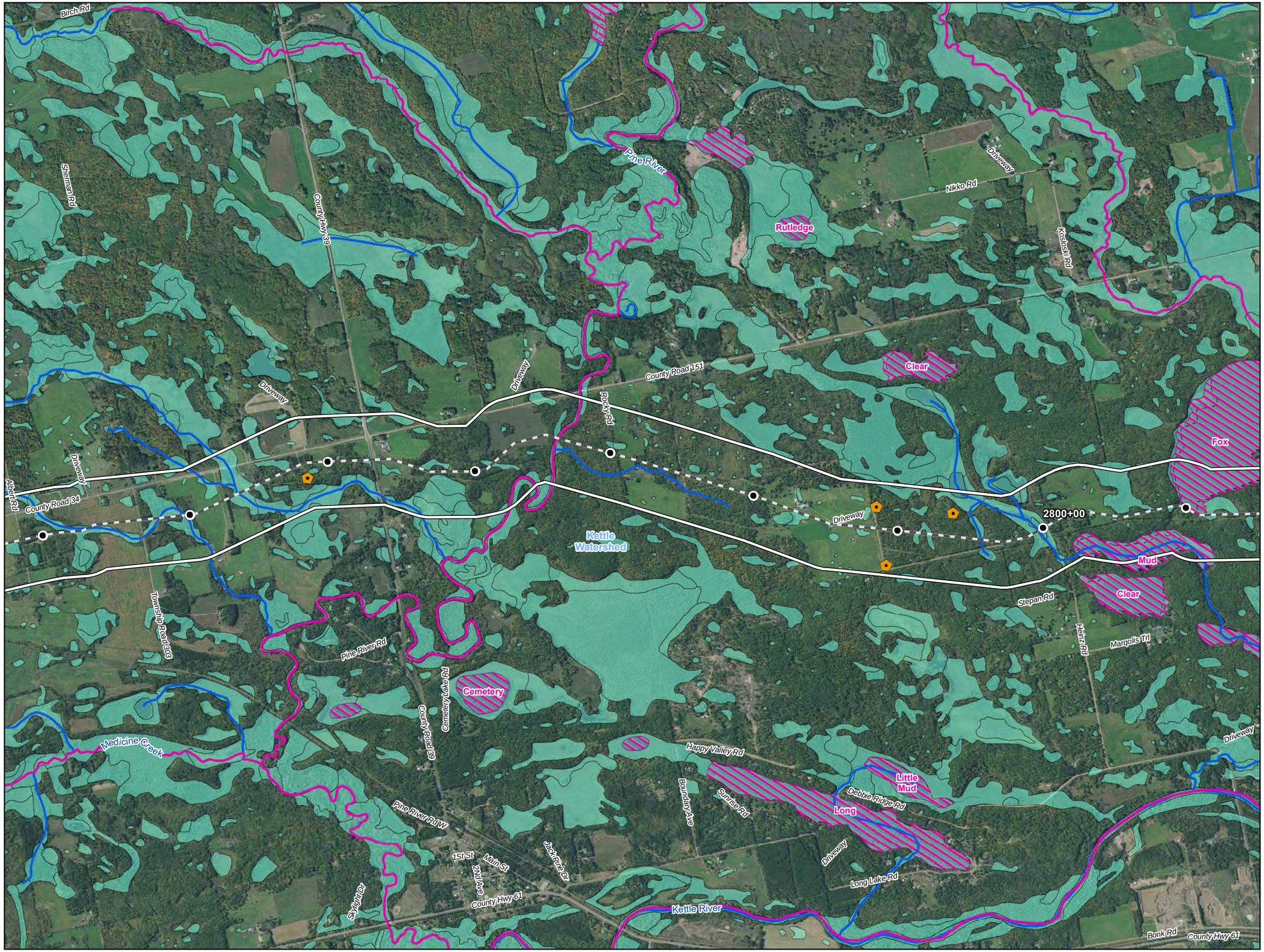
Pine County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_FR\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-03AM-L3.mxd

Date: (10/18/2016)



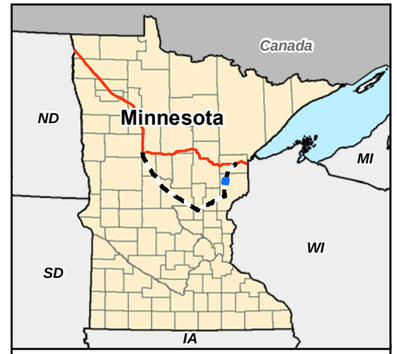


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Figure 36

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Pine County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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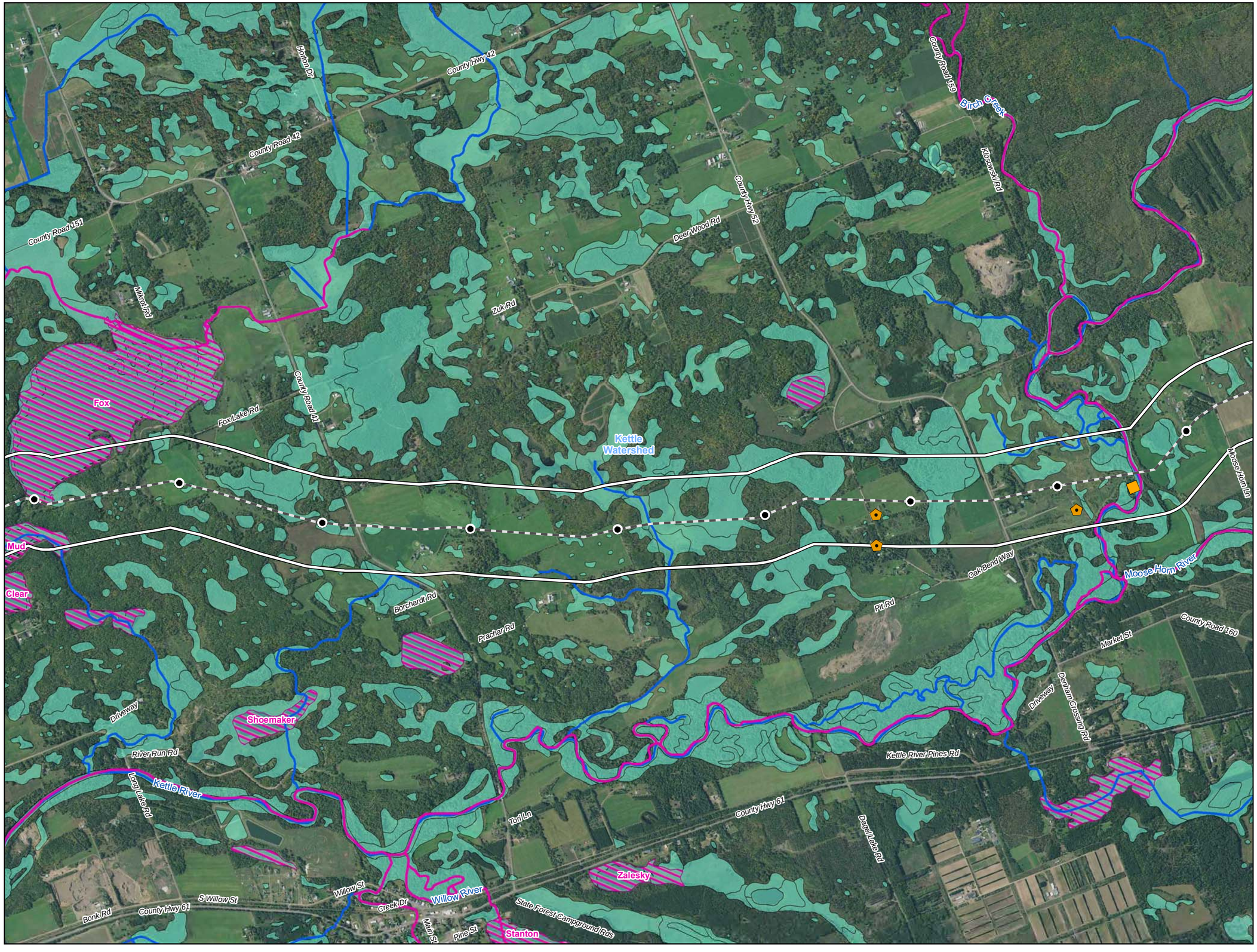



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Figure 37

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Pine County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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Date: (10/18/2016)

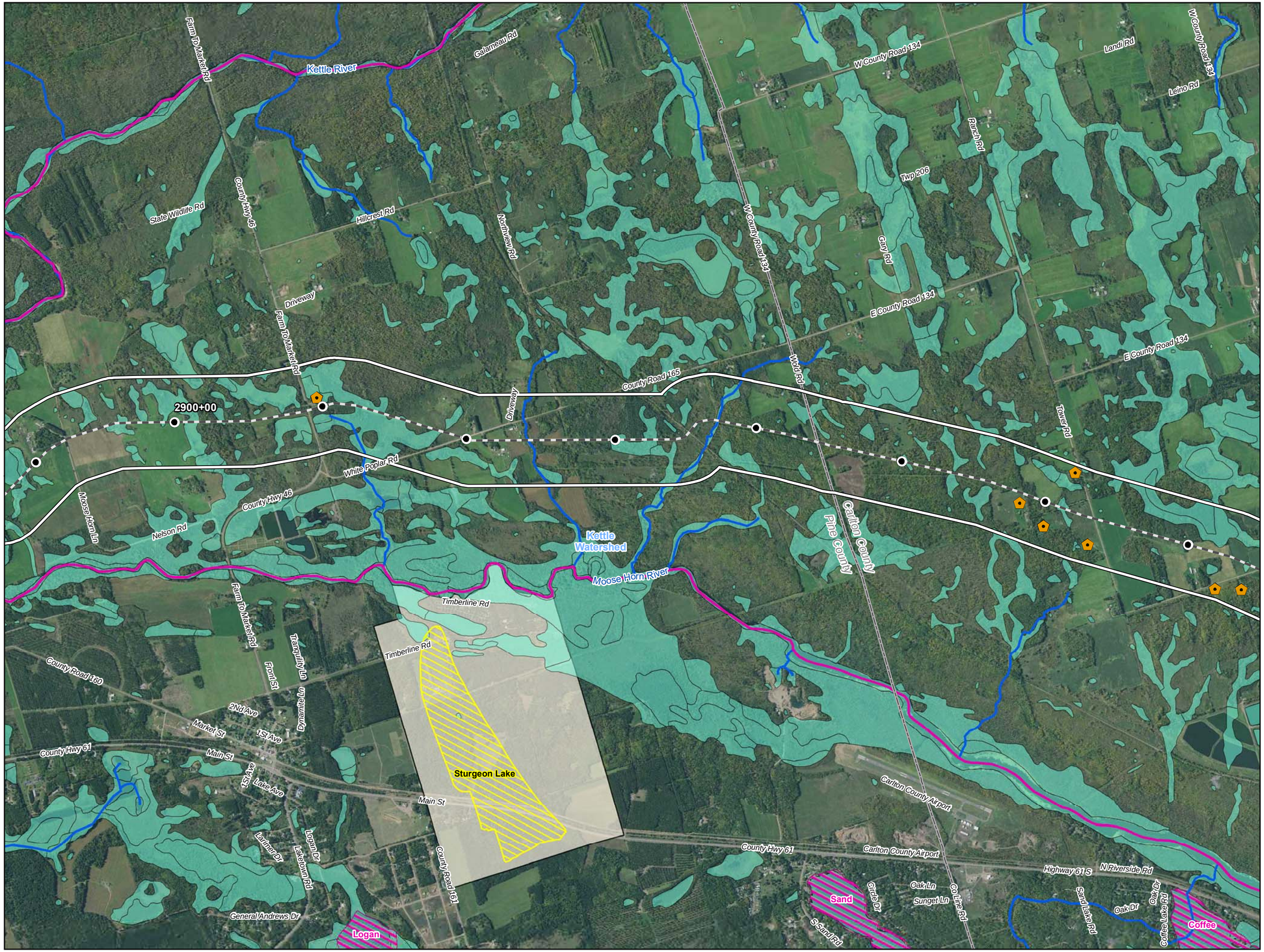

Figure 38

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Pine County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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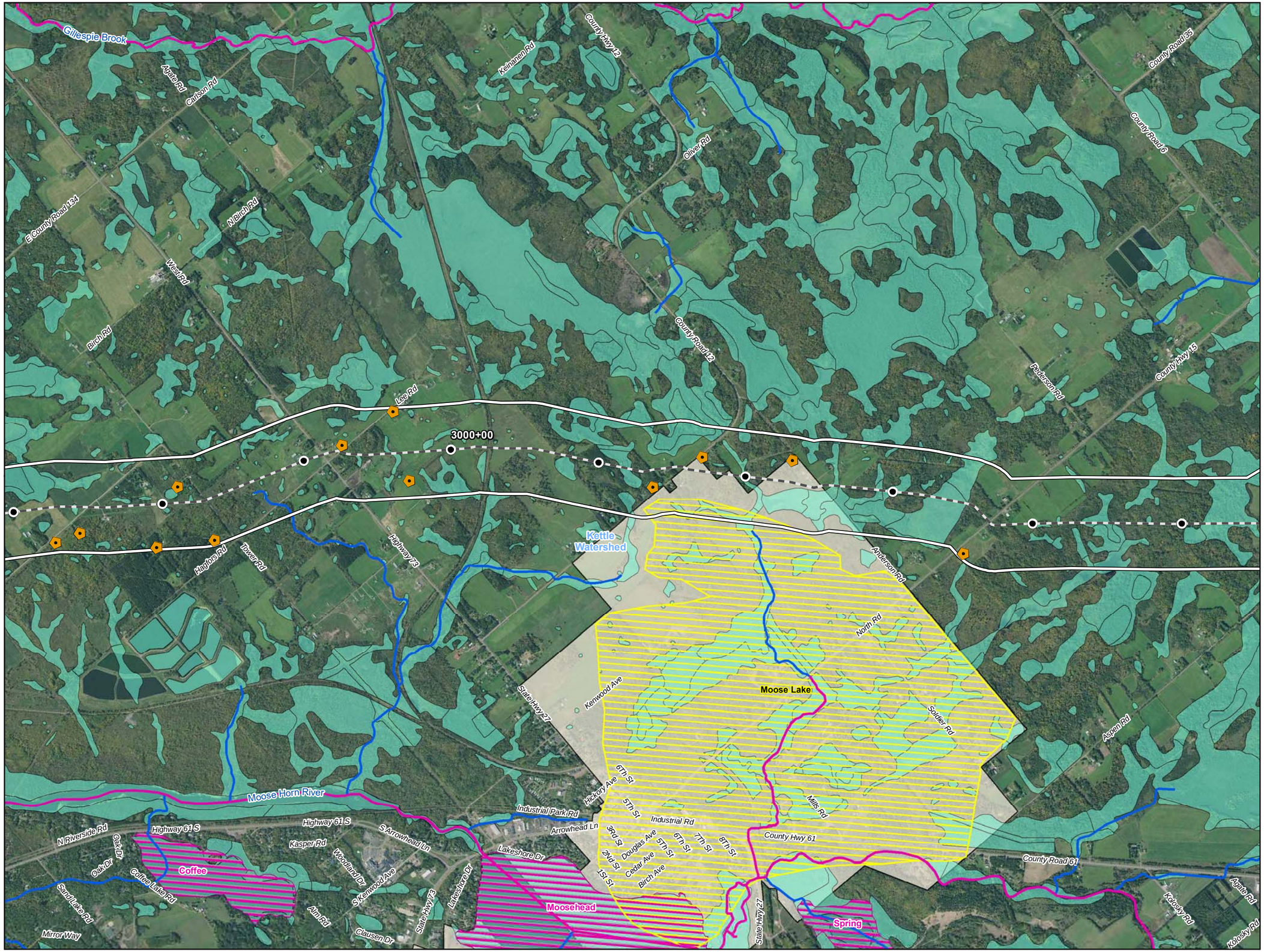
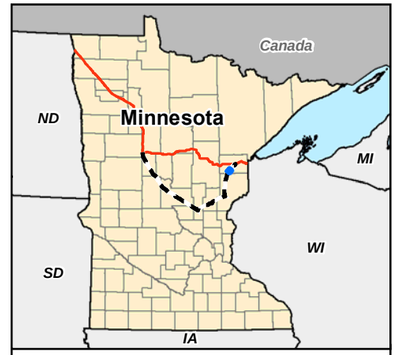
Date: (10/18/2016)





0 1,000 2,000 Feet

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- WHPA
- DWSMA
- County Boundary

Figure 39

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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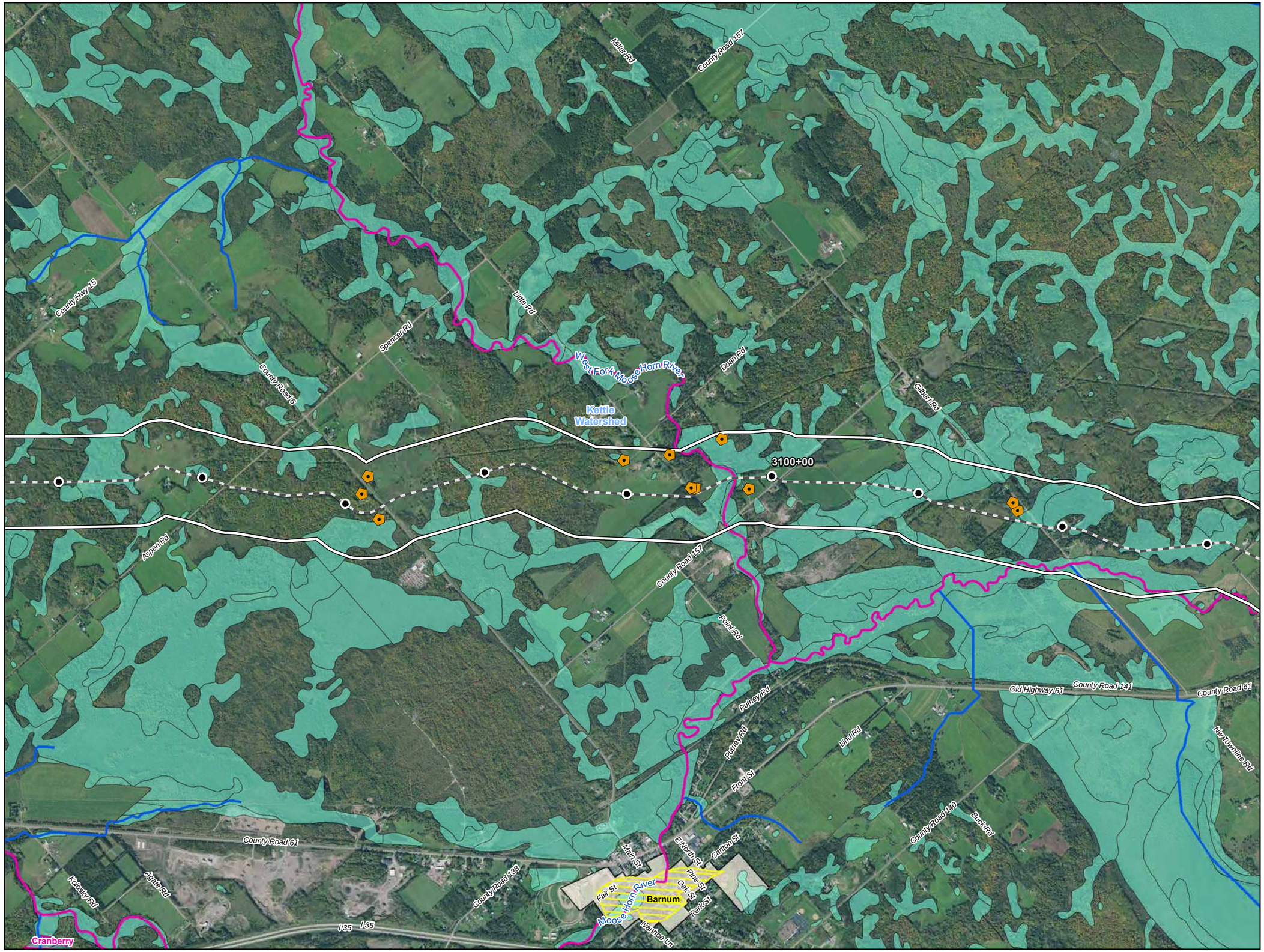
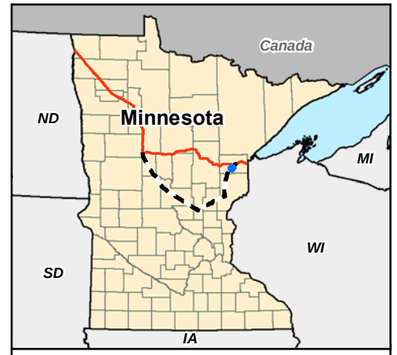
Date: (10/18/2016)





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- DWSMA
- County Boundary

Figure 40

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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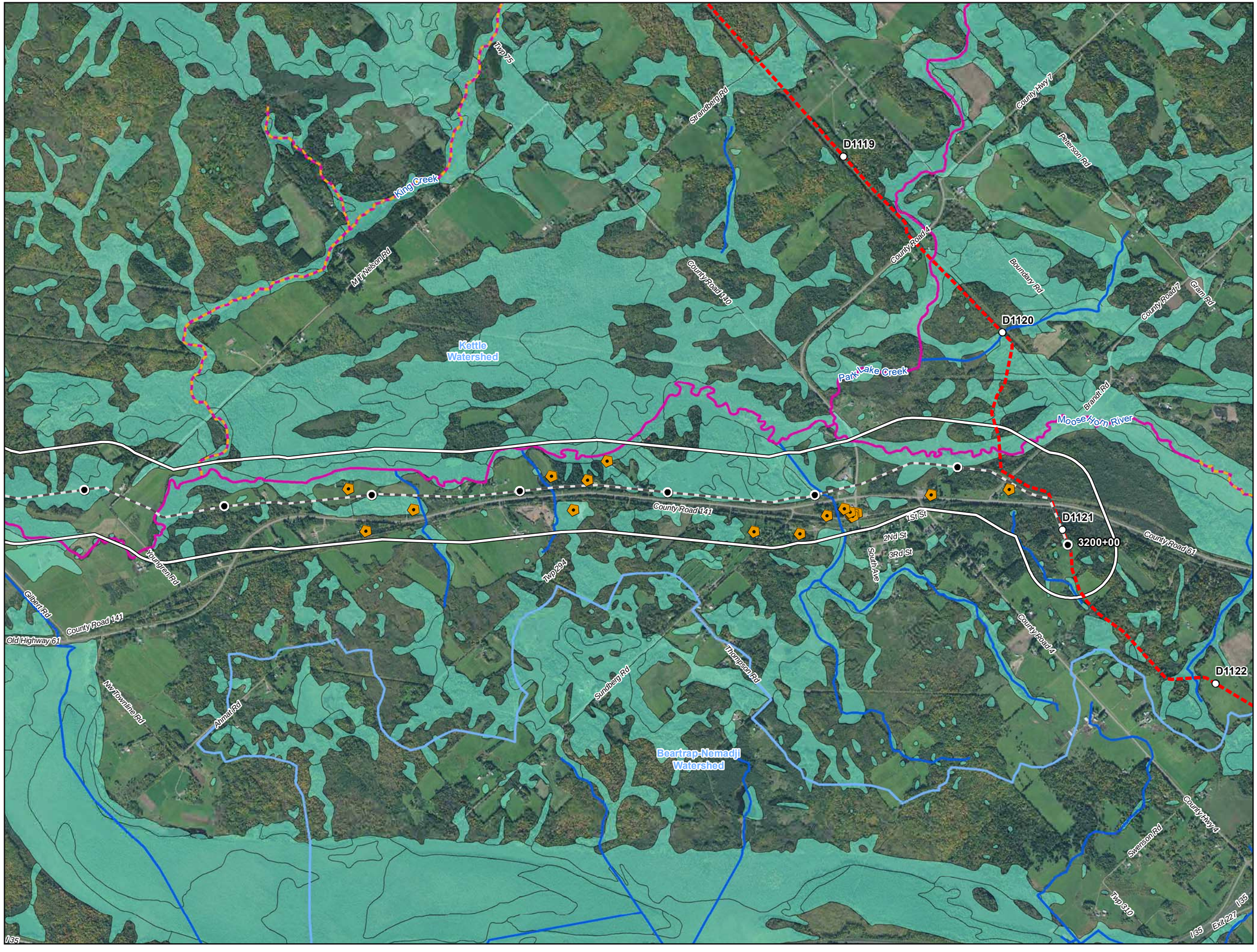
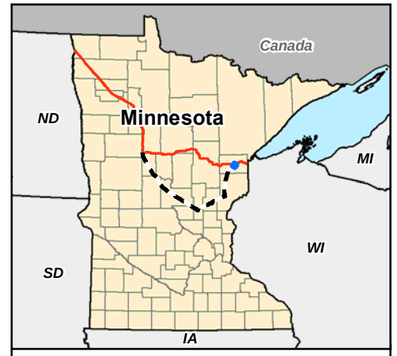
Date: (10/18/2016)





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- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 41

Line 3 Replacement Project

RA-03AM-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Alternative (RA)-06

DRAFT

Table 1
Line 3 Replacement Project – RA-06-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Clearwater	**7**	**3.6**
Clearwater	4	2.5
Beltrami	3	1.1
Red Lakes	**15**	**9.1**
Beltrami	15	9.1
Big Fork	**29**	**18.3**
Itasca	29	18.3
Little Fork	**6**	**4.5**
Itasca	6	4.5
Prairie-Willow	**4**	**2.2**
Itasca	4	2.2
St. Louis	**12**	**6.7**
Itasca	5	3.0
St. Louis	5	2.6
Carlton	2	1.1
Grand Total [c]	**73**	**44.3**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RA-06-L3
Summary of Waterbodies Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Clearwater	**4**	**6**	**1**	**11**	**1.7**	**5.4**	**0.3**	**7.3**
Clearwater	1	6	1	8	0.9	4.7	0.3	5.9
Beltrami	3			3	0.8	0.7		1.5
Red Lakes	**13**	**12**	**4**	**29**	**7.0**	**6.5**	**2.4**	**15.9**
Beltrami	13	12	4	29	7.0	6.5	2.4	15.9
Big Fork	**26**	**2**	**6**	**34**	**17.9**	**1.0**	**3.6**	**22.5**
Itasca	26	2	6	34	17.9	1.0	3.6	22.5
Little Fork	**5**	**4**	**2**	**11**	**4.2**	**2.5**	**1.2**	**7.9**
Itasca	5	4	2	11	4.2	2.5	1.2	7.9
Prairie-Willow	**4**	**1**	**2**	**7**	**3.3**	**1.2**	**1.5**	**6.0**
Itasca	4	1	2	7	3.3	1.2	1.5	6.0
St. Louis	**16**	**2**	**16**	**34**	**7.6**	**1.1**	**9.2**	**17.9**
Itasca	5		6	11	2.4	0.1	3.0	5.5
Aitkin			4	4			1.6	1.6
St. Louis	5	2	4	11	2.9	1.0	3.8	7.6
Carlton	6		2	8	2.3		0.9	3.2
Grand Total [c]	**68**	**27**	**31**	**126**	**41.7**	**17.7**	**18.3**	**77.7**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RA-06-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Clearwater	**0.5**	**1.4**	**-**	**1.9**	**166.8**	**250.3**	**10.7**	**427.8**
Clearwater	0.5	1.2	-	1.7	163.2	217.3	2.6	383.0
Beltrami	0.0	0.2	-	0.2	3.7	33.1	8.1	44.8
Red Lakes	**3.5**	**6.6**	**0.7**	**10.8**	**688.9**	**1553.5**	**175.4**	**2417.8**
Beltrami	3.4	5.4	0.7	9.4	662.0	1266.7	173.6	2102.4
Itasca	0.1	1.2	<0.1	1.4	26.9	286.7	1.8	315.5
Mississippi Headwaters	**-**	**0.5**	**-**	**0.5**	**5.3**	**104.9**	**0.9**	**111.1**
Itasca	-	0.5	-	0.5	5.3	104.9	0.9	111.1
Big Fork	**2.5**	**10.2**	**1.6**	**14.2**	**589.6**	**2629.1**	**390.5**	**3609.2**
Itasca	2.5	10.2	1.6	14.2	589.6	2629.1	390.5	3609.2
Little Fork	**0.2**	**7.5**	**0.1**	**7.7**	**88.4**	**1638.9**	**51.8**	**1779.1**
Itasca	0.2	7.5	0.1	7.7	88.4	1638.9	51.8	1779.1
Prairie-Willow	**1.1**	**3.8**	**2.4**	**7.3**	**268.0**	**947.5**	**415.3**	**1630.9**
Itasca	1.1	3.8	2.4	7.3	268.0	947.5	415.3	1630.9
St. Louis	**1.3**	**21.1**	**1.9**	**24.3**	**288.0**	**5391.3**	**439.6**	**6118.9**
Itasca	0.3	7.5	1.8	9.6	104.9	1789.9	406.9	2301.7
Aitkin	-	0.8	-	0.8	-	159.7	-	159.7
St. Louis	0.4	6.9	<0.1	7.3	71.3	2056.0	17.8	2145.0
Carlton	0.6	6.0	0.1	6.7	111.8	1385.8	14.9	1512.5
Kettle	**0.5**	**0.2**	**<0.1**	**0.7**	**54.2**	**78.1**	**1.4**	**133.7**
Carlton	0.5	0.2	<0.1	0.7	54.2	78.1	1.4	133.7
Beartrap-Nemadji	-	**-**	**-**	**-**	-	**0.4**	**0.9**	**1.3**
Carlton	**-**	-	-	-	**-**	0.4	0.9	1.3
Grand Total [d]	**9.5**	**51.2**	**6.7**	**67.5**	**2149.3**	**12594.0**	**1486.5**	**16229.8**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route alternative centerline.

b Total acres of NWI within the 2000-ft-wide route alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RA-06-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	Miles Crossed by the Route Alternative Centerline [a]		Acres Within the Route Alternative Corridor [b]	
County	Wetlands	Basins	Wetlands	Basins
Clearwater	**-**	**-**	**8.5**	**2.5**
Clearwater	-	-	8.5	2.5
Red Lakes	**0.1**	**1.0**	**33.8**	**188.8**
Beltrami	0.1	1.0	33.8	188.8
Big Fork	**0.2**	**1.0**	**28.4**	**298.4**
Itasca	0.2	1.0	28.4	298.4
Little Fork	**-**	**-**	**-**	**3.7**
Itasca	-	-	-	3.7
Prairie-Willow	**-**	**1.1**	**-**	**219.3**
Itasca	-	1.1	-	219.3
St. Louis	**0.1**	**1.9**	**34.7**	**410.7**
Itasca	0.1	1.9	34.7	410.7
Grand Total [c]	**0.4**	**5.0**	**105.3**	**1123.5**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the route alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RA-06-L3
Summary of Trout Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Clearwater	**3**	**1.1**
Beltrami	3	1.1
Red Lakes	**3**	**1.1**
Beltrami	3	1.1
Little Fork	**2**	**2.3**
Itasca	2	2.3
St. Louis	**2**	**1.9**
Itasca	1	0.6
Carlton	1	1.3
Grand Total [c]	**10**	**6.5**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RA-06-L3
Wells within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Clearwater	Clearwater	Domestic	859	4
			681	
			490	
			383	
		Industrial	502	2
			413	
		Monitoring	40	2
			292	
Red Lake	Beltrami	Domestic	621	8
			487	
			47	
			555	
			813	
			367	
			714	
			231	
		Unknown	238	1
Big Fork	Itasca	Abandoned	705	1
		Domestic	365	9
			586	
			855	
			748	
			15	
			83	
			238	
			839	
			189	
		Exploration	412	4
			913	
			441	
			343	
		Other	421	1
		Test Well	705	1
Little Fork	Itasca	Exploration	877	4
			816	
			304	
			127	
Prairie-Willow	Itasca	Abandoned	258	9
			262	

Prairie-Willow (cont.)	Itasca (cont.)	Abandoned (cont.)	273	9 (cont.)
			338	
			371	
			431	
			445	
			582	
			602	
		Elevator	647	1
		Exploration	888	225
			876	
			875	
			875	
			875	
			875	
			874	
			874	
			874	
			874	
			874	
			873	
			873	
			873	
			872	
			855	
			785	
			784	
			784	
			783	
			782	
			774	
			774	
			774	
			774	
			773	
			773	
			773	
			771	
			692	
			676	
			675	
			675	
			675	
			675	
			675	

Prairie-Willow (cont.)	Itasca (cont.)	Exploration (cont.)	675	225 (cont.)
			674	
			674	
			674	
			674	
			673	
			673	
			673	
			673	
			492	
			489	
			485	
			484	
			483	
			483	
			483	
			479	
			475	
			475	
			475	
			475	
			474	
			474	
			474	
			474	
			474	
			474	
			473	
			473	
			473	
			473	
			472	
			472	
			472	
			472	
			472	
			472	
			394	
			382	
			367	
			318	
			308	
			275	
			275	

Prairie-Willow (cont.)	Itasca (cont.)	Exploration (cont.)	274	225 (cont.)
			274	
			274	
			274	
			274	
			274	
			274	
			274	
			273	
			273	
			273	
			273	
			273	
			185	
			184	
			184	
			184	
			183	
			174	
			174	
			173	
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			173	
			172	
			75	
			75	
			75	
			75	
			74	
			74	
			74	
			74	
			74	
			74	
			73	
			73	
			73	
			73	
			73	
			72	
			72	
			98	
			115	
			116	

Prairie-Willow (cont.)	Itasca (cont.)	Exploration (cont.)	116	225 (cont.)
			117	
			118	
			118	
			125	
			125	
			125	
			126	
			126	
			126	
			126	
			126	
			126	
			126	
			127	
			128	
			128	
			128	
			128	
			128	
			130	
			136	
			280	
			325	
			325	
			325	
			326	
			326	
			326	
			327	
			327	
			328	
			328	
			336	
			342	
			343	
			346	
			370	
			415	
			416	
			416	
			417	
			417	
			418	

Prairie-Willow (cont.)	Itasca (cont.)	Exploration (cont.)	418	225 (cont.)
			426	
			426	
			427	
			443	
			444	
			444	
			488	
			505	
			522	
			524	
			525	
			525	
			525	
			526	
			526	
			526	
			526	
			527	
			527	
			527	
			528	
			534	
			540	
			595	
			644	
			645	
			648	
			715	
			715	
			716	
			716	
			717	
			717	
			717	
			718	
			725	
			726	
			726	
			727	
			727	
			728	
			728	
			728	

Prairie-Willow (cont.)	Itasca (cont.)	Exploration (cont.)	729	225 (cont.)
			752	
			881	
			925	
			926	
			926	
			926	
			927	
			928	
			928	
			937	
			937	
			973	
		Scientific Investigation	968	5
			943	
			659	
			240	
			876	
St. Louis	St. Louis	Abandoned	2	3
			7	
			10	
		Domestic	259	5
			284	
			588	
			749	
			728	
		Monitoring	426	8
			270	
			9	
			56	
			108	
			388	
			274	
			386	
	Carlton	Domestic	4	16
			732	
			904	
			634	
			609	
			515	
			94	
			561	
			293	
			435	

St. Louis (cont.)	Carlton (cont.)	Domestic (cont.)	21	16 (cont.)
			655	
			576	
			254	
			147	
			35	
		Monitoring	752	3
			693	
			747	
		Other	56	3
			54	
			54	
County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip a Municipal wells are not included in the source data.				

Table 7
Line 3 Replacement Project – RA-06-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Route Alternative Centerline [b]	Acres Within the Route Alternative Corridor [c]
Prairie Willow	Itasca	8961+00 8967+00 8990+00 8992+00	Keetac WHPA (2 crossings)	0.9	205.8
			Keetac DWSMA (2 crossings)	1.2	287.1
Prairie Willow	Itasca	8990+00 8992+00 9020+00 9022+00	Keewatin WHPA (2 crossings)	1.0	231.2
			Keewatin DWSMA (2 crossings)	1.2	282.2

DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest route alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the route alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide route alternative corridor.

Table 8
Line 3 Replacement Project – RA-06-L3
Surface Water Intakes within the 2,000-ft-wide Route Alternative Corridor in Minnesota [a]

Watershed Name	County	Permit Type	Permit Status	Total
Clearwater	Clearwater	General Permit Authorization	Active	1
			Inactive	4
		Individual Permit	Inactive	11
Big Fork	Itasca	Individual Permit	Inactive	1
Prairie-Willow	Itasca	General Permit Authorization	Active	1
		Individual Permit	Active	2
			Inactive	1
Little Fork	Itasca	Individual Permit	Inactive	1
Prairie-Willow	Itasca	Individual Permit	Active	3
Little Fork	Itasca	Individual Permit	Inactive	1
Prairie-Willow	Itasca	Individual Permit	Inactive	2
St. Louis	Aitkin	General Permit Authorization	Inactive	1
	St. Louis	General Permit Authorization	Active	1
			Inactive	36
		Individual Permit	Inactive	1
	Carlton	General Permit Authorization	Inactive	11
		Individual Permit	Inactive	4
Kettle	Carlton	General Permit Authorization	Inactive	1
St. Louis	Carlton	General Permit Authorization	Active	4
			Inactive	3
		Individual Permit	Inactive	2

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.

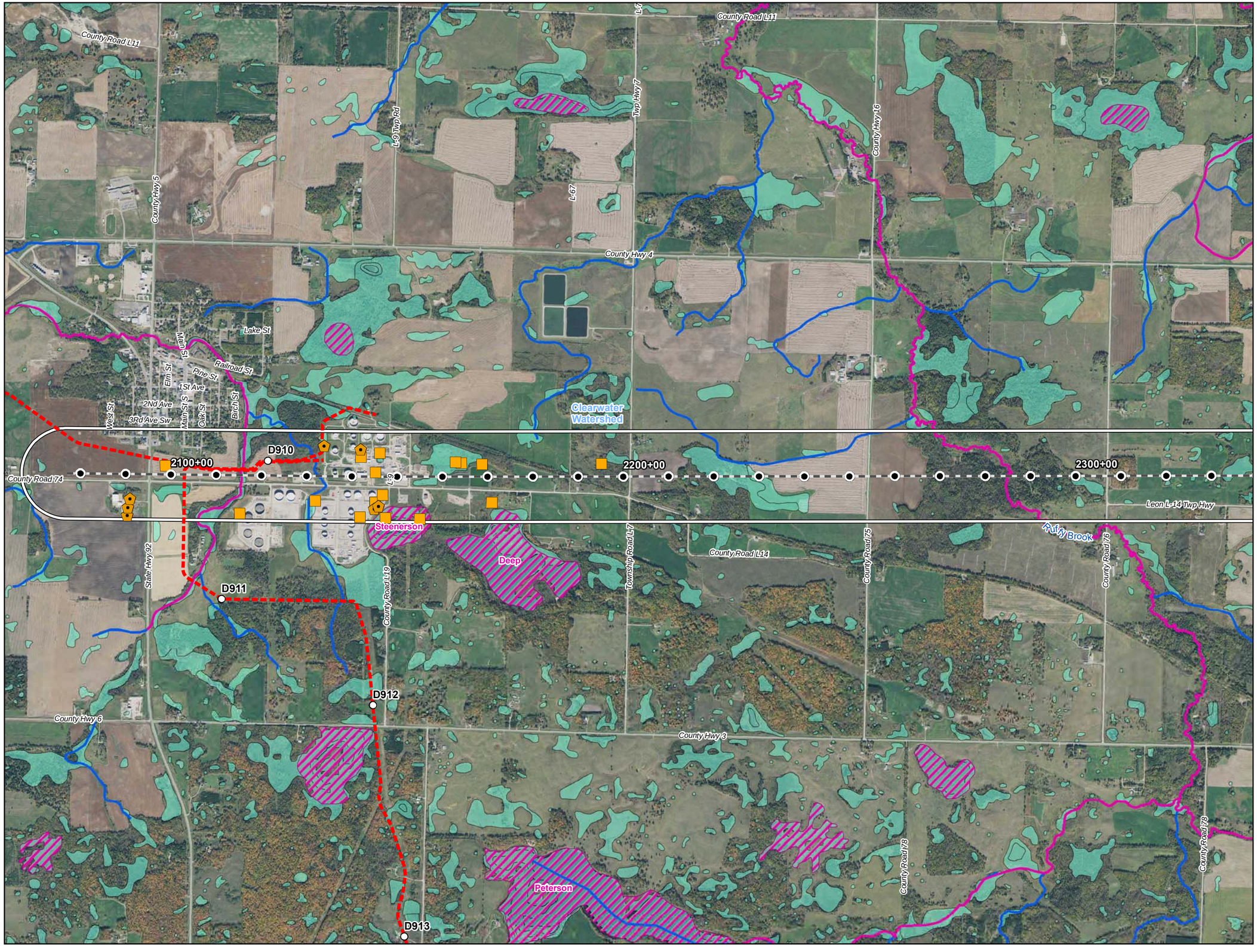

Figure 1

Line 3 Replacement Project

RA-06-L3

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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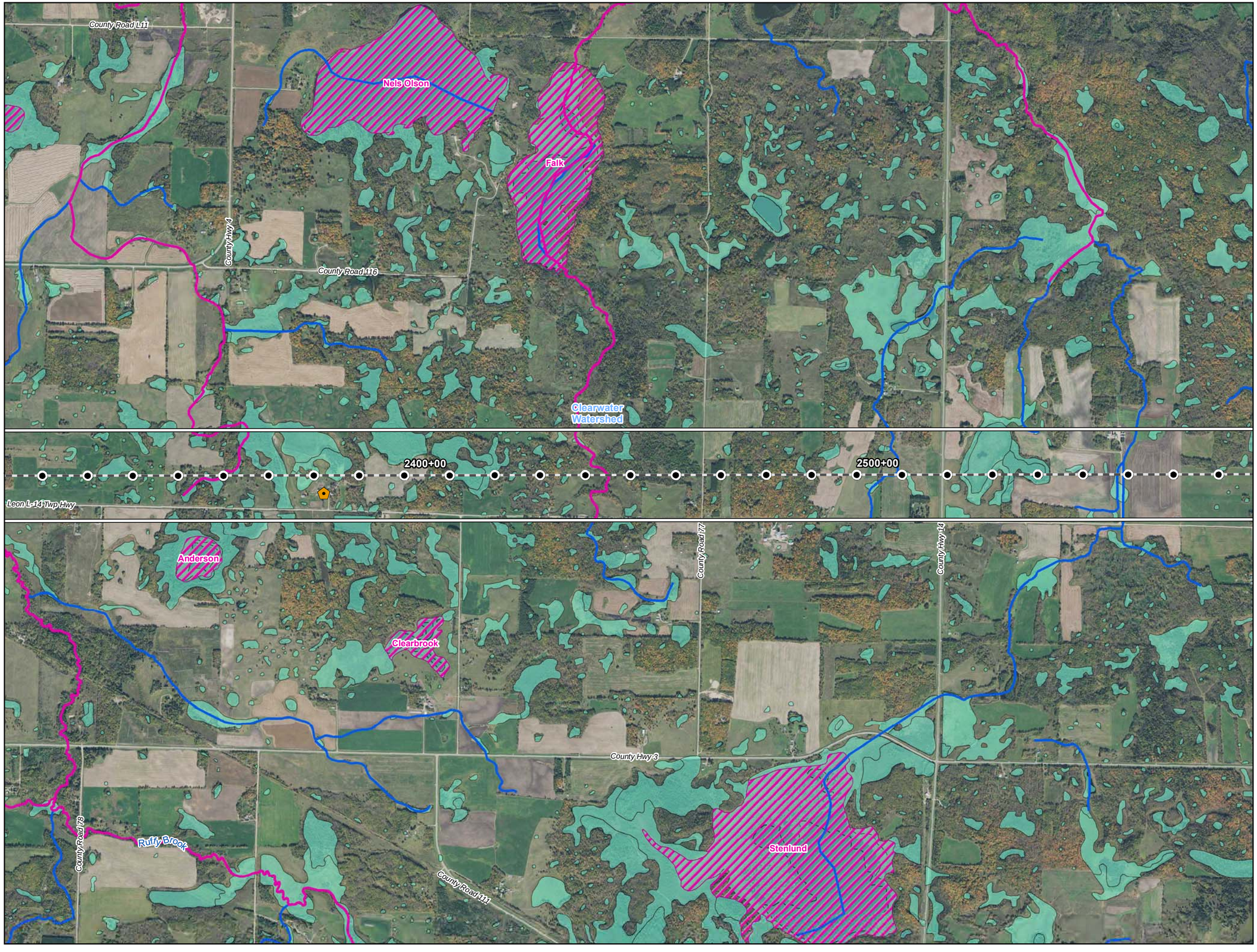
Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RA-06-L3

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Clearwater County, Minnesota

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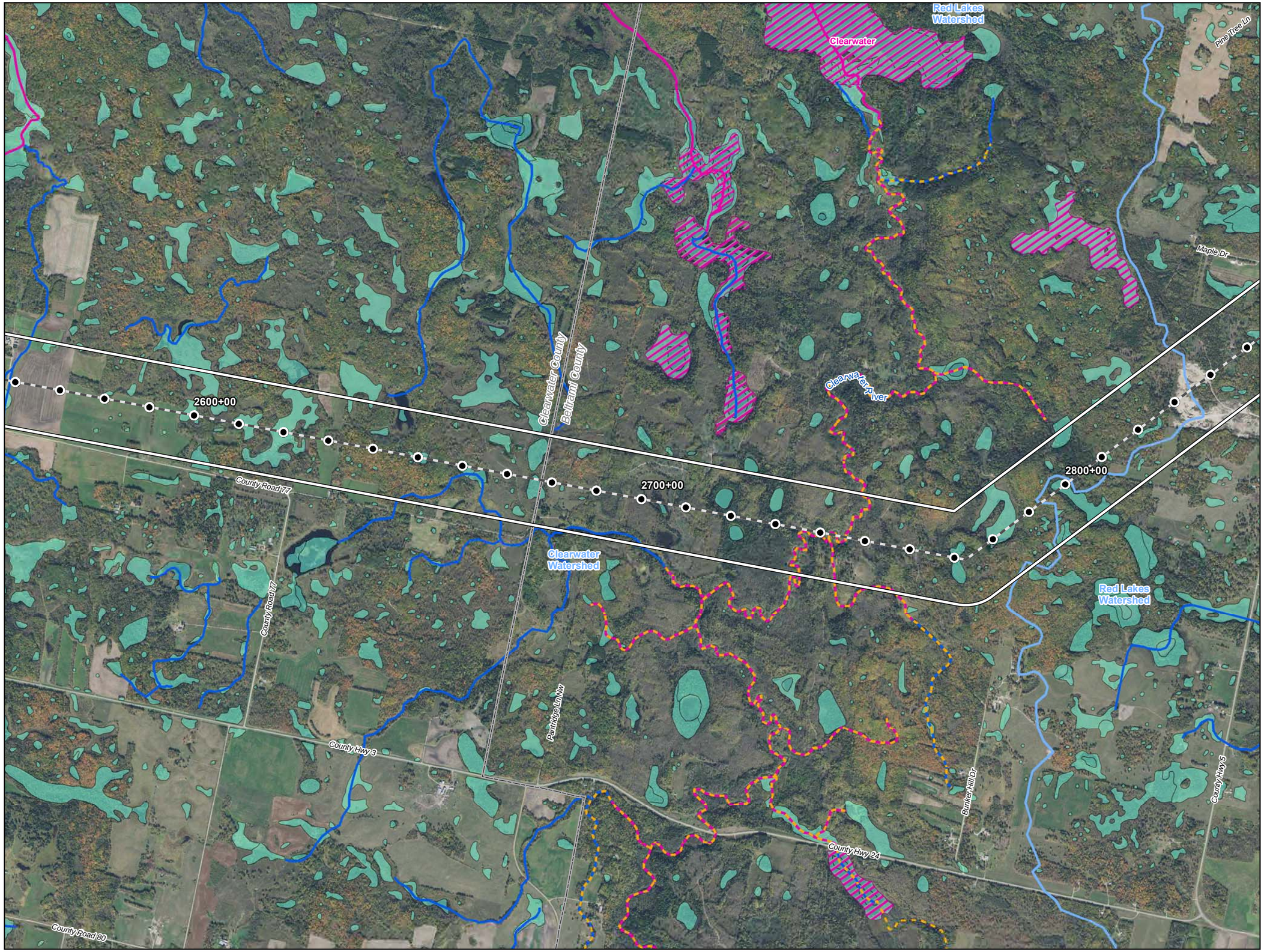



0 1,000 2,000 Feet

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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 3

Line 3 Replacement Project

RA-06-L3

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Beltrami County, Minnesota

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-06-L3.mxd

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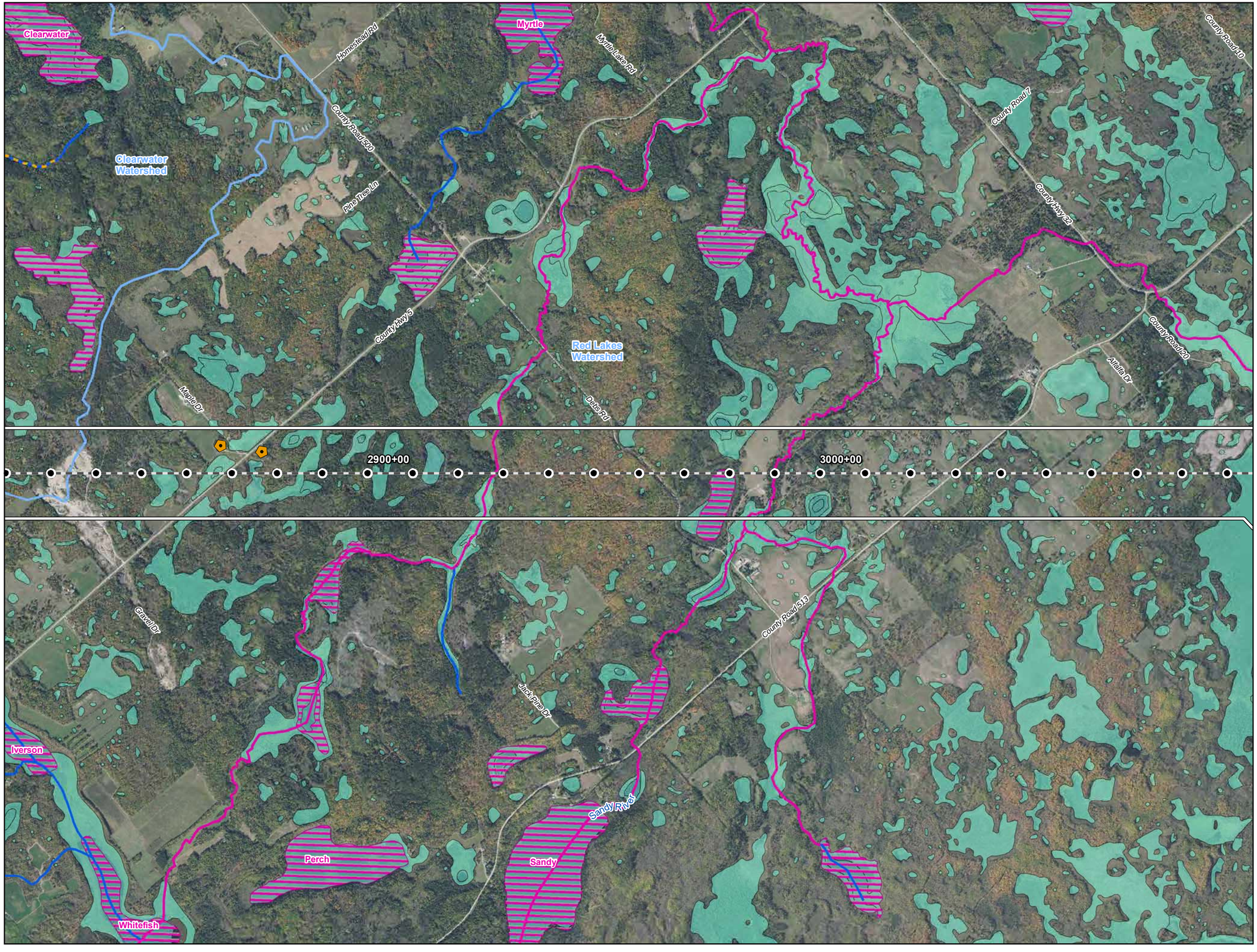



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
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- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 4

Line 3 Replacement Project

RA-06-L3

Enbridge

Beltrami County, Minnesota

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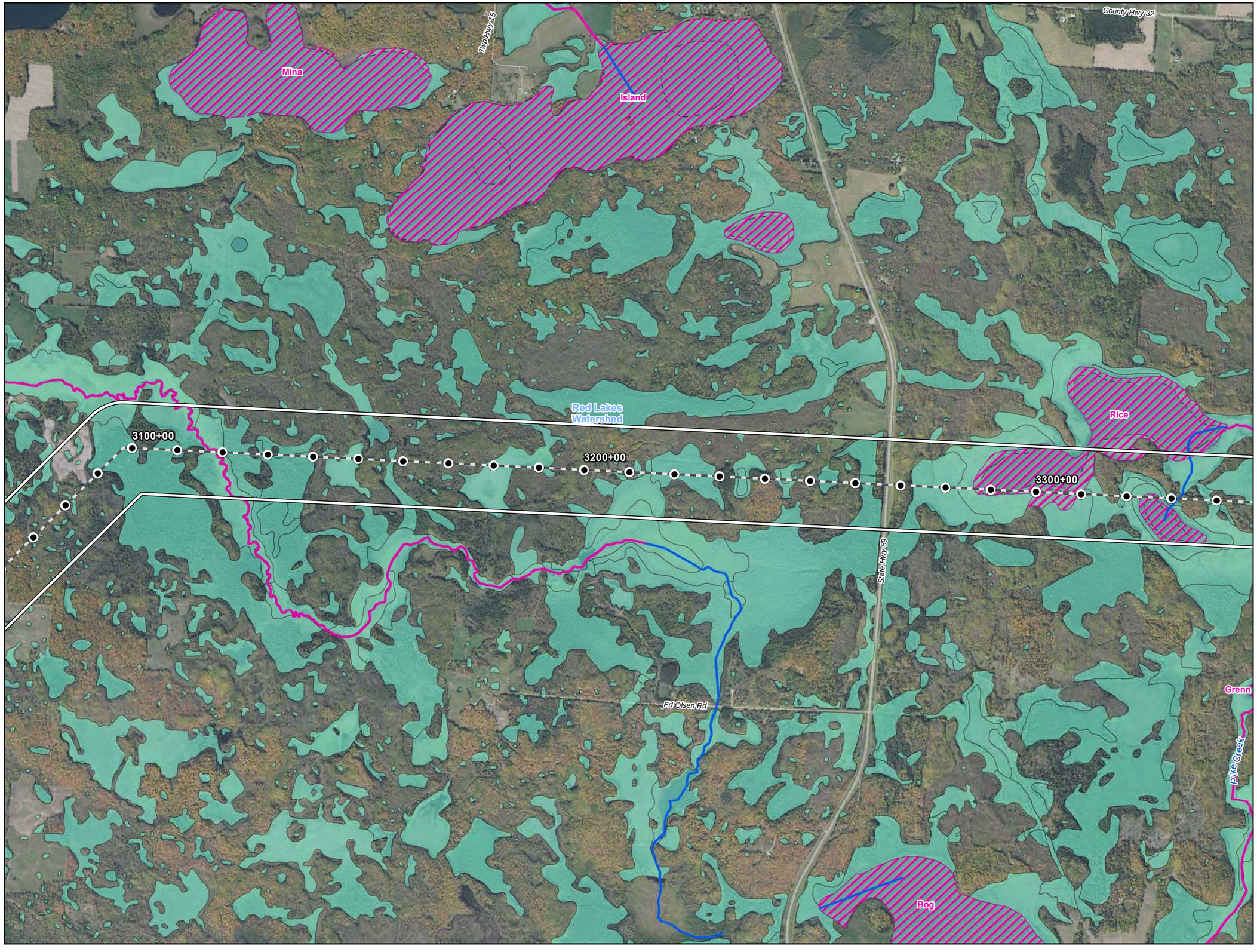



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
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- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 5

Line 3 Replacement Project

RA-06-L3

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Beltrami County, Minnesota

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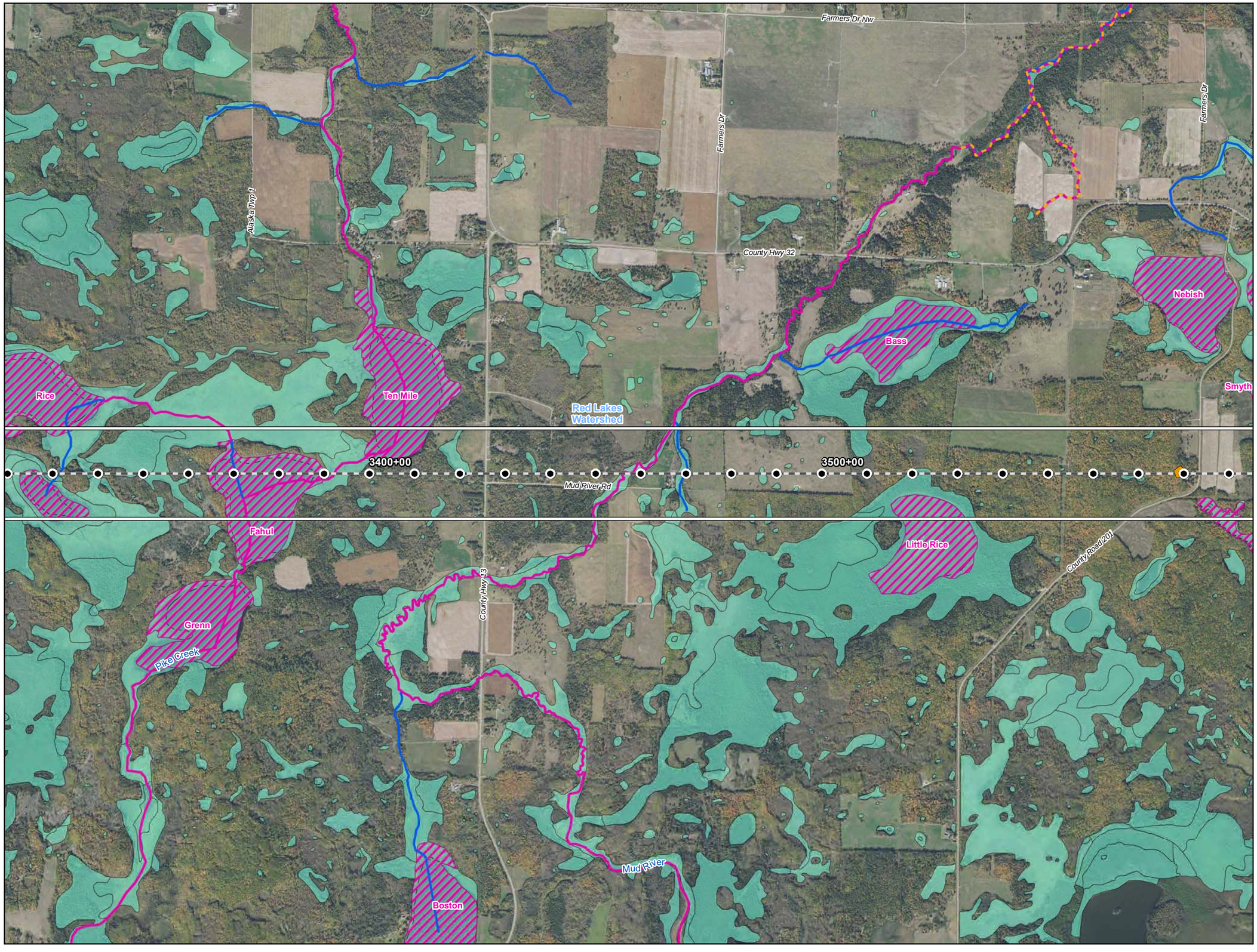



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
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- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 6

Line 3 Replacement Project

RA-06-L3

Enbridge

Beltrami County, Minnesota

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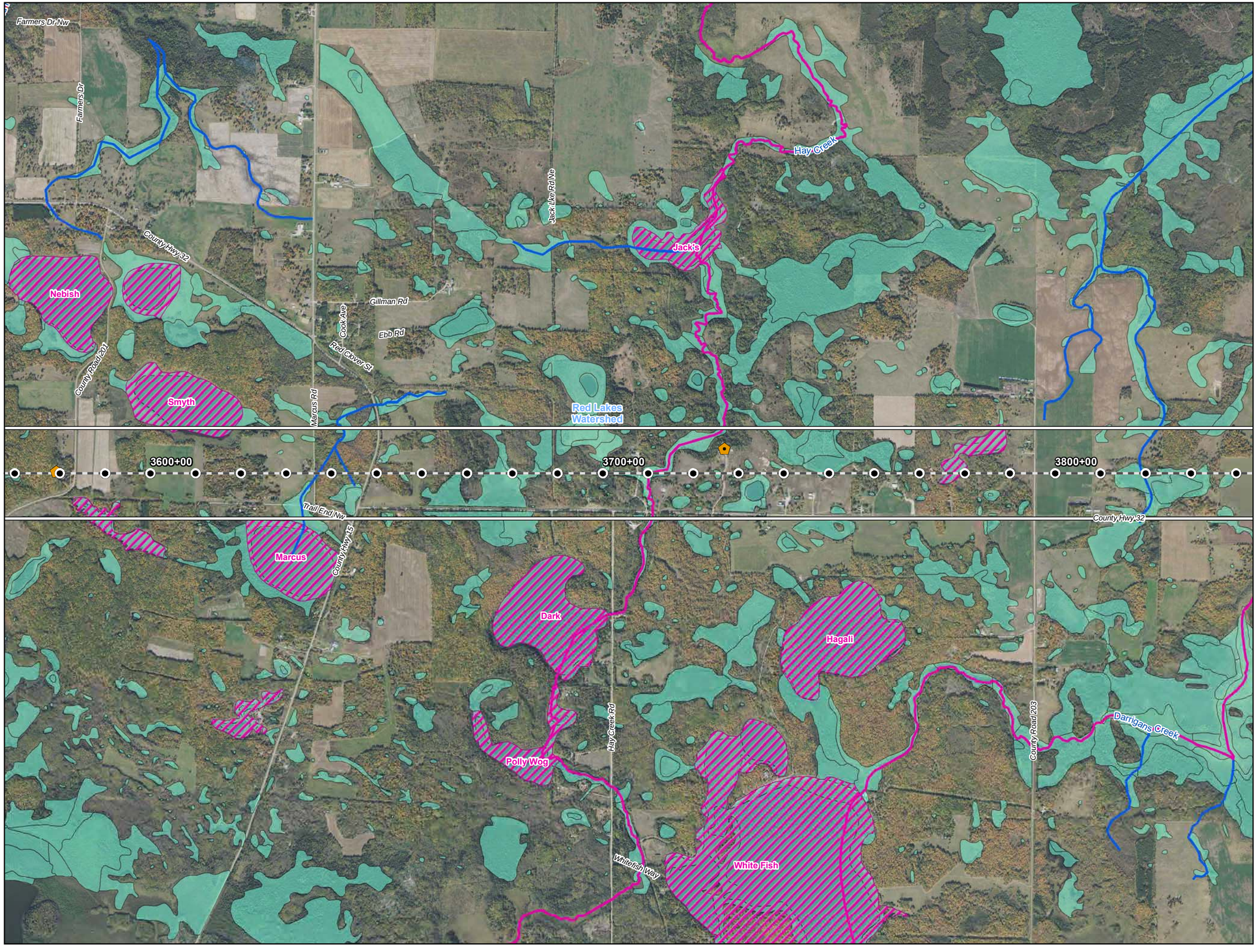



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 7

Line 3 Replacement Project

RA-06-L3

Enbridge

Beltrami County, Minnesota

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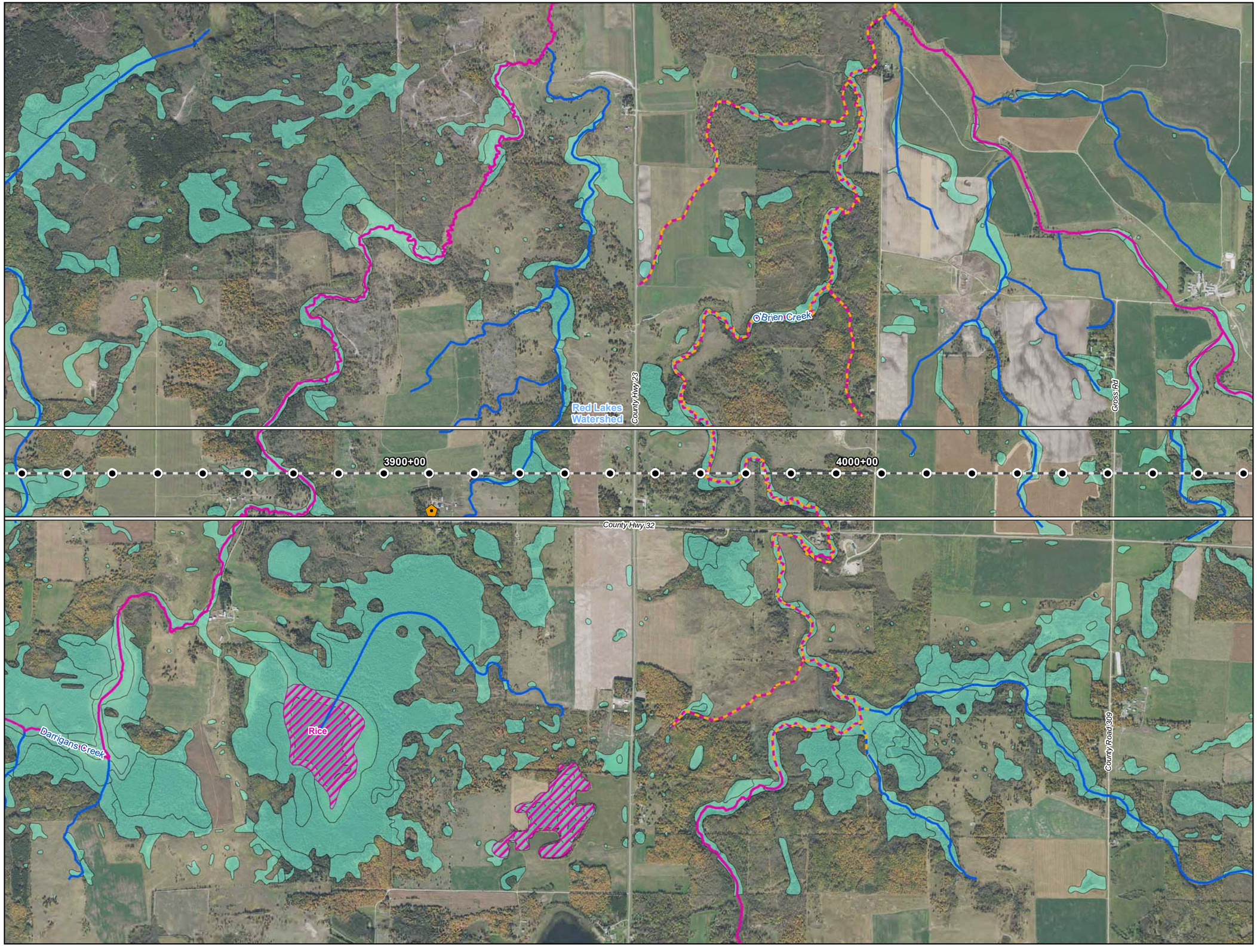



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
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- Proposed Line 3 Replacement Pipeline
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- 2,000 ft Alternative Corridor
- Trout Stream
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- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 8

Line 3 Replacement Project

RA-06-L3

Enbridge

Beltrami County, Minnesota

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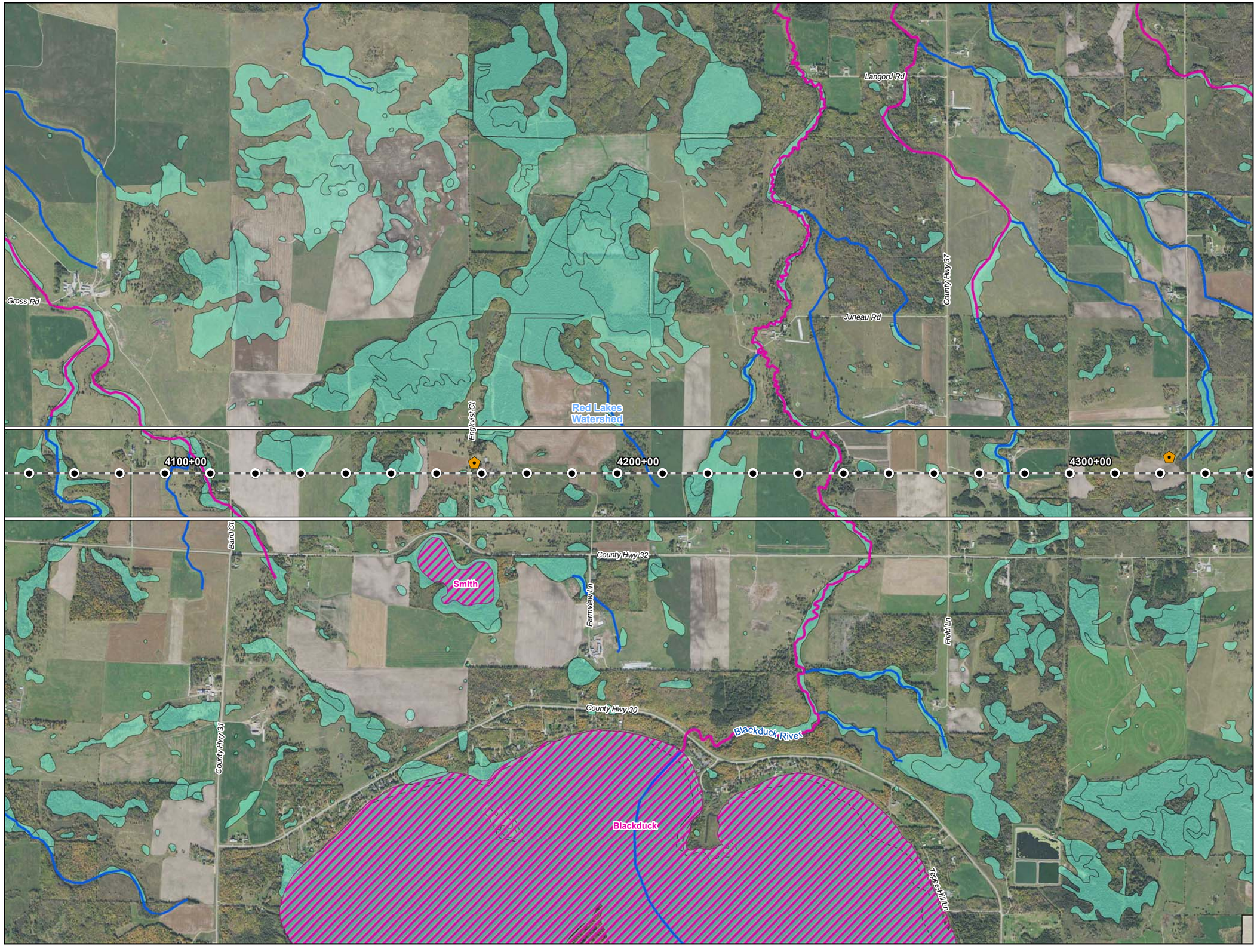



0 1,000 2,000 Feet

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N W E S

- Water Well
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- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 9

Line 3 Replacement Project

RA-06-L3

Enbridge

Beltrami County, Minnesota

ENBRIDGE

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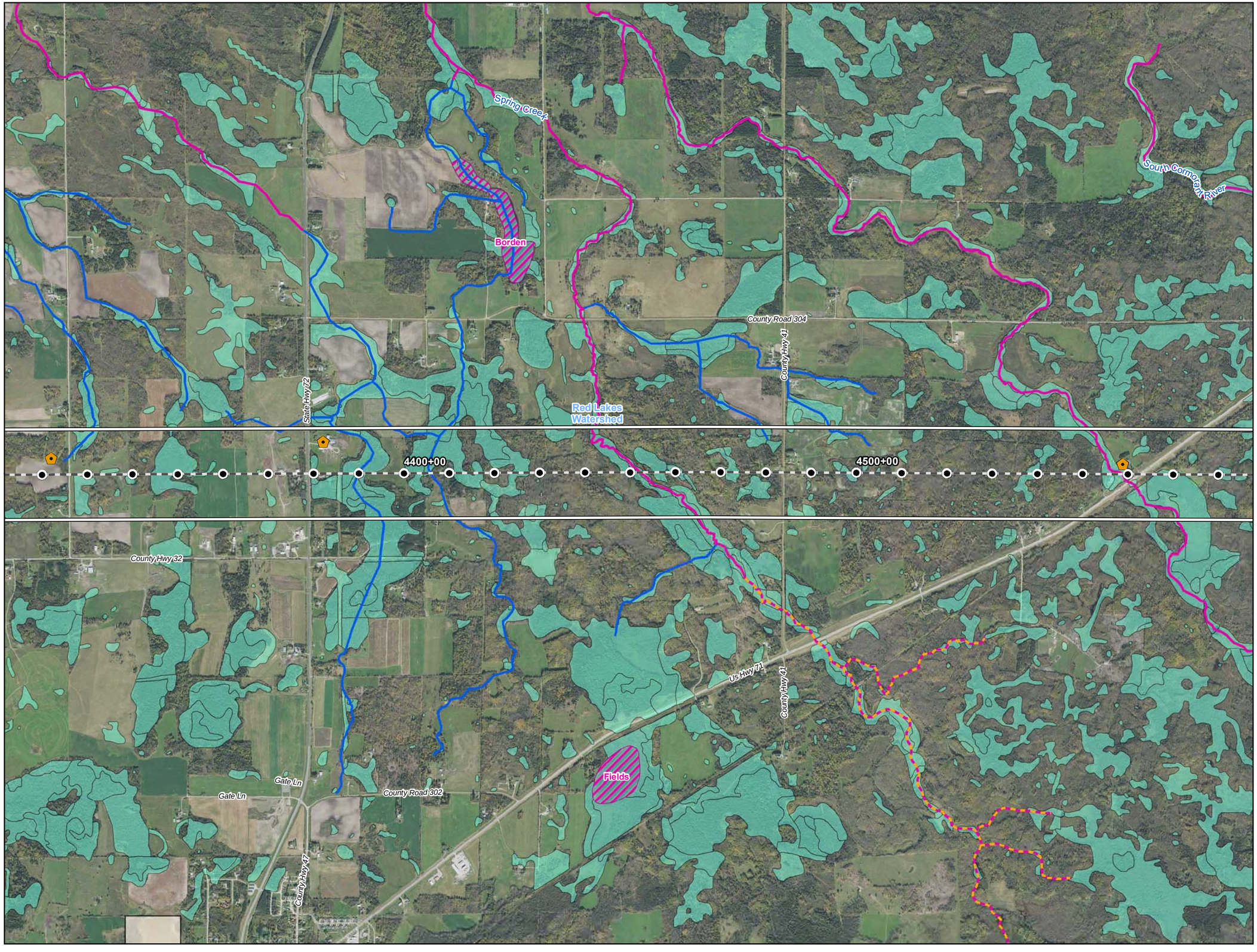
Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 10

Line 3 Replacement Project

RA-06-L3

Enbridge

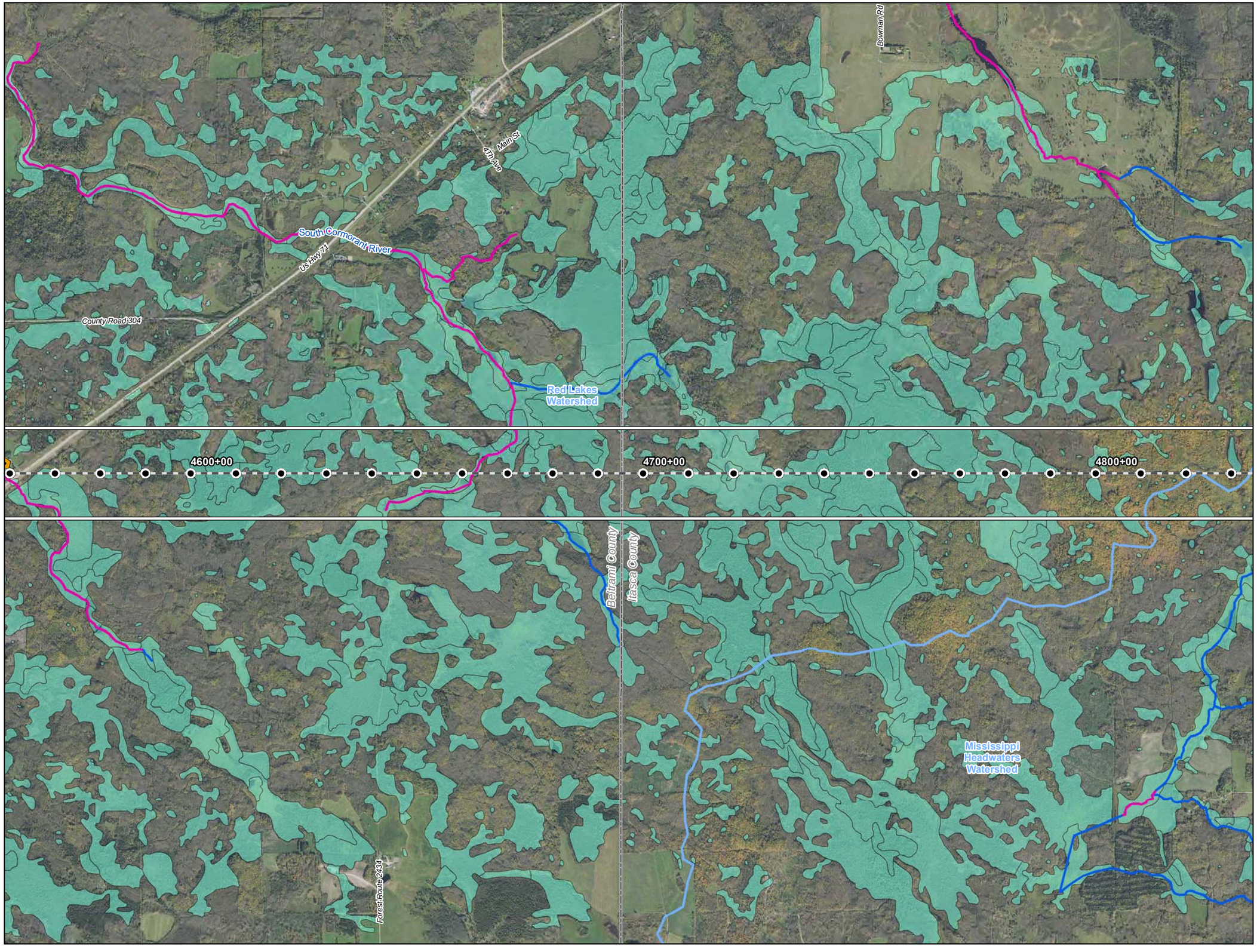
Beltrami County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 11

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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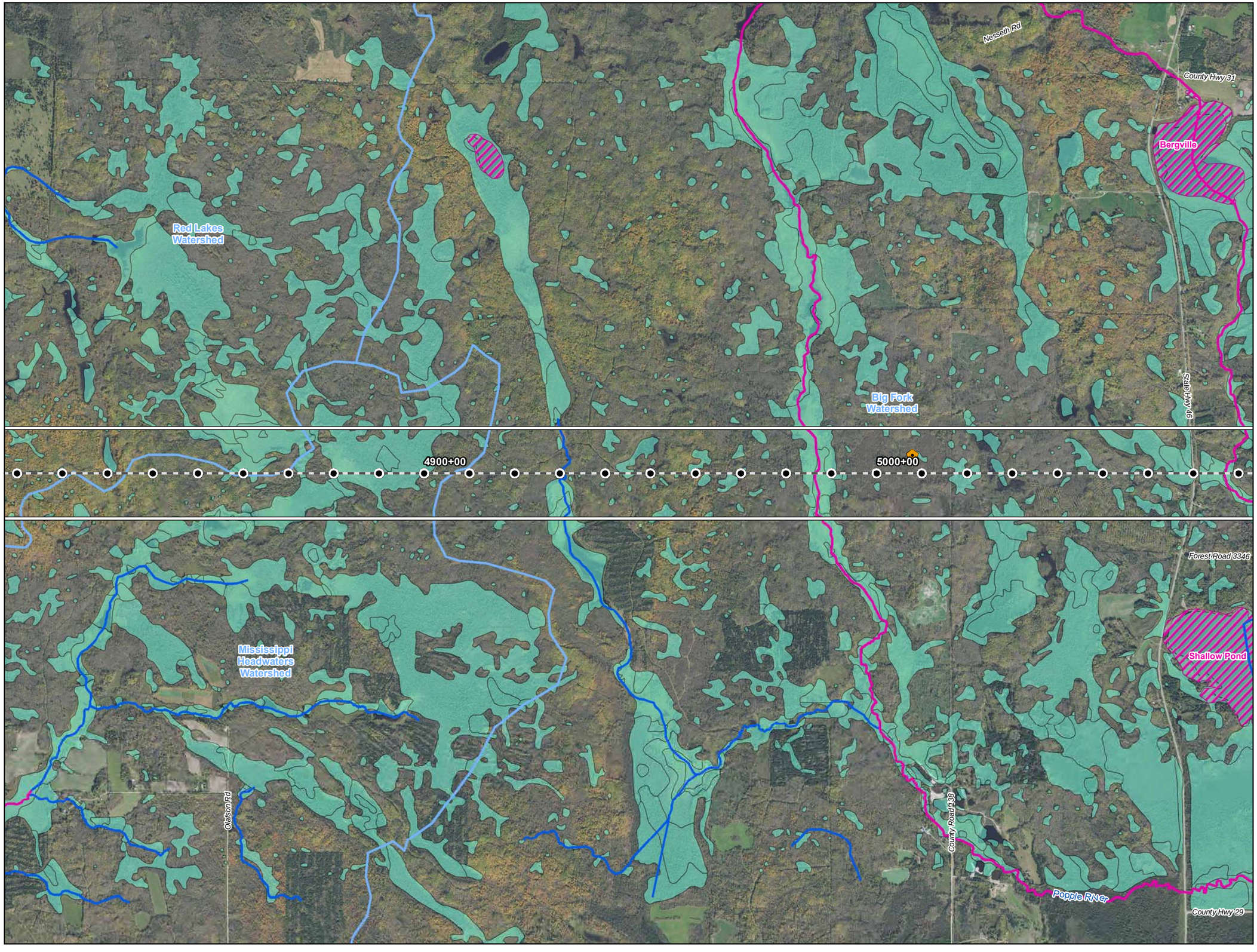
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 12

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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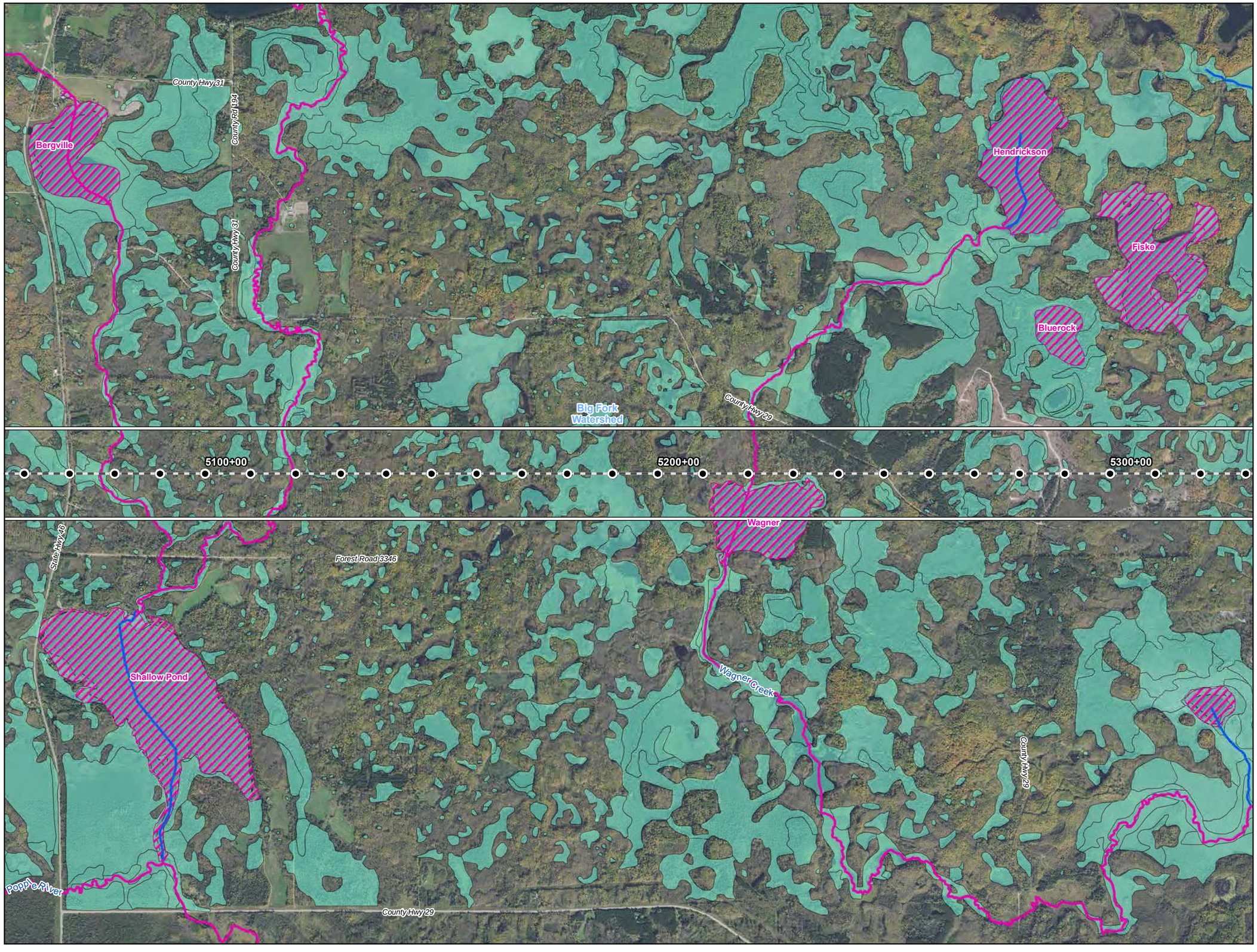
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 13

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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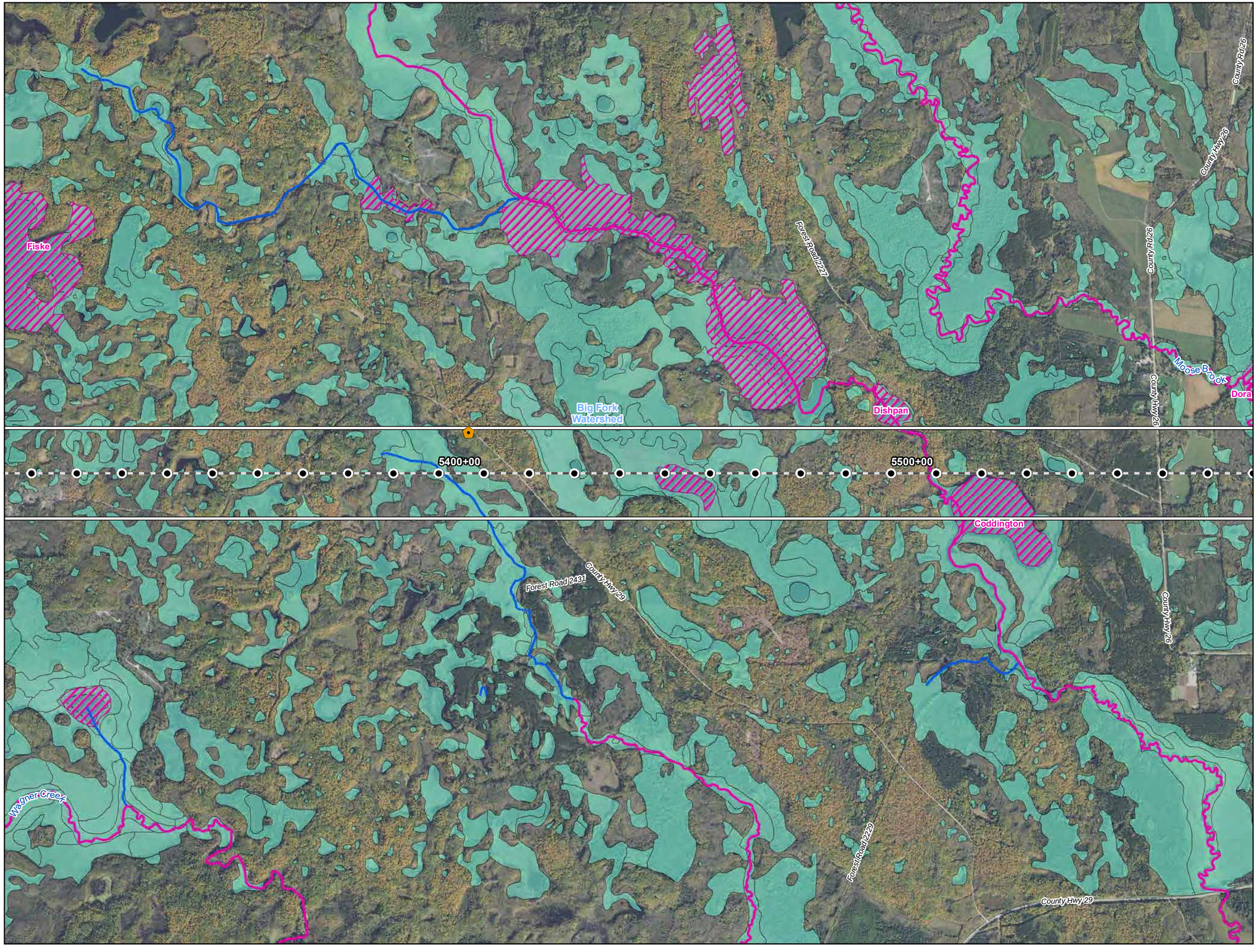
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 14

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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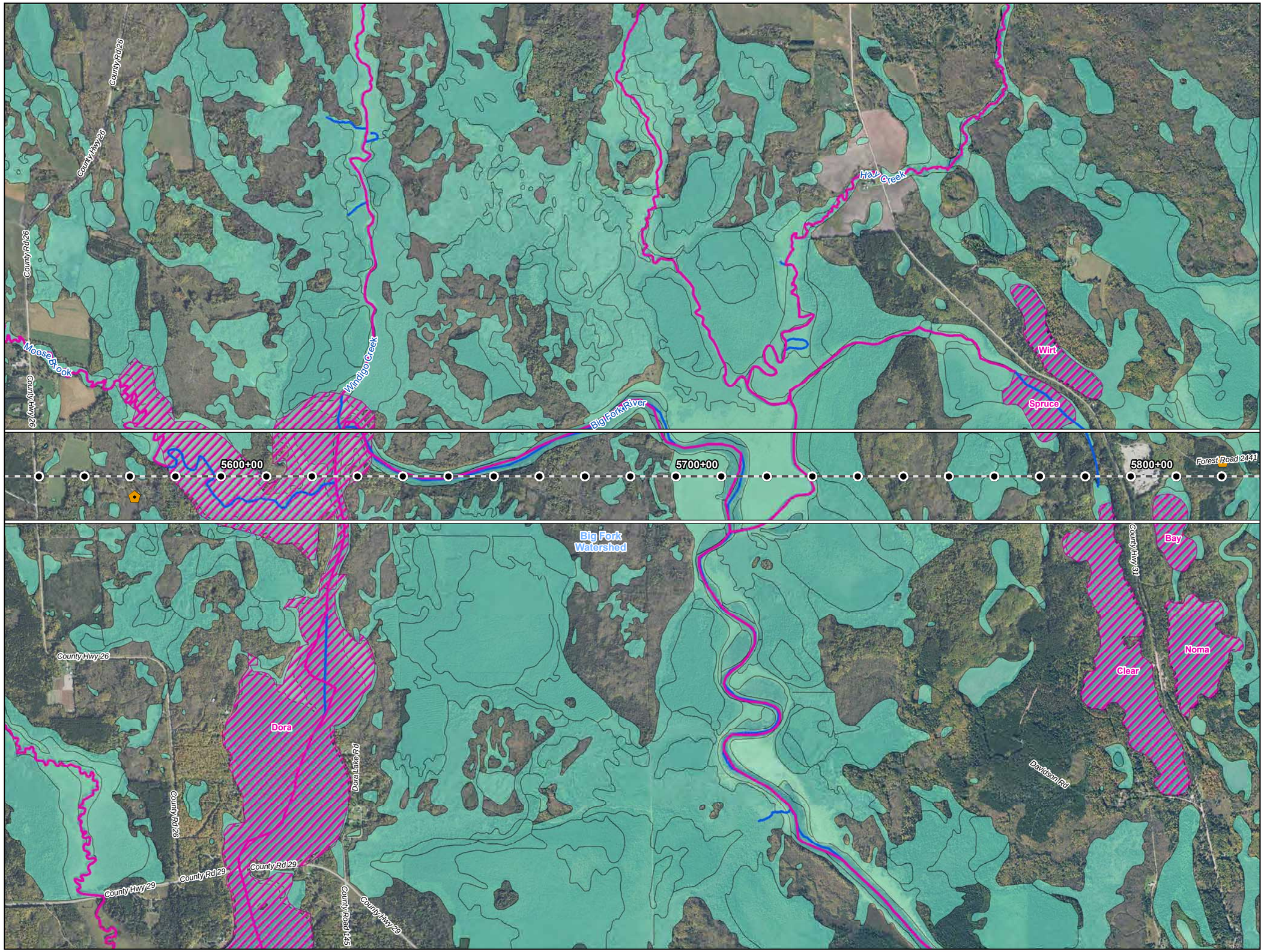
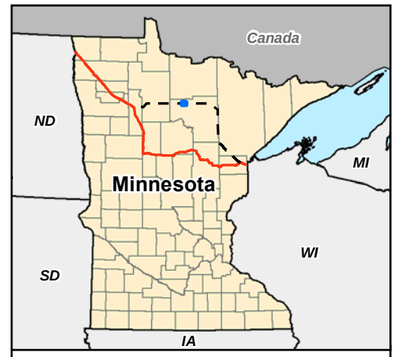
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 15

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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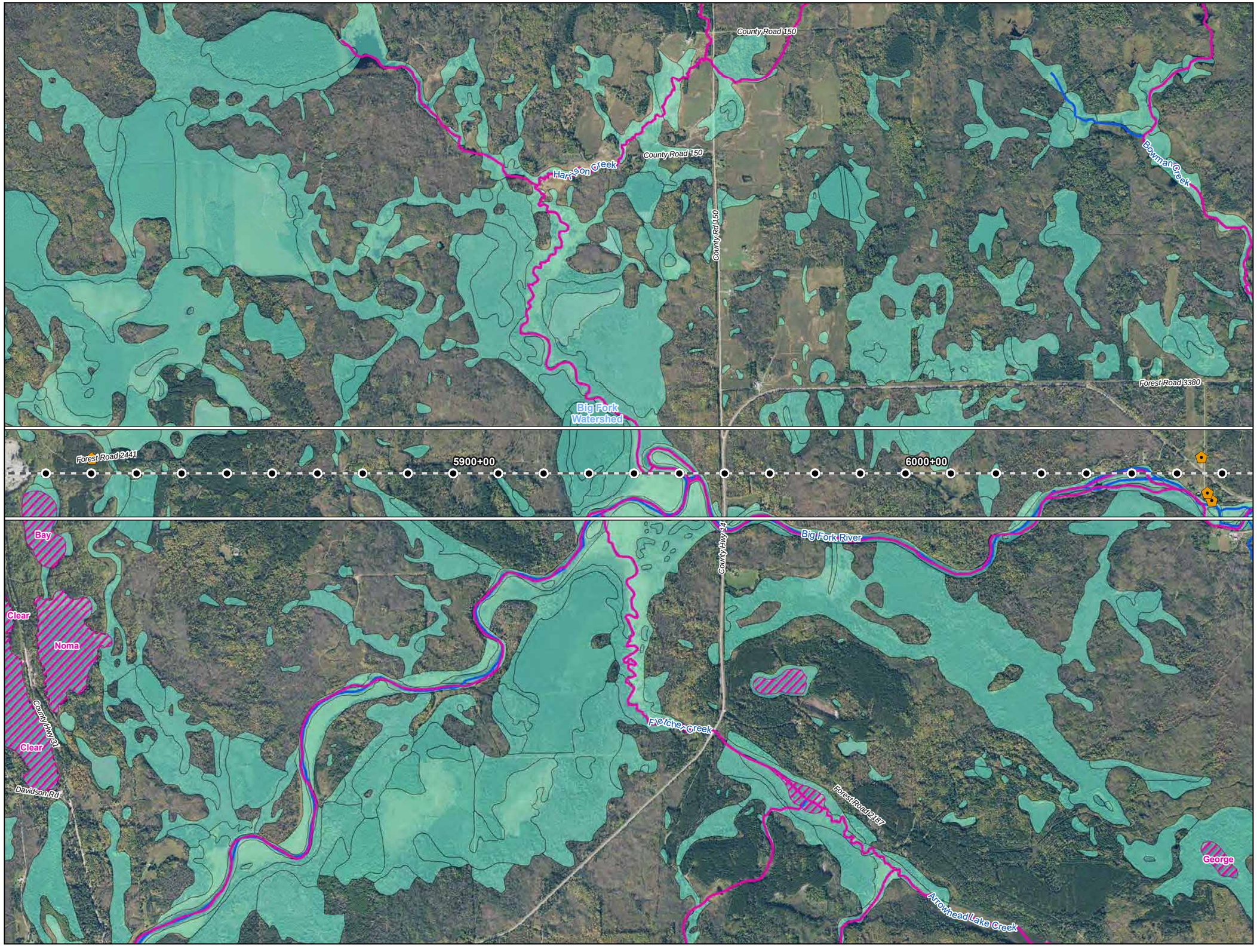
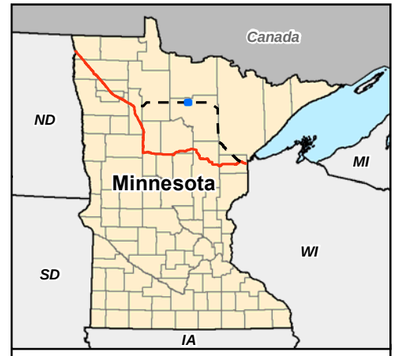
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 16

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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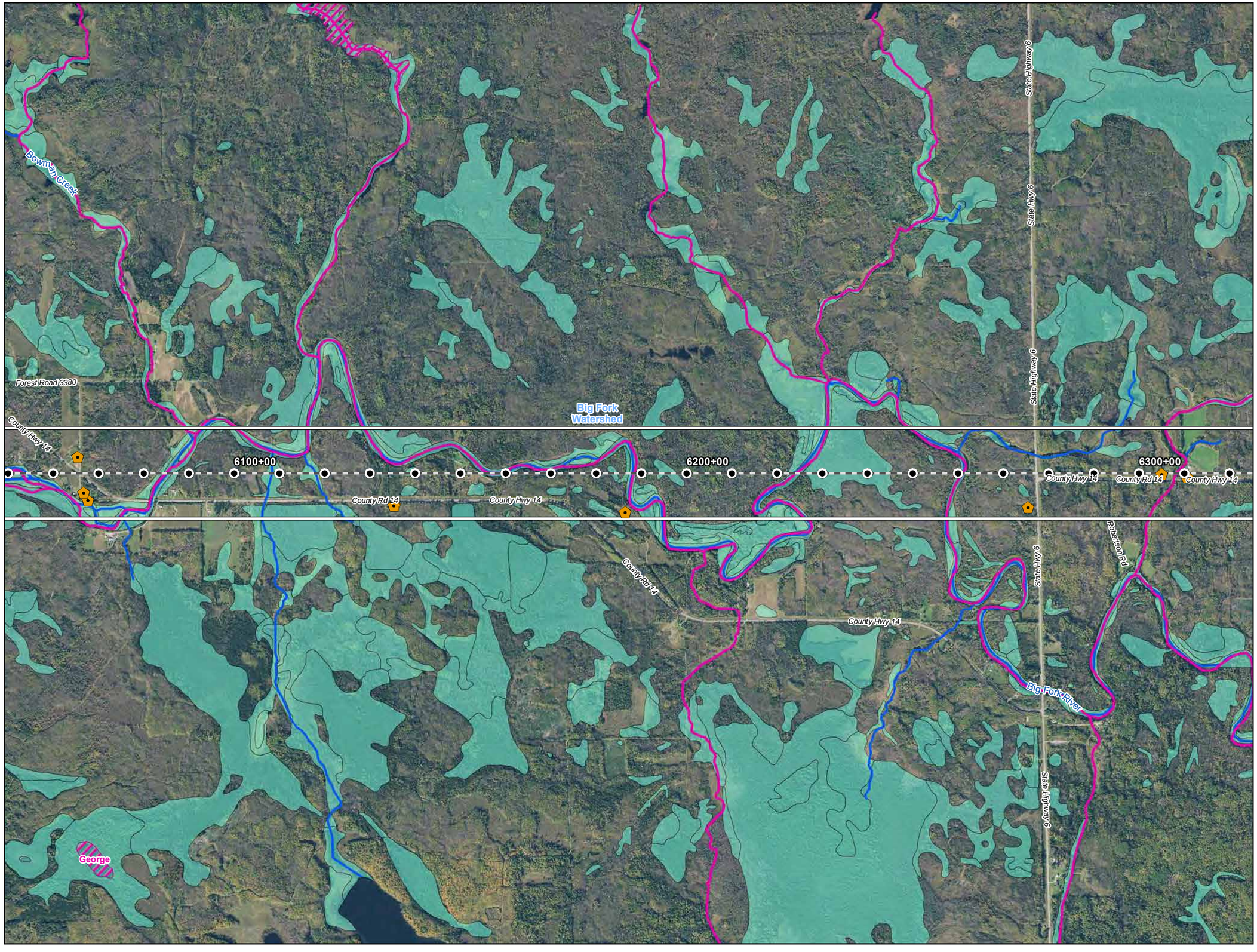
Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 17

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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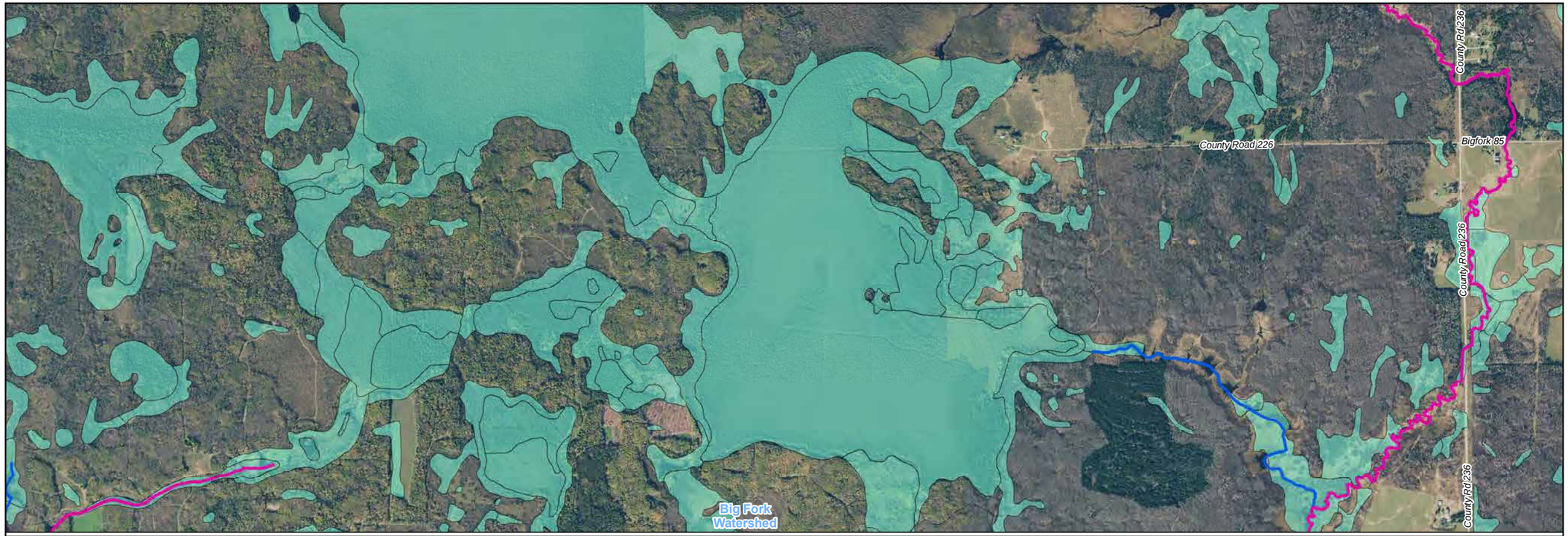
Source: Z:\Clients\E_R\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 18

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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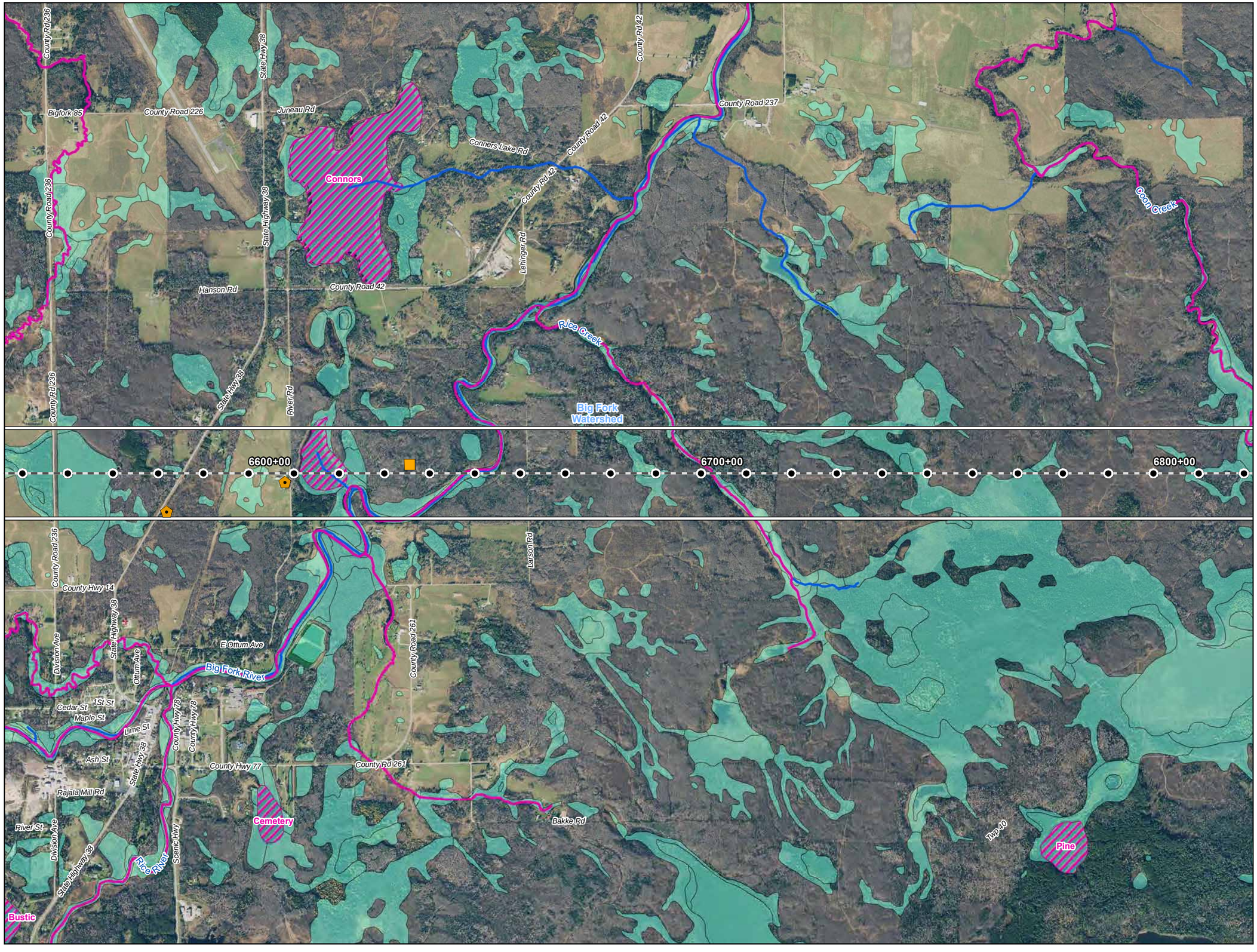
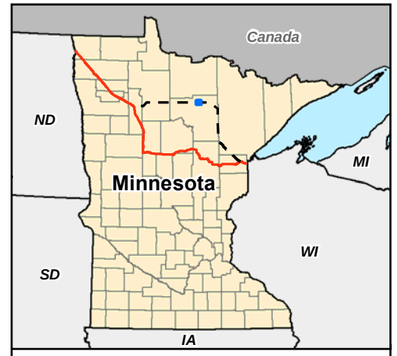
Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 19

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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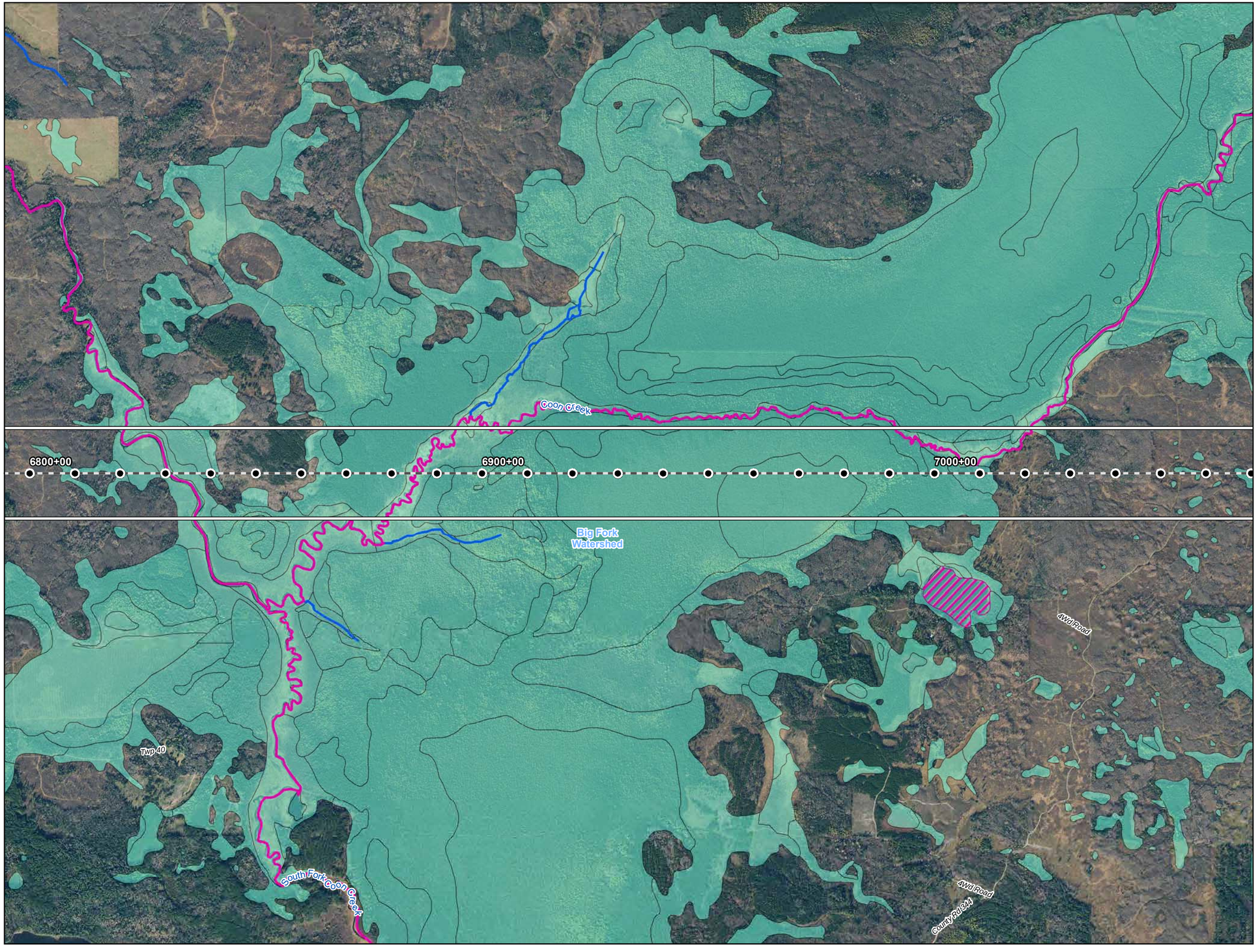
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 20

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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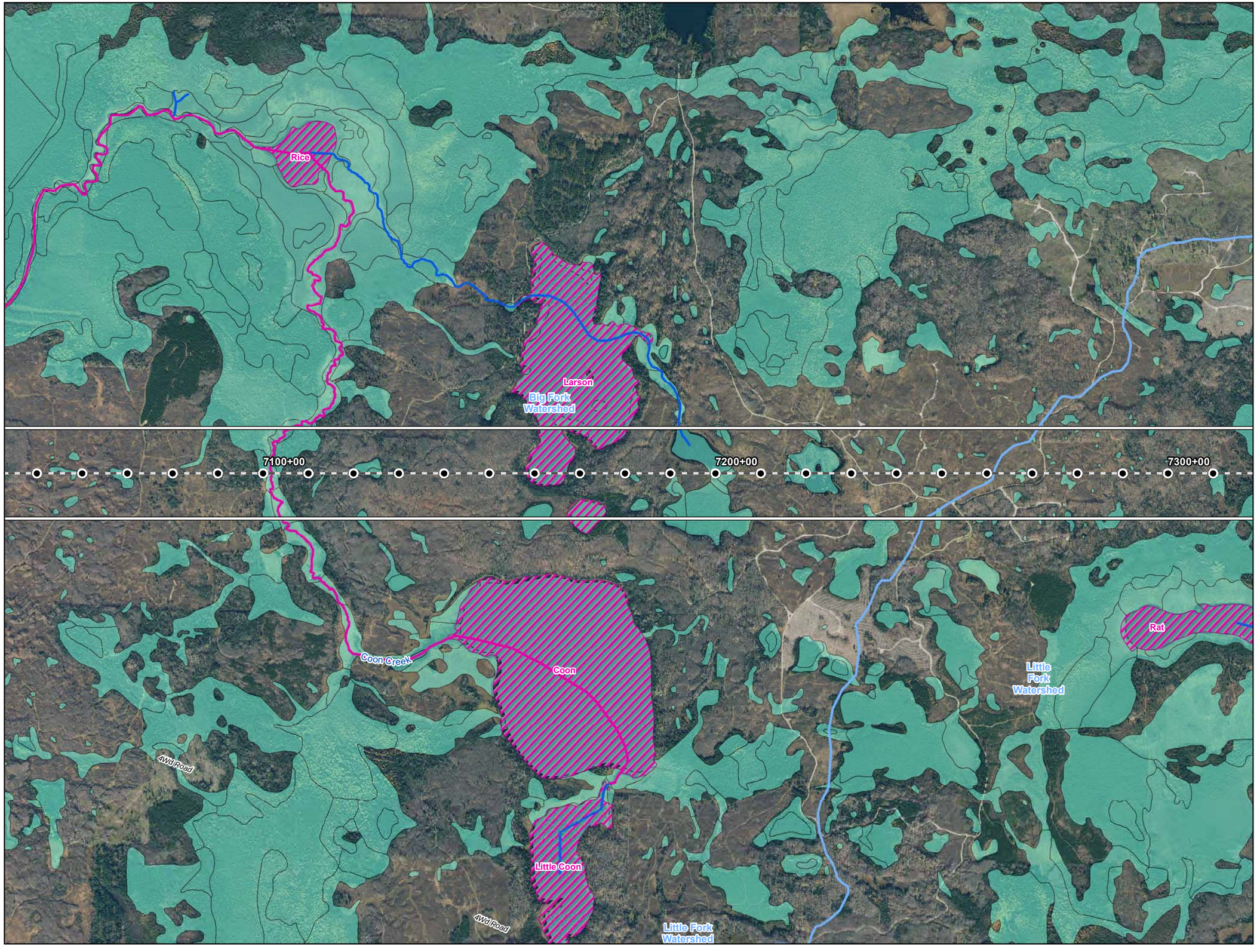
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 21

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

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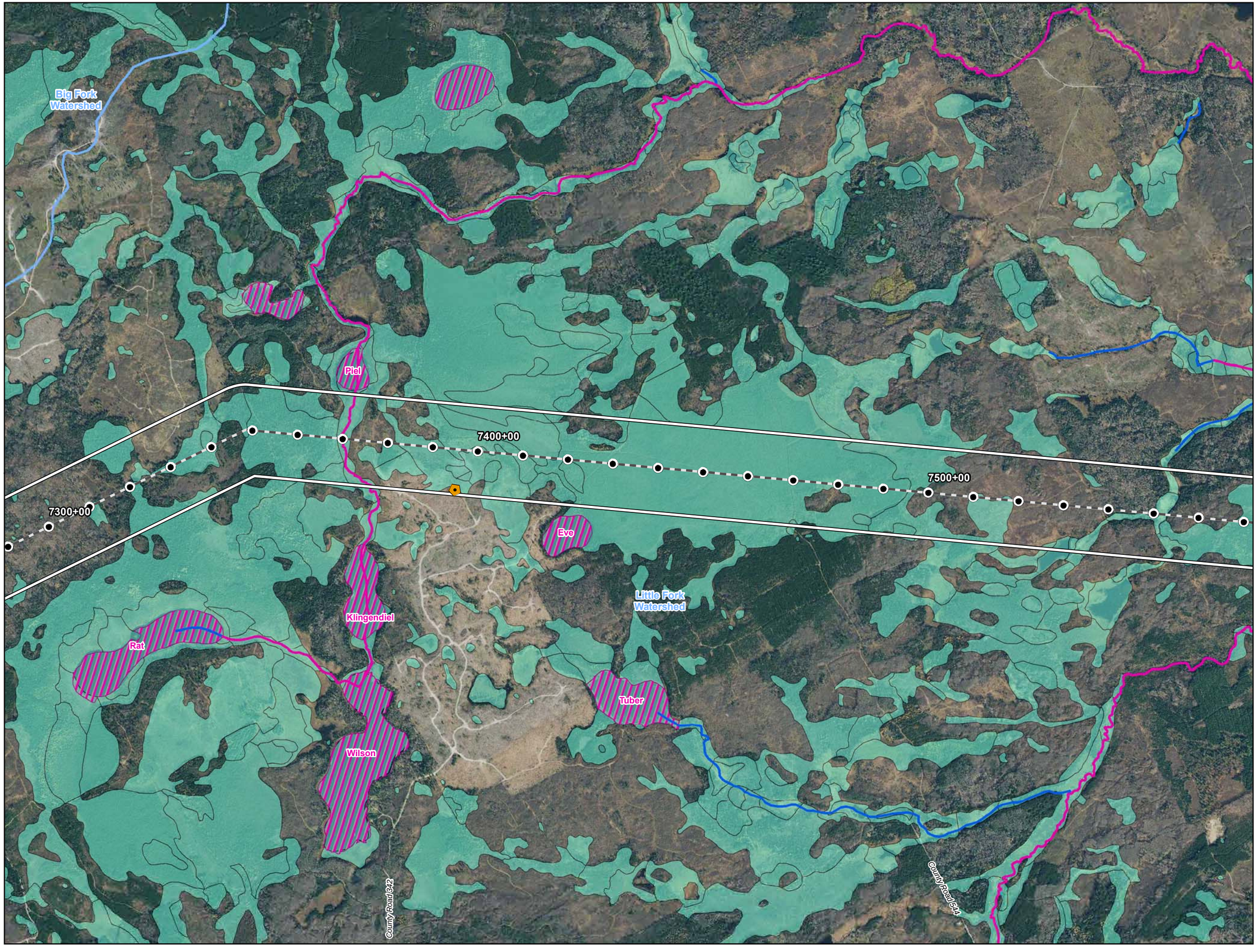



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 22

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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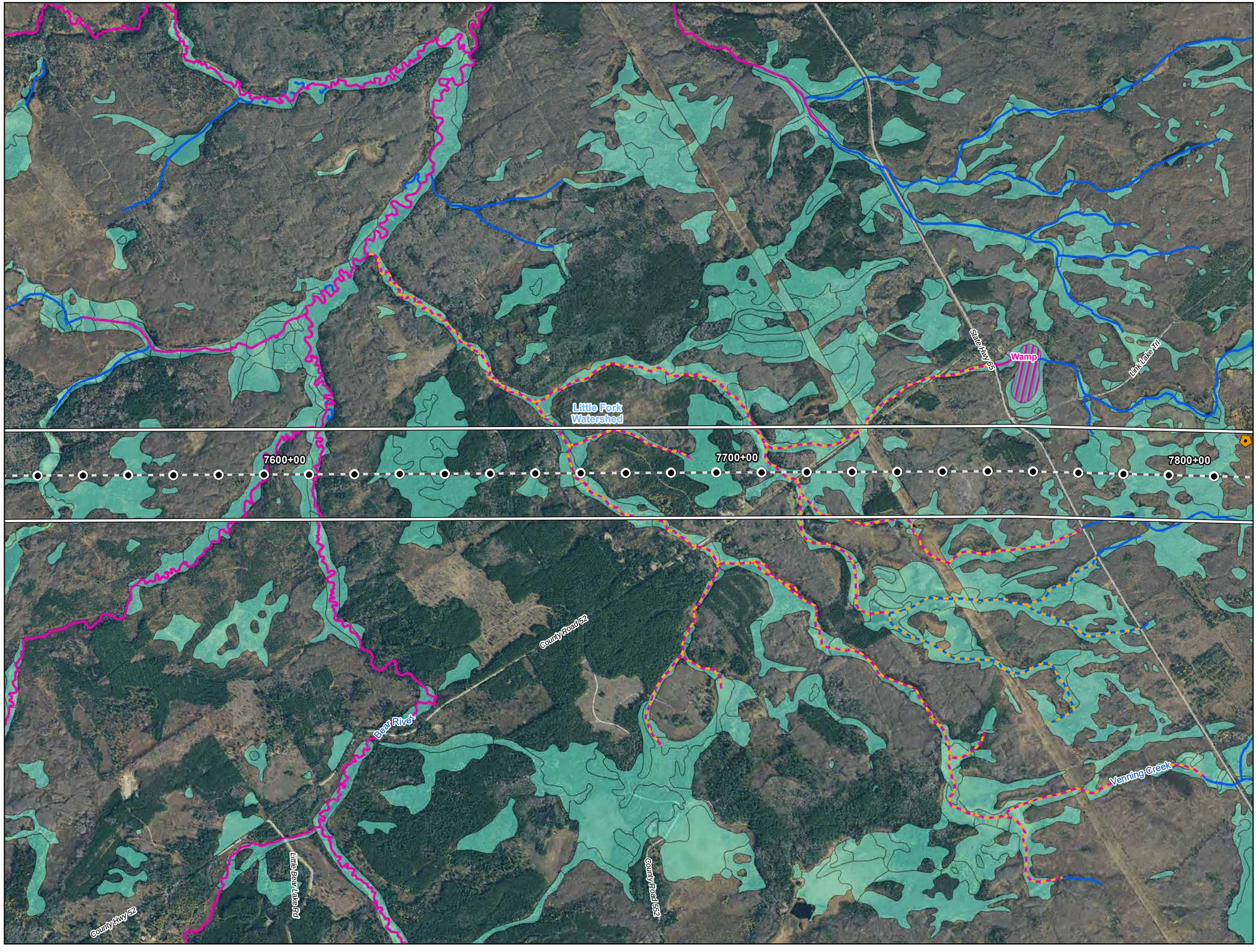

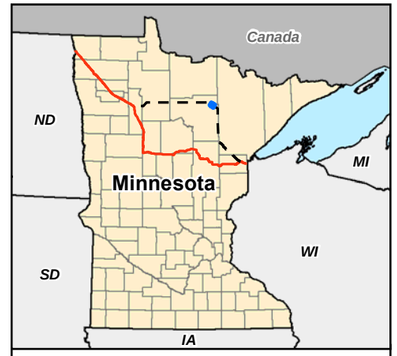

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 23

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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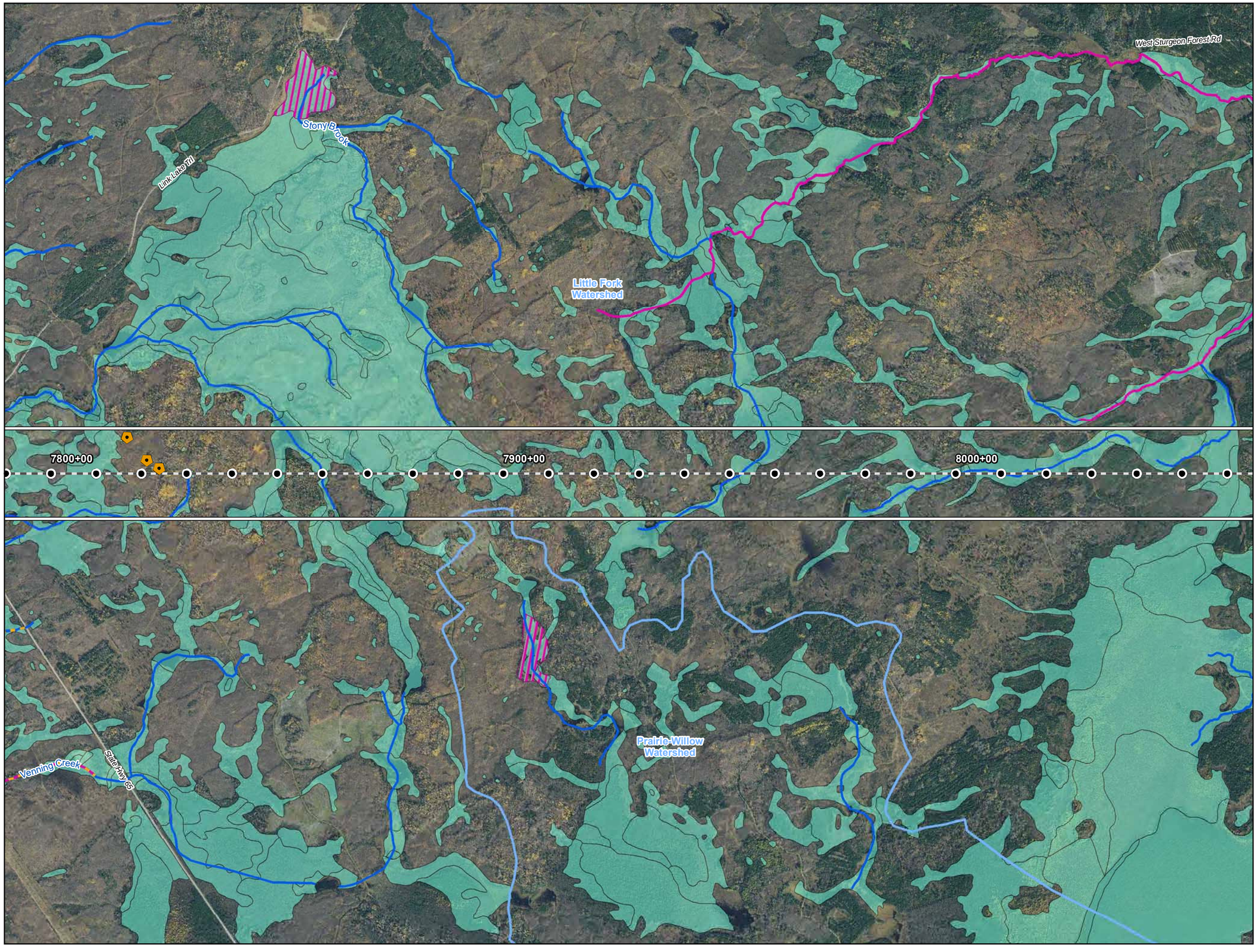

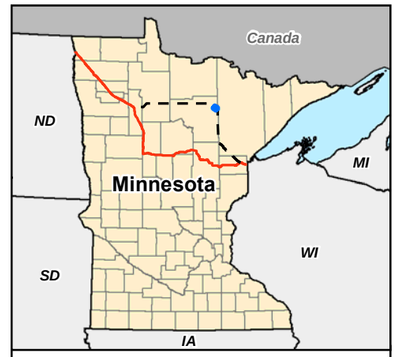

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 24

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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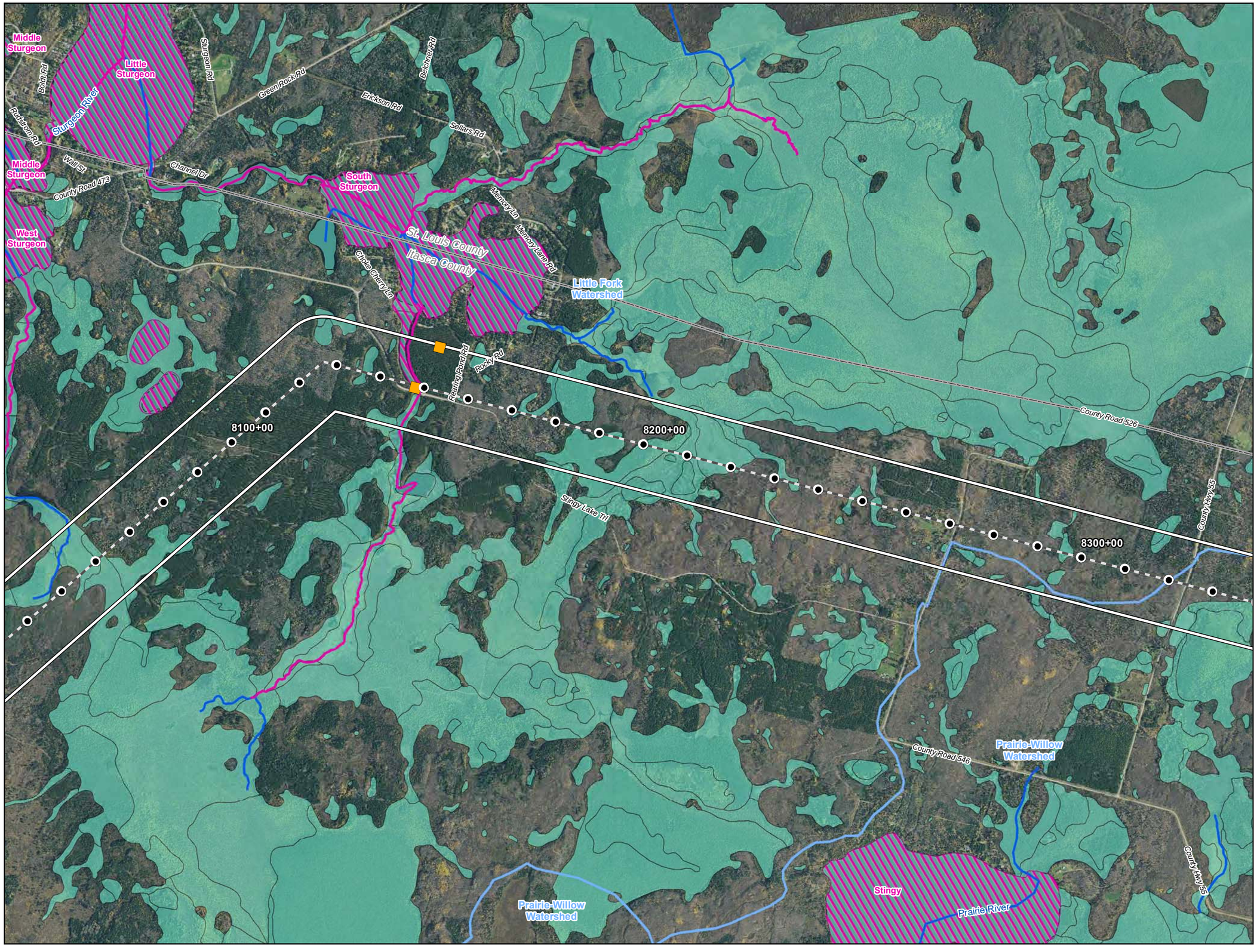
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 25

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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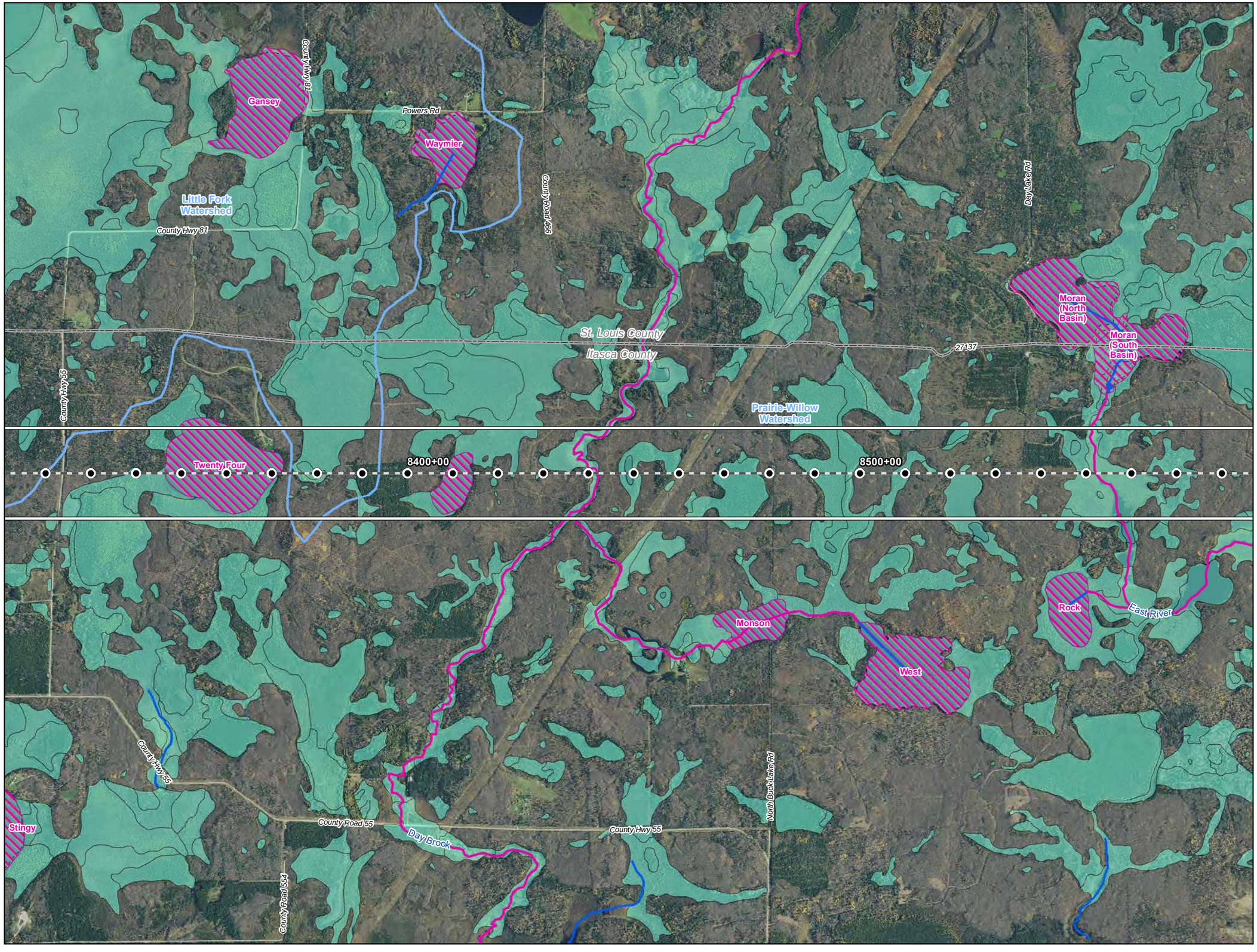
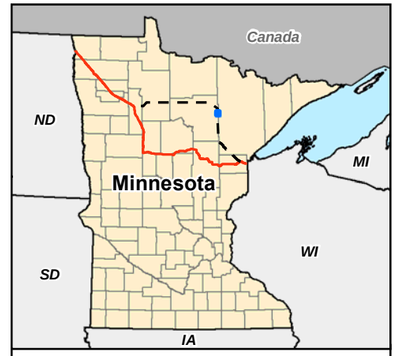




0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 26

Line 3 Replacement Project

RA-06-L3

Enbridge

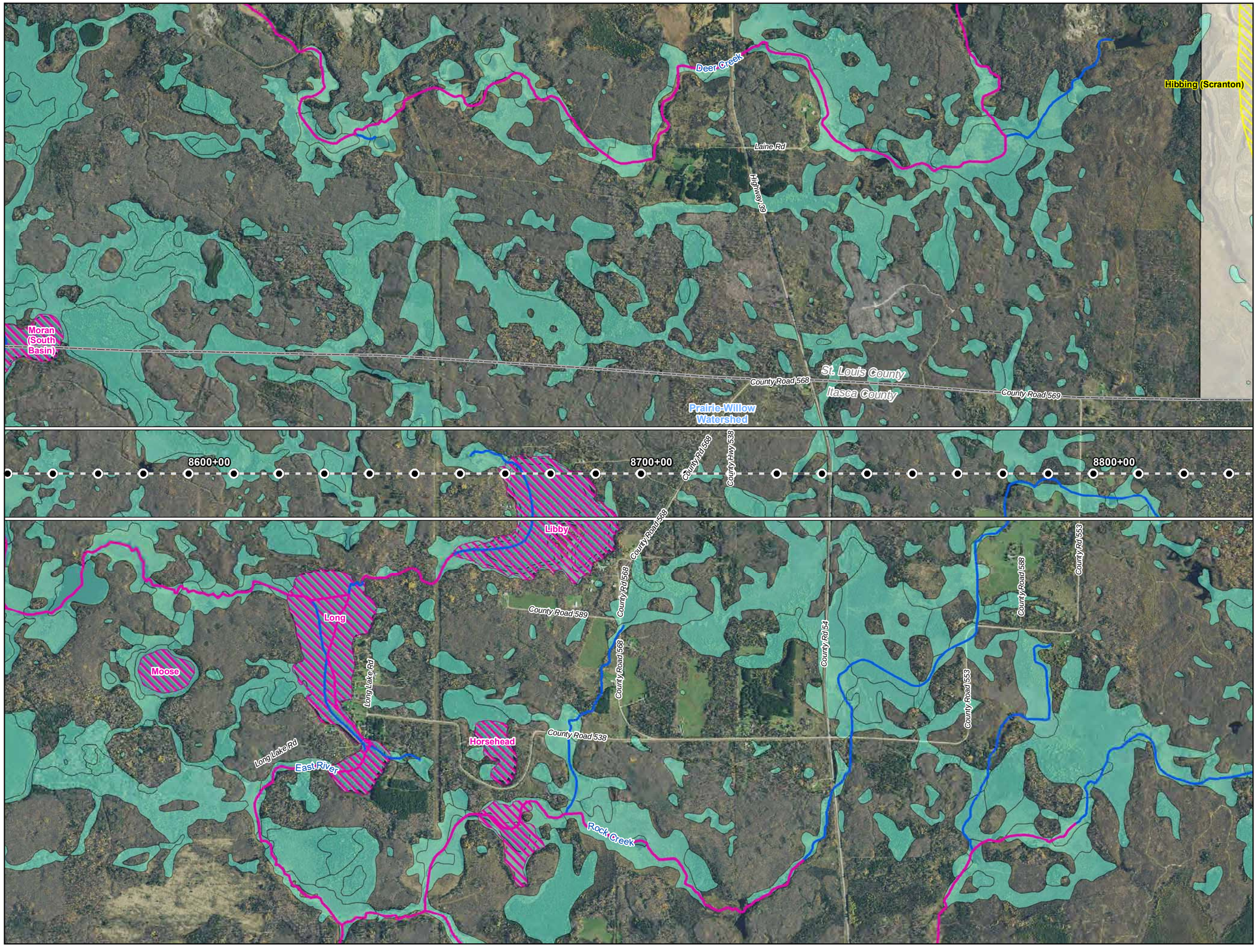
Itasca County, Minnesota

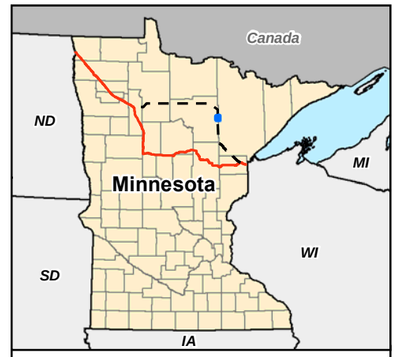
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 27

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

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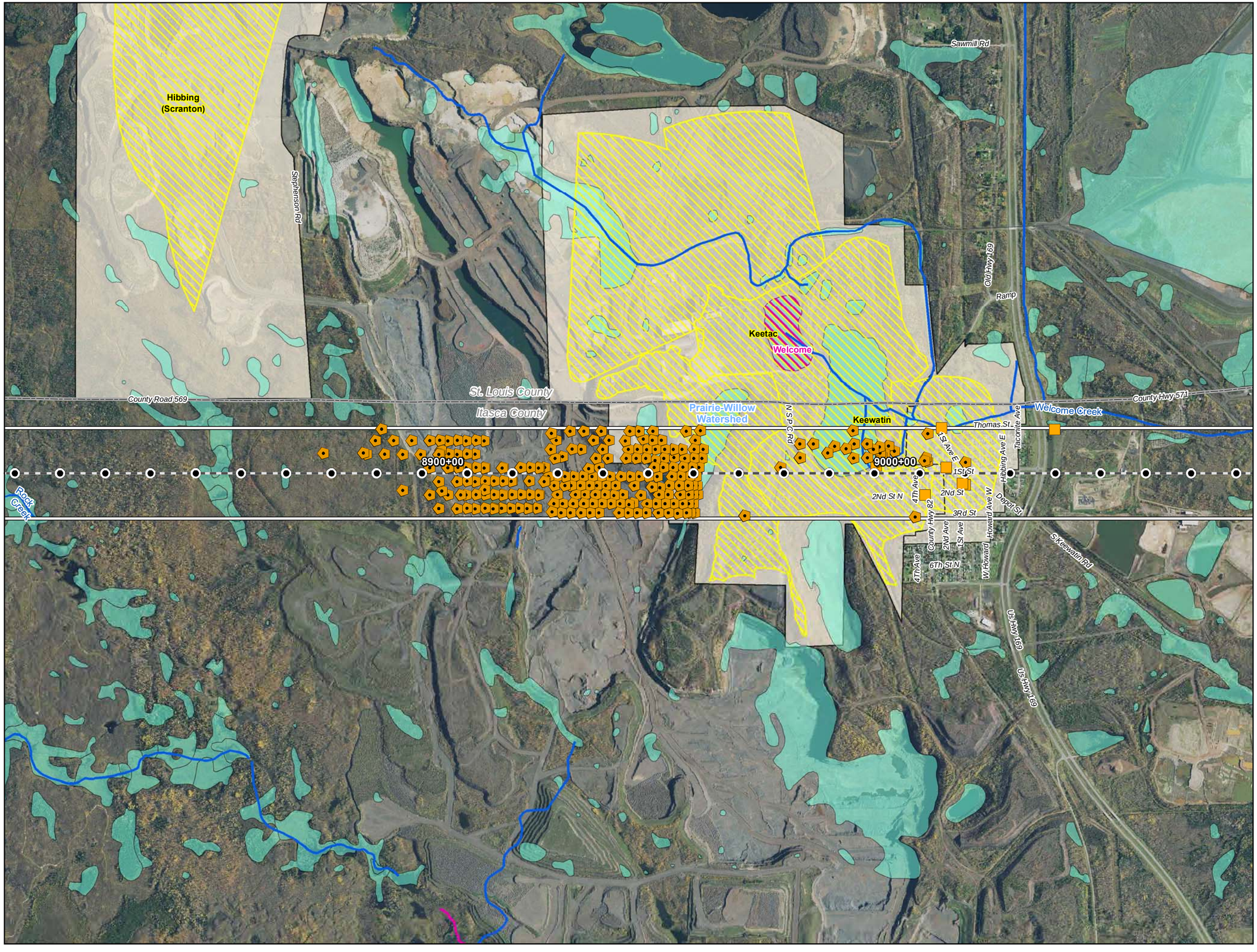

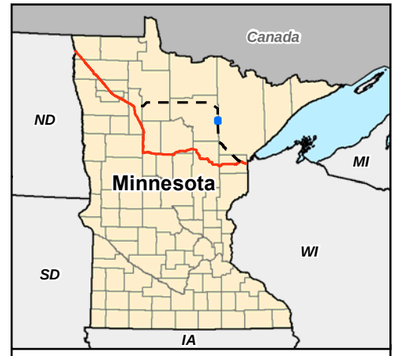

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 28

Line 3 Replacement Project

RA-06-L3

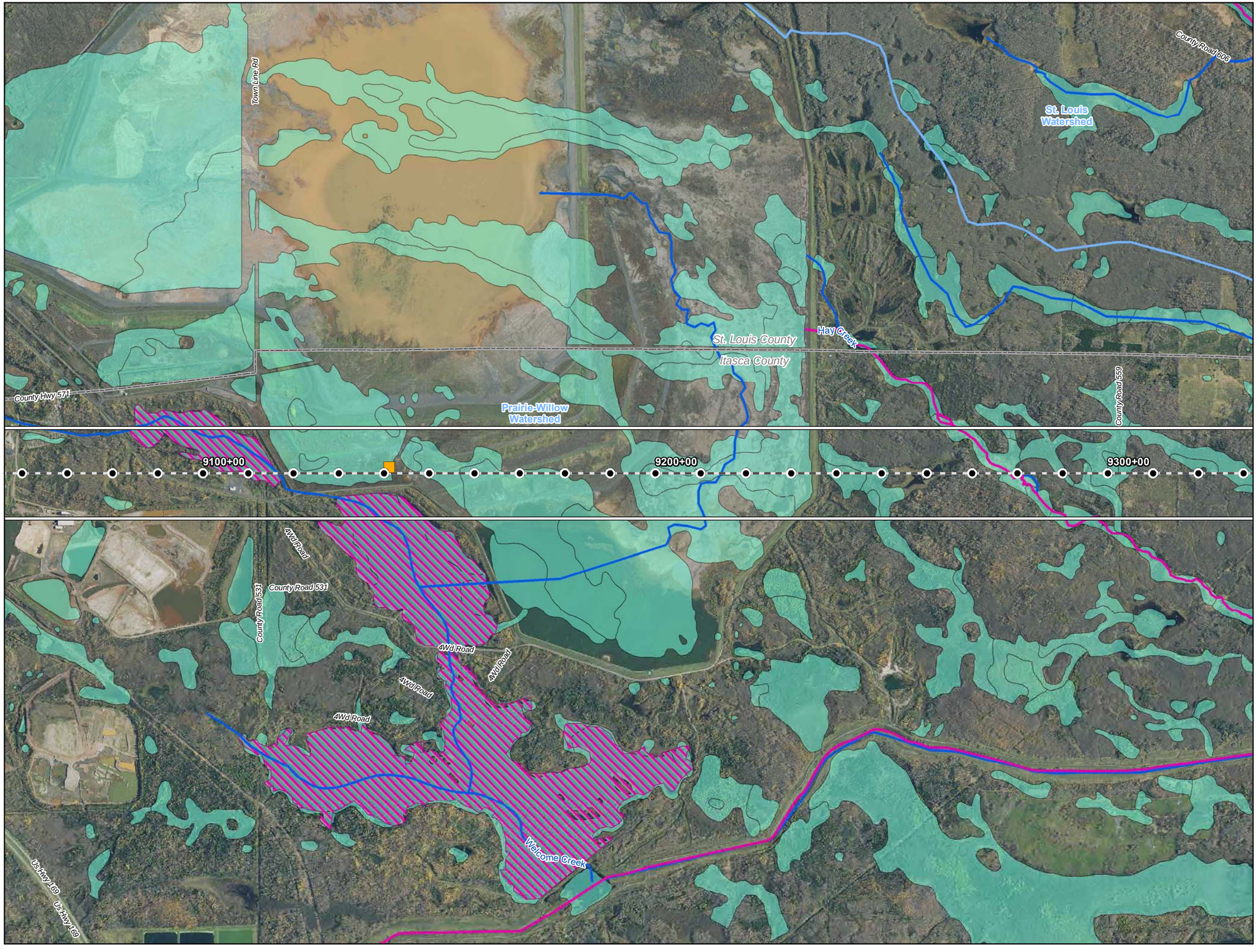
Enbridge

Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 29

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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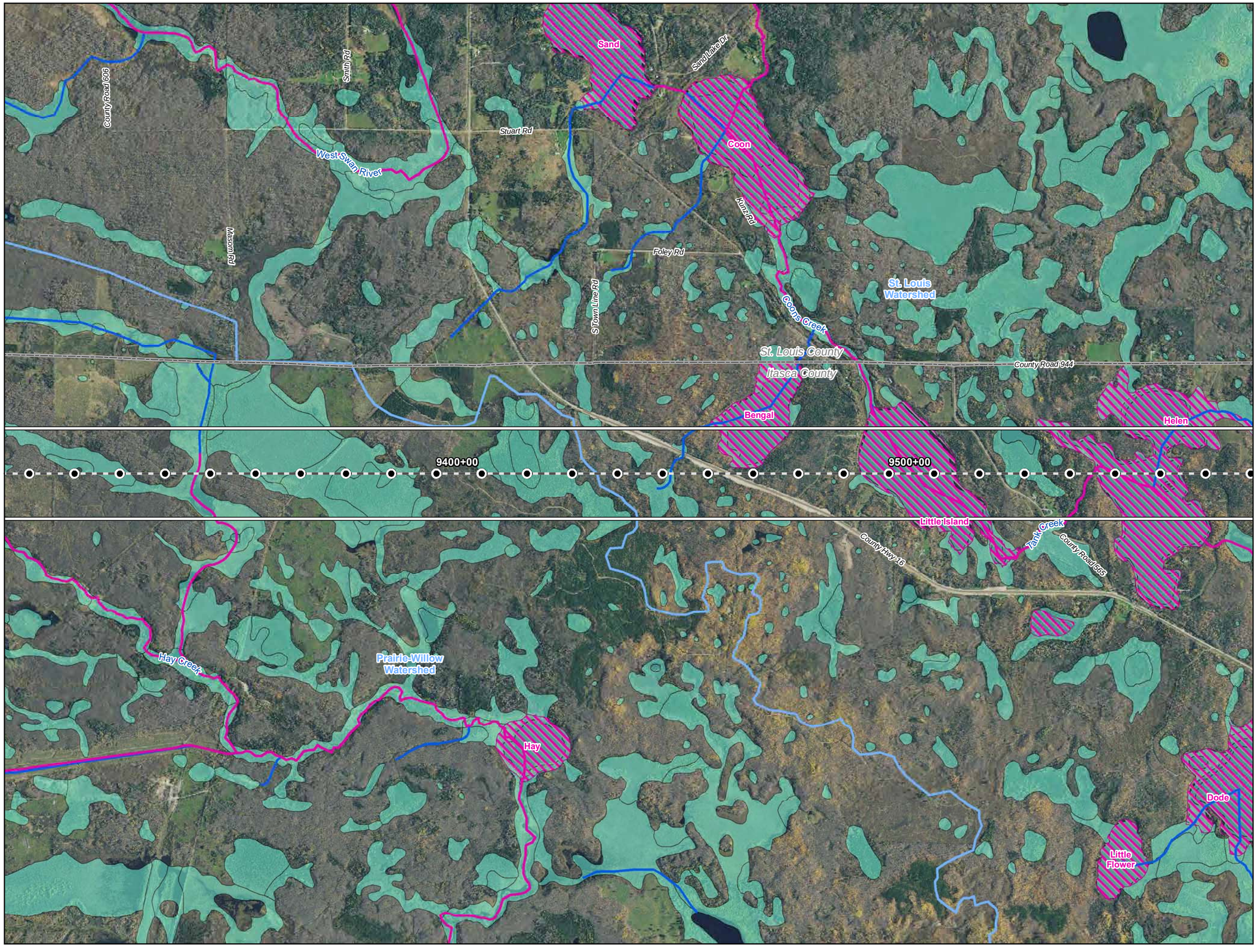
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 30

Line 3 Replacement Project

RA-06-L3

Enbridge

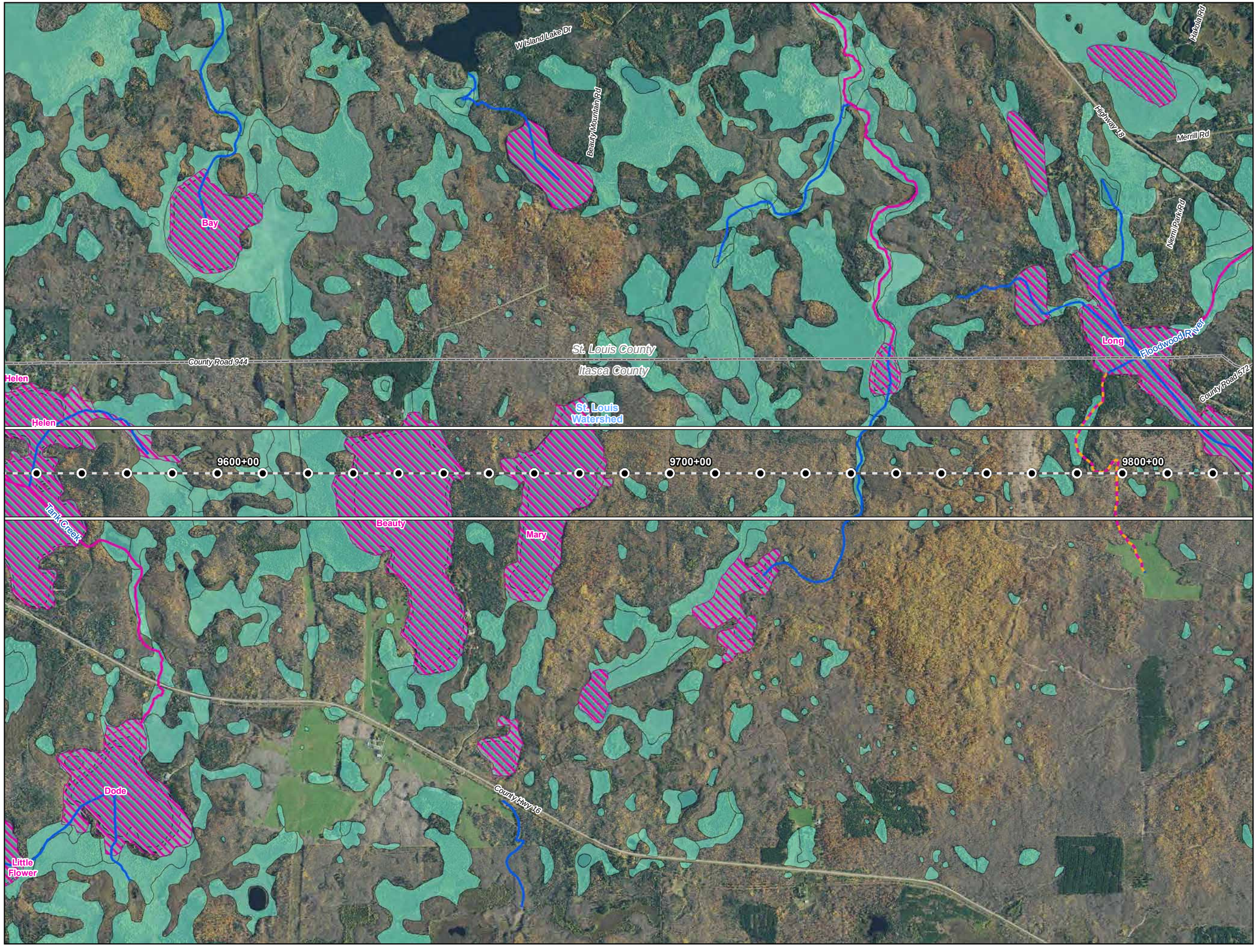
Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
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- Calcareous Fen
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- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 31

Line 3 Replacement Project

RA-06-L3

Enbridge

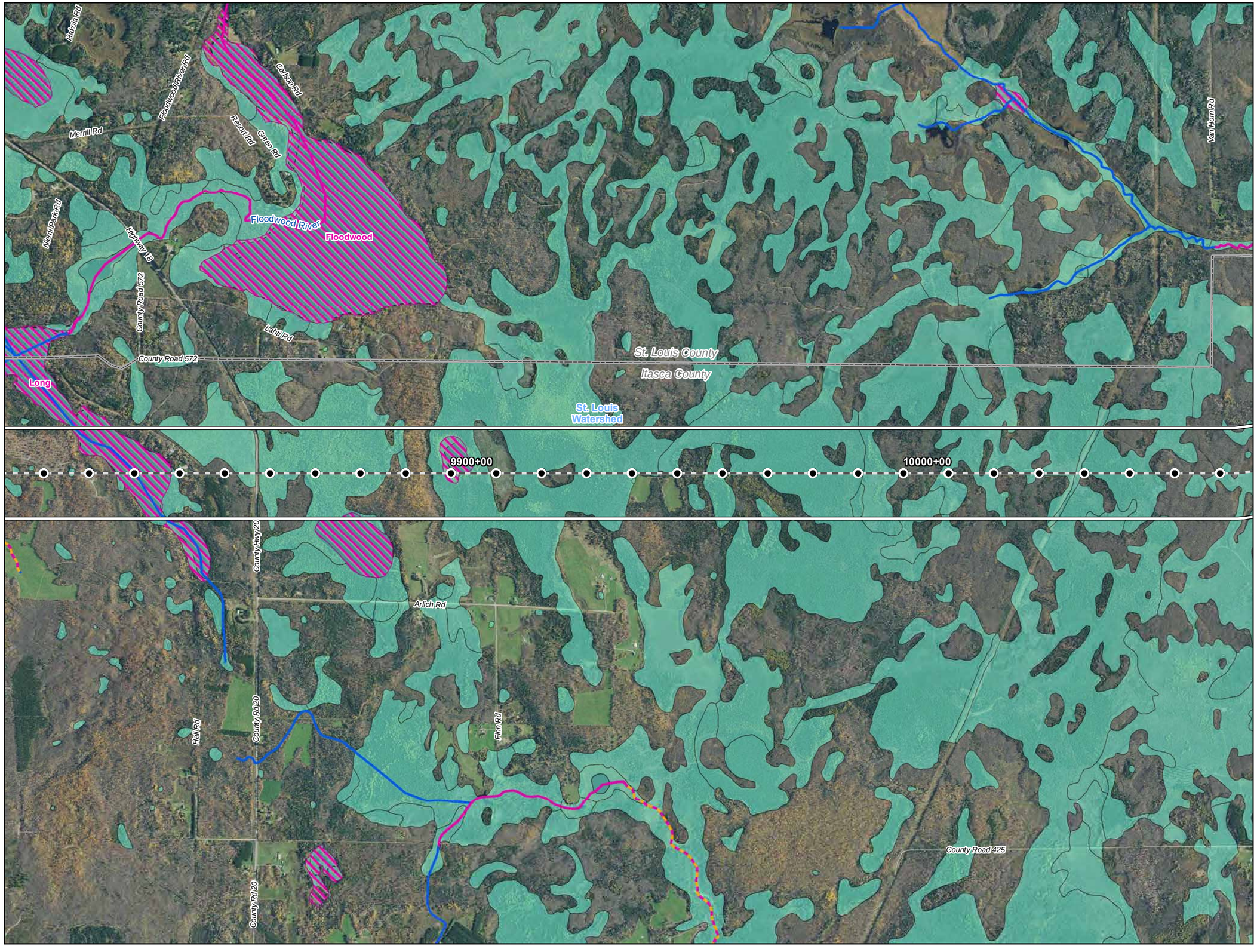
Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
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- Calcareous Fen
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- Alternative Centerline
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 32

Line 3 Replacement Project

RA-06-L3

Enbridge

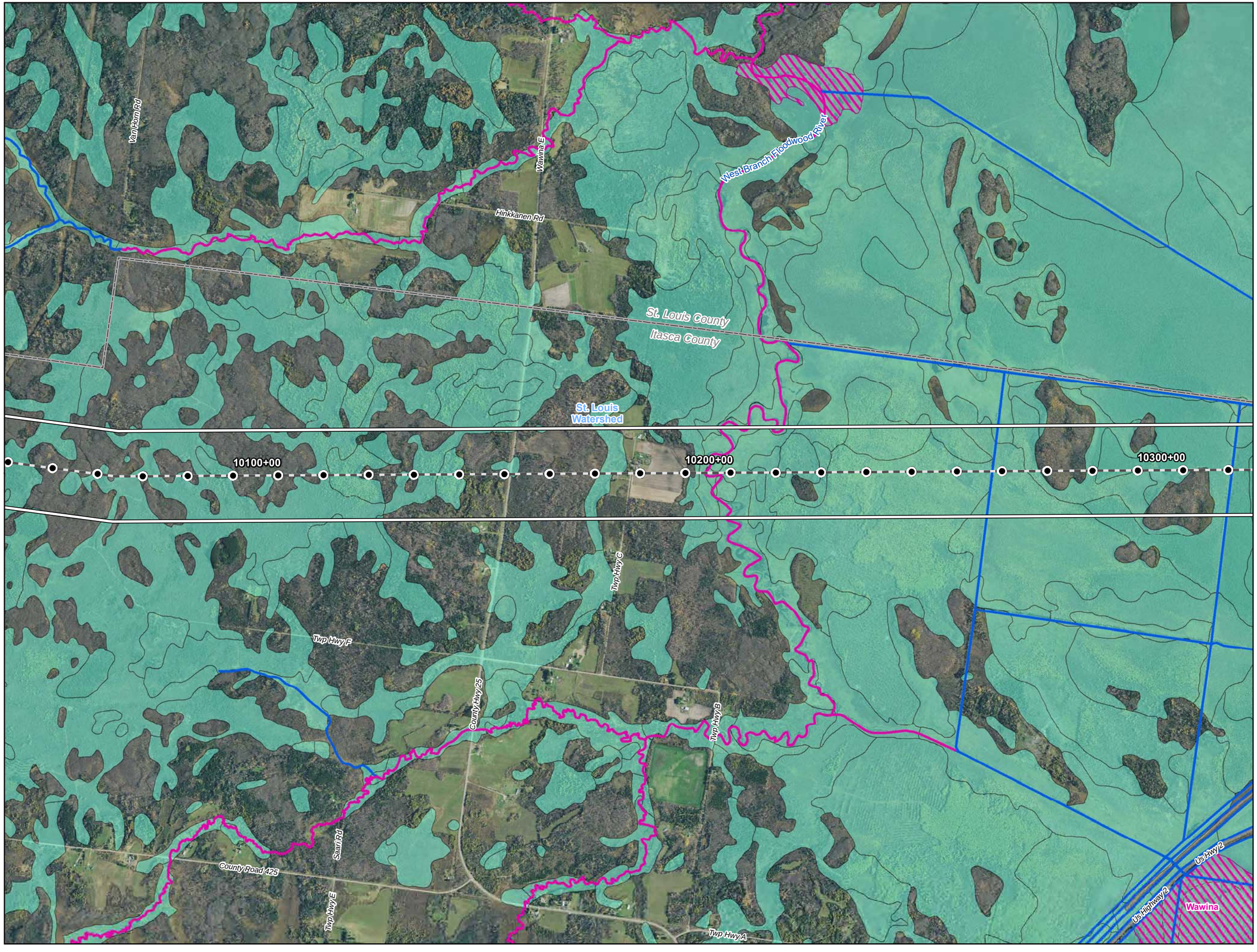
Itasca County, Minnesota

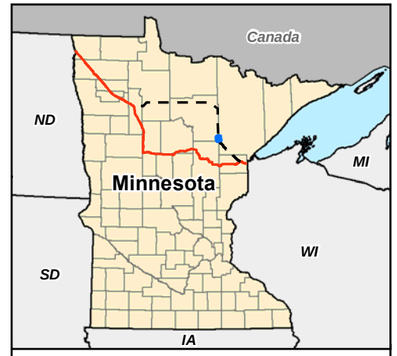
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\01\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
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- Alternative Stationing
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- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 33

Line 3 Replacement Project

RA-06-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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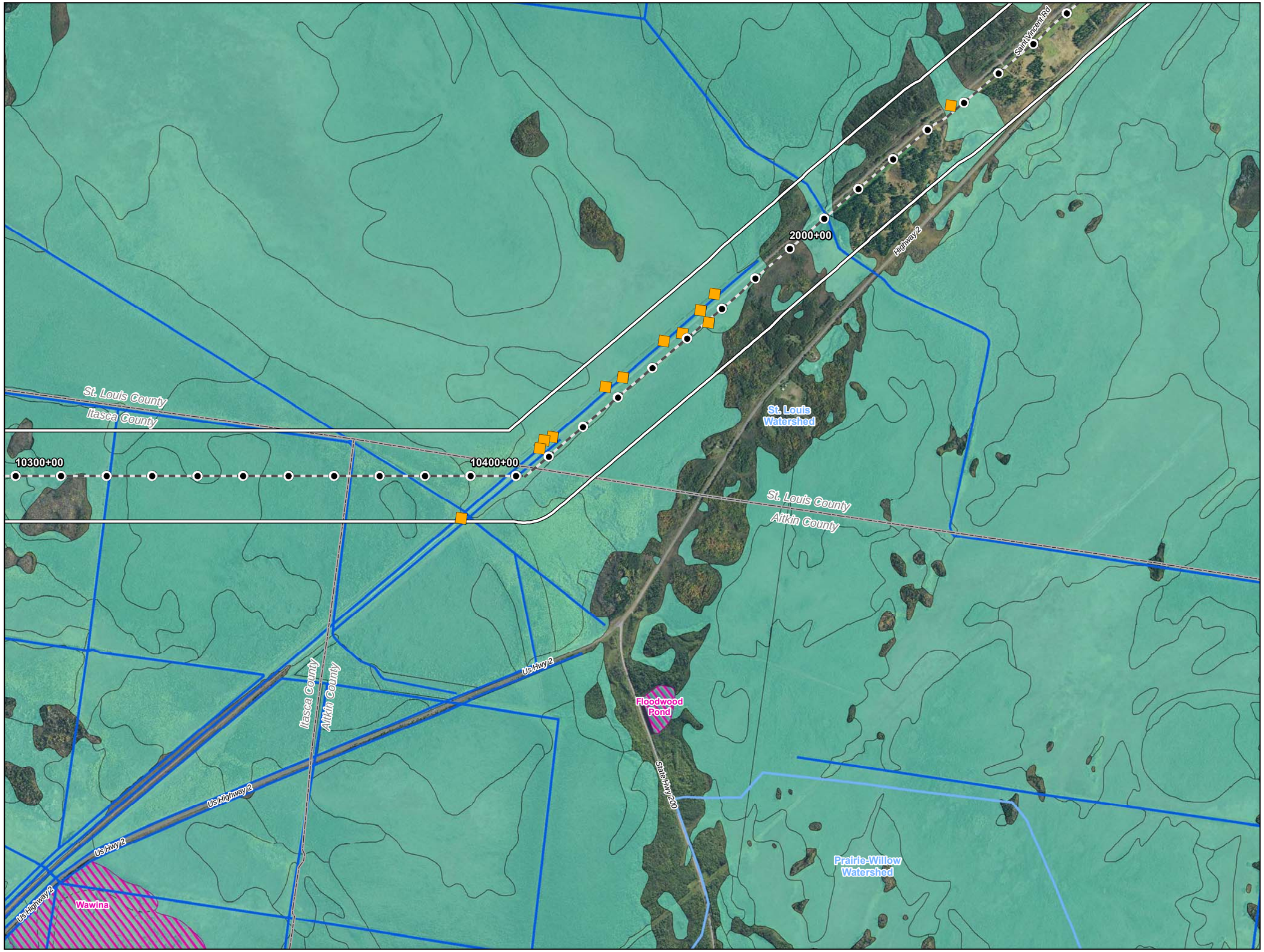
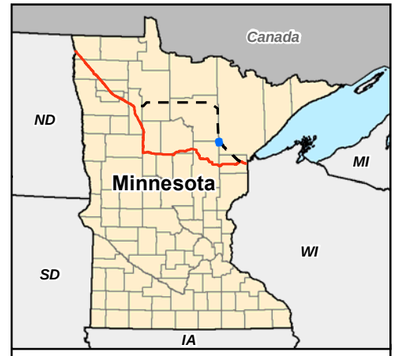
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
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- Alternative Centerline
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 34

Line 3 Replacement Project

RA-06-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 35

Line 3 Replacement Project

RA-06-L3

Enbridge

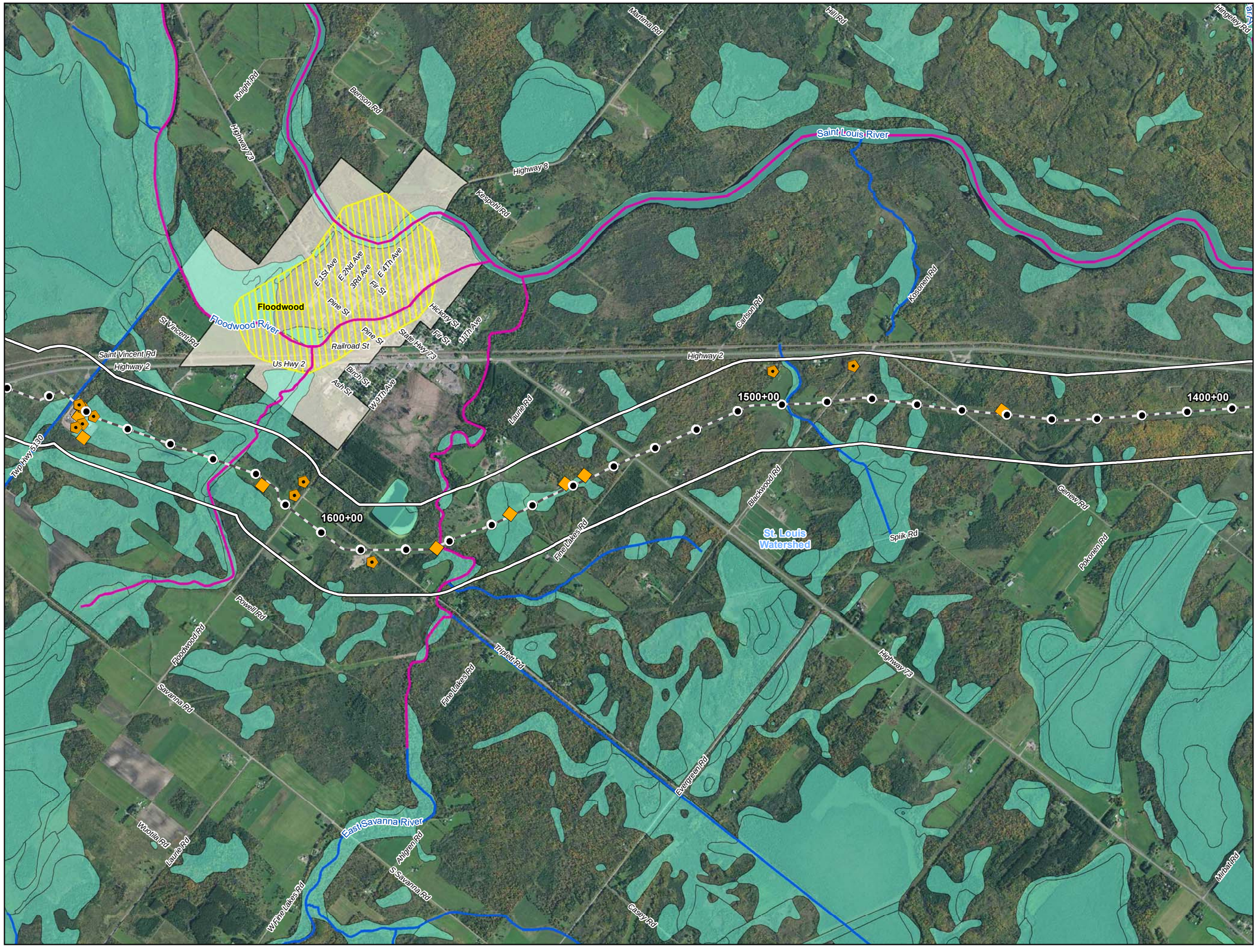
St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 36

Line 3 Replacement Project

RA-06-L3

Enbridge

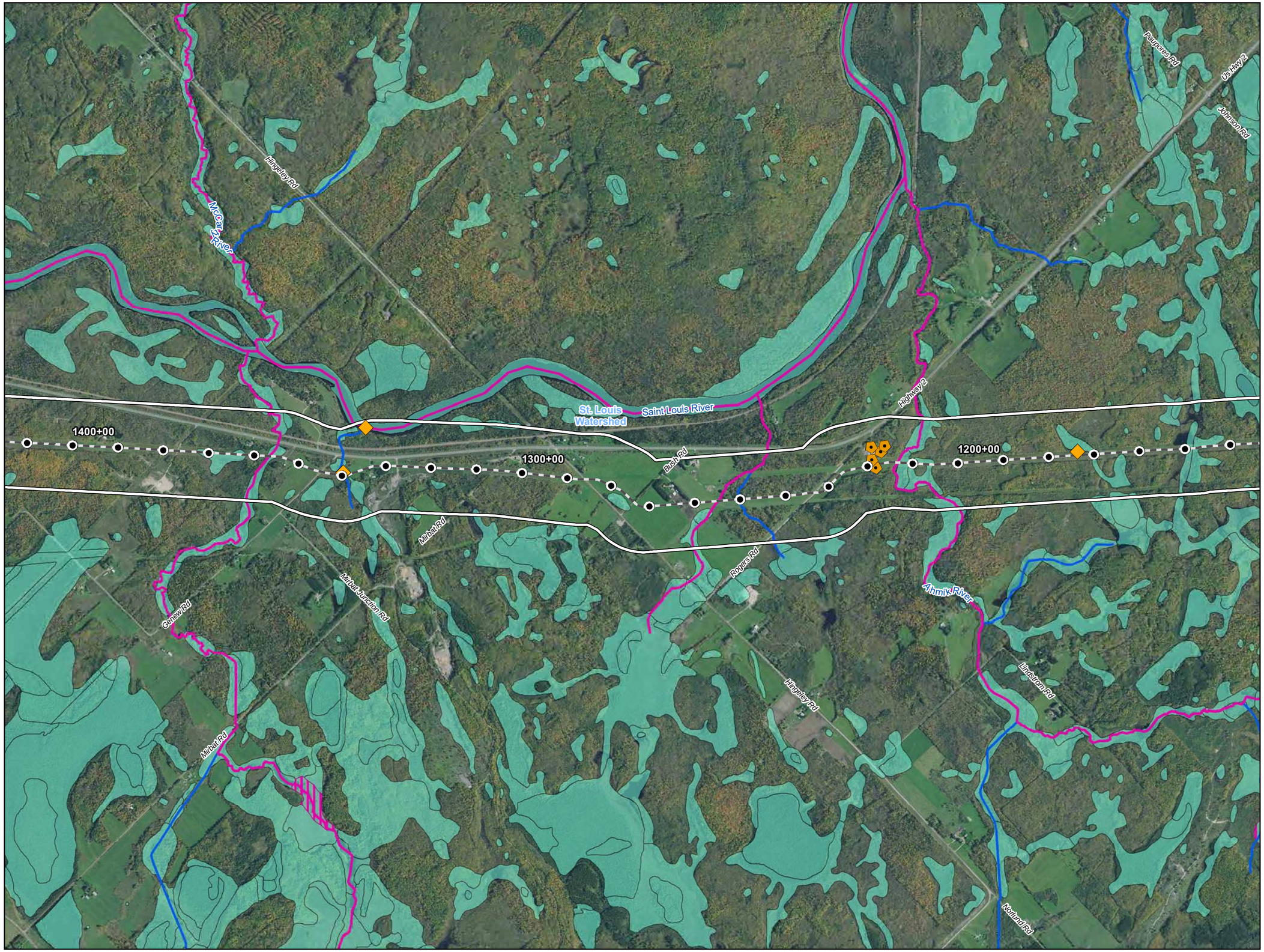
St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

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- Water Well
- Surface Water Intake
- Calcareous Fen
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- Trout Stream
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- PWI Basin
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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 37

Line 3 Replacement Project

RA-06-L3

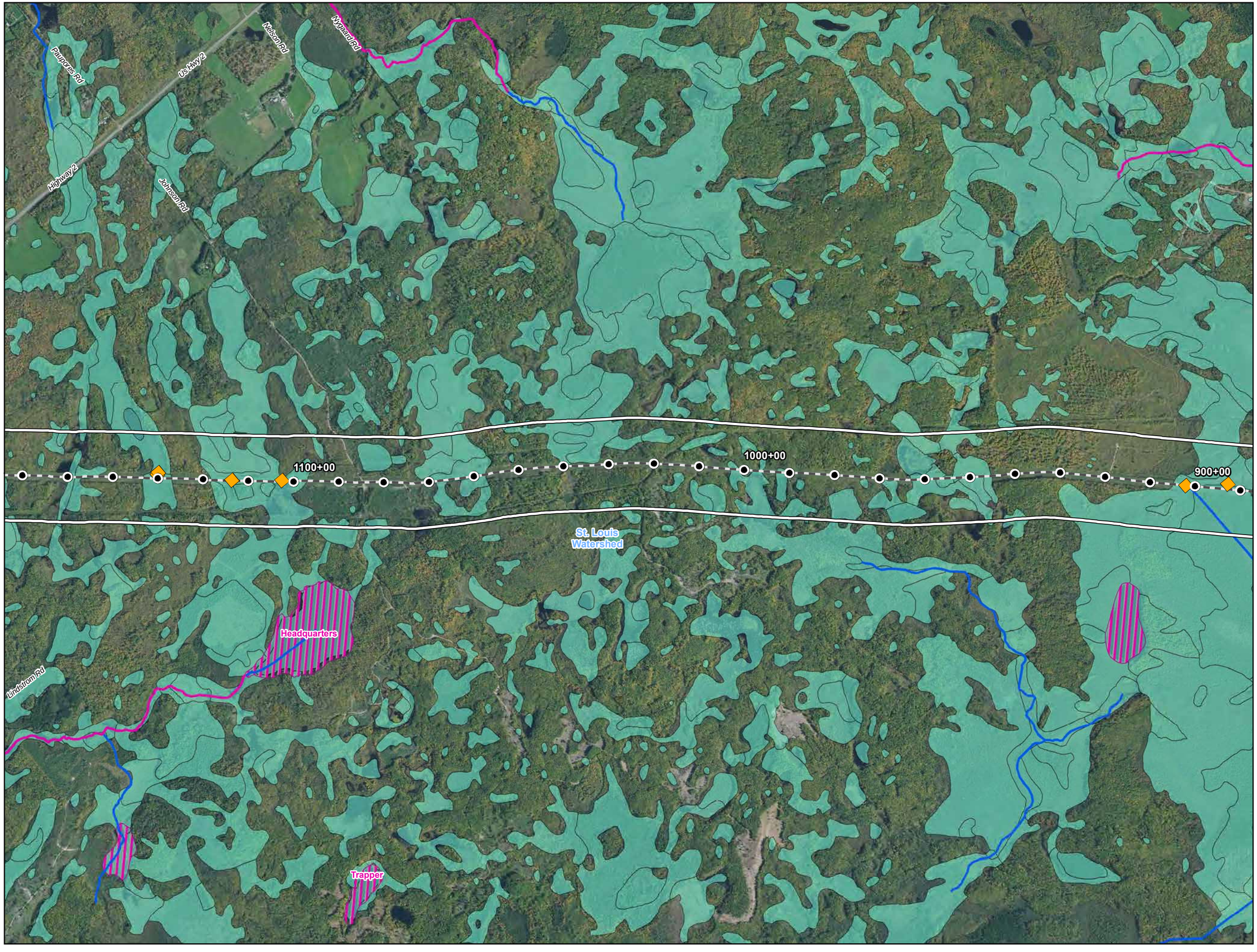
Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd
Date: (10/19/2016)





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- Water Well
- Surface Water Intake
- Calcareous Fen
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- Alternative Centerline
- 2,000 ft Alternative Corridor
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- PWI Basin
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- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 38

Line 3 Replacement Project

RA-06-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

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Date: (10/19/2016)





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- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 39

Line 3 Replacement Project

RA-06-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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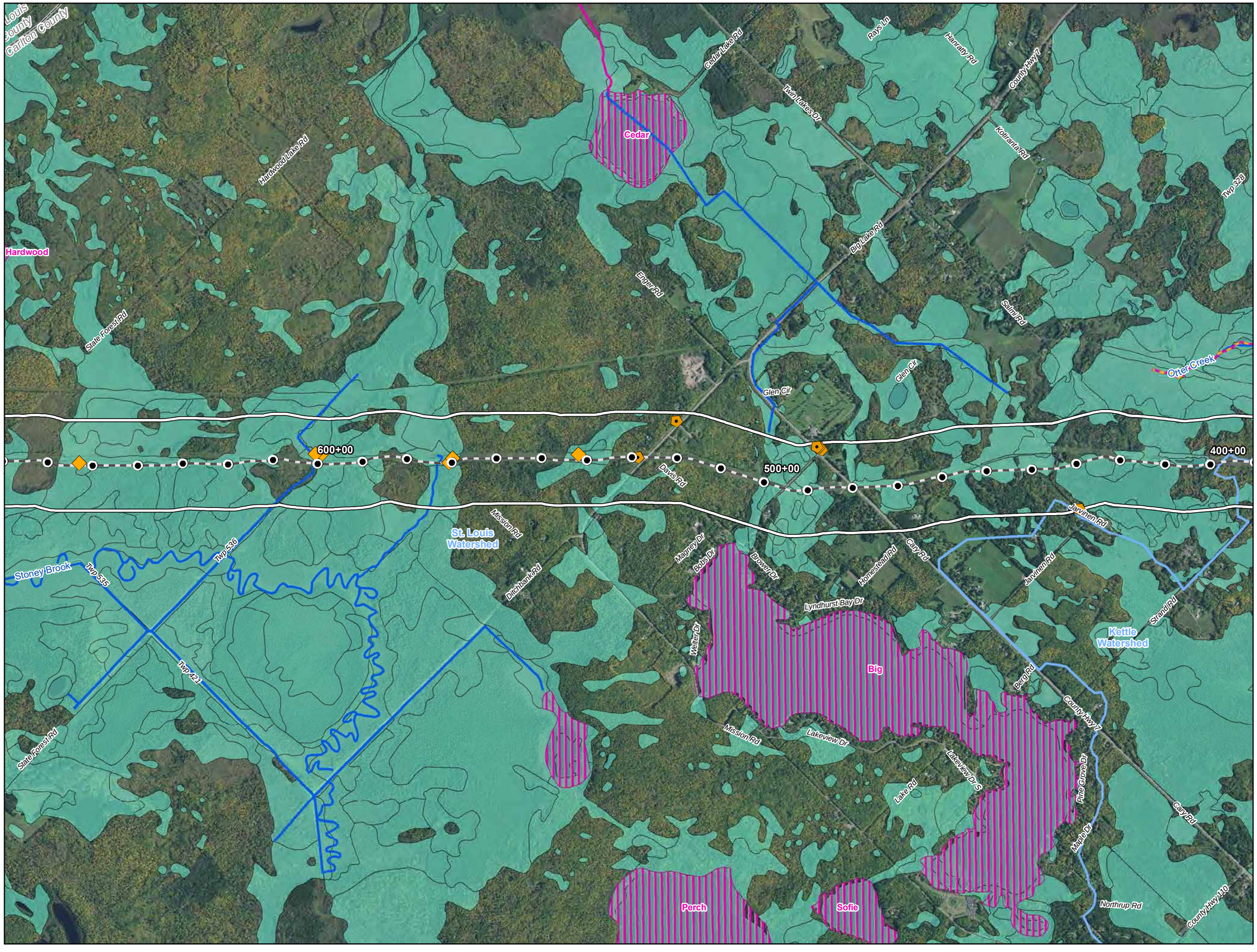
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 40

Line 3 Replacement Project

RA-06-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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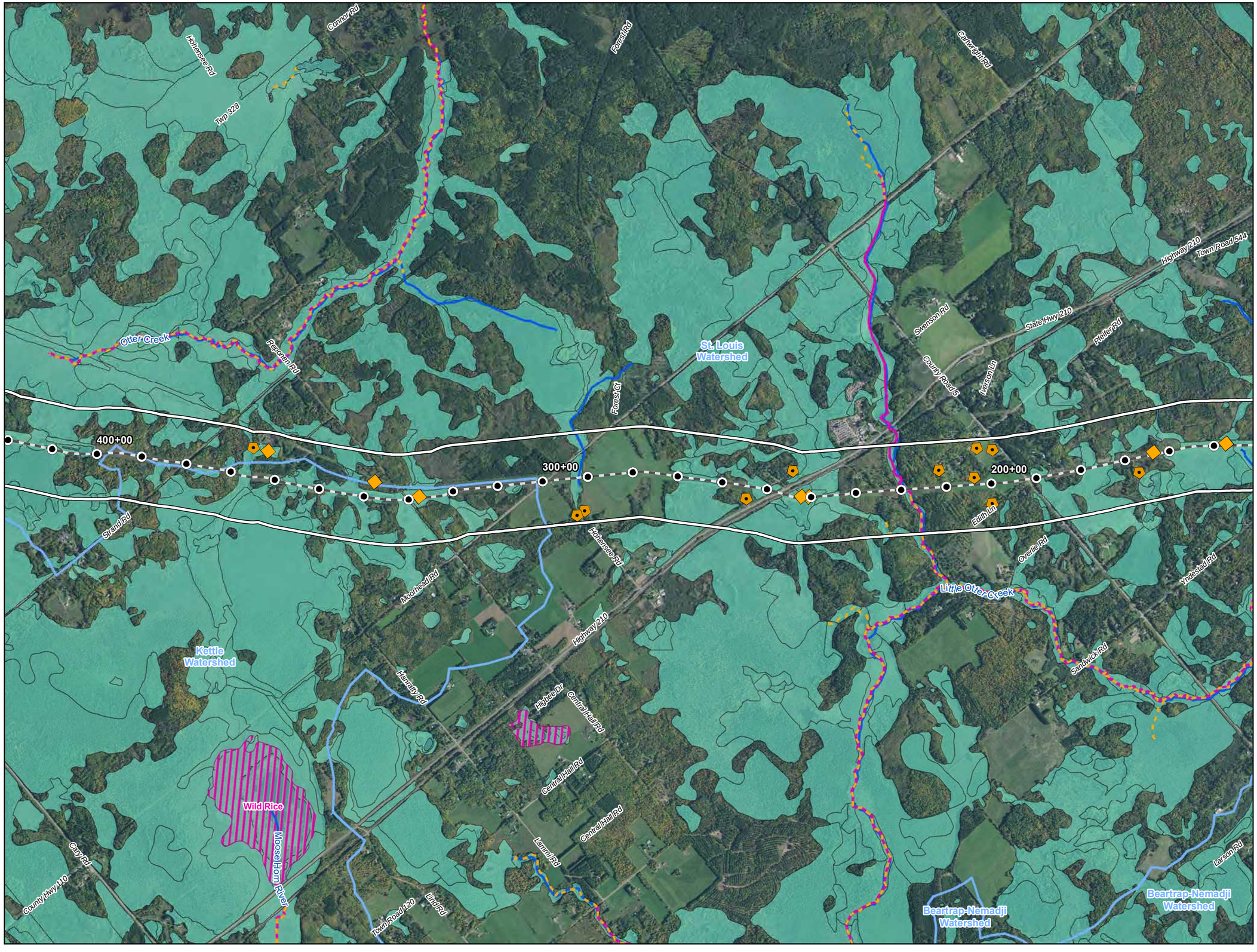
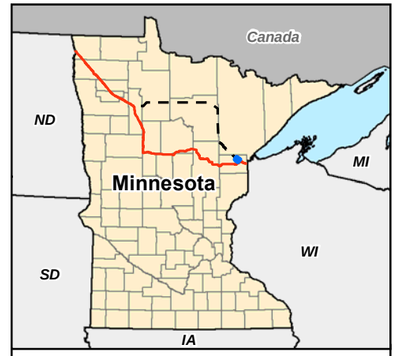
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 41

Line 3 Replacement Project

RA-06-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_FH\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-06-L3.mxd

Date: (10/19/2016)

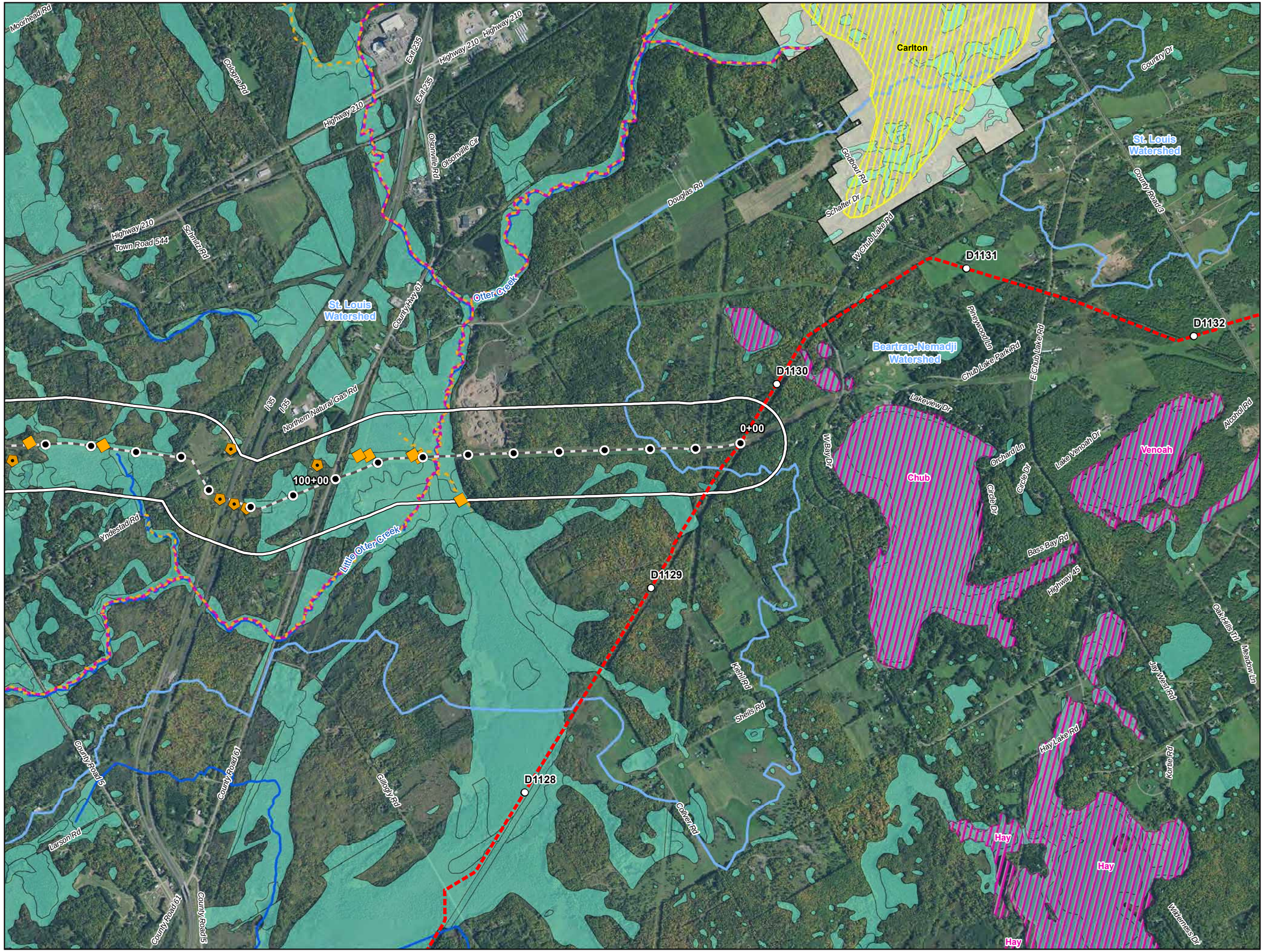


Figure 42

Line 3 Replacement Project

RA-06-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Alternative (RA)-07

DRAFT

Table 1
Line 3 Replacement Project – RA-07-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Alternative Centerline [a]	Miles Within the 2,000-ft-wide Route Alternative Corridor [b]
Clearwater	**9**	**6.3**
Clearwater	7	5.6
Beltrami	2	0.7
Mississippi Headwaters	**10**	**5.9**
Beltrami	5	3.4
Cass	1	0.6
Itasca	4	2.0
Leech Lake	**3**	**5.4**
Hubbard	3	5.4
Prairie-Willow	**4**	**2.1**
Itasca	4	2.1
St. Louis	**7**	**4.1**
St. Louis	5	3.0
Carlton	2	1.1
Grand Total [c]	**33**	**23.8**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RA-07-L3
Summary of Waterbodies Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Clearwater	**6**	**4**	**2**	**12**	**5.1**	**2.6**	**0.8**	**8.5**
Clearwater	4	4	2	10	4.3	2.6	0.8	7.6
Beltrami	2	-	-	2	0.8	-	-	0.8
Mississippi Headwaters	**12**	**4**	**4**	**20**	**7.0**	**2.3**	**3.4**	**12.7**
Beltrami	6	-	-	6	3.7	-	0.1	3.8
Itasca	4	4	3	11	2.4	1.5	2.2	6.1
Hubbard	-	-	-	-	-	-	<0.1	<0.1
Cass	2		1	3	0.9	0.8	1.1	2.9
Leech Lake	**2**	**7**	**5**	**14**	**1.7**	**7.4**	**3.7**	**12.8**
Beltrami	-	3	-	3	-	1.4	-	1.4
Hubbard	-	4	-	4	-	5.9	0.2	6.1
Cass	2		5	7	1.7	0.1	3.5	5.3
Prairie-Willow	**2**	**4**	**4**	**10**	**1.8**	**1.9**	**1.6**	**5.2**
Itasca	2	4	4	10	1.8	1.9	1.6	5.2
St. Louis	**11**	**2**	**10**	**23**	**5.2**	**1.0**	**18.7**	**24.9**
Itasca	-	-	2	2	-	-	11.0	11.0
Aitkin	-	-	2	2	-	-	3.1	3.1
St. Louis	5	2	4	11	2.9	1.0	3.7	7.6
Carlton	6	-	2	8	2.3	-	0.9	3.2
Grand Total [c]	**33**	**21**	**25**	**79**	**20.9**	**15.2**	**28.1**	**64.2**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RA-07-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Alternative Proposed Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Clearwater	**0.8**	**0.6**	**0.3**	**1.7**	**258.5**	**223.9**	**83.5**	**565.9**
Beltrami	0.2	-	-	0.2	59.5	7.1	4.8	71.5
Clearwater	0.5	0.6	0.3	1.5	199.0	216.7	78.7	494.4
Mississippi Headwaters	**1.8**	**8.1**	**0.1**	**10.0**	**679.6**	**2001.2**	**378.9**	**3059.7**
Beltrami	0.3	0.8	-	1.1	136.9	201.0	64.0	401.9
Cass	0.5	2.8	0.1	3.3	262.3	483.8	237.7	983.8
Hubbard	-	0.1	-	0.1	6.4	19.6	31.8	57.8
Itasca	1.0	4.5	-	5.5	274.1	1296.7	45.5	1616.2
Leech Lake	**1.4**	**7.3**	**-**	**8.7**	**334.3**	**1750.4**	**68.2**	**2153.0**
Beltrami	-	-	-	-	2.4	9.4	0.6	12.3
Cass	1.2	6.9	-	8.1	258.5	1388.9	63.5	1711.0
Hubbard	0.1	0.5	-	0.6	73.4	352.2	4.1	429.7
Prairie-Willow	**0.5**	**5.9**	**0.1**	**6.4**	**180.2**	**1378.2**	**82.6**	**1641.0**
Itasca	0.5	5.9	0.1	6.4	180.2	1378.2	82.6	1641.0
Kettle	**0.5**	**0.2**	**-**	**0.7**	**54.2**	**78.1**	**1.4**	**133.7**
Carlton	0.5	0.2	-	0.7	54.2	78.1	1.4	133.7
Beartrap-Nemadji		**-**	**-**	**-**	-	**0.4**	**0.9**	**1.3**
Carlton		-	-	-	**-**	0.4	0.9	1.3
St. Louis	**1.3**	**18.2**	**0.1**	**19.6**	**234.7**	**4597.5**	**32.7**	**4864.9**
Aitkin	-	1.1	-	1.1	2.6	271.7	-	274.3
Carlton	0.6	6.0	0.1	6.7	111.8	1385.8	14.9	1512.5
Itasca	0.3	4.2	-	4.5	49.0	917.1	-	966.1
St. Louis	0.4	6.9	-	7.3	71.3	2022.9	17.8	2111.9
Grand Total [d]	**6.2**	**40.3**	**0.7**	**47.3**	**1741.6**	**10029.7**	**648.1**	**12419.5**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route alternative centerline.

b Total acres of NWI within the 2000-ft-wide route alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RA-07-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	Miles Crossed by the Route Alternative Centerline [a]		Acres Within the Route Alternative Corridor [b]	
County	Wetlands	Basins	Wetlands	Basins
Clearwater	**-**	**0.4**	**2.3**	**144.8**
Clearwater	-	0.4	2.3	135.0
Beltrami	-	-	-	9.9
Mississippi Headwaters	**-**	**1.1**	**27.3**	**586.2**
Beltrami	-	-	11.7	59.1
Hubbard	-	-	-	41.5
Cass	-	0.2	15.7	290.4
Itasca	-	1.0	-	195.2
Leech Lake	-	**0.4**	**-**	**124.6**
Cass	**-**	0.4	-	124.6
Prairie-Willow	**-**	**-**	**36.8**	**39.3**
Itasca	-	-	36.8	39.3
St. Louis	-	**-**	**-**	**42.4**
Itasca	**-**	-	-	42.4
Grand Total [c]	**-**	**2.0**	**66.4**	**937.3**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the route alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RA-07-L3
Summary of Trout Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Clearwater	**2**	**0.8**
Beltrami	**2**	0.8
Leech Lake	**3**	**5.6**
Hubbard	3	5.6
St. Louis	**1**	**1.3**
Carlton	1	1.3
Grand Total [c]	**6**	**7.7**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RA-07-L3
Wells within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Clearwater	Clearwater	Abandoned	239	5
			309	
			540	
			383	
			225	
		Domestic	490	6
			463	
			398	
			985	
			828	
			266	
		Monitoring	40	3
			236	
			292	
Mississippi Headwaters	Beltrami	Abandoned	226	3
			871	
			338	
		Dewatering	977	1
		Domestic	142	27
			687	
			969	
			375	
			301	
			889	
			402	
			858	
			829	
			641	
			910	
			755	
			819	
			603	
			720	
			838	
			471	
			648	
			857	
			578	
			130	

Mississippi Headwaters (cont.)	Beltrami (cont.)	Domestic (cont.)	335	27 (cont.)
			959	
			499	
			349	
			146	
			675	
		Monitoring	47	12
			45	
			121	
			232	
			263	
			280	
			982	
			917	
			65	
			230	
			198	
			79	
		Observation	21	43
			335	
			167	
			8	
			53	
			50	
			84	
			117	
			30	
			215	
			135	
			207	
			141	
			92	
			478	
			367	
			300	
			370	
			297	
			530	
			329	
			437	
			358	
			327	
			518	
			512	

Mississippi Headwaters (cont.)	Beltrami (cont.)	Observation (cont.)	425	43 (cont.)
			457	
			328	
			484	
			568	
			459	
			747	
			631	
			722	
			683	
			748	
			693	
			686	
			829	
			67	
			936	
			394	
		Scientific Investigation	764	1
		Unknown	280	1
Leech Lake	Beltrami	Domestic	459	5
			856	
			136	
			913	
			559	
	Hubbard	Domestic	480	13
			508	
			197	
			405	
			173	
			367	
			149	
			365	
			130	
			705	
			464	
			460	
			247	
Mississippi Headwaters	Hubbard	Abandoned	272	5
			248	
			269	
			258	
			290	
		Test Well	55	1

Mississippi Headwaters (cont.)	Cass	Abandoned	828	3
			666	
			725	
		Domestic	722	14
			935	
			23	
			495	
			871	
			863	
			884	
			654	
			659	
			773	
			219	
			198	
			103	
			928	
		Monitoring	299	42
			387	
			292	
			155	
			146	
			208	
			329	
			203	
			15	
			83	
			161	
			148	
			223	
			273	
			220	
			229	
			237	
			713	
			680	
			74	
			78	
			957	
			972	
			883	
			904	
			848	
			816	

Mississippi Headwaters (cont.)	Cass (cont.)	Monitoring (cont.)	810	42 (cont.)
			752	
			747	
			918	
			691	
			675	
			662	
			668	
			854	
			484	
			489	
			824	
			80	
			245	
			83	
		Observation	6	1
		Other	240	1
		Pump Out	273	9
			681	
			497	
			996	
			921	
			847	
			786	
			720	
			662	
		Remedial	311	2
			304	
		Test Well	934	1
Leech Lake	Cass	Domestic	905	1
		Environ. Bore Hole	79	3
			8	
			18	
		Test Well	13	1
Mississippi Headwaters	Cass	Test Well	369	1
Leech Lake	Cass	Abandoned	657	1
		Domestic	558	8
			827	
			477	
			951	
			751	
			801	
			520	

Leech Lake (cont.)	Cass (cont.)	Domestic (cont.)	365	8 (cont.)
		Monitoring	163	1
Mississippi Headwaters	Itasca	Abandoned	453	2
			80	
		Domestic	253	30
			242	
			784	
			904	
			467	
			323	
			221	
			381	
			73	
			362	
			324	
			366	
			375	
			151	
			606	
			167	
			332	
			129	
			669	
			570	
			178	
			724	
			328	
			399	
			711	
			740	
			326	
			354	
			876	
			520	
Prairie-Willow	Itasca	Abandoned	68	3
			272	
			964	
		Domestic	964	52
			302	
			439	
			255	
			265	
			494	
			225	

Prairie-Willow (cont.)	Itasca (cont.)	Domestic (cont.)	375	52 (cont.)
			597	
			442	
			403	
			577	
			506	
			637	
			741	
			984	
			359	
			720	
			950	
			985	
			924	
			814	
			421	
			912	
			566	
			508	
			51	
			38	
			691	
			451	
			494	
			707	
			773	
			399	
			900	
			377	
			926	
			554	
			653	
			207	
			140	
			427	
			147	
			238	
			258	
			323	
			519	
			498	
			815	
			659	
			456	
			368	

Prairie-Willow (cont.)	Itasca (cont.)	Exploration	829	12
			46	
			686	
			45	
			106	
			919	
			31	
			150	
			605	
			806	
			560	
			557	
		Unknown	870	1
St. Louis	Itasca	Domestic	790	1
	St. Louis	Abandoned	2	3
			7	
			10	
		Domestic	259	5
			284	
			588	
			749	
			728	
		Monitoring	426	8
			270	
			9	
			56	
			108	
			388	
			274	
			386	
	Carlton	Domestic	4	16
			732	
			904	
			634	
			609	
			515	
			94	
			561	
			293	
			435	
			21	
			655	

St. Louis (cont.)	Carlton (cont.)	Domestic (cont.)	576	16 (cont.)
			254	
			147	
			35	
		Monitoring	752	3
			693	
			747	
		Other	56	3
			54	
			54	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

a Municipal wells are not included in the source data.

Table 7
Line 3 Replacement Project – RA-07-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Route Alternative Centerline [b]	Acres Within the Route Alternative Corridor [c]
Mississippi Headwaters	Itasca	5278+00 5287+00	Grand Rapids Central WHPA	-	12.7
			Grand Rapids DWSMA	0.2	65.6
Prairie Willow	Itasca	5341+00 5361+00 5362+00	Grand Rapids Central Grand Rapids 2 WHPA (3 crossings)	2.4	523.9
		5415+00 5436+00	Grand Rapids DWSMA	2.6	688.7

DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest route alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the route alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide route alternative corridor.

Table 8
Line 3 Replacement Project – RA-07-L3
Surface Water Intakes within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Clearwater	Clearwater	General Permit Authorization	Active	2
			Inactive	9
	Beltrami	General Permit Authorization	Inactive	2
	Clearwater	Individual Permit	Inactive	6
Mississippi Headwaters	Beltrami	General Permit Authorization	Active	2
			Inactive	3
		Individual Permit	Active	1
			Inactive	7
Leech Lake	Hubbard	General Permit Authorization	Inactive	10
		Individual Permit	Active	3
			Inactive	1
Mississippi Headwaters	Hubbard	General Permit Authorization	Active	1
			Inactive	4
	Cass	General Permit Authorization	Inactive	10
		Individual Permit	Active	5
			Inactive	2
Leech Lake	Cass	General Permit Authorization	Active	1
			Inactive	7
Mississippi Headwaters	Cass	General Permit Authorization	Active	1
Leech Lake	Cass	General Permit Authorization	Inactive	1
Mississippi Headwaters	Cass	Individual Permit	Inactive	1
Leech Lake	Cass	General Permit Authorization	Inactive	4
Mississippi Headwaters	Cass	General Permit Authorization	Inactive	1
Leech Lake	Cass	General Permit Authorization	Inactive	16
		Individual Permit	Inactive	2
Mississippi Headwaters	Cass	General Permit Authorization	Inactive	12
	Itasca	General Permit Authorization	Active	4
			Inactive	13
		Individual Permit	Active	1
			Inactive	8

Prairie-Willow	Itasca	General Permit Authorization	Inactive	5
		Individual Permit	Active	1
			Inactive	2
		General Permit Authorization	Active	2
			Inactive	7
		Individual Permit	Inactive	9
St. Louis	Itasca	General Permit Authorization	Active	1
			Inactive	9
		Individual Permit	Inactive	1
	Aitkin	General Permit Authorization	Inactive	3
	St. Louis	General Permit Authorization	Active	1
			Inactive	36
		Individual Permit	Inactive	1
	Carlton	General Permit Authorization	Active	4
			Inactive	11
Kettle	Carlton	General Permit Authorization	Inactive	1
St. Louis	Carlton	General Permit Authorization	Inactive	3
		Individual Permit	Inactive	6

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679

a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RA-07-L3

Enbridge

Clearwater County, Minnesota

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-07-L3.mxd

Date: (10/18/2016)

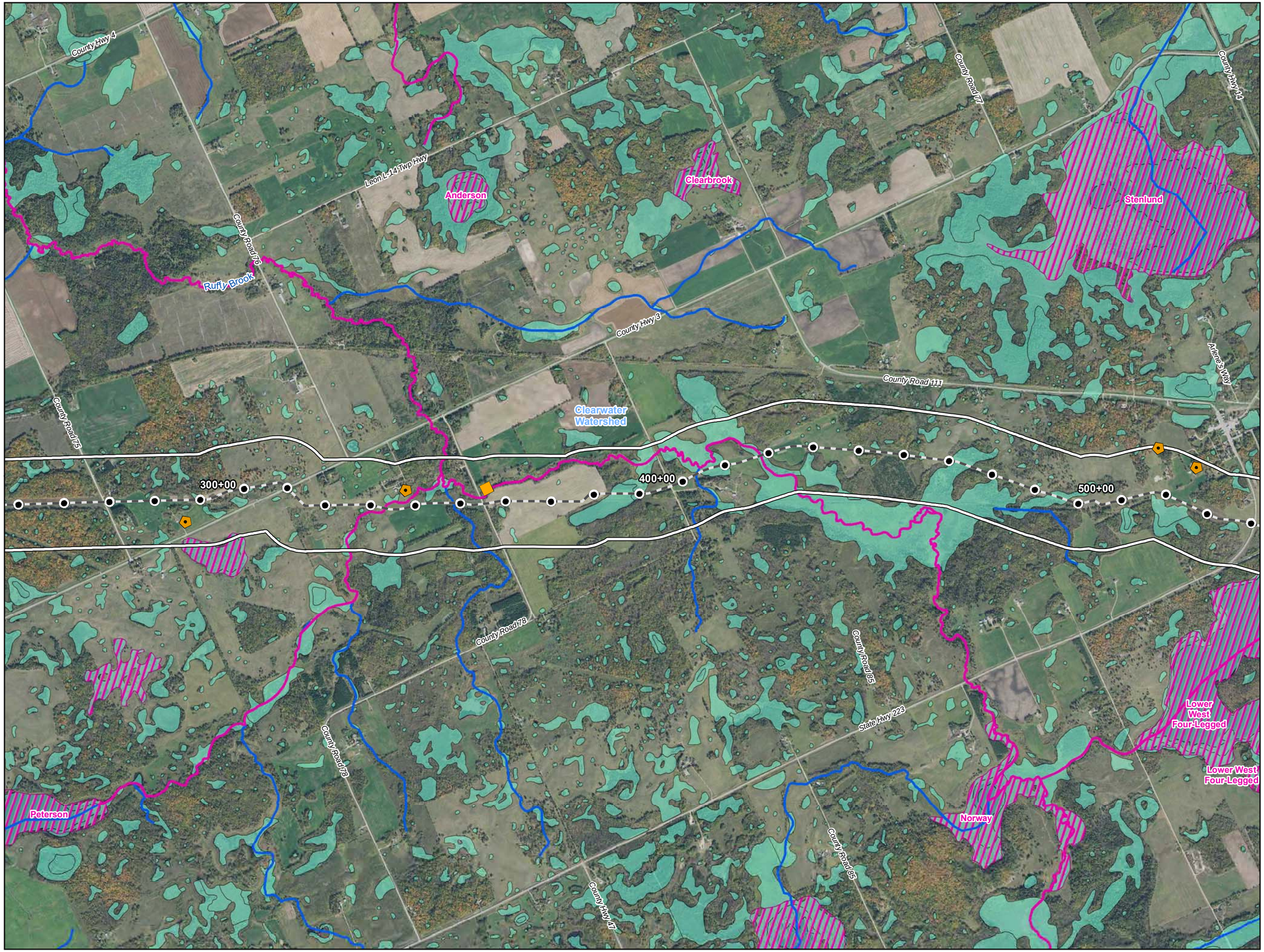

Figure 2

Line 3 Replacement Project

RA-07-L3

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Clearwater County, Minnesota

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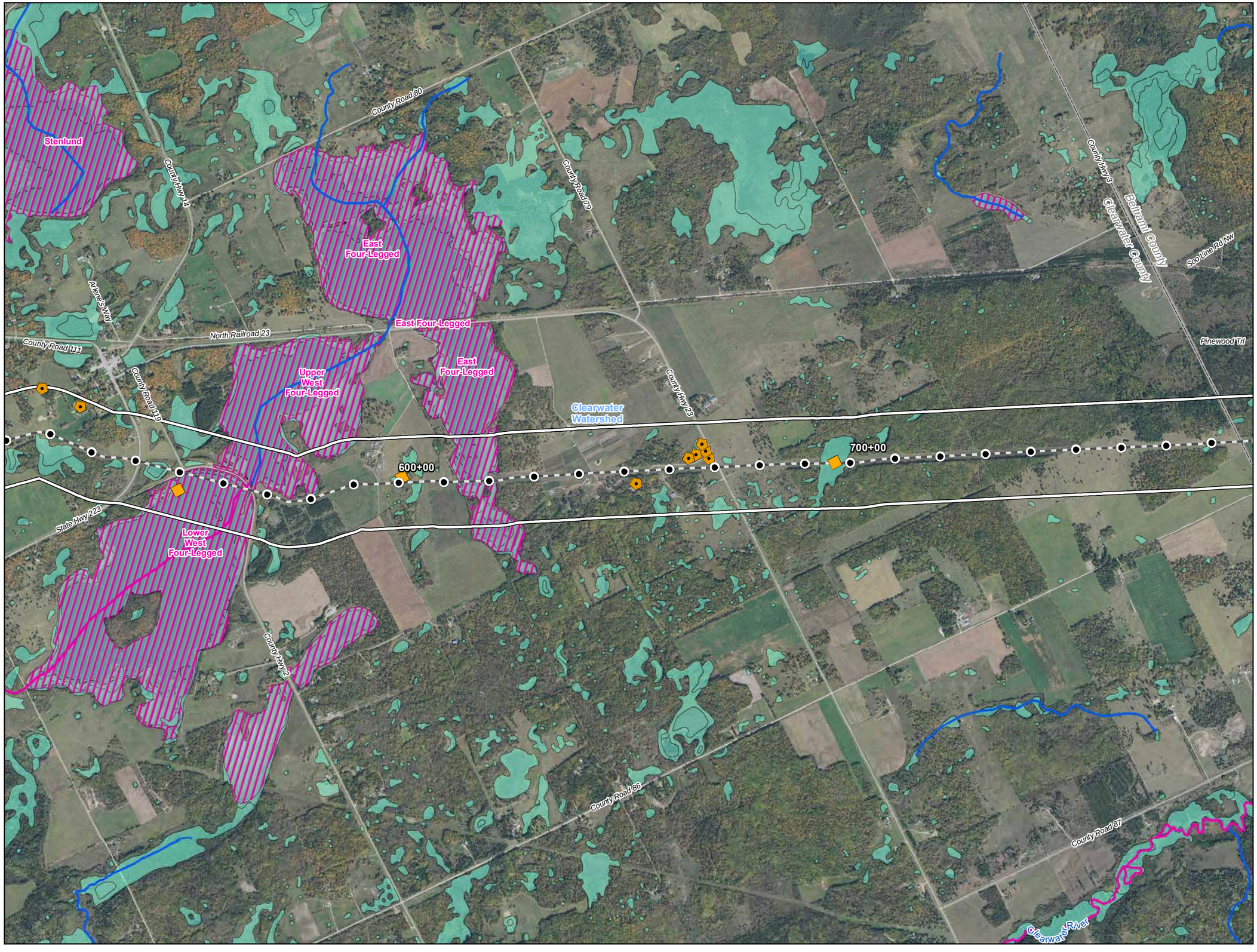

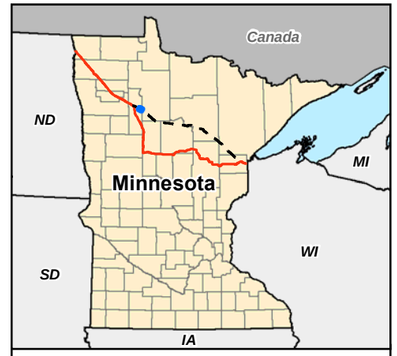

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 3

Line 3 Replacement Project

RA-07-L3

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Clearwater County, Minnesota

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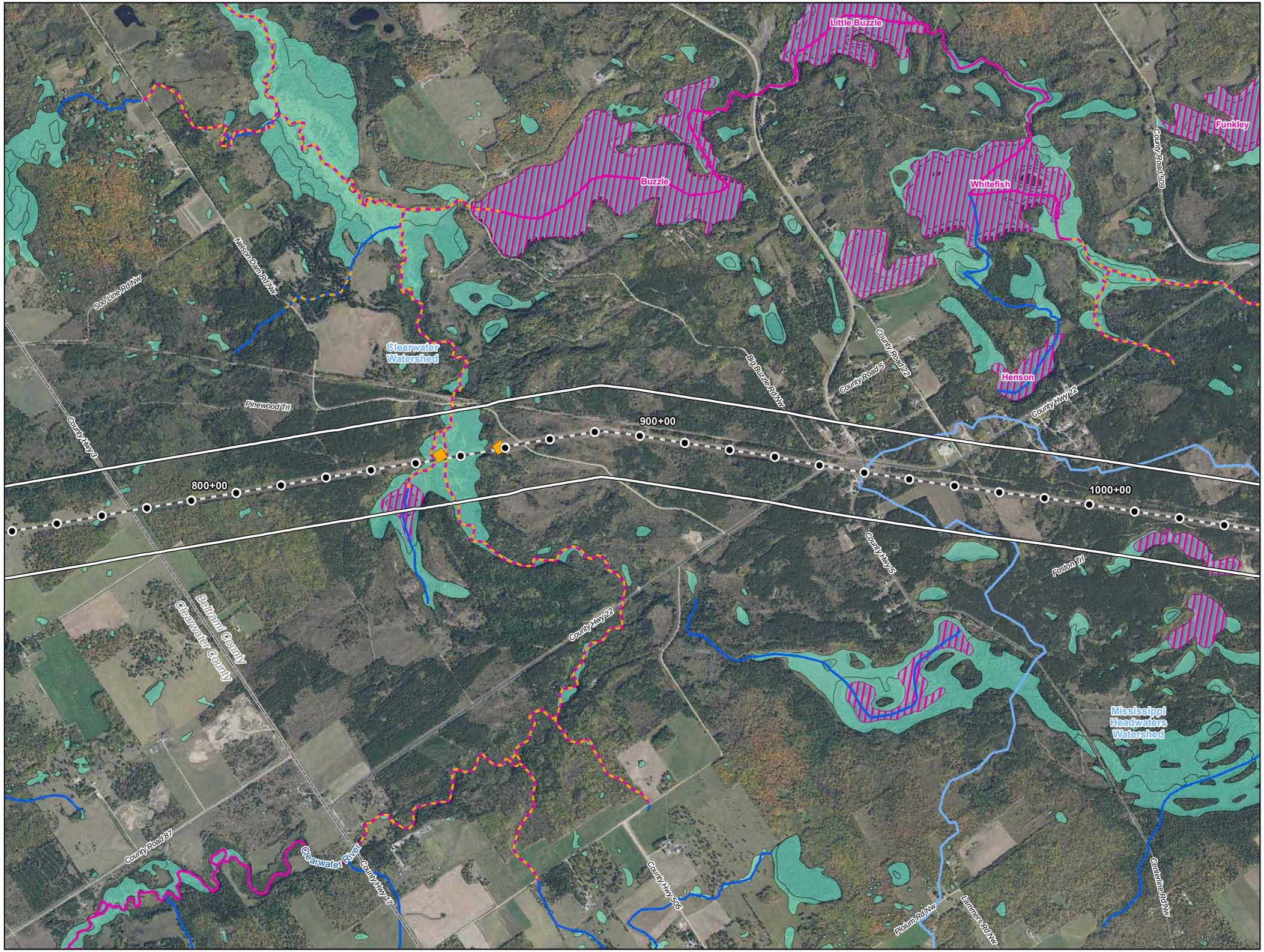



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 4

Line 3 Replacement Project

RA-07-L3

Enbridge

Beltrami County, Minnesota

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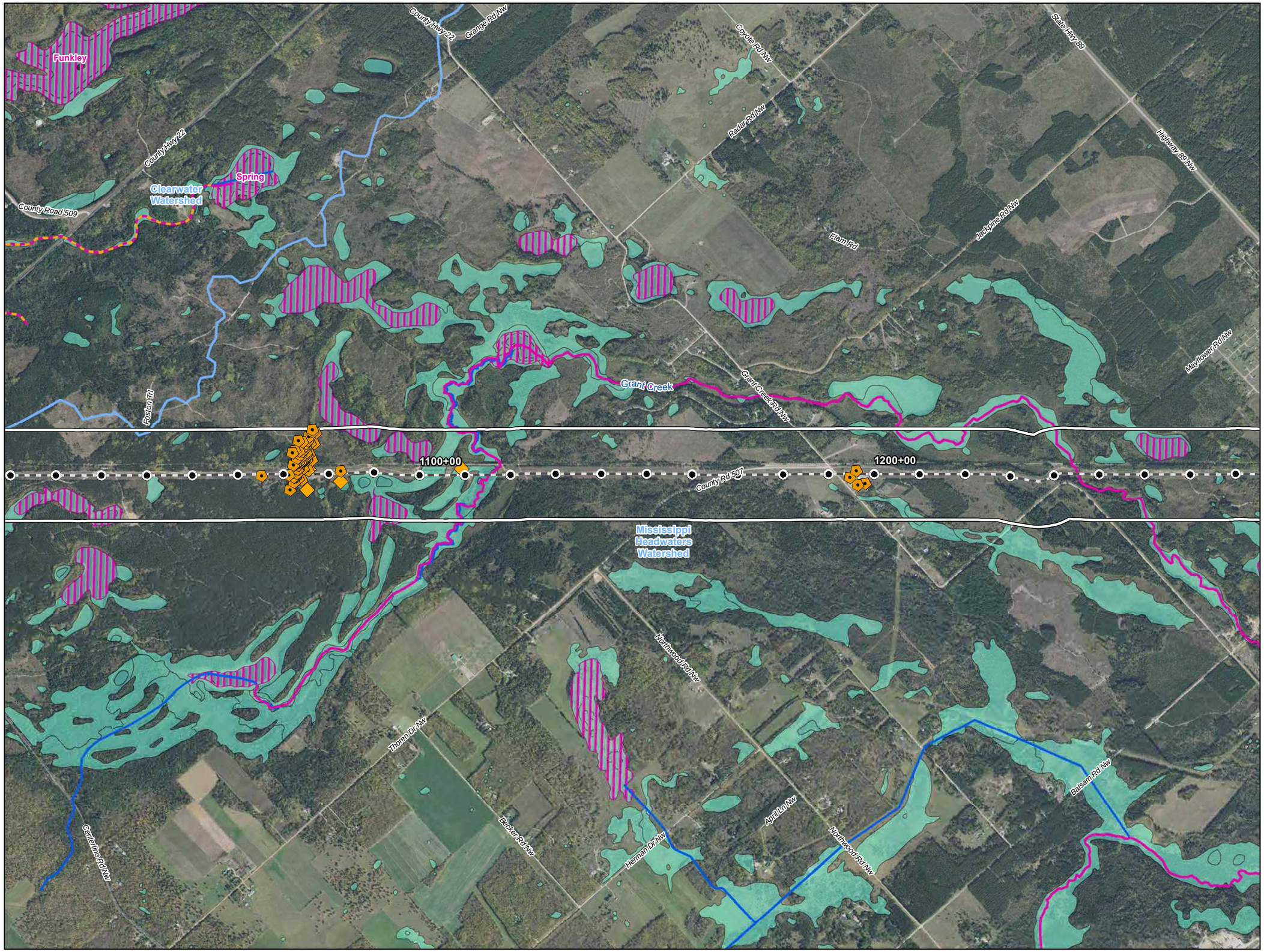

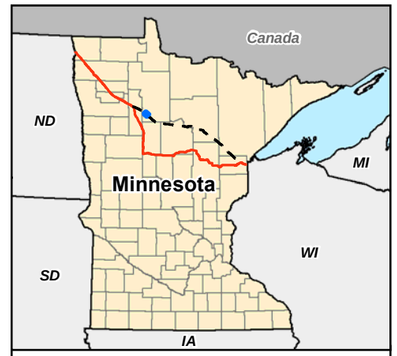

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 5

Line 3 Replacement Project

RA-07-L3

Enbridge

Beltrami County, Minnesota

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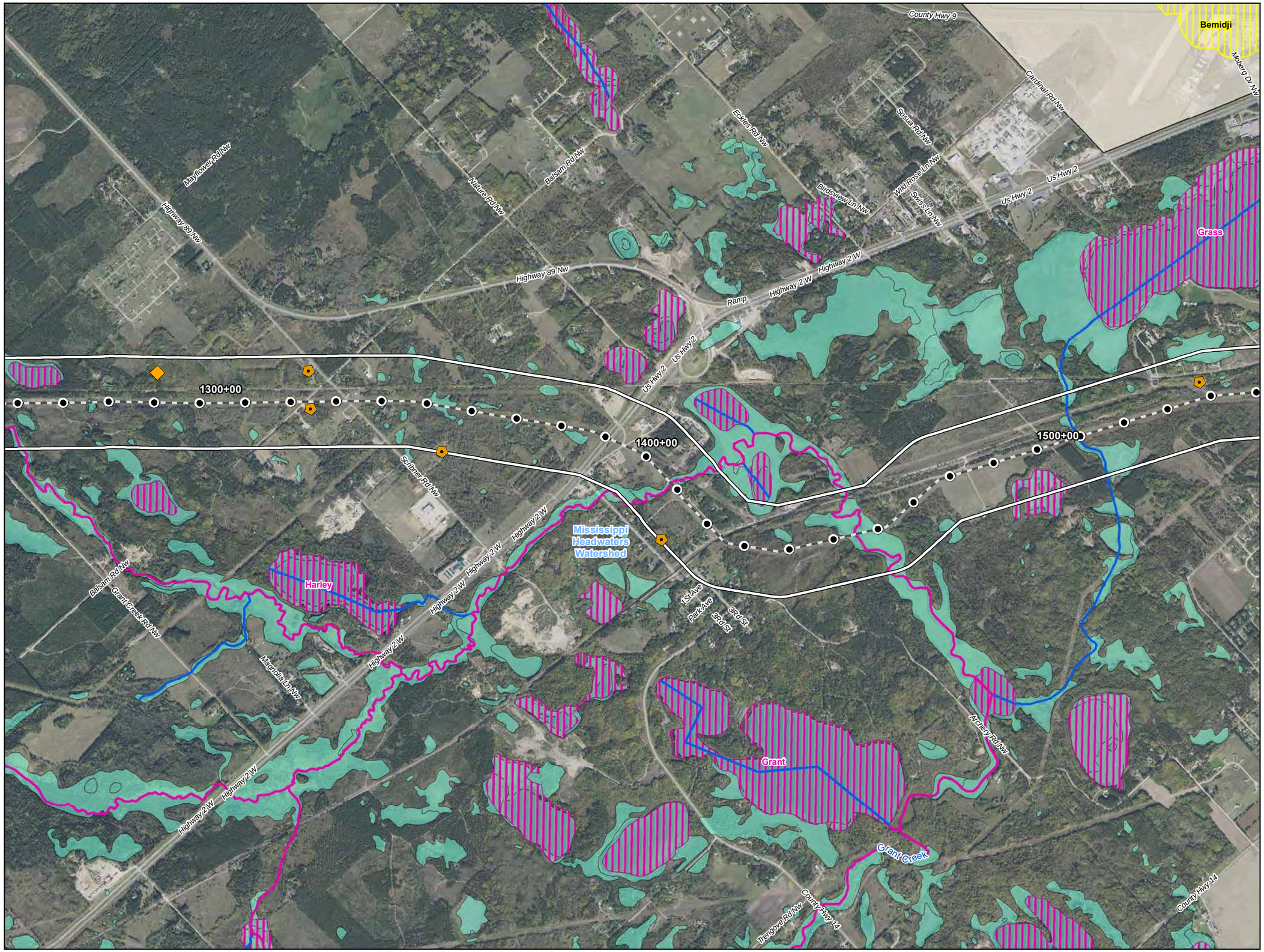



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 6

Line 3 Replacement Project

RA-07-L3

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Beltrami County, Minnesota

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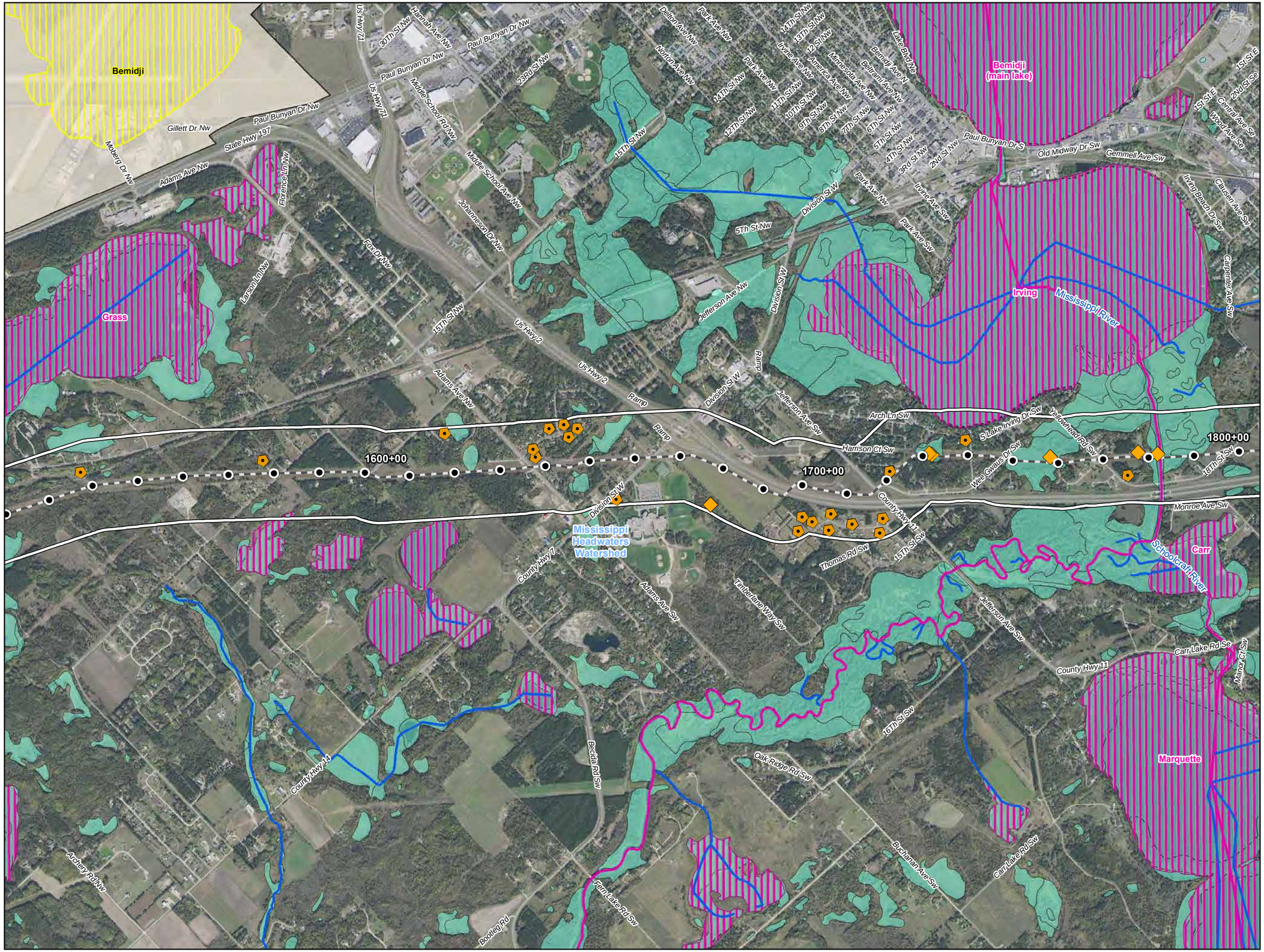



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 7

Line 3 Replacement Project

RA-07-L3

Enbridge

Beltrami County, Minnesota

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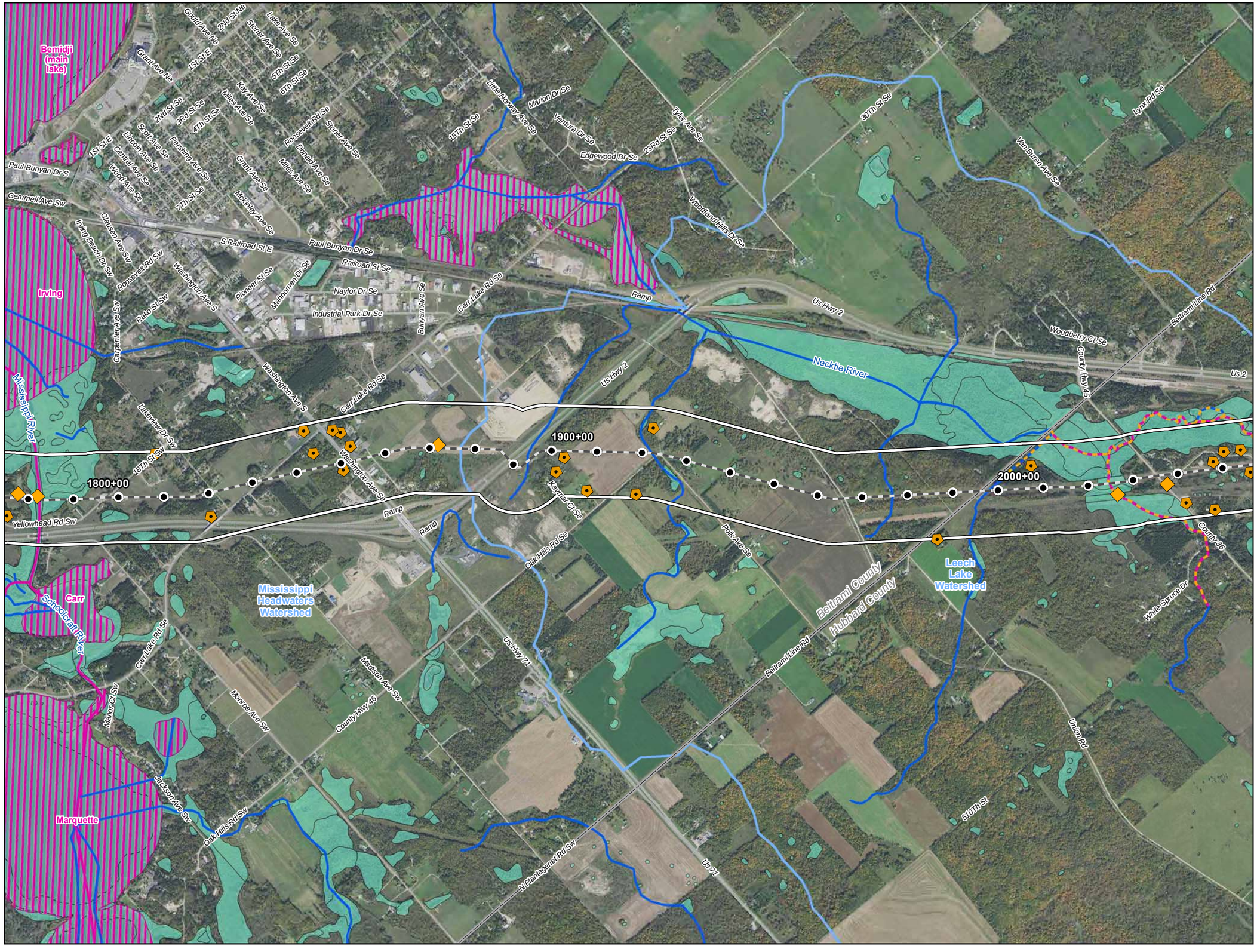

Figure 8

Line 3 Replacement Project

RA-07-L3

Enbridge

Beltrami County, Minnesota

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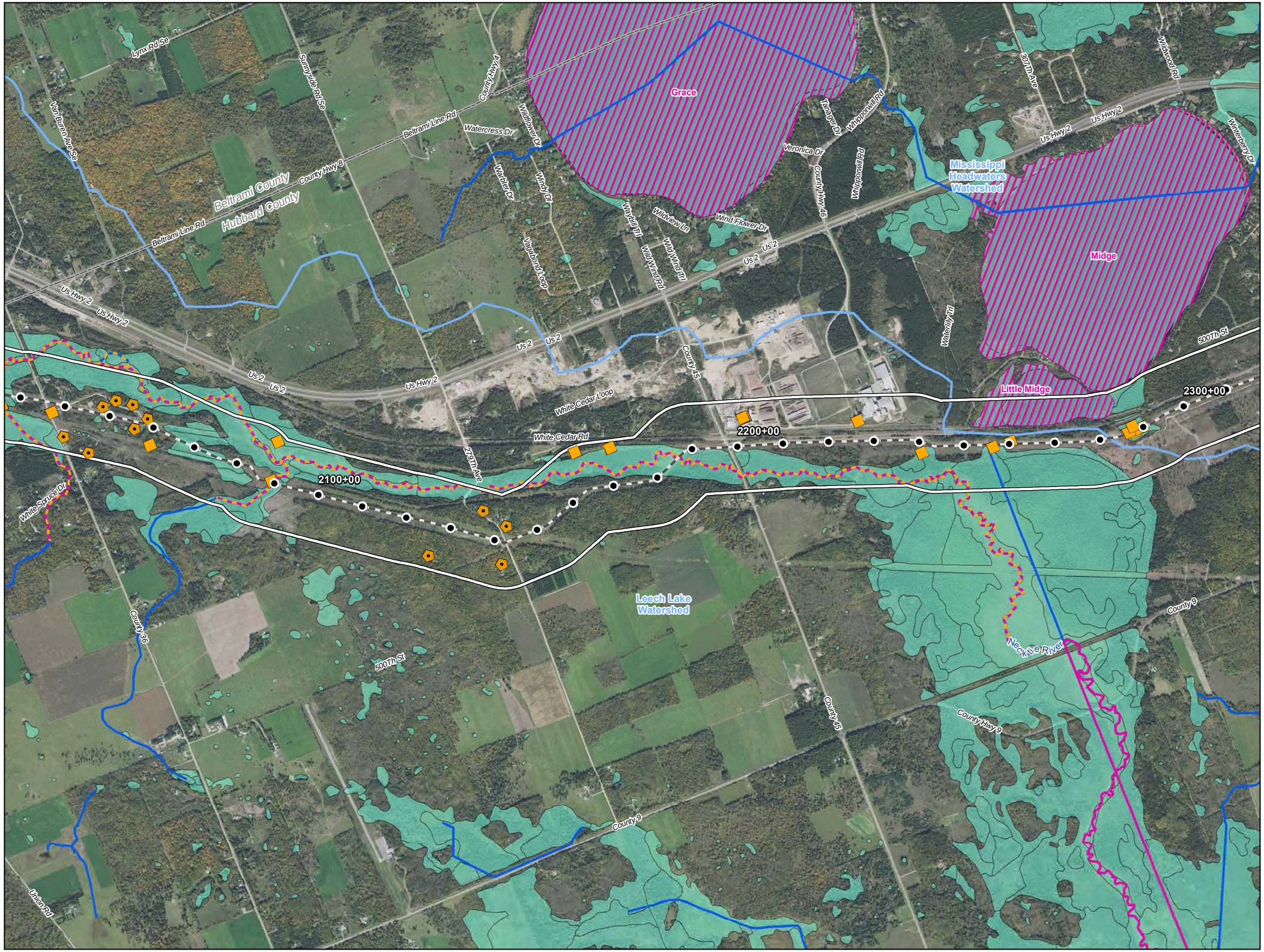



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 9

Line 3 Replacement Project

RA-07-L3

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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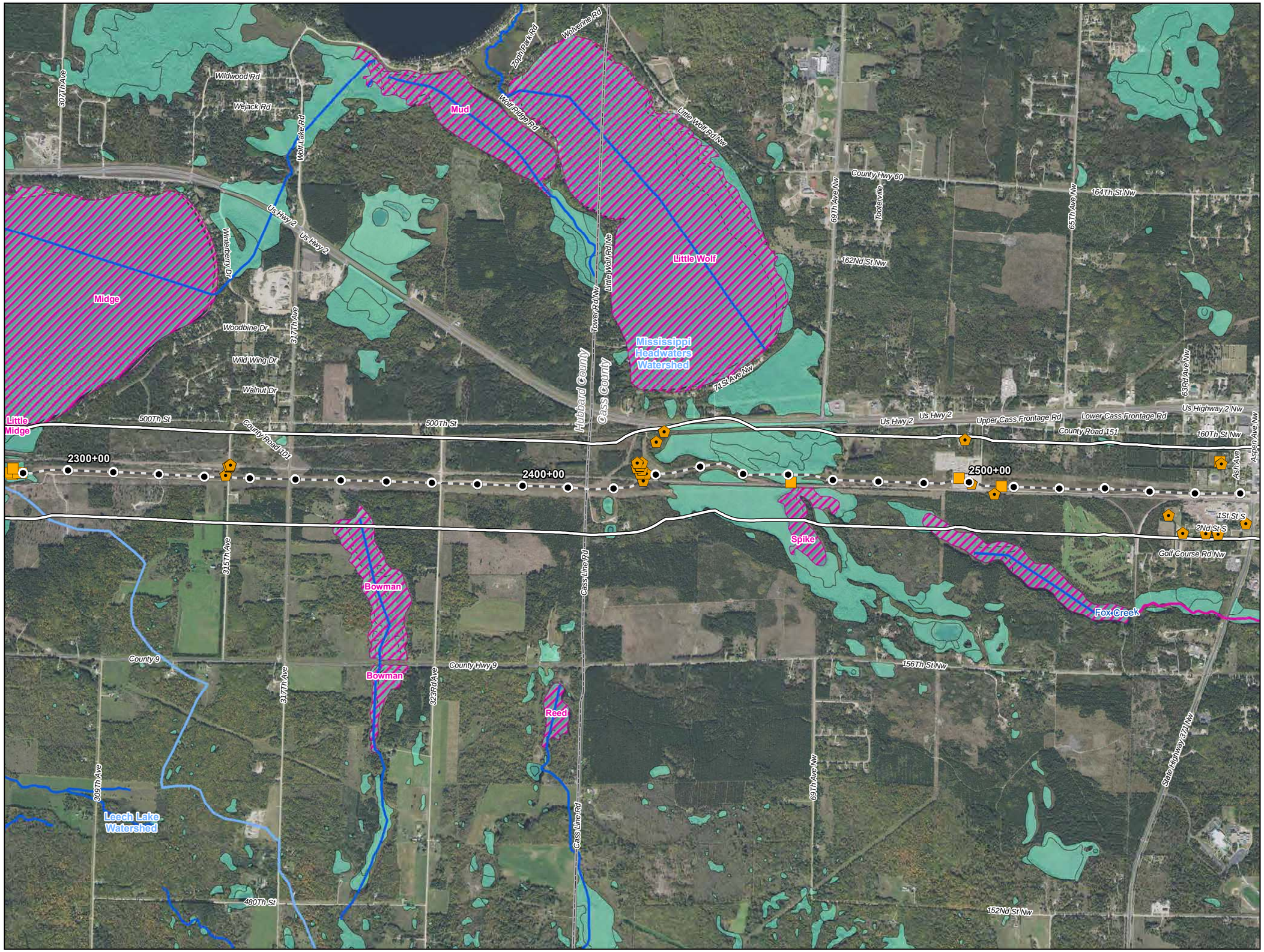

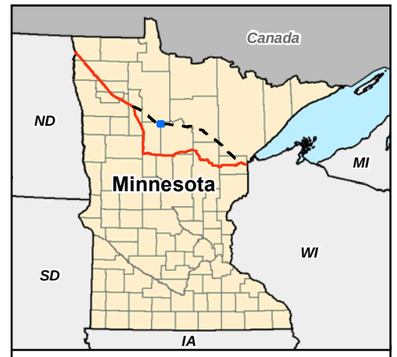

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 10

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 11

Line 3 Replacement Project

RA-07-L3

Enbridge

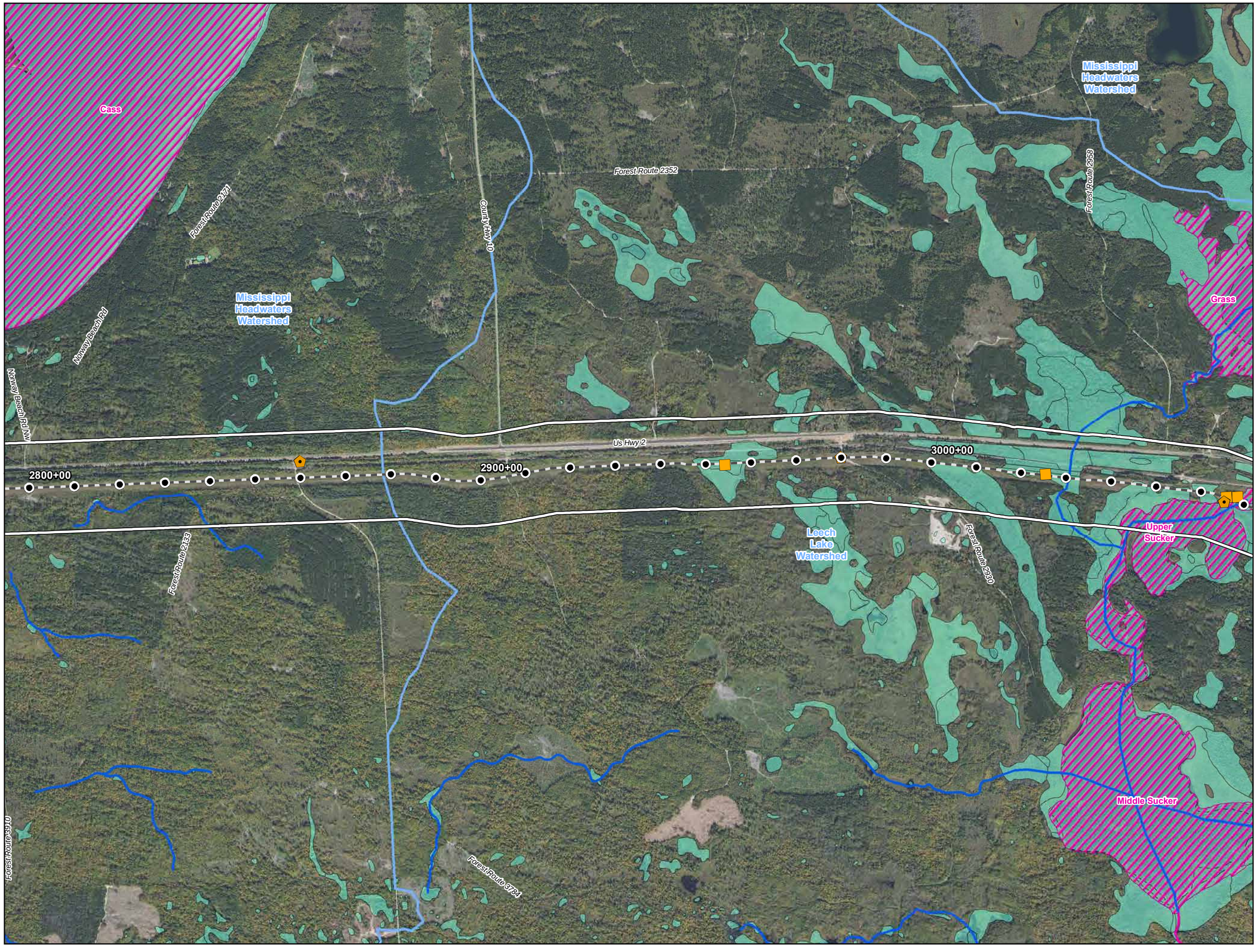
Cass County, Minnesota

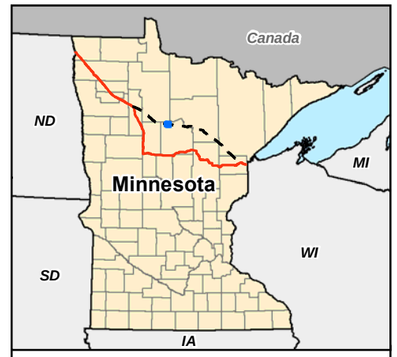
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 12

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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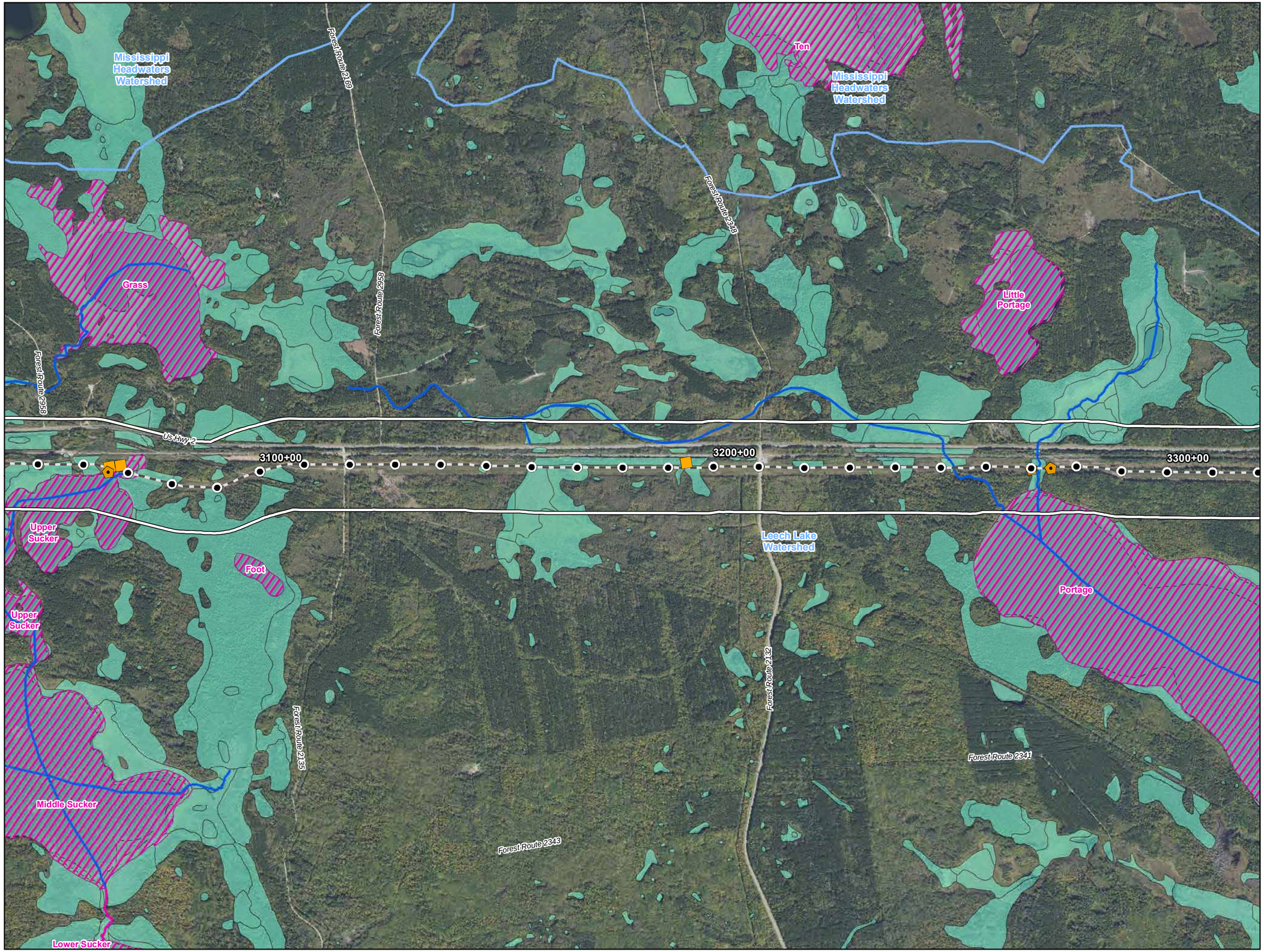

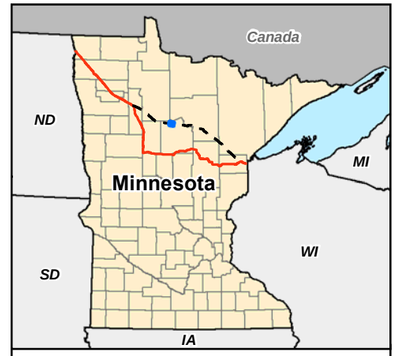

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 13

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

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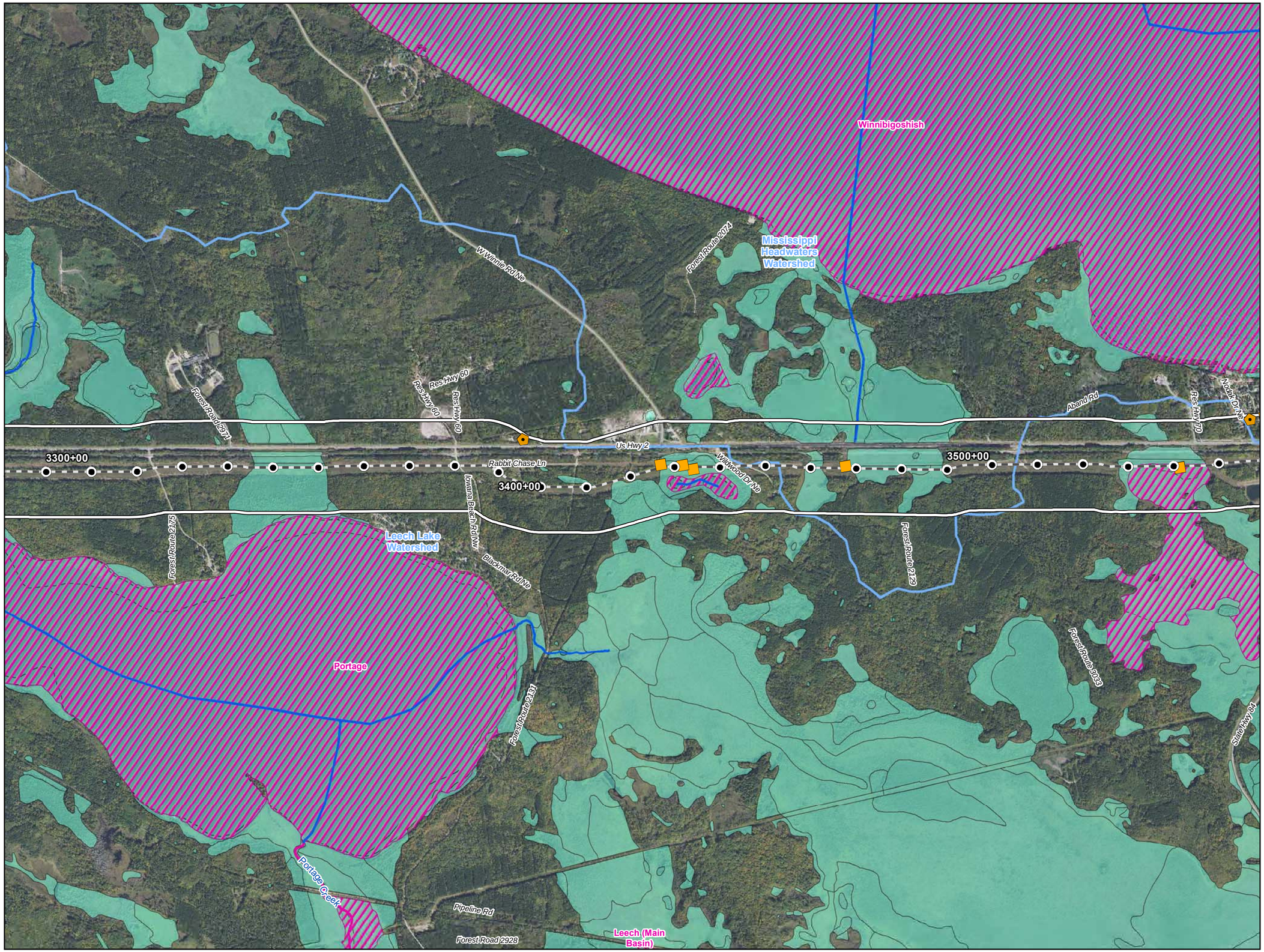



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 14

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

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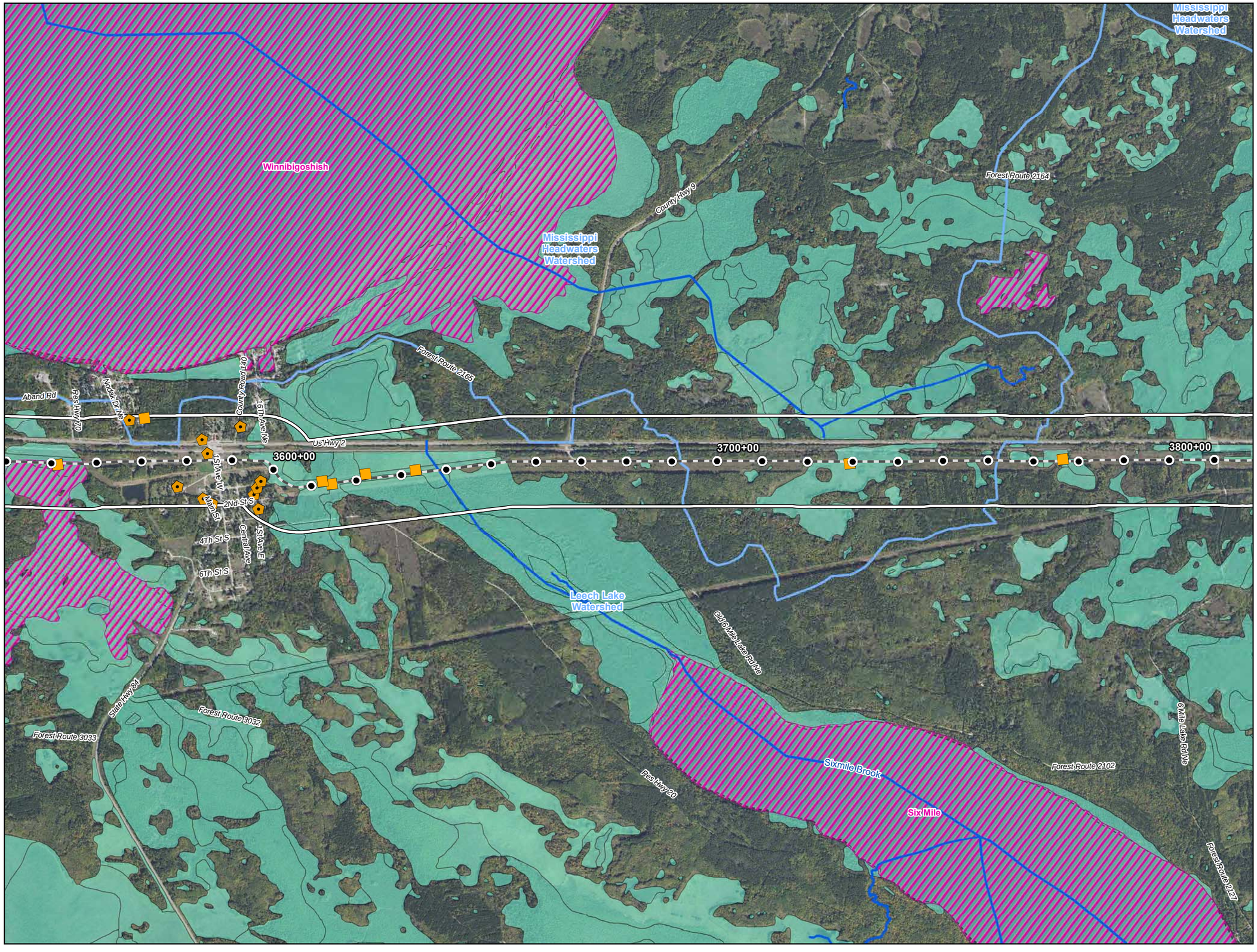
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 15

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

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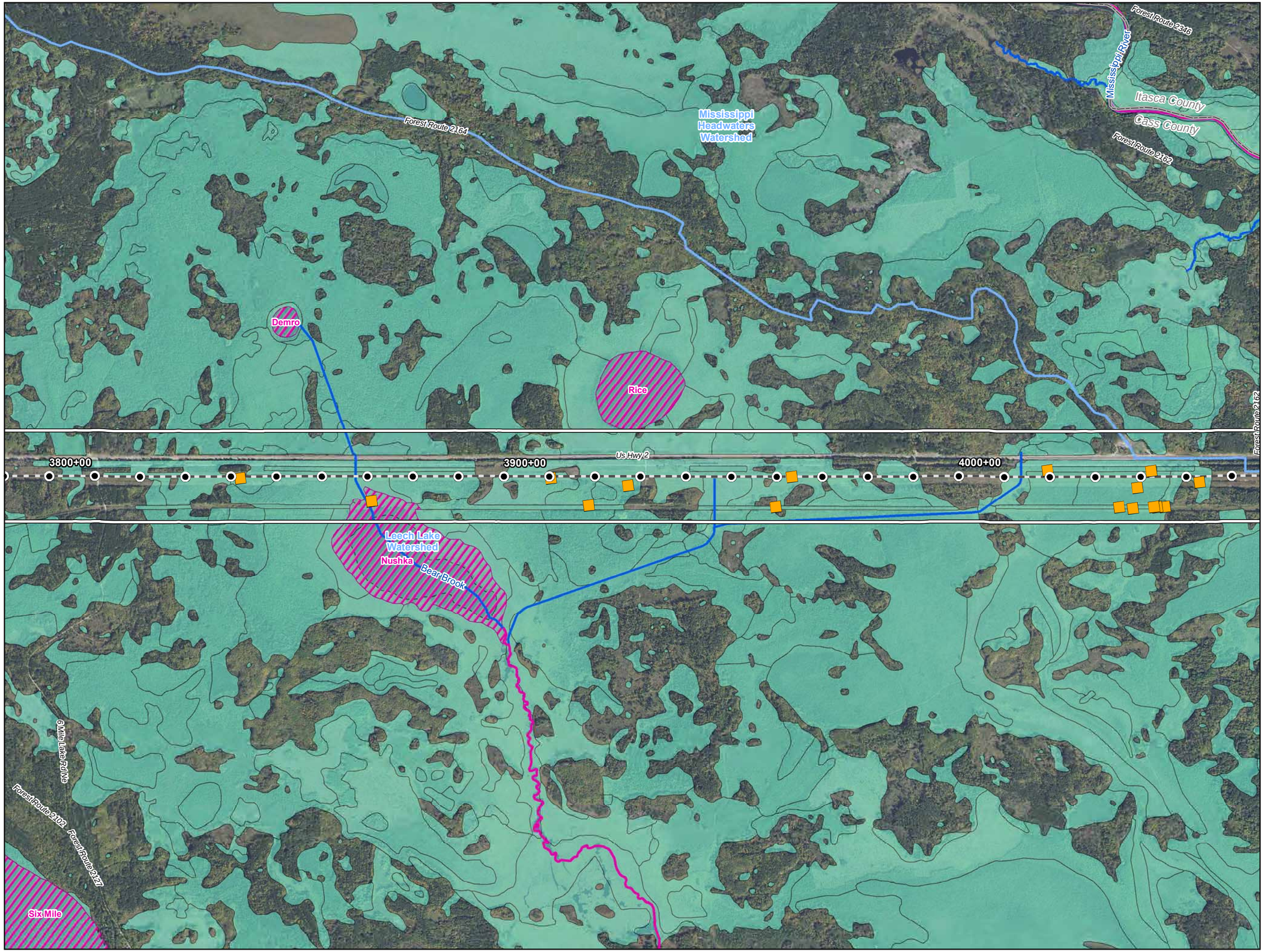

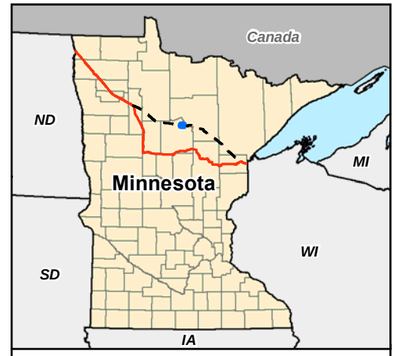

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 16

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 17

Line 3 Replacement Project

RA-07-L3

Enbridge

Cass County, Minnesota

For Environmental Review Purposes Only

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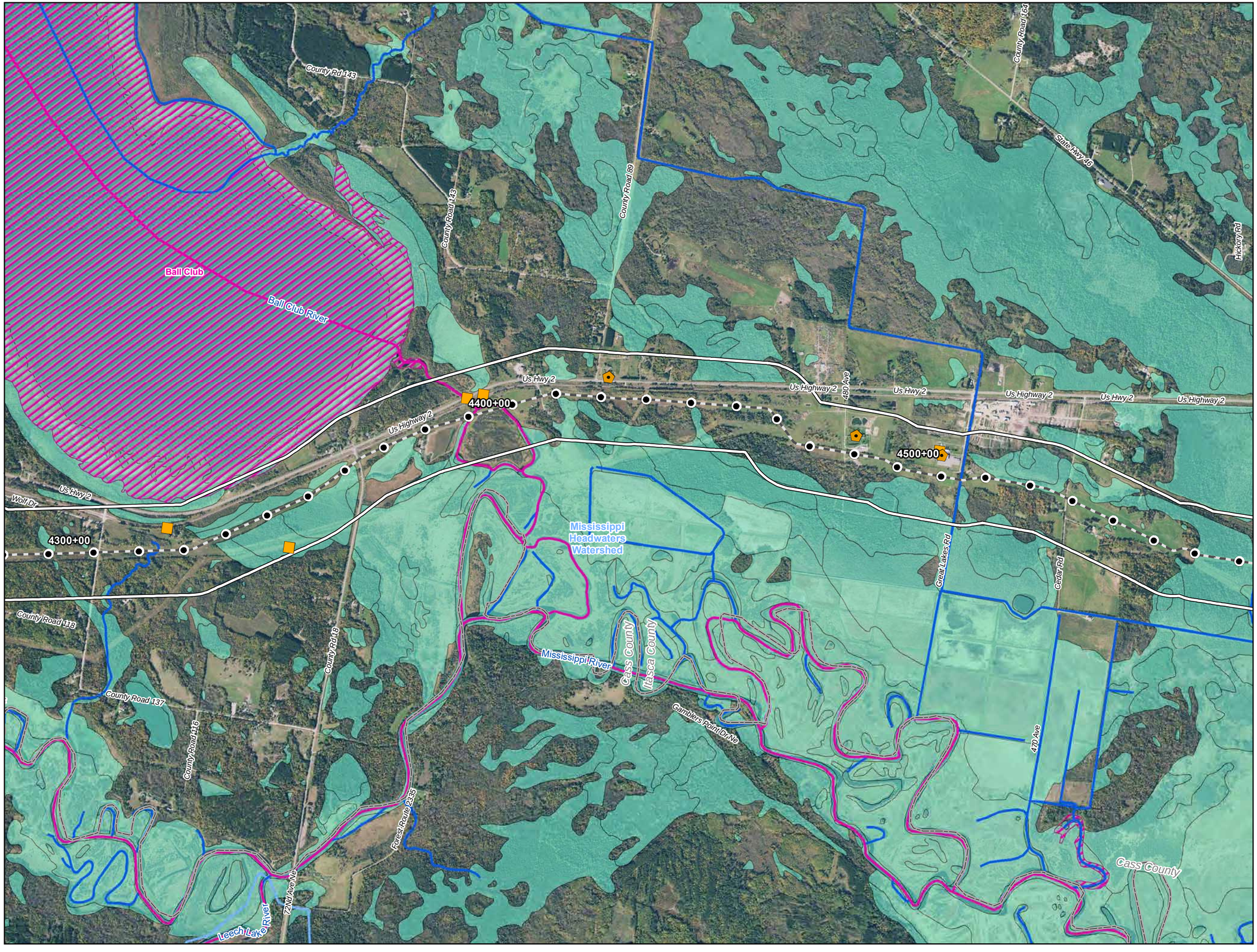
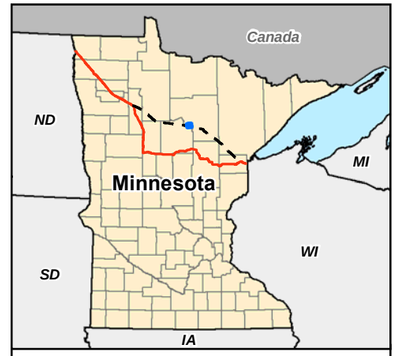
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 18

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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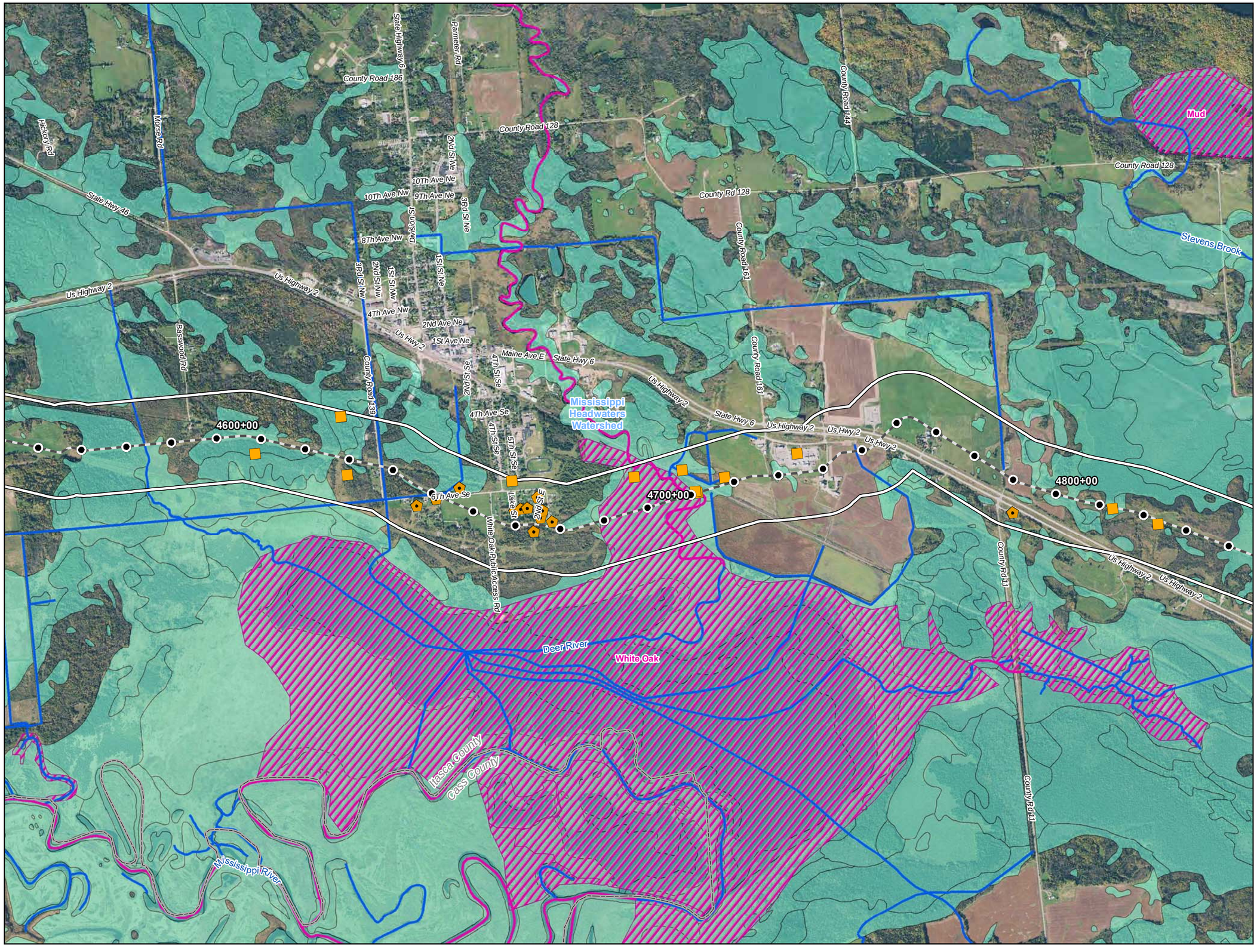



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 19

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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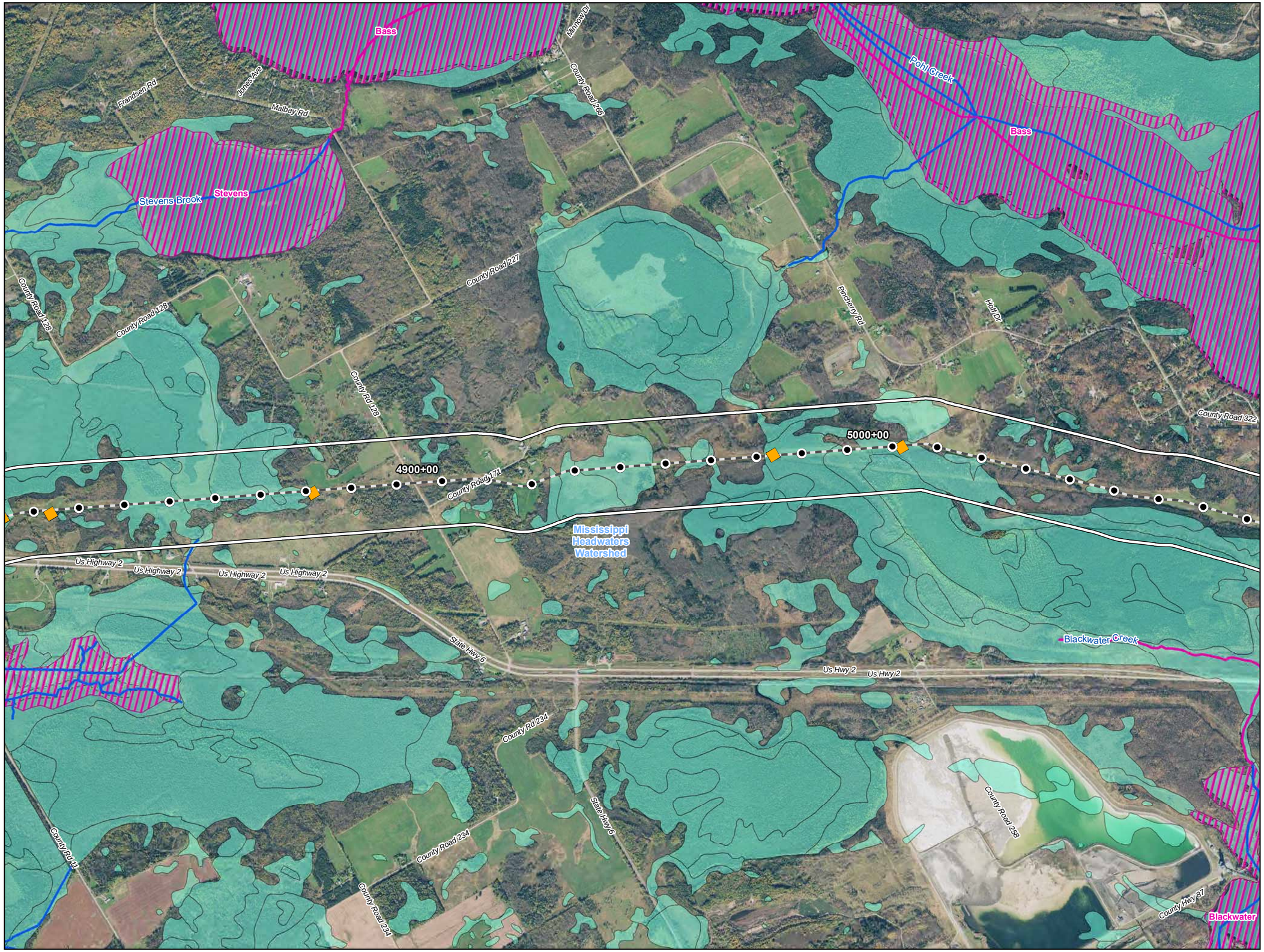



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 20

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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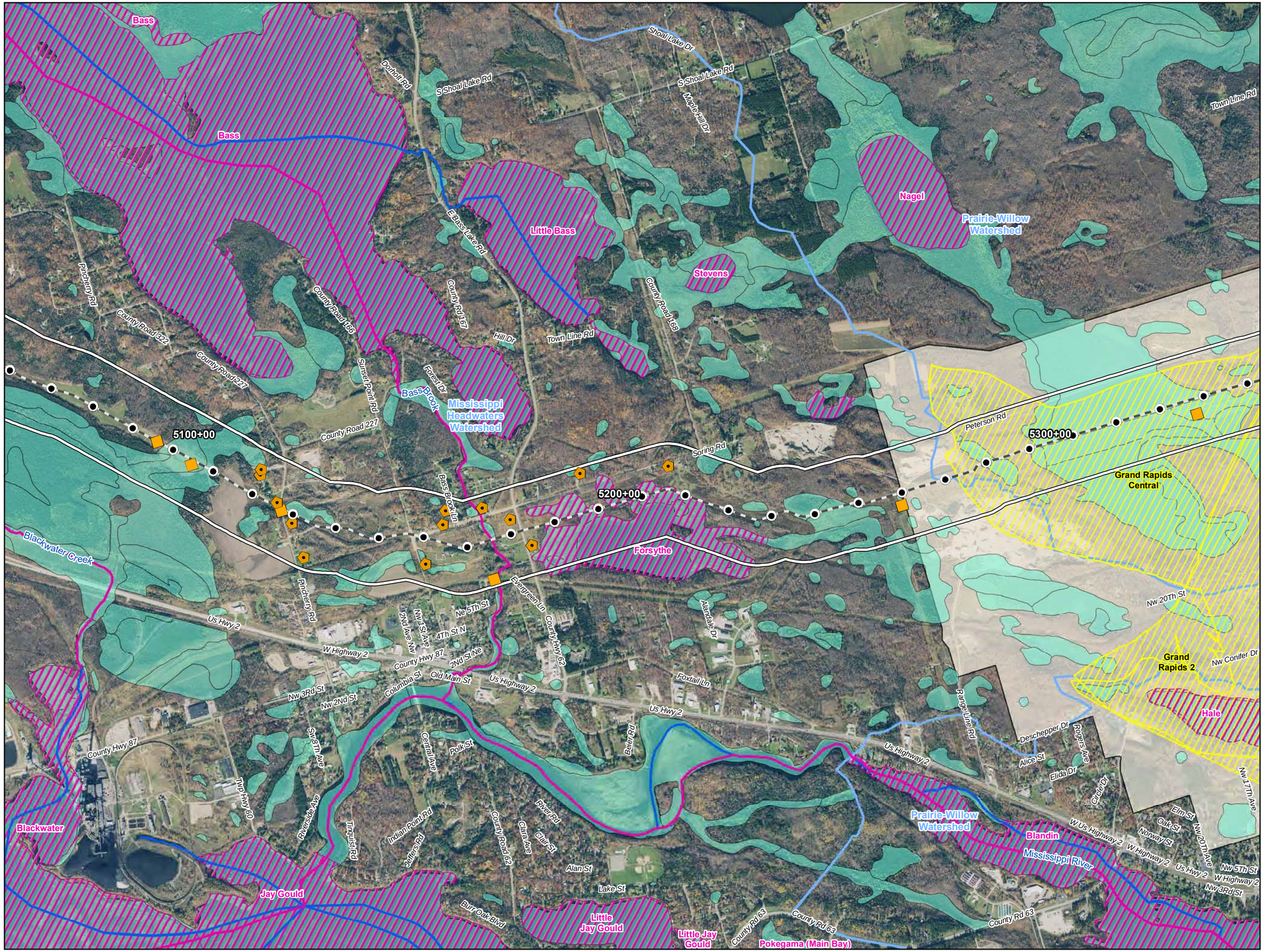

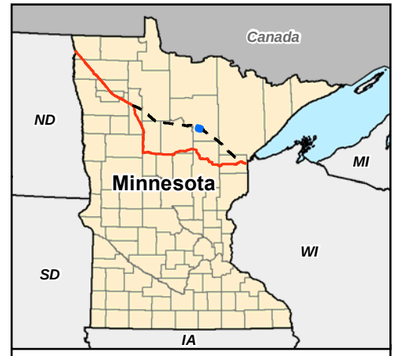

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 21

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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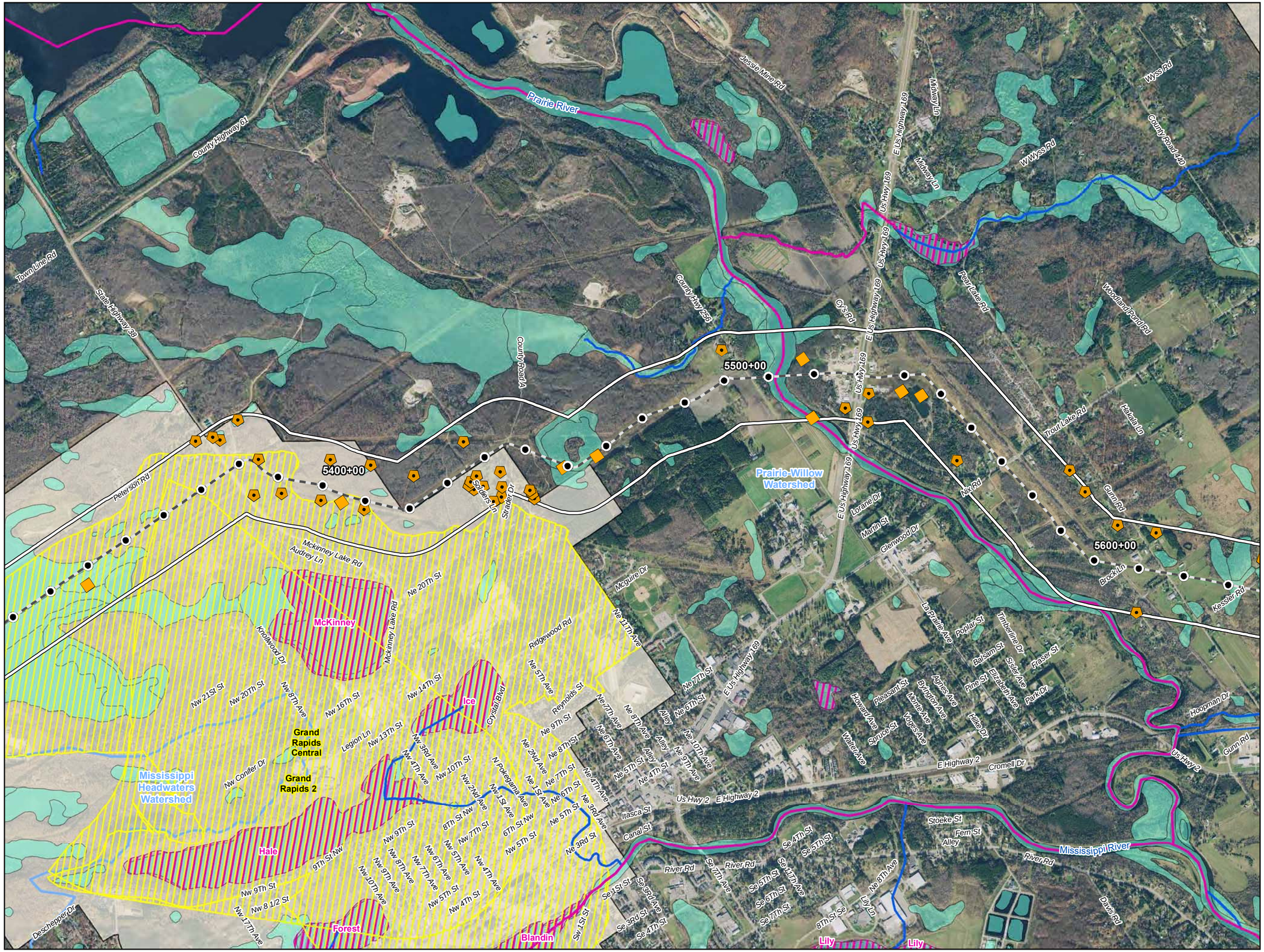



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 22

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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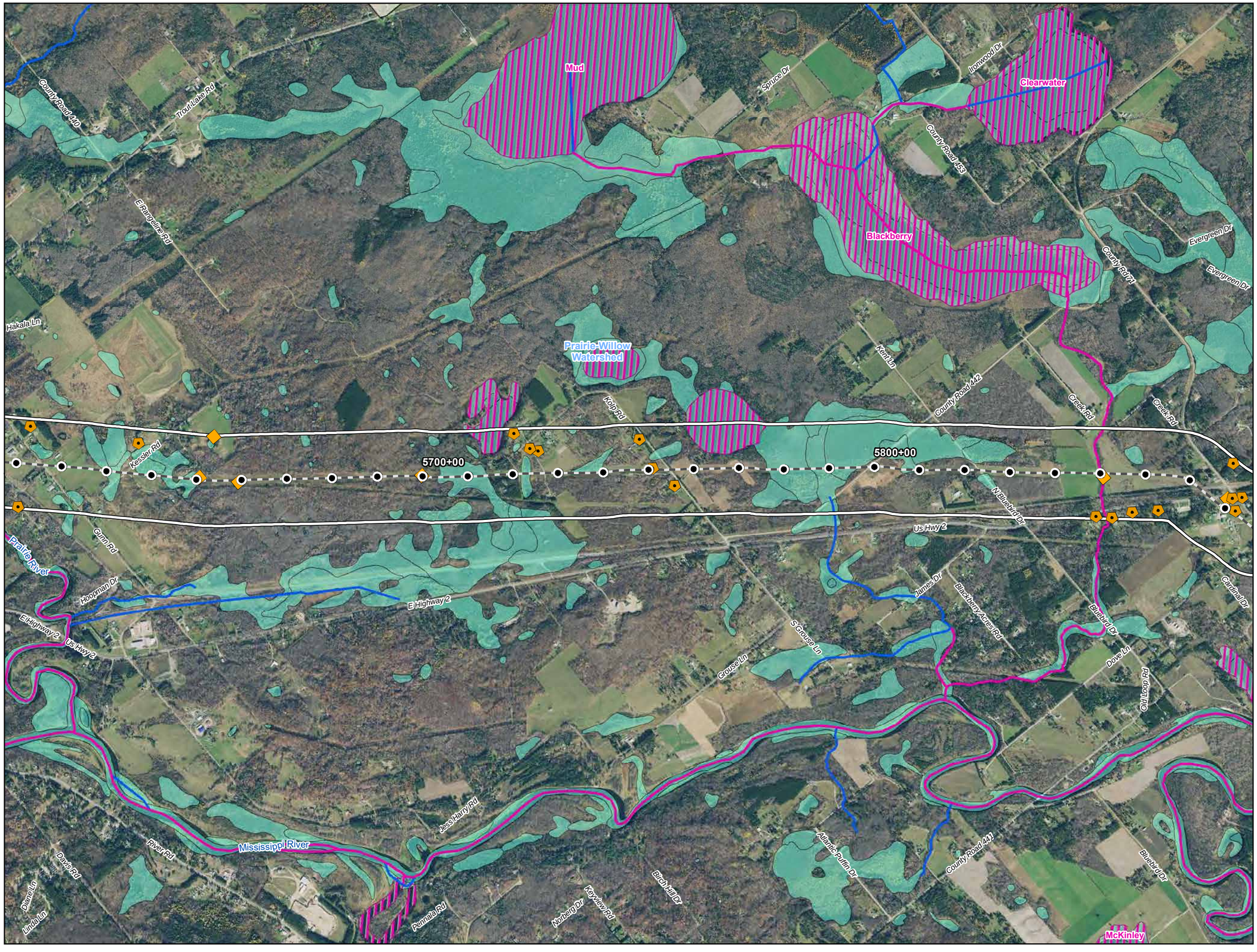
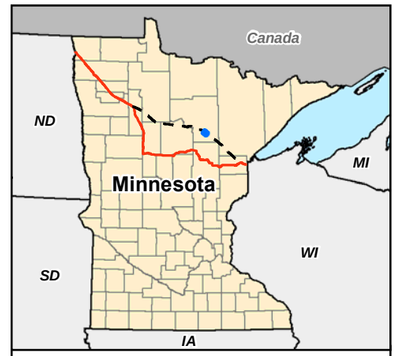
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 23

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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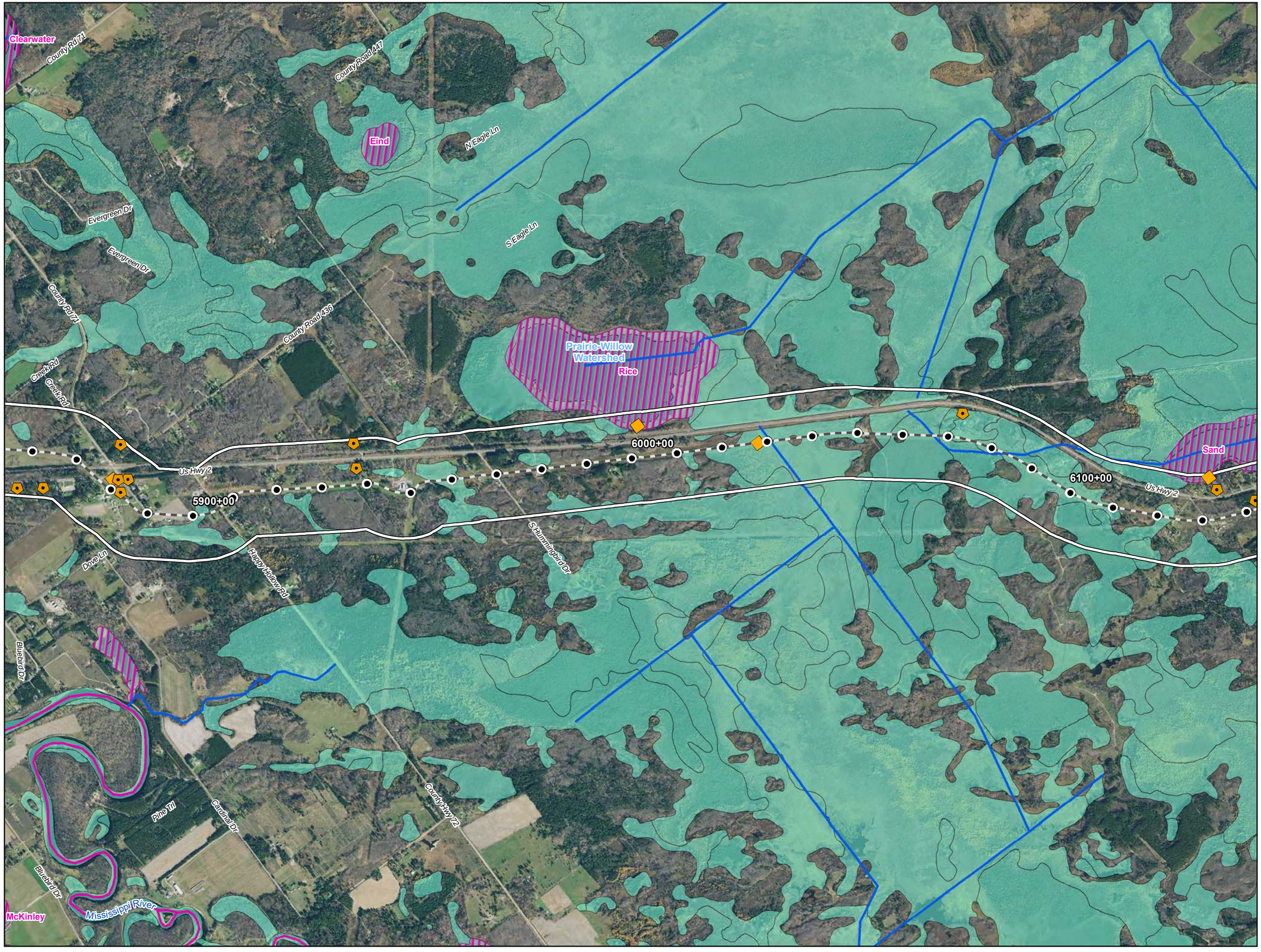
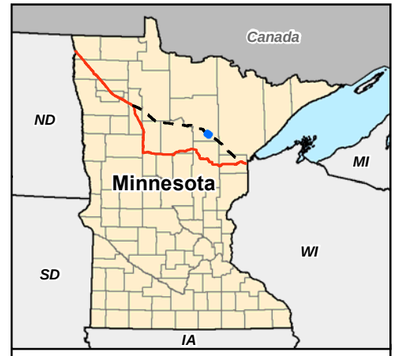
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 24

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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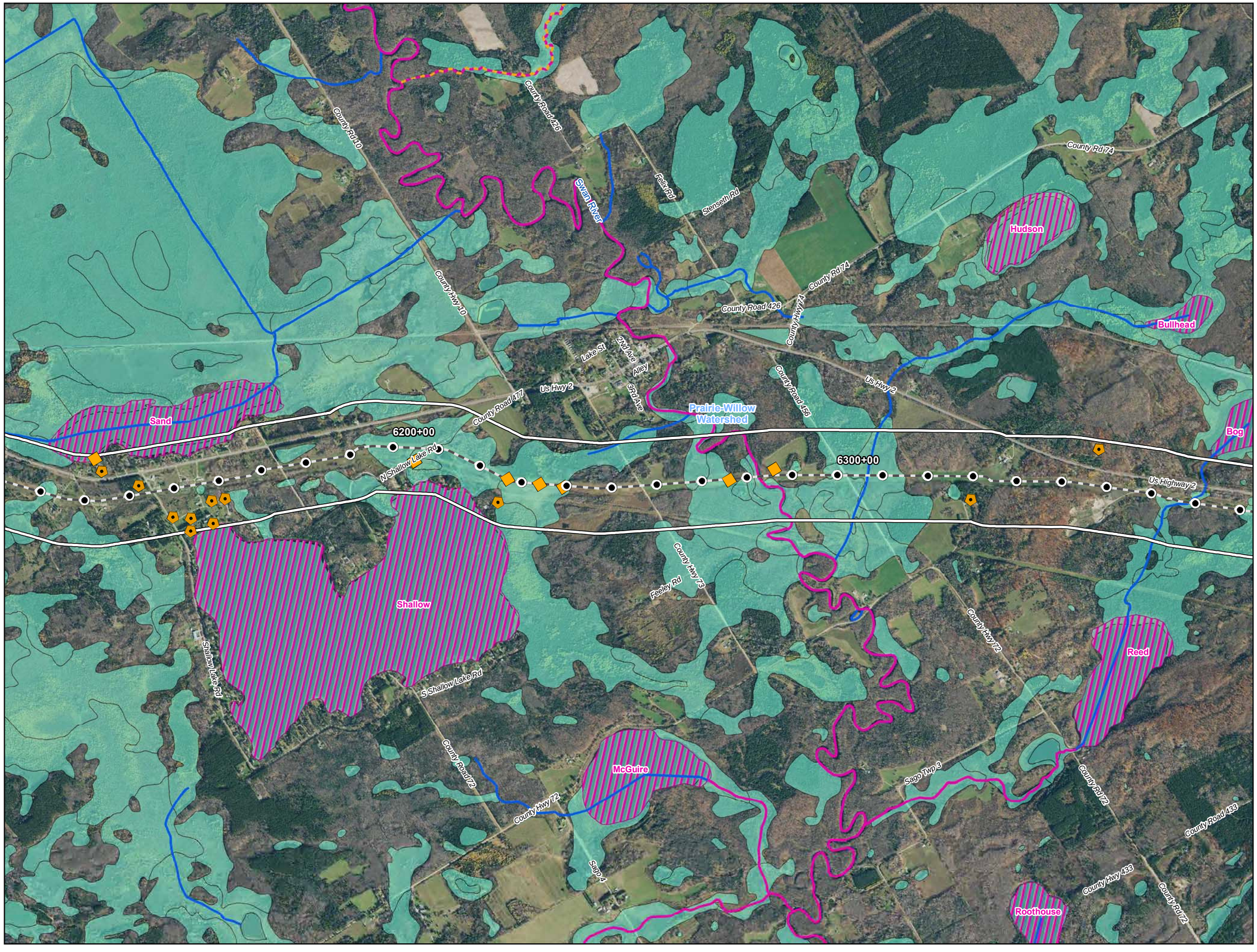

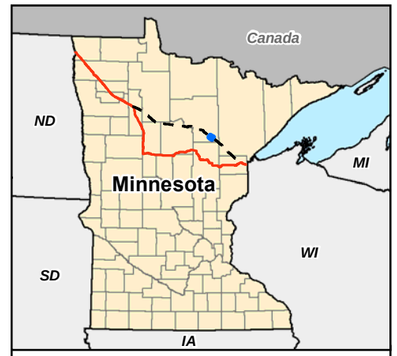

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 25

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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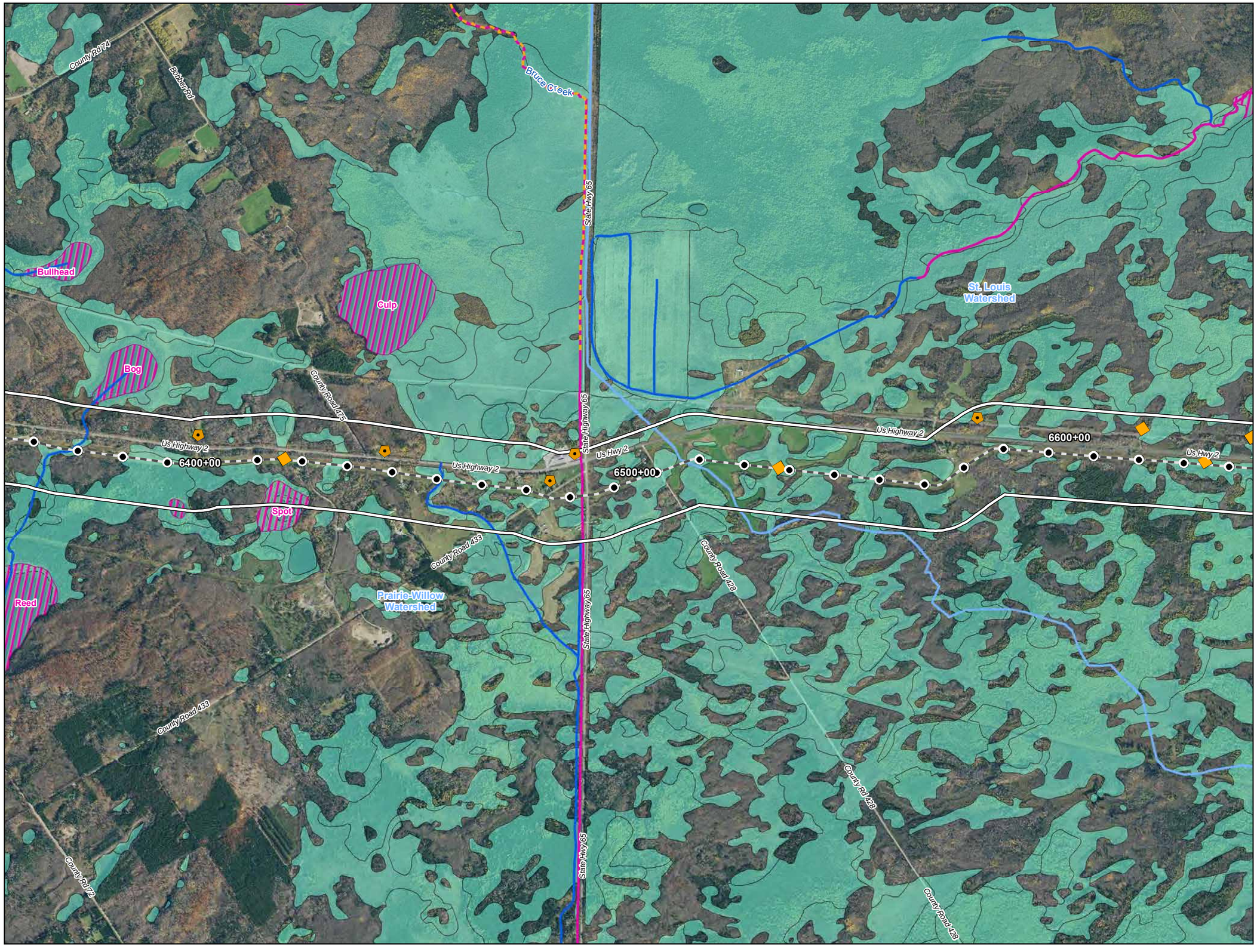

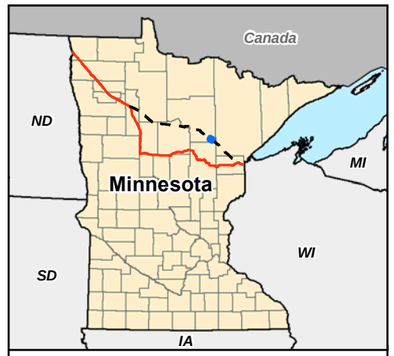

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 26

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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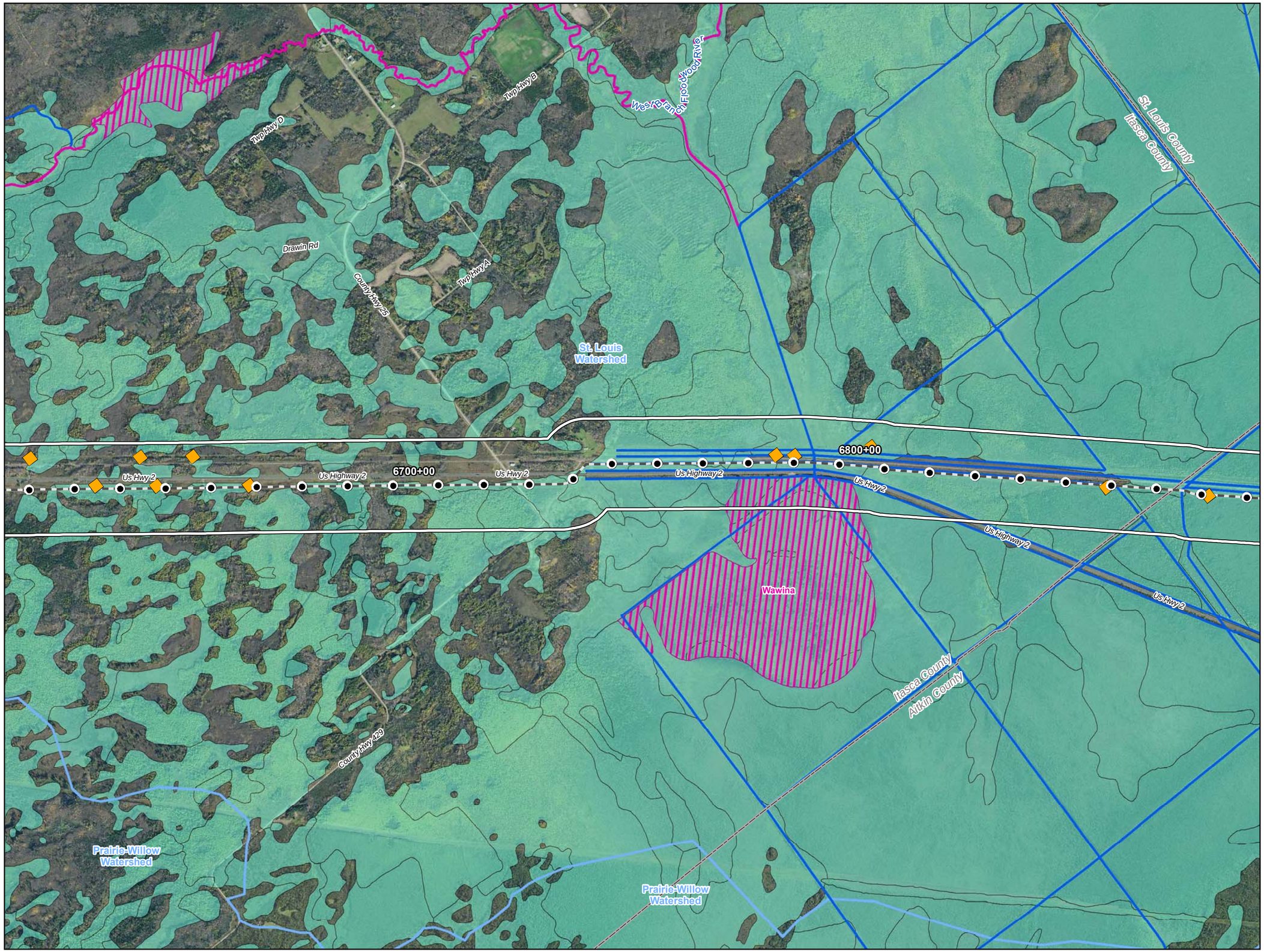

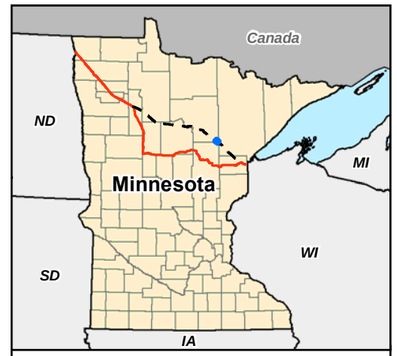

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 27

Line 3 Replacement Project

RA-07-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 28

Line 3 Replacement Project

RA-07-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

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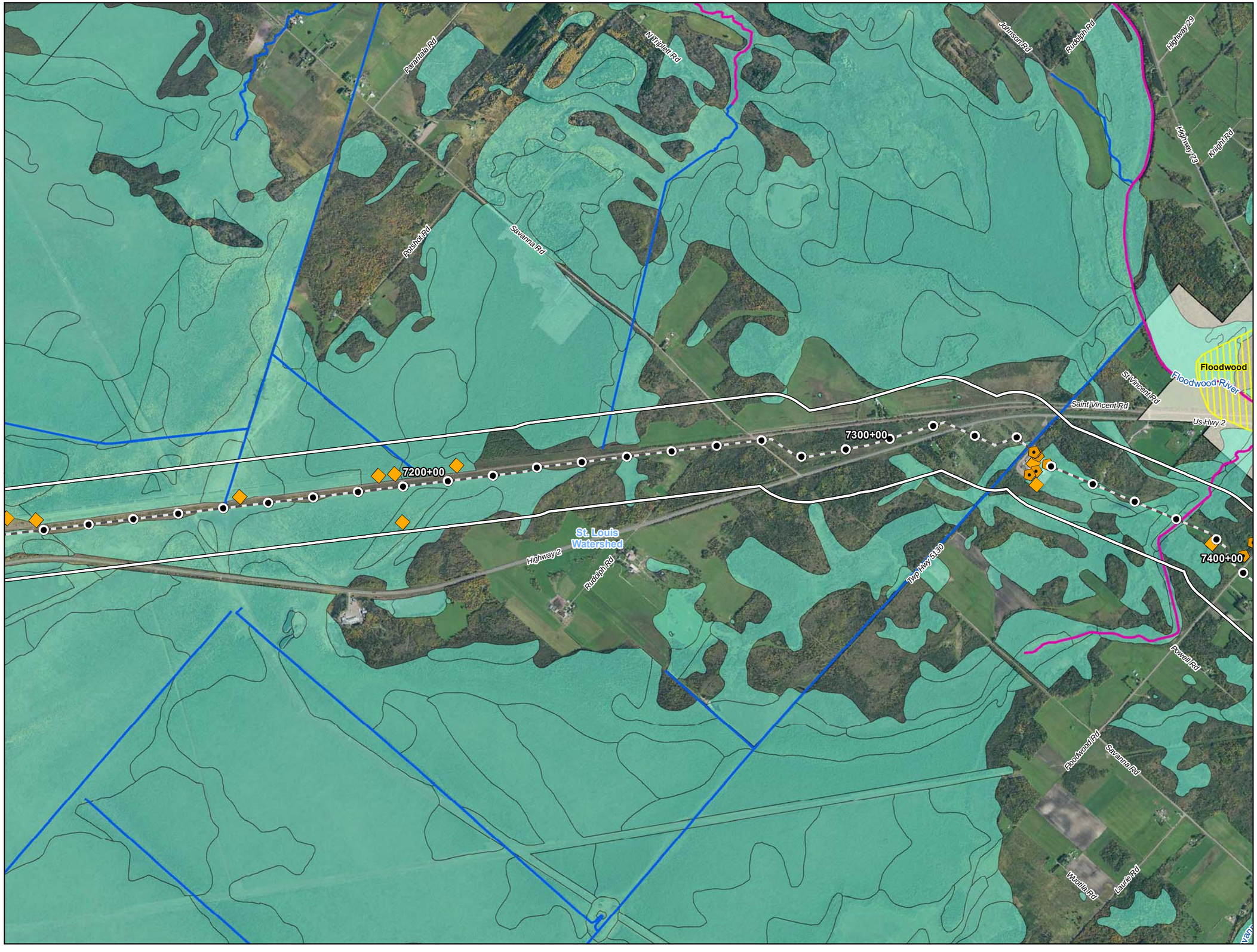

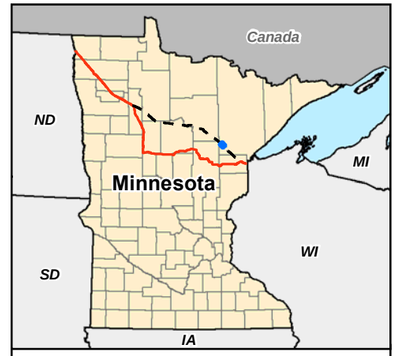

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 29

Line 3 Replacement Project

RA-07-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

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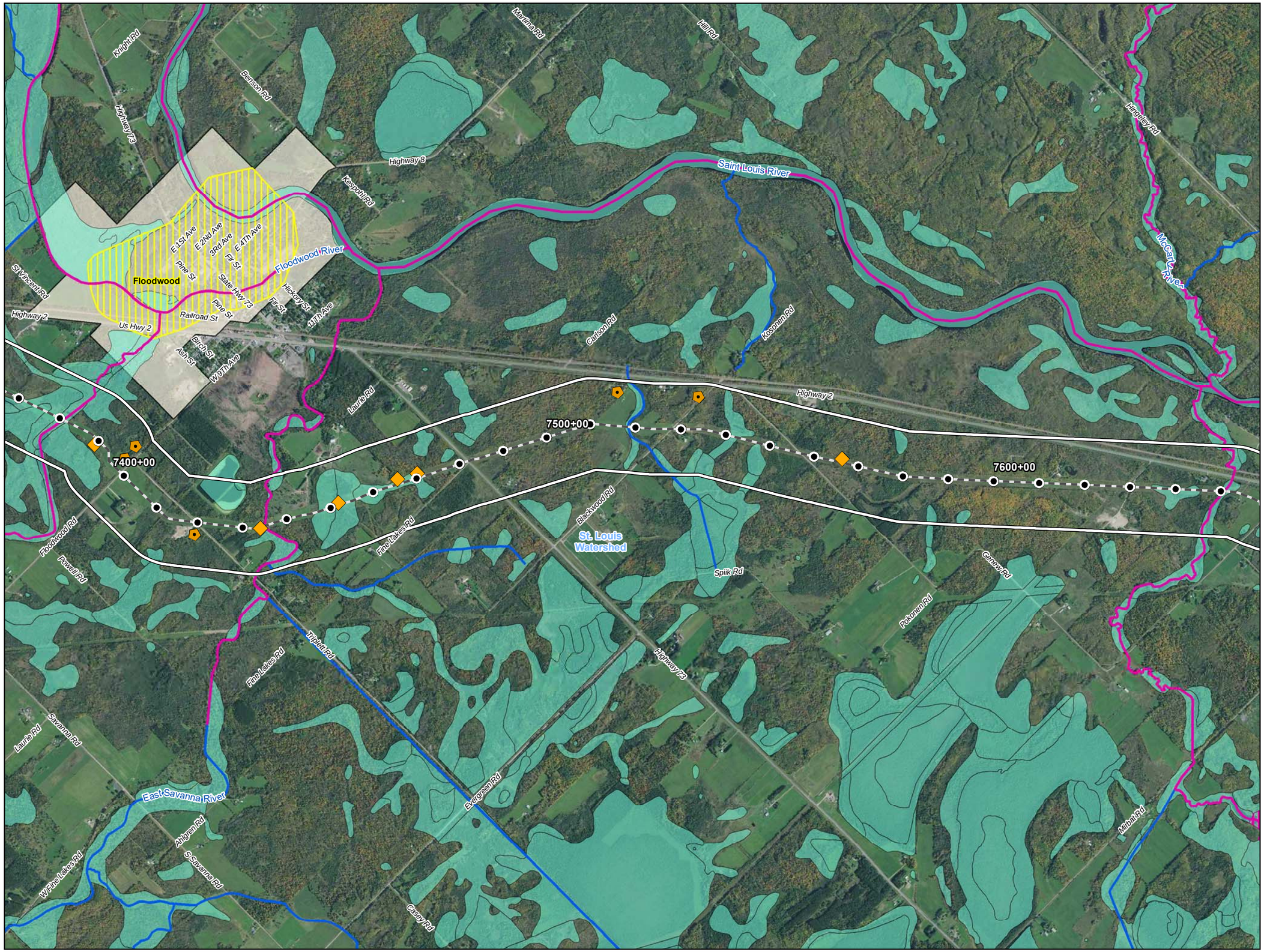
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 30

Line 3 Replacement Project

RA-07-L3

Enbridge

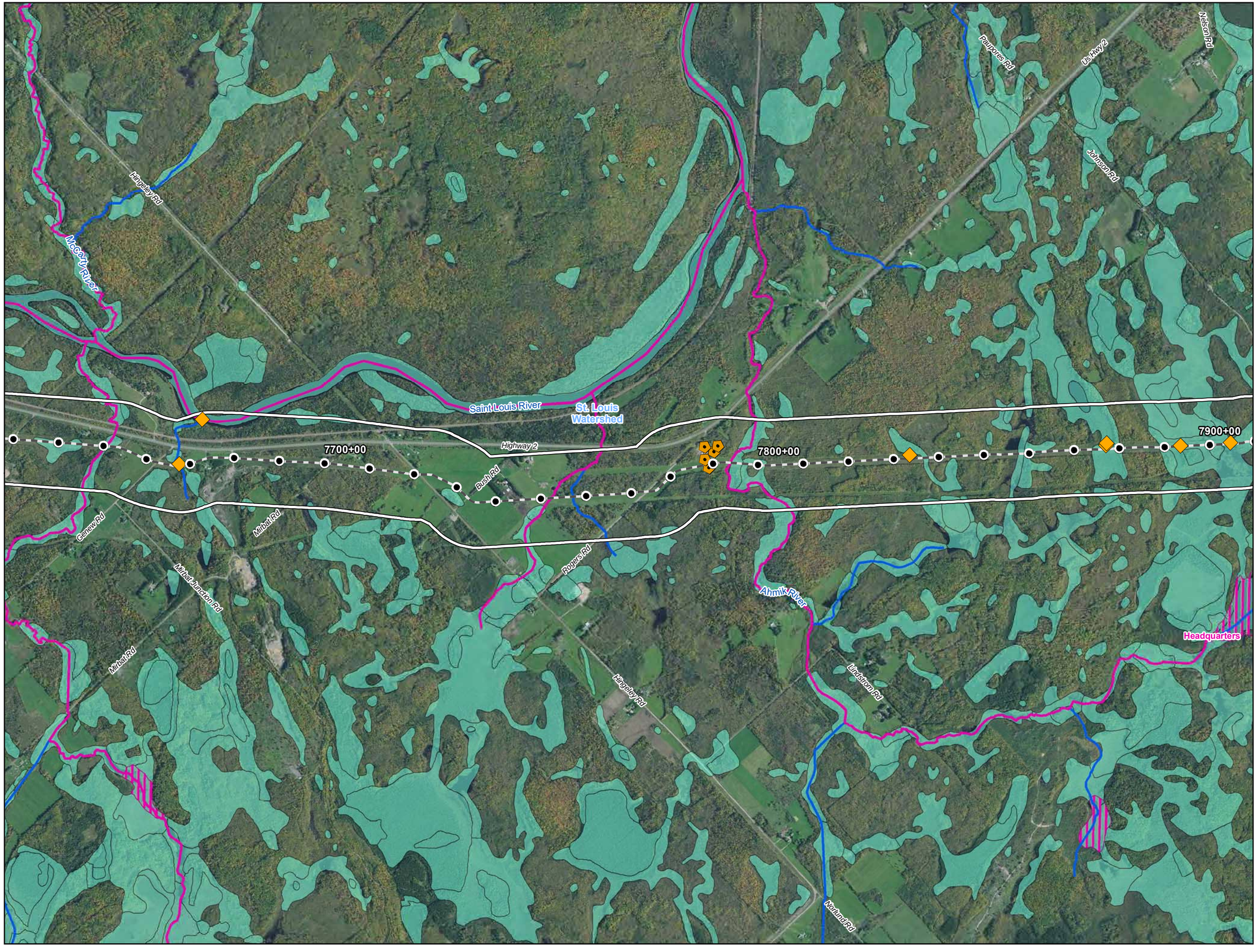
St. Louis County, Minnesota

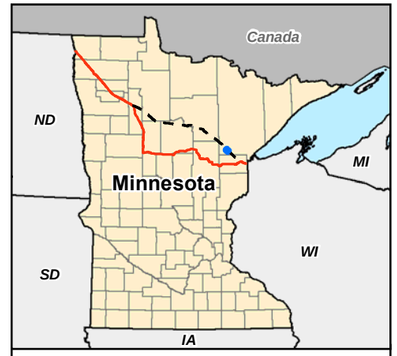
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd

Date: (10/18/2016)





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- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 31

Line 3 Replacement Project

RA-07-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\20161010\Pinhole_Maps\RA-07-L3.mxd

Date: (10/18/2016)

US Hwy 2
Nelson Rd
Nygaard Rd
Johnson Rd
Brandon Rd
Niemi Rd
7900+00
8000+00
8100+00
St. Louis Watershed
Headquarters
Trapper
St. Louis County
Carlton County



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 32

Line 3 Replacement Project

RA-07-L3

Enbridge

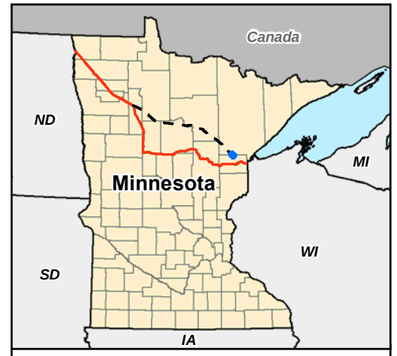
St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd
Date: 11/18/2016





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 33

Line 3 Replacement Project

RA-07-L3

Enbridge

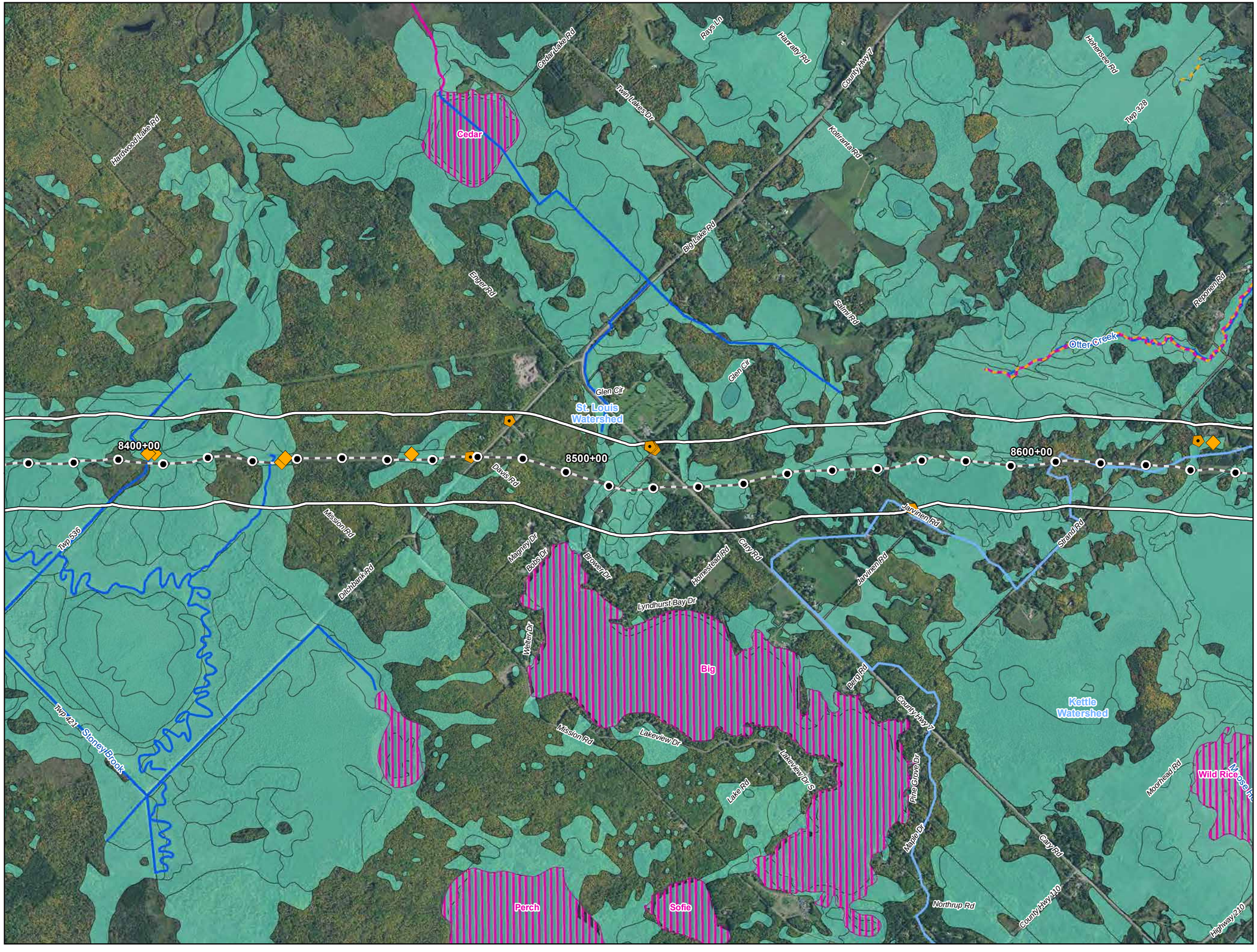
Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd

Date: (10/18/2016)





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1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 34

Line 3 Replacement Project

RA-07-L3

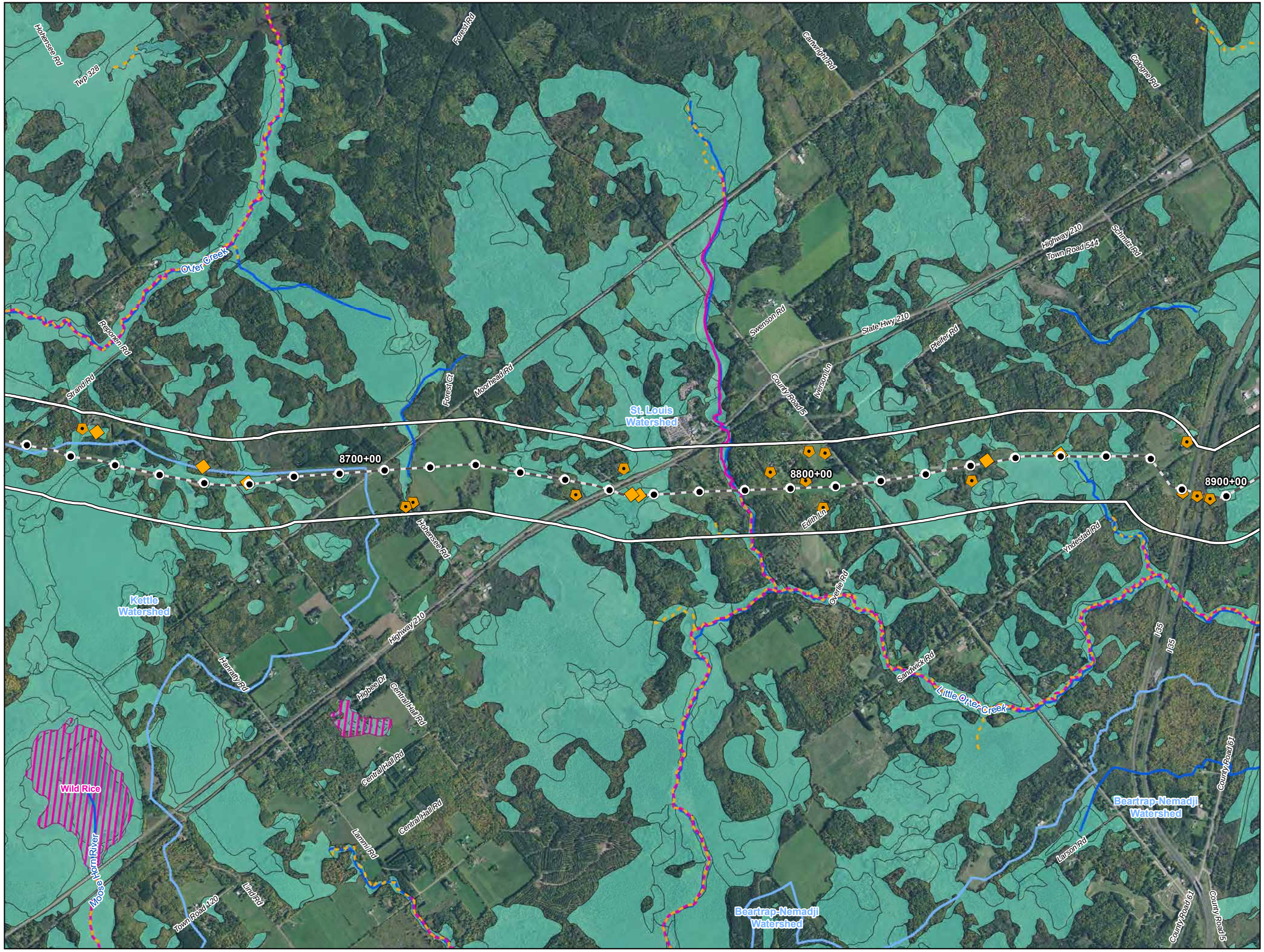
Enbridge

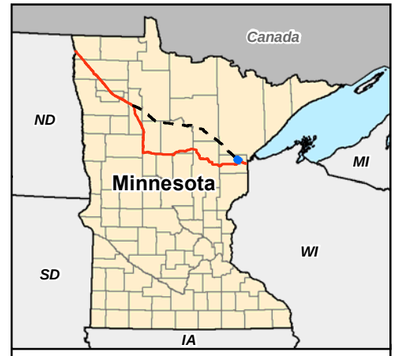
Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd
Date: (10/18/2016)





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- Alternative Centerline
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 35

Line 3 Replacement Project

RA-07-L3

Enbridge

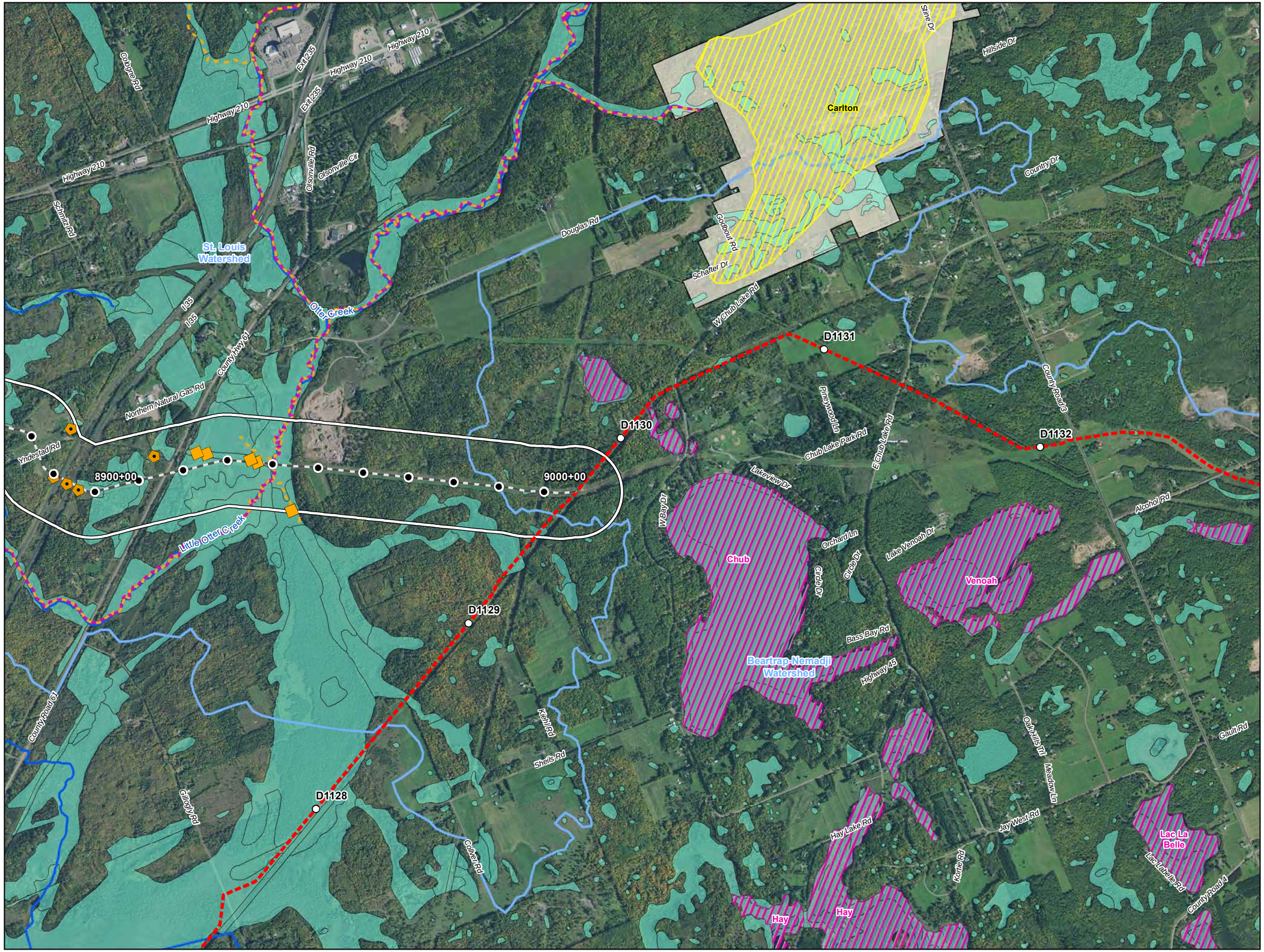
Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-07-L3.mxd

Date: (10/18/2016)





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- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 36

Line 3 Replacement Project

RA-07-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-07-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Alternative (RA)-08

DRAFT

Table 1
Line 3 Replacement Project – RA-08-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Clearwater	**7**	**3.1**
Clearwater	7	3.1
Mississippi Headwaters	**10**	**3.9**
Beltrami	5	0.9
Cass	1	3.0
Itasca	4	**7.0**
Leech Lake	**5**	2.6
Cass	2	1.3
Hubbard	3	3.0
Prairie-Willow	**6**	**2.7**
Itasca	6	2.7
St. Louis	**10**	**3.6**
St. Louis	8	2.6
Carlton	2	1.1
Grand Total [c]	**38**	**20.3**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RA-08-L3
Summary of Waterbodies Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Clearwater	**5**	**5**	**-**	**10**	**2.1**	**3.0**	**0.0**	**5.2**
Clearwater	5	5	-	10	2.1	3.0	0.0	5.2
Mississippi Headwaters	**12**	**10**	**12**	**34**	**8.5**	**6.1**	**7.3**	**21.9**
Itasca	5	3	5	13	4.0	1.5	3.9	9.5
Clearwater		3	-	3	-	1.5	-	1.5
Beltrami	6	3	4	13	2.8	2.5	2.2	7.6
Hubbard	-	-	1	1	-	0.1	0.4	0.5
Cass	1	1	2	4	1.7	0.4	0.7	2.8
Leech Lake	**3**	**8**	**7**	**18**	**1.6**	**7.5**	**4.1**	**13.2**
Beltrami	-	2	-	2	-	0.9	-	0.9
Hubbard	-	4	1	5	-	3.6	0.4	4.0
Cass	3	2	6	11	1.6	3.0	3.7	8.3
Prairie-Willow	**4**	**5**	**3**	**12**	**1.9**	**2.1**	**1.6**	**5.6**
Itasca	4	5	3	12	1.9	2.1	1.3	5.3
Aitkin	-	-	-	-	-	-	0.3	0.3
St. Louis	**12**		**14**	**26**	**4.7**	**0.6**	**6.4**	**11.7**
Aitkin	-	-	5	5	-	-	2.2	2.2
St. Louis	8	-	7	15	2.4	0.-6	3.4	6.4
Carlton	4	-	2	6	2.3	-	0.9	3.2
Grand Total [c]	**36**	**28**	**36**	**100**	**18.8**	**19.3**	**19.5**	**57.6**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RA-08-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Clearwater	**1.5**	**0.9**	**0.1**	**2.5**	**274.3**	**189.4**	**55.2**	**519.0**
Clearwater	1.3	0.8	0.1	2.1	245.0	176.4	54.9	476.3
Beltrami	0.2	0.1	<0.1	0.4	29.4	13.0	0.3	42.6
Mississippi Headwaters	**3.6**	**7.1**	**0.8**	**11.5**	**912.5**	**1872.3**	**197.5**	**2982.3**
Clearwater	0.2	<0.1	-	0.2	55.6	23.6	-	79.3
Beltrami	0.6	0.4	<0.1	1.0	187.4	273.4	48.3	509.1
Hubbard	0.0	0.1	-	0.1	6.7	14.0	0.1	20.9
Cass	0.5	0.3	0.3	1.0	124.2	187.9	60.5	372.6
Itasca	2.4	6.3	0.5	9.2	538.5	1373.4	88.6	2000.5
Leech Lake	**5.3**	**5.0**	**0.1**	**10.3**	**478.2**	**2218.5**	**84.8**	**2781.4**
Beltrami	-	-	-	-	3.9	3.2	0.9	8.0
Hubbard	0.1	1.6	<0.1	1.7	80.3	384.0	2.6	466.9
Cass	5.2	3.4	0.1	8.6	394.0	1831.3	81.3	2306.6
Prairie-Willow	**0.3**	**9.7**	**0.5**	**10.6**	**122.8**	**2253.2**	**174.5**	**2550.6**
Itasca	0.3	8.9	0.5	9.7	122.8	1977.8	174.5	2275.2
Aitkin	-	0.8	-	0.8	-	275.4	-	275.4
St. Louis	**0.6**	**21.0**	**0.2**	**21.9**	**149.4**	**5012.1**	**15.0**	**5176.5**
Itasca	-	1.1	-	1.1	0.9	272.7	-	273.6
Aitkin	-	3.4	-	3.4	-	749.8	-	749.8
St. Louis	0.1	10.7	-	10.8	40.1	2622.0	-	2662.1
Carlton	0.5	5.9	0.2	6.6	108.4	1367.6	15.0	1491.0
Kettle	**0.5**	**0.2**	**<0.1**	**0.8**	**51.4**	**78.4**	**1.4**	**131.1**
Carlton	0.5	0.2	<0.1	0.8	51.4	78.4	1.4	131.1
Beartrap-Nemadji		**-**	**-**	**-**	-	**0.4**	**0.9**	**1.3**
Carlton		**-**	**-**	**-**	-	0.4	0.9	1.3
Grand Total [d]	**11.8**	**44.0**	**1.8**	**57.5**	**1988.7**	**11624.2**	**529.4**	**14142.3**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route alternative centerline.

b Total acres of NWI within the 2000-ft-wide route alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RA-08-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	Miles Crossed by the Route Alternative Centerline [a]		Acres Within the Route Alternative Corridor [b]	
County	Wetlands	Basins	Wetlands	Basins
Clearwater	**0.1**	**0.4**	**88.0**	**61.6**
Clearwater	0.1	0.4	88.0	61.6
Mississippi Headwaters	**0.1**	**1.4**	**52.5**	**354.0**
Beltrami	0.1	0.0	52.5	24.1
Hubbard	-	0.0	-	0.2
Cass	-	0.2	-	42.6
Itasca	-	1.2	-	287.0
Leech Lake	**0.2**	**0.3**	**42.7**	**108.0**
Cass	0.2	0.3	42.7	108.0
Prairie-Willow	**0.0**	**0.4**	**26.9**	**138.0**
Itasca	0.0	0.4	26.9	138.0
Grand Total [c]	**0.4**	**2.4**	**210.2**	**661.5**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the route alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RA-08-L3
Summary of Trout Streams Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Leech Lake	**3**	**3.1**
Hubbard	3	3.1
St. Louis	**1**	**1.4**
Carlton	1	1.4
Grand Total [c]	**4**	**4.5**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RA-08-L3
Wells within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Clearwater	Clearwater	Domestic	859	5
			681	
			490	
			880	
			888	
		Industrial	502	2
			413	
		Monitoring	40	2
			292	
		Test Well	559	3
			558	
			587	
		Unknown	312	1
Mississippi Headwaters	Beltrami	Domestic	879	29
			561	
			157	
			299	
			297	
			331	
			677	
			783	
			443	
			165	
			780	
			574	
			170	
			867	
			477	
			682	
			659	
			175	
			863	
			632	
			278	
			143	
			666	
			236	
			405	
			624	

Mississippi Headwaters (cont.)	Beltrami (cont.)	Domestic (cont.)	246	29 (cont.)
			508	
			695	
		Test Well	745	1
Leech Lake	Beltrami	Domestic	217	2
			205	
		Scientific Investigation	513	1
	Hubbard	Domestic	562	20
			480	
			508	
			197	
			405	
			173	
			367	
			149	
			365	
			130	
			705	
			464	
			460	
			247	
			331	
			174	
			309	
			218	
			719	
			53	
		Test Well	180	1
Mississippi Headwaters	Hubbard	Domestic	402	1
Leech Lake	Cass	Domestic	920	1
Mississippi Headwaters	Cass	Domestic	586	2
			975	
Leech Lake	Cass	Domestic	340	1
Mississippi Headwaters	Cass	Domestic	343	1
Leech Lake	Cass	Domestic	297	1
Mississippi Headwaters	Cass	Domestic	779	1
Leech Lake	Cass	Domestic	577	3
			649	
			687	
		Test Well	156	1
Mississippi Headwaters	Itasca	Domestic	253	18
			242	
			323	
			221	

Mississippi Headwaters (cont.)	Itasca (cont.)	Domestic (cont.)	381	18 (cont.)
			73	
			324	
			366	
			375	
			151	
			167	
			332	
			129	
			669	
			377	
			724	
			328	
			354	
		Industrial	830	1
Prairie-Willow	Itasca	Domestic	900	57
			728	
			302	
			439	
			255	
			265	
			494	
			225	
			123	
			375	
			101	
			597	
			256	
			442	
			403	
			577	
			506	
			695	
			654	
			800	
			337	
			944	
			440	
			846	
			569	
			950	
			814	
			421	
			912	

Prairie-Willow (cont.)	Itasca (cont.)	Domestic (cont.)	566	57 (cont.)
			508	
			51	
			812	
			38	
			691	
			950	
			451	
			494	
			942	
			707	
			773	
			455	
			444	
			695	
			653	
			207	
			140	
			427	
			147	
			238	
			258	
			323	
			486	
			557	
			519	
			921	
			331	
		Exploration	46	8
			45	
			106	
			31	
			150	
			605	
			806	
			560	
		Irrigation	385	2
			978	
		Unknown	870	1
St. Louis	St. Louis	Domestic	357	3
			876	
			699	
		Monitoring	56	5
			108	

St. Louis (cont.)	St. Louis (cont.)	Monitoring (cont.)	388	5 (cont.)
			274	
			386	
	Carlton	Domestic	4	17
			824	
			904	
			634	
			609	
			515	
			94	
			561	
			293	
			435	
			21	
			892	
			655	
			576	
			254	
			147	
			35	
		Monitoring	752	4
			693	
			747	
			841	
		Other	56	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

a Municipal wells are not included in the source data.

Table 7
Line 3 Replacement Project – RA-08-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Route Alternative Centerline [b]	Acres Within the Route Alternative Corridor [c]
Mississippi Headwaters	Itasca	5132+00	Grand Rapids Central WHPA	0.1	20.7
		5142+00	Grand Rapids DWSMA	0.31	76.84
Prairie Willow	Itasca	5173+00 5212+00 5213+00	Grand Rapids Central WHPA (3 crossings) Grand Rapids 2 WHPA	2.6	651.9
		5236+00	Grand Rapids DWSMA	3.16	733.36

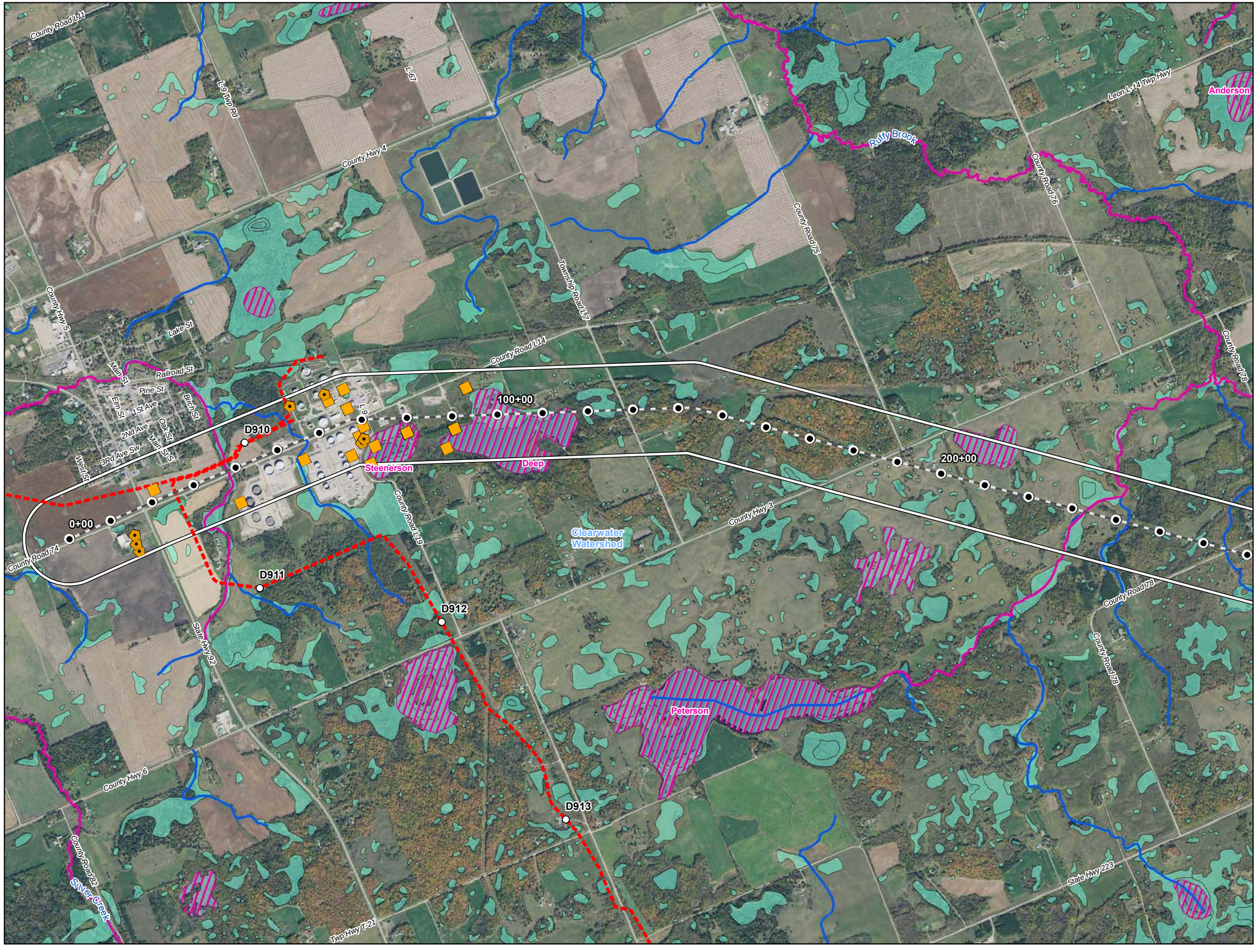
DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest route alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the route alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide route alternative corridor.

Table 8
Line 3 Replacement Project – RA-08-L3
Surface Water Intakes within the 2,000-ft-wide Route Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Clearwater	Clearwater	General Permit Authorization	Active	1
			Inactive	1
		Individual Permit	Active	1
			Inactive	15
Mississippi Headwaters	Clearwater	Individual Permit	Inactive	1
Clearwater	Beltrami	Individual Permit	Inactive	1
Mississippi Headwaters	Beltrami	Individual Permit	Active	2
			Inactive	4
Leech Lake	Hubbard	General Permit Authorization	Inactive	4
		Individual Permit	Inactive	2
	Cass	General Permit Authorization	Inactive	15
		Individual Permit	Inactive	4
Mississippi Headwaters	Cass	General Permit Authorization	Inactive	12
	Itasca	General Permit Authorization	Inactive	13
		Individual Permit	Active	1
			Inactive	9
Prairie-Willow	Itasca	General Permit Authorization	Active	1
			Inactive	10
		Individual Permit	Active	2
			Inactive	11
St. Louis	Itasca	General Permit Authorization	Inactive	1
	Aitkin	General Permit Authorization	Inactive	1
		Individual Permit	Inactive	1
	St. Louis	General Permit Authorization	Inactive	13
		Individual Permit	Inactive	2
	Carlton	General Permit Authorization	Active	4
			Inactive	10

Kettle	Carlton	General Permit Authorization	Inactive	1
St. Louis	Carlton	General Permit Authorization	Inactive	4
		Individual Permit	Inactive	4
MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679 a Municipal wells are not included in the source data.				





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RA-08-L3

Enbridge

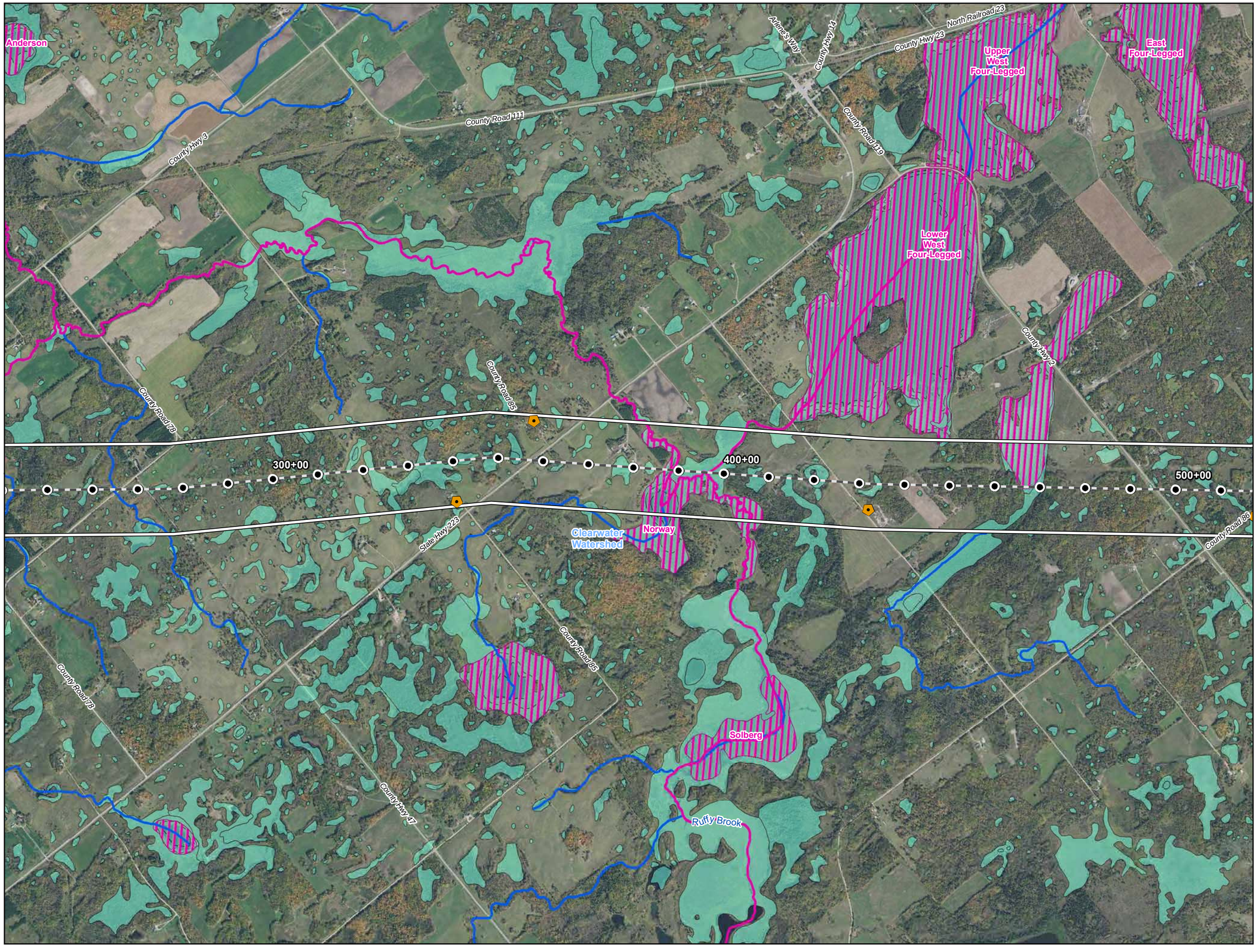
Clearwater County, Minnesota

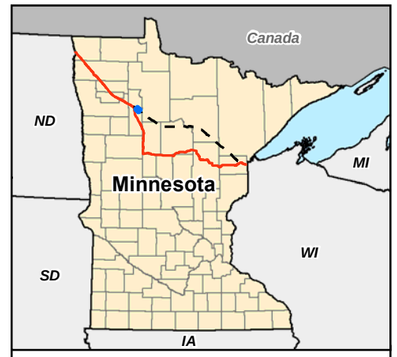
ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_Pl\Enbridge\Line_3_Full_Replacement\ArcGIS\20160\10\Pinnole_Maps\RA-08-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

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- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
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- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RA-08-L3

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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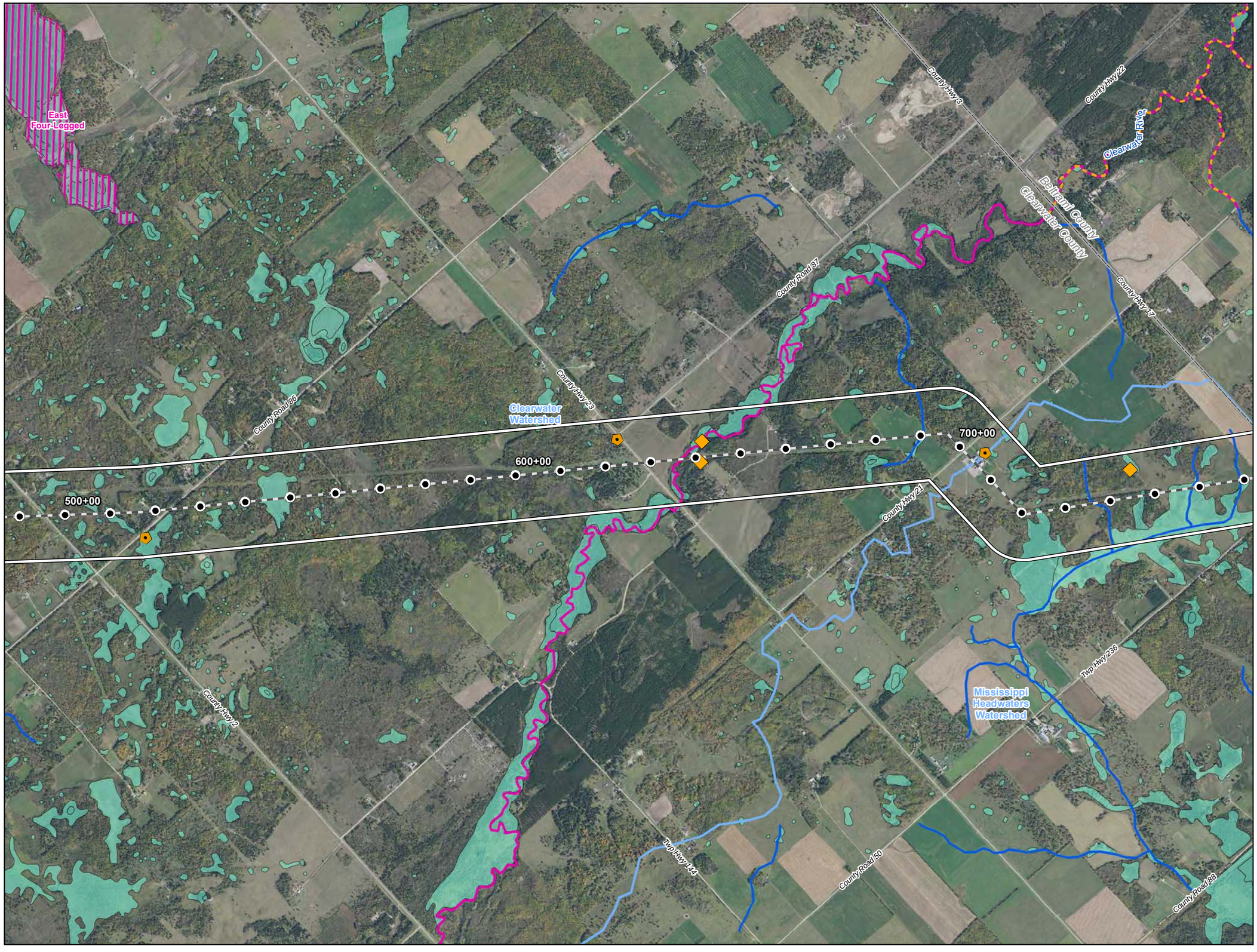
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RA-08-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 3

Line 3 Replacement Project

RA-08-L3

Enbridge

Clearwater County, Minnesota

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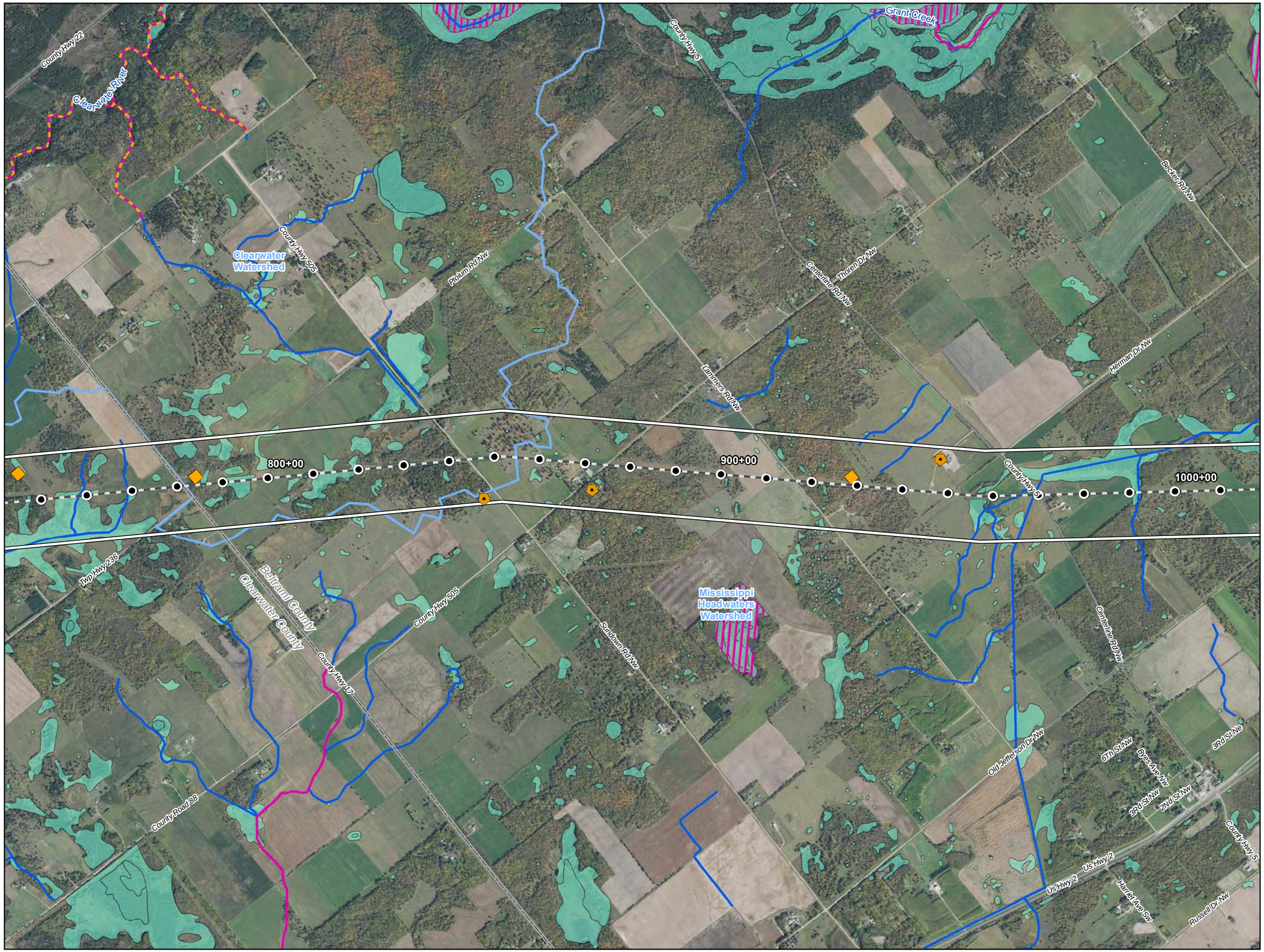

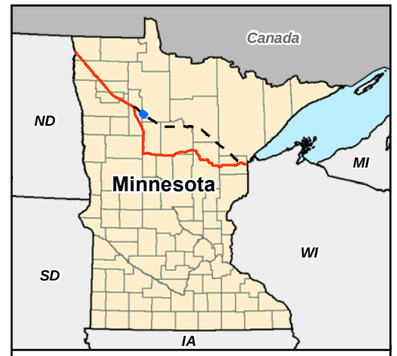

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 4

Line 3 Replacement Project

RA-08-L3

Enbridge

Beltrami County, Minnesota

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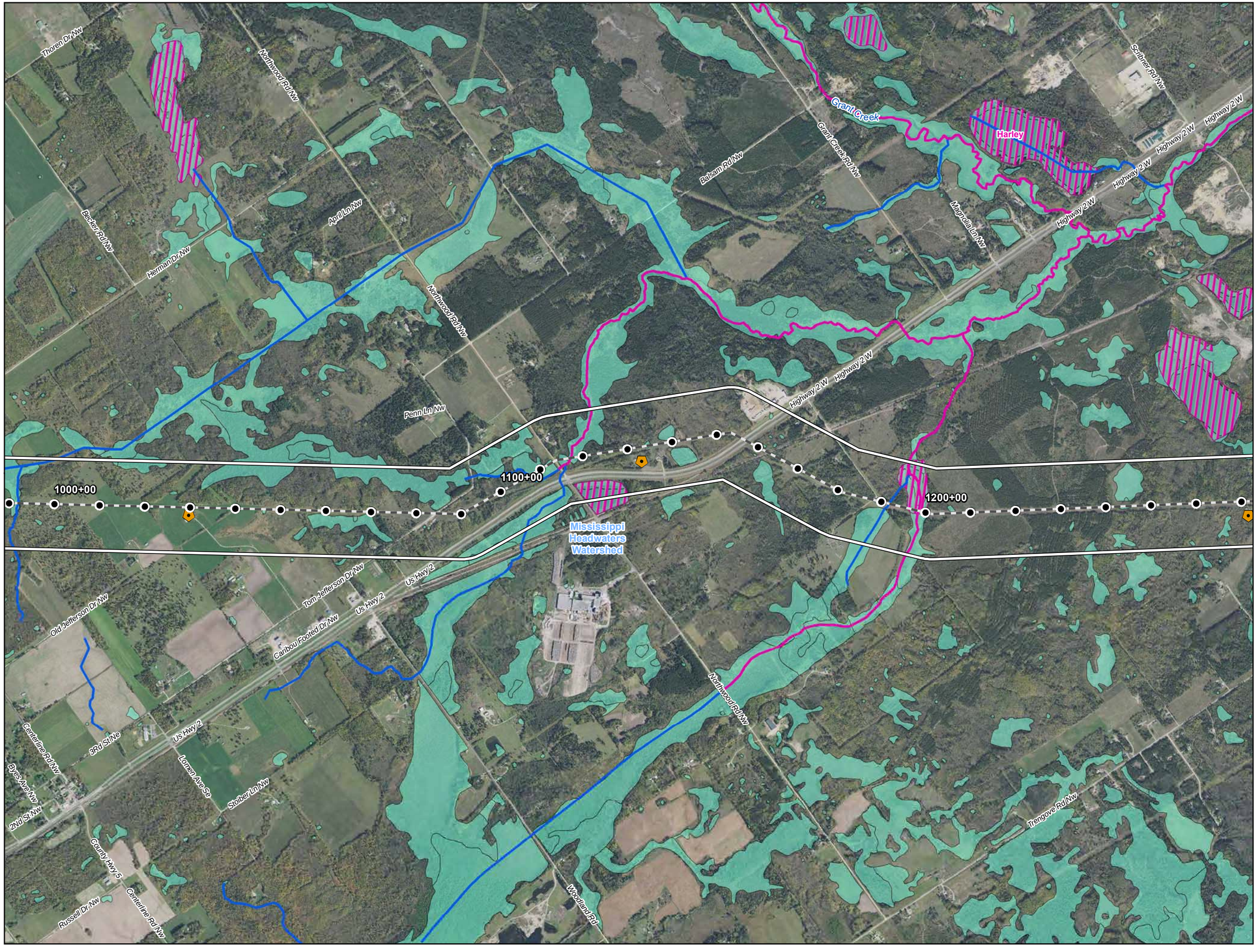
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 5

Line 3 Replacement Project

RA-08-L3

Enbridge

Beltrami County, Minnesota

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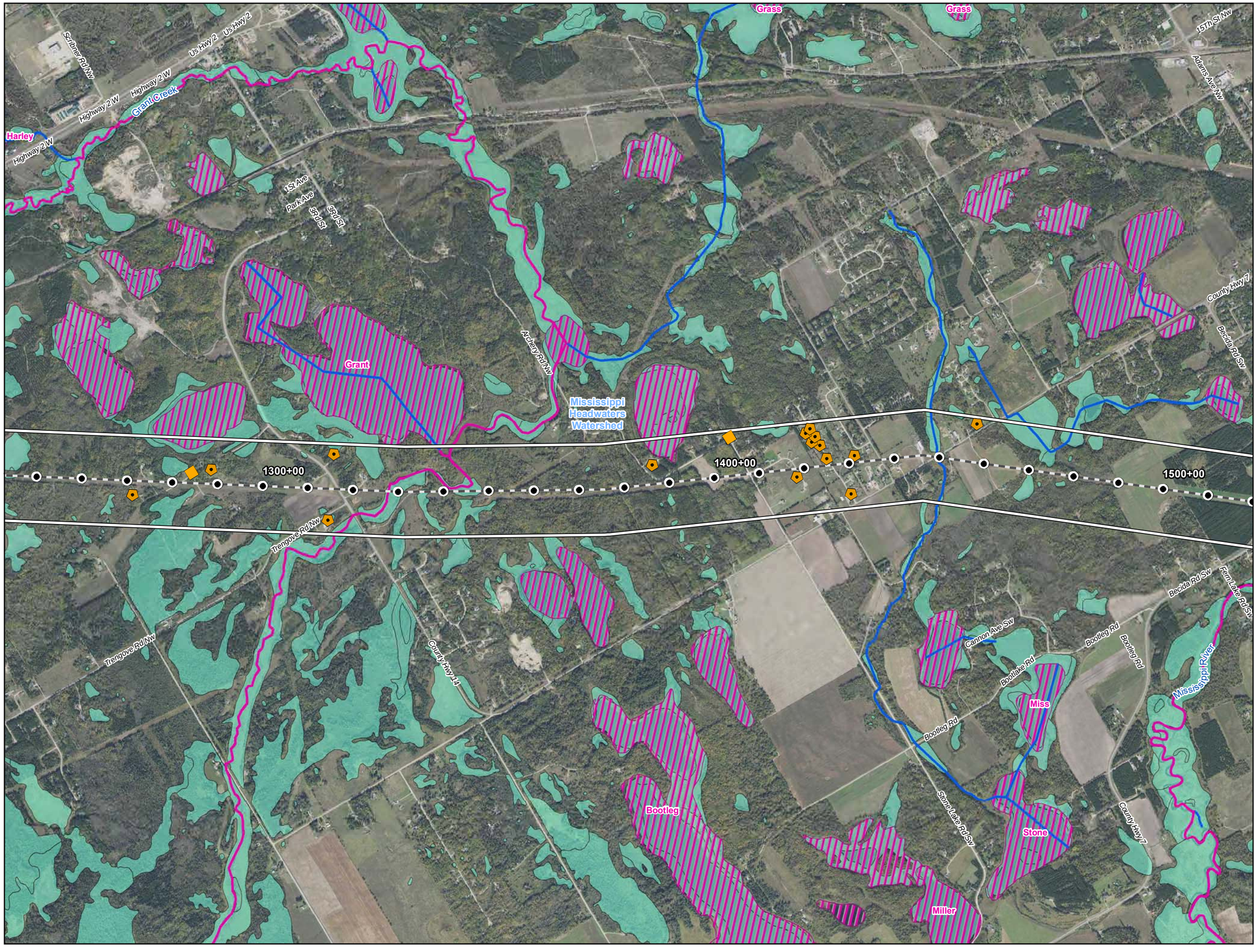



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 6

Line 3 Replacement Project

RA-08-L3

Enbridge

Beltrami County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-08-L3.mxd

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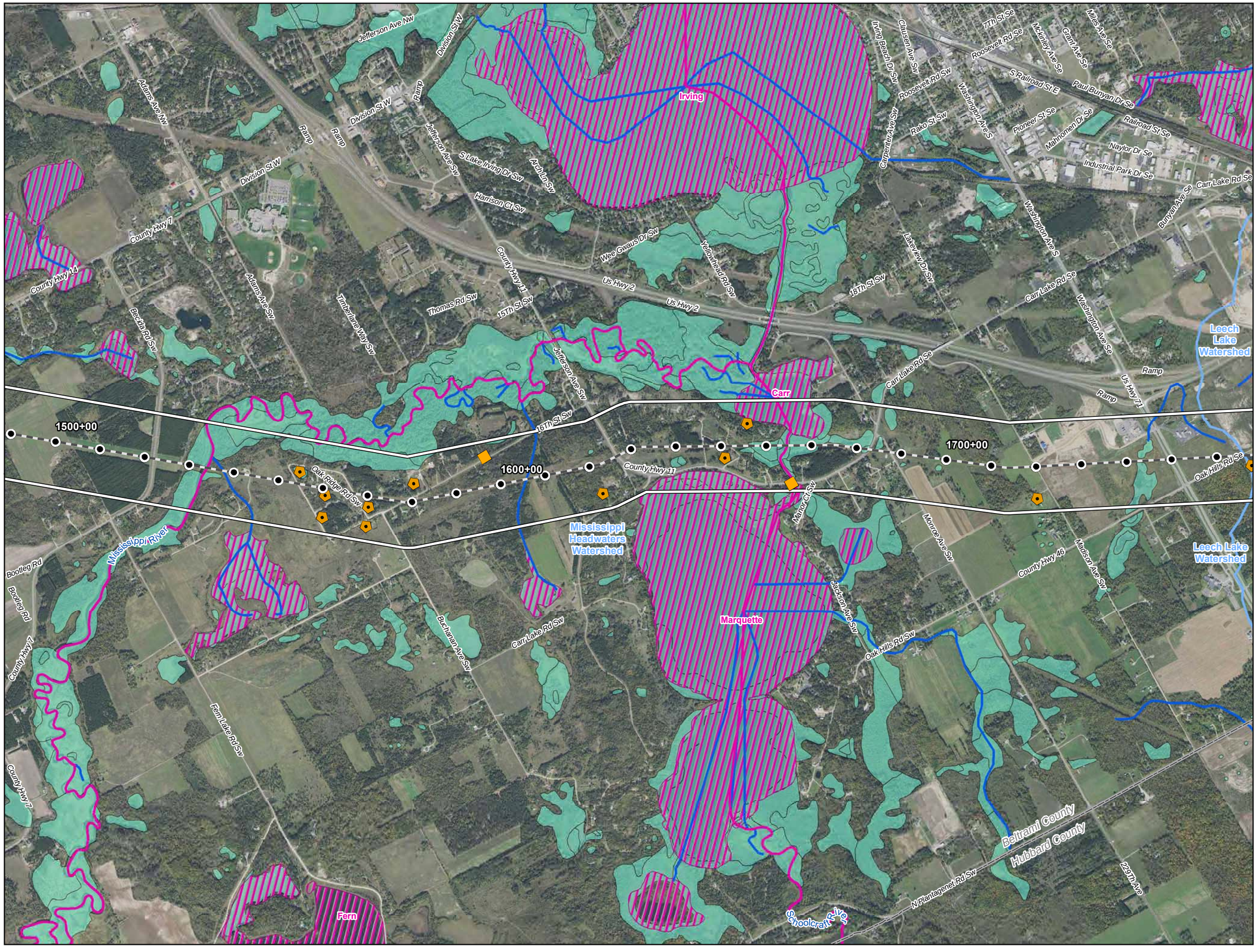

Figure 7

Line 3 Replacement Project

RA-08-L3

Enbridge

Beltrami County, Minnesota

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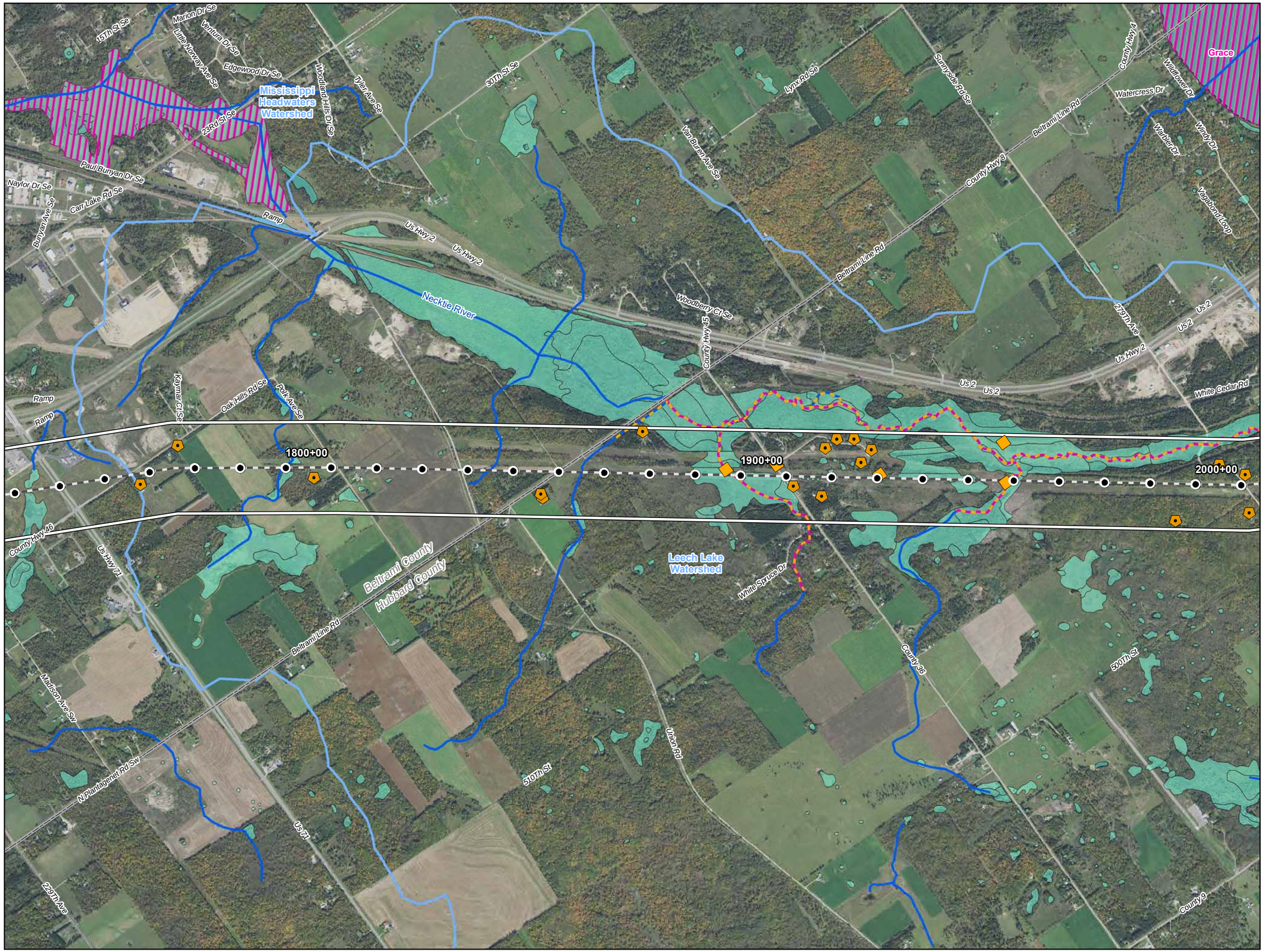



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 8

Line 3 Replacement Project

RA-08-L3

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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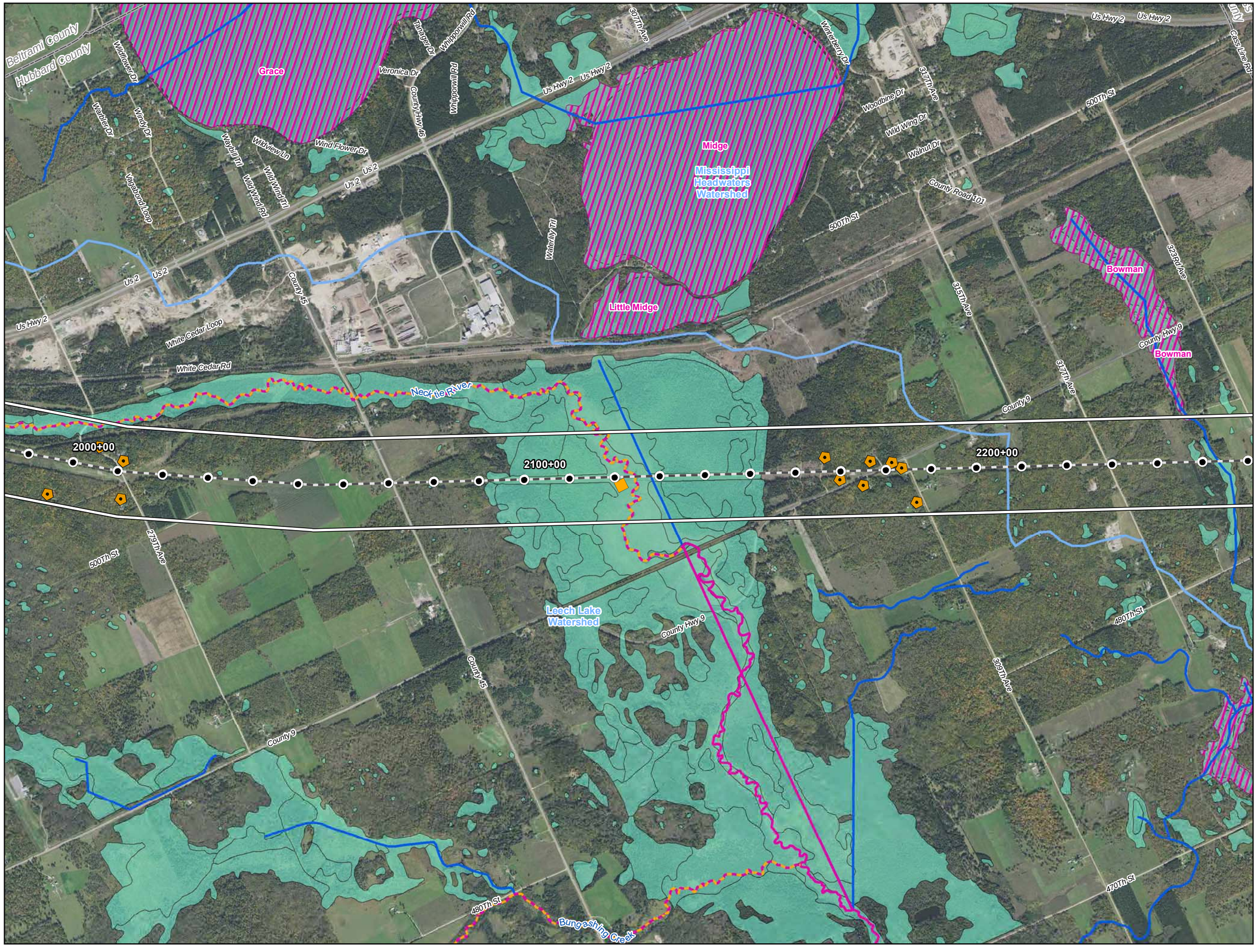

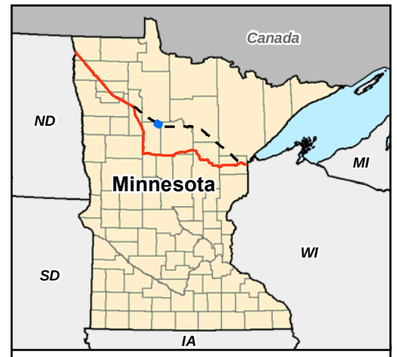

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 9

Line 3 Replacement Project

RA-08-L3

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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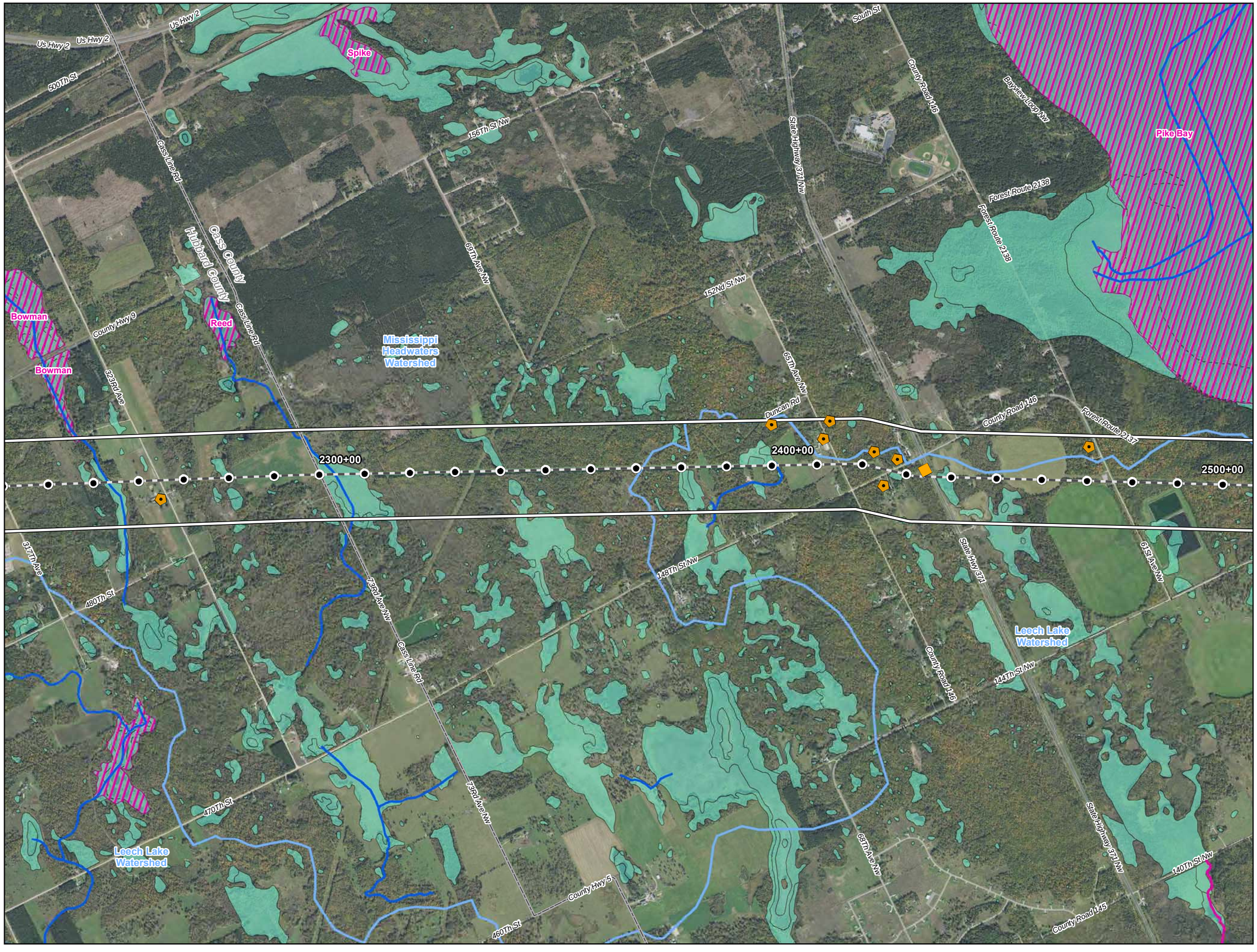



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 10

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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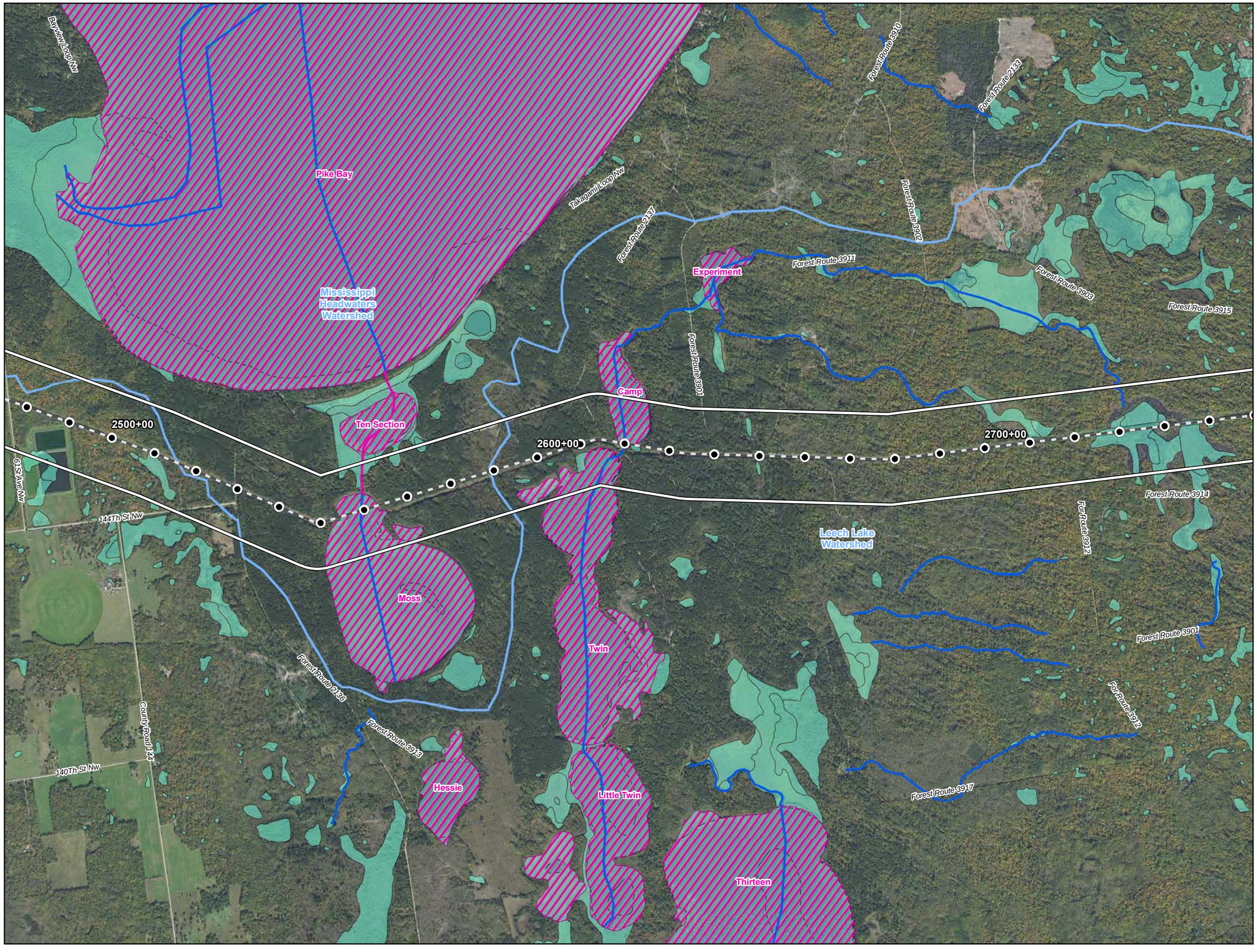



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 11

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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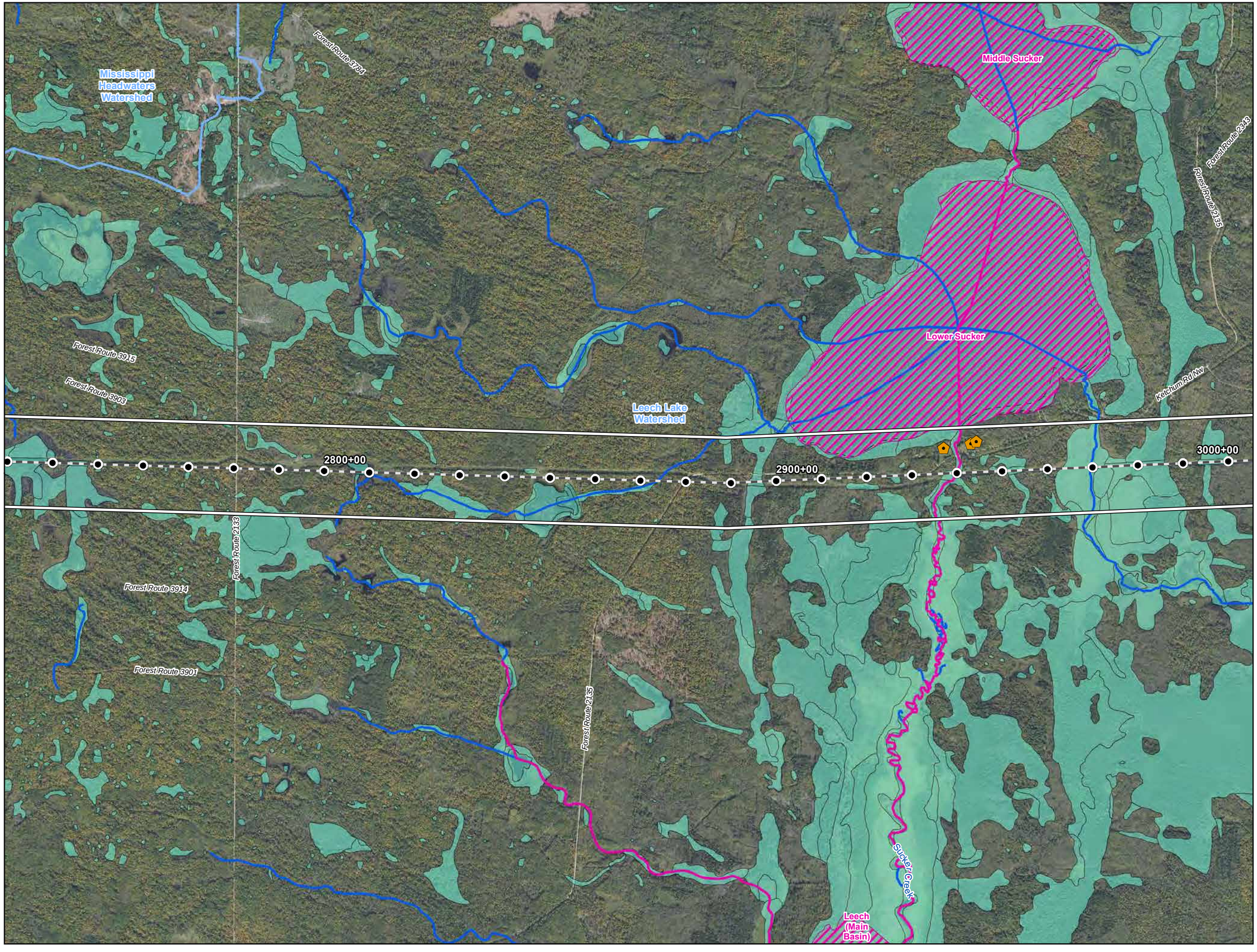

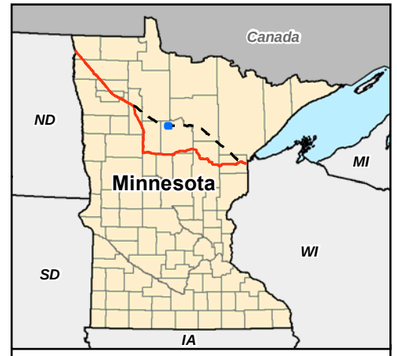

0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 12

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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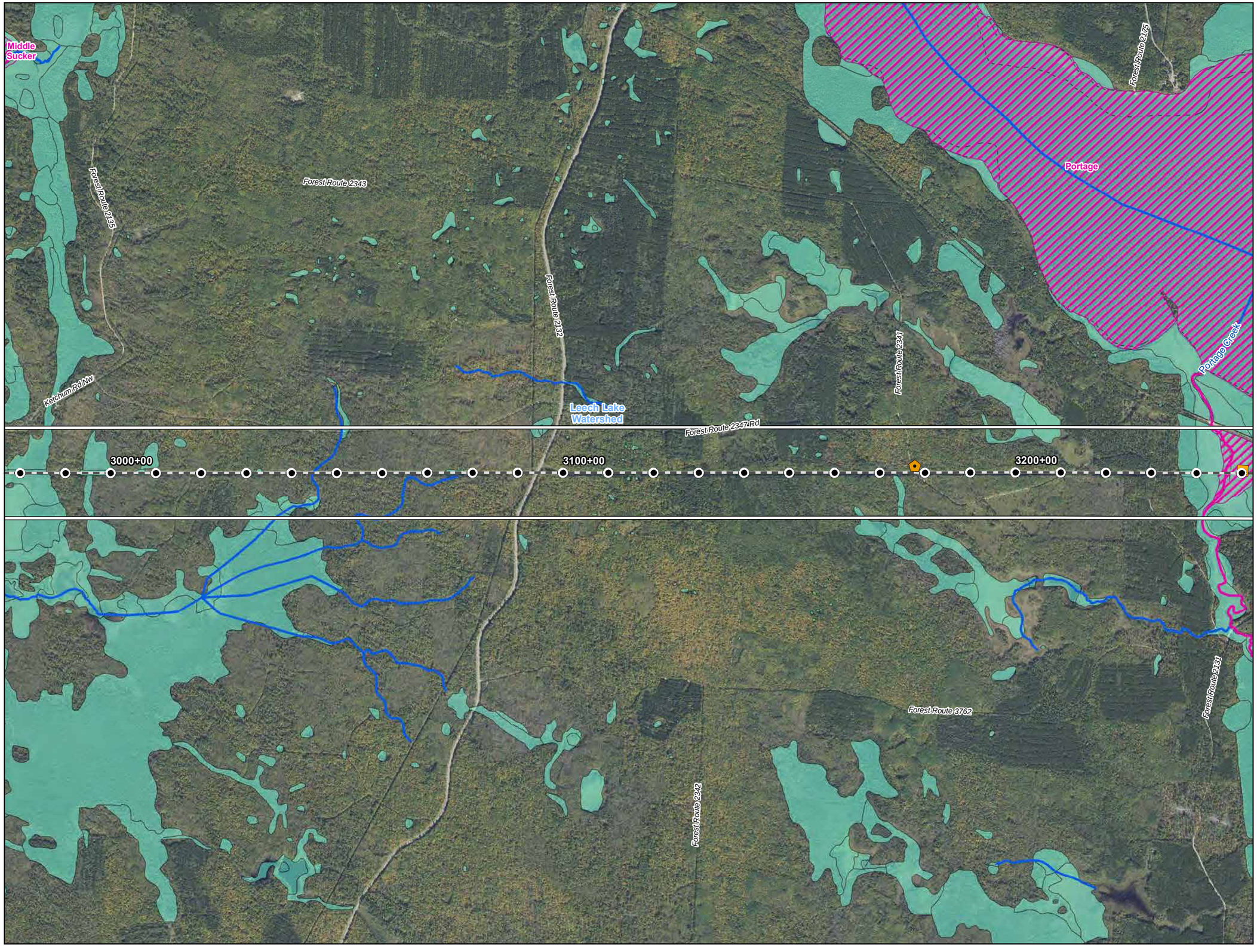



0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 13

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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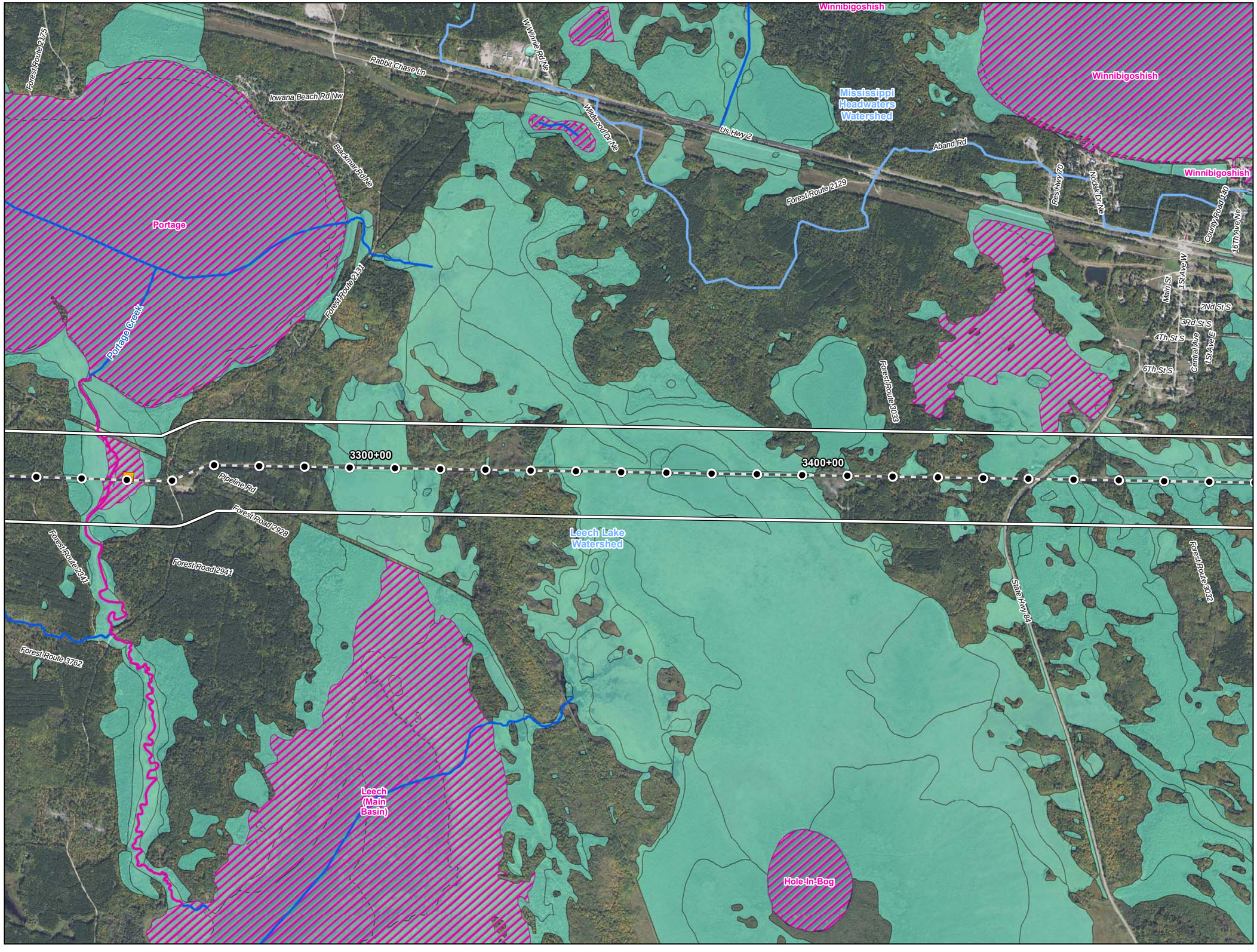

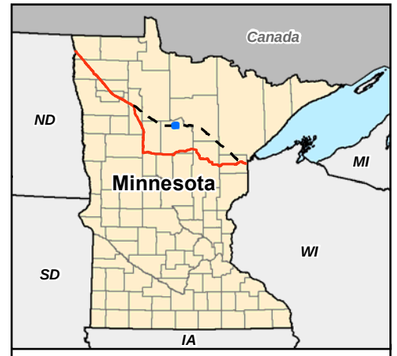

0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
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- Line 3 Milepost
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- Proposed Line 3 Replacement Pipeline
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- Trout Stream
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- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 14

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

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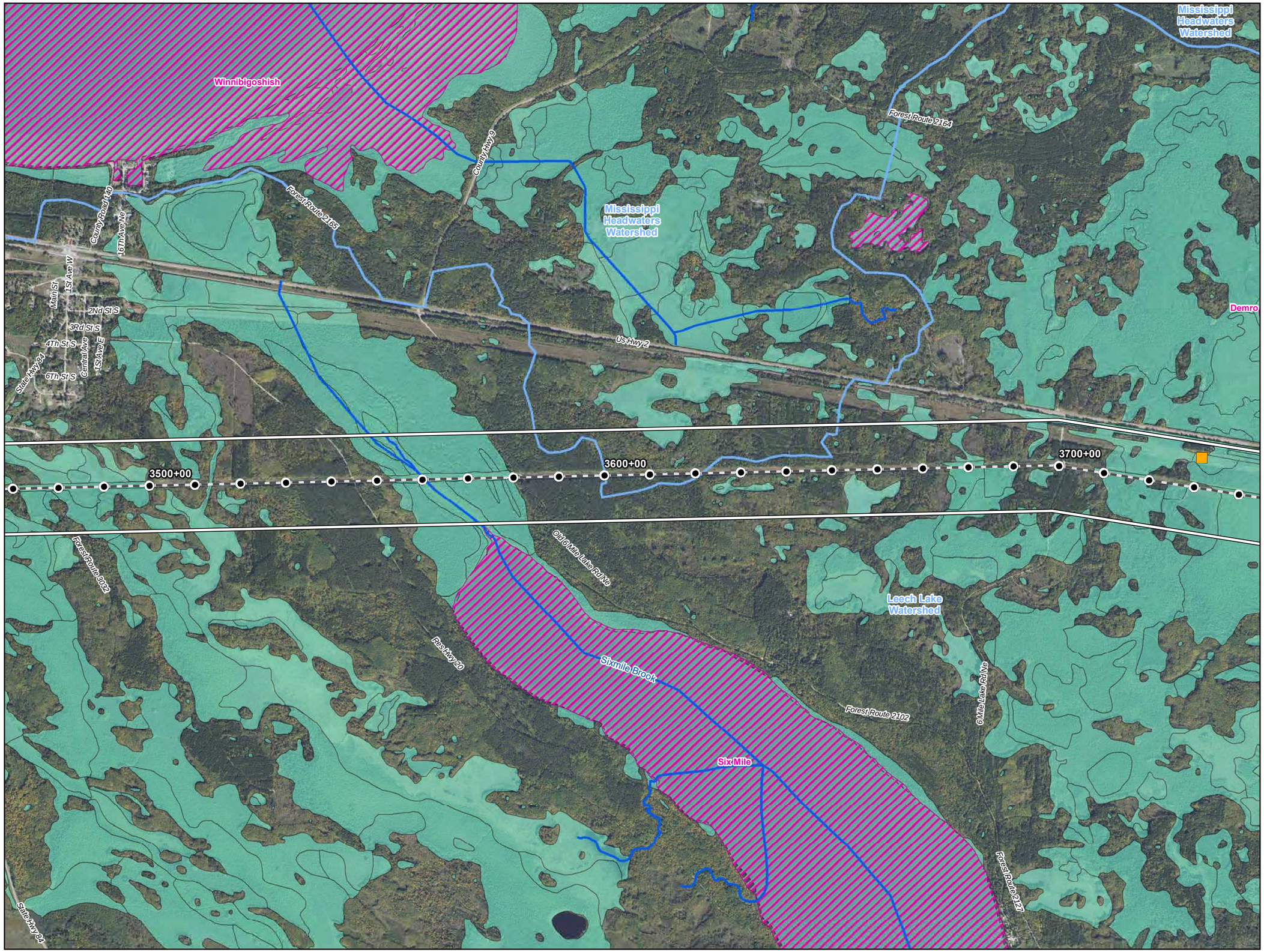
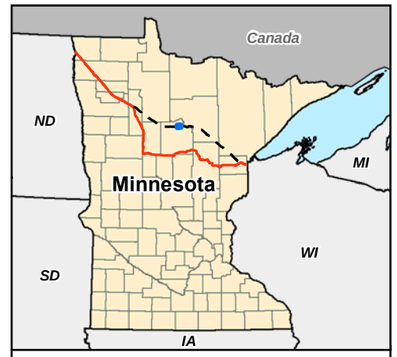
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 15

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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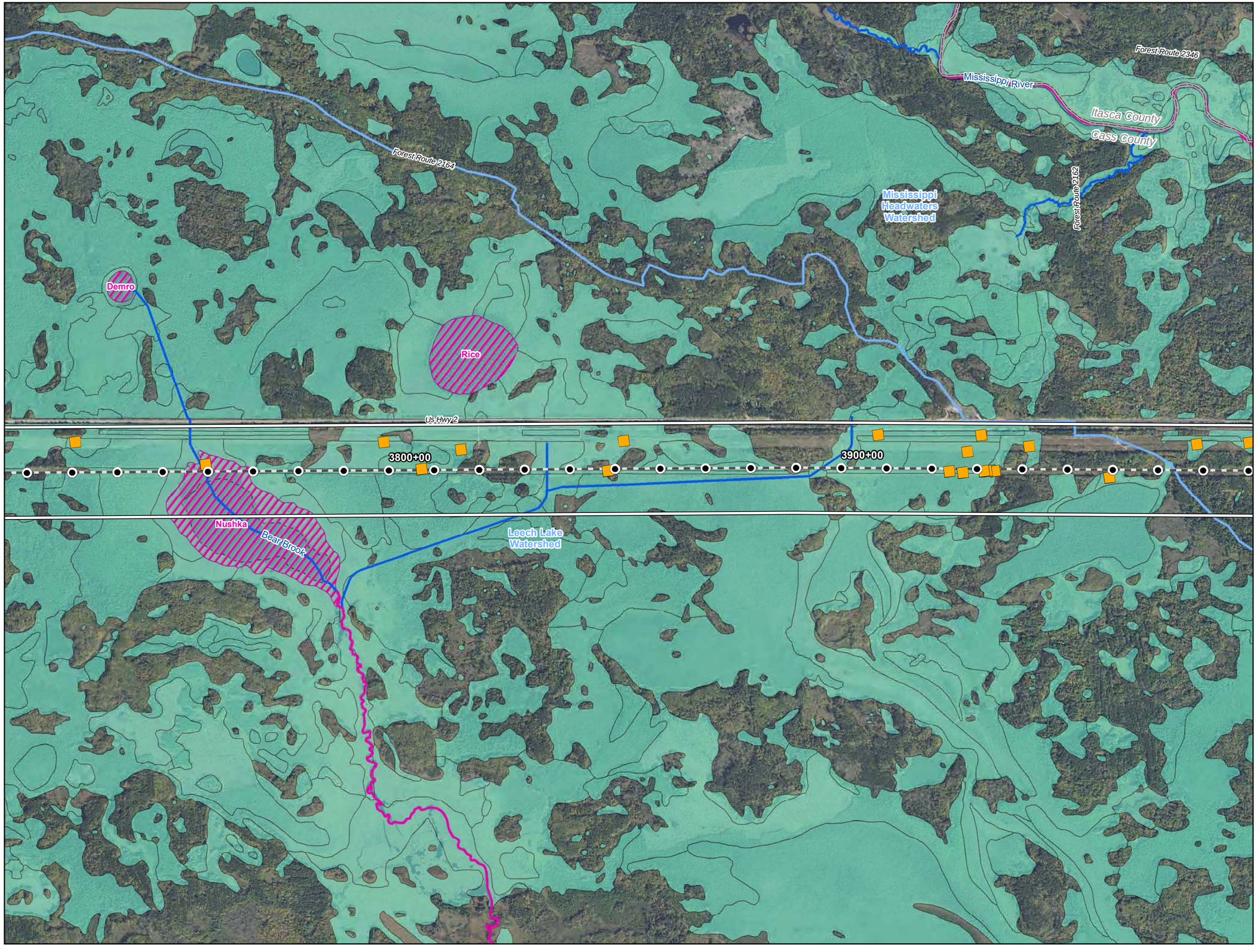



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 16

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RA-08-L3.mxd

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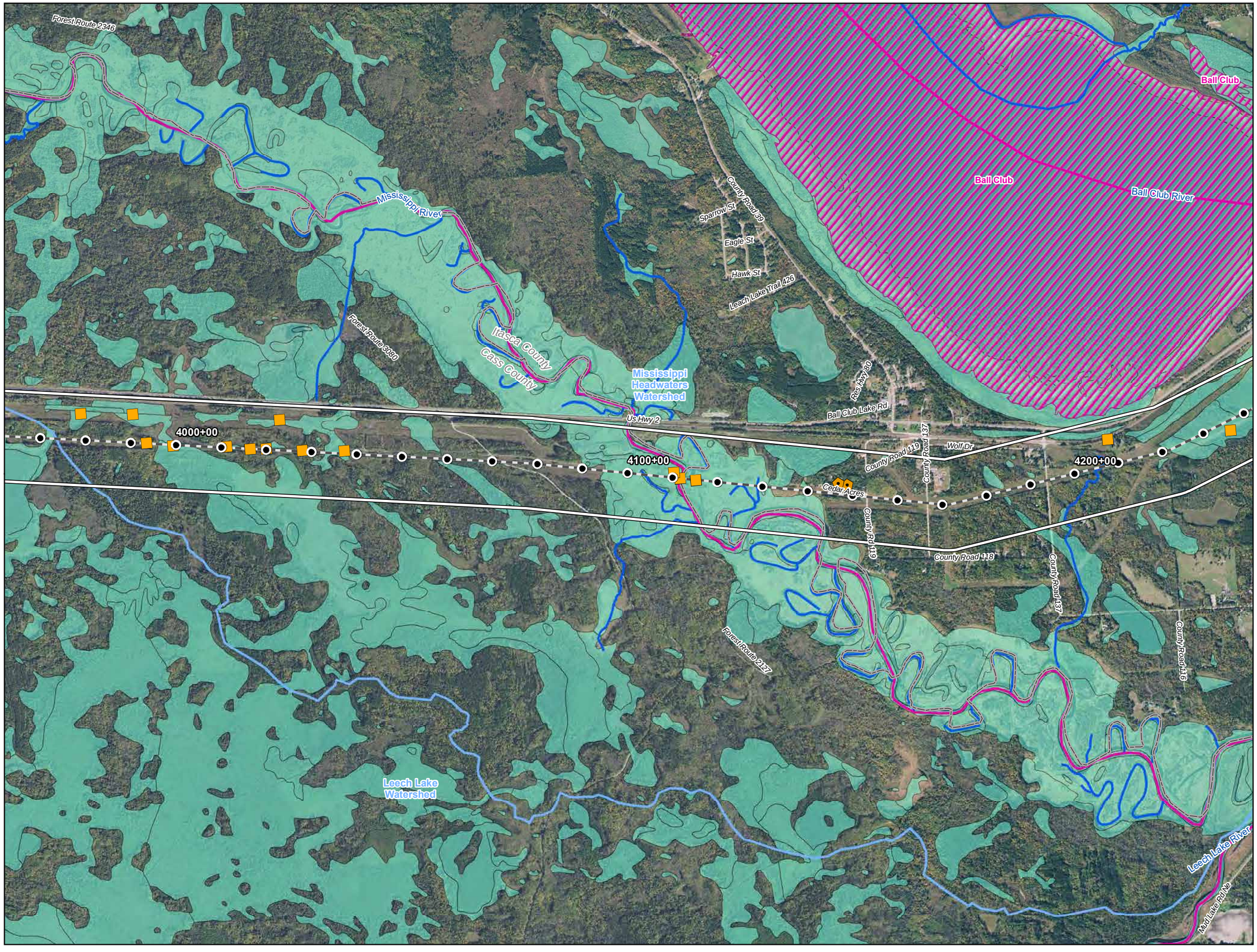



0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 17

Line 3 Replacement Project

RA-08-L3

Enbridge

Cass County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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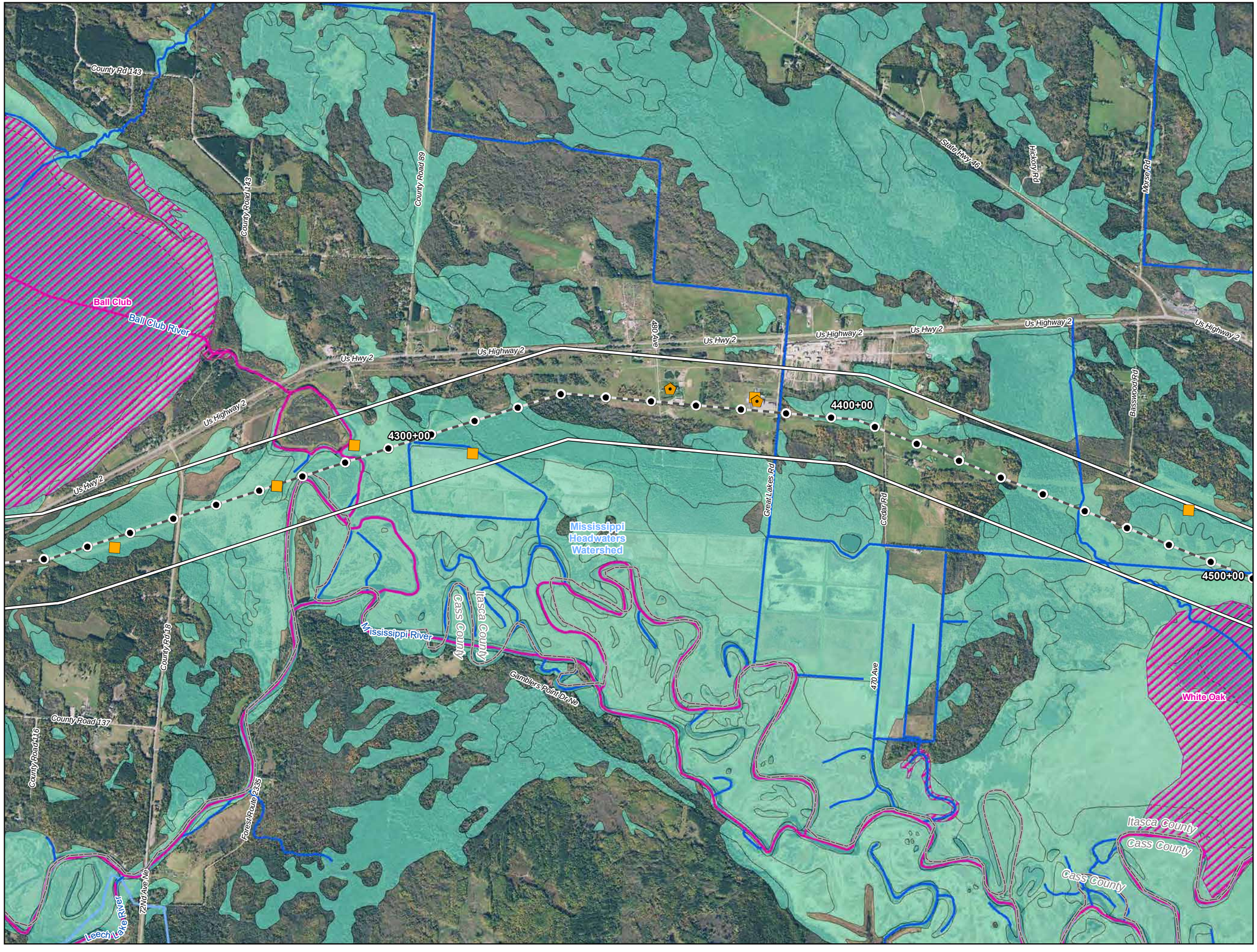
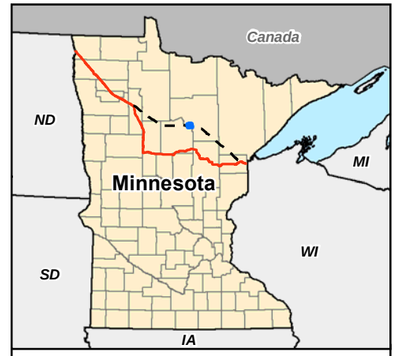
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N
W E
S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 18

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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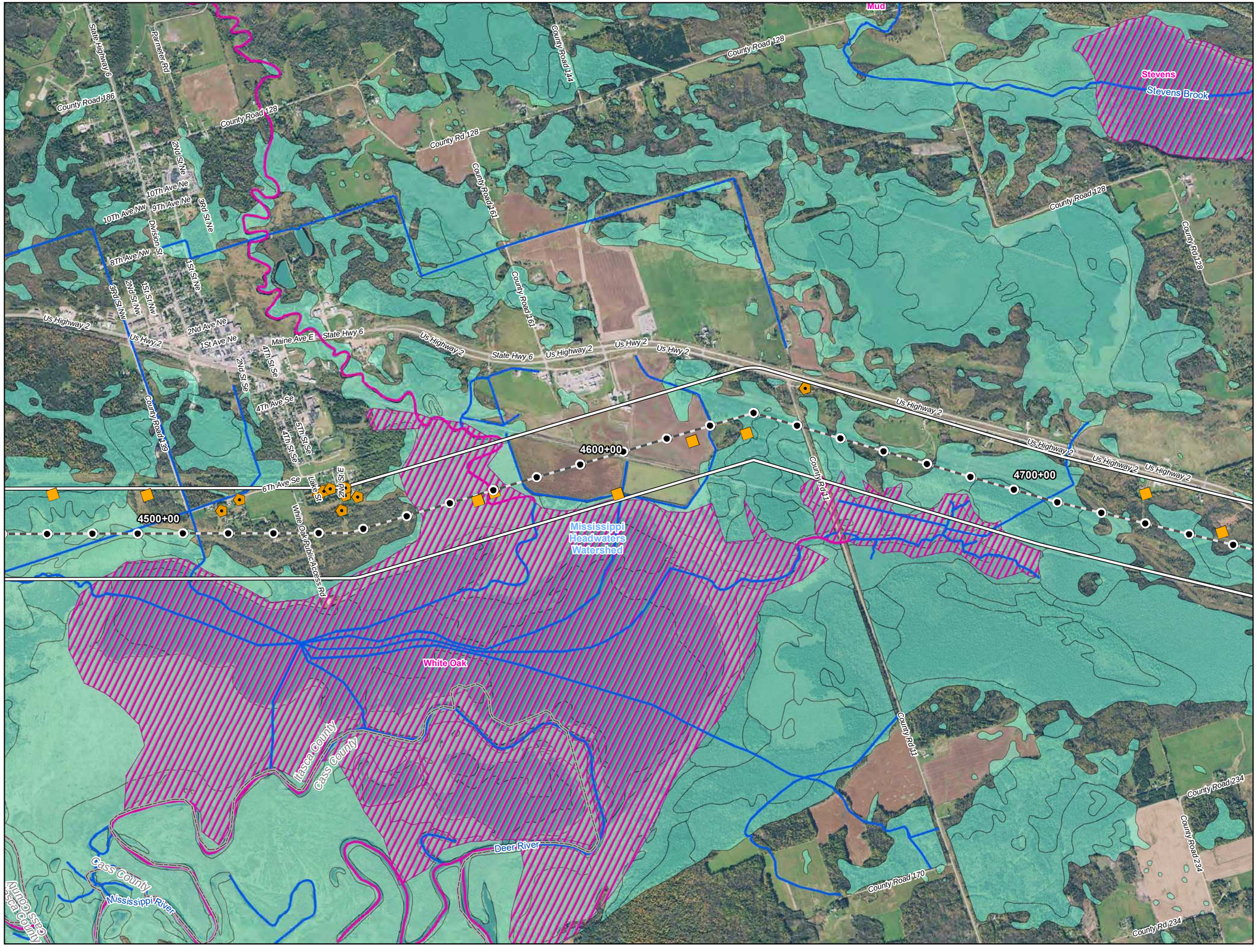
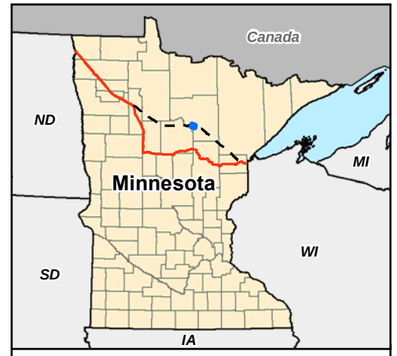
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 19

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

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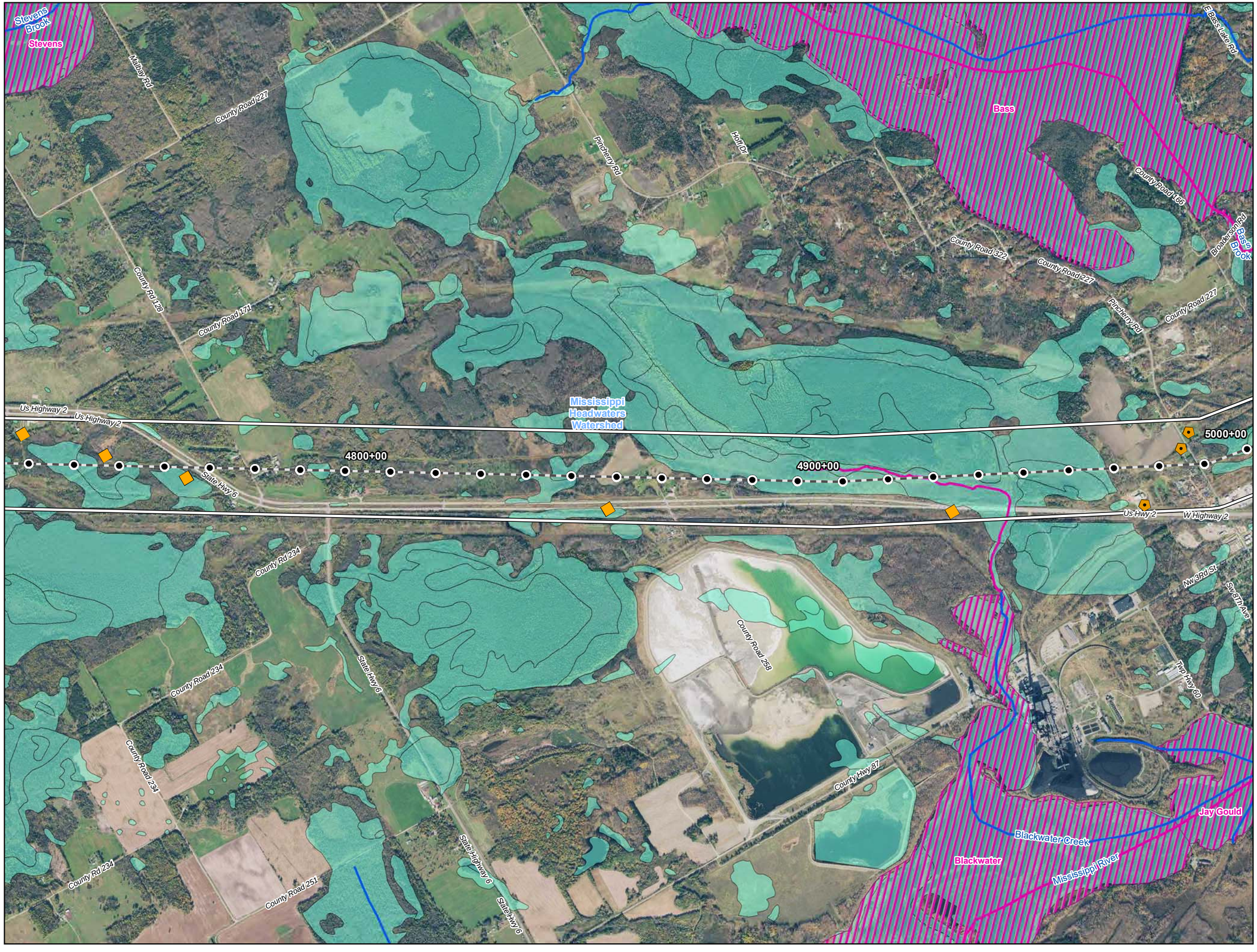

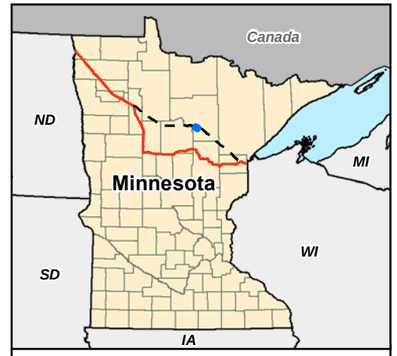

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 20

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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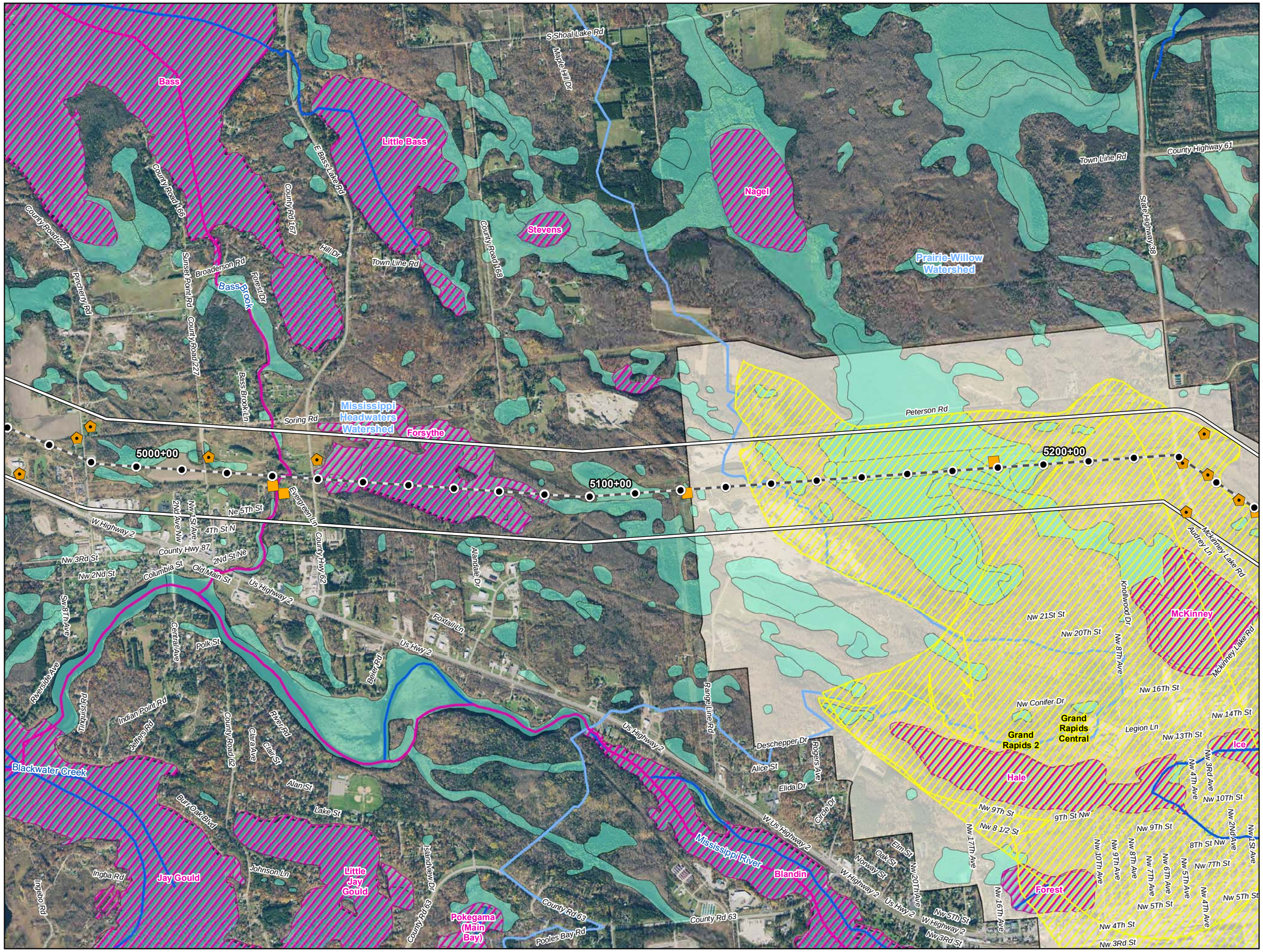

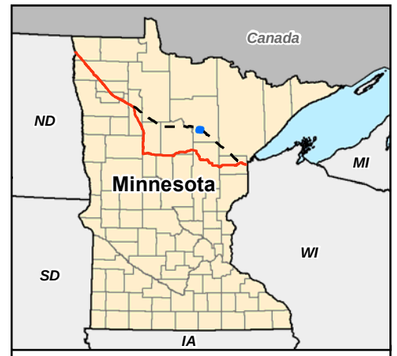

0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 21

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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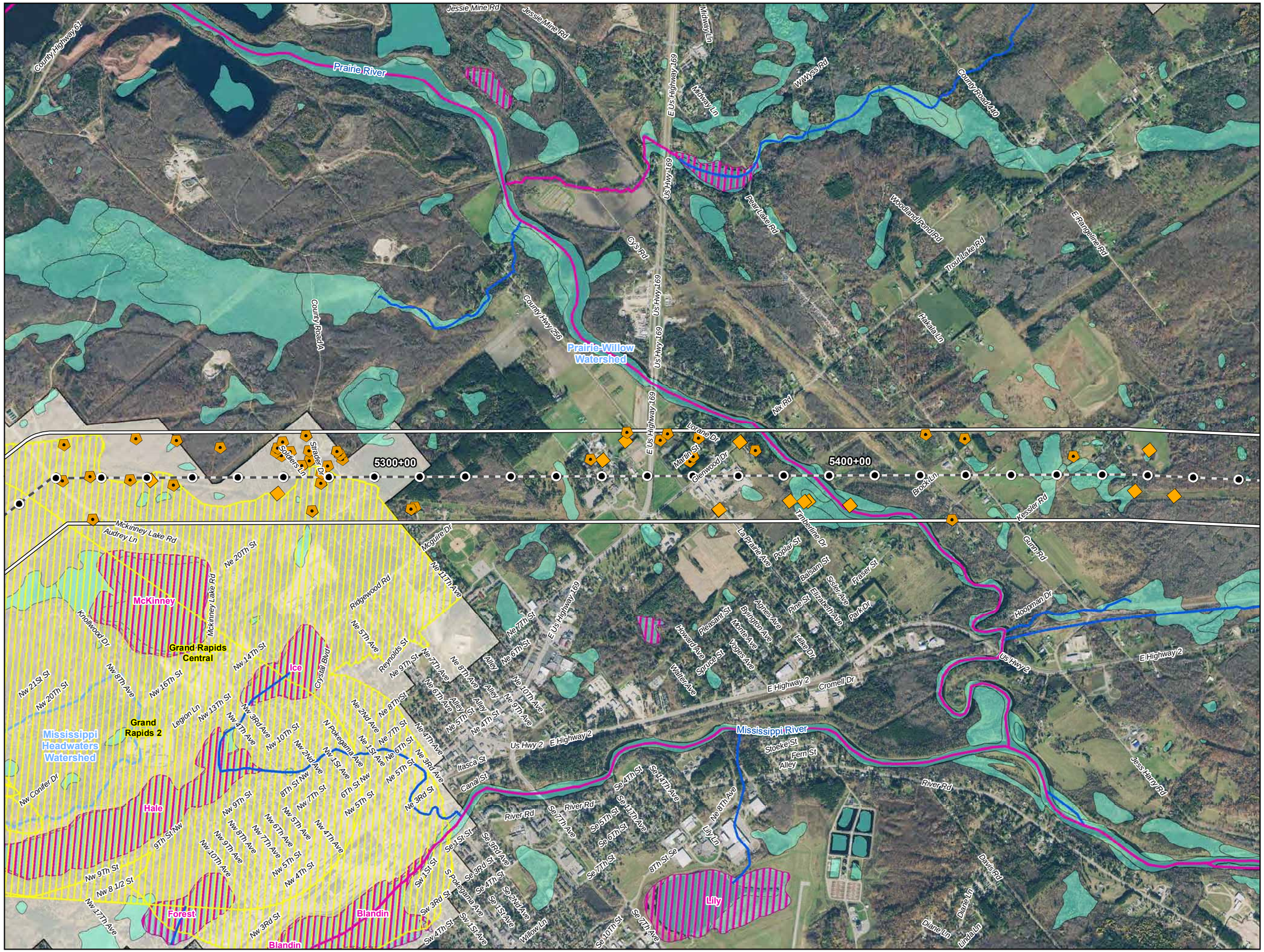

Figure 22

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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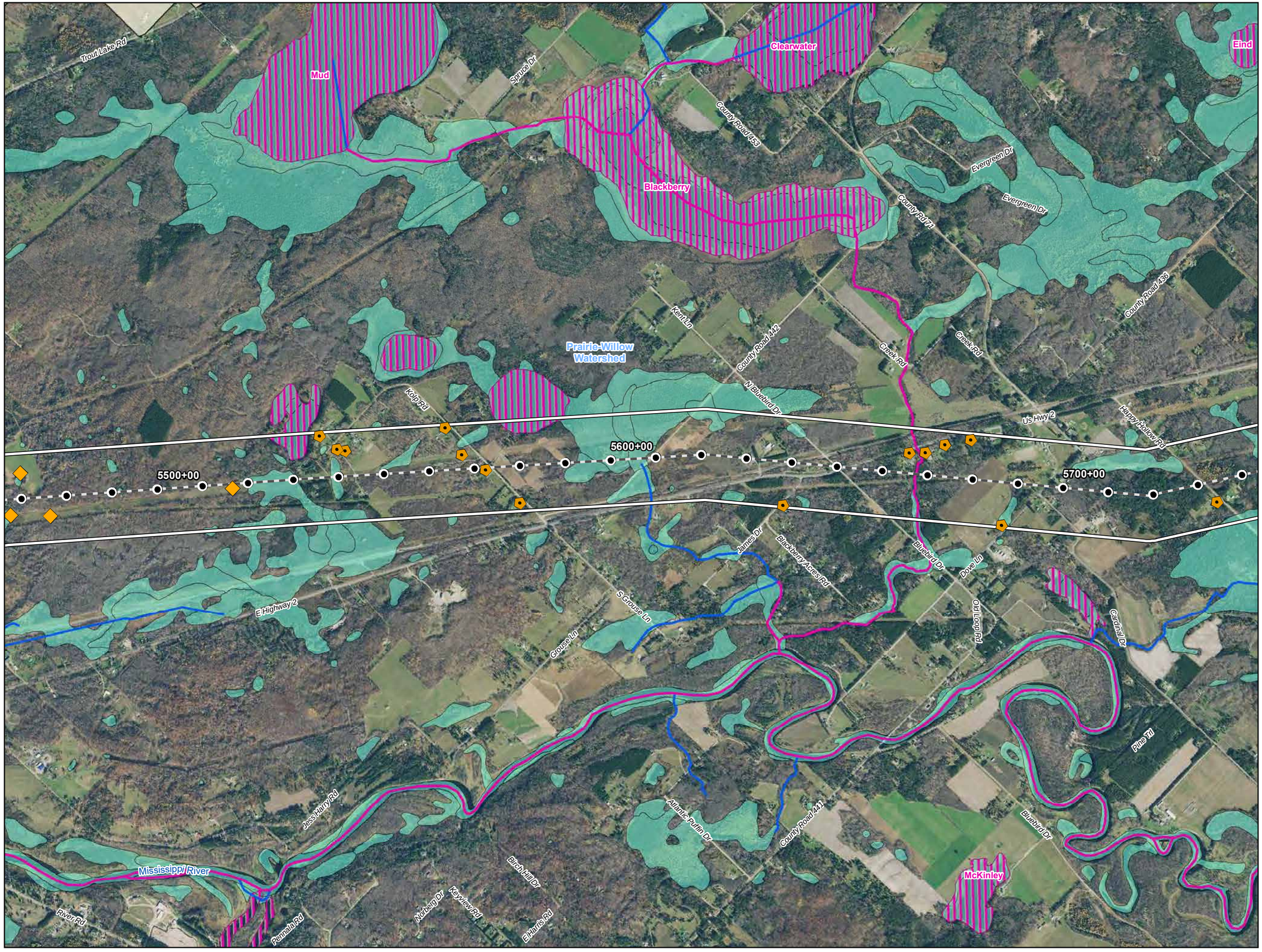

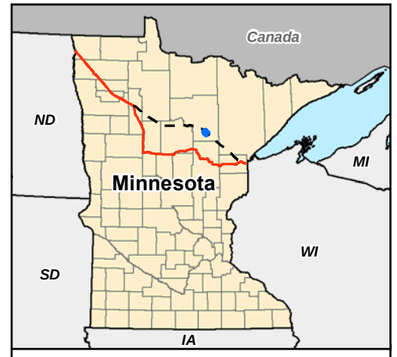

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 23

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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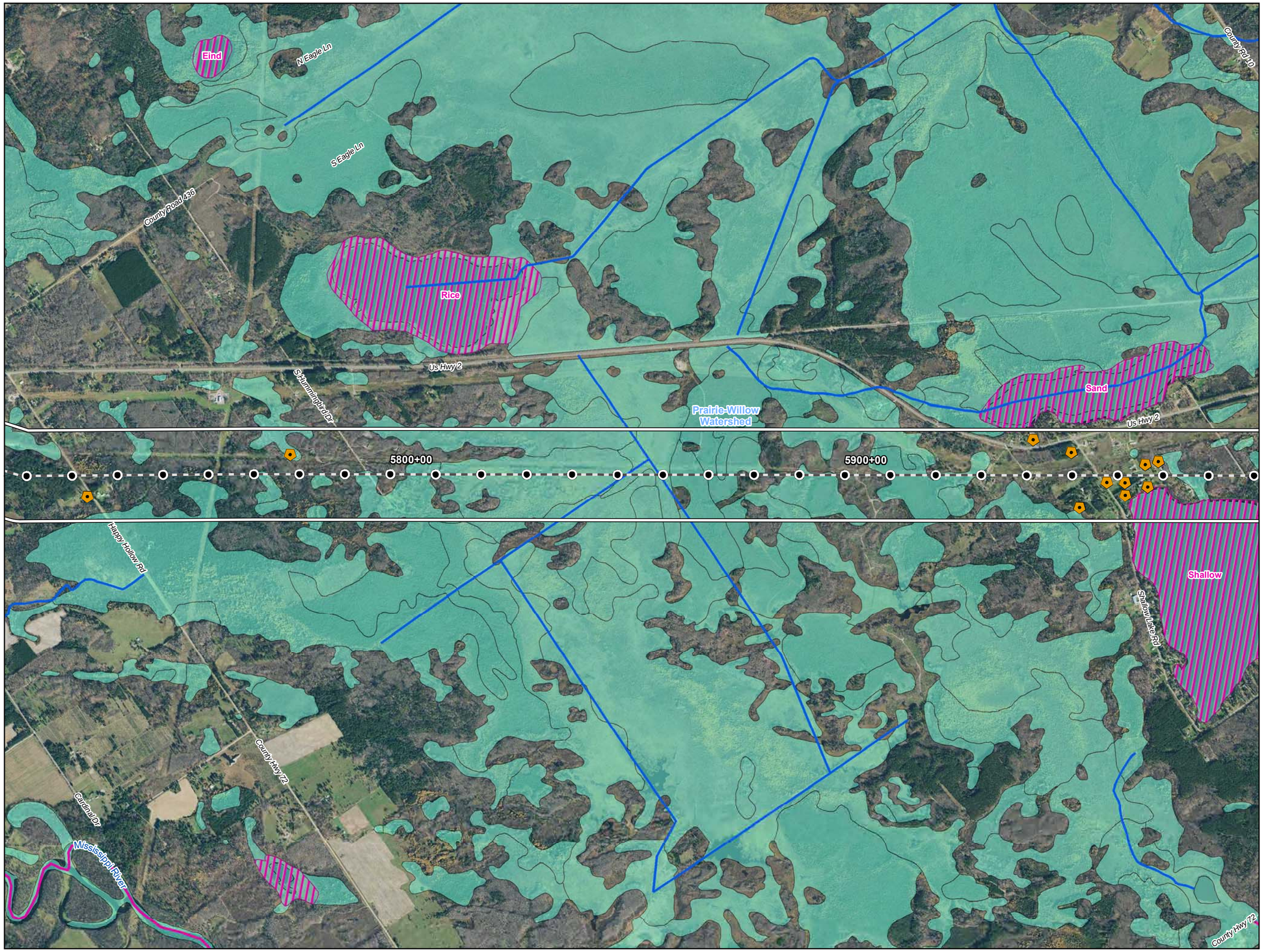



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 24

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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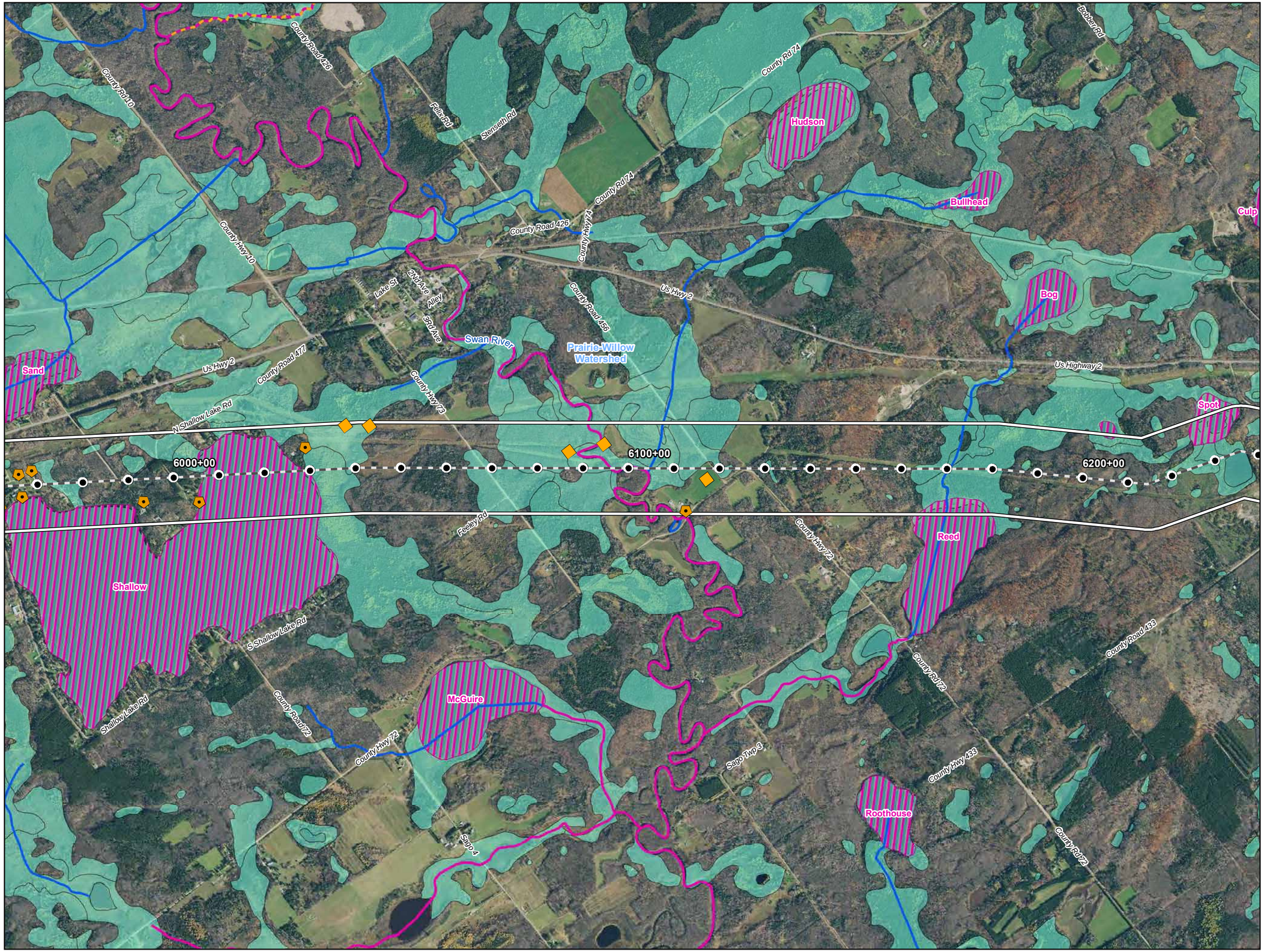

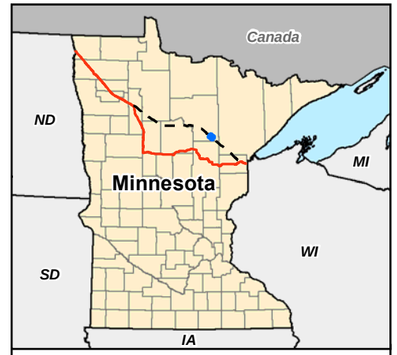

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 25

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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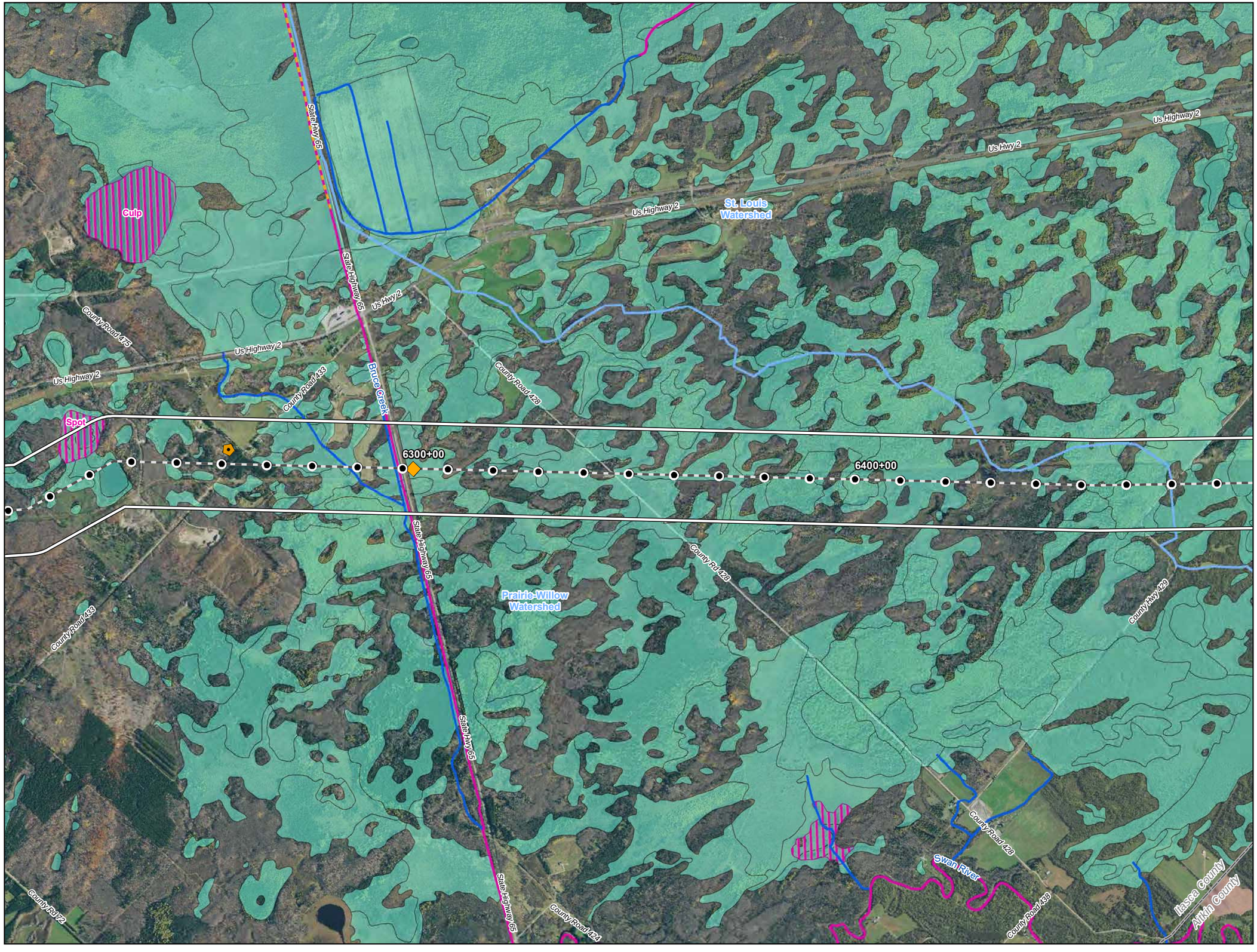
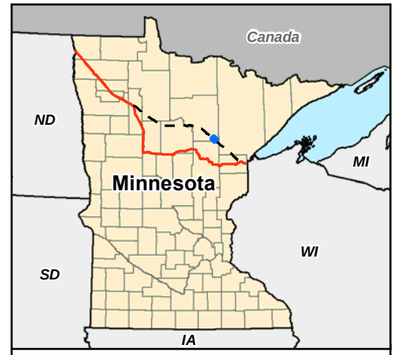
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 26

Line 3 Replacement Project

RA-08-L3

Enbridge

Itasca County, Minnesota

ENBRIDGE

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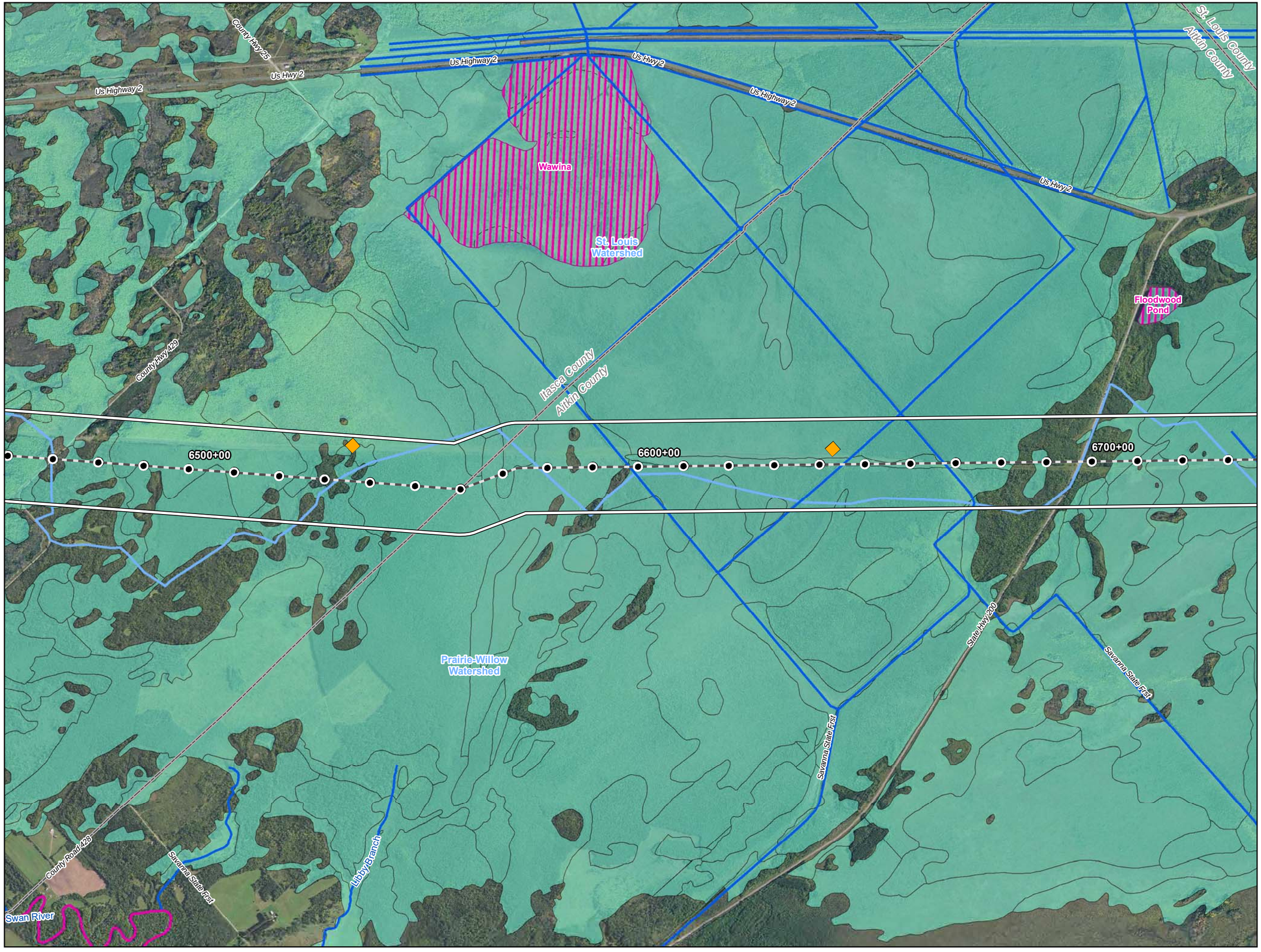

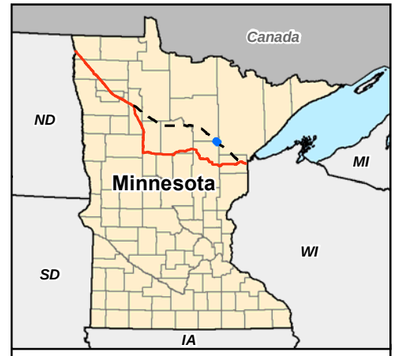

0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 27

Line 3 Replacement Project

RA-08-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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0 1,000 2,000 Feet

1 inch = 2,000 feet

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- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 28

Line 3 Replacement Project

RA-08-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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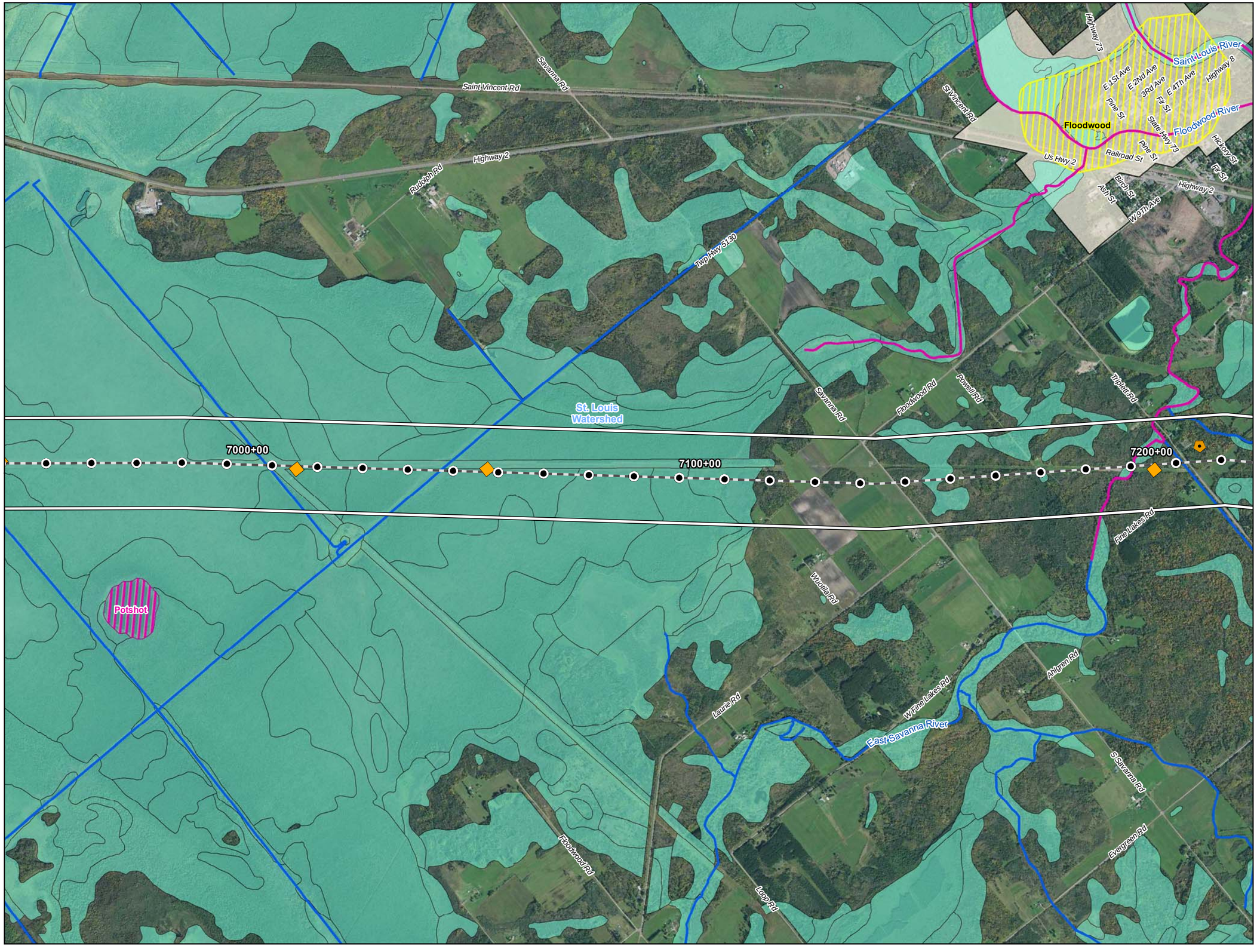
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 29

Line 3 Replacement Project

RA-08-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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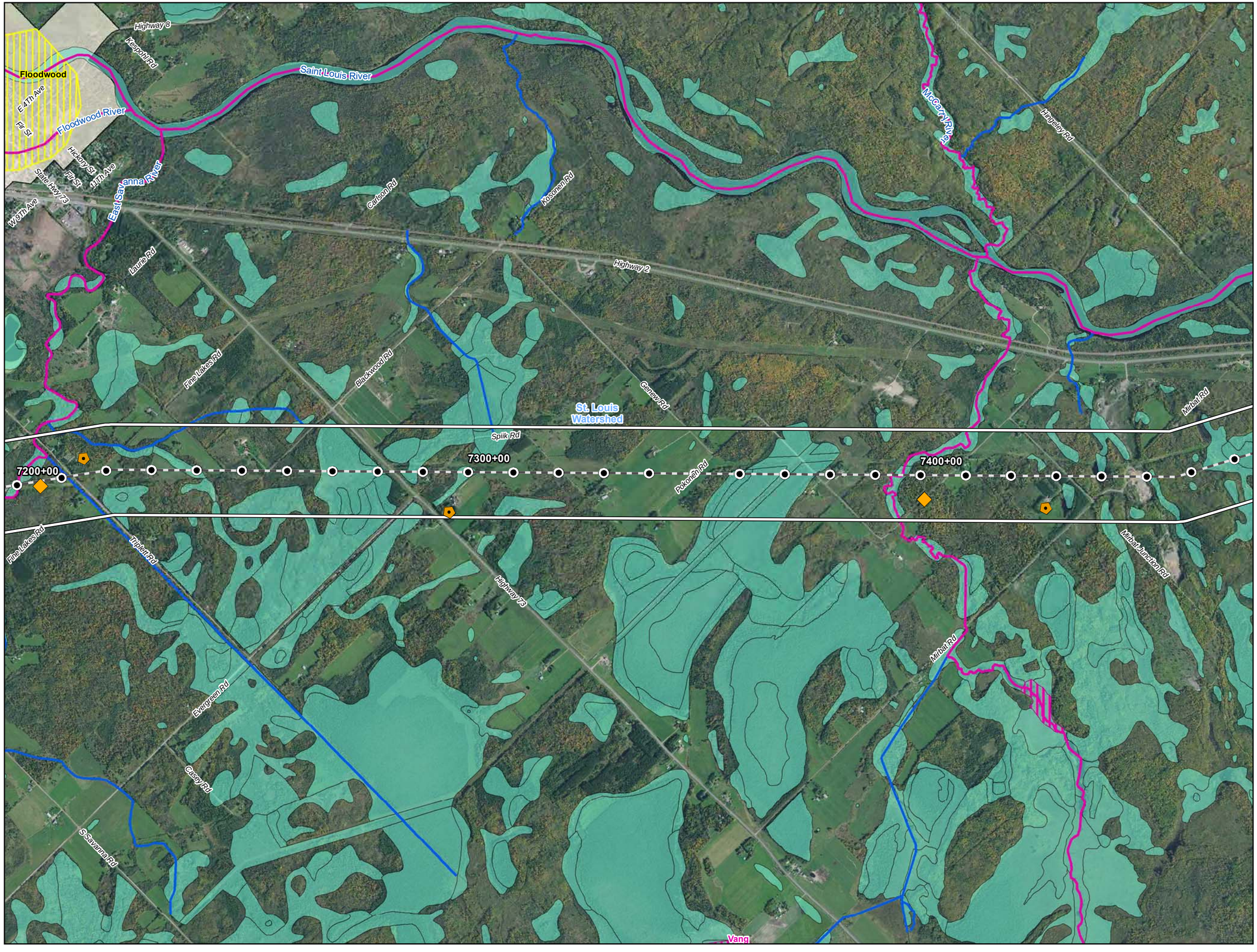
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 30

Line 3 Replacement Project

RA-08-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

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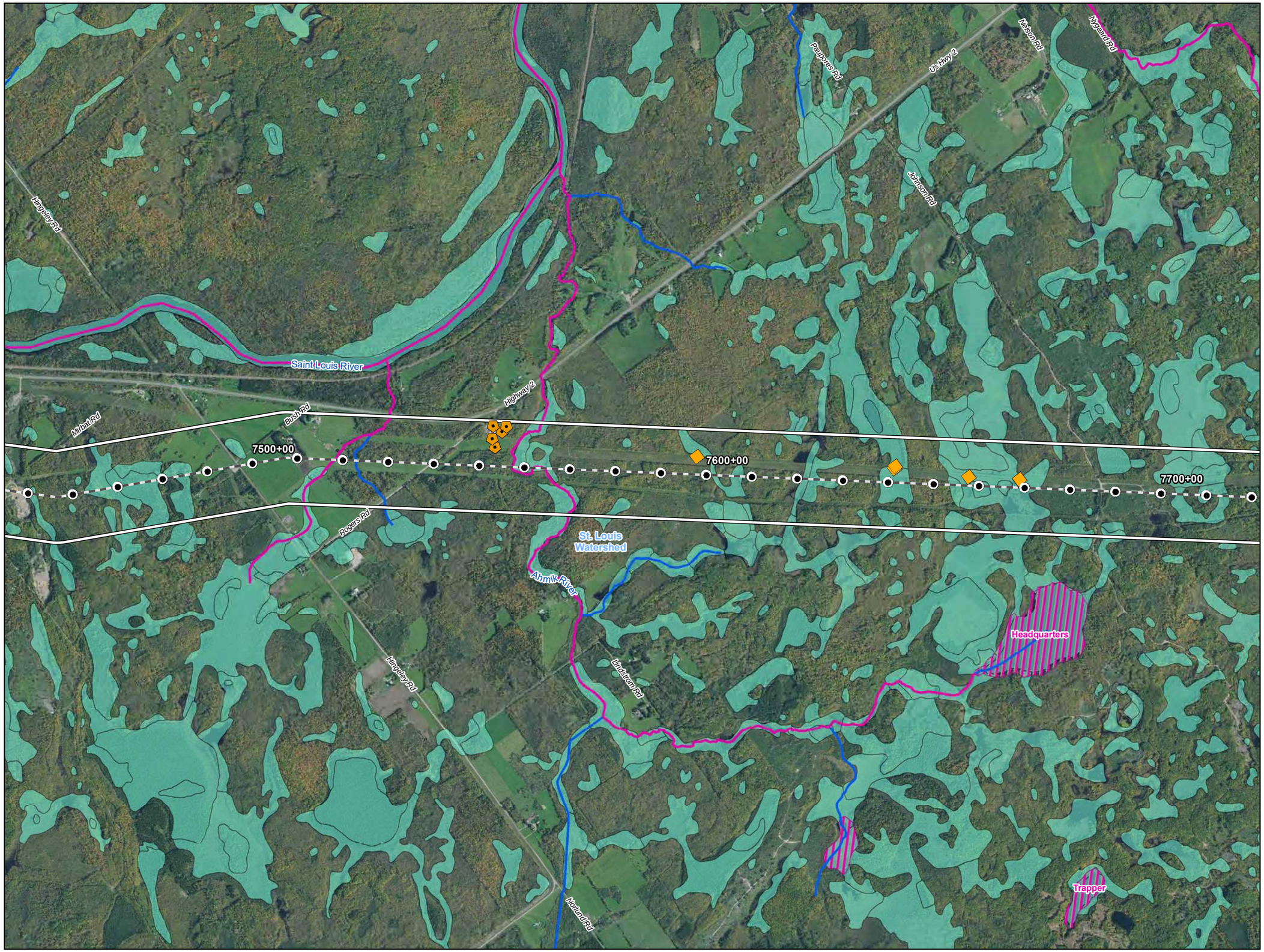



0 1,000 2,000 Feet

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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 31

Line 3 Replacement Project

RA-08-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

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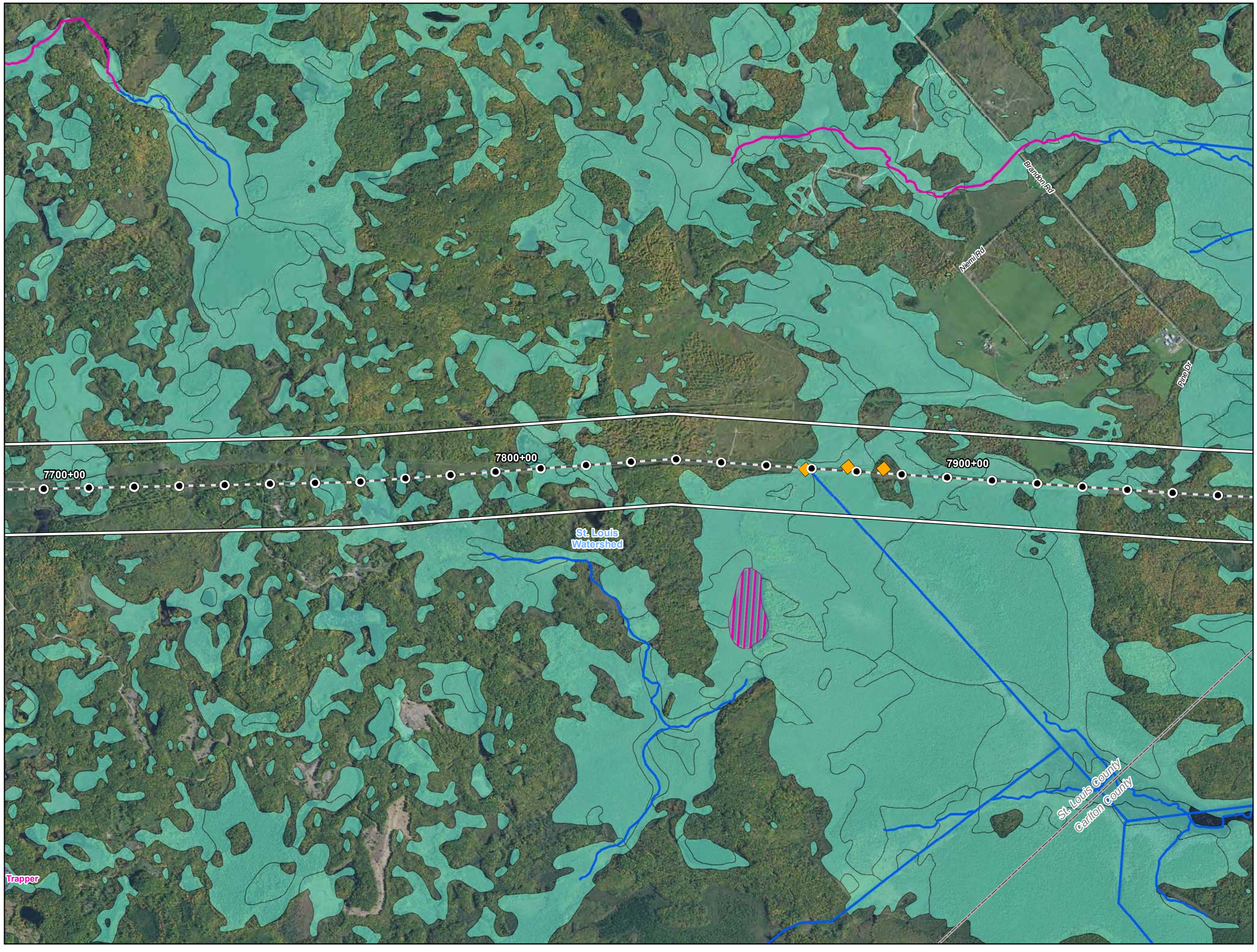



0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
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- Line 3 Milepost
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- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 32

Line 3 Replacement Project

RA-08-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

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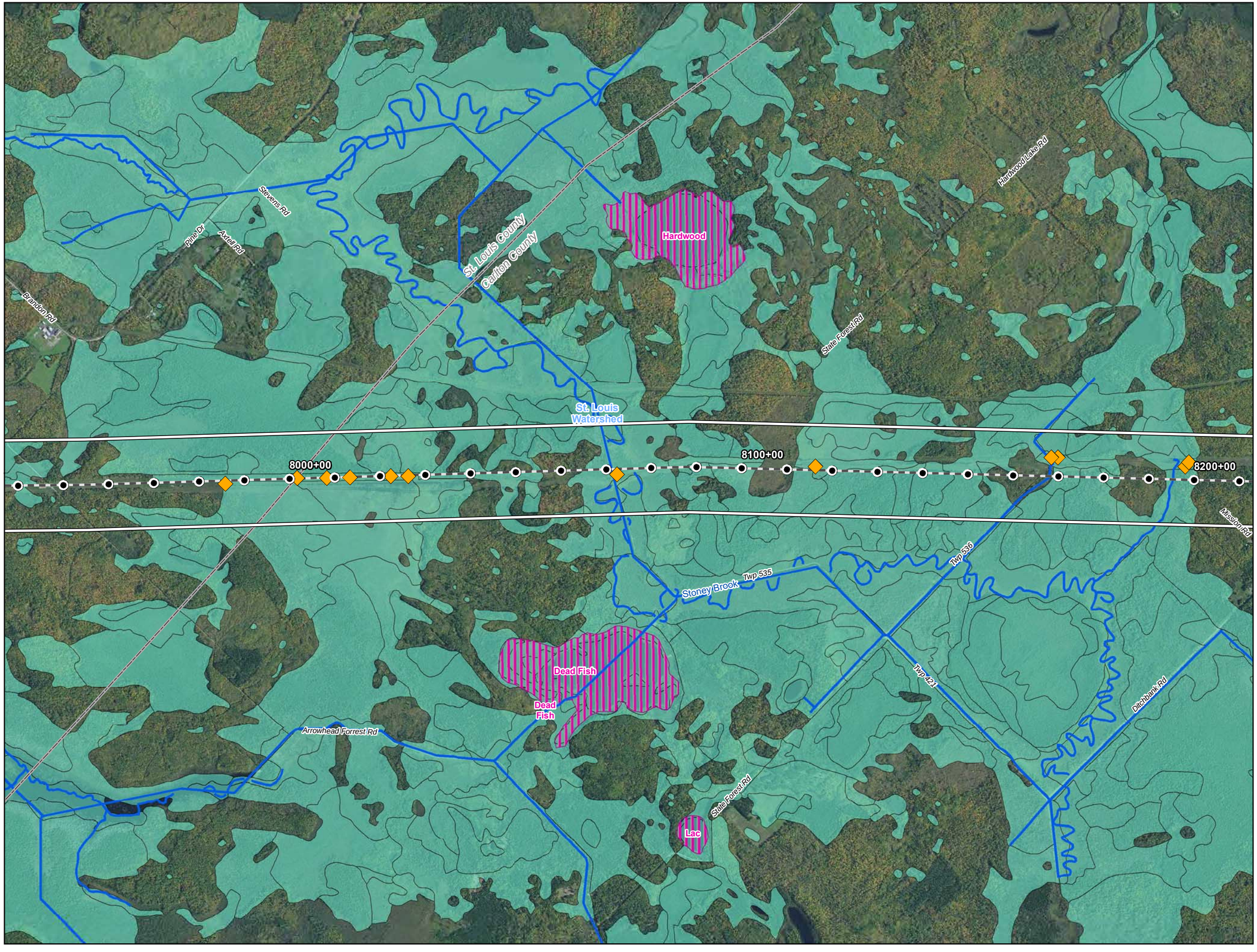
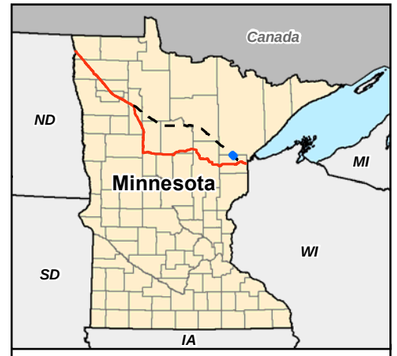
Date: (10/19/2016)





0 1,000 2,000 Feet

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- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
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- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 33

Line 3 Replacement Project

RA-08-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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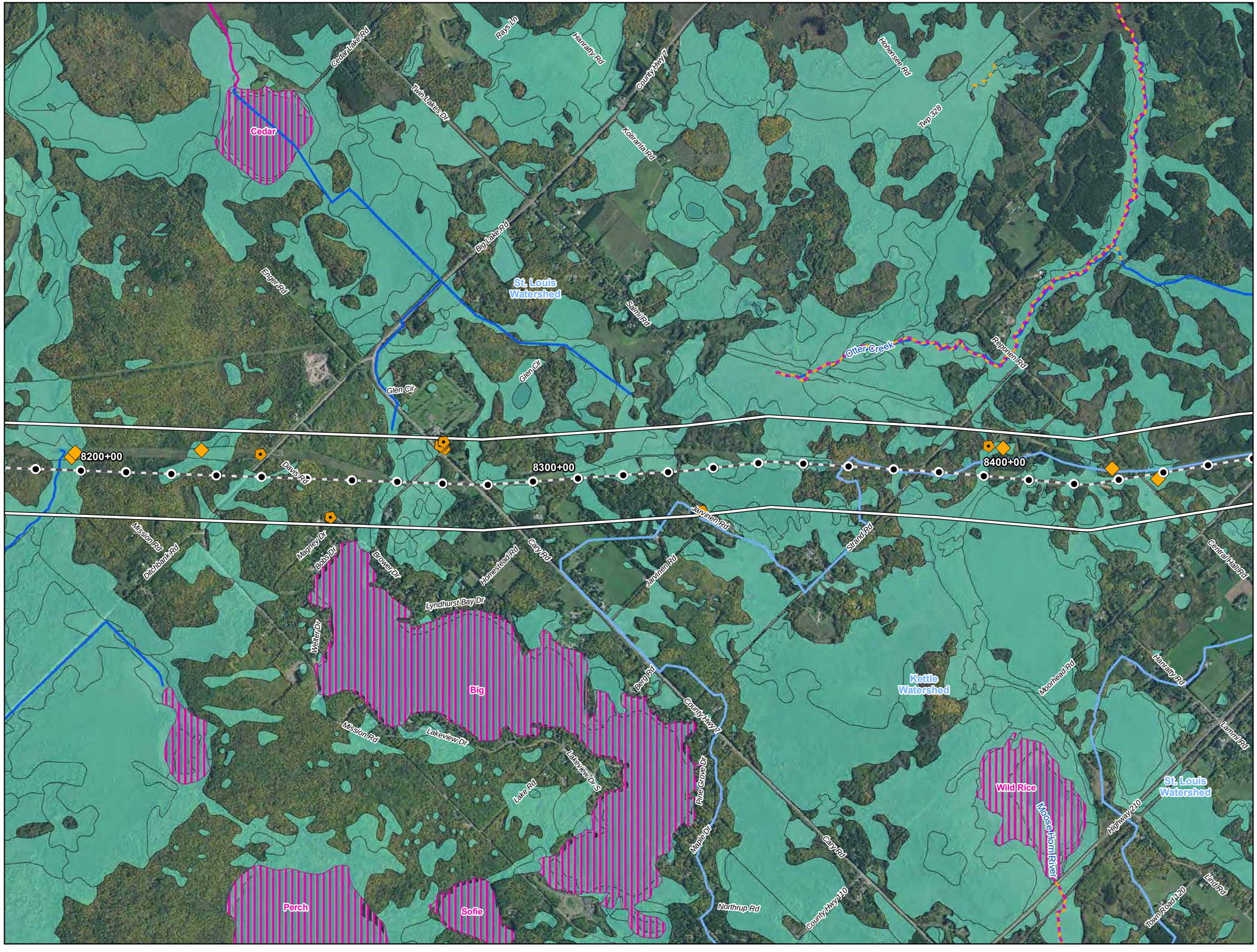

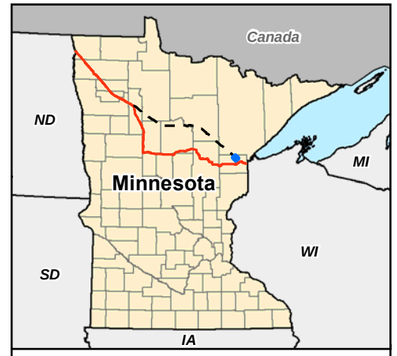

0 1,000 2,000 Feet

1 inch = 2,000 feet

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- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 34

Line 3 Replacement Project

RA-08-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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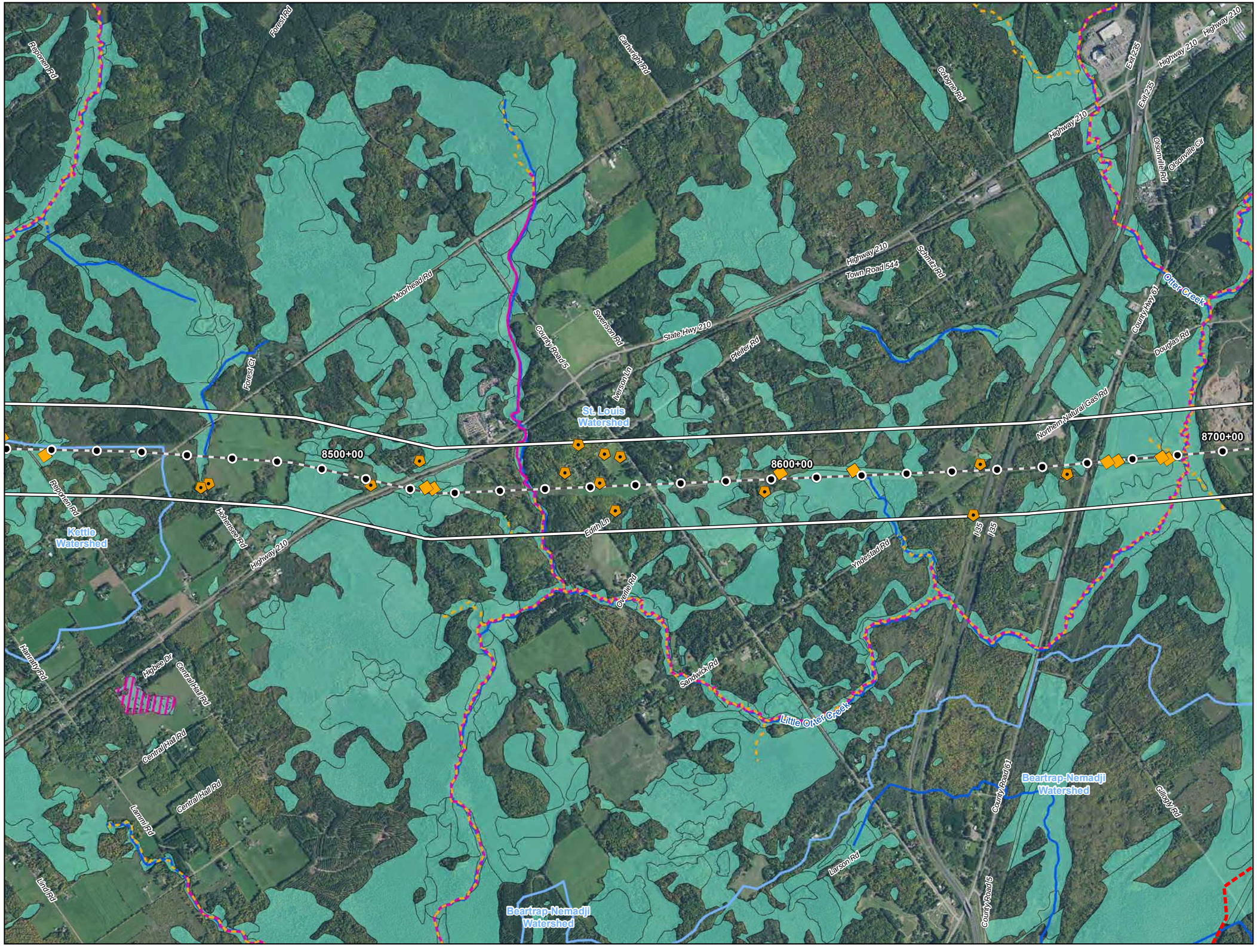

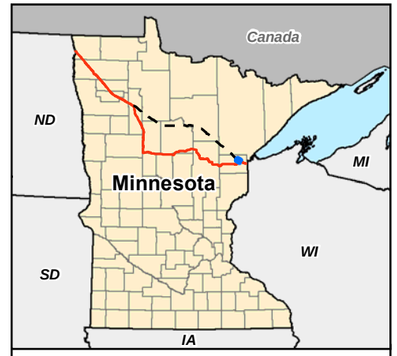

0 1,000 2,000 Feet

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- Water Well
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- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 35

Line 3 Replacement Project

RA-08-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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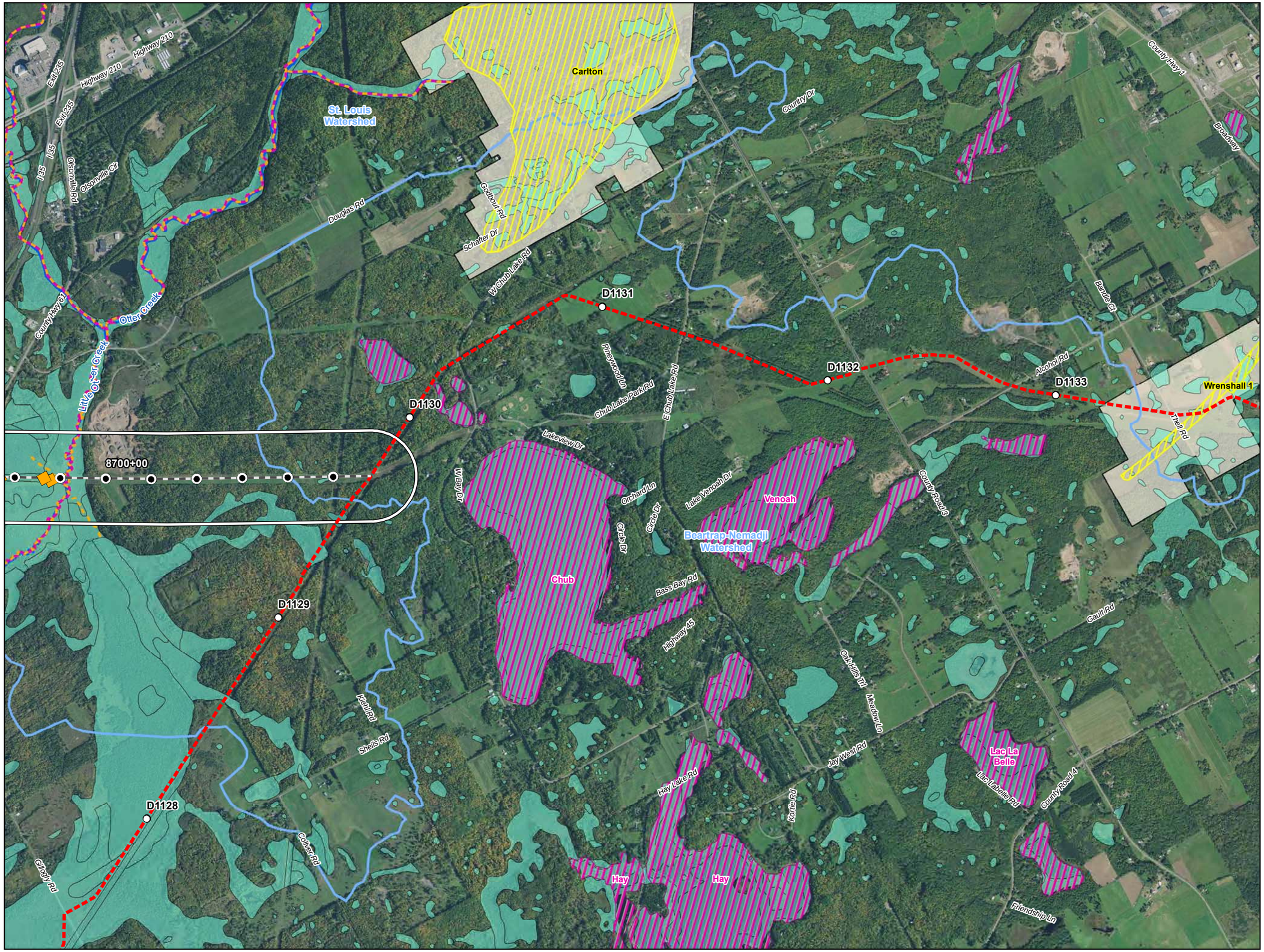
Date: (10/19/2016)





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- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 36

Line 3 Replacement Project

RA-08-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-Blandin

DRAFT

Table 1
Line 3 Replacement Project – RSA-Blandin-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	-	-	-	-	-	**<0.1**	-	**<0.1**
Aitkin	-	-	-	-	-	<0.1	-	<0.1
Grand Total [c]	-	-	-	-	-	**<0.1**	-	**<0.1**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-Blandin-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**-**	**0.2**	**-**	**0.2**	**49.1**	**137.2**	**-**	**186.3**
Aitkin	-	0.2	-	0.2	49.1	137.2	-	186.3
Grand Total [d]	**0.0**	**0.2**	**0.0**	**0.2**	**49.1**	**137.2**	**0.0**	**186.3**

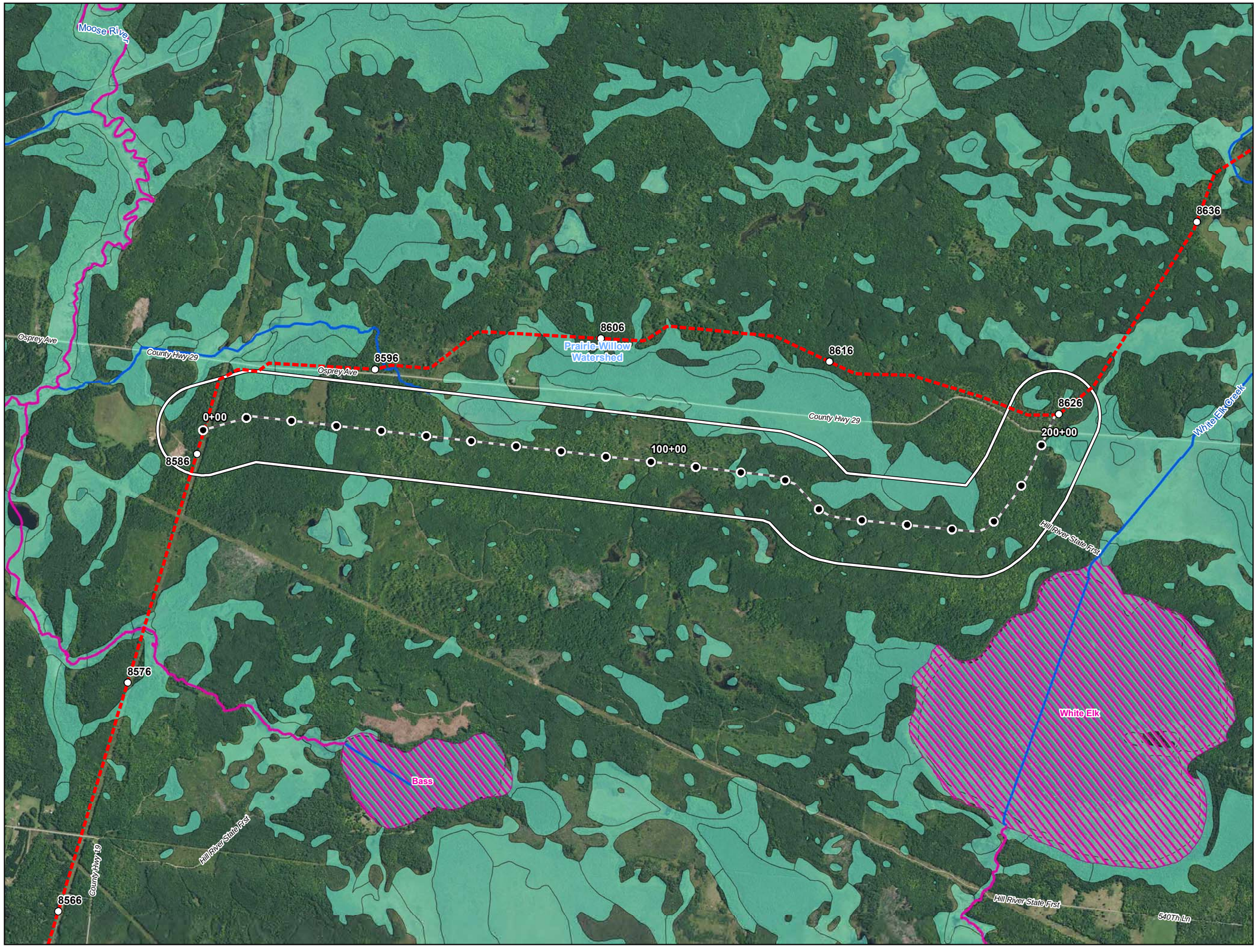
USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-Blandin-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-Blandin-L3.mxd
Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-05

DRAFT

Table 1
Line 3 Replacement Project – RSA-05-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Clearwater	**1**	**0.5**
Clearwater	1	0.5
Mississippi Headwaters	**3**	**3.2**
Clearwater	3	3.2
Grand Total [c]	**4**	**3.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-05-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Clearwater	-	**2**	**-**	**2**	-	**0.8**	**0.1**	**0.9**
Clearwater	**-**	2	-	2	**-**	0.8	0.1	0.9
Mississippi Headwaters	**1**	**4**	**-**	**5**	**1.1**	**3.5**	**0.6**	**5.1**
Clearwater	1	4	-	5	1.1	3.5	0.6	5.1
Grand Total [c]	**1**	**6**	**-**	**7**	**1.1**	**4.2**	**0.7**	**6.1**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-05-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Clearwater	**0.1**	**0.1**	**-**	**0.2**	**24.3**	**20.0**	**9.9**	**54.2**
Clearwater	0.1	**0.1**	-	**0.2**	24.3	20.0	9.9	54.2
Mississippi Headwaters	**0.5**	**0.6**	**-**	**1.0**	**111.8**	**126.9**	**2.0**	**240.6**
Clearwater	0.5	0.6	-	1.0	111.8	126.9	2.0	240.6
Grand Total [d]	**0.6**	**0.6**	**0.0**	**1.2**	**136.1**	**146.9**	**11.9**	**294.8**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RA-05-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Clearwater	**-**	**-**	**3.1**	-
Clearwater	-	-	3.1	**-**
Mississippi Headwaters	**-**	**-**	**5.5**	-
Clearwater	-	-	5.5	**-**
Grand Total [c]	**-**	**-**	**8.5**	**-**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-05-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Mississippi Headwaters	Clearwater	Domestic	845	3
			966	
			519	

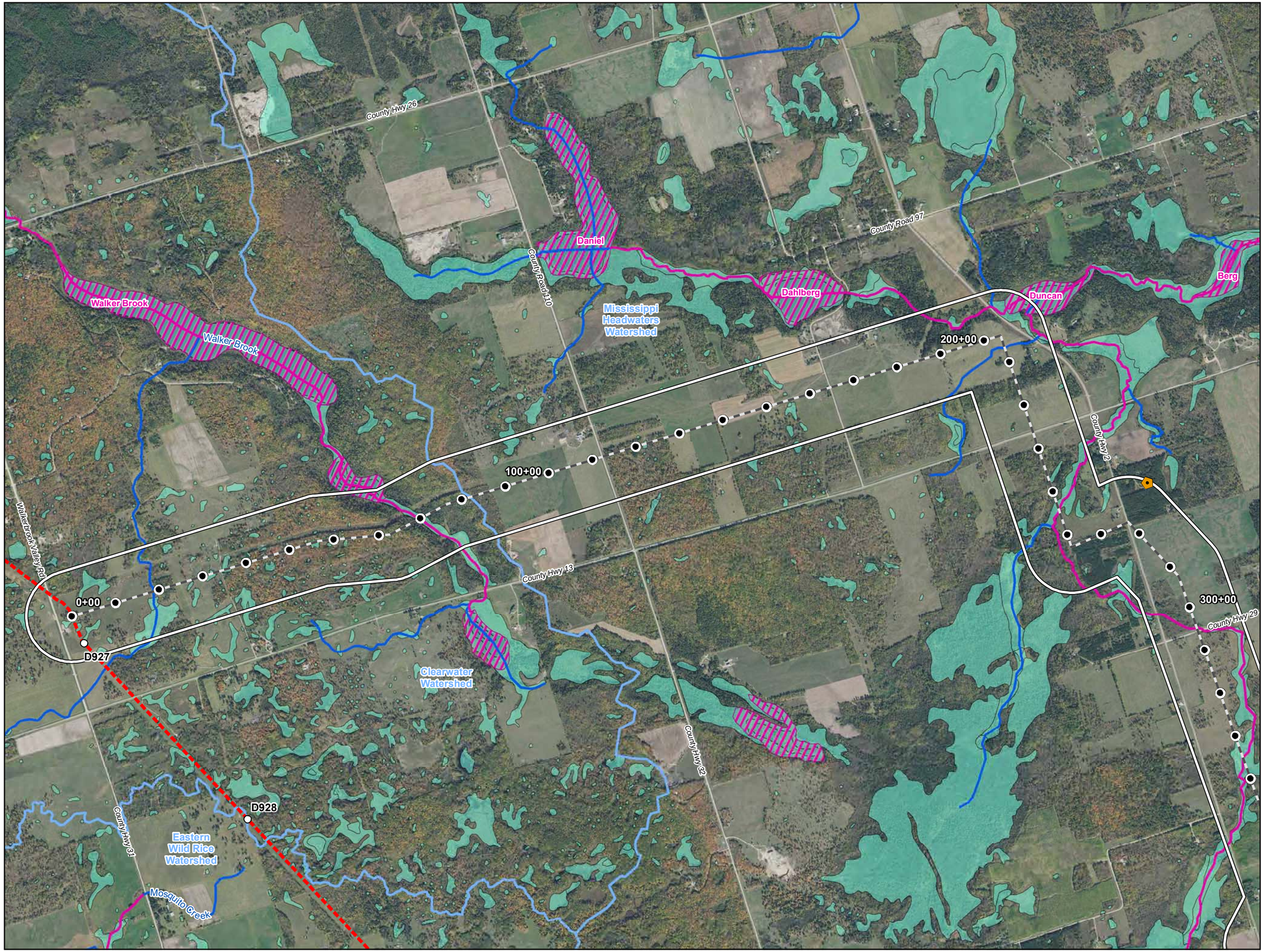
County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

a Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – RSA-05-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Mississippi Headwaters	Clearwater	General Permit Authorization	Inactive	1
		Individual Permit	Active	2

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-05-L3

Enbridge

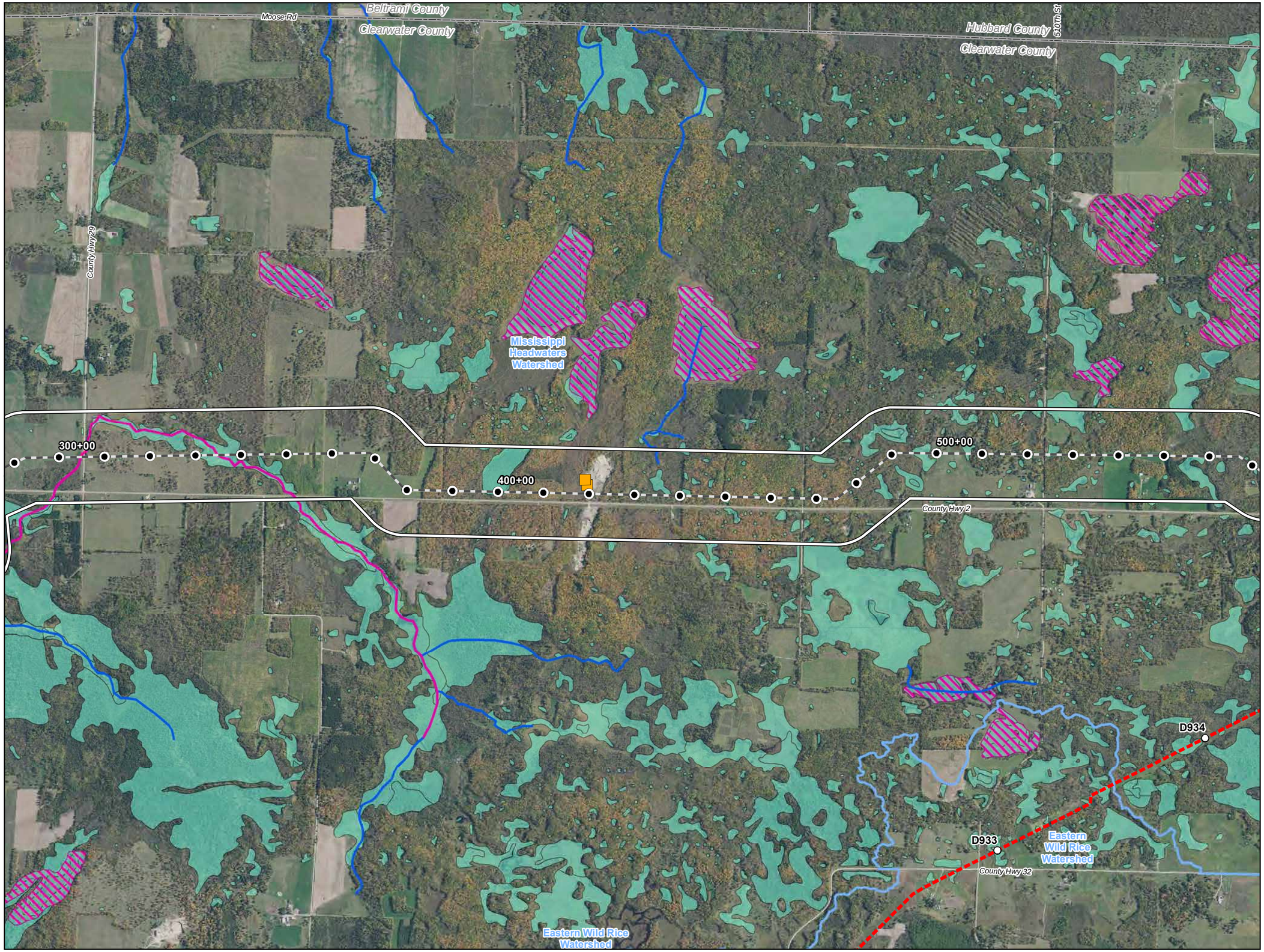
Clearwater County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line 3 Full Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-05-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
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- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-05-L3

Enbridge

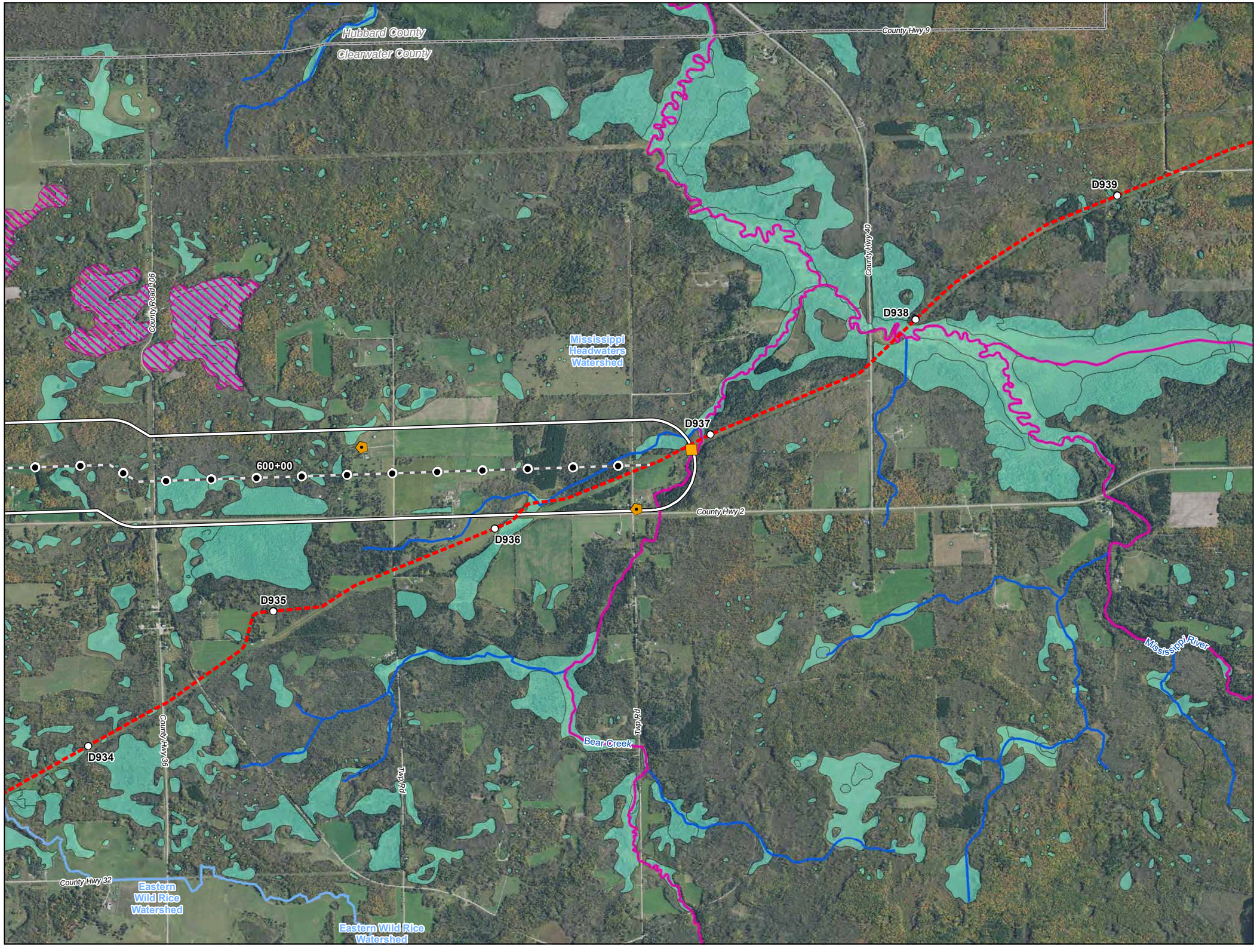
Clearwater County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line 3 Full Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-05-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N E S W

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 3

Line 3 Replacement Project

RSA-05-L3

Enbridge

Clearwater County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-05-L3.mxd
Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-10

DRAFT

Table 1
Line 3 Replacement Project – RSA-10-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Rum	**3**	**2.1**
Mille Lacs	3	2.1
Snake	**13**	**8.7**
Kanabec	8	5.9
Pine	5	2.8
Grand Total [c]	**16**	**10.8**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-10-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Snake	**9**	**3**	**8**	**20**	**6.7**	**1.6**	**3.6**	**11.9**
Pine	4	1	2	7	2.2	0.4	0.8	3.5
Kanabec	5	1	6	12	4.5	0.7	2.7	7.9
Mille Lacs	-	1	-	1	-	0.5	-	0.5
Rum	**2**	**-**	**4**	**6**	**1.2**	**0.1**	**2.5**	**3.8**
Mille Lacs	2	-	4	6	1.2	0.1	2.5	3.8
Grand Total [c]	**11**	**3**	**12**	**26**	**7.9**	**1.8**	**6.1**	**15.7**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-10-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Rum	**0.5**	**0.1**	**-**	**0.6**	**218.9**	**43.5**	**12.6**	**275.0**
Mille Lacs	0.5	0.1	-	0.6	218.9	43.5	12.6	275.0
Snake	**1.9**	**0.7**	**0.1**	**2.7**	**825.7**	**479.5**	**41.4**	**1346.6**
Mille Lacs	0.1	-	-	0.1	31.1	5.0	-	36.1
Kanabec	0.7	0.5	0.1	1.3	420.5	291.4	39.0	751.0
Pine	1.0	0.2	-	1.3	374.0	183.1	2.4	559.5
Grand Total [d]	**2.4**	**0.8**	**0.1**	**3.2**	**1044.6**	**523.0**	**54.0**	**1621.6**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-10-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Snake	**-**	**-**	**-**	**2.1**
Kanabec	-	-	-	2.1
Grand Total [c]	**-**	**-**	**-**	**2.1**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-10-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Snake	**1**	**0.4**
Pine	**1**	0.4
Grand Total [c]	**1**	**0.4**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the Route Segment Alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RSA-10-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Rum	Mille Lacs	Abandoned	505	7
			792	
			264	
			548	
			753	
			275	
			807	
		Domestic	304	10
			38	
			182	
			508	
			641	
			345	
			278	
			278	
			308	
			952	
		Monitoring	415	14
			418	
			380	
			454	
			400	
			408	
			445	
			589	
			577	
			748	
			432	
			498	
			500	
			504	
Snake	Mille Lacs	Domestic	824	3
			603	
			514	
	Kanabec	Abandoned	909	9
			114	
			253	
			271	
			203	

Snake (cont.)	Kanabec (cont.)	Abandoned (cont.)	241	9 (cont.)
			132	
			163	
			91	
		Domestic	213	98
			394	
			774	
			511	
			432	
			915	
			339	
			325	
			427	
			692	
			413	
			245	
			168	
			634	
			642	
			907	
			825	
			158	
			27	
			21	
			337	
			615	
			893	
			372	
			338	
			834	
			138	
			211	
			565	
			201	
			256	
			824	
			271	
			553	
			723	
			432	
			342	
			355	
			96	
			438	

Snake (cont.)	Kanabec (cont.)	Domestic (cont.)	271	98 (cont.)
			471	
			223	
			893	
			258	
			421	
			237	
			171	
			114	
			100	
			717	
			232	
			880	
			740	
			107	
			246	
			179	
			958	
			574	
			474	
			882	
			913	
			430	
			383	
			233	
			221	
			951	
			22	
			530	
			306	
			932	
			957	
			553	
			381	
			328	
			625	
			433	
			730	
			492	
			131	
			755	
			302	
			739	
			162	

Snake (cont.)	Kanabec (cont.)	Domestic (cont.)	366	98 (cont.)
			118	
			280	
			186	
			687	
			115	
			848	
			126	
			152	
			519	
			705	
			110	
			262	
			171	
		Irrigation	914	1
		Monitoring	199	7
			224	
			164	
			252	
			584	
			258	
			172	
		Observation	272	1
		Test Well	1	7
			178	
			4	
			407	
			623	
			952	
			57	
		Unknown	6	5
			315	
			289	
			27	
			159	
	Pine	Abandoned	448	9
			499	
			430	
			548	
			883	
			737	
			775	
			717	
			821	

Snake (cont.)	Pine (cont.)	Commercial	136	1
		Domestic	735	20
			422	
			148	
			914	
			979	
			961	
			740	
			916	
			758	
			101	
			19	
			421	
			660	
			518	
			131	
			528	
			64	
			227	
			354	
			445	
		Monitoring	889	16
			672	
			460	
			481	
			632	
			493	
			446	
			541	
			580	
			865	
			772	
			784	
			728	
			535	
			895	
			905	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

[a] Municipal wells are not included in the source data.

Table 7
Line 3 Replacement Project – RSA-10-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Route Segment Alternative Centerline [b]	Acres Within the Route Segment Alternative Corridor [c]
Rum	Mille Lacs	358+00	Bock WHPA	-	18.6
		361+00	Bock DWSMA	-	40.1
Snake	Kanabec	685+00	Ogilvie WHPA	-	32.4
		689+00	Ogilvie DWSMA	-	75.0

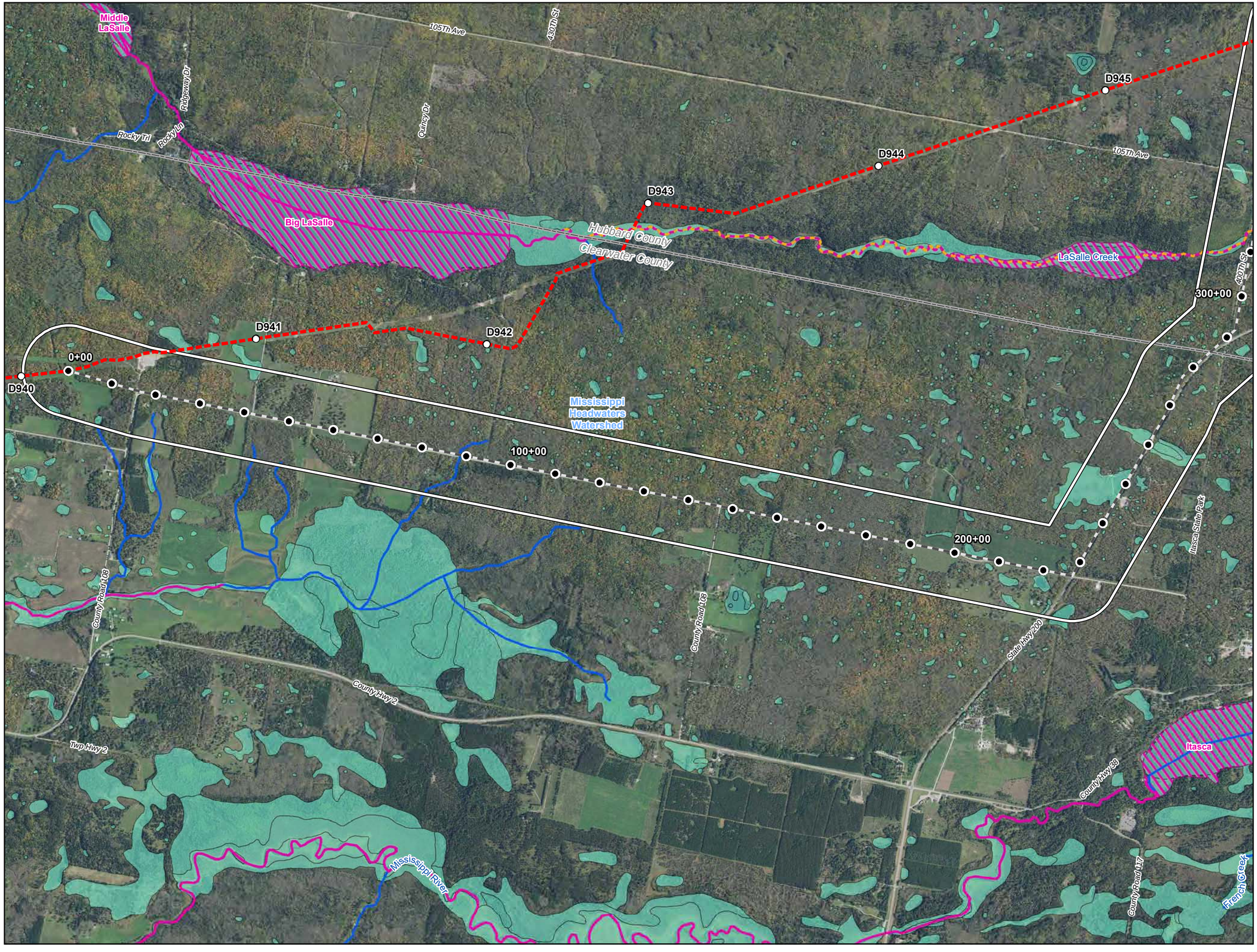
DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest Route Segment Alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the Route Segment Alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide Route Segment Alternative corridor.

Table 8
Line 3 Replacement Project – RSA-10-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Rum	Mille Lacs	Individual Permit	Inactive	1
Snake	Kanabec	Individual Permit	Active	3
	Pine	Individual Permit	Active	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-10-L3

Enbridge

Clearwater County, Minnesota

ENBRIDGE

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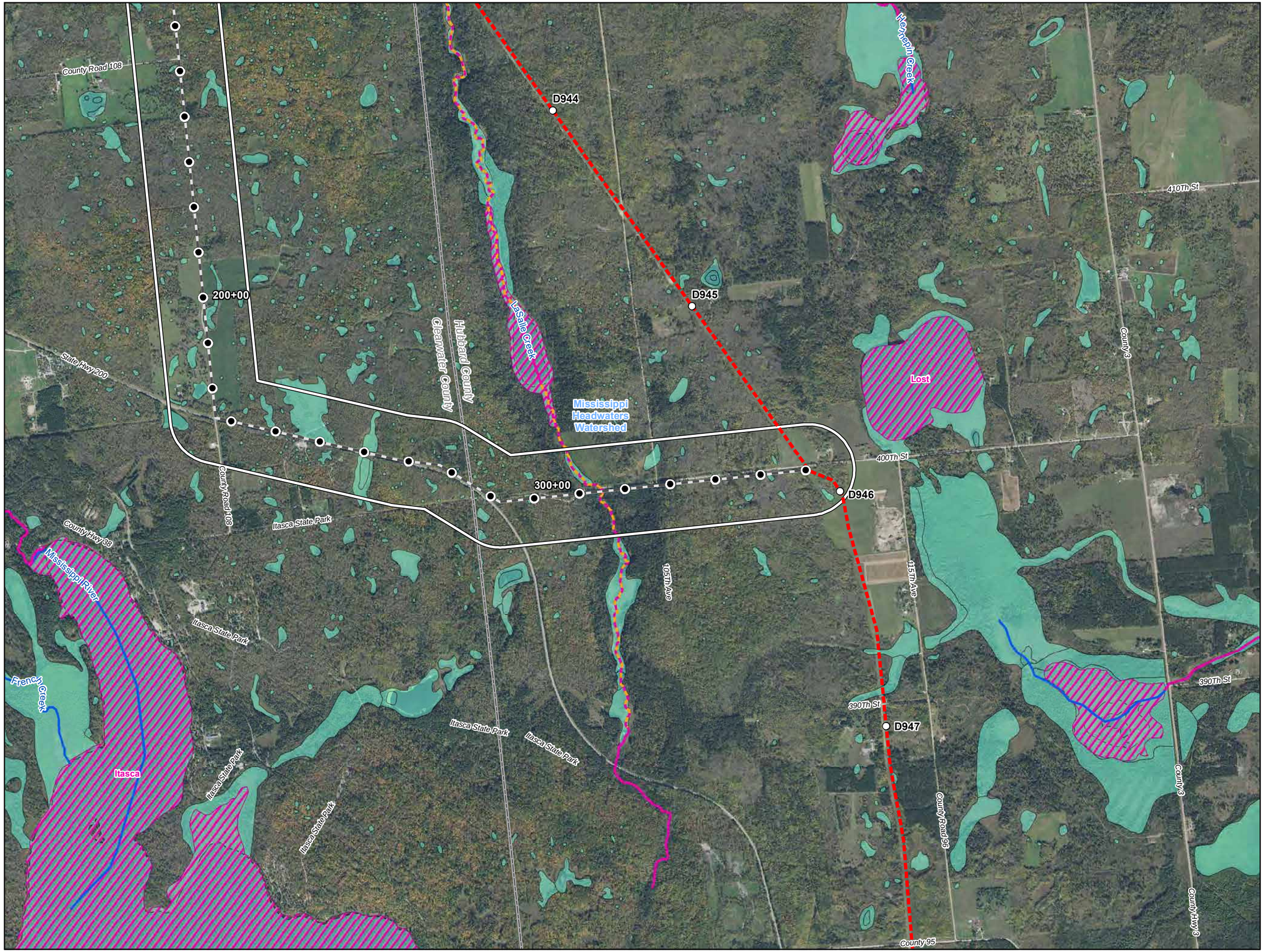
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-10-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
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- County Boundary

Figure 2

Line 3 Replacement Project

RSA-10-L3

Enbridge

Hubbard County, Minnesota

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-10-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-15

DRAFT

Table 1
Line 3 Replacement Project – RSA-15-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Crow Wing	**1**	**1.4**
Hubbard	1	1.4
Grand Total [c]	**1**	**1.4**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-15-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Crow Wing	**1**	**-**	**-**	**1**	**1.9**	**-**	**-**	**1.9**
Hubbard	1	-	-	1	1.9	-	-	1.9
Grand Total [c]	**1**	**-**	**-**	**1**	**1.9**	**-**	**-**	**1.9**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-15-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Crow Wing	**0.7**	**1.4**	**-**	**2.1**	**147.7**	**383.6**	**25.8**	**557.0**
Hubbard	0.7	1.4	-	2.1	147.7	383.6	25.8	557.0
Grand Total [d]	**0.7**	**1.4**	**-**	**2.1**	**147.7**	**383.6**	**25.8**	**557.0**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-15-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Crow Wing	**-**	**-**	**14.6**	**-**
Hubbard	-	-	14.6	-
Grand Total [c]	**-**	**-**	**14.6**	**-**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-15-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Crow Wing	Hubbard	Domestic	182	33
			46	
			474	
			468	
			437	
			881	
			301	
			667	
			205	
			104	
			216	
			147	
			101	
			386	
			909	
			301	
			309	
			900	
			278	
			281	
			3	
			246	
			209	
			313	
			112	
			721	
			475	
			401	
			238	
			371	
			459	
			176	
			329	
		Irrigation	350	3
			333	
			998	
		Monitoring	179	4
			592	
			603	
			598	

Crow Wing (cont.)	Hubbard (cont.)	Test Well	281	2
			931	
County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip [a] Municipal wells are not included in the source data.				

Table 6
Line 3 Replacement Project – RSA-15-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Crow Wing	Hubbard	Individual Permit	Active	4
			Inactive	4

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

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N W E S

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- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-15-L3

Enbridge

Hubbard County, Minnesota

ENBRIDGE

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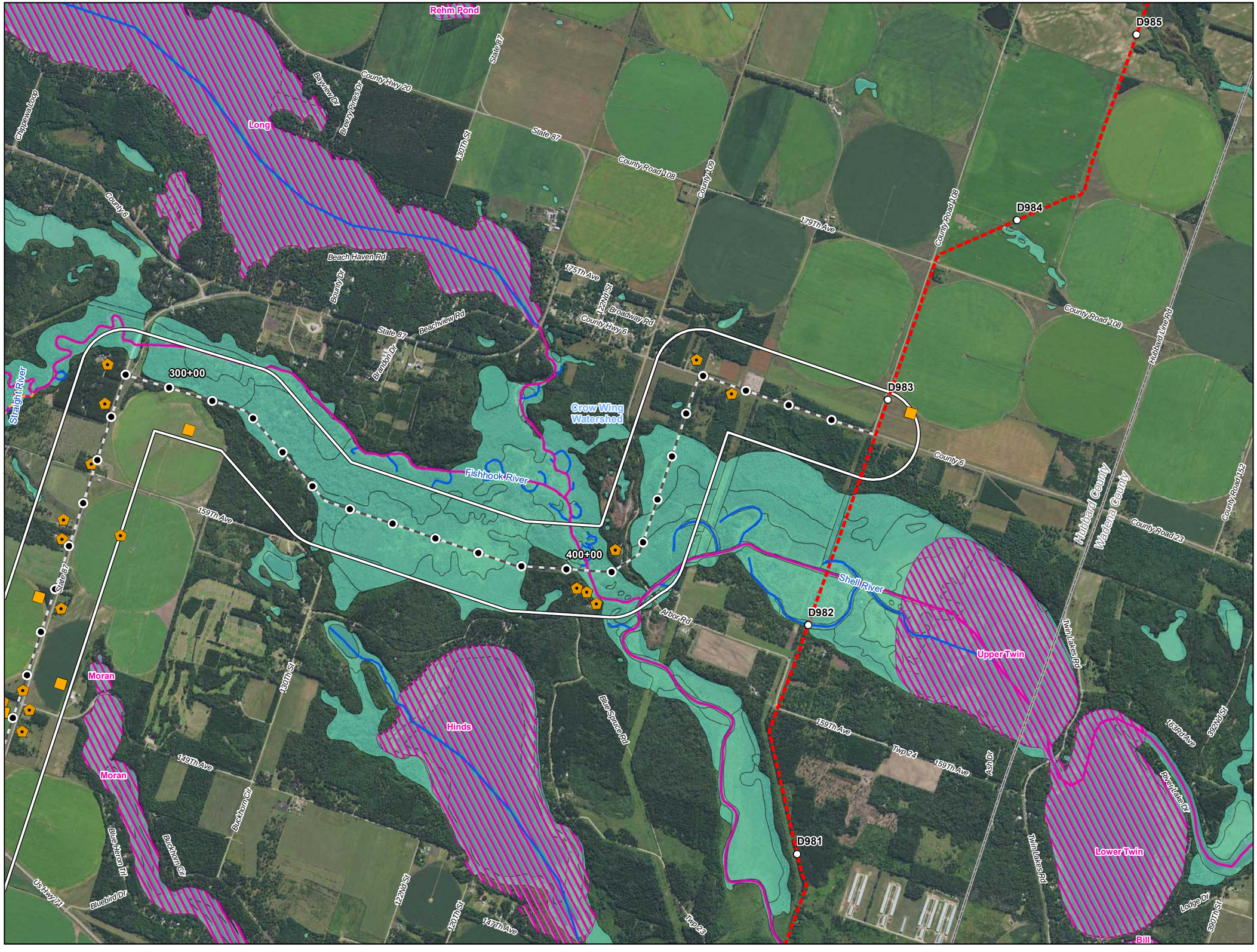
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-15-L3.mxd

Date: (10/18/2016)





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- County Boundary

Figure 2

Line 3 Replacement Project

RSA-15-L3

Enbridge

Hubbard County, Minnesota

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Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-21

DRAFT

Table 1
Line 3 Replacement Project – RSA-21-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**7**	**4.3**
Aitkin	5	3.2
St. Louis	1	0.6
Carlton	1	0.4
Grand Total [c]	**7**	**4.3**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-21-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**7**	**2**	**5**	**14**	**4.3**	**1.0**	**3.5**	**8.9**
Aitkin	5	2	4	11	3.2	1.0	2.6	6.7
St. Louis	1	-	1	2	0.6	-	1.0	1.6
Carlton	1	-	-	1	0.5	-	-	0.5
St. Louis	**1**	**1**	**9**	**11**	**0.4**	**0.5**	**8.7**	**9.5**
Aitkin	1	1	1	3	0.3	0.5	3.3	4.1
St. Louis	-	-	8	8	0.1	-	5.3	5.4
Grand Total [c]	**8**	**3**	**14**	**25**	**4.7**	**1.5**	**12.2**	**18.4**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-21-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**2.1**	**13.8**	**0.2**	**16.2**	**462.4**	**3751.0**	**53.5**	**4266.9**
Aitkin	2.0	7.1	0.2	9.3	409.8	2151.0	51.5	2612.3
St. Louis	<0.1	2.0	-	2.1	12.9	512.3	0.4	525.5
Carlton	0.1	4.7	-	4.8	39.7	1087.8	1.6	1129.1
St. Louis	-	**9.1**	**-**	**9.1**	-	**2421.3**	**2.2**	**2423.5**
Aitkin	**-**	3.8	-	3.8	**-**	1124.8	2.2	1127.0
St. Louis	-	5.3	-	5.3	-	1296.5	-	1296.5
Kettle	**-**	**2.5**	**-**	**2.5**	**1.0**	**638.9**	**-**	**639.9**
Carlton	-	2.5	-	2.5	1.0	638.9	-	639.9
Grand Total [d]	**2.1**	**25.4**	**0.2**	**27.8**	**463.4**	**6811.2**	**55.7**	**7330.3**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-21-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Prairie-Willow	**-**	**0.2**	**4.5**	**50.5**
Aitkin	**-**	0.2	-	50.5
Carlton	-	-	4.5	-
Grand Total [c]	**-**	**0.2**	**4.5**	**50.5**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-21-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**1**	**0.9**
Aitkin	**1**	0.9
Grand Total [c]	**1**	**0.9**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the proposed Route Segment Alternative centerline.

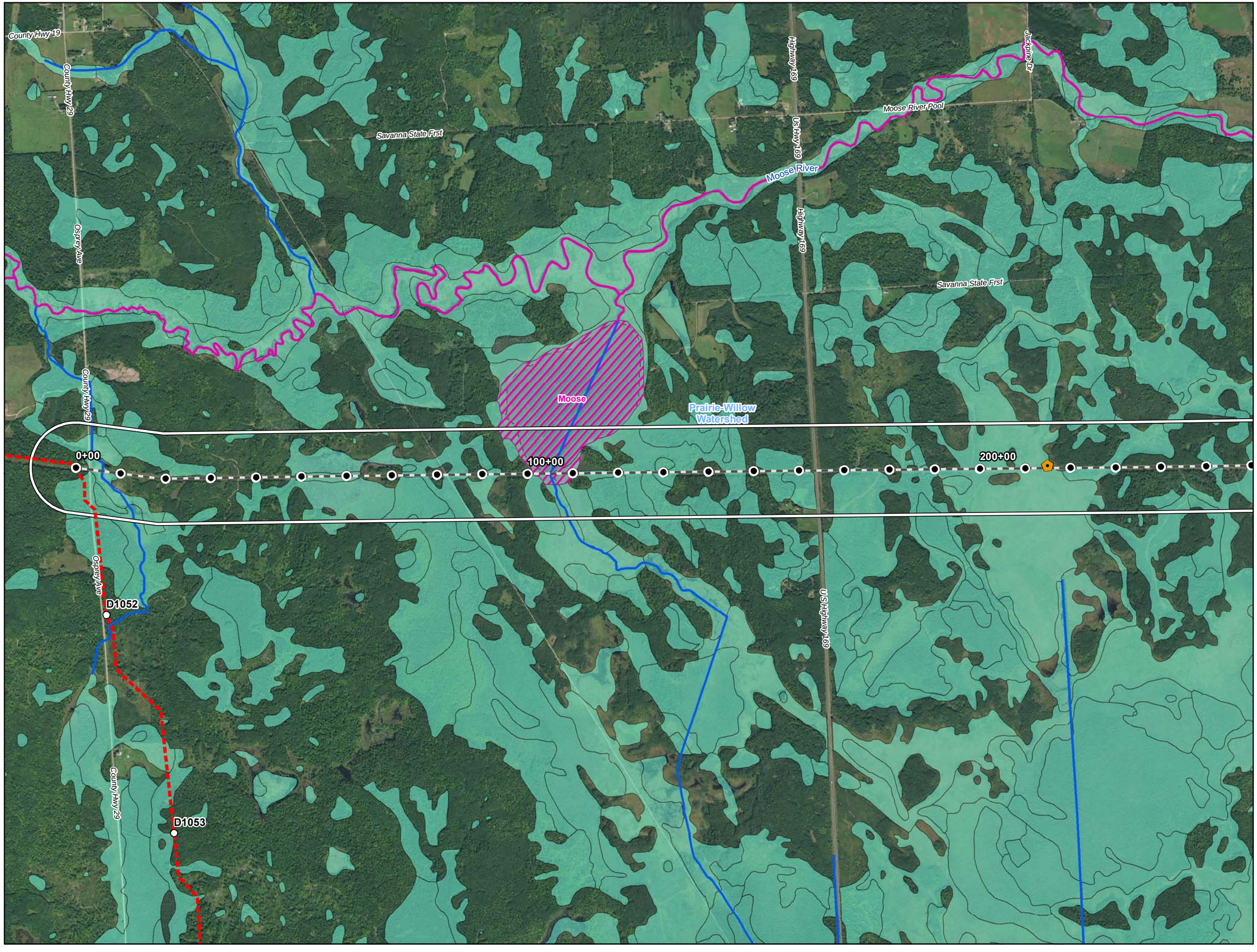
b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RSA-21-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Exploration	64	1
		Domestic	734	2
			811	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

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N W E S

- Water Well
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Figure 1

Line 3 Replacement Project

RSA-21-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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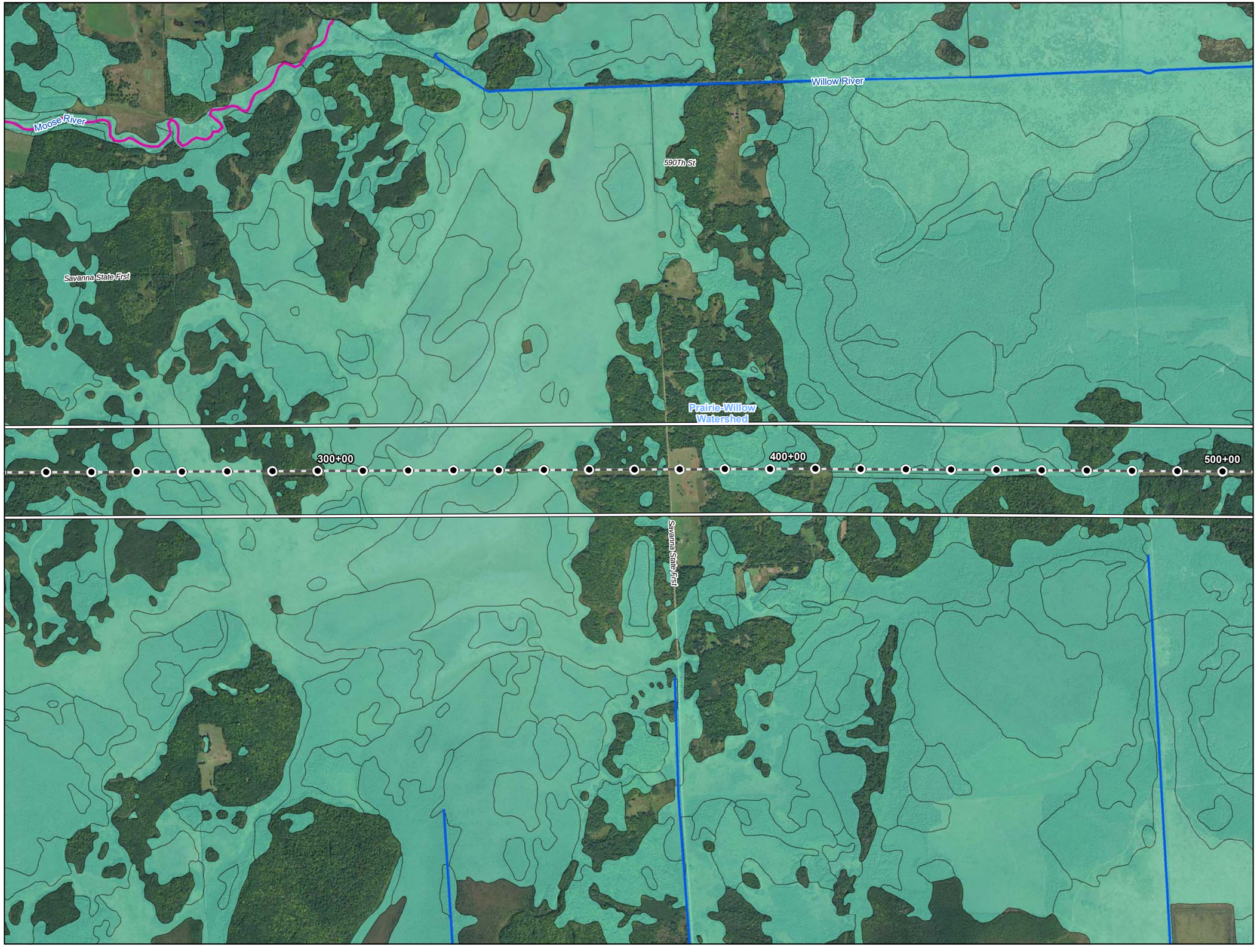



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Figure 2

Line 3 Replacement Project

RSA-21-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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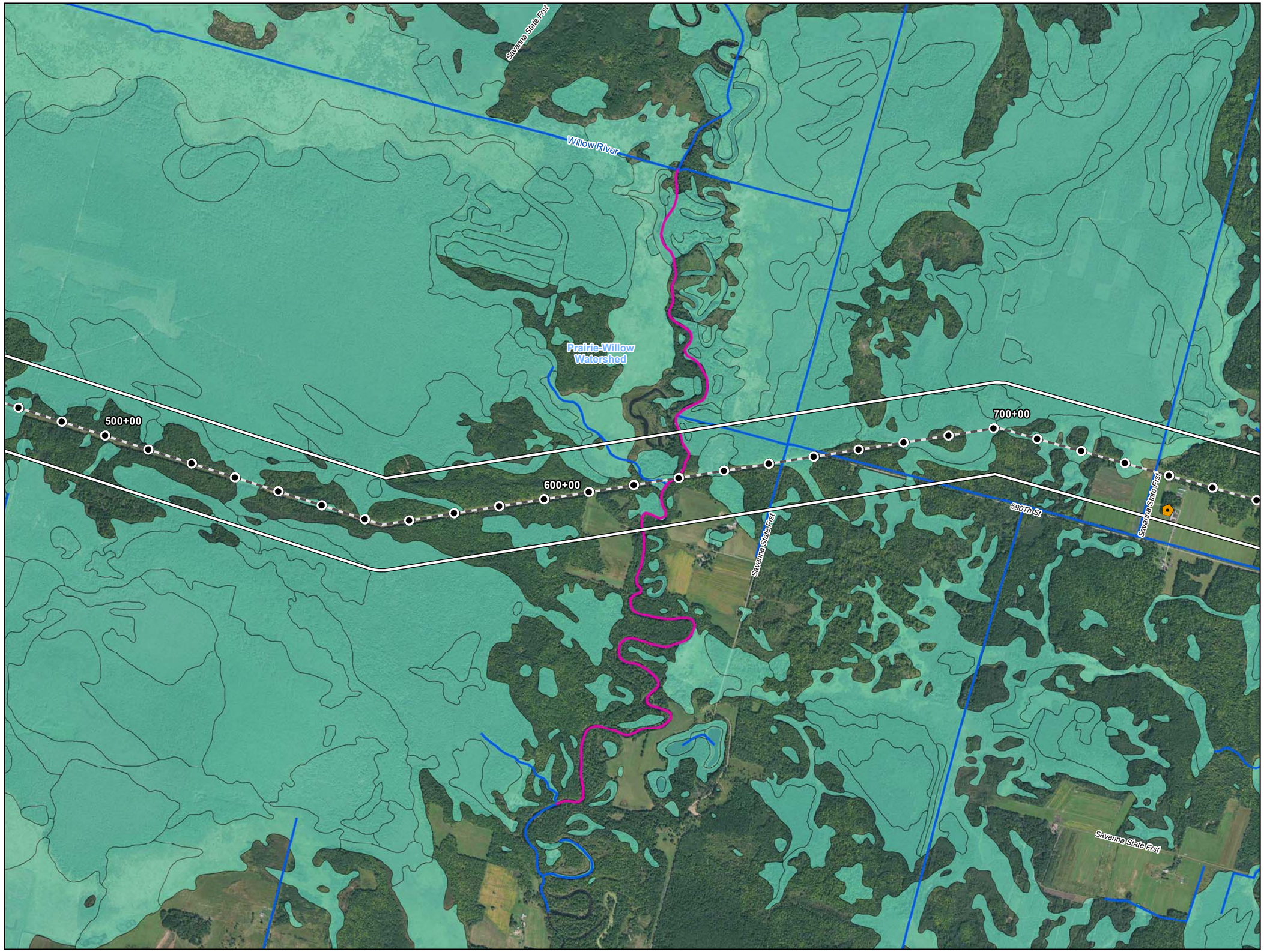



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Figure 3

Line 3 Replacement Project

RSA-21-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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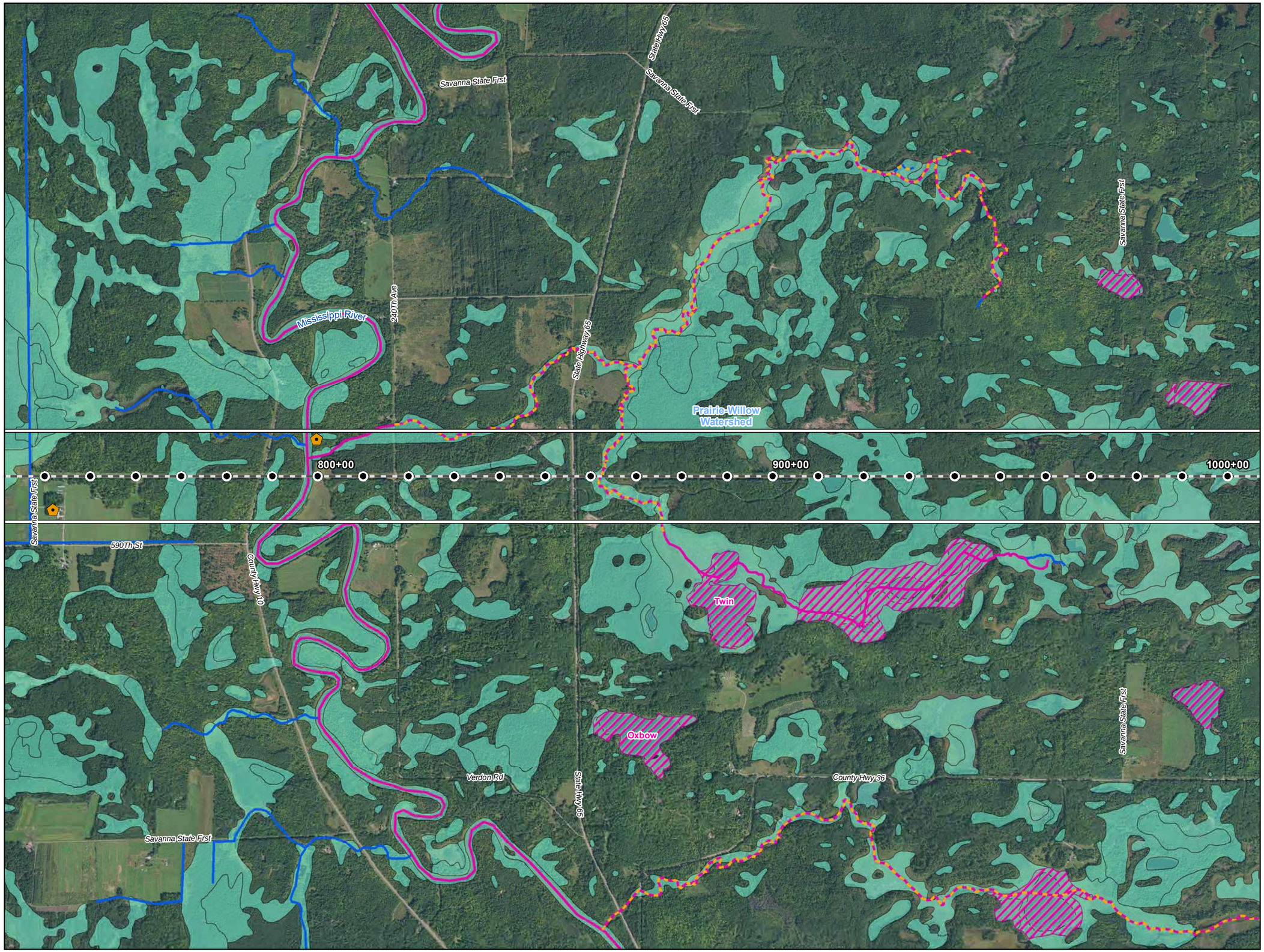



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Figure 4

Line 3 Replacement Project

RSA-21-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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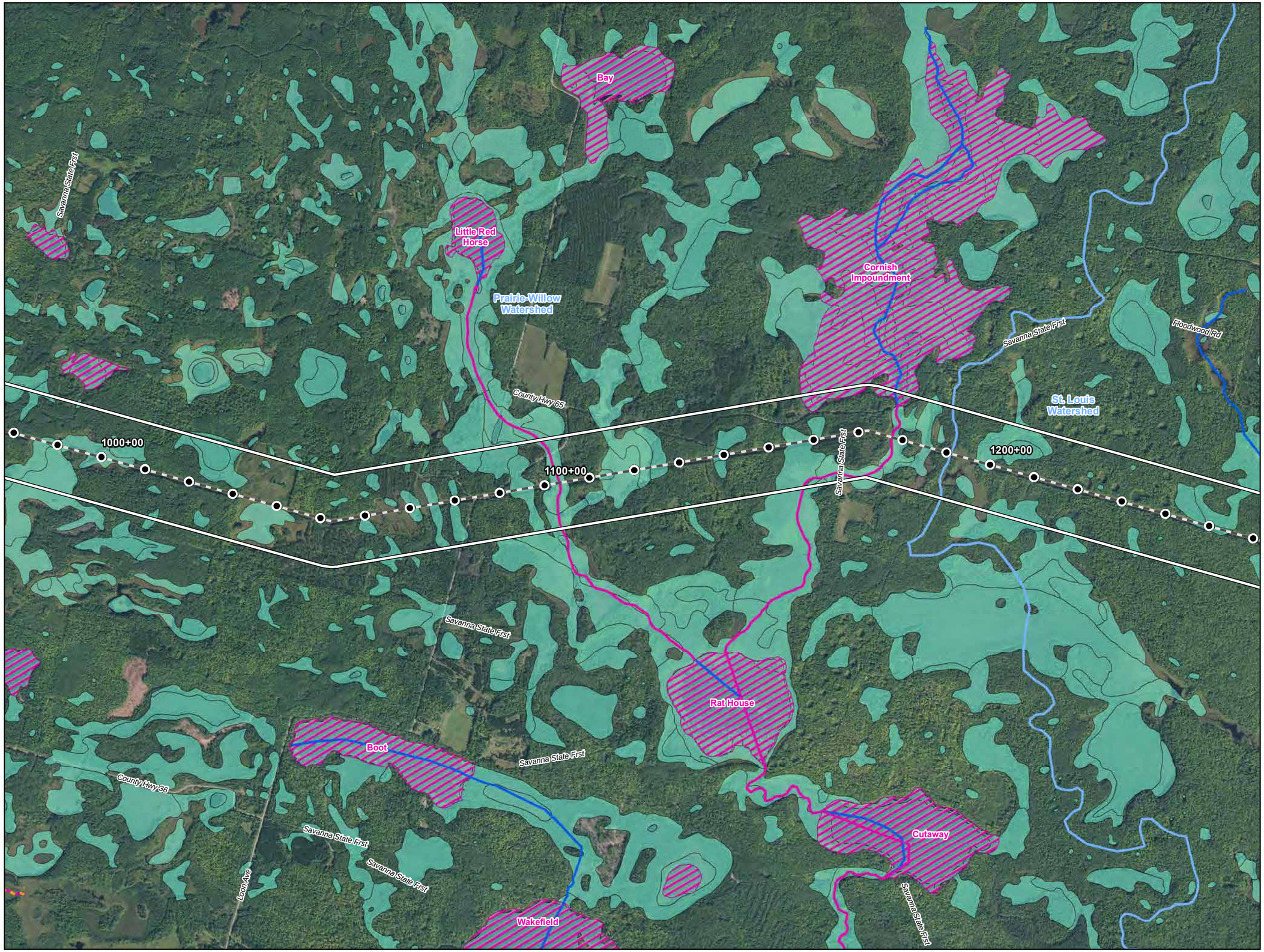



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Figure 5

Line 3 Replacement Project

RSA-21-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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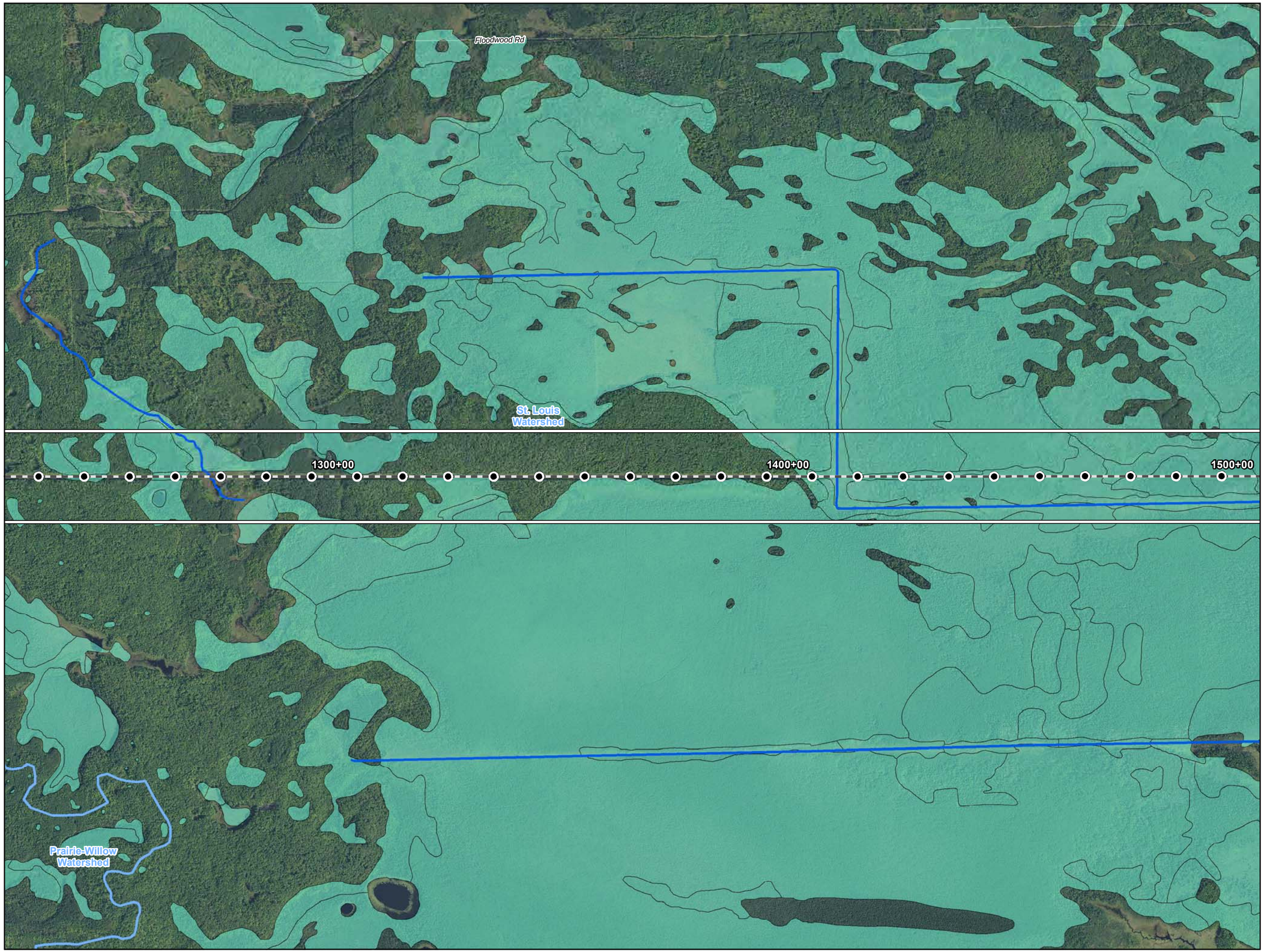



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Figure 6

Line 3 Replacement Project

RSA-21-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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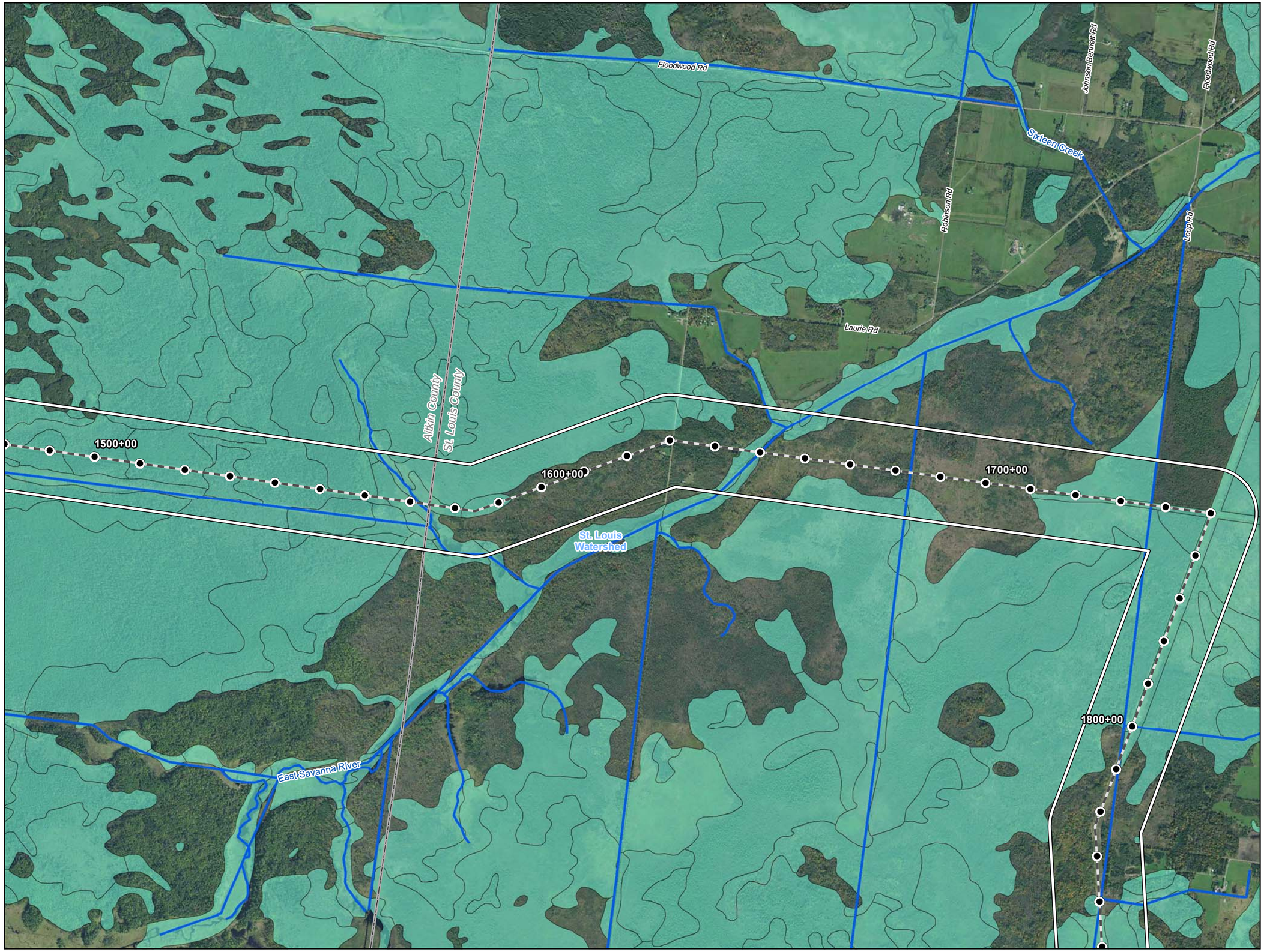



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Figure 7

Line 3 Replacement Project

RSA-21-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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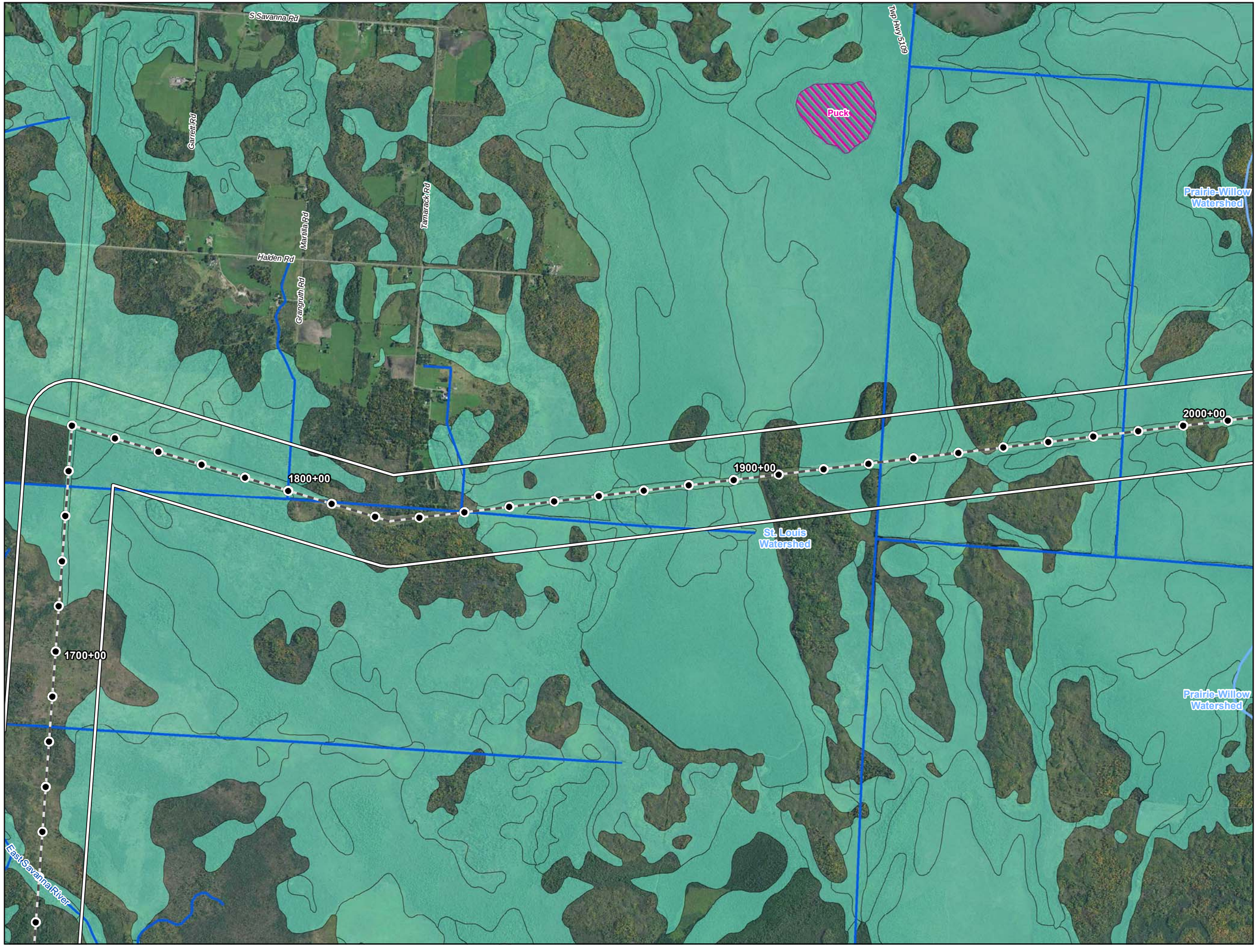



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- County Boundary

Figure 8

Line 3 Replacement Project

RSA-21-L3

Enbridge

St. Louis County, Minnesota

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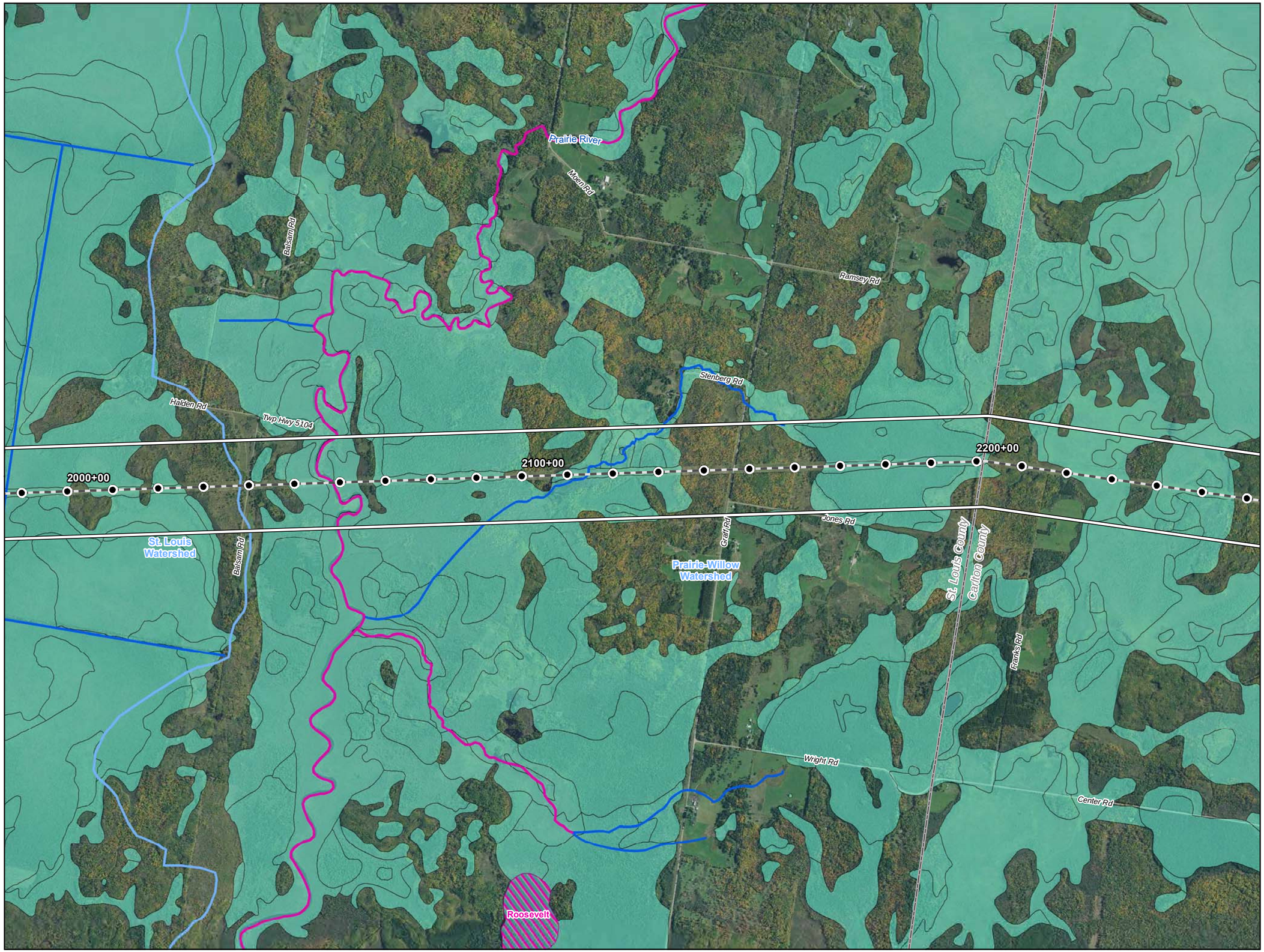



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Figure 9

Line 3 Replacement Project

RSA-21-L3

Enbridge

St. Louis County, Minnesota

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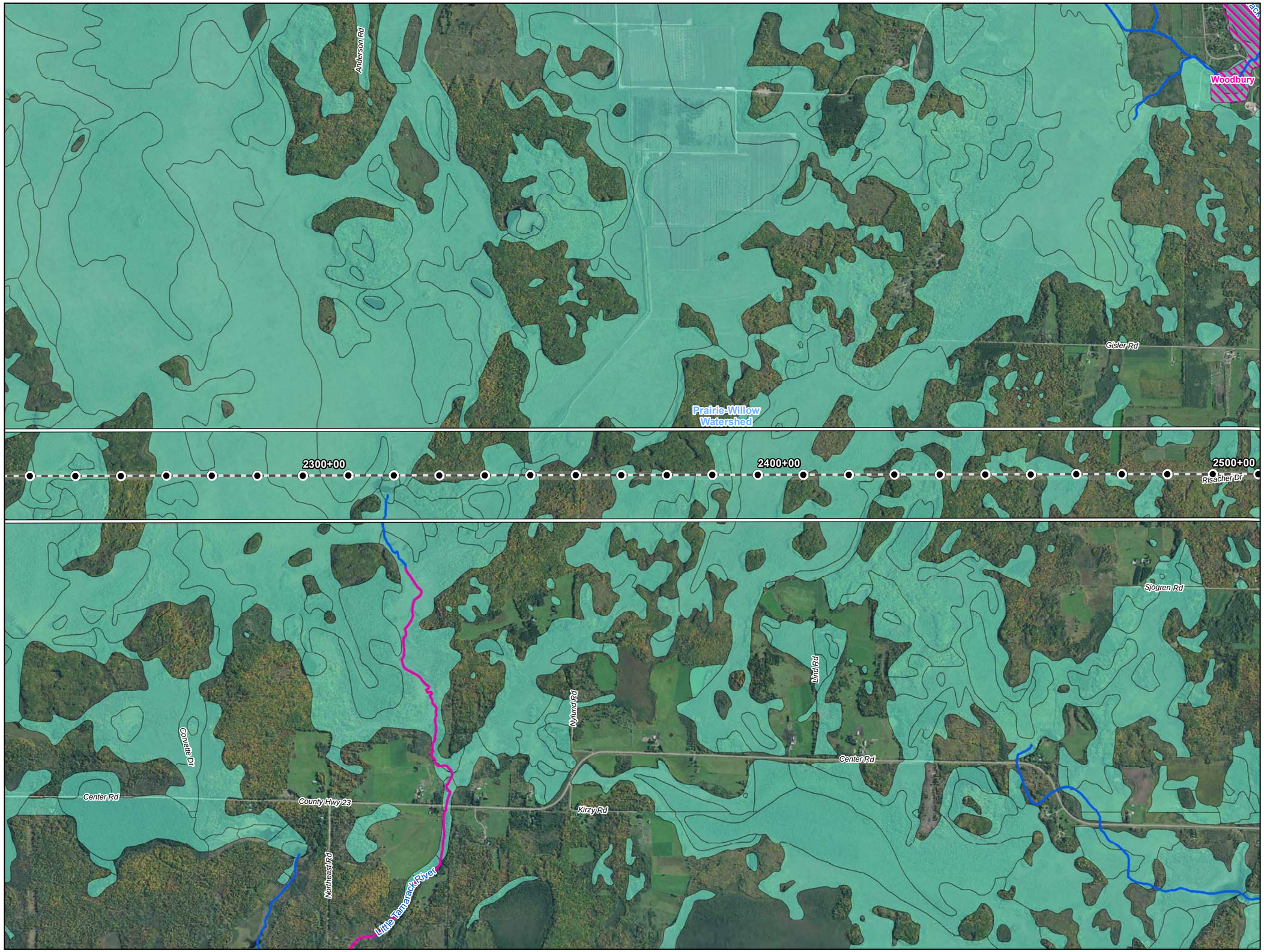

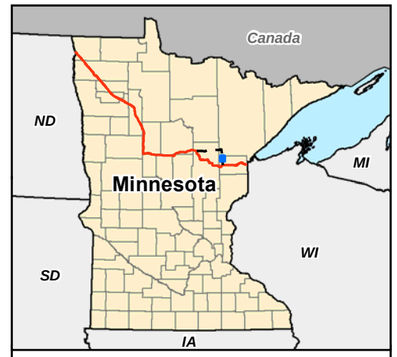

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Figure 10

Line 3 Replacement Project

RSA-21-L3

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Carlton County, Minnesota

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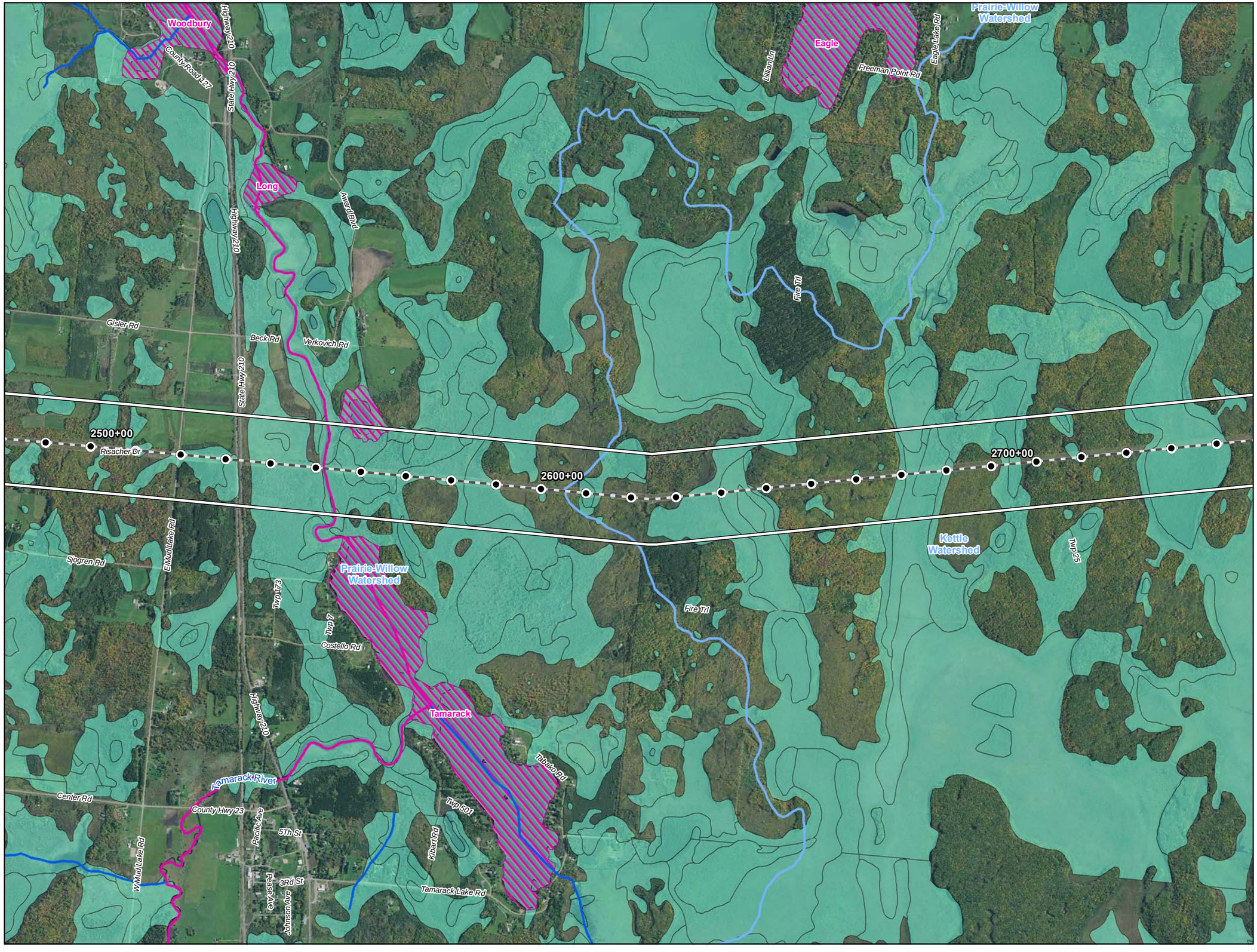



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Figure 11

Line 3 Replacement Project

RSA-21-L3

Enbridge

Carlton County, Minnesota

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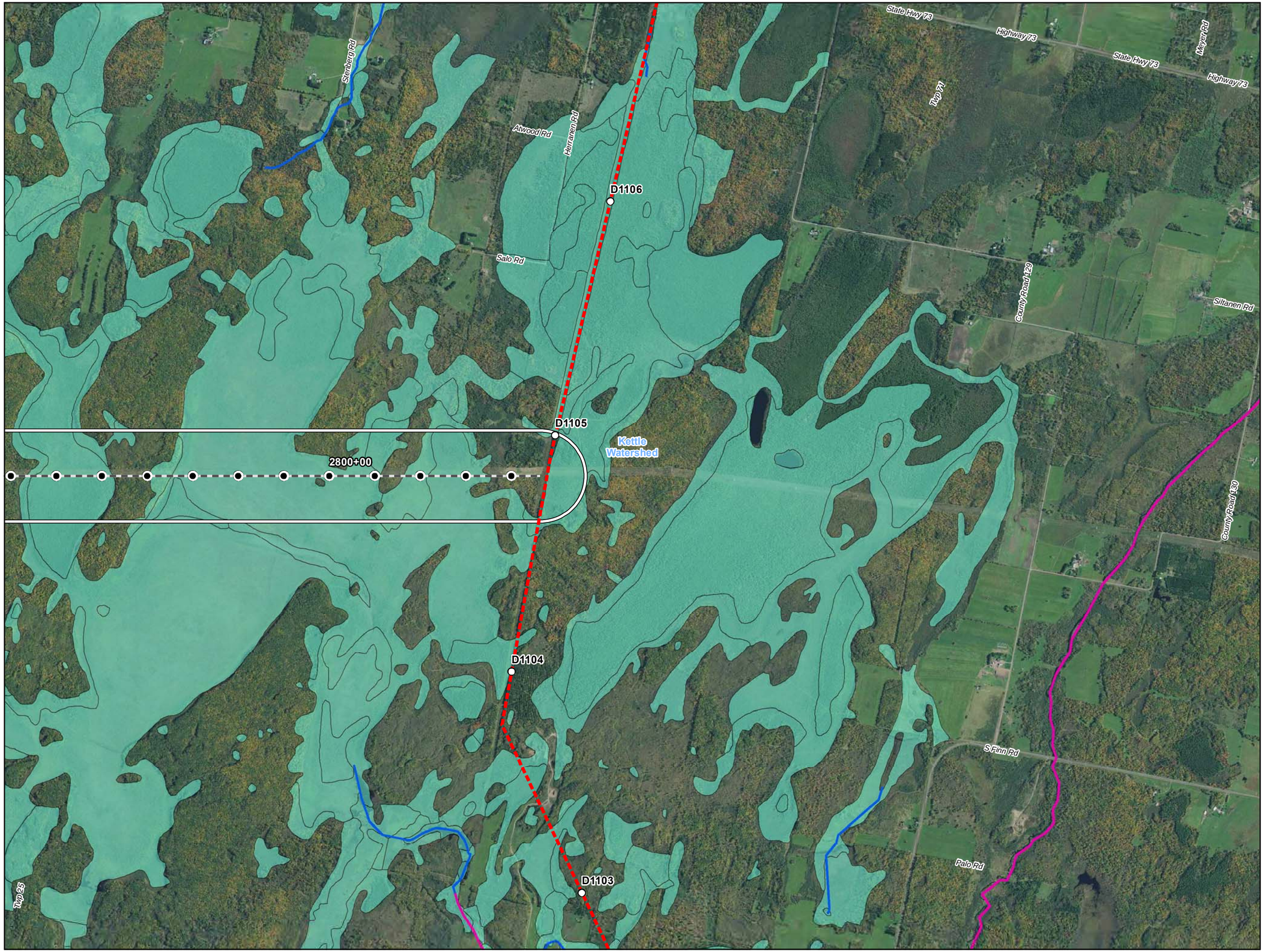



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Figure 12

Line 3 Replacement Project

RSA-21-L3

Enbridge

Carlton County, Minnesota

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ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-22

DRAFT

Table 1
Line 3 Replacement Project – RSA-22-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**5**	**3.3**
Aitkin	5	3.3
St. Louis	**5**	**2.9**
St. Louis	3	1.8
Carlton	2	1.1
Grand Total [c]	**10**	**6.2**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-22-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**5**	**2**	**4**	**11**	**3.2**	**1.0**	**2.6**	**6.8**
Aitkin	5	2	4	11	3.2	1.0	2.6	6.8
St. Louis	**10**	**1**	**8**	**19**	**5.3**	**0.8**	**6.7**	**12.8**
Aitkin	1	1	1	3	0.3	0.5	3.3	4.1
St. Louis	5	-	5	10	2.8	0.3	2.4	5.5
Carlton	4	-	2	6	2.3	-	0.9	3.2
Grand Total [c]	**15**	**3**	**12**	**30**	**8.5**	**1.8**	**9.3**	**19.6**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-22-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**2.0**	**7.1**	**0.2**	**9.4**	**410.5**	**2152.5**	**51.4**	**2614.4**
Aitkin	2.0	7.1	0.2	9.4	410.5	2152.5	51.4	2614.4
St. Louis	**0.8**	**17.8**	**0.2**	**18.8**	**152.7**	**4504.7**	**21.8**	**4679.2**
Aitkin	-	3.9	-	3.9	-	1126.1	2.2	1128.3
St. Louis	0.1	8.5	-	8.6	41.6	2008.8	3.9	2054.3
Carlton	0.7	5.5	0.2	6.3	111.1	1369.9	15.7	1496.6
Kettle	**0.4**	**0.2**	**<0.1**	**0.6**	**48.9**	**70.2**	**1.4**	**120.5**
Carlton	0.4	0.2	<0.1	0.6	48.9	70.2	1.4	120.5
Beartrap-Nemadji	-	-	**<0.1**	**0.0**	-	**0.3**	**0.9**	**1.3**
Carlton	-	-	<0.1	0.0	-	0.3	0.9	1.3
Grand Total [d]	**3.3**	**25.1**	**0.4**	**28.8**	**612.1**	**6727.7**	**75.5**	**7415.3**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-22-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Proposed Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Prairie-Willow	-	**0.2**	-	**50.5**
Aitkin	-	0.2	-	50.5
Grand Total [c]	-	**0.2**	-	**50.5**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the proposed Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-22-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**1**	**0.9**
Aitkin	1	0.9
St. Louis	**1**	**1.3**
Carlton	1	1.3
Grand Total [c]	**2**	**2.2**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
Line 3 Replacement Project – RSA-22-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

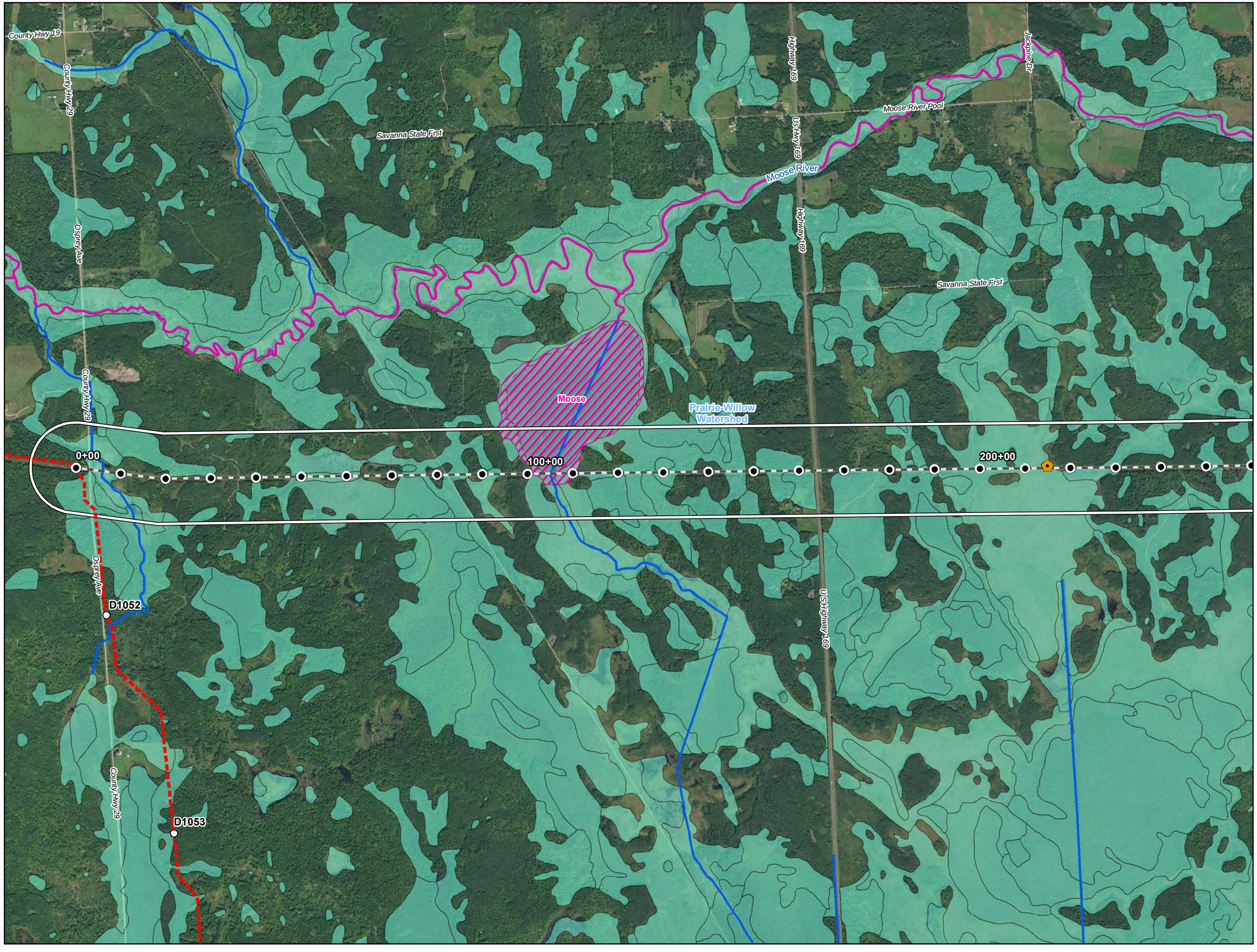
Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Domestic	734	2
			811	
		Exploration	64	1
St. Louis	St. Louis	Monitoring	56	5
			108	
			388	
			274	
			386	
	Carlton	Domestic	4	18
			732	
			985	
			904	
			634	
			609	
			515	
			94	
			561	
			293	
			435	
			21	
			892	
			655	
			576	
			254	
			147	
			35	
		Monitoring	752	4
			693	
			747	
			841	
		Other	56	3
			54	
			54	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.

Table 7
Line 3 Replacement Project – RSA-22-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
St. Louis	St. Louis	General Permit Authorization	Inactive	10
		Individual Permit	Inactive	1
	Carlton	General Permit Authorization	Inactive	11
		Individual Permit	Inactive	3
Kettle	Carlton	General Permit Authorization	Inactive	1
St. Louis	Carlton	General Permit Authorization	Active	4
			Inactive	3
		Individual Permit	Inactive	2

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

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Figure 1

Line 3 Replacement Project

RSA-22-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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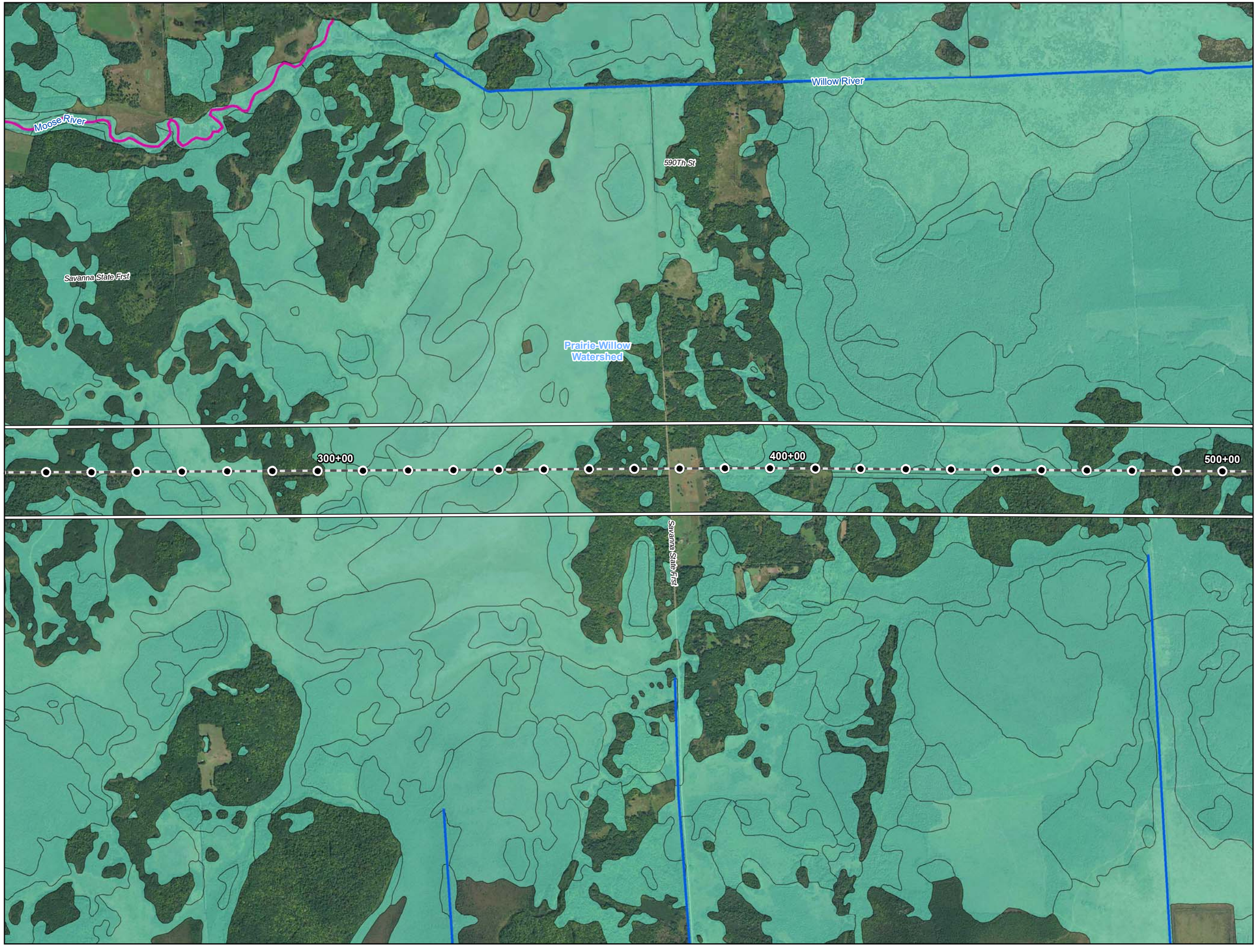



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Figure 2

Line 3 Replacement Project

RSA-22-L3

Enbridge

Aitkin County, Minnesota

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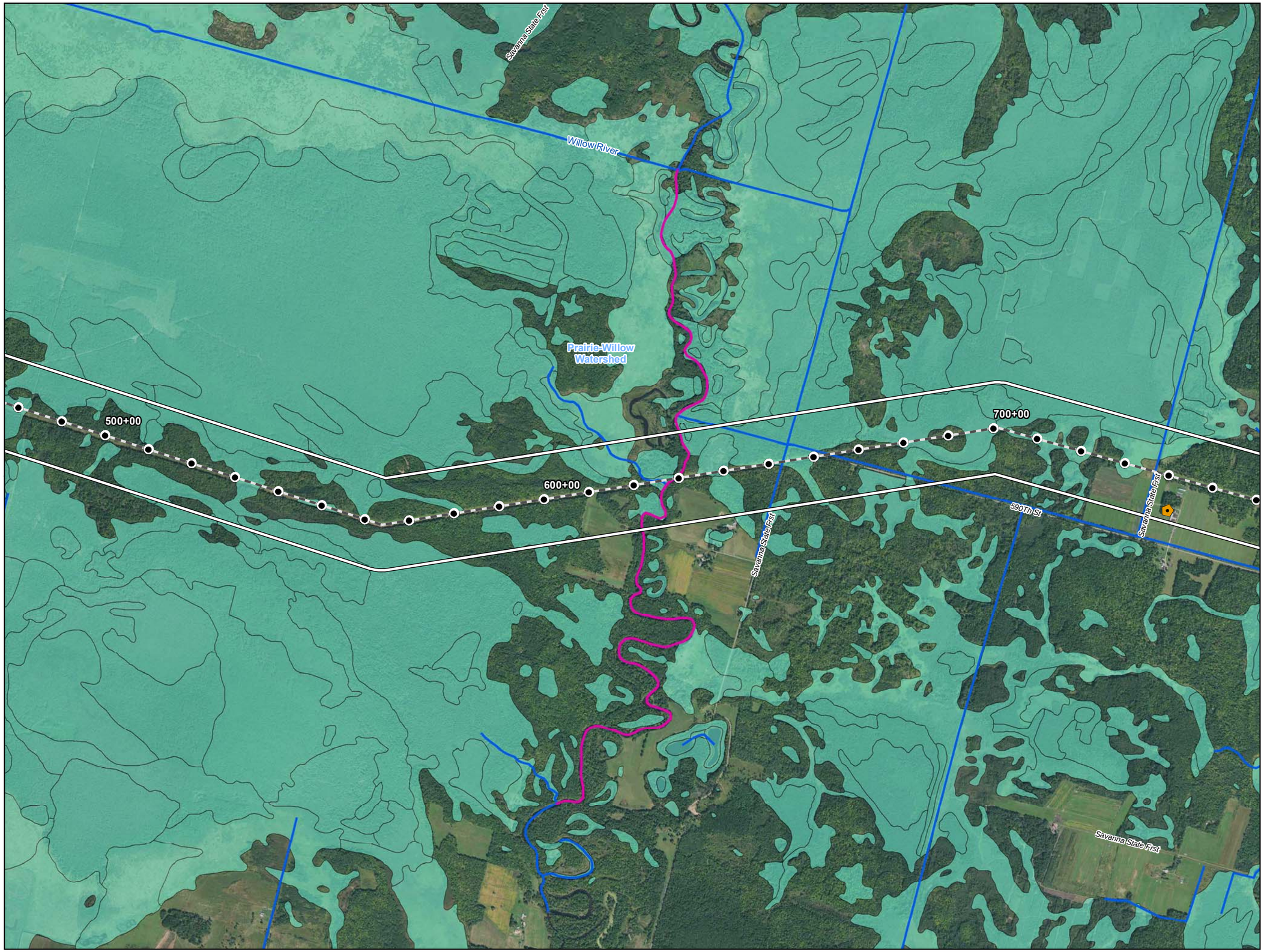



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Figure 3

Line 3 Replacement Project

RSA-22-L3

Enbridge

Aitkin County, Minnesota

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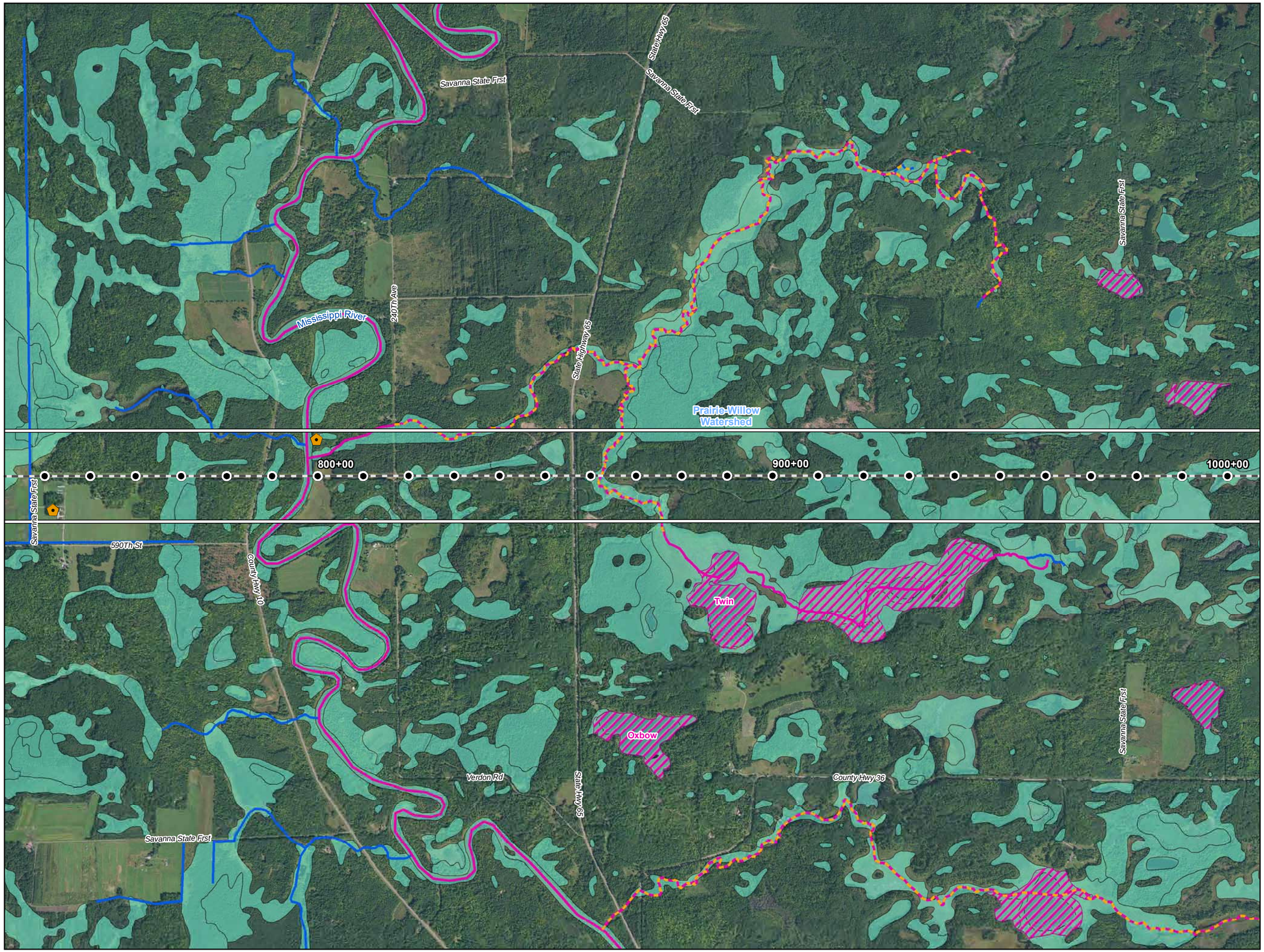



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Figure 4

Line 3 Replacement Project

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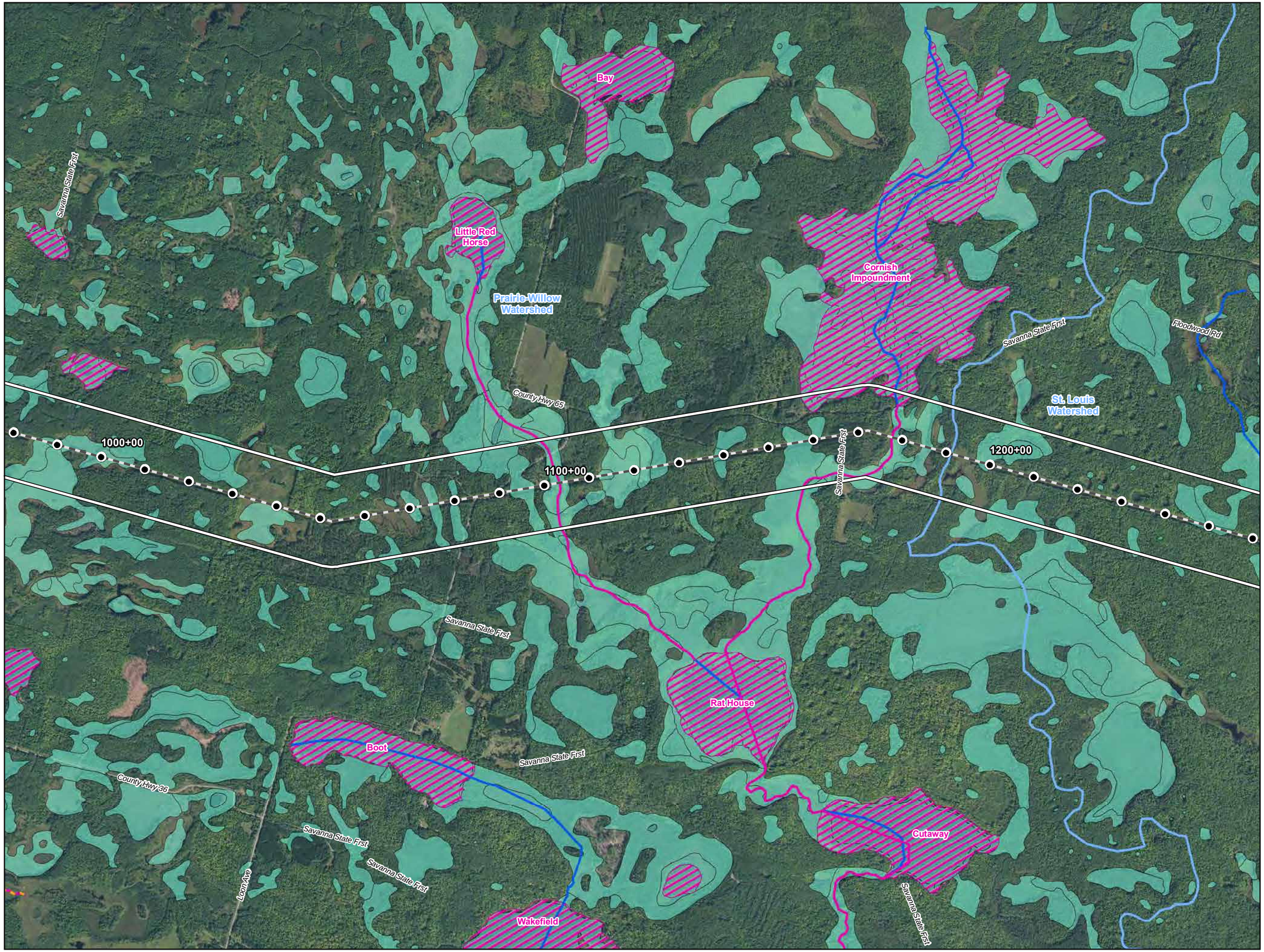



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Line 3 Replacement Project

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Enbridge

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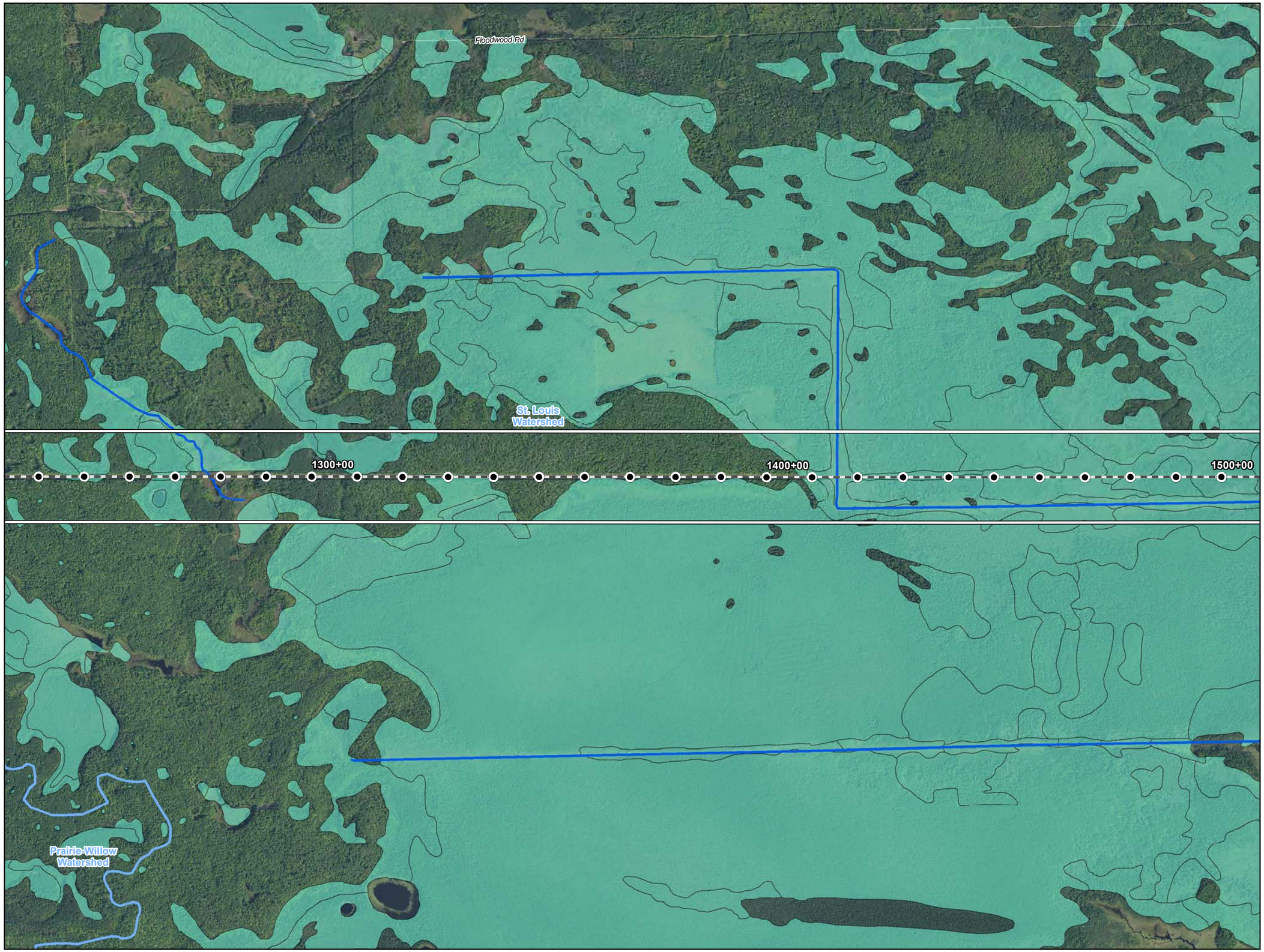



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Figure 6

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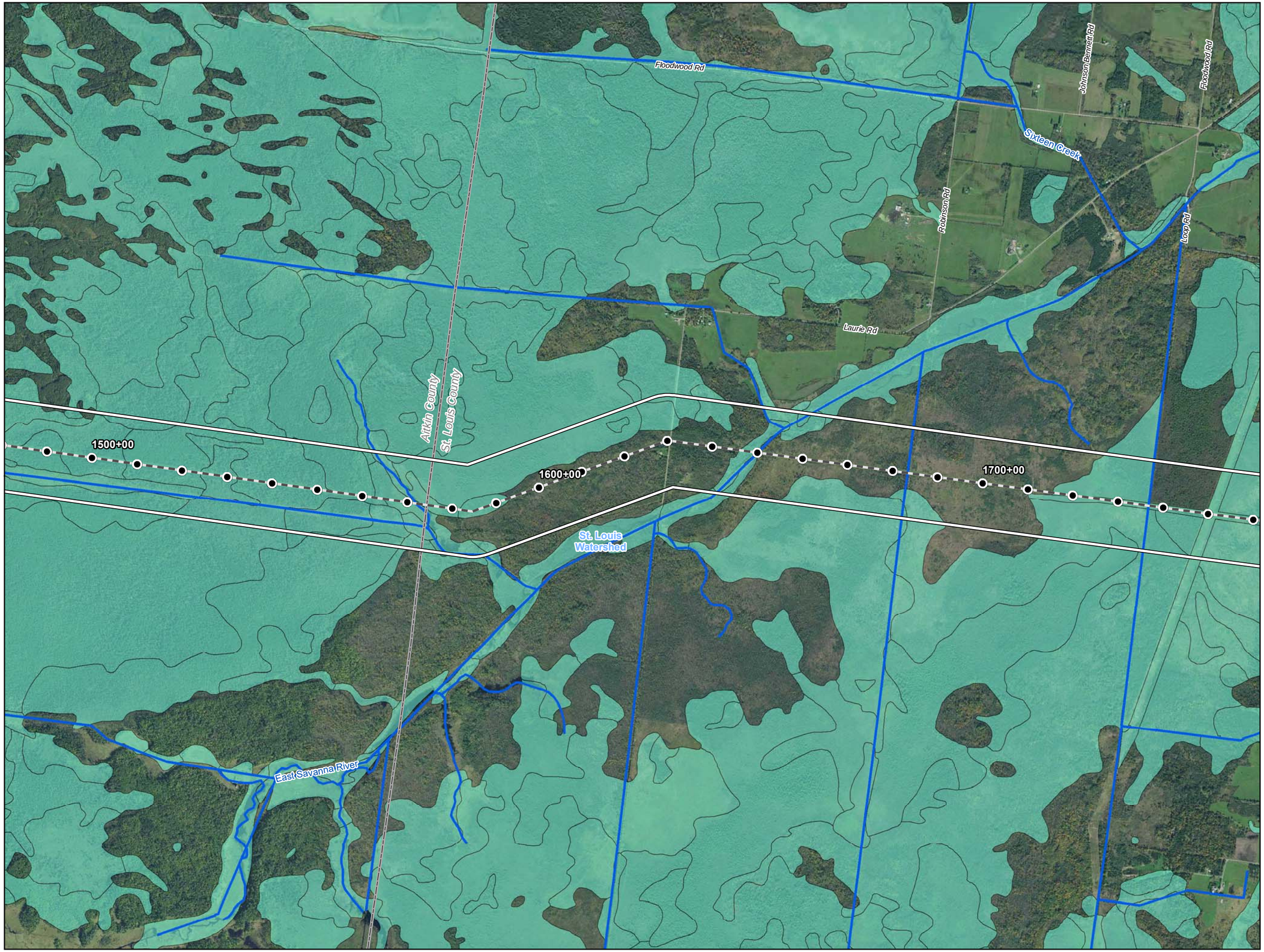



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Figure 7

Line 3 Replacement Project

RSA-22-L3

Enbridge

St. Louis County, Minnesota

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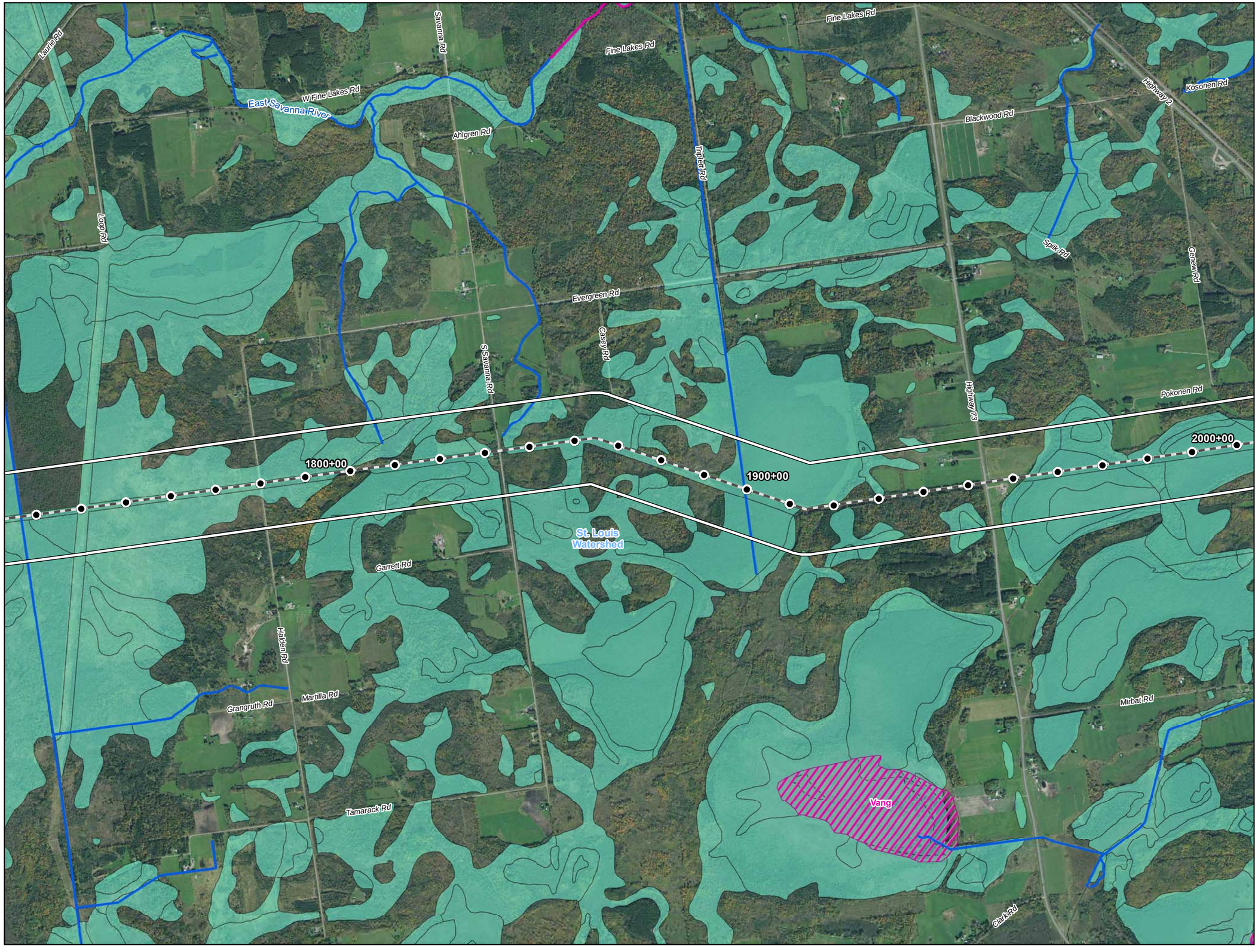

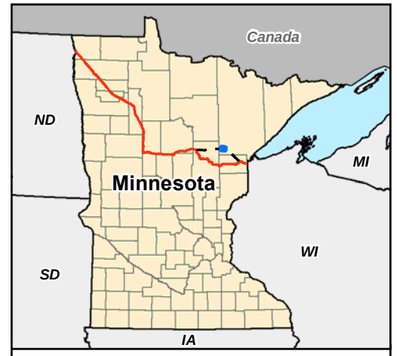

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Figure 8

Line 3 Replacement Project

RSA-22-L3

Enbridge

St. Louis County, Minnesota

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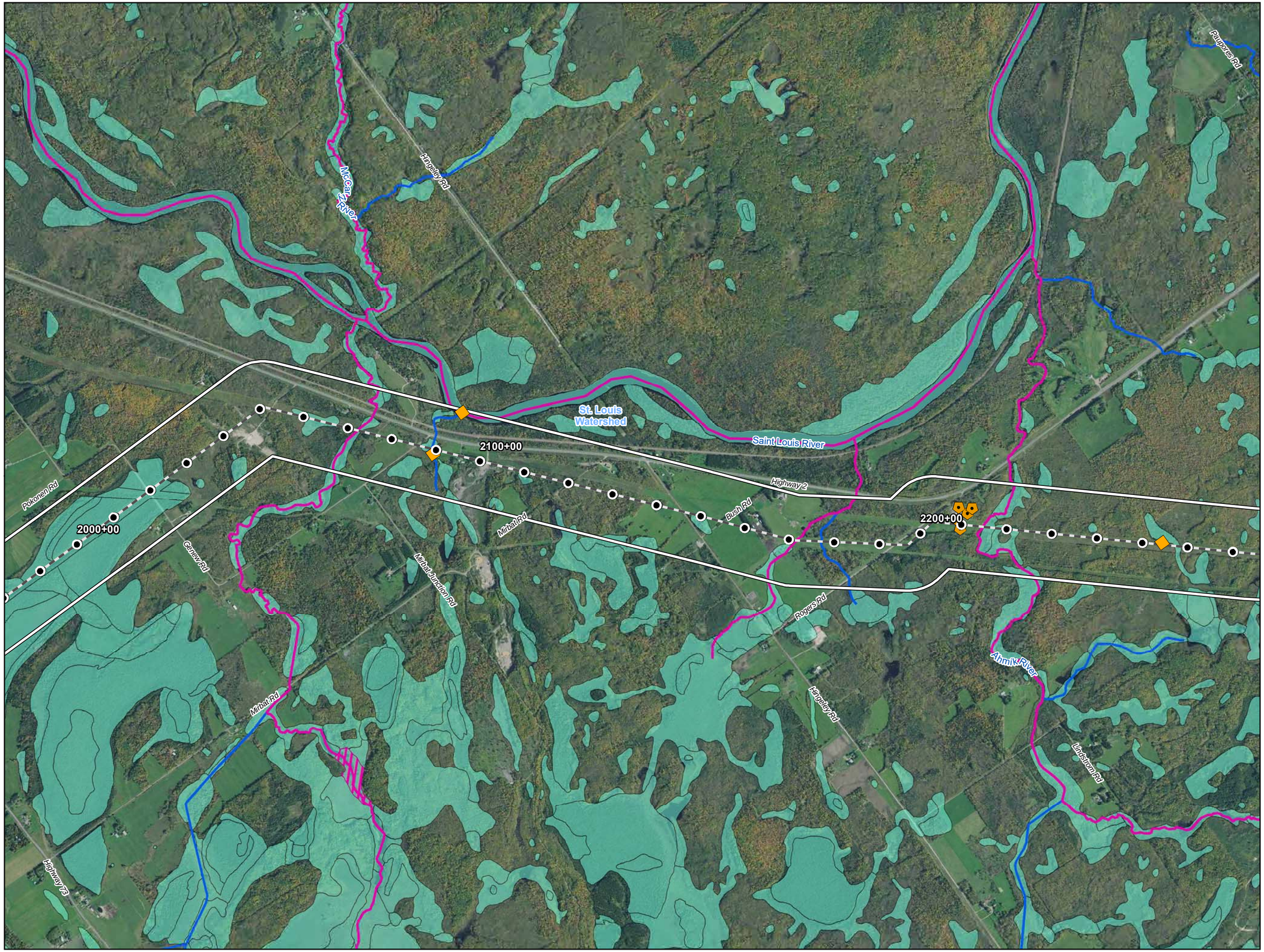



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Figure 9

Line 3 Replacement Project

RSA-22-L3

Enbridge

St. Louis County, Minnesota

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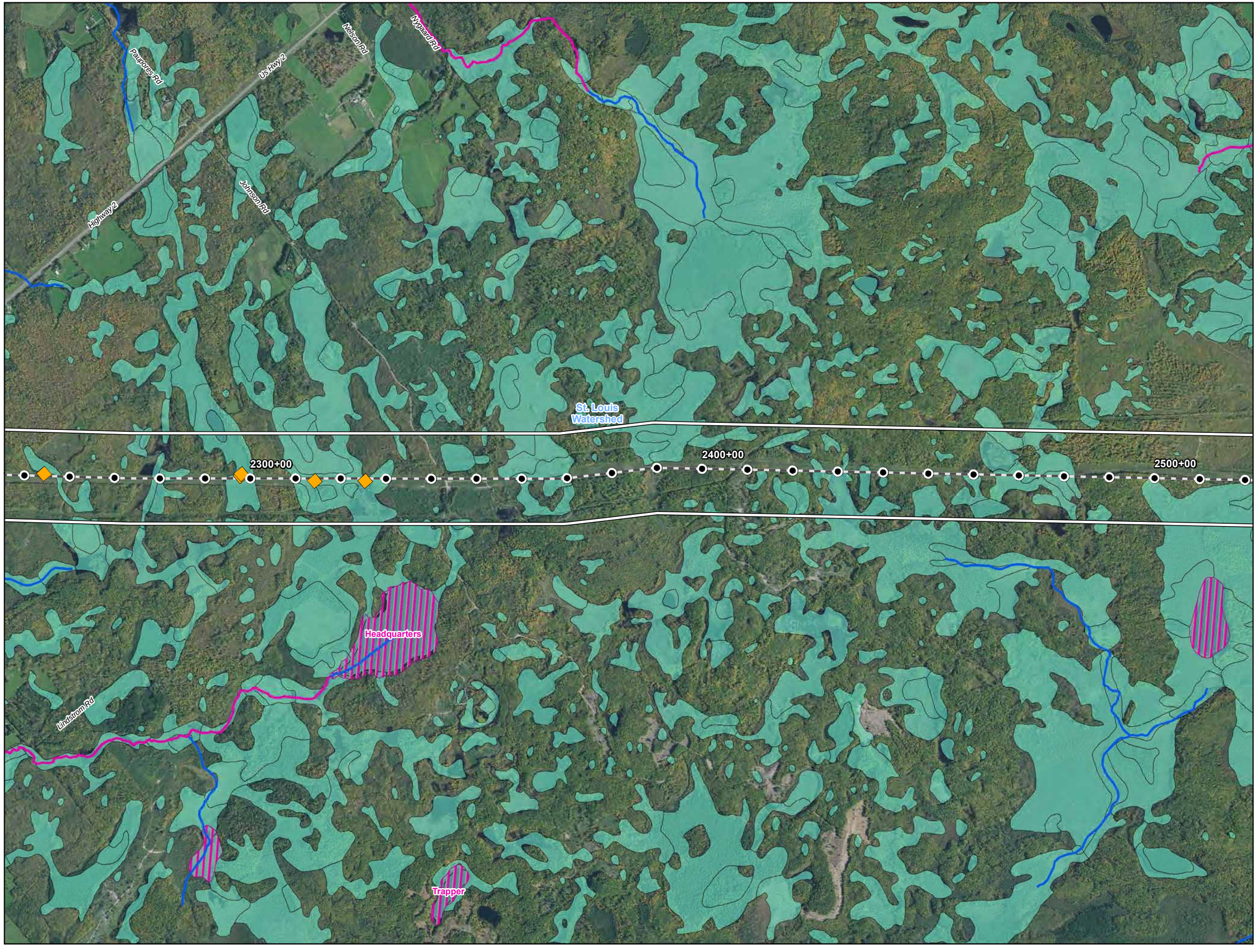
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 10

Line 3 Replacement Project

RSA-22-L3

Enbridge

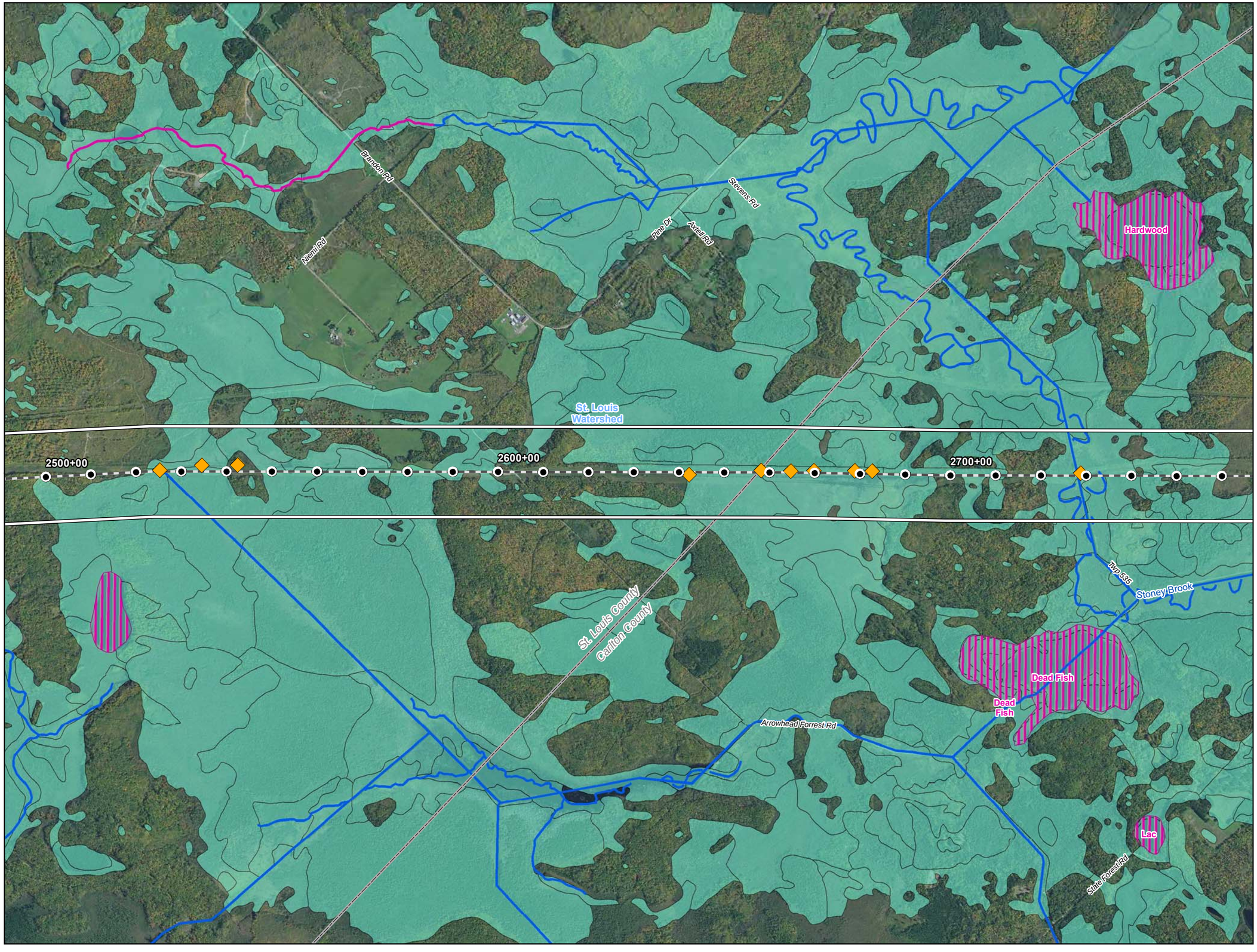
St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-22-L3.mxd

Date: (10/19/2016)





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- Water Well
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- County Boundary

Figure 11

Line 3 Replacement Project

RSA-22-L3

Enbridge

St. Louis County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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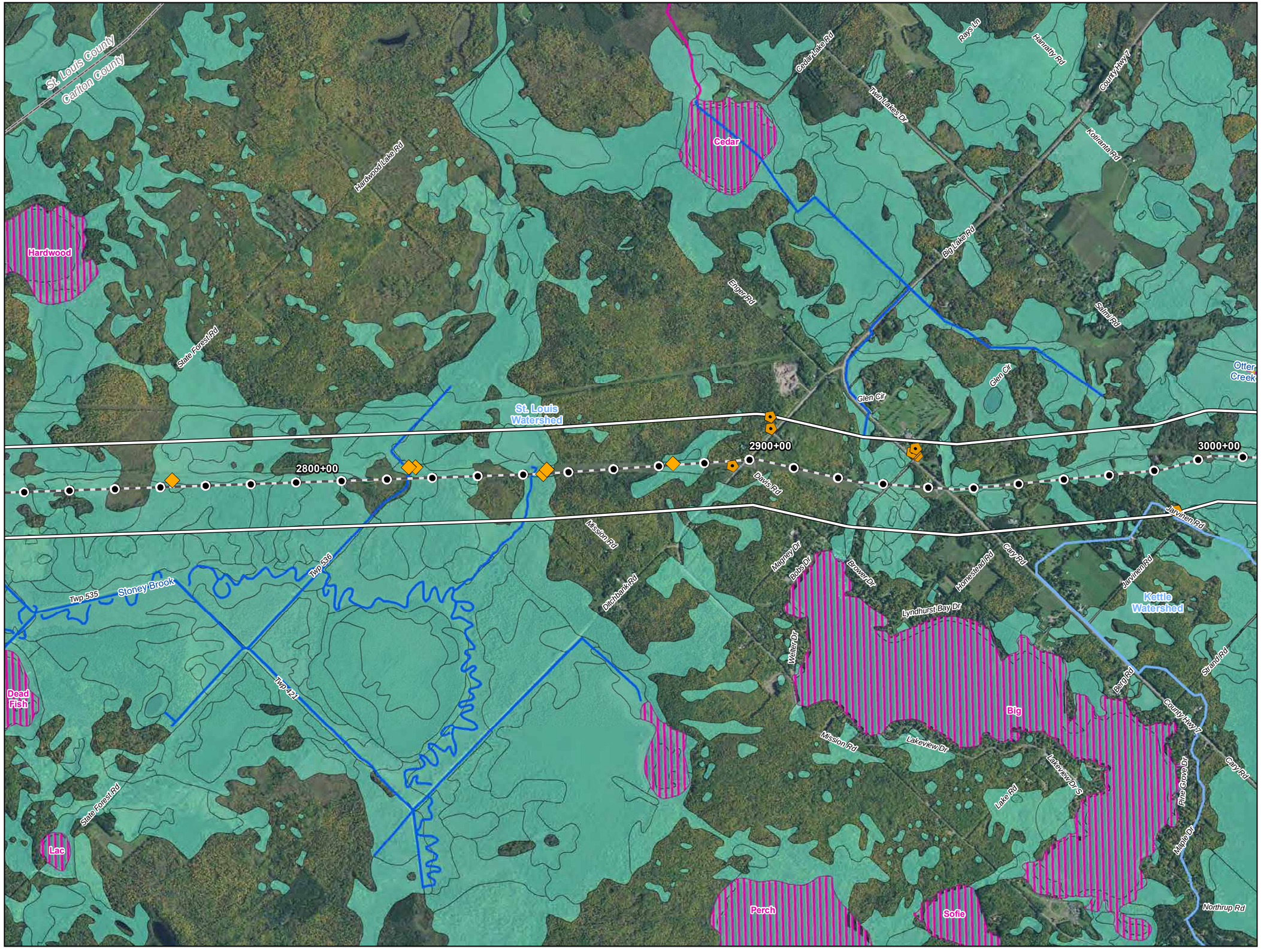
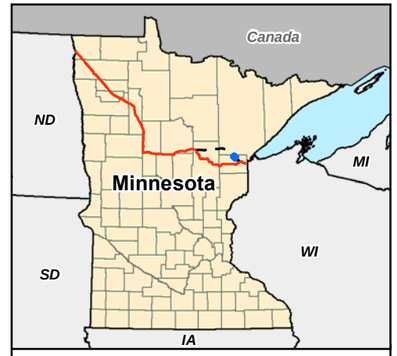
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
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- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 12

Line 3 Replacement Project

RSA-22-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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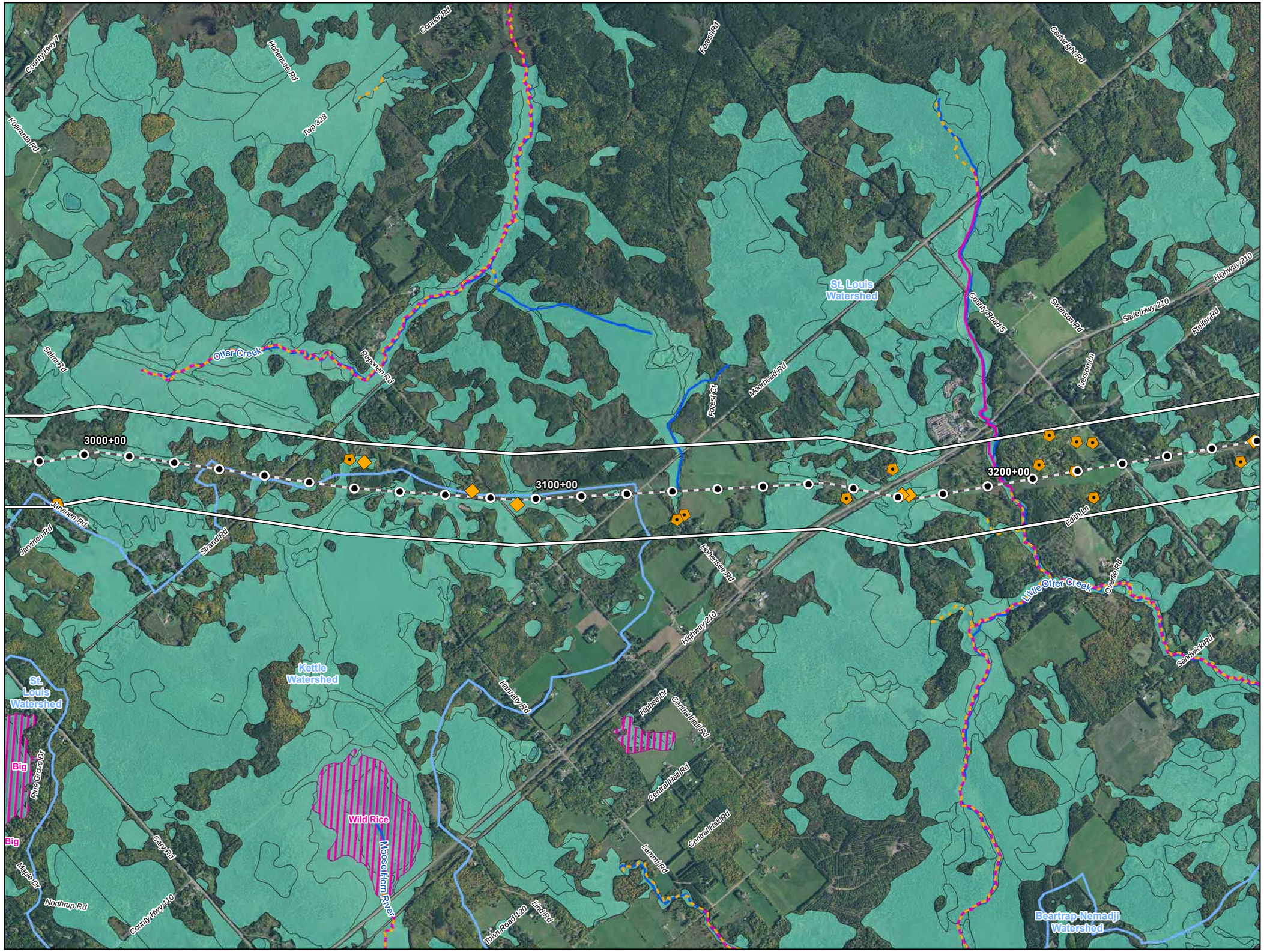
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-22-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 13

Line 3 Replacement Project

RSA-22-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-22-L3.mxd
Date: (10/19/2016)

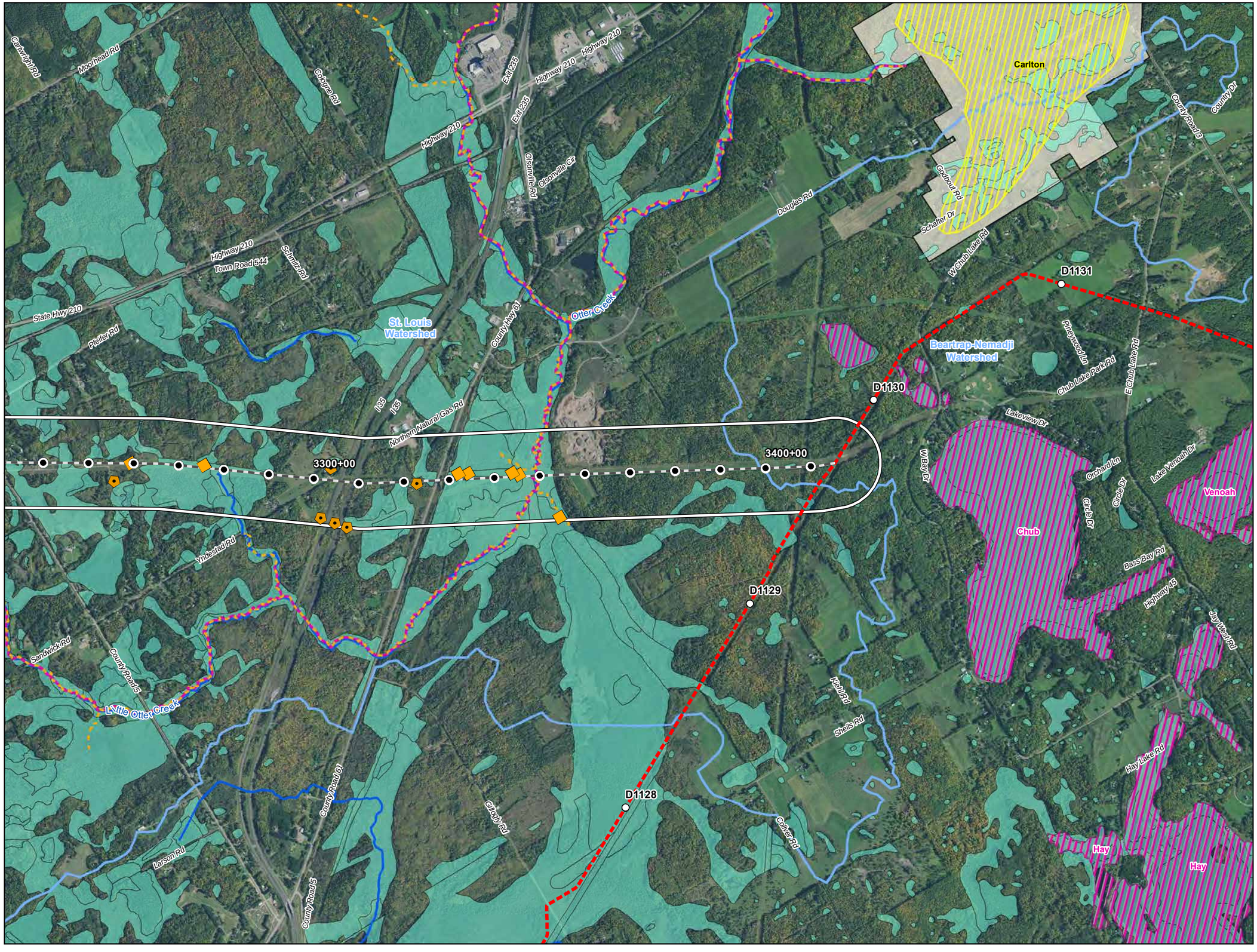


Figure 14

Line 3 Replacement Project

RSA-22-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-22-L3.mxd

Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-23

DRAFT

Table 1
Line 3 Replacement Project – RSA-23-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**4**	**2.7**
Aitkin	4	2.7
Grand Total [c]	**4**	**2.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-23-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**-**	**-**	**1**	**1**	**3.6**	**3.7**	**6.1**	**13.4**
Aitkin	-	-	1	1	3.6	3.7	6.1	13.4
Elk-Nokasippi	**6**	**3**	**7**	**16**	-	**0.2**	**1.0**	**1.2**
Aitkin	6	3	7	16	-	0.2	1.0	1.2
Grand Total [c]	**6**	**3**	**8**	**17**	**3.6**	**3.8**	**7.2**	**14.5**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-23-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**4.8**	**13.5**	**<0.1**	**18.3**	**1075.0**	**3130.2**	**78.3**	**4283.5**
Aitkin	4.8	13.5	<0.1	18.3	1075.0	3130.2	78.3	4283.5
Elk-Nokasippi	**0.8**	**0.6**	**-**	**1.4**	**151.4**	**254.1**	**-**	**405.4**
Aitkin	0.8	0.6	-	1.4	151.4	254.1	-	405.4
Grand Total [d]	**5.6**	**14.2**	**<0.1**	**19.8**	**1226.4**	**3384.3**	**78.3**	**4689.0**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-23-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Proposed Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Prairie-Willow	**-**	**0.4**	**-**	**131.6**
Aitkin	-	0.4	-	131.6
Grand Total [c]	**-**	**0.4**	**-**	**131.6**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the proposed Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-23-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Abandoned	750	8
			747	
			859	
			337	
			394	
			224	
			315	
			90	
		Domestic	840	18
			192	
			284	
			125	
			964	
			923	
			323	
			769	
			617	
			699	
			399	
			730	
			611	
			85	
			877	
			734	
			957	
			619	
		Unknown	414	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – RSA-23-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Proposed Route Segment Alternative Centerline [b]	Acres Within the Route Segment Alternative Corridor [c]
Prairie Willow	Aitkin	1366+00	McGregor WHPA	-	2.87
			McGregor DWSMA	-	22.61

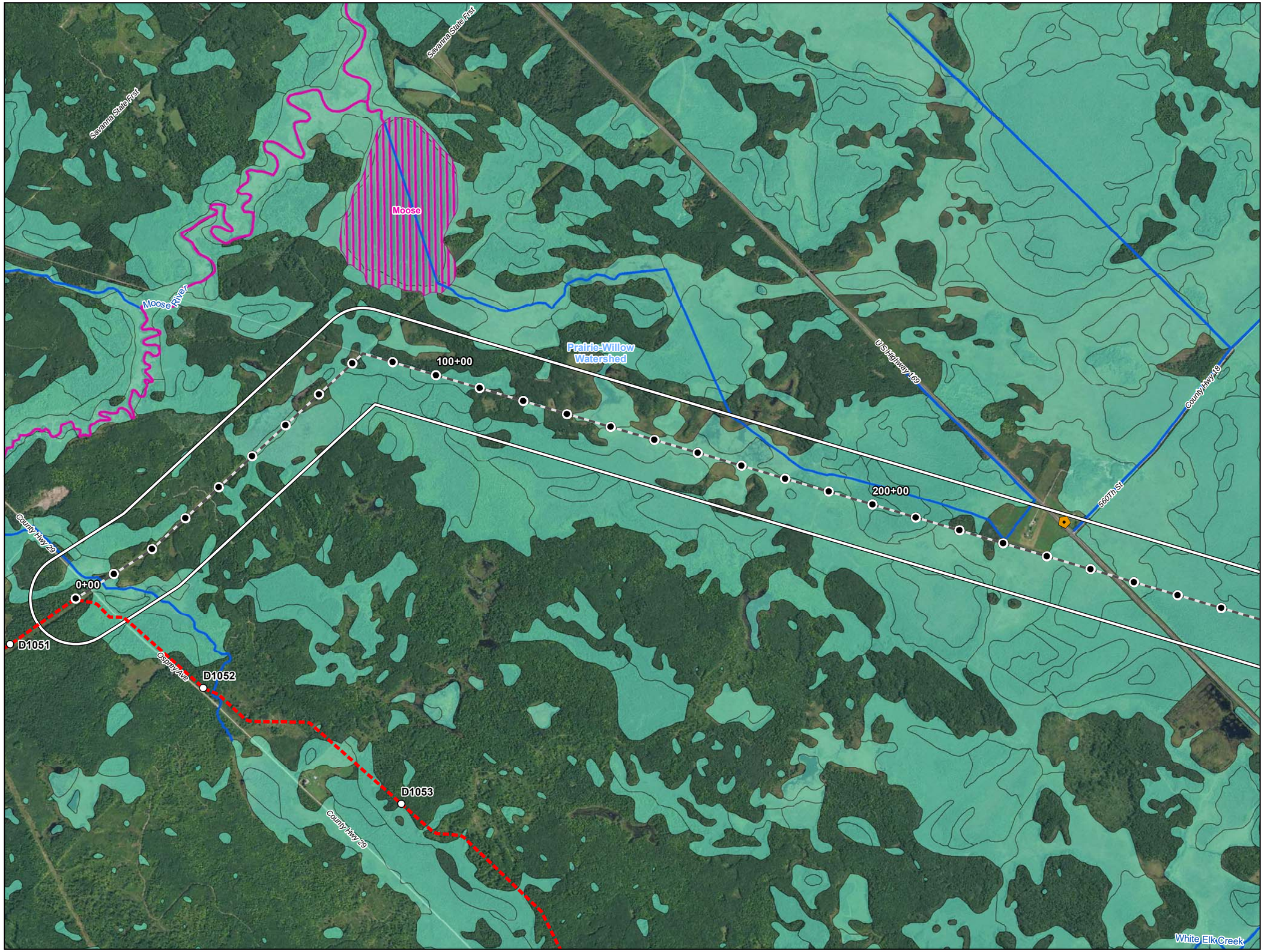
DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest proposed Route Segment Alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the proposed Route Segment Alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide Route Segment Alternative corridor.

Table 7
Line 3 Replacement Project – RSA-23-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Prairie-Willow	Aitkin	General Permit Authorization	Inactive	1
		Individual Permit	Active	2
			Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
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- Line 3 Milepost
- Alternative Stationing
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- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-23-L3

Enbridge

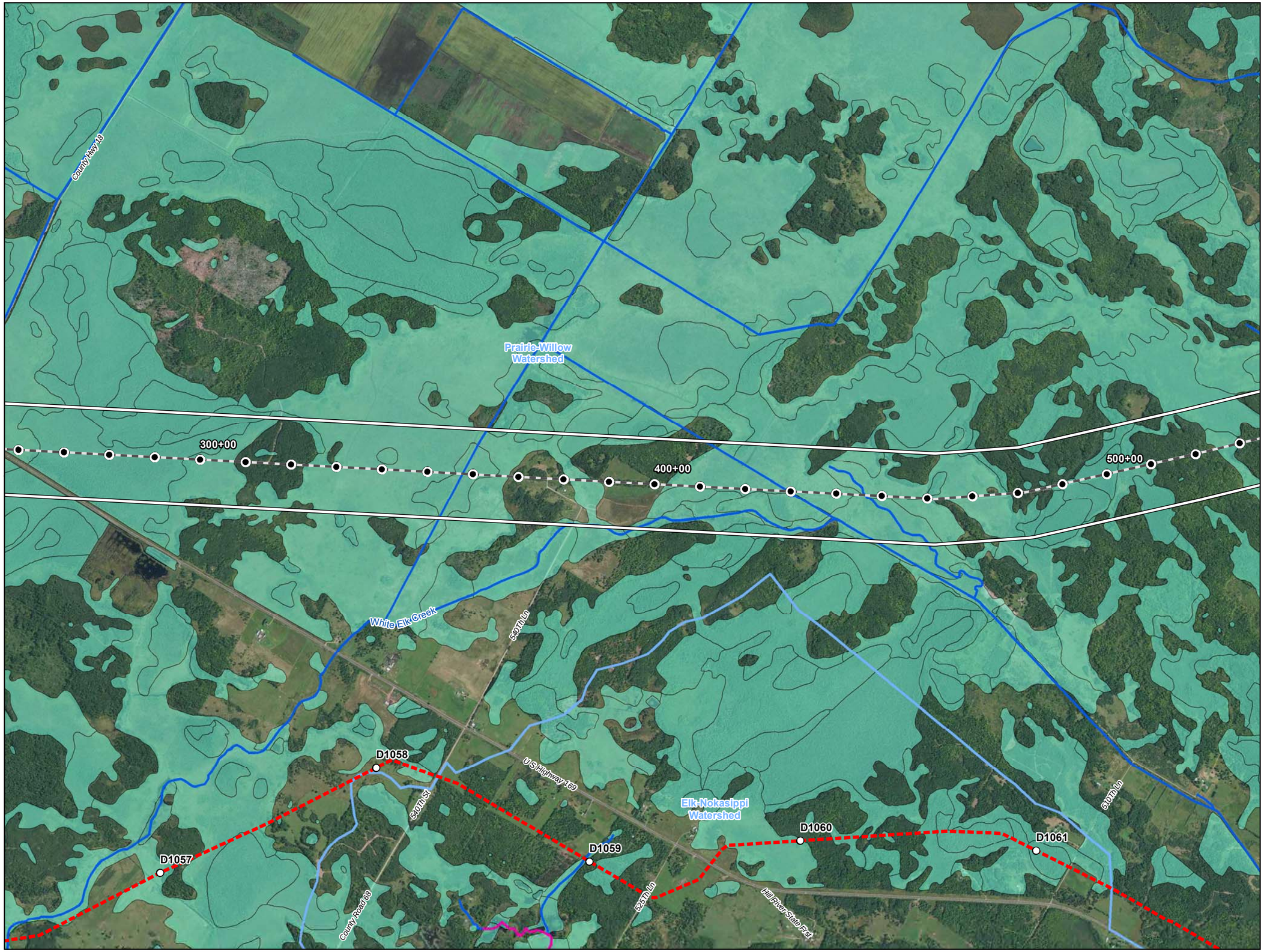
Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-23-L3.mxd

Date: (10/18/2016)





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- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-23-L3

Enbridge

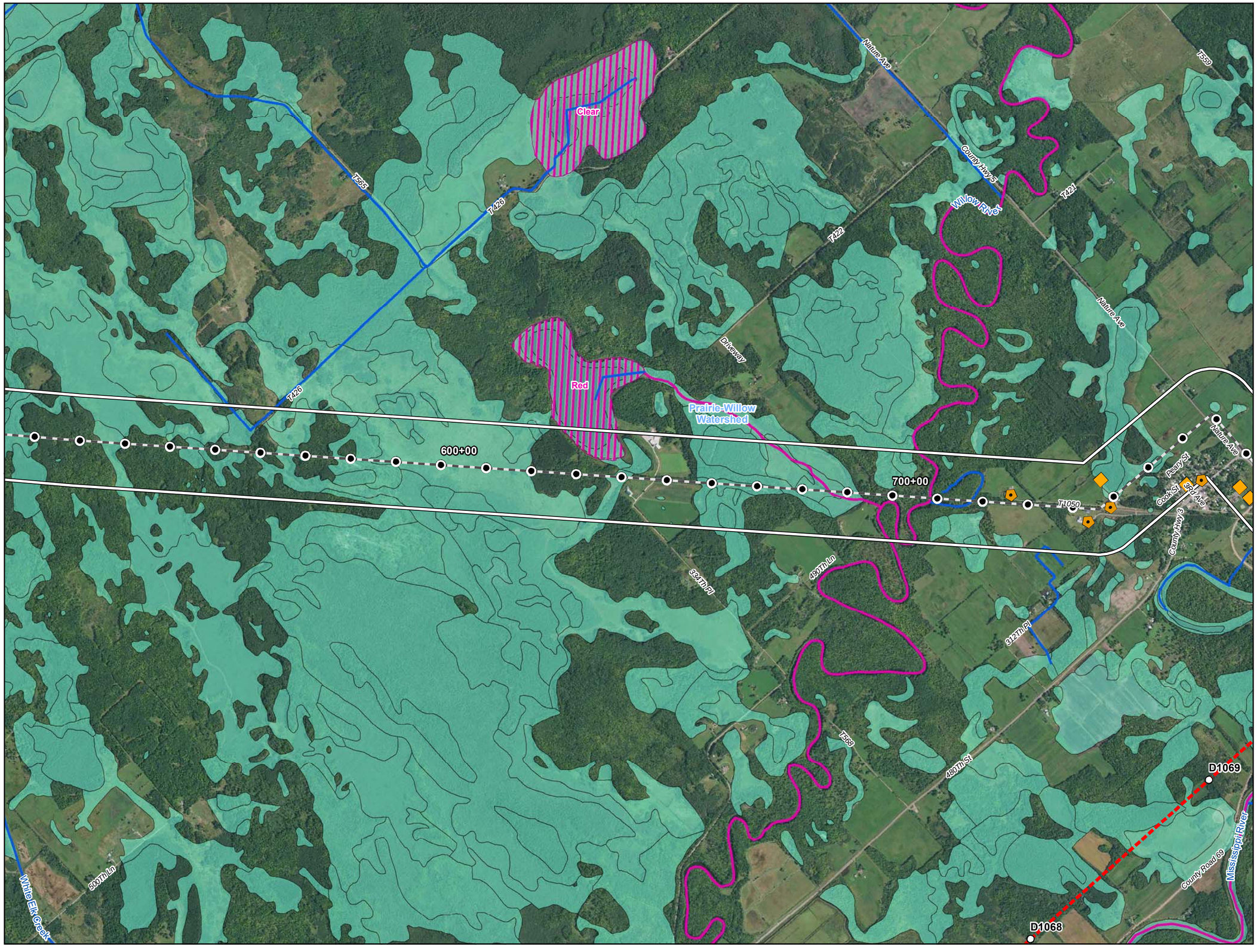
Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\Pinhole_Maps\RSA-23-L3.mxd

Date: (10/18/2016)





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- County Boundary

Figure 3

Line 3 Replacement Project

RSA-23-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-23-L3.mxd

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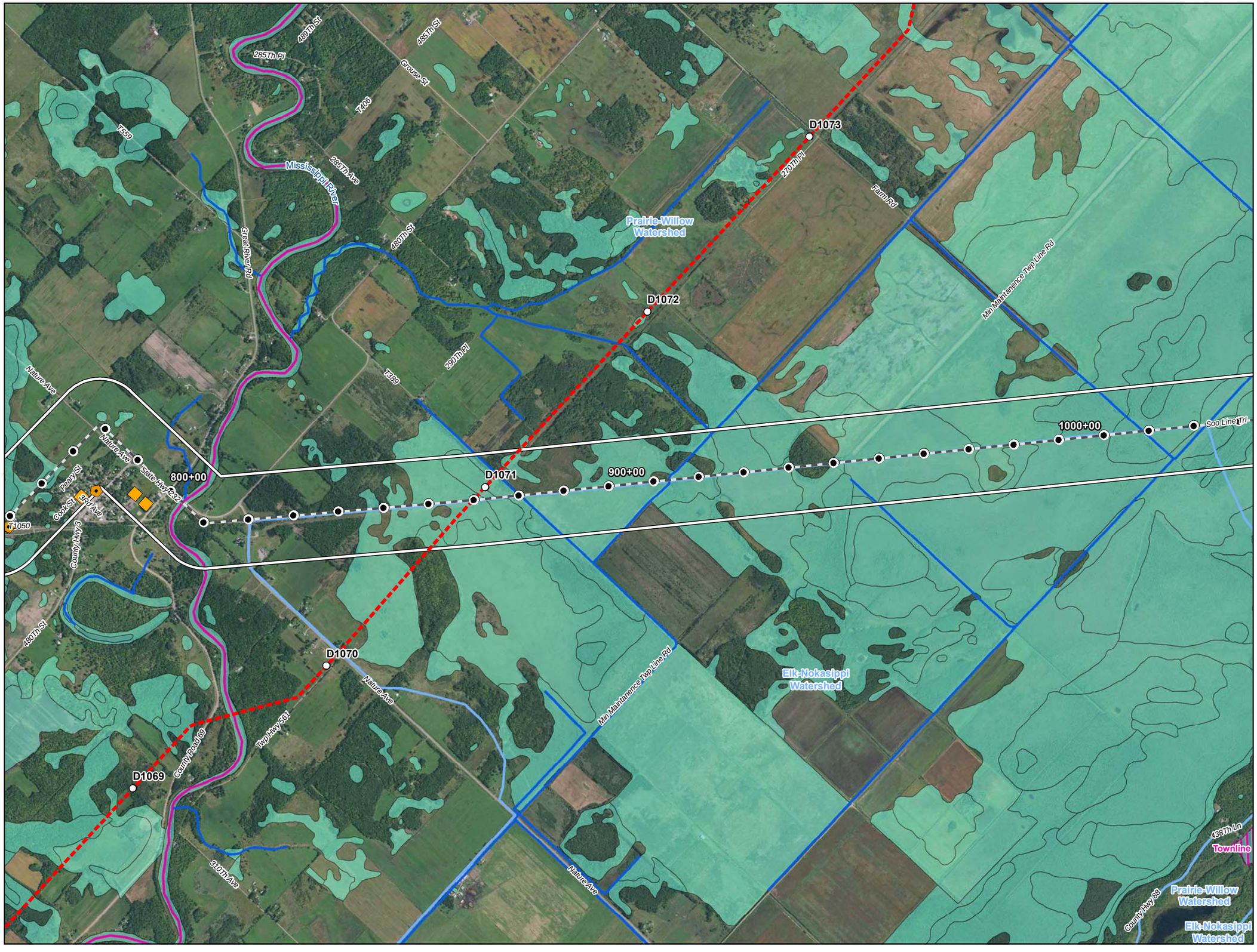



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Figure 4

Line 3 Replacement Project

RSA-23-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

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Date: (10/18/2016)

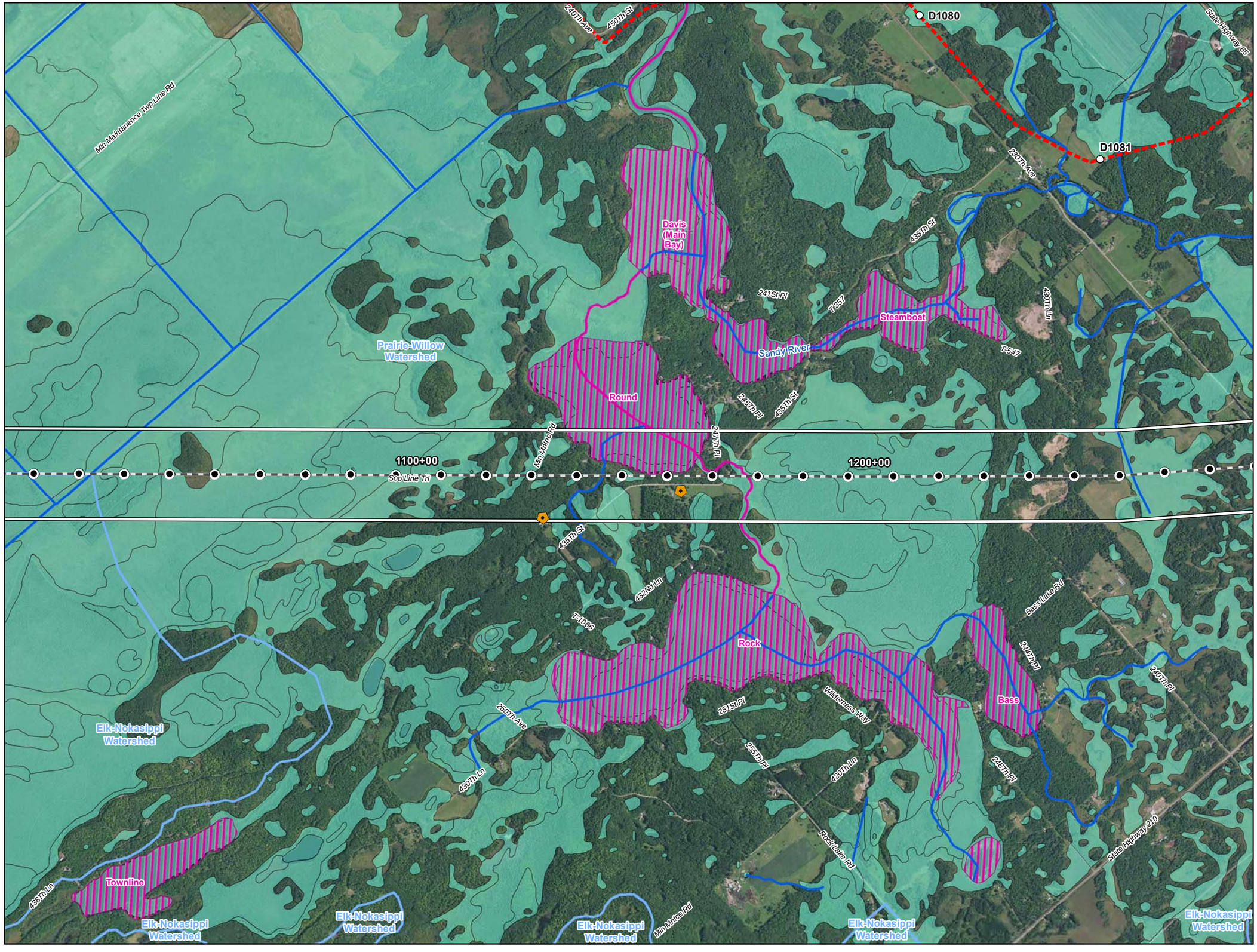



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Figure 5

Line 3 Replacement Project

RSA-23-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-23-L3.mxd

Date: (10/18/2016)

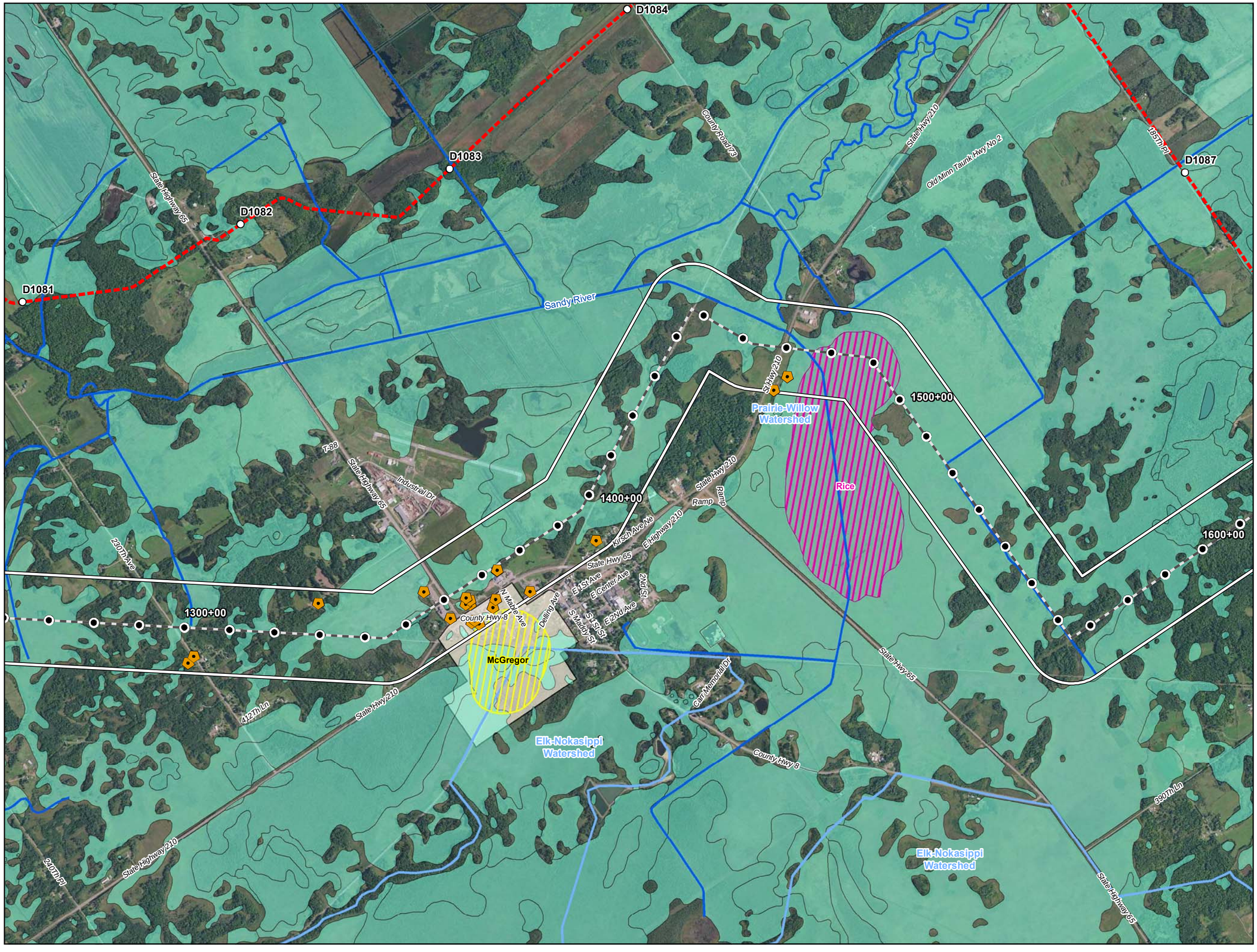

Figure 6

Line 3 Replacement Project

RSA-23-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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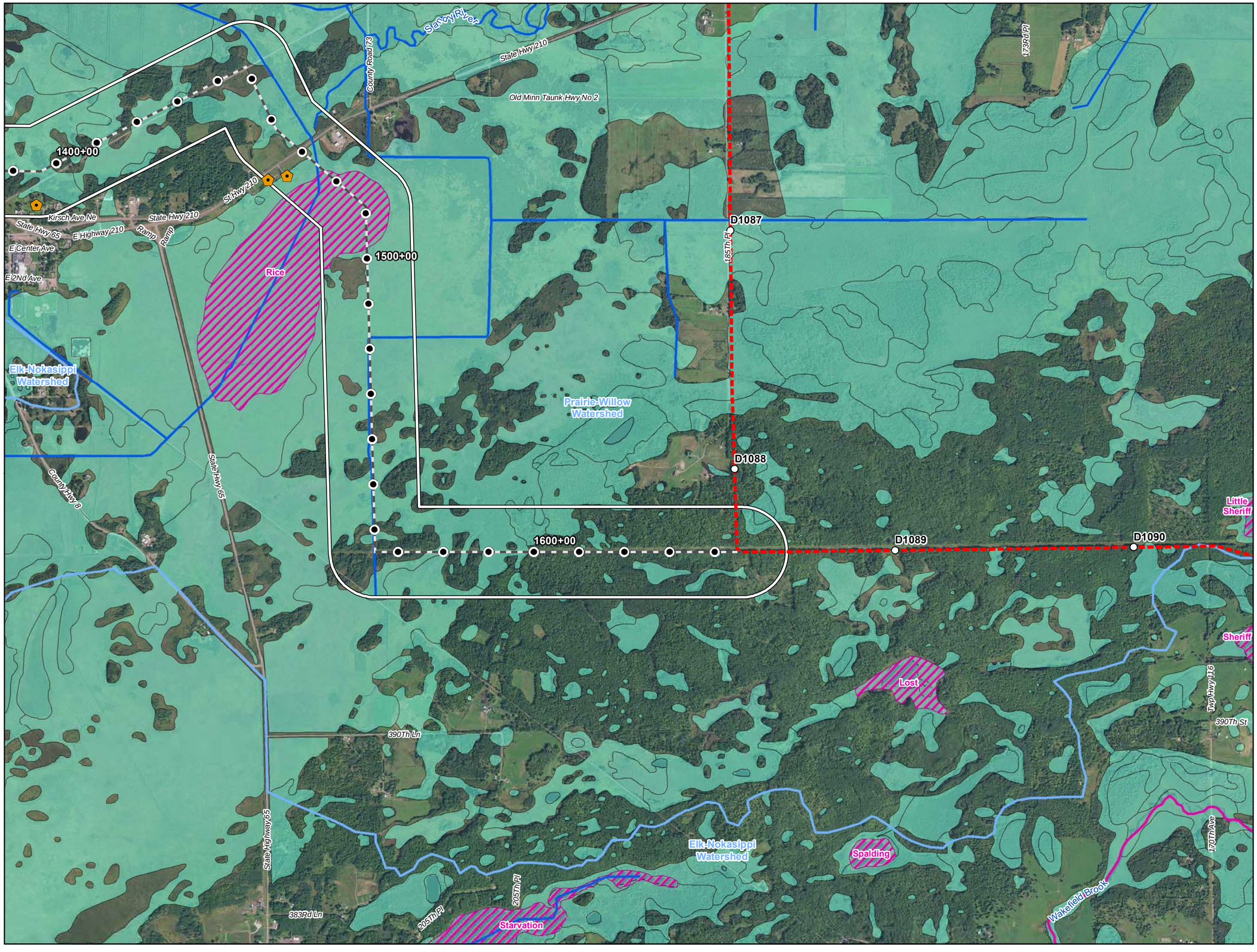
Date: (10/18/2016)





0 1,000 2,000 Feet

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N W E S

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Figure 7

Line 3 Replacement Project

RSA-23-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-27

DRAFT

Table 1
Line 3 Replacement Project – RSA-27-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**1**	**0.7**
Aitkin	1	0.7
Grand Total [c]	**1**	**0.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-27-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Elk-Nokasippi	**-**	**-**	**1**	**1**	**-**	**0.2**	**1.0**	**1.2**
Aitkin	-	-	1	1	-	0.2	1.0	1.2
Prairie-Willow	**1**	**2**	**5**	**8**	**0.5**	**1.0**	**4.2**	**5.7**
Aitkin	1	2	5	8	0.5	1.0	4.2	5.7
Grand Total [c]	**1**	**2**	**6**	**9**	**0.5**	**1.2**	**5.2**	**6.8**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-27-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Elk-Nokasippi	**0.8**	**0.6**	**-**	**1.4**	**460.3**	**1417.6**	**50.3**	**1928.2**
Aitkin	0.8	0.6	-	1.4	460.3	1417.6	50.3	1928.2
Prairie-Willow	**1.6**	**6.5**	**-**	**8.1**	**145.5**	**230.3**	**-**	**375.8**
Aitkin	1.6	6.5	-	8.1	145.5	230.3	-	375.8
Grand Total [d]	**2.4**	**7.1**	**-**	**9.6**	**605.8**	**1647.9**	**50.3**	**2304.1**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-27-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Proposed Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Prairie-Willow	**-**	**0.3**	**-**	**111.0**
Aitkin	-	0.3	-	111.0
Grand Total [c]	**-**	**0.3**	**-**	**111.0**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the proposed Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-27-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Abandoned	750	8
			747	
			859	
			337	
			394	
			224	
			315	
			90	
		Domestic	923	13
			323	
			769	
			617	
			699	
			399	
			730	
			611	
			85	
			877	
			734	
			957	
			619	
		Unknown	414	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – RSA-27-L3
Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA)
Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed	County	Approximate Stationing [a]	Name	Miles Crossed by the Route Segment Alternative Centerline [b]	Acres Within the Route Segment Alternative Corridor [c]
Prairie Willow	Aitkin	496+00	McGregor WHPA	-	2.87
			McGregor DWSMA	-	22.61

DWSMA Data Source: https://gisdata.mn.gov/dataset/water-drinking-water-supply
WHPA Data Source: https://gisdata.mn.gov/dataset/water-wellhead-protection-areas

a Stationing for features not crossed by the centerline are interpolated based on the closest proposed Route Segment Alternative centerline stationing.
b Total miles of DWSMA and WHPA crossed by the proposed Route Segment Alternative centerline.
c Total acres of DWSMA and WHPA crossed by the 2000-ft-wide Route Segment Alternative corridor.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-27-L3

Enbridge

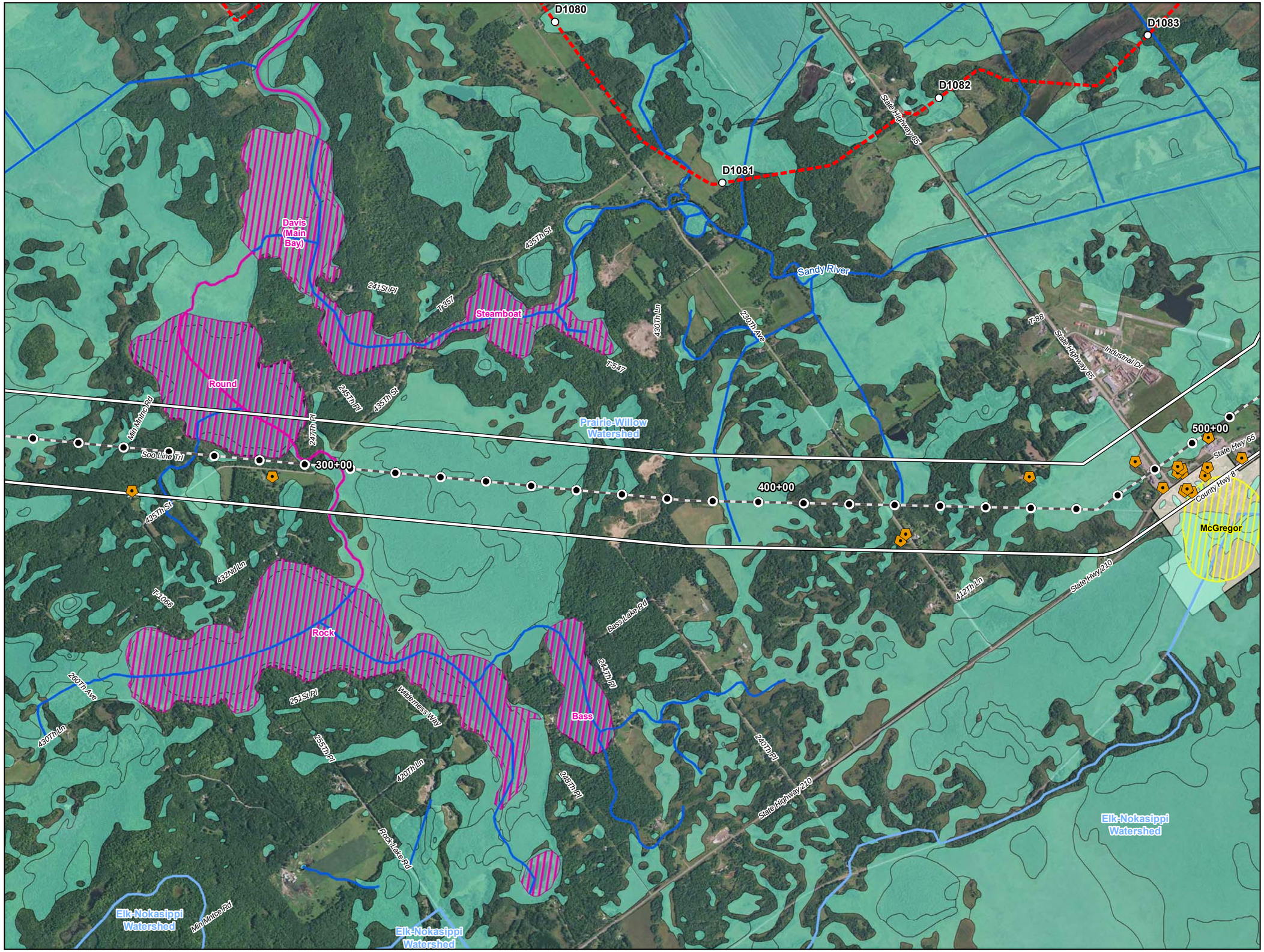
Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-27-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-27-L3

Enbridge

Aitkin County, Minnesota

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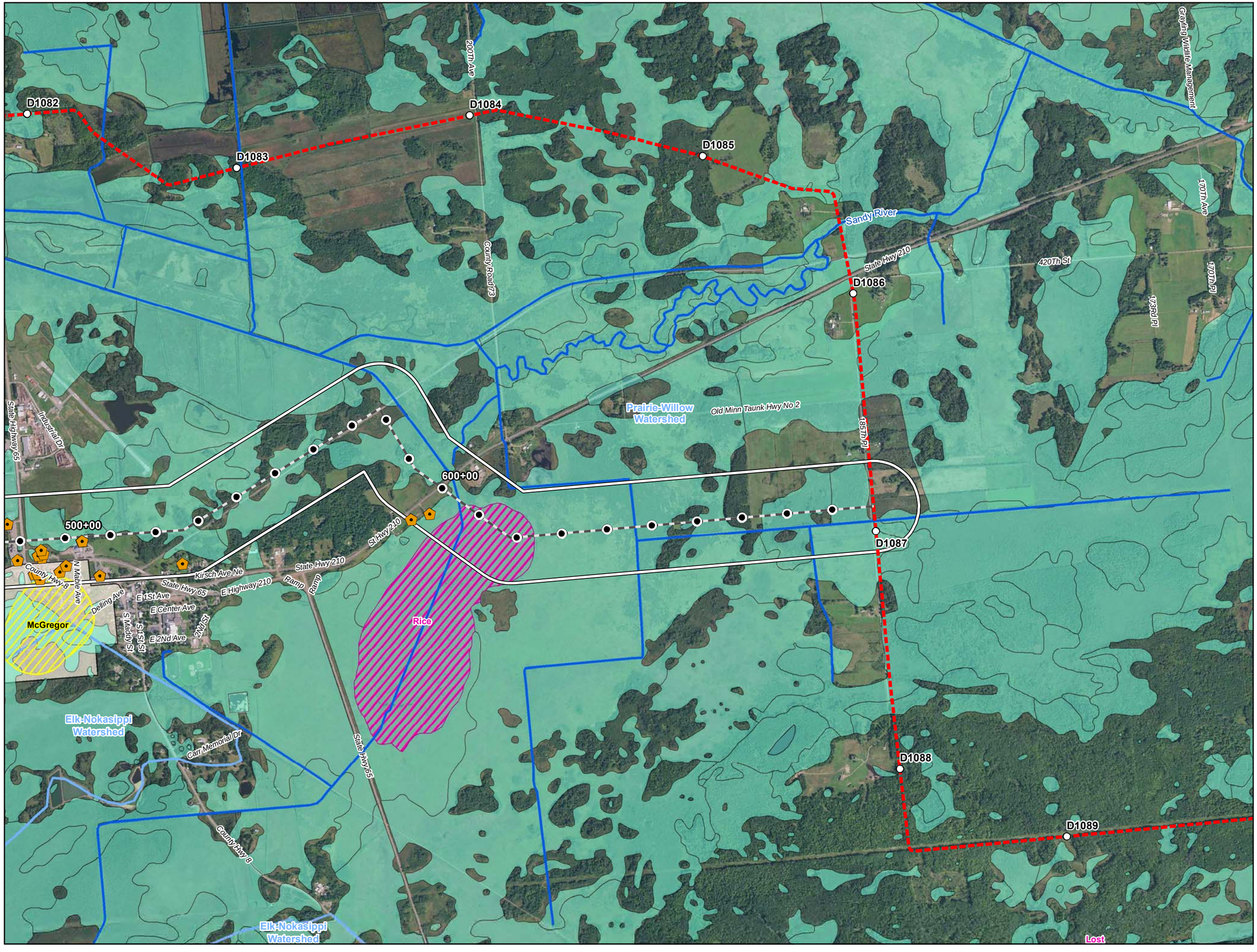
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-27-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 3

Line 3 Replacement Project

RSA-27-L3

Enbridge

Aitkin County, Minnesota

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-27-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-28

DRAFT

Table 1
Line 3 Replacement Project - RSA-28-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**-**	**-**	**7**	**7**	**-**	**-**	**4.3**	**4.3**
Aitkin	-	-	7	7	-	-	4.3	4.3
Grand Total [c]	-	-	**7**	**7**	-	-	**4.3**	**4.3**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-28-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**1.1**	**-**	**-**	**1.1**	**347.3**	**5.3**	**-**	**352.6**
Aitkin	1.1	-	-	1.1	347.3	5.3	-	352.6
Grand Total [d]	**1.1**	**-**	**-**	**1.1**	**347.3**	**5.3**	**-**	**352.6**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

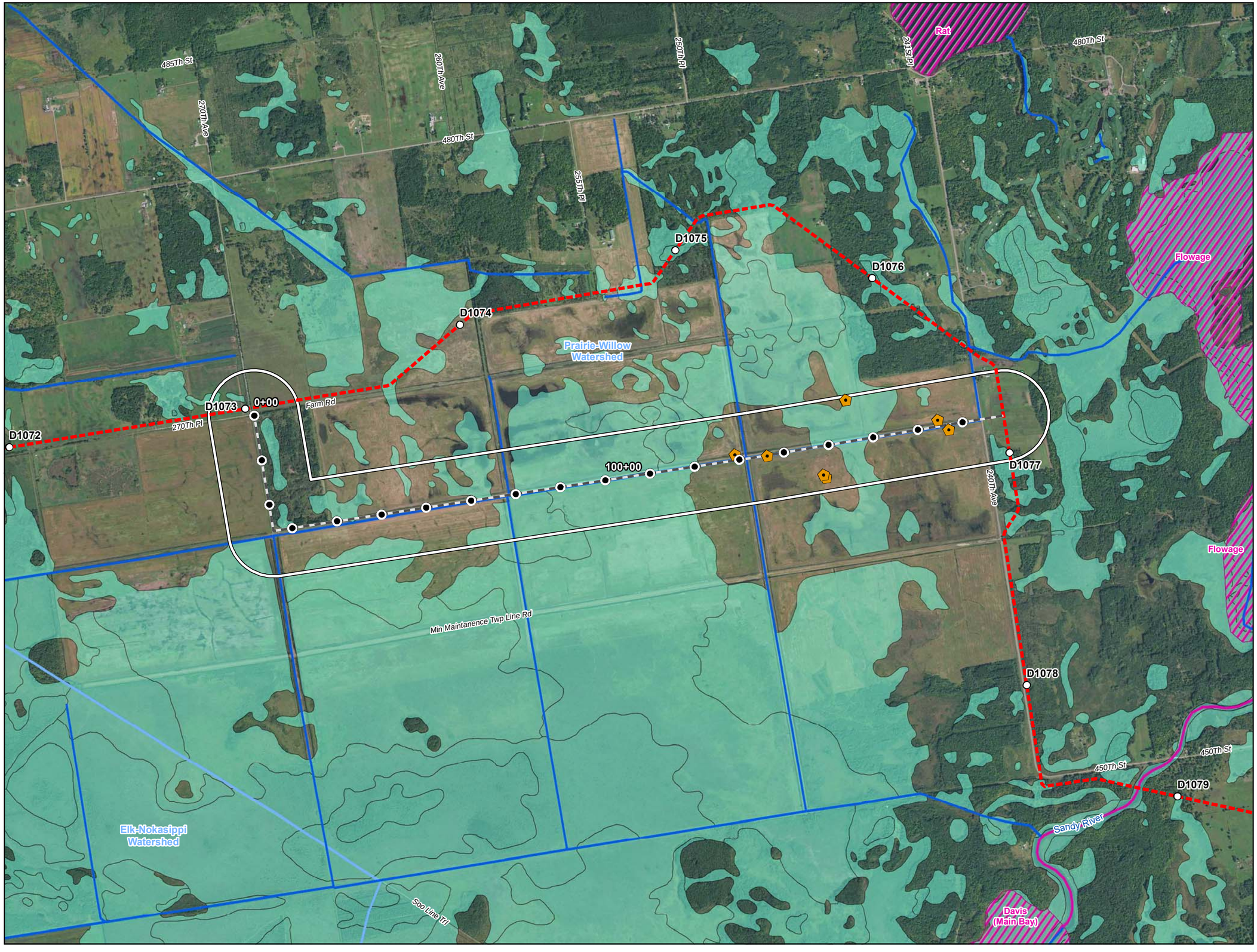
c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-28-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Other	921	2
			154	
		Piezometer	137	6
			2	
			627	
			696	
			924	
			101	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-28-L3

Enbridge

Aitkin County, Minnesota

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Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-31

DRAFT

Table 1
Line 3 Replacement Project – RSA-31-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Crossed by the Proposed Route Alternative Centerline**	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
Prairie-Willow	**1**	**0.5**
Aitkin	1	0.5
Grand Total	**1**	**0.5**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-31-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**1**	**2**	**-**	**3**	**0.5**	**1.0**	**0.2**	**1.8**
Aitkin	1	2	-	3	0.5	1.0	0.2	1.8
Grand Total [c]	**1**	**2**	**-**	**3**	**0.5**	**1.0**	**0.2**	**1.8**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-31-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Proposed Route Segment Alternative Centerline** [a]				**Acres Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]			
	PEM [c]	**PFO/PSS** [c]	**Pond/Lake/ Riverine**	**Total** [d]	**PEM** [c]	**PFO/PSS** [c]	**Pond/Lake/ Riverine**	**Total** [d]
Prairie-Willow	**0.3**	**2.1**	**0.1**	**2.6**	**62.2**	**571.9**	**14.4**	**648.5**
Aitkin	0.3	2.1	0.1	2.6	62.2	571.9	14.4	648.5
Grand Total [d]	**0.3**	**2.1**	**0.1**	**2.6**	**62.2**	**571.9**	**14.4**	**648.5**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-31-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

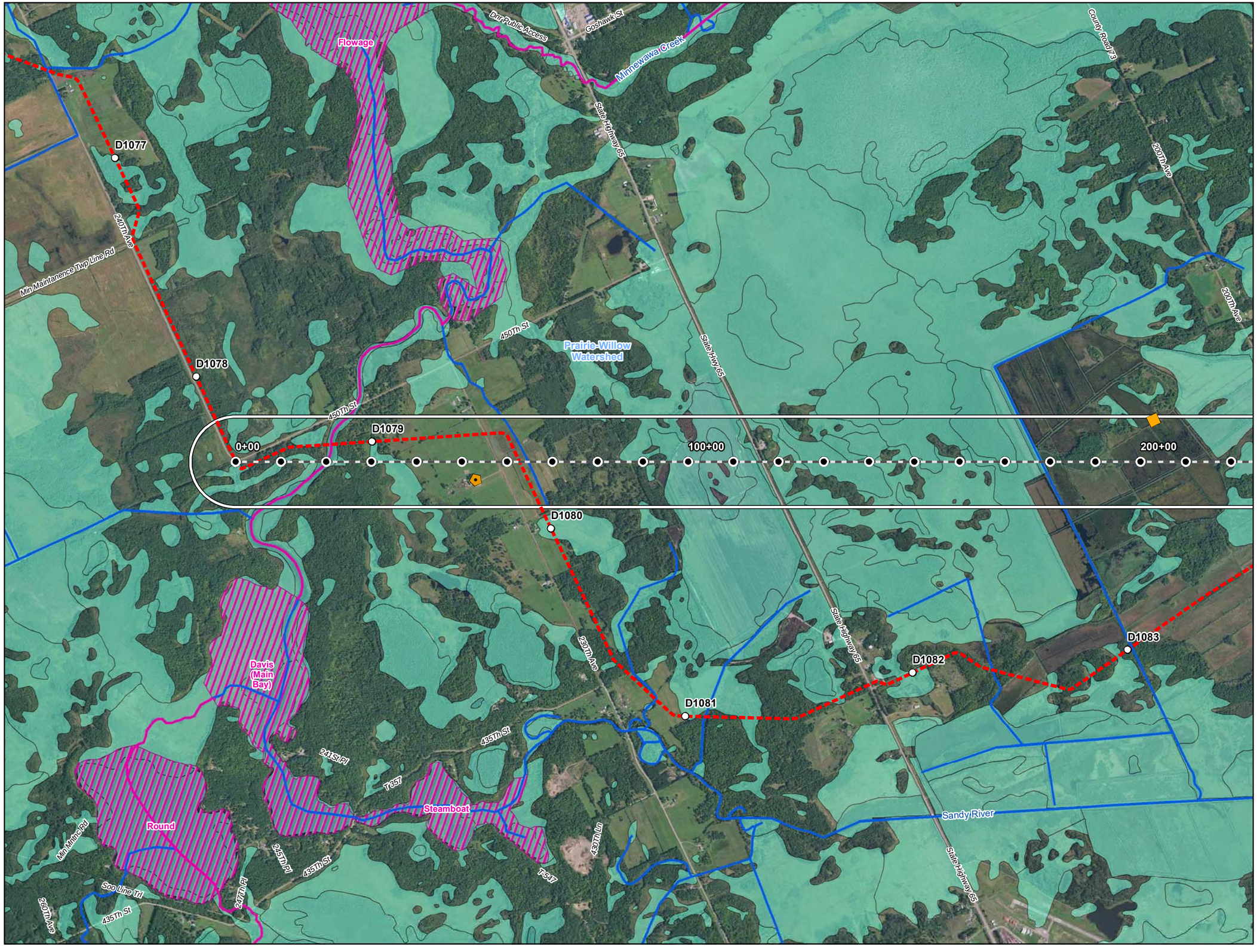
Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Domestic	385	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.

Table 5
Line 3 Replacement Project – RSA-31-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Prairie-Willow	Aitkin	Individual Permit	Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-31-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line 3 Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-31-L3.mxd
Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-31-L3

Enbridge

Aitkin County, Minnesota

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Source: Z:\Clients\LE_HE\nbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-31-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-33

DRAFT

Table 1
Line 3 Replacement Project – RSA-33-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**-**	**3**	**-**	**3**	**-**	**1.2**	**-**	**1.2**
Aitkin	-	3	-	3	-	1.2	-	1.2
Grand Total [c]	**-**	**3**	**-**	**3**	**-**	**1.2**	**-**	**1.2**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-33-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**-**	**0.8**	**-**	**0.8**	**-**	**212.3**	**-**	**212.3**
Aitkin	-	0.8	-	0.8	-	212.3	-	212.3
Grand Total [d]	**-**	**0.8**	**-**	**0.8**	**-**	**212.3**	**-**	**212.3**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-33-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Prairie-Willow	Aitkin	Individual Permit	Active	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
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- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-33-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-34

DRAFT

Table 1
Line 3 Replacement Project - RSA-34-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**-**	**3**	**-**	**3**	**-**	**2.0**	**-**	**2.0**
Aitkin	-	3	-	3	-	2.0	-	2.0
Grand Total [c]	**-**	**3**	**-**	**3**	**-**	**2.0**	**-**	**2.0**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-34-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Proposed Route Segment Alternative Centerline** [a]				**Acres Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]			
	PEM [c]	**PFO/PSS** [c]	**Pond/Lake/ Riverine**	**Total** [d]	**PEM** [c]	**PFO/PSS** [c]	**Pond/Lake/ Riverine**	**Total** [d]
Prairie-Willow	**0.1**	**1.0**	**-**	**1.0**	**24.1**	**276.8**	**-**	**300.9**
Aitkin	0.1	1.0	-	1.0	24.1	276.8	-	300.9
Grand Total [d]	**0.1**	**1.0**	**-**	**1.0**	**24.1**	**276.8**	**-**	**300.9**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-34-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

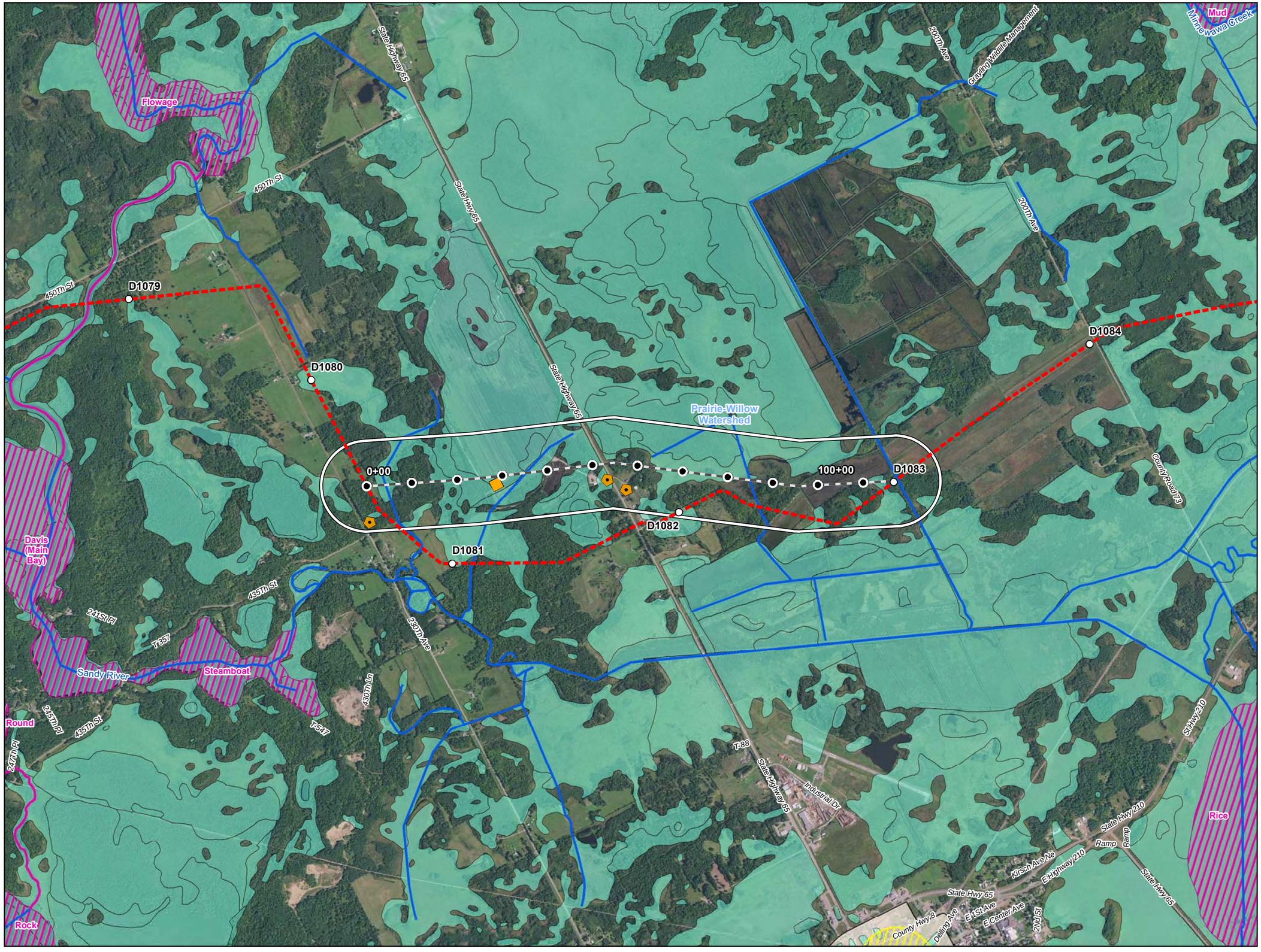
Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Domestic	783	3
			348	
			548	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.

Table 4
Line 3 Replacement Project -RSA-34-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Prairie-Willow	Aitkin	Individual Permit	Active	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

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- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
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- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-34-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-34-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-35

DRAFT

Table 1
Line 3 Replacement Project – RSA-35-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**-**	**1**	**-**	**1**	**0.7**	**0.8**	**0.3**	**1.8**
Aitkin	-	1	-	1	0.7	0.8	0.3	1.8
Grand Total [c]	**-**	**1**	**-**	**1**	**0.7**	**0.8**	**0.3**	**1.8**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-35-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Proposed Route Segment Alternative Centerline** [a]				**Acres Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]			
	PEM [c]	**PFO/PSS** [c]	**Pond/Lake/ Riverine**	**Total** [d]	**PEM** [c]	**PFO/PSS** [c]	**Pond/Lake/ Riverine**	**Total** [d]
Prairie-Willow	**0.9**	**0.2**	**-**	**1.1**	**181.0**	**70.5**	**-**	**251.5**
Aitkin	0.9	0.2	-	1.1	181.0	70.5	-	251.5
Grand Total [d]	**0.9**	**0.2**	**-**	**1.1**	**181.0**	**70.5**	**-**	**251.5**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

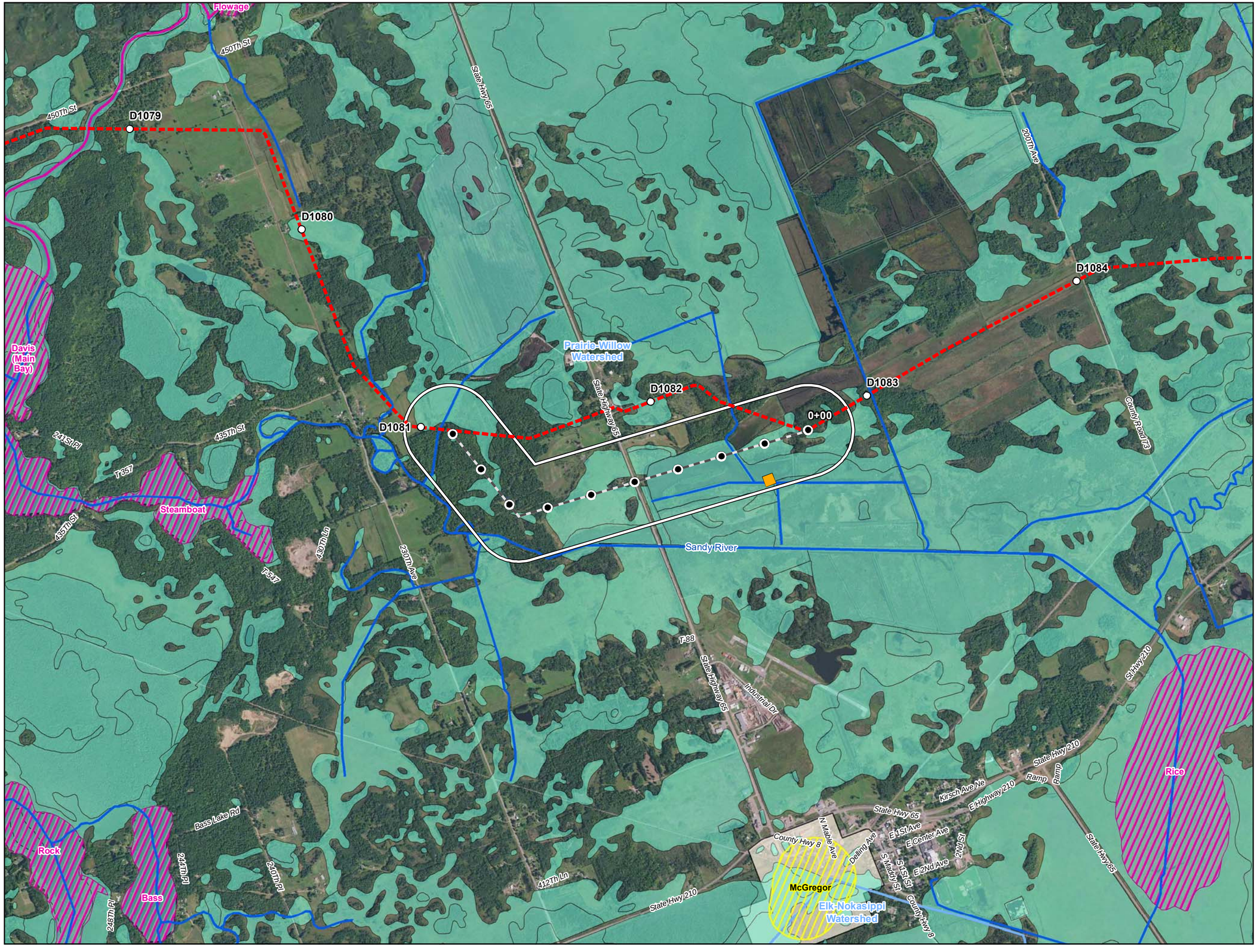
c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-35-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Prairie-Willow	Aitkin	Individual Permit	Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-35-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-35-L3.mxd
Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-37

DRAFT

Table 1
Line 3 Replacement Project – RSA-37-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**2**	**0.9**
Carlton	2	0.9
Prairie-Willow	**6**	**2.2**
Kanabec	6	2.2
St. Louis	**2**	**1.1**
Pine	2	1.1
Grand Total [c]	**10**	**4.1**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-37-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**6**	**3**	**3**	**12**	**2.3**	**1.9**	**1.6**	**5.8**
Aitkin	-	1	2	3	0.1	0.3	1.1	1.6
Carlton	6	2	1	9	2.2	1.6	0.5	4.2
Kettle	**2**	**1**	**6**	**9**	**1.0**	**0.3**	**1.8**	**3.1**
Carlton	2	1	6	9	1.0	0.3	1.8	3.1
St. Louis	**2**	**-**	**2**	**4**	**1.2**	**-**	**1.6**	**2.7**
Carlton	2	-	2	4	1.2	-	1.6	2.7
Grand Total [c]	**10**	**4**	**11**	**25**	**4.4**	**2.2**	**5.0**	**11.6**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-37-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**4.3**	**3.3**	**0.3**	**7.9**	**775.0**	**974.7**	**91.9**	**1841.6**
Aitkin	3.9	0.7	-	4.6	720.5	269.2	9.6	999.2
Carlton	0.4	2.6	0.3	3.3	54.5	705.6	82.3	842.4
Kettle	**0.1**	**3.3**	**-**	**3.4**	**25.1**	**788.3**	**3.8**	**817.3**
Carlton	0.1	3.3	-	3.4	25.1	788.3	3.8	817.3
St. Louis	**0.3**	**4.5**	**0.2**	**5.0**	**74.2**	**1031.3**	**64.6**	**1170.0**
Carlton	0.3	4.5	0.2	5.0	74.2	1031.3	64.6	1170.0
Beartrap-Nemadji	-	**-**	**-**	**-**	-	**0.4**	**0.9**	**1.3**
Carlton	**-**	-	-	-	**-**	0.4	0.9	1.3
Grand Total [d]	**4.8**	**11.1**	**0.5**	**16.3**	**874.3**	**2794.7**	**161.2**	**3830.2**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-37-L3
Summary of Public Waters Inventory Wetlands and Basins Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Miles Crossed by the Route Segment Alternative Centerline** [a]		**Acres Within the Route Segment Alternative Corridor** [b]	
	Wetlands	**Basins**	**Wetlands**	**Basins**
Prairie-Willow	**0.20**	**0.14**	**17.30**	**73.20**
Carlton	0.20	0.14	17.30	73.20
Kettle	-	-	-	**7.89**
Carlton	-	-	-	7.89
St. Louis	**0.11**	**0.18**	**13.16**	**55.36**
Carlton	0.11	0.18	13.16	55.36
Grand Total [c]	**0.31**	**0.32**	**30.46**	**136.45**

PWI Wetland and Basin Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Total miles of PWI wetlands and basins crossed by the Route Segment Alternative centerline.

b Total acres of PWI wetlands and basins crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-37-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**1**	**0.48**
Carlton	1	0.48
St. Louis	**1**	**1.36**
Carlton	1	1.36
Grand Total [c]	**2**	**1.84**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the Route Segment Alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 6
L3 Replacement Project – RSA-37-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Abandoned	621	2
			960	
		Domestic	91	8
			786	
			516	
			875	
			486	
			776	
			199	
			983	
		Exploration	756	1
	Carlton	Abandoned	48	6
			776	
			663	
			716	
			540	
			570	
		Domestic	293	18
			16	
			278	
			807	
			469	
			765	
			89	
			289	
			585	
			88	
			590	
			60	
			838	
			527	
			12	
			266	
			787	
			998	
		Monitoring	408	1
Kettle	Carlton	Domestic	886	4
			669	
			734	

Kettle (cont.)	Carlton (cont.)	Domestic (cont.)	753	4 (cont.)
St. Louis	Carlton	Domestic	206	3
			945	
			824	
Kettle	Carlton	Abandoned	330	1
		Domestic	151	2
			545	
St. Louis	Carlton	Domestic	921	14
			364	
			115	
			94	
			561	
			293	
			435	
			21	
			892	
			655	
			576	
			254	
			147	
			35	
		Other	56	1
		Unknown	414	1

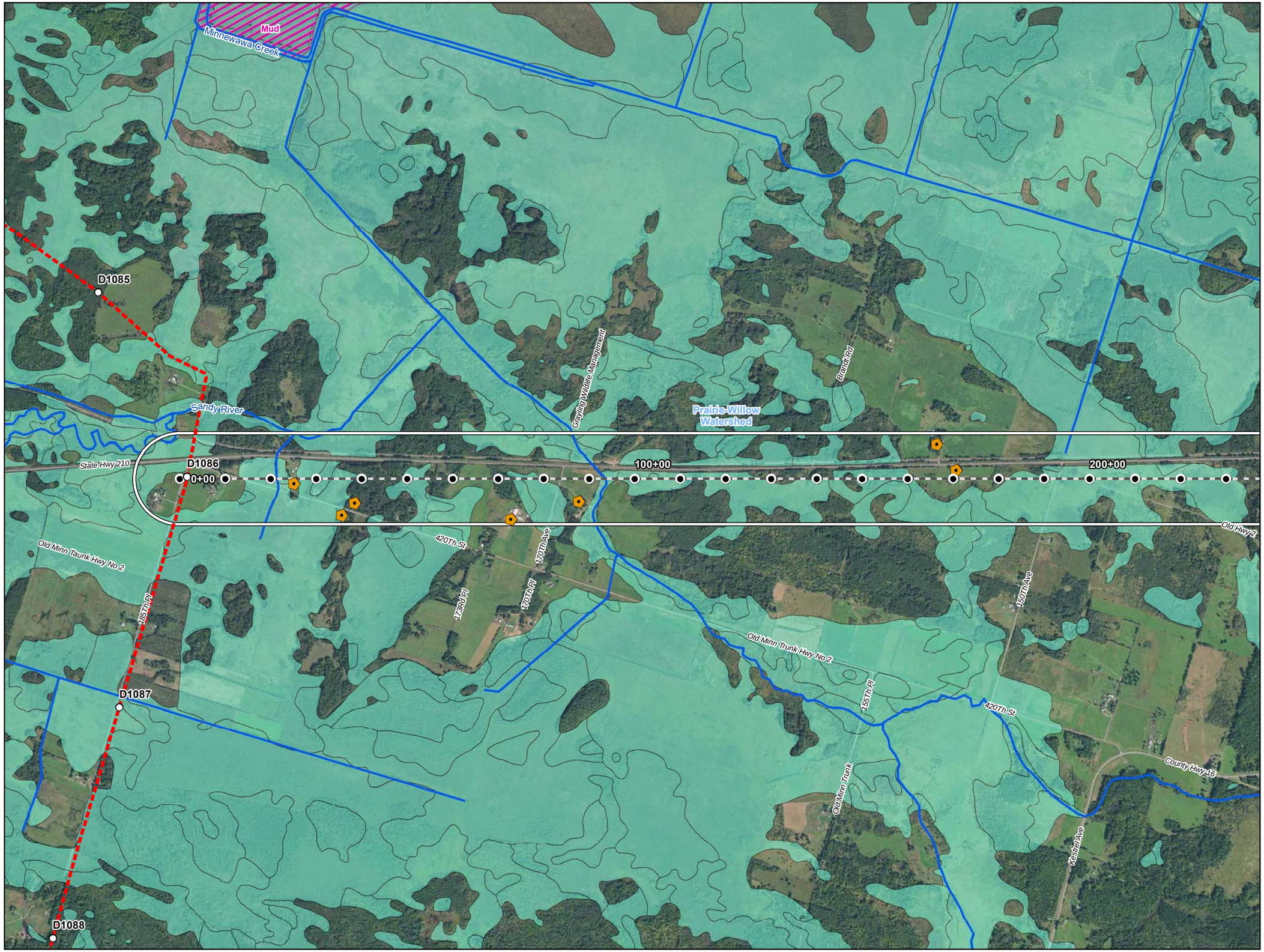
County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip

[a] Municipal wells are not included in the source data

Table 7
Line 3 Replacement Project – RSA-37-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
Prairie-Willow	Carlton	Individual Permit	Active	1
			Inactive	2
St. Louis	Carlton	Individual Permit	Inactive	1
Kettle	Carlton	Individual Permit	Inactive	1
St. Louis	Carlton	General Permit Authorization	Active	4
			Inactive	3
		Individual Permit	Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-37-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-37-L3.mxd

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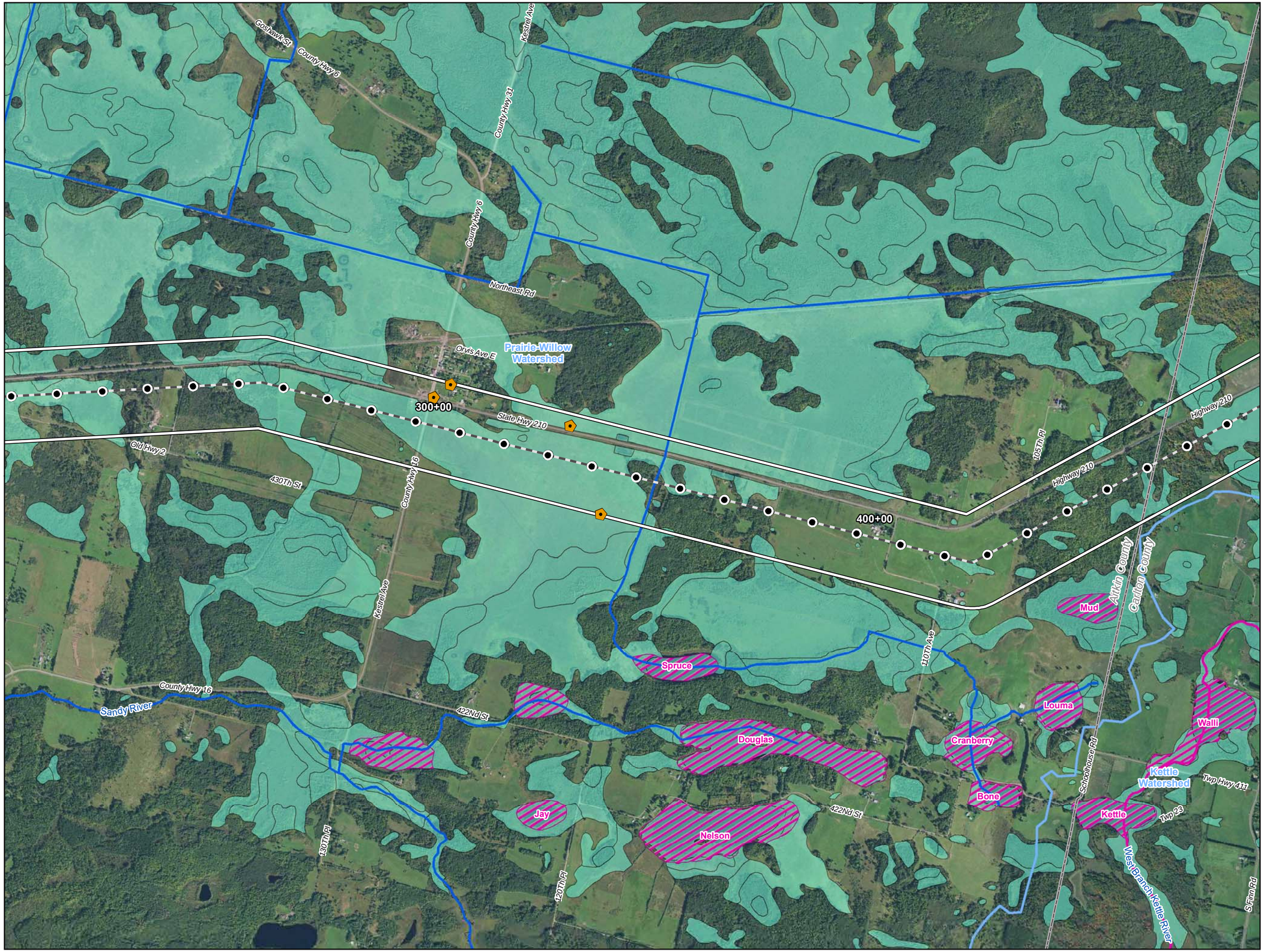



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Figure 2

Line 3 Replacement Project

RSA-37-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

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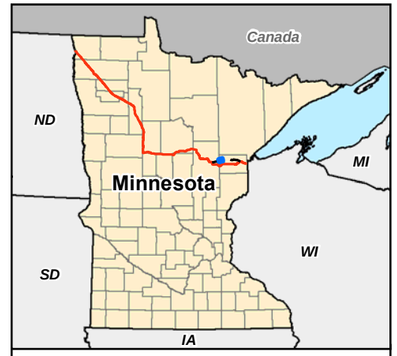

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Figure 3

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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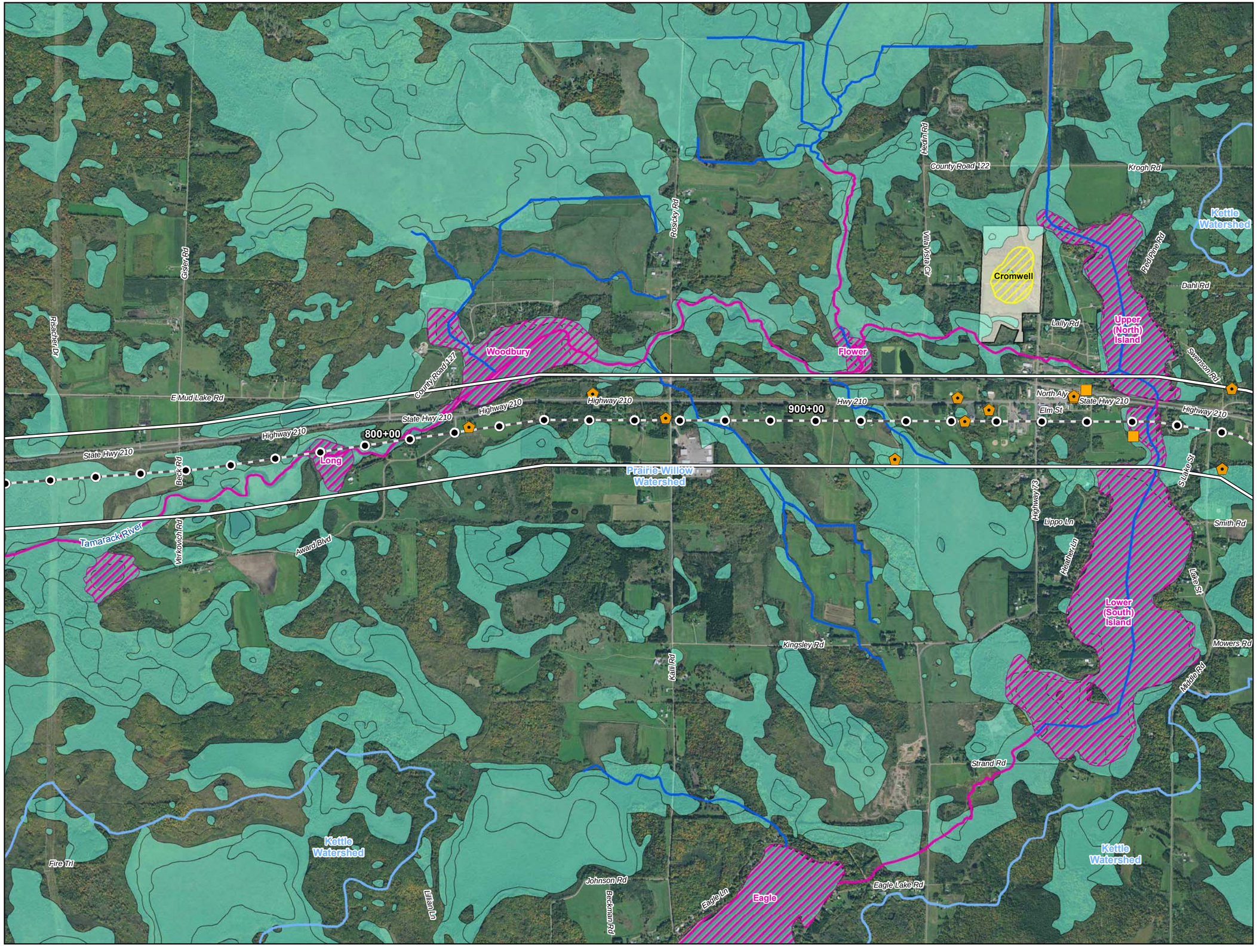

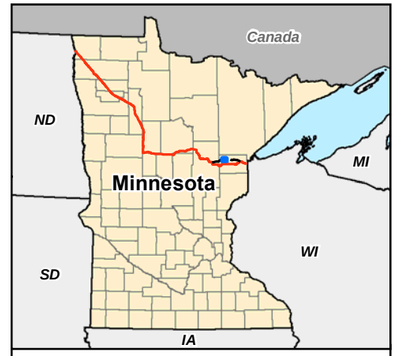

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Figure 4

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

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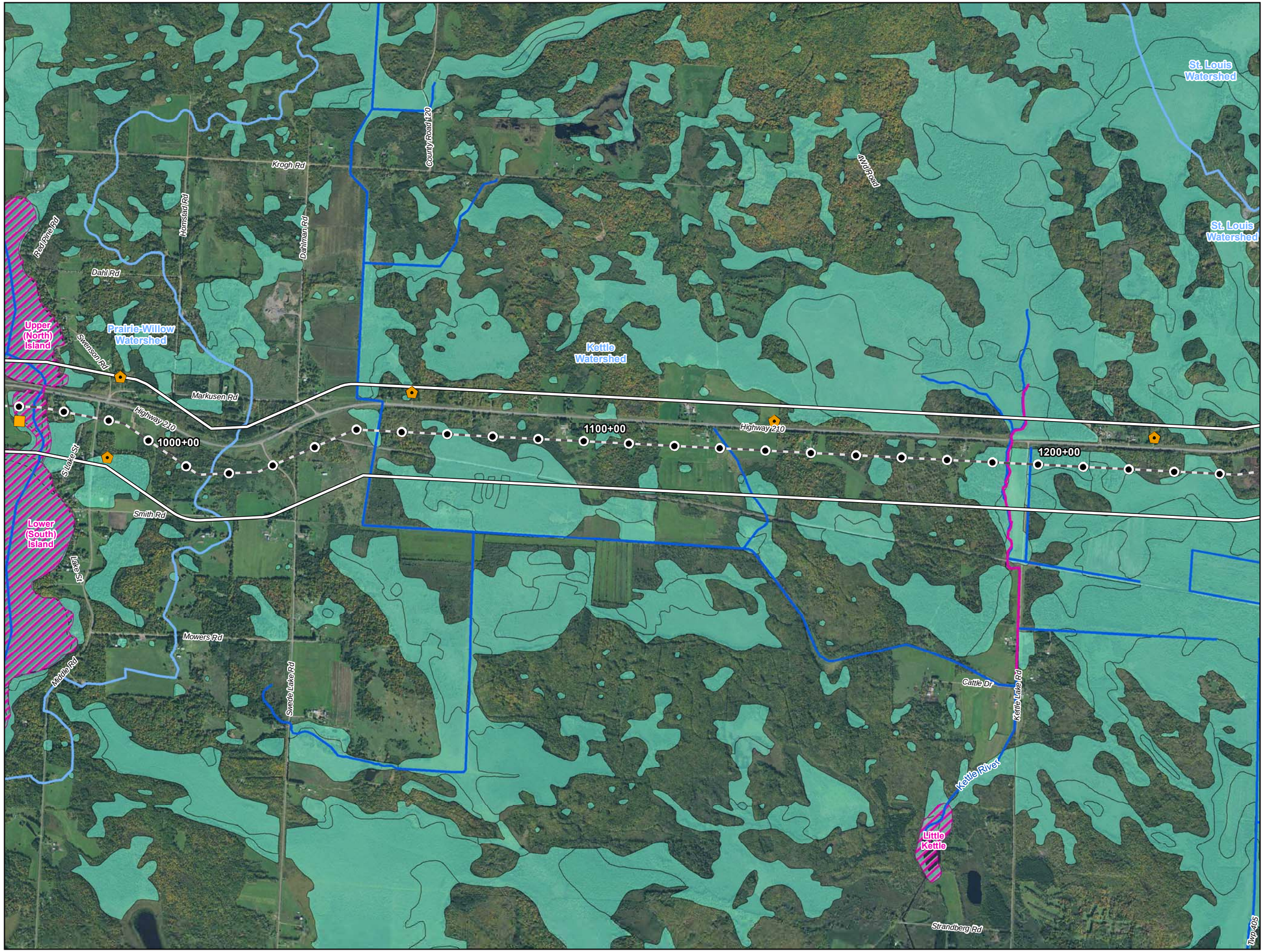



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Figure 5

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

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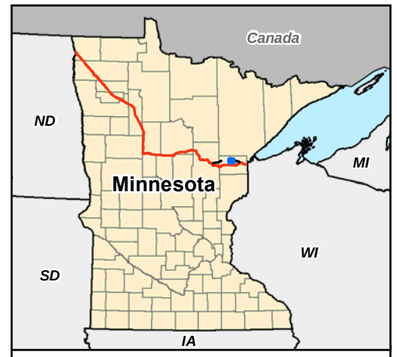

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Figure 6

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

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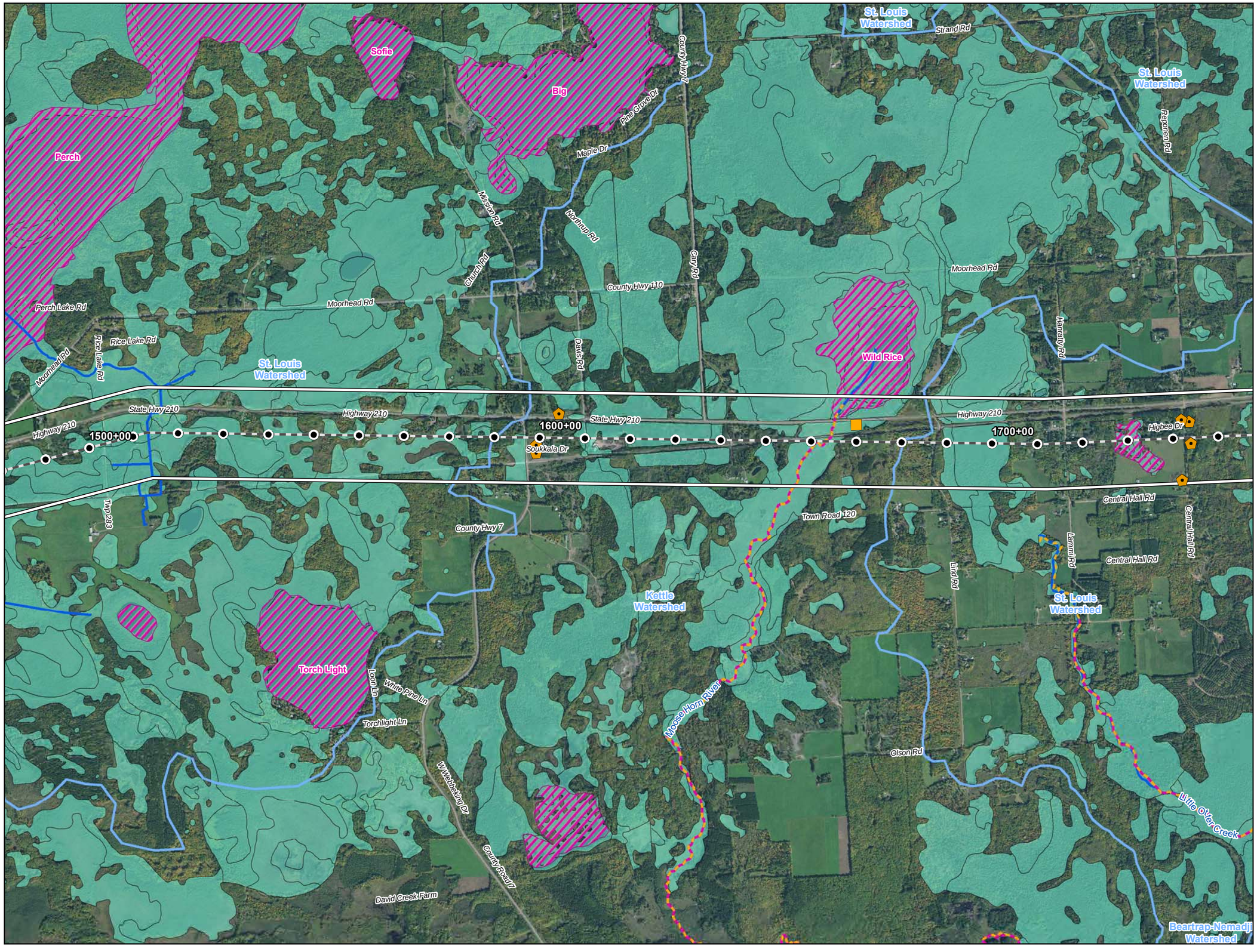

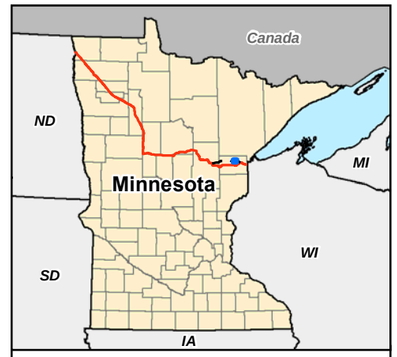

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Figure 7

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

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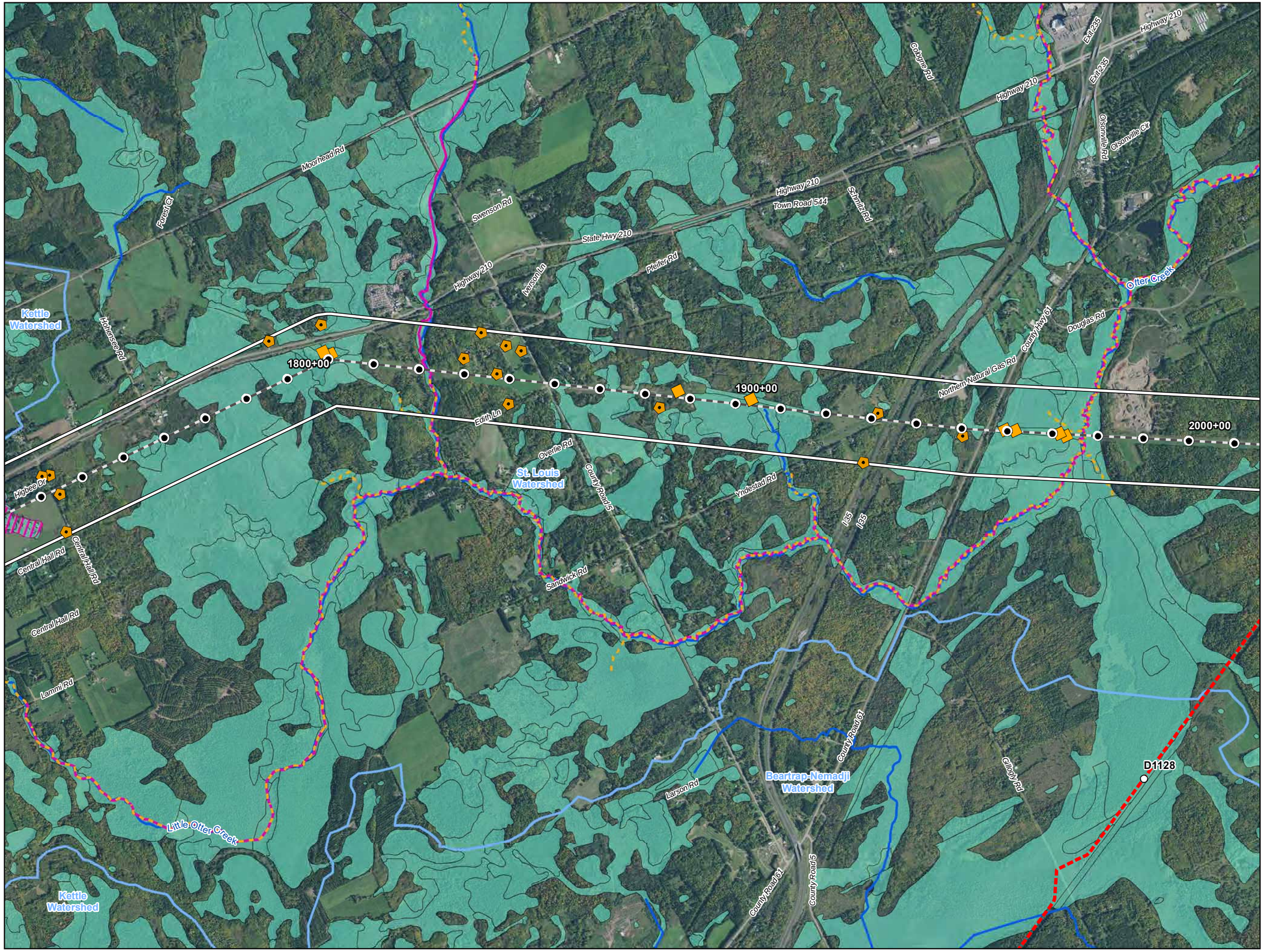

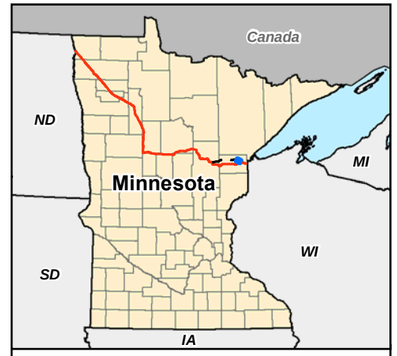

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Figure 8

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

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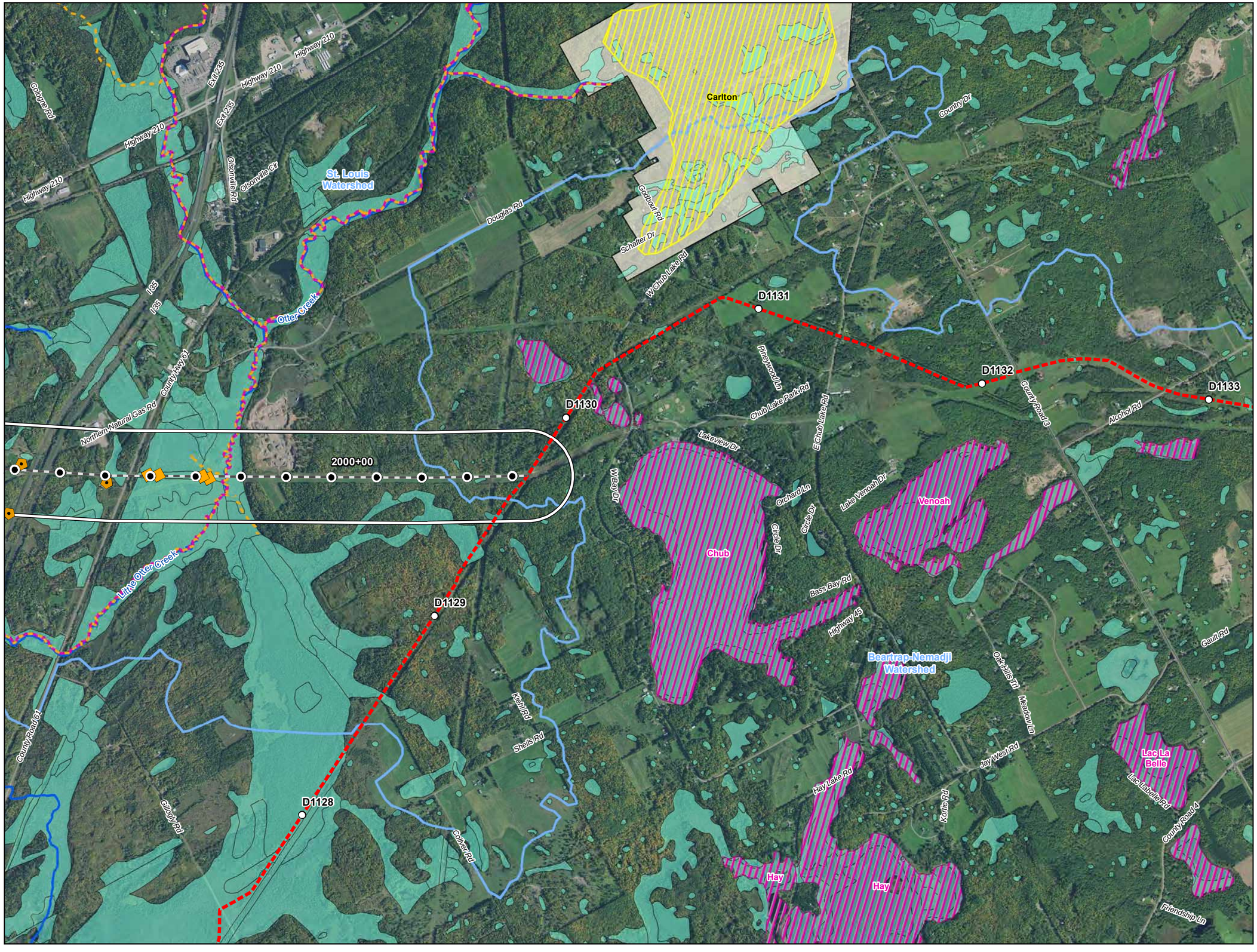

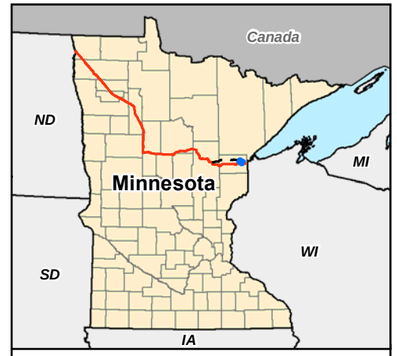

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Figure 9

Line 3 Replacement Project

RSA-37-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Date: 11/0/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-42

DRAFT

Table 1
Line 3 Replacement Project – RSA-42-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**1**	**2.47**
Carlton	1	2.47
Grand Total [c]	**1**	**2.47**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RA-42-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Kettle	**1**	**1**	**1**	**3**	**2.5**	**0.7**	**1.0**	**4.1**
Carlton	1	1	1	3	2.5	0.7	1.0	4.1
Beartrap-Nemadji	-	**-**	**-**	**-**	**0.4**	**-**	**-**	**0.4**
Carlton	**-**	**-**	**-**	**-**	0.4	-	**-**	0.4
Grand Total [c]	**1**	**1**	**1**	**3**	**2.9**	**0.7**	**1.0**	**4.5**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-42-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Kettle	**0.7**	**1.1**	**-**	**1.8**	**57.1**	**288.1**	**-**	**345.1**
Carlton	0.7	1.1	-	1.8	57.1	288.1	-	345.1
Beartrap-Nemadji	**0.0**	**0.4**	**-**	**0.4**	**6.1**	**112.4**	**-**	**118.5**
Carlton	0.0	0.4	-	0.4	6.1	112.4	-	118.5
Grand Total [d]	**0.7**	**1.5**	**0.0**	**2.2**	**63.1**	**400.5**	**0.0**	**463.6**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-42-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**2**	**2.45**
Carlton	2	2.45
Grand Total [c]	**2**	**2.45**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the Route Segment Alternative centerline.

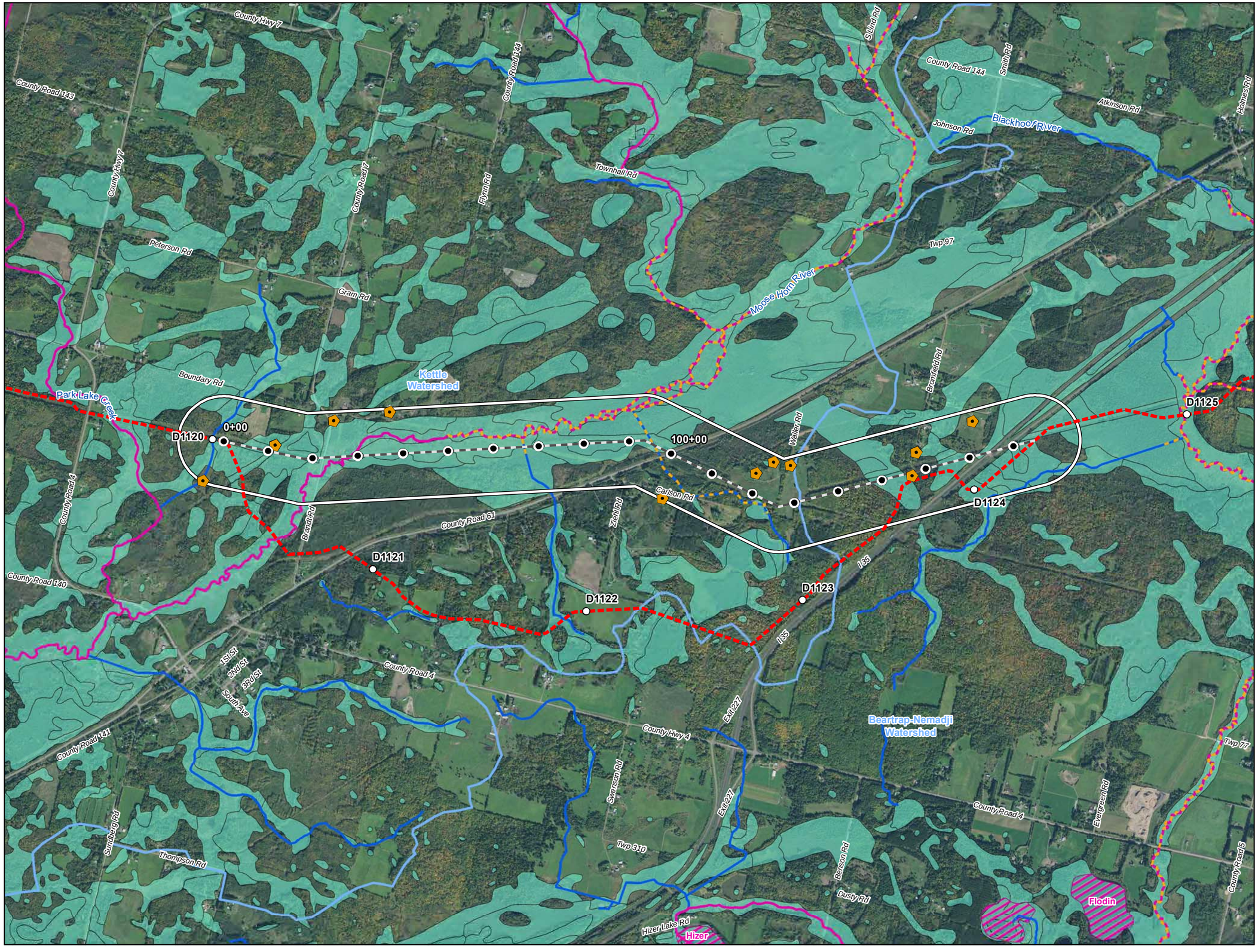
b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-42-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Kettle	Carlton	Domestic	811	6
			936	
			964	
			445	
			635	
			381	
		Exploration	976	2
			162	
Beartrap-Nemadji	Carlton	Domestic	406	3
			68	
			760	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-42-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-42-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-43

DRAFT

Table 1
Line 3 Replacement Project – RSA-43-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**-**	**0.59**
Carlton	-	0.59
Grand Total [c]	**-**	**0.59**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-43-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Kettle	**-**	**1**	**1**	**2**	**0.6**	**0.5**	**1.0**	**2.1**
Carlton	-	1	1	2	0.6	0.5	1.0	2.1
Beartrap-Nemadji	-	-	**-**	**-**	**0.4**	**-**	**-**	**0.4**
Carlton	**-**	**-**	**-**	**-**	0.4	-	**-**	0.4
Grand Total [c]	**-**	**1**	**1**	**2**	**1.0**	**0.5**	**1.0**	**2.5**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-43-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Kettle	**-**	**0.5**	**-**	**0.5**	**2.7**	**139.9**	**-**	**142.6**
Carlton	-	0.5	-	0.5	2.7	139.9	-	142.6
Beartrap-Nemadji	**-**	**0.4**	**-**	**0.4**	**6.1**	**112.4**	**-**	**118.5**
Carlton	-	0.4	-	0.4	6.1	112.4	-	118.5
Grand Total [d]	**0.0**	**0.9**	**0.0**	**0.9**	**8.7**	**252.4**	**0.0**	**261.1**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-43-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**1**	**1.44**
Carlton	**1**	1.44
Grand Total [c]	**1**	**1.44**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the Route Segment Alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-43-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Kettle	Carlton	Domestic	123	7
			711	
			819	
			964	
			445	
			635	
			381	
Beartrap-Nemadji	Carlton	Domestic	406	3
			68	
			760	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-43-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-43-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-44

DRAFT

Table 1
Line 3 Replacement Project – RSA-44-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**-**	**1.3**
Carlton	-	1.3
St. Louis	**2**	**1.1**
Carlton	2	1.1
Grand Total [c]	**2**	**2.4**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-44-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Kettle	**-**	**1**	**1**	**2**	**1.3**	**0.5**	**0.4**	**2.1**
Carlton	-	1	1	2	1.3	0.5	0.4	2.1
Beartrap-Nemadji	**2**	**1**	**-**	**3**	**1.0**	**0.5**	**-**	**1.5**
Carlton	2	1	-	3	1.0	0.5	-	1.5
St. Louis	**2**	**-**	**-**	**2**	**1.0**	**-**	**-**	**1.0**
Carlton	2	-	-	2	1.0	-	-	1.0
Grand Total [c]	**4**	**2**	**1**	**7**	**3.3**	**1.0**	**0.4**	**4.7**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed Route Segment Alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-44-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Kettle	**0.1**	**1.4**	**-**	**1.5**	**10.2**	**274.3**	**-**	**284.5**
Carlton	0.1	1.4	-	1.5	10.2	274.3	-	284.5
Beartrap-Nemadji	**-**	**1.1**	-	**1.1**	**16.5**	**170.2**	**1.5**	**188.2**
Carlton	-	1.1	-	1.1	16.5	170.2	1.5	188.2
St. Louis	**-**	**1.0**	-	**1.0**	**16.8**	**177.0**	**1.4**	**195.2**
Carlton	-	1.0	-	1.0	16.8	177.0	1.4	195.2
Grand Total [d]	**0.1**	**3.5**	-	**3.6**	**43.5**	**621.4**	**3.0**	**667.9**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed Route Segment Alternative centerline.

b Total acres of NWI within the 2000-ft-wide Route Segment Alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RA-44-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**1**	**1.7**
Carlton	**1**	1.7
St. Louis	**2**	**1.5**
Carlton	2	1.5
Grand Total [c]	**3**	**3.2**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the proposed Route Segment Alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide Route Segment Alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project - RSA-44-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

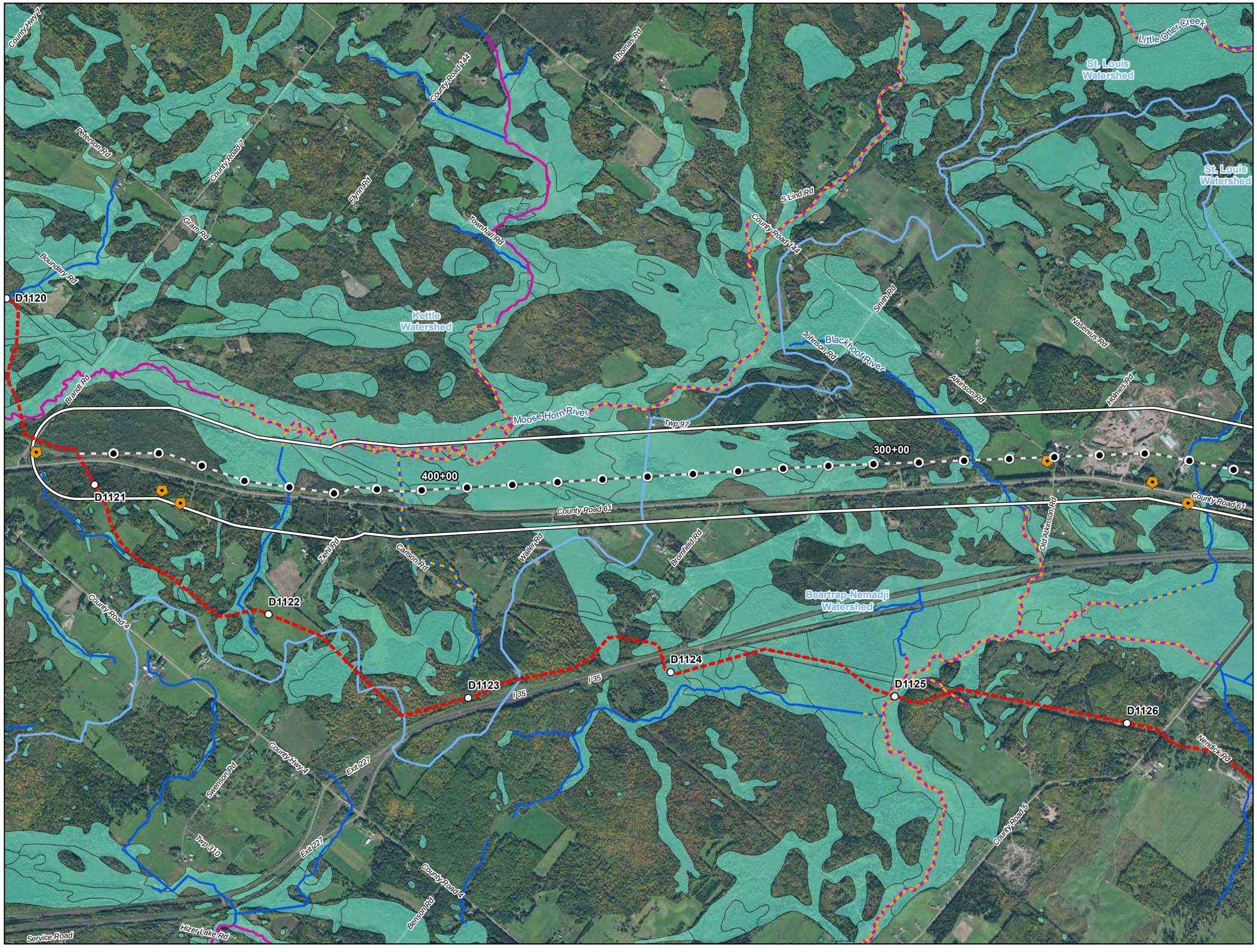
Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Kettle	Carlton	Domestic	123	3
			711	
			819	
Beartrap-Nemadji	Carlton	Domestic	68	4
			610	
			743	
			15	
St. Louis	Carlton	Domestic	23	3
			338	
			35	
		Other	54	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – RSA-44-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Permit Type	Permit Status	Total
St. Louis	Carlton	General Permit Authorization	Active	3
			Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-44-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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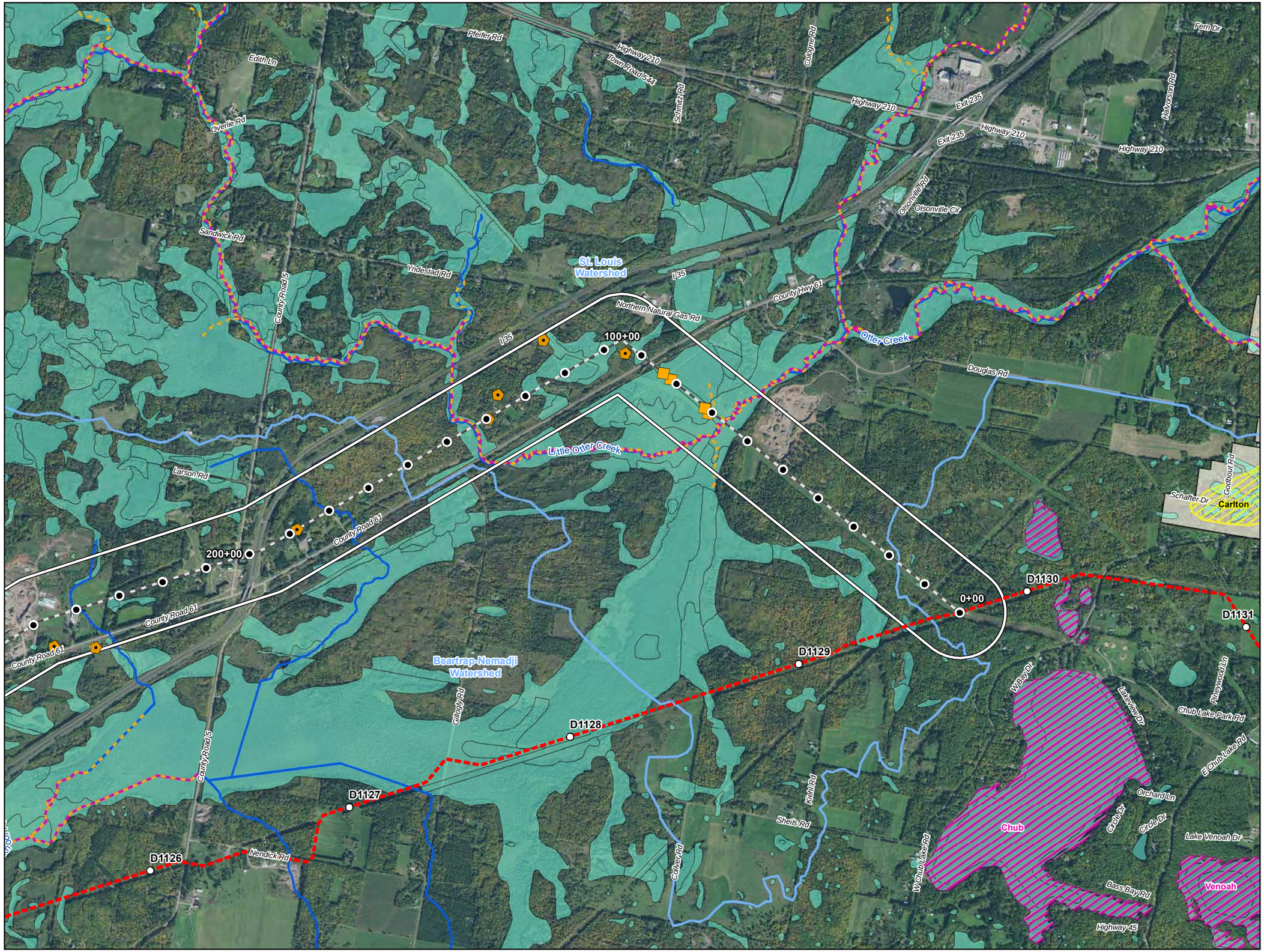
Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\20161\0\Pinhole_Maps\RSA-44-L3.mxd

Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
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- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-44-L3

Enbridge

Carlton County, Minnesota

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-44-L3.mxd
Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-45

DRAFT

Table 1
Line 3 Replacement Project – RSA-45-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Kettle	**-**	**0.6**
Carlton	-	0.6
Beartrap-Nemadji	**1**	**0.4**
Carlton	1	0.4
St. Louis	**2**	**1.7**
Carlton	2	1.7
Grand Total [c]	**3**	**2.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route segment alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-45-L3
Summary of Waterbodies Crossed by the Proposed Segment Route Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
St. Louis	**2**	**-**	**-**	**2**	**1.4**	**-**	**-**	**1.4**
Carlton	2	-	-	2	1.4	-	-	1.4
Beartrap-Nemadji	**2**	**1**	**-**	**3**	**1.6**	**0.4**	**-**	**2.1**
Carlton	2	1	-	3	1.6	0.4	-	2.1
Kettle	-	**1**	**1**	**2**	**0.6**	**0.5**	**1.0**	**2.0**
Carlton	-	1	1	2	0.6	0.5	1.0	2.0
Grand Total [c]	**4**	**2**	**1**	**7**	**3.6**	**0.9**	**1.0**	**5.5**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-45-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Kettle	**0.0**	**0.5**	**0**	**0.5**	**2.0**	**139.2**	**0**	**141.3**
Carlton	0.0	0.5	0	0.5	2.0	139.2	0	141.3
Beartrap-Nemadji	**0.2**	**2.0**	**0**	**2.2**	**45.1**	**406.0**	**2.0**	**453.1**
Carlton	0.2	2.0	0	2.2	45.1	406.0	2.0	453.1
St. Louis	**0.1**	**0.5**	**0**	**0.7**	**20.9**	**175.2**	**1.4**	**197.5**
Carlton	0.1	0.5	0	0.7	20.9	175.2	1.4	197.5
Grand Total	**0.3**	**3.1**	**0**	**3.4**	**68.0**	**720.4**	**3.5**	**791.9**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-45-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Alternative Corridor** [b]
St. Louis	**2**	**2.0**
Carlton	2	2.0
Beartrap-Nemadji	**1**	**0.5**
Carlton	1	0.5
Kettle	**1**	**1.4**
Carlton	1	1.4
Grand Total [c]	**4**	**3.9**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route segment alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-45-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Kettle	Carlton	Domestic	123	7
			711	
			819	
			964	
			445	
			635	
			381	
Beartrap-Nemadji	Carlton	Domestic	530	15
			406	
			376	
			820	
			193	
			440	
			760	
			955	
			902	
			488	
			880	
			743	
			521	
			506	
			378	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – RA-45-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota [a]

Watershed Name	County	Permit Type	Permit Status	Total
St. Louis	Carlton	General Permit Authorization	Active	3
			Inactive	1
		Individual Permit	Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.

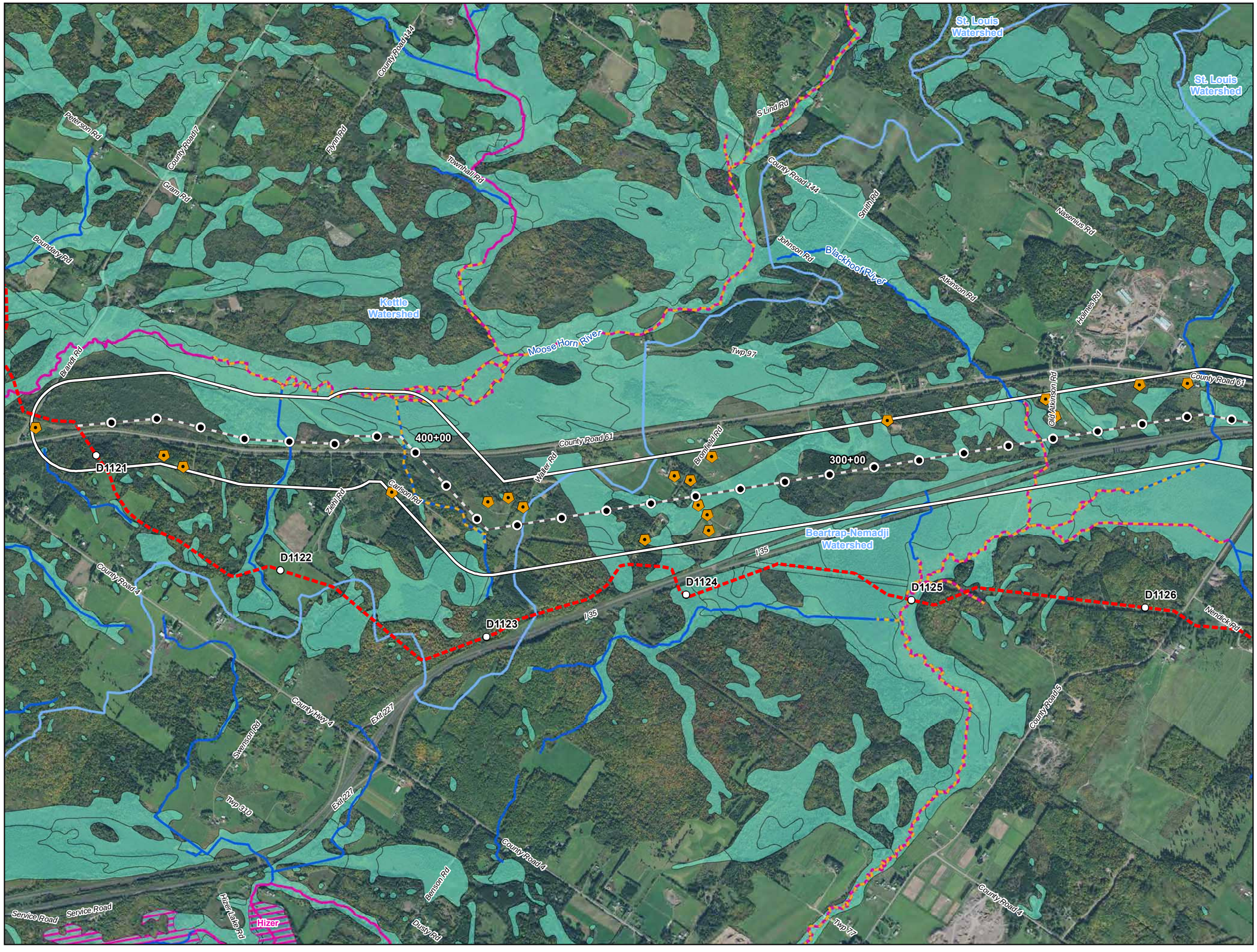


Figure 1

Line 3 Replacement Project

RSA-45-L3

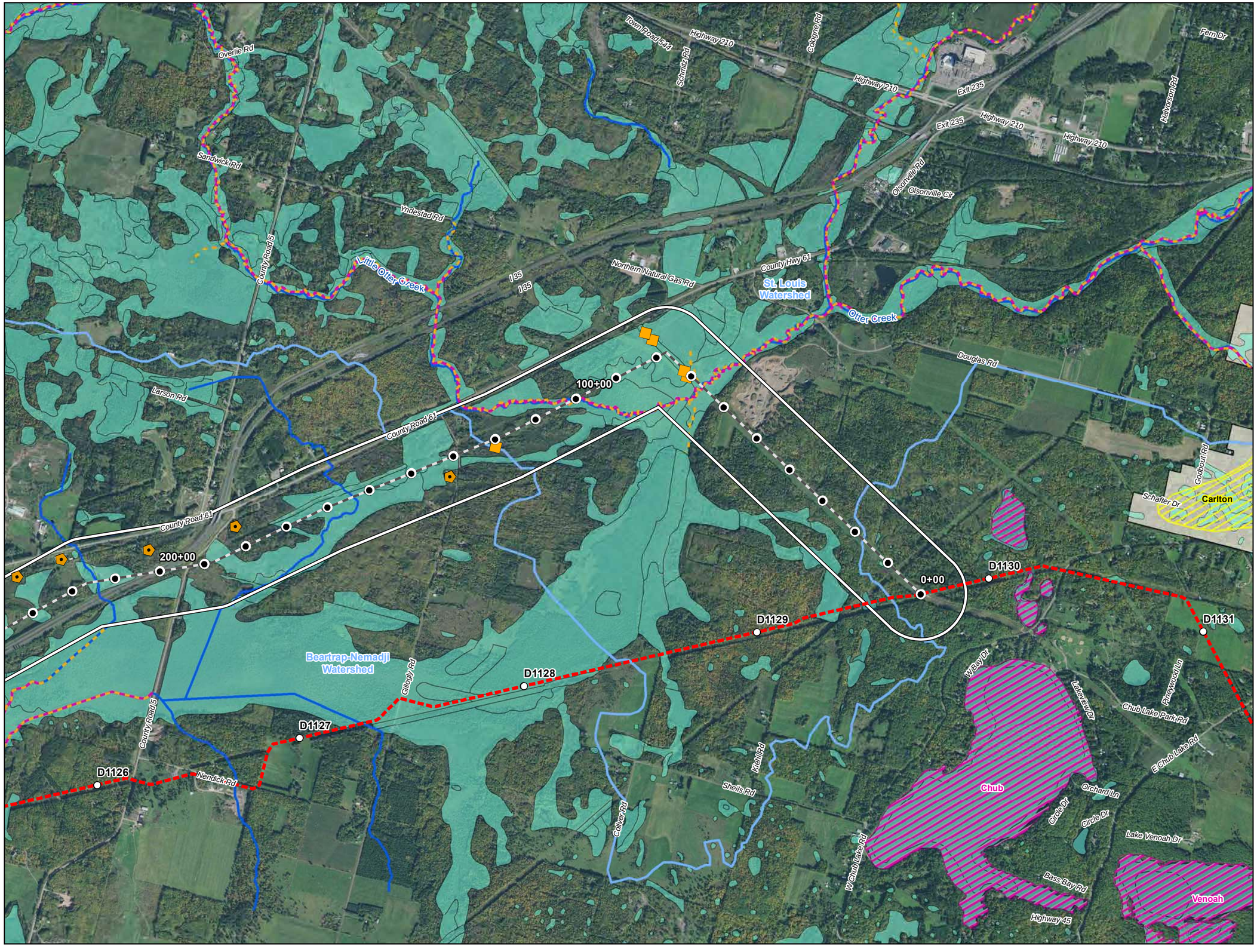
Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-45-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-45-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_P\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-45-L3.mxd

Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-46

DRAFT

Table 1
Line 3 Replacement Project - RSA-46-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Kettle	-	-	-	-	-	**0.8**	-	**0.8**
Carlton	-	-	-	-	-	0.8	-	0.8
Grand Total [c]	-	-	-	-	-	**0.8**	-	**0.8**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project – RSA-46-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Kettle	**0**	**0.4**	**0**	**0.4**	**2.1**	**56.7**	**0**	**58.8**
Carlton	0	0.4	0	0.4	2.1	56.7	0	58.8
Beartrap-Nemadji	**0**	**0.2**	**0**	**0.2**	**0**	**38.1**	**0**	**38.1**
Carlton	0	0.2	0	0.2	0	38.1	0	38.1
Grand Total	**0**	**0.6**	**0**	**0.6**	**2.1**	**94.8**	**0**	**96.9**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

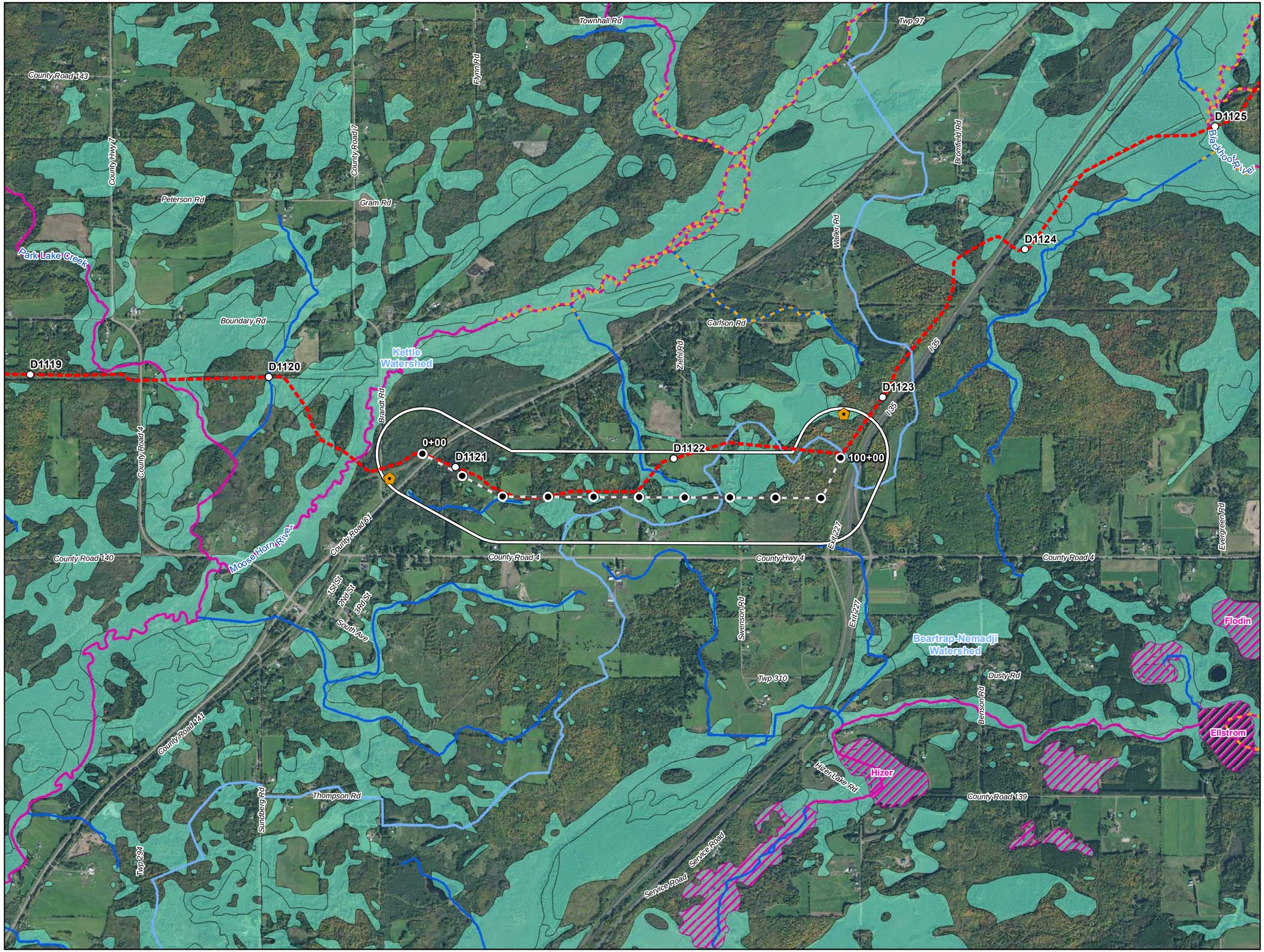
c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-46-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Kettle	Carlton	Domestic	123	1
		Exploration	883	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-46-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-46-L3.mxd

Date: (10/18/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-49

DRAFT

Table 1
Line 3 Replacement Project – RSA-49-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Beartrap-Nemadji	**3**	**2.0**
Carlton	3	2.0
St. Louis	**2**	**1.7**
Carlton	2	1.7
Grand Total [c]	**5**	**3.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route segment alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-49-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Number Crossed by the Proposed Route Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Beartrap-Nemadji	**3**	**3**	-	**6**	**3.6**	**0.8**	-	**4.5**
Carlton	3	3	-	6	3.6	0.8	-	4.5
St. Louis	**2**	**-**	**-**	**2**	**1.4**	**-**	**-**	**1.4**
Carlton	2	-	-	2	1.4	-	-	1.4
Grand Total [c]	**5**	**3**	**-**	**8**	**5.0**	**0.8**	**-**	**5.9**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-49-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Beartrap-Nemadji	**0.0**	**3.0**	**0.0**	**3.0**	**37.8**	**513.8**	**0.9**	**552.5**
Carlton	0.0	3.0	0.0	3.0	37.8	513.8	0.9	552.5
St. Louis	**0.1**	**0.5**	**0.0**	**0.7**	**20.9**	**175.2**	**1.4**	**197.5**
Carlton	0.1	0.5	0.0	0.7	20.9	175.2	1.4	197.5
Grand Total	**0.1**	**3.5**	**0.0**	**3.7**	**58.6**	**689.0**	**2.4**	**750.0**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-49-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Beartrap-Nemadji	**3**	**2.4**
Carlton	3	2.4
St. Louis	**2**	**2.0**
Carlton	2	2.0
Grand Total [c]	**5**	**4.4**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route segment alternative centerline.

b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-49-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota [a]

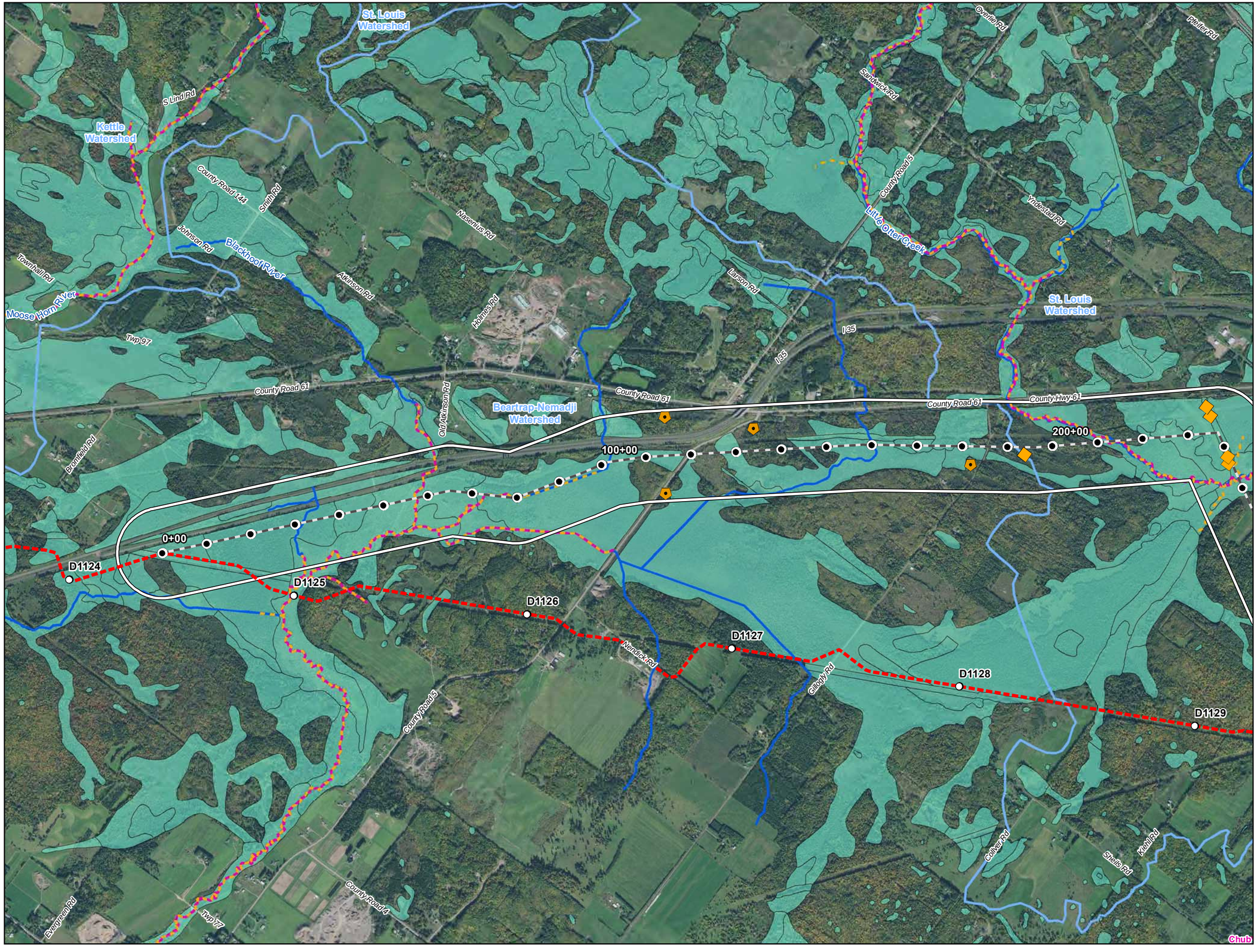
Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Beartrap-Nemadji	Carlton	Domestic	521	4
			814	
			506	
			378	

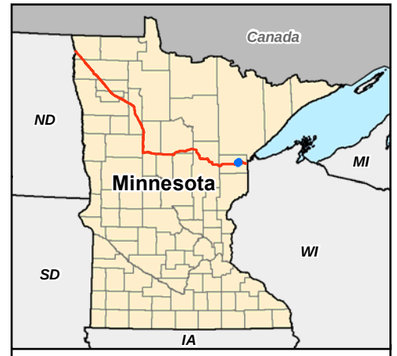
County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.

Table 6
Line 3 Replacement Project – RSA-49-L3
Surface Water Intakes within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota [a]

Watershed Name	County	Permit Type	Permit Status	Total
St. Louis	Carlton	General Permit Authorization	Active	3
			Inactive	1
		Individual Permit	Inactive	1

MPARS Minnesota DNR, Ecological and Water Resources, Sean Hunt, 651-259-5679
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-49-L3

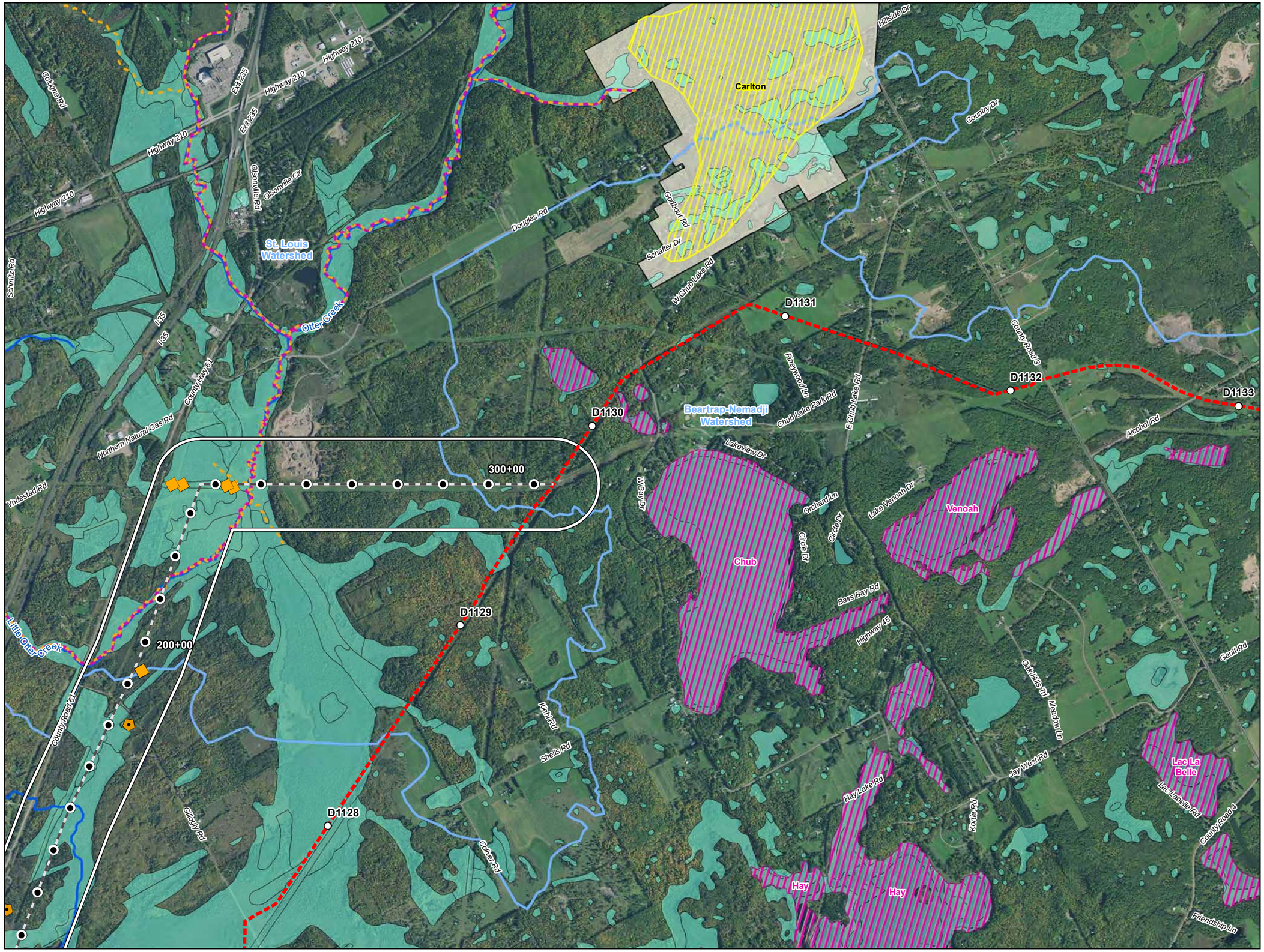
Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-49-L3.mxd
Date: (10/19/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-49-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-49-L3.mxd

Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-51

DRAFT

Table 1
Line 3 Replacement Project – RSA-51-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Beartrap-Nemadji	**2**	**0.7**
Carlton	2	0.7
Grand Total [c]	**2**	**0.7**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route segment alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Sandpiper Pipeline Project - RSA-51-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Beartrap-Nemadji	**3**	-	-	**3**	**1.3**	**0.1**	**0.8**	**2.2**
Carlton	3	-	-	3	1.3	0.1	0.8	2.2
Grand Total [c]	**3**	-	-	**3**	**1.3**	**0.1**	**0.8**	**2.2**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-51-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Beartrap-Nemadji	**0**	**0.7**	**0**	**0.7**	**0**	**166.1**	**0**	**166.1**
Carlton	0	0.7	0	0.7	0	166.1	0	166.1
Grand Total	**0**	**0.7**	**0**	**0.7**	**0**	**166.1**	**0**	**166.1**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-51-L3
Summary of Trout Streams Crossed by the Proposed Segment Route Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Beartrap-Nemadji	**2**	**0.8**
Carlton	2	0.8
Grand Total [c]	**2**	**0.8**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route segment alternative centerline.

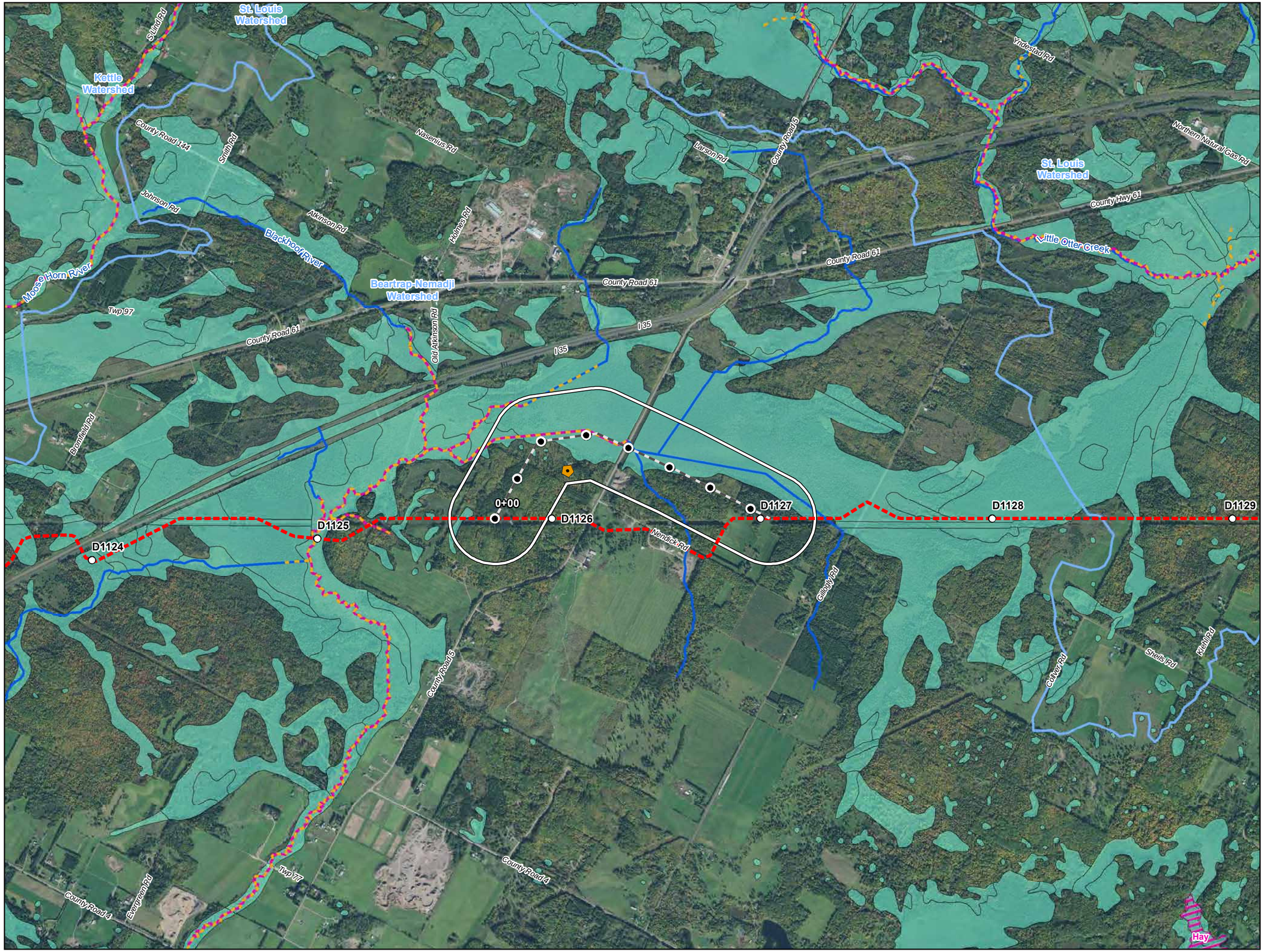
b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

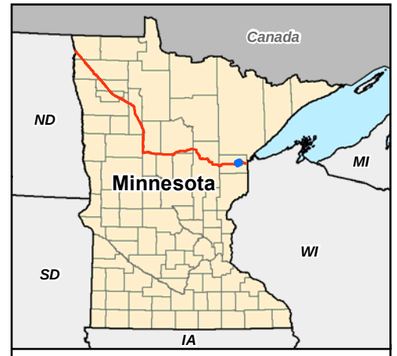
c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-51-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota [a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Beartrap-Nemadji	Carlton	Domestic	703	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
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- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-51-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

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Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-51-L3.mxd

Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-52

DRAFT

Table 1
Line 3 Replacement Project – RSA-52-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Beartrap-Nemadji	**-**	**0.1**
Carlton	-	0.1
Grand Total [c]	**-**	**0.1**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route segment alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-52-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Beartrap-Nemadji	**1**	-	-	**1**	**0.7**	-	**0.8**	**1.5**
Carlton	1	-	-	1	0.7	-	0.8	1.5
Grand Total [c]	**1**	-	-	**1**	**0.7**	-	**0.8**	**1.5**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-52-L3
Summary of USFWS National Wetlands Inventory Crossed by the Route Segment Alternative Proposed Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Beartrap-Nemadji	**0**	**0.1**	**0**	**0.1**	**0**	**83.1**	**0**	**83.1**
Carlton	0	0.1	0	0.1	0	83.1	0	83.1
Grand Total	**0**	**0.1**	**0**	**0.1**	**0**	**83.1**	**0**	**83.1**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-52-L3
Summary of Trout Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Beartrap-Nemadji	**0**	**0.1**
Carlton	0	0.1
Grand Total [c]	**0**	**0.1**

Trout Stream Data Source: https://gisdata.mn.gov/dataset/env-trout-stream-designations

a Number of trout streams crossed by the route segment alternative centerline.

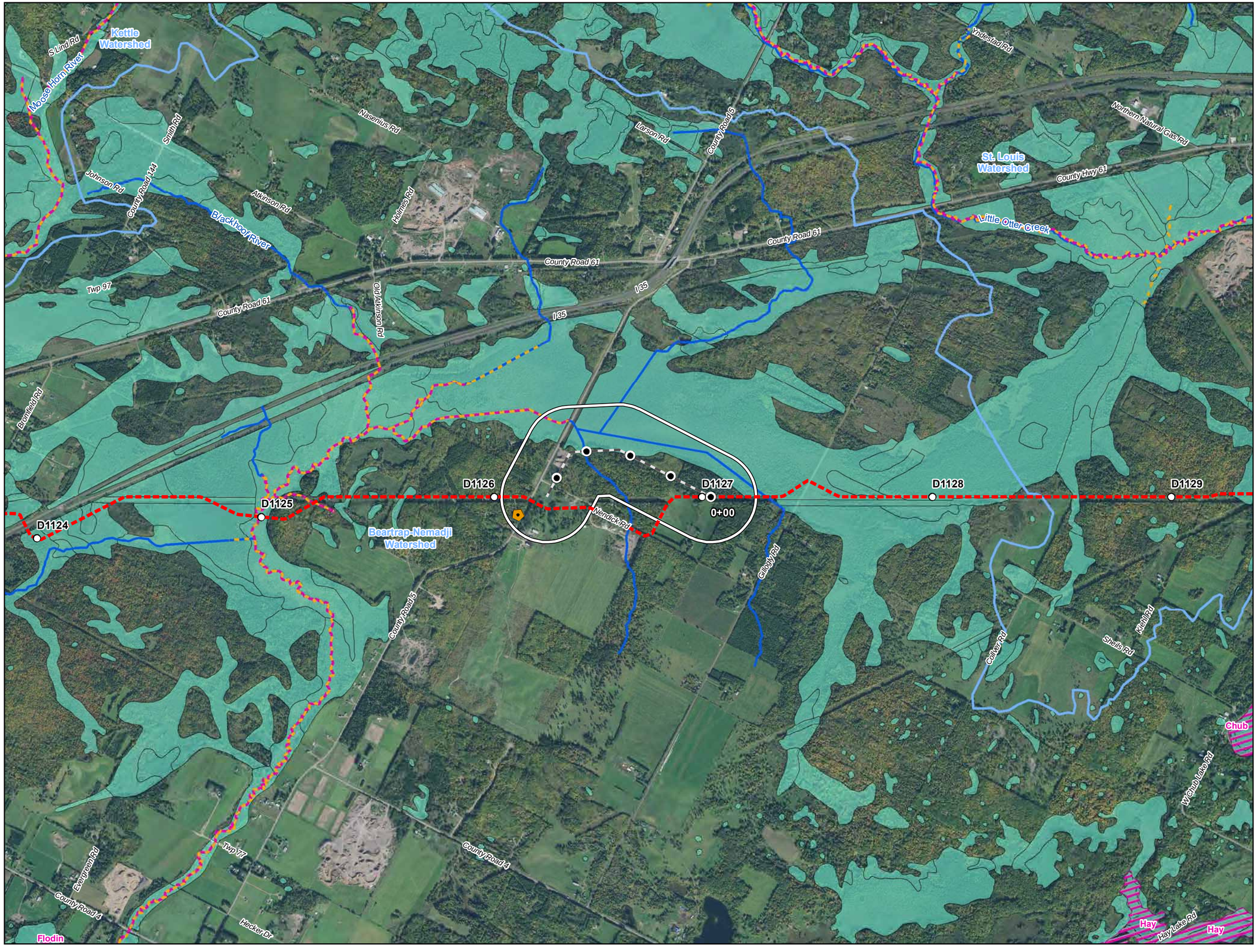
b Total miles of trout stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 5
Line 3 Replacement Project – RSA-52-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota [a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Beartrap-Nemadji	Carlton	Unknown	733	1

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
a Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-52-L3

Enbridge

Carlton County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinnole_Maps\RSA-52-L3.mxd
Date: (10/19/2016)

ATTACHMENT A

Natural Resource and Water Supply Summary Tables and Figures

Line 3 Replacement Project Route Segment Alternative (RSA)-White Elk Lake

DRAFT

Table 1
Line 3 Replacement Project – RSA-White Elk Lake-L3
Summary of Public Waters Inventory Streams Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	**Number Crossed by the Proposed Route Segment Alternative Centerline** [a]	**Miles Within the 2,000-ft-wide Route Segment Alternative Corridor** [b]
Prairie-Willow	**1**	**0.5**
Aitkin	1	0.5
Grand Total [c]	**1**	**0.5**

Public Waters Inventory (PWI) Stream Data Source: https://gisdata.mn.gov/dataset/water-mn-public-waters

a Number of Public Waters Inventory streams crossed by the proposed route segment alternative centerline.

b Total miles of Public Waters Inventory stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 2
Line 3 Replacement Project - RSA-White Elk Lake-L3
Summary of Waterbodies Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed / County	Number Crossed by the Proposed Route Segment Alternative Centerline [a]				Miles Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]	Perennial	Intermittent	Canal/Ditch/ Artificial Path/ Connector	Total [c]
Prairie-Willow	**1**	**1**	**-**	**2**	**0.8**	**0.4**	**0.1**	**1.3**
Aitkin	1	1	-	2	0.8	0.4	0.1	1.3
Grand Total [c]	**1**	**1**	**-**	**2**	**0.8**	**0.4**	**0.1**	**1.3**

USGS National Hydrography Dataset (NHD) Data Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

a Number of NHD waterbodies crossed by the proposed route segment alternative centerline.

b Miles of NHD stream segment(s) crossed by the 2000-ft-wide route segment alternative corridor.

c Numbers may not total consistently due to rounding.

Table 3
Line 3 Replacement Project – RSA-White Elk Lake-L3
Summary of USFWS National Wetlands Inventory Crossed by the Proposed Route Segment Alternative Centerline and within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota

Watershed County	Miles Crossed by the Proposed Route Segment Alternative Centerline [a]				Acres Within the 2,000-ft-wide Route Segment Alternative Corridor [b]			
	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]	PEM [c]	PFO/PSS [c]	Pond/Lake/ Riverine	Total [d]
Prairie-Willow	**1.3**	**1.0**	**-**	**2.3**	**274.4**	**352.2**	**0.9**	**627.5**
Aitkin	1.3	1.0	-	2.3	274.4	352.2	0.9	627.5
Elk-Nokasippi	**-**	**0.2**	**-**	**0.2**	**4.5**	**73.8**	**-**	**78.2**
Aitkin	-	0.2	-	0.2	4.5	73.8	-	78.2
Grand Total [d]	**1.3**	**1.2**	**-**	**2.5**	**278.8**	**426.0**	**0.9**	**705.7**

USFWS National Wetlands Inventory (NWI) Data Source: http://www.fws.gov/wetlands/data/Data-Download.html

a Total miles of NWI crossed by the proposed route segment alternative centerline.

b Total acres of NWI within the 2000-ft-wide route segment alternative corridor.

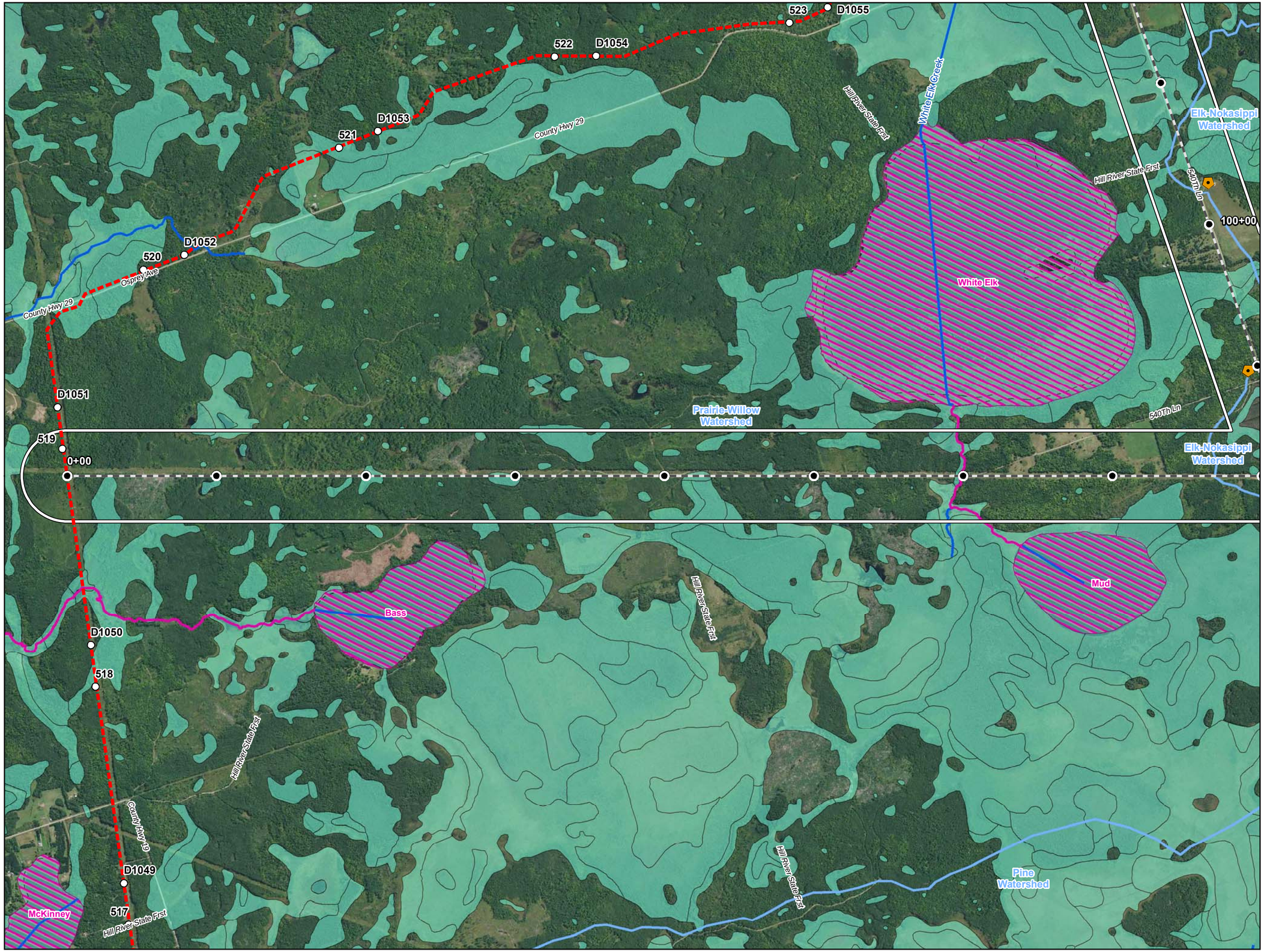
c PEM = Palustrine Emergent; PSS = Palustrine Scrub Shrub; PFO = Palustrine Forested (Cowardin et al. 1979).

d Numbers may not total consistently due to rounding.

Table 4
Line 3 Replacement Project – RSA-White Elk Lake-L3
Wells within the 2,000-ft-wide Route Segment Alternative Corridor in Minnesota[a]

Watershed Name	County	Well Type	Distance from Centerline (feet)	Total Number of Wells
Prairie-Willow	Aitkin	Domestic	242	1
Elk-Nokasippi	Aitkin	Domestic	258	1
Prairie-Willow	Aitkin	Domestic	683	3
			483	
			246	

County Well Index (CWI) Data Source: ftp://mgssun6.mngs.umn.edu/pub2/cwi4/cwilocs_nps.zip
[a] Municipal wells are not included in the source data.





0 1,000 2,000 Feet

1 inch = 2,000 feet

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 1

Line 3 Replacement Project

RSA-White Elk Lake-L3

Enbridge

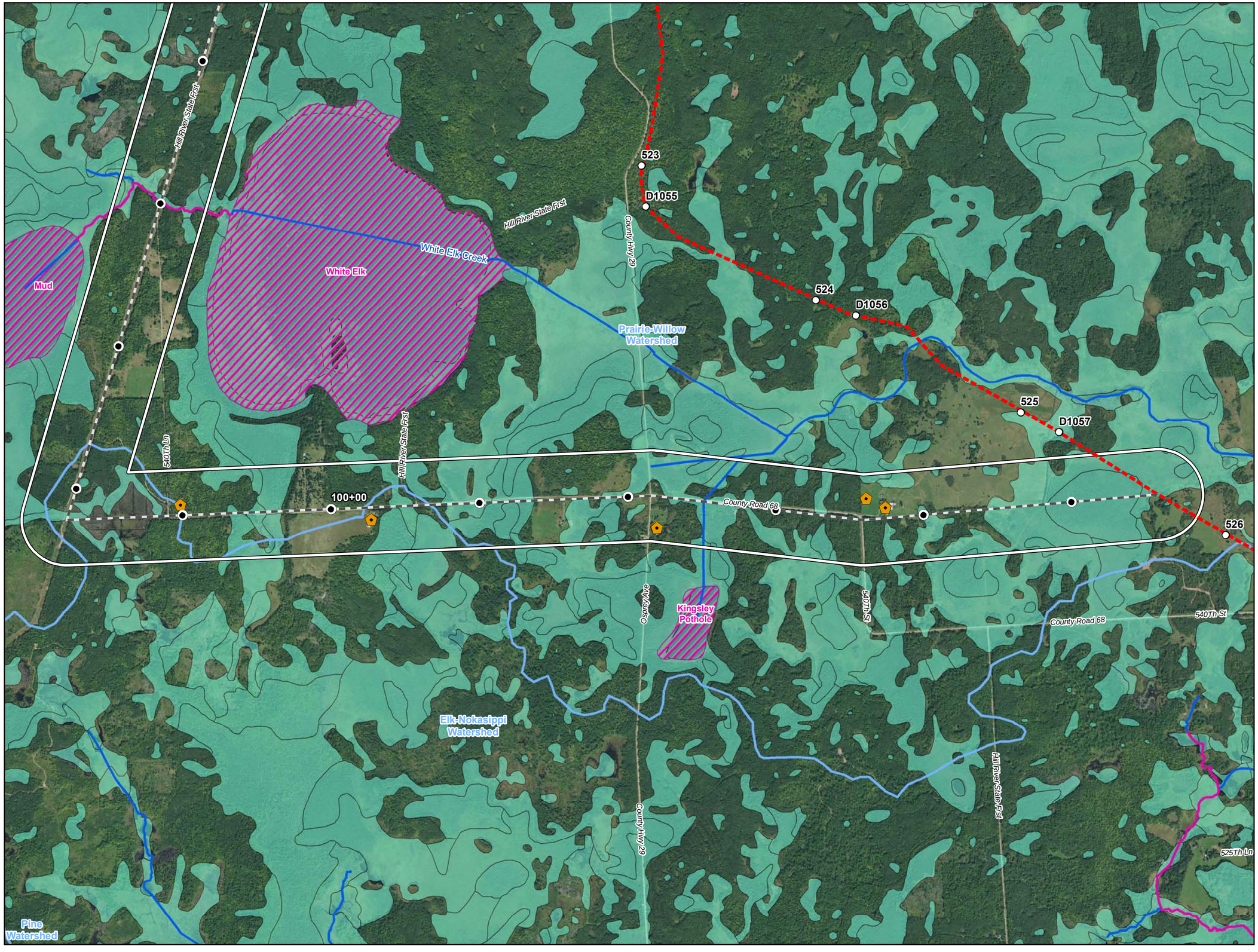
Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\10\Pinhole_Maps\RSA-WhiteEarthLake-L3.mxd

Date: (10/18/2016)





0 1,000 2,000 Feet

1 inch = 2,000 feet

N W E S

- Water Well
- Surface Water Intake
- Calcareous Fen
- Line 3 Milepost
- Alternative Stationing
- Proposed Line 3 Replacement Pipeline
- Alternative Centerline
- 2,000 ft Alternative Corridor
- Trout Stream
- PWI Stream
- NHD Stream
- PWI Basin
- NWI
- Watershed Boundary
- WHPA
- DWSMA
- County Boundary

Figure 2

Line 3 Replacement Project

RSA-White Elk Lake-L3

Enbridge

Aitkin County, Minnesota

ENBRIDGE

For Environmental Review Purposes Only

Source: Z:\Clients\E_H\Enbridge\Line_3_Full_Replacement\ArcGIS\2016\Pinnole_Maps\RSA-WhiteElkLake-L3.mxd

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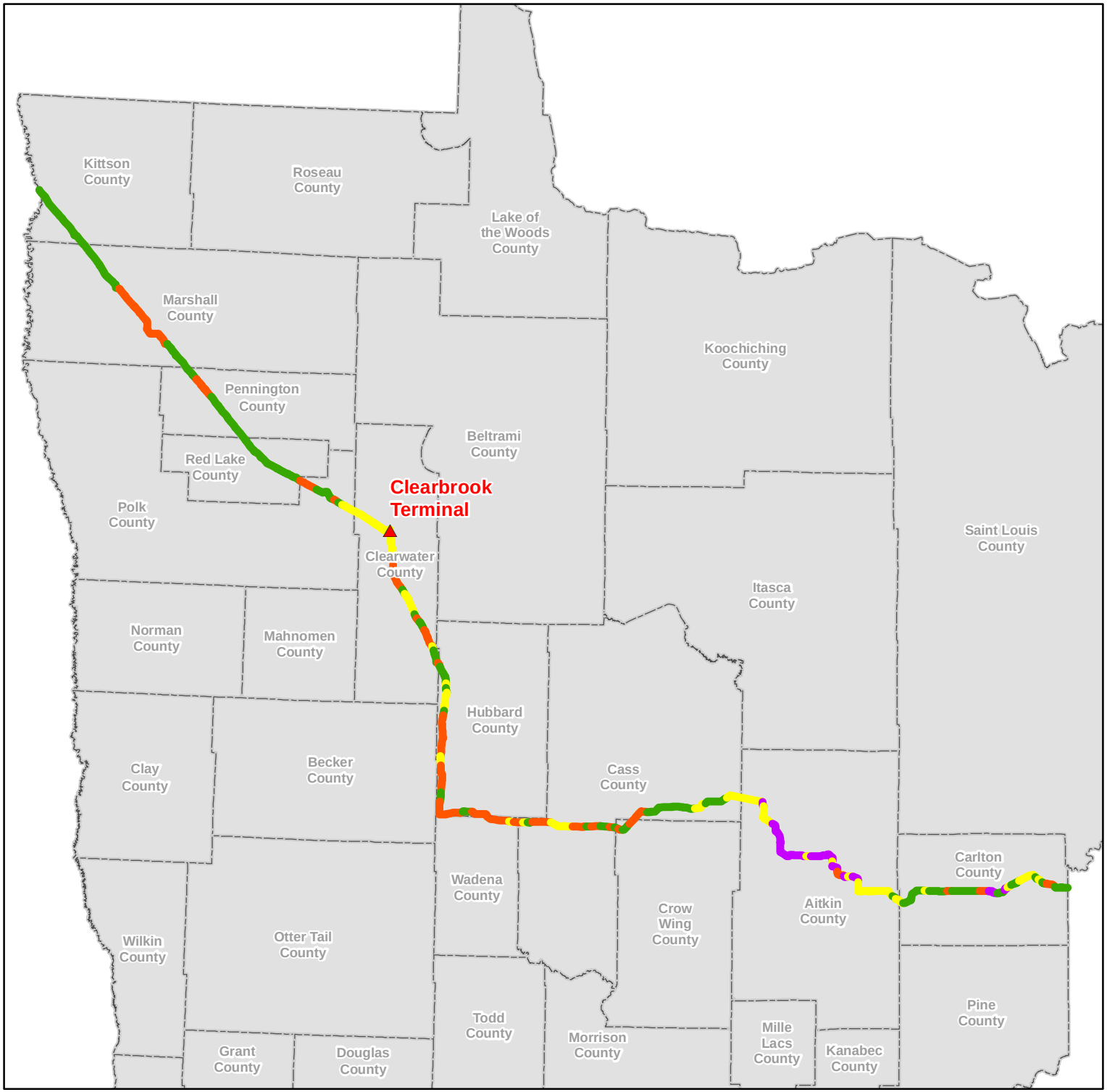
ATTACHMENT B



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

Preferred Route
Groundwater Susceptibility

ENBRIDGE

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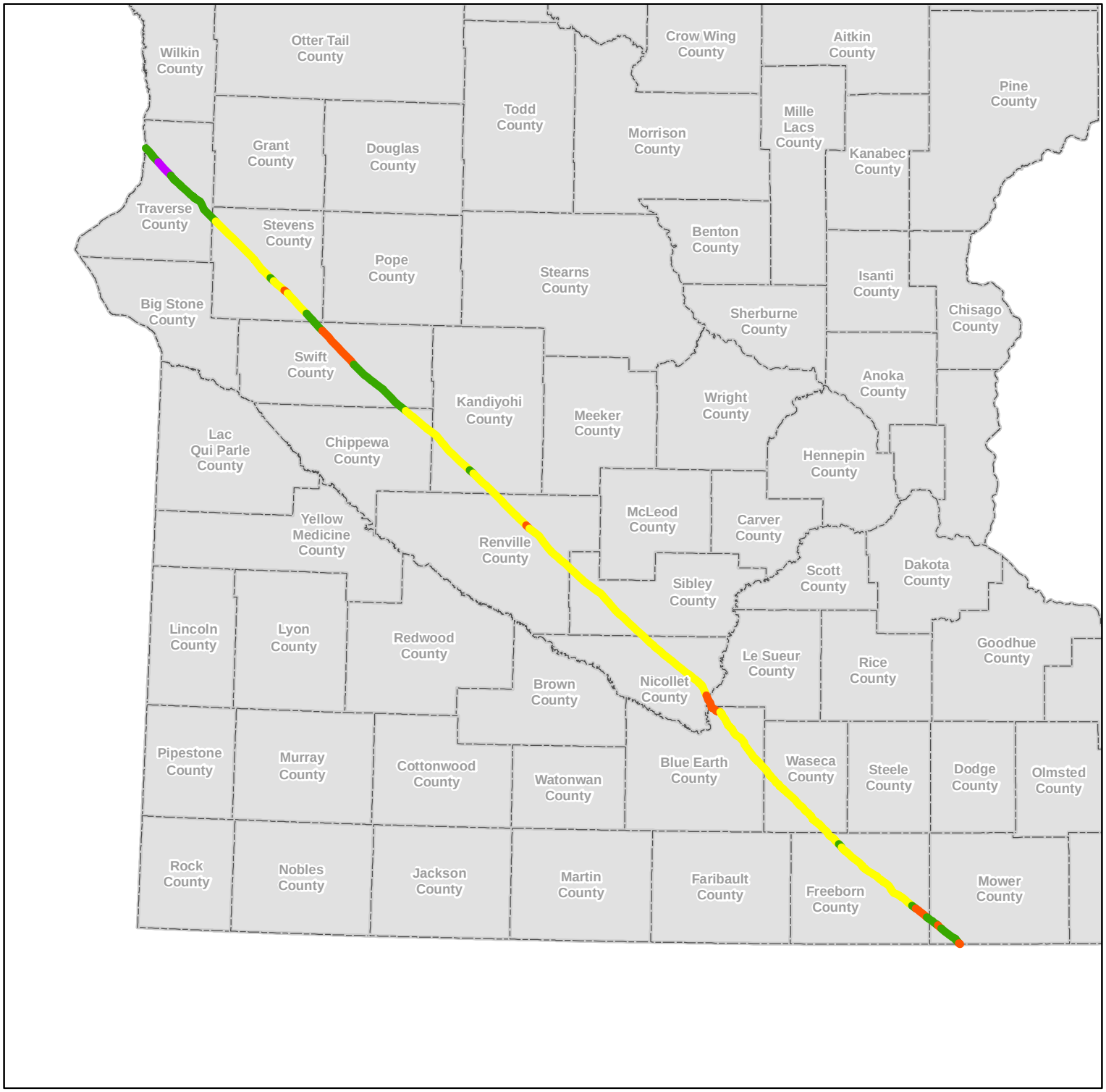


Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

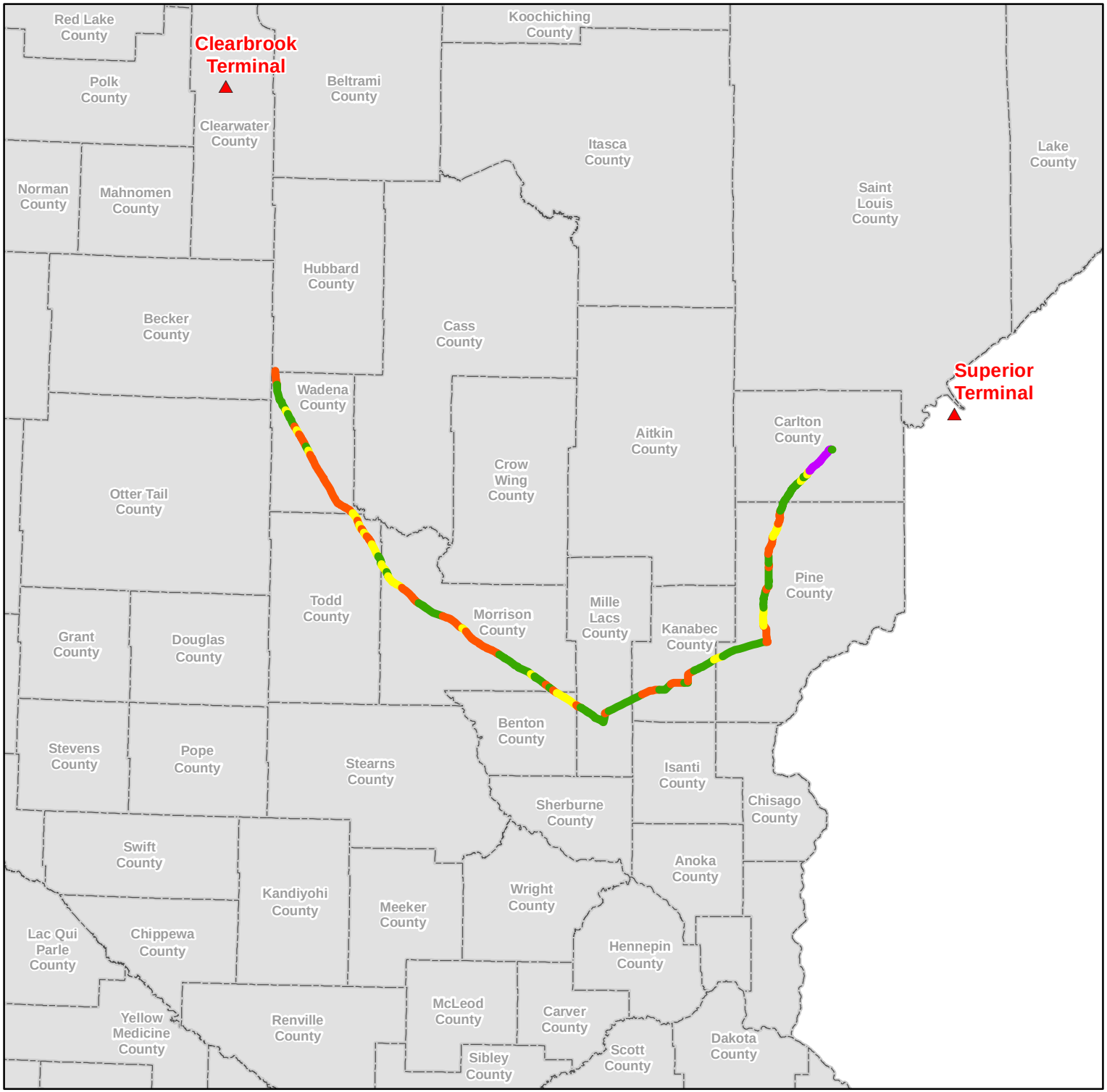
0 30 60

Miles

1 Inch = 30 Miles

SA-04-L3
Groundwater Susceptibility

ENBRIDGE



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RA-03AM-L3
Groundwater Susceptibility

ENBRIDGE

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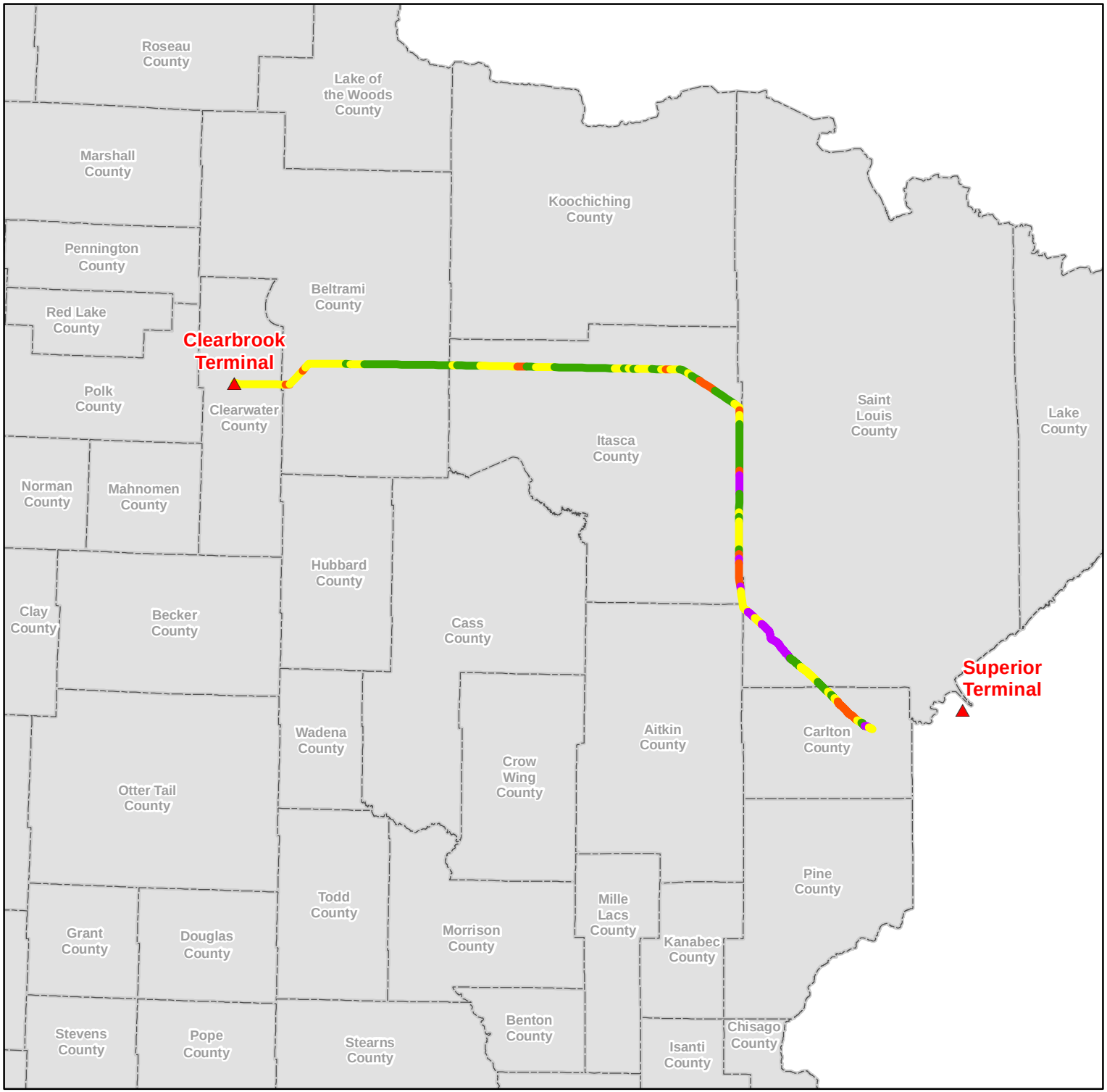

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RA-06-L3
Groundwater Susceptibility

ENBRIDGE

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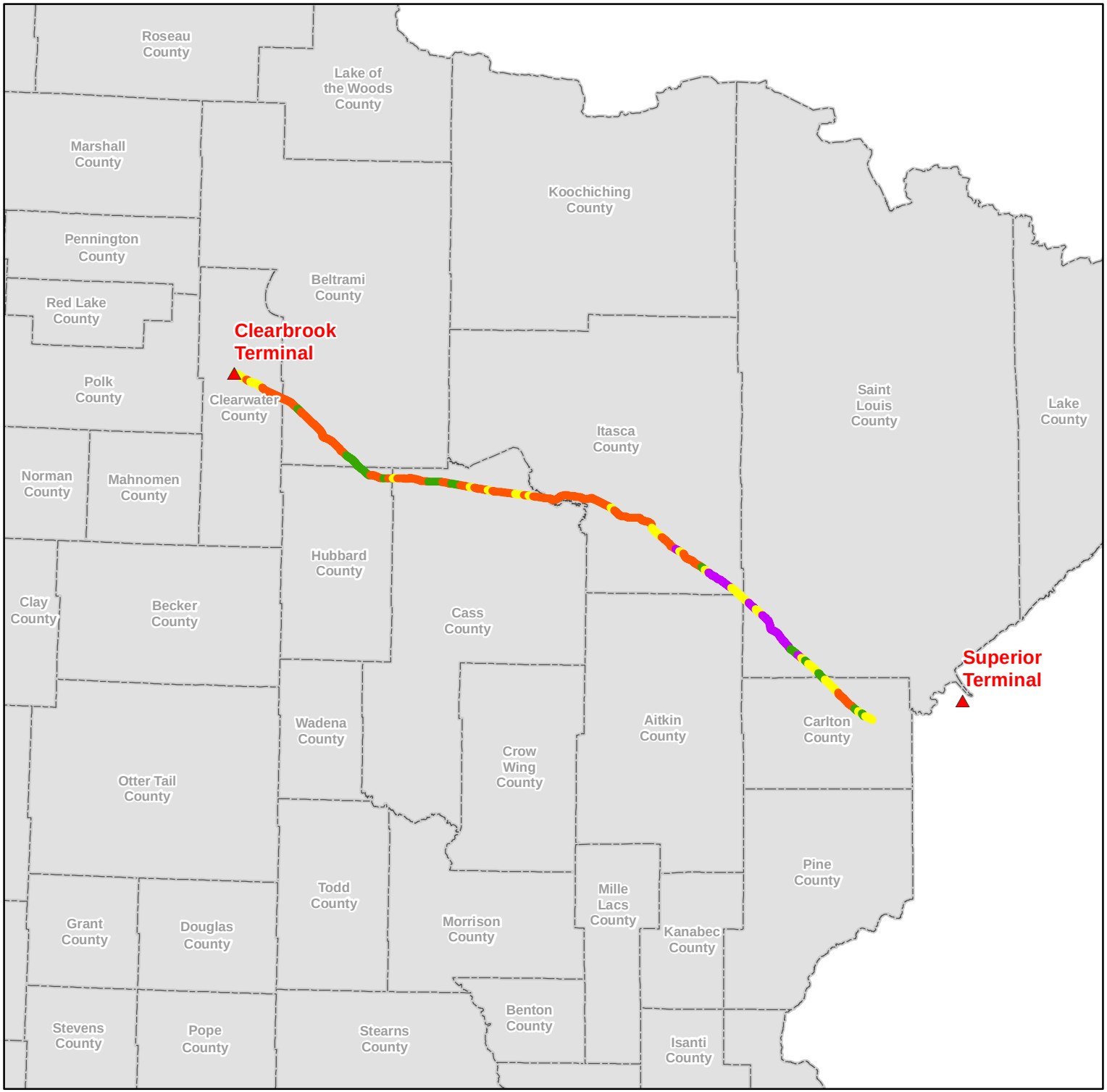

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RA-07-L3
Groundwater Susceptibility

ENBRIDGE

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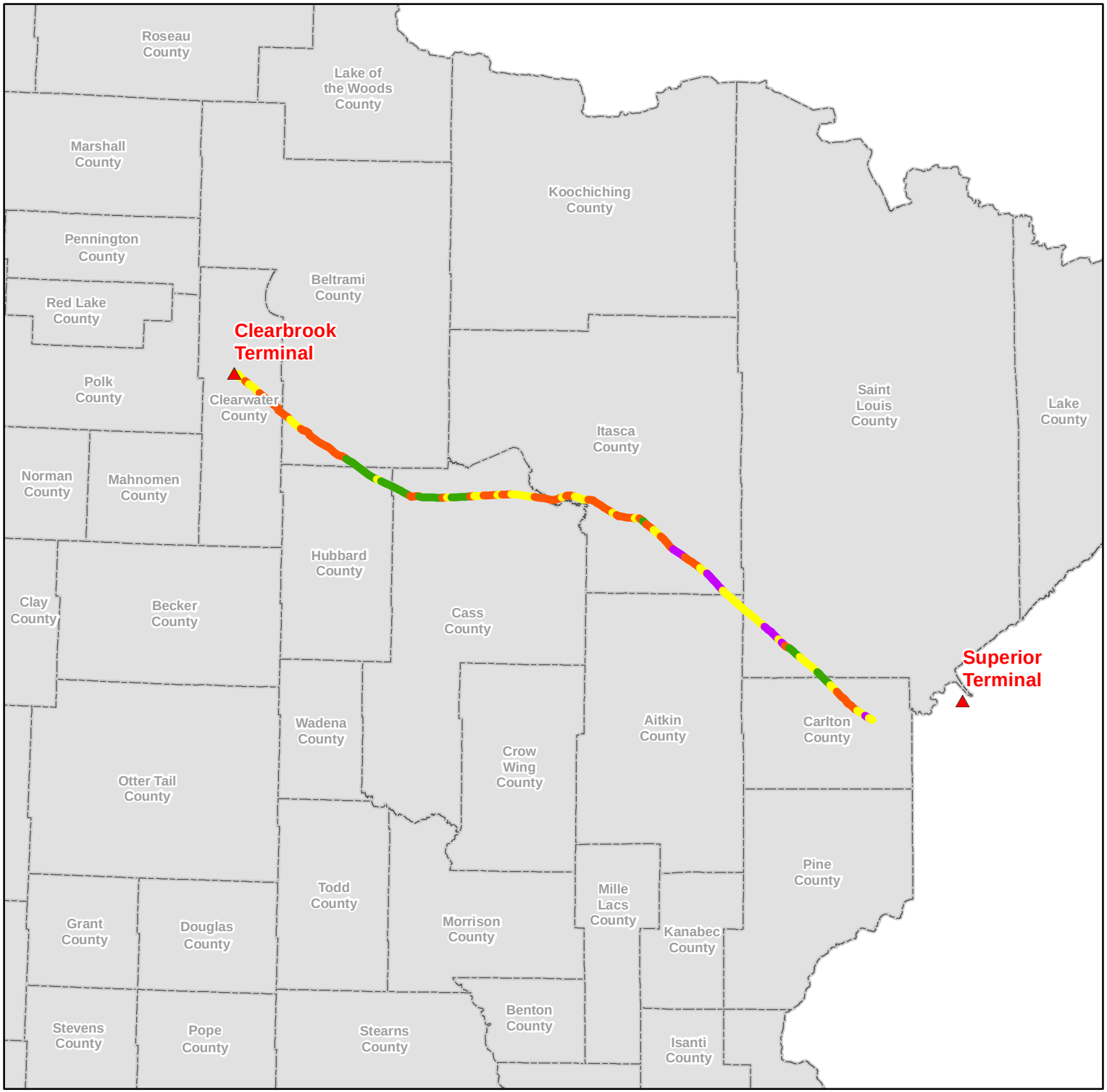

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RA-08-L3
Groundwater Susceptibility

ENBRIDGE

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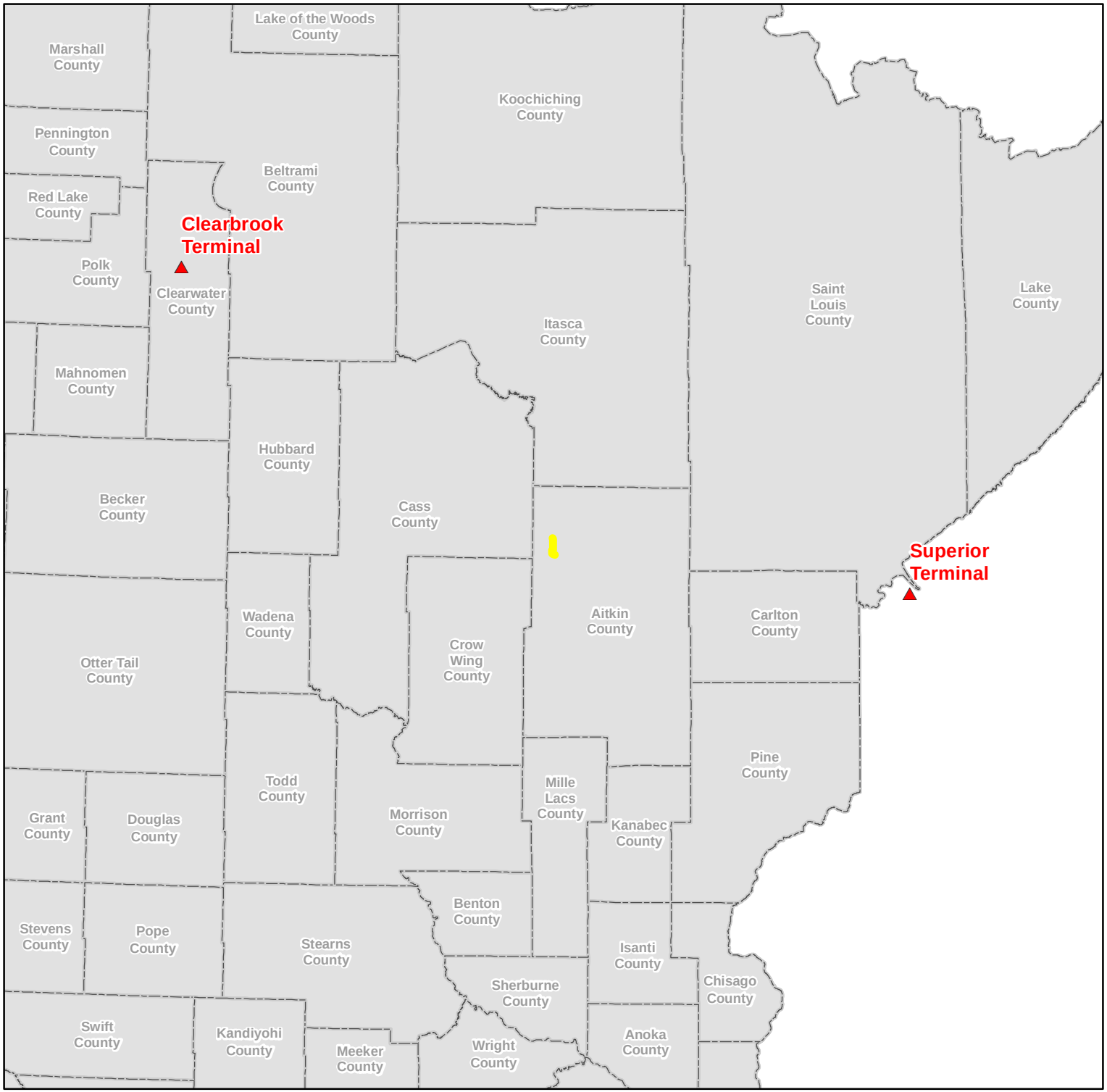

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RSA-Blandin-L3
Groundwater Susceptibility

ENBRIDGE

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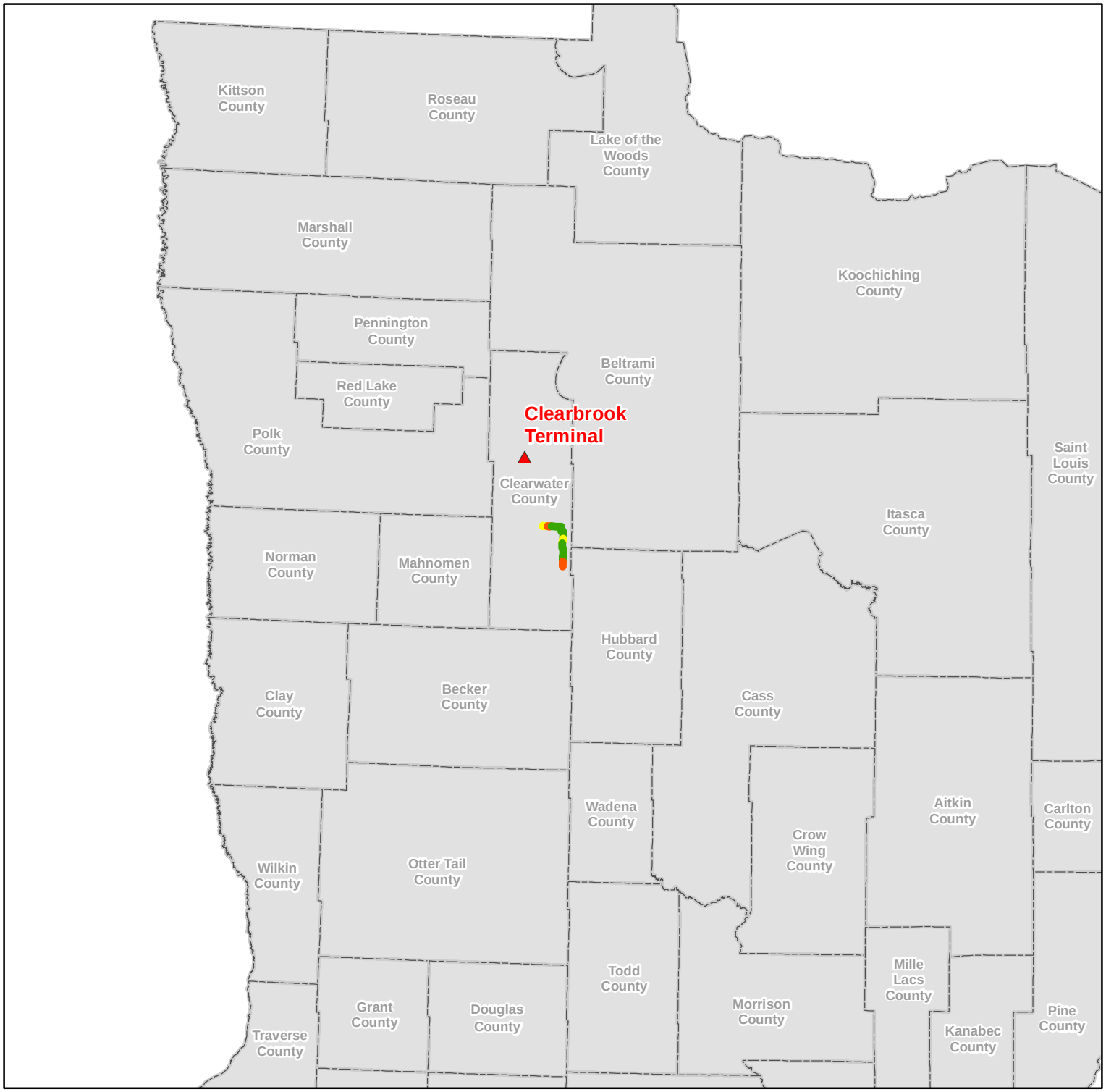

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RSA-05-L3
Groundwater Susceptibility

ENBRIDGE

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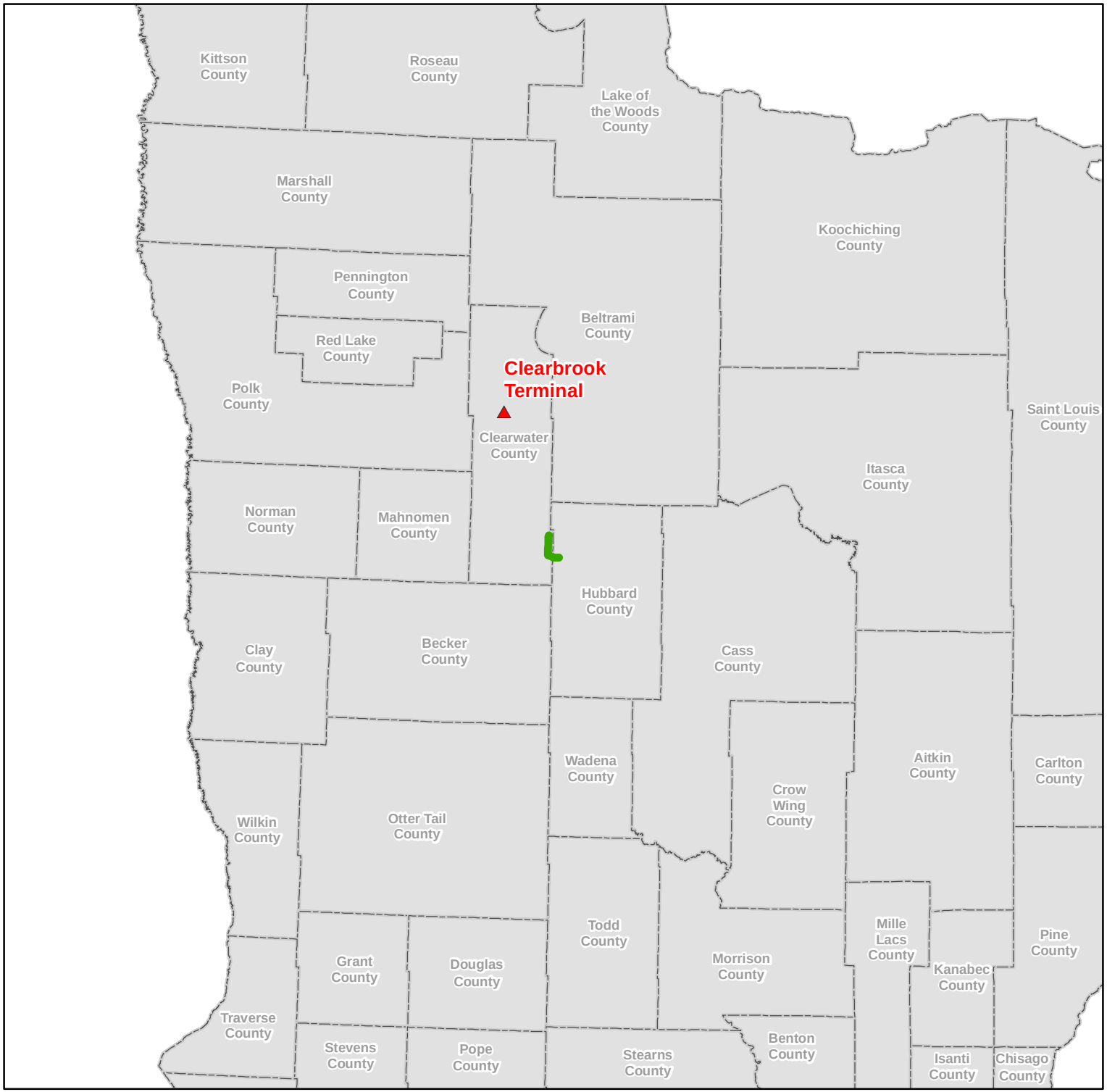

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RSA-10-L3
Groundwater Susceptibility

ENBRIDGE

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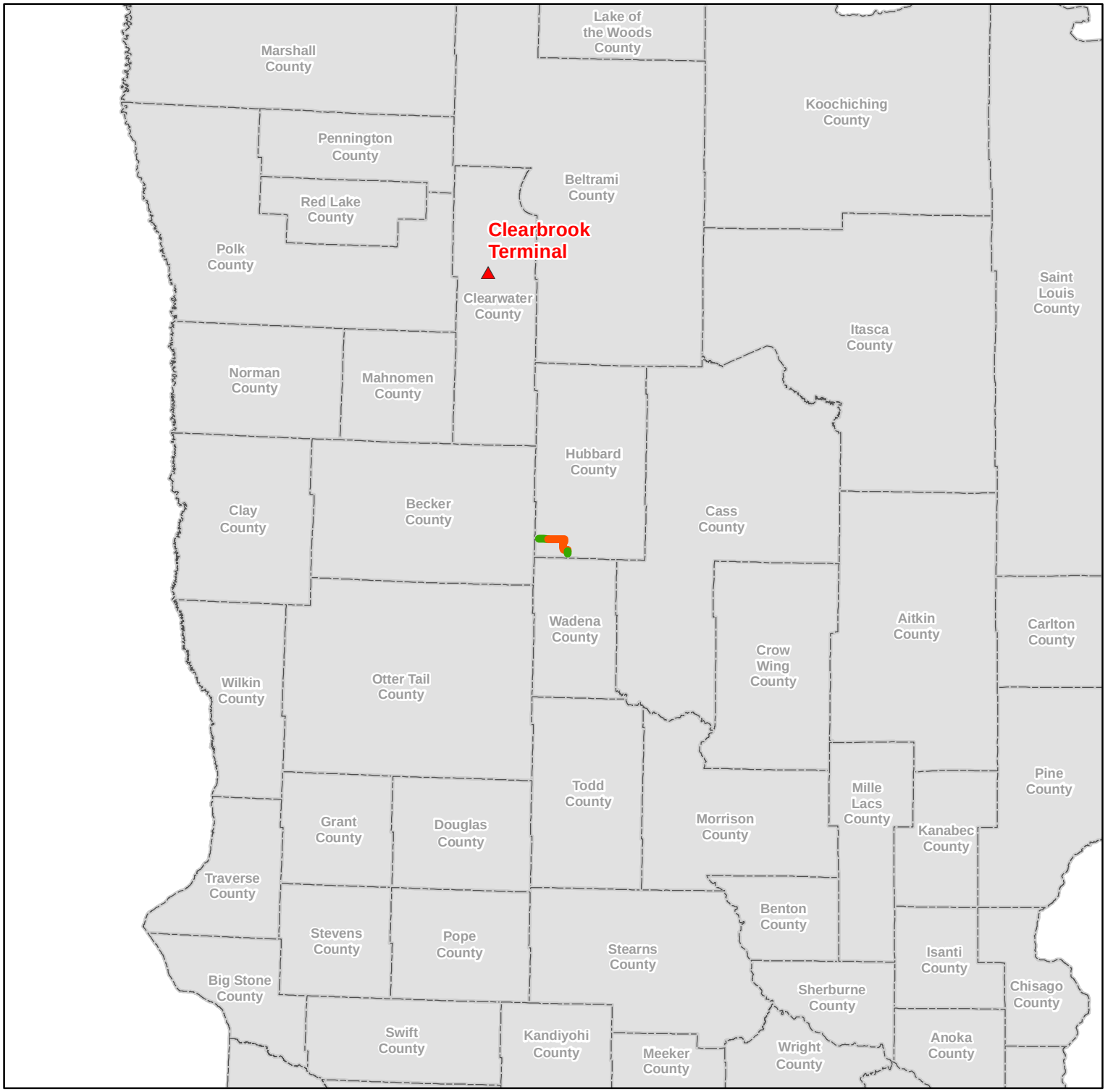

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RSA-15-L3
Groundwater Susceptibility

ENBRIDGE

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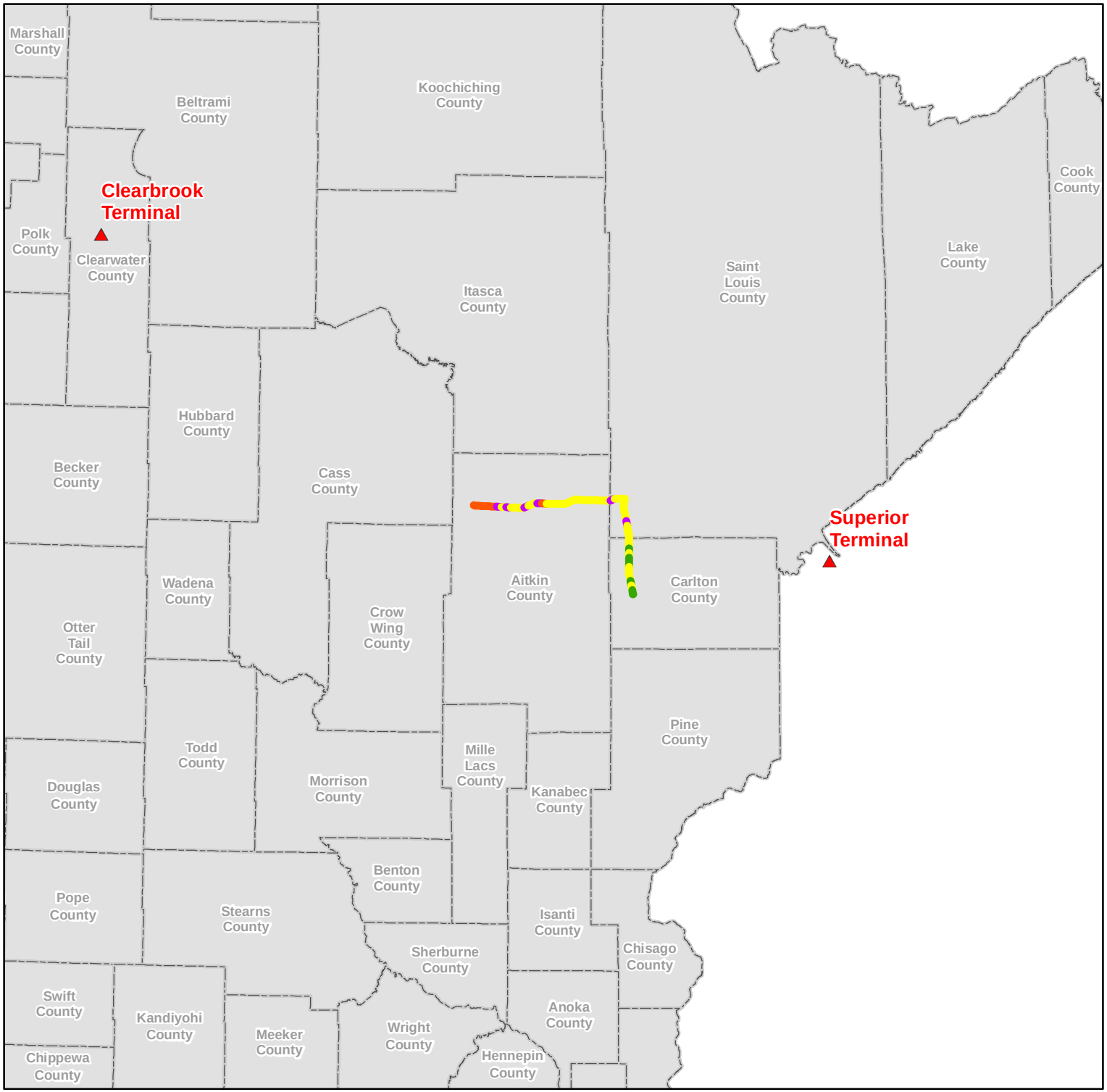

Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RSA-21-L3
Groundwater Susceptibility

ENBRIDGE

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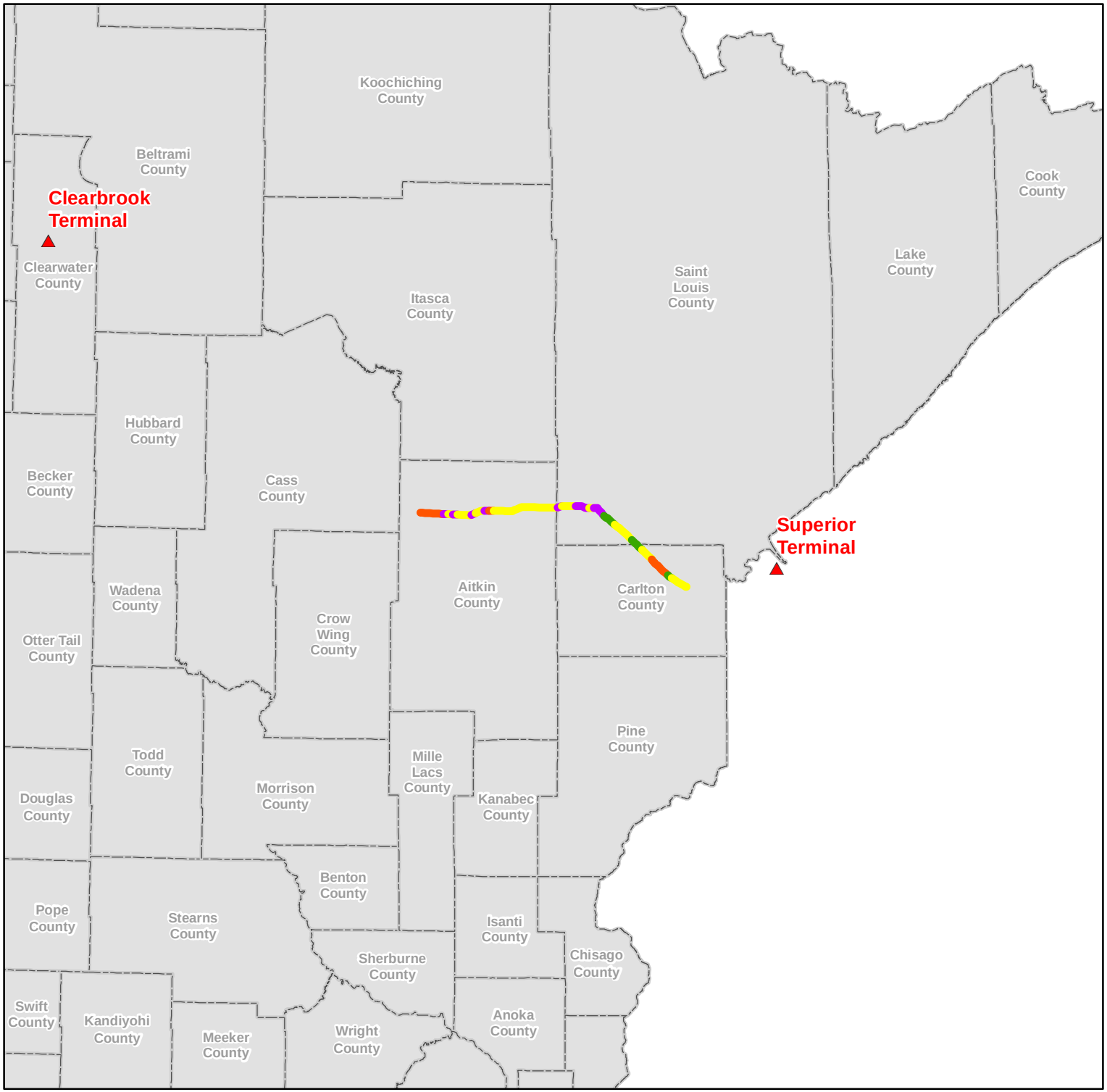


Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

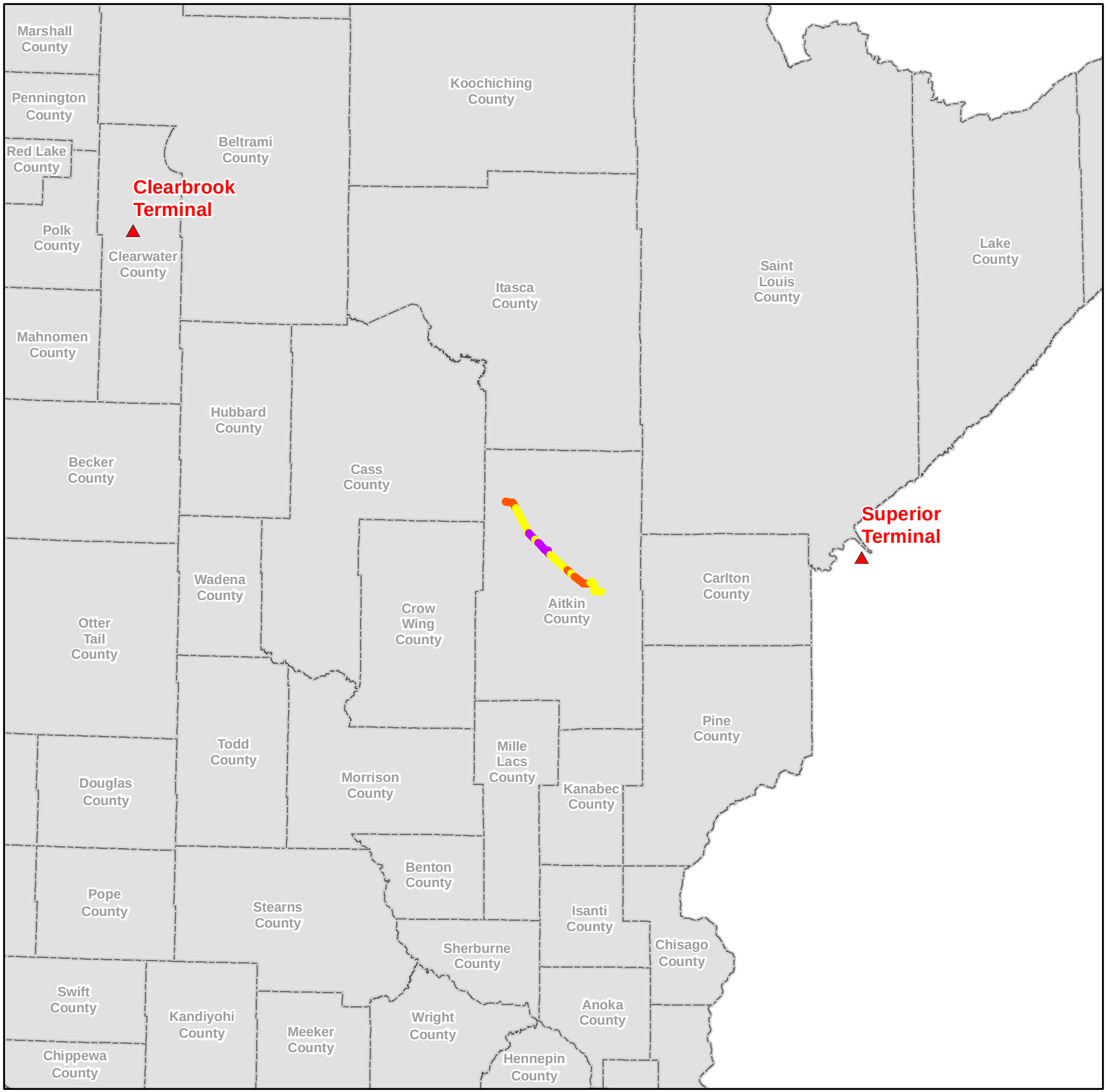
Miles

1 Inch = 30 Miles

RSA-22-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

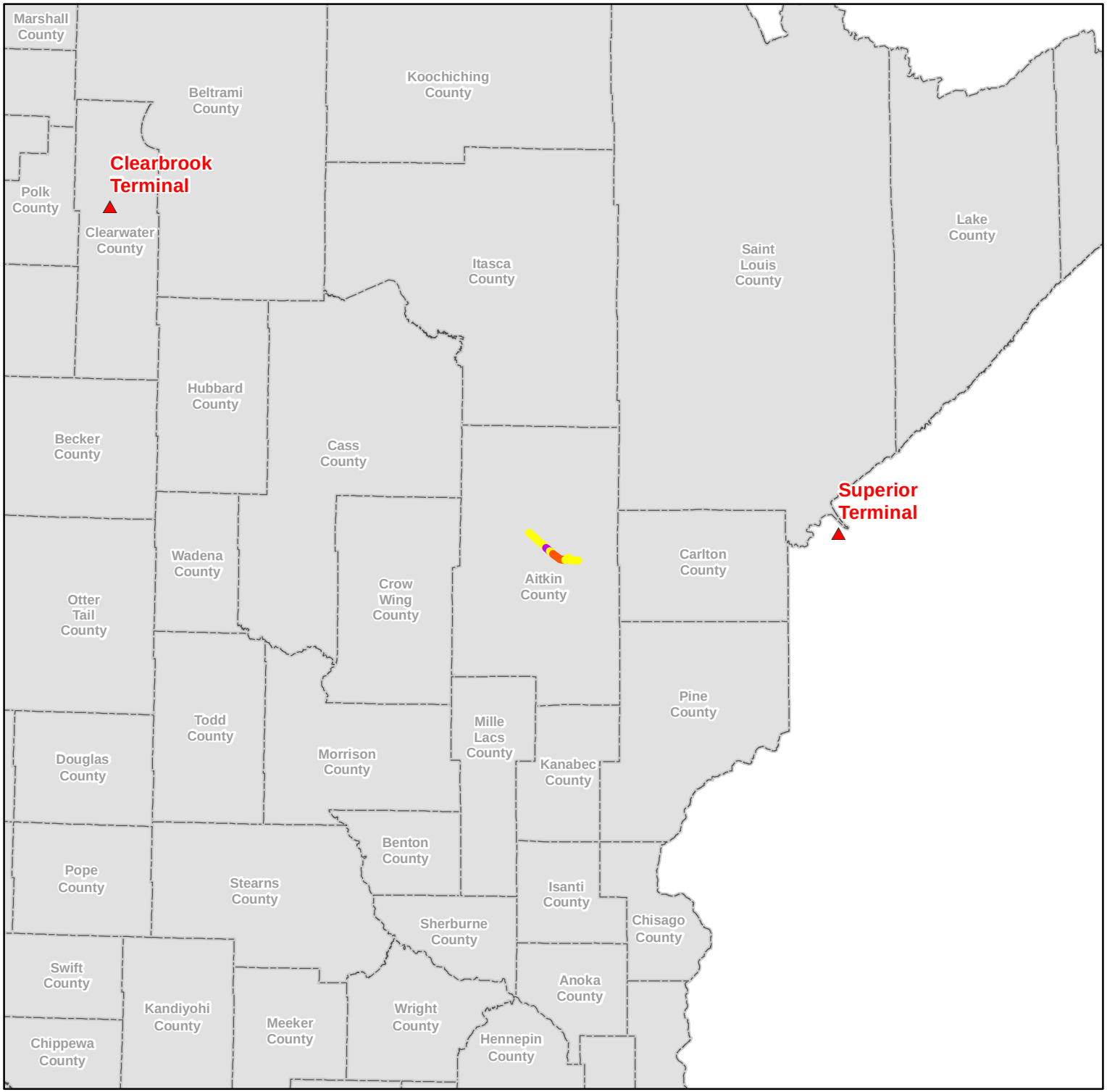
Miles

1 Inch = 30 Miles

RSA-23-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

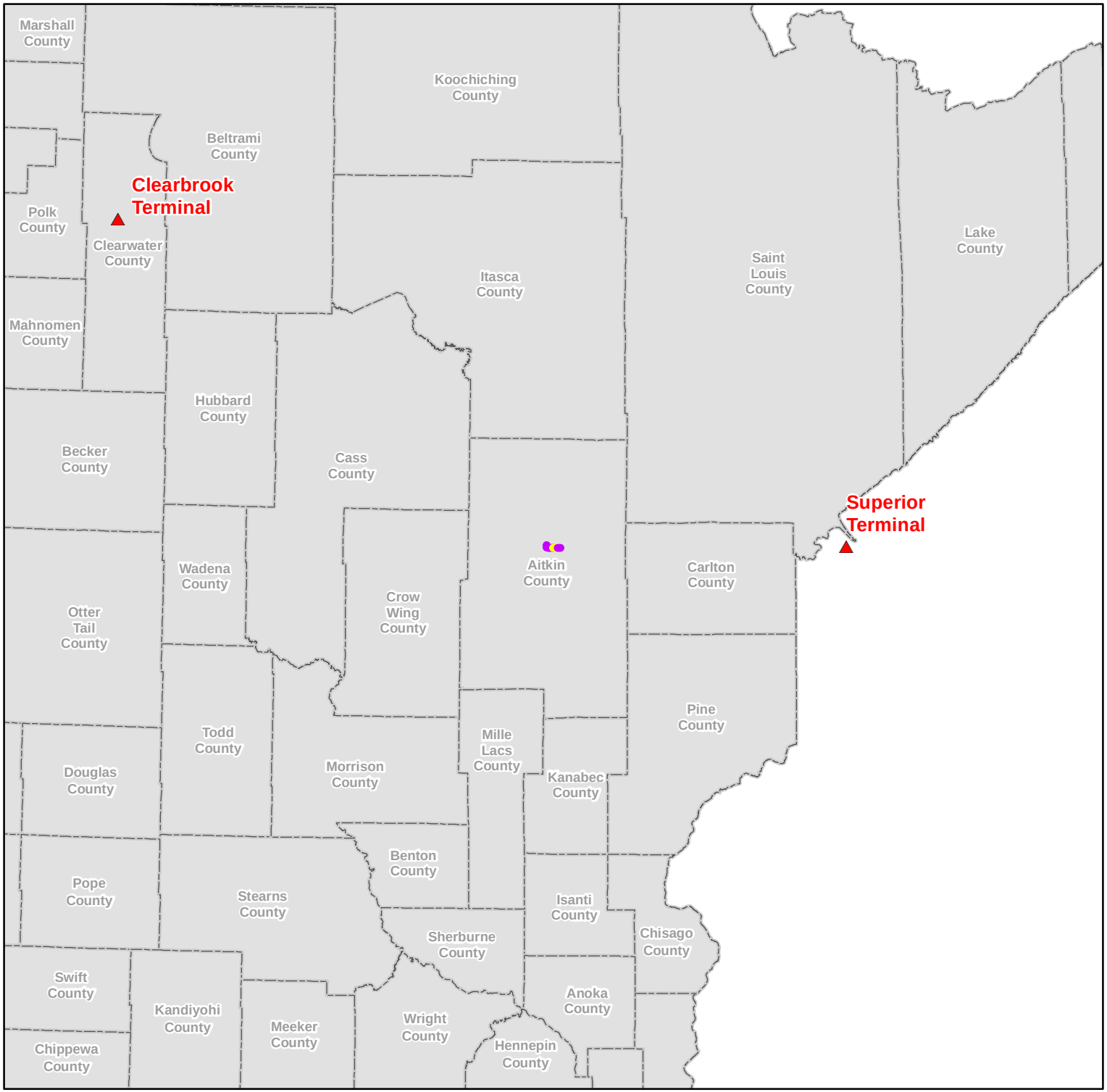
Miles

1 Inch = 30 Miles

RSA-27-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

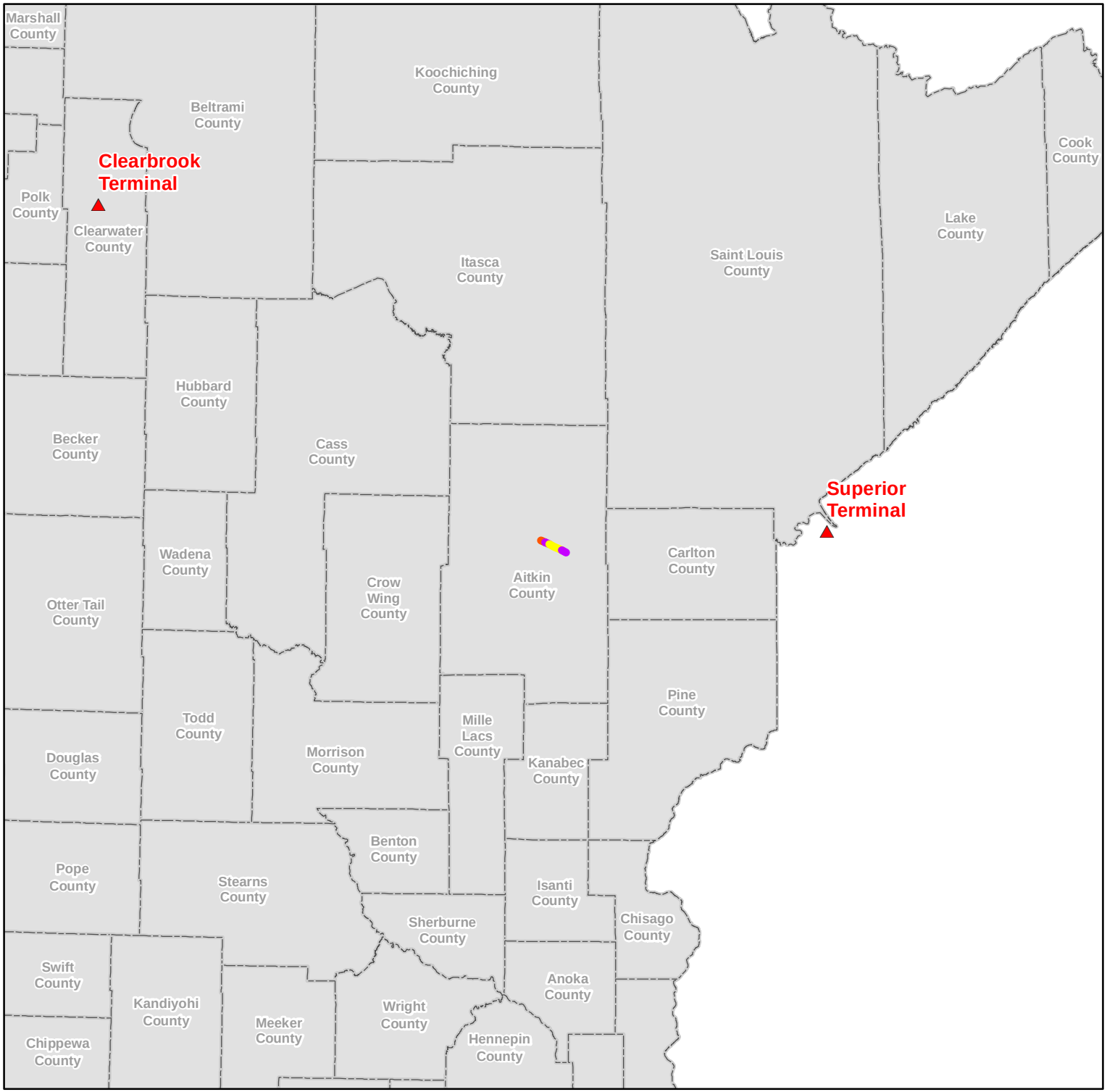
Miles

1 Inch = 30 Miles

RSA-28-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

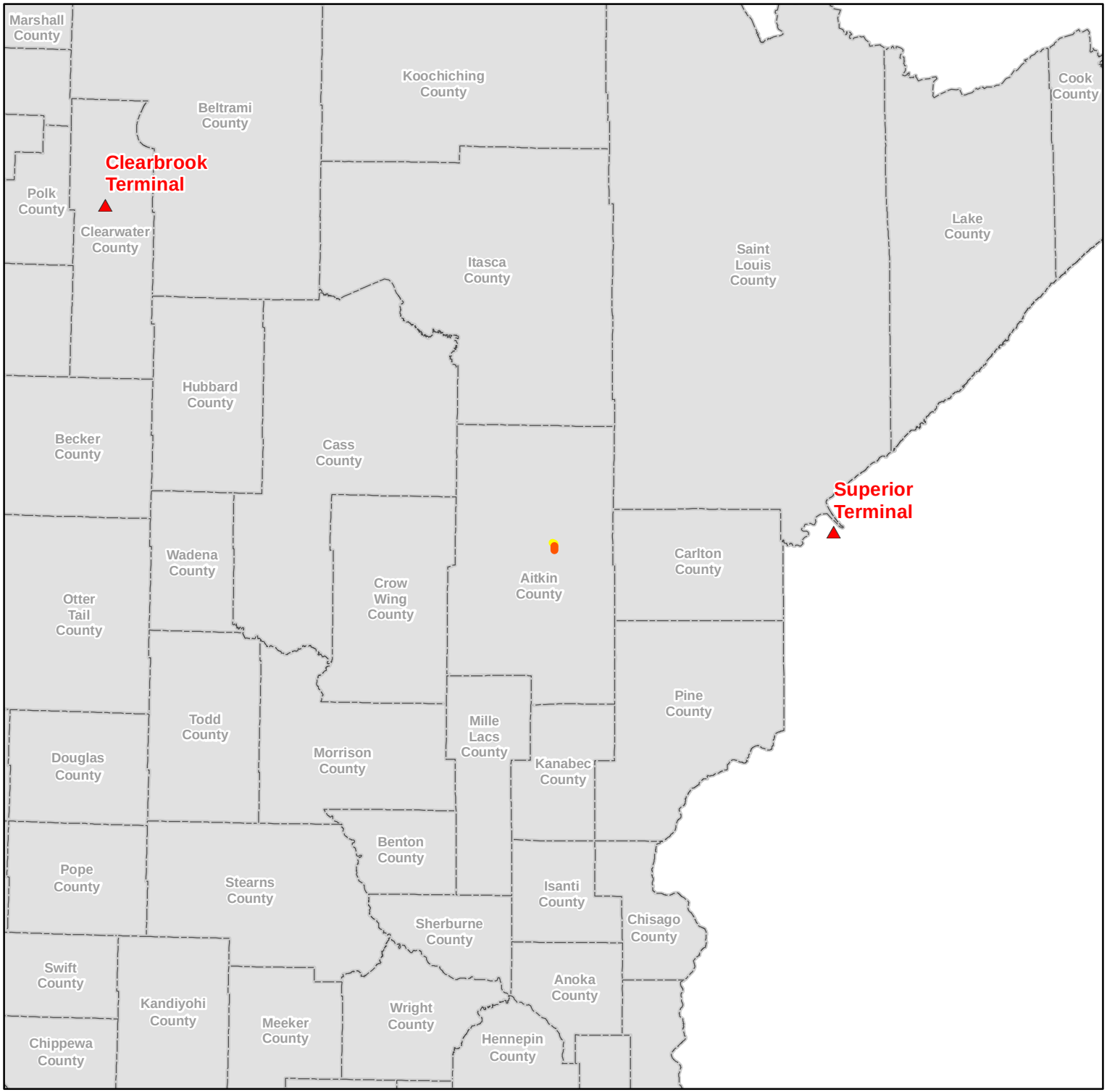
Miles

1 Inch = 30 Miles

RSA-31-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

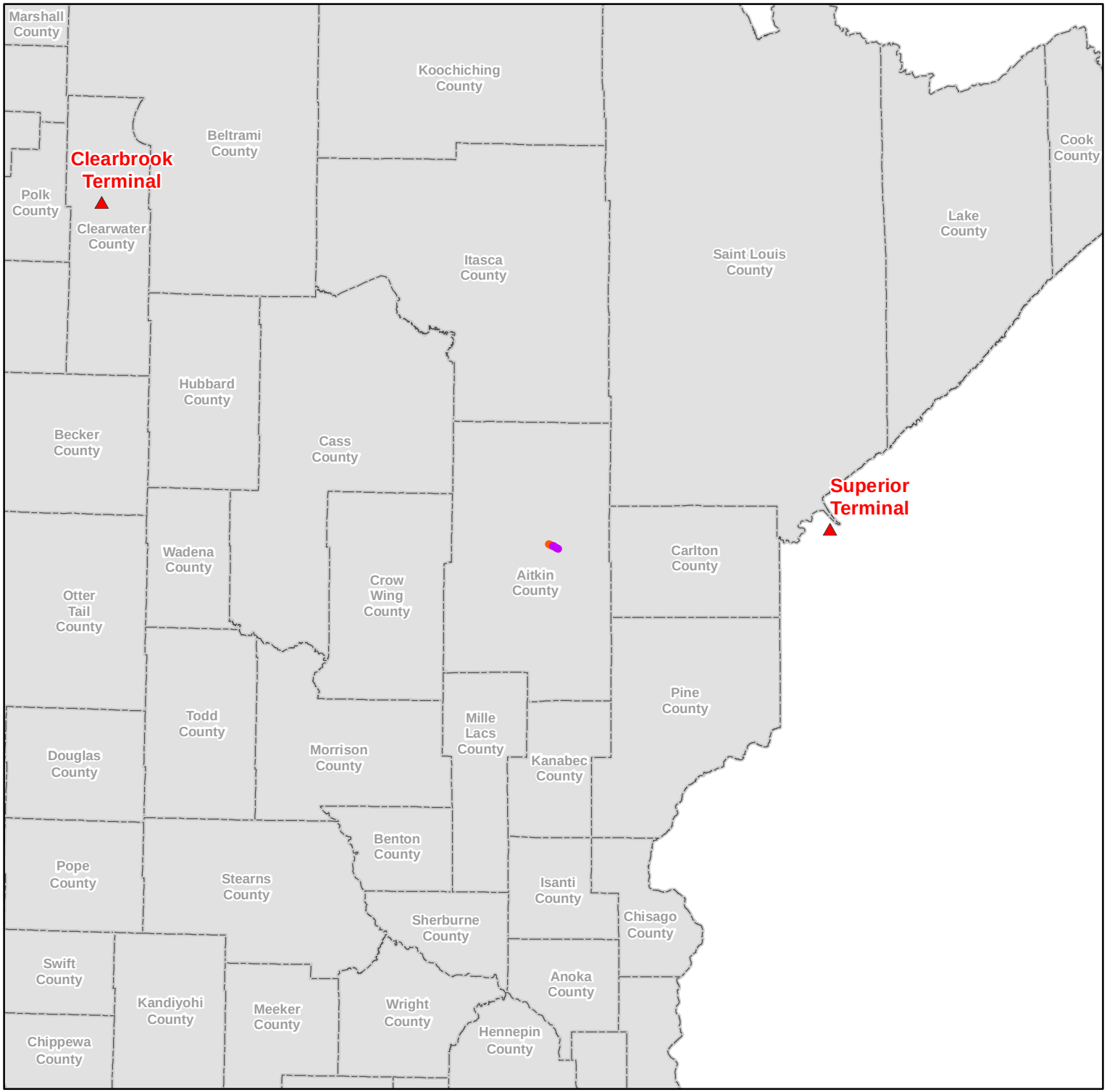
Miles

1 Inch = 30 Miles

RSA-33-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

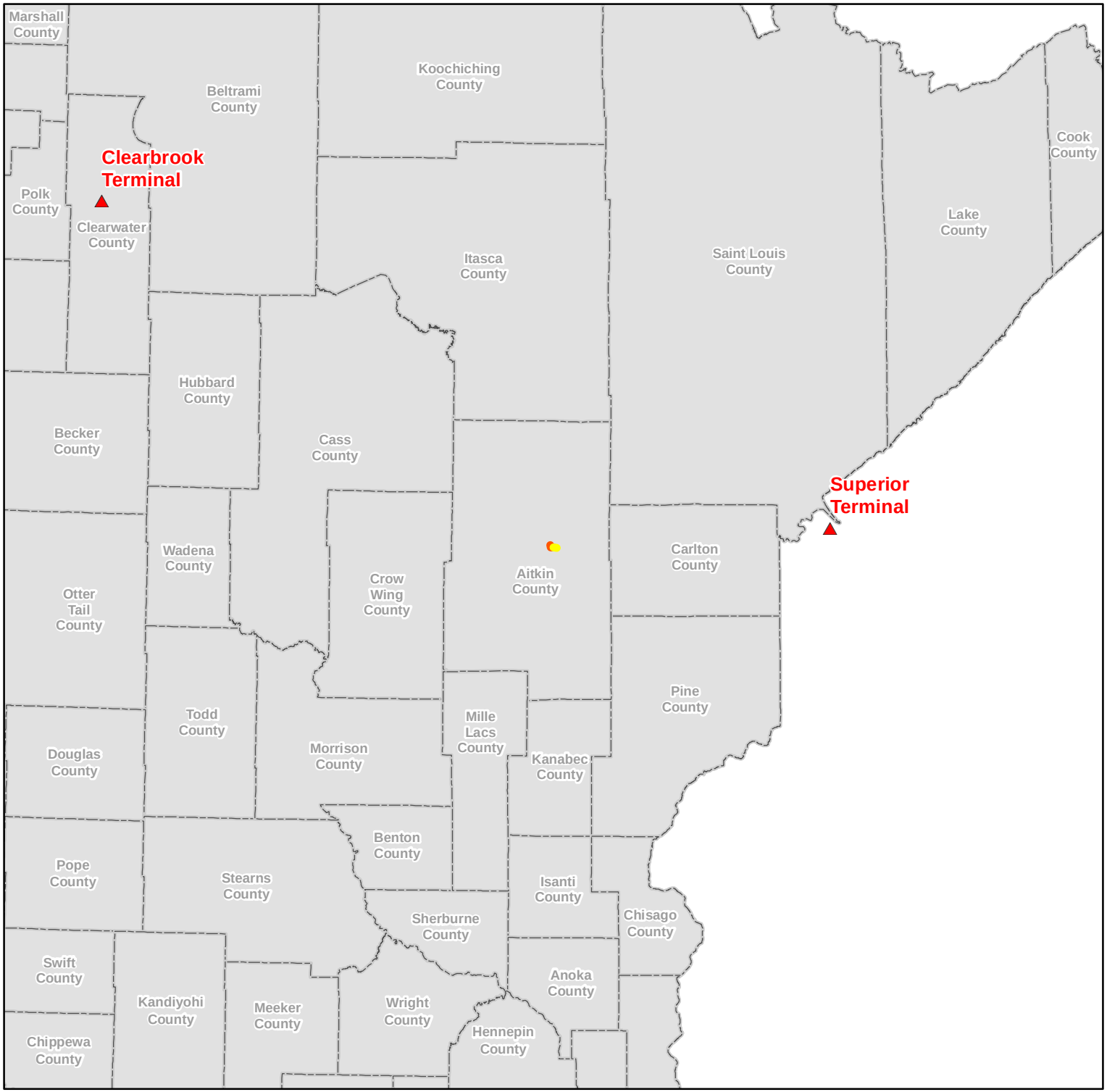
Miles

1 Inch = 30 Miles

RSA-34-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

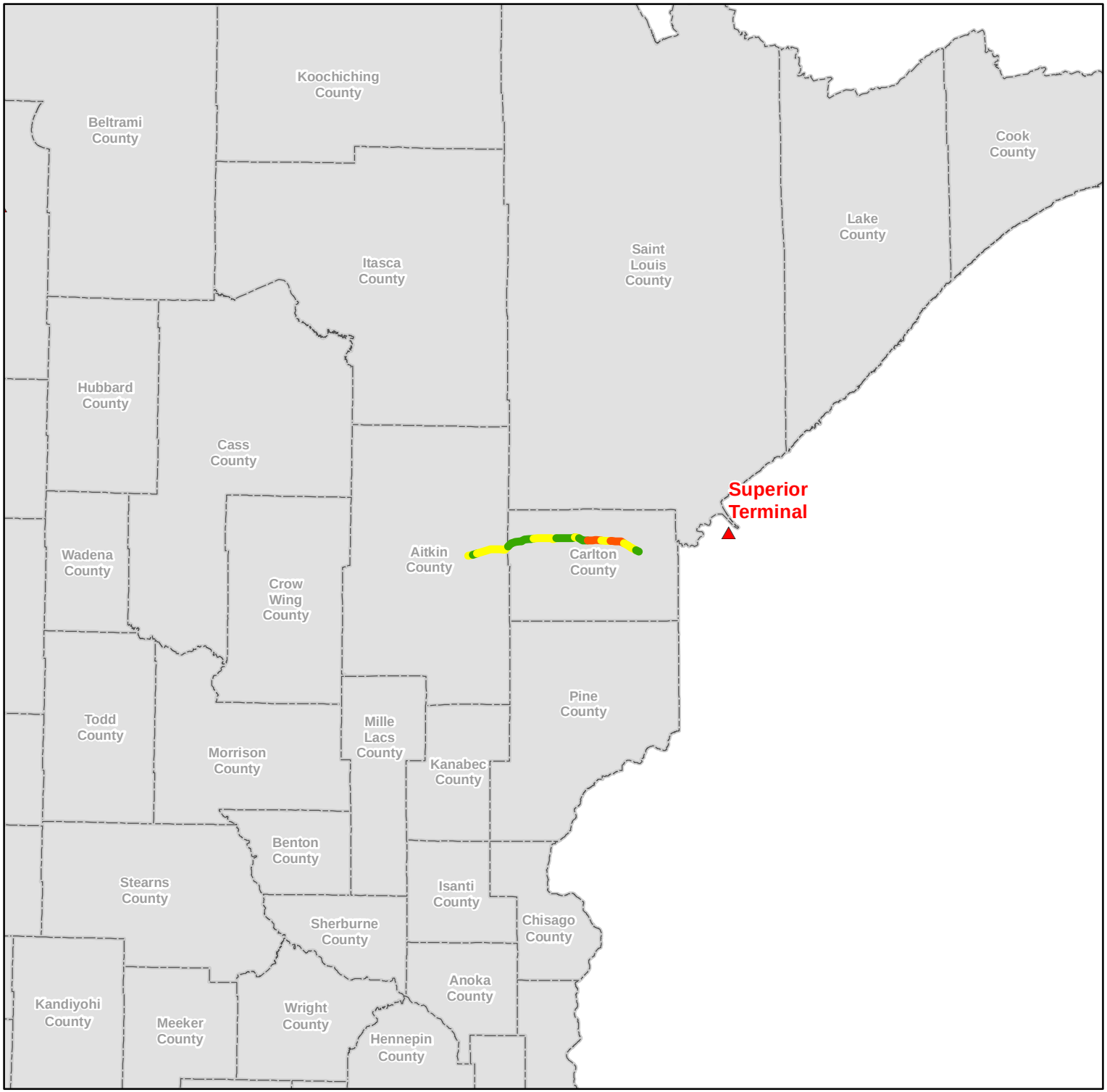
Miles

1 Inch = 30 Miles

RSA-35-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

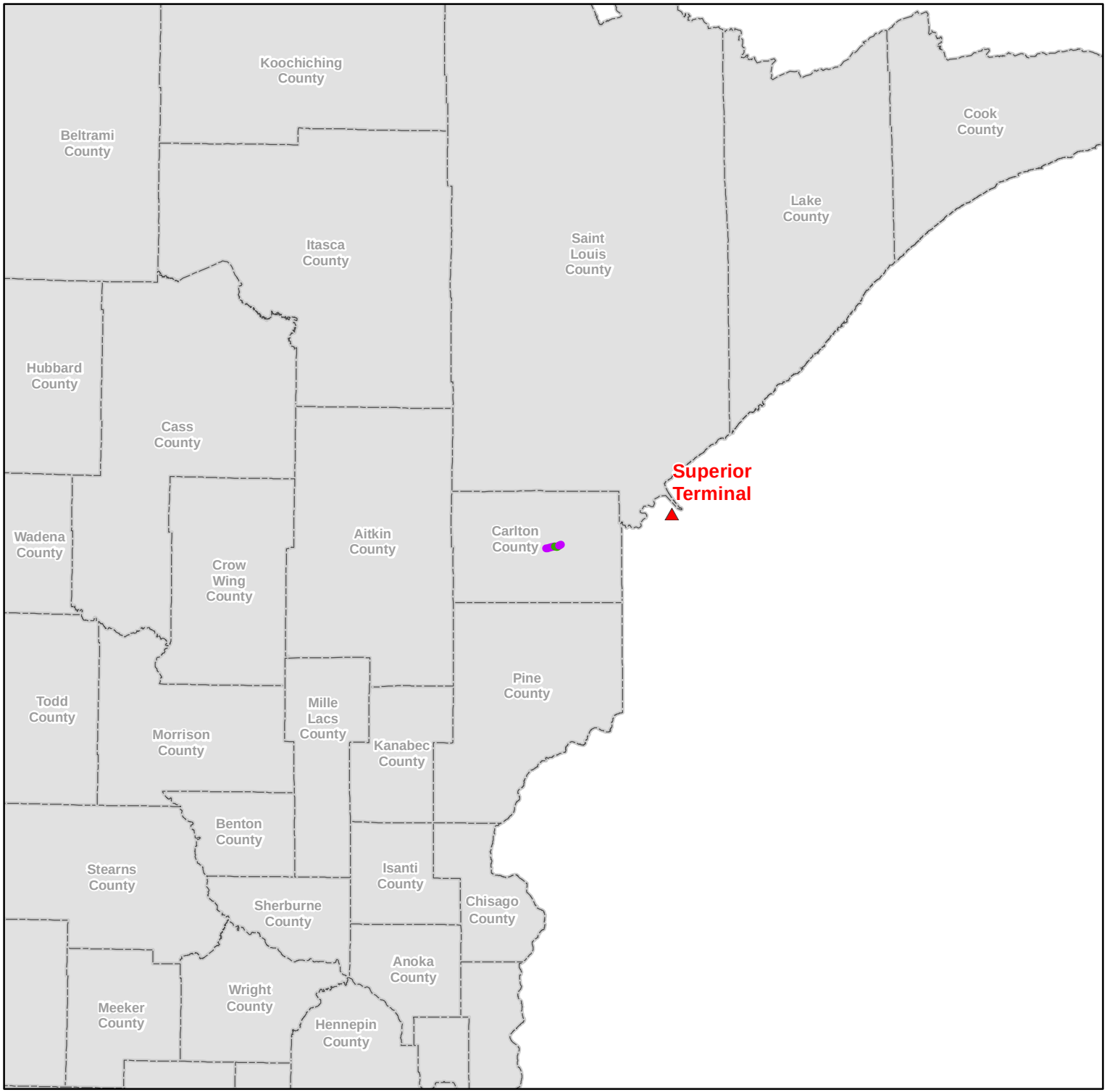
Miles

1 Inch = 30 Miles

RSA-37-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

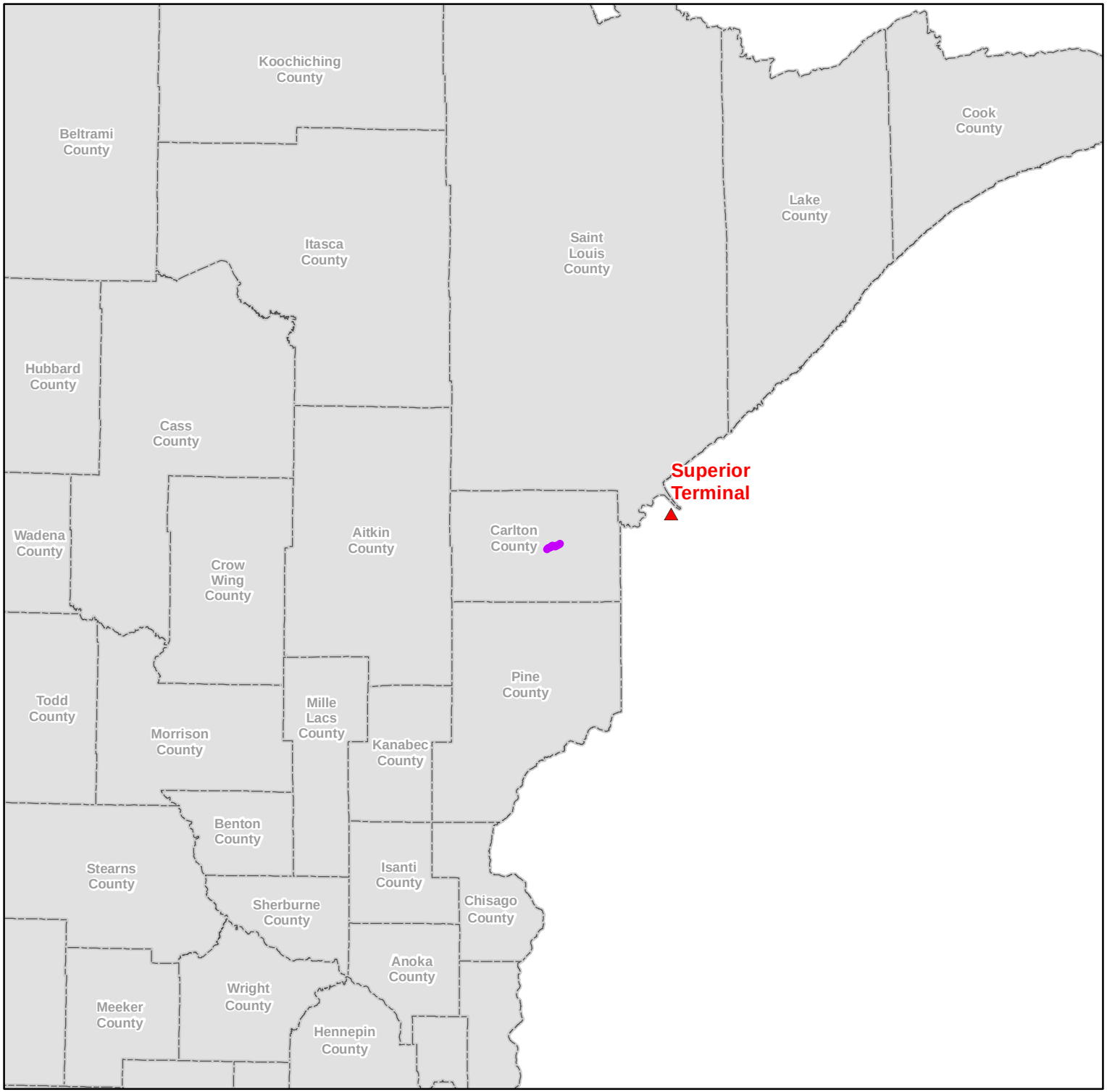
Miles

1 Inch = 30 Miles

RSA-42-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

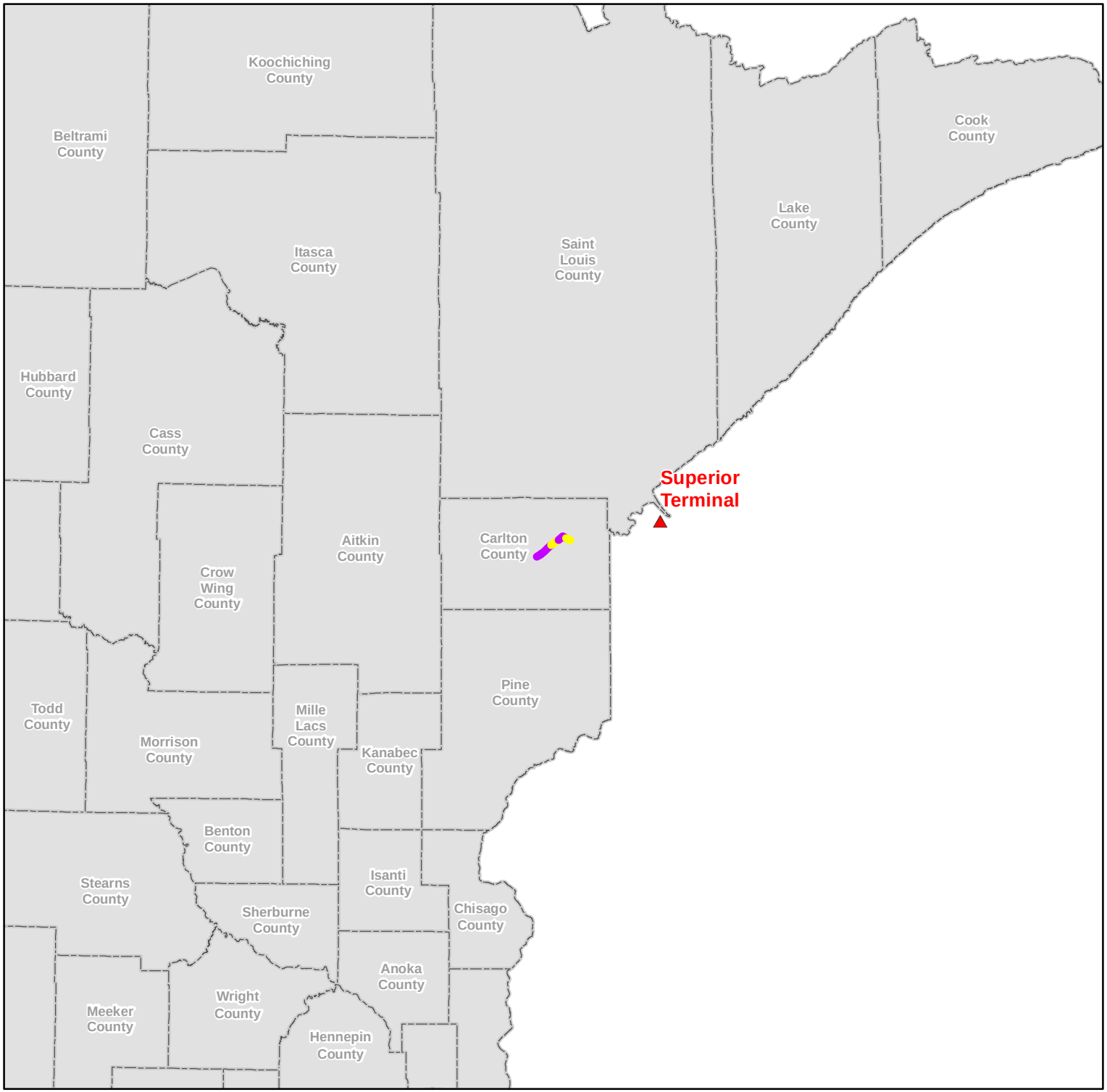
Miles

1 Inch = 30 Miles

RSA-43-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

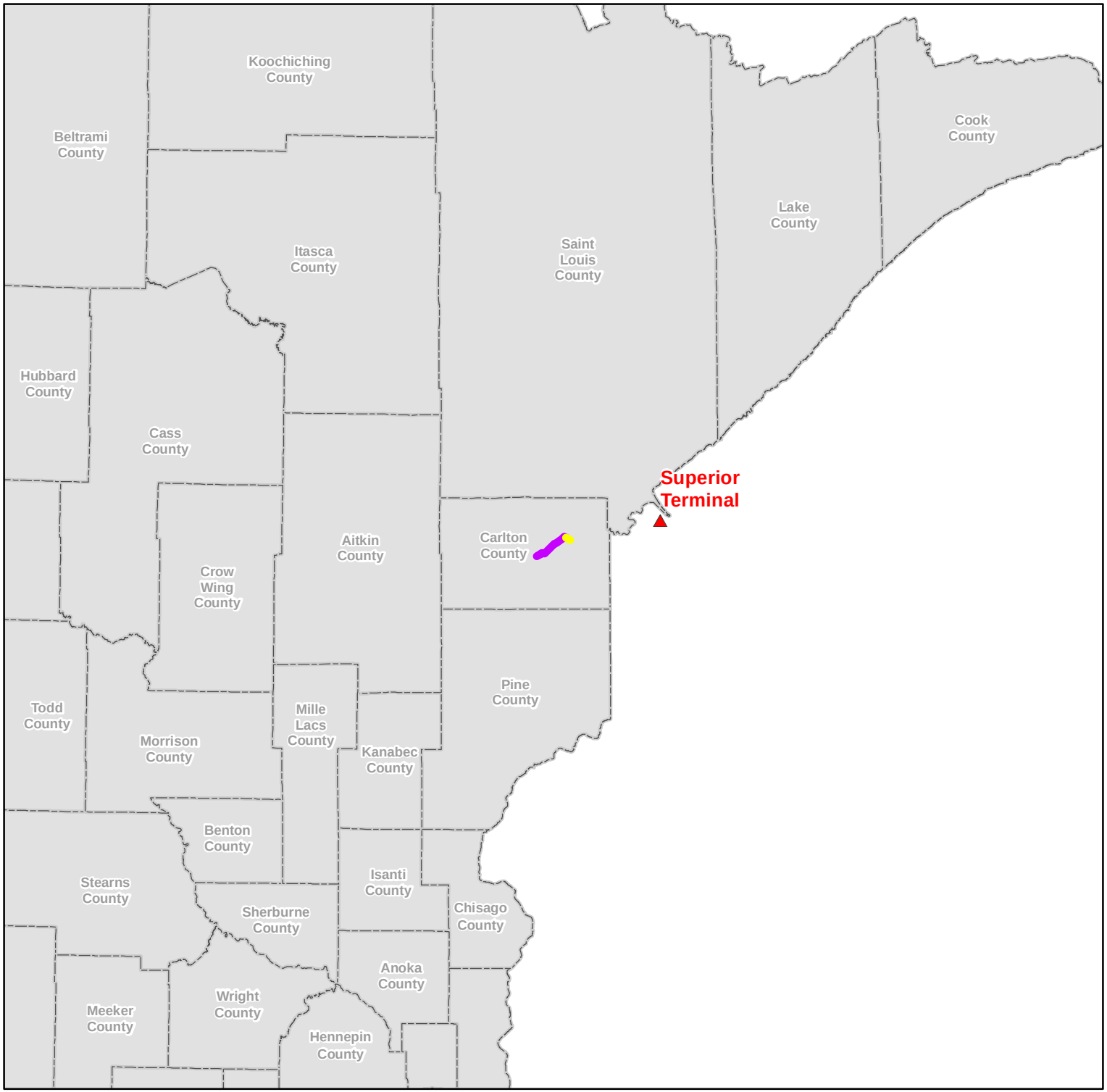
Miles

1 Inch = 30 Miles

RSA-44-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

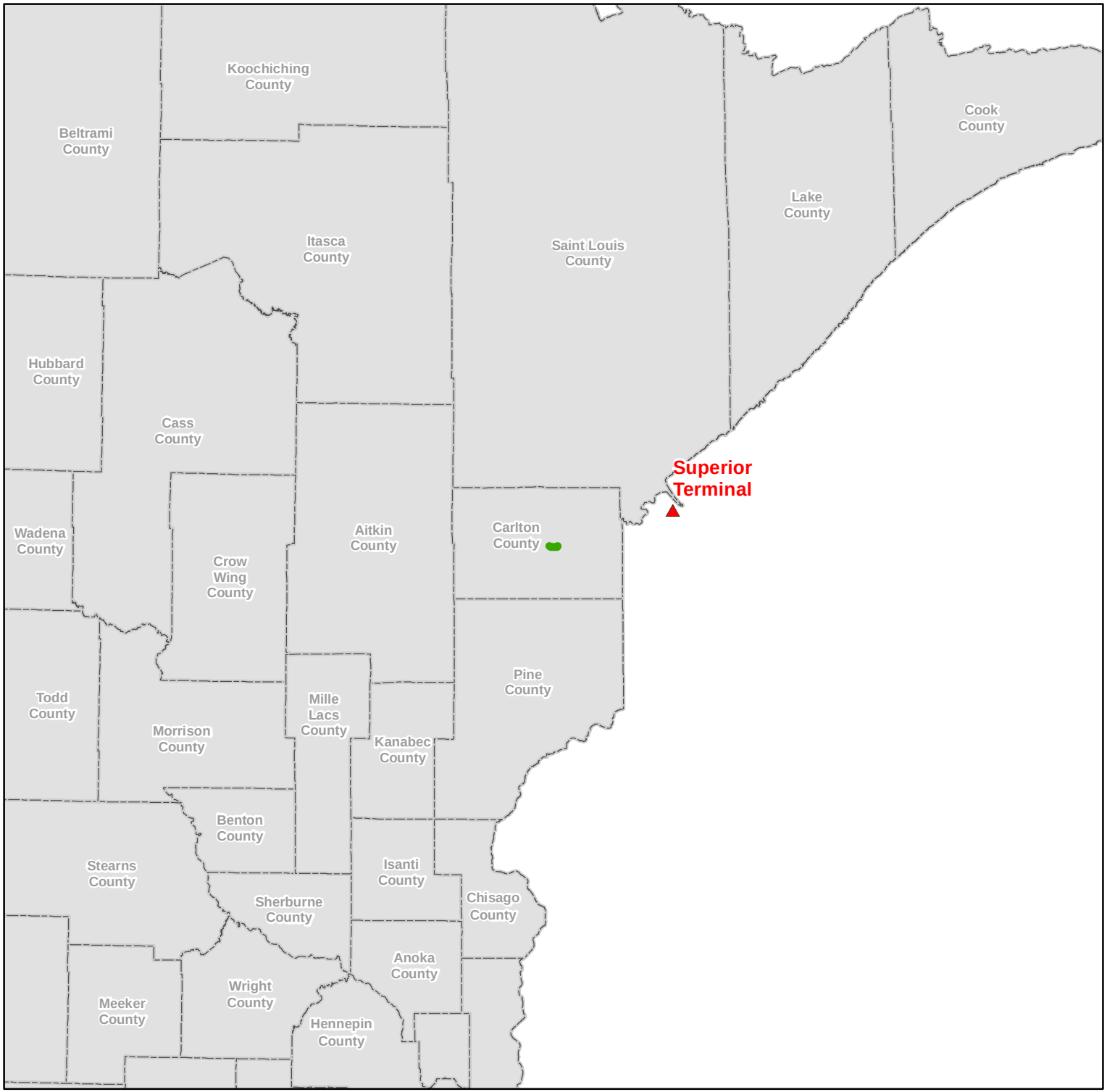
Miles

1 Inch = 30 Miles

RSA-45-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

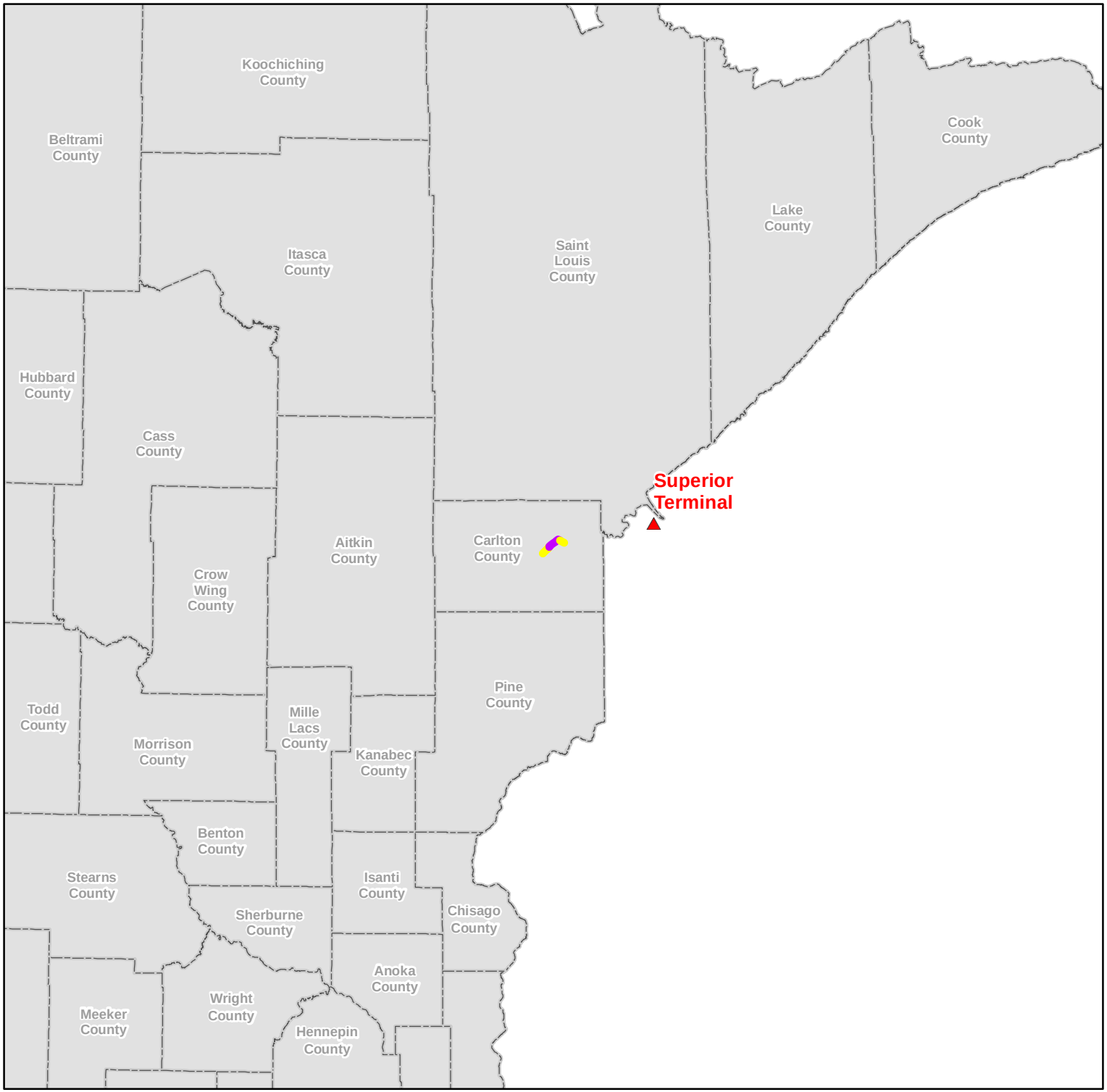
Miles

1 Inch = 30 Miles

RSA-46-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

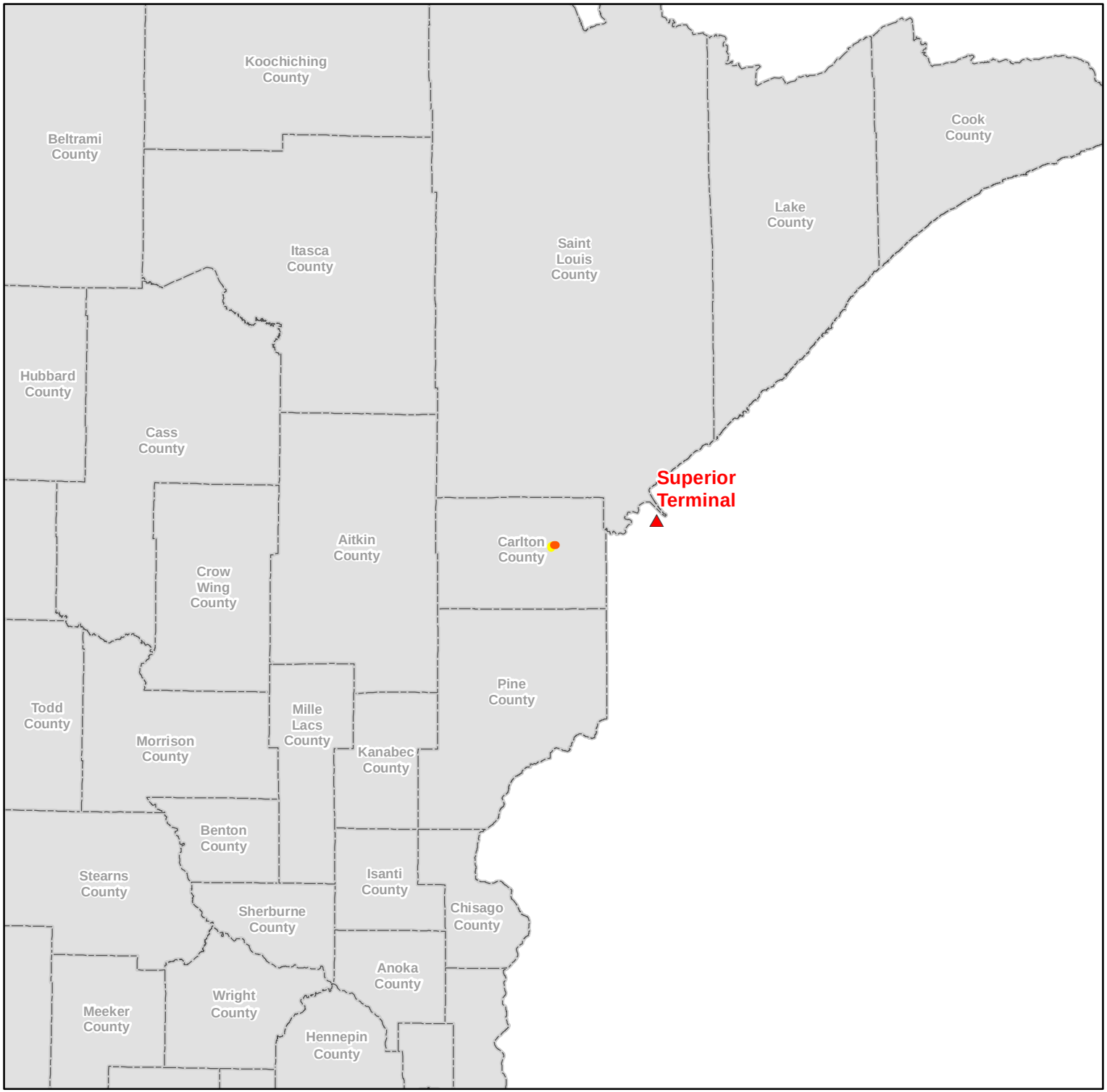
Miles

1 Inch = 30 Miles

RSA-49-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

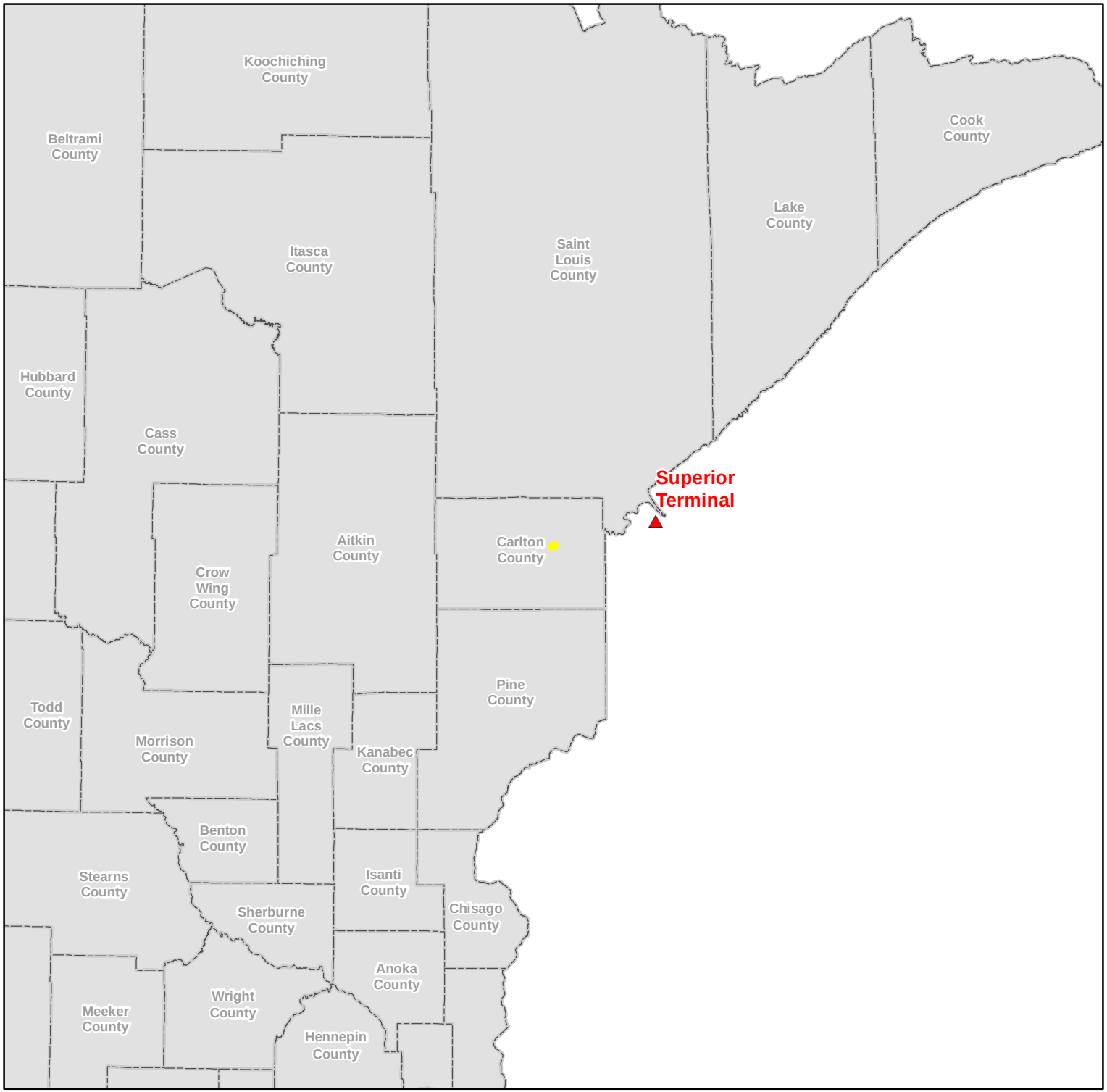
Miles

1 Inch = 30 Miles

RSA-51-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

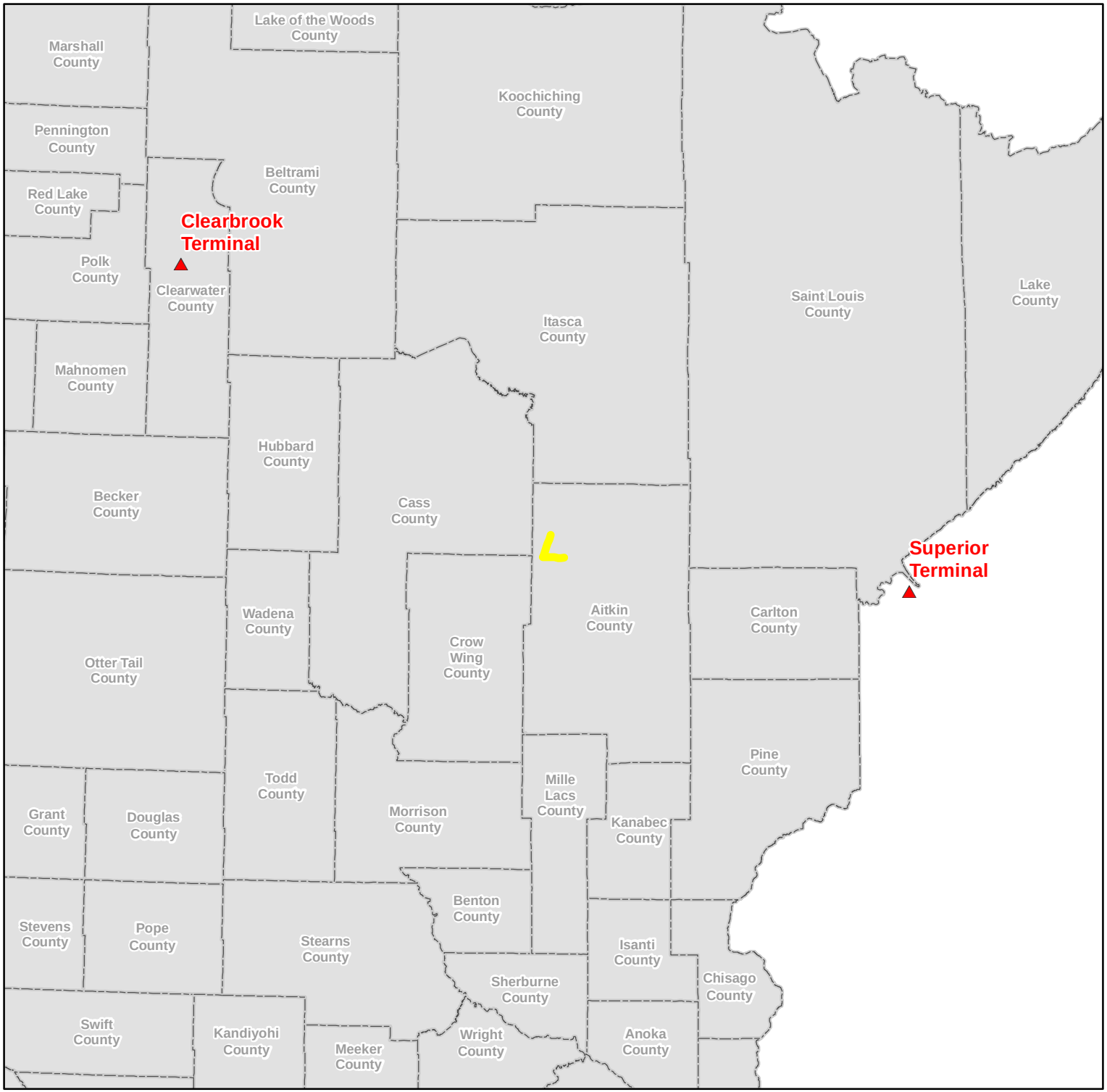
Miles

1 Inch = 30 Miles

RSA-52-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

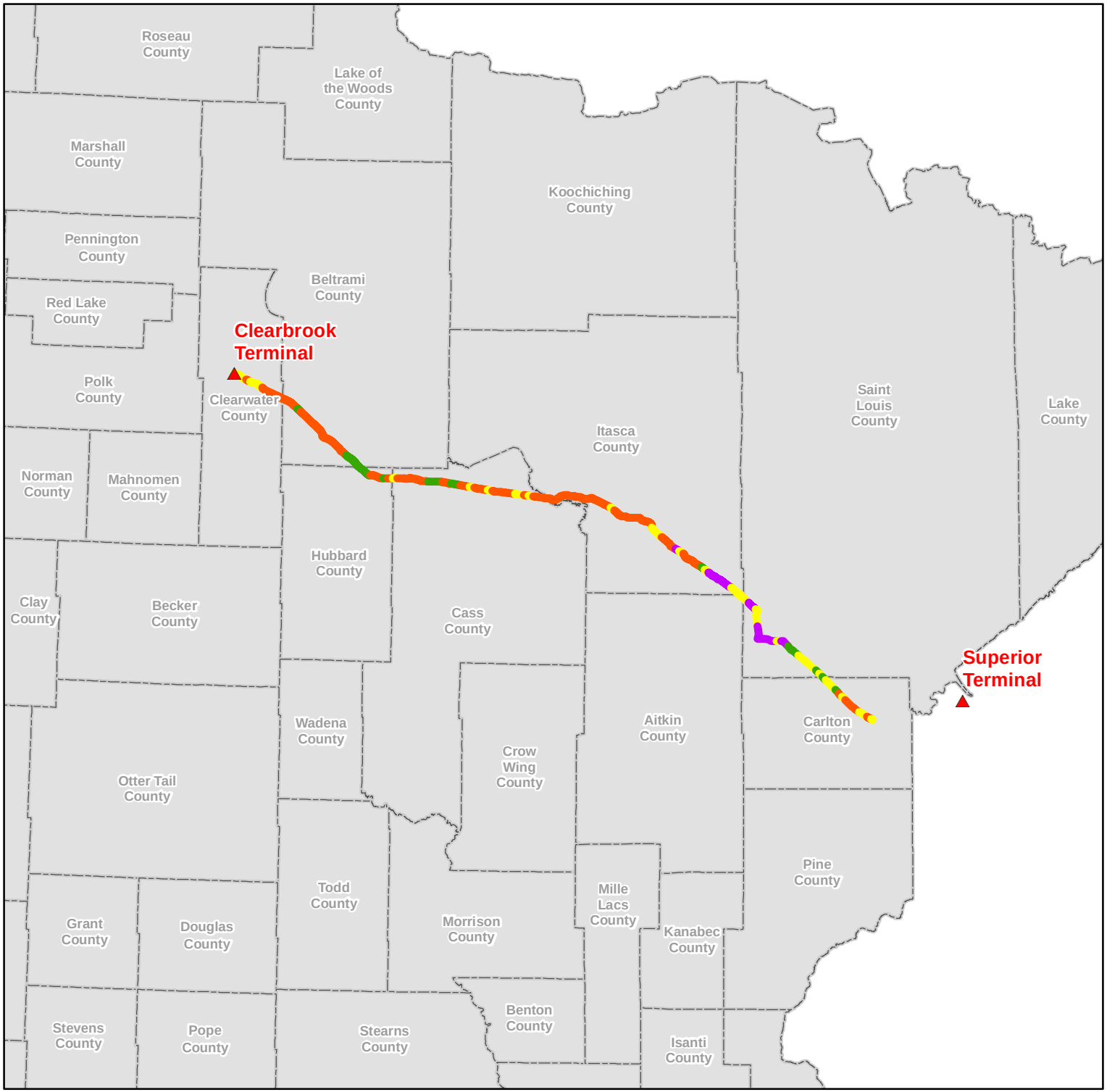
Miles

1 Inch = 30 Miles

RSA-White Elk Lake-L3
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk



Enbridge Terminal

County

Water Table Aquifer Susceptibility

Low

Medium

High

Unrated

Sources:
(1) Minnesota Water Table Aquifer Vulnerability; Date of Content: 5/28/2015
(2) Depth to Water Table, MN Hydrogeology Atlas; Date of Content: 6/2/2016

Vulnerability ratings from dataset (1) modified as follows:
-Lacustrine materials assigned low vulnerability
-Low vulnerability assigned where depth to water table is > 40 feet

N

0 30 60

Miles

1 Inch = 30 Miles

RSA-53
Groundwater Susceptibility

ENBRIDGE

Barr Footer: ArcGIS 10.4, 2017-01-04 15:22 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\23691530\Maps\Reports\Line3\Water_Table_Susceptability\MapBook_L3R_SA_RA_RSA_01042017_Groundwater_Susceptability_8x11.mxd User: jwk